GROUNDWATER QUALITY IMPACT ASSESSMENT REPORT

Southgate Solar Project

FINAL – March 2015

DILLON
CONSULTING

Table of Contents

Page

1. Introduction 1
    1.1 Project Description 1
    1.2 Objectives and Work Scope 3
    1.3 Report Organization 3
    1.4 Initial Disclaimer and Limiting Conditions 3
2. Study Methodology 4
    2.1 Study Approach 4
    2.2 Information Sources 4
    2.3 Consultation with Regulatory Officials 4
    2.4 Well Water Sampling and Resident Survey 6
        2.4.1 Sample Collection 6
        2.4.2 Sampling Survey 6
        2.4.3 Sampling Results Notification 7
        2.4.4 Quality Assurance/Quality Control 7
3. Study Results 8
    3.1 Physical Setting 8
        3.1.1 Topography and Physiography 8
        3.1.2 Bedrock Geology 8
        3.1.3 Overburden Geology 10
        3.1.4 Hydrogeology and Groundwater Flow 12
    3.2 Water Quality Sampling Results 16
        3.2.1 Residential Sampling Program and Survey 16
        3.2.2 Water Quality Testing Results 18
4. Groundwater Impact Assessment 20
    4.1 Potential Contaminating Activities 20
        4.1.1 Construction-Related Activities 20
        4.1.2 Operation Activities 22
    4.2 Aquifer Vulnerability and Usage 23
    4.3 Groundwater Recharge 23
    4.4 Groundwater Impact Risk Evaluation 24

5. Proposed Monitoring and Contingency Program ... 25
  5.1 Construction Phase ... 25
  5.2 Operations Phase ... 25
  5.3 Complaint Resolution and Contingency Plan ... 25
6. Summary of Conclusions ... 27
7. Limitations ... 29
8. References ... 30

List of Figures

Figure 1: Site Location ... 2
Figure 2: Bedrock Geology ... 9
Figure 3: Surficial Geology ... 11
Figure 4: Water Well Information and Groundwater Flow ... 15
Figure 5: Private Well Sampling Locations ... 17

List of Tables

Table 1: Summary of Private Well Sampling Program ... 16
Table 2: Summary of Homeowner Survey Results ... 16
Table 3: Summary of Water Quality Testing Results ... 18

List of Appendices

Appendix A: Consultation Correspondence
  Appendix A.1: Communication Record with Ontario Ministry of Environment and Climate Change
  Appendix A.2: Communication Record with Saugeen Valley Conservation Authority
  Appendix A.3: Example Residential Well Survey Invitation Letter
  Appendix A.4: Example Residential Well Survey
  Appendix A.5: Example Residential Well Sampling Results Letter
Appendix B: Background Hydrogeological Information
Appendix C: MOE Water Well Records
Appendix D: Geotechnical Information

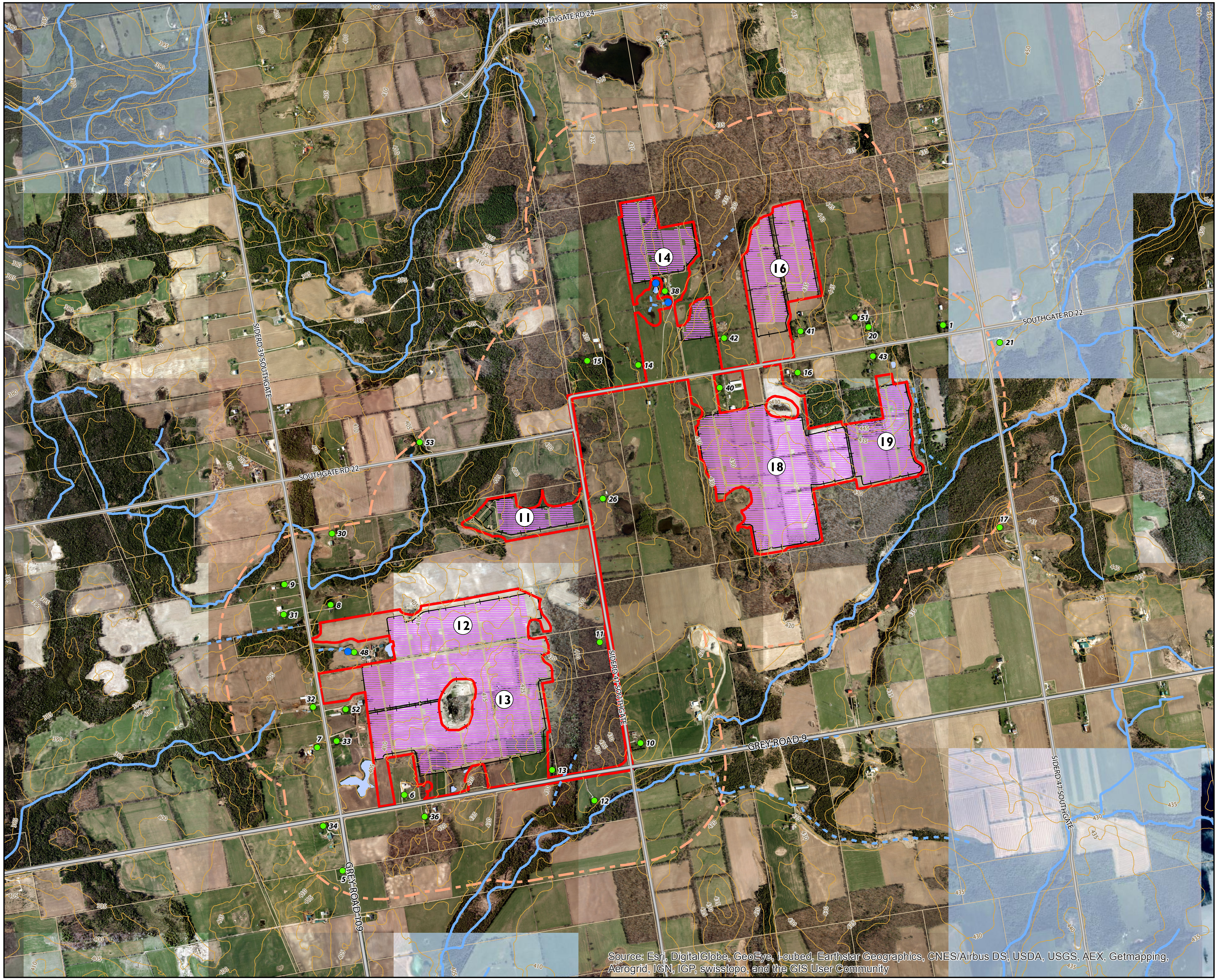
1. INTRODUCTION

Dillon Consulting Limited (Dillon) was retained by Southgate Solar LP to conduct a groundwater quality impact assessment for the proposed Southgate Solar Project (the Project). The purpose of the assessment was to obtain background information on the use of the local aquifers as a water supply, and to assess the risk of water quality impacts from the Project to the groundwater resource. Implementation of a groundwater monitoring and contingency program is a common requirement of the Renewable Energy Approval (REA), issued by the Ministry of the Environment and Climate Change (MOECC), for sites that have been identified as being in a sensitive groundwater area. Information collected in this study was used to determine if the Project is located in a sensitive groundwater area, and to make recommendations on whether groundwater monitoring is warranted during construction and operation of the facility. This report is being provided to the MOECC as part of the REA application package for the Project, to assist the MOECC in making a determination as to whether groundwater monitoring is necessary.

1.1 Project Description

The proposed 50 megawatt alternating current (MWac) Project will be located within the Township of Southgate, in the County of Grey, approximately 11 kilometres north of the community of Mount Forest. (see **Figure 1**). The overall optioned lands available for development (referred to herein as the Project Location) consist of approximately 235 hectares (581 acres). The proposed Project Location is contained within an area bounded on the north by Southgate Road 24, Southgate Road 14 to the south, Southgate Road 47 to the east, and Highway 6 to the west. REA documents and technical reports are developed for a Project Location which incorporates lands in excess of those required for the construction of solar facility components sufficient to generate 50 MWac. The approved layout will be refined during detailed design to incorporate only the quantity of project components required for a 50 MWac solar facility.

The Project will consist of approximately 197,000 to 207,000 solar photovoltaic (PV) panels, approximately 34 Medium Voltage (MV) stations containing inverters and MV transformers, a high voltage main substation transformer (within a substation yard, that will also contain an operations and maintenance building and communications tower), a collector system of overhead /underground cabling, and internal access roads. Temporary project components that will be utilized during the construction phase only will include equipment laydown and storage areas and some access roads. The Project Location will be fenced, with gates located at entrance points.



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

SOUTHGATE SOLAR PROJECT

FIGURE 1
SITE LOCATION

- ⑪ Project Area
- ● Seepage Area
- ● Residential Building/Potential Well Location
- ━ Permanent Stream
- ┅ Intermittent Stream
- ─ Land Elevation 5 m Contour
- ▭ Project Location
- ┼ Fence
- ─ Access Road
- ─ Solar Panel
- ┅ Project Location 500 m Setback
- ▭ Parcel Boundary
- ▨ Open Aquatic Area

1:20,000

0 0.5 1 km

N W E S

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR

MAP CREATED BY: GM
MAP CHECKED BY: JP
MAP PROJECTION: NAD 1983 UTM Zone 17N

FILE LOCATION: I:\GIS\149154 - Samsung Southgate\mxd\Groundwater Report

DILLON
CONSULTING

PROJECT: 149154

STATUS: FINAL

DATE: 3/25/2015

1.2 Objectives and Work Scope

The objectives and scope of work of the groundwater quality impact assessment are summarized below:

- Review of available information on the hydrogeology of the Study Area and an assessment of the current use of local aquifers as a water supply. For the purpose of this investigation, the Study Area is defined as the Project Location, and all lands within 500 m of the Project Location boundary.
- Consultation with the MOECC and the local Conservation Authority on the study work scope, groundwater sensitivity and potential groundwater monitoring conditions that may be included in the REA.
- Identification of select property owners for participation in a water well sampling program and groundwater use survey (where water wells are identified).
- Collection of untreated well water samples at participating addresses, and submission of the samples to an analytical laboratory for testing; water samples were tested for general potability requirements including general chemistry, nutrients, select metals and bacteria.
- Completion of a homeowner survey to provide knowledge on well construction, water quality/quantity characteristics and location of potential nearby activities (septic systems, fuel storage etc.) that may pose a groundwater quality threat to the groundwater supply.
- Provision of the chemical testing results to homeowners.
- Recommending a groundwater monitoring program to be implemented during construction and operation of the Project, if required.
- Submission of a report to Southgate Solar LP and the MOECC documenting the results.

1.3 Report Organization

This report is divided into several sections. **Section 1** introduces the study and outlines the work scope and objectives. **Section 2** summarizes the study methodologies, and **Section 3** presents the investigation results. A discussion of the findings of the study, and assessment of the risk of the construction and operation of the Project to groundwater resources, are provided in **Section 4.** The proposed monitoring and contingency program is outlined in **Section 5.** Study conclusions are summarized in **Section 6.** Study limitations and references are provided in **Sections 7** and **8**, respectively. Background support information is presented in appendices.

1.4 Initial Disclaimer and Limiting Conditions

This report was prepared by Dillon for the sole benefit of Southgate Solar LP. The conclusions reflect Dillon's best judgment in light of the information available to Dillon at the time of the report's preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it are the responsibilities of such said third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

2. STUDY METHODOLOGY

Investigative methodologies implemented during this study are described in this section.

2.1 Study Approach

The approach taken in this study was to perform a hydrogeological assessment of the Study Area, and perform a risk evaluation of the potential for the Project to cause water quality impacts to aquifers that are used as local water supplies. The scope of the work was based on input received by Dillon from the MOECC for other similar solar project hydrogeological studies. In particular, the study methodology followed a similar approach taken by Dillon for the Sol-Luce Solar PV Energy Project, in the City of Kingston and Loyalist Township, Ontario, where technical direction was provided by Mr. Frank Crossley, Hydrogeologist, with the MOECC Kingston Regional office (Dillon, 2012). For that project, Mr. Crossley recommended that a hydrogeological assessment be conducted that would involve an inventory and selective sampling of water wells within 500 m of the project boundary. The results of the sampling would be used to assess pre-construction baseline groundwater quality. Mr. Crossley also provided general information on typical groundwater-related environmental risks associated with large solar projects.

2.2 Information Sources

The following information sources were used in the hydrogeological analysis and impact assessment:

- Published government geological and hydrogeological reports
- Source protection related watershed characterization and assessment report mapping
- MOECC Water Well Record Database
- Information from a homeowner well survey on well water use on select properties within 500 m of the Project
- Sampling and testing of untreated well water samples at select residences, and comparison of the testing results to the Ontario Drinking Water Standards
- Geotechnical drilling results for the Project
- Design and construction information for the Project

Methodologies associated with the review and analyses of information provided from the above sources are described within the relevant results section of this report.

2.3 Consultation with Regulatory Officials

During implementation of the work program, Dillon consulted with the MOECC and the Saugeen Valley Conservation Authority (SVCA) to discuss the groundwater assessment and study methodologies, and to identify any specific groundwater impact concerns that they may have with the Project in general. A summary of the consultation efforts is presented below.

Ontario Ministry of the Environment and Climate Change

Mr. Darin Burr, Hydrogeologist with Dillon, consulted with Mr. Romic Zeljko, Senior Program Support Coordinator, Environmental Approvals Access and Service Integration Branch of the MOECC. Mr. Zeljko was contacted to discuss the proposed investigation methodologies for the Project and to discuss the potential for groundwater monitoring conditions being included in the REA. Discussions were held between Dillon and the MOECC on several occasions in August and September 2014, via email and telephone. Mr. Zeljko is coordinating the Southgate Solar Project and Windsor Solar Project approvals, and input on investigation methodologies for both studies was received concurrently.

Mr. Zeljko stated that, in general, REAs for solar facilities typically includes groundwater monitoring requirements. Mr. Zeljko also stated that determination of the conditions placed in the REA, should they be required, would be established once the application has been submitted to the MOECC for technical review. The MOECC was not in a position at the time of Mr. Burr's inquiry to discuss specific conditions that may be applied to the Project's REA. A copy of the correspondence between Dillon and the MOECC is presented in ***Appendix A*** (Appendix A.1).

Saugeen Valley Conservation Authority

Mr. Darin Burr contacted Mr. Erick Downing, Manager of Environmental Planning & Regulations of SVCA, by telephone on January 22, 2015, to discuss whether SVCA had any groundwater-related concerns with the Project. Mr. Downing directed Dillon to speak to Mr. David Ellingwood, Project Manager, of the Saugeen, Grey Sauble, Northern Bruce Peninsula Source Protection Region. Mr. Ellingwood did not have any specific concerns with the Southgate Solar Project. He did state that common issues with renewable energy projects that are sometimes raised by the public include: a) potential for foundations of infrastructure to interfere with groundwater recharge or to act as preferential pathways for contaminants to migrate into the subsurface; and, b) potential impacts to the environment from chemical/fuel spillage during construction. Mr. Burr told Mr. Ellingwood that the groundwater impact assessment report will assess these concerns.

A general discussion of aquifer vulnerability was conducted. Mr. Ellingwood stated that source protection mapping has identified the general area of the project as having a medium to high aquifer vulnerability. The vulnerability mapping is based on the methodologies followed in the source protection area Assessment Report. Dillon noted that this methodology addresses the shallow most aquifer, which is not necessarily the aquifer that is used by nearby wells. As a result, vulnerability mapping within the Assessment Report is considered conservative for the Study Area. Mr. Ellingwood stated that the vulnerability mapping is coarse as a result of the sparsity of data points (individual water well data) and the analysis method. A summary of the discussion between Dillon and ERCA is presented in ***Appendix A*** (Appendix A.2).

2.4 Well Water Sampling and Resident Survey

Well water sampling was conducted between November 19 and December 10, 2014. The sampling program was designed to collect a representative number of water well samples over the geographic area that covers the majority of the proposed major development sites (i.e., Project Areas). Selection of well sampling locations was based on several factors including proximity of the well to the proposed development area and position of the well relative to the estimated local groundwater flow direction. Preference was given to those wells located topographically down gradient and within 500 m of proposed Project Areas. Where more than one well was present in a given direction, the well closest to the Project Area was chosen for sampling. It should be noted that the ability to sample selected properties relied on the willingness and/or availability of the homeowner to participate in the survey.

Initial communication with the residences was performed by mailing or hand delivering an invitation letter asking the residences if they wished to participate in the sampling program. A copy of the invitation letter is provided in ***Appendix A*** (*Appendix A.3*). Attempts were made to contact 34 addresses by letter or in person. A total of 20 addresses were available for sampling. Of the 14 addresses that were not sampled, 4 addresses declined participating in the program, while 10 addresses were contacted, but no response was received.

2.4.1 Sample Collection

Well water samples were collected following standard industry protocols and were analyzed for bacteria, alkalinity, ammonia, nitrate, nitrite, calcium, chloride, colour, conductivity, dissolved organic carbon (DOC), hardness, heavy metals, pH, sulphate, total dissolved solids (TDS) and turbidity, as recommended by the MOECC for previous groundwater investigations at solar projects. Water samples were collected from each address participating in the groundwater study and placed immediately on ice. Where a treatment system was present (e.g., sediment filter, UV light, or water softener etc.), an attempt was made to collect the sample prior to treatment. When collecting a sample from a water faucet or outdoor hose bib, the surface of the tap was cleaned with diluted bleach placed on a clean paper towel. Aerators on the water faucet were removed. The water was allowed to run for a minimum of five minutes prior to sample collection. Samples were submitted to Maxxam Analytical of Mississauga, Ontario for analysis within 24 hours of collection.

2.4.2 Sampling Survey

At the time of sample collection, property owners were asked to complete an information survey which included a series of questions about their experience with their water supply. The survey included questions on the well water quality and quantity, frequency of water testing, water use, etc. The level of completion of each survey varied considerably, depending on the amount of time the residence owner had occupied the dwelling, and depending on the residents’ knowledge of their water system. The survey form is reprinted in ***Appendix A*** (Appendix A.4).

2.4.3 Sampling Results Notification

Bacteriological testing results, including total coliform, and *E. Coli* were provided to Dillon by the laboratory within two business days of sample collection. Where contact could be made, owners of wells where *E. Coli* was detected at concentrations significantly exceeding the Ontario Drinking Water Standards were notified by telephone upon receipt of the laboratory report. At the completion of the study, the analytical reports were mailed to each sampling participant. A letter was provided with the reports identifying exceedances of the health and non-health related Ontario Drinking Water Standards for the tested parameters. An example homeowner report is presented in ***Appendix A*** (Appendix A.5).

2.4.4 Quality Assurance/Quality Control

Quality assurance and quality control (QA/QC) were conducted for the field work, laboratory analysis and reporting elements of the project. QA/QC procedures were implemented in the field and by the laboratory to demonstrate that the data generated was of a level of quality suitable for its intended purposes. Field QA/QC procedures included the use of new sampling equipment and/or appropriate equipment cleaning procedures, proper sample containment, preservation, handling and transportation and adherence to published standards for field methodologies. Laboratory QA/QC procedures included the use of an accredited laboratory, the use of detection limits appropriate for the required evaluation, the use of acceptable laboratory methods, analysis of laboratory blank and spike samples and laboratory reference standards.

3. STUDY RESULTS

3.1 Physical Setting

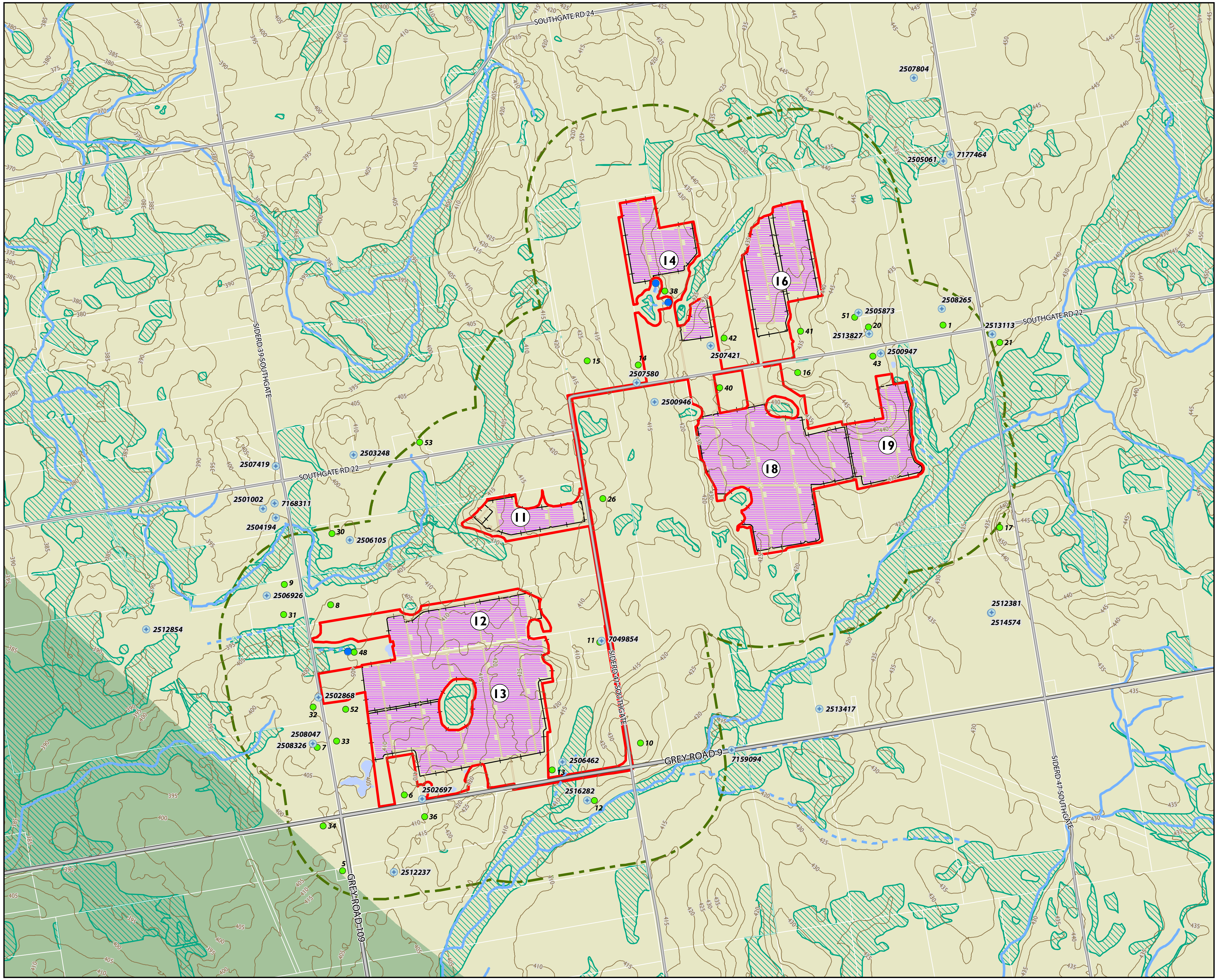
3.1.1 Topography and Physiography

The proposed development is located in the physiographic area referred to as the Dundalk Till Plains (Chapman and Putnam, 1984). This region is characterized by gently undulating land, mainly covered by glacial till, and interspersed with swamps and bogs. Kame moraines and glacial spillway deposits containing sand and gravel overlie the till plain in the vicinity of the Project Location. A physiography map is reprinted in ***Appendix B.*** and land elevations are shown in **Figure 1**. Across the Project Location, land elevation ranges from approximately 405 metres above sea level (masl) to 445 masl (Ontario Base Mapping, 2014). The ground surface is highest at two locations: along Southgate Road 22, between Project Area 16 and 19 (elevation of 445 masl); and at the eastern portion of Project Area 13 (elevation of 425 masl). From these local elevated areas, the land slopes gently to the west, south and east.

Water features near the Project Location are shown on **Figure 1**. The southern portion of the Project Location drains south and southeast to the Beatty Saugeen River, while the northern portion of the Project Location drains west and northwest to headwater tributaries of the Upper Main Saugeen River. The Beatty Saugeen River is located approximately 100 m from the Project Location, being closest to the southeastern portion of Project Area 13 and the eastern side of Project Area 19. A tributary of the Main Saugeen River is located approximately 200 m northwest of Project Area 11. Within the Study Area, wetlands are prevalent along tributary flood plains, and within localized topographic depressions. These wetland filled depressions are noted in Project Areas 13 and 14, and near the peripheries of Project Area 18. Their presence is attributed to poor surface water drainage; however, some of these features may also be supported by localized groundwater discharge. Springs have been noted at Project Area 14 and west of Project Area 12 (Dillon, 2015a). Intermittent streams, also potentially supported by groundwater discharge, have been mapped in these areas, as well as on the east side of Project Area 19 and near the northwest side of Project Area 16.

3.1.2 Bedrock Geology

Bedrock underlying the Study Area is Middle-Silurian dolostone of the Guelph Formation. A map of the bedrock geology relative to the Project Location is presented as **Figure 2**. Underlying the Guelph Formation is dolostone of the Amabel Formation. Bedrock dips to the southwest at a slope of between 5 to 7 metres per kilometre. As reported by SVSPA (2011), both the Guelph and Amabel Formations are important bedrock aquifers in the watershed.



SOUTHGATE SOLAR PROJECT

FIGURE 2
BEDROCK GEOLOGY

11	Project Area
●	Seepage Area
⊕	MOECC Water Well within 1 km of Project Location
●	Residential Building/Potential Well Location
—	Permanent Stream
- -	Intermittent Stream
—	Land Elevation 5 m Contour
🟥	Project Location
—+—	Fence
—	Access Road
—	Solar Panel
⬚	Project Location 500 m Setback
☐	Parcel Boundary
▨	Wetland
■	Open Aquatic Area
■	Sandstone, shale, dolostone, siltstone - Guelph Fm.
🟩	Sandstone, shale, dolostone, siltstone - Salina Fm.

1:20,000

0 0.5 1 km

N
W E
S

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR

MAP CREATED BY: GM
MAP CHECKED BY: JP
MAP PROJECTION: NAD 1983 UTM Zone 17N

FILE LOCATION: I:\GIS\149154 - Samsung Southgate\mxd\Groundwater Report

DILLON
CONSULTING

PROJECT: 149154
STATUS: FINAL
DATE: 3/25/2015

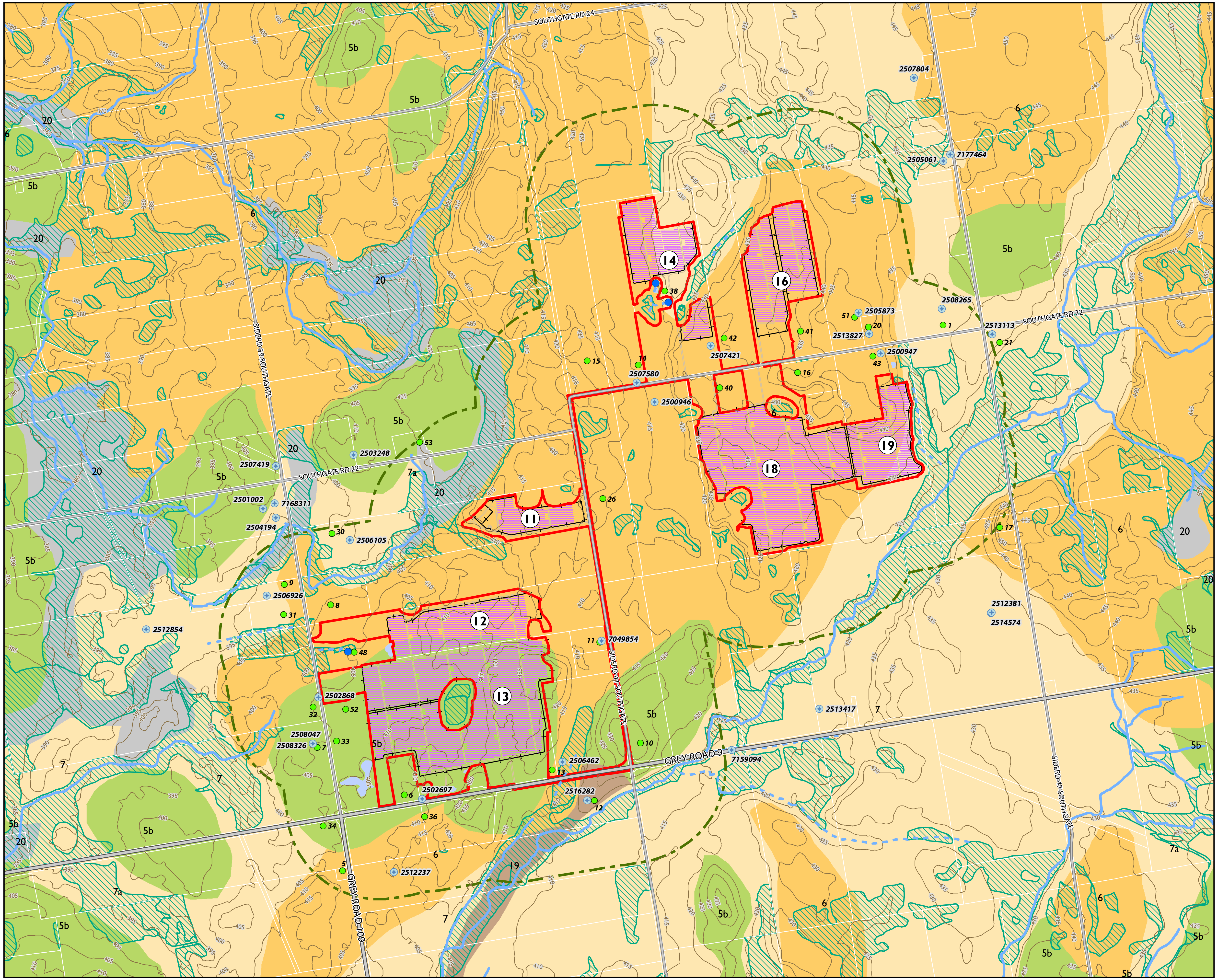
3.1.3 Overburden Geology

The surficial geology in the Study Area is shown in **Figure 3**. Ice-contact stratified deposits, often containing an interbedded mixture of sand, gravel and silt, are mapped as the surficial geological unit under all Project Areas, with the exception of Project Areas 13 and the northern portion of Project Area 12. In these areas, surficial geology is mapped as glacial till. Surficial geology in the eastern section of Project Area 14 and the southeastern portion of Project Area 19 is mapped as glaciofluvial deposits.

The overburden geology in the Study Area was assessed through the review of available MOECC water well records and other available geological mapping. **Figure 3** shows the location of the MOECC mapped water wells that are within 1 km of the Project Location. Overall, the well records provide good regional coverage north, south, east and west of the Project Locations. A summary of the lithological conditions observed at each well are tabulated in ***Appendix C***. Well records show that the overburden thickness ranges from 19.2m (well #2506926 located west of Project Area 12) to 59.7m (well #2512237 south of Project Area 13); with typical thicknesses in the 30m to 40m range. In general, the overburden consists of interlayered sand and gravel overlying till, which in turn overlays the dolostone bedrock. Sand and gravel layers are also found below the till. MOECC water well records for those wells that are drilled completely through the overburden intercept till layers ranging in thickness from 8.8m (well #2506929) to 29.5m (well #2505873). Overall, 17 of the 18 MOECC well records in the Study Area intercepted till, indicating that till deposits are fairly prevalent and continuous across the entire Study Area.

Shallow overburden conditions within each of the Project Areas were investigated by LVM Inc. as part of their geotechnical investigation (LVM, 2014). The work involved drilling of 14 boreholes throughout the Project Areas to a depth of approximately 5m. Drilling locations, borehole logs and grain size analyses are presented in ***Appendix D***. A summary of the encountered soil and groundwater conditions for each of the Project Areas is as follows:

- Project Area 11 (BH-01-14, BH-02-14 and BH-03-14): sand and gravel with silt horizons in BH-01-14 and BH-02-14; holes dry upon completion
- Project Area 12 (BH-04-14): sand and gravel overlying sand; hole dry upon completion
- Project Area 13 (BH-05-14; BH-06-14 and BH-07-14): sand and gravel to sand and silt layers, overlying sand, silt and/or gravel; groundwater levels measured at 4.5m in BH-07-14, other holes were dry upon completion
- Project Area 14 (BH-14-14): silt and sand overlying sand and gravel, water level measured in hole at 2.1 mbgs
- Project Area 16 (BH-13-14 and BH-12-14): sand and gravel to silt and sand; BH-13-14 was dry upon completion, while water level in BH-14-14 was measured at 2.1mbgs
- Project Area 18 (BH-08-14 and BH-09-14); silt overlying sand and gravel at BH-08-14 and silt and fine sand at BH-09-14; holes dry upon completion
- Project Area 19 (BH-10-14 and BH-11-14); sand and gravel with some silty sand layers; holes dry



SOUTHGATE SOLAR PROJECT

FIGURE 3
SURFICIAL GEOLOGY

⑪	Project Area
●	Seepage Area
⊕	MOECC Water Well within 1 km of Project Location
●	Residential Building/Potential Well Location
—	Permanent Stream
- -	Intermittent Stream
—	Land Elevation 5 m Contour
▭	Project Location
┼	Fence
—	Access Road
—	Solar Panel
⌐ ¬	Project Location 500 m Setback
▭	Parcel Boundary
▨	Wetland
■	Open Aquatic Area
■	5b: Stone-poor, carbonate-derived silty to sandy till
■	6: Ice-contact stratified deposits
■	7: Glaciofluvial deposits
■	7a: Sandy deposits
■	19: Modern alluvial deposits
■	20: Organic deposits

1:20,000

0 0.5 1 km

N
W E
S

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR

MAP CREATED BY: GM
MAP CHECKED BY: JP
MAP PROJECTION: NAD 1983 UTM Zone 17N

FILE LOCATION: I:\GIS\149154 - Samsung Southgate\mxd\Groundwater Report

DILLON
CONSULTING

PROJECT: 149154
STATUS: FINAL
DATE: 3/25/2015

3.1.4 Hydrogeology and Groundwater Flow

Aquifer Characteristics

Descriptions of the location and physical characteristics of aquifers in the Study Area are based primarily from work conducted by WHI (2003) and SVSPA (2011), and from a review of available MOECC water well records. Background hydrogeological information is presented in ***Appendix C***. Based on these information sources, both overburden and bedrock aquifers are used as a potable water source in the Study Area. A general description of these aquifers is as follows:

Bedrock Aquifer – WHI (2003) reported that 85% of all wells in Grey County are bedrock wells, and that bedrock wells are typically completed in the top 10m to 30m of the bedrock. Major bedrock aquifers in the vicinity of the Study Area are the Guelph and Amabel Formations. Yields from the fractured rock aquifer are commonly 0.8 to 3.8 L/s (11 to 50 Igpm). Based on a review of MOECC water well records for those wells within the Study Area (see ***Appendix C***), the bedrock aquifer appears to be largely confined by till. Water well records show that static water levels in the bedrock wells are within or above the overlying till, suggesting confining conditions. Static water levels in the bedrock wells range from 1 mbgs to 10 mbgs in the vicinity of Project Areas 11, 12 and 13. Static water levels in bedrock wells located along Southgate Road 22 (near Project Areas 14, 16, 18 and 19) are deeper, being generally between 10 and 20 mbgs. The lower static levels are associated with elevated local topography in these locations.

Overburden Aquifers – Overburden aquifers are present where thick sequences of saturated sands and gravels are present. Overburden deposits in the Study Area are highly variable in both thickness and composition. Therefore, the presence and transmissivity of overburden aquifers will differ between locations. The best overburden aquifers are located where coarse grained glaciofluvial deposits are present.

Groundwater springs have been documented at Project Area 14 and west of Project Area 12. Springs develop where the watertable intercepts the ground surface, usually in places where the local land topography is steep, or within localized ground depressions. Springs often form where an underlying deposit of low permeability (e.g., till) crops out to surface.

Groundwater Flow

Groundwater flow characteristics for the overburden and bedrock aquifers are presented below.

Groundwater flow within the dolostone bedrock will be along vertical and horizontal fractures. Flow rates are commonly in the order of metres per day. Where chemical dissolution is significant, karstic conditions in the bedrock may develop, and flow rates are much greater. Considering the depth of the bedrock (generally 20 m to 60 m), groundwater flow in this aquifer is expected to reflect regional groundwater flow patterns, as opposed to local topography. Estimation of groundwater flow direction was performed by contouring the static water levels reported in the MOECC water well records for all bedrock wells within 4 km of the Project Locations.

The resulting potentiometric surface map is presented in **Figure 4**, and shows a general east to west flow direction. This trend is consistent with MOECC source protection Assessment Report mapping performed by SVSPA (2011).

Groundwater flow directions in the overburden aquifer are expected to be variable depending upon the depth of the well and whether the pumped overburden aquifer is confined or unconfined (i.e., water table aquifer). Where the well is completed in material above the till, unconfined conditions are expected, and groundwater flow directions will be largely controlled by surface topography. Where the well is completed in material below the till, and confined conditions exist, flow directions will likely reflect more regional patterns. Mapping of the watertable and/or potentiometric surface in the overburden aquifer was not possible because of the limited number of overburden wells in the MOECC data set. As a surrogate to well water data, topographic elevation contours were conservatively used to estimate potential shallow groundwater flow conditions. Shallow groundwater flow is expected to travel from areas of high to low elevation, with elevated lands acting as recharge areas, and low lands (e.g, wetlands and tributaries) potentially being groundwater discharge locations. A map of the expected shallow groundwater flow conditions in the overburden aquifer is presented as **Figure 4**. Based on this analysis, groundwater flow in the vicinity of Project Area 11, 12 and 13 is expected to be largely west to northwest. Shallow groundwater flow along the east side of Project Area 13 is anticipated to be southeast, east to northeast. Shallow groundwater flow at Project Area 14 and 16 is expected to be to the northwest to west, with some groundwater flow at the south end of Project Area 14 to be directed to the southeast. At Project Areas 18 and 19, shallow groundwater flow is expected to be radially outward to the southwest, south and southeast.

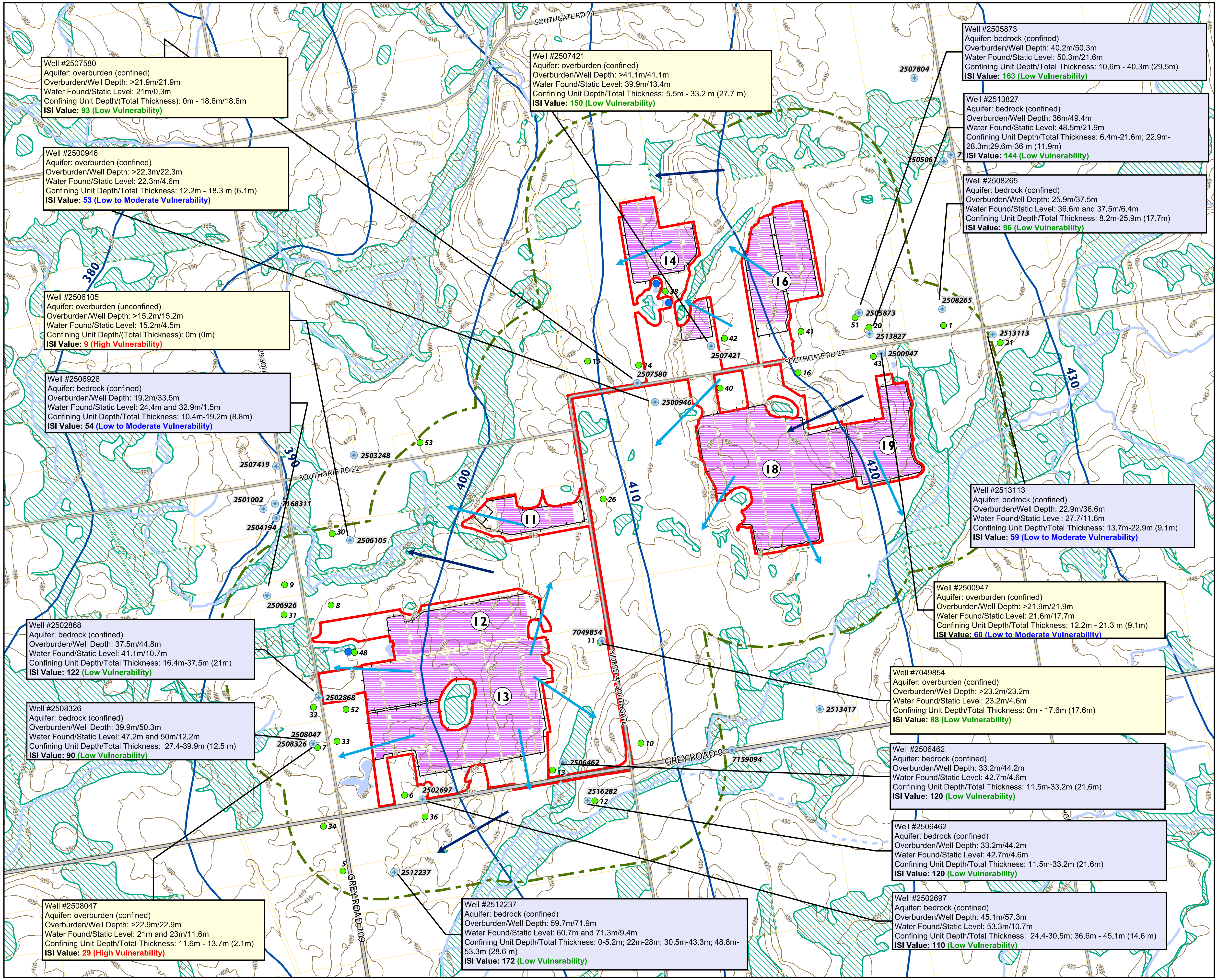
Groundwater/Surface Water Interaction

Groundwater/surface water interaction is manifested in the Study Area as springs, seeps, and potentially as intermittent streams. These features are typical of the physiography of the Study Area, where land topography is undulatory, and permeable coarse grained deposits interbedded with lower permeable materials, are present. The location of significant seeps and springs are documented in the Water Assessment Report (Dillon, 2015a), and include two springs near Project Area 14 and a spring west of Project Area 12. Mapped locations of intermittent streams east of Project Area 19, southwest of Project Areas 13 and near Project Areas 12 and 14 may also receive groundwater discharge, as intermittent streams are often generated by groundwater discharge during spring and fall when the watertable is high.

<u>Aquifer Vulnerability and Significant Groundwater Recharge Areas</u>

Aquifer vulnerability and significant groundwater recharge maps were generated by the Saugeen Valley Source Protection Area (SVSPA) as part of the Assessment Report for the watershed. Reprints of these maps (with the Project Location added by Dillon for reference purposes) are presented in ***Appendix B***. These maps were generated by SVSPA following Assessment Report technical guidelines developed by the MOECC. The high vulnerability aquifer (HVA) map estimates the vulnerability of the 1st encountered aquifer from ground surface. In essence, the map identifies areas where saturated permeable materials are present near the surface, and are not overlain by a significant thickness of low permeability deposits. The significant groundwater recharge area (SGRA) map shows areas where land conditions (e.g., land topography, land cover and soil lithology) are such that a relatively high proportion of runoff will infiltrate. The maps shows that Project Areas 11, 12 and 13 are located in an area mapped as a high aquifer vulnerability, and that all Project Areas fall on land identified as a significant groundwater recharge area.

The aquifer vulnerability mapping conducted by the SVSPA focuses on the first encountered aquifer from ground surface, which in most of the Study Area is the top portion of the overburden aquifer, which is largely unconfined. Considering that the majority of wells pump from deeper confined overburden or bedrock aquifers, the SVSPA aquifer vulnerability mapping is deemed to be conservative. For the current study, aquifer vulnerability mapping of the aquifer being pumped at each water well was performed, where MOECC well records were present. The evaluation involved calculating Intrinsic Susceptibility Index (ISI) values based on an adaption of the MOECC (2006) protocols. ISI values are a measure of the aquifer vulnerability. The method used during the current study differed from the MOECC (2006) approach in that the vulnerability of the pumped aquifer at each well was calculated rather than the vulnerability of the first aquifer encountered from ground surface. The results of the ISI calculations for the pumped aquifer at each well (where well records are available) are presented on **Figure 4**. Of the 18 wells used in the analysis, 67% had a low vulnerability score (ISI values ranging from 93 to 172); 22% had a low to moderate vulnerability score (ISI values ranging from 53 to 60) and 11% had a high vulnerability score (ISI values ranging from 9 to 29). In general, wells that pump from an aquifer overlain by till received low vulnerability scores. Highest vulnerability scores were given to wells that were completed in the overburden and did not intercept thick layers of low permeability till. Based on this analysis, the majority of wells in the Study Area are deemed to be at low risk to impact from surface activities. Nevertheless, the shallow overburden is used as a water supply in some locations via dug wells or springs. Therefore, for conservative purposes, the shallow overburden aquifer, while not often used, is considered vulnerable to contamination.



Well #2507580
Aquifer: overburden (confined)
Overburden/Well Depth: >21.9m/21.9m
Water Found/Static Level: 21m/0.3m
Confining Unit Depth/(Total Thickness): 0m - 18.6m/18.6m
ISI Value: 93 (Low Vulnerability)

Well #2507421
Aquifer: overburden (confined)
Overburden/Well Depth: >41.1m/41.1m
Water Found/Static Level: 39.9m/13.4m
Confining Unit Depth/Total Thickness: 5.5m - 33.2 m (27.7 m)
ISI Value: 150 (Low Vulnerability)

Well #2505873
Aquifer: bedrock (confined)
Overburden/Well Depth: 40.2m/50.3m
Water Found/Static Level: 50.3m/21.6m
Confining Unit Depth/Total Thickness: 10.6m - 40.3m (29.5m)
ISI Value: 163 (Low Vulnerability)

Well #2513827
Aquifer: bedrock (confined)
Overburden/Well Depth: 36m/49.4m
Water Found/Static Level: 48.5m/21.9m
Confining Unit Depth/Total Thickness: 6.4m-21.6m; 22.9m-28.3m;29.6m-36 m (11.9m)
ISI Value: 144 (Low Vulnerability)

Well #2508265
Aquifer: bedrock (confined)
Overburden/Well Depth: 25.9m/37.5m
Water Found/Static Level: 36.6m and 37.5m/6.4m
Confining Unit Depth/Total Thickness: 8.2m-25.9m (17.7m)
ISI Value: 96 (Low Vulnerability)

Well #2500946
Aquifer: overburden (confined)
Overburden/Well Depth: >22.3m/22.3m
Water Found/Static Level: 22.3m/4.6m
Confining Unit Depth/Total Thickness: 12.2m - 18.3 m (6.1m)
ISI Value: 53 (Low to Moderate Vulnerability)

Well #2506105
Aquifer: overburden (unconfined)
Overburden/Well Depth: >15.2m/15.2m
Water Found/Static Level: 15.2m/4.5m
Confining Unit Depth/(Total Thickness): 0m (0m)
ISI Value: 9 (High Vulnerability)

Well #2506926
Aquifer: bedrock (confined)
Overburden/Well Depth: 19.2m/33.5m
Water Found/Static Level: 24.4m and 32.9m/1.5m
Confining Unit Depth/Total Thickness: 10.4m-19.2m (8.8m)
ISI Value: 54 (Low to Moderate Vulnerability)

Well #2513113
Aquifer: bedrock (confined)
Overburden/Well Depth: 22.9m/36.6m
Water Found/Static Level: 27.7/11.6m
Confining Unit Depth/Total Thickness: 13.7m-22.9m (9.1m)
ISI Value: 59 (Low to Moderate Vulnerability)

Well #2500947
Aquifer: overburden (confined)
Overburden/Well Depth: >21.9m/21.9m
Water Found/Static Level: 21.6m/17.7m
Confining Unit Depth/Total Thickness: 12.2m - 21.3 m (9.1m)
ISI Value: 60 (Low to Moderate Vulnerability)

Well #2502868
Aquifer: bedrock (confined)
Overburden/Well Depth: 37.5m/44.8m
Water Found/Static Level: 41.1m/10.7m
Confining Unit Depth/Total Thickness: 16.4m-37.5m (21m)
ISI Value: 122 (Low Vulnerability)

Well #7049854
Aquifer: overburden (confined)
Overburden/Well Depth: >23.2m/23.2m
Water Found/Static Level: 23.2m/4.6m
Confining Unit Depth/Total Thickness: 0m - 17.6m (17.6m)
ISI Value: 88 (Low Vulnerability)

Well #2508326
Aquifer: bedrock (confined)
Overburden/Well Depth: 39.9m/50.3m
Water Found/Static Level: 47.2m and 50m/12.2m
Confining Unit Depth/Total Thickness: 27.4-39.9m (12.5 m)
ISI Value: 90 (Low Vulnerability)

Well #2506462
Aquifer: bedrock (confined)
Overburden/Well Depth: 33.2m/44.2m
Water Found/Static Level: 42.7m/4.6m
Confining Unit Depth/Total Thickness: 11.5m-33.2m (21.6m)
ISI Value: 120 (Low Vulnerability)

Well #2506462
Aquifer: bedrock (confined)
Overburden/Well Depth: 33.2m/44.2m
Water Found/Static Level: 42.7m/4.6m
Confining Unit Depth/Total Thickness: 11.5m-33.2m (21.6m)
ISI Value: 120 (Low Vulnerability)

Well #2508047
Aquifer: overburden (confined)
Overburden/Well Depth: >22.9m/22.9m
Water Found/Static Level: 21m and 23m/11.6m
Confining Unit Depth/Total Thickness: 11.6m - 13.7m (2.1m)
ISI Value: 29 (High Vulnerability)

Well #2512237
Aquifer: bedrock (confined)
Overburden/Well Depth: 59.7m/71.9m
Water Found/Static Level: 60.7m and 71.3m/9.4m
Confining Unit Depth/Total Thickness: 0-5.2m; 22m-28m; 30.5m-43.3m; 48.8m-53.3m (28.6 m)
ISI Value: 172 (Low Vulnerability)

Well #2502697
Aquifer: bedrock (confined)
Overburden/Well Depth: 45.1m/57.3m
Water Found/Static Level: 53.3m/10.7m
Confining Unit Depth/Total Thickness: 24.4-30.5m; 36.6m - 45.1m (14.6 m)
ISI Value: 110 (Low Vulnerability)

SOUTHGATE SOLAR PROJECT

FIGURE 4
WATER WELL INFORMATION AND GROUNDWATER FLOW

⓫	Project Area
●	Seepage Area
✦	MOECC Water Well within 1 km of Project Location
●	Residential Building/Potential Well Location
→	Estimated Direction of Groundwater Flow in Bedrock
→	Estimated Direction of Shallow Groundwater 430 m amsl Flow in Overburden
—	Permanent Stream
- -	Intermittent Stream
—	Potentiometric Surface in Bedrock Aquifer
—	Land Elevation 5 m Contour
▭	Project Location
┼	Fence
—	Access Road
—	Solar Panel
▭	Project Location 500 m Setback
▭	Parcel Boundary
▨	Wetland
▭	Open Aquatic Area

1:20,000
0 0.5 1 km

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR

MAP CREATED BY: GM
MAP CHECKED BY: JP
MAP PROJECTION: NAD 1983 UTM Zone 17N

FILE LOCATION: I:\GIS\149154 - Samsung Southgate\mxd\Groundwater Report

DILLON CONSULTING

PROJECT: 149154
STATUS: FINAL
DATE: 1/28/2015

3.2 Water Quality Sampling Results

This section provides the results of the residential well survey and water quality testing program.

3.2.1 Residential Sampling Program and Survey

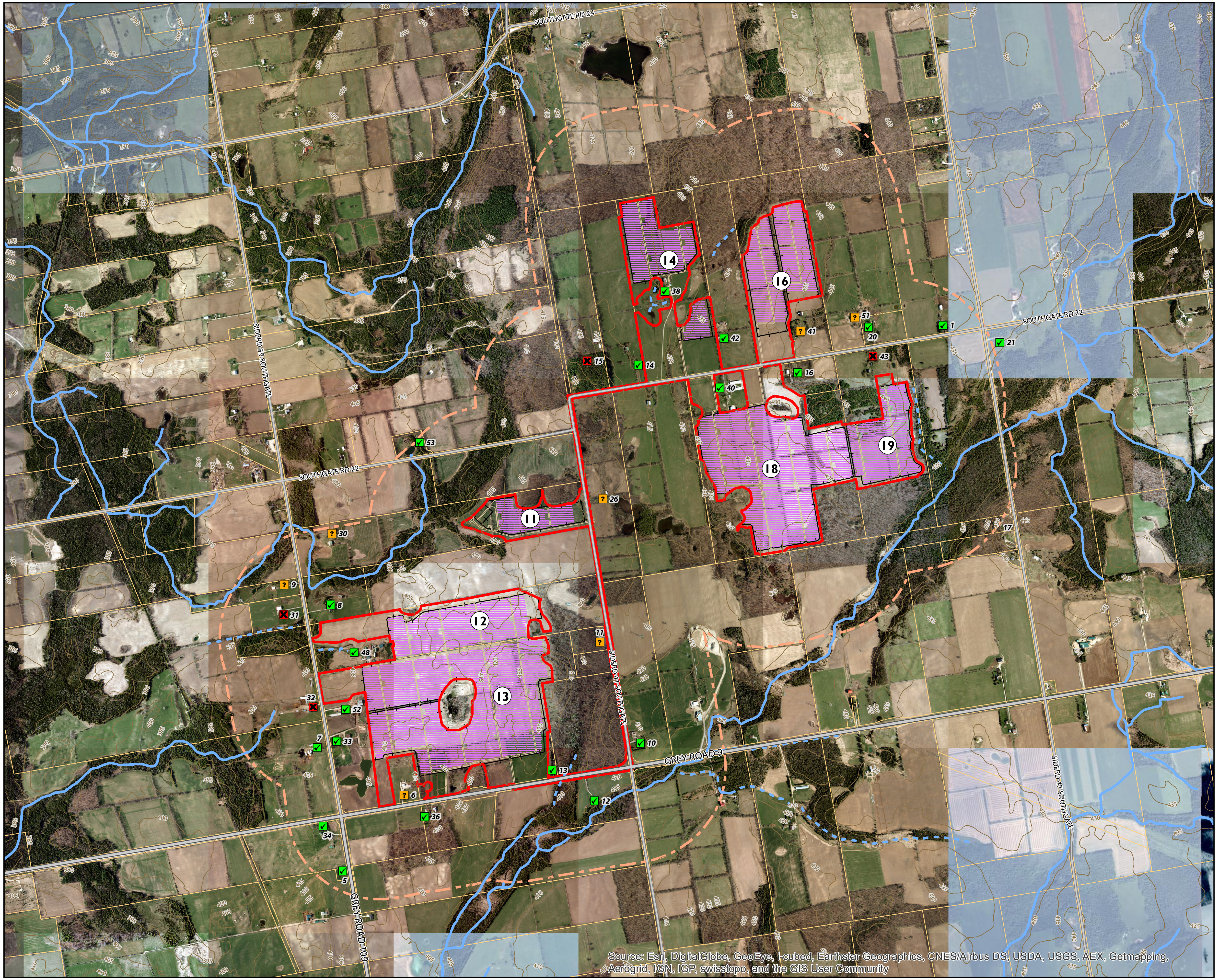
A summary of the number of addresses contacted and samples obtained is presented in **Table 1**. Sampling locations are presented in **Figure 5**.

Table 1: Summary of Private Well Sampling Program

Category	Number of Addresses
Number of Addresses Contacted	34
Number of Samples Obtained	20
Addresses that could not be reached/unavailable	10
Addresses that declined sampling	4

Table 2: Summary of Homeowner Survey Results

Category	Results
Number of Residences who completed survey	20 (100%)
Well Type	
Number of dug wells	3 (15% of total)
Reported minimum, maximum and median depth of wells	1.5 m, 7.3 m, 4.2 m
Number of drilled wells	17 (85% of total)
Reported minimum, maximum and median depth of wells	8 m, 101 m, 37 m
Wells of unknown construction	0 (0% of total)
Water Quantity Comments	
Reported number of wells where water quantity has been restricted from time to time, well has gone dry, or water has been trucked in	0 out of 20 (0% of reported total)
Water Quality Comments	
Sulphur odour and/or taste or other smell	8 out of 20 (40%)
Occasional discolouration	6 out of 20 (30%)
Iron problems	3 out of 20 (15%)
No problems reported	11 out of 20 (55%)



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

SOUTHGATE SOLAR PROJECT

FIGURE 5
PRIVATE WELL SAMPLING LOCATIONS

- ⑪ Project Area
- ☑ Well Sampled
- ? Resident Contacted but no Response/Unavailable
- ☒ Resident Declined Sampling
- — Permanent Stream
- - - Intermittent Stream
- — Land Elevation 5 m Contour
- ▭ Project Location
- ▭ Project Location 500 m Setback
- ┼ Fence
- — Access Road
- — Solar Panel
- ▭ Parcel Boundary

1:20,000

0 0.5 1 km

N E S W

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR

MAP CREATED BY: GM
MAP CHECKED BY: JP
MAP PROJECTION: NAD 1983 UTM Zone 17N

FILE LOCATION: I:\GIS\149154 - Samsung Southgate\mxd\Groundwater Report

DILLON
CONSULTING

PROJECT: 149154
STATUS: FINAL
DATE: 3/25/2015

The survey indicated that most of the potable water supply is from drilled wells (85% of systems), with a relatively small amount (15%) being dug wells or springs. The reported median depth of the drilled wells was 37m, with the deepest well being 101m. The median depth of the dug wells was 4.2m. In comparison, MOECC well records, which included 7 of the wells in the survey and 11 other wells in the local area, indicated well depths ranging from 22 to 72m.

Overall, the majority of residences who were interviewed were generally satisfied with the quality and quantity of their water supply. Common reported issues were sulphur smell/taste (40% of responses), occasional discolouration (30% of responses), and iron problems (15% of responses). None of the interviewed residences had concerns with the ability of their water supply to meet water demand.

3.2.2 *Water Quality Testing Results*

Water quality testing results are summarized in **Table 3**.

Table 3:Summary of Water Quality Testing Results

Parameter	Units	ODWS	All Wells		
			Range	Median	Existing ODWS
Microbiology					
Total Coliforms	CFU/100mL	0	0 - 54	0	27%
E. Coli	CFU/100mL	0	0 - 13	0	5%
General Chemistry					
Total Ammonia-N	mg/L	NV	<0.050 - 0.64	<0.050	NV
Colour	TCU	5 (AO)	<2 - 10	<2	5%
Conductivity	umho/cm	NV	380 - 980	540	NV
Dissolved Organic Carbon	mg/L	5 (AO)	0.38 - 5.9	0.605	5%
pH	pH	6.5-8.5(OG)	7.65 - 8.15	8.015	0%
Dissolved Sulphate (SO4)	mg/L	500 (AO)	7 - 44	14	0%
Turbidity (lab)	NTU	5 (AO)	<0.2 - 45	<0.2	9%
Turbidity (field)	NTU	5 (AO)	0.1 - 1.44	0.52	0
Alkalinity (Total as CaCO3)	mg/L	30-500 (OG)	200 - 440	265	0
Dissolved Chloride (Cl)	mg/L	250 (AO)	<1 - 27	5	0
Nitrite (N)	mg/L	1 (MAC)	<0.010 - 0.012	<0.01	0
Nitrate (N)	mg/L	10 (MAC)	<0.10 - 13.3	1.51	5%
Nitrate + Nitrite	mg/L	NV	<0.10 - 13.3	1.51	NV
Calculated TDS	mg/L	500 (AO)	210 - 570	305	5%
Hardness (CaCO3)	mg/L	80-100 (OG)	<1.0 - 470	250	86%

Parameter	Units	ODWS	All Wells		
			Range	Median	Existing ODWS
Metals					
Antimony (Sb)	ug/L	6(IMAC)	<0.50 - <0.50	<0.50	0%
Arsenic (As)	ug/L	25(IMAC)	<1.0 - 11	<1.0	0%
Barium (Ba)	ug/L	1000(MAC)	<2.0 - 77	21	0%
Boron (B)	ug/L	5000(IMAC)	11 - 44	14	0%
Cadmium (Cd)	ug/L	5(MAC)	<0.10 - 0.48	<0.10	0%
Calcium (Ca)	ug/L	NV	220 - 110000	55000	NV
Chromium (Cr)	ug/L	50(MAC)	<5.0 - <5.0	<5.0	0%
Copper (Cu)	ug/L	1000(AO)	<1.0 - 47	2.25	0%
Iron (Fe)	ug/L	300 (AO)	<100 - 3000	<100	14%
Lead (Pb)	ug/L	10(MAC)	<0.50 - 2.1	<0.50	0%
Magnesium (Mg)	ug/L	NV	96 - 47000	28500	NV
Manganese (Mn)	ug/L	50 (AO)	<2.0 - 38	<2.0	0%
Selenium (Se)	ug/L	10(MAC)	<2.0 - <2.0	<2.0	0%
Sodium (Na)	ug/L	200,000 (AO)	1600 - 160000	7400	0%
Uranium (U)	ug/L	20(MAC)	<0.10 - 1.4	0.23	0%
Vanadium (V)	ug/L	NV	<0.50 - 0.58	<0.50	NV

NV: No applicable ODWS
AO: Aesthetic Objective
MAC: Maximum Allowable Concentration
IMAC: Interim Maximum Allowable Concentration
OG: Operational Guideline

Key observations from the water quality survey are as follows:

- Bacteria were detected in 27% of the wells, with *E. Coli* detected in 5% of the wells. The ODWS for bacteria, including *E. Coli* is non-detect.
- Nitrates were detected in 5% of the wells above the ODWS
- Well water is hard, 86% of the wells testing greater than the ODWS
- Iron was detected above ODWS in only a few wells (14% of wells)
- Raw water turbidity is within ODWS for most wells.

Overall, the testing results indicate that the groundwater is generally of high quality; however, it is hard and is susceptible to sulphur and iron problems. Impacts from surface contamination such as road and nitrates/bacteria from septic systems do not appear to be overly prevalent.

4. GROUNDWATER IMPACT ASSESSMENT

An assessment of the potential for the Project to impact the groundwater resource during either construction or operation phases was performed. This assessment included evaluation of the potential sources of contamination associated with the Project, potential pathways for the contaminants to reach the local aquifers, and potential receptors (i.e., water wells). A detailed assessment of potential negative effects, mitigation strategies, monitoring plans and contingency measures for all project construction and operation activities is presented in the Environmental Effects Mitigation and Monitoring Plan in the Design and Operations Report submitted as part of the REA application package. A review of particular Project-related activities that may pose a risk to groundwater, and an assessment of the significance of these risks, is discussed in the sections below.

4.1 Potential Contaminating Activities

Potential contaminating activities associated with the Project are discussed below. The discussion is organized by whether the activity is construction or operation related.

4.1.1 Construction-Related Activities

Impacts from Accidental Fuel Spillage/Releases from Equipment

Accidental spillage/releases of petroleum fuels from construction equipment are identified as a potential contaminant source. During the construction period, the potential does exist for spills from service vehicles that will be used to refuel major construction equipment that cannot easily leave the site during construction. The likelihood of accidental spills that would result in adverse effects to the environment will be prevented or greatly reduced through the proper handling of fuels and lubricants during construction. Mitigative actions to prevent adverse impacts from accidental fuel spillage from equipment will be identified in a Spills Response Plan and Emergency Response and Communication Plan. These plans will be implemented by the selected contractor as part of the construction contract, who will be required to clean up spills in an effective and timely manner. Procedures to ensure appropriate storage/handling/transportation of wastes generated during construction will be detailed in a Hazardous and Non-Hazardous Waste Management Plan. Notification will be provided immediately to the MOECC (Spills Action Centre) and SVCA in the event of a spill.

Impacts from Stormwater Run-off

Impacts to aquifers from suspended solids contained in stormwater run-off have been documented at some solar projects in Eastern Ontario, where the local aquifer is shallow bedrock. Based on information provided to Dillon by the MOECC (Mr. Frank Crossley, Hydrogeologist with Eastern Region, Personnel Communication), the impacts were associated with sediment-laden run-off water entering into open boreholes that had been drilled into the shallow bedrock to support the pile foundations. Some of the nearby water wells in the bedrock aquifer experienced temporary turbidity issues.

For the Southgate Solar Project, the risk of impacts to groundwater from stormwater run-off is considered low. Setbacks between the active construction zone and nearby properties (minimum 100 m), as well as the use of stormwater and erosion controls during construction (as detailed in the Construction Plan Report), is expected to mitigate risks. Based on the preliminary geotechnical study, the native soil in the Study Area is largely comprised of silt, sand and gravel materials. The presence of porous media above the pumped aquifer zones will restrict movement of fine grained material into the aquifer. Furthermore, water well records indicate that many of the wells pump from the confined bedrock which will be protected from surface contamination. At most risk of impact from stormwater run-off will be shallow springs; however, erosion controls and setback requirements in place during construction will mitigate potential issues.

Impacts from Waste Generation

As described in the Construction Plan Report, minor quantities of waste materials will be generated during construction such as packaging, pallets and scrap metal. Quantities of non-hazardous wastes and domestic waste will be removed to a licensed landfill. Minor amounts of hazardous waste that are generated by construction equipment maintenance (e.g., used oil) will be stored in a secured area and removed by a licensed waste contractor. Handling of such wastes will be outlined in the Hazardous and Non-hazardous Waste Management Plan. Washroom facilities for the construction crews will be portable, and wastes will be removed by a licensed waste hauler. As a result of these mitigative actions, no potential negative effects to the aquifer from waste generation during construction are identified.

Impacts from PV Panel Foundation Supports

The design of the solar installation will involve the construction of numerous solar panel support foundations that will extend into the overburden. Each of the racking structures will be assembled on site. To support the racks, it is estimated that approximately 25,000-55,000 piles will be installed. These piles would be installed using a mechanical, hydraulic drive motor that would rotate the screw pile into the ground mounted on a specialized rig, excavator or boom truck. Earth excavation, soil disposal or the use of concrete is not required. The exact type of method will be determined based on the geotechnical investigation and at the time of final design. The depth of the foundations will depend upon local soil conditions, but is expected to be within 3 m to 5 m of the ground surface.

The risk of significantly increasing the vulnerability of the underlying aquifers is deemed low based on the proposed foundation construction methodology, and the hydrogeology of the area. Based on a review of MOE water well records, the majority of wells in the Study Area are completed in either the confined bedrock or a confined/semi-confined overburden aquifer. The vulnerability of the bedrock aquifer has been assessed in this study, and a low vulnerability ranking was determined. In addition, the watertable in many areas of the Project is relative deep, with groundwater encountered at depths of 2.1m and 4.5 m in only two of the 14 boreholes drilled during the geotechnical study.

The construction methodology will involve screwing the foundation into the ground with minimal displacement of soil, and therefore will not produce a preferential groundwater flow pathway. Overall, the risk of the foundations acting as preferential pathways and causing impacted groundwater to affect the aquifers is considered low.

4.1.2 Operation Activities

Impacts from Sewage Disposal – Operations and Maintenance Building

An operations and maintenance building will be constructed as part of the Project and would provide a reception area, office(s) for operation staff, a washroom, lunch room, warehouse and parking area.

If feasible and readily available, water for use in toilets and sinks would be supplied from the municipal system. If not feasible, water would either be taken from an on-site well or be trucked in from a municipal supply using a local water hauler, and stored in an above-ground water tank within the building. Bottled water would be provided for drinking purposes. If the water needed for the washroom and kitchen facilities in the operation and maintenance building is taken from an on-site well, the volume of water pumped from aquifers would be very minor. No negative effects to aquifer groundwater quality or quantity are expected.

Sewage from the washroom and kitchen facilities would be directed to a septic holding tank, designed in accordance with the Ontario Building Code and municipal building standards, and daily flows would be very minimal. A level gauge would be provided to monitor the need for emptying the tank by a licensed septic tank hauler, and high-level alarms with audible and visual warning would be provided to prevent overfilling. No significant impacts on groundwater are expected.

Impacts from Operational Waste Generation

The Design and Operations Report submitted as part of the REA application package states that no significant quantities of wastes will be generated during the site operations. Waste materials would be primarily limited to materials generated during maintenance activities such as batteries and minor amounts of domestic waste. For these wastes, a site-specific waste collection and disposal management plan will be implemented during operation. No adverse impacts are expected to the environment based on waste generation activities at the facility.

Impacts from Chemical/Fuel Usage and Accidental Releases

With the exception of transformer oil fluids associated with the substation, bulk storage of fuels or chemicals will not occur. Mitigative strategies identified in the Design and Operations Report include: a) implementation of a Spills Action Plan and Emergency Response and Communications Plans to minimize any spill impacts, and b) provision of secondary containment for the substation transformer that will allow detection and containment of leaks. Once the mitigative actions are applied, no significant impacts to the environment and/or groundwater are expected.

Routine Maintenance Activities

Cleaning of the PV modules may be occasionally required. Cleaning will use potable water from off-site sources and will not use chemical cleaners. As a result, no potential effects to the environment and/or groundwater are expected from cleaning activities.

Short native vegetation may be planted once construction activities are complete. It will be necessary to maintain the land in such a way that vegetation does not shade or in other ways impact the solar panels. Regular scheduled maintenance will also occur to manage weed growth as required. There is also potential for maintenance of the vegetation by grazing livestock (sheep), however details of this will be determined during the detailed design stage. This will be done in consideration of any seasonal limitations outlined in the Natural Heritage Assessment. It is not anticipated that herbicides will be used to manage vegetation. Overall, no impacts to the environment and/or groundwater are expected.

4.2 Aquifer Vulnerability and Usage

Within the Study Area, groundwater is obtained from both bedrock and overburden aquifers. Drilled wells are the most common; however, dug overburden wells are used on some properties. In addition to wells, some landowners utilize natural springs and seeps that are common in the area. Groundwater is used for both domestic consumption and for farming purposes.

Based on geological mapping and information from available MOECC water well records, the bedrock aquifer is considered to have a low vulnerability to contamination. Water well record data indicates that the bedrock aquifer in the Study Area is buried beneath 19 to 60 m of a mixture of sand, gravel, silt and till overburden. The bedrock aquifer is considered to be confined by an overlying lower permeability till. Overburden wells are considered intrinsically more vulnerable to contamination then bedrock wells, because they are generally shallower, and may not fully intercept the till unit that is commonly present about the bedrock. Nevertheless, well records indicate that the majority of overburden wells, where MOECC well records were available, pumped from confined or semi-confined aquifers. Therefore, the majority of overburden wells are considered to have a low to moderate vulnerability of contamination from surface activities. The most vulnerable potable water supplies are those that receive groundwater from springs. Springs were identified near Project Area 14 and west of Project Area 12.

4.3 Groundwater Recharge

The Project Location has been mapped by SVSPA as being within a significant groundwater recharge area. Recharging water will maintain water levels in the underlying aquifers, and support the hydrological function of local springs, seeps and potentially some intermittent streams.

With respect to risks associated with the Project affecting groundwater recharge, the potential risks are considered small. Precipitation falling on the solar panels will be directed to the lower drip edge of the panel, which will discharge to the ground, where it will infiltrate into the relatively permeable surficial materials. No net decrease in infiltration is anticipated, and therefore groundwater levels in the aquifers are expected to be maintained.

4.4 Groundwater Impact Risk Evaluation

Based on the review of the potentially contaminating activities associated with the construction and operation of the Project and information on the aquifer vulnerability and aquifer usage, the risk of groundwater quality or quantity impacts to potable water supplies from the Project are considered low. Nevertheless, the Project is located in an area where landowners rely solely on the groundwater as a water supply. Therefore, monitoring of groundwater quality during the initial stages of operation of the project is considered prudent.

5. PROPOSED MONITORING AND CONTINGENCY PROGRAM

The following monitoring and contingency program is identified to be implemented during the construction and operation phases of the Project. This program is specific to addressing potential impacts associated with groundwater quality to the nearby water wells. Additional information on mitigative and monitoring activities is presented in the Environmental Effects Mitigation and Monitoring Plan in the Design and Operations Report (Dillon, 2015b).

5.1 Construction Phase

The following monitoring program is recommended during construction:

- Implementation of all monitoring and reporting activities identified in the Environmental Effects Mitigation and Monitoring Plan in the Design and Operations Report (Dillon, 2015b).
- Ongoing monitoring of runoff conditions should be performed to ensure that runoff water is not allowed to pond within 100 m of nearby private wells.

5.2 Operations Phase

The need and extent of monitoring during operation will be based on further consultation with the MOECC. It is our understanding the MOECC (Approvals) has recently required groundwater monitoring programs to be implemented as a condition of approval on some large-scale solar projects in Ontario (e.g., Grand Renewalable Solar LP – solar component; Kingston Solar LP etc). For these projects, monitoring of water quality in the vicinity of the project is required on an annual basis for two years following construction. For the Southgate Solar Project, we recommend the following monitoring program:

- Water samples be collected from select homeowner’s water wells within 500m of, and downgradient from, the Project Areas.
- Water samples be analyzed for general chemistry, nutrients, bacteria and select metals. Field turbidity measurements are to be taken.
- Sampling and analysis of the waterwells to be conducted annually for the first two years following project completion.

5.3 Complaint Resolution and Contingency Plan

In the event that a water quality complaint arises during the construction or operation of the Southgate Solar project, it is recommended that the following contingency plan be implemented. This plan is based on input from the Eastern Regional MOECC Office that was used to design the Kingston Solar LP monitoring program. We recommend that the contingency plan be adaptive in nature, as the course of action will depend upon the specific situation and severity of the identified issue.

As a minimum, the contingency plan will include the following:

- A water sample will be obtained from the well water in question and submitted as "high priority" to a qualified laboratory. The data will be assessed by a qualified person, and if the problem is related to construction or operation activities at the site, then bottled water will be immediately provided to the impacted party.
- The MOECC will be notified of any complaints and provided with an action plan to address these complaints. The action plan will be based on the nature and severity of the complaint. Discussions will be held with MOECC staff to confirm the appropriate frequency and duration of water quality testing for the affected well.
- Implementation of the agreed upon monitoring program will occur and the results will be provided to the homeowner and the MOECC.
- Depending upon the outcome of the investigation, an alternate water supply will be provided to the affected property owner, as required.

6. SUMMARY OF CONCLUSIONS

The following conclusions are made based on the results of this study:

1. Southgate Solar LP is proposing to construct a 50 MWac solar facility within the Township of Southgate, in the County of Grey, approximately 11km north of the community of Mount Forest. The overall optioned lands available for development (referred to as the Project Location) consist of approximately 235 hectares (581 acres). The Project will consist of approximately 197,000 to 207,000 PV panels, 34 MV Stations containing inverters and MV transformers, a high voltage substation transformer (within a substation yard that will also contain an operations and maintenance building and communications tower), and a collector system of underground power lines and access roads. Temporary project components that will be utilized during the construction phase only will include equipment laydown and storage areas and access roads.
2. A review of geological reports and available water well records indicate that the Project is situated in an area of thick sand, gravel and till overburden (20m to 70m in thickness) overlying dolostone bedrock. Both the overburden and bedrock are used as aquifers to supply potable water. The bedrock aquifer, which is the most commonly used aquifer in the area, is considered to have a low vulnerability to contamination from surface activities. The overburden aquifer, which is used by some landowners, is considered to have a low to moderate vulnerability for the most part; however, the aquifer is conservatively assessed as having a high vulnerability in areas where shallow overburden wells or springs are used for local water supplies.
3. A water well sampling program was implemented based on consultation with the MOECC. The sampling program focused on taking raw water quality samples from a select number of private wells that are within 500 m of the proposed Project Location. This information was collected to assess the baseline groundwater conditions prior to construction of the Project. A total of 34 addresses were contacted by letter, telephone or in person to request their participation in the sampling program. Of the 34 contacted addresses, 20 addresses were available to be sampled. Collected water samples were tested for general chemistry, metals and bacteria, and compared to the Ontario Drinking Water Standards. A homeowner survey was also completed at the time of water sampling.
4. Raw water quality testing results indicated that the groundwater is of generally good quality. Water quality is hard, and iron and sulphur content is elevated in some wells. Total coliform and *E. Coli* concentrations were detected in excess of the Ontario Drinking Water Standards in 27% and 5% of the sampled wells, respectively, which is typical for private water wells.
5. An assessment of the activities that would potentially discharge contaminants to the environment from the construction and operation of the Project was conducted. The risk associated with potential contaminating activities will be managed through implementation of the Hazardous and Non-Hazardous Waste Management Plan, Spills Action Plan and the Emergency Response and Communication Plans.

6. The risk of the Project causing water quality impacts to the aquifers is deemed low, considering the low risk of significant contaminant releases to the environment from the construction/operation of the Project, and the fact that most aquifers have a low to moderate vulnerability to contamination from surface activities. Nevertheless, for conservative purposes, it is recommended that groundwater monitoring be implemented during initial operation of the Project. The monitoring program should include sampling of select water wells located in downgradient locations of the Project Location and testing of this water for general chemical parameters including bacteria, nutrients and select metals.
7. A contingency program is identified for any well water complaints that may arise during the construction and operation of the facility. This contingency program includes notification and reporting requirements, assessment of the complaint by a qualified engineer or geoscientist, and the requirement to provide a temporary source of potable water to the complainant should the solar facility be identified as the cause of the well water quality issue.

7. LIMITATIONS

This report was prepared exclusively for the purposes, Project and Study Area outlined in the report. The report is based on information provided to, or obtained by, Dillon as indicated in the report, and applies solely to conditions existing at the time of the study.

This report was prepared by Dillon for the sole benefit of Southgate Solar LP. The material in the report reflects Dillon's best judgment in light of the information available to Dillon at the time of preparation. Any use which a third party (i.e., a party other than our Client) makes of this report, or any reliance on, or decisions made, based on it are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

DILLON CONSULTING LIMTED
London, Ontario

PROFESSIONAL GEOSCIENTIST
3/22/15
DARIN T. BURR
PRACTISING MEMBER
1103
ONTARIO

Darin Burr, M.Sc., P.Geo.
Hydrogeologist

APPENDIX A

Consultation Correspondence

Appendix A.1:
Communication Record with Ontario Ministry of Environment and Climate Change

RE: Windsor Solar Project - Results of private well assessment

1 message

Romic, Zeljko (ENE) <Zeljko.Romic@ontario.ca> Fri, Sep 19, 2014 at 10:07 AM
To: "Burr, Darin" <dburr@dillon.ca>

Hi Darin,

Thanks for the follow-up on the groundwater monitoring program issue. Since a Renewable Energy Approval (REA) application for this project hasn't even been submitted yet, a reviewing hydrogeologist has not yet been assigned, and the ministry would not be in a position to discuss specific conditions related to your project until the technical review occurs. For your reference purposes, the REA approval process is as follows:

1) **Submission** - the proponent submits the REA application to the ministry for review (including all assessments/studies/reports);

2) **Screening for Completeness** - the ministry screens the application and determines whether the application meets all of our "complete submission" requirements;

3) **Technical Review and EBR Posting** - if it's determined that the REA application is complete and contains all of the supporting documentation, the application is posted on the Environmental Registry for public comments, and the ministry begins the thorough technical review of materials submitted;

4) **Drafting of REA conditions and REA decision** – based on the technical review, the ministry determines whether to issue an approval, and if so, what conditions would go into the REA approval

5) Issuance of REA (or rejection) – REA is issued (or rejection letter)

Note: the Windsor project is still in the pre-submission phase.

Your assessment and conclusion below, suggesting that a monitoring program not be required as a condition of the approval that will ultimately be sought for this REA project will be reviewed and considered by our experts during the technical review phase. At that point the ministry experts will determine whether they are in agreement and based on our previous discussions on this issue and general feedback you've received, it sounds like your conclusion is reasonable, but again, the final determination on what conditions will be included cannot be made until the technical review occurs.

If you have any other questions about the REA process or additional groundwater questions (of general nature), please let me know and I will try to provide clarification.

Thanks,

Zeljko Romic | Senior Program Support Coordinator**|** Service Integration **|** Environmental Approvals Access and Service Integration Branch I Ministry of the Environment and Climate Change
2 St. Clair Ave W. 12a Floor Toronto, Ontario, M4V 1L5 **|** Phone: 416-314-8204 **|** zeljko.romic@ontario.ca

Appendix A.2:
Communication Record with Saugeen Valley Conservation Authority

MEMO

DILLON
CONSULTING

TO: File

FROM: Darin Burr

DATE: January 22, 2015

SUBJECT: Telephone Discussion with David Ellingwood, Water Protection
1-519-470-3000 ext 102

OUR FILE: 14-9154-7000

Erick Downing, Manager of Environmental Planning & Regulations of Saugen Valley Conservation was contacted by telephone to inquire about any groundwater related concerns that his CA may have on the Southgate Solar Project. Erick directed Dillon to contact David Ellingwood of the Saugeen, Grey Sauble, North Bruce Peninsula Source Protection Region to discuss any groundwater related issues.

David was contacted, and the following items were discussed

- David was not aware of any particular environmental issues with Solar installations; however, common issues that have come forward from the public regarding renewable energy development projects includes: a) potential for foundations of infrastructure to interfere with groundwater recharge, or to act as transport pathways for contaminants to migrate into the subsurface; and b) potential impacts from construction activities. David was informed that we will address these issues in our report.

- David directed Dillon to their website (www.waterprotection.ca) where additional information on source protection related mapping on high vulnerability areas can be found. This mapping was conducted following MOECC technical guidance requirements for the groundwater and assessment reports related to source protection. David stated that the majority of the area has been mapped as medium to high aquifer vulnerability. It was noted that the level of mapping is fairly course as a result of the scarcity of water well data used in the analysis.

- David was not aware of the project area falling within a well head protection area.

Appendix A.3:
Example Residential Well Survey Invitation Letter

SOUTHGATE SOLAR LP
2050 Derry Road West, 2nd Floor, Mississauga, ON L5N 0B9 Canada TEL: 905-817-6498

November 7, 2014

Invitation to Participate in a Water Well Survey

Dear Resident

As you may know, Southgate Solar LP proposes to develop a 50 megawatt alternating current (50 MWac) solar facility, located near Mount Forest, in the Township of Southgate, County of Grey, Ontario. The renewable energy facility will be known as the Southgate Solar Project. Southgate Solar LP has initiated the project with the Ontario Power Authority. The project will require approval under *Ontario Regulation 359/09 – Renewable Energy Approval (REA)* under Part V.0.1 of the *Ontario Environmental Protection Act*. Dillon Consulting Limited (Dillon) has been retained by Southgate Solar LP to undertake the technical studies that are required under this regulation to receive a REA for the project.

Under the guidance of the Ministry of the Environment and Climate Change (MOECC), Southgate Solar LP has taken the initiative to conduct a background study of water well water quality for a select number of properties within 500 m of the proposed solar facility. The purpose of the program is to gain a better understanding of the groundwater quality in your area and to establish baseline water quality in the vicinity of the project prior to development. Your property has been selected as a potential site for the sampling program; it is anticipated that up to 30 representative properties will be sampled in total, depending on the responses received from property owners. Please note that this program is completely funded by Southgate Solar LP, and there is no cost to the property owner.

If you are using a well as a water supply, and wish to become involved in the well water sampling program, we kindly ask that you contact Dillon by mail, email or phone to schedule an appointment. The well water sampling program will involve obtaining a water sample from your water supply system and testing the water for bacteria, metals and general chemistry. The results will then be provided to you. At the time of water sampling, we will also be asking you to complete a questionnaire on your well water use and whether you have any comments on your water quality.

Thank you in advance for your consideration of our request.

Sincerely,

Darin Burr, P.Geo.
Dillon Consulting Limited
130 Dufferin Avenue
Suite 1400
London, Ontario
Email: dburr@dillon.ca
Ph # 519-438-1288 ext. 1236
Toll Free 1-866-234-7094

Appendix A.4:
Example Residential Well Survey

WATER WELL SURVEY FORM

Southgate Solar Project

PROPERTY LOCATION & USE

Address (911 Number):	***Municipality, Postal Code:***
Mailing Address (if different from above):	***Municipality, Postal Code:***

RESIDENT / OWNER INFORMATION

Person Interviewed ☐ Resident ☐ Owner ☐ Other	***Address:*** ***Telephone:***
If Resident is not Owner, indicate Owner's name:	***Address:*** ***Telephone:***
Were there any previous owners? ☐ Yes ☐ No	***If yes, please indicate previous owner's name(s):***

WATER WELL CONSTRUCTION

☐ **Photos Taken**

***Note:* All information below is to be provided by well owner or resident. Do not open the well under any circumstances.**

Number of wells on property (use one form per well on property):	***Usage Activity (active, dormant):***
MOE Well Number: # (☐ *Not available*)	***Well usage (e.g. domestic, irrigation, washing):***
Well Type: ☐ Drilled ☐ Dug ☐ N/A-Unknown ☐ Overburden ☐ Bedrock ☐ N/A-Unknown	***Date Installed:*** ***Name of Well Driller:*** ***Is driller's borehole record available (Yes/No)?***
Well depth (ft/m):	***Static water level (ft/m bgs):***
Casing material (steel, concrete):	***Diameter of Well Casing (inches or mm):***

Screen presence, depth (open hole in bedrock):	***Pump Type (submersible, jet, hand, etc.):***
Well Coordinates (GPS) ***Easting:*** ***Northing:*** ***Datum:***	***Screen presence, depth (open hole in bedrock):***

WATER QUANTITY

How many years has the interviewed person used the well?	***How often does the well run dry (never, daily, weekly, monthly, annually, once)?***
If so, what activity is associated with the well running dry (washing, irrigation, etc.)?	***Is the well ever recharged by water truck (Yes/No)?***

WATER TREATMENT SYSTEMS

☐ **Photos Taken**

Indicate all applicable components below:

☐ Water Softener
☐ Reverse Osmosis
☐ Iron Filter
☐ Sediment Filter
☐ UV
☐ Chlorination
☐ Other (specify)_________
☐ Other (specify)_________

WELL VULNERABILITY

☐ **Photos Taken**

Direction of ground slope:	***Well head stick-up above ground (inches/centimetres):***
Casing condition (cracks, decayed wood, holes, etc.):	***Drainage at wellhead (level, mound, even slope, inward ditch, pit?):***
Condition of well lid (material, cracks, holes, rotted wood, insects, etc.):	***Do livestock/pets have access to wellhead area?:***

WATER QUALITY HISTORY

Odour concerns/problems:	***Taste concerns/problems:***
Colour concerns/problems:	***Staining of fixtures or laundry:***
Encrustation at fixtures or pipes:	***Is the water used for drinking by occupants?***
Is there any history with illness associated with the water? Frequency?	***Was the water tested for chemistry/microbiology by a laboratory and what were the results?***
Has the water quality changed over time?	***Additional comments by interviewed well user:***

WATER SAMPLING RECORD

Date and time of sample:	***Sampling point:***
Confirm sampling point is off-line from treatment systems (Yes/No):	***Number of bottles:*** ***Turbidity Reading (NTU):***
Was the water sampled purged before sampling?	***If sample water was purged, how much?*** ***vol (L)__________ time (min)__________***

DRAFT PROPERTY SKETCH

Bring prepared background sketch prior to site visit. In the space provided below, indicate the following features:

Property boundary, houses and other buildings, well, septic tank, septic field, road, driveway, north arrow, distances between well and septic field, ground slope direction (downward), ditches, water pipe connections, fuel storage / heating oil tanks, and watercourses, ponds, lakes.

Completed By: ______________________________

Date: ______________________________

Appendix A.5:
Example Residential Well Sampling Results Letter

14-9154
Corr

DILLON
CONSULTING

130
Dufferin Avenue
London, Ontario
Canada
N6A 5R2
Mail: Box 426
London, Ontario
Canada
N6A 4W7
Telephone
(519) 438-6192
Fax
(519) 672-8209

January 5, 2015

RR #2
Holstein, Ontario
N0G 2A0

Private Well Water Quality Sample Results

Dear

This letter presents the results of the laboratory analysis performed on a water sample from your well, which was collected at the above-mentioned location on December 6, 2014. Sampling was performed as part of a well water survey being conducted by Southgate Solar LP to assess groundwater conditions in the vicinity of the proposed Southgate Solar Project.

The well water sample was analyzed for several parameters including bacteria, metals and general chemistry. The results of the analysis were compared to the Ministry of the Environment and Climate Change Ontario Drinking Water Standards (ODWS) and are presented in the attached table and laboratory report. An information bulletin that describes the water quality standards for the tested parameters and an information bulletin from the local health department on how to interpret the bacteriological (*E. coli* and Total Coliform) results are also attached.

The results of the analysis indicate that the well water sample meets the ODWS for the measured parameters.

Thank you for participating in the well sampling program. If you have any questions, please contact the undersigned.

Yours sincerely,

DILLON CONSULTING LIMITED

Darin Burr, M.Sc., P.Geo.
Hydrogeologist

DTB:rrs
Encls.

Our file: 14-9154-7000-01

Dillon Consulting
Limited

W - WATER QUALITY LABORATORY RE RT

			Location ID	
			Sample Date	2014/12/06
Parameter	Units	EQL	Ontario Drinking Water Standard	
Calculated Parameters				
Calculated TDS	mg/L	1.0	**500 (AO)**	380
Hardness (CaCO3)	mg/L	1.0	**80-100 (OG)**	1.0
Inorganics				
Total Ammonia-N	mg/L	0.050	**NV**	<0.050
Colour	TCU	2	**5 (AO)**	<2
Conductivity	umho/cm	1.0	**NV**	640
Dissolved Organic Carbon	mg/L	0.20	**5 (AO)**	0.60
pH	pH	N/A	**6.5-8.5(OG)**	8.01
Dissolved Sulphate (SO4)	mg/L	1	**500 (AO)**	10
Turbidity (lab)	NTU	0.2	**5 (AO)**	<0.2
Turbidity (lab)	NTU	N/A	**5 (AO)**	0.99
Alkalinity (Total as CaCO3)	mg/L	1.0	**30-500 (OG)**	280
Dissolved Chloride (Cl)	mg/L	1	**250 (AO)**	27
Nitrite (N)	mg/L	0.010	**1 (MAC)**	<0.010
Nitrate (N)	mg/L	0.10	**10 (MAC)**	1.46
Nitrate + Nitrite	mg/L	0.10	**NV**	1.46
Metals				
Aluminum (Al)	ug/L	5.0	**100(OG)**	<5.0
Antimony (Sb)	ug/L	0.50	**6(IMAC)**	<0.50
Arsenic (As)	ug/L	1.0	**25(IMAC)**	<1.0
Barium (Ba)	ug/L	2.0	**1000(MAC)**	<2.0
Boron (B)	ug/L	10	**5000(IMAC)**	<10
Cadmium (Cd)	ug/L	0.10	**5(MAC)**	<0.10
Calcium (Ca)	ug/L	200	**NV**	240
Chromium (Cr)	ug/L	5.0	**50(MAC)**	<5.0
Copper (Cu)	ug/L	1.0	**1000(AO)**	10
Iron (Fe)	ug/L	100	**300 (AO)**	<100
Lead (Pb)	ug/L	0.50	**10(MAC)**	<0.50
Magnesium (Mg)	ug/L	50	**NV**	100
Manganese (Mn)	ug/L	2.0	**50 (AO)**	<2.0
Selenium (Se)	ug/L	2.0	**10(MAC)**	<2.0
Sodium (Na)	ug/L	100	**200,000 (AO)**	160000
Uranium (U)	ug/L	0.10	**20(MAC)**	0.21
Vanadium (V)	ug/L	0.50	**NV**	<0.50
Microbiological				
Background	CFU/100mL	NV	**NV**	0
Total Coliforms	CFU/100mL	NV	**0 (MAC)**	0
Escherichia coli	CFU/100mL	NV	**0 (MAC)**	0

Notes

ODWS	Ontario Drinking Water Standards, June 2003 (revised 2006)
DL	Estimated Quantification Limit (e.g, detection limit)
MAC	Maximum Allowable Concentration
IMAC	Interim Maximum Allowable Concentration
OG	Operational Guideline
AO	Aesthetic Objective
NV	No value
▨	Value exceeds Ontario Drinking Water Standard
mg/L	Milligrams per litre
cfu	Colony forming unit
NTU	Nephelometric turbidity unit

Your Project #: 14-9154-7000
Site Location: .
Your C.O.C. #: 496464-01-01

Attention:Darin Burr
Dillon Consulting Limited
130 Dufferin Ave
Suite 1400
London, ON
N6A 5R2

Report Date: 2014/12/15
Report #: R3256619
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4N1688
Received: 2014/12/06, 16:30

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	1	N/A	2014/12/10	CAM SOP-00448	SM 22 2320 B m
Chloride by Automated Colourimetry	1	N/A	2014/12/11	CAM SOP-00463	EPA 325.2 m
Colour	1	N/A	2014/12/09	CAM SOP-00412	SM 22 2120 m
Conductivity	1	N/A	2014/12/10	CAM SOP-00414	SM 22 2510 m
Dissolved Organic Carbon (DOC) (1)	1	N/A	2014/12/09	CAM SOP-00446	SM 22 5310 B m
Hardness (calculated as CaCO3)	1	N/A	2014/12/12	CAM SOP 00102/00408/00447	SM 2340 B
Metals Analysis by ICPMS (as received) (2)	1	2014/12/12	2014/12/12	CAM SOP-00447	EPA 6020 m
Total Coliforms/ E. coli, CFU/100mL	1	N/A	2014/12/08	CAM SOP-00551	MOE E3407
Total Ammonia-N	1	N/A	2014/12/12	CAM SOP-00441	EPA GS I-2522-90 m
Nitrate (NO3) and Nitrite (NO2) in Water (3)	1	N/A	2014/12/10	CAM SOP-00440	SM 22 4500-NO3I/NO2B
pH	1	N/A	2014/12/10	CAM SOP-00413	SM 4500H+ B
Sulphate by Automated Colourimetry	1	N/A	2014/12/11	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (TDS calc)	1	N/A	2014/12/12		
Turbidity	1	N/A	2014/12/08	CAM SOP-00417	SM 22 2130 B m

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

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

Your Project #: 14-9154-7000
Site Location: .
Your C.O.C. #: 496464-01-01

Attention:Darin Burr

Dillon Consulting Limited
130 Dufferin Ave
Suite 1400
London, ON
N6A 5R2

Report Date: 2014/12/15
Report #: R3256619
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4N1688
Received: 2014/12/06, 16:30

(1) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.
(2) Metals analysis was performed on the sample 'as received'.
(3) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Christine Gripton, Senior Project Manager
Email: CGripton@maxxam.ca
Phone# (800)268-7396 Ext:250
==

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 : 2

RESULTS OF ANALYSES OF WATER

Maxxam ID		YT5372		
Sampling Date		2014/12/06		
COC Number		496464-01-01		
	Units		**RDL**	**QC Batch**
Calculated Parameters				
Calculated TDS	mg/L	380	1.0	3851753
Hardness (CaCO3)	mg/L	1.0	1.0	3851754
Inorganics				
Total Ammonia-N	mg/L	<0.050	0.050	3856860
Colour	TCU	<2	2	3852545
Conductivity	umho/cm	640	1.0	3854515
Dissolved Organic Carbon	mg/L	0.60	0.20	3853476
pH	pH	8.01	N/A	3854514
Dissolved Sulphate (SO4)	mg/L	10	1	3855281
Turbidity	NTU	<0.2	0.2	3852357
Alkalinity (Total as CaCO3)	mg/L	280	1.0	3854513
Dissolved Chloride (Cl)	mg/L	27	1	3855279
Nitrite (N)	mg/L	<0.010	0.010	3854564
Nitrate (N)	mg/L	1.46	0.10	3854564
Nitrate + Nitrite	mg/L	1.46	0.10	3854564

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID		YT5372		
Sampling Date		2014/12/06		
COC Number		496464-01-01		
	Units	[redacted]	**RDL**	**QC Batch**
Metals				
. Aluminum (Al)	ug/L	<5.0	5.0	3857726
. Antimony (Sb)	ug/L	<0.50	0.50	3857726
. Arsenic (As)	ug/L	<1.0	1.0	3857726
. Barium (Ba)	ug/L	<2.0	2.0	3857726
. Boron (B)	ug/L	<10	10	3857726
. Cadmium (Cd)	ug/L	<0.10	0.10	3857726
. Calcium (Ca)	ug/L	240	200	3857726
. Chromium (Cr)	ug/L	<5.0	5.0	3857726
. Copper (Cu)	ug/L	10	1.0	3857726
. Iron (Fe)	ug/L	<100	100	3857726
. Lead (Pb)	ug/L	<0.50	0.50	3857726
. Magnesium (Mg)	ug/L	100	50	3857726
. Manganese (Mn)	ug/L	<2.0	2.0	3857726
. Selenium (Se)	ug/L	<2.0	2.0	3857726
. Sodium (Na)	ug/L	160000	100	3857726
. Uranium (U)	ug/L	0.21	0.10	3857726
. Vanadium (V)	ug/L	<0.50	0.50	3857726

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Job #: B4N1688
Report Date: 2014/12/15

Dillon Consulting Limited
Client Project #: 14-9154-7000
Site Location: .

MICROBIOLOGY (WATER)

Maxxam ID		YT5372	
Sampling Date		2014/12/06	
COC Number		496464-01-01	
	Units		QC Batch
Microbiological			
Background	CFU/100mL	0	3851784
Total Coliforms	CFU/100mL	0	3851784
Escherichia coli	CFU/100mL	0	3851784
QC Batch = Quality Control Batch			

TEST SUMMARY

Maxxam ID: YT5372
Sample ID:
Matrix: Water

Collected: 2014/12/06
Shipped:
Received: 2014/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3854513	N/A	2014/12/10	Surinder Rai
Chloride by Automated Colourimetry	AC	3855279	N/A	2014/12/11	Deonarine Ramnarine
Colour	SPEC	3852545	N/A	2014/12/09	Christine Pham
Conductivity	COND	3854515	N/A	2014/12/10	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3853476	N/A	2014/12/09	Elsamma Alex
Hardness (calculated as CaCO3)		3851754	N/A	2014/12/12	Automated Statchk
Metals Analysis by ICPMS (as received)	ICP/MS	3857726	2014/12/12	2014/12/12	Arefa Dabhad
Total Coliforms/ E. coli, CFU/100mL	PL	3851784	N/A	2014/12/08	Tharmini Sivalingam
Total Ammonia-N	LACH/NH4	3856860	N/A	2014/12/12	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3854564	N/A	2014/12/10	Chandra Nandlal
pH	PH	3854514	N/A	2014/12/10	Surinder Rai
Sulphate by Automated Colourimetry	AC	3855281	N/A	2014/12/11	Deonarine Ramnarine
Total Dissolved Solids (TDS calc)	CALC	3851753	N/A	2014/12/12	Automated Statchk
Turbidity	TURB	3852357	N/A	2014/12/08	Lemeneh Addis

GENERAL COMMENTS

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
3852357	Turbidity	2014/12/08					<0.2	NTU	NC	20	95	85 - 115
3852545	Colour	2014/12/09			99	85 - 115	<2	TCU	NC	25		
3853476	Dissolved Organic Carbon	2014/12/09	NC	80 - 120	98	80 - 120	<0.20	mg/L	1.4	20		
3854513	Alkalinity (Total as CaCO3)	2014/12/10			96	85 - 115	<1.0	mg/L	0.15	25		
3854514	pH	2014/12/10			102	98 - 103			0.76	N/A		
3854515	Conductivity	2014/12/10			102	85 - 115	<1.0	umho/cm	0.63	25		
3854564	Nitrate (N)	2014/12/10	97	80 - 120	99	80 - 120	<0.10	mg/L	0.30	25		
3854564	Nitrite (N)	2014/12/10	100	80 - 120	100	80 - 120	<0.010	mg/L	NC	25		
3855279	Dissolved Chloride (Cl)	2014/12/11	NC	80 - 120	102	80 - 120	<1	mg/L	0.34	20		
3855281	Dissolved Sulphate (SO4)	2014/12/11	NC	75 - 125	102	80 - 120	<1	mg/L	5.8	20		
3856860	Total Ammonia-N	2014/12/12	97	80 - 120	98	85 - 115	<0.050	mg/L	NC	20		
3857726	. Aluminum (Al)	2014/12/12	101	80 - 120	106	80 - 120	<5.0	ug/L	NC	20		
3857726	. Antimony (Sb)	2014/12/12	99	80 - 120	102	80 - 120	<0.50	ug/L	NC	20		
3857726	. Arsenic (As)	2014/12/12	96	80 - 120	99	80 - 120	<1.0	ug/L	NC	20		
3857726	. Barium (Ba)	2014/12/12	98	80 - 120	102	80 - 120	<2.0	ug/L	0.64	20		
3857726	. Boron (B)	2014/12/12	91	80 - 120	97	80 - 120	<10	ug/L	NC	20		
3857726	. Cadmium (Cd)	2014/12/12	98	80 - 120	100	80 - 120	<0.10	ug/L	NC	20		
3857726	. Calcium (Ca)	2014/12/12	NC	80 - 120	102	80 - 120	<200	ug/L	1.1	20		
3857726	. Chromium (Cr)	2014/12/12	94	80 - 120	99	80 - 120	<5.0	ug/L	NC	20		
3857726	. Copper (Cu)	2014/12/12	90	80 - 120	95	80 - 120	<1.0	ug/L	NC	20		
3857726	. Iron (Fe)	2014/12/12	95	80 - 120	98	80 - 120	<100	ug/L	NC	20		
3857726	. Lead (Pb)	2014/12/12	92	80 - 120	97	80 - 120	<0.50	ug/L	NC	20		
3857726	. Magnesium (Mg)	2014/12/12	NC	80 - 120	100	80 - 120	<50	ug/L	1.2	20		
3857726	. Manganese (Mn)	2014/12/12	97	80 - 120	99	80 - 120	<2.0	ug/L	NC	20		
3857726	. Selenium (Se)	2014/12/12	97	80 - 120	101	80 - 120	<2.0	ug/L	NC	20		
3857726	. Sodium (Na)	2014/12/12	98	80 - 120	104	80 - 120	130, RDL=100	ug/L	1.5	20		
3857726	. Uranium (U)	2014/12/12	89	80 - 120	94	80 - 120	<0.10	ug/L	NC	20		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
3857726	Vanadium (V)	2014/12/12	95	80 - 120	98	80 - 120	<0.50	ug/L	NC	20		

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 sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

VALIDATION SIGNATURE PAGE

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

Brad Newman, Scientific Specialist

S. Tharmini

Tharmini Sivalingam, Team Leader

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.

6-Dec-14 16:30
Christine Gripton
B4N1688
AKP ENV-626

) DRINKING WATER CHAIN OF CUSTODY RECORD

023 Meadowbrook Drive, London, Ontario Canada N6L www.maxxam.ca
:-9444 MICRO Fax:(519) 652-8189

Bottle Order #: 496464
COC #: C#496464-01-01

Please indicate which regulation applies to the samples being submitted:

☐ 170 ☐ 318/319 ☐ 243 ☐ 170Pb

☒ Not regulated (however water is for human consumption)

CAM FCD 01101/1

Page of

INVOICE TO:

Company Name: #4590 Dillon Consulting Limited
Attention: Darin Burr
Address: 130 Dufferin Ave Suite 1400 London ON N6A 5R2
Tel: (519) 438-1288 x236 Project: 14-9154-7000
Fax: (519) 672-8209 P.O. #:
Email: dburr@dillon.ca

REPORT TO:

Same as Invoice To ✓
Company Name:
Attention:
Address:
Tel: Fax:
Email:

*DRINKING WATER TYPE LEGEND: [R=Raw Water] [T=Treated/POE] [D=Distribution] [P=Plumbing] [S=Standing] [F=Flushed]

	Sample Identification/Location	Date Sampled	Time Sampled	*WATER TYPE (R,T,D,P,S,F)	MOE/MOH Adverse Notifcation Required?		Field Chlorine		Field Turbidity	Field pH	Watertrax SPL#	Resample Y/N?	# of Bottles	Analysis Requested: Total Coliforms/ E. coli, CFU/100mL	pH, Conduct, Alkalinity	Anions - Cl, NO2, NO3, SO4	Colour, DOC, NH4	TDS (calculated), Turbidity	Ca, Mg, Na, Fe, Mn + Hardness				
					Yes	No	Free	Total															
1		[redacted]				x								✓	✓	✓	✓	✓	✓				
2		[redacted]				x																	
3						x																	
4						x																	
5						x																	
6						x																	
7																							
8																							
9																							

It is mandatory that all notification information below be completed prior to analysis for regulated drinking water submissions.

TAT (TURNAROUND TIME):	ADVERSE NOTIFICATION INFORMATION		LABORATORY USE ONLY
RUSH TAT MUST HAVE PRIOR APPROVAL	Waterworks Name:	**Medical Officer of Health/Public Health Unit**	Received By (Print): Kavita Verma.
	Waterworks Number:	Name/Region:	Received By (Sign): Kavita V
☐ Regular (5-15 Working Days)	Address:	Contact:	Date: 2014/12/06 Time: 4:10
☐ RUSH (Specify Below)	Contact:	Address:	Comments
Date Due	Tel: Fax:	Tel:	
RUSH #	Cell:	Fax:	
	Email:	After Hours:	Receiving Temp: 9 / 9 / 9°C

Sampled By (Print) D Burr	Sampled By (Sign)	Date Dec 6/14	Time	Cooling Media Present Y/N? ☑
Relinquished By (Print)	Relinquished By (Sign)	Date	Time	Metals Preservation Check Y/N? ☐

Water Quality Interpretation Information Sheet

Escherichia Coli (E. coli)

Escherichia Coli should not be detected/present in any drinking water sample. *Escherichia Coli* is a fecal coliform and is present in fecal matter and prevalent in sewage, but is rapidly destroyed by chorine. It is a strong indicator of recent fecal pollution. Contamination with sewage as shown by positive E-coli tests would strongly suggest presence of pathogenic bacteria and viruses, as well as more chlorine resistant pathogens such as *Giardia* and *Cryptosporidum*, which are much more difficult to detect.

Total Coliforms

Total Coliforms include a large number of non-disease-causing bacteria arising from soil and vegetation. The Ontario Drinking Water standard for Total Coliforms is "not detected". The presence of any total coliform bacteria in water leaving a treatment unit or in any treated water immediately following treatment signifies inadequate treatment.

Alkalinity as CaCO3 (inorganic)

Alkalinity is a measure of the resistance of water to the effects of acids added to water. The recommended range for alkalinity is 30 to 500 mg/L expressed as calcium carbonate. Water with low alkalinity may tend to accelerate natural corrosion leading to "red water" problems whereas high alkalinity waters may produce scale incrustations on utensils, service pipes and water heaters.

Chloride (Cl)

Chloride is a common non-toxic material present in small amounts in drinking water and produces a detectable salty taste at the aesthetic objective level of 250 mg/L. Chloride is widely distributed in nature, generally as the sodium (NaCl), potassium (KCl) and calcium ($CaCl_2$) salts.

Colour (physical)

The aesthetic objective for colour in drinking water is 5 TCU (True Colour Units). Water can have a faint yellow/brown colour which is often caused by organic materials created by decay of vegetation. Sometimes colour may be contributed to by iron and manganese compounds produced by processes occurring in natural sediments or in aquifers.

Dissolved Organic Carbon (DOC) (Organic)

The aesthetic objective for dissolved organic carbon (DOC) in drinking water is 5 mg/L. High DOC is an indicator of possible water quality deterioration during storage and distribution due to the carbon being a growth nutrient for bacteria. High DOC is also an indicator of potential chlorination by-product problems.

Fluoride (F)

Where fluoride is added to drinking water, it is recommended that the concentration be adjusted to 0.5 - 0.8 mg/L, the optimum level for control of tooth decay. Where supplies contain naturally occurring fluoride at levels higher than 1.5 mg/L mg/L but less than 2.4 mg/L the Ministry of Health and Long-Term Care recommends an approach through local boards of health to raise public and professional awareness to control excessive exposure to fluoride from other sources. Levels above the MAC must be reported to the local Medical Officer of Health.

N-NO2 (Nitrite)

The maximum acceptable concentration of nitrite in drinking water is 1.0 mg/L as nitrogen. Nitrate may occur in groundwater, however, if chlorination is practiced, the nitrate will usually be oxidized to nitrate.

N-NO3 (Nitrate)

The maximum acceptable concentration of nitrates in drinking water is 10 mg/L nitrogen. Nitrates are present in water (particular groundwater) as a result of decay of plant or animal material, the use of agricultural fertilizers, domestic sewage or treated wastewater contamination, or geological formations containing soluble nitrogen compounds. There is a risk that babies and small children may suffer blood related problems (methaemoglobinaemia) with excess nitrate intake.

pH (physical-chemical)

pH is a parameter that indicates the acidity of a water sample. The operational guideline recommended in drinking water is to maintain a pH between 6.5 and 8.5. The principal objective in controlling pH is to produce a water that is neither corrosive nor produces incrustation. At pH levels above 8.5, mineral incrustations and bitter tastes can occur. Corrosion is commonly associated with pH levels below 6.5 and elevated levels of certain undesirable chemical parameters may result from corrosion of specific types of pipe.

Total Dissolved Solids (TDS)

The aesthetic objective for total dissolved solids in drinking water is 500 mg/L. The term "total dissolved solids" (TDS) refers mainly to the inorganic substances dissolved in water. The principal constituents of TDS are chloride, sulphates, calcium, magnesium and bicarbonates. The effects of TDS on drinking water quality depend on the levels of the individual components. Excessive hardness, taste, mineral deposition or corrosion are common properties of highly mineralized water. The palatability of drinking water with a TDS level less than 500 mg/L is generally considered to be good.

Sulphate (SO4)

The aesthetic objective for sulfate in drinking water is 500 mg/L. At levels above this concentration, sulphate can have a laxative effect, however, regular users adapt to high levels of sulphate in drinking water and problems are usually only experienced by visitors and new consumers. The presence of sulphate in drinking water above 150 mg/L may result in noticeable taste. The taste threshold concentration, however, depends on the associated metals present in the water. High levels of sulphate may be associated with calcium, which is a major component of scale in boilers and heat exchangers. In addition, sulphate can be converted into sulfide by some anaerobic bacteria creating odour problems and potentially greatly accelerating corrosion.

Turbidity

Control of turbidity in drinking-water systems is important for both health and aesthetic reasons. The substances and particles that cause turbidity can be responsible for significant interference with disinfection, can be a source of disease-causing organisms and can shield pathogenic organisms from the disinfection process.

Turbidity in excess of 5.0 NTU becomes visible to the naked eye and as such a majority of consumers may object to its presence. Therefore, an aesthetic objective of 5.0 NTU has been set for all waters at the point of consumption.

Hardness as CaCO3

Hardness is caused by dissolved calcium and magnesium, and is expressed as the equivalent quantity of calcium carbonate. On heating, hard water has a tendency to form scale deposits and can form excessive scum with regular soaps. However, certain detergents are largely unaffected by hardness. Conversely, soft water may result in accelerated corrosion of water pipes. Hardness levels between 80 and 100 mg/L as calcium carbonate ($CaCO_3$) are considered to provide an acceptable balance between corrosion and incrustation. Water supplies with hardness greater than 200 mg/L are considered poor but tolerable. Hardness in excess of 500 mg/L in drinking water is unacceptable for most domestic purposes.

Aluminum (Al)

Aluminum in untreated water is present in the form of very fine particles of alumino-silicate clay. These clay particles are effectively removed in coagulation/filtration. Aluminum found in coagulant treated water is due to the presence of aluminum left over from use of the coagulant. Optimization of treatment should be applied to reduce this "residual" aluminum to under the operational guideline of 0.1 mg/L. High residual aluminum can cause coating of the pipes in the distribution system resulting in increased energy requirements for pumping, interferences with certain industrial processes and flocculation in the distribution system.

Medical studies have not provided clear evidence that residual aluminum has any effect on health.

Antimony (Sb)

The interim maximum acceptable concentration for antimony in drinking water is 0.006 mg/L. The standard is set to protect against increased blood cholesterol and decreased blood glucose, as well as prevention of nausea, vomiting and diarrhea upon short-term exposure. Antimony is rarely detected in Ontario drinking water.

Arsenic (As)

The interim maximum acceptable concentration for arsenic in drinking water is 0.025 mg/L. Arsenic is a known carcinogen and must therefore be removed by treatment where present at levels over this concentration.

Arsenic is sometimes found at higher levels in ground water in hard rock areas (e.g. Canadian Shield) in Ontario through the natural dissolution of arsenic containing minerals, in some mine drainage waters and in some mine leachates. Arsenic is present at very low concentrations in most surface waters.

Barium (Ba)

The maximum acceptable concentration for barium in drinking water is 1.0 mg/L. Barium is a common constituent in sedimentary rocks such as limestone and dolomite where it is accompanied by strontium and much larger amounts of calcium. As a result, hard water contains small amounts of barium but seldom at concentrations greater than 1 mg/L. Most treatment methods used for water softening are effective for barium removal.

Boron (B)

The interim maximum acceptable concentration for boron in drinking water is 5.0 mg/L. Boron in water is most commonly found as borate. Acute boron poisonings have resulted from the use of borates as antiseptic agents and from accidental ingestion, however, the amount consumed was much higher than would be encountered through drinking water. Infants, the elderly and individuals with kidney diseases are most susceptible to the toxic effects of boron compounds.

Cadmium (Cd)

The maximum acceptable concentration for cadmium in drinking water is 0.005 mg/L. Cadmium is a relatively rare element that is extremely unlikely to be present as a significant natural contaminant in drinking water. Cadmium compounds used in electroplated materials and electroplating wastes may be a significant source of drinking water contamination. Other than occupational exposure and inhalation from cigarette smoke, food is the main source of cadmium intake.

Copper (Cu)

The aesthetic objective for copper in drinking water is 1.0 mg/L. Copper occurs naturally in the environment but is rarely present in raw water. Copper is used extensively in domestic plumbing in tubing and fittings and is an essential trace component in food. Drinking water has the potential to be corrosive and to cause copper to dissolve in water. At levels above 1.0 mg/L, copper may impact an objectionable taste to the water. Although the intake of large doses of copper has resulted in adverse health effects such as stomach upsets, the levels at which this occurs are much higher than the aesthetic objective.

Chromium (Cr)

The maximum acceptable concentration for chromium in drinking water is 0.05 mg/L. Trivalent chromium, the most common and naturally occurring state of chromium, is not considered to be toxic. However, if chromium is present in raw water, it may be oxidized to a more harmful hexavalent form during chlorination. Chromium in the more highly oxidized form may be present in older yellow paints and in residues from plating operations and around old recirculating water cooling systems.

Iron (Fe)

Iron may be present in ground water as a result of mineral deposits and chemically reducing underground conditions. It may also be present in surface waters as a result of anaerobic decay in sediments and complex formation. The aesthetic objective for iron, set by appearance effects, in drinking water is 0.3 mg/L. Excessive levels of iron in drinking water supplies may impart a brownish colour to laundered goods, plumbing fixtures and the water itself; it may produce a bitter, astringent taste in water and beverages; and the precipitation of iron can also promote the growth of iron bacteria in water mains and service pipes. Iron based coagulants such as ferric sulfate can be highly effective in treatment processes at removing particles from water and leave very little residual iron in the treated water.

Lead (Pb)

The maximum acceptable concentration for lead in drinking water is 0.01 mg/L. This applies to water at the point of consumption since lead is only present as a result of corrosion of lead solder, lead containing brass fittings or lead pipes which are found close to or in domestic plumbing and the service connection to buildings. Lead ingestion should be avoided particularly by pregnant women and young children, who are most susceptible. It is recommended that only the cold water supply be used for drinking/consumption and only after five minutes of flushing to rid the system of standing water. Corrosion inhibitor addition or other water chemistry adjustments may be made at the treatment plant to reduce lead corrosion rates where necessary.

Manganese (Mn)

The colour related aesthetic objective for manganese in drinking water is 0.05 mg/L. Like iron, manganese is objectionable in water supplies because it stains laundry and fixtures black, and at excessive concentrations causes undesirable tastes in beverages. Manganese is present in some groundwaters because of chemically reducing underground conditions coupled with presence of manganese mineral deposits. Manganese is also occasionally present, seasonally, in surface waters when anaerobic decay processes in sediments is occurring.

Mercury (Hg)

The maximum acceptable concentration for mercury in drinking water is 0.001 mg/L. Possible sources of mercury in drinking water include air pollution from coal combustion, waste incineration and from metal refining operations and from natural mineral deposits in some hard rock areas. Food is the major source of human exposure to mercury, with freshwater fish being the most significant local source.

Selenium (Se)

The maximum acceptable concentration for selenium in drinking water is 0.01 mg/L. Selenium occurs naturally in waters at trace levels as a result of geochemical processes such as weathering of rocks. It is difficult to establish levels of selenium that can be considered toxic because of the complex inter-relationships between selenium and dietary constituents such as protein, vitamin E and other trace elements. Food is the main source of selenium intake other than occupational exposure. Selenium is an essential trace element in the human diet. Drinking water containing selenium at the maximum acceptable concentration of 0.01 mg/L would be the source of only 10 per cent of total selenium intake. The maximum acceptable concentration, therefore, is considered to provide a satisfactory factor of safety against known adverse effects.

Sodium (inorganic)

The aesthetic objective for sodium in drinking water is 200 mg/L at which it can be detected by a salty taste. Sodium is not toxic. Consumption of sodium in excess of 10 grams per day by normal adults does not result in any apparent adverse health effects. In addition, the average intake of sodium from water is only a small fraction of that consumed in a normal diet. A maximum acceptable concentration for sodium in drinking water has, therefore, not been specified. Persons suffering from hypertension or congestive heart disease may require a sodium-restricted diet, in which case, the intake of sodium from drinking water could become significant. It is therefore recommended that the measurement of sodium levels be included in routine monitoring programs of water supplies. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L, so that this information may be passed on to local physicians.

Softening using a domestic water softener increases the sodium level in drinking water and may contribute a significant percentage to the daily sodium intake for a consumer on a sodium restricted diet. It is recommended that a separate unsoftened supply be retained for cooking and drinking purposes.

Uranium (U)

The maximum acceptable concentration of uranium in drinking water is 0.02 mg/L. Uranium is normally present in biological systems and aqueous media as the uranyl ion (UO22+). Ingestion of large quantities of uranyl ion may result in damage to the kidneys. The uranyl ion may also be responsible for objectionable taste and colour in water, at much higher levels than the concentrations which may cause kidney damage.

Zinc (Zn)

The taste related aesthetic objective for zinc in drinking water is 5.0 mg/L. The concentration of zinc may be considerably higher at the consumer's tap in standing water because of corrosion taking place in galvanized pipes, but this can be cleared easily by brief flushing. Corrosion control using small concentrations of zinc based inhibitors has been found effective in some water systems.

Information Sources

Ministry of the Environment, 2006. Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines. File PIBS 4449e01

FACT SHEET
Grey Bruce Health Unit, 101 17th Street East, Owen Sound, N4K 0A5
519-376-9420 • www.publichealthgreybruce.on.ca • 1-800-263-3456

INTERPRETATION OF RESIDENTIAL WATER SAMPLE TESTS

Private citizens may submit drinking water samples from home well water for bacteriological analysis. Containers supplied by the Ontario Ministry of Health, Laboratories Branch must be used and are available from the Grey Bruce Health Unit.

Samples are not to be submitted from untreated surface water supplies such as lakes or rivers as these supplies are subject to contamination and are therefore not considered suitable for drinking purposes unless properly treated.

Questions concerning the interpretation of the results and corrective actions should be directed to a public health inspector.

Total Coliforms (cfu/100 ml water)	**E. coli** (cfu/100 ml water)	**Interpretation**
0 -5	0	**The water is safe** for drinking
6 or more	0	**The water is unsafe** for drinking unless boiled or otherwise treated
Est (estimate)	Est (estimate)	**The water is unsafe** for drinking unless boiled or otherwise treated. (Coliform and E. coli counts are estimated, the plate is overgrown but the lab can determine the growth of some coliform and E. coli colonies.)
o/g (overgrown)	o/g (overgrown)	**The water is unsafe** for drinking unless boiled or otherwise treated. (Coliform and E. coli counts cannot be determined because the test was overgrown with bacteria.)

Coliforms

The presence of coliforms may be indicative of a contaminated water supply. Coliforms occur naturally in soil and decaying vegetation, but may also be associated with human or animal faecal contamination. Low levels of coliform bacteria (1 to 5) may be tolerated in a private water supply, provided at least 3 repeat samples have been taken over a six week period, the system is secure and not subject to contamination from other sources, and an attempt has been made to disinfect the distribution lines.

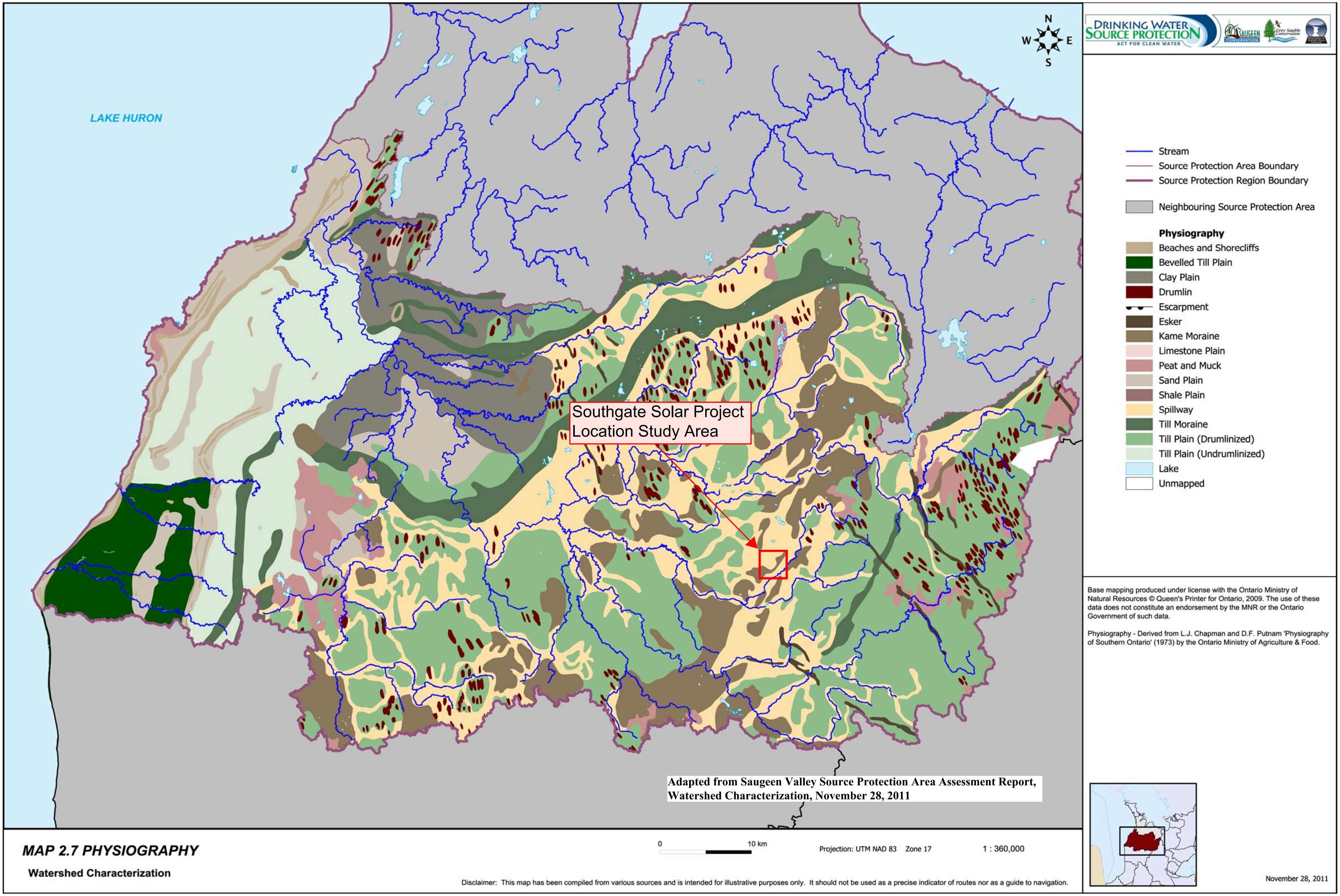
The persistent detection of more than 5 coliform bacteria from any drinking water system indicates an unsafe condition.

E. coli

Water is considered unsafe for drinking if any E.coli bacteria are present. E.coli usually indicates faecal contamination from a human or animal source.

APPENDIX B

Background Hydrogeological Information



Adapted from Saugeen Valley Source Protection Area Assessment Report, Watershed Characterization, November 28, 2011

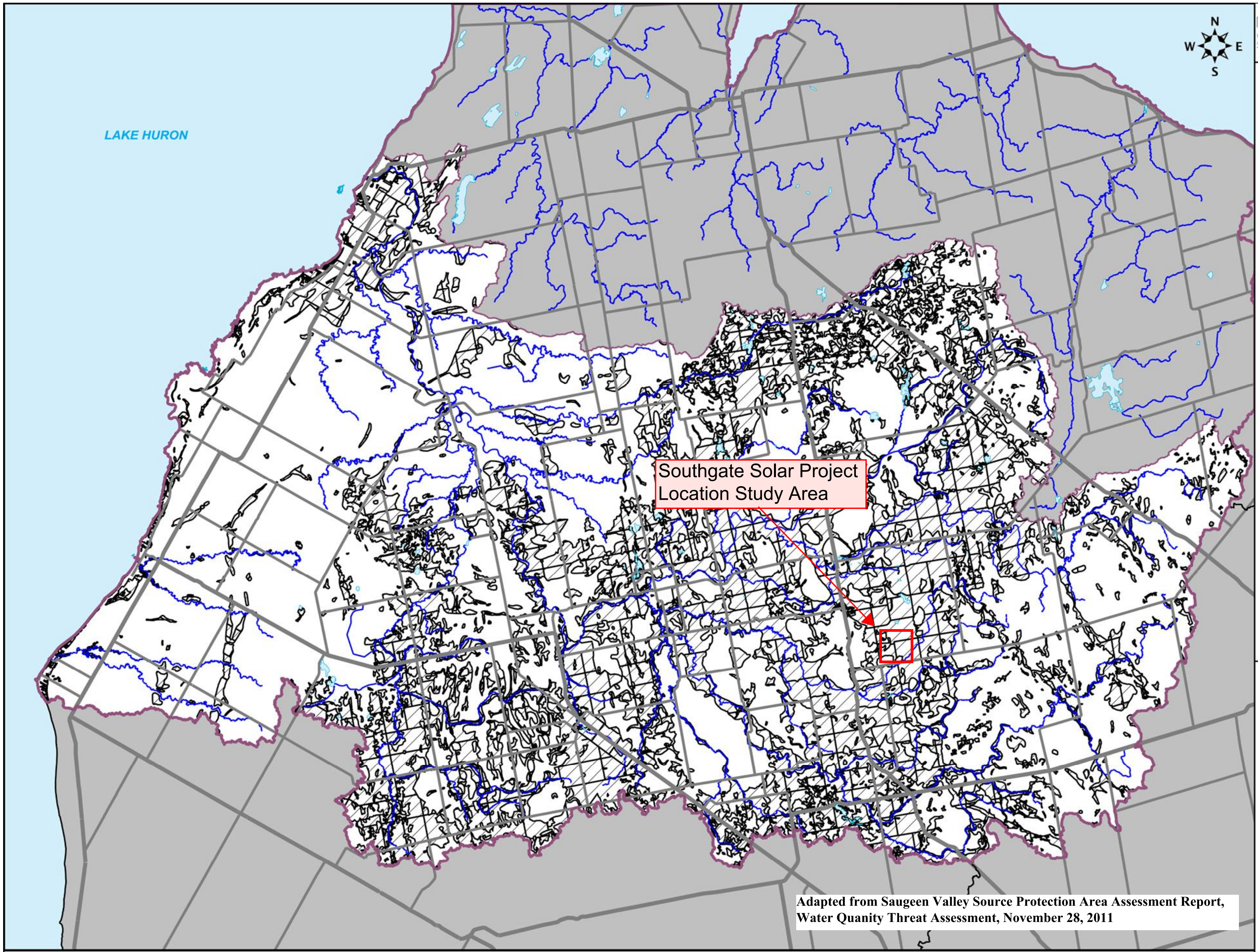
MAP 2.7 PHYSIOGRAPHY

Watershed Characterization

Base mapping produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2009. The use of these data does not constitute an endorsement by the MNR or the Ontario Government of such data.

Physiography - Derived from L.J. Chapman and D.F. Putnam 'Physiography of Southern Ontario' (1973) by the Ontario Ministry of Agriculture & Food.

November 28, 2011



Adapted from Saugeen Valley Source Protection Area Assessment Report, Water Quanity Threat Assessment, November 28, 2011

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

- County Road
- Highway
- Stream
- Source Protection Area Boundary
- Source Protection Region Boundary
- Neighbouring Source Protection Area
- Lake
- ▨ Significant Groundwater Recharge Area

Base mapping produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2009. The use of these data does not constitute an endorsement by the MNR or the Ontario Government of such data.

Significant Groundwater Recharge Areas were delineated by DWSP staff using the Hydrologic Response Units created by AquaResource Inc. as part of the Saugeen, Grey Sauble, Northern Bruce Peninsula Conceptual Geological Model and Three Dimensional Groundwater Flow Model Project, 2005/2006.

MAP 3.11 SIGNIFICANT GROUNDWATER RECHARGE AREAS

Water Quantity Stress Assessment

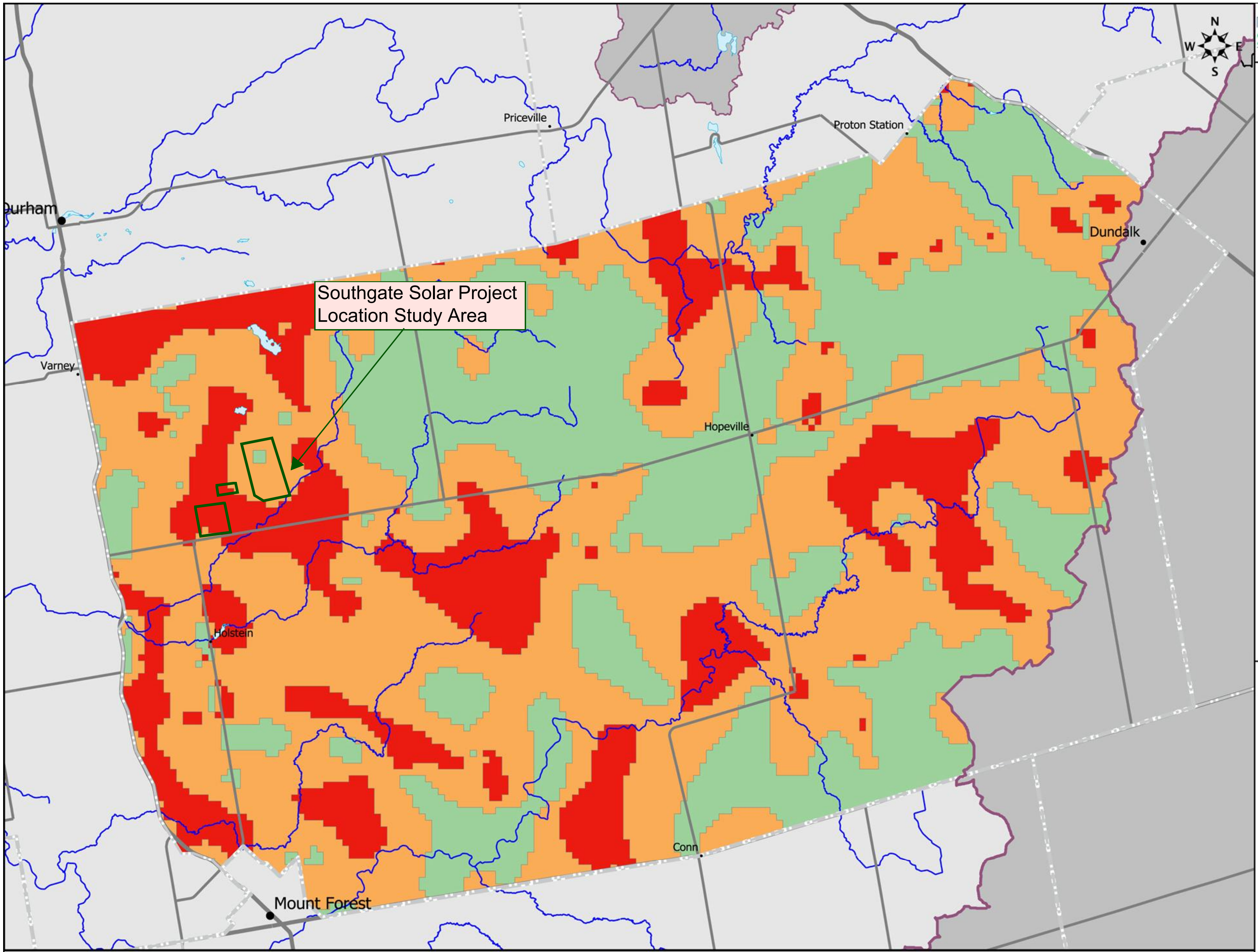
0 10 km

Projection: UTM NAD 83 Zone 17

1 : 360,000

Disclaimer: This map has been compiled from various sources and is intended for illustrative purposes only. It should not be used as a precise indicator of routes nor as a guide to navigation.

November 28, 2011



DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

- · Community
- • Town/Village
- ● City

- County Road
- Highway
- Stream
- County Boundary
- Source Protection Area Boundary
- Source Protection Region Boundary

- Neighbouring Municipality
- Neighbouring Source Protection Area
- Lake

Intrinsic Susceptibility Index

- 🟥 High
- 🟧 Medium
- 🟩 Low

Base mapping produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2009. The use of these data does not constitute an endorsement by the MNR or the Ontario Government of such data.

Intrinsic Susceptibility Index (ISI) - Waterloo Hydrogeologic Inc.: AEMOT Karst Study, 2005.

MAP 4.11.M1 INTRINSIC SUSCEPTIBILITY INDEX

Water Quality Threats and Issues - Township of Southgate

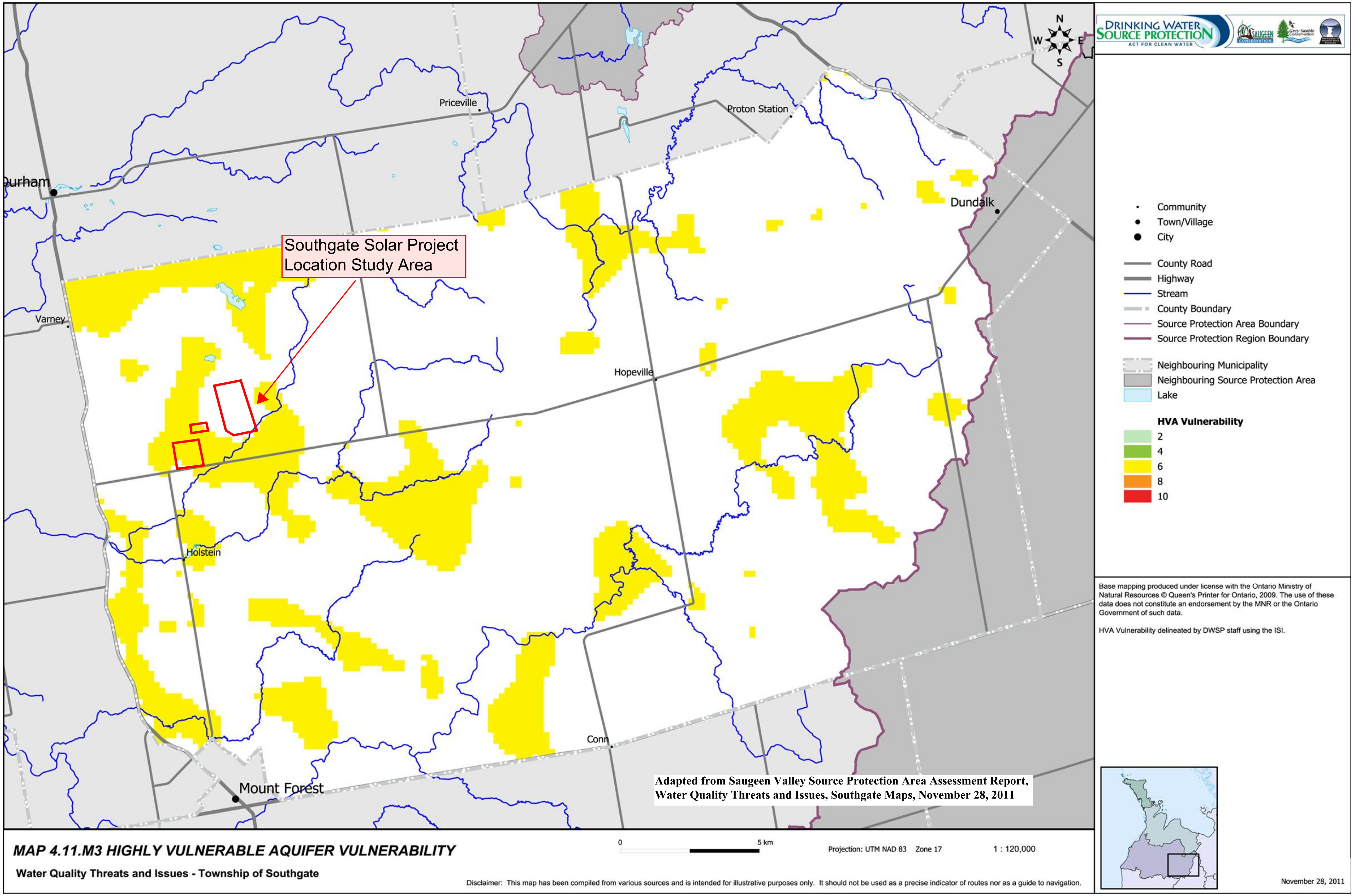
0 5 km

Projection: UTM NAD 83 Zone 17

1 : 120,000

Disclaimer: This map has been compiled from various sources and is intended for illustrative purposes only. It should not be used as a precise indicator of routes nor as a guide to navigation.

November 28, 2011



Adapted from Saugeen Valley Source Protection Area Assessment Report, Water Quality Threats and Issues, Southgate Maps, November 28, 2011

MAP 4.11.M3 HIGHLY VULNERABLE AQUIFER VULNERABILITY

Water Quality Threats and Issues - Township of Southgate

Base mapping produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2009. The use of these data does not constitute an endorsement by the MNR or the Ontario Government of such data.

HVA Vulnerability delineated by DWSP staff using the ISI.

Disclaimer: This map has been compiled from various sources and is intended for illustrative purposes only. It should not be used as a precise indicator of routes nor as a guide to navigation.

November 28, 2011

APPENDIX C

MOE Water Well Records

MOECC WATER WELL RECORDS
SOUTHGATE SOLAR PROJECT

Well ID	Easting	Northing	Elevation (masl)	Material 1	Material 2	Material 3	Unit Top Depth (m)	Unit Base Depth (m)	Well Depth (m)	Bedrock Depth (m)	Static Water Level (m)	Static Water Level Elevation (masl)	Water Found Depth (m)
2500946	520412.2	4883871	416.82	PREV. DUG			0.0	7.0	22.3	>22.3	4.57	412.25	22.3
				BOULDERS			7.0	9.1					
				MEDIUM SAND			9.1	12.2					
				BOULDERS	HARDPAN		12.2	18.3					
				GRAVEL			18.3	22.3					
2500947	521634.2	4884134	441.86	MEDIUM SAND			0.0	2.4	21.9	>21.9	17.68	424.18	21.9
				GRAVEL			2.4	12.2					
				CLAY	MEDIUM SAND	GRAVEL	12.2	21.3					
				GRAVEL			21.3	21.9					
2502697	519154.2	4881724	408.58	PREV. DRILLED			0.0	7.9	57.3	45.1	10.67	397.91	53.3
				GRAVEL	MEDIUM SAND		7.9	24.4					
				CLAY	BOULDERS		24.4	30.5					
				MEDIUM SAND			30.5	36.6					
				CLAY	GRAVEL		36.6	45.1					
				LIMESTONE			45.1	57.3					
2502868	518594.2	4882274	406.55	GRAVEL	BOULDERS		0.0	16.5	44.8	37.5	10.67	395.88	41.1
				CLAY	BOULDERS		16.5	37.5					
				LIMESTONE			37.5	41.1					
				ROCK			41.1	44.8					
2505873	521514.2	4884354	448.42	GRAVEL			0.0	10.7	50.3	40.2	21.64	426.77	50.3
				CLAY			10.7	12.2					
				HARDPAN	GRAVEL		12.2	20.7					
				GRAVEL	CEMENTED		20.7	29.0					
				HARDPAN	GRAVEL		29.0	40.2					
				LIMESTONE	SHALE		40.2	50.3					
2506105	518764.2	4883124	398.82	TOPSOIL			0.0	0.3	15.2	>15.2	4.57	394.25	15.2
				SAND			0.3	1.2					
				GRAVEL	BOULDERS		1.2	15.2					
2506462	519914.2	4881924	410.56	FILL	BOULDERS		0.0	2.1	44.2	33.2	4.57	405.99	42.7
				GRAVEL	BOULDERS	SAND	2.1	11.6					
				HARDPAN	BOULDERS		11.6	33.2					
				LIMESTONE	SHALE	LAYERED	33.2	44.2					
2506926	518314.2	4882824	397.09	TOPSOIL			0.0	0.3	33.5	19.2	1.52	395.56	24.4
				GRAVEL	SAND		0.3	10.4					
				HARDPAN	GRAVEL		10.4	19.2					
				LIMESTONE			19.2	28.0					
				LIMESTONE	HARD		28.0	33.5					
2507421	520714.2	4884174	432.62	TOPSOIL			0.0	0.3	41.1	>41.1	13.41	419.21	39.9
				SAND	STONES		0.3	5.5					
				CLAY	GRAVEL		5.5	20.7					
				HARDPAN	GRAVEL		20.7	33.2					
				GRAVEL	SAND		33.2	37.5					
				GRAVEL	CLEAN		37.5	41.1					

MOECC WATER WELL RECORDS
SOUTHGATE SOLAR PROJECT

Well ID	Easting	Northing	Elevation (masl)	Material 1	Material 2	Material 3	Unit Top Depth (m)	Unit Base Depth (m)	Well Depth (m)	Bedrock Depth (m)	Static Water Level (m)	Static Water Level Elevation (masl)	Water Found Depth (m)
2507580	520314.2	4883974	414.48	FILL			0.0	0.6	21.9	>21.9	0.30	414.17	21.0
				CLAY	STONES		0.6	7.3					
				GRAVEL	CEMENTED		7.3	18.6					
				GRAVEL			18.6	20.7					
				FINE GRAVEL			20.7	21.9					
2508047	518564.2	4882024	404.40	TOPSOIL			0.0	0.3	22.9	>22.9	11.58	392.81	21.3
				GRAVEL	SAND	BOULDERS	0.3	11.6					
				CLAY			11.6	13.7					
				GRAVEL			13.7	22.9					
2508265	521964.2	4884374	433.01	TOPSOIL			0.0	0.3	37.5	25.9	6.40	426.60	36.6
				GRAVEL	SAND		0.3	8.2					
				CLAY	GRAVEL		8.2	12.2					
				HARDPAN	LIMESTONE		12.2	25.9					
				LIMESTONE			25.9	37.5					
2508326	518564.2	4882024	404.40	PREV. DRILLED			0.0	22.9	50.3	39.9	12.19	392.20	47.2
				GRAVEL			22.9	27.4					
				HARDPAN	BOULDERS		27.4	39.9					
				LIMESTONE	SHALE	LAYERED	39.9	50.3					
2512237	519003	4881329	409.06	FILL			0.0	0.6	71.9	59.7	9.45	399.61	60.7
				SILT			0.6	5.2					
				GRAVEL	BOULDERS		5.2	21.9					
				GRAVEL	CLAY		21.9	28.0					
				SAND	GRAVEL	BEARING	28.0	30.5					
				CLAY			30.5	43.3					
				GRAVEL	SAND	BEARING	43.3	48.8					
				CLAY	GRAVEL	STONES	48.8	53.3					
				QUICKSAND	GRAVEL		53.3	59.7					
				LIMESTONE			59.7	64.0					
				LIMESTONE			64.0	71.9					
2513113	522238	4884236	438.04	GRAVEL			0.0	13.7	36.6	22.9	11.58	426.46	27.7
				GRAVEL	CLAY		13.7	22.9					
				LIMESTONE	FRACTURED		22.9	26.5					
				LIMESTONE	HARD		26.5	29.6					
				LIMESTONE	FRACTURED		29.6	36.6					
2513827	521571	4884240	444.66	TOPSOIL			0.0	0.3	49.4	36.0	21.95	422.72	48.5
				STONES	GRAVEL		0.3	6.4					
				CLAY	STONES	GRAVEL	6.4	21.6					
				GRAVEL			21.6	22.9					
				CLAY	GRAVEL		22.9	28.3					
				GRAVEL			28.3	29.6					
				CLAY	STONES	GRAVEL	29.6	36.0					
				LIMESTONE			36.0	49.4					
7049854	520126	4882578	411.92	TOPSOIL			0.0	0.3	23.2	>23.2	4.57	407.35	23.2
				CLAY	GRAVEL	SANDY	0.3	8.8					
				CLAY	GRAVEL	SILTY	8.8	17.7					
				SAND	GRAVEL	GRAVEL	17.7	23.2					

MOECC WATER WELL RECORDS
SOUTHGATE SOLAR PROJECT

Well ID	Easting	Northing	Elevation (masl)	Material 1	Material 2	Material 3	Unit Top Depth (m)	Unit Base Depth (m)	Well Depth (m)	Bedrock Depth (m)	Static Water Level (m)	Static Water Level Elevation (masl)	Water Found Depth (m)
2516282	520047	4881717	NA	TOPSOIL			0.0	1.5	29.9	>29.9	12.04	NA	28.4
				SAND	GRAVEL		1.5	8.5					
				CLAY	STONES		8.5	24.4					
				GRAVEL			24.4	29.9					

APPENDIX D

Geotechnical Information

LEGEND

BH-01-14 ● BOREHOLE LOCATION

GPS locations of boreholes as drilled

Borehole	Northing	Easting
BH01-14	N 4883290	E 519493
BH02-14	N 4883251	E 519491
BH03-14	N4883160	E 519804
BH04-14	N 4882531	E 519260
BH05-14	N 4882239	E 519086
BH06-14	N 4882440	E 519644
BH07-14	N 4882057	E 519621
BH08-14	N 4883663	E 520844
BH09-14	N4883438	E 520887
BH10-14	N 4883521	E 521693
BH11-14	N 4883800	E 521661
BH12-14	N 4884502	E 521095
BH13-14	N 4884725	E 521143
BH14-14	N 4884689	E 520448

Notes :

1-References : Dillon Consulting , Southgate Solar: , Proposed borehole locations:, 2014-09-23.

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

0 100 200 300 400 500 m

SCALE 1:12500

Project

Southgate Solar LP

Holstein, Southgate Township

Title

Site Plan

LVM inc.
12-60 Meg Drive
London (Ontario) N6E 3T6
Telephone : 519.685.6400
Fax : 519.685.0943

Prepared **A.Stewart**
Drawn **A.Stewart**
Checked **S.Burt**

Discipline **GEOTECHNICAL**
Scale 1 : 12500
Date 2014-11-12

Project manager
W.Beck
Sequence no. 02
Rev. 00

M. dept.	Project	Work pckg.	Sub-w.p.	Disc.	Drawing no.	Rev.
161	P6928-1	100	000	GE	02	00

10 cm 5 4 3 2 1 0

G:\161\PROJECTS\2014\GEOTECHNICAL\P-0006928_SOUTHGALE SOLAR, HOLSTEIN\25_CAD\P-6928-1_SITE PLAN_DWG2 11X17.DWG

LIST OF ABBREVIATIONS

The abbreviations commonly employed on the borehole logs, on the figures, and in the text of the report, are as follows:

Sample Types	
AS	Auger Sample
CS	Chunk Sample
RC	Rock Core
SS	Split Spoon
TW	Thinwall, Open
WS	Wash Sample
BS	Bulk Sample
GS	Grab Sample
WC	Water Content Sample
TP	Thinwall, Piston

Soil Tests and Properties	
SPT	Standard Penetration Test
UC	Unconfined Compression
FV	Field Vane Test
ø	Angle of internal friction
γ	Unit weight
w_p	Plastic limit
w	Water content
w_l	Liquid limit
I_L	Liquidity index
I_p	Plasticity index
PP	Pocket penetrometer

Penetration Resistances

Dynamic Penetration Resistance	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) diameter 60 ° cone a distance 300 m (12 in.). The cone is attached to 'A' size drill rods and casing is not used.
Standard Penetration Resistance, N (ASTM D1586)	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a standard split spoon sampler 300 m (12 in.)
WH	sampler advanced by static weight of hammer
PH	sampler advanced by hydraulic pressure
PM	sampler advanced by manual pressure

Soil Description

Cohesionless Soils **Compactness Condition**	**SPT N-Value** (blows per 0.30 m)	**Relative Density (D_r)** (%)
Very Loose	0 to 4	0 to 20
Loose	4 to 10	20 to 40
Compact	10 to 30	40 to 60
Dense	30 to 50	60 to 80
Very Dense	over 50	80 to 100

Cohesive Soils	**Undrained Shear Strength (C_u)**	
Consistency	**kPa**	**psf**
Very Soft	less than 12	less than 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very Stiff	100 to 200	2000 to 4000
Hard	over 200	over 4000

DTPL	Drier than plastic limit
APL	About plastic limit
WTPL	Wetter than plastic limit

LVM

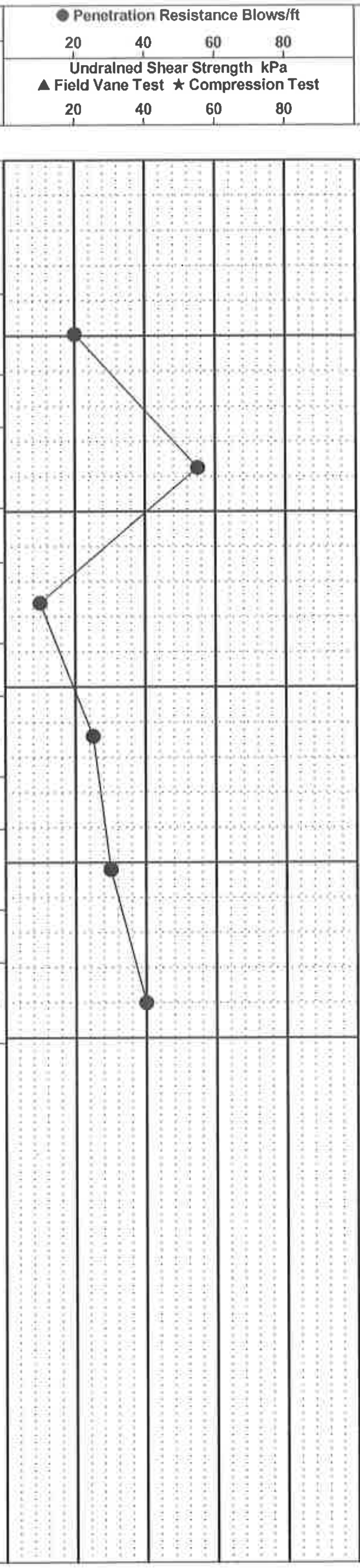
REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.
BH-01-14

Encl. No. 1 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 5, 0201

SUBSURFACE PROFILE

Elev. metres	Depth metres	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
417.42	0	380mm TOPSOIL.								
417		Loose, brown SILT & fine SAND, moist.								
416 415	1 2	Compact to dense, brown SAND & GRAVEL, trace to some silt, occasional cobble & boulder, damp.			1 2 3	ss ss ss	20 55 10		5 3 5	
414	3	Compact, brown, sandy SILT, some gravel, clayey seams, moist.			4	ss	25		9	
413	4	Dense, brown SILT, SAND & GRAVEL, moist.			5 6	ss ss	30 40		8 7	
	5	End of Borehole. Hole dry and open at completion.								



LVM

CONSULTING SOILS AND MATERIALS ENGINEERS

12 - 60 Meg Drive, London, ON, N6E 3T6 **Phone: 519-685-6400 Fax: 519-685-0943**

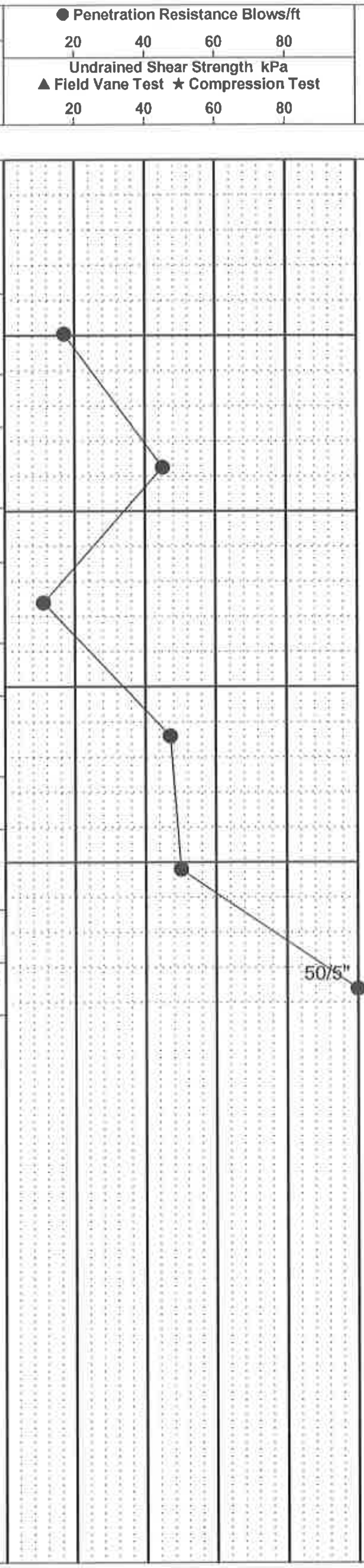
REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.
BH-02-14

Encl. No. 2 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 5, 0201

SUBSURFACE PROFILE

Elev. metres	Depth metres	DESCRIPTION	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
415.99	0	300mm TOPSOIL.	PIEZOMETER						
		Loose, brown sandy SILT, very moist.							
415	1	Compact to dense, brown SILT, SAND & GRAVEL to silty SAND & GRAVEL, occasional cobble, moist.		1	ss	17		12	
				2	ss	45		5	
414	2								
		Hard, brown, sandy clayey SILT, some gravel, DTPL.		3	ss	11		10	
413	3	Dense to very dense, brown SAND & GRAVEL, trace to some silt, occasional cobble, damp.		4	ss	47		2	
412	4			5	ss	50		2	
				6	ss	50/ 5"		4	
		End of Borehole. Hole dry and cave-in at 3.5m depth at completion. Piezometer dry at completion of installation.							



LVM
CONSULTING SOILS AND MATERIALS ENGINEERS
12 - 60 Meg Drive, London, ON, N6E 3T6
Phone: 519-685-6400 Fax: 519-685-0943

LOG OF BOREHOLE NO.

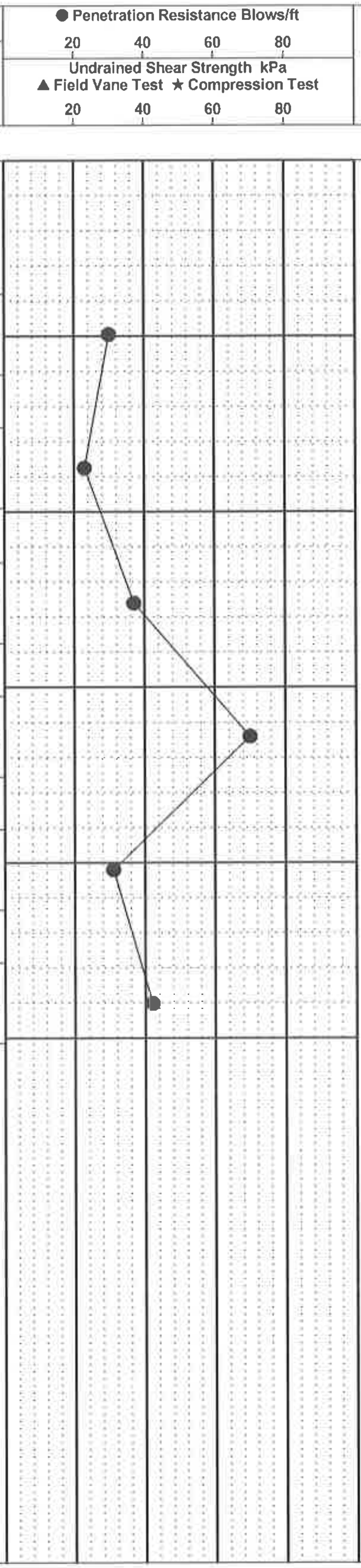
BH-03-14

REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

Encl. No. 3 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 5, 0201

SUBSURFACE PROFILE

Elev. metres	Depth metres	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
415.24	0	300mm TOPSOIL.								
		Loose, brown, silty SAND, moist.								
		Compact, brown, silty SAND & GRAVEL, occasional cobble, damp.			1	ss	30		3	
					2	ss	23		3	
		Dense to very dense, brown SAND & GRAVEL, trace to some silt, occasional cobble, gravelly silt seam, damp.			3	ss	37		3	
					4	ss	70		2	
					5	ss	31		6	
					6	ss	42		5	
		End of Borehole. Hole dry and cave-in at 3.4m depth at completion.								



LVM

CONSULTING SOILS AND MATERIALS ENGINEERS

12 - 60 Meg Drive, London, ON, N6E 3T6

Phone: 519-685-6400 Fax: 519-685-0943

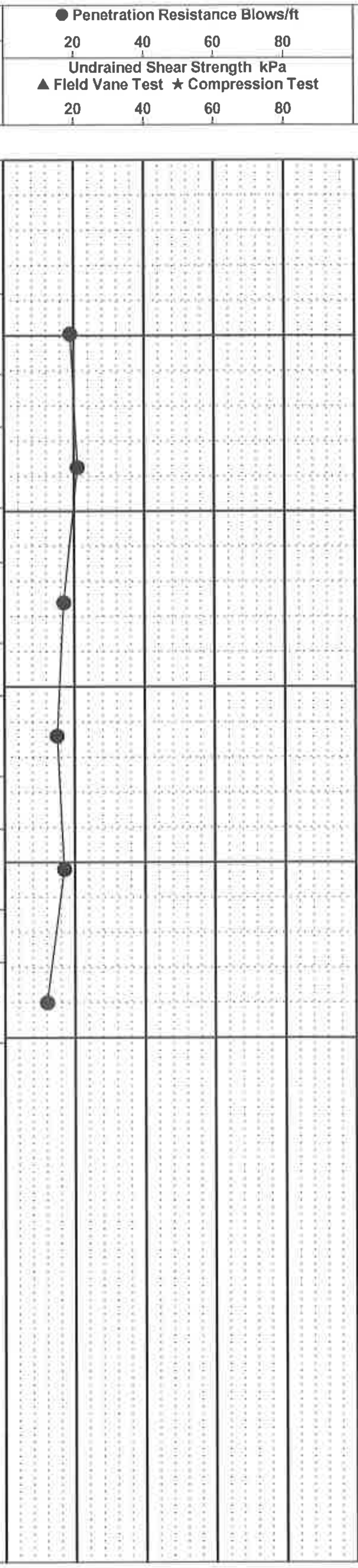
REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.
BH-04-14

Encl. No. 4 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 5, 0201

SUBSURFACE PROFILE

Elev. metres	Depth metres	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
409.77	0	150mm TOPSOIL.		PIEZOMETER						
		Compact, brown SAND & GRAVEL, trace to some silt, occasionalcobble, moist.			1	ss	19		3	
					2	ss	21		12	
		Compact, brown, fine SAND, some silt, moist.			3	ss	17		5	
					4	ss	15		5	
		Compact, brown SAND, traces of silt & gravel, lower silt seams, moist.			5	ss	17		3	
					6	ss	12		10	
	5	End of Borehole. Hole dry and open at completion. Piezometer dry at completion of installation.								



LVM

CONSULTING SOILS AND MATERIALS ENGINEERS

12 - 60 Meg Drive, London, ON, N6E 3T6

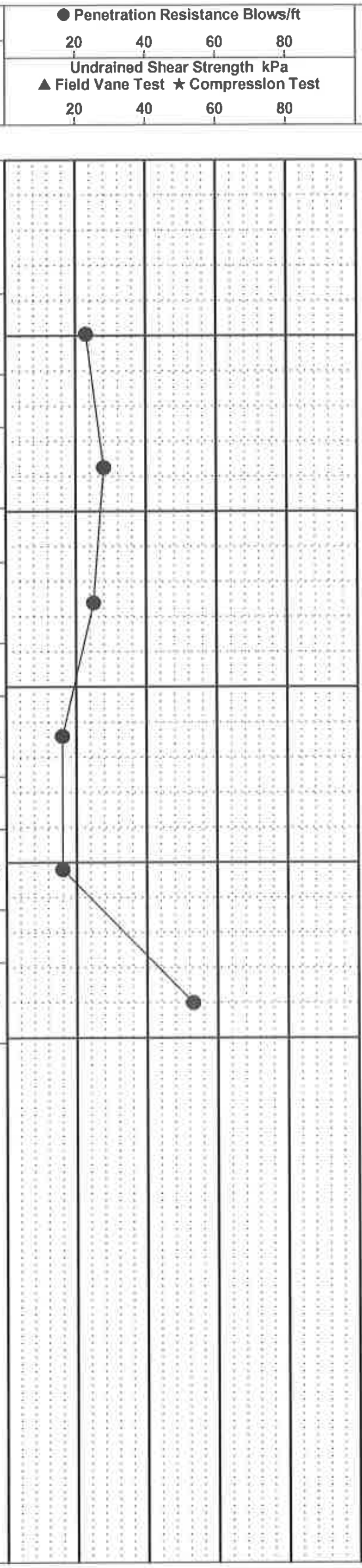
Phone: 519-685-6400 Fax: 519-685-0943

REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.
BH-05-14

Encl. No. 5 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 5, 0201

Elev. metres	Depth metres	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
410.32	0	430mm TOPSOIL.		PIEZOMETER						
		Compact, brown SAND & GRAVEL, trace to some silt, occasional cobble, damp.			1	ss	23		5	
					2	ss	28		3	
					3	ss	25		4	
		Compact, brown, silty fine SAND, trace of gravel, sandy silt seams, very moist.			4	ss	16		16	
					5	ss	16		12	
		Very dense, brown SAND & GRAVEL, some silt, damp.			6	ss	53		4	
	5	End of Borehole. Hole dry and open at completion. Piezometer dry at completion of installation.								



LOG OF BOREHOLE P-0006928-01-100.GPJ ATK_DAV.GDT 25/11/14

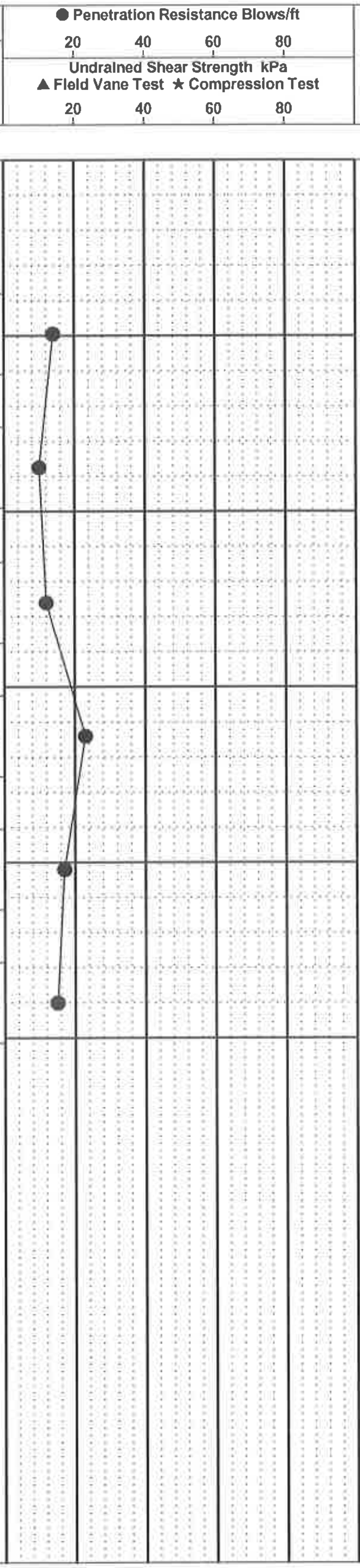
REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.

BH-06-14

Encl. No. 6 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 5, 0201

Elev. metres	Depth metres	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
424.50	0	300mm TOPSOIL.								
		Compact, brown SAND, some silt to silty, gravelly seams, very moist.			1	ss	14		14	
					2	ss	10		12	
		Stiff, brown, sandy clayey SILT, some gravel, DTPL.			3	ss	12		9	
		Compact, brown sandy SILT, gravelly seams, moist.			4	ss	23		6	
		Compact, brown SAND & GRAVEL, trace to some silt, occasional cobble, damp.			5	ss	17		2	
					6	ss	15		3	
	5	End of Borehole. Hole dry and open at completion.								



LVM

CONSULTING SOILS AND MATERIALS ENGINEERS

12 - 60 Meg Drive, London, ON, N6E 3T6

Phone: 519-685-6400 Fax: 519-685-0943

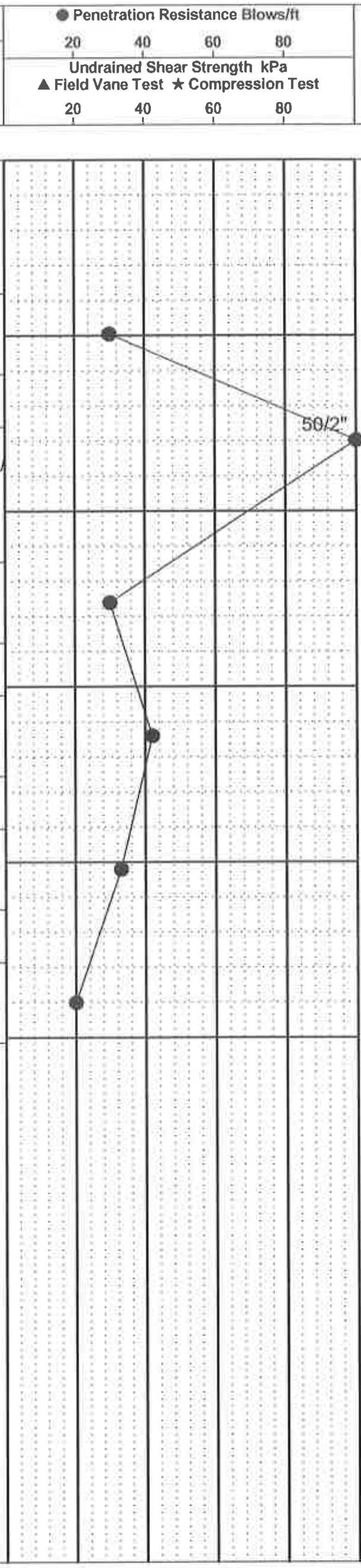
REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.
BH-07-14

Encl. No. 7 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 5, 0201

SUBSURFACE PROFILE

Elev. metres	Depth metres	DESCRIPTION	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
418.50	0	300mm TOPSOIL.	PIEZOMETER						
		Compact to dense, brown, gravelly SILT & SAND, occasional cobble and boulder, moist.		1	ss	30		11	
				2	ss	50/ 2"		7	
				3	ss	30		8	
				4	ss	42		8	
	4	Saturated.		5	ss	33		18	
			▽	6	ss	20		17	
	5	End of Borehole. Water level in piezometer at 4.5m depth at completion of installation.							



REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.

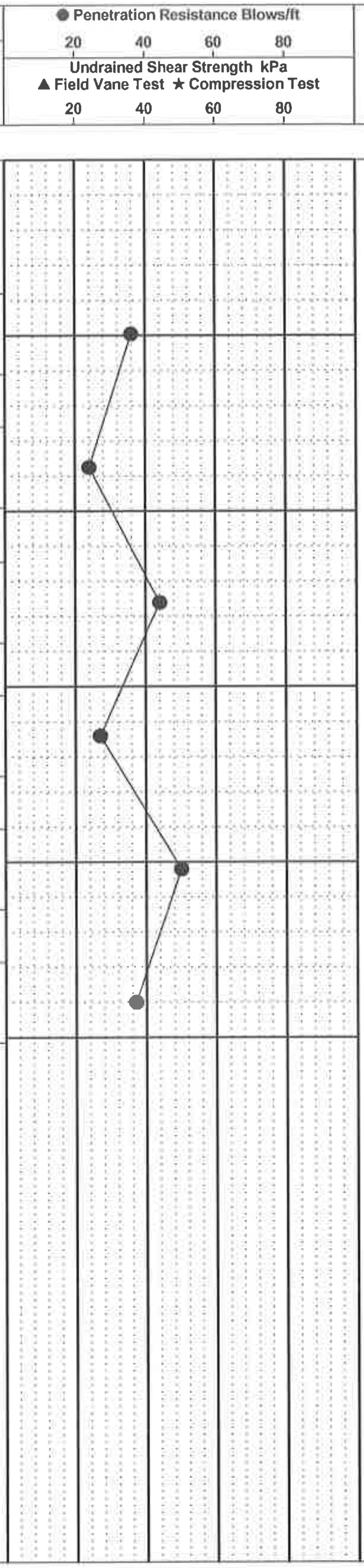
BH-08-14

Encl. No. 8 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 6, 0201

SUBSURFACE PROFILE

Elev. metres	Depth metres	DESCRIPTION
429.05	0	350mm TOPSOIL.
		Stiff, brown, sandy clayey SILT, APL.
		Compact to dense, brown SAND & GRAVEL, trace to some silt, occasional cobble & boulder, damp.
		Dense, brown, fine SAND, some silt, damp.
		End of Borehole. Hole dry and open at completion.

Elev. metres	Depth metres	NUMBER	TYPE	"N" Blows/ft	NATURAL WATER %
428	1	1	ss	36	3
		2	ss	24	2
427	2				
		3	ss	44	6
426	3				
		4	ss	27	2
425	4	5	ss	50	2
		6	ss	37	3
	5				



PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT %

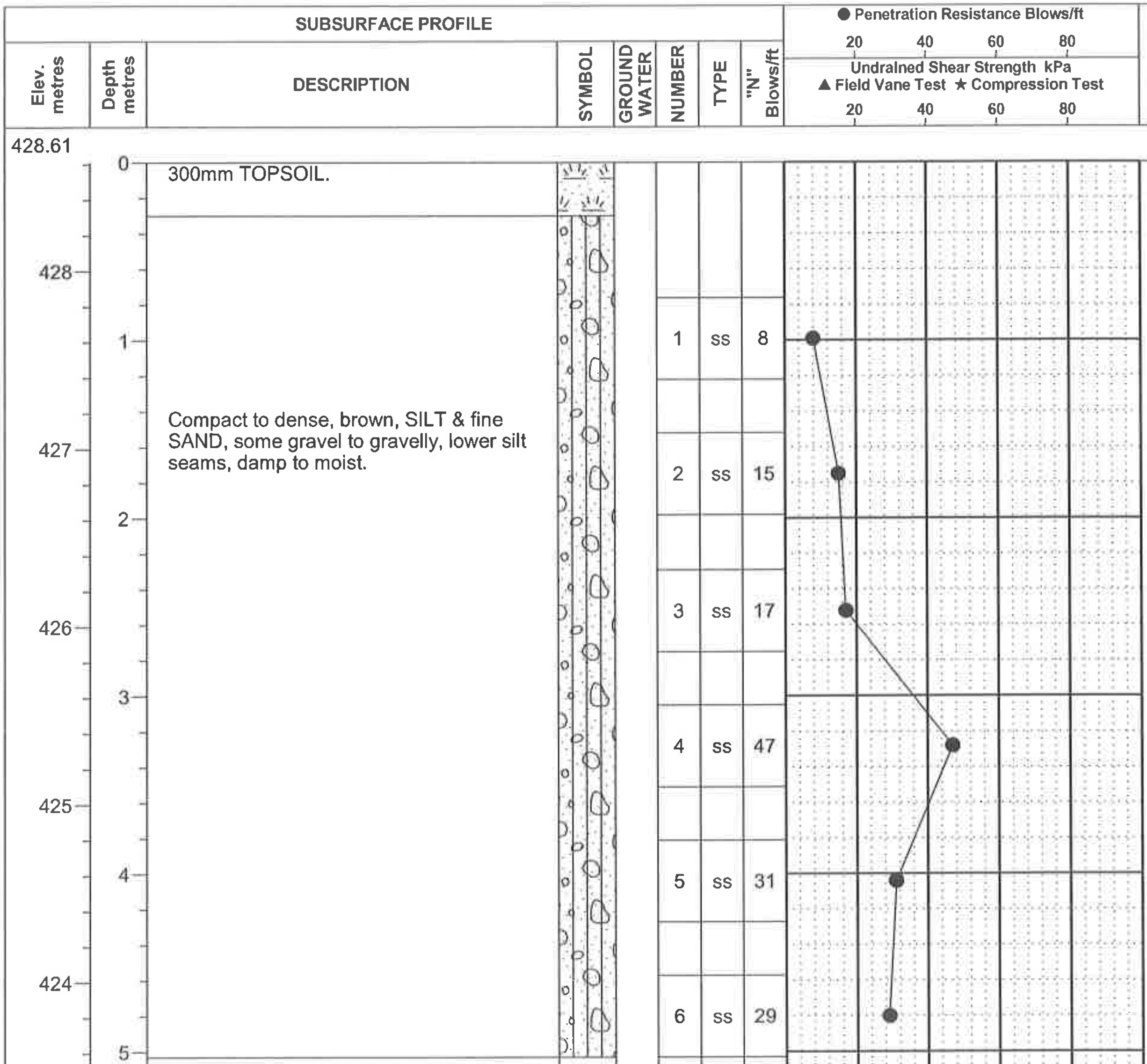
LVM
CONSULTING SOILS AND MATERIALS ENGINEERS
12 - 60 Meg Drive, London, ON, N6E 3T6
Phone: 519-685-6400 Fax: 519-685-0943

REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.
BH-09-14

Encl. No. 9 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 6, 0201

SUBSURFACE PROFILE								PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
Elev. metres	Depth metres	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	"N" Blows/ft			
428.61	0	300mm TOPSOIL.								
		Compact to dense, brown, SILT & fine SAND, some gravel to gravelly, lower silt seams, damp to moist.			1	ss	8		6	
					2	ss	15		3	
					3	ss	17		5	
					4	ss	47		2	
					5	ss	31		10	
					6	ss	29		12	
	5	End of Borehole. Hole dry and open at completion.								



L V M

CONSULTING SOILS AND MATERIALS ENGINEERS

12 - 60 Meg Drive, London, ON, N6E 3T6 **Phone: 519-685-6400 Fax: 519-685-0943**

REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

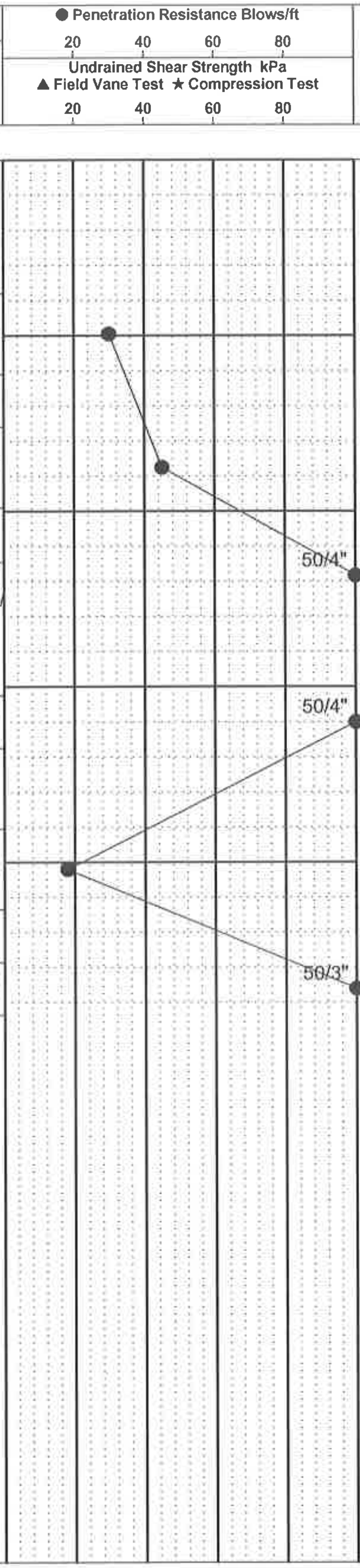
LOG OF BOREHOLE NO.
BH-10-14

Encl. No. 10 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 6, 0201

SUBSURFACE PROFILE

Elev. metres	Depth metres	DESCRIPTION	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
429.84	0	300mm TOPSOIL.	PIEZOMETER						
		Dense to very dense, brown SAND & GRAVEL, trace to some silt, occasional cobble & boulders, damp.		1	ss	30		10	
				2	ss	45		4	
				3	ss	50/ 4"		4	
				4	ss	50/ 4"		4	
		Compact, brown SILT & fine SAND, trace of gravel, wet.		5	ss	18		18	
		Very dense, brown SAND & GRAVEL, some silt, moist.		6	ss	50/ 3"		4	
		End of Borehole. Piezometer dry 18 hours after installation.							

Elev. metres: 429, 428, 427, 426, 425
Depth metres: 0, 1, 2, 3, 4



L V M
CONSULTING SOILS AND MATERIALS ENGINEERS
12 - 60 Meg Drive, London, ON, N6E 3T6 **Phone: 519-685-6400 Fax: 519-685-0943**

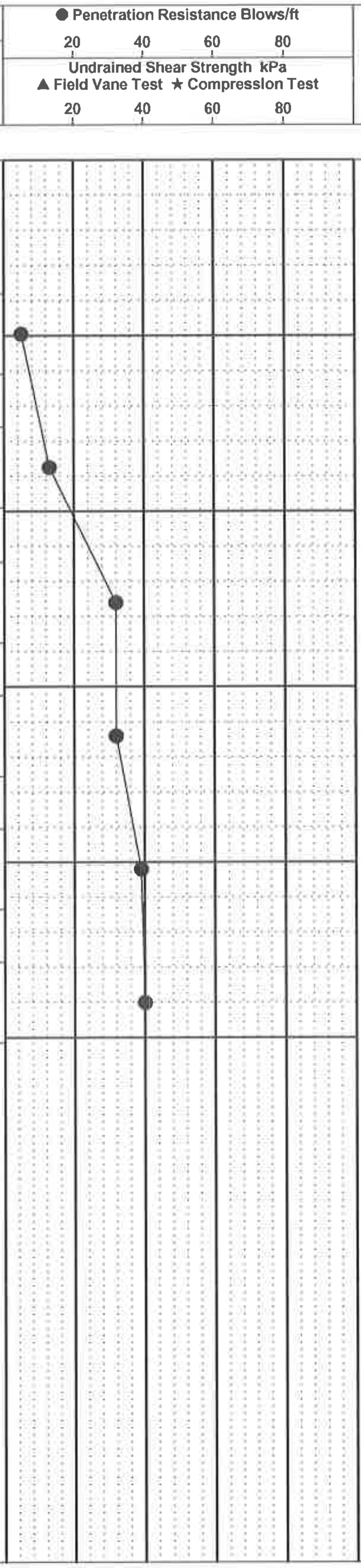
REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.
BH-11-14

Encl. No. 11 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 6, 0201

SUBSURFACE PROFILE

Elev. metres	Depth metres	DESCRIPTION	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
443.48	0	400mm TOPSOIL.							
		Loose to compact, brown, silty SAND, some gravel, moist.		1	ss	5		9	
				2	ss	13		7	
		Dense, brown, silty SAND & GRAVEL, silt seams, moist.		3	ss	32		8	
				4	ss	32		6	
				5	ss	39		9	
				6	ss	40		6	
	5	End of Borehole. Hole dry and open 18 hours after completion of drilling.							



L V M

CONSULTING SOILS AND MATERIALS ENGINEERS

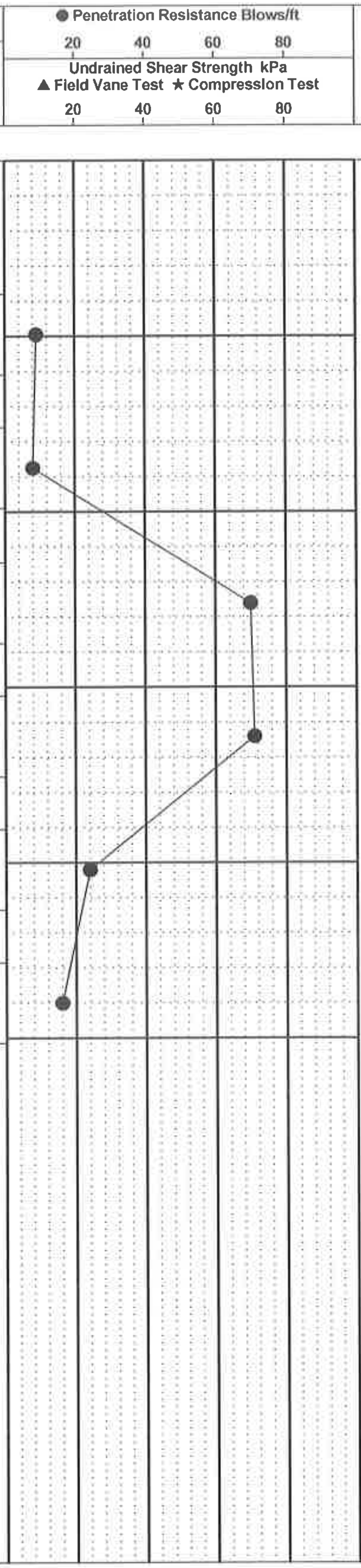
12 - 60 Meg Drive, London, ON, N6E 3T6 **Phone: 519-685-6400 Fax: 519-685-0943**

REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.
BH-12-14

Encl. No. 12 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 7, 0201

Elev. metres	Depth metres	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
434.68	0	300mm TOPSOIL.		PIEZOMETER						
		Loose, brown SILT & SAND, clayey seams, very moist.			1	ss	9		17	
					2	ss	8		9	
		Compact to very dense, brown SAND & GRAVEL, trace to some silt, occasional cobble & boulder, lower clayey silt seams, damp.			3	ss	70		2	
					4	ss	71		2	
					5	ss	24		3	
					6	ss	16		4	
	5	End of Borehole. Dry cave-in at 3.7 m depth at completion. Piezometer dry at completion of installation.								



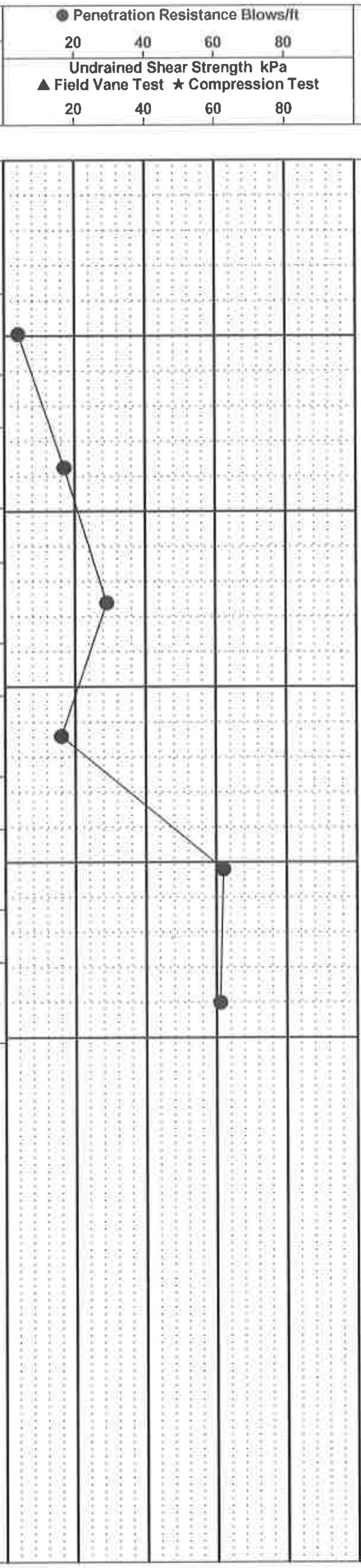
REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.
BH-13-14

Encl. No. 13 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 7, 0201

SUBSURFACE PROFILE

Elev. metres	Depth metres	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
435.80	0	750mm TOPSOIL.								
435	1	Loose, brown, silty SAND & GRAVEL, very moist.			1	ss	4		16	
434	2	Compact, brown SAND & GRAVEL, trace to some silt, occasional cobble, moist.			2	ss	17		9	
					3	ss	29		4	
433	3	Compact, brown, sandy SILT, some gravel, moist.			4	ss	16		10	
432	4	Very dense, brown SAND & GRAVEL, trace to some silt, occasional cobble, damp.			5	ss	62		3	
431					6	ss	61		2	
	5	End of Borehole. Hole dry and open at completion.								



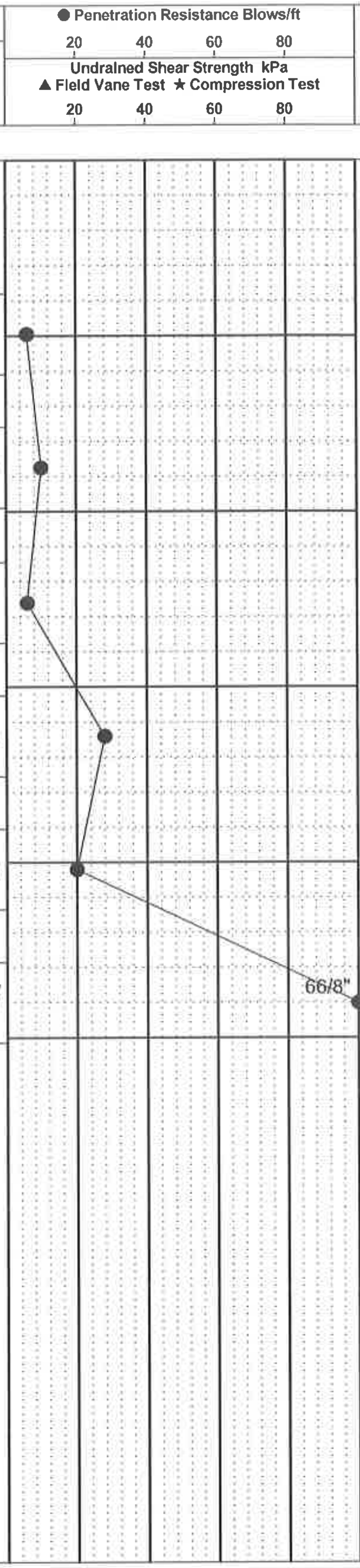
REF. NO.: P-0006928-01-100
CLIENT: Dillon Consulting Limited
PROJECT: Southgate Solar Project
LOCATION: Holstein, Ontario
DATUM ELEVATION: Existing Ground Surface

LOG OF BOREHOLE NO.
BH-14-14

Encl. No. 14 (Sheet 1 of 1)
DRILLING DATA: Marooka Rig
METHOD: Solid Stem Augors
DIAMETER: 150mm
DATE: Nov 7, 0201

SUBSURFACE PROFILE

Elev. metres	Depth metres	DESCRIPTION	GROUND WATER	NUMBER	TYPE	"N" Blows/ft	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
427.31	0	300mm TOPSOIL.	PIEZOMETER						
		Loose, dark brown, gravelly SILT & SAND, very moist.		1	ss	6		16	
		Loose, brown SILT & SAND, some gravel, clayey seams, wet.	▽	2	ss	10		8	
				3	ss	6		11	
		Compact to very dense, brown, silty SAND & GRAVEL, upper silt & sand seams, wet.		4	ss	28		11	
				5	ss	20		10	
				6	ss	66/ 8"		9	
	5	End of Borehole. Water level in standpipe at 2.1m depth at completion of installation.							



Appendix 3 Figures

Figures 1 & 2: Particle Size Distribution Analyses

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

	Location	Source	Sample #	Depth/Elev.	Sample Information
○	Borehole 01-14		Sample 2	1.8m / 415.6	SAND & GRAVEL, trace of silt.
□	Borehole 04-14		Sample 3	2.5m / 407.3	Fine SAND, some silt, trace of gravel.
△	Borehole 07-14		Sample 3	2.5m / 416.0	Gravelly SILT & SAND, trace of clay.

Project No. P-0006928-01-100 **Client** Dillon Consulting Limited

Figure 1

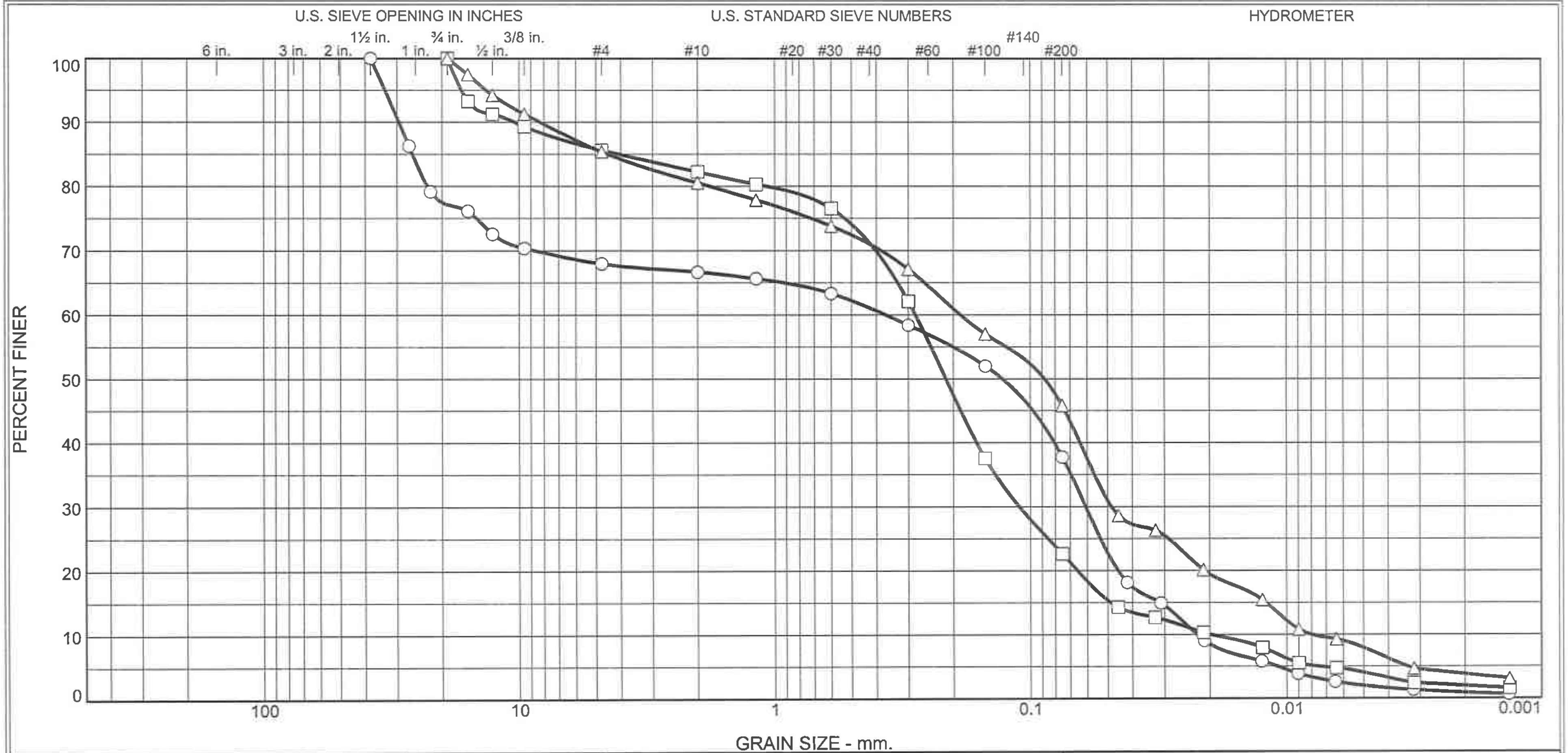
Grain Size Analysis

Southgate Solar Project, Holstein, Southgate Township

LVM, Inc.

London, Ontario

Tested By: AH **Checked By:** SB



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

	Location	Source	Sample #	Depth/Elev.	Sample Information
○	Borehole 09-14		Sample 3	2.5m / 426.1	Gravelly, sandy SILT, trace of clay.
□	Borehole 11-14		Sample 2	1.8m / 441.7	Silty SAND, some gravel, trace of clay.
△	Borehole 14-14		Sample 3	2.5m / 424.8	SILT & SAND, some gravel, trace of clay.

Project No. P-0006928-01-100 **Client** Dillon Consulting Limited

Figure 2

Grain Size Analysis

Southgate Solar Project, Holstein, Southgate Township

LVM, Inc.

London, Ontario

Tested By: AH **Checked By:** SB