PRELIMINARY GEOTECHNICAL INVESTIGATION

CS-6: WILLIAM RUTLEY SOLAR PARK

15041 COLONIAL DRIVE

INGLESIDE, ONTARIO

Date: **January 13, 2011**	Reference No**.: T020822-A6**

INSPEC-SOL
ENGINEERING SOLUTIONS

INSPEC-SOL INC. 179 Colonnade Rd., Suite 400, Nepean, Ontario K2E 7J4 • Tel.: (613) 727-0895 • Fax: (613) 727-0581

Reference No.: T020822-A6

January 13, 2011

Mr. Jeff Roy
Project Manager
Canadian Solar Solutions Inc.
67A Sparks Street, Suite 300
Ottawa, Ontario
K1P 5A5

Re: Preliminary Geotechnical Investigation
CS-6: William Rutley Solar Park
15041 Colonial Drive
Ingleside, Ontario

Dear Mr. Roy,

In accordance with your instructions, Inspec-Sol Inc. (**Inspec-Sol**) has completed a Preliminary Geotechnical Investigation at the above-mentioned Site and is pleased to present the findings.

We trust this information meets with your approval. Please do not hesitate to contact us should any questions arise.

Yours very truly,

INSPEC-SOL INC.

Joseph B. Bennett, P. Eng.
Vice-President

SD/vl

Dist: Mr. Jeff Roy – Email - (jeff.roy@canadian-solar.com),

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1.0 INTRODUCTION

Inspec-Sol Inc**.** (**Inspec-Sol**) was authorized to carry out a Preliminary Geotechnical Investigation for the proposed William Rutley Solar Park which is located at 15041 Colonial Drive in Ingleside, Ontario (Site). Authorization to proceed with this study was provided by Mr. Jeff Roy representing Canadian Solar Solutions Inc. (Client).

The purpose of the investigation was to carry out a preliminary field program to evaluate the subsoil stratigraphy found at test locations; and based upon the collected preliminary data, provide recommendations concerning foundation options and associated bearing pressures, as well as provide comments to assist designers and the Client in regard to excavations, backfill, access roads, underground services, and construction field review.

This report has been prepared with the understanding that the design will be carried out in accordance with all applicable codes and standards. Any changes to the described project will require a review by **Inspec-Sol** to assess the impact of the changes on the report recommendations provided herein. Additional field programs involving boreholes will be carried out in the near future.

The scope of work for **Inspec-Sol** consisted of the following activities:

- **Desktop Study:** Consultation of publicly available soil and bedrock mapping in the vicinity of the Site, if available.
- **Field Work:** Excavation of twelve (12) test pits located approximately equally spaced across the Site;
- **Laboratory Testing:** Submittal of five (5) grab samples to the laboratory for analysis of pH, redox potential, sulfate concentration, chloride concentration, and resistivity; and
- **Analysis and Report:** Review of field results, laboratory testing, and preparation of geotechnical report to provide comments and recommendations for design and construction of the proposed solar farm.

2.0 SITE DESCRIPTION

The proposed solar farm is located at a municipal address of 15041 Colonial Drive in Ingleside, Ontario. The project boundaries form parts of Lot 16 and 17 on Concession 2 in Osnabruck Township. Our understanding of the project boundaries is based on the "Plan View PV System Layout" (Canadian Solar, Ref No. OICI-2010-0071, dated October 18, 2010), received from the Client. The location of the Site within the town of Ingleside is shown on the attached *Site Location Map: T020822-A6-1*

The Site is currently undeveloped and has grass or crop cover. There are localized areas of small tree and brush along the borderlines between the individual fields. It was reported by the Client and Landowner that there is a weeping tile system in place across the Site. The Site topography is relatively flat and appears to be gently sloping downward towards the north. There appeared to be ongoing efforts to clear the land of trees and brush.

3.0 GEOLOGICAL DISCUSSION

The desktop study component of the Preliminary Geotechnical Investigation consisted of consulting publicly available soils and bedrock maps, as well as previous **Inspec-Sol** reports. For this Site, the following resources were consulted:

- Ontario Well Registry Data, updates ongoing;
- "Surficial Geology – Winchester, ON" Geological Survey of Canada, 1982; and
- Two (2) nearby **Inspec-Sol** reports (Cornwall and Finch).

Based on the above sources, the local soils were expected to consist of surficial sands overlying Glacial Till with a significant cobble and boulder content. Bedrock was estimated at a depth of approximately 5 m to 6 m below the surface grade. The bedrock in this area is expected to consist of a limestone of the Trenton Formation.

The groundwater level is reported to be ranging in depth from 2 m to 6 m below the ground surface.

4.0 FIELDWORK

4.1 Test Pit Program

The test pit component of the fieldwork for this Preliminary Geotechnical Investigation was undertaken on November 4, 2010, by means of a rubber tired tractor backhoe, under the supervision of **Inspec-Sol** field staff. A total of twelve (12) test pits were dug to practical refusal or to the full reach of the equipment, within the native till. They were dug to an average depth of 2.5 m blow the existing ground surface. The location of these test pits can be found on the attached *Test Pit Location Plan: T020822-A6-2.*

A leveling survey of the test pit locations was not completed as part of this Preliminary Geotechnical Investigation.

5.0 LABORATORY TESTING

The laboratory testing component of this Preliminary Geotechnical Investigation consisted of the following tests. Five (5) samples were submitted to Maxxam Analytics on November 11, 2010 under chain of custody number 572721. The samples were submitted for the parameters of redox potential, resistivity, sulphate, chloride, and pH. The testing results were received on November 17, 2010, under report number BOG2743. The *Certificate of Analysis* received from the laboratory can be found attached as *Enclosure No.: 3*.

6.0 SUBSOIL CONDITIONS

The soils encountered within the twelve (12) test pit locations, were found to be relatively consistent. In general most test pit locations had organic topsoil overlying a native glacial till. In test pits TP-1, TP-2, and TP-5, a grey more cohesive till was found to be underlying this. The findings of the Preliminary Geotechnical Investigation are in general agreement with the published geology this area.

The subsoil encountered at each test pit location is presented in the *Test Pit Logs* attached as *Enclosure No.:1*. Each soil type is described in more detail in the following sections. The *Results of Laboratory Testing* for each of the submitted samples is presented as *Enclosure No.:* 2, at the end of this report.

6.1 Surficial Topsoil

In all test pit locations, except TP-1, there was found to be a surficial covering of topsoil. This topsoil is described as dark brown with many organics. It was soft in consistency, and was recovered in a moist to wet condition. The thickness of this topsoil layer ranged from approximately 0.2 m in test pits TP-2, TP-3, TP-4, TP-5, TP-6, and TP-11; up to approximately 0.8 m in TP-7. The topsoil descriptions found within this report and in the test pit logs should not be used for quantity takeoffs or quality assessments.

6.2 Sandy Silt with some Clay (Glacial Till)

In all cases the surficial topsoil was found to be underlain by native sandy silt with some clay. Trace amounts of cobbles and boulders were found within this layer in test pits TP-2, TP-4, TP-5, and TP-10. This deposit behaves as a cohesive soil, and was stiff in consistency. The soil was light to medium mottled brown in colour, and it was recovered in a damp to moist condition. Test pits TP-3, TP-4, TP-6, TP-7, TP-8, TP-9, TP-10, TP-11 and TP-12 were terminated within this layer near 3.0 m. Locations TP-8, TP-11, and TP-9 found difficulty of excavation through the cobbles and boulders and terminated at a shallower depth.

6.3 Clayey Silt with some Sand (Glacial Till)

In test pits TP-1, TP-2, and TP-5, the cohesive sandy silt described above was underlain by a clayey silt till. It was found at depths of approximately 3.3 m, 2.7 m, and 2.7 m, respectively. This till can be described as a clayey silt with some sand and trace gravel. It was firm to stiff in consistency and was recovered in a moist to wet condition. It was medium grey in colour. The presence of cobbles, some in excess of 1.2 m in nominal diameter were also noted within this deeper grey till. Test pits TP-1, TP-2, and TP-5 were terminated near 3.0 m within this soil and this depth represents the full reach of the backhoe.

6.4 Bedrock

Bedrock was not encountered within the depth of the test pits at any of the test locations.

7.0 GROUNDWATER CONDITIONS

No standpipes were installed as part of this scope of work.

As there was heavy rain during the day of fieldwork program, it was difficult to indicate the groundwater level, if any, within the test pits. The Site was low-lying and in some areas had standing water near the surface. In test pit TP-6 water infiltration was observed through the wall of the excavation at a depth of approximately 1.4 m. Additionally, based on the grey colour of the deeper till samples, the groundwater level should be expected at a depth of approximately 1 m to 2 m below the existing grade.

A review of the Ontario Well Registry data indicates that the water levels in this area range from approximately 1.5 m to approximately 6.0 m below the ground surface.

It should be noted that the groundwater table is expected to be subject to seasonal fluctuations and precipitation events it is typically at its highest level during the thaw in early spring.

8.0 DISCUSSION AND RECOMMENDATIONS

8.1 Project Description

Based on the information provided by the Client's *Request for Quotation* (Ref No: 2010-06-10, dated June 10, 2010) and the *Plan View PV System Layout* (Canadian Solar, Ref No. OICI-2010-0071, dated October 18, 2010), the proposed project scope is summarized as follows:

- Design forces for solar panel foundations are considered to be 9 kN horizontally, at a height of 1.2 m above the ground surface; 23 kN vertically in the downward direction; and 9 kN vertically in the upward direction;
- The tolerable movement of the foundation systems are 50 mm in the horizontal direction or a maximum settlement of 25 mm in the vertical direction;
- Various concrete slabs for electrical equipment pads are to be installed on grade;
- A network of connecting underground electrical circuits installed in open cut trenches to a maximum depth of 1.8 m; and
- A network of connecting gravel access roads is planned across the Site.

If any of these assumptions are incorrect or these facts change through the design or construction process, **Inspec-Sol** should be notified and retained to assess the impact of these changes from a geotechnical standpoint.

8.2 General Considerations

Based upon the results of the Preliminary Geotechnical Investigation and assuming that they are representative of the soil conditions of this Site, comments and recommendations are offered in the following sections for the solar panels and related infrastructure.

The most significant geotechnical considerations for the design and construction of the proposed project are related to the following:

- Frost protection for solar panel foundation elements; and
- Contract allowances for the presence of cobbles and boulders during drilling and within general excavations.

8.3 Site Preparation

It is expected that site preparation will consist of the removal of trees, brush, topsoil, and root zone to expose the native soils beneath the connecting access roads. Once exposed, native subgrades should be assessed by geotechnical personnel by means of proof rolling under heavy construction equipment, to look for local anomalies or soft spots. The soils on this Site are considered to be sensitive to disturbance by construction traffic as well as moisture damage.

An adequate ditching and pumping system may be necessary in order to collect surface run-off or shallow groundwater, and to provide stable working conditions.

8.4 Excavation and Dewatering

Excavations for the structures and site services for this project are expected to extend to a maximum depth of approximately 2.0 m below the existing surface grade.

All excavations should be completed and maintained in accordance with the Occupational Health and Safety Act (OHSA) requirements. Based on the results of the Geotechnical Investigation, the native soils encountered within the expected excavation depth are considered to be a “Type 2 Soils”, as defined in the OHSA Regulations for Construction.

Any excavated soils should be handled, transported and disposed of in an environmentally suitable manner meeting all current environmental legislation.

The groundwater level has been estimated to be between approximately 1.5 to 2.5 m below the existing ground surface. Groundwater infiltration into excavations should be expected. This seepage will require adequate handling so as to minimize interference with construction.

8.5 Solar Panel Foundations

Based on the project description in *Section 8.1*, the foundation options that the Client typically considers consist of either pad foundations systems founded on the native glacial till, piles (driven or drilled), or helical pile foundation systems advanced into the native glacial till. Designers and Contractors should consider the soil descriptions contained within this report carefully to asses the advantages of each foundation system. Again, it should be noted that frequent cobbles and boulders are likely to be present on this Site which may interfere with the advancement of any foundation system.

8.5.1 Pad Foundations Systems

Based on the results of this Preliminary Geotechnical Investigation, the recommended preliminary design bearing capacity for pad foundations founded on the native glacial till is 150 kPa under Serviceability Limit States (SLS) conditions and 350 kPa (factored) under Ultimate Limit States (ULS) conditions. For footings founded on the native till and designed using the recommended bearing pressures under SLS conditions is expected to be less then 25 mm total and 12 mm differential.

Due to the frequency of cobbles and boulders observed during the fieldwork, it is recommended that an allowance for the excavation of cobbles, boulders be included within the Contract Documents.

8.5.2 Helical Pile Foundation Systems

It is understood that the Client is considering the use of helical pile foundation system to support the solar panel arrays. Helical systems are typically proprietary and we would recommend that the information presented below is to assist Designers with selection of approximate numbers of anchors and foundation or cap details. However, we recommend that the final tender documents allow for this item to be a “Design/Build” type. The Designers and Contractor should be aware that installation may be difficult due to the presence of cobbles and boulders in the native till. And that this Site is not ideally suited for this foundation option.

If used, helical pile foundation systems should be installed to a depth such that all helixes are below the frost depth, which is considered to be 1.8 m for unheated or isolated structures in this area. Furthermore, if adhesion between the steel stem and the native soil is considered in the design, it should be considered to be nil (0) within this 1.8 m frost zone.

The following parameters are provided for the preliminary concept design of helical piles. It should be noted that these parameters may be later adjusted based on the results of the upcoming borehole fieldwork program and the accompanying laboratory testing program.

Table 1: Suggested Parameters for Screw Piles for Preliminary Design

GEOTECHNICAL PARAMETER	PRELIMINARY DESIGN VALUE
Average Unit Weight of Native Till [γ]	20 kN/m^3
Adhesion Between Till and Steel [f_s]	40 kPa*
End Bearing Capacity in Native Till [Q]	100 kPa (SLS)
End Bearing Capacity in Native Till [Q]	300 kPa (factored ULS)**

* According to the Canadian Foundation Engineering Manual (CFEM-2006) adhesion between the native soils and stem should not be considered in the design if the stem has a diameter of less than 100 mm.

** Based on a geotechnical resistance factor of (Φ = 0.4);

It is recommended that a compression load testing program be performed on several of the helical piles at the outset of the project to verify that design capacities are being achieved in the field.

Again, due to the frequency of cobbles and boulders observed during the fieldwork, it is recommended that an allowance for cobbles and boulders be included within the Contract Documents.

8.5.3 Resisting Foundation Uplift

Regardless of the foundation system selected, uplift capacities are assumed to be resisted by the dead weight of the foundation and the overlying soil. These comments are based on our understanding that design uplift is approximately 9 kN. If increased uplift capacities are required, **Inspec-Sol** should be retained to review. Greater uplift capacities may need to be proven in the field using a program of tension testing.

8.5.4 Frost Protection of Foundations

8.5.4.1 Protection of Bearing Soils

The native soils found on Site are considered to be frost susceptible. All bearing surfaces will require a minimum of 1.8 m of soil cover, or an equivalent insulation detail. **Inspec-Sol** should be retained to review a specific insulation detail if this option is chosen.

8.5.4.2 Frost Adhesion

In order to minimize the effects of adfreezing on the foundation systems (anchor shafts, piles, etc.), it is recommended that the foundation elements be backfilled with a coarse grained non frost susceptible soil. One example would be an OPSS Granular 'B', Type I. Also, we recommend that the use of a bond break be incorporated into the design of the foundation system to prevent frost adhering to foundation elements. The upcoming final Geotechnical Reports, however, will provide further comments and recommended adfreezing parameters

8.5.5 Seismic Site Classification

Based on the test pit program that was undertaken as part of this Preliminary Geotechnical Investigation, bedrock was not encountered within the sampling depths. An additional borehole program is planned as part of the second phase of Geotechnical Investigation which may serve to locate the bedrock. At this point there is not enough information available to assign a Site Classification for Seismic Site Response.

Designers should confirm whether these ground mount solar panels are governed by Part 4 of the Ontario Building Code (OBC-2006). If a Site Classification for Seismic Site Response according to Table 4.1.8.4.A of OBC-2006 is required, additional work such as geophysical testing may be required. Please inform **Inspec-Sol** if this is required so we can discuss the available options.

8.5.6 Engineered Fill

The fill operations for Engineered Fill if necessary on this Site, must satisfy the following criteria:

- Engineered Fill must be placed under continuous supervision of the Geotechnical Engineer. Prior to placing any Engineered Fill, all unsuitable fill materials must be removed, and the subgrade proof rolled, and approved. Any deficient areas should be repaired.
- Prior to the placement of Engineered Fill, the source or borrow areas for the Engineered Fill must be evaluated for its suitability. Samples of proposed fill material must be provided to the Geotechnical Engineer and tested in the geotechnical laboratory for Standard Proctor Maximum Dry Density (SPMDD) and grain size, prior to approval of the material for use as Engineered Fill. The Engineered Fill must consist of environmentally suitable soils (as per industry standard procedures of federal or provincial guidelines/regulations), free of organics and other deleterious material (building debris such as wood, bricks, metal, and the like), compactable, and of suitable moisture content so that it is within -2% to +0.5% of the Optimum Moisture as determined by the Standard Proctor test. Imported granular soils meeting the requirements of Granular 'A'.
- The Engineered Fill must be placed in maximum loose lift thicknesses of 0.2 m. Each lift of Engineered Fill must be compacted with a heavy roller to 100% of its SPMDD.
- Field density tests must be taken by the Geotechnical Engineer, on each lift of Engineered Fill. Any Engineered Fill, which is tested and found to not meet the specifications, shall be either removed or reworked and retested.

8.6 Construction of Underground Services

8.6.1 Bedding and Cover

The following are recommendations for service trench bedding and cover materials:

- Bedding for buried utilities should be OPSS Granular 'A' and placed in accordance with pertinent Ontario Provincial Standard Drawings (OPSD).
- Use of clear 19 mm stone is not recommended for use as bedding.
- The cover material should be a sand material or Granular 'A' and the dimensions should comply with pertinent OPSD standards.
- The bedding material and cover materials should be compacted as per OPSS 501 and 514 and to at least 95% of its SPMDD.
- Compaction equipment should be used in such a way that the utility pipes are not damaged during construction.

8.6.2 Service Trench Backfill

Backfill above the cover for buried utilities should be in accordance with the following recommendations:

- For service trenches under access roads, the backfill should be placed and compacted in uniform thickness compatible with the selected compaction equipment and not thicker than 200 mm. Each lift should be compacted to a minimum of 95% of its SPMDD.
- The backfill placed in the upper 300 mm below the access road subgrade elevation should be compacted to a minimum of 100% of its SPMDD.
- To reduce the potential for differential settlement and frost heave, the selected backfill materials should reasonably match the existing soil profile within the frost penetration zone (1.8 m below finished grade). Alternatively, if imported backfill, including granular materials, are used then the excavation sides should have frost tapers as per OPSD 800 series which essentially indicates that there should be a backslope of 10H:1V from the bedding grade to the finished grade.

- If the native excavated soils are used as backfill, this material should be protected from moisture increases during construction. The native excavated soils should be assessed and approved by a Geotechnical Engineer prior to placement.
- Excavated soils that are too wet (i.e. greater than 5% above the optimum moisture content based upon a Standard Proctor Test) will become problematic to compact and may not perform properly during construction period. If such conditions occur, the options include drying of the soils; compacting and leaving the area untravelled for a period of time; importation of more suitable material; or a combination of above and the use of geotextiles at the base and possibly additional layers within the access road structure's granular courses. The appropriate measures will need to be discussed during construction period and be such to achieve adequate performance from the access roads.

8.7 Construction of Gravel Access Roads

Gravel access roads are expected to be constructed over the existing till subgrade. In order to prepare the Site for the roadway structure, it is recommended that the topsoil be stripped and the exposed subgrade be proof-rolled with heavy construction equipment to identify "soft spots" or local anomalies. Any areas where rutting or appreciable deflection is noted should be sub-excavated and replaced with suitable fill, and use of geotextiles may be warranted for strength improvement. Any fill used to raise the grade below future access road structure should be considered Engineered Fill and should be treated as such.

The gravel sections described in *Table 1* below are general recommendations for areas subjected to parking lot and access road traffic. Alternative designs would require additional testing and analysis.

Table 2: Recommended Access Road Structure

Pavement Layer	Light Duty (Parking Areas)	Heavy Duty (Travelled Roadways)
Granular A Base	200 mm	250 mm
Granular B Type II Subbase	300 mm	350 mm

Drainage of the granular layers is important. The surface of each layer of the access road section should be provided with a suitable cross fall (approximately 2%) to prevent water from ponding on the surface and beneath the layers. Surface runoff should be directed into ditches.

Sufficient field-testing should be carried out during construction to assess compaction of each lift of the granular courses. All granular base and sub-base course materials should be compacted to 100% of their SPMDD.

The recommended access road structures provided within this report are considered sufficient for the expected end-use conditions only, which includes light vehicular traffic and occasional maintenance vehicles. These granular thicknesses may be required to be increased to properly support heavy equipment during construction period. Regular maintenance will be required to achieve maximum life expectancy.

9.0 CONSTRUCTION FIELD REVIEW

The discussion and recommendations provided within this report are based upon our current understanding of the project. **Inspec-Sol** requests to be retained to review the structural plans and specifications once they become available to verify that the recommendations within this report have been adequately addressed, and to look for obvious geotechnical problems.

The recommendations provided in this report are also based on an adequate level of construction monitoring being conducted during the construction phase of the proposed development. Due to the nature of the proposed development, an adequate level of construction monitoring is considered to be as follows:

- Prior to construction of footings, the exposed footing subgrade should be examined by a Geotechnical Engineer or a qualified technologist acting under the supervision of a Geotechnical Engineer, to assess whether the subgrade conditions correspond to those encountered in the test pits, and that the recommendations provided in this report have been implemented.
- The use of Engineered Fill, if necessary should be monitored on a full-time basis by a qualified engineering technologist.
- The materials proposed to be used as backfill or granular courses should be submitted to a geotechnical engineer for testing and approval prior to use.

- Backfilling operations should be conducted in the presence of a qualified technologist to ensure that proper material is employed and specified compaction is achieved.
- Testing of concrete strength should be conducted by a qualified technologist to ensure the specifications for the project have been met.
- A Site specific program of Quality Control or Quality Assurance should be developed to verify the ongoing installation of the helical pile foundation systems.
- Several compression and tension load testing programs should be undertaken at the outset of the Project to ensure that design uplift and bearing capacities are being achieved.

10.0 REPORT CONDITIONS AND LIMITATIONS

This report is intended solely for Canadian Solar Solutions Inc. and the other parties explicitly identified within the report. It is prohibited for use by others without **Inspec-Sol**'s prior written consent. This report is considered **Inspec-Sol**'s professional work product and shall remain the sole property of **Inspec-Sol**. Any unauthorized reuse, redistribution of or reliance on the report shall be at the Client and recipient's sole risk, without liability to **Inspec-Sol**. Client shall defend, indemnify and hold **Inspec-Sol** harmless from any liability arising from or related to Client's unauthorized distribution of the report. No portion of this report may be used as a separate entity; it is to be read in its entirety and shall include all supporting drawings and appendices.

The recommendations made in this report are in accordance with our present understanding of the project, the current site use, ground surface elevations and conditions, and are based on the work scope approved by the Client and described in the report. The services were performed in a manner consistent with that level of care and skill ordinarily exercised by members of geotechnical engineering professions currently practicing under similar conditions in the same locality. No other representations, and no warranties or representations of any kind, either expressed or implied, are made. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.

All details of design and construction are rarely known at the time of completion of a geotechnical study. The recommendations and comments made in the study report are based on our subsurface investigation and resulting understanding of the project, as defined at the time of the study. We should be retained to review our recommendations when the drawings and specifications are complete. Without this review, **Inspec-Sol** will not be liable for any misunderstanding of our recommendations or their application and adaptation into the final design.

By issuing this report, **Inspec-Sol** is the geotechnical engineer of record. It is recommended that **Inspec-Sol** be retained during construction of all foundations and during earthwork operations to confirm the conditions of the subsoil are actually similar to those observed during our study. The intent of this requirement is to verify that conditions encountered during construction are consistent with the findings in the report and that inherent knowledge developed as part of our study is correctly carried forward to the construction phases.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments included in this report are based on the results obtained at the twelve (12) test pit locations only. The subsurface conditions confirmed at these twelve (12) test locations may vary at other locations. Soil and groundwater conditions between and beyond the test locations may differ both horizontally and vertically from those encountered at the test locations and conditions may become apparent during construction which could not be detected or anticipated at the time of our investigation. Should any conditions at the Site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations. If changed conditions are identified during construction, no matter how minor, the recommendations in this report shall be considered invalid until sufficient review and written assessment of said conditions by **Inspec-Sol** is completed.

INSPEC-SOL INC.

Shane Dunstan, B.A.Sc., E.I.T.

Joseph B. Bennett, P. Eng.

REGISTERED PROFESSIONAL ENGINEER
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SD/vl

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D R A W I N G S

SITE LOCATION MAP
BOREHOLE LOCATION PLAN

INSPEC-SOL

T020822-A6-1
SITE LOCATION PLAN
GEOTECHNICAL INVESTIGATION
PROPOSED NEW SOLAR FARM
15041 COLONIAL DRIVE, INGLESIDE, ONTARIO
CANADIAN SOLAR SOLUTIONS INC

INSPEC•SOL

T020822-A6-2
TEST PIT LOCATION PLAN
GEOTECHNICAL INVESTIGATION
PROPOSED NEW SOLAR FARM
COLONIAL DRIVE, INGLESIDE, ONTARIO
CANADIAN SOLAR SOLUTIONS INC.

E N C L O S U R E S

TEST PIT LOGS
RESULTS OF LABORATORY TESTING
CERTIFICATE OF ANALYSIS FROM LABORATORY

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Reference No.: **T020822-A6**
Client: **Canadian Solar Solutions Inc.**
Project: **WILLIAM RUTLEY SOLAR PARK, Ingleside, ON**

Enclosure No.:1 Test Pit Logs

Location	Depth (m)	Description
TP-1	0.0 - 1.5	Sandy Silt, some clay, stiff, mottled brown, damp
	1.5 - 3.3	Clayey Silt, some sand, trace gravel, soft, grey, moist
TP-2	0.0 - 0.2	Topsoil, dark brown, moist, many organics
	0.2 - 1.5	Sandy Silt, some clay, stiff, mottled brown, damp
	1.5 - 2.7	Clayey Silt, some sand, trace cobbles and boulders, firm, grey, moist
TP-3	0.0 - 0.2	Topsoil, dark brown, moist, many organics
	0.2 - 2.8	Sandy Silt, some clay, stiff, mottled brown, damp
	2.8	End of test pit on dense cobbles and boulders
TP-4	0.0 - 0.2	Topsoil, dark brown, moist, many organics
	0.2 - 2.7	Sandy Silt, some clay, stiff, mottled brown, damp
	2.7	Sandy Silt, some gravel, trace clay, trace cobbles and boulders, firm, grey, moist
TP-5	0.0 - 0.2	Topsoil, dark brown, moist, many organics
	0.2 - 2.7	Sandy Silt, some clay, stiff, mottled brown, damp
	2.7	Clayey silt, some sand trace gravel, trace cobbles, firm, grey, wet
TP-6	0.0 - 0.2	Topsoil, dark brown, moist, many organics
	0.2 - 2.8	Sandy Silt, some clay, stiff, mottled brown, damp
TP-7	0.0 - 0.8	Topsoil, dark brown, moist, many organics
	0.8 - 2.9	Sandy Silt, some clay, stiff, mottled brown, damp
TP-8	0.0 - 0.6	Topsoil, dark brown, moist, many organics
	0.6 - 2.4	Sandy Silt, some clay, cobbles and boulders, stiff, mottled brown, damp
TP-9	0.0 - 0.6	Topsoil, dark brown, moist, many organics
	0.6 - 1.9	Sandy Silt, some clay, stiff, mottled brown, damp
TP-10	0.0 - 0.3	Topsoil, dark brown, moist, many organics
	0.3 - 1.5	Sandy Silt, some clay, stiff, mottled brown, damp
	1.5 - 2.8	Difficulty excavating due to dense cobbles and boulders
TP-11	0.0 - 0.2	Topsoil, dark brown, moist, many organics
	0.2 - 2.4	Sandy Silt, some clay, boulders in excess of 1.2 m, stiff, mottled brown, damp
TP-12	0.0 - 0.5	Topsoil, dark brown, moist, many organics
	0.5 - 2.9	Sand and Silt, some gravel, trace cobbles and boulders, compact, light brown, wet

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Reference No.: **T020822-A6**
Client: **Canadian Solar Solutions Inc.**
Project: **WILLIAM RUTLEY SOLAR PARK, Ingleside, ON**

Enclosure No.:2 Results of Laboratory Testing

Sample No.	**TP1, GS2**	**TP3, GS1**	**TP7, GS1**	**TP9, GS1**	**TP12, GS1**
Depth (m)	1.5 - 3.3	0.2 - 2.8	0.8 - 2.9	0.6 - 1.9	0.5 - 2.9
Soil Type	Glacial Till	Glacial Till	Glacial Till	Glacial Till	Glacial Till
Parameter					
pH	7.70	7.73	7.71	7.53	7.74
Chloride [Cl^-] (ug/g)	ND	ND	ND	ND	ND
Sulphate [SO_4^-] (ug/g)	160	ND	ND	ND	ND
Redox Potential (mV)	184	160	108	141	134
Conductivity (umho/cm)	258	117	130	152	120

Success Through Science®

Your Project #: T020822-AG
Site: WILLIAM RUTLEY, INGLESIDE, ON
Your C.O.C. #: 00572721

Attention: Shane Dunstan
Inspec-Sol Inc
179 Colonnade Rd
Suite 400
Nepean, ON
CANADA K2E 7J4

Report Date: 2010/11/17

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B0G2743
Received: 2010/11/12, 11:22

Sample Matrix: Soil
Samples Received: 5

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Chloride (20:1 extract)	5	N/A	2010/11/17	CAM SOP-00463	
Conductivity	5	N/A	2010/11/17	CAM SOP-00414	APHA 2510
pH CaCl2 EXTRACT	5	2010/11/17	2010/11/17	CAM SOP-00413	SM 4500 H
Resistivity of Soil	5	2010/11/12	2010/11/17	CAM SOP-00414	APHA 2510
Sulphate (20:1 Extract)	5	N/A	2010/11/17	CAM SOP-00464	EPA 375.4
Redox Potential (1)	5	2010/11/15	2010/11/17	APHA-SM 2580 B (18th Edition:1992) Mod. & ASTM D1498-76 Mod.	

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

(1) This test was performed by Maxxam Sladeview Petrochemical

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

JULIE CLEMENT, Ottawa Customer Service
Email: JClement@maxxam.ca
Phone# (613) 274-3549

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam Job #: B0G2743
Report Date: 2010/11/17

Inspec-Sol Inc
Client Project #: T020822-AG
Project name: WILLIAM RUTLEY, INGLESIDE, ON
Sampler Initials: DH

RESULTS OF ANALYSES OF SOIL

Maxxam ID		HV4783	HV4784	HV4785	HV4786	HV4787		
Sampling Date		2010/11/06	2010/11/06	2010/11/06	2010/11/06	2010/11/06		
COC Number		00572721	00572721	00572721	00572721	00572721		
	Units	**TP1, GS2**	**TP3, GS1**	**TP7, GS1**	**TP9, GS1**	**TP12, GS1**	**RDL**	**QC Batch**
Calculated Parameters								
Resistivity	ohm-cm	3900	8600	7700	6600	8300		2328110
Inorganics								
Soluble (20:1) Chloride (Cl)	ug/g	ND	ND	ND	ND	ND	20	2332361
Conductivity	umho/cm	258	117	130	152	120	2	2332132
Available (CaCl2) pH	pH	7.70	7.73	7.71	7.53	7.74		2332060
Soluble (20:1) Sulphate (SO4)	ug/g	160	ND	ND	ND	ND	20	2332363
Subcontracted Analysis								
Redox Potential	mV	+184	+160	+108	+141	+134		2329716

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

GENERAL COMMENTS

Results relate only to the items tested.

Inspec-Sol Inc
Attention: Shane Dunstan
Client Project #: T020822-AG
P.O. #:
Project name: WILLIAM RUTLEY, INGLESIDE, ON

Quality Assurance Report

Maxxam Job Number: TB0G2743

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
2329716 VSZ	QC Standard	Redox Potential	2010/11/17		+241	%	N/A
	Method Blank	Redox Potential	2010/11/17	+340		mV	
	RPD [HV4787-01]	Redox Potential	2010/11/17	5.4		%	N/A
2332132 YPA	QC Standard	Conductivity	2010/11/17		103	%	75 - 125
	Method Blank	Conductivity	2010/11/17	ND, RDL=2		umho/cm	
	RPD	Conductivity	2010/11/17	0.6		%	35
2332361 DRM	Matrix Spike [HV4783-01]	Soluble (20:1) Chloride (Cl)	2010/11/17		102	%	75 - 125
	Spiked Blank	Soluble (20:1) Chloride (Cl)	2010/11/17		109	%	85 - 115
	Method Blank	Soluble (20:1) Chloride (Cl)	2010/11/17	ND, RDL=20		ug/g	
	RPD [HV4783-01]	Soluble (20:1) Chloride (Cl)	2010/11/17	NC		%	35
2332363 DRM	Matrix Spike [HV4783-01]	Soluble (20:1) Sulphate (SO4)	2010/11/17		93	%	75 - 125
	Spiked Blank	Soluble (20:1) Sulphate (SO4)	2010/11/17		96	%	85 - 115
	Method Blank	Soluble (20:1) Sulphate (SO4)	2010/11/17	ND, RDL=20		ug/g	
	RPD [HV4783-01]	Soluble (20:1) Sulphate (SO4)	2010/11/17	3.6		%	35

N/A = Not Applicable
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Validation Signature Page

Maxxam Job #: B0G2743

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

CHARTERED
Eva Pranjic
CHEMIST

EWA PRANJIC, M.Sc., C.Chem, Scientific Specialist

CHARTERED
Grace M. Sison
CHEMIST

GRACE SISON, Technical and Customer Service Coordinator

==

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APPENDIX

EXPLANATORY NOTES FOR BOREHOLE AND TEST PIT LOGS

NOTES ON BOREHOLE AND TEST PIT REPORTS

INSPEC•SOL

SOIL DESCRIPTION:

Each subsoil stratum is described using the following terminology. The relative density of granular soils is determined by the standard penetration index ("N" value), while the consistency of clayey soils is measured by the value of the undrained shear strength (Cu).

CLASSIFICATION (UNIFIED SYSTEM)

Clay	< 0,002mm		
Silt	0,002 to 0,075mm		
Sand	0,075 to 4,75mm	fine	0,075 to 0,425mm
		medium	0,425mm to 2,0mm
		coarse	2,0 to 4,75mm
Gravel	4,75 to 75mm	fine	4,75mm to 19mm
		coarse	19 to 75mm
Cobbles	75 to 300mm		
Boulders	> 300mm		

TERMINOLOGY

"traces"	1 - 10%
"some"	10 - 20%
adjective (silty, sandy)	20 - 35%
"and"	35 - 50%

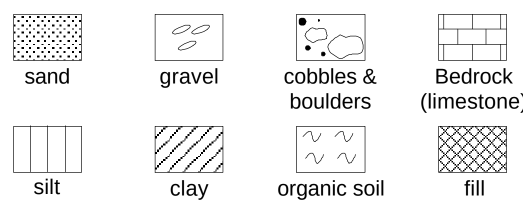
RELATIVE DENSITY OF GRANULAR SOILS	STANDARD PENETRATION INDEX "N" VALUE (BLOWS/ft - 300mm)
Very loose	0 - 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very dense	> 50

CONSISTANCY OF COHESIVE SOILS	UNDRAINED SHEAR STRENGTH (Cu) (P.S.F.)	(kPa)
Very soft	< 250	< 12
Soft	250 - 500	12 - 25
Medium	500 - 1000	25 - 50
Stiff	1000 - 2000	50 - 100
Very stiff	2000 - 4000	100 - 200
Hard	> 4000	> 200

ROCK QUALITY DESIGNATION

"RQD" (%) VALUE	QUALIFICATIVE
< 25	very poor
25 - 50	poor
50 - 75	fair
75 - 90	good
> 90	excellent

STRATIGRAPHIC LEGEND



SAMPLES:

TYPE AND NUMBER

The type of sample recovered is shown on the log by the abbreviation listed hereafter. The numbering of samples is sequential for each type of sample.

SS: Split spoon
SSE, GSE, AGE: Environnemental sampling
ST: Shelby tube
PS: Piston sample (Osterberg)
AG: Auger
RC: Rock core
GS: Grab sample

RECOVERY

The recovery, shown as a percentage, is the ratio of length of the sample obtained to the distance the sampler was driven/pushed into the soil.

RQD

The "Rock Quality Designation" or "RQD" value, expressed as a percentage, is the ratio of the total length of all core fragments of 4 inches (10cm) or more to the total length of the run.

IN-SITU TESTS:

N: Standard penetration index
R: Refusal to penetration
N_C: Dynamic cone penetration index
Cu: Undrained shear strength
Pr: Pressuremeter
k: Permeability
ABS: Absorption (Packer test)

LABORATORY TESTS:

I_p: Plasticity index
W_l: Liquid limit
W_p: Plastic limit
H: Hydrometer analysis
GSA: Grain size analysis
A: Atterberg limits
w: Water content
g: Unit weight
C: Consolidation
CS: Swedish fall cone
CHEM: Chemical analysis
O.V.: Organic vapor

A- Soil Sampling

Soil samples are normally recovered with a split-spoon sampler or a thin-walled Shelby tube. The split spoon is dynamically driven into the ground and takes a remoulded sample of the soil found at depth. A standard penetration test is thereby obtained, and is described in the following paragraph. The Shelby tube is pushed into the ground to obtain undisturbed samples of clay or clayey soils. Rock samples are obtained by drilling a core barrel into the rock formation; the diameter of the recovered sample varies with the size of the drilling bit used.

B- Standard Penetration Test (SPT)

A standard penetration test consists of driving a standard split-spoon sampler into the soil be dropping a 140 lb. weight (63.5 kg) from a height of 30 inches (76 cm). The sampler is driven 18 inches (45 cm) into the soil and the number of blows of the drop weight is recorded for every 6 inches (15 cm) of penetration. The total number of blows for the last 12 inches (30 cm) of penetration is the standard penetration index ("N" value). This value obtained at regular intervals provides vital information from which the density, compressibility and bearing capacity of the various soil horizons can be estimated. The test is however seldom used in clayey soils.

C- Dynamic Penetration Test

A dynamic penetration test (or cone penetration test) is similar to a standard penetration test with the difference that the split-spoon sampler is replaced by a conical point 10 cm^2 in area. The number of blows is recorded continuously for every foot of penetration (30 cm) thus obtaining a systematic indication of the relative density of the materials encountered at depth. This test also helps in determining the depth to a dense soil horizon or bedrock.

Note: The presence of large gravel, cobbles or boulders in the subsoil may distort the results of both the standard penetration test and the dynamic penetration test by giving abnormally high resistance values. When it becomes impossible to drive the cone deeper a refusal ("R") is then recorded.

D- Shear Test

An undrained shear test may be carried out by pushing into the undisturbed soil a vane shear apparatus consisting of a four-bladed vane connected to a rod and by measuring the torque value required to shear the clay. This test may be repeated at regular intervals and the torque values calculated to obtain the undrained shear strength of the clay at each test level. The shear strength profiles permit the calculation of the allowable bearing capacity of the clay. The apparatus used is the "Nilcon" of Scandinavian origin.

E- Permeability Test (Lefranc)

This test consists of determining the coefficient of permeability K of the soil around a permeable lens of known dimensions and which has been formed below the driving shoe. The procedure used is the falling head method. Tests of the Lefranc type are carried out in soils with average granulometry and average permeability.

F- Packer Test

This test is conducted in bedrock by sealing off a section of the borehole with one or two inflatable rubber packers and then pumping water into the isolated section of the hole. The permeability of the rock adjacent to the isolated section of the borehole is measured as a function of the pumping head (pressure) and rate of water loss (absorption) from the sealed-off section over a fixed period of time.

G- Menard Pressuremeter Test

The pressuremeter test developed by Menard (1956) consists of laterally loading the sidewalls of a borehole by dilating a cylindrical probe. The test permits the determination of the modulus E_M and the limit pressure p_l, which are a measure of the strength of the soil, and enables the calculation of the bearing capacity and settlements for foundations.