GEOCRES # 30M5-213

PROJECT NO: SM 98111-GA

MAY 4, 1998

FOUNDATION INVESTIGATION
PROPOSED OAKVILLE NORTH INSPECTION STATION UPGRADE
3.5KM EAST OF BRONTE ROAD
OAKVILLE, ONTARIO
CONTRACT WP 2506 - 97 - 00

PREPARED FOR:

STANLEY CONSULTING GROUP LTD.

Soil-Mat

BY

SOIL-MAT ENGINEERS AND CONSULTANTS LTD.
130 LANCING DRIVE
HAMILTON, ONTARIO
L8W 3A1

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PROJECT NO.: SM 98111-GA

May 4, 1998

STANLEY CONSULTING GROUP LTD.
1400 Rymal Road East
Hamilton, Ontario
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Attention: Mr. F. Evan Wilson, P. Eng.
Manager, Highway Department

FOUNDATION INVESTIGATION
PROPOSED OAKVILLE NORTH INSPECTION STATION UPGRADE
3.5KM EAST OF BRONTE ROAD, OAKVILLE, ONTARIO
CONTRACT WP 2506 - 97 - 00

Dear Mr. Wilson,

Further to your verbal authorization, we have completed the fieldwork and laboratory testing associated with the above noted project. Our comments and recommendations, based on our findings at the three borehole locations, are presented in the following paragraphs.

1. INTRODUCTION

It is understood that the proposed project will consist of the construction of a single storey basementless addition to the west side of the existing inspection station Construction will include the installation of underground services, concrete walkways, asphalt paved access roads and parking lot areas. The purpose of this geotechnical investigation was to determine the subsurface conditions at the three borehole locations and to provide our comments and recommendations to the design team from a geotechnical point-of-view. The information contained in this geotechnical investigation report in no way reflects upon the environmental aspects of the site and therefore have not been addressed in this document, as this information is beyond the formatted scope and terms of reference.

This report is provided on the basis of the aforementioned description of the project and on the assumption that the design will be in accordance with applicable codes and standards. If there are any changes to the design features relevant to the geotechnical analyses, or if any queries arise regarding the geotechnical aspects, then this office must be contacted to review the design.

2. PROCEDURE

Three [3] boreholes were advanced at the locations indicated on the enclosed Borehole Plan, Drawing 1. The boreholes were advanced with solid stem continuous flight auger equipment on March 26, 1998 under the direction and supervision of a staff member of Soil-Mat Engineers & Consultants Ltd. [SOIL-MAT]. The boreholes were advanced to a depth of about 2.4 to 2.7 metres below grade.

Representative samples of the subsoils were recovered from the boreholes using a split barrel sampler driven in accordance with the Standard Penetration Resistance [N value] test procedure as required under CSA test specification A 119.1 [ASTM test specification D1586]. After undergoing a general field examination, the samples were preserved and transported to the Soil-Mat laboratory for analyses. In the laboratory the samples were identified as to their visual, textural and olfactory characteristics. Moisture content testing was carried out on all of the soil samples.

Details of the conditions encountered in the borings, together with the results of the field and laboratory tests, are presented on the Borehole Log Nos. 1A, 2A and 3A. The boreholes were located in the field by representatives of Soil-Mat Engineers.

3. SITE DESCRIPTION AND SUBSOIL CONDITIONS

The proposed addition will be constructed on the west side of the existing inspection station building located on the north side of the Queen Elizabeth Highway about 3.5 kilometres east of Bronte Road in Oakville, Ontario. The subject property is relatively flat and primarily covered with a veneer of asphalt pavement.

Detailed descriptions of the subsoils encountered in the boreholes, together with the laboratory test results are presented in the Borehole Log Nos. 1A, 2A and 3A, following the text of this document. It must be stressed that the boundaries of soil types indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and therefore should not be construed as exact planes of geological change.

A brief summary of the stratigraphy encountered at the borehole locations follows

Borehole No. 1A

A fill material was found to depth of about one metre below the existing grade. The fill material was found to consist of a crusher run limestone material mixed with silty clay in the lower level. A stiff silty clay fill was found beneath the upper granular fill material. Weathered Queenston Shale bedrock was proven to underlie the silty clay fill. The upper levels of the Queenston Shale are considered to be highly weathered and exhibit properties of soil [higher moisture content, high Slaking and a low Durability Index]. The shale became more sound and exhibited lower moisture contents with increasing depth. More resistant layers were occasionally encountered in the Queenston Shale. The Queenston Shale bedrock was proven to the termination depth of the borehole.

Borehole No. 2A

A 100 millimetre veneer of topsoil overlying a compact granular fill material was encountered in Borehole No. 2A. Weathered Queenston Shale was proven to underlie the granular fill material. The upper levels of the Queenston Shale are considered to be highly weathered and exhibit properties of soil [higher moisture content, high Slaking and a low Durability Index]. The shale became more sound and exhibited lower moisture contents with increasing depth. More resistant layers were occasionally encountered in the Queenston Shale. The Queenston Shale bedrock was proven to the termination depth of the borehole.

Borehole No. 3A

A pavement structure consisting a 125 millimetres of asphaltic concrete over a 225 millimetre granular base layer was encountered in Borehole No. 3A. Weathered Queenston Shale was proven to underlie the pavement structure. . The upper levels of the Queenston Shale are considered to be highly weathered and exhibit properties of soil [higher moisture content, high Slaking and a low Durability Index]. The shale became more sound and exhibited lower moisture contents with increasing depth. More resistant layers were occasionally encountered in the Queenston Shale. The Queenston Shale bedrock was proven to the termination depth of the borehole.

Groundwater Comments

Free groundwater was encountered during the course of the fieldwork and our observations have been recorded as footnotes on the borehole logs. This data indicates that groundwater was encountered at a depth of 0.6 metres in Borehole No.

2A and at a depth of 1.2 metres in Borehole 3A following withdrawal of the augers. Borehole No. 1A was noted to be 'dry' and backfilled on completion. Groundwater must be expected into the excavations, during construction, from within the overlying fill material and from more permeable seams and pockets in the Queenston Shale and from surface runoff. It should be possible to control and remove any groundwater using conventional 'dewatering' techniques, such as, pumping form sumps and ditches.

4. FOUNDATION CONSIDERATIONS

The native subsoil conditions, at the borehole locations [Borehole Nos. 1A and 2A] were found to be such as to be able to support the proposed one storey basementless addition on conventional spread footings. The footings may be designed employing an allowable net bearing pressures of up to 250 kPa [~5,000 psf] founded on weathered Queenston Shale encountered in the borings.

All footings exposed to the environment must be provided with a minimum of 1.2 metres of earth cover or equivalent insulation to protect against frost penetration. This frost protection would also be required if construction is undertaken during the winter months. All footings must be proportioned as required above and by the Ontario Provincial Building Code.

With the footings set on the native weathered Queenston Shale, total and differential settlements of the structure are expected to remain well below the normally tolerated limits of 25 and 20 millimetres, respectively; provided that careful attention is paid to construction detail and the aforementioned bearing pressure is not exceeded. Some minor differential settlements should be expected between the addition and the existing building, thus requiring some mechanism whereby these relative movements can be accommodated.

In sections where it will be necessary to have adjacent footings at different founding levels, the lower footing should be constructed before the higher footing is constructed, if possible, and the higher footing should be set below an imaginary line drawn up from the edge of the lower footing at 10 horizontal to 7 vertical. The addition footing level must coincide with the existing adjacent footings. This procedure would limit the stress transference to the lower footings. This concept would also apply to service trenches and the like.

In order to ensure compliance with the design concepts, the engineering recommendations of this report, and to allow for design changes in the event of actual subsurface conditions which differ from the conditions anticipated as a result of this investigation; it is imperative that a soils engineer from this office be retained to provide geotechnical engineering services during the excavation and foundation construction phases of the project.

5. EARTHQUAKE DESIGN CONSIDERATIONS

The Ontario Building Code Act, Ontario Regulation 413/90, specifies that all buildings shall be designed to withstand an equivalent lateral force representing elastic response, V_e, which is assumed to act non-concurrently in any direction according to the following formula:

$$V_e = v.S.I.F.W.$$

where, v, the zonal velocity ratio for the Oakville area is 0.05 and the foundation factor, F, applicable to the site subsoil conditions is 1.0. The other terms are evaluated by the structural engineers.

6. FLOOR SLAB AND PERMANENT DRAINAGE

The building floor slab maybe constructed using conventional slab-on-ground techniques on a prepared subgrade. The topsoil material must be removed and the exposed subgrade surface should then be examined and proofrolled with a large smooth drum compactor in the presence of a representative of Soil-Mat. Any soft spots delineated by this or other means must be subexcavated and replaced with quality backfill material. The existing pavement structure and granular fill material may remain beneath the proposed floor slab area. The subgrade level can be brought to design level with a well graded granular fill material compacted to 100 per cent of its standard Proctor density.

A moisture barrier will be required beneath floor slabs to act as a 'capillary' break. A recommended moisture barrier consists of at least 200 millimetres of well compacted 20 millimetre clear crushed stone. In any event the moisture barrier material should contain no more than 10 per cent passing the No. 4 sieve.

A permanent perimeter drainage tile system will only be required around areas where the interior floor slab-on-ground elevation is less than 300 millimetres above the final exterior grade. The exterior grade around the structure should be sloped away from the structure.

7. EXCAVATIONS

It is anticipated that the excavations for the proposed sewer and other underground services will extend to depths of about 3 metres below present grade. The upper level of the Queenston Shale bedrock [1 to 2 metres], is highly weathered, and should yield to a heavy hydraulic excavator equipped with 'rock' teeth. However, the rate of excavation will become slower for deeper excavations, or where more resistant layers are encountered, and therefore the use of mechanical rock splitters may be necessary. Excavation side slopes in the Queenston Shale should remain stable at near vertical slopes to the depths anticipated for construction. Side slopes in the overlying fill material should remain stable for temporary construction at a slope of 45 degrees to the horizontal. All excavations must comply with the current Occupational Health and Safety Act and Regulations for Construction Projects.

Some seepage of groundwater 'perched' in the overlying fill materials and from groundwater 'trapped' in more permeable seams in the Queenston Shale and from surface runoff should be anticipated in the excavations. However it should be possible to adequately control this water using conventional construction "dewatering" techniques, such as, pumping from sumps and ditches. Substantially more water control may be required when connections are made to existing underground services.

7. BACKFILL CONSIDERATIONS

The majority of excavated material on this project will consist of Queenston Shale bedrock. It is cautioned that Queenston Shale used, as backfill will continue to settle for many years if it is not properly graded, even if it is well compacted. Individual particles in the Queenston Shale backfill will soften with time as water gains access. The contact points between the hard shale particles begin to crush/fail and squeeze together, allowing the backfill to settle into a tighter mass. This process requires significant time since the water must gain access to the backfill under the pavement structure. Consequently, settlements may continue for a number of years, necessitating repeated padding of the pavement surface and delaying the placement of the surface course asphalt layer. We would suggest that the Queenston Shale material be restricted for use as backfill within the proposed addition area.

To render the excavated Queenston Shale suitable for backfilling purposes, it must be broken down into a well graded material. This could be achieved by excavating the shale in a manner that would result in particle sizes no larger than 100 to 150 millimetres and 'working' the material to achieve the requisite well graded product. The potential high 'fines' content of this material would be of little concern. Ideally, the well graded material would be allowed to sit in relatively thin layers stockpiled beside the trench to allow it to absorb water and to weather before it is returned to the trench as backfill. The weathered shale material would be further broken down by dozers blading the material during placement and by the compaction equipment. However, since it may be impractical, from a logistics point-of-view, to stockpile the shale material along side the trenches for even a few days, the contractor should be prepared to add water to the Queenston Shale backfill, possibly as much as 10 per cent by weight of the backfill material placed, and be prepared to provide additional compactive effort. The shale backfill must be placed in lifts no greater than 200 to 300 millimetre, loose thickness, and compacted with a large [10 ton] pad-toe or sheepsfoot vibratory compactor until the specified compaction has been achieved. The time required and the amount of compactive effort required will be a function of the Slaking and Durability properties of the Queenston Shale backfill and will therefore be best assessed in the field at the time of construction. Special care will be required in compacting the shale fill around the manholes and catchbasins, and near the end of compaction runs or where access is not readily available for the equipment being employed on the project. Imported granular material should be employed around all manholes and catchbasins to minimize settlement problems.

The fill required in service trenches or to raise the subgrade elevation should have its moisture contents within 3 per cent of its optimum moisture content and meet the necessary environmental guidelines.

The backfilling and compaction operations should be monitored by a representative of Soil-Mat to confirm uniform compaction of the backfill material to project specification requirements. The backfill material should be compacted to 100 per cent of its Standard Proctor maximum dry density within the building area and 95 per cent elsewhere. The Queenston Shale fill should be compacted to 100 per cent standard Proctor maximum dry density. The lift thickness would depend on the moisture content of the backfill material and size of compaction equipment used by the contractor. A method should be developed to assess compaction efficiency employing the on-site compaction equipment and backfill materials during construction. Under optimum moisture conditions, 200 millimetre lift thickness are the norm.

8. GENERAL COMMENTS

The comments provided in this document are intended only for the guidance of the design team. The borehole descriptions and logs are not to be considered descriptive of the conditions at locations other than at the borehole locations. Contractors bidding on or undertaking this project should decide on their own exploration and own interpretation of the factual borehole results, so that they might decide on how the subsurface conditions will effect their operations.

We trust that this geotechnical report is sufficient for your purposes. We will be contacting you shortly should you require any clarification to this document or need any additional information.

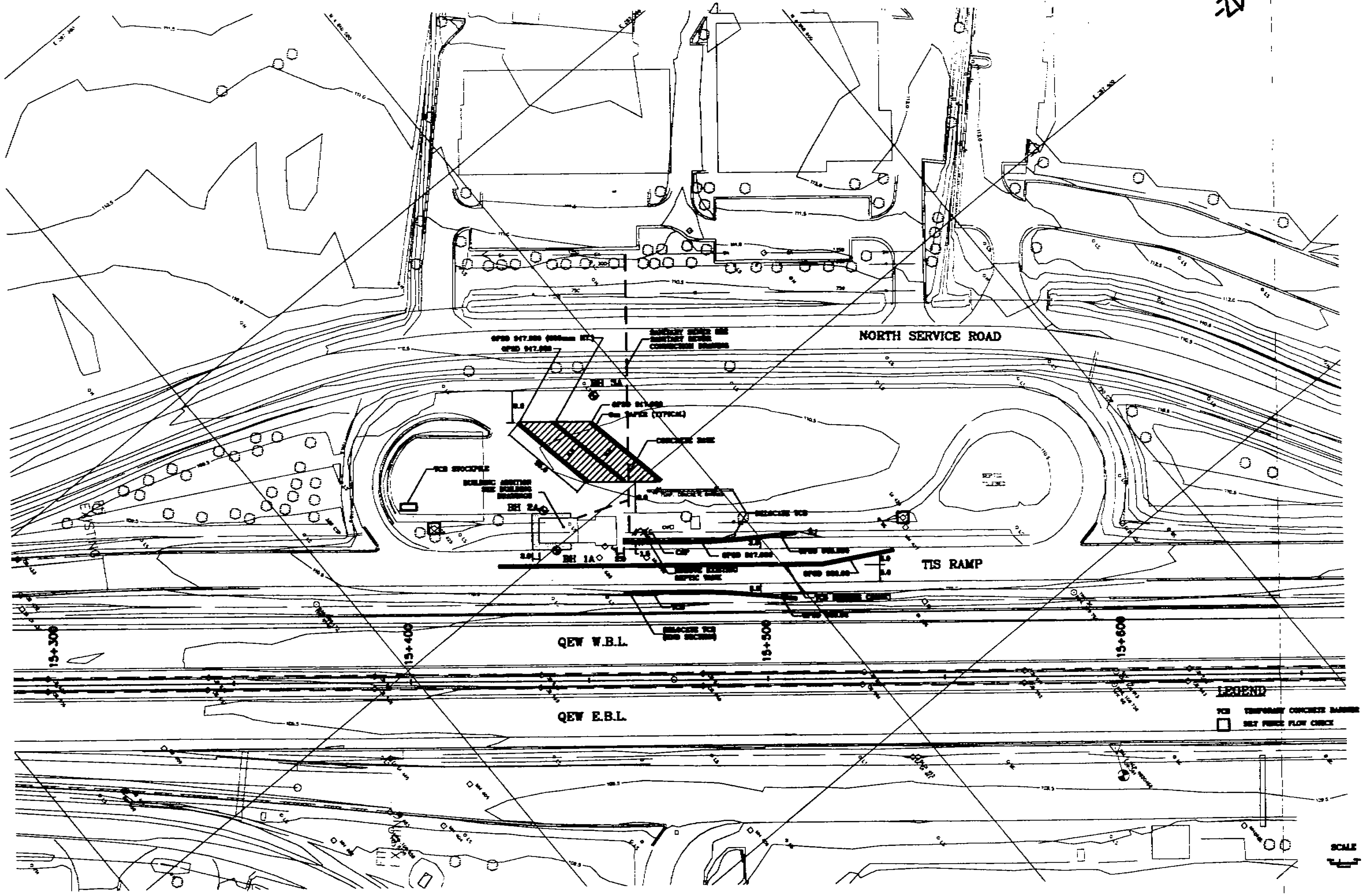
Yours very truly,
SOIL-MAT ENGINEERS & CONSULTANTS LTD.

John Monkman, P. Eng.
Project Engineer

Robert Horvath, Ph.D., P. Eng.
Review Engineer

Enclosures: Drawing 1, Plan Showing Borehole Locations
Borehole Log Nos. 1A, 2A and 3A

Distribution: Stanley Consulting Group Ltd. [4]



Drawing provided by Stanley Consulting Group Ltd.

LEGEND

BH 1A ⊕ Borehole

NOTES:

1. This drawing should be read in conjunction with Soil-Mat Engineers & Consultants Ltd. report number SM98111-GA.
2. Soil samples will be discarded after 3 months unless directed otherwise by client.

Soil-Mat Engineers & Consultants Ltd.

CLIENT
Stanley Consulting Group Ltd.

PROJECT TITLE
G.I.: Oakville North Truck Inspection Station
Q.E.W. 3.5km E of Bronte Rd.
Oakville, Ontario

DRAWING TITLE
Plan Showing Borehole Locations

PROJECT No.	SM98111-GA
SCALE	As Shown
DATE	May 1998
DESIGN	
DRAWN	
CHK'D	
FILENAME	111GA1SS.DWG

Drawing 1

Project No: SM 98111-GA

Project: Truck Inspection Station

Location: Oakville, Ontario

Client: Stanley Consultants

Borehole # 1A

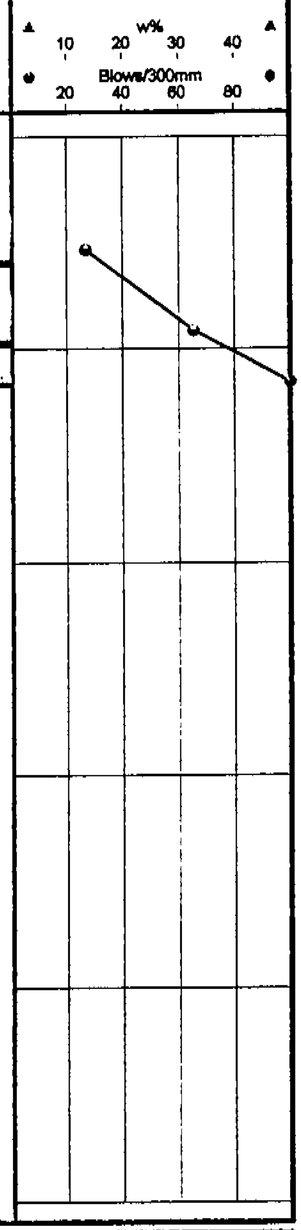
Borehole Location: As per Drawing

Project Manager: John Monkman, P. Eng.

Soil-Mat

SUBSURFACE PROFILE				SAMPLE					
Depth	Symbol	Description	Depth/Elev.	Type	Number	Blows/300mm	PP (kgf/cm2)	U.Wt.(kN/m3)	Recovery
ft m 0		Ground Surface	0						
		Fill 25mm Minus Crusher Run Limestone, mixed with reddish brown silty clay in lower level.	0						
			1	SS	1	27			
		Silty Clay Fill Reddish brown, stiff.	1.3						
		Queenston Shale Reddish brown, occasional greenish grey seams, becoming sounder with depth, weathered.	-1.3	SS	2	66			
			2.36	SS	3	50for3			
		End of Borehole	-2.36						

Moisture Content/Std. Penetration 'N'



NOTES:
1. Borehole advanced with hollow stem continuous flight augers to 2.36m depth on March 26, 1998.
2. Soil samples will be kept for 3 months unless otherwise directed by client.

Drill Method: Hollow Stem

Drill Date: March 26, 1998

Hole Size: 200mm

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Checked by: JM

Sheet: 1 of 1

Project No: SM 98111-GA

Project: Truck Inspection Station

Location: Oakville, Ontario

Client: Stanley Consultants

Borehole # 2A

Borehole Location: As per Drawing

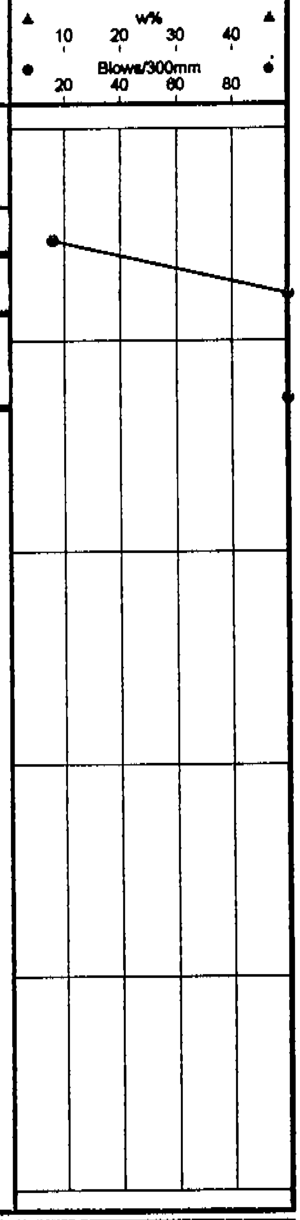
Project Manager: John Monkman, P. Eng.

Soil-Mat

SUBSURFACE PROFILE / SAMPLE

Depth (ft / m)	Symbol	Description	Depth/Elev.	Type	Number	Blows/300mm	PP (kgf/cm2)	U.Wt.(kN/m3)	Recovery
0 / 0		Ground Surface	0						
		Granular Fill Approximately 225mm.	0.23 / -0.23						
		Queenston Shale Reddish brown occasional greenish grey seams, highly weathered in upper level, becoming sounder with depth.		SS	1	16			
				SS	2	60for4			
			2.66 / -2.66	SS	3	87for3			
		End of Borehole							

Moisture Content/Std. Penetration 'N'



NOTES:
1. Borehole advanced with hollow stem continuous flight augers to 2.66m depth on March 26, 1998.
2. Soil samples will be kept for 3 months unless otherwise directed by client.

Drill Method: Hollow Stem

Drill Date: March 26, 1998

Hole Size: 200mm

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Sheet: 1 of 1

Project No: SM 98111-GA

Project: Truck Inspection Station

Location: Oakville, Ontario

Client: Stanley Consultants

Borehole # 3A

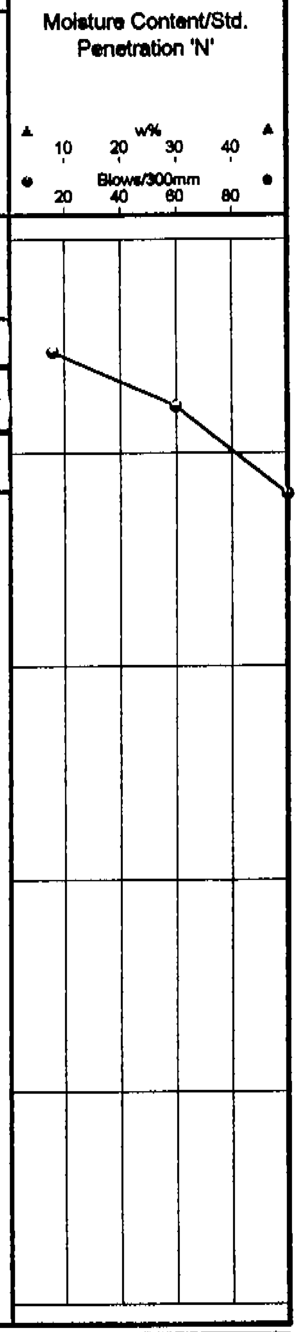
Borehole Location: As per Drawing

Project Manager: John Monkman, P. Eng.

Soil-Mat

Depth (ft / m)	Symbol	SUBSURFACE PROFILE – Description	Depth/Elev.	SAMPLE – Type	Number	Blows/300mm	PP (kgf/cm2)	U.Wt.(kN/m3)	Recovery
0 ft / 0 m		Ground Surface	0						
		Granular Fill Approximately 225mm.	0.23 / -0.23						
		Queenston Shale Reddish brown occasional greenish grey seams, highly weathered in upper level, becoming sounder with increased depth.		SS	1	38			
				SS	2	60			
			2.39	SS	3	60/or4			
		End of Borehole	-2.39						

Depth scale: ft 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32; m 0, 2, 4, 6, 8, 10



NOTES:

1. Borehole advanced with hollow stem continuous flight augers to 2.39m depth on March 26, 1998.
2. Soil samples will be kept for 3 months unless otherwise directed by client.

Drill Method: Hollow Stem

Drill Date: March 26, 1998

Hole Size: 200mm

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Sheet: 1 of 1