

MC CLYMONT & RAK ENGINEERS, INC.

GEO-ENVIRONMENTAL CONSULTANTS

117 DISCO ROAD, REXDALE, ONTARIO, M9W 1M3 TEL: (416) 675-0160 FAX: (416) 675-6371

PHILADELPHIA, PENNSYLVANIA - PENNSAUKEN, NEW JERSEY - TAMPA, FLORIDA - TORONTO, CANADA

G2039

AUGUST 1998

**SLOPE STABILITY-
FOUNDATION INVESTIGATION REPORT
FOR
QEW AND RIDGEMOUNT AND NETHERBY ROAD
AND HWY 406 AND FOURTH AVENUE**

AGREEMENT NO. 9820-7411-2791

WO 98-11004

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PREPARED FOR

MINISTRY OF TRANSPORTATION OF ONTARIO
1201 WILSON AVENUE
ROOM 315, CENTRAL BUILDING
DOWNSVIEW, ONTARIO
M3M 1J8

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June 15/98.

Site visit to establish contract limits

Suggest 3:1 or flatter.

Consider trench drain every 10m draining
to subdrain at base.

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WO 98-1100⁴

INTRODUCTION

This report summarizes the results of a slope stability and foundation investigation for three embankment sites, where slope instability has occurred. The investigation was carried out at the request of the Engineering Support Section of the Ministry of Transportation of Ontario.

The investigated sites are at the following locations:

- 1) QEW and Ridgemount Road - the approach embankments in all four quadrants.
- 2) QEW and Netherby Road - paved shoulder on the east side of the S-EW ramp.
- 3) Highway 406 and Fourth Avenue - the cut slope on Highway 406.

This report contains the summary of the encountered geotechnical conditions and recommendations for the reconstruction of the affected slopes.

QEW AND RIDGEMOUNT ROAD

SITE DESCRIPTION AND GEOLOGY

The site is located at the intersection of QEW and Ridgemount Road in the Town of Fort Erie, Ontario.

The area topography is relatively flat, with nominal 2H: 1V of the roadway embankments. The approach fills to the Ridgemount Road Overpass slope down gently, away from the bridge. The embankments are covered by light vegetation, grass and shrubs.

Slope instability failures have occurred at all four quadrants. At the north east and south west quadrants, severe cracking and settlement have occurred at the edges of the roadway pavement, adjacent to the crest of the slopes. Along the edge of the roadway, a crack approximately 100 to 150 mm in width with settlement of approximately 600 mm. At the crest of each embankment slope, settlement of approximately 600 to 800 mm has occurred along the ground surface. is evident at the north east quadrant.

The guard rails along the north east and south west quadrants have moved laterally, along with the ground surface and appear to be gradually shifting down the slopes.

A large number of longitudinal and some perpendicular cracks are evident in the paved crown/shoulders, along the embankment slopes. The cracks measure approximately 100 to 150 mm in width and approximately 200 to 600 mm in depth. The magnitude of the recorded settlement of the ground surface was measured at approximately 150 to 600 mm. It is most evident along the top of slopes and near the toe of the slopes. Cracks are also evident in the native ground surface along the flat lands along the toe of the slopes.

Geologically, the site consists of medium plasticity silty clay deposits.

PROCEDURE

The initial field investigation was carried out between the period of August 7 and 19, 1998. An additional borehole was drilled on September 28, 1998. The fieldwork consisted of drilling nine boreholes, i.e. five boreholes were drilled at the crest of the embankment slopes and four at the toe of the embankments.

The boreholes at the crest were drilled to a maximum depth ranging from 12.6 to 14.2 m, and the boreholes at the toe of the embankments were advanced to a maximum depth of 3.0 m.

The boreholes at the top were advanced using a truck mounted CME 55 equipped with solid stem augers. Due to the access problems, the boreholes at the toe were advanced with manually driven hammer and the PionJar 120 Sampling System. Disturbed samples were recovered by means of a 50 mm O.D. split spoon sampler driven into the soil, all according to the specification of the Standard penetration Test (ASTM D 1587-8).

Field vane tests were carried out in the upper fill in Borehole 109, and in Boreholes 103, 106 and 107, to assess the in situ shear strength of the native clay deposit and the embankment fills. The vane test results are shown on the Borehole Logs and summarized in Table 1 (Appendix A).

The elevations and co-ordinates of the boreholes were obtained from topographic Plans provided by MTO's Central Region Survey and Plans Office.

Laboratory testing, carried out on representative samples to identify and determine the physical properties of the overburden, included:

- o Natural moisture content
- o Grain size distribution
- o Atterberg Limit
- o Unit Weight

SUBSURFACE CONDITIONS

The predominant subsurface deposit consists of a firm to hard cohesive medium plasticity silty clay. Fill overlies the silty clay deposits at the embankments and is present in all the boreholes drilled at the crest, i.e. road crown level, as well as in Borehole 104 at the toe of the embankment.

The boundaries of the different strata, together with the field and laboratory test results, are shown on the Record of Borehole sheets appended to this report. Also refer to the sheets for the locations and elevations of the boreholes. Stratigraphic sections of the subsurface conditions are shown on Drawing Nos. SP-1. Detailed description of the encountered strata is provided below.

Asphalt/Granular Fill

Asphalt pavement, overlying granular fill material, was encountered at the surface of Boreholes 102, 103, 106, 107 and 109. The thickness of the asphalt varies from 9.5 to 12 cm. The thickness of the granular fill varied from 48 to 70 cm.

Topsoil

Surficial topsoil was encountered in Boreholes 101, 105 and 108. The thickness of the surficial topsoil varies from 25 to 45 cm.

Silty Clay (Fill)

The fill material was encountered at Boreholes 102, 103, 104, 106, 107 and 109. In Boreholes 103, 104 and 106, the fill extends to the underlying silty clay at depths ranging from 0.2 to 7.9 m, Elevations ranging from 170.3 to 174.1, and to the original topsoil layer at depths ranging from 7.0 to 7.2 m, Elevations ranging from 174.5 to 174.8 m in Boreholes 102, 107 and 109.

The surficial fill was placed upon completion of the construction of the approach embankments. The embankment fill consists of silty clay, with traces of sand, gravel, rootlets and some topsoil, with an occasional trace of organics. In addition, a 5 cm thick asphalt fragment/layer with slight petroleum odour was encountered at a depth of 7.0 m in Borehole 106.

The 'N' values vary from 4 blows per 30 cm penetration, to 50 blows per 15 cm penetration, indicating the fill is loosely to well compacted. Generally, it is in a loosely compacted state. The moisture content ranges from 3 to 38 percent. The unit weight is 19.5 kN/cu.m. Typical gradation curve and atterberg limits are shown on Figures 1 and 2, respectively.

The field vane test results indicated in situ shear strengths ranging from 93.9 to > 117.3 kPa.

Original Topsoil

The original topsoil layer was encountered below the embankment fill layer in Boreholes 102, 107 and 109. The thickness of the topsoil layer varies from 30 cm to 40 cm.

Silty Clay

Underlying the surficial topsoil in Boreholes 101, 105 and 108, the fill in Boreholes 103, 104 and 106 and the original topsoil in Boreholes 102, 107 and 109 is the deposit of the silty clay. Silt and sand seams/layers and occasional gravel are present in the stratum. This deposit extends to the maximum depth of the investigation in all of the boreholes, i.e. depths ranging from about 3.0 to 14.2 m, Elevations ranging from 167.5 to 172.0 m.

The 'N' values, ranging from 5 blows 30 cm penetration to 32 blows per 30 cm penetration, were obtained during field testing reflecting a consistency ranging from firm to hard. More typically, the upper portion is very stiff and then becomes softer with increasing depth. The silty clay exhibits medium plasticity, as shown in Figure 4.

Laboratory testing yielded the following physical properties:

Property	Range	Average
Natural Moisture Content (%)	9 - 37	24.3
Liquid Limit (%)	48.6	48.6
Plasticity Index	36	36
Unit Weight (kN/cu.m)	21.5	21.5

Grain size distribution envelope is given in Figure 3.

Field vane test results indicated in situ shear strengths ranging from 92.5 to > 194.8 Kpa.

Groundwater Conditions

Observation of the groundwater levels was carried out by measuring the water levels upon completion of drilling. At the time of investigation, all of the boreholes were dry except for Borehole 107 where the water level was at a depth of 11.6 m below grade, Elevation 170.1 m.

DISCUSSIONS AND RECOMMENDATIONS

The two approach embankments of the bridge consist of fill materials with a varying amount of organics (reportedly derived from the nearby excavations), placed over the original topsoil layer and the relatively soft underlying original soils. The cross-sections of the slopes are given on Drawing No. SP-1.

The embankments reach about 6 m in height with an approximate slope geometry of 2.0 horizontal to 1.0 vertical. The slopes, as constructed, are not stable and moderate to severe cracks were observed at the top of the embankments, i.e. in the shoulders of Ridgemount Road, and within the slopes.

The slope instability is further exacerbated by the surface run off from the bridge deck, which now discharges directly into the approach fills/embankments. It should be noted that the existing catch basins are not effective in collecting the run off as they are torn off the road crown due to the slope dislocation.

The stability analyses of the existing embankments were carried out by the Simplified Bishop Method for circular slip surfaces. A commercial program, SB-Slope, was primarily used for two dimensional analyses.

The slope stability was carried out for a typical Section, i.e. Section A-A, Drawing SP-1. The grid search analysis, along with project data and the assumed soil parameters, are given in Appendix 'A'. In addition, deep seated failures were evaluated using radius options with minimum depth and elevation search.

The slip failure circles are shown on Drawing SS-1. A factor of safety of a minimum of 1.3 is considered to be stable.

Based on the results of the detailed stability analyses, line of the stable slope, at the top of the embankment, appears to be within the existing road pavement. As a result, the enclosed computer modelling of the long term stability indicates that the roadway will be subject to further cracking and a long term settlement.

Embankment Rehabilitation

The results of the investigation indicate that the subject embankments were not constructed in accordance with the acceptable road building practise. We believe that the original contract document would specify that all topsoil must be removed prior to the placement of embankment fill.

The presence of organics in the embankment fill material, and more importantly, the presence of the original topsoil layer with measured thickness of up to 40 cm, is of additional concern. The run off infiltration into the approach fill and the resulting saturation/increase in unit weight, accelerated the failure process. We noted during our site inspection on September 28, 1998 that further slope movement has taken place since the completion of the field work.

Based on the results of the investigation and our re-inspection of the site we propose the following rehabilitation alternatives be considered;

ALTERNATIVE I;

Our experience with roadway embankments, where built over organic deposits, indicates extraordinary and ongoing maintenance/repair costs. Should sufficient funds be available the existing fill and the underlying topsoil layer should be removed and the approach embankments rebuilt.

The organic topsoil is, by definition subject to a volume change, due to the long term decomposition of the organic matter. The volume change will manifest itself as a long term settlement of the approach embankments.

Prior to placing the new embankment fill, the topsoil should be removed and the base should be proof rolled and any soft spot should be removed and replaced with inorganic fill, compacted to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD).

However, in order to accurately determine the horizontal extent of the topsoil layer, and the organic content of the fill, additional boreholes along the affected embankment are recommended.

In addition, the embankments should be constructed utilizing the reinforced earth reinforced systems, perhaps in combination with retaining structures.

ALTERNATIVE II

We note that several of the approach fills, in the general area of the investigation, are showing similar signs of settlement induced distress. Given the nominal traffic volumes carried by these roadways, and the current budgetary constraints, it is not likely that sufficient funds will be allocated to rebuild the approach fills. As a result, we suggest that other, less expensive, remedial works be considered.

Given the magnitude of a potential liability due to the shear failures within the existing shoulders, the initial remedial work, i.e. the drainage improvement, should be carried out immediately. The suggested sequence of Phase 1 remedial work should be as follows;

- Plan for the fall of 1998 to excavate "drainage ribs", at the location of the existing catch basins, perpendicular to the centre line of the roadway. The ribs should be about 1.0 m in width/depth and should extend, at the foot of the embankment, into the native silty clays.
- Time/weather permitting, reconstruct all four catch basins, connect new drainage pipes, provide positive gravity drainage (away from the toe of the slope) and backfill the ribs with size 25 to 50 mm crushed stone, riverstone, recycled concrete aggregate or other suitable/less expensive materials.
- Excavate trenches along the affected shoulders, placing all the loosened material temporarily onto the paved roadway, to a depth of say 0.5 m below the pavement level. Provide a bench, say 0.3 m wide, and excavate second and deeper trench (where possible), extending below the upper failure. Proof roll the trench bottom and place the removed material in layers and compact to 95 % of SPMDD.

- Upon completion of the shoulder reconstruction and of all four catch basins, repeat rib excavations and stone backfill, both sides of the embankments, for the length of the affected slope, at say 5 to 7.5 m intervals to facilitate drainage of the embankment soils. To improve efficiency/longevity of the ribs they should be wrapped in a geotextile filter fabric, Terrafix 270 R, or equivalent.
- Connect the ribs to a drainage ditch/blanket constructed along the toe of the slope, both sides of the embankment. The drainage blanket should extend below the underlying organic material, into the competent silty clay deposit. The blanket should be about 2 m in width and about 1 m deep and must be provided, at its invert level, with positive drainage outlet. (consider excavating a dewatering trench to a nearest gravity outlet)
- Monitor, by frequent visual inspections, the shoulders and slopes for further signs of settlement. Should the approach embankments stabilize, consider paving the completed shoulders with a nominal layer of asphalt and redress embankment slopes.

Should the results of the proposed Phase 1 remedial work prove unsatisfactory, in some of the repaired segments, over the period of monitoring of about 12 months, proceed with Phase 2 as follows;

- Construct gravity type retaining walls, we suggest the relatively inexpensive Gabion type wall, placed directly on top of the drainage ditch/blankets. The gabion walls should be placed along the length of the unstable slope segment, to be determined in the field at the end of the monitoring period. It is anticipated that the retaining walls would be maximum of about 1.5 m in height.
- Upon completion of the gabion walls, to be constructed with inclined face at 1:6, place filter fabric, Terrafix 270 R or equivalent, on the inside face of the wall. Backfill the slopes to a flatter grade, subject to the final wall height and preferably 2.5 : 1, and hydroseed for better erosion control. Provide a bench, mid height of the slope, with a minimum width of 1.5 m.

QEW AND NETHERBY ROAD

SITE DESCRIPTION AND GEOLOGY

The site is located at the east slope of the S-EW ramp to the QEW Highway at the Netherby Road interchange in the Town of Fort Erie, Ontario.

The topography is relatively flat, outside the nominal 2H:1V slope of the roadway embankments. The roadway on the S-EW ramp slopes up gently from the QEW Highway towards Netherby Road. The portion of the embankment, where the shoulder/slope instability occurred, is now covered by a 400 mm thick granular fill (crushed limestone) slope dressing which extends from the crest to the toe of the slope. The remainder of the area is covered by light vegetation, grass and shrubs.

A relatively large crack approximately 20 m in length, 150 mm in width and 600 mm in depth has developed along the right shoulder of the S-EW ramp, adjacent to the crest of the slope. Settlement of the pavement was observed along the crack and additional cracks/settlement are present around the guard rail posts, located along the edge of the shoulder.

Settlement of approximately 150 to 200 mm was observed along the shoulder at the crest of the embankment slope. Surface cracks and displacement bulging of the ground surface are present along the mid height of the slope. The ground surface at the toe of the slope is "spongy" and some of the surface granular material appears to be sliding down towards the toe of the slope. Cracks are also present in the ground surface in the flat lands adjacent to the toe of the slope, where the ground surface is excessively wet.

Geologically, the site consists of medium plasticity silty clay deposits.

PROCEDURE

The field investigation was carried out on August 12 and 13, 1998. The fieldwork consisted of drilling two boreholes, i.e. one borehole was drilled at the crest of the embankment slope and one at the toe of the embankment. The borehole at the crest was drilled to a maximum depth of 11.9 m and the borehole at the toe of the embankment was advanced to a maximum depth of 2.4 m.

The borehole at the crest was advanced using a truck mounted C.M.E. 55 equipped with solid stem augers and at the toe with a manually driven hammer.

Disturbed samples were recovered by means of a 50 mm O.D. split spoon sampler driven into the soil, all according to the specification of the Standard penetration Test (ASTM D 1587-8).

A field vane test was carried out in Borehole 201 to assess the in situ shear strength of the native clay deposit. The vane test results are presented on the Borehole Logs and summarized in Table 2 (Appendix B).

The elevations and co-ordinates of the boreholes were obtained from topographic Plans provided by the MTO's Central Region Survey and Plans Office.

Laboratory testing, carried out on representative samples to identify and determine the physical properties of the overburden, included:

- o Natural moisture content
- o Grain size distribution
- o Atterberg Limit
- o Unit Weight

SUBSURFACE CONDITIONS

The predominant subsurface deposit consists of a firm to hard cohesive medium plasticity silty clay. Fill overlies the native silty clay deposits at the ramp embankments.

The boundaries of the different strata, together with the field and laboratory test results, are shown on the Record of Borehole sheets appended to this report. Also refer to the sheets for the locations and elevations of the boreholes. Stratigraphic sections of the subsurface conditions are shown on Drawing No. SP-2. Detailed description of the different strata is provided below.

Asphalt/Granular Fill

The thickness of the flexible pavement structure included asphalt pavement of about 18 cm, with the thickness of the granular fill of 52 cm.

Silty clay (Fill)

The fill material was encountered below the granular fill in Borehole 201. The fill extends to the underlying original topsoil layer at a depth of 5.8 m, Elevation 175.9 m.

The surficial fill was placed during/after the construction of the ramp embankment. The fill consists of silty clay, with traces of gravel and rootlets.

The 'N' values vary from 8 to 15 blows per 30 cm penetration, indicating that the fill is loosely to well compacted. Generally, it is in a well compacted state. The moisture content ranges from 12 to 21 percent. The unit weight is 21.7 kN/cu.m. Typical gradation curve and atterberg limits are shown on Figures 5 and 6, respectively.

Topsoil

The original topsoil layer was encountered at the surface of Borehole 202 and below the fill in Borehole 201. The thickness of the topsoil layer varies from 15 cm in Borehole 202 to 30 cm in Borehole 201.

Silty Clay

Underlying the surficial topsoil is the deposit of silty clay with sand and occasional sand lenses. The silty clay deposit extended to the underlying shale bedrock, encountered at a depth of approximately 11.6 m, Elevation 170.1 m, in Borehole 201 and to the maximum depth of the investigation in Borehole 202.

The 'N' values, ranging from 6 to 52 blows per 30 cm penetration, were obtained during field testing reflecting a consistency ranging from stiff to hard. The silty clay exhibits medium plasticity, as shown in Figure 8. Laboratory testing yielded the following physical properties:

Property	Range	Average
Natural Moisture Content (%)	18 - 28	22.6
Liquid Limit (%)	45.2	45.2
Plasticity Index	33.0	33.0
Unit Weight (kN/cu.m)	20.7	20.7

Grain size distribution envelope is given in Figure 7.

The field vane test results indicated an in situ shear strength > 194.8 kPa.

Shale Bedrock

The sedimentary shale/limestone bedrock formation was encountered below the silty clay in Borehole 201. This deposit extended to the maximum depth of the borehole, Elevation 169.8 m.

Groundwater Conditions

Observation of the groundwater levels was carried out by measuring the water levels upon completion of drilling. At the time of investigation, Borehole 202 was dry and the water level was at the surface of the shale bedrock in Borehole 201, at a depth of 11.6 m, Elevation 170.1 m.

DISCUSSIONS AND RECOMMENDATIONS

The present condition represents an immediate hazard to the on ramp vehicular traffic a potential liability. The proposed "instant" remedial measures, using granular materials only, should be implemented immediately and the expanded scope of work could continue into the winter season.

The existing ramp embankment consists of fill materials, with a varying amount of organics, placed over the original topsoil layer and relatively soft native soils. The cross-section of the embankment slope is given on Drawing No. SP-2.

The affected slope is about 6 to 7 m high with an approximate geometry in the range of less than 2.0 horizontal to 1.0 vertical. The slope, as constructed, is too steep and will remain unstable unless restrained.

The slope stability was carried out for a typical Section, i.e. Section A-A, Drawing SP-2. The stability analyses of the existing ramp embankment were carried out by the Simplified Bishop Method for circular slip surfaces. A commercial program, SB-Slope, was primarily used for two dimensional analyses.

The grid search analysis, along with project data and soil parameters, are provided in Appendix 'A'. In addition, deep seated failures were evaluated using radius options with minimum depth and elevation search.

The slip failure circles are shown on Drawing SS-2. A factor of safety of a minimum of 1.3 is considered to be stable.

Based on the results of the computer modelling, the line of stable slope, at the top of the embankment, is within the existing pavement structure. Based on the results of the enclosed computer modelling of the long term slope stability, the subject road/embankment will be subject to further cracking and settlements.

Embankment Rehabilitation

The investigated slope, given the type of the embankment fill used and the underlying soils, is too steep for the required long term stability. However, there appears to be a sufficient right of way available to restrain the embankment with a soil berm or a retaining wall and flatten the long term slope.

ALTERNATIVE I

Based on the encountered soil conditions, i.e. the organic inclusions in the fill and the presence of the original topsoil layer with a thickness up to 0.4 m, it is recommended that the existing fill and the underlying topsoil layer be removed.

The existing ramp is to be reconstructed to flatter slope, perhaps utilizing gabion type retaining wall or an earth berm, all carried out under a temporary detour.

Prior to placing new embankment fill, the base should be proof rolled and any soft organic soils/topsoil should be removed and replaced with inorganic fill, compacted to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD). In order to minimize long term maintenance costs surface erosion protection materials, such as Terrafix Curlex 3 or equivalent, could be utilized.

However, in order to accurately determine the horizontal extent of the topsoil layer and the fill with organic inclusions, i.e. if similar soil conditions exist at the other side of the ramp, additional boreholes/test pits are recommended.

ALTERNATIVE II

Given the liability concerns, some of the "instant" remedial measures could be (1) provision of a traffic barrier, (2) a temporary widening of the pavement over the left shoulder and (3) removal of the failed shoulder material and placement /compaction of the same.

It is noted that due to the super elevation of the paved ramp, there is virtually no surface run off onto the investigated slope (although the opposite slope is subject to a cumulative infiltration).

Given the time schedule/current budgetary constraints, gravity type gabion retaining wall, and/or preferably a berm, could be constructed along the toe of the present slope.

The drainage ditch/blanket should utilize the crushed limestone presently used for the slope dressing, together with recycled concrete aggregate, natural river stone or other less expensive rock fill. The blanket, about 2 m in width and 1 m in depth should be placed at the toe of the affected slope, in a trench excavation, and should be provided with positive/gravity outlet.

The proposed retaining wall/soil berm should be placed directly on a drainage blanket (use filter fabric between the blanket and underside of the soil berm). The inside face of the retaining wall should also be covered with filter fabric, prior to placement of the backfill.

The existing slope should be benched (by a small Case dozer at about four locations down the slope), prior to the placement of the additional embankment fill. A permanent intermediate bench, about 1.5 m in width, half way up to the reconstructed slope, with a reversed slope of say 3 %, together with hydro seeding and planting would alleviate erosion problems.

The reconstructed embankment should be monitored for further signs of settlements/cracking for a period of say 12 months. Should the remedial work yield satisfactory results, consideration should be given to placing nominal asphalt coat over the exposed shoulders. Further surficial improvements, such as asphalt dykes, localized placement of Curlex 3, drainage ribs/channels and landscaping could then be initiated.

HIGHWAY 406 AND FOURTH AVENUE

SITE DESCRIPTION AND GEOLOGY

The site is located in the cut slope adjacent to the northbound lanes of Hwy. 406, south of the Fourth Avenue exit ramp in the City of St. Catharines, Ontario.

The topography slopes down approximately 2H:1V from Yates Street to Brewery Street where it remains relatively flat to the top of the subject slope which is nominal 2H:1V to Hwy 406. The slope is covered by light vegetation, grass, shrubs and trees.

The subject slope can be divided into two sections. The southern half is bordered at the top by Brewery Street and the northern half is limited by a gravel pathway, with Salina Street being located in the middle of the slope.

Relatively severe slope instability has occurred along the entire slope, especially in the northern two thirds of the investigated area. More importantly, what appears to be a progressive failure is developing along the gravel pathway. In addition, cracks of approximately 15 to 100 mm in width, are developing longitudinally along the pathway.

At the crest of the slope, from approximately 30 m south to 80 m north of Salina Street, settlements of approximately 600 to 800 mm, accompanied by surficial erosion are present. Tree roots are exposed and little to no vegetation is present. A chain link fence runs longitudinally at approximately mid height of the slope and the fence posts were embedded in concrete bases.

At the time of the investigation, the fence was leaning down the slope and the concrete bases were exposed. A random longitudinal crack, approximately 150 mm wide and 250 mm deep, runs from post base to post base.

Longitudinal and some perpendicular cracks can be found throughout the entire slope surface. It should be noted that the longitudinal cracks appear to be wider. Some displacement "bulging" is evident along the mid height of the slope, in the northern half and also below the fence line.

Some of the trees are leaning down the slope and some roots are partially exposed. Settlement and surface erosion are also evident in the lower portion of the slope in this area.

Geologically, the site consists of medium plasticity silty clay, medium to non plastic glacial till formations, non plastic sandy silts to silty sand and a weathered shale bedrock.

PROCEDURE

The field investigation was carried out between the period of August 12 and 24, 1998. The fieldwork consisted of drilling eleven boreholes, i.e. five boreholes were drilled at the crest of the embankment slope, two at the mid-height and four at the toe of the slope. The boreholes at the crest were drilled to a maximum depth ranging from 21.6 to 27.4 m, at the mid-height of the slope to 3.0 m and from 2.6 to 4.9 m at the toe of the slope.

The boreholes at the crest were advanced using a truck mounted C.M.E. 55 equipped with solid stem augers, and at the mid-height and the toe with a manually driven hammer. Disturbed samples were recovered by means of a 50 mm O.D. split spoon sampler driven into the soil, all according to the specification of the Standard penetration Test (ASTM D 1587-8).

Field vane tests were carried out in Boreholes 306 and 310 to assess the in situ shear strength of the native silty clay and silty clay till deposits. The vane test results are shown on the Borehole Logs and summarized in Table 3 (Appendix C).

The elevations and co-ordinates of the boreholes were obtained from topographic Plans provided by MTO's Central Region Survey and Plans Office.

Laboratory testing, carried out on representative samples to identify and determine the physical properties of the overburden, included:

- o Natural moisture content
- o Grain size distribution
- o Atterberg Limit
- o Unit Weight

SUBSURFACE CONDITIONS

The predominant subsurface deposits consist of a soft to hard cohesive medium plasticity silty clay and medium plasticity silty clay (glacial Till). With greater depths, the cohesive glacial deposit becomes cohesionless, changing to compact to very dense sandy silt (glacial till). Below the cohesionless glacial till, is a cohesionless till/shale stratum which is separated from the sandy silt till in Boreholes 306, 308, 309 and 310 by a cohesionless sandy silt to silty sand deposit. Fill/granular fill overlies the glacial till deposits at all the borehole locations.

The boundaries of the different strata, together with the field and laboratory test results, are shown on the Record of Borehole sheets appended to this report. Also refer to the sheets for the locations and elevations of the boreholes. Stratigraphic sections of the subsurface conditions are shown on Drawing No. SP-3. Detailed description of the different strata is provided below.

Topsoil

Surficial topsoil was encountered in Boreholes 301 to 305 and Boreholes 309 and 310. The thickness of the surficial topsoil varies from 10 to 40 cm.

Granular Fill

Granular fill material was encountered below the surficial topsoil in Boreholes 301 and 302, and at the surface in Boreholes 306 to 308. The thickness of the granular fill varies from 15 to 230 cm.

Silty Clay (Fill)

The fill material was encountered below the surficial topsoil in Boreholes 303 to 305 and 309 and 310 and below the granular fill in Boreholes 306 to 308. The fill extends to depths ranging from 1.5 m to 4.6 m, or about Elevation 82.4 to 92.5 m. The fill extends to the maximum depth of the investigation in Boreholes 303 and 303A, i.e. depth of 2.6 m and Elevation 82.4 and 82.9 m.

The fill appears to have been placed during the construction of the existing houses and roadway and/or during the demolition of previous structures. The fill consists of silty clay, with traces of sand and gravel, and contains traces of rootlets, organics and varying amounts of topsoil. The fill also contains inclusions of brick, asphalt and coal, at some locations.

The 'N' values vary from 4 blows per 30 cm penetration to 20 blows per 0 cm penetration, indicating the fill is loosely to well compacted. Generally, it is in a loosely compacted state. The moisture content ranges from 3 to 32 percent. The unit weight is 21.6 kN/cu.m. Typical gradation curve and atterberg limits are shown on Figures 9 and 10, respectively.

Original Topsoil

A layer of original topsoil, with a thickness of about 20 cm, underlies to fill in Borehole 310.

Silt

The silt deposit was encountered below the granular fill in Borehole 302 and extends to a depth of 1.7 m. The Standard Penetration Test 'N' value of 10 blows per 30 cm penetration, indicates the in situ density in the compact range. The moisture content for this material is 23 percent.

Silty Clay

Underlying the fill in Boreholes 303 to 309 and the original topsoil in Borehole 310 is the silty clay deposit. This deposit contains silt and sand seams and layers and traces of fine rootlets, in the upper levels of some boreholes. The deposit extends to the maximum depth of investigation in Boreholes 304 and 305, i.e. depth of 3.0 m and Elevation 85.5 to 87.7 m and to depths ranging from 7.0 to 10.1 m, Elevation 83.3 to 86.9 m.

The 'N' values, ranging from 4 blows per 30 cm penetration to 19 blows per 30 cm penetration, were obtained during field testing reflecting a consistency ranging from soft to very stiff. The silty clay exhibits medium plasticity as shown in Figure 12. Laboratory testing yielded the following physical properties:

Property	Range
Natural Moisture Content (%)	9 -35
Liquid Limit (%)	38.0
Plasticity Index	19.5
Unit Weight (kN/cu.m)	20.1

Grain size distribution envelope is given in Figure 11.

The field vane test results indicated in situ shear strengths ranging from 136.4 to > 194.8 kPa.

Silty Clay (Glacial Till)

Underlying the granular fill in Borehole 301, the silt layer in Borehole 302 and the silty clay in Boreholes 306 to 310, is the deposit of silty clay (cohesive glacial till). This deposit contains inclusions of gravel, and silt and sand seams and layers are frequent. The cohesive till extends to the maximum depth of the investigation in Borehole 302, i.e. depth of 3.0 m and Elevation 82.5 m. The thickness of the deposit varies from depths of 3.7 to 14.7 m, Elevation 78.7 to 82.8 m in the other boreholes.

The 'N' values, ranging from 3 blows per 30 cm penetration to 33 blows per 30 cm penetration, were obtained during field testing reflecting a consistency ranging from soft to hard. The moisture content ranges from 9 to 32 percent

The field vane test results indicated an in situ shear strength of 77.9 kPa.

Sandy Silt (Non cohesive glacial till)

The non cohesive glacial till strata was encountered below the silty clay (glacial till) at Boreholes 301 and 306 to 310. This material extends to the maximum explored in Borehole 301, i.e. depth of 4.9 m, Elevation 81.6 m, and to depths ranging from 13.7 to 19.3 m, Elevation 74.1 to 80.1 in the other boreholes. Based on the Standard Penetration test values of 10 blows per 30 cm penetration to 60 per 15 cm penetration, the deposit is in a compact to very dense state. The moisture content ranges from 8 to 18 percent and the unit weight is 20.3 kN/cu.m. Typical gradation curve is shown on Figure 13.

Sandy Silt to Silty Sand

The sandy silt to silty sand deposit was encountered below the sandy silt (non cohesive glacial till) in Boreholes 306 to 310 and extends to depths ranging from 16.0 to 21.5 m, Elevation 71.9 to 77.8. The Standard Penetration Test 'N' value of 27 blows per 30 cm penetration to 50 blows per 13 cm penetration, indicates the in situ density in the compact to very dense range. The moisture content for this material varies from 9 to 18 percent. Typical gradation curve is shown on Figure 14.

Till/Shale Complex

Underlying the sandy silt to silty sand layer in Boreholes 306 to 310 is the till/shale complex. This material extends to depths ranging from 21.3 to 25.9 m, Elevation 67.5 to 73.5 m. Based on the Standard Penetration test values of 50 blows per 13 cm penetration to 165 blows per 7.5 cm penetration, the deposit is in a very dense state. The moisture content ranges from 4 to 15 percent.

Weathered Shale Bedrock

Underlying the till/shale complex strata in Boreholes 306 to 310 is the highly weathered to weathered shale bedrock. This weathered shale extends to the maximum depth explored in the boreholes, i.e. 21.6 to 27.4 m, Elevation 66.0 to 73.2 m. Based on the Standard Penetration test values of 60 blows per 15 cm penetration to 50 blows per 0 cm penetration, the deposit is in a hard state. The moisture content ranges from 5 to 15 percent.

Groundwater Conditions

Observation of the groundwater levels was carried out by measuring the water levels upon completion of drilling. At the time of investigation, Boreholes 302, 304 and 305 remained dry and the water levels in the remaining boreholes varied from 1.8 m to 12.2 m, Elevation 81.5 to 85.4 m.

Based on the groundwater levels recorded and the topography of the area, the groundwater flow is in the northerly direction towards the Twelve Mile Creek and Lake Ontario.

DISCUSSIONS AND RECOMMENDATIONS

The subject slope exhibits signs of localized failures, especially within the central portion of the slope. It should be pointed out, however, that there is no eminent danger of slope failure, and the present liability is related to the breached access control fence.

As a result, there is no need for immediate repairs/remedial work to mitigate potential traffic hazards.

In general, the investigated slope consists of fill underlain by the original undisturbed soils. The fill extends to a depth ranging from 2.0 to 4.6 m. The soil profiles, at the crest and the toe of the slope, are given on Drawing No. SP-3.

The height of the slope varies from about 6 m to 12.0 m with an approximate geometry in the range of 2.0 horizontal to 1.0 vertical. The slope shows localized shallow failures, especially in the central section along the existing fence line.

The slope stability was carried out for a typical Section, i.e. Section C-C, Drawing SP-3. The stability analyses of the existing slope were carried out by the Simplified Bishop Method for circular slip surfaces. A commercial program, SB-Slope, was primarily used for two dimensional analyses.

The grid search analysis, along with project data and soil parameters, are given in Appendix 'A'. In addition, deep seated failures were evaluated using radius options with minimum depth and elevation search.

The slip failure circles are shown on Drawing SS-3. A factor of safety of a minimum of 1.3 is considered to be stable.

Based on the stability analyses, relatively shallow failures, extending to a depth of about 3.0 m were detected.

It should be noted that the fence foundations, at the lower edge of the central section of the slope, were placed at a nominal depth and above the failure slip surface. It appears that additional horizontal forces, such as surface runoff/erosion and perhaps an excessive snow accumulation, have had an adverse affect on the slope/fence foundations.

Embankment Rehabilitation

It should be noted that surface run off from the upper Salina Street discharges directly into the investigated slopes. The first step in the proposed slope remediation must be the provision of surface run off/drainage measure. We suggest that a combination of asphalt dykes with catch basins should be installed at the earliest convenience.

In addition, a deep access/vent shaft indicates a presence of a large diameter storm sewer within the central portion of the investigated slope. The storm sewer should be inspected and its potential impact on the long term stability of the slope assessed, prior to commencement of any remedial work.

The above concerns should be discussed with City of St. Catharines works department. In addition, the as built drawings for Salina Street and the storm sewer should be reviewed, prior to the conceptual design of suitable remedial works.

Given the encountered subsurface conditions and the as built slope geometry the following remedial actions could then be considered;

ALTERNATIVE I

Given sufficient funds the entire slope could be re-built, using reinforced earth system. The slope reconstruction would commence in the lower portion of the slope with the removal of the existing trees.

We understand that no gabion type retaining structures are permitted, due to aesthetic reasons, along the 406 series highways. The Terrafix MESA system or equivalent, could however be placed to a height of approximately 1 m at the toe of the present slope, between Boreholes 302 and 304.

The first segment of the MESA reinforced earth system would extend to the existing chain link fence, at a flatter slope. The access control fence would be then removed and rebuilt on top of the second MESA wall segment, installed along the present fence line. The second wall segment may have to be founded on a strip of engineered fill, extending below the localized failure plane.

The height of the second wall segment could be extended to the level of the existing pathway/ lower Salina Street. Upon placement of backfill within the central section of the slope, a virtually flat surface would be created (the very effective mid slope bench, which would stabilize/restrain the upper slope), which could be landscaped and made accessible to public/immediate neighbourhood. The upper section of the slope appears stable.

ALTERNATIVE II

The investigated slope appears to be virtually stable in the lower third of the slope. The critical section of the slope is in the mid height, and north of the access control chain link fence. This alternative would limit construction access to the existing pathway/Salina Street rather than to the HWY 406 as required by Alternative I.

Based on the encountered subsurface conditions in the mid section, the surface fill should be removed to beyond the failure surface, i.e. about 3.0 m in depth, in a strip about 6 m in width and placed back as engineered fill, compacted to 95 % of SPMDD.

The MESA wall system would then be constructed (same as the above Alternative I/Segment 2) on top of the engineered fill. The wall height could be limited to about 1 m and the fence could be re-build on the flat ground, directly along the existing pathway.

The foundation system for the proposed reconstruction of the access control fence, i.e. sono tubes/caissons, should extend at least 1.5 m below the finished grade. A series of snow fences, in combination of improved tree/shrubs cover should be placed along the upper slope to minimize formation of a substantial snow drifts at the fence line.


MISCELLANEOUS


The fieldwork for this investigation was carried out under the supervision of Intermediate Geotechnical Engineer Mr. O. Benjamin, P.Eng. The equipment was owned and operated by Ellerton Drilling.

The project was carried out under the supervision of Mr. G. S. Semaan, Project Manager. The report was written by Mr. G. S. Semaan and reviewed by the Project Director Mr. L.J. Rak.

Submitted by

MCCLYMONT AND RAK ENGINEERS INC.


G. S. Semaan, P.Eng.


L.J. Rak, P.Eng.



APPENDIX A

**QEW AND RIDGEMOUNT
BOREHOLE DATA SHEETS, SLOPE STABILTY ANALYSES**

RECORD OF BOREHOLE No 101

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4 756 838; E 345 090 ORIGINATED BY O.B.
 DIST CR HWY QEW/RIDG BOREHOLE TYPE PionJar 120 Sampling System COMPILED BY O.B.
 DATUM Geodetic DATE 98.08.07 - 98.08.07 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)				
175.0	Ground Surface						20 40 60 80 100										
0.0	Topsoil/Peat 45cm Silty Clay, trace of rootlets, fine rootlets below 0.6m, varved, brown to reddish brown, moist to very moist, firm to stiff, very stiff between 1.2 and 2.4m		1	SS											○		
			2	SS											○		
			3	SS											○		
			4	SS											○		
			5	SS											○		
172.0	End of Borehole																
3.0	Notes: 1) Borehole remained dry on completion of drilling																

RECORD OF BOREHOLE No 102

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4 756 837; E 345 078 ORIGINATED BY O.B.
DIST CR HWY QEW/RIDG BOREHOLE TYPE Continuous Flight Solid Stem Auger COMPILED BY O.B.
DATUM Geodetic DATE 98.08.10 - 98.08.10 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
181.8	Ground Surface													
0.0	Asphalt 12cm													
181.2	Granular Fill 48cm		1	SS	17									
0.6	Silty Clay, trace of gravel, trace of organics, some to trace of topsoil, dark brown/ black to reddish brown with dark brown seams, moist, firm to stiff (Fill)		2	SS	9		181							
			3	SS	7		180							
			4	SS	5		179							
			5	SS	7		178							
			6	SS	10		177							
			7	SS	12		176							
							175							
174.8	Original Topsoil black, moist						174							
7.0							173							
174.5	Silty Clay, trace of fine rootlets above 8.8m, some silt and sand partings, varved, mottled brown to reddish brown, moist to very moist, very stiff to firm		8	SS	16		172							
7.3			9	SS	22		171							
			10	SS	16		170							
			11	SS	9									
			12	SS	9									
			13	SS	6									
168.8	End of Borehole						169							
13.0	Notes: 1) Borehole remained dry on completion of drilling 2) Combustible vapour reading < 1% L.E.L. at 1.5m depth in open borehole													

RECORD OF BOREHOLE No 103

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4 756 836; E 345 070 ORIGINATED BY O.B.
DIST CR HWY QEW/RIDG BOREHOLE TYPE Continuous Flight Solid Stem Auger COMPILED BY O.B.
DATUM Geodetic DATE 98.08.10 - 98.08.10 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								20 40 60 80 100								
							20 40 60 80 100					10 20 30				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
181.8	Ground Surface															
0.0	Asphalt 9.5cm Granular Fill 60.5cm		1	SS	20											
181.1																
0.7	Silty Clay, trace of gravel, trace of rootlets and other organics, trace to some topsoil, dark greyish brown to reddish brown with dark brown seams, moist, firm to stiff (Fill)		2	SS	5		181									
			3	SS	4		180									
			4	SS	6		179									
			5	SS	9		178									
	-100mm of black topsoil below 3.4m		6	SS	11		177									
							176									
	-black organic layers below 6.1m		7	SS	9		175									
							174									
173.9			8	SS	14		173									
7.9	Silty Clay, trace of fine rootlets above 9.6m, some silt and sand partings, varved, reddish brown, moist to very moist, very stiff to stiff		9	SS	19		172									
			10	SS	21		171									
			11	SS	13											
			12	SS	8											

RECORD OF BOREHOLE No 104

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4 756 835; E 345 049 ORIGINATED BY O.B.
DIST CR HWY QEW/RIDG BOREHOLE TYPE PionJar 120 Sampling System COMPILED BY O.B.
DATUM Geodetic DATE 98.08.07 - 98.08.07 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
174.5	Ground Surface																
170.8 0.2	Silty Clay, trace of rootlets, some topsoil, (Fill)		1	SS			174										
	Silty Clay, trace of fine rootlets above 1.8m, varved, brown to reddish brown, moist to very moist, very stiff to firm		2	SS													
			3	SS			173										
			4	SS													
			5	SS			172										
171.5 3.0	-trace of gravel below 2.7m -dark brown seam with trace of roots below 2.8m End of Borehole Notes: 1) Borehole remained dry on completion of drilling																

RECORD OF BOREHOLE No 105

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4 756 673; E 345 112 ORIGINATED BY O.B.
 DIST CR HWY QEW/RIDG BOREHOLE TYPE Manual SPT COMPILED BY O.B.
 DATUM Geodetic DATE 98.08.07 - 98.08.07 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
174.8	Ground Surface							20	40	60	80	100								
0.0	Topsoil 25cm Silty Clay, trace of fine rootlets above 1.2m, silt partings and coarse sand lenses below 1.2m, varved, mottled brown to reddish brown, moist to very moist, firm to very stiff,		1	SS	6		174							○						
			2	SS	7										○					
			3	SS	13		173							○						
			4	SS	29										○					
	-coarse sand and quartz fragments below 2.4m		5	SS	16		172								○					
171.8	End of Borehole																			
3.0	Notes: 1) Borehole remained dry on completion of drilling																			

RECORD OF BOREHOLE No 106

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4 756 675; E 345 091 ORIGINATED BY O.B.
DIST CR HWY QEW/RIDG BOREHOLE TYPE Continuous Flight Solid Stem Auger COMPILED BY O.B.
DATUM Geodetic DATE 98.08.19 - 98.08.19 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
181.7	Ground Surface													
0.0	Asphalt 10cm		1	SS	12									
181.0	Granular Fill 60cm		2	SS	9									
0.7	Silty Clay, trace of sand, trace of gravel, with to some, dark brown and reddish brown, moist, stiff, (Fill)		3	SS	6									
			4	SS	12									
			5	SS	9									
			6	SS	11									
			7	SS	12									
			8	SS	50/ 15cm									
174.1	-50mm of asphalt with slight petroleum odour at 7.0m		9	SS	25									
7.6	Silty Clay, trace of fine rootlets above 8.1m, some silt and coarse sand lenses, varved, mottled brown to reddish brown, moist to very moist, very stiff to stiff, -firm below 10.7m		10	SS	29									
			11	SS	14									
			12	SS	7									
			13	SS	7									
167.5	-stiff below 13.7m		14	SS	10									
14.2	End of Borehole Notes: 1) Borehole remained dry on completion of drilling 2) Combustible vapour reading < 1% L.E.L. at 7.6m depth in open borehole													

RECORD OF BOREHOLE No 107

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4 756 678; E 345 086 ORIGINATED BY O.B.
DIST CR HWY QEW/RIDG BOREHOLE TYPE Continuous Flight Solid Stem Auger COMPILED BY O.B.
DATUM Geodetic DATE 98.08.11 - 98.08.11 CHECKED BY G.S.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
181.7	Ground Surface												
0.0	Asphalt 12cm												
181.1	Granular Fill 48cm		1	SS	7								
0.6	Silty Clay, trace to some sand, trace of gravel, trace of rootlets, some topsoil, reddish brown with dark brown and black layers, moist, firm to stiff (Fill)		2	SS	6	181						55.5	1 10 21 68
			3	SS	11	180							
			4	SS	11	179							
			5	SS	10	178							
			6	SS	6	177							
			7	SS	11	176							
			8	SS	8	175							
174.5	Original Topsoil black, moist		9	SS	20	174							
174.1	Silty Clay, trace of fine rootlets above 8.1m, silt and sand lenses, varved, mottled brown to reddish brown, moist to very moist, very stiff to firm		10	SS	21	173							
7.6			11	SS	16	172							
			12	SS	10	171							
			13	SS	9	170							
			14	SS	5	169							
168.7	End of Borehole												
13.0	Notes: 1) Water level at 11.6m depth in open borehole on completion of drilling 2) Combustible vapour reading < 5 ppm at 2.3m depth in open borehole												

RECORD OF BOREHOLE No 108

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4 756 676; E 345 067 ORIGINATED BY O.B.
DIST CR HWY QEW/RIDG BOREHOLE TYPE Manual SPT COMPILED BY O.B.
DATUM Geodetic DATE 98.08.07 - 98.08.07 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			20	40	60	80	100					
175.0	Ground Surface																
0.0	Topsoil 28cm Silty Clay, trace of fine rootlets above 1.2m, silt partings and coarse sand seams below 1.2m, varved, mottled brown to reddish brown, moist to very moist, firm to very stiff, -hard at 1.8m -dark brown seam with trace of roots below 2.4m		1	SS	5		174										
			2	SS	6												
			3	SS	18												
			4	SS	32		173										
			5	SS	29												
172.0	End of Borehole						172										
3.0	Notes: 1) Borehole remained dry on completion of drilling																

RECORD OF BOREHOLE No 109

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4 756 838; E 345 077 ORIGINATED BY O.B.
 DIST CR HWY QEW/RIDG BOREHOLE TYPE Continuous Flight Solid Stem Auger COMPILED BY O.B.
 DATUM Geodetic DATE 98.09.28 - 98.09.28 CHECKED BY G.S.

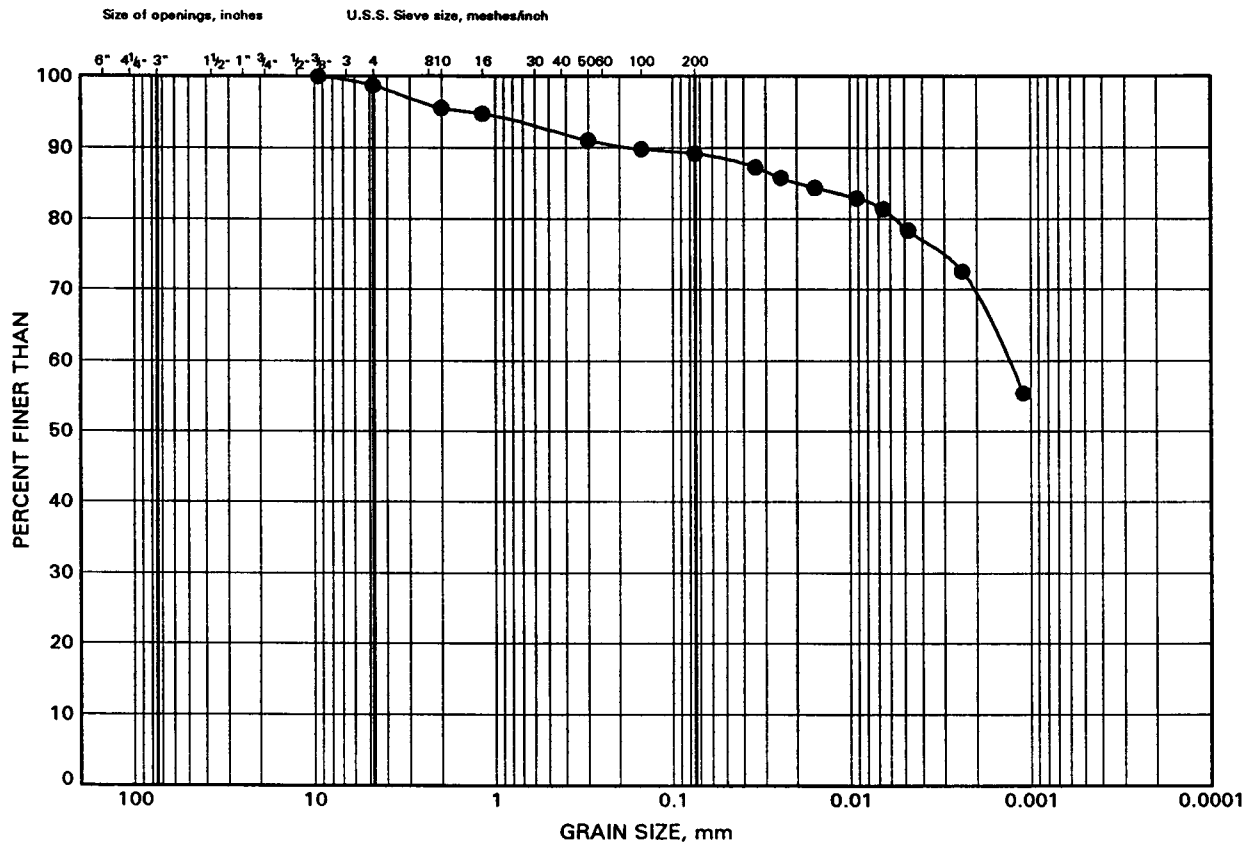
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE												
								● QUICK TRIAXIAL × LAB VANE												
							20	40	60	80	100	10	20	30	kN/m ³	GR SA SI CL				
181.9	Ground Surface																			
0.0	Asphalt 10cm Granular Fill 70cm		1	SS	19															
181.1																				
0.8	Silty Clay, trace of gravel, trace of organics, with topsoil above 2.3m, dark brown/ black to reddish brown with dark brown seams, moist, very stiff to hard, firm between 1.1 and 2.7m, (Fill)		2	SS	6															
			1	AS																
			3	SS	7															
			2	AS																
			4	SS	13															
			5	SS	15															
			3	AS																
	-trace to some topsoil/organics below 6.1m.		6	SS	17															
174.8			7	SS	31															
7.1	Original Topsoil																			
174.4	black, moist																			
7.5	Silty Clay, trace of fine rootlets above 7.9m, trace of silt and sand, varved, brown, moist, very stiff to hard		8	SS	25															
173.1			9	SS	30															
8.8	End of Borehole Notes: 1) Borehole remained dry on completion of drilling 2) Combustible vapour reading < 1% L.E.L. at 1.5m depth in open borehole																			

Table 1 - Summary Field Vane Test Results

Borehole No.	Depth (m)	Shear Strength (kPa)
102	9.1	175.3
102	13.0	97.4
103	11.4	194.8
106	11.4	136.4
107	11.4	194.8
107	13.0	92.5
109	1.1	> 117.3
109	1.8	93.9
109	3.0	> 117.3
109	4.6	> 117.3
109	5.3	> 117.3

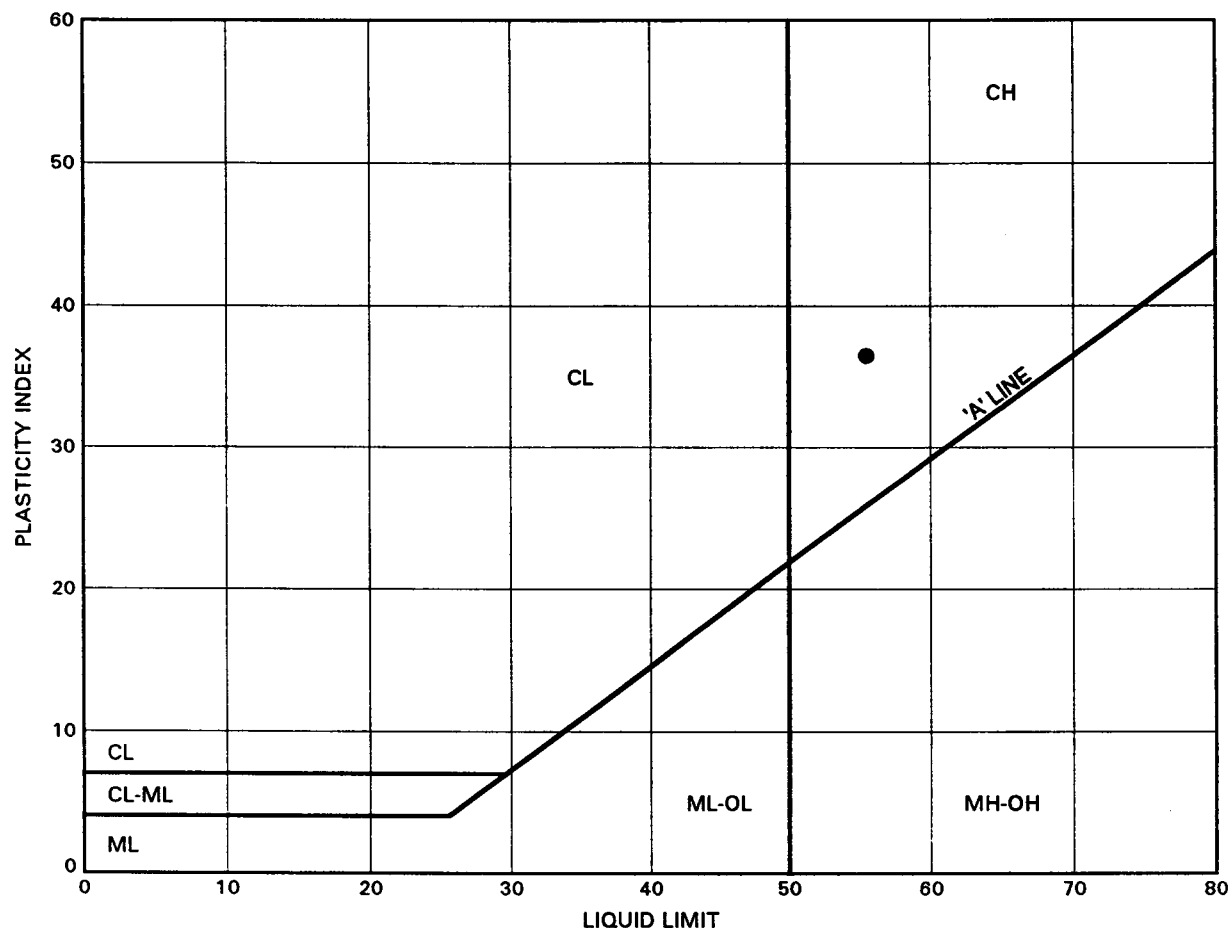
GRAIN SIZE DISTRIBUTION

FIGURE 1



ATTERBERG LIMITS TEST RESULTS

FIGURE 2



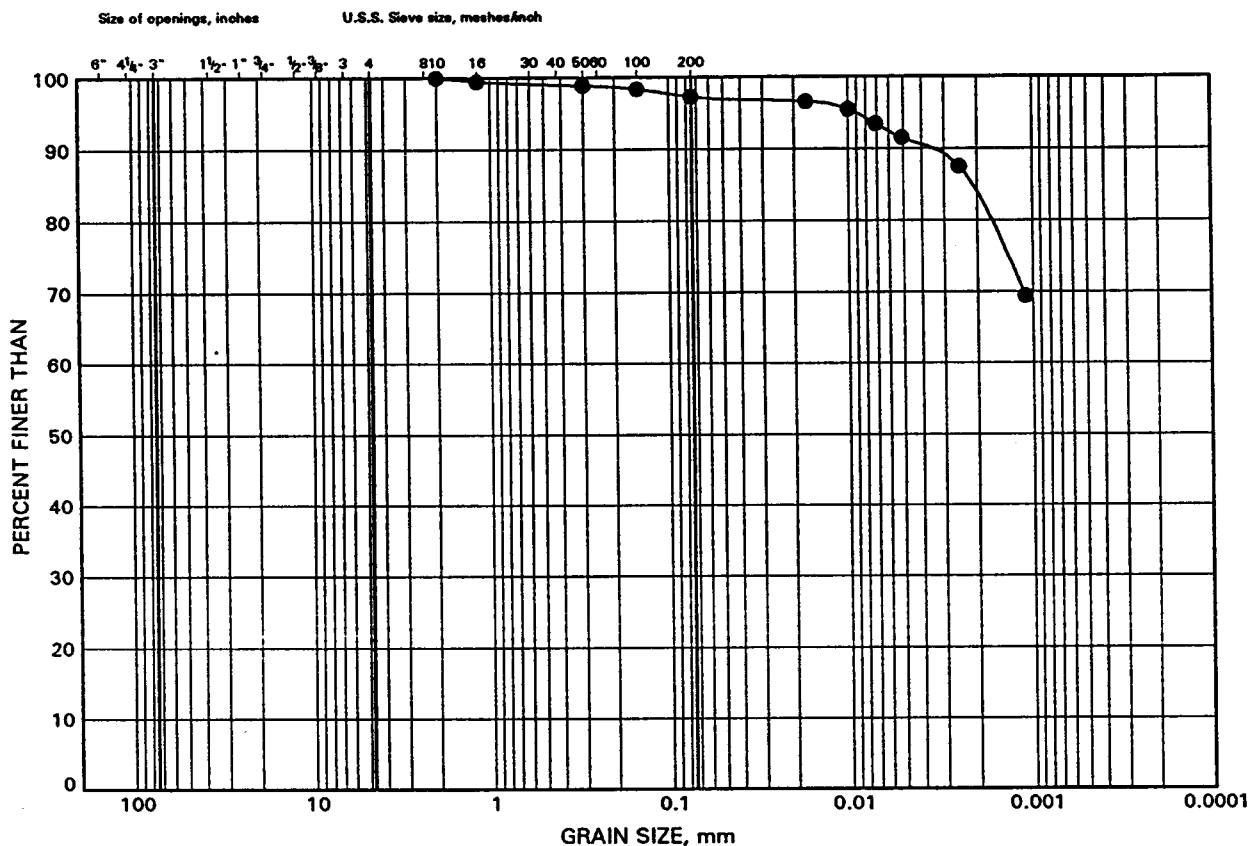
SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	107	1.0	180.7

Date September 1998
Project 9820-7411-2791

MC CLYMONT & RAK
ENGINEERS, INC.

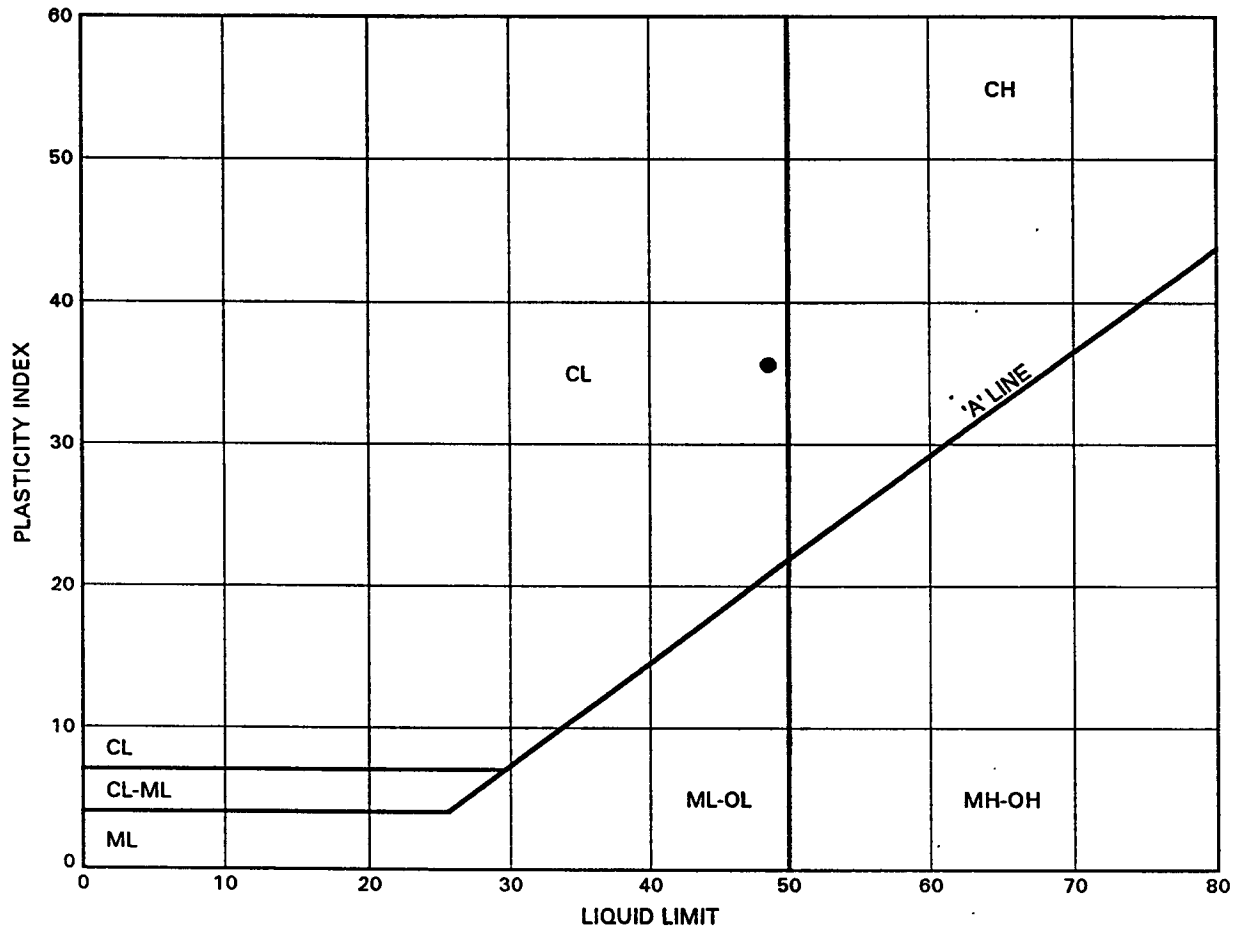
Prep'd O.B.
Chkd. G.S.

GRAIN SIZE DISTRIBUTION



ATTERBERG LIMITS TEST RESULTS

FIGURE 4



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
•	102	8.6	173.2

Date August 1998

Project 9820-7411-2791

MC CLYMONT & RAK
ENGINEERS, INC.

Prep'd O.B.

Chkd. G.S.

SB-SLOPE

Simplified Bishop Slope Stability Analysis

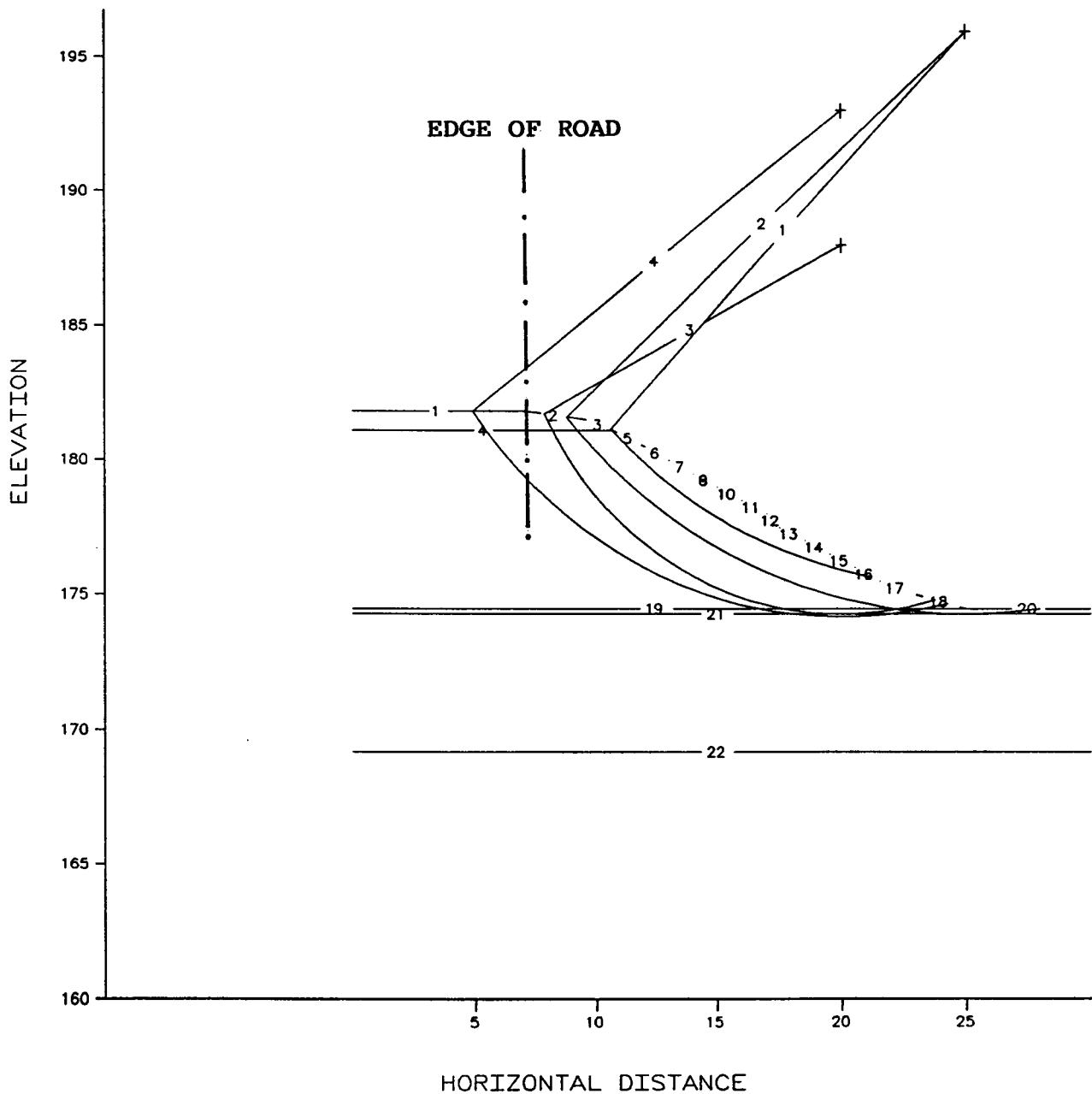
PROJECT: RIDGEMOUNT AND QEW, SOUTH WEST QUADRANT EMBANKMENT

LOCATION: FORT ERIE ONTARIO

FILE: RIDGE1

COMPLETE SLOPE CROSS SECTION

CIRCLE	X	Y	RADIUS	FS
1	25.0	196.0	20.7	1.05
2	25.0	196.0	21.7	1.17
3	20.0	188.0	13.7	1.27
4	20.0	193.0	18.8	1.43



Grid search; initial parameters:

	initial	final	increment
x	5.0	25.0	5.0
y	176.0	220.0	5.0

radius increment is 0.1

minimum perpendicular depth is 1.0

limit at elevation 170.0

MINIMUM FOR CENTER:	x =	5.0,	y =	176.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	5.0,	y =	181.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	5.0,	y =	186.0,	r =	6.5,	FS =	30.187	
MINIMUM FOR CENTER:	x =	5.0,	y =	191.0,	r =	10.4,	FS =	29.678	
MINIMUM FOR CENTER:	x =	5.0,	y =	196.0,	r =	10.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	5.0,	y =	201.0,	r =	10.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	5.0,	y =	206.0,	r =	10.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	5.0,	y =	211.0,	r =	10.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	5.0,	y =	216.0,	r =	10.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	10.0,	y =	176.0,	r =	10.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	10.0,	y =	181.0,	r =	10.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	10.0,	y =	186.0,	r =	5.6,	FS =	2.987	
MINIMUM FOR CENTER:	x =	10.0,	y =	191.0,	r =	12.1,	FS =	3.405	
MINIMUM FOR CENTER:	x =	10.0,	y =	196.0,	r =	17.4,	FS =	3.654	
MINIMUM FOR CENTER:	x =	10.0,	y =	201.0,	r =	21.6,	FS =	4.057	
MINIMUM FOR CENTER:	x =	10.0,	y =	206.0,	r =	26.1,	FS =	4.590	
MINIMUM FOR CENTER:	x =	10.0,	y =	211.0,	r =	30.9,	FS =	5.088	
MINIMUM FOR CENTER:	x =	10.0,	y =	216.0,	r =	35.6,	FS =	5.662	
MINIMUM FOR CENTER:	x =	15.0,	y =	176.0,	r =	35.6,	FS =	99.000	
MINIMUM FOR CENTER:	x =	15.0,	y =	181.0,	r =	2.8,	FS =	1.544	
MINIMUM FOR CENTER:	x =	15.0,	y =	186.0,	r =	7.3,	FS =	1.301	
MINIMUM FOR CENTER:	x =	15.0,	y =	191.0,	r =	11.8,	FS =	1.497	
MINIMUM FOR CENTER:	x =	15.0,	y =	196.0,	r =	16.5,	FS =	1.787	
MINIMUM FOR CENTER:	x =	15.0,	y =	201.0,	r =	21.5,	FS =	2.099	
MINIMUM FOR CENTER:	x =	15.0,	y =	206.0,	r =	26.8,	FS =	2.384	
MINIMUM FOR CENTER:	x =	15.0,	y =	211.0,	r =	32.7,	FS =	2.627	
MINIMUM FOR CENTER:	x =	15.0,	y =	216.0,	r =	37.3,	FS =	2.852	
MINIMUM FOR CENTER:	x =	20.0,	y =	176.0,	r =	37.3,	FS =	99.000	
MINIMUM FOR CENTER:	x =	20.0,	y =	181.0,	r =	5.2,	FS =	1.180	- low FS
MINIMUM FOR CENTER:	x =	20.0,	y =	186.0,	r =	9.5,	FS =	1.078	- low FS
MINIMUM FOR CENTER:	x =	20.0,	y =	191.0,	r =	14.0,	FS =	1.118	- low FS
MINIMUM FOR CENTER:	x =	20.0,	y =	196.0,	r =	18.4,	FS =	1.235	- low FS
MINIMUM FOR CENTER:	x =	20.0,	y =	201.0,	r =	23.0,	FS =	1.377	
MINIMUM FOR CENTER:	x =	20.0,	y =	206.0,	r =	27.6,	FS =	1.548	
MINIMUM FOR CENTER:	x =	20.0,	y =	211.0,	r =	32.3,	FS =	1.739	
MINIMUM FOR CENTER:	x =	20.0,	y =	216.0,	r =	37.3,	FS =	1.935	
MINIMUM FOR CENTER:	x =	25.0,	y =	176.0,	r =	2.5,	FS =	5.526	
MINIMUM FOR CENTER:	x =	25.0,	y =	181.0,	r =	7.3,	FS =	2.502	
MINIMUM FOR CENTER:	x =	25.0,	y =	186.0,	r =	12.0,	FS =	1.474	
MINIMUM FOR CENTER:	x =	25.0,	y =	191.0,	r =	16.3,	FS =	1.083	- low FS
MINIMUM FOR CENTER:	x =	25.0,	y =	196.0,	r =	20.7,	FS =	1.048	- low FS
MINIMUM FOR CENTER:	x =	25.0,	y =	201.0,	r =	25.1,	FS =	1.101	- low FS
MINIMUM FOR CENTER:	x =	25.0,	y =	206.0,	r =	29.6,	FS =	1.197	- low FS
MINIMUM FOR CENTER:	x =	25.0,	y =	211.0,	r =	34.1,	FS =	1.319	
MINIMUM FOR CENTER:	x =	25.0,	y =	216.0,	r =	38.7,	FS =	1.441	
OVERALL MINIMUM:	x =	25.0,	y =	196.0,	r =	20.7,	FS =	1.048	- low FS

Grid search; initial parameters:

	initial	final	increment
x	5.0	25.0	5.0
y	176.0	220.0	5.0

radius increment is 0.1

minimum perpendicular depth is 2.0

limit at elevation 170.0

MINIMUM FOR CENTER:	x =	5.0,	y =	176.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	181.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	186.0,	r =	6.5,	FS =	30.187
MINIMUM FOR CENTER:	x =	5.0,	y =	191.0,	r =	6.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	196.0,	r =	6.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	201.0,	r =	6.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	206.0,	r =	6.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	211.0,	r =	6.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	216.0,	r =	6.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	176.0,	r =	6.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	181.0,	r =	6.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	186.0,	r =	6.5,	FS =	3.107
MINIMUM FOR CENTER:	x =	10.0,	y =	191.0,	r =	12.1,	FS =	3.405
MINIMUM FOR CENTER:	x =	10.0,	y =	196.0,	r =	17.4,	FS =	3.654
MINIMUM FOR CENTER:	x =	10.0,	y =	201.0,	r =	21.6,	FS =	4.057
MINIMUM FOR CENTER:	x =	10.0,	y =	206.0,	r =	21.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	211.0,	r =	21.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	216.0,	r =	21.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	15.0,	y =	176.0,	r =	21.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	15.0,	y =	181.0,	r =	3.8,	FS =	1.875
MINIMUM FOR CENTER:	x =	15.0,	y =	186.0,	r =	8.3,	FS =	1.510
MINIMUM FOR CENTER:	x =	15.0,	y =	191.0,	r =	12.8,	FS =	1.650
MINIMUM FOR CENTER:	x =	15.0,	y =	196.0,	r =	17.5,	FS =	1.882
MINIMUM FOR CENTER:	x =	15.0,	y =	201.0,	r =	22.3,	FS =	2.133
MINIMUM FOR CENTER:	x =	15.0,	y =	206.0,	r =	27.1,	FS =	2.387
MINIMUM FOR CENTER:	x =	15.0,	y =	211.0,	r =	32.7,	FS =	2.627
MINIMUM FOR CENTER:	x =	15.0,	y =	216.0,	r =	37.3,	FS =	2.852
MINIMUM FOR CENTER:	x =	20.0,	y =	176.0,	r =	37.3,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	181.0,	r =	6.6,	FS =	1.342
MINIMUM FOR CENTER:	x =	20.0,	y =	186.0,	r =	10.5,	FS =	1.206 - low FS
MINIMUM FOR CENTER:	x =	20.0,	y =	191.0,	r =	15.0,	FS =	1.221 - low FS
MINIMUM FOR CENTER:	x =	20.0,	y =	196.0,	r =	19.4,	FS =	1.321
MINIMUM FOR CENTER:	x =	20.0,	y =	201.0,	r =	24.0,	FS =	1.459
MINIMUM FOR CENTER:	x =	20.0,	y =	206.0,	r =	28.6,	FS =	1.620
MINIMUM FOR CENTER:	x =	20.0,	y =	211.0,	r =	33.3,	FS =	1.790
MINIMUM FOR CENTER:	x =	20.0,	y =	216.0,	r =	38.1,	FS =	1.957
MINIMUM FOR CENTER:	x =	25.0,	y =	176.0,	r =	3.5,	FS =	6.947
MINIMUM FOR CENTER:	x =	25.0,	y =	181.0,	r =	3.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	186.0,	r =	3.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	191.0,	r =	3.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	196.0,	r =	21.7,	FS =	1.174 - low FS
MINIMUM FOR CENTER:	x =	25.0,	y =	201.0,	r =	26.1,	FS =	1.204 - low FS
MINIMUM FOR CENTER:	x =	25.0,	y =	206.0,	r =	30.6,	FS =	1.278 - low FS
MINIMUM FOR CENTER:	x =	25.0,	y =	211.0,	r =	35.1,	FS =	1.378
MINIMUM FOR CENTER:	x =	25.0,	y =	216.0,	r =	39.7,	FS =	1.491
OVERALL MINIMUM:	x =	25.0,	y =	196.0,	r =	21.7,	FS =	1.174 - low FS

Grid search; initial parameters:

	initial	final	increment
x	5.0	30.0	5.0
y	178.0	220.0	5.0

radius increment is 0.1

minimum perpendicular depth is 3.0

limit at elevation 170.0

MINIMUM FOR CENTER:	x =	5.0,	y =	178.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	183.0,	r =	5.1,	FS =	43.353
MINIMUM FOR CENTER:	x =	5.0,	y =	188.0,	r =	5.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	193.0,	r =	5.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	198.0,	r =	5.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	203.0,	r =	5.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	208.0,	r =	5.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	213.0,	r =	5.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	218.0,	r =	5.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	178.0,	r =	5.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	183.0,	r =	4.6,	FS =	3.606
MINIMUM FOR CENTER:	x =	10.0,	y =	188.0,	r =	9.5,	FS =	3.302
MINIMUM FOR CENTER:	x =	10.0,	y =	193.0,	r =	15.0,	FS =	3.495
MINIMUM FOR CENTER:	x =	10.0,	y =	198.0,	r =	15.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	203.0,	r =	15.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	208.0,	r =	15.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	213.0,	r =	15.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	218.0,	r =	15.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	15.0,	y =	178.0,	r =	15.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	15.0,	y =	183.0,	r =	6.6,	FS =	1.731
MINIMUM FOR CENTER:	x =	15.0,	y =	188.0,	r =	11.1,	FS =	1.692
MINIMUM FOR CENTER:	x =	15.0,	y =	193.0,	r =	15.7,	FS =	1.860
MINIMUM FOR CENTER:	x =	15.0,	y =	198.0,	r =	20.4,	FS =	2.072
MINIMUM FOR CENTER:	x =	15.0,	y =	203.0,	r =	25.2,	FS =	2.288
MINIMUM FOR CENTER:	x =	15.0,	y =	208.0,	r =	30.1,	FS =	2.502
MINIMUM FOR CENTER:	x =	15.0,	y =	213.0,	r =	30.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	15.0,	y =	218.0,	r =	30.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	178.0,	r =	30.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	183.0,	r =	8.8,	FS =	1.376
MINIMUM FOR CENTER:	x =	20.0,	y =	188.0,	r =	13.7,	FS =	1.267 - low FS
MINIMUM FOR CENTER:	x =	20.0,	y =	193.0,	r =	17.8,	FS =	1.364
MINIMUM FOR CENTER:	x =	20.0,	y =	198.0,	r =	22.2,	FS =	1.467
MINIMUM FOR CENTER:	x =	20.0,	y =	203.0,	r =	26.8,	FS =	1.596
MINIMUM FOR CENTER:	x =	20.0,	y =	208.0,	r =	31.5,	FS =	1.742
MINIMUM FOR CENTER:	x =	20.0,	y =	213.0,	r =	36.2,	FS =	1.894
MINIMUM FOR CENTER:	x =	20.0,	y =	218.0,	r =	41.0,	FS =	2.049
MINIMUM FOR CENTER:	x =	25.0,	y =	178.0,	r =	41.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	183.0,	r =	41.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	188.0,	r =	41.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	193.0,	r =	41.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	198.0,	r =	41.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	203.0,	r =	41.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	208.0,	r =	33.4,	FS =	1.412
MINIMUM FOR CENTER:	x =	25.0,	y =	213.0,	r =	38.0,	FS =	1.492
MINIMUM FOR CENTER:	x =	25.0,	y =	218.0,	r =	42.6,	FS =	1.596
MINIMUM FOR CENTER:	x =	30.0,	y =	178.0,	r =	42.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	183.0,	r =	42.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	188.0,	r =	42.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	193.0,	r =	42.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	198.0,	r =	42.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	203.0,	r =	42.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	208.0,	r =	42.6,	FS =	99.000

MINIMUM FOR CENTER: x = 30.0, y = 213.0, r = 43.6, FS = 99.000
MINIMUM FOR CENTER: x = 30.0, y = 218.0, r = 43.6, FS = 99.000
OVERALL MINIMUM: x = 20.0, y = 193.0, r = 18.8, FS = 1.425

APPENDIX B

QEW AND NETHERBY ROAD

BOREHOLE DATA SHEETS, SLOPE STABILTY ANALYSES

RECORD OF BOREHOLE No 201

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4 758 793; E 343 316 ORIGINATED BY O.B.
DIST CR HWY QEW/NETH BOREHOLE TYPE Continuous Flight Solid Stem Auger COMPILED BY O.B.
DATUM Geodetic DATE 98.08.12 - 98.08.12 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
							WATER CONTENT (%)							
							w p w w L							
							10 20 30							
181.7	Ground Surface													
0.0	Asphalt 18cm													
	Granular Fill 52cm													
181.0			1	SS	18									
0.7	Silty Clay, trace of gravel, trace to some rootlets, reddish brown with mottled brown layers, moist, stiff (Fill)		2	SS	11									
			3	SS	9									
			4	SS	11									
			5	SS	12									
			6	SS	8									
175.9			7	SS	15									
5.8	Original Topsoil													
	black, moist													
175.6			8	SS	15									
6.1	Silty Clay, trace to some fine rootlets above 7.0m, silt partings and sand lenses, varved, mottled brown to reddish brown, moist to very moist, very stiff to stiff													
			9	SS	29									
			10	SS	20									
			11	SS	20									
			12	SS	10									
	-coarse sand lens at 9.1m													
	-trace of gravel below 10.7m													
	-50mm wet sand seam at 10.8m		13	SS	13									
170.1														
11.6	SHALE BEDROCK													
169.8	-auger refusal at 11.9m		14	SS	50/ 0cm									
11.9	End of Borehole													
	Notes:													
	1) Water level at 11.6m depth on completion of drilling													
	2) Combustible vapour reading was 50 ppm at 1.2m depth in open borehole													

RECORD OF BOREHOLE No 202

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4758 800; E 343 330 ORIGINATED BY O.B.
 DIST CR HWY QEW/NETH BOREHOLE TYPE Manual Sampling COMPILED BY O.B.
 DATUM Geodetic DATE 98.08.13 - 98.08.13 CHECKED BY G.S.

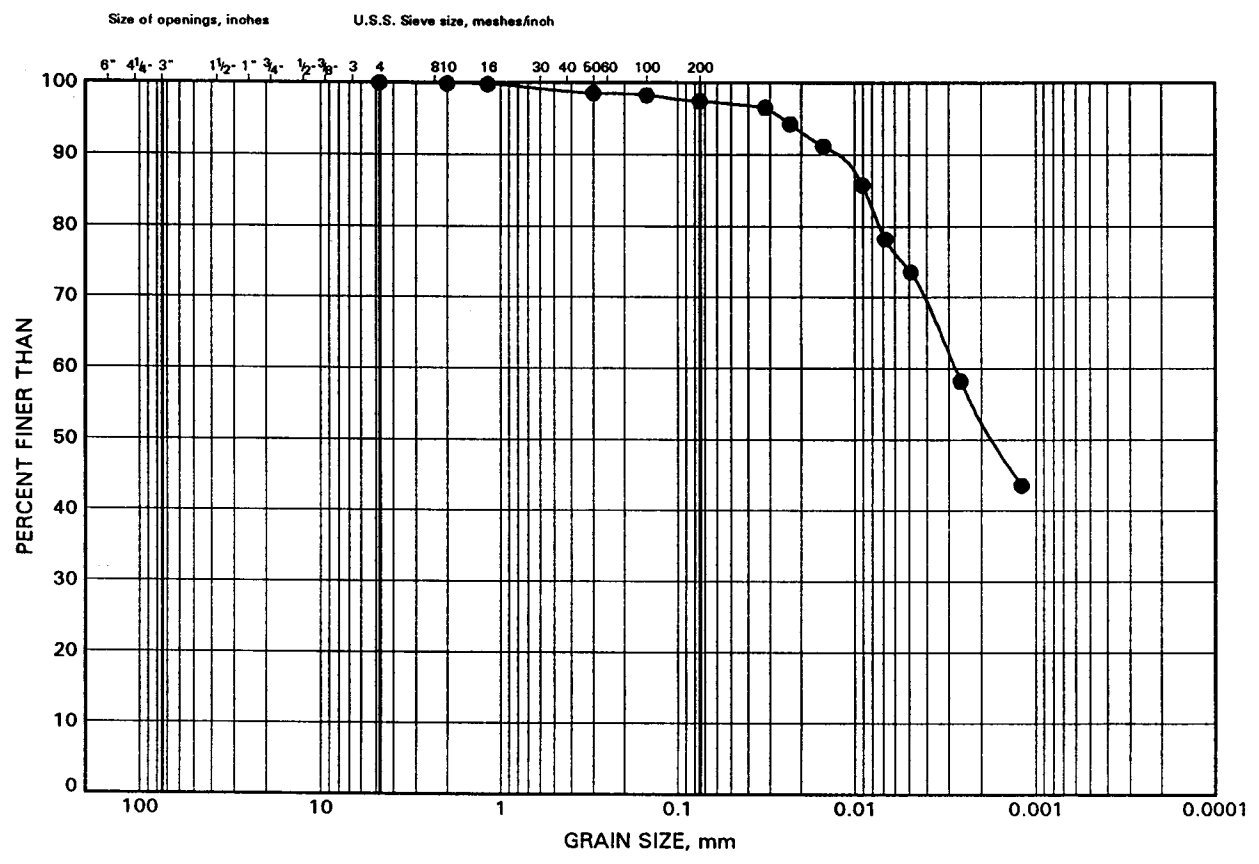
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%) 10 20 30 W P W W L				
176.4	Ground Surface																
0.0	Topsoil 15cm Silty Clay, trace of rootlets above 1.2m, silt partings below 1.2m, varved, reddish brown to brown, moist, firm to hard		1	SS	6		176										
			2	SS	15												
			3	SS	36		175										
			4	SS	52												
174.0	End of Borehole						174										
2.4	Notes: 1) Borehole remained dry on completion of drilling																

Table 2 - Summary Field Vane Test Results

Borehole No.	Depth (m)	Shear Strength (kPa)
201	11.4	> 194.8

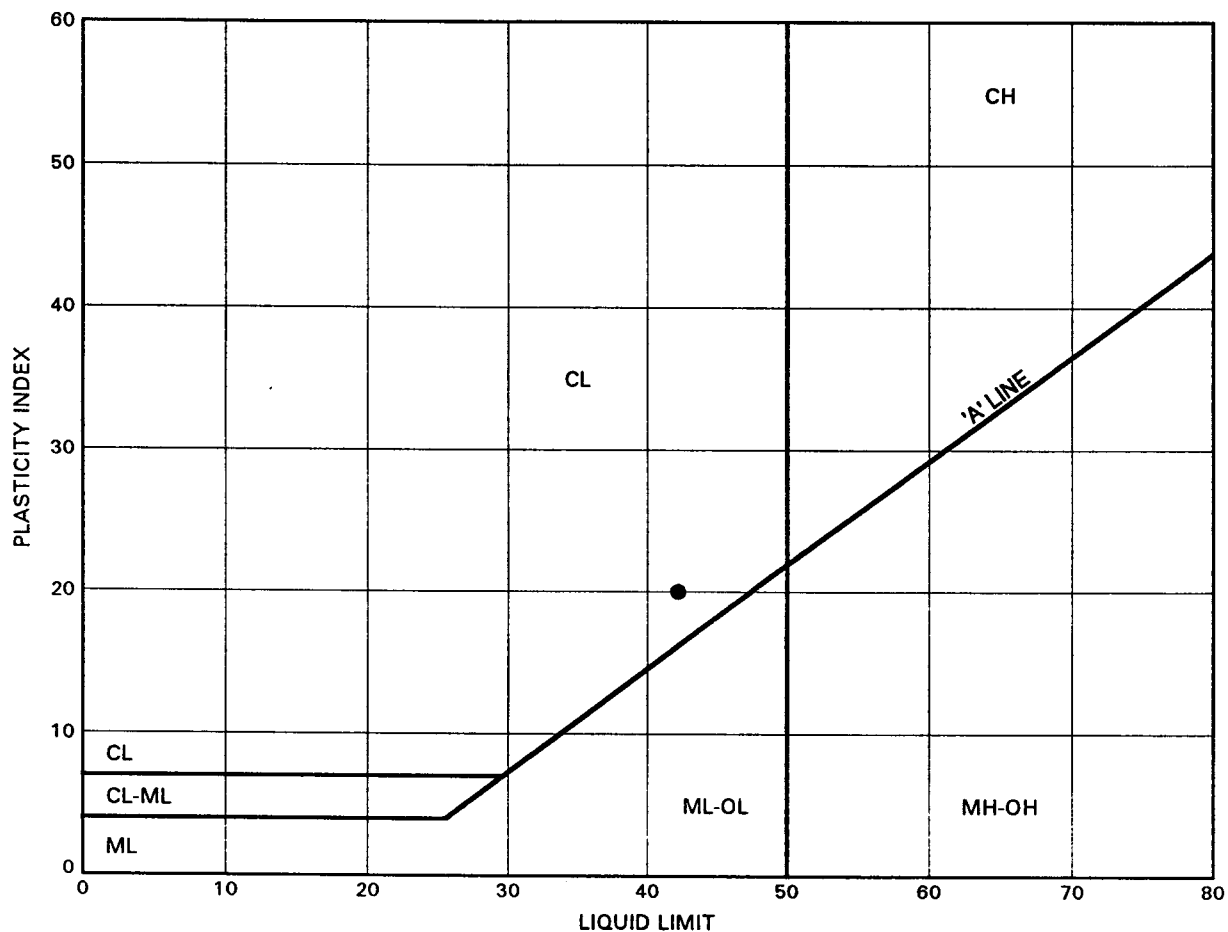
GRAIN SIZE DISTRIBUTION

FIGURE 5



ATTERBERG LIMITS TEST RESULTS

FIGURE 6



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	201	1.8	179.9

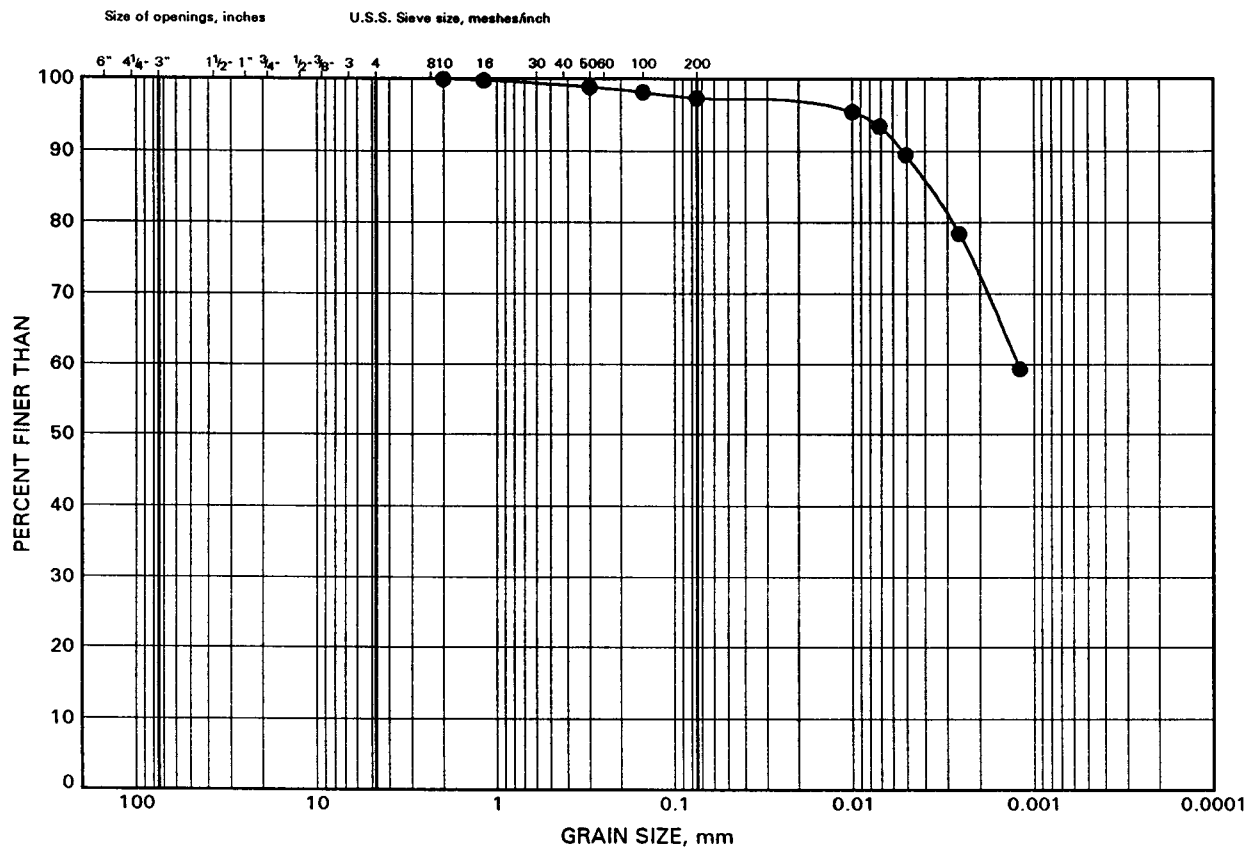
Date September 1998
Project 9820-7411-2791

**MC CLYMONT & RAK
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Prep'd O.B.
Chkd. G.S.

GRAIN SIZE DISTRIBUTION

FIGURE 7



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

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	201	7.8	173.9

Date August 1998

Project 9820-7411-2791

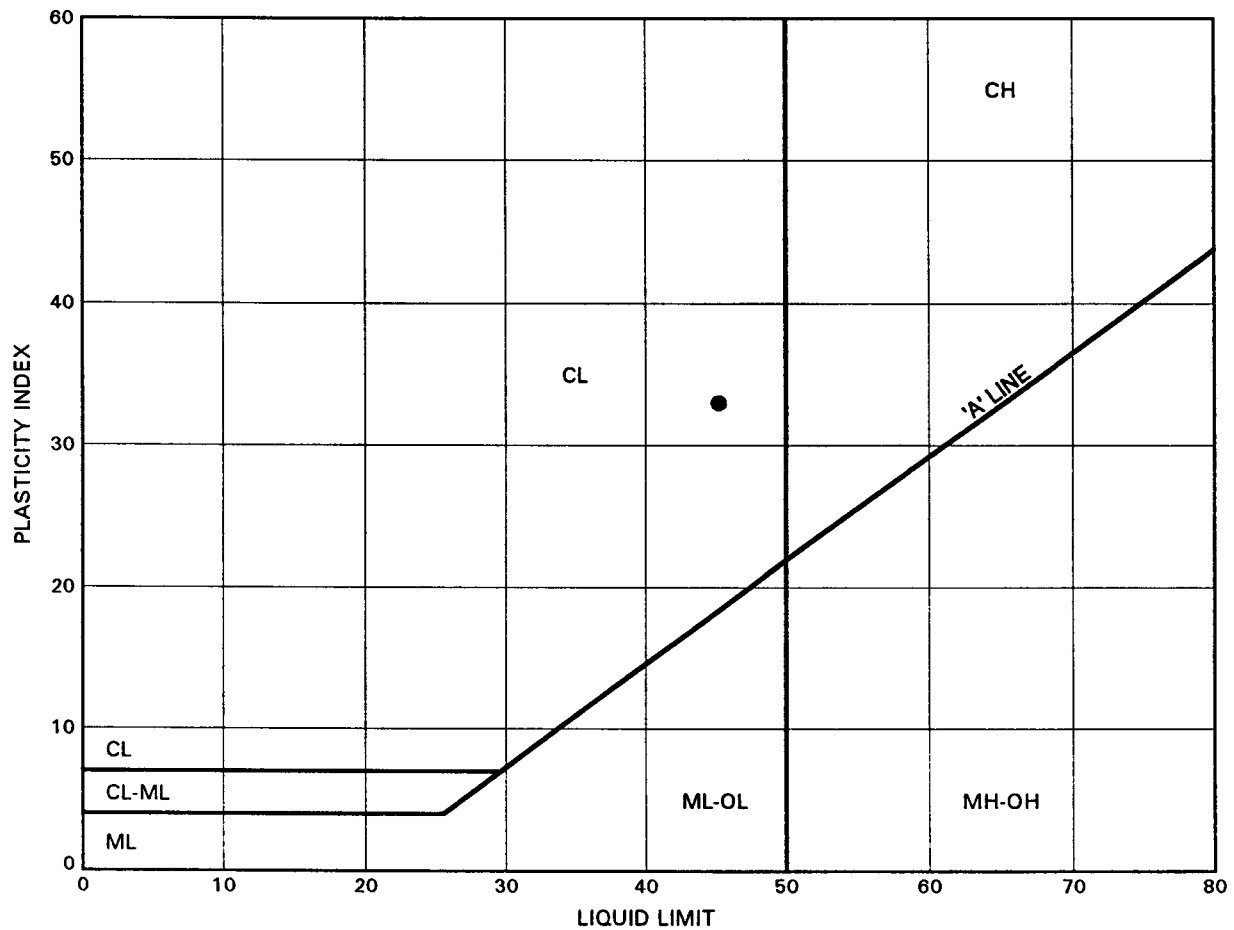
**MC CLYMONT & RAK
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Prep'd O.B.

Chkd. G.S.

ATTERBERG LIMITS TEST RESULTS

FIGURE 8



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
•	201	7.8	173.9

Date August 1998

Project 9820-7411-2791

MC CLYMONT & RAK
ENGINEERS, INC.

Prep'd O.B.

Chkd. G.S.

SB-SLOPE

Simplified Bishop Slope Stability Analysis

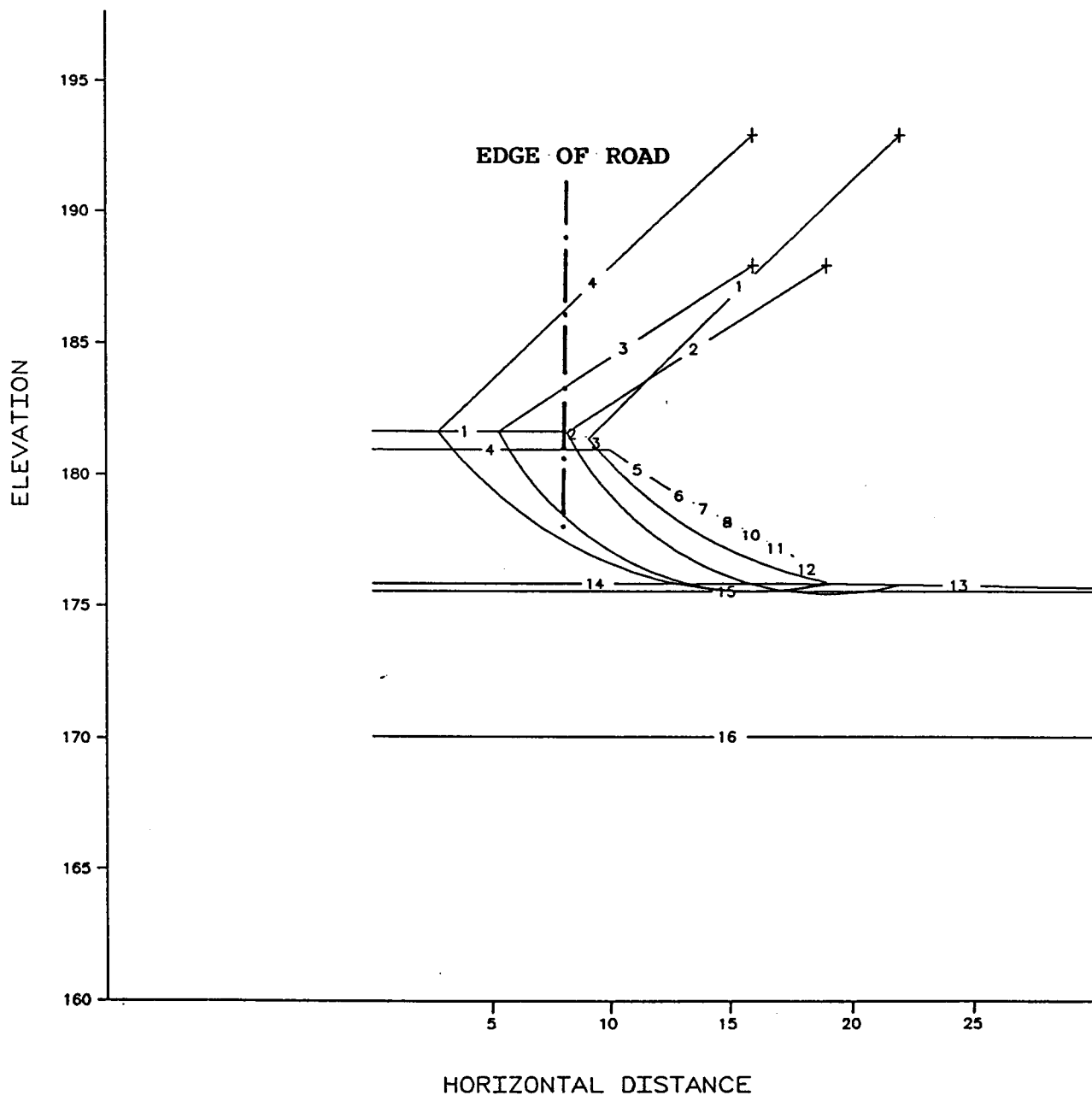
PROJECT: NETHERBY ROAD AND QEW RAMP EMBANKMENT

LOCATION: FORT ERIE, ONTARIO

FILE: NETHERB1

COMPLETE SLOPE CROSS SECTION

CIRCLE	X	Y	RADIUS	FS
1	22.0	193.0	17.3	1.05
2	19.0	188.0	12.5	1.17
3	16.0	188.0	12.4	1.31
4	16.0	193.0	17.4	1.52



Grid search; initial parameters:

	initial	final	increment
	4.0	24.0	3.0
y	178.0	220.0	5.0

radius increment is 0.1

minimum perpendicular depth is 1.0

limit at elevation 168.0

MINIMUM FOR CENTER:	x =	4.0,	y =	178.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	183.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	188.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	193.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	198.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	203.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	208.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	213.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	218.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	7.0,	y =	178.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	7.0,	y =	183.0,	r =	7.1,	FS =	6.917	
MINIMUM FOR CENTER:	x =	7.0,	y =	188.0,	r =	9.4,	FS =	5.788	
MINIMUM FOR CENTER:	x =	7.0,	y =	193.0,	r =	13.2,	FS =	6.679	
MINIMUM FOR CENTER:	x =	7.0,	y =	198.0,	r =	17.7,	FS =	7.889	
MINIMUM FOR CENTER:	x =	7.0,	y =	203.0,	r =	22.4,	FS =	9.362	
MINIMUM FOR CENTER:	x =	7.0,	y =	208.0,	r =	22.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	7.0,	y =	213.0,	r =	22.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	7.0,	y =	218.0,	r =	22.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	10.0,	y =	178.0,	r =	22.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	10.0,	y =	183.0,	r =	2.8,	FS =	1.815	
MINIMUM FOR CENTER:	x =	10.0,	y =	188.0,	r =	8.0,	FS =	2.513	
MINIMUM FOR CENTER:	x =	10.0,	y =	193.0,	r =	14.4,	FS =	2.934	
MINIMUM FOR CENTER:	x =	10.0,	y =	198.0,	r =	19.1,	FS =	3.262	
MINIMUM FOR CENTER:	x =	10.0,	y =	203.0,	r =	23.5,	FS =	3.730	
MINIMUM FOR CENTER:	x =	10.0,	y =	208.0,	r =	28.1,	FS =	4.283	
MINIMUM FOR CENTER:	x =	10.0,	y =	213.0,	r =	32.8,	FS =	4.918	
MINIMUM FOR CENTER:	x =	10.0,	y =	218.0,	r =	37.6,	FS =	5.592	
MINIMUM FOR CENTER:	x =	13.0,	y =	178.0,	r =	37.6,	FS =	99.000	
MINIMUM FOR CENTER:	x =	13.0,	y =	183.0,	r =	4.3,	FS =	1.200	- low FS
MINIMUM FOR CENTER:	x =	13.0,	y =	188.0,	r =	8.6,	FS =	1.329	
MINIMUM FOR CENTER:	x =	13.0,	y =	193.0,	r =	13.2,	FS =	1.734	
MINIMUM FOR CENTER:	x =	13.0,	y =	198.0,	r =	18.6,	FS =	2.133	
MINIMUM FOR CENTER:	x =	13.0,	y =	203.0,	r =	24.2,	FS =	2.451	
MINIMUM FOR CENTER:	x =	13.0,	y =	208.0,	r =	29.3,	FS =	2.719	
MINIMUM FOR CENTER:	x =	13.0,	y =	213.0,	r =	33.8,	FS =	3.024	
MINIMUM FOR CENTER:	x =	13.0,	y =	218.0,	r =	38.5,	FS =	3.339	
MINIMUM FOR CENTER:	x =	16.0,	y =	178.0,	r =	38.5,	FS =	99.000	
MINIMUM FOR CENTER:	x =	16.0,	y =	183.0,	r =	5.7,	FS =	1.238	- low FS
MINIMUM FOR CENTER:	x =	16.0,	y =	188.0,	r =	10.1,	FS =	1.111	- low FS
MINIMUM FOR CENTER:	x =	16.0,	y =	193.0,	r =	14.4,	FS =	1.235	- low FS
MINIMUM FOR CENTER:	x =	16.0,	y =	198.0,	r =	18.9,	FS =	1.478	
MINIMUM FOR CENTER:	x =	16.0,	y =	203.0,	r =	23.8,	FS =	1.765	
MINIMUM FOR CENTER:	x =	16.0,	y =	208.0,	r =	29.0,	FS =	2.030	
MINIMUM FOR CENTER:	x =	16.0,	y =	213.0,	r =	34.4,	FS =	2.266	
MINIMUM FOR CENTER:	x =	16.0,	y =	218.0,	r =	39.7,	FS =	2.475	
MINIMUM FOR CENTER:	x =	19.0,	y =	178.0,	r =	2.7,	FS =	1.607	
MINIMUM FOR CENTER:	x =	19.0,	y =	183.0,	r =	7.2,	FS =	1.115	- low FS
MINIMUM FOR CENTER:	x =	19.0,	y =	188.0,	r =	11.5,	FS =	1.106	- low FS
MINIMUM FOR CENTER:	x =	19.0,	y =	193.0,	r =	15.9,	FS =	1.105	- low FS
MINIMUM FOR CENTER:	x =	19.0,	y =	198.0,	r =	20.2,	FS =	1.194	- low FS
MINIMUM FOR CENTER:	x =	19.0,	y =	203.0,	r =	24.7,	FS =	1.360	
MINIMUM FOR CENTER:	x =	19.0,	y =	208.0,	r =	29.3,	FS =	1.569	

MINIMUM FOR CENTER: x = 19.0, y = 213.0, r = 34.3, FS = 1.780
MINIMUM FOR CENTER: x = 19.0, y = 218.0, r = 39.5, FS = 1.981
MINIMUM FOR CENTER: x = 22.0, y = 178.0, r = 6.4, FS = 8.851
MINIMUM FOR CENTER: x = 22.0, y = 183.0, r = 8.9, FS = 3.510
MINIMUM FOR CENTER: x = 22.0, y = 188.0, r = 12.9, FS = 1.860
MINIMUM FOR CENTER: x = 22.0, y = 193.0, r = 17.3, FS = 1.046 - low FS
MINIMUM FOR CENTER: x = 22.0, y = 198.0, r = 21.8, FS = 1.098 - low FS
MINIMUM FOR CENTER: x = 22.0, y = 203.0, r = 26.1, FS = 1.171 - low FS
MINIMUM FOR CENTER: x = 22.0, y = 208.0, r = 30.5, FS = 1.293 - low FS
MINIMUM FOR CENTER: x = 22.0, y = 213.0, r = 35.1, FS = 1.449
MINIMUM FOR CENTER: x = 22.0, y = 218.0, r = 39.9, FS = 1.621
OVERALL MINIMUM: x = 22.0, y = 193.0, r = 17.3, FS = 1.046 - low FS

grid search; initial parameters:

initial final increment

x 4.0 24.0 3.0

y 178.0 220.0 5.0

radius increment is 0.1

minimum perpendicular depth is 2.0

limit at elevation 168.0

MINIMUM FOR CENTER:	x =	4.0,	y =	178.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	183.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	188.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	193.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	198.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	203.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	208.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	213.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	4.0,	y =	218.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	7.0,	y =	178.0,	r =	0.0,	FS =	99.000	
MINIMUM FOR CENTER:	x =	7.0,	y =	183.0,	r =	7.1,	FS =	6.917	
MINIMUM FOR CENTER:	x =	7.0,	y =	188.0,	r =	9.4,	FS =	5.788	
MINIMUM FOR CENTER:	x =	7.0,	y =	193.0,	r =	9.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	7.0,	y =	198.0,	r =	9.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	7.0,	y =	203.0,	r =	9.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	7.0,	y =	208.0,	r =	9.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	7.0,	y =	213.0,	r =	9.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	7.0,	y =	218.0,	r =	9.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	10.0,	y =	178.0,	r =	9.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	10.0,	y =	183.0,	r =	3.8,	FS =	2.232	
MINIMUM FOR CENTER:	x =	10.0,	y =	188.0,	r =	8.6,	FS =	2.538	
MINIMUM FOR CENTER:	x =	10.0,	y =	193.0,	r =	14.4,	FS =	2.934	
MINIMUM FOR CENTER:	x =	10.0,	y =	198.0,	r =	19.1,	FS =	3.262	
MINIMUM FOR CENTER:	x =	10.0,	y =	203.0,	r =	23.5,	FS =	3.730	
MINIMUM FOR CENTER:	x =	10.0,	y =	208.0,	r =	23.5,	FS =	99.000	
MINIMUM FOR CENTER:	x =	10.0,	y =	213.0,	r =	23.5,	FS =	99.000	
MINIMUM FOR CENTER:	x =	10.0,	y =	218.0,	r =	23.5,	FS =	99.000	
MINIMUM FOR CENTER:	x =	13.0,	y =	178.0,	r =	23.5,	FS =	99.000	
MINIMUM FOR CENTER:	x =	13.0,	y =	183.0,	r =	5.3,	FS =	1.483	
MINIMUM FOR CENTER:	x =	13.0,	y =	188.0,	r =	9.6,	FS =	1.541	
MINIMUM FOR CENTER:	x =	13.0,	y =	193.0,	r =	14.2,	FS =	1.821	
MINIMUM FOR CENTER:	x =	13.0,	y =	198.0,	r =	19.0,	FS =	2.143	
MINIMUM FOR CENTER:	x =	13.0,	y =	203.0,	r =	24.2,	FS =	2.451	
MINIMUM FOR CENTER:	x =	13.0,	y =	208.0,	r =	29.3,	FS =	2.719	
MINIMUM FOR CENTER:	x =	13.0,	y =	213.0,	r =	33.8,	FS =	3.024	
MINIMUM FOR CENTER:	x =	13.0,	y =	218.0,	r =	33.8,	FS =	99.000	
MINIMUM FOR CENTER:	x =	16.0,	y =	178.0,	r =	33.8,	FS =	99.000	
MINIMUM FOR CENTER:	x =	16.0,	y =	183.0,	r =	7.4,	FS =	1.254	- low FS
MINIMUM FOR CENTER:	x =	16.0,	y =	188.0,	r =	11.1,	FS =	1.291	- low FS
MINIMUM FOR CENTER:	x =	16.0,	y =	193.0,	r =	15.4,	FS =	1.401	
MINIMUM FOR CENTER:	x =	16.0,	y =	198.0,	r =	19.9,	FS =	1.586	
MINIMUM FOR CENTER:	x =	16.0,	y =	203.0,	r =	24.6,	FS =	1.807	
MINIMUM FOR CENTER:	x =	16.0,	y =	208.0,	r =	29.4,	FS =	2.037	
MINIMUM FOR CENTER:	x =	16.0,	y =	213.0,	r =	34.4,	FS =	2.266	
MINIMUM FOR CENTER:	x =	16.0,	y =	218.0,	r =	39.7,	FS =	2.475	
MINIMUM FOR CENTER:	x =	19.0,	y =	178.0,	r =	39.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	19.0,	y =	183.0,	r =	8.0,	FS =	1.498	
MINIMUM FOR CENTER:	x =	19.0,	y =	188.0,	r =	12.5,	FS =	1.166	- low FS
MINIMUM FOR CENTER:	x =	19.0,	y =	193.0,	r =	16.9,	FS =	1.225	- low FS
MINIMUM FOR CENTER:	x =	19.0,	y =	198.0,	r =	21.2,	FS =	1.332	
MINIMUM FOR CENTER:	x =	19.0,	y =	203.0,	r =	25.7,	FS =	1.468	
MINIMUM FOR CENTER:	x =	19.0,	y =	208.0,	r =	30.3,	FS =	1.629	

MINIMUM FOR CENTER: x = 19.0, y = 213.0, r = 35.0, FS = 1.805
MINIMUM FOR CENTER: x = 19.0, y = 218.0, r = 39.8, FS = 1.986
MINIMUM FOR CENTER: x = 22.0, y = 178.0, r = 6.4, FS = 8.851
MINIMUM FOR CENTER: x = 22.0, y = 183.0, r = 9.5, FS = 3.549
MINIMUM FOR CENTER: x = 22.0, y = 188.0, r = 13.9, FS = 2.212
MINIMUM FOR CENTER: x = 22.0, y = 193.0, r = 18.3, FS = 1.644
MINIMUM FOR CENTER: x = 22.0, y = 198.0, r = 22.8, FS = 1.389
MINIMUM FOR CENTER: x = 22.0, y = 203.0, r = 27.1, FS = 1.278 - low FS
MINIMUM FOR CENTER: x = 22.0, y = 208.0, r = 31.5, FS = 1.395
MINIMUM FOR CENTER: x = 22.0, y = 213.0, r = 36.1, FS = 1.521
MINIMUM FOR CENTER: x = 22.0, y = 218.0, r = 40.7, FS = 1.659
OVERALL MINIMUM: x = 19.0, y = 188.0, r = 12.5, FS = 1.166 - low FS

MINIMUM FOR CENTER: x = 19.0, y = 213.0, r = 32.3, FS = 99.000
MINIMUM FOR CENTER: x = 19.0, y = 218.0, r = 32.3, FS = 99.000
MINIMUM FOR CENTER: x = 22.0, y = 178.0, r = 6.4, FS = 8.851
MINIMUM FOR CENTER: x = 22.0, y = 183.0, r = 6.4, FS = 99.000
MINIMUM FOR CENTER: x = 22.0, y = 188.0, r = 6.4, FS = 99.000
MINIMUM FOR CENTER: x = 22.0, y = 193.0, r = 6.4, FS = 99.000
MINIMUM FOR CENTER: x = 22.0, y = 198.0, r = 6.4, FS = 99.000
MINIMUM FOR CENTER: x = 22.0, y = 203.0, r = 6.4, FS = 99.000
MINIMUM FOR CENTER: x = 22.0, y = 208.0, r = 6.4, FS = 99.000
MINIMUM FOR CENTER: x = 22.0, y = 213.0, r = 38.1, FS = 1.884
MINIMUM FOR CENTER: x = 22.0, y = 218.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 25.0, y = 178.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 25.0, y = 183.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 25.0, y = 188.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 25.0, y = 193.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 25.0, y = 198.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 25.0, y = 203.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 25.0, y = 208.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 25.0, y = 213.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 25.0, y = 218.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 28.0, y = 178.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 28.0, y = 183.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 28.0, y = 188.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 28.0, y = 193.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 28.0, y = 198.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 28.0, y = 203.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 28.0, y = 208.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 28.0, y = 213.0, r = 38.1, FS = 99.000
MINIMUM FOR CENTER: x = 28.0, y = 218.0, r = 38.1, FS = 99.000
OVERALL MINIMUM: x = 16.0, y = 193.0, r = 17.4, FS = 1.520

Grid search; initial parameters:

	initial	final	increment
x	4.0	24.0	3.0
y	178.0	220.0	5.0

radius increment is 0.1

minimum perpendicular depth is 3.0

limit at elevation 168.0

MINIMUM FOR CENTER: x =	4.0,	y =	178.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER: x =	4.0,	y =	183.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER: x =	4.0,	y =	188.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER: x =	4.0,	y =	193.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER: x =	4.0,	y =	198.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER: x =	4.0,	y =	203.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER: x =	4.0,	y =	208.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER: x =	4.0,	y =	213.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER: x =	4.0,	y =	218.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER: x =	7.0,	y =	178.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER: x =	7.0,	y =	183.0,	r =	7.1,	FS =	6.917
MINIMUM FOR CENTER: x =	7.0,	y =	188.0,	r =	9.4,	FS =	5.788
MINIMUM FOR CENTER: x =	7.0,	y =	193.0,	r =	9.4,	FS =	99.000
MINIMUM FOR CENTER: x =	7.0,	y =	198.0,	r =	9.4,	FS =	99.000
MINIMUM FOR CENTER: x =	7.0,	y =	203.0,	r =	9.4,	FS =	99.000
MINIMUM FOR CENTER: x =	7.0,	y =	208.0,	r =	9.4,	FS =	99.000
MINIMUM FOR CENTER: x =	7.0,	y =	213.0,	r =	9.4,	FS =	99.000
MINIMUM FOR CENTER: x =	7.0,	y =	218.0,	r =	9.4,	FS =	99.000
MINIMUM FOR CENTER: x =	10.0,	y =	178.0,	r =	9.4,	FS =	99.000
MINIMUM FOR CENTER: x =	10.0,	y =	183.0,	r =	4.8,	FS =	2.571
MINIMUM FOR CENTER: x =	10.0,	y =	188.0,	r =	9.6,	FS =	2.637
MINIMUM FOR CENTER: x =	10.0,	y =	193.0,	r =	14.5,	FS =	2.934
MINIMUM FOR CENTER: x =	10.0,	y =	198.0,	r =	14.5,	FS =	99.000
MINIMUM FOR CENTER: x =	10.0,	y =	203.0,	r =	14.5,	FS =	99.000
MINIMUM FOR CENTER: x =	10.0,	y =	208.0,	r =	14.5,	FS =	99.000
MINIMUM FOR CENTER: x =	10.0,	y =	213.0,	r =	14.5,	FS =	99.000
MINIMUM FOR CENTER: x =	10.0,	y =	218.0,	r =	14.5,	FS =	99.000
MINIMUM FOR CENTER: x =	13.0,	y =	178.0,	r =	14.5,	FS =	99.000
MINIMUM FOR CENTER: x =	13.0,	y =	183.0,	r =	6.3,	FS =	1.742
MINIMUM FOR CENTER: x =	13.0,	y =	188.0,	r =	10.6,	FS =	1.741
MINIMUM FOR CENTER: x =	13.0,	y =	193.0,	r =	15.2,	FS =	1.952
MINIMUM FOR CENTER: x =	13.0,	y =	198.0,	r =	20.0,	FS =	2.208
MINIMUM FOR CENTER: x =	13.0,	y =	203.0,	r =	24.9,	FS =	2.461
MINIMUM FOR CENTER: x =	13.0,	y =	208.0,	r =	24.9,	FS =	99.000
MINIMUM FOR CENTER: x =	13.0,	y =	213.0,	r =	24.9,	FS =	99.000
MINIMUM FOR CENTER: x =	13.0,	y =	218.0,	r =	24.9,	FS =	99.000
MINIMUM FOR CENTER: x =	16.0,	y =	178.0,	r =	24.9,	FS =	99.000
MINIMUM FOR CENTER: x =	16.0,	y =	183.0,	r =	7.7,	FS =	1.427
MINIMUM FOR CENTER: x =	16.0,	y =	188.0,	r =	12.4,	FS =	1.305
MINIMUM FOR CENTER: x =	16.0,	y =	193.0,	r =	17.3,	FS =	1.495
MINIMUM FOR CENTER: x =	16.0,	y =	198.0,	r =	22.3,	FS =	1.675
MINIMUM FOR CENTER: x =	16.0,	y =	203.0,	r =	25.6,	FS =	1.889
MINIMUM FOR CENTER: x =	16.0,	y =	208.0,	r =	30.4,	FS =	2.086
MINIMUM FOR CENTER: x =	16.0,	y =	213.0,	r =	30.4,	FS =	99.000
MINIMUM FOR CENTER: x =	16.0,	y =	218.0,	r =	30.4,	FS =	99.000
MINIMUM FOR CENTER: x =	19.0,	y =	178.0,	r =	30.4,	FS =	99.000
MINIMUM FOR CENTER: x =	19.0,	y =	183.0,	r =	9.0,	FS =	1.907
MINIMUM FOR CENTER: x =	19.0,	y =	188.0,	r =	13.5,	FS =	1.520
MINIMUM FOR CENTER: x =	19.0,	y =	193.0,	r =	17.9,	FS =	1.417
MINIMUM FOR CENTER: x =	19.0,	y =	198.0,	r =	22.3,	FS =	1.397
MINIMUM FOR CENTER: x =	19.0,	y =	203.0,	r =	26.7,	FS =	1.564
MINIMUM FOR CENTER: x =	19.0,	y =	208.0,	r =	31.3,	FS =	1.712

MINIMUM FOR CENTER: x = 19.0, y = 213.0, r = 36.0, FS = 1.867
MINIMUM FOR CENTER: x = 19.0, y = 218.0, r = 40.8, FS = 2.024
MINIMUM FOR CENTER: x = 22.0, y = 178.0, r = 6.4, FS = 8.851
MINIMUM FOR CENTER: x = 22.0, y = 183.0, r = 10.5, FS = 3.702
MINIMUM FOR CENTER: x = 22.0, y = 188.0, r = 10.5, FS = 99.000
MINIMUM FOR CENTER: x = 22.0, y = 193.0, r = 10.5, FS = 99.000
MINIMUM FOR CENTER: x = 22.0, y = 198.0, r = 10.5, FS = 99.000
MINIMUM FOR CENTER: x = 22.0, y = 203.0, r = 28.1, FS = 1.631
MINIMUM FOR CENTER: x = 22.0, y = 208.0, r = 32.5, FS = 1.542
MINIMUM FOR CENTER: x = 22.0, y = 213.0, r = 37.1, FS = 1.589
MINIMUM FOR CENTER: x = 22.0, y = 218.0, r = 41.7, FS = 1.720
OVERALL MINIMUM: x = 16.0, y = 188.0, r = 12.4, FS = 1.305

Grid search; initial parameters:

initial final increment

x 4.0 30.0 3.0

y 178.0 220.0 5.0

radius increment is 0.1

minimum perpendicular depth is 4.0

limit at elevation 168.0

MINIMUM FOR CENTER:	x =	4.0,	y =	178.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	4.0,	y =	183.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	4.0,	y =	188.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	4.0,	y =	193.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	4.0,	y =	198.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	4.0,	y =	203.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	4.0,	y =	208.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	4.0,	y =	213.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	4.0,	y =	218.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	7.0,	y =	178.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	7.0,	y =	183.0,	r =	7.1,	FS =	6.917
MINIMUM FOR CENTER:	x =	7.0,	y =	188.0,	r =	7.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	7.0,	y =	193.0,	r =	7.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	7.0,	y =	198.0,	r =	7.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	7.0,	y =	203.0,	r =	7.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	7.0,	y =	208.0,	r =	7.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	7.0,	y =	213.0,	r =	7.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	7.0,	y =	218.0,	r =	7.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	178.0,	r =	7.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	183.0,	r =	7.4,	FS =	2.827
MINIMUM FOR CENTER:	x =	10.0,	y =	188.0,	r =	10.6,	FS =	2.768
MINIMUM FOR CENTER:	x =	10.0,	y =	193.0,	r =	10.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	198.0,	r =	10.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	203.0,	r =	10.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	208.0,	r =	10.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	213.0,	r =	10.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	218.0,	r =	10.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	13.0,	y =	178.0,	r =	10.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	13.0,	y =	183.0,	r =	7.4,	FS =	1.752
MINIMUM FOR CENTER:	x =	13.0,	y =	188.0,	r =	12.4,	FS =	1.804
MINIMUM FOR CENTER:	x =	13.0,	y =	193.0,	r =	17.2,	FS =	2.045
MINIMUM FOR CENTER:	x =	13.0,	y =	198.0,	r =	17.2,	FS =	99.000
MINIMUM FOR CENTER:	x =	13.0,	y =	203.0,	r =	17.2,	FS =	99.000
MINIMUM FOR CENTER:	x =	13.0,	y =	208.0,	r =	17.2,	FS =	99.000
MINIMUM FOR CENTER:	x =	13.0,	y =	213.0,	r =	17.2,	FS =	99.000
MINIMUM FOR CENTER:	x =	13.0,	y =	218.0,	r =	17.2,	FS =	99.000
MINIMUM FOR CENTER:	x =	16.0,	y =	178.0,	r =	17.2,	FS =	99.000
MINIMUM FOR CENTER:	x =	16.0,	y =	183.0,	r =	8.7,	FS =	1.656
MINIMUM FOR CENTER:	x =	16.0,	y =	188.0,	r =	13.1,	FS =	1.547
MINIMUM FOR CENTER:	x =	16.0,	y =	193.0,	r =	17.4,	FS =	1.520
MINIMUM FOR CENTER:	x =	16.0,	y =	198.0,	r =	22.3,	FS =	1.675
MINIMUM FOR CENTER:	x =	16.0,	y =	203.0,	r =	26.6,	FS =	1.966
MINIMUM FOR CENTER:	x =	16.0,	y =	208.0,	r =	26.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	16.0,	y =	213.0,	r =	26.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	16.0,	y =	218.0,	r =	26.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	19.0,	y =	178.0,	r =	26.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	19.0,	y =	183.0,	r =	10.0,	FS =	2.242
MINIMUM FOR CENTER:	x =	19.0,	y =	188.0,	r =	14.5,	FS =	1.849
MINIMUM FOR CENTER:	x =	19.0,	y =	193.0,	r =	18.9,	FS =	1.747
MINIMUM FOR CENTER:	x =	19.0,	y =	198.0,	r =	23.2,	FS =	1.671
MINIMUM FOR CENTER:	x =	19.0,	y =	203.0,	r =	27.7,	FS =	1.663
MINIMUM FOR CENTER:	x =	19.0,	y =	208.0,	r =	32.3,	FS =	1.722

APPENDIX C

HIGHWAY 406 AND FOURTH AVENUE

BOREHOLE DATA SHEETS, SLOPE STABILTY ANALYSES

RECORD OF BOREHOLE No 301

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4,779,218; E 324,927 ORIGINATED BY O.B.
 DIST CR HWY 406 BOREHOLE TYPE Manual Sampling COMPILED BY O.B.
 DATUM Geodetic DATE 98.08.12 - 98.08.12 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
86.5	Ground Surface																
0.0	Topsoil 10cm Granular Fill 230cm		1	SS	12		86										
			2	SS	15												
			3	SS	31		85										
84.1			4	SS	8												
2.4	Silty Clay, trace of sand, trace of gravel, grey with reddish brown layers, moist, firm to hard (Glacial Till)		5	SS	7		84										
			6	SS	33												
82.8	-5cm gravelly sand layer over 5cm silty sand layer at 3.4m						83										
3.7	Sandy Silt, trace of clay, trace of gravel, reddish brown to grey, moist, compact (Glacial Till)		7	SS	20												
			8	SS	23		82										
81.6																	
4.9	End of Borehole Notes: 1) Water level at 2.3m depth on completion of drilling 2) Combustible vapour reading was 30 ppm at 4.0m depth in open borehole																

RECORD OF BOREHOLE No 302

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4,779,176; E 324,982 ORIGINATED BY O.B.
DIST CR HWY 406 BOREHOLE TYPE Manual Sampling COMPILED BY O.B.
DATUM Geodetic DATE 98.08.12 - 98.08.12 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
85.5	Ground Surface																
0.0	Topsoil 10cm Granular Fill 110cm		1	SS	13		85										
84.3			2	SS	23												
1.2	Silt with silty sand seams, dilatant, brown, wet, compact		3	SS	10		84										
83.8																	
1.7	Silty Clay, trace of sand, trace of gravel, grey, moist, stiff to very stiff (Glacial Till)		4	SS	12												
			5	SS	22		83										
82.5																	
3.0	End of Borehole Notes: 1) Borehole remained dry on completion of drilling 2) Combustible vapour reading was 50 ppm at 3.0m depth in open borehole																

RECORD OF BOREHOLE No 303

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4,779,142; E 325,074 ORIGINATED BY O.B.
 DIST CR HWY 406 BOREHOLE TYPE Manual Sampling COMPILED BY O.B.
 DATUM Geodetic DATE 98.08.13 - 98.08.13 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
85.5	Ground Surface																
0.0	Topsoil 10cm Silty Clay, trace of gravel, trace of rootlets, trace to some topsoil, black asphalt fragments and trace of coal at 2.6m, brown to dark brown, grey below 2.4m, moist, stiff (Fill)		1	SS	10												
			2	SS	7												
			3	SS	5												
			4	SS	9												
82.9			5	SS	20/												
2.6	refusal due to subsurface obstruction at 2.6m End of Borehole Notes: 1) Water level at 2.1m depth on completion of drilling																

RECORD OF BOREHOLE No 303A

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4,779,142; E 325,071 ORIGINATED BY O.B.
DIST CR HWY 406 BOREHOLE TYPE Manual Sampling COMPILED BY O.B.
DATUM Geodetic DATE 98.08.13 - 98.08.13 CHECKED BY G.S.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
						20 40 60 80 100					10 20 30					
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
85.0	Ground Surface															
0.0	Topsoil 15cm		1	SS	10											
	Silty Clay, trace of gravel, trace of rootlets, trace to some topsoil, trace of brick, coal and wood, black asphalt- like material at 2.4m, brown to dark brown, moist, stiff (Fill)		2	SS	6											
			3	SS	6											
			4	SS	11											
82.4	refusal due to subsurface obstruction at 2.4m															
2.6	End of Borehole															
	Notes: 1) Water level at 1.8m depth on completion of drilling															

RECORD OF BOREHOLE No 304

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4,779,205; E 324,956 ORIGINATED BY Z.X.
 DIST CR HWY 406 BOREHOLE TYPE Manual Sampling COMPILED BY O.B.
 DATUM Geodetic DATE 98.08.13 - 98.08.13 CHECKED BY G.S.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
90.7	Ground Surface															
0.0	Topsoil 40cm		1	SS	12											
	Silty Clay, trace of gravel, trace of rootlets, dark brown to brown, moist, stiff (Fill)		2	SS	15	90										
89.2			3	SS	8											
1.5	Silty Clay, silt seams and layers, varved, brown to reddish brown, moist, stiff		4	SS	9	89										
			5	SS	12	88										
87.7																
3.0	End of Borehole Notes: 1) Borehole remained dry on completion of drilling															

RECORD OF BOREHOLE No 305

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4,779,158; E 325,039 ORIGINATED BY O.B.
 DIST CR HWY 406 BOREHOLE TYPE Manual Sampling COMPILED BY O.B.
 DATUM Geodetic DATE 98.08.13 - 98.08.13 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _P	W	W _L		
88.5	Ground Surface																
0.0	Topsail 25cm Silty Clay, trace of gravel, trace of rootlets, some to with topsoil, trace of brick, dark brown to greyish brown, moist, firm to soft (Fill)		1	SS	7		88										
			2	SS	4												
86.8			3	SS	5		87										
1.7	Silty Clay, trace of fine rootlets above 2.4m, silt seams below 2.4m, varved, mottled brown to brown, moist, firm to very stiff		4	SS	13												
			5	SS	19		86										
85.5																	
3.0	End of Borehole Notes: 1) Borehole remained dry on completion of drilling																

RECORD OF BOREHOLE No 306

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4,779,237; E 324,937 ORIGINATED BY O.B./Z.X.
DIST CR HWY 406 BOREHOLE TYPE Continuous Flight Solid Stem Auger COMPILED BY O.B.
DATUM Geodetic DATE 98.08.20 - 98.08.21 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
93.8	Ground Surface							20	40	60	80	100					
0.0	Granular Fill 15cm Silty Clay, trace of gravel, trace of rootlets, trace to some topsoil, trace of brick in upper 1.5m, dark brown to brown, moist, stiff (Fill)		1	SS	26												
			2	SS	13												
			3	SS	6												
			4	SS	6												
			5	SS	9												
89.8							92										
4.0	Silty Clay, with silt seams and layers, varved, brown, grey below 6.4m, moist to very moist, stiff to firm -trace of gravel below 6.1m		6	SS	12												
			7	SS	9												
			8	SS	6												
85.2							86										
8.6	Silty Clay, trace of sand, trace of gravel, reddish grey to grey, moist, stiff to very stiff (Glacial Till)		9	SS	13												
			10	SS	25												
82.1																	
11.7	Sandy Silt, trace of clay, trace of gravel, reddish brown to reddish grey, moist, dense (Glacial Till)		11	SS	30												
80.1																	
13.7	Sandy Silt to Silty Sand, reddish brown to reddish grey, wet to saturated, very dense to compact		12	SS	64												
77.8	-30cm saturated silty sand layer at 15.2m		13	SS	27												
16.0	Sandy silt with weathered shale, red with wet grey shale layers, moist to dry, wet seam at 16.8m, hard (Till/Shale Complex) -trace of clay at 19.8m		14	SS	75/ 7.5cm												
			15	SS	125/ 15cm												
			16	SS	132/ 15cm												
			17	SS	185/ 15cm												
			18	SS	165/ 7.5cm												
69.4																	
24.4	Weathered Shale, red with grey layers, dry, hard (Weathered Shale Bedrock)		19	SS	60/ 15cm												
68.8																	
25.0																	
	End of Borehole																
	Notes:																
	1) Water level at 11.3m depth on completion of drilling																

1 OF 1

METRIC**LOCATION**

Co-ords: N 4.779.212: E 324.981

ORIGINATED BY Z.X.

DIST CR

HWY 406

BOREHOLE TYPE

Continuous Flight Solid Stem Auger

COMPILED BY O.B.

DATUM Geodetic

DATE _____

98.08.22 - 98.08.22

CHECKED BY G.S.

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

RECORD OF BOREHOLE No 308

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4,779,189; E 325,003 ORIGINATED BY Z.X.
DIST CR HWY 406 BOREHOLE TYPE Continuous Flight Solid Stem Auger COMPILED BY O.B.
DATUM Geodetic DATE 98.08.23 - 98.08.23 CHECKED BY G.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	10 20 30		
94.8	Ground Surface											
0.0	Topsoil 15cm		1	SS	26		94					
	Silty Clay, trace of gravel, trace of rootlets, trace of brick at 1.5m, dark brown to brown, moist, very stiff (Fill)		2	SS	18							
92.5			3	SS	24							
2.3	Silty Clay, silt seams and layers, trace of gravel, varved, brown, moist to very moist, very stiff to stiff		4	SS	18		92					
			5	SS	17							
			6	SS	14		90					
			7	SS	13		88					
86.9			8	SS	11						20.1	
7.9	Silty Clay, trace of sand, trace of gravel, grey with reddish grey seams, saturated to moist, stiff (Glacial Till)		9	SS	6		86					
			10	SS	8		84					
			11	SS	12		82					
	-7.5cm coarse sand layer at 13.7m		12	SS	15		80					
80.1	Sandy Silt, trace of clay, silty sand layers, trace of gravel, reddish brown to reddish grey, wet to very moist, compact (Glacial Till)		13	SS	18		78				20.3	3 32 57 9
14.7			14	SS	22							
77.0	-5cm gravelly sand layer at 15.5m		15	SS	50/ 13cm		76					
17.8	Sandy Silt to Silty Sand, with silty clay layers below 19.8m grey, saturated, very dense		16	SS	50/ 13cm		74					
75.7												
19.1	Sandy silt with weathered shale, trace of gravel and limestone, red with wet grey shale layers, moist to dry, hard (Till/Shale Complex)											
73.5												
21.3	Weathered Shale, with limestone layers, red with grey layers, dry, hard (Weathered Shale Bedrock)											
73.2												
21.6	End of Borehole Notes: 1) Water level at 9.4m depth on completion of drilling											

RECORD OF BOREHOLE No 309

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4,779,170; E 325,040 ORIGINATED BY Z.X.
 DIST CR HWY 406 BOREHOLE TYPE Continuous Flight Solid Stem Auger COMPILED BY O.B.
 DATUM Geodetic DATE 98.08.24 - 98.08.24 CHECKED BY G.S.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
93.4	Ground Surface												
0.0	Topsoil 23cm		1	SS	12								
	Silty Clay, trace of gravel, trace of rootlets, asphalt and brick pieces between 0.8 and 2.0m, trace of topsoil at 2.3m, brown to dark brown with black seams, moist, stiff (Fill)		2	SS	15								
			3	SS	10								
			4	SS	13								
			5	SS	8								
88.8													
4.6	Silty Clay with silt seams and layers, varved, brown to reddish brown, grey below 9.1m, moist, very moist to saturated below 9.1m, stiff to firm		6	SS	11								
			7	SS	11								
			8	SS	10								
			9	SS	7								
83.3													
10.1	Silty Clay, trace of sand, silt seams, trace of gravel, reddish grey to grey, moist to very moist, very moist to saturated below 13.7m, stiff to firm (Glacial Till) -2.5cm gravel layer at 11.0m		10	SS	11								
			11	SS	16								
			12	SS	7								
78.7													
14.7	Sandy Silt, trace of clay, silty sand layers below 18.2m, trace of gravel, reddish brown, moist to wet, very dense (Glacial Till)		13	SS	50/ 13cm								
			14	SS	50/ 13cm								
			15	SS	100								
74.1													
19.3	Sandy Silt to Silty Sand, some clay, reddish brown to reddish grey, wet, dense		16	SS	49								
71.9													
21.5	Sandy silt with weathered shale, trace of gravel and limestone, red with wet grey shale layers, moist to dry, hard (Till/Shale Complex)		17	SS	100								
			18	SS	50/ 13cm								
			19	SS	100								
67.5													
25.9	Weathered Shale, with limestone layers, red with grey layers, dry, hard (Weathered Shale Bedrock)		20	SS	50/ 0cm								
66.0													
27.4	End of Borehole Notes: 1) Water level at 8.8m depth on completion of drilling		21	SS	50/ 0cm								

GEOSYSTEM SLOPE STABILITY PROGRAM
SB-SLOPE

PROJECT DATA:

Project: HWY 406 EMBANKMENT, SOUTH OF FOURTH AVENUE

Location: ST. CATHERINE, ONTARIO

Filename: 406-2 Description: HWY 406 AND FOURTH AVENUE EMBANKMENT C-C MTO

ANALYSIS DATA:

Point Coordinates			Line Left Right Soil			Soil Density Cohesion Phi			
No.	X	Y	No.	Point	Point	No.	kN/cu.m	kPa	Deg
1	0.0	103.0	1	1	2	1	20.0	0.0	28.0
2	7.0	102.5	2	2	3	1	21.0	20.0	30.0
3	11.5	102.0	3	3	4	1	22.0	0.0	35.0
4	12.5	101.5	4	4	5	2	22.0	0.0	40.0
5	13.5	101.0	5	5	6	2			
6	14.5	100.5	6	6	7	2			
7	16.5	100.0	7	7	8	2			
8	17.8	99.5	8	8	9	2			
9	18.8	99.0	9	9	10	2			
10	20.0	98.5	10	10	11	2			
11	21.0	98.0	11	11	12	2			
12	22.5	97.5	12	12	13	2			
13	23.5	97.0	13	13	14	2			
14	24.2	96.5	14	14	15	2			
15	25.2	96.0	15	15	16	2			
16	26.0	95.5	16	16	17	2			
17	27.5	95.0	17	17	18	2			
18	32.5	95.0	18	18	19	2			
19	35.5	94.5	19	19	20	1			
20	36.5	94.0	20	20	21	1			
21	37.0	93.5	21	21	22	1			
22	38.5	93.0	22	22	23	1			
23	39.5	92.5	23	23	24	2			
24	40.0	92.0	24	24	25	2			
25	41.4	91.5	25	25	26	2			
26	42.1	91.0	26	26	27	2			
27	43.1	90.5	27	27	28	2			
28	44.0	90.0	28	28	29	2			
29	44.4	89.5	29	29	30	2			
30	45.5	89.0	30	30	31	2			
31	47.0	88.5	31	31	32	2			
32	47.7	88.0	32	32	33	2			
33	48.5	87.5	33	33	34	2			
34	49.5	87.0	34	34	35	2			
35	50.5	86.5	35	35	36	2			
36	51.3	86.0	36	36	37	2			
37	61.5	85.5	37	37	38	3			
38	70.0	85.5	38	39	40	3			
39	0.0	84.3	39	41	23	2			
40	70.0	84.3	40	42	43	4			
41	0.0	92.5	41	44	45	4			
42	0.0	77.0							
43	70.0	77.0							
44	0.0	73.5							
45	70.0	73.5							

SB-SLOPE

Simplified Bishop Slope Stability Analysis

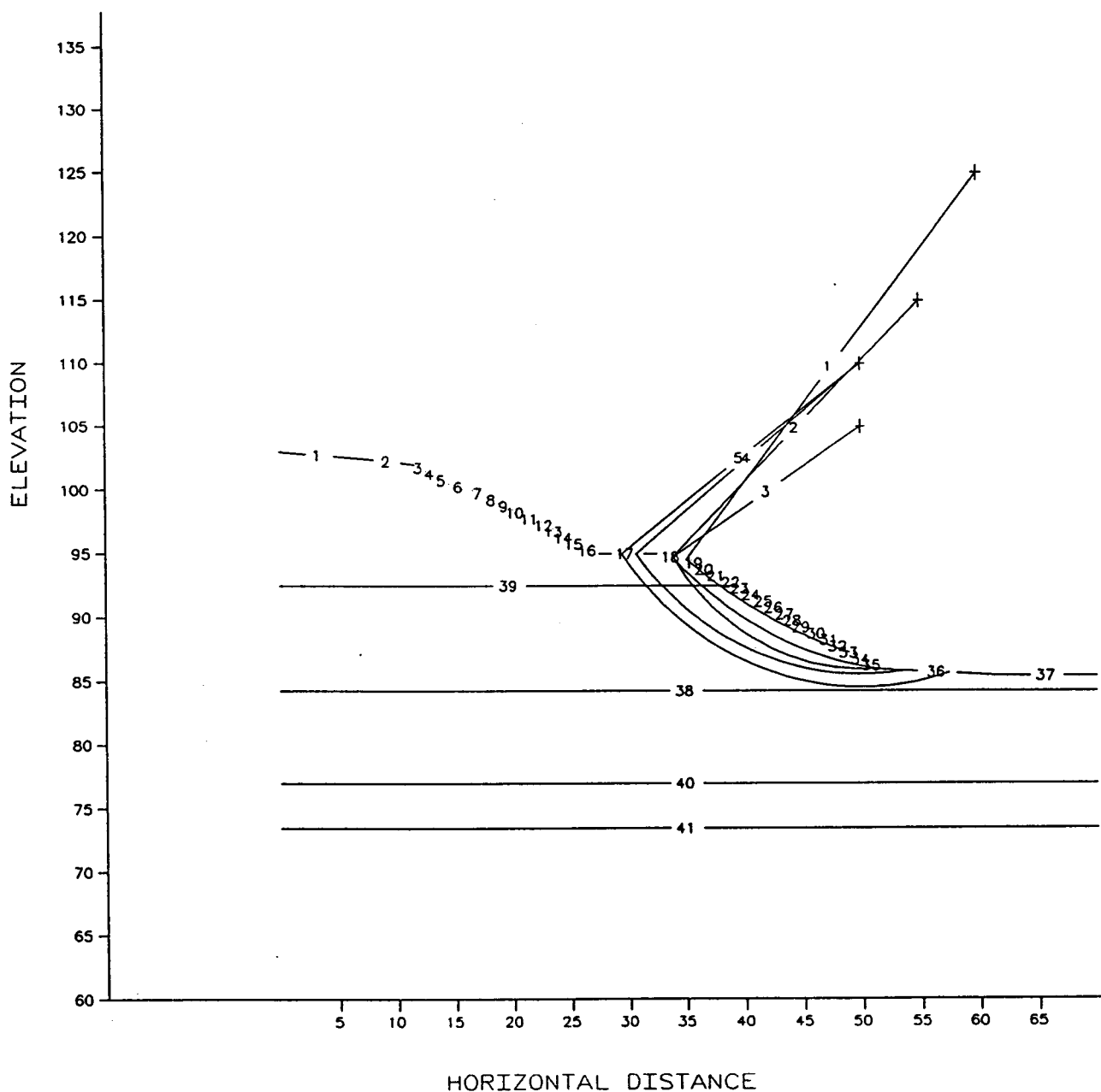
PROJECT: HWY 406 EMBANKMENT, SOUTH OF FOURTH AVENUE

LOCATION: ST. CATHERINE, ONTARIO

FILE: 406-2

COMPLETE SLOPE CROSS SECTION

CIRCLE	X	Y	RADIUS	FS
1	60.0	125.0	39.3	1.14
2	55.0	115.0	29.2	1.22
3	50.0	105.0	19.0	1.34
4	50.0	110.0	24.4	1.47
5	50.0	110.0	25.4	1.65



RECORD OF BOREHOLE No 310

1 OF 1

METRIC

W.P. 9820-7411-2791 LOCATION Co-ords: N 4,779,181; E 325,075 ORIGINATED BY O.B.
DIST CR HWY 406 BOREHOLE TYPE Continuous Flight Solid Stem Auger COMPILED BY O.B.
DATUM Geodetic DATE 98.08.19 - 98.08.20 CHECKED BY G.S.

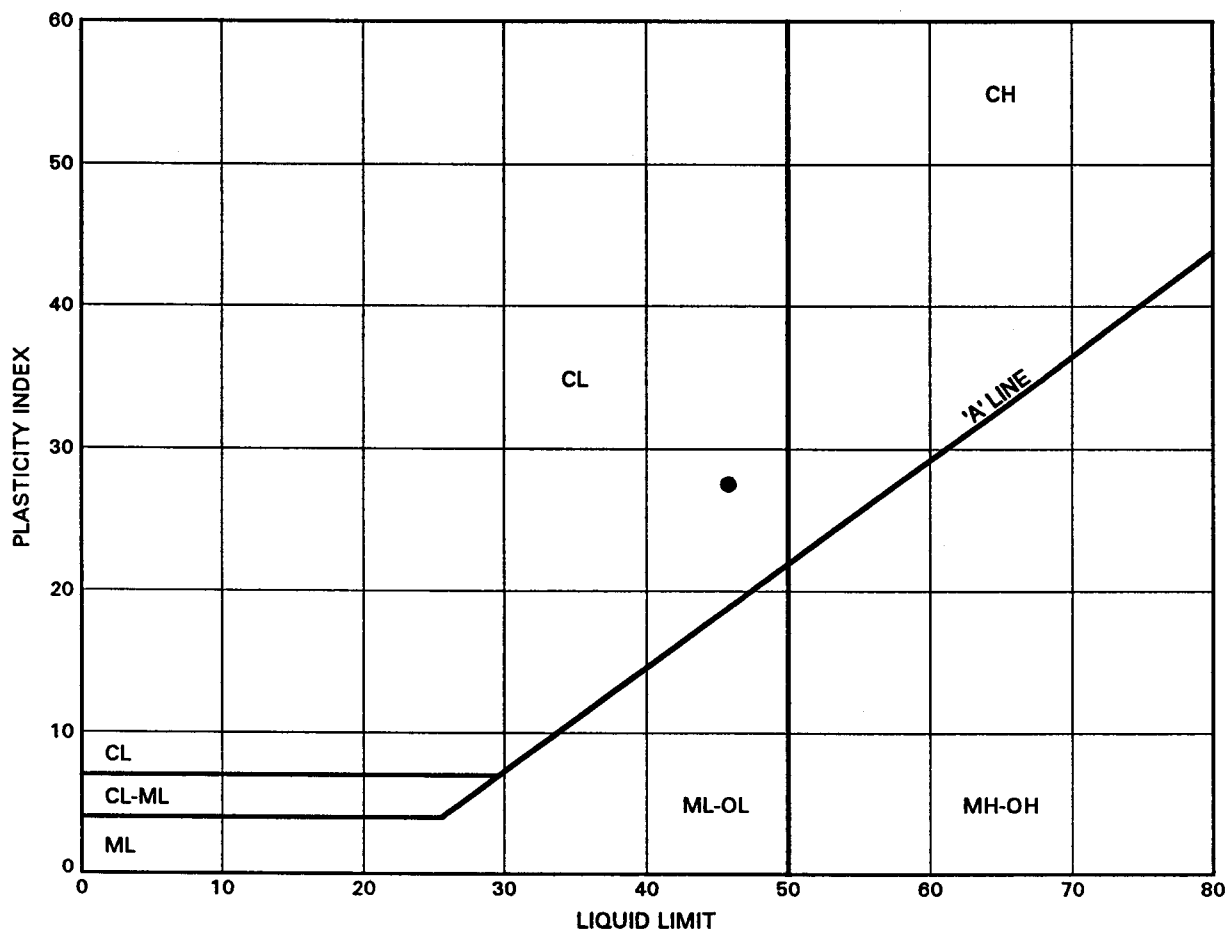
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
91.7	Ground Surface																
0.0	Topsoil 25cm		1	SS	16												
	Silty Clay, trace of sand, trace of rootlets, some topsoil above 0.8m, brick and asphalt fragments below 0.8m, dark brown to brown, moist, very stiff to soft		2	SS	21												
			3	SS	9												
			4	SS	4												
88.3	(Fill)		5	SS	4												
3.4	Original Topsoil		6	SS	8												
88.1	black moist		7	SS	8												
3.6	Silty Clay with silt seams, trace of sand, 30cm very moist sandy silt layer at 3.8m, varved, reddish brown, moist, firm to stiff		8	SS	8												
84.7			9	SS	3												
7.0	Silty Clay, trace of sand, trace of gravel, 30cm gravelly layer below 7.1m, brown, grey below 7.9m, very moist, soft to stiff		10	SS	7												
	(Glacial Till)		11	SS	4												
	-20cm wet sandy silt layer below 7.7m -boulder at 8.8m -very moist to wet below 9.1m		12	SS	10												
79.3			13	SS	50/ 15cm												
12.4	Sandy Silt, trace of clay, wet silty sand seams and layers, trace of gravel, reddish brown, grey below 15.2m, moist to very moist, very dense (Glacial Till)		14	SS	100												
75.5			15	SS	66												
16.2	Sandy Silt to Silty Sand, trace of gravel, wet sand seams, reddish grey to grey, very moist, very dense		16	SS	50/ 13cm												
73.3	-15cm wet coarse sand layer at 18.3m		17	SS	62/ 15cm												
18.4	Sandy silt with weathered shale, trace of gravel and limestone, red with wet grey shale layers, moist to dry, hard (Till/Shale Complex)		18	SS	80/ 15cm												
68.8			19	SS	80/ 15cm												
22.9	Highly Weathered Shale, with limestone layers, red with grey layers, dry, hard (Weathered Shale Bedrock)																
68.7																	
23.0	End of Borehole Notes: 1) Water level at 7.6m depth on completion of drilling																

Table 3 - Summary Field Vane Test Results

Borehole No.	Depth (m)	Shear Strength (kPa)
306	6.9	136.4
310	6.9	194.8
310	8.4	77.92

ATTERBERG LIMITS TEST RESULTS

FIGURE 10



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
•	310	1.0	90.7

Date September 1998

Project 9820-7411-2791

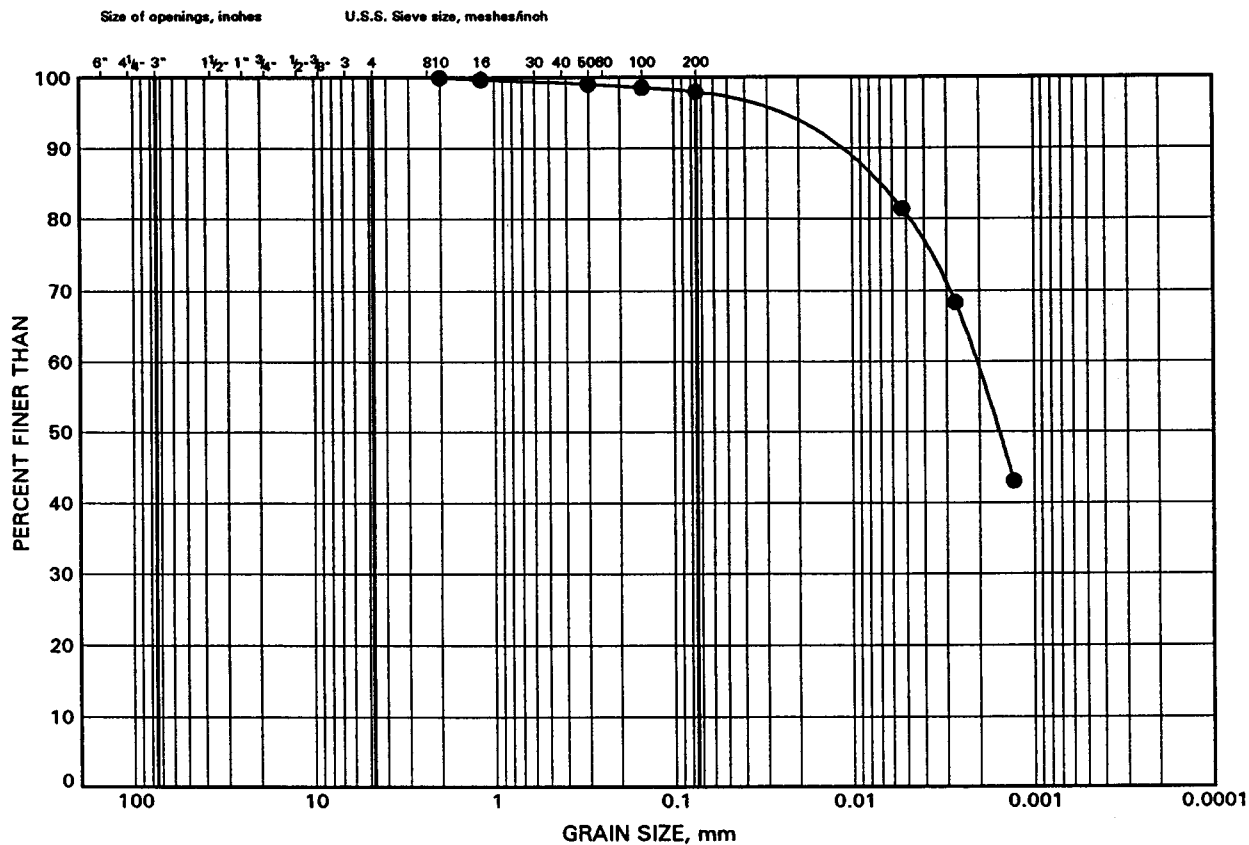
MC CLYMONT & RAK
ENGINEERS, INC.

Prep'd O.B.....

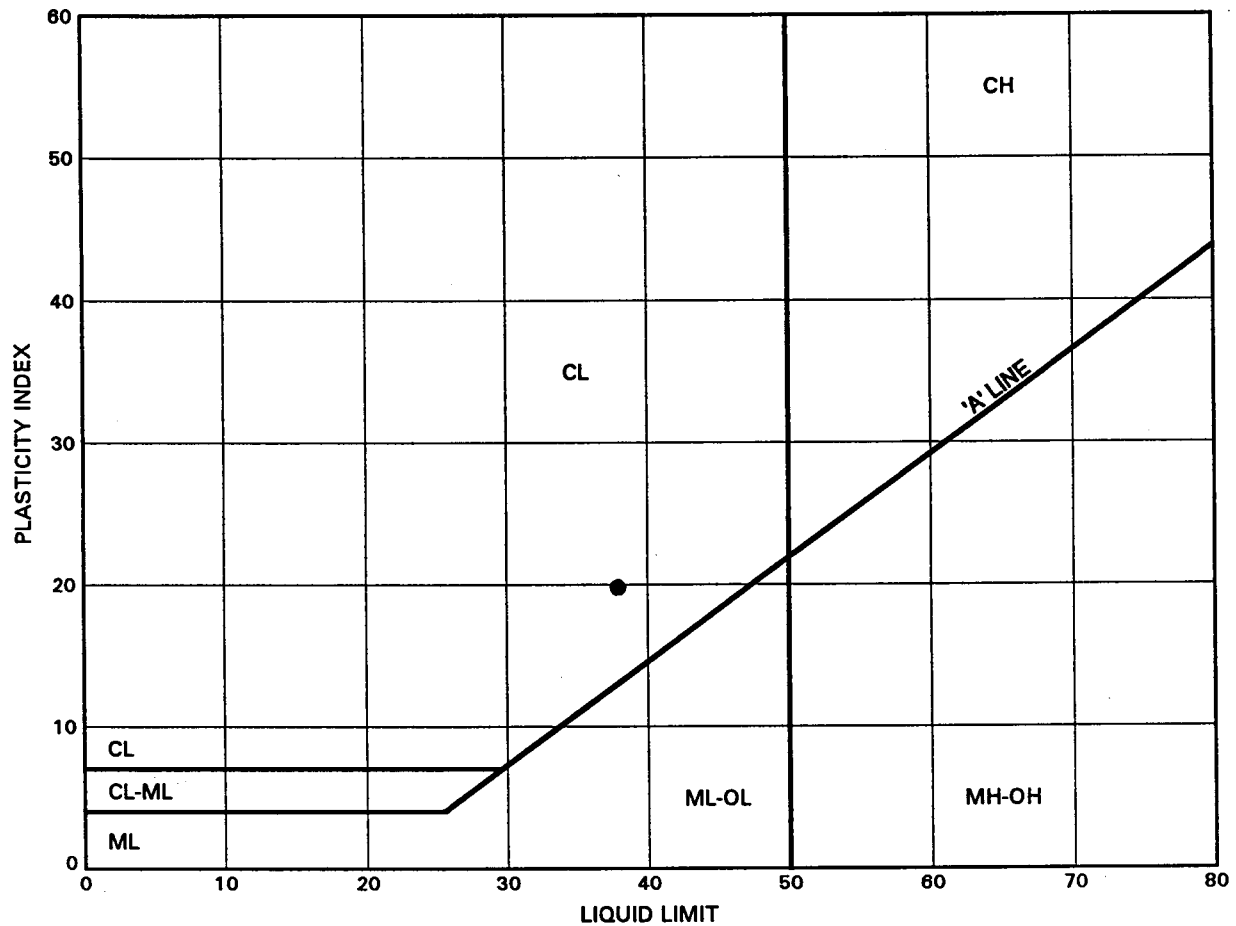
Chkd. G.S.....

GRAIN SIZE DISTRIBUTION

FIGURE 11



ATTERBERG LIMITS TEST RESULTS



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	310	6.3	85.4

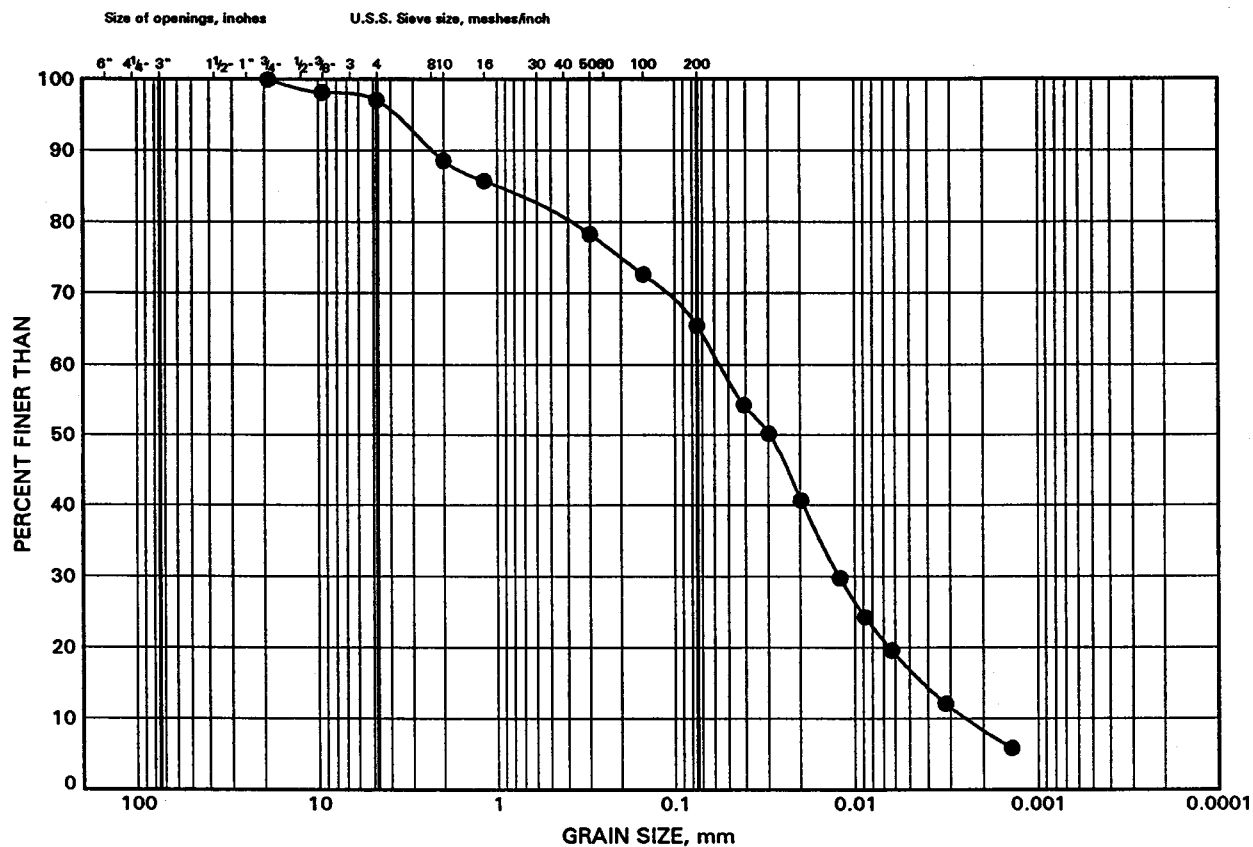
RAKALTR 2039C 98/08/29

Date August 1998
Project 9820-7411-2791

**MC CLYMONT & RAK
ENGINEERS, INC.**

Prep'd O.B.
Chkd. G.S.

GRAIN SIZE DISTRIBUTION



Grid search; initial parameters:

	initial	final	increment
x	20.0	70.0	5.0
y	85.0	130.0	5.0

radius increment is 0.1

minimum perpendicular depth is 1.0

limit at elevation 75.0

MINIMUM FOR CENTER:	x =	20.0,	y =	85.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	90.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	95.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	100.0,	r =	2.4,	FS =	2.020
MINIMUM FOR CENTER:	x =	20.0,	y =	105.0,	r =	6.9,	FS =	1.706
MINIMUM FOR CENTER:	x =	20.0,	y =	110.0,	r =	11.8,	FS =	1.674
MINIMUM FOR CENTER:	x =	20.0,	y =	115.0,	r =	16.4,	FS =	1.670
MINIMUM FOR CENTER:	x =	20.0,	y =	120.0,	r =	20.9,	FS =	1.735
MINIMUM FOR CENTER:	x =	20.0,	y =	125.0,	r =	25.5,	FS =	1.819
MINIMUM FOR CENTER:	x =	20.0,	y =	130.0,	r =	30.3,	FS =	1.934
MINIMUM FOR CENTER:	x =	25.0,	y =	85.0,	r =	30.3,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	90.0,	r =	30.3,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	95.0,	r =	30.3,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	100.0,	r =	4.4,	FS =	1.436
MINIMUM FOR CENTER:	x =	25.0,	y =	105.0,	r =	8.9,	FS =	1.460
MINIMUM FOR CENTER:	x =	25.0,	y =	110.0,	r =	13.5,	FS =	1.491
MINIMUM FOR CENTER:	x =	25.0,	y =	115.0,	r =	18.9,	FS =	1.571
MINIMUM FOR CENTER:	x =	25.0,	y =	120.0,	r =	22.7,	FS =	1.555
MINIMUM FOR CENTER:	x =	25.0,	y =	125.0,	r =	27.4,	FS =	1.582
MINIMUM FOR CENTER:	x =	25.0,	y =	130.0,	r =	32.1,	FS =	1.663
MINIMUM FOR CENTER:	x =	30.0,	y =	85.0,	r =	32.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	90.0,	r =	32.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	95.0,	r =	32.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	100.0,	r =	13.4,	FS =	4.154
MINIMUM FOR CENTER:	x =	30.0,	y =	105.0,	r =	14.3,	FS =	3.011
MINIMUM FOR CENTER:	x =	30.0,	y =	110.0,	r =	15.5,	FS =	2.008
MINIMUM FOR CENTER:	x =	30.0,	y =	115.0,	r =	20.0,	FS =	1.330
MINIMUM FOR CENTER:	x =	30.0,	y =	120.0,	r =	24.7,	FS =	1.412
MINIMUM FOR CENTER:	x =	30.0,	y =	125.0,	r =	29.8,	FS =	1.470
MINIMUM FOR CENTER:	x =	30.0,	y =	130.0,	r =	34.0,	FS =	1.512
MINIMUM FOR CENTER:	x =	35.0,	y =	85.0,	r =	34.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	35.0,	y =	90.0,	r =	34.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	35.0,	y =	95.0,	r =	2.4,	FS =	4.523
MINIMUM FOR CENTER:	x =	35.0,	y =	100.0,	r =	7.1,	FS =	3.343
MINIMUM FOR CENTER:	x =	35.0,	y =	105.0,	r =	19.7,	FS =	2.784
MINIMUM FOR CENTER:	x =	35.0,	y =	110.0,	r =	23.6,	FS =	2.476
MINIMUM FOR CENTER:	x =	35.0,	y =	115.0,	r =	27.7,	FS =	2.287
MINIMUM FOR CENTER:	x =	35.0,	y =	120.0,	r =	30.5,	FS =	2.173
MINIMUM FOR CENTER:	x =	35.0,	y =	125.0,	r =	33.9,	FS =	2.089
MINIMUM FOR CENTER:	x =	35.0,	y =	130.0,	r =	35.8,	FS =	1.923
MINIMUM FOR CENTER:	x =	40.0,	y =	85.0,	r =	35.8,	FS =	99.000
MINIMUM FOR CENTER:	x =	40.0,	y =	90.0,	r =	35.8,	FS =	99.000
MINIMUM FOR CENTER:	x =	40.0,	y =	95.0,	r =	3.5,	FS =	1.558
MINIMUM FOR CENTER:	x =	40.0,	y =	100.0,	r =	7.9,	FS =	1.376
MINIMUM FOR CENTER:	x =	40.0,	y =	105.0,	r =	12.4,	FS =	1.560
MINIMUM FOR CENTER:	x =	40.0,	y =	110.0,	r =	17.1,	FS =	1.879
MINIMUM FOR CENTER:	x =	40.0,	y =	115.0,	r =	28.6,	FS =	2.127
MINIMUM FOR CENTER:	x =	40.0,	y =	120.0,	r =	34.0,	FS =	2.053
MINIMUM FOR CENTER:	x =	40.0,	y =	125.0,	r =	37.5,	FS =	2.001
MINIMUM FOR CENTER:	x =	40.0,	y =	130.0,	r =	41.6,	FS =	1.971
MINIMUM FOR CENTER:	x =	45.0,	y =	85.0,	r =	41.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	45.0,	y =	90.0,	r =	41.6,	FS =	99.000

MINIMUM FOR CENTER: x = 45.0, y = 95.0, r = 5.9, FS = 1.241 - low FS
MINIMUM FOR CENTER: x = 45.0, y = 100.0, r = 10.2, FS = 1.254 - low FS
MINIMUM FOR CENTER: x = 45.0, y = 110.0, r = 19.1, FS = 1.332
MINIMUM FOR CENTER: x = 45.0, y = 115.0, r = 23.6, FS = 1.445
MINIMUM FOR CENTER: x = 45.0, y = 120.0, r = 28.2, FS = 1.624
MINIMUM FOR CENTER: x = 45.0, y = 125.0, r = 32.9, FS = 1.826
MINIMUM FOR CENTER: x = 45.0, y = 130.0, r = 44.4, FS = 1.863
MINIMUM FOR CENTER: x = 50.0, y = 85.0, r = 44.4, FS = 99.000
MINIMUM FOR CENTER: x = 50.0, y = 90.0, r = 3.9, FS = 1.441
MINIMUM FOR CENTER: x = 50.0, y = 95.0, r = 8.2, FS = 1.289 - low FS
MINIMUM FOR CENTER: x = 50.0, y = 100.0, r = 12.7, FS = 1.200 - low FS
MINIMUM FOR CENTER: x = 50.0, y = 105.0, r = 17.0, FS = 1.163 - low FS
MINIMUM FOR CENTER: x = 50.0, y = 110.0, r = 21.4, FS = 1.149 - low FS
MINIMUM FOR CENTER: x = 50.0, y = 115.0, r = 25.8, FS = 1.224 - low FS
MINIMUM FOR CENTER: x = 50.0, y = 120.0, r = 30.3, FS = 1.312
MINIMUM FOR CENTER: x = 50.0, y = 125.0, r = 34.8, FS = 1.406
MINIMUM FOR CENTER: x = 50.0, y = 130.0, r = 39.3, FS = 1.512
MINIMUM FOR CENTER: x = 55.0, y = 85.0, r = 39.3, FS = 99.000
MINIMUM FOR CENTER: x = 55.0, y = 90.0, r = 9.0, FS = 7.784
MINIMUM FOR CENTER: x = 55.0, y = 95.0, r = 10.6, FS = 3.774
MINIMUM FOR CENTER: x = 55.0, y = 100.0, r = 15.0, FS = 2.287
MINIMUM FOR CENTER: x = 55.0, y = 105.0, r = 19.3, FS = 1.168 - low FS
MINIMUM FOR CENTER: x = 55.0, y = 110.0, r = 23.8, FS = 1.152 - low FS
MINIMUM FOR CENTER: x = 55.0, y = 115.0, r = 28.2, FS = 1.152 - low FS
MINIMUM FOR CENTER: x = 55.0, y = 120.0, r = 32.6, FS = 1.154 - low FS
MINIMUM FOR CENTER: x = 55.0, y = 125.0, r = 37.0, FS = 1.216 - low FS
MINIMUM FOR CENTER: x = 55.0, y = 130.0, r = 41.5, FS = 1.299 - low FS
MINIMUM FOR CENTER: x = 60.0, y = 85.0, r = 41.5, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 90.0, r = 5.4, FS = 18.513
MINIMUM FOR CENTER: x = 60.0, y = 95.0, r = 10.4, FS = 18.969
MINIMUM FOR CENTER: x = 60.0, y = 100.0, r = 17.6, FS = 12.345
MINIMUM FOR CENTER: x = 60.0, y = 105.0, r = 21.9, FS = 7.943
MINIMUM FOR CENTER: x = 60.0, y = 110.0, r = 26.4, FS = 4.836
MINIMUM FOR CENTER: x = 60.0, y = 115.0, r = 30.6, FS = 3.095
MINIMUM FOR CENTER: x = 60.0, y = 120.0, r = 35.0, FS = 1.148 - low FS
MINIMUM FOR CENTER: x = 60.0, y = 125.0, r = 39.3, FS = 1.139 - low FS
MINIMUM FOR CENTER: x = 60.0, y = 130.0, r = 43.7, FS = 1.166 - low FS
MINIMUM FOR CENTER: x = 65.0, y = 85.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 90.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 95.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 100.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 105.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 110.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 115.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 120.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 125.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 130.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 85.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 90.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 95.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 100.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 105.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 110.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 115.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 120.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 125.0, r = 43.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 130.0, r = 43.7, FS = 99.000
OVERALL MINIMUM: x = 60.0, y = 125.0, r = 39.3, FS = 1.139 - low FS

Grid search; initial parameters:

	initial	final	increment
x	20.0	70.0	5.0
y	95.0	140.0	5.0

radius increment is 0.1

minimum perpendicular depth is 2.0

limit at elevation 75.0

MINIMUM FOR CENTER:	x =	20.0,	y =	95.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	100.0,	r =	3.4,	FS =	2.573
MINIMUM FOR CENTER:	x =	20.0,	y =	105.0,	r =	7.9,	FS =	1.916
MINIMUM FOR CENTER:	x =	20.0,	y =	110.0,	r =	12.6,	FS =	1.747
MINIMUM FOR CENTER:	x =	20.0,	y =	115.0,	r =	17.4,	FS =	1.813
MINIMUM FOR CENTER:	x =	20.0,	y =	120.0,	r =	21.9,	FS =	1.890
MINIMUM FOR CENTER:	x =	20.0,	y =	125.0,	r =	26.5,	FS =	2.000
MINIMUM FOR CENTER:	x =	20.0,	y =	130.0,	r =	31.3,	FS =	2.129
MINIMUM FOR CENTER:	x =	20.0,	y =	135.0,	r =	36.1,	FS =	2.268
MINIMUM FOR CENTER:	x =	20.0,	y =	140.0,	r =	40.9,	FS =	2.409
MINIMUM FOR CENTER:	x =	25.0,	y =	95.0,	r =	40.9,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	100.0,	r =	5.4,	FS =	1.736
MINIMUM FOR CENTER:	x =	25.0,	y =	105.0,	r =	9.9,	FS =	1.548
MINIMUM FOR CENTER:	x =	25.0,	y =	110.0,	r =	14.5,	FS =	1.577
MINIMUM FOR CENTER:	x =	25.0,	y =	115.0,	r =	19.1,	FS =	1.575
MINIMUM FOR CENTER:	x =	25.0,	y =	120.0,	r =	23.7,	FS =	1.615
MINIMUM FOR CENTER:	x =	25.0,	y =	125.0,	r =	28.4,	FS =	1.693
MINIMUM FOR CENTER:	x =	25.0,	y =	130.0,	r =	33.1,	FS =	1.778
MINIMUM FOR CENTER:	x =	25.0,	y =	135.0,	r =	37.7,	FS =	1.852
MINIMUM FOR CENTER:	x =	25.0,	y =	140.0,	r =	42.3,	FS =	1.941
MINIMUM FOR CENTER:	x =	30.0,	y =	95.0,	r =	42.3,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	100.0,	r =	13.4,	FS =	4.154
MINIMUM FOR CENTER:	x =	30.0,	y =	105.0,	r =	14.3,	FS =	3.011
MINIMUM FOR CENTER:	x =	30.0,	y =	110.0,	r =	16.5,	FS =	2.344
MINIMUM FOR CENTER:	x =	30.0,	y =	115.0,	r =	21.0,	FS =	1.960
MINIMUM FOR CENTER:	x =	30.0,	y =	120.0,	r =	25.7,	FS =	1.762
MINIMUM FOR CENTER:	x =	30.0,	y =	125.0,	r =	30.3,	FS =	1.578
MINIMUM FOR CENTER:	x =	30.0,	y =	130.0,	r =	34.8,	FS =	1.537
MINIMUM FOR CENTER:	x =	30.0,	y =	135.0,	r =	39.5,	FS =	1.610
MINIMUM FOR CENTER:	x =	30.0,	y =	140.0,	r =	44.2,	FS =	1.688
MINIMUM FOR CENTER:	x =	35.0,	y =	95.0,	r =	2.4,	FS =	4.523
MINIMUM FOR CENTER:	x =	35.0,	y =	100.0,	r =	7.3,	FS =	3.356
MINIMUM FOR CENTER:	x =	35.0,	y =	105.0,	r =	19.7,	FS =	2.784
MINIMUM FOR CENTER:	x =	35.0,	y =	110.0,	r =	23.6,	FS =	2.476
MINIMUM FOR CENTER:	x =	35.0,	y =	115.0,	r =	27.7,	FS =	2.287
MINIMUM FOR CENTER:	x =	35.0,	y =	120.0,	r =	30.5,	FS =	2.173
MINIMUM FOR CENTER:	x =	35.0,	y =	125.0,	r =	33.9,	FS =	2.089
MINIMUM FOR CENTER:	x =	35.0,	y =	130.0,	r =	36.9,	FS =	1.986
MINIMUM FOR CENTER:	x =	35.0,	y =	135.0,	r =	41.4,	FS =	1.887
MINIMUM FOR CENTER:	x =	35.0,	y =	140.0,	r =	46.0,	FS =	1.797
MINIMUM FOR CENTER:	x =	40.0,	y =	95.0,	r =	4.5,	FS =	1.862
MINIMUM FOR CENTER:	x =	40.0,	y =	100.0,	r =	8.9,	FS =	1.672
MINIMUM FOR CENTER:	x =	40.0,	y =	105.0,	r =	13.4,	FS =	1.837
MINIMUM FOR CENTER:	x =	40.0,	y =	110.0,	r =	18.1,	FS =	2.113
MINIMUM FOR CENTER:	x =	40.0,	y =	115.0,	r =	28.6,	FS =	2.127
MINIMUM FOR CENTER:	x =	40.0,	y =	120.0,	r =	34.0,	FS =	2.053
MINIMUM FOR CENTER:	x =	40.0,	y =	125.0,	r =	37.5,	FS =	2.001
MINIMUM FOR CENTER:	x =	40.0,	y =	130.0,	r =	41.6,	FS =	1.971
MINIMUM FOR CENTER:	x =	40.0,	y =	135.0,	r =	45.9,	FS =	1.964
MINIMUM FOR CENTER:	x =	40.0,	y =	140.0,	r =	49.1,	FS =	1.958
MINIMUM FOR CENTER:	x =	45.0,	y =	95.0,	r =	6.9,	FS =	1.465
MINIMUM FOR CENTER:	x =	45.0,	y =	100.0,	r =	11.2,	FS =	1.320

MINIMUM FOR CENTER:	x =	45.0,	y =	105.0,	r =	15.6,	FS =	1.375	
MINIMUM FOR CENTER:	x =	45.0,	y =	110.0,	r =	20.1,	FS =	1.506	
MINIMUM FOR CENTER:	x =	45.0,	y =	115.0,	r =	24.6,	FS =	1.650	
MINIMUM FOR CENTER:	x =	45.0,	y =	120.0,	r =	29.2,	FS =	1.823	
MINIMUM FOR CENTER:	x =	45.0,	y =	125.0,	r =	39.0,	FS =	1.886	
MINIMUM FOR CENTER:	x =	45.0,	y =	130.0,	r =	44.4,	FS =	1.863	
MINIMUM FOR CENTER:	x =	45.0,	y =	135.0,	r =	48.4,	FS =	1.855	
MINIMUM FOR CENTER:	x =	45.0,	y =	140.0,	r =	52.6,	FS =	1.858	
MINIMUM FOR CENTER:	x =	50.0,	y =	95.0,	r =	9.2,	FS =	1.390	
MINIMUM FOR CENTER:	x =	50.0,	y =	100.0,	r =	13.7,	FS =	1.290	- low FS
MINIMUM FOR CENTER:	x =	50.0,	y =	105.0,	r =	18.0,	FS =	1.248	- low FS
MINIMUM FOR CENTER:	x =	50.0,	y =	110.0,	r =	22.4,	FS =	1.273	- low FS
MINIMUM FOR CENTER:	x =	50.0,	y =	115.0,	r =	26.8,	FS =	1.342	
MINIMUM FOR CENTER:	x =	50.0,	y =	120.0,	r =	31.3,	FS =	1.435	
MINIMUM FOR CENTER:	x =	50.0,	y =	125.0,	r =	35.8,	FS =	1.558	
MINIMUM FOR CENTER:	x =	50.0,	y =	130.0,	r =	40.3,	FS =	1.686	
MINIMUM FOR CENTER:	x =	50.0,	y =	135.0,	r =	49.1,	FS =	1.764	
MINIMUM FOR CENTER:	x =	50.0,	y =	140.0,	r =	54.2,	FS =	1.765	
MINIMUM FOR CENTER:	x =	55.0,	y =	95.0,	r =	11.6,	FS =	4.119	
MINIMUM FOR CENTER:	x =	55.0,	y =	100.0,	r =	16.0,	FS =	2.629	
MINIMUM FOR CENTER:	x =	55.0,	y =	105.0,	r =	20.3,	FS =	1.809	
MINIMUM FOR CENTER:	x =	55.0,	y =	110.0,	r =	24.8,	FS =	1.453	
MINIMUM FOR CENTER:	x =	55.0,	y =	115.0,	r =	29.2,	FS =	1.218	- low FS
MINIMUM FOR CENTER:	x =	55.0,	y =	120.0,	r =	33.6,	FS =	1.265	- low FS
MINIMUM FOR CENTER:	x =	55.0,	y =	125.0,	r =	38.0,	FS =	1.333	
MINIMUM FOR CENTER:	x =	55.0,	y =	130.0,	r =	42.5,	FS =	1.412	
MINIMUM FOR CENTER:	x =	55.0,	y =	135.0,	r =	46.9,	FS =	1.495	
MINIMUM FOR CENTER:	x =	55.0,	y =	140.0,	r =	51.5,	FS =	1.601	
MINIMUM FOR CENTER:	x =	60.0,	y =	95.0,	r =	13.7,	FS =	21.048	
MINIMUM FOR CENTER:	x =	60.0,	y =	100.0,	r =	17.6,	FS =	12.345	
MINIMUM FOR CENTER:	x =	60.0,	y =	105.0,	r =	21.9,	FS =	7.943	
MINIMUM FOR CENTER:	x =	60.0,	y =	110.0,	r =	26.4,	FS =	4.836	
MINIMUM FOR CENTER:	x =	60.0,	y =	115.0,	r =	26.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	60.0,	y =	120.0,	r =	26.4,	FS =	99.000	
MINIMUM FOR CENTER:	x =	60.0,	y =	125.0,	r =	40.3,	FS =	1.825	
MINIMUM FOR CENTER:	x =	60.0,	y =	130.0,	r =	44.7,	FS =	1.266	- low FS
MINIMUM FOR CENTER:	x =	60.0,	y =	135.0,	r =	49.2,	FS =	1.325	
MINIMUM FOR CENTER:	x =	60.0,	y =	140.0,	r =	53.7,	FS =	1.393	
MINIMUM FOR CENTER:	x =	65.0,	y =	95.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	65.0,	y =	100.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	65.0,	y =	105.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	65.0,	y =	110.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	65.0,	y =	115.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	65.0,	y =	120.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	65.0,	y =	125.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	65.0,	y =	130.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	65.0,	y =	135.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	65.0,	y =	140.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	70.0,	y =	95.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	70.0,	y =	100.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	70.0,	y =	105.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	70.0,	y =	110.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	70.0,	y =	115.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	70.0,	y =	120.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	70.0,	y =	125.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	70.0,	y =	130.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	70.0,	y =	135.0,	r =	53.7,	FS =	99.000	
MINIMUM FOR CENTER:	x =	70.0,	y =	140.0,	r =	53.7,	FS =	99.000	
OVERALL MINIMUM:	x =	55.0,	y =	115.0,	r =	29.2,	FS =	1.218	- low FS

MINIMUM FOR CENTER:	x =	45.0,	y =	105.0,	r =	16.6,	FS =	1.493
MINIMUM FOR CENTER:	x =	45.0,	y =	110.0,	r =	21.1,	FS =	1.600
MINIMUM FOR CENTER:	x =	45.0,	y =	115.0,	r =	25.6,	FS =	1.746
MINIMUM FOR CENTER:	x =	45.0,	y =	120.0,	r =	34.6,	FS =	1.905
MINIMUM FOR CENTER:	x =	45.0,	y =	125.0,	r =	39.0,	FS =	1.886
MINIMUM FOR CENTER:	x =	45.0,	y =	130.0,	r =	44.4,	FS =	1.863
MINIMUM FOR CENTER:	x =	45.0,	y =	135.0,	r =	48.4,	FS =	1.855
MINIMUM FOR CENTER:	x =	45.0,	y =	140.0,	r =	52.6,	FS =	1.858
MINIMUM FOR CENTER:	x =	50.0,	y =	95.0,	r =	10.2,	FS =	1.640
MINIMUM FOR CENTER:	x =	50.0,	y =	100.0,	r =	14.7,	FS =	1.427
MINIMUM FOR CENTER:	x =	50.0,	y =	105.0,	r =	19.0,	FS =	1.336
MINIMUM FOR CENTER:	x =	50.0,	y =	110.0,	r =	23.4,	FS =	1.367
MINIMUM FOR CENTER:	x =	50.0,	y =	115.0,	r =	27.8,	FS =	1.438
MINIMUM FOR CENTER:	x =	50.0,	y =	120.0,	r =	32.3,	FS =	1.534
MINIMUM FOR CENTER:	x =	50.0,	y =	125.0,	r =	36.8,	FS =	1.635
MINIMUM FOR CENTER:	x =	50.0,	y =	130.0,	r =	41.3,	FS =	1.748
MINIMUM FOR CENTER:	x =	50.0,	y =	135.0,	r =	49.1,	FS =	1.764
MINIMUM FOR CENTER:	x =	50.0,	y =	140.0,	r =	54.2,	FS =	1.765
MINIMUM FOR CENTER:	x =	55.0,	y =	95.0,	r =	12.6,	FS =	4.356
MINIMUM FOR CENTER:	x =	55.0,	y =	100.0,	r =	17.0,	FS =	2.995
MINIMUM FOR CENTER:	x =	55.0,	y =	105.0,	r =	21.3,	FS =	2.243
MINIMUM FOR CENTER:	x =	55.0,	y =	110.0,	r =	25.8,	FS =	1.810
MINIMUM FOR CENTER:	x =	55.0,	y =	115.0,	r =	30.2,	FS =	1.537
MINIMUM FOR CENTER:	x =	55.0,	y =	120.0,	r =	34.6,	FS =	1.423
MINIMUM FOR CENTER:	x =	55.0,	y =	125.0,	r =	39.0,	FS =	1.412
MINIMUM FOR CENTER:	x =	55.0,	y =	130.0,	r =	43.5,	FS =	1.490
MINIMUM FOR CENTER:	x =	55.0,	y =	135.0,	r =	47.9,	FS =	1.573
MINIMUM FOR CENTER:	x =	55.0,	y =	140.0,	r =	52.5,	FS =	1.666
MINIMUM FOR CENTER:	x =	60.0,	y =	95.0,	r =	13.7,	FS =	21.048
MINIMUM FOR CENTER:	x =	60.0,	y =	100.0,	r =	17.6,	FS =	12.345
MINIMUM FOR CENTER:	x =	60.0,	y =	105.0,	r =	17.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	60.0,	y =	110.0,	r =	17.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	60.0,	y =	115.0,	r =	17.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	60.0,	y =	120.0,	r =	17.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	60.0,	y =	125.0,	r =	17.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	60.0,	y =	130.0,	r =	17.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	60.0,	y =	135.0,	r =	50.2,	FS =	1.741
MINIMUM FOR CENTER:	x =	60.0,	y =	140.0,	r =	54.7,	FS =	1.461
MINIMUM FOR CENTER:	x =	65.0,	y =	95.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	65.0,	y =	100.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	65.0,	y =	105.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	65.0,	y =	110.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	65.0,	y =	115.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	65.0,	y =	120.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	65.0,	y =	125.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	65.0,	y =	130.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	65.0,	y =	135.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	65.0,	y =	140.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	70.0,	y =	95.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	70.0,	y =	100.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	70.0,	y =	105.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	70.0,	y =	110.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	70.0,	y =	115.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	70.0,	y =	120.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	70.0,	y =	125.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	70.0,	y =	130.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	70.0,	y =	135.0,	r =	54.7,	FS =	99.000
MINIMUM FOR CENTER:	x =	70.0,	y =	140.0,	r =	54.7,	FS =	99.000
OVERALL MINIMUM:	x =	50.0,	y =	105.0,	r =	19.0,	FS =	1.336

Grid search; initial parameters:

	initial	final	increment
x	20.0	70.0	5.0
y	95.0	140.0	5.0

radius increment is 0.1

minimum perpendicular depth is 4.0

limit at elevation 75.0

MINIMUM FOR CENTER:	x =	20.0,	y =	95.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	100.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	105.0,	r =	9.9,	FS =	2.151
MINIMUM FOR CENTER:	x =	20.0,	y =	110.0,	r =	14.6,	FS =	2.016
MINIMUM FOR CENTER:	x =	20.0,	y =	115.0,	r =	19.4,	FS =	2.058
MINIMUM FOR CENTER:	x =	20.0,	y =	120.0,	r =	23.9,	FS =	2.119
MINIMUM FOR CENTER:	x =	20.0,	y =	125.0,	r =	28.5,	FS =	2.206
MINIMUM FOR CENTER:	x =	20.0,	y =	130.0,	r =	33.3,	FS =	2.307
MINIMUM FOR CENTER:	x =	20.0,	y =	135.0,	r =	33.3,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	140.0,	r =	33.3,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	95.0,	r =	33.3,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	100.0,	r =	7.4,	FS =	2.529
MINIMUM FOR CENTER:	x =	25.0,	y =	105.0,	r =	11.9,	FS =	2.078
MINIMUM FOR CENTER:	x =	25.0,	y =	110.0,	r =	16.5,	FS =	1.893
MINIMUM FOR CENTER:	x =	25.0,	y =	115.0,	r =	21.1,	FS =	1.812
MINIMUM FOR CENTER:	x =	25.0,	y =	120.0,	r =	25.7,	FS =	1.809
MINIMUM FOR CENTER:	x =	25.0,	y =	125.0,	r =	30.4,	FS =	1.848
MINIMUM FOR CENTER:	x =	25.0,	y =	130.0,	r =	35.1,	FS =	1.909
MINIMUM FOR CENTER:	x =	25.0,	y =	135.0,	r =	39.7,	FS =	1.986
MINIMUM FOR CENTER:	x =	25.0,	y =	140.0,	r =	44.3,	FS =	2.074
MINIMUM FOR CENTER:	x =	30.0,	y =	95.0,	r =	44.3,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	100.0,	r =	13.4,	FS =	4.154
MINIMUM FOR CENTER:	x =	30.0,	y =	105.0,	r =	14.3,	FS =	3.011
MINIMUM FOR CENTER:	x =	30.0,	y =	110.0,	r =	18.5,	FS =	2.506
MINIMUM FOR CENTER:	x =	30.0,	y =	115.0,	r =	23.0,	FS =	2.227
MINIMUM FOR CENTER:	x =	30.0,	y =	120.0,	r =	27.7,	FS =	2.101
MINIMUM FOR CENTER:	x =	30.0,	y =	125.0,	r =	32.3,	FS =	2.041
MINIMUM FOR CENTER:	x =	30.0,	y =	130.0,	r =	36.8,	FS =	2.014
MINIMUM FOR CENTER:	x =	30.0,	y =	135.0,	r =	41.5,	FS =	2.013
MINIMUM FOR CENTER:	x =	30.0,	y =	140.0,	r =	46.2,	FS =	2.024
MINIMUM FOR CENTER:	x =	35.0,	y =	95.0,	r =	46.2,	FS =	99.000
MINIMUM FOR CENTER:	x =	35.0,	y =	100.0,	r =	15.5,	FS =	3.417
MINIMUM FOR CENTER:	x =	35.0,	y =	105.0,	r =	19.7,	FS =	2.784
MINIMUM FOR CENTER:	x =	35.0,	y =	110.0,	r =	23.6,	FS =	2.476
MINIMUM FOR CENTER:	x =	35.0,	y =	115.0,	r =	27.7,	FS =	2.287
MINIMUM FOR CENTER:	x =	35.0,	y =	120.0,	r =	30.5,	FS =	2.173
MINIMUM FOR CENTER:	x =	35.0,	y =	125.0,	r =	34.1,	FS =	2.091
MINIMUM FOR CENTER:	x =	35.0,	y =	130.0,	r =	38.8,	FS =	2.049
MINIMUM FOR CENTER:	x =	35.0,	y =	135.0,	r =	43.4,	FS =	2.035
MINIMUM FOR CENTER:	x =	35.0,	y =	140.0,	r =	48.0,	FS =	2.034
MINIMUM FOR CENTER:	x =	40.0,	y =	95.0,	r =	6.5,	FS =	2.320
MINIMUM FOR CENTER:	x =	40.0,	y =	100.0,	r =	10.9,	FS =	2.044
MINIMUM FOR CENTER:	x =	40.0,	y =	105.0,	r =	15.4,	FS =	2.151
MINIMUM FOR CENTER:	x =	40.0,	y =	110.0,	r =	24.2,	FS =	2.238
MINIMUM FOR CENTER:	x =	40.0,	y =	115.0,	r =	28.6,	FS =	2.127
MINIMUM FOR CENTER:	x =	40.0,	y =	120.0,	r =	34.0,	FS =	2.053
MINIMUM FOR CENTER:	x =	40.0,	y =	125.0,	r =	37.5,	FS =	2.001
MINIMUM FOR CENTER:	x =	40.0,	y =	130.0,	r =	41.6,	FS =	1.971
MINIMUM FOR CENTER:	x =	40.0,	y =	135.0,	r =	45.9,	FS =	1.964
MINIMUM FOR CENTER:	x =	40.0,	y =	140.0,	r =	49.6,	FS =	1.960
MINIMUM FOR CENTER:	x =	45.0,	y =	95.0,	r =	8.9,	FS =	1.805
MINIMUM FOR CENTER:	x =	45.0,	y =	100.0,	r =	13.2,	FS =	1.593

MINIMUM FOR CENTER: x = 45.0, y = 105.0, r = 17.6, FS = 1.617
MINIMUM FOR CENTER: x = 45.0, y = 110.0, r = 22.1, FS = 1.717
MINIMUM FOR CENTER: x = 45.0, y = 115.0, r = 26.6, FS = 1.835
MINIMUM FOR CENTER: x = 45.0, y = 120.0, r = 34.6, FS = 1.905
MINIMUM FOR CENTER: x = 45.0, y = 125.0, r = 39.0, FS = 1.886
MINIMUM FOR CENTER: x = 45.0, y = 130.0, r = 44.4, FS = 1.863
MINIMUM FOR CENTER: x = 45.0, y = 135.0, r = 48.4, FS = 1.855
MINIMUM FOR CENTER: x = 45.0, y = 140.0, r = 52.6, FS = 1.858
MINIMUM FOR CENTER: x = 50.0, y = 95.0, r = 11.2, FS = 2.050
MINIMUM FOR CENTER: x = 50.0, y = 100.0, r = 15.7, FS = 1.632
MINIMUM FOR CENTER: x = 50.0, y = 105.0, r = 20.0, FS = 1.491
MINIMUM FOR CENTER: x = 50.0, y = 110.0, r = 24.4, FS = 1.468
MINIMUM FOR CENTER: x = 50.0, y = 115.0, r = 28.8, FS = 1.525
MINIMUM FOR CENTER: x = 50.0, y = 120.0, r = 33.3, FS = 1.615
MINIMUM FOR CENTER: x = 50.0, y = 125.0, r = 37.8, FS = 1.711
MINIMUM FOR CENTER: x = 50.0, y = 130.0, r = 44.1, FS = 1.763
MINIMUM FOR CENTER: x = 50.0, y = 135.0, r = 49.1, FS = 1.764
MINIMUM FOR CENTER: x = 50.0, y = 140.0, r = 54.2, FS = 1.765
MINIMUM FOR CENTER: x = 55.0, y = 95.0, r = 13.6, FS = 4.570
MINIMUM FOR CENTER: x = 55.0, y = 100.0, r = 18.0, FS = 3.268
MINIMUM FOR CENTER: x = 55.0, y = 105.0, r = 22.3, FS = 2.574
MINIMUM FOR CENTER: x = 55.0, y = 110.0, r = 26.8, FS = 2.203
MINIMUM FOR CENTER: x = 55.0, y = 115.0, r = 31.2, FS = 1.915
MINIMUM FOR CENTER: x = 55.0, y = 120.0, r = 35.6, FS = 1.711
MINIMUM FOR CENTER: x = 55.0, y = 125.0, r = 40.0, FS = 1.634
MINIMUM FOR CENTER: x = 55.0, y = 130.0, r = 44.5, FS = 1.603
MINIMUM FOR CENTER: x = 55.0, y = 135.0, r = 48.9, FS = 1.636
MINIMUM FOR CENTER: x = 55.0, y = 140.0, r = 54.1, FS = 1.687
MINIMUM FOR CENTER: x = 60.0, y = 95.0, r = 13.7, FS = 21.048
MINIMUM FOR CENTER: x = 60.0, y = 100.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 105.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 110.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 115.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 120.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 125.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 130.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 135.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 140.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 95.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 100.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 105.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 110.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 115.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 120.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 125.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 130.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 135.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 140.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 95.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 100.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 105.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 110.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 115.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 120.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 125.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 130.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 135.0, r = 13.7, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 140.0, r = 13.7, FS = 99.000
OVERALL MINIMUM: x = 50.0, y = 110.0, r = 24.4, FS = 1.468

Grid search; initial parameters:

	initial	final	increment
x	20.0	70.0	5.0
y	95.0	140.0	5.0

radius increment is 0.1

minimum perpendicular depth is 5.0

limit at elevation 75.0

MINIMUM FOR CENTER:	x =	20.0,	y =	95.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	100.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	105.0,	r =	10.9,	FS =	2.270
MINIMUM FOR CENTER:	x =	20.0,	y =	110.0,	r =	15.6,	FS =	2.123
MINIMUM FOR CENTER:	x =	20.0,	y =	115.0,	r =	20.4,	FS =	2.149
MINIMUM FOR CENTER:	x =	20.0,	y =	120.0,	r =	24.9,	FS =	2.196
MINIMUM FOR CENTER:	x =	20.0,	y =	125.0,	r =	29.5,	FS =	2.271
MINIMUM FOR CENTER:	x =	20.0,	y =	130.0,	r =	29.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	135.0,	r =	29.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	140.0,	r =	29.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	95.0,	r =	29.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	100.0,	r =	8.4,	FS =	2.977
MINIMUM FOR CENTER:	x =	25.0,	y =	105.0,	r =	12.9,	FS =	2.386
MINIMUM FOR CENTER:	x =	25.0,	y =	110.0,	r =	17.5,	FS =	2.139
MINIMUM FOR CENTER:	x =	25.0,	y =	115.0,	r =	22.1,	FS =	2.046
MINIMUM FOR CENTER:	x =	25.0,	y =	120.0,	r =	26.7,	FS =	2.031
MINIMUM FOR CENTER:	x =	25.0,	y =	125.0,	r =	31.4,	FS =	2.051
MINIMUM FOR CENTER:	x =	25.0,	y =	130.0,	r =	36.1,	FS =	2.079
MINIMUM FOR CENTER:	x =	25.0,	y =	135.0,	r =	36.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	140.0,	r =	36.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	95.0,	r =	36.1,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	100.0,	r =	13.4,	FS =	4.154
MINIMUM FOR CENTER:	x =	30.0,	y =	105.0,	r =	15.2,	FS =	3.032
MINIMUM FOR CENTER:	x =	30.0,	y =	110.0,	r =	19.5,	FS =	2.557
MINIMUM FOR CENTER:	x =	30.0,	y =	115.0,	r =	24.0,	FS =	2.298
MINIMUM FOR CENTER:	x =	30.0,	y =	120.0,	r =	28.7,	FS =	2.198
MINIMUM FOR CENTER:	x =	30.0,	y =	125.0,	r =	33.3,	FS =	2.149
MINIMUM FOR CENTER:	x =	30.0,	y =	130.0,	r =	37.8,	FS =	2.130
MINIMUM FOR CENTER:	x =	30.0,	y =	135.0,	r =	42.5,	FS =	2.142
MINIMUM FOR CENTER:	x =	30.0,	y =	140.0,	r =	47.2,	FS =	2.166
MINIMUM FOR CENTER:	x =	35.0,	y =	95.0,	r =	47.2,	FS =	99.000
MINIMUM FOR CENTER:	x =	35.0,	y =	100.0,	r =	15.5,	FS =	3.417
MINIMUM FOR CENTER:	x =	35.0,	y =	105.0,	r =	19.7,	FS =	2.784
MINIMUM FOR CENTER:	x =	35.0,	y =	110.0,	r =	23.6,	FS =	2.476
MINIMUM FOR CENTER:	x =	35.0,	y =	115.0,	r =	27.7,	FS =	2.287
MINIMUM FOR CENTER:	x =	35.0,	y =	120.0,	r =	30.5,	FS =	2.173
MINIMUM FOR CENTER:	x =	35.0,	y =	125.0,	r =	35.1,	FS =	2.107
MINIMUM FOR CENTER:	x =	35.0,	y =	130.0,	r =	39.8,	FS =	2.086
MINIMUM FOR CENTER:	x =	35.0,	y =	135.0,	r =	44.4,	FS =	2.085
MINIMUM FOR CENTER:	x =	35.0,	y =	140.0,	r =	49.0,	FS =	2.093
MINIMUM FOR CENTER:	x =	40.0,	y =	95.0,	r =	7.5,	FS =	2.463
MINIMUM FOR CENTER:	x =	40.0,	y =	100.0,	r =	11.9,	FS =	2.184
MINIMUM FOR CENTER:	x =	40.0,	y =	105.0,	r =	16.4,	FS =	2.258
MINIMUM FOR CENTER:	x =	40.0,	y =	110.0,	r =	24.2,	FS =	2.238
MINIMUM FOR CENTER:	x =	40.0,	y =	115.0,	r =	28.6,	FS =	2.127
MINIMUM FOR CENTER:	x =	40.0,	y =	120.0,	r =	34.0,	FS =	2.053
MINIMUM FOR CENTER:	x =	40.0,	y =	125.0,	r =	37.5,	FS =	2.001
MINIMUM FOR CENTER:	x =	40.0,	y =	130.0,	r =	41.6,	FS =	1.971
MINIMUM FOR CENTER:	x =	40.0,	y =	135.0,	r =	45.9,	FS =	1.964
MINIMUM FOR CENTER:	x =	40.0,	y =	140.0,	r =	50.6,	FS =	1.972
MINIMUM FOR CENTER:	x =	45.0,	y =	95.0,	r =	9.9,	FS =	1.928
MINIMUM FOR CENTER:	x =	45.0,	y =	100.0,	r =	14.2,	FS =	1.711

MINIMUM FOR CENTER: x = 45.0, y = 105.0, r = 18.6, FS = 1.727
MINIMUM FOR CENTER: x = 45.0, y = 110.0, r = 23.1, FS = 1.815
MINIMUM FOR CENTER: x = 45.0, y = 115.0, r = 27.6, FS = 1.903
MINIMUM FOR CENTER: x = 45.0, y = 120.0, r = 34.6, FS = 1.905
MINIMUM FOR CENTER: x = 45.0, y = 125.0, r = 39.0, FS = 1.886
MINIMUM FOR CENTER: x = 45.0, y = 130.0, r = 44.4, FS = 1.863
MINIMUM FOR CENTER: x = 45.0, y = 135.0, r = 48.4, FS = 1.855
MINIMUM FOR CENTER: x = 45.0, y = 140.0, r = 52.6, FS = 1.858
MINIMUM FOR CENTER: x = 50.0, y = 95.0, r = 12.2, FS = 2.418
MINIMUM FOR CENTER: x = 50.0, y = 100.0, r = 16.7, FS = 2.001
MINIMUM FOR CENTER: x = 50.0, y = 105.0, r = 21.0, FS = 1.762
MINIMUM FOR CENTER: x = 50.0, y = 110.0, r = 25.4, FS = 1.646
MINIMUM FOR CENTER: x = 50.0, y = 115.0, r = 29.8, FS = 1.651
MINIMUM FOR CENTER: x = 50.0, y = 120.0, r = 34.3, FS = 1.692
MINIMUM FOR CENTER: x = 50.0, y = 125.0, r = 39.0, FS = 1.741
MINIMUM FOR CENTER: x = 50.0, y = 130.0, r = 44.1, FS = 1.763
MINIMUM FOR CENTER: x = 50.0, y = 135.0, r = 49.1, FS = 1.764
MINIMUM FOR CENTER: x = 50.0, y = 140.0, r = 54.2, FS = 1.765
MINIMUM FOR CENTER: x = 55.0, y = 95.0, r = 14.6, FS = 4.764
MINIMUM FOR CENTER: x = 55.0, y = 100.0, r = 19.0, FS = 3.527
MINIMUM FOR CENTER: x = 55.0, y = 105.0, r = 23.3, FS = 2.858
MINIMUM FOR CENTER: x = 55.0, y = 110.0, r = 27.8, FS = 2.526
MINIMUM FOR CENTER: x = 55.0, y = 115.0, r = 32.2, FS = 2.282
MINIMUM FOR CENTER: x = 55.0, y = 120.0, r = 36.6, FS = 2.118
MINIMUM FOR CENTER: x = 55.0, y = 125.0, r = 41.0, FS = 1.973
MINIMUM FOR CENTER: x = 55.0, y = 130.0, r = 45.5, FS = 1.842
MINIMUM FOR CENTER: x = 55.0, y = 135.0, r = 49.9, FS = 1.762
MINIMUM FOR CENTER: x = 55.0, y = 140.0, r = 54.5, FS = 1.719
MINIMUM FOR CENTER: x = 60.0, y = 95.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 100.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 105.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 110.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 115.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 120.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 125.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 130.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 135.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 60.0, y = 140.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 95.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 100.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 105.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 110.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 115.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 120.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 125.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 130.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 135.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 65.0, y = 140.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 95.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 100.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 105.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 110.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 115.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 120.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 125.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 130.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 135.0, r = 54.5, FS = 99.000
MINIMUM FOR CENTER: x = 70.0, y = 140.0, r = 54.5, FS = 99.000
OVERALL MINIMUM: x = 50.0, y = 110.0, r = 25.4, FS = 1.646

Grid search; initial parameters:

	initial	final	increment
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x	5.0	30.0	5.0
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y	178.0	220.0	5.0
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radius increment is 0.1

minimum perpendicular depth is 4.0

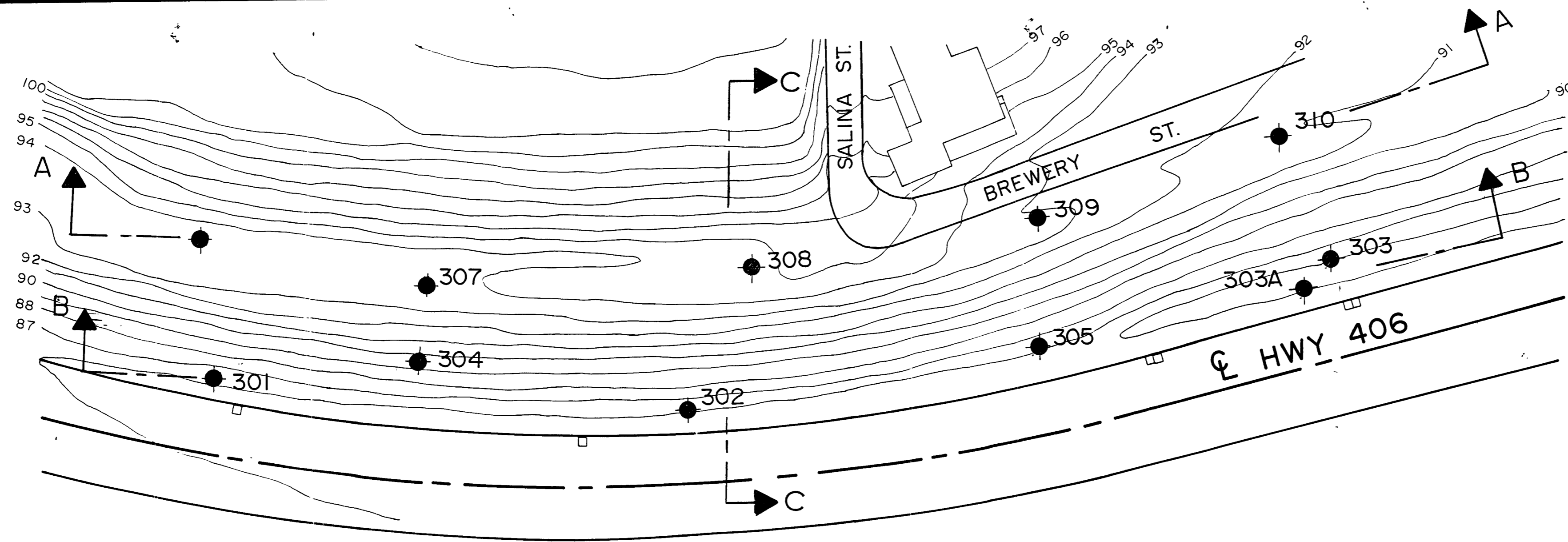
limit at elevation 170.0

MINIMUM FOR CENTER:	x =	5.0,	y =	178.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	183.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	188.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	193.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	198.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	203.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	208.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	213.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	5.0,	y =	218.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	178.0,	r =	0.0,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	183.0,	r =	5.6,	FS =	3.865
MINIMUM FOR CENTER:	x =	10.0,	y =	188.0,	r =	10.5,	FS =	3.406
MINIMUM FOR CENTER:	x =	10.0,	y =	193.0,	r =	10.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	198.0,	r =	10.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	203.0,	r =	10.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	208.0,	r =	10.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	213.0,	r =	10.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	10.0,	y =	218.0,	r =	10.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	15.0,	y =	178.0,	r =	10.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	15.0,	y =	183.0,	r =	8.7,	FS =	1.880
MINIMUM FOR CENTER:	x =	15.0,	y =	188.0,	r =	12.1,	FS =	1.826
MINIMUM FOR CENTER:	x =	15.0,	y =	193.0,	r =	16.7,	FS =	1.955
MINIMUM FOR CENTER:	x =	15.0,	y =	198.0,	r =	21.4,	FS =	2.133
MINIMUM FOR CENTER:	x =	15.0,	y =	203.0,	r =	21.4,	FS =	99.000
MINIMUM FOR CENTER:	x =	15.0,	y =	208.0,	r =	21.4,	FS =	99.000
MINIMUM FOR CENTER:	x =	15.0,	y =	213.0,	r =	21.4,	FS =	99.000
MINIMUM FOR CENTER:	x =	15.0,	y =	218.0,	r =	21.4,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	178.0,	r =	21.4,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	183.0,	r =	9.8,	FS =	1.595
MINIMUM FOR CENTER:	x =	20.0,	y =	188.0,	r =	14.3,	FS =	1.438
MINIMUM FOR CENTER:	x =	20.0,	y =	193.0,	r =	18.8,	FS =	1.425
MINIMUM FOR CENTER:	x =	20.0,	y =	198.0,	r =	23.6,	FS =	1.525
MINIMUM FOR CENTER:	x =	20.0,	y =	203.0,	r =	28.7,	FS =	1.655
MINIMUM FOR CENTER:	x =	20.0,	y =	208.0,	r =	32.5,	FS =	1.806
MINIMUM FOR CENTER:	x =	20.0,	y =	213.0,	r =	32.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	20.0,	y =	218.0,	r =	32.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	178.0,	r =	32.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	183.0,	r =	32.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	188.0,	r =	32.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	193.0,	r =	32.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	198.0,	r =	32.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	203.0,	r =	32.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	208.0,	r =	32.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	213.0,	r =	32.5,	FS =	99.000
MINIMUM FOR CENTER:	x =	25.0,	y =	218.0,	r =	43.6,	FS =	1.669
MINIMUM FOR CENTER:	x =	30.0,	y =	178.0,	r =	43.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	183.0,	r =	43.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	188.0,	r =	43.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	193.0,	r =	43.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	198.0,	r =	43.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	203.0,	r =	43.6,	FS =	99.000
MINIMUM FOR CENTER:	x =	30.0,	y =	208.0,	r =	43.6,	FS =	99.000

MINIMUM FOR CENTER: $x = 30.0$, $y = 213.0$, $r = 42.6$, $FS = 99.000$

MINIMUM FOR CENTER: $x = 30.0$, $y = 218.0$, $r = 42.6$, $FS = 99.000$

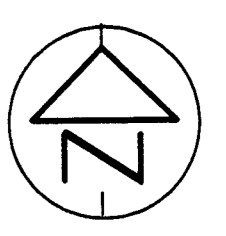
OVERALL MINIMUM: $x = 20.0$, $y = 188.0$, $r = 13.7$, $FS = 1.267$ - low FS



PLAN
SCALE 10 5 0 10 20m

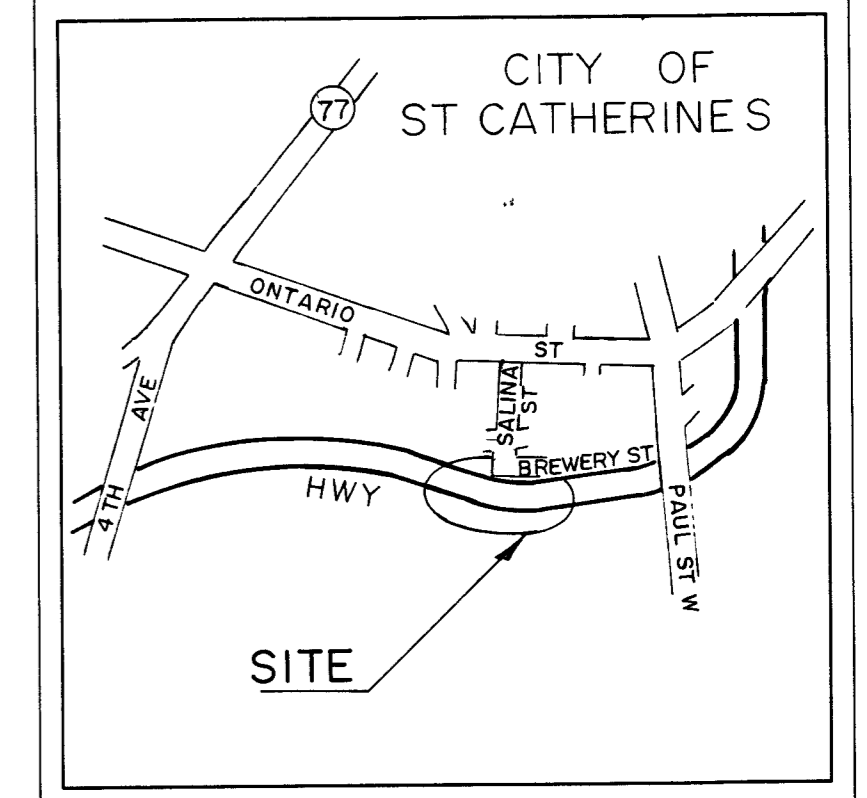
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No	WP No
HWY 406 / 4TH AVE.	
BORE HOLE LOCATIONS & SOIL STRATA	



SHEET

**McCLYMONT & RAK
ENGINEERING INC.**

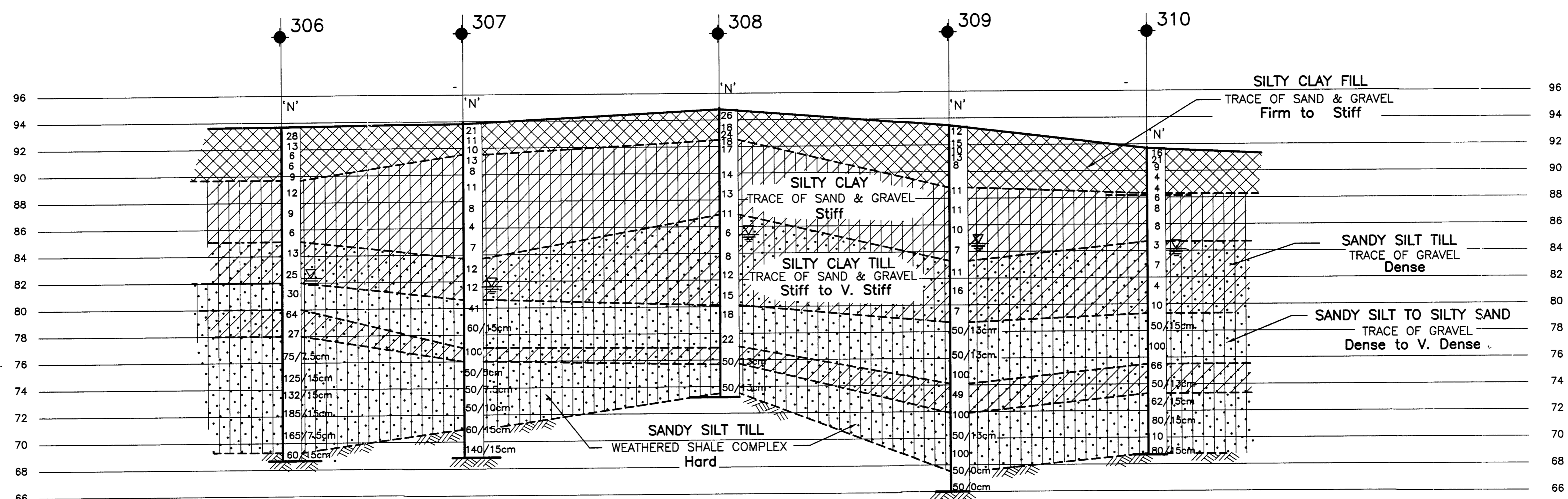


KEY PLAN
NTS

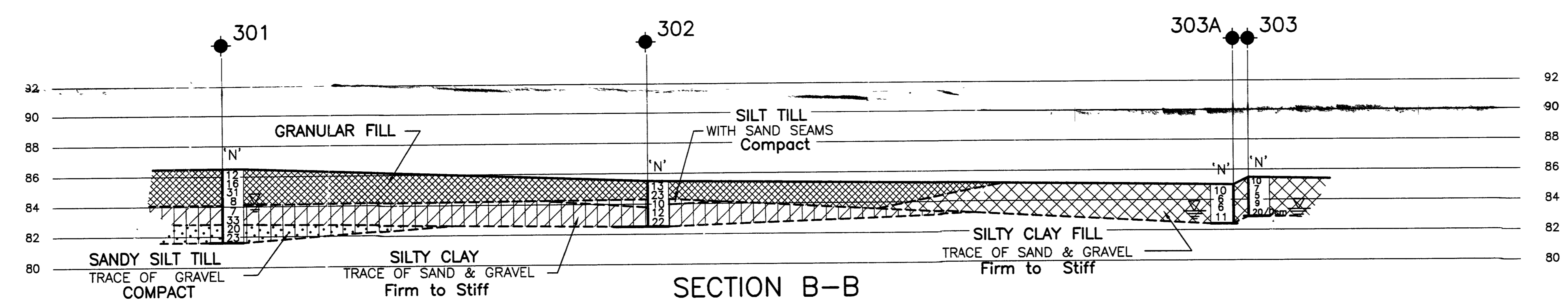
LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475J/blow)
- CONE Blows/0.3m (60° Cone, 475J/blow)
- WL at time of investigation Nov. 1996
- ▽ Head Artesian Water
- ⊥ Piezometer

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
301	86.5	4 779 218	324 927
302	85.5	4 779 176	324 982
303	85.5	4 779 142	325 074
303A	85.0	4 779 142	325 071
304	90.7	4 779 205	324 956
305	88.5	4 779 158	325 039
306	93.8	4 779 237	324 937
307	93.7	4 779 212	324 981
308	94.8	4 779 189	325 003
309	83.4	4 779 170	325 040
310	91.7	4 779 181	325 075



SECTION A-A



SECTION B-B

SCALE
HOR. 5 2.5 0 10 20m
VERT. 4 2 0 4 8

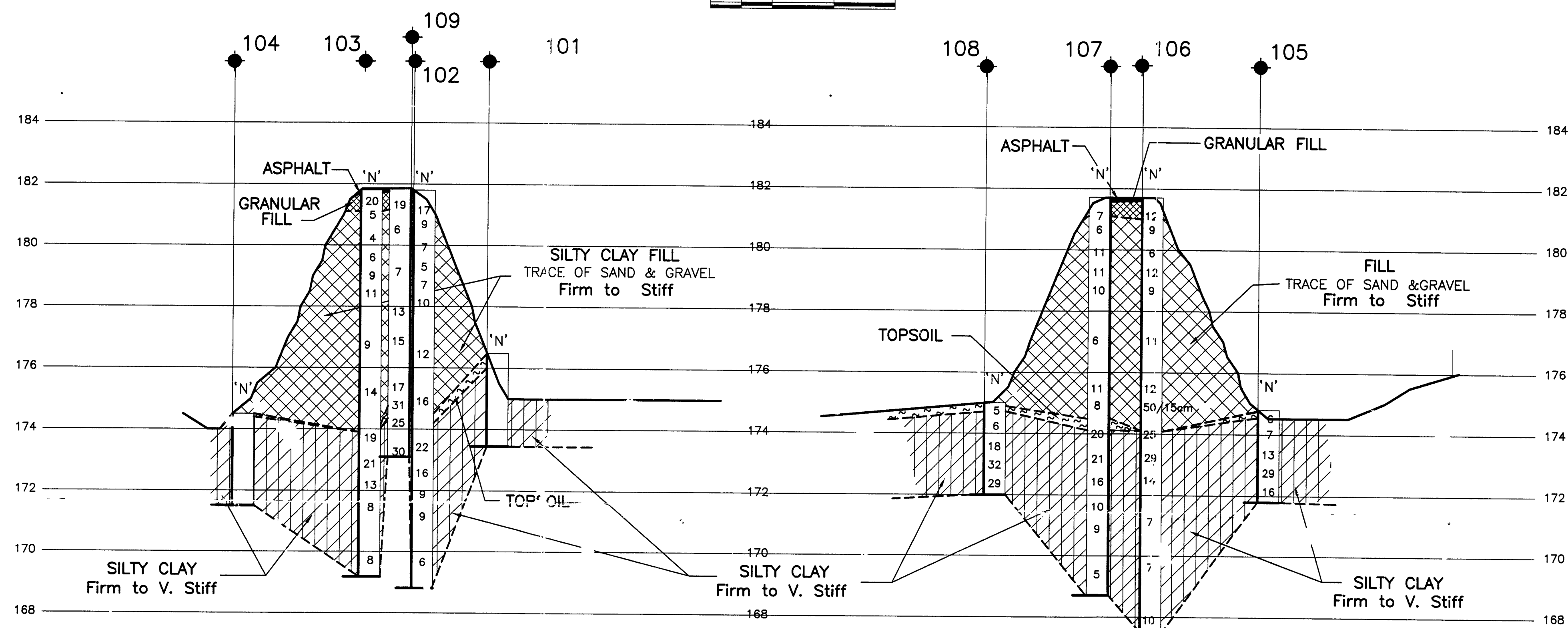
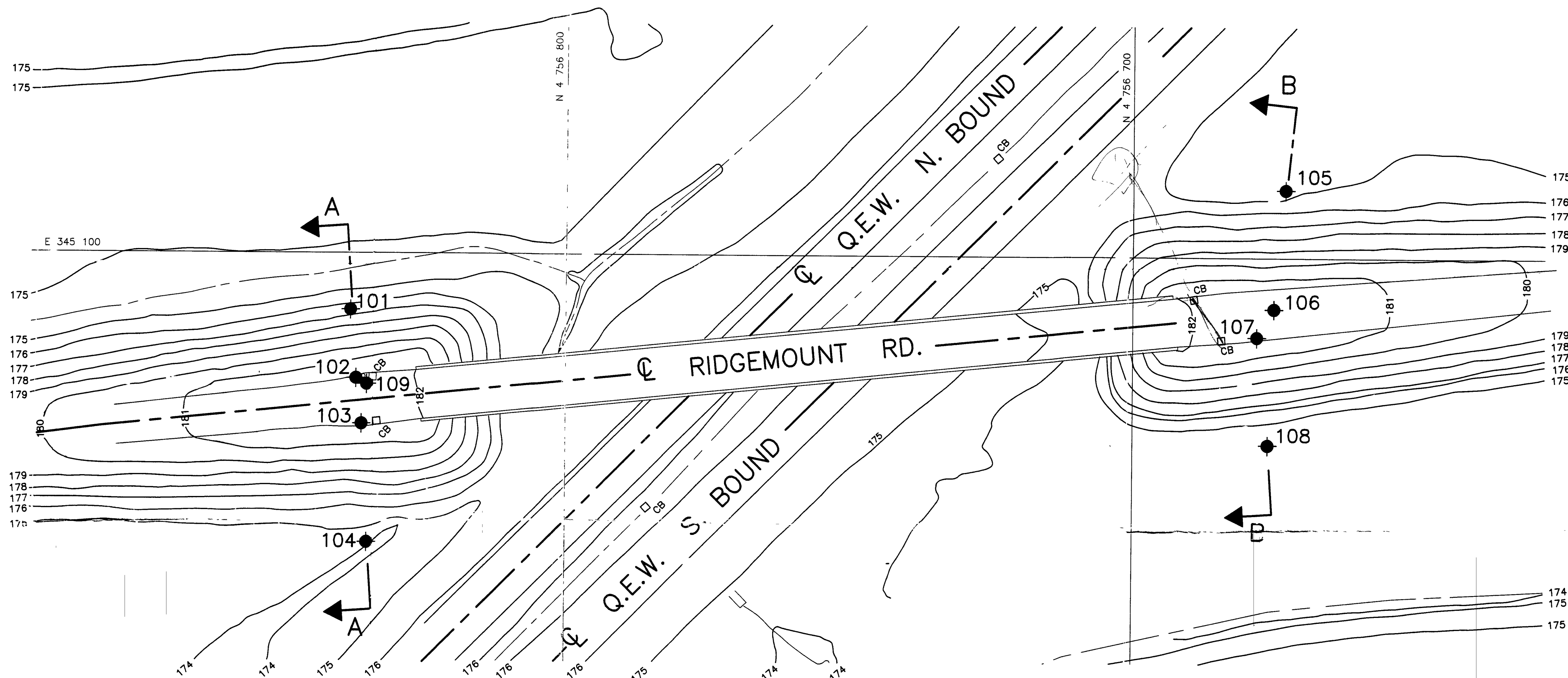
NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Hole 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 office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

DATE	BY	DESCRIPTION

HWY No	Q.E.W./406	DIST	
SUBM'D	CHECKED	DATE	AUG. 28, 98
DRAWN	DW	CHECKED	APPROVED
SITE	G 2039-3	DWG	SP-3



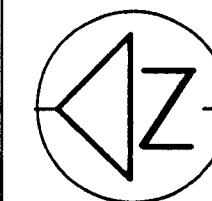
METRIC

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

CONT No
WP No

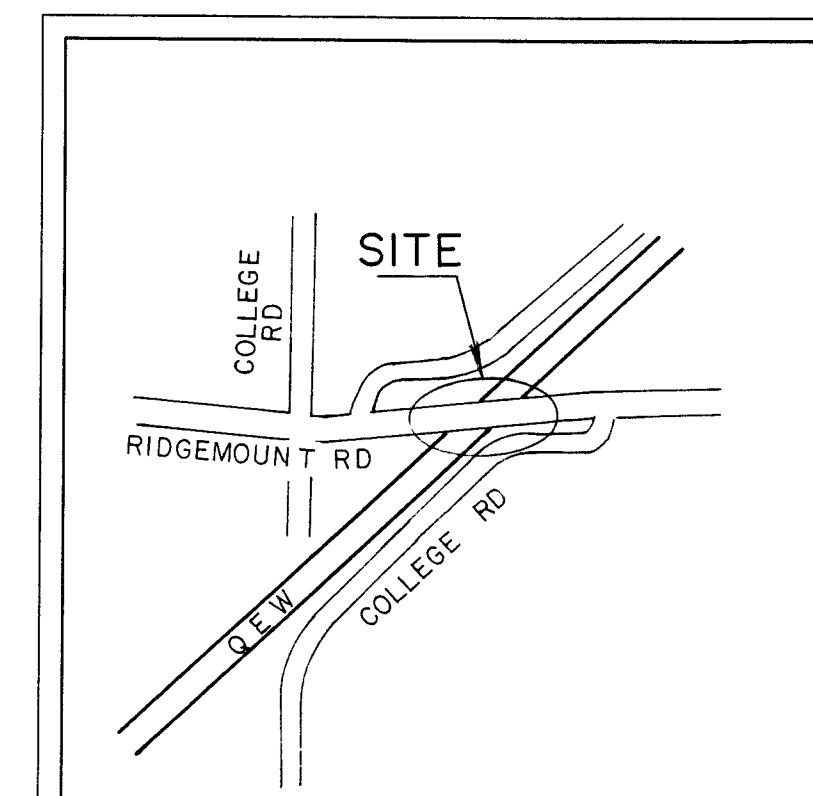
QEW & RIDGEMOUNT ROAD

BORE HOLE LOCATIONS & SOIL STRATA



SHEET

**McCLYMONT & RAK
ENGINEERING INC.**



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475J/blow)
- CON Blows/0.3m (60° Cone, 475J/blow)
- WL at time of investigation Nov. 1996
- ⊕ Head Artesian Water
- ⊕ Piezometer

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
101	175.0	4 756 838	345 090
102	181.8	4 756 837	345 078
103	181.8	4 756 836	345 070
104	174.5	4 756 835	345 049
105	174.8	4 756 673	345 112
106	181.7	4 756 675	345 091
107	181.7	4 756 678	345 086
108	175.0	4 756 676	345 067
109	181.9	4 756 834	345 098

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Hole 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 office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.







REV.	DATE	BY	DESCRIPTION
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HWY No	Q.E.W./RIDGEMOUNT ROAD	DIST
SUBM'D	CHECKED	DATE AUG. 28, 98
DRAWN DW	CHECKED	APPROVED
		SITE G 2039-1
		DWG SP-1

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



QEW & NETHERBY ROAD
BORE HOLE LOCATIONS & SOIL STRATA

	Bore Hole
	Dynamic Cone Penetration Test (Cone)
	Bore Hole & Cone
N	Blows/0.3m (Std Pen Test, 475J/blow)
CONE	Blows/0.3m (60° Cone, 475J/blow)
	WL at time of investigation Nov. 1996
	Head Artesian Water
	Piezometer

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
201	181.7	4 758 973	343 316
202	176.4	4 758 800	343 330

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Hole 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 office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV.			
	DATE	BY	DESCRIPTION

HWY No	Q.E.W./NETHERBY ROAD		DIST
SUBM'D	CHECKED	DATE AUG. 28, 98	SITE G 2039-2
DRAWN DW	CHECKED	APPROVED	DWG SP-2

PLAN

SCALE

10 5 0 10 20m

201 202

SECTION A-A