KINGSTON SOLAR LP
SOL-LUCE KINGSTON
SOLAR PV ENERGY PROJECT

DESIGN AND OPERATIONS REPORT

Submitted to:

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EXECUTIVE SUMMARY

The Sol-luce Kingston Solar PV Energy Project ("the Project") is being planned by Kingston Solar LP (the “Proponent”). The Project has a maximum name plate capacity of 100 MW AC, located in the City of Kingston and Loyalist Township in Eastern Ontario. This *Design and Operations Report* has been prepared under the requirements of the Renewable Energy Approvals (REA) process as outlined in *Ontario Regulation 359/09* and is being made available for agency, aboriginal organizations and public review and comment.

The *Design and Operations Report* provides a description of key facility design components, descriptions related to the operation of the facility, as well as the potential environmental effects from operations phase and proposed mitigation and monitoring measures. Environmental impacts are described as they relate to the Project Location and lands within 300 m of the Project components.

Key facility design plan is comprised of civil components including security fencing, access roads, water crossings, foundations and structural support, as well as electrical components such as PV modules, inverter stations, substation, switchyard, water supply and stormwater management. To minimize the potential for environmental effects during the operations phase, the operations team will be made aware of the environmental management commitments that have been made and need to be met. An Environmental Effects Monitoring Plan (EEMP) for the operations phase is included in Section 5.0 of the report. An Emergency Response and Communications Plan for the Project is described in Section 6.0.

Sufficient fieldwork and data collection was performed to assist in the determination of potential effects to environment during the operations phase. Various mitigation measures to manage these potential effects have been identified. Significant adverse effects from operations to the natural and social environment will be avoided through careful facility design and layout planning, the application of appropriate mitigation measures, and adherence to all regulatory requirements.

The *Natural Heritage Assessment and Environmental Impact Study (NHA/EIS) Report* identified the boundaries and assessed the significance of natural features occurring partially or wholly within 120 metres (m) of the Project Location. By way of a Records Review, information was gathered about the Study Area to identify known or potential natural features occurring within 120 m of the Project Location. Natural features include woodlands, wetlands, protected lands (provincial and national parks, or ANSIs), and wildlife habitat. Site Investigation confirmed the presence and boundaries of natural features reported in the Records Review which occurred within 120 m of the Project Location.

The *Stormwater Management (SWM) Plan* for the Project was developed for runoff control from the substation property in accordance with the Ministry of Environment (MOE) and Cataraqui Region Conservation Authority (CRCA) guidelines. The *SWM Plan* concluded that runoff from the Project can be effectively managed through grass berming. The *SWM Plan* is provided in **Appendix B** of this report.

A study of impacts on surface water and groundwater was completed as part of the inventory of natural features and the results of Study Area provided in the *Water Assessment and Water Body Report* (Refer to **Appendix C**). The study concluded that with implementation of the mitigation measures no adverse effects on surface and groundwater are predicted from the operation of the Project.

Project's noise sources would include the inverter stations and the substation. These were modelled to confirm compliance with the Provincial noise standards. The *Noise Study Report* concluded that noise levels from the operation of the Project will not exceed the applicable noise guidelines set out by MOE in NPC-233 and NPC-205. The technical analysis of the modelling and results are provided in **Appendix D** of this report.

The proposed Project is of low-profile and of non-obtrusive use. Once constructed, the Project will have no moving parts and produce no significant off-site noise, no harmful emissions or any other form of waste product. The overall conclusion of the *Design and Operations Report* is that this Project can be operated without any significant adverse residual effects to the natural or social environment.

For more information about the Project, please refer to the documents provided in the appendices of the *Design and Operations Report*. These additional reports are provided as part of a completed submission package to the MOE and were prepared in accordance with *Ontario Regulation 359/09*.

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1.0 INTRODUCTION

1.1 Overview

Kingston Solar LP (hereinafter referred to as the "Proponent") proposes to develop a solar facility with a maximum name plate capacity of approximately 100 MW AC (megawatts of alternating current). The Project will span a total area of approximately 261 hectares (ha). The proposed Project site are to be located to the north and south of Unity Road and south of Mud Lake Road in the City of Kingston and Loyalist Township (Figure 1-1 and Figure 1-2). The renewable energy facility is to be known as the "Sol-luce Kingston Solar PV Energy Project" (hereinafter referred to as "the Project") and will be rated as a Class 3 Solar Facility. The Project will require a Renewable Energy Approval (REA) as per Ontario Regulation *O.Reg. 359/09* under Part V.0.1 of the *Ontario Environmental Protection Act*.

The development of the Project will help the Province of Ontario meet its goal of increasing the proportion of electricity generated from renewable sources. If approved, this facility would use photovoltaic (PV) technology to convert solar energy into electricity. Power generated by the Project will be fed into the provincial grid via a substation located adjacent to the Hydro One Networks Inc. (HONI) transmission line which crosses the study area.

This *Design and Operations Report* provides a description of key facility design components, descriptions related to the operation of the facility, as well as the potential environmental effects from operations phase and proposed mitigation and monitoring measures. Environmental impacts are described as they relate to the Project Location and lands within 300 m of the Project components.

A more details about the Project are provided in the *Project Description Report* which has been issued under a separate cover.

The Project will consist of:

- Multiple sites consisting of arrays of Photovoltaic (PV) panels, with the cumulative capacity to generate up to 100 MW of power located as shown in Figure 1-2;
- Arrays mounted to aluminum or galvanized steel racking anchored to the ground or foundations;
- PV arrays grouped in blocks of approximately 1 MW and connected to an inverter station to convert the incoming power from direct current (DC) to alternating current (AC);
- A transformer at the inverter station that will transform the outgoing AC power to 34.5 kilovolts (kV);

- Underground and/or overhead collector lines to transmit power from the Project to the substation via the municipal road right-of-way. The collector line is estimated to be approximately 33 km in length;

- Transformers to transform the power to 230 kV for interconnection to the adjacent HONI transmission line;

- A maintenance and control building to be located at the substation site for operations and maintenance use; and

- Security fencing around Project site.

The Proponent will provide design, construction, operation, and decommissioning plan of the Project. The proposed schedule is to commence construction in early 2013 with completion by 2014.

Figure 1-1: Regional Study Area

Figure 1-2: Project Location

1.2 Contact Information

Kingston Solar LP (the "Proponent"), is coordinating and managing the approvals process for the Project. The Proponent would be pleased to receive any comments, concerns or questions about the project or this *Design and Operations Report* and is committed to public consultation throughout the REA process. Contact information for Kingston Solar LP is as follows:

Company Name:	Kingston Solar LP
Company Address:	55 Standish Court, 9th Floor Mississauga, Ontario L5R 4B2
Company Website:	http://www.samsungrenewableenergy.ca/
Prime Contact:	A. José De Armas
Telephone:	905-501-5658 (1-855-359-2342)
Fax:	905-285-1852
Email:	solucekingston@samsungrenewableenergy.ca

AMEC is the consultant responsible for the preparation of REA-related reports for the Project. The contact at AMEC is:

Full Name of Company:	AMEC Environment & Infrastructure, a Division of AMEC Americas Limited (AMEC)
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1.3 Purpose of the Report

The purpose of the *Design and Operations Report* (hereinafter referred to as the "Report") is to provide the public, Aboriginal communities, municipalities, and regulatory agencies with an understanding of the design and operations components of the Project.

1.4 Report Requirements

The Proponent retained AMEC Americas to assist in the preparation of studies and reports in support of a Renewable Energy Approval (REA) application for the Project. The REA application is a requirement under Ontario Regulation 359/09 - Renewable Energy Approvals under Part V.0.1 of the Act of the *Environmental Protection Act* (O.Reg. 359/09). The Project is designated as a Class 3 solar facility as defined by Section 4 of O.Reg. 359/09.

O.Reg. 359/09 sets out specific content requirements for the *Design and Operations Report* as provided in the MOE's *Checklist for Requirements under O.Reg. 359/09*. This Report has been prepared in accordance with Item 4, Table 1 of O.Reg. 359/09 and the Ministry of the Environment's (MOE's) "*Technical Guide to Renewable Energy Approvals – Chapter 6: Guidance for Preparing the Design and Operations Report*" (MOE 2011). Revisions to the Renewable Energy Approval (REA) regulation (O.Reg. 359/09) and the Technical Guide for Renewable Energy Approvals (Technical Guide, 2012) are currently under review. Once the revised O.Reg. 359/09 and the Technical Guide are finalized, the Proponent may incorporate, where applicable, revisions to the *Design and Operations Report* and/or the appended reports to reflect changes in the O.Reg. 359/09 or the Technical Guide.

The following table provides the requirements of the *Design and Operations Report* as prescribed in the Regulation and the relevant sections where it can be found within this document.

Table 1-1: Design and Operations Report Requirements per Ontario Regulation 359/09

ID	Requirements	Section Number
1	**Set out a site plan of the project location at which the renewable energy project will be engaged in, including,**	
	i. one or more maps or diagrams of:	
	A. all buildings, structures, roads, utility corridors, rights of way and easements required in respect of the renewable energy generation facility and situated within 300 m of the facility	**Appendix A**
	B. any ground water and surface water supplies used at the facility	Not Applicable
	C. any things from which contaminants are discharged into the air	Not Applicable
	D. any works for the collection, transmission, treatment and disposal of sewage	**Appendix A**
	E. any areas where waste, biomass, source separated organics and farm material are stored, handled, processed or disposed of	Not Applicable
	F. the project location in relation to any of the following within 125 m • the portion of the Oak Ridges Moraine Conservation Plan Area that is subject to the Oak Ridges Moraine Conservation Plan • the area of the Niagara Escarpment Plan • the Protected Countryside • the Lake Simcoe watershed	Not Applicable
	G. any noise receptors or odour receptors that may be negatively affected by the use or operation of the facility	**Appendix A**
	ii. a description of each item diagrammed under subparagraph i	3.0 and 5.0
	iii. one or more maps or diagrams of land contours, surface water drainage and any of the following, if they have been identified in complying with this Regulation • properties described in Column 1 of the Table to section 19 • heritage resources • archaeological resources • water bodies • significant or provincially significant natural features • any other natural features identified in the Protected Countryside or in the	Figure 1

ID	Requirements	Section Number
	portion of the Oak Ridges Moraine Conservation Plan Area that is subject to the Oak Ridges Moraine Plan	
2	**Set out conceptual plans, specifications and descriptions related to the design of the renewable energy generation facility, including a description of:**	
	i. any works for the collection, transmission, treatment and disposal of sewage, including details of any sediment control features and storm water management facilities	3.3.6, 3.3.7, 4.3, 4.5.1 and **Appendix C**
	ii. any things from which contaminants are discharged into the air	4.5
	iii. any systems, facilities and equipment for receiving, handling, storing and processing any waste, biomass, source separated organics, farm material and biogas	4.5
3	**Set out conceptual plans, specifications and descriptions related to the operation of the renewable energy generation facility, including:**	
	i. in respect of any water takings	
	A. a description of the time period and duration of water takings expected to be associated with the operation of the facility	4.4
	B. a description of the expected water takings, including rates, amounts and an assessment of the availability of water to meet the expected demand	4.4
	C. an assessment of and documentation showing the potential for the facility to interfere with existing uses of the water expected to be taken	4.4
	ii. a description of the expected quantity of sewage produced and the expected quality of that sewage at the project location and the manner in which it will be disposed of, including details of any sediment control features and storm water management facilities	4.5 and 4.5.1
	iii. a description of any expected concentration of air contaminants discharged from the facility	4.2
	iv. in respect of any biomass, source separated organics and material at the facility	Not Applicable
	A. the maximum daily quantity that will be accepted	Not Applicable
	B. the estimated annual average quantity that will be accepted	Not Applicable
	C. the estimated average time that it will remain at the facility	Not Applicable
	D. the estimated average rate at which it will be used	Not Applicable
	v. in respect of any waste generated as a result of processes at the project location, the management and disposal of such waste, including:	
	A. the expected types of waste to be generated	4.5
	B. the estimated maximum daily quantity of waste to be generated, by type	4.5
	C. processes for the storage of waste	4.5
	D. processes for final disposal of waste	4.5
4	**Include an environmental effects monitoring plan in respect of any negative environmental effects that may result from engaging in the renewable energy project, setting out:**	
	i. performance objectives in respect of the negative environmental effects	5.0
	ii. mitigation measures to assist in achieving the performance objectives mentioned in subparagraph i	5.0
	iii. a program for monitoring negative environmental effects for the duration of the time that the project is engaged in, including a contingency plan to be implemented if any mitigation measures fail	5.0
5	**Include a response plan setting out a description of the actions to be taken while engaging in the renewable energy project to inform the public,**	

ID	Requirements	Section Number
	aboriginal communities and municipalities, local roads boards and Local Services Boards with respect to the project, including:	
	i. measures to provide information regarding the activities occurring at the project location, including emergencies	6.1 – 6.3
	ii. means by which persons responsible for engaging in the project may be contacted	6.2
	iii. means by which correspondence directed to the persons responsible for engaging in the project will be recorded and addressed	6.3
6	**If the project location is in the Lake Simcoe watershed, a description of whether the project requires alteration of the shore of Lake Simcoe, the shore of a fresh water estuary of a stream connected to Lake Simcoe or other lakes or any permanent or intermittent stream and:**	Not Applicable
	i. how the project may impact any shoreline, including the ecological functions of the shoreline	Not Applicable
	ii. how the project will be engaged in to:	Not Applicable
	A. maintain the natural contour of the shoreline through the implementation of natural shoreline treatments, such as planting of natural vegetation and bioengineering	Not Applicable
	B. use a vegetative riparian area, unless the project location is used for agricultural purposes and will continue to be used for such purposes	Not Applicable

Table 1-2 provides the requirements of the *Design and Operations Report* as prescribed in *Technical Guide to Renewable Energy Approvals – Chapter 6: Guidance for preparing the Design and Operations Report* (MOE 2011).

Table 1-2: Design and Operations Report Requirements per Technical Guide to Renewable Energy Approvals

Requirement per Technical Bulletin Two	Section Number
Introduction	1
Site Plan	2
Facility Design Plan	3
Facility Operations Plan	4
Environmental Effects Monitoring Plan	5
Emergency Response and Communications Plan	6

2.0 SITE PLANS

The Site Plan drawing (Figure 1-2 Project Location; also provided unbound) conform to O.Reg. 359/09 and provide information as follows:

- Buildings, structures, roads, utility corridors, rights of way and easements required in respect of the renewable energy generation facility and situated within 300 m of the Project sites;
- Noise receptors that may be affected by the use or operation of the facility;
- Land contours;
- Surface water drainage and water bodies; and
- Significant or provincially significant natural features within 120 m of the Project sites.

2.1 Facility Components

Drawings of the facility components shown in the Site Plan (Figure 1-2 Project Location) are provided in **Appendix A**.

2.2 Setback Distances

O.Reg. 359/09 provides setback distances between the facility, and:

- Significant and provincially significant natural features;
- Provincial parks and conservation reserves; and
- REA defined water bodies.

In addition, Kingston Solar LP proposes to implement additional setbacks and screening devices as summarized in **Appendix E**.

Visual representation of the setback distances are illustrated in Figure 1-2 and **Appendix E**.

2.3 Cultural Heritage and Archaeological Resources

2.3.1 Cultural Heritage Resources

In accordance with O.Reg. 359/09, a cultural heritage assessment was undertaken for the Project, and a *Cultural Heritage Assessment Report* was provided for review to the Ministry of Tourism, Culture and Sport (MTCS). The assessment investigated the presence of protected properties in the vicinity of the Project sites and the potential for heritage resources. The report is included under separate cover as part of the REA application.

The *Cultural Heritage Assessment Report* concluded that while all the properties exhibit varying degrees of association with the historical theme of land settlement and related agricultural activity, (namely they are remnant agricultural fields in a larger contextual rural landscape) and possess some contextual value due to historical linkages with their surroundings, none are of sufficient cultural heritage value or interest that would warrant not-developing these lands for solar energy installations. The following properties were identified:

- Westbrook Road, Property 12 - Where remnants of log structure were identified, this should be noted for potential archaeological mitigation; and

- 4017 Unity Road, Land located between Property 14B and 14C - The stone facility house and frame barn are located between two properties identified as Project sites and are not anticipated to be demolished or removed as part of this Project. Edge treatments or buffer and screening devices around the periphery of these features are recommended to filter or break up views to any solar energy installations beyond.

2.3.2 Archaeological Resources

As part of the Renewable Energy Approval Application, Stage 1 and 2 Archaeological Assessments (AAs) were completed on all lands directly affected by construction and/or operations activities during 2011 and 2012. Reports have been submitted to the Ministry of Tourism, Culture and Sport (MTCS). The Proponent has received written acknowledgement that the field work completed in 2011 and associated reports were carried out in accordance with the Standards and Guidelines for Consultant Archaeologists. The Proponent is expecting written acknowledgement for 2012 fieldwork and reports in June 2012.

Due to sensitivity of the information, and to protect the resource, the location of any artefacts found during the archaeological investigations cannot be disclosed (Refer to MOE "*Technical Guide to Renewable Energy Approvals"* page 115*)*. Additional Stage 3 and 4 AAs will be completed as necessary prior to construction.

2.4 Natural Heritage

In accordance with O.Reg. 359/09, a *Natural Heritage Assessment/Environmental Impact Study (NHA/EIS) Report* was completed for the Project, under separate cover as part of the REA application.

As per the requirements of the Records Review (O.Reg. 359/09, s.25), background data was collected and reviewed to identify natural features located in, or within 120 m of the Project sites. The results of the Records Review search were used to determine whether the Project sites are in, or within 120 m of a natural feature, a Provincially Significant Wetland (PSW), a life science area of natural and scientific interest (ANSI) and/or within 50 m of an earth science ANSI.

The Site Investigations (O.Reg 359/09, s.26) were completed with the purpose of confirming the status and boundaries of natural features identified through the Records Review and identifying any additional features. Data collected during the Records Review concerning natural features, species occurrences and candidate significant wildlife habitat were used to guide the scope and direction of Site Investigations. The Site Investigation program involved detailed assessments and inventory of the vegetation communities, wetlands and wildlife.

Natural heritage information collected from the Records Review and the Site Investigation were analyzed to determine the significance of the natural features (Evaluation of Significance) and the sensitivity of existing ecological features and functions. Where Project components would be within 120 m of a significant natural feature, a *Environmental Impact Study (*EIS) was prepared for review and approval of the Ministry of Natural Resources (MNR). The EIS identifies and assesses negative environmental effects and proposes mitigation measures to avoid or minimize the potential negative effects associated with the planning, design, construction, operation and decommissioning of the Project.

If possible, in developing the site layout, Project components were sited beyond 120 m of the natural feature. The locations of all natural features within 120 m of the Project sites are shown on the Figures included within this report. Further detailed discussion of the natural heritage features can be found in the *NHA/EIS Report*.

2.5 Water Bodies

The Project Area is crossed by a number of watercourses. A study of the water courses and aquatic habitat was completed as part of the inventory of natural features and the results of study area provided in the *Water Assessment and Water Body Report* (Refer to **Appendix C**). The report includes mapping of the water bodies and the Project components. Encroachments of the Project within 120 m of the water bodies are also shown on the maps.

Access roads cross several watercourses, and in some cases, underground collector lines are associated with these access roads. Culverts installed for the Project would be designed and installed in a manner that would not impede fish movement or water passage and where possible, habitat enhancement measures would be incorporated into the design. Overhead collector lines will also cross watercourses. All water body crossings will be reviewed in consultation with the Cataraqui Region Conservation Authority (CRCA), prior to construction and any requisite permits would be obtained.

2.6 Environmental Noise and Odour Emissions

During operation of the Project, sound would be generated by the periodic use of maintenance equipment to repair the PV modules over the life of the Project. Personnel vehicles and waste management haulers would also travel to and from the substation property during normal working hours in accordance with the City of Kingston’s noise By-Law No. 2004-52, and Loyalist Township's noise By-Law No. 2011-6. The audible sound at receptors and substation property is expected to be a minor, short-term in disruption.

A *Noise Study Report* has been prepared for the Project components (substation and inverter stations) in accordance with the MOE's document entitled *"Basic Comprehensive Certificates of Approval (Air) – User Guide* (MOE 2011)", requirements as set out in NPC-232, NPC-233, NPC-205, and O.Reg. 359/09. The *Noise Study Report* is provided in **Appendix D**.

Based upon the Project design, the analysis carried out in the *Noise Study Report* indicates that with the proposed mitigation measures, sound produced by the Project was found to be within the acceptable limits established by the MOE at all noise receptors.

There will be no sources of odour emissions from the Project. Therefore, no mitigation measures are required.

3.0 FACILITY DESIGN PLAN

This section provides a description of the key facility design components. Preliminary Engineering Drawings are included in **Appendix A**. These drawings include:

- General arrangement of solar panels;
- Operation and maintenance building layout;
- Sub-station layout;
- Solar panel foundation design layout;
- 34.5 kV collector line pole design;
- Solar module/panel specification (example only; subject to change); and
- Inverter station specification (example only).

A general description of each Project component is provided in the *Project Description Report*.

During siting of the Project the key mitigation strategy used to address potential environmental effects from operation of the facility was the avoidance of significant natural features and water bodies to the extent possible. Where avoidance is not possible, and Project components are located within minimum setbacks, mitigation measures and recommendations for further monitoring are proposed (Chapter 5 and Table 5-1).

The following sub-sections provide description of various facility components including civil components, electrical components, distribution line, as well as stormwater management and sewage disposal systems.

3.1 Civil Components

3.1.1 Security Fencing

The Project sites will be fenced and gated with additional security measures installed by the Proponent as required. The security fencing will consist of 1.8 m high chain link fence with barbed wire around the perimeter of all sites. Manual lockable swing gates will be provided at all access entrance locations from the municipal roadways.

3.1.2 Access Roads

Access roads are required at each of the solar facilities from existing municipal roads to complete maintenance activities. An approximately 6 m wide and 23 km long gravel access road would be included to provide operations and maintenance access from the municipal road infrastructure. The proposed access roads will have ditches, swales and culverts where necessary to facilitate proper stormwater runoff and site drainage and to minimize road and soil erosion.

3.1.3 Water Crossings

The Figures included within this report identify locations where the proposed access roads cross defined water courses and typical details of a road crossing. Culverts would be required for each of these water crossings. The culverts would be sized to meet flow conditions. Electrical and data cabling would either be installed in conduits below streams using directional drilling or would be installed overhead on utility poles. The *Water Assessment and Water Body Report* (**Appendix C**) provides the mitigation measures to be applied during construction and operation. Permits would be required from the CRCA for the water crossings.

3.1.4 Foundations and Structural Support

At the substation site concrete foundations will be required for the operations building, equipment pads and supports and the transformer containment pits. Excavations would be backfilled using construction fill and excavated materials. Following the major civil works, the site would be underlain by a grounding grid for connection of the electrical equipment and then backfilled with a surface layer of gravel to meet the site plan design.

Concrete pads would be poured for each of the inverter stations. In addition, concrete foundations would be poured for attachment of solar panel racking in locations of poor soil conditions. The concrete would be delivered by truck from a local supplier.

The PV modules will be fixed-mounted on racks to be assembled on site and anchored to the ground. The type of anchor would vary depending on the soil conditions within the site. (Refer to **Appendix A** for preliminary design information of the foundation options and pictures of the racking system installation). The design will be in accordance with the Ontario Building Code incorporating local climatic data for the City of Kingston and Loyalist Township area.

3.2 Operation and Maintenance Building

The Operation and Maintenance Building would be the operational hub of the Project. This facility would provide reception area, operation manager office, technical staff office, meeting room, male/female washroom, lunch room, warehouse, and parking area for ten passenger vehicles and one utility truck. The facility would be operated, monitored and controlled from the Operation and Maintenance Building located on the property next to HONI corridor. The project would also be monitored 24 hours a day from a remote central solar operations and monitoring centre. The Operations and Maintenance building would also include secure areas for hazardous materials storage. (Refer to **Appendix A** for building layout plans).

3.3 Electrical Components

The Project is designed to generate 100 MW AC of electricity using approximately 426,000 solar PV panels, arranged in 1 MW blocks consisting of approximately 4,260 PV panels. Each 1 MW block will report to an inverter station. The main electrical components of the Project include the PV modules, inverters, step up transformer, substation, switchyard, and the equipment control

and monitoring system. The following sections provide more detailed information for each component.

3.3.1 PV Modules /Panels

The Project will utilize approximately 426,000 PV panels in total, each with nameplate capacity of 0.27 kW, arranged in predominantly 1 MW blocks consisting of approximately 4,260 PV panels. Canadian Solar (or equivalent) is the manufacturer of the PV modules. The PV panel model (or equivalent) would be MaxPower CS6X-270P. Manufacturer's information on the panels is included in **Appendix A**.

The PV modules will be connected in series forming a string. String length will satisfy requirements of Ontario Electrical Safety Code and shall be within the inverter operating voltage range. Each string will be connected to DC combiner boxes. The size of the combiner box is flexible and typically ranges from 8 to 24 string inputs per combiner box.

3.3.2 Inverter Stations

The inverter station will be a skid mounted 1 MVA enclosure consisting of two 500 kVA inverters, DC disconnects, control and supply panels and 1 MVA step up transformer housed separately.

The inverter is manufactured by SMA. The inverter model would be Sunny Central HE-500 CA, (or equivalent), with 1 MVA Skid Model of SC1000MVS-CA, (or equivalent). Manufacturer's information on the Inverter station is included in **Appendix A**.

3.3.3 Substation

The 230 kV/34.5 kV substation would be located on the property near the 230 kV Point of Common Coupling (PCC) beside HONI right of way. The substation would house one 245 kV motorized disconnect switch, 230 kV revenue metering equipment, one 245 kV circuit breaker, one 34.5 kV/240 kV step up transformer, 34.5 kV bus duct, 34.5 kV medium voltage switchgear, 34.5 kV capacitor banks, and protection and control equipment. At the substation/switchyard, the voltage is stepped up from 34.5 kV to 230 kV via main output transformers. The substation will be connected to a 230 kV transmission line in close vicinity of the Project via overhead conductors. The substation site would be largely covered with gravel and underlain by a grounding grid. The substation site would be surrounded by a chain-link fence equipped with a locked vehicle gate to allow for maintenance access for security.

Of particular interest in regards to the development of the stormwater management plan for the substation is the proposed transformer containment pit system to prevent accidental spills of oil from leaving the site or contaminating. A general outline of this system is provided below:

- A "double containment system" will be implemented for transformers at the substation. In addition to the "first stage" of containment, namely the transformer enclosures

(conservator, tank, etc.), a “second stage” of containment will be in the form of a transformer containment pit system.

- The stormwater containment area that will serve the transformer will have a minimum volume equal to the volume of transformer oil and lubricants plus the volume equivalent to providing a minimum 24-hour duration, 25-year return storm capacity for the stormwater drainage area around the transformer under normal operating conditions.

- The containment facility will have a freeboard of 0.25 m terminating approximately 0.30 m above grade, and an impervious floor, stoned filled and walls of reinforced concrete with impervious plastic liners and sloped floors leading to an oil control device.

- Drainage from the transformer pit would be removed by either manually or automatically operating a sump pump to discharge the liquid. In either case, an oil sensor would be mounted on the pump to detect any oil/grease in the liquid. If oil/grease is detected, the liquid would be removed from site via a licensed waste hauler and the source of the leakage would be identified. If no oil/grease is detected in the liquid, discharge would be via the stormwater collection system.

3.3.4 Switchyard

The substation site would include a switchyard, which would interconnect with the provincial power grid for dispatch of the electricity. The switchyard portion of the site would be transferred to HONI for construction and operation of the switchyard. The switchyard would have its own security fencing and access gate.

3.3.4.1 Collector Lines and Communications System

The 34.5 kV collector lines will be installed overhead and/or underground depending on conditions. Where these are overhead they will be installed on utility poles (see **Appendix A** for typical arrangements of the overhead and underground installations). Communication system design between inverter blocks and main substation will be based on single mode/multi mode fibre optic cables that will follow the 34.5 kV collector system.

3.3.5 Water Supply

Water for use in toilets and the kitchen sink would be taken from an on-site well or 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.

3.3.6 Sewage Disposal

The operation and maintenance building would contain a female/male washroom and kitchen facilities. Sewage from the washroom and kitchen facilities would be directed to a septic holding tank, designed to meet the Ontario Building Code and local building standards. A level gauge

would be provided to monitor the need for emptying by a licensed septic tank hauler. High level alarms with audible and visual warning would be provided to prevent overfilling. A maintenance program would be designed based on the type of tank selected and would include regular monitoring and maintenance, as required. Septic tanks are typically constructed of fibreglass or concrete, and the tank selected for the Project would conform to local building code requirements and industry standards as required.

3.3.7 Stormwater Management

A *Stormwater Management (SWM) Plan* (see **Appendix B**) was developed for runoff control from the Project. The objective of the *SWM Plan* was to control stormwater runoff from the Project, specifically to ensure that surface water quality would meet discharge guidelines, and to manage surface water quantity (i.e., runoff peak flow rates) discharging from each of the Project sites.

The surface water quantity objective of the *SWM Plan* was to maintain minimal change in peak flows discharging from the Project site for post-development versus pre-development conditions, up to and including the 100 year return period design event. Hydrologic modelling was completed to estimate peak flows for these two conditions from the Project. The results from the two scenarios were compared to evaluate the impact of the development on stormwater drainage and the need for quantity control.

The *SWM Plan* was designed in compliance with the "*Stormwater Management Planning and Design Manual*" (MOE, 2003) and CRCA guidelines. The overall *SWM Plan* incorporates the following requirements:

- The quality control aspect of the *SWM Plan* was designed based on the Normal protection level of treatment; and

- The Ministry of Natural Resources (MNR) *Flood Plain Management in Ontario, Technical Guidelines* (MNR, 1988) indicate the Site is located within Regulatory Flood Zone 2. As such, the 100 year (Regulatory Storm) was used as the extreme design rainfall event for this Site.

The *SWM Plan* concluded that, based on the results of hydrologic modelling, the computed increases in peak flows from the Project (substation and solar sites) would be negligible and therefore 'quantity' control would unnecessary. Therefore, the focus of the *SWM Plan* was stormwater 'quality' control.

To achieve 'quality' control, grassed filter strips would be used to improve the quality of stormwater runoff by using biological and chemical processes in soils and vegetation to filter out constituents. The grassed filter strips improve the quality of stormwater runoff by using biological and chemical processes in soils and vegetation to filter out constituents. They function by slowing runoff velocities and filtering out sediment and other contaminants, and providing

some infiltration into underlying soils. Filter strips were originally used as an agricultural treatment practice, and have more recently evolved into an urban practice.

After construction, the site for areas under and within the panel arrays blocks will be seeded with ‘pasture’ grass varieties. These plantings will essentially act as grassed filter strips for the site. The proposed plantings over a 10 m flow length will provide effective stormwater runoff quality control given the minimal contributing impervious area.

As noted previously (Section 3.3.3), the substation would also have a “double containment system” for transformers at the site which will be an integral component of the ‘quality’ control component to mitigate the potential adverse effect of spills.

4.0 FACILITY OPERATIONS PLAN

4.1 General Description of Operations and Maintenance

Overall, few activities are associated with the operational phase of the Project. Five to 10 permanent on-site operators will be required for the daily operation of the facility.

The Project would have a Supervisory Control And Data Acquisition (SCADA) system designed to provide real time monitoring of PV modules' performance. Each inverter station represents a single or double connection point consisting of two 500 kW inverters tied to 1 MVA pad mounted transformer. The connection to the main SCADA switch would be via fibre optic cable link. Fibre connections from the inverter station would be made to the main SCADA switch. In addition, SCADA monitoring enclosure would house HMI PC, the historian PC, an alarm PLC and telecommunication equipment. The SCADA software would consist of primary software with GUI that replicates operating function of the facility, real time animations, calculations and control functions. Historian software would manage data storage and retrievals. Additional software would facilitate field communication and would allow for remote monitoring, support, notifications and site security surveillance.

Any damages or faults with the PV modules or the electrical systems would be identified through SCADA remotely and reported to staff so that repairs can be done by qualified professionals. The Proponent may retain a specialized Operations and Maintenance Contractor for specific maintenance tasks. Scheduled maintenance would be based on the operating hours or conditions of the equipment and the manufacturers' recommendations.

Prior to the start-up of the Project, an Operations and Maintenance Program would be developed. The program would be designed to ensure compliance with all regulatory requirements. The program would include policies and procedures to cover:

- Staff training;
- Environmental compliance;
- Communications and complaint response protocol;
- Maintenance - predictive/preventative, routine, unscheduled;
- Annual overhauls;
- Inspection of equipment and components;
- Schedule for maintenance and inspections; and
- Spare parts – inventory and procurement.

The Operators would be responsible for inspecting, maintaining and monitoring the facilities in accordance with the duties outlined in the Operations and Maintenance Program.

The integrity of the security systems (gates and fencing) would be inspected to prevent unauthorized access and ensure public safety at all Project sites.

The vegetation cover under the PV modules and around the switchyard would be monitored regularly and some form of vegetation control and tree trimming may be required a few times over the summer months.

It is anticipated that the rain and snow would generally be sufficient for cleaning the PV modules/panels; however, depending on the quantity and frequency of rain and snow at the Project sites, the modules may require periodic cleaning. If required, water trucks would bring water to the Project site to supply the water. No chemical cleaning would be used.

The transformers would be visually inspected and their status recorded on a monthly basis. Any leaks would be repaired and spills cleaned up immediately using spill response equipment that would be available on-site. Periodic maintenance on the collector lines and substation would be completed by specialized contractors.

Drainage systems would be maintained and monitored on a regular basis. The Project site would be visually inspected for any erosion or sedimentation issues and remediation would be implemented as necessary to mitigate any impacts.

4.2 Air and Noise Emissions

The Project would not be a source of air emissions other than the use of vehicles for operation and maintenance checks. Vehicles would also be a noise source. The following policies would be adopted to mitigate vehicle emissions and noise:

- Company and maintenance personnel would avoid idling of vehicles when not necessary for operations activities;

- Vehicles would be maintained in good working order with functioning mufflers and emission control systems to meet the standards of the original vehicle manufacturer; and,

- All vehicles would be fitted with catalytic converters as required to meet the emissions requirements of the MOE and/or Ministry of Transportation (MTO).

Project noise sources would include the inverter stations and the substation. These were modelled to confirm compliance with Provincial noise standards. The technical analysis of the modelling and results are provided in the *Noise Study Report* (**Appendix D**). To confirm the inverter stations and substation meet regulatory criteria, noise monitoring will be completed within three months of start-up.

Should there be complaints or other community issues, the Project would have a Communications and Complaint Response Protocol in effect to respond to complaints. This plan is further discussed in Section 6.3 of this report.

With the application of the mitigation measures outlined above, the Project would not have a significant effect on air quality or noise.

4.3 Waste Generation

The Project operation would not result in significant quantities of waste for disposal. Waste materials from maintenance activities such as batteries and a minor amount of domestic waste (i.e., garbage, recycling, and organics), would be generated during normal operations.

Waste materials would be temporarily stored at the operation and maintenance building and would be reused, recycled and/or disposed at an appropriate off-site facility. Litter generated during operations is expected to be minimal. There would be no on-site disposal of waste during the operation of the facility. If there were any minor quantities of hazardous waste, such waste would be stored in a secure area until removal by a certified contractor with the appropriate manifests in place.

During operations, the Proponent would implement a site-specific waste collection and disposal management plan, which may include good site practices such as:

- Systematic collection and separation of waste materials within on-site storage areas in weather-protected areas located at the operation and maintenance building;
- Operators and Contractors would be required to remove all waste materials from the solar facility areas during maintenance activities;
- All waste materials and recycling would be transported off-site by private waste material collection contractors licensed with a Certificate of Approval – Waste Management System;
- Labelling and proper storage of liquid wastes (e.g., oil and solvents from maintenance activities) in a secure area that would ensure containment of the material in the event of a spill. As per s.13 of the Environmental Protection Act, all spills that could potentially have an adverse environmental effect, are outside the normal course of events, or are in excess of the prescribed regulatory levels would be reported to the MOE's Spills Action Centre;
- As appropriate, spill kits (e.g., containing absorbent cloths and disposal containers) would be provided on-site during maintenance activities and at the operation and maintenance building;
- Dumping or burying wastes within the Project sites would be prohibited;
- Disposal of non-hazardous waste would be at a registered waste disposal site(s);

- For waste other than solid non-hazardous, a Generator Registration Number is required from the MOE and the generator would have an obligation to manifest waste when the waste is removed from site for disposal Compliance with Schedule 4 of Regulation 347 is mandatory when determining waste category; and

- Implementation of an on-going waste management program consisting of reduction, reuse, and recycling of materials.

With the application of the mitigation measures outlined above, no net effects from waste material disposal would occur on-site during operation.

4.4 Water Taking

The Project will not take water from ground or surface water sources for the generation of power. Water for toilets and kitchen facilities would be obtained from an on-site well or be trucked to site from a municipal supply using a local water hauler. This water would be stored in an above ground tank and replenished as necessary. Bottled water would be provided for drinking purposes.

The estimated usage of water would be minor. Based on ten staff the water usage would be less than 1,500 L/day and therefore no negative effects are predicted.

4.5 Sewage Management

The Project design would include a septic tank for holding sanitary wastes from the washrooms and kitchen in the Operations and Maintenance building. The septic tank would have a level monitoring system and include a high level alarm. A contract would be arranged with a licensed septic hauler for emptying the tank.

The sewage system would be designed and permitted in accordance with provincial codes and building standards. Flows would be less than 1,500 L/day. No significant negative effects on groundwater or surface water are predicted.

4.5.1 Stormwater Management

A *Stormwater Management (SWM) Plan* (**Appendix B**) was developed for runoff control from the substation property in accordance with the "*Stormwater Management Planning and Design Manual*" (MOE 2003) and Cataraqui Region Conservation Authority guidelines. A summary of the *SWM Plan* is provided in Section 3.3.7 above.

The potential for effects on watercourses exists from soil erosion resulting from unavoidable removal of stabilizing vegetative cover during maintenance activities. Erosion can cause downstream sediment transport and a short-term increase in surface water turbidity, including associated impacts to fish and fish habitat. Due to the Project Area's rural and agricultural land uses, the watercourses are not highly sensitive to temporary disturbances. However, the

magnitude and duration of potential effects to watercourses depend on the specific characteristics of each watercourse (e.g., flow regime, water velocity, bed substrates, bank conditions, local soils and the extent and duration of exposure).

Drainage systems including culverts would be maintained and monitored on a regular basis. The Project site would be visually inspected for any erosion or sedimentation issues and remediation would be implemented as necessary to mitigate any impacts. Proper maintenance would be required for maximum filter-strip effectiveness. The maintenance requirements for the grass filter strips within this development are based on information provided in MOE (2003). The following maintenance items are recommended:

- Inspect the filter strip frequently, especially after intense rainfall events and runoff events of long duration. Small breaks in the sod and small erosion channels quickly become large problems;

- Minimize the development of erosion channels within the filter. Even small channels may allow much of the runoff from the field to bypass the filter. These areas should be repaired and reseeded immediately to help ensure proper flow of runoff through the filter;

- Reseed or inter-seed bare areas of the filter. Since it may be difficult to re-establish vegetation in an established filter strip, the use of mulch or sod can help to reduce some problems;

- Mow and remove hay as required to maintain moderate vegetation height;

- Soil test periodically and apply soil amendments according to test results and recommendations;

- Control trees, brush, noxious weeds, and Canada thistle in the filter using either mechanical or other means. No hazardous chemicals would be used for vegetation control; and

- Inspect culverts at access road crossings for erosion or debris build-up and maintain as necessary.

Other mitigation measures to prevent adverse effects on stormwater are as follows:

- It is anticipated that the rain and snow would generally be sufficient for cleaning the PV modules; however, depending on the quantity and frequency of rain and snow at the Project Area, the modules may require periodic cleaning. As described earlier, if required, water trucks would bring water to the Project site to supply the water. No chemical cleaning would be used.

- The transformers would be visually inspected and their status recorded on a monthly basis. Any leaks would be repaired and spills cleaned up immediately using spill response equipment that would be available on-site. Periodic maintenance on the collector lines and substation would be completed by specialized contractors.

With the application of the mitigation measures outlined above, no adverse effect on stormwater runoff is anticipated.

5.0 ENVIRONMENTAL EFFECTS MONITORING PLAN

O.Reg. 359/09 requires that any adverse environmental effects that may result from operations activities be described within a 300 m radius of those activities (see Figure 1-2 for locations of Project components). An Environmental Effects Monitoring Plan (EEMP) outlines how potential negative environmental effects of the proposed project will be mitigated and ongoing monitoring will occur to meet the requirements set out in O.Reg. 359/09. Given the nature of solar power generation, few if any effects are expected during the operations period.

As per MOE's *Technical Guide to Renewable Energy Approvals – Chapter 6: Guidance for Preparing the Design and Operations Report* (MOE 2011, 2012), the environmental effects monitoring plan for the design and operations phase of the Project can be comprised of summary tables, text descriptions and references to other reports prepared for submission to the REA. More specifically, the following fulfillments are included in the EEMP:

1. A summary of all potential negative environmental effects caused by the Project as given in the description of negative environmental effects in the *Project Description Report*.

2. Performance objectives for each potential negative effect, such that, if the performance objective is achieved, the effect will be substantially mitigated.

3. A description of all mitigation strategies planned to achieve performance objectives.

4. If there is an ongoing risk of potential negative environmental effects, a description of how the Project will be monitored will be provided to ensure that mitigation strategies are meeting performance objectives.

5. Contingency measures will be provided should monitoring reveal that negative effects are continuing to occur.

Several Project reports have been prepared that document the potential negative environmental effects of the Project and the proposed mitigation and monitoring measures on how potential negative environmental effects will be mitigated. These reports forming part of the REA application are provided under separate covers and are as follows:

- *Project Description Report* – preliminary potential negative environmental effects for features within 300 m of the Project;

- *Construction Plan Report* – potential negative environmental effects resulting from construction activities;

- *Natural Heritage Assessment & Environmental Impact Study (NHA/EIS) Report* – potential negative effects to significant natural heritage features within 120 m of the Project during construction, operation and decommissioning phases;

- *Noise Study Report* – potential negative environmental effects caused by transformers and inverters during Project operations;

- *Stage 1 and 2 Archaeological Assessment* – potential negative environmental effects to archaeological resources resulting from construction activities;

- *Water Assessment and Water Body Report*– potential negative effects to water bodies within 120 m of the Project for construction, operation and decommissioning phases; and

- *Cultural Heritage Assessment Study Report* – potential negative effects on built heritage and cultural heritage landscape resulting from Project activities.

A summary of the potential negative environmental effects as a result of the Project development, during all phases of construction, operations and decommissioning and the proposed mitigation measures to be employed are provided in the *Project Description Report*.

To fulfill requirements 2 through 5 as indicated above, descriptions of the mitigation measures incorporated within the design and environmental effects monitoring plans are included in the Sections 3 and 4 of this report.

Table 5-1 identifies the effects monitoring program specific to the operations phase including:

- The potential negative effects that have an ongoing risk of occurrence throughout the operational period;

- The performance objectives and mitigation measures to address those effects;

- Monitoring protocols to confirm that performance objectives are being met; and,

- Contingency measures in the event that objectives are not being met.

Minor, indirect impacts such as emissions or leaks/spills from construction vehicles, dust, erosion, short term hydrological changes, and disturbance to habitat and wildlife are anticipated. Impacts and mitigation measures are described in Table 5-3 of the *NHA/EIS Report*. However, with the implementation of best management practices and periodic monitoring and inspection involving standard site control measures, the net residual effects of the operation of the proposed Project on wildlife and significant natural features will be low to none. Therefore, no net effects due to the operations phase are anticipated and, as such, no future monitoring plans are proposed. Identified effects will be more pronounced during the construction phase. The Construction Environmental Management Plan (CEMP) associated with the construction phase is described in the *Construction Plan Report*. In addition to the monitoring plan for the environmental effects listed in Table 5-1, the Proponent would also complete any additional

monitoring during operations as required by the Ministry of Natural Resources, the Ministry of Tourism, Culture and Sport and the Cataraqui Region Conservation Authority based on the comments received from those agencies during the review period.

Table 5-1: Environmental Effects Monitoring Plan – Operations Phase

Negative Effect	Mitigation Strategy	Performance Objective	Monitoring Plan				Contingency Measures
			Methodology	Monitoring Locations & Frequency	Rationale	Reporting Requirements	
Potential effects on wildlife	Best management practices and periodic monitoring and inspection of the facilities involving standard site control measures.	No long term environmental effects on wildlife or significant natural features.	Best management practices and periodic monitoring and inspection of the facilities involving standard site control measures.	Routine inspections of all Project sites at least twice per year. Monthly visual inspections of roads, culverts and fences.	To provide early detection of any negative effects on wildlife.	Results of the inspections to be summarized in an annual report and to be provided to the MNR for ongoing discussions.	To be determined through consultation with the MNR.
Potential changes in stormwater runoff quantity and quality from Project sites.	A *Stormwater Management (SWM) Plan* (**Appendix B**) was developed for runoff control from the substation property and areas under and within the panel array blocks. Substation transformers would be installed in a concrete containment pit, to retain oil in event of a transformer leak. Grassed filter strips would be used on down-slope ends of all Project sites to improve the quality of stormwater runoff.	To minimize changes in stormwater runoff to receiving drainage/water bodies.	The drainage systems will be maintained and monitored on a regular basis. The Project sites will be visually inspected for any erosion or sedimentation issues and remediation will be implemented as necessary to mitigate any impacts.	Monthly visual inspection of transformers and containment for leaks. Inspection of drainage pathways and grassed filter strips at each Project site twice per year. Inspect culverts for debris build-up and erosion at least twice per year	To provide early detection of oil leaks and potential for contamination of runoff. To repair grassed filter strips as necessary to maintain effectiveness. To repair bank erosion and prevent flooding due to debris blockages.	Operator to maintain log of the inspections and any resultant mitigation Results of the inspections to be summarized in an annual report. Results of the inspections to be summarized in an annual report.	Stormwater management measures will be examined as necessary to ensure that they are functioning as designed.
Potential soils, surface water and groundwater contamination	Protocol to minimize spills impact is provided in the Emergency Response and Communications Plan.	No long term environmental effects due to spills.	Accidental spills would be spatially limited and of short duration.	Routine inspections of all Project sites at least twice per year.	Spill control and prevention measures to be monitored to ensure they are	Frequency of inspections and actions taken reported in annual	Implement spill contingency measures as necessary.

Negative Effect	Mitigation Strategy	Performance Objective	Monitoring Plan				Contingency Measures
			Methodology	Monitoring Locations & Frequency	Rationale	Reporting Requirements	
	The transformer at the substation would be installed in a concrete pit, to provide secondary containment in the event of a transformer leak. Cleaning of the PV modules would use water only. (No chemical cleaning).	Prevention of oil spills to the environment. No effects to surface or groundwater.	No chemical use	Monthly visual inspection of transformers and containment for leaks. Cleaning of the PV modules on an as needed basis.	functioning as planned and protocols are being implemented as specified in plans to meet performance objectives. Prevention of adverse effects.	operational environmental monitoring report.	Measures will be reviewed following a spill to verify adequacy and amend as necessary.
Noise emissions at noise receptors	Noise assessment was completed for the facility to confirm compliance with Provincial noise criteria. Mitigation includes installation of noise barrier around transformer at substation.	To minimize noise emissions at nearby noise receptors in accordance with MOE guidelines and regulations.	Noise level monitoring as per requirements documented in the REA issued for the Project.	Noise monitoring within 3-months of start-up to confirm inverter stations and substation meet regulatory requirements, or as per the frequency documented in the REA issued for the Project.	Noise level monitoring will ensure that noise emissions from the Project meet performance objectives.	Reported in the first annual operational environmental monitoring report.	Additional noise mitigation will be installed as necessary if performance objectives are not met.
Potential risk to the facility as well as public safety, should unauthorized access occur.	Public access to the facility will be restricted through the use of fences, gates, “No Trespassing” signage and any other security measures as needed.	To eliminate risk to public and facility safety.	Project site security monitoring will be ongoing to ensure adequacy of security measures.	Throughout the Project sites and facility perimeter:	Project site security monitoring will identify any breech in facility security.	Operator to maintain log of the inspections and any resultant mitigation.	Additional security measures will be implemented as necessary if performance objectives are not met.

6.0 EMERGENCY RESPONSE AND COMMUNICATIONS PLAN

The following sets out a description of the actions to be taken during all Project phases to inform the public, Aboriginal communities, the municipalities, leaseholders and relevant Ministries of the Ontario Government regarding activities occurring at the Project site (including emergencies), means by which stakeholders can contact the Proponent and/or the Contractor, and means by which correspondence sent to the Proponent and/or the Contractor would be recorded and addressed.

As appropriate, the Proponent and/or the Contractor would review the Emergency Response and Communications Plan prior to and during each phase of the Project. Notification of any significant changes to the Emergency Response and Communications Plan would be provided to key stakeholders.

6.1 Communication Plan for Emergencies

The Proponent and/or the relevant Contractor would finalize a detailed Emergency Response and Communications Plan for each Project phase in collaboration with the Loyalist Township and the City of Kingston's Emergency Services Departments.

The Emergency Response and Communications Plan would include a plan for the proper handling of material spills and associated procedures to be undertaken at the event of a spill. The plan would also specify containment and clean-up materials and their storage locations as well as general procedures for personnel training. As appropriate, the plan may cover fire preparedness, evacuation procedures, and medical emergencies. Developing this plan with local emergency services personnel would allow the Proponent to determine the extent of emergency response resources and response actions of those involved.

The plan would include key contact information for emergency service providers, a description of the chain of communications and how information would be disseminated between the Proponent and/or the Contractor and the relevant responders. The plan would also indicate how the Proponent and/or the Contractor would contact (via phone or in-person) Project stakeholders who may be directly impacted by an emergency so that the appropriate actions can be taken to protect stakeholders health and safety.

The communication plan for emergencies would be developed in collaboration with local emergency responders, and would be prepared following consultations with the Municipalities' Emergency Services Departments, including the local fire department.

6.2 Communication Plan for Project Updates and Activities

The Proponent and/or the Contractor would engage with Project stakeholders (public, Aboriginal communities, and the municipalities) during all phases of the Project including providing updates on the Project website (http://samsungrenewableenergy.ca/kingston). As a long-term presence in the City of Kingston and Loyalist Township, the Proponent would continue to develop

contacts and to develop local relationships and channels of communication. Additional updates may be provided to stakeholders via letters/newsletters, newspaper notices, and/or direct contact.

The Proponent will continue its stakeholder engagement activities through the project operations phase. Planned stakeholder consultation and communication activities include:

- The appointment of an Operations Manager to receive project information and help address community concerns during all project stages;
- Project update newsletters will be mailed or hand delivered to keep project area residents apprised of the progress of construction including dates and timing of any traffic disruptions connected with the project and any other matters that may affect or be of interest to area residents and other project stakeholders;
- Newspaper notices regarding traffic disruptions and construction timings of interest;
- Personal consultations as requested or if warranted;
- Meetings with municipal and other local and Provincial government authorities;
- Ongoing communication with relevant responders such as the local fire department; and
- Meetings with Aboriginals or Aboriginal Groups as requested.

Broad community relations activities are also seen as essential to the implementation of a successful project. To date, the following activities will be undertaken:

- Conduct on-site tours with community leaders, local media and other interested parties during construction and periodically during operations;
- Keep the project website up to date with all activities and events;
- Erect signs as needed; and
- Establish a reporting mechanism for status reports with key regulatory stakeholders.

6.3 Communications and Complaint Response Protocol

The following has been developed for all Project phases to address any reasonable concern from the public and would be implemented by the Proponent and/or the Contractor.

A telephone number for contacting the Proponent and/or the Contractor along with the mailing/ e-mail address would be posted on the Project website:

http://samsungrenewableenergy.ca/kingston) and provided directly to the Loyalist Township, City of Kingston and the MOE. These would be the direct contact points for the Proponent and/or the Contractor during all phases of the Project. The Emergency Response and Communications Plan would include key contact information for emergency service providers, a description of the chain of communications and how information would be disseminated between the Proponent and/or the Contractor and the relevant responders. This information would be obtained during consultations with the municipalities' Emergency Services Departments.

The telephone number provided for the reporting of concerns and/or complaints would be equipped with a voice message system used to record the name, address, telephone number of the complainant, time and date of the complaint along with details of the complaint. All messages would be recorded in a Complaint Response Document to maintain a record of all complaints. The Proponent and/or the Contractor would endeavour to respond to messages within 48 hours. All reasonable efforts would be made to take appropriate action as a result of concerns as soon as practicable. The actions taken to remediate the cause of the complaint and the proposed actions to be taken to prevent reoccurrences of the same complaint in the future would also be recorded within the Complaint Response Document. If appropriate, the MOE Spills Action Centre would be contacted to notify them of the complaint. Correspondence would be shared with other stakeholders, such as the MOE, as required and/or as deemed appropriate.

Ongoing stakeholder communication would allow the Proponent and/or the Contractor to receive and respond to community issues on an ongoing basis.

6.4 Public Safety Plan

In addition to the Public Safety Plan that would be developed by the Construction Contractor for the protection of public safety during the construction and decommissioning phases, the Proponent and/or the Operation and Maintenance Contractor would prepare and implement a Public Safety Plan for operation of the Project. As previously noted and as appropriate, the Proponent and/or the Operation and Maintenance Contractor would develop or have an existing operations training program to ensure personnel receive appropriate training in relation to operation and maintenance programs, environmental, health and safety procedures, and an Emergency Response and Communications Plan. Proper training would ensure operational safety for Project personnel.

Operational safety to minimize potential risks to the public would include:

- Site access restrictions (with the exception of maintenance and emergency personnel);
- Security fencing at all facilities;
- Appropriate signage; and
- Development of an Emergency Response and Communications Plan.

Signage may include, but would not be limited to, signs associated with potential risks at the Project. Signs may be posted in the vicinity of buried cables, high voltage equipment, and warning of the presence of maintenance vehicles along the access roads.

Access restrictions would include “No Trespassing” signs within the substation site. In addition, fencing would be placed around the substation to restrict unauthorized access. Access roads would not have restricted access (e.g., gates), thus allowing emergency vehicles to access the substation property and all solar panel locations in the event of an emergency.

As previously noted, during pre-operational mobilization the Proponent and/or the Operation and Maintenance Contractor would finalize an Emergency Response and Communications Plan for the operational activities in collaboration with the municipalities’ Emergency Services Departments. The development of and proper execution of the Emergency Response and Communications Plan would help ensure public safety is maintained throughout the operation of the facility.

7.0 CONSIDERATIONS FOR PROJECTS SUBJECT TO SPECIFIC LAND USE PLANS

A search and analysis of the records and resources did not identify any portion of the Ontario Greenbelt, the Oak Ridges Moraine, the Niagara Escarpment or any local greenlands within the Project Location or the surrounding 125 meters. The results of the site investigation and consultation with the appropriate agencies and municipalities verified this determination.

8.0 CONCLUSION

The overall conclusion of this *Design and Operations Report* is that this Project can be operated without any significant adverse residual effects to the natural or social environment.

9.0 CLOSURE

AMEC has completed this report for the exclusive use of the Proponent for specific application to the Sol-luce Kingston Solar PV Energy Project. The work has been completed using generally accepted practices and with reference to *Technical Guide to Renewable Energy Approvals – Chapter 6: Guidance for Preparing the Design and Operations Report* (MOE, 2011).

Sincerely,
AMEC Environment & Infrastructure
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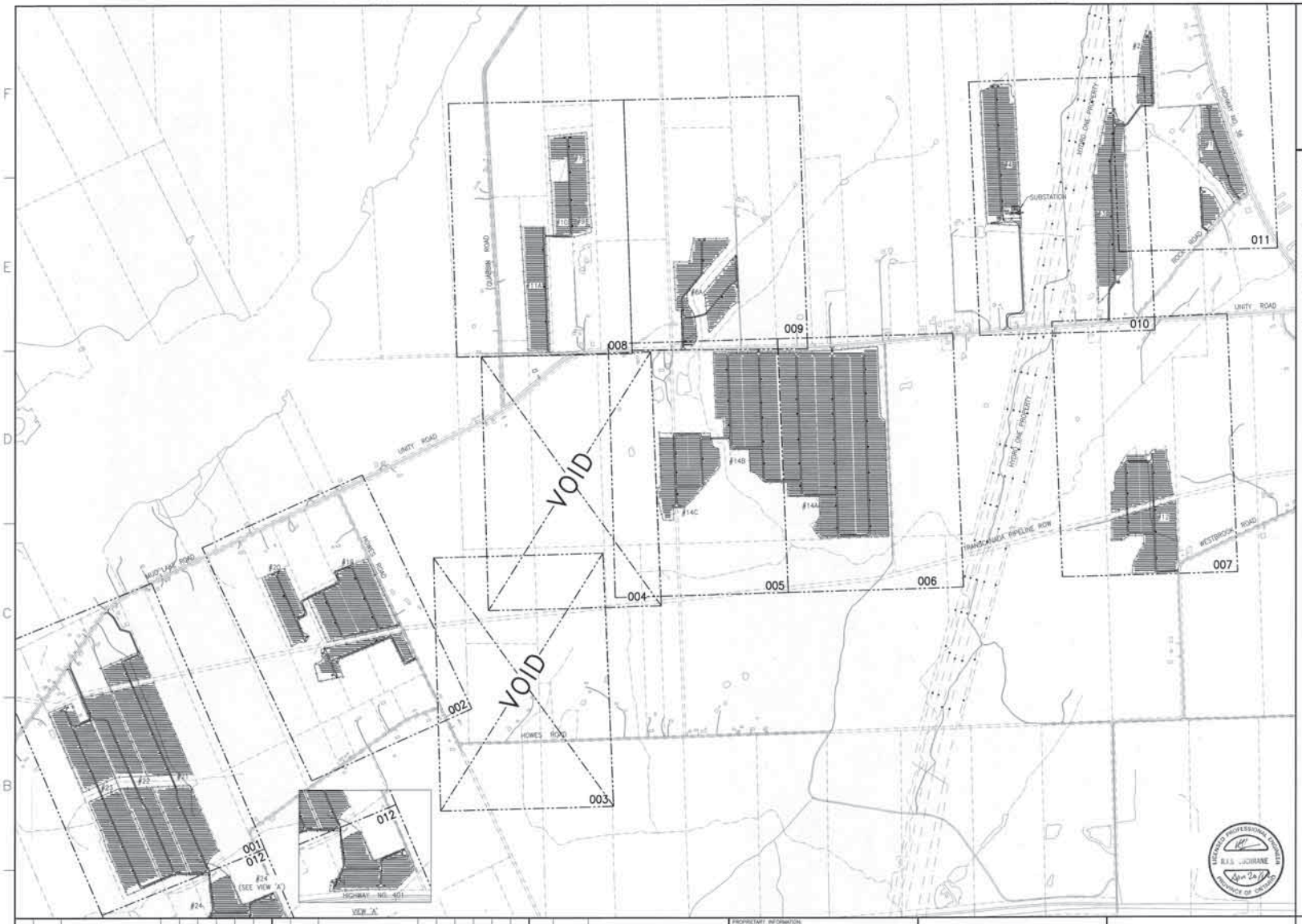
APPENDIX A

ENGINEERING INFORMATION

PRELIMINARY ENGINEERING DRAWINGS



NOTES

1. BASE FILE PROPERTY LIMITS ARE APPROXIMATE ONLY AND ARE BASED ON AVAILABLE MAPPING AND MUNICIPAL DRAWINGS.
2. DEVELOPMENT AREA BOUNDARIES ARE BASED ON PRELIMINARY CONSTRAINTS AND ARE SUBJECT TO FINALIZATION OF REA STUDY.
3. PANEL SETBACK FROM PROPERTY LINES ASSUMED AT 10M FOR ACCESS AND MAINTENANCE.
4. MAIN ACCESS ROAD LAYOUT IS BASED ON 9.1M LONG MAINTENANCE VEHICLE.
5. UTM ZONE 18 N CSRS PROJECTION
6. ALL DRAWING SHEET REFERENCES SHOWN REFER TO DRAWING NOS. 168335-0002-LYD-0001-001 TO 011.
7. ALL FENCE AND GATE LOCATIONS ARE CONCEPTUAL AND SUBJECT TO FINAL ROAD AND PANEL LAYOUTS.

PROPERTY	AC POWER CAPACITY (MW)
1	3
1/2	1
3	5.5
4	4.5
5	–
6A	3
6B	–
7/9/10	3.5
11A	2.5
11B	–
12	6.5
13	–
14A	21
14B	8
14C	4
15	–
16	–
17	–
18	–
19	5
20	1
19/20	1
21	9
22	5.5
23	6.5
24	3
TOTAL	93.5

PRELIMINARY

0m 100 200 300 400 500
1:10000

REV	DD/MMM/YY	REVISION / ISSUE DESCRIPTION	DRN	CHK	APP	APP	APP
A	23APR12	RE-ISSUED FOR USE	SZ	RC	SC		
3	16APR12	RE-ISSUED FOR USE	SZ	RC	SC		
2	15FEB12	RE-ISSUED FOR USE	SZ	RC	SC		
1	07FEB12	RE-ISSUED FOR USE	SZ	RC	SC		
0	15DEC11	ISSUED FOR USE	SZ	RC	MP	SC	
B	08DEC11	ISSUED FOR CLIENT REVIEW	SZ	RC		SC	
C	30NOV11	ISSUED FOR CLIENT REVIEW	SZ	RC		SC	
B	14OCT11	ISSUED FOR CLIENT REVIEW	SZ	RC	MP	SC	
A	14OCT11	ISSUED FOR SIGNED CHECK	SZ	RC	MP	SC	

PROPRIETARY INFORMATION:
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STAMP/SEAL

CONCEPTUAL DRAWING ONLY NOT TO BE USED FOR CONSTRUCTION

CLIENT PROJECT MGR.	DEPARTMENT MGR.	PROJECT MGR.
PROJECT PHASE: PRELIMINARY		
PROJECT NO.: 168335	ACTIVITY NO.:	
SCALE: 1:10000	PACKAGE CODE:	

	BY	DD/MMM/YY
DSN	RB/RC	14OCT11
DRN	SZ	14OCT11
CHK	MP	14OCT11
APP	SC	14OCT11

KINGSTON SOLAR LP

AREA:

SUBJECT: SOL-LUCE KINGSTON ENERGY PROJECT GENERAL ARRANGEMENTS

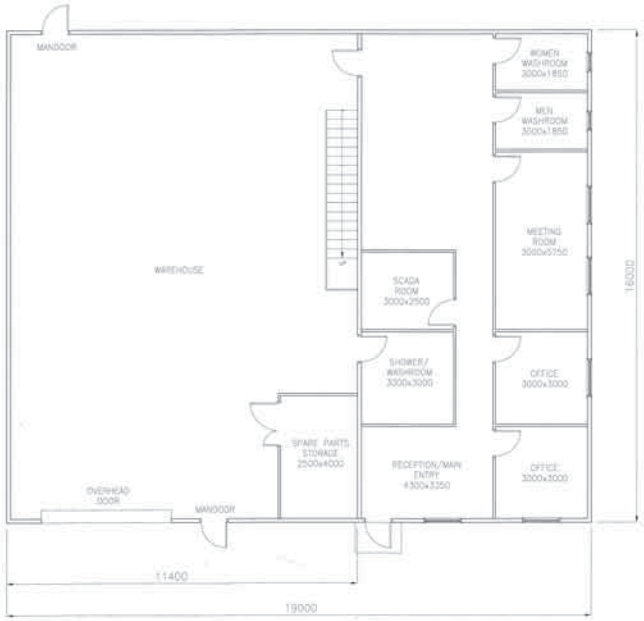
CLIENT DWG. NO.:

DRAWING NO.: 168335-0002-121-GAD-0001-001

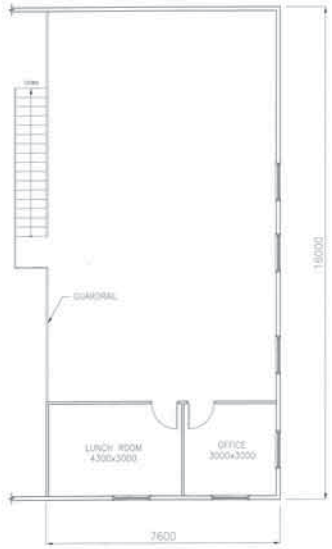
REV.: 4

amec

SAVED: 20-Apr-12 3:00 PM | PLOTTED: 20-Apr-12 3:00 PM | USER: SHANMUGAN, RAJAN



OPERATION & MAINTENANCE BUILDING
FLOOR PLAN
SCALE 1:75



OPERATION & MAINTENANCE BUILDING
MEZZANINE FLOOR PLAN
SCALE 1:75

NOTES

1. ALL DIMENSION ARE IN MILLIMETRE.
2. THIS PLAN IS ONLY CONCEPTUAL.
3. THE BUILDING CLEARANCE SHALL BE AT LEAST 6800 MM FOR THE WAREHOUSE AND 3000 MM FOR THE OFFICES.
4. THE WHOLE BUILDING SHALL BE INSULATED.

LEGEND

PRELIMINARY

REV	DD/MMM/YY	REVISION / ISSUE DESCRIPTION	DRN	CHK	APP	APP	APP
C	28OCT11	ISSUED FOR REVIEW	RS	SL	MP	SC	
B	13OCT11	ISSUED FOR CLIENT REVIEW	RS	SL	MP	SC	
A	11OCT11	ISSUED FOR SQUAD CHECK	RS	SL	MP	SC	

REF	NUMBER	TITLE
REFERENCES		

STAMP/SEAL

CONCEPTUAL DRAWING ONLY NOT TO BE USED FOR CONSTRUCTION

CLIENT PROJECT MGR. DEPARTMENT MGR. PROJECT MGR.

PROJECT PHASE: PRELIMINARY

PROJECT NO.	ACTIVITY NO.
168335	
SCALE: AS NOTED	PACKAGE CODE:

	BY	DD/MMM/YY
DSN	SL	11OCT11
DRN	RS	11AUG11
CHK	MP	12OCT11
APP	SC	12OCT11

SAMSUNG RENEWABLE ENERGY INC.

AREA:

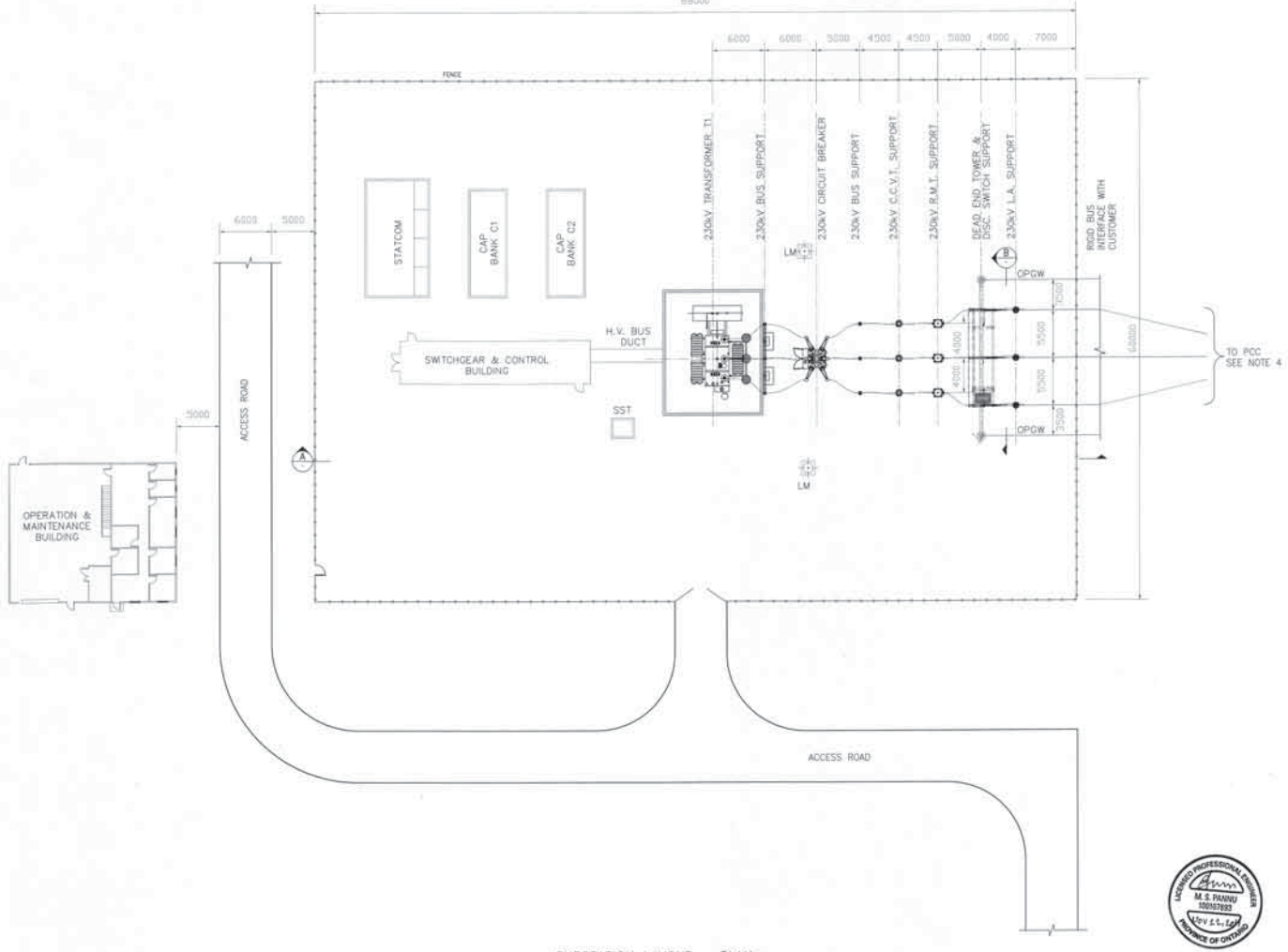
SUBJECT: SOL-LUCE KINGSTON ENERGY PROJECT
OPERATION & MAINTENANCE
BUILDING LAYOUT

CLIENT DWG. NO.:

DRAWING NO.: 168335-0000-141-LYD-0005-001

REV.: C

SAVED: 28-Oct-11 10:14 AM PLOTTED: 28-Oct-11 10:15 AM USER: SHAHBAZIAN, NAZANIN



SUBSTATION LAYOUT – PLAN
NTS

NOTES

1. SUBSTATION LOCATION IS DEPENDENT UPON LOCATION OF HYDRO ONE 230kV TAKEOFF.
2. SUBSTATION LOCATION ASSUMES A SIMPLE TAP FOR THE 230kV INTERCONNECTION TO TRANSMISSION LINE "X3H".
3. LOCATION AND CONFIGURATION OF SUBSTATION IS PRELIMINARY AND SUBJECT TO CHANGE DURING DETAILED DESIGN.
4. LINE DESIGN BETWEEN SUBSTATION DEAD END STRUCTURE AND PPC BY HYDRO ONE.
5. ALL DIMENSIONS ARE IN MILLIMETRE, UNLESS OTHERWISE SPECIFIED.
6. FOR SECTION VIEW SEE DWG # 168335-0002-141-CSD-0001-001.

LEGEND

- PERMANENT ROADS & PARKING
- NEW SUBSTATION FENCING

B	BUS SUPPORT
CB	CIRCUIT BREAKER
DE	DEAD END STRUCTURE
DS	DISCONNECT SWITCH
L	LOW LEVEL BUSWORK OR POLE
LM	LIGHTNING MAST
RM	REVENUE METERING CT/PT COMBO
CCVT	VOLTAGE TRANSFORMER
SA	SURGE ARRESTER
SST	STATION SERVICE TRANSFORMER
XFMR	TRANSFORMER
PCC	POINT OF COMMON COUPLING

THIS DRAWING SUPERSEDES DWG # 168335-0000-141-GAD-0001-001.

PRELIMINARY

M. S. PANNU 100167693 PROVINCE OF ONTARIO

REV	COMMITT	REVISION / ISSUE DESCRIPTION	DRN	CHK	APP	APP	APP	APP
0	21NOV11	ISSUED FOR USE	RS	IB	MP	SC		
A	10NOV11	ISSUED FOR MINOR REVISION	RS	IB	MP	SC		

REF | NUMBER | TITLE
REFERENCES

PROPRIETARY INFORMATION:
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STAMP/SEAL

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CLIENT PROJECT MGR. | DEPARTMENT MGR. | PROJECT MGR.

PROJECT PHASE: PRELIMINARY

PROJECT NO.	ACTIVITY NO.
168335	

SCALE: NTS | PACKAGE CODE:

	BY	DD/MMM/YY
DSN	IB	03OCT11
DRN	RS	04OCT11
CHK	MP	12OCT11
APP	SC	12OCT11

SAMSUNG RENEWABLE ENERGY INC.

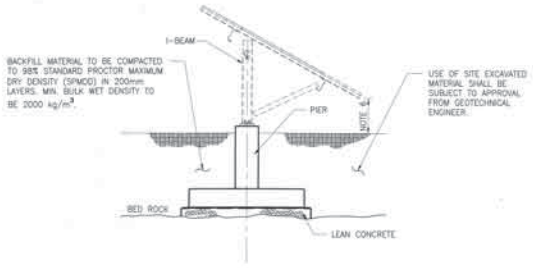
AREA

SUBJECT: SOL-LUCE KINGSTON ENERGY PROJECT SUBSTATION LAYOUT

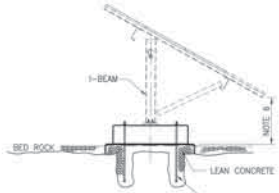
CLIENT DWG. NO.

DRAWING NO. 168335-0002-141-GAD-0001-001 | REV. 0

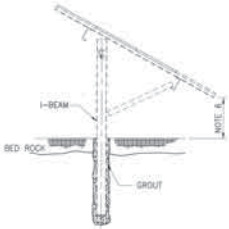
PLOTTED: 21-Nov-11 10:35 AM | USER: SHANMUGAN, RADHIK | SAVED: 21-Nov-11 9:54 AM



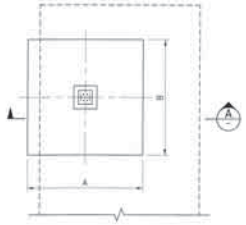
SECTION A
NTS



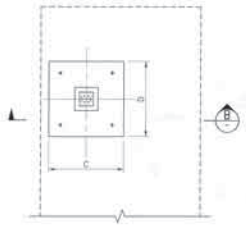
SECTION B
NTS



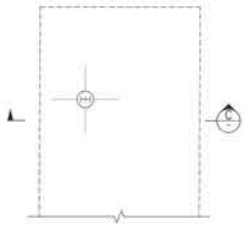
SECTION C
NTS



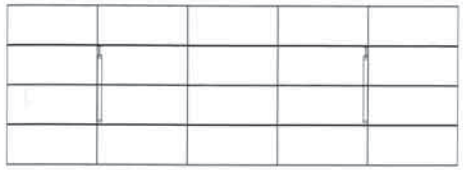
FOUNDATION OPTION 1 – PLAN
NTS



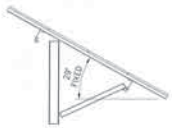
FOUNDATION OPTION 2 – PLAN
NTS



FOUNDATION OPTION 3 – PLAN
NTS



PLAN VIEW
NTS



SIDE VIEW
NTS

RACKING ARRANGEMENT

NOTES

1. ROCK SURFACE SHALL BE CLEANED UP AND LEVELLED WITH LEAN CONCRETE.
2. UNDISTURBED TILL OR ENGINEERED FILL CAN BOTH BE BEARING SOIL.
3. TOP SOIL SHALL BE REMOVED.
4. I-BEAM EMBEDMENT LENGTH TO BE DETERMINED IN DETAILED DESIGN.
5. THIS DRAWING IS FOR CONCEPT DESIGN ONLY. SINCE THERE IS NO WIND LOAD INFORMATION FROM SOLAR PANEL SUPPLIER.
6. MINIMUM DISTANCE FROM LOWER EDGE OF THE PV PANEL TO THE GROUND IS 600MM ± 5MM.

PRELIMINARY

REV	DD/MMM/YY	REVISION / ISSUE DESCRIPTION	DRN	CHK	APP	APP	APP
0	10NOV11	ISSUED FOR USE	RS	SL	MF	SC	
C	26OCT11	ISSUED FOR REVIEW	RS	SL	MF	SC	
B	25OCT11	ISSUED FOR SQUAD CHECK	RS	LH	MF	SC	
A	24OCT11	ISSUED FOR REVIEW	RS	LH	MF	SC	

REF	NUMBER	TITLE
REFERENCES		

STAMP / SEAL

CONCEPTUAL DRAWING ONLY NOT TO BE USED FOR CONSTRUCTION

LICENSED PROFESSIONAL ENGINEER Y. Z. LIU 100081047 PROVINCE OF ONTARIO
Foundation structural only

CLIENT PROJECT MGR.	DEPARTMENT MGR.	PROJECT MGR.
PROJECT PHASE: PRELIMINARY		

PROJECT NO.	ACTIVITY NO.
168335	
SCALE: NTS	PACKAGE CODE

	BY	DD/MMM/YY
DSN	SL	17OCT11
DRN	RS	18OCT11
CHK	LH	21OCT11
APP	SC	21OCT11

SAMSUNG RENEWABLE ENERGY INC.

AREA

SUBJECT: SOL-LUCE KINGSTON ENERGY PROJECT FOUNDATION – OPTIONS DESIGN LAYOUT

amec

CLIENT DWG. NO.

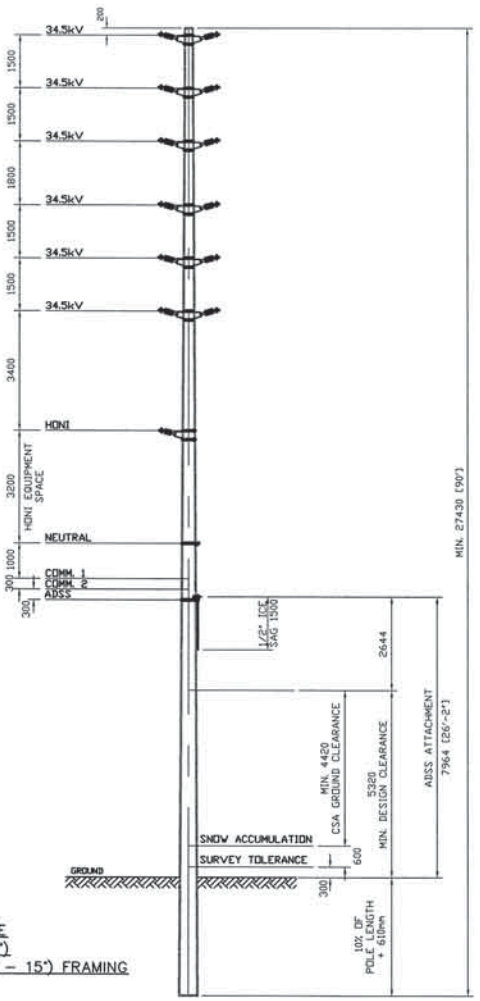
DRAWING NO.: 168335-0002-121-LYD-0201-001

REV.: 0

CAD NAME: \CIV\MF\168335-0002-121-LYD-0201-001.DWG

PLOTTED: 10-Nov-11 10:09 AM JOOB: SHANGHAI, PRC

SAVED: 10-Nov-11 10:08 AM



34.5kV COLLECTOR LINE
4CCT TANGENT (0 – 2°)
JOINT-USE WITH HONI EXISTING 1Ø (0 – 15°) FRAMING
W-Q35JS28-02-02

DESIGN NOTES:

THE PROPOSED STRUCTURE FRAMING, POLE REQUIREMENT AND RECOMMENDATION STANDARD SPAN ARE BASED ON THE FOLLOWING DESIGN DATA:

A. DESIGN CRITERIA

1. MEAN ANNUAL SNOW ACCUMULATION: 0.6 m
2. ADDITIONAL SURVEY TOLERANCE: 0.3 m
3. MINIMUM DESIGN LOADING
   CSA HEAVY CONDITION
   - HOURLY WIND 400 Pa
   - RADIAL ICE THICKNESS 12.7 mm (1/2")
   - CONDUCTOR TEMPERATION -20°C
4. WIND LOADING:
   - (i) HOURLY WIND (1/100) 520 Pa (~105 km/hr)
   - (ii) HOURLY WIND (1/50) 470 Pa (~100 km/hr)
   - (iii) HOURLY WIND (1/30) 430 Pa (~95 km/hr)
   - (iv) GUST WIND 160 km/hr
5. ICE LOADING:
   - RADIAL ICE THICKNESS (STRUCTURAL) 25.4 mm (1")
   - RADIAL ICE THICKNESS (CLEARANCE) 12.7 mm (1/2")

B. CLEARANCE CRITERIA

1. VERTICAL GROUND CLEARANCE
   - COMMUNICATION CABLE (ADSS) 5.12 m
   - 13.8 kV - 34.5 kV CONDUCTOR 5.45 m
2. JOINT USE CLEARANCE
   - 34.5 kV CONDUCTOR SAG + 1.8 m

CABLE SAG DATA:

A. 34.5 kV CONDUCTOR
795 MCM AAC (ARBUTUS)

CABLE CONDITION	STANDARD SPAN 50 m	55 m	60 m
100°C Conductor Temp.	1.54 m	1.73 m	1.92 m
1/2" Radial Ice	0.69 m	0.82 m	0.96 m
Design Temp. (75°C)	1.36 m	1.53 m	1.71 m

B. COMMUNICATION CABLE (ADSS)
AFL ADSS Mini-Span 535 (DNA-8557)

CABLE CONDITION	STANDARD SPAN 50 m	55 m	60 m
40°C Cable Temp.	0.46 m	0.55 m	0.56 m
1/2" Radial Ice	1.30 m	1.50 m	1.65 m

LICENSED PROFESSIONAL ENGINEER
M. S. PANNU
100107893
NOV 22, 2011
PROVINCE OF ONTARIO

NOT TO BE USED FOR CONSTRUCTION

REV	DDMMMYY	REVISION / ISSUE DESCRIPTION	DRN	CHK	APP	APP	APP	APP
0	21NOV11	ISSUED FOR USE	RS	IB	MP	SC		
B	31OCT11	ISSUED FOR REVIEW	RS	IB	MP	SC		
A	31OCT11	ISSUED FOR SQUAD CHECK	RS	IB	MP	SC		

REF	NUMBER	TITLE
1	1135-P2421	CHIMAX DRAWING

REFERENCES

CLIENT PM	DEPT MGR	PROJ MGR
PROJECT PHASE		
PROJECT NO. 168335	ACTIVITY NO.	
SCALE NTS	PACKAGE CODE	

	BY	DDMMMYY
DSN	I. BOZIC	26OCT11
DRN	R. SHAHBAZIAN	27OCT11
CHK	M. PANNU	31OCT11
APP	S. CREBER	31OCT11

SAMSUNG RENEWABLE ENERGY INC.

AREA

SUBJECT
SOL-LUCE KINGSTON ENERGY PROJECT
34.5kV COLLECTOR LINE
4CCT TANGENT (0 – 2°) TRIANGLE
JOINT-USE WITH HONI EXISTING 1Ø (0 – 15°) FRAMING
W-Q35JS28-02-02

amec

CLIENT DWG. NO.

DRAWING NO. 168335-0002-141-DTL-0017-001

REV. 0

SOLAR MODULE SPECIFICATION SHEET

CanadianSolar

Kingston Project
Model CS6X 270

MaxPower CS6X

260/265/270/275/280/285/290/295/300P

All-purpose Module

MaxPower CS6X is a robust solar module with 72 solar cells. These modules can be used for on-grid solar applications. Our meticulous design and production techniques ensure a high-yield, long-term performance for every module produced. Our rigorous quality control and in-house testing facilities guarantee Canadian Solar's modules meet the highest quality standards possible.

Key Features

- Industry largest silicon solar module, generating more Watt per panel and reducing BOS cost
- 6 years product warranty (materials and workmanship); 25 years module power output warranty
- Industry leading plus only power tolerance: +5W (+1.7%)
- Strong framed module, passing mechanical load test of 5400Pa to withstand heavier snow load
- The 1st manufacturer in the PV industry certified for ISO:TS16949 (The automotive quality management system) in module production since 2003
- ISO17025 qualified manufacturer owned testing lab, fully complying to IEC, TUV, UL testing standards

Applications

- Utility
- Commercial/industrial roof-tops
- Rural area applications
- Other on-grid and off-grid applications

Quality Certificates

- IEC 61215 / IEC 61730, UL 1703,CE
- ISO9001: 2008: Standards for quality management systems
- ISO/TS16949:2009: The automotive quality management system

Environment Certificates

- ISO14001:2004: Standards for Environmental management systems
- QC080000 HSPM: The Certification for Hazardous Substances Regulations

www.canadiansolar.com

CS6X-260/265/270/275/280/285/290/295/300P
MaxPower

Electrical Data

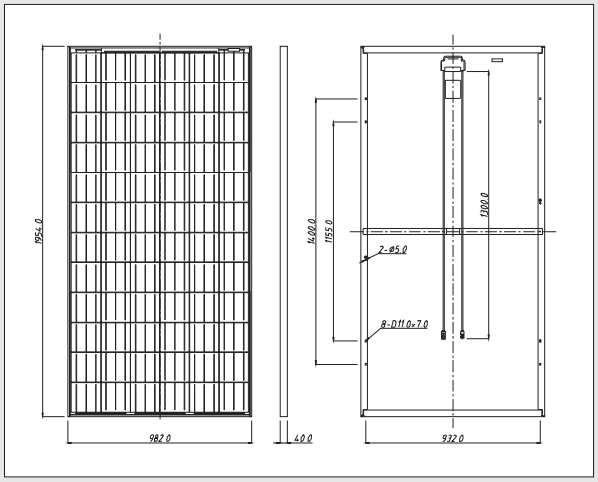
		CS6X-260P	CS6X-265P	CS6X-270P	CS6X-275P	CS6X-280P	CS6X-285P	CS6X-290P	CS6X-295P	CS6X-300P
Nominal Maximum Power at STC (Pmax)		260W	265W	270W	275W	280W	285W	290W	295W	300W
Optimum Operating Voltage (Vmp)		34.9V	35.1V	35.3V	35.5V	35.6V	35.8V	35.9V	36.0V	36.1V
Optimum Operating Current (Imp)		7.45A	7.55A	7.65A	7.76A	7.86A	7.96A	8.08A	8.19A	8.30A
Open Circuit Voltage (Voc)		43.8V	43.9V	44.1V	44.1V	44.2V	44.3V	44.4V	44.5V	44.6V
Short Circuit Current (Isc)		8.04A	8.10A	8.19A	8.31A	8.42A	8.53A	8.64A	8.76A	8.87A
Operating Temperature		-40℃~+85℃								
Maximum System Voltage		1000V (IEC) /600V (UL)								
Maximum Series Fuse Rating		15A								
Power Tolerance		+5W								
Temperature Coefficient	Pmax	-0.43%/℃								
	Voc	-0.34 %/℃								
	Isc	0.065 %/℃								
	NOCT	45℃								

Under Standard Test Conditions (STC) of irradiance of 1000W/m^2, spectrum AM 1.5 and cell temperature of 25℃

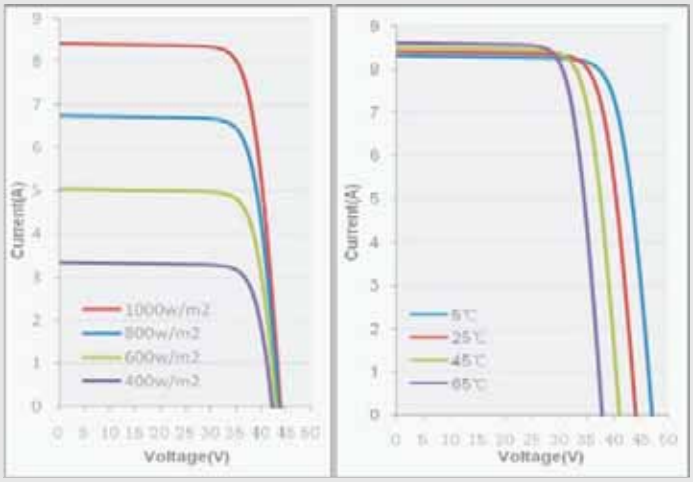
Mechanical Data

Cell Type	Poly-crystalline
Cell Arrangement	72 (6 x 12)
Dimensions	1954 x 982 x 40mm (76.93 x 38.7 x 1.57in)
Weight	27kg (59.52 lbs)
Front Cover	Tempered glass
Frame Material	Anodized aluminium alloy
Standard Packaging (Modules per Pallet)	20pcs

Engineering Drawings



I-V Curves (CS6X-280P)



*Specifications included in this datasheet are subject to change without prior notice.

About Canadian Solar

Canadian Solar Inc. is one of the world's largest solar companies. As a leading vertically-integrated manufacturer of ingots, wafers, cells, solar modules and solar systems. Canadian Solar delivers solar power products of uncompromising quality to worldwide customers. Canadian Solar's world class team of professionals works closely with our customers to provide them with solutions for all their solar needs.

Canadian Solar was founded in Canada in 2001 and was successfully listed on NASDAQ Exchange (symbol: CSIQ) in November 2006. Canadian Solar is on track to expand cell capacity to 700MW and module capacity to 1.3GW in 2010.

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Tel: +1-519-954-2057
Fax: +1-519-578-2097
inquire.ca@canadiansolar.com
www.canadiansolar.com

SUBSTATION TRANSFORMER SPECIFICATION SHEET

Data Sheet

Generator Step-Up Transformer

Item No.	Item Description	Specified	Proposed
1.0	**GENERAL**		
.A	Equipment Name	GSU Transformer	
.B	Equipment Tag No.	T1	
.C	Quantity	One (1)	
.D	Reference Drawing / Document	NA	
2.0	**SITE CONDITIONS**		
.A	Altitude	100 m	1250 m
.B	Ambient temperature	**-**40°C to +40°C	**-**50°C to +40°C
.C	Maximum 24 Hour Average Temperature	+26°C	+26°C
.D	Relative Humidity	5% to 95%	5% to 95%
.E	Wind loading	0.40 kPa	0.40 kPa
.F	Ice loading - radial thickness	12.5 mm	12.5 mm
.G	Type of Installation	Outdoor	Outdoor
3.0	**CODES & STANDARDS**		
3.1	**CSA Standards**		
.i	• Manufacturing	C-88	C-88
.ii	• Oil	C50	C50
.iii	• Bushings	C88.1	C88.1
.iv	• Instrument Transformers	C60044 Series	C60044 Series
.v	• Electromagnetic Noise	C108.3.1	C108.3.1
3.2	**IEEE Standards**		
.i	• Testing	C57.12.90	C57.12.90
.ii	• Bushings	C57.19.01	C57.19.01
.iii	• Instrument Transformers	C57.13	C57.13
.iv	• Load Tap Changers	C57.131	C57.131
.v	• Surge Arresters	C62.11	C62.11
4.0	**QUALITY ASSUARANCE**		
.A	ISO Registration	ISO 9001	ISO 9001

Item No.	Item Description	Specified	Proposed
5.0	**ELECTRICAL SYSTEM**		
5.1	**Primary**		
.A	Nominal Voltage	34.5 kV	
.B	Maximum Continuous Voltage	38 kV	
.C	Minimum Continuous Voltage	31.5 kV	
.D	Maximum 3 Phase - Fault from Primary side	40 kA	
.E	Maximum L-G Fault - Fault from Primary side	5 kA	
5.2	**Secondary**		
.A	Nominal Voltage	240 kV	
.B	Maximum Continuous Voltage	255 kV	
.C	Minimum Continuous Voltage	222 kV	
	Maximum 3 Phase Fault - Fault from Secondary side	50 kA	
.D	Maximum L-G Fault - Fault from Secondary side	50 kA	
6.0	**TRANSFORMER RATINGS**		
6.1	**General Ratings**		
.A	Type	Oil Filled	
.B	Rated MVA	66 / 88 / 110 MVA	
.C	Cooling	ONAN / ONAF / ONAF	
.D	Temperature Rise	65°C Average rise by winding resistance method	
.E	Primary Rated Voltage	34.5 kV	
.F	Secondary Rated Voltage	240 kV	
.G	Tertiary Rated Voltage	13.8 kV	
.H	Tertiary Rated MVA	22 MVA @ ONAN Rating	
.I	Number of Phases	Three (3)	
.J	Rated Frequency	60 Hz	
.K	Vector Group (Phase Displacement)	YNYn1d	

Item No.	Item Description	Specified	Proposed
.L	Positive Sequence Impedance between Primary & Secondary at base MVA, rated Voltage and 75°C.	7.0 %	
.M	Positive Sequence Impedance between Primary & Tertiary at base MVA, rated Voltage and 75°C.	Per Supplier Design	
.N	Positive Sequence Impedance between Secondary & Tertiary at base MVA, rated Voltage and 75°C.	Per Supplier Design	
.O	Audible Sound Level at 105% Voltage & Mid tap – with all fans operating.	82 db	
6.2	**Winding Impulse Withstand**		
.A	Basic Impulse Level		
.i	• 240 kV Line	950 kV	
.ii	• 240 kV Neutral	250 kV	
.iii	• 34.5 kV Line	250 kV	
.iv	• 34.5 kV Neutral	150 kV	
.v	• 13.8 kV Line	110 kV	
.vi	• 13.8 kV Neutral	NA	
.B	Dry 1 Minute Power Wave Withstand Voltage		
.i	• 240 kV Line	485 kV	
.ii	• 240 kV Neutral	120 kV	
.iii	• 34.5 kV Line	120 kV	
.iv	• 34.5 kV Neutral	70 kV	
.v	• 13.8 kV	50 kV	
.vi	• 13.8 kV Line	NA	
7.0	**CONSTRUCTION FEATURES**		
7.1	**Winding Construction**		
.A	Primary (34.5 kV)Winding Material	Copper	
.B	Primary (34.5 kV) Winding Connections	Wye, Impedance grounded	
.C	Secondary (240 kV) Winding Material	Copper	

Item No.	Item Description	Specified	Proposed
.D	Secondary (240 kV) Winding Connection	Wye, solidly grounded	
.E	Tertiary (13.8 kV) Winding Material	Copper	
.F	Tertiary (13.8kV) Winding Connection	Delta	
7.2	**Bushings**		
.A	240 kV Line Bushings		
.i	• Location	Outdoor, mounted on cover	
.ii	• Basic Impulse Level	1300 kV	
.iii	• Material	Porcelain	
.B	240 kV Neutral Bushings		
.i	• Location	Outdoor, mounted on cover	
.ii	• Basic Impulse Level	450 kV	
.iii	• Material	Porcelain	
.C	34.5 kV Line Bushings		
.i	• Location	Outdoor, mounted on side wall	
.ii	• Basic Impulse Level	250 kV	
.iii	• Material	Porcelain	
.D	34.5 kV Neutral Bushings		
.i	• Location	Outdoor, mounted on side wall	
.ii	• Basic Impulse Level	250 kV	
.iii	• Material	Porcelain	
.E	13.8 kV Bushings	Porcelain	
.i	• Location	Outdoor, mounted on cover	
.ii	• Basic Impulse Level	125 kV	
.iii	• Material	Porcelain	
7.3	**Tap Changer**		
.A	Type	Under Load	
.B	Location	HV Winding	
.C	Range & Steps	21(+8 / -12 X 0.625%)	

Item No.	Item Description	Specified	Proposed
.D	Capacity	Full MVA Rating on all taps	
7.4	**Insulation System**		
.A	Type	Oil - Class A, Type II per CSA C50	
.B	Liquid Preservation System	Conservator	
.C	Oil Separation system between air & oil	Air bladder	
7.5	**Radiator**		
.A	Type	Detachable, complete with individual shut off valves.	
.B	Accessories	Drain Valves, Vent plugs and lifting eyes for each detachable radiator.	
7.6	**Fan Motors**		
.A	Type	Totally enclosed, weatherproof with sealed ball bearings and galvanized guards.	
.B	Power source	240 V, 1 Phase	
7.7	**Current Transformers**		
.A	240 kV Line		
.i	• Quantity	Two sets of 3	
.ii	• Type	Bushing	
.iii	• Ratio	1200-5A MR	
.iv	• Accuracy	C800	
.B	240 kV Neutral		
.i	• Quantity	Two sets of 1	
.ii	• Type	Bushing	
.iii	• Ratio	1200-5A MR	
.iv	• Accuracy	C800	
.C	34.5 kV Line		
.i	• Quantity	Two sets of 3	
.ii	• Type	Bushing	
.iii	• Ratio	2000-5A MR	
.iv	• Accuracy	C800	

Item No.	Item Description	Specified	Proposed
.D	34.5 kV Neutral		
.i	• Quantity	Two sets of 1	
.ii	• Type	Bushing	
.iii	• Ratio	2000-5A MR	
.iv	• Accuracy	C800	
.E	13.8 kV Winding		
.i	• Quantity	Two sets of 1	
.ii	• Type	Bushing	
.iii	• Ratio	2000-5A MR	
.iv	• Accuracy	C800	
.v	•		
7.8	**Surge Arresters**		
.A	Surge arrester with tank mounting supports and brackets	Required on HV & LV Windings	
.B	Surge Arrester Discharge Counter	Required	
7.9	**Instrumentation**		
.A	Buchholz (Gas) Relay	Required	
.B	Sudden Pressure Relief Device	Required	
.C	Oil Level Gauge	Required	
.D	Top Oil Temperature Gauge	Required	
.E	Winding Oil Temperature Gauge	Required	
.F	Combined Electronic Top Oil and Winding Temperature Gauge	Required	
.G	On Line Oil Analyzer for Moisture & gas (H2, CO)	Required	
7.10	**Control Compartment**		
.A	Type	Weatherproof with anti interior condensation coating.	
.B	Auxiliary Power Source	1 Phase, 240 Volts, 60 Hz	
.C	Automatic control of fans	Required	
8.0	**TEST REQUIREMENTS**		
.A	Routine Tests	Required	Required
.B	Design and Other Tests	Not Required, except as indicated below:	Not Required, except as indicated below:

Item No.	Item Description	Specified	Proposed
.C	Oil test for Dissolved Gas Analysis at the following times. Before all Tests		
.i	• Before all tests	Required	
.ii	• Before ONAF Temperature Rise	Required	
.iii	• After ONAF Temperature Rise	Required	
.iv	• Before Impulse	Required	
.v	• After Impulse	Required	
.vi	• After all tests	Required	
.D	Excitation current and losses at 90%, 100%, and 110% of rated voltage on middle tap	Required	
.E	Excitation current and losses at 90%, 100%, and 110% of rated voltage on maximum and minimum taps	Required	
.F	Positive Sequence Impedance on all taps	Required	
.G	Zero Sequence Impedance on all taps	Required	
.H	Temperature Rise Test First ONAF rating and then at ONAN	Required	
.I	Impulse Routine Test for Class II Transformer	Required	
.J	Radio Influence Voltage	Required	
.K	Bushing Power Factor	Required	
.L	Insulation Resistance	Required	
.M	Insulation Power Factor	Required	
.N	Audible Sound Level at 100% Voltage & Mid tap – with and without all fans operating	Required	
.O	Audible Sound Level at 105% Voltage & Mid tap – with all fans operating.	Required	
.P	Current transformers		
.i	• secondary resistance test	Required for all ratios	
.ii	• Saturation	Required	

Item No.	Item Description	Specified	Proposed
.iii	• Polarity	Required	
.iv	• ratio test	Required for all ratios	
.v	• Excitation curve	Required (from X1 to all other taps)	
.Q	Certified Test Reports for all Tests	Required	
9.0	**SUPPLIER'S DATA**		
.A	Manufacturer	By Supplier	
.B	Manufacturing Country	By Supplier	
.C	Losses		
.i	• No Load Losses	Per Supplier Design	
.ii	• Load Losses	Per Supplier Design	
.iii	• Total Losses	Per Supplier Design	
.D	Efficiency		
.i	• At Base ONAN rating	Per Supplier Design	
.ii	• At ONAF Stage 1 Rating	Per Supplier Design	
.iii	• At ONAF Stage 2 Rating	Per Supplier Design	
.E	Maximum Audible Sound Level		
.i	• Audible Sound Level at 100% Voltage & Mid tap – with and without all fans operating	Per Supplier Design	
.ii	• Audible Sound Level at 105% Voltage & Mid tap – with all fans operating.	Per Supplier Design	
.F	Mass		
.i	• Tank Core and Windings	Per Supplier Design	
.ii	• Oil	Per Supplier Design	
.iii	• Total Weight	Per Supplier Design	
.G	Installed Dimensions		
.i	• Length	Per Supplier Design	
.ii	• Width	Per Supplier Design	
.iii	• Height	Per Supplier Design	
.H	Shipping Dimensions of Tank		
.i	• Length	Per Supplier Design	

Item No.	Item Description	Specified	Proposed
.ii	• Width	Per Supplier Design	
.iii	• Height	Per Supplier Design	

INVERTER STATION

3.3.3 Skid Basic with Enclosure

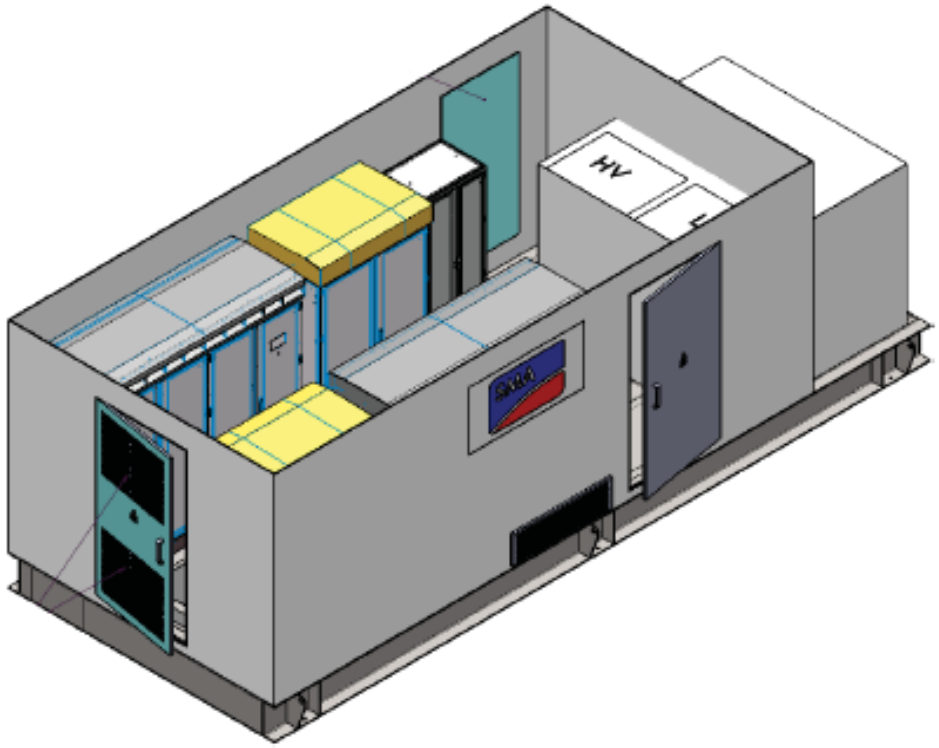
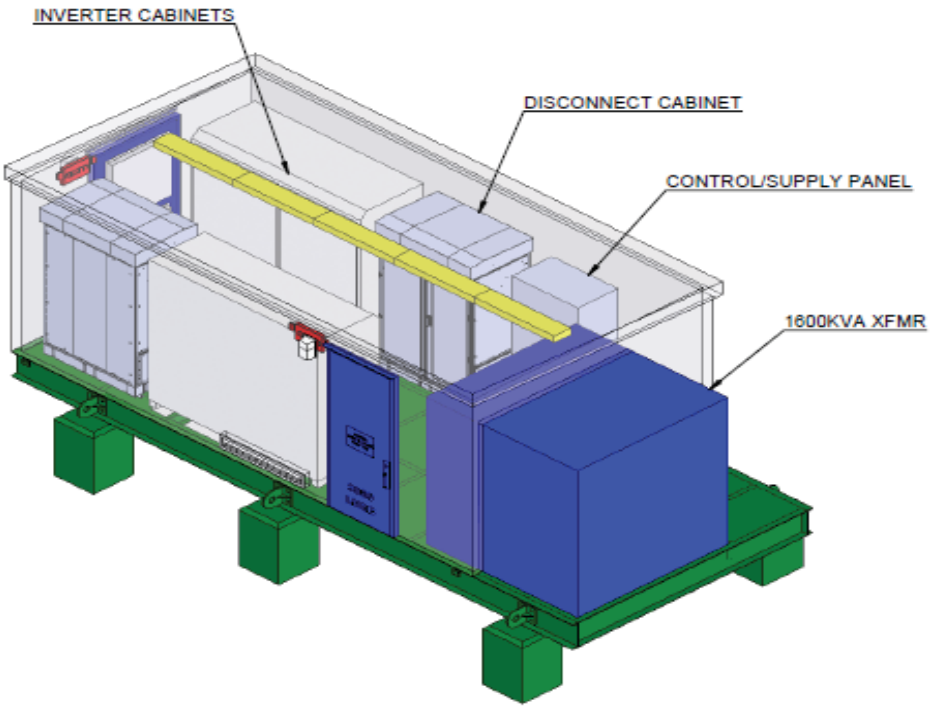


Figure 3: Skid with enclosure, inverters, disconnect units, transformer and Control& Supply panel

Mechanical Configuration of the SMA 1.0 MVA 600 VDC Medium Voltage Station



ISOMETRIC VIEW

3.4.1 Arrangement of the Components

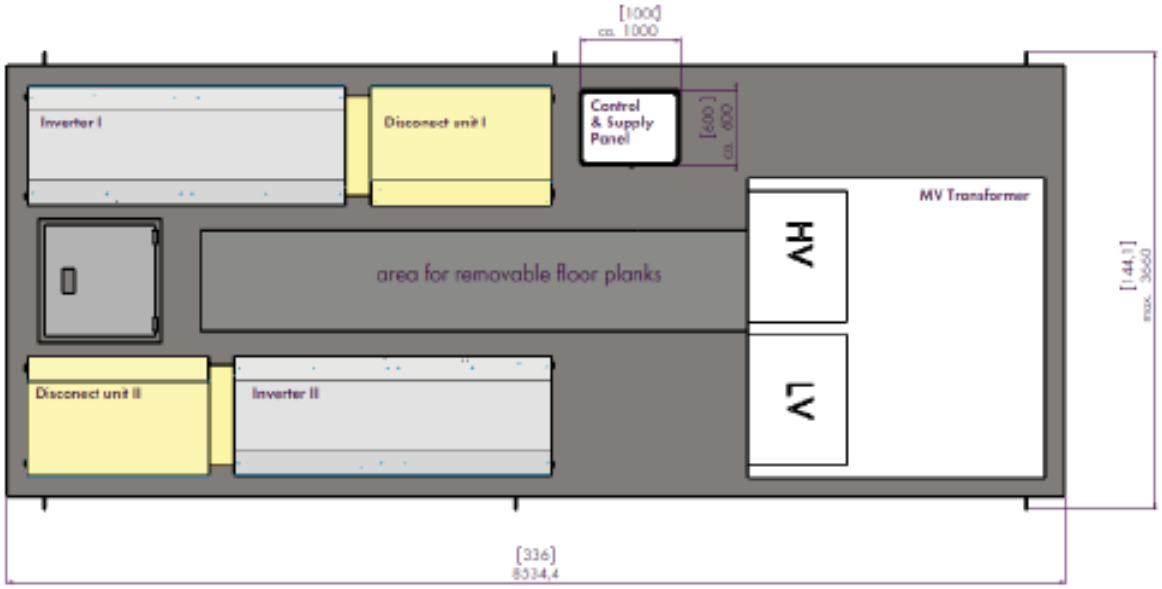


Figure 5: Footprint of the Skid with inverters, disconnect units, transformer and Control& Supply panel

3.4.2 Clearances

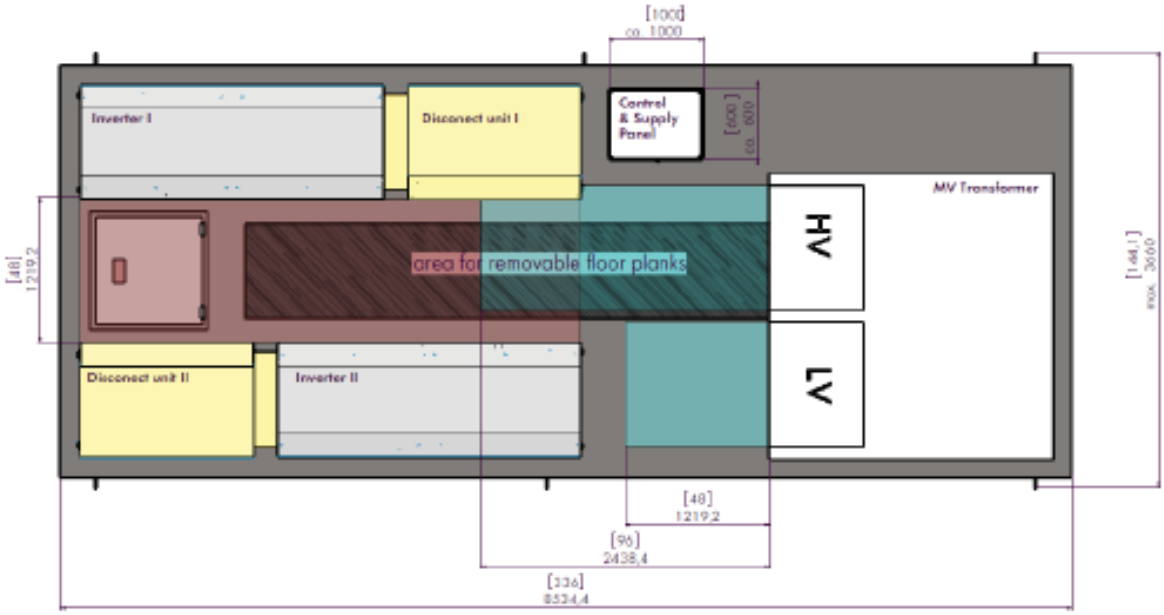


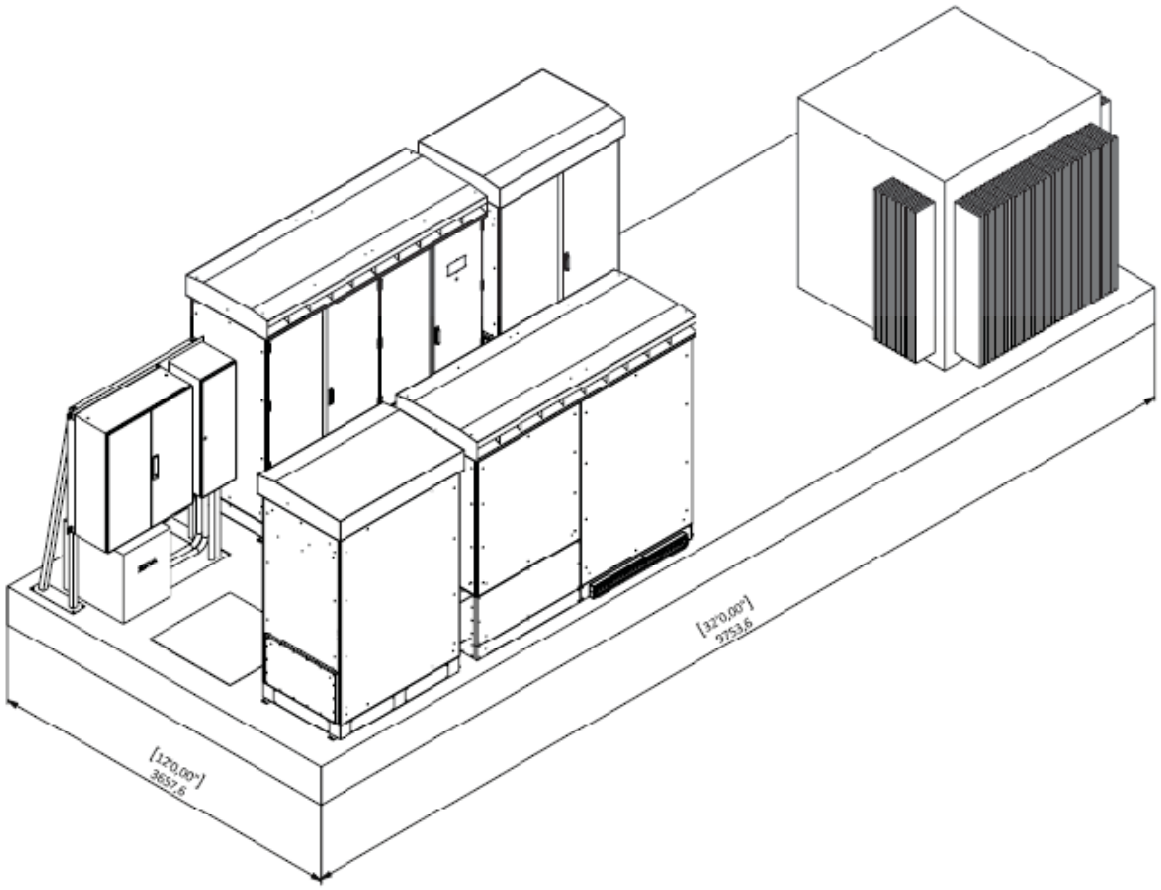
Figure 6: Footprint of the Skid with marked clearances between the mounted cabinets

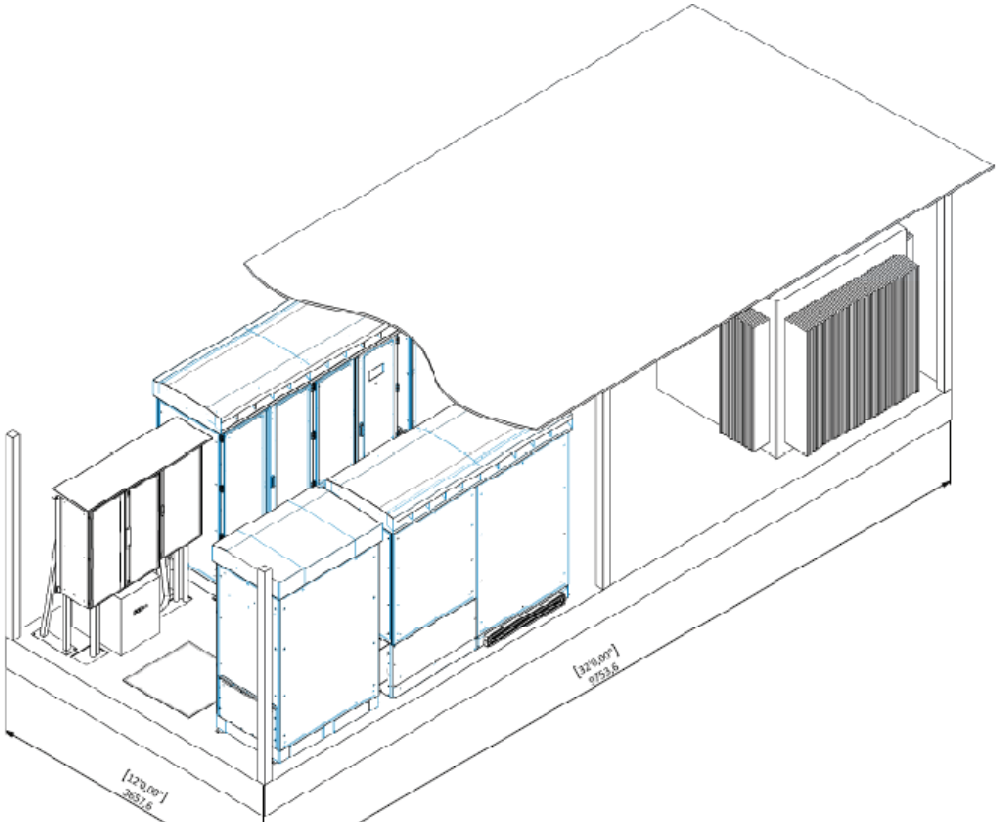
Technical Data 1 MW Skid Assembly_1.0

Skid - data		1 MW Skid Assembly 600 Vdc	1 MW Skid Assembly 1000 Vdc
Type designation		SKID1000HE	SKID1000CP
Input Data (DC)			
PV voltage range, MPPT	U_{DC}	330 V ... 480 V	430 V ... 820 V [a]
PV startup voltage	$U_{DC, Start}$	390 V	500 V
Max. DC voltage	$U_{DC, max}$	600 V	1000V / 1100 V [b]
Max. DC input current	$I_{DC, max}$	3200 A	2500 A
Number of fused DC inputs		18	18
Output Data (AC)			
Nominal AC power	$S_{AC, nom}$	1000 kVA @50°C	1000 kVA @50°C
Maximum AC power	$S_{AC, max}$	1000 kVA @50°C	1100 kVA @25°C
Nominal AC voltage options	$U_{AC\ nom}$	12.47 kV; 13.8 kV; 20.6 kV; 24.9 kV; 27.6 kV; 34.5 kV	12.47 kV; 13.8 kV; 20.6 kV; 24.9 kV; 27.6 kV; 34.5 kV
Total Harmonic Distortion of grid current	THD_{IAC}	< 3 % @ nominal power	< 3 % @ nominal power
Grid frequency	f_{AC}	60 Hz	50 Hz / 60 Hz
Power factor (adjustable)	cos φ	>0.99	0.90_{lead} - 0.90_{lag}
Power consumption			
Internal consumption in operation (inverter + transformer)	P_{leak}	< 3400 VA + < 12 kVA	< 3000 VA + < 12 kVA
Standby consumption (inverter + transformer)	$P_{Standby}$	< 220 VA + < 1500 VA	< 200 VA + < 1500VA
Supply via internal PV power /external power supply	U_{Aux}	Optional / Optional	Optional / Optional
External auxiliary supply voltage	U_{Aux}	208 V	208 V; 480 V
Efficiency			
Maximum Efficiency	η @ U_AC nenn	TBD	TBD
Euro-eta Efficiency	η @ U_AC nenn	TBD	TBD
CEC-eta Efficiency	η @ U_AC nenn	TBD	TBD
Skid assembly type			
Open Skid – long version including Disconnect Unit			
Width / Height / Depth [mm]	W/H/D	32' / 9'2" / 12'	32' / 9'2" / 12'
Weight	lb	<46,000	<46,000
Skid with canopy - long version including Disconnect Unit			
Width / Height / Depth [mm]	W/H/D	32' / 10'6" / 12'	32' / 10'6" / 12'
Weight	lb	<48,000	<48,000
Skid with enclosure- long version including Disconnect Unit			
Width / Height / Depth [mm]	W/H/D	32' / 10'6" / 12'	32' / 10'6" / 12'
Weight	lb	<49,000	<49,000
Protection rating and ambient conditions			

Protection rating		NEMA 3R	NEMA 3R
Operation temperature range @ nominal power	T	-20 °C ... +45 °C	-20 °C ... +50 °C
Relative humidity	%	15 % ... 95 %	15 % ... 95 %
Fresh air consumption	CFM	3531.6 CFM	3531.6 CFM
Max. altitude above sea level	m	2000	2000
Features			
Disconnect Unit		Optional	Optional
Costumer communication compartment		Optional	Optional
12.5 kVA power supply for tracker motors etc.		Optional	Optional
AC circuit breakers located in inverter / Disconnect Unit		Standard / Optional	Standard / Optional
Overvoltage-protection auxiliary power / tracker motors		Optional / Optional	Optional / Optional
On skid receptacles 120 V		Standard	Standard
Delivery on site		Optional	Optional

a) @ 1.05 U_{ACnom} and cos φ = 1
b) Standard: 1000 V DC, optional 1100 V DC with a start-up < 1000 V DC

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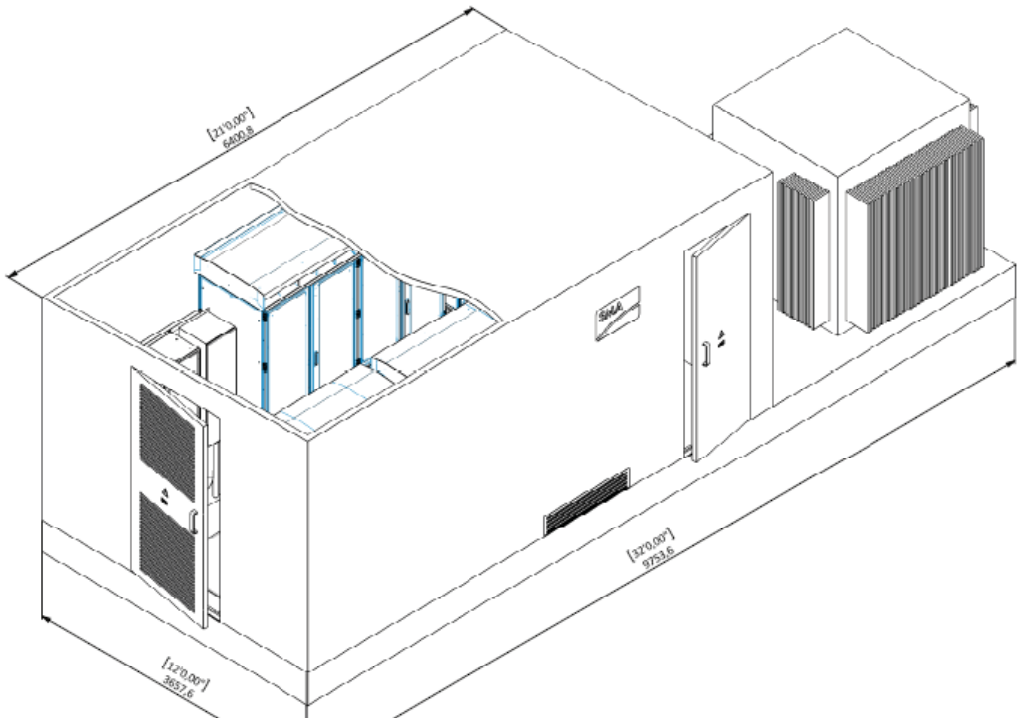
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Compliant

- Full compliance to safety standards of NEC 2008

Flexible

- Adaptable to all US inverters
- Switching handles inside or on front
- Extendable up to six switch-disconnectors
- Available with or without AC switch

Compact

- All load break switches in one enclosure
- Available as integrated complete skid assembly

Safe

- Easy access and fast handling
- Reliable separation even under full load

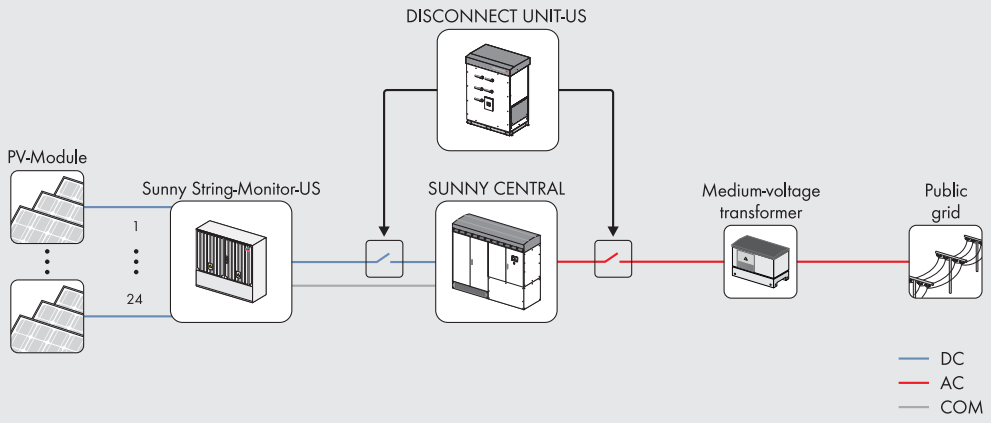
DISCONNECT UNIT

Full NEC conformity in a single enclosure

The new Disconnect Unit combines all safety measures into a single, compact enclosure. It is suited perfectly for North American Sunny Central inverters in 600 V to 1000 V systems. All load break switches are located on a single switchboard, working under full load conditions and ampacity reserves required by the NEC 2008. The switching handles can be installed either in the lockable cabinet or directly on the front. This guarantees a secure and fast separation of all energy from the inverter in case of emergency or maintenance.

Technical data	Disconnect Unit 600 V	Disconnect Unit 1000 V
Inverter type	SC250-US, SC500-US, SC500HE-US, SC500HE-CA	SCxxxCP-series
DC input data		
DC voltage range	0 ... 600 V	0 ... 1000 V / 1100 V [1]
Max. nominal DC current	1600 A	1600 A
Number of DC inputs	4 - 10	6 - 10
Max. short-circuit current / input	288.5 A	288.5 A
DC switch data		
Switch type	Load break switch	Load break switch
Max. short-circuit current / input	288 A	288 A
Max. short-circuit current	20 kA rms	20 kA rms
Number of DC switching handles	2 - 5	3 - 5
AC switch data		
Switch type	SC250-US, SC500-US: Load break switch SC500HE-US, SC500HE-CA: Circuit breaker	Circuit breaker
AC voltage range	128 ... 528 V	128 ... 528 V
AC switch current / Max. short-circuit current	400 A / 200 kA; 800 A / 100 kA; 1600 A / 42, 65, 85 kA	1600 A / 42, 65, 85 kA
Number of AC switching handles	1	1
Ambient conditions		
Operating temperature range	–25°C ... +50°C (–13 °F ... +122°F)	–25°C ... +50°C (–13 °F ... +122°F)
Storage temperature range	–40°C ... +60°C (–40°F ... 140°F)	–40°C ... +60°C (–40°F ... 140°F)
Protection rating	NEMA 3R	NEMA 3R
Installation indoors / outdoors	Yes / Yes	Yes / Yes
Relative humidity	15 % ... 95 % (condensation allowed)	15 % ... 95 % (condensation allowed)
Cooling system	Passive	Passive
Max. altitude in m (ft)	4000 (13000) Derating above 2000 (6500)	2000 (6500)
Dimensions and weight		
Height in mm (in)	2027 / 2277 (80 / 90)	2277 (90)
Width in mm (in)	1400 (55)	1400 (55)
Depth in mm (in)	956 (38)	956 (38)
Weight in kg (lb)	600 (1323)	600 (1323)
Certificates / listings		
Certificates	UL 1741	UL 1741 (pending)
Conformity	NEC 2008	NEC 2008
Features		
Chemical aggressive environment	Yes	Yes
Wire input side / bottom	Yes / Yes	Yes / Yes
Options		
Switch handles inside cabinet /on front	Optional / Optional	Optional / Optional
Connection via lug / screw terminal	Optional / Optional	Optional / Optional
Type designation	DU-SC-US	DU-SC-US

1) Startup at DC voltage < 1000 V



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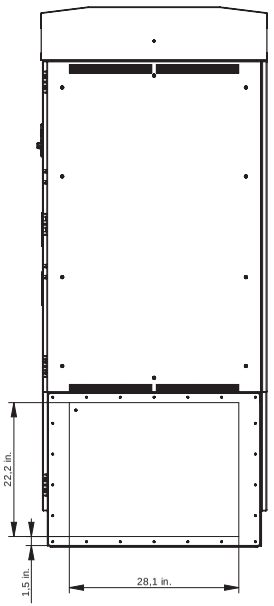
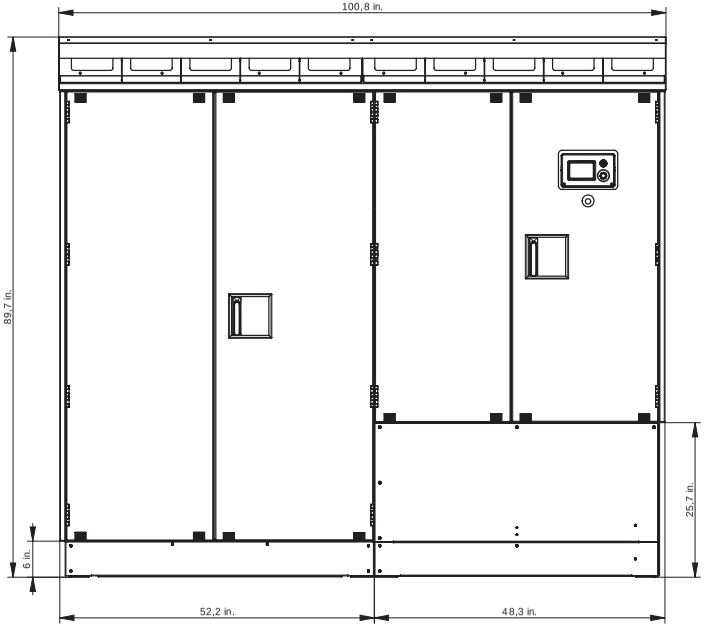
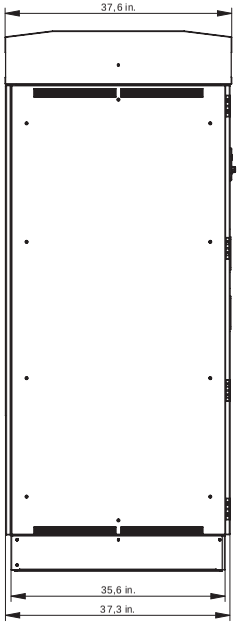
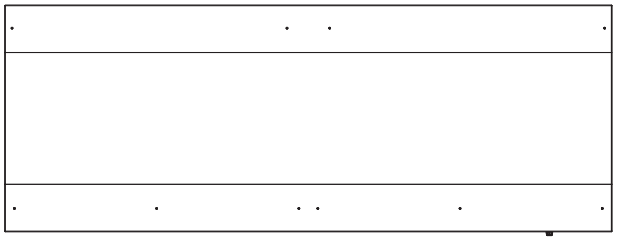
www.SMA-America.com

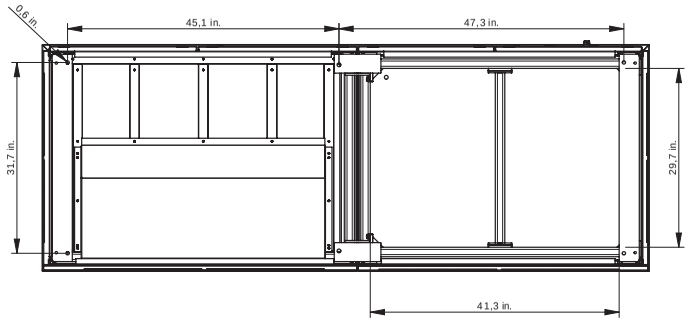
SMA America, LLC











RoHS-konform
nach Richtlinie 2002/95/EG

Verwendbar für:

Maße ohne Toleranzangabe: DIN ISO 2768-1 m, DIN ISO 2768-2 K
Oberfläche: DIN ISO 1302

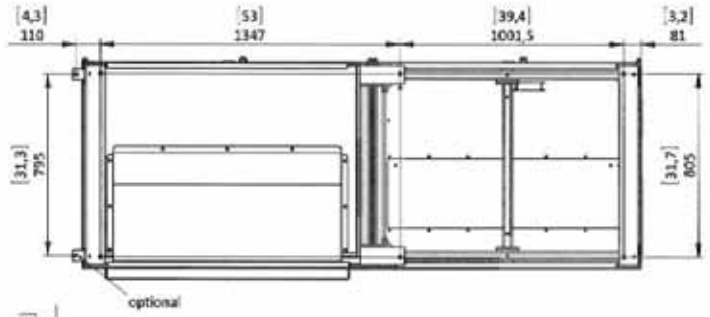
	Datum	Name
Bearb.	28.09.2009	Mihelic
Gepr.		
Norm		
Freigabe		

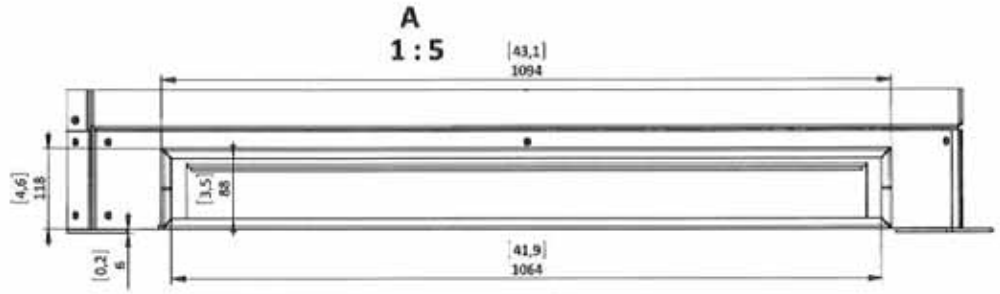
SMA Solar Technology AG
Sonnenallee 1
34266 Niestetal
Tel.: +49 561 9522-0

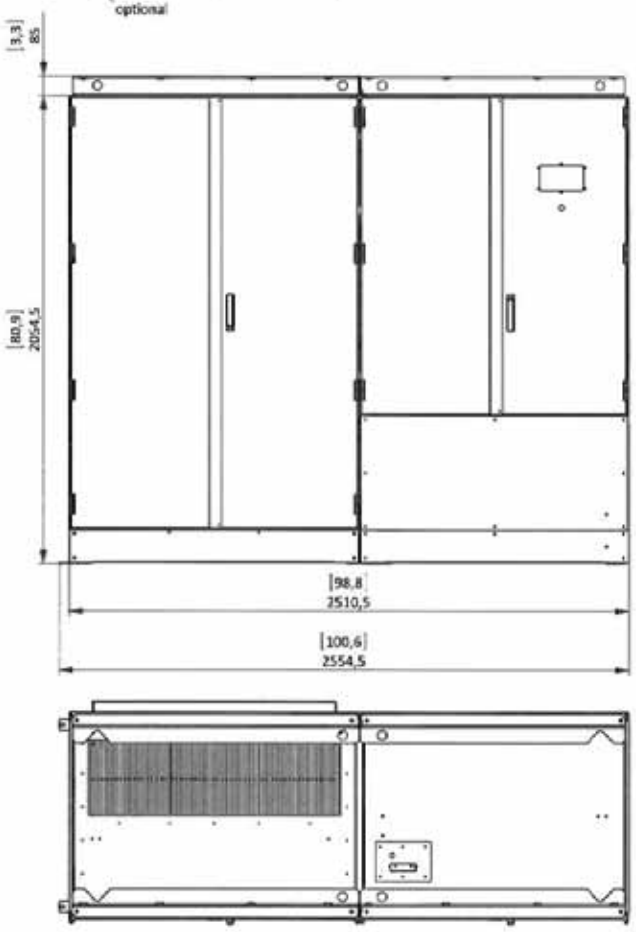
SMA SAP-Nr.:
Ausgabe
Datum
Maßstab: 1 : 15
Gewicht:
Material:

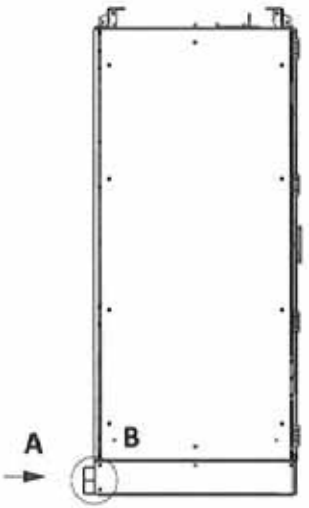
SC500HE-US
Stand : 2009.09.25

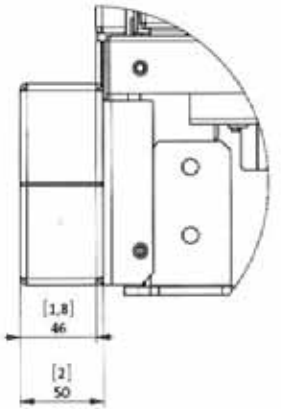
Z-Nr.: SC500HE-US
3D-Vkr.: p:\me\3D CAD Zeichnungen...
Ers. f.:
Ers. d.:
Ursp.:
Zust. | Änderung | Datum | Name | Gepr.
A2 | Blatt 1 | Bl. 1
Erstellt mit SolidWorks











RoHS-konform

SCxxxCP / SCxxxHE-US

V. 9.x / 2010.12.02

High Yields
- 98% CEC efficiency
- Suitable for ambient temperatures of up to 60 °C (140 °F)
- OptiCool™ intelligent temperature management

Low System Costs
- Outdoor-rated enclosure
- Couples to medium-voltage external transformer
- Available as integrated solution

Strong Peripherals
- Optional DC & AC disconnects
- Optional combiner boxes with string monitoring
- Sunny WebBox, Modbus® & OPC compatible

UL Certified
- UL 1741 / IEEE-1547 compliant

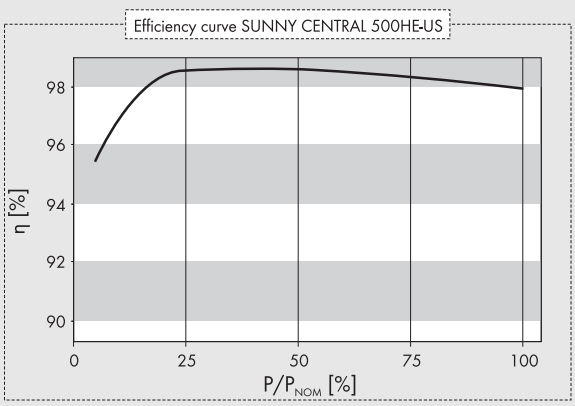
SUNNY CENTRAL 500HE-US

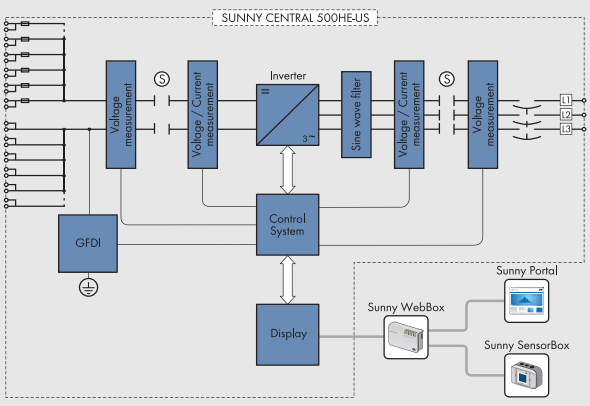
The ideal solution for large-scale North American solar power plants

The Sunny Central 500HE-US couples to an external medium-voltage transformer to accommodate long distance power feeds to distribution substations and delivers the highest efficiency available for large PV inverters. An updated user interface features a large LCD that provides a graphical view of the daily plant production as well as the status of the inverter and the utility grid. Flexible plant monitoring is available through various communications solutions such as Ethernet, Modbus, RS485 and OPC. Designed for easy installation, operation and performance monitoring, the UL-certified Sunny Central 500HE-US is the ideal choice for large-scale PV projects.

Technical data	Sunny Central 500HE-US
Input data	
Max. DC power	565 kWp [1]
MPP voltage range	330 V – 600 V
Max. DC voltage	600 V
Feed starting at [U] / [P]	380 V / 5000 W
Max. DC current	1600 A
Number of DC inputs	6 – 9
Output data	
Nominal AC power	500 kVA @ 45 °C (113 °F)
Max. AC current	1470 A @ 200 V
AC grid frequency	60 Hz
AC voltage range	180 V – 220 V
AC voltage range, full active power	196 V – 210 V
Power factor (cos φ)	> 0.99
Max. THD	< 5%
Efficiency [2]	
Max. efficiency	98.6%
CEC efficiency	98.0%
Euro-eta	97.9%
Ambient conditions	
Operating temperature range	–25 °C ... +60 °C (–13 °F ... +140 °F)
Max. temperature for nominal conditions	+45 °C (+113 °F)
Protection rating	NEMA 3R
Installation indoors / outdoors	●/●
Rel. humidity	15% ... 95%
Fresh air consumption	3000 m³/h
Internal consumption at nominal power	< 1600 W
Standby consumption (P_{night})	< 110 W
Dimensions and weight	
Height	2277 mm (90 in)
Width	2562 mm (101 in)
Depth	956 mm (38 in)
Weight	< 1800 kg (3970 lb)
Certificates / listings	
Certificates	UL 1741, UL 1998, IEEE 1547
EMC conformity	FCC, Part 15, Class A
Interfaces	
RS485 / Ethernet / analog	o/o/o
Display: text line / graphic	–/●
Communication protocols	Modbus / TCP
SSM-US connection	RS485
Plant monitoring	Sunny Portal
● Standard features o Optional features – Not available	
Type designation	SC 500HE-US

1) Specifications apply to irradiation values below STC
2) Measured without an internal power supply at U_{DC} = 330 V





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- 98% CEC efficiency
- Couples to medium voltage external transformer

- Graphical LCD interface
- Sunny WebBox, Modbus® & OPC compatible

- Optional combiner boxes with string monitoring
- Optional DC & AC disconnects
- UL 1741 / IEEE-1547 certified

SUNNY CENTRAL 500HE-US

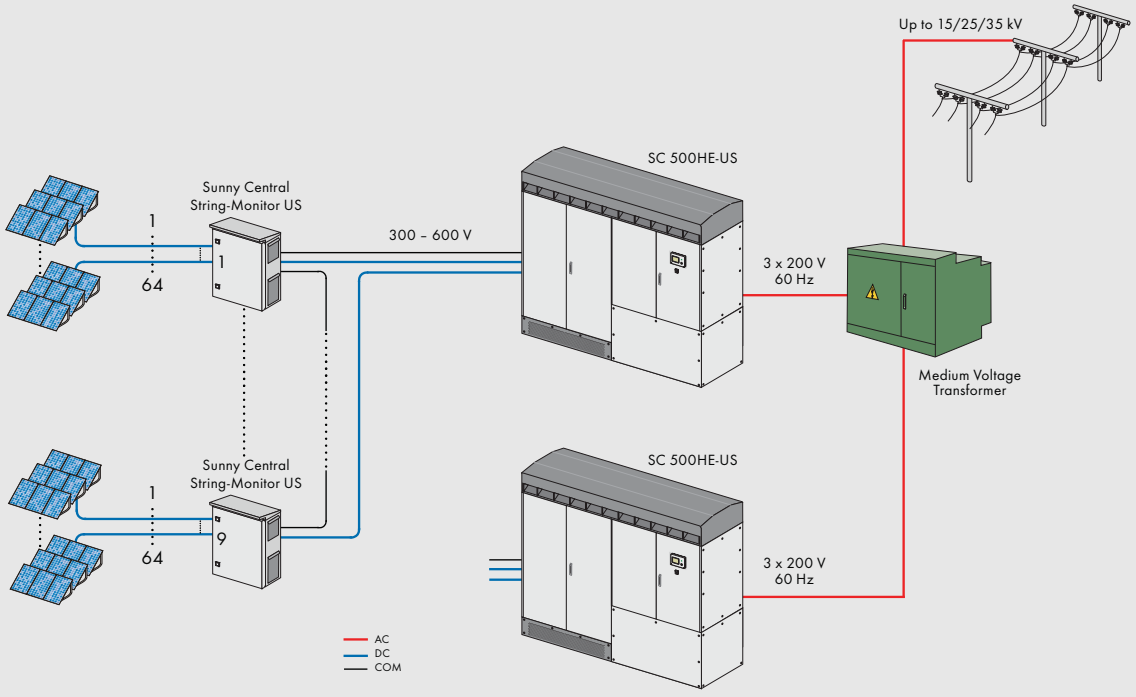
The ideal inverter for large scale PV power systems

The new Sunny Central 500HE-US couples to an external medium voltage transformer to accomodate long distance power feeds to distribution substations and delivers the highest efficiency available for large PV inverters. An updated user interface features a large LCD that provides a graphical view of the daily plant production as well as the status of the inverter and the utility grid. With the optional Sunny WebBox, users can now choose from either RS485 or Ethernet based communications. Designed for easy installation, operation and performance monitoring, the new SC 500HE-US is the ideal choice for your large scale PV project.

Technical Data

	Sunny Central 500HE-US
Inverter Technology	True sine wave, high frequency PWM
AC Power Output	500 kW
AC Voltage	200 V (range 180 – 220 V)
AC Frequency	60 Hz
Current THD	< 5%
Power Factor at Nominal Power	> 0.99
AC Output Current Limit	1470 A at 200 V
DC Input Voltage Range	300 – 600 V_{DC}
MPP Tracking	330 – 480 V_{DC}
PV Start Voltage (Configurable from 300 – 600 V_{DC})	300 V_{DC}
Maximum DC Current	1600 A_{DC}
Peak Efficiency	98.6%
CEC Weighted Efficiency	98.0%
Power Consumption	<110 W Standby, <1600 W with fans
Ambient Operating Temperature	–13 to 113 °F at full power output up to 122 °F at reduced power
Cooling	Variable-speed forced air (temperature controlled)
Enclosure	NEMA 3R
Dimensions: W x H x D in inches	98 x 90 x 35
Weight	3970 lbs
Certification	UL 1741, IEEE-1547
Type designation	SC 500HE-US

Sample System Diagram



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SMA America, LLC

Transformer Requirements

requirements of medium-voltage transformers for

SUNNY CENTRAL 500HE-US / SUNNY CENTRAL 500HE-CA

Contents

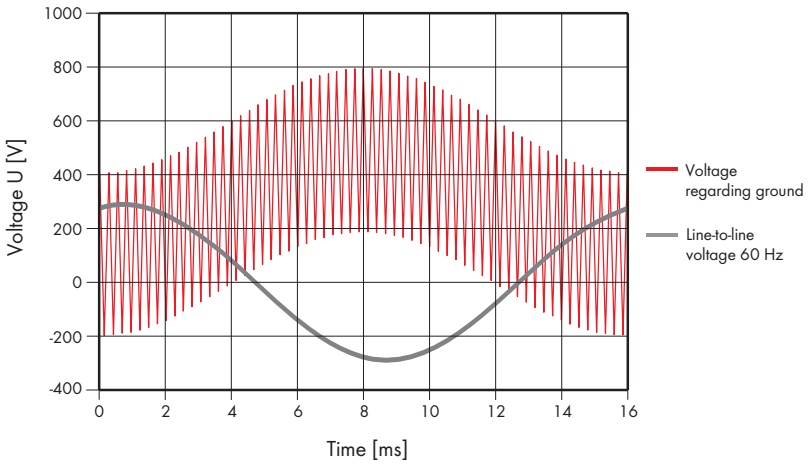
This document describes the requirements of medium-voltage transformers that are connected to Sunny Central 500HE-US or Sunny Central 500HE-CA.

SMA America, LLC only accepts the warranty for transformers that have been purchased from SMA America, LLC.

1 Technical properties

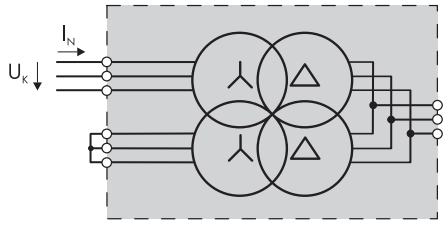
The transformer must comply with the following technical specifications:

1. The transformer must be suitable for operation with a pulsed inverter.
2. The transformer must be designed for the voltages that arise during pulsed operation of the inverter. The voltages can reach a magnitude of maximum ±800 V regarding ground. The rms-value of the voltages regarding ground is maximum 390 V (see following diagram).

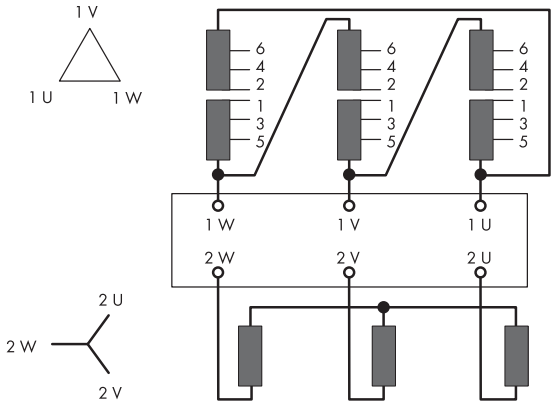


3. The transformer must be designed for voltages on its low-voltage windings that can exhibit a voltage gradient dU/dt of up to 500 V/µs regarding ground. The line to line voltages are sinusoidal.
4. A shield winding that is grounded to the tank is necessary between the low-voltage windings and the high-voltage windings. This serves as an additional dU/dt filter.
5. The transformer is provided with separate galvanically isolated low-voltage windings for every Sunny Central.
6. The impedance voltage Z (%) of the transformer has to be in relation to every inverter 5 % < Z (%) ≤ 6 %.

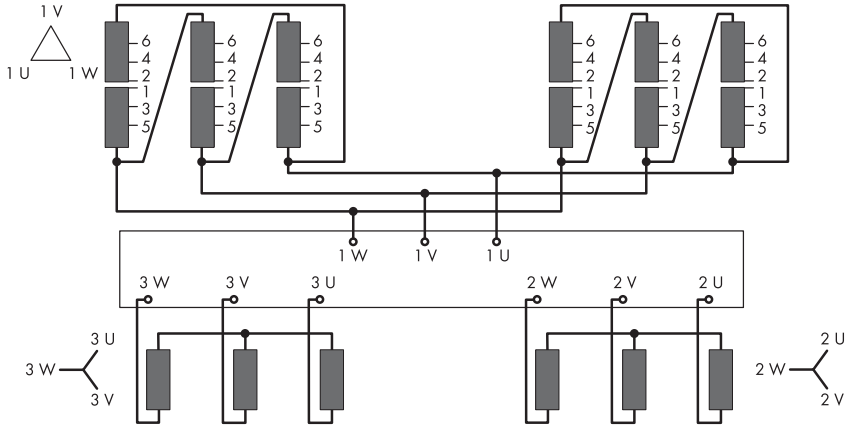
7. The impedance voltage Z (%) between both low-voltage windings has to be 10 %. The tolerance limits of this impedance voltage of between 9 % and 11 % must be maintained. This value can be measured when one of the low-voltage windings is short-circuited and the voltage on the other low-voltage winding is increased until the nominal current flows. At the same time the high-voltage windings are in idle (see following diagram).



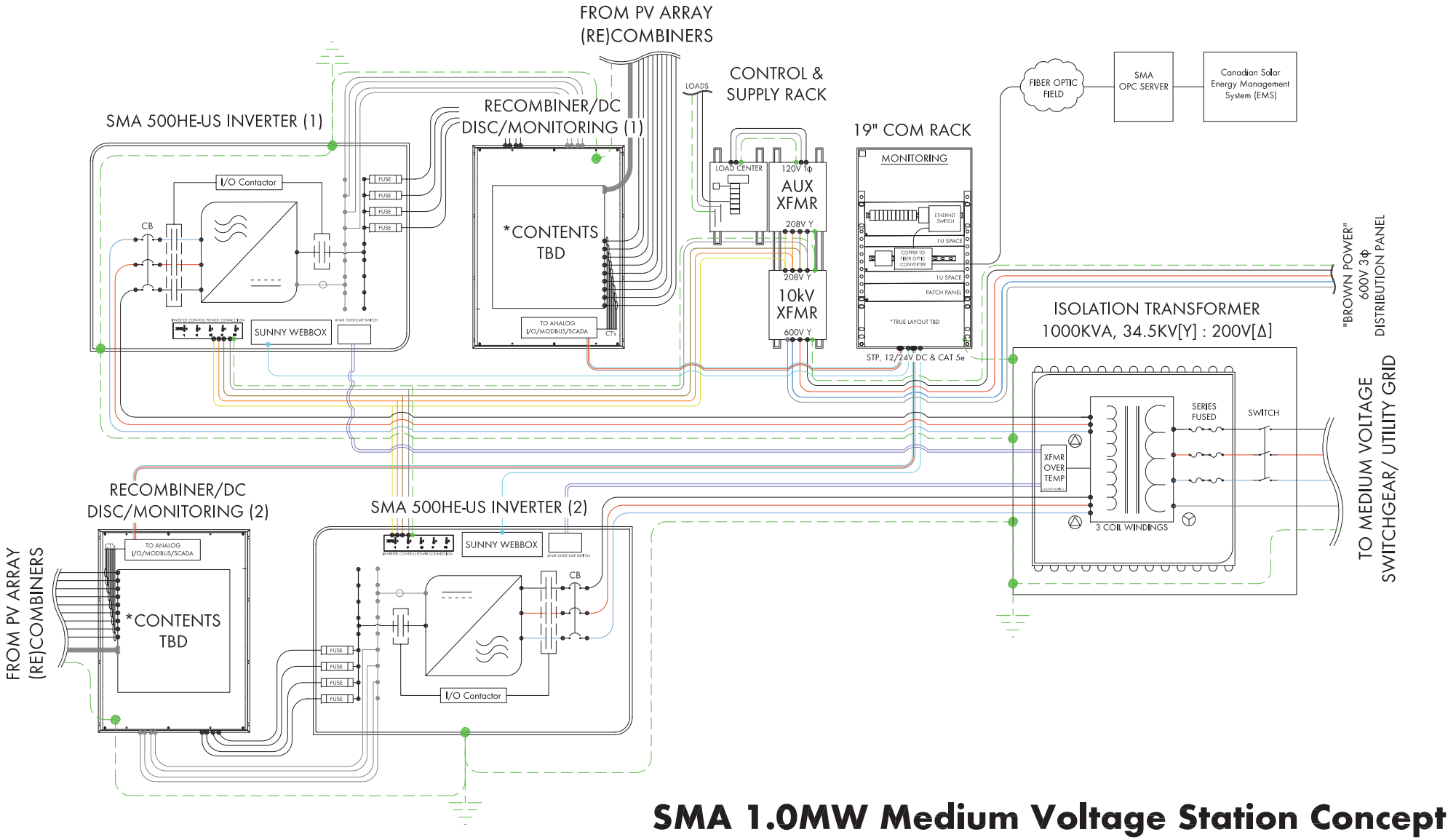
8. The line to line output voltage of the Sunny Central 500HE-US or Sunny Central 500HE-CA is 200 V.
9. The three phases of the low-voltage side of the transformer have to be connected to the inverter. An external neutral point of the transformer on the low-voltage side is not required. If the transformer has an external neutral point at the low-voltage side it is not allowed to connect this neutral to the inverter or to the ground in any manner.
10. Two-winding transformers can be used to connect one Sunny Central 500HE-US or Sunny Central 500HE-CA to the grid. The following vector groups are possible: YNd11, YNd5, YNd1 or Yy0, Dy1, Dy5, Dy11 with an ungrounded neutral point on the low-voltage side (see following diagram as an example).



11. Four-winding transformers (double storey transformer) are required to connect 2 Sunny Central 500HE-US or 2 Sunny Central 500HE-CA to the grid. The following vector groups are possible: YNd11d11, YNd5d5, YNd1d1 or Yy0y0, Dy1y1, Dy5y5, Dy11y11with an ungrounded neutral point on the low-voltage side (see following diagram as an example).



12. SMA America, LLC recommends the use of a transformer with a tap changer on the high-voltage side that enables an alignment to the voltage level of the medium-voltage grid.
13. The Sunny Central 500HE-US and Sunny Central 500HE-CA have a continuous power up to ambient temperatures of 113 °F (45 °C). In ambient temperatures above 113 °F (45 °C) a derating occurs.
14. During thermal rating, the load curve and the ambient conditions at the respective installation site must be taken into account.
15. This document does not and is not intended to replace any local, state, provincial, federal or national laws, regulation or codes applicable to the installation and use of the SMA inverter, including without limitation applicable electrical safety codes.



SMA 1.0MW Medium Voltage Station Concept

SMA AMERICA, LLC.
6020 West Oaks Blvd, STE 300
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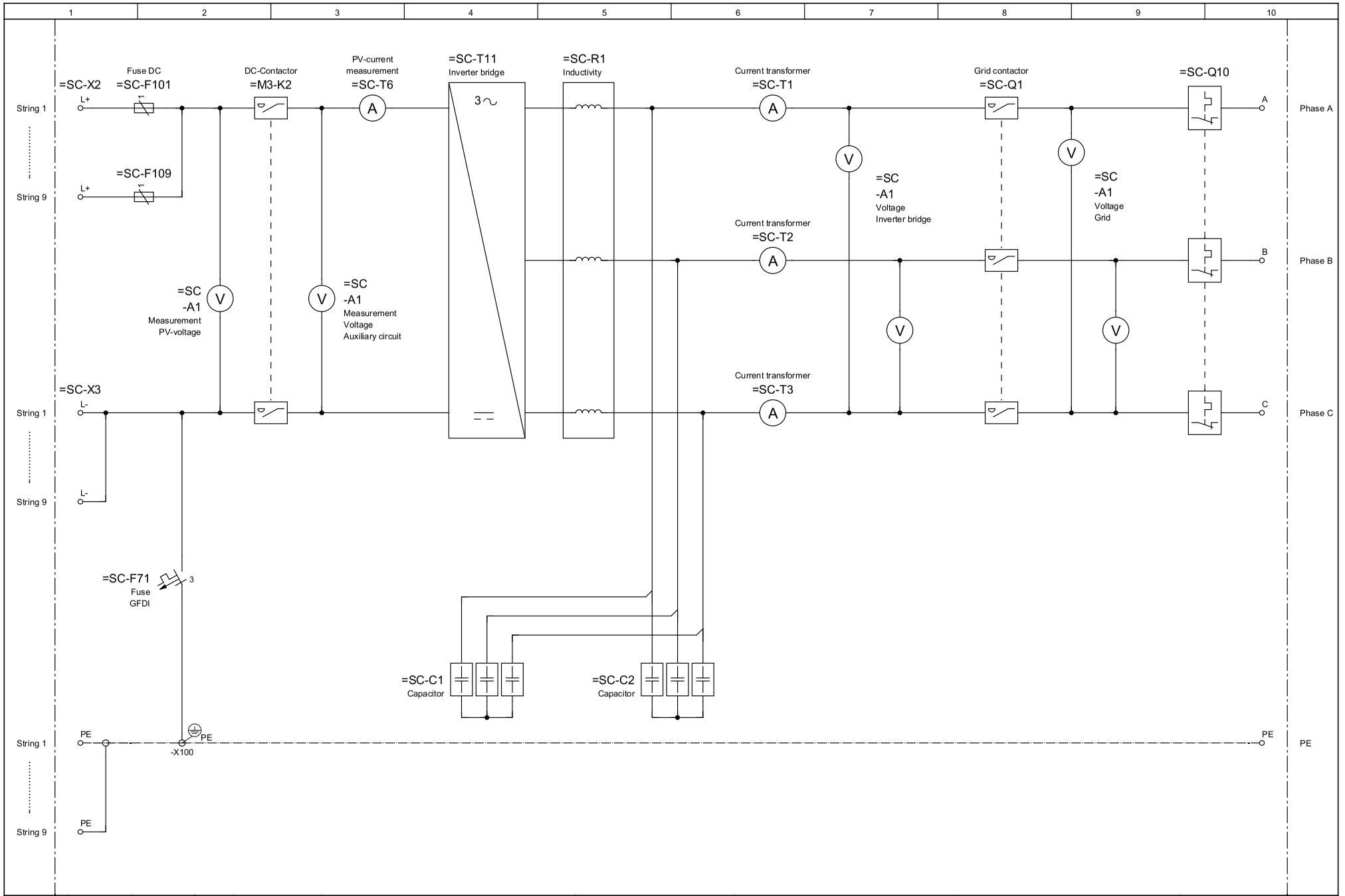
CANADIAN SOLAR SOLUTIONS PROJECT			
TBD			
DESIGNER:	RYAN LEBLANC	(707) 591-1950	DATE: 4.7.2011
CONTACT:			DATE:
COMPANY:			

GENERAL NOTES

PROPOSAL ONLY, ACTUAL SYSTEM IS CONTINGENT UPON VERIFICATION OF:
- BUILDING STRUCTURAL QUALIFICATIONS
- NEW AND EXISTING SHADING OBSTRUCTIONS
- ACTUAL SITE CONDITIONS, AVAILABILITY & CONDITION
- LOCAL SEISMIC & WIND CATEGORIES
- APPROVAL BY THE AUTHORITY HAVING JURISDICTION

E1. LINE DIAGRAM
- Not For Construction -

MVS1MW-E1 | REV. 1.0



			Date	11.09.2009	Sunny Central 500HE-US	SMA	SMA Solar Technology AG D-34266 Niestetal +49 (0)561 - 9522 - 0	Wiring diagram overview	SC-500HE-US:P	SC-500HE-US	&EFA
			Ed. by	R.Branz							BA1
			Appr.	J.Goldau							
Modification	Date	Name	Orig.		Replacement for	Replaced by					

SOLAR MODULE MOUNTING

APPENDIX B

STORMWATER MANAGEMENT PLAN

KINGSTON SOLAR LP
SOL-LUCE KINGSTON
SOLAR PV ENERGY PROJECT

STORMWATER MANAGEMENT PLAN

Submitted to:

Kingston Solar LP
55 Standish Court, 9th Floor
Mississauga, Ontario
L5R 4B2

Submitted by:

AMEC Environment & Infrastructure
a Division of AMEC Americas Limited
160 Traders Blvd. E., Suite 110
Mississauga, Ontario
L4Z 3K7

September 2012

TC111406
168335-0002-160-RPT-0021

IMPORTANT NOTICE

This Document was prepared exclusively for Kingston Solar LP, (the "Proponent") by AMEC Americas Limited. The quality of information contained herein is consistent with the level of effort involved in AMEC services and based on: i) information available at the time of preparation, ii) data supplied by outside sources, and iii) the assumptions, conditions and qualifications set forth in this document. This document is intended to be used by the Proponent only, subject to the terms and conditions of its contract with AMEC. Any other use of, or reliance upon this document by any third party for any other purpose will be at that party's sole risk.

REV.	DATE	DETAILS OR PURPOSE OF REVISION	PREPARED	CHECKED	APPROVED
A	24/11/2011	Issued for client review			
B	4/5/2012	Issued for client review			
0	8/5/2012	Issued for Use			
1	18/9/2012	Issued for REA Application			

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1.0 INTRODUCTION

Kingston Solar LP (hereinafter referred to as "Proponent") proposes to develop a solar facility with a maximum name plate capacity of approximately 100 MW AC (megawatts of alternating current) in Eastern Ontario located in the City of Kingston and Loyalist Township. If approved, this facility would use photovoltaic (PV) technology to convert solar energy into electricity. Power generated by the proposed facility would be fed into the provincial grid via a substation located adjacent to the Hydro One Networks Inc. (HONI) transmission line which crosses the study area. The output of the solar PV Project will be collected and connected to an electrical substation capable of transforming the power from distribution voltage to a transmission voltage of 230 kV.

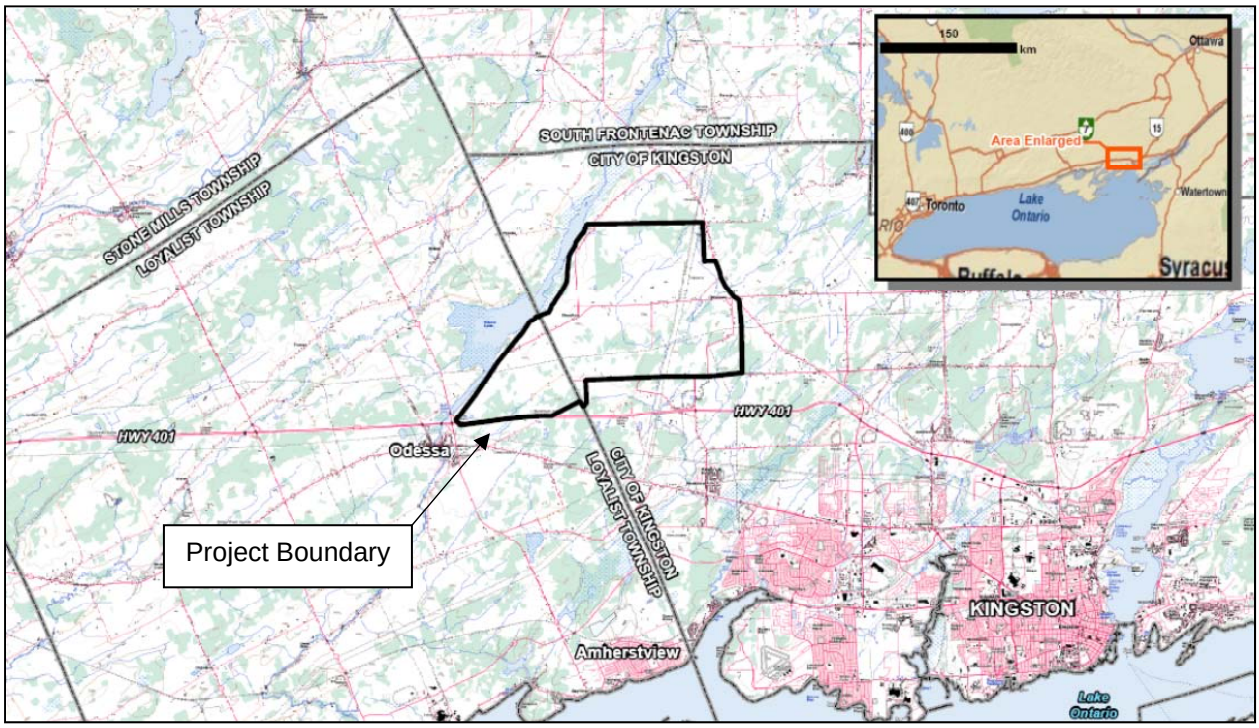
The proposed facility is to be known as the "Sol-luce Kingston Solar PV Energy Project" (hereinafter referred to as "the Project"). The Project is designated as a Class 3 solar facility in accordance with the definition in Section 4 of O.Reg. 359/09. The development of the Project would help the Province of Ontario meet its goal of increasing the proportion of electricity generated from renewable energy sources.

The Project is proposed in the City of Kingston and Loyalist Township and is generally bounded by a northing of 4910430 (NAD 83 UTM), Highway 38 to the east, Millhaven Creek and Odessa Lake to the west and Highway 401 to the south (Figures 1-1 and 1-2).

The basic components of the Project include fixed ground mounted photovoltaic panels (crystalline solar cells) located on sections of privately owned, leased lands within the Project Location, which covers an area of approximately 261 ha.

The Project Location includes all land and buildings/structures associated with the Project. This includes structures such as solar panels, access roads, and power distribution lines as well as any temporary construction zones surrounding access roads (constructible areas) which will be required during the construction of the Project. This also includes the corridors surrounding infrastructure such as access roads in which the final infrastructure may be located.

Figure 1-1: Project Boundary, Regional Context



The Project would consist of:

- Multiple sites consisting of arrays of photovoltaic (PV) modules or panels, with the cumulative capacity to generate up to 100 MW AC of power located as shown in Figure 1-3;

- The arrays would be mounted to aluminum or galvanized racking anchored to the ground or foundations;

- The PV arrays would be grouped in blocks of approximately 1 MW and connected to an inverter station to convert the incoming power from direct current (DC) to alternating current (AC). A transformer at the inverter station will transform the outgoing AC power to 34.5 kilovolts (kV);

- Power from solar sites would be transmitted by underground and/or overhead collector lines to the substation via the municipal road right-of-way;

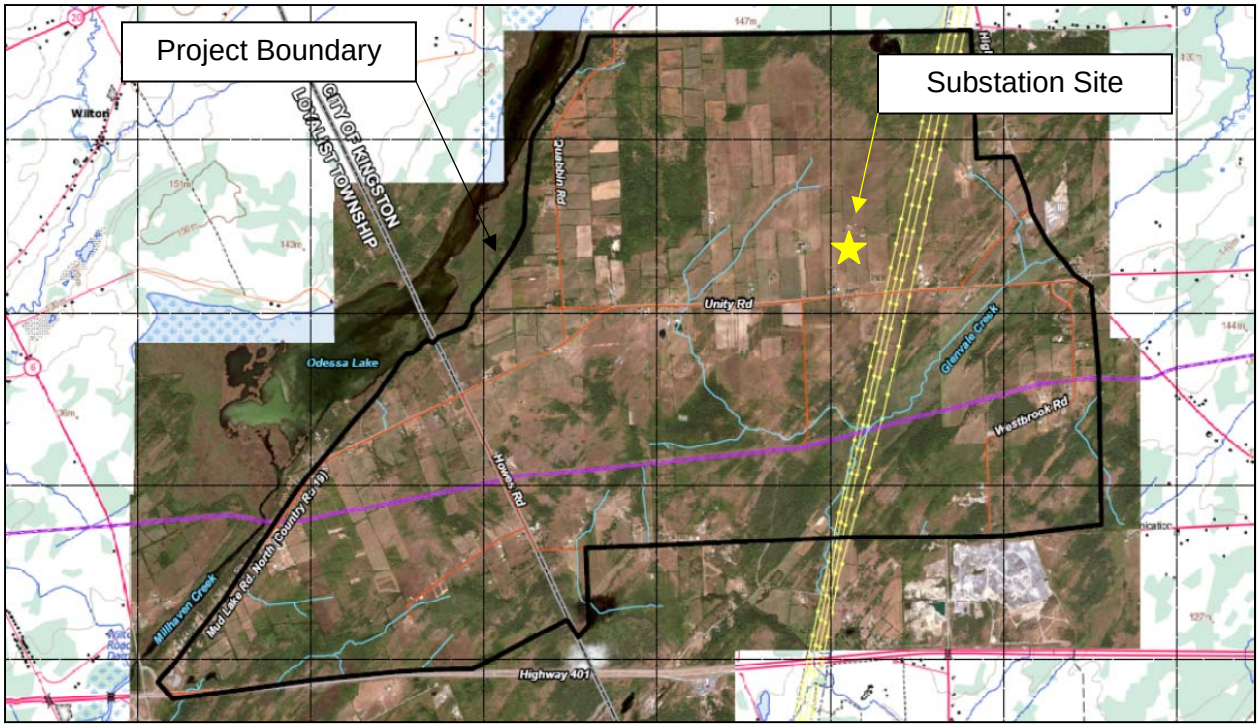
- At the substation, transformers would transform the power to 230 kV for interconnection to the adjacent Hydro One Networks Inc. (HONI) transmission line. The collector line is estimated to be approximately 33 km in length;

- A maintenance and control building would be located at the substation site for operations and maintenance use; and

- All Project sites will be surrounded by security fencing.

For additional details of the Project reference can be made to the *Project Description Report*.

Figure 1-2: Project Boundary, Local Context



The Proponent will provide for the design, construction, operation, and decommissioning of the Project. The proposed schedule is to commence construction in the first half of 2013 with completion in 2014. The lifespan of the Project is 20 years following which it would be decommissioned.

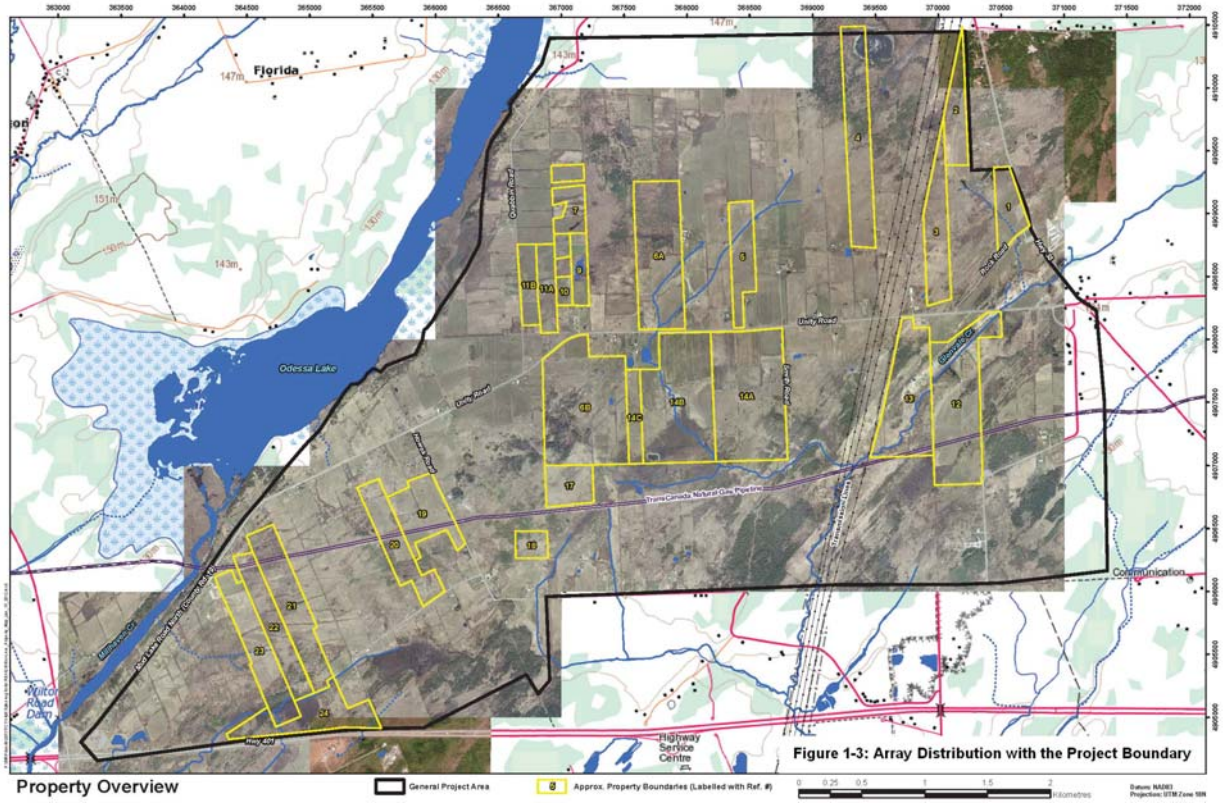
The Stormwater Management (SWM) Plan will address storm runoff from solar panel arrays within the Project boundary and the substation/switchyard. The Project boundary lies wholly within the jurisdiction of the Cataraqui Region Conservation Authority (CRCA).

This report summarizes the development of the concept SWM Plan for the Project.

1.1 Array Location

The solar arrays are distributed within the Project boundary (Figure 1-3) across 19 properties.

Figure 1-3: Array Distribution with the Project Boundary

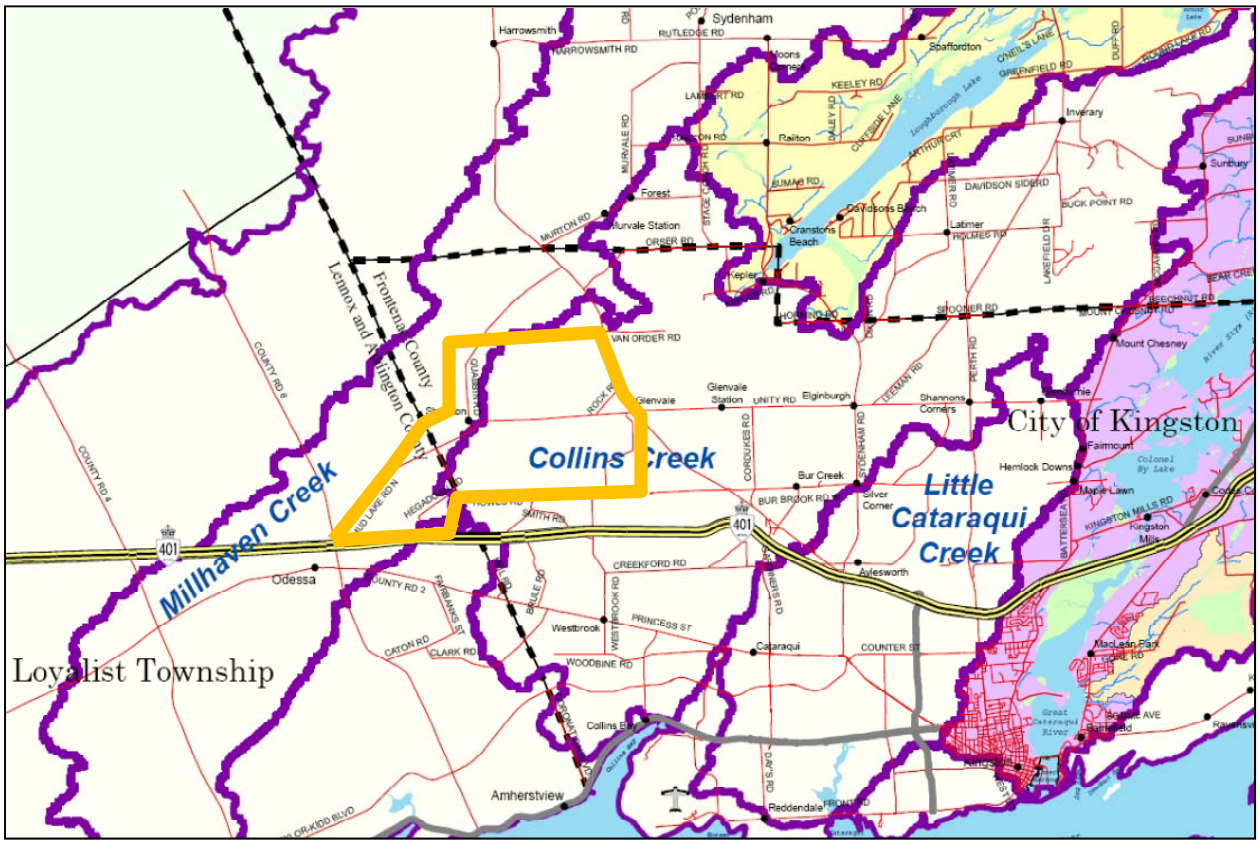


As illustrated in Figure 1-4, the Project boundary spans three subwatersheds within the jurisdiction of the CRCA, namely, the drainage areas associated with Millhaven Creek, Collins Creek and Parrot's Creek (from CRCA, 2011, Map 2-2). These three watersheds drain to Lake Ontario directly.

Some considerations regarding stormwater management planning for the Properties include construction associated with installation of the arrays. The installation will occur on existing ground (i.e., existing topography will be maintained) to the extent possible, and following construction, the site will be seeded to stabilize areas disturbed from construction activities.

As such, although the solar panels are an impervious surface, the underlying soils and topography will change from pre-development conditions. Rain water flowing off the solar panels will fall to the existing ground surface, runoff will travel an unchanged path therefore maintaining the opportunity to infiltrate in a manner equalling pre-development. Areas to be covered by solar arrays are not considered to change in terms of their runoff potential between pre-development and post-development because only minimal hard surfaces (access roads) will be constructed for this development and a vegetated buffer will be maintained between the arrays and the boundary of a Property.

Figure 1-4: Project Boundary with Respect to CRCA Drainage Areas



Note: the background image was taken from Figure 1-16a of the Cataraqui Source Protection Area, Amended Proposed Assessment Report, June 2011.

The following information is relevant for the properties which make up the Project:

- The Project is located within the area known as the Limestone Plain (from Map 2-1 [CRCA, 2011]);
- The bedrock geology underlying the Project is generally comprised of the Gull River Palaeozoic Formation (from Map 2-3 [CRCA, 2011]);
- The surficial geology underlying the Project is substantially comprised of the Palaeozoic Bedrock Drift Complex with some small elements of Fine Textured Glaciolacustrine (from Map 2-4 [CRCA, 2011]);
- The till soils overlying the Precambrian Shield are generally thin within the Project boundary. The soil materials along the southern border of Frontenac County consist of stone free clay deposits broken in places by numerous outcroppings of Precambrian rock. (Gillespie et al, 1966);

- Surficial soils within the Project boundary are generally characterized as loams (from Map 1-5a [CRCA, 2011]) of the Farmington, Guerin, Bondhead, Lyons and Lindsey complexes (Gillespie et al, 1963 and 1966). These complexes are described as well drained (Farmington), imperfectly drained (Guerin) and poorly drained (Lyons, Lindsey) (Gillespie et al, 1963 and 1966);

- The dominant surficial soils are the Farmington, Guerin and Lindsey complexes representing 64%, 15% and 15%, respectively, of the area covered by the Project boundary;

- Overburden thickness across the Project boundary is generally less than 0.9 m (from Map 1-13 [CRCA, 2011]);

- The general drainage pattern within the Project boundary southwesterly;

- Land cover is a mix of agriculture, forest and swamp within the Project boundary (from Map 1-14 [CRCA, 2011]);

- No water control structures are located within the Project boundary (from Map 2-9 [CRCA, 2011]);

- No streamflow gauging stations are located within the Project boundary (from Map 3-1 [CRCA, 2011]);

- The Millhaven Creek and Collins Creek watersheds are considered to be under “Significant” surface water stress while the Parrot’s Creek watershed is considered to be under “Moderate” surface water stress (from Map 3-3 [CRCA, 2011]);

- The Millhaven Creek watershed is considered to be under “Low” groundwater stress while the Parrot’s Creek and Collin’s Creek watersheds are considered to be under “Significant” and “Moderate” ground water stress, respectively (from Map 3-4 [CRCA, 2011]);

- No surface water intake protection zones or wellhead protection areas are located within (wholly or partially) the Project boundary (from Map 4-1 [CRCA, 2011]);

- The underlying aquifer across virtually the entire area encompassing the Project boundary is considered “Highly Vulnerable” (from Map 5-1e [CRCA, 2011]);

- Some areas within the Project boundary are considered to be “Significant” groundwater recharge areas (from Map 5-7 [CRCA, 2011]); and,

- No tile drains have been identified (to date) on any of the Properties.

1.2 Substation Development

The substation facility would be located approximately ½ km west of the intersection of Unity Road and Rock Road and approximately ½ km north of Unity Road (Figures 1-2 and 1-5). The substation would house the switchyard, control, protection, communication and metering system required to support the operation of the substation. The substation would have a foot print of approximately 1.5 ha. The site would include a switchyard to interconnect with the provincial power grid operated by HONI. The site would be largely covered with gravel, and underlain by a grounding grid. The substation site would be surrounded by a chain-link fence equipped with a locked vehicle gate to allow for maintenance access for security (for layout of the substation (Figure 1-6).

The substation is a component of the proposed development on Property #4. Property #4 covers a total area of about 13.5 ha, of which, the area proposed for the substation is about 1.5 ha.

Of particular interest in regards to the development of the SWM Plan for the substation is the proposed transformer containment pit system. A general outline of this system is provided below:

- A “double containment system” will be implemented for transformers at the substation. In addition to the “first stage” of containment, namely the transformer enclosures (conservator, tank, etc.), a “second stage” of containment will be in the form of a transformer containment pit system;

- The stormwater containment area for the transformer will have a minimum volume equal to the volume of transformer oil plus the volume equivalent to providing a minimum 24-hour duration, 25-year return storm capacity for the stormwater drainage area around the transformer under normal operating conditions;

- The containment facility will have a freeboard of 0.25 m approximately 0.30 m above grade, and an impervious floor, stoned filled and walls of reinforced concrete with an impervious plastic liner with sloped floors leading to an oil control device;

- Drainage from the transformer pit would be removed by either manually or automatically operating a sump pump to discharge the liquid. In either case, an oil/grease sensor would be mounted on the pump to detect any oil/grease in the liquid. If oil/grease is detected, the liquid would be removed from site via a licensed waste hauler and the source of the leakage would be identified. If no oil/grease is detected in the liquid, discharge would be via the stormwater collection system; and,

- A clean stormwater outlet draining from the containment facility.

Figure 1-5: Proposed Substation Location

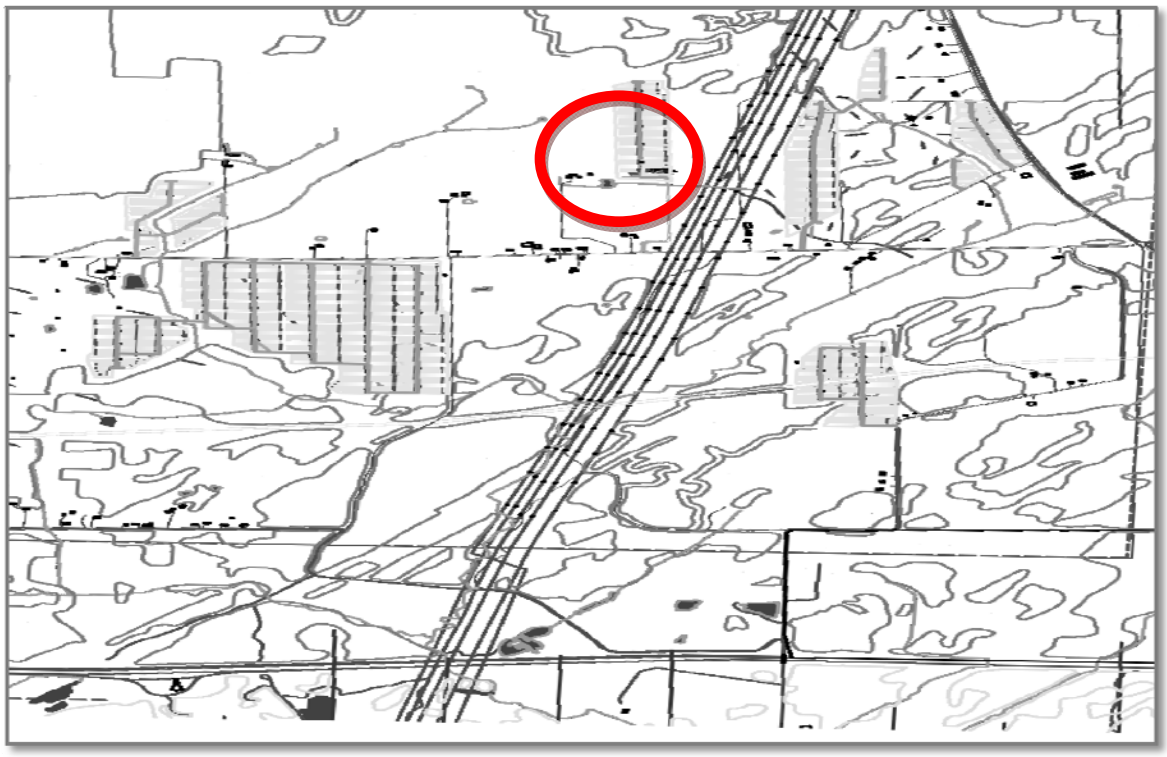
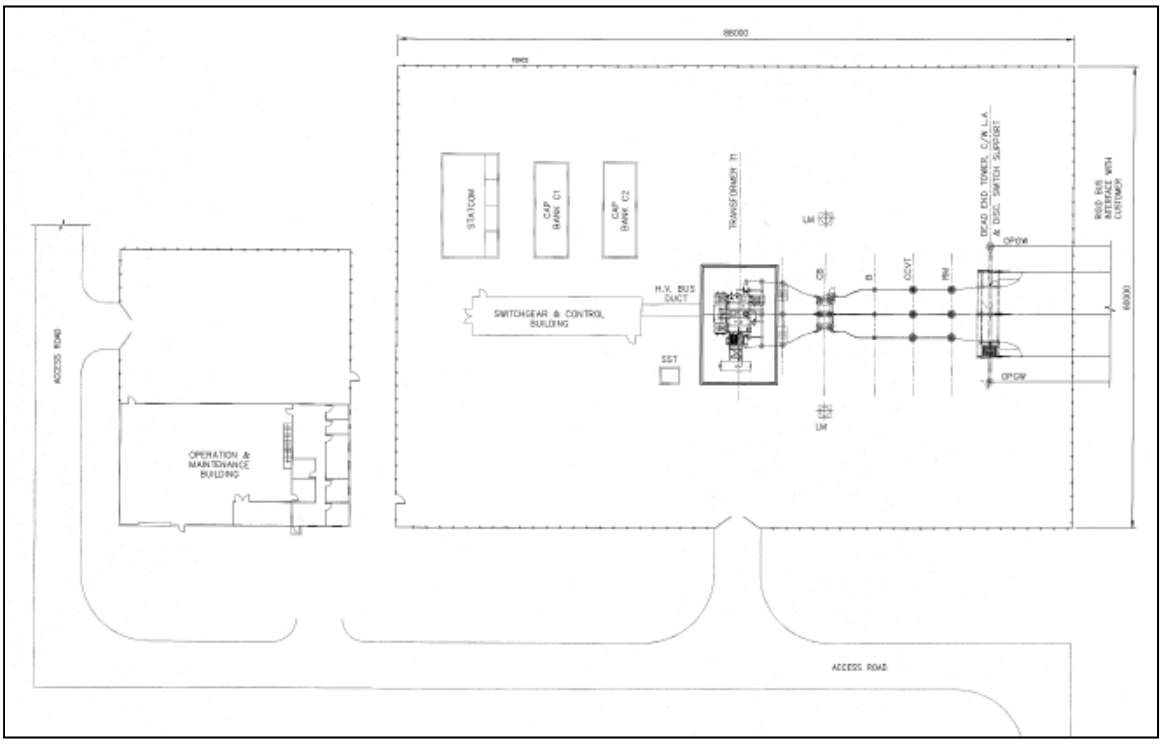


Figure 1-6: Proposed Substation Layout



1.3 Stormwater Management Plan Overview

The objective of a SWM Plan is to control stormwater runoff from the Site, specifically to ensure that surface water quality meet discharge guidelines, and to manage surface water quantity (i.e., runoff peak flow rates) discharging from a development site.

The surface water quantity objective of the SWM Plan is to maintain no increase in peak flows discharging from a development site for post-development versus pre-development conditions, up to and including the 100 year return period design event. Hydrologic modelling was completed to estimate peak flows for these two conditions from the Project. The results from the two scenarios were compared to evaluate the impact of the development on stormwater drainage and the need for quantity control.

The SWM Plan has been designed in compliance with the "*Stormwater Management Planning and Design Manual*" (MOE, 2003) and CRCA guidelines. The overall SWM Plan incorporates the following requirements:

- The quality control aspect of the SWM Plan has been designed based in consideration of the enhanced protection level of treatment; and
- The Ministry of Natural Resources (MNR) *Flood Plain Management in Ontario, Technical Guidelines* (MNR, 1988) indicate the Site is located within Regulatory Flood Zone 2. As such, the 100 year (Regulatory Storm) was used as the extreme design rainfall event for this Site.

2.0 HYDROLOGIC MODELLING

Single event hydrologic modelling has been used to obtain quantitative estimates of stormwater runoff rates and volumes for pre-development and post-development conditions for the Project.

2.1 Model Selection

The surface runoff has been calculated using the computer model Visual OTTHYMO v2.0 (VO2). OTTHYMO is a hydrologic management model that has been used for watershed studies, sub-watershed studies, master drainage plans, functional stormwater management plans, site plans, and stormwater management pond design. VO2 is the second version of the INTERHYMO – OTTHYMO hydrologic modelling tool designed for Microsoft Windows OS. VO2 has been accepted by the Ministry of the Environment (MOE), the Ministry of Natural Resources (MNR), the Ministry of Transportation (MTO), the Ministry of Municipal Affairs and Housing (MMAH), the Association of Conservation Authorities of Ontario, and most municipal governments, as a valid hydrologic simulation program.

2.2 Design Storms

Precipitation data from the Atmospheric Environment Services' in the form of an Intensity Duration Frequency (IDF) relationship is required to develop the design storms for use in this assessment. A number of possible gauges are available in proximity to the Project, namely:

Table 2-1: Rainfall Gauging Stations in Proximity to the Site

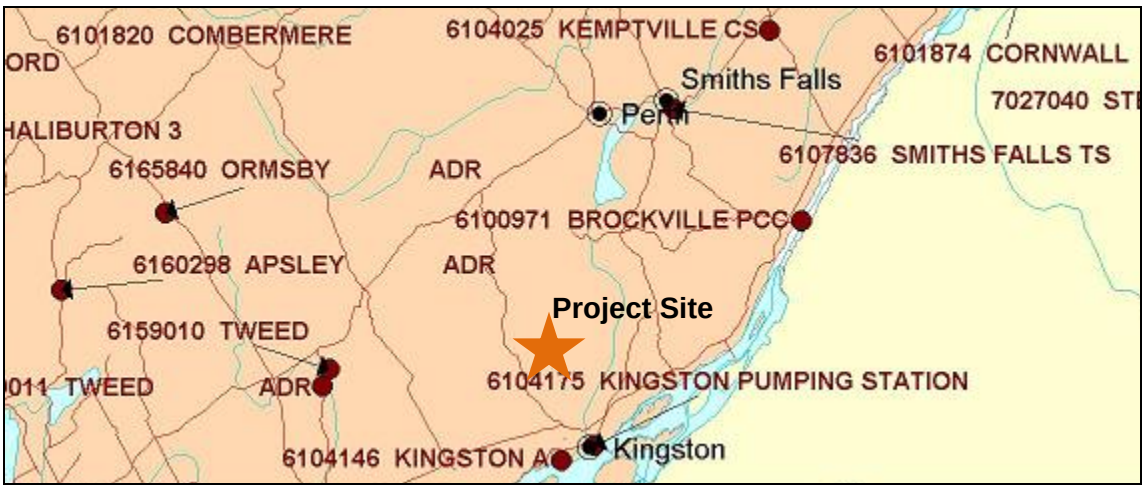
Location	Gauge #	Distance from Site[1] (km)
Kingston Airport	6104146	12.3
Kingston Pumping Station	6104175	16.0
Tweed	6159010	54.7
Brockville PCC	6100971	82.9

Notes: To approximately the centroid of the Project boundary

Table 2-2: Return Period Rainfall Totals for Selected Gauges in Southeastern Ontario

Return Period	24 Hour Rainfall Totals (mm)	
	Kingston Airport	Kingston Pumping Station
2 year	41.5	47.2
5 year	54.3	60.6
10 year	62.8	69.6
25 year	73.5	80.9
50 year	81.5	89.2
100 year	89.4	97.5
Period of Record	17 years	60 years

Figure 2-1: Rainfall Gauges in Southwestern Ontario with IDF Data



The Project lies within similar distances of two gauging stations (Kingston Airport, Kingston Pumping Station), with the Kingston Airport gauge being marginally closer. A comparison of the design events provided in Table 2-2, indicates rainfall totals only marginally higher for the Kingston Pumping Station location. As such, and in consideration of the period of record from the two stations, the Kingston Pumping Station rainfall data has been selected for use in this assessment (Table 2-3).

Design storms with return periods of 2, 5, 10, 25, 50, and 100-years were developed and used to determine design hydrographs to enable evaluation of the total runoff from the site.

The MNR *Flood Plain Management in Ontario, Technical Guidelines* indicates the site is located within Regulatory Flood Zone 2. As such, the 100 year design storm was used as the Regional (extreme) design rainfall event for this site.

A critical duration assessment was completed to determine the critical rainfall design event for this assessment. The critical design event was taken to be that which produced the highest peak flows. The Atmospheric Environment Service (AES) 1 hr and 12 hr storm distributions were evaluated as for design storms due to the applicability of the AES distribution in Ontario (Watt, 1989). Further, given the limited durations available with the AES distribution, the Soil Conservation Service (SCS) Type II 6, 12, and 24 hour storm distributions were also evaluated. A time increment of five minutes was selected for all design storms.

Table 2-3: Total Rainfall Depth

Event	Event Depth (mm) by Duration			
	1 hour	6 hour	12 hour	24 hour
2 year	20.8	35.0	41.2	47.2
5 year	27.8	46.5	54.9	60.6
10 year	32.5	54.1	63.9	69.6
25 year	38.3	63.7	75.4	80.9
50 year	42.7	70.8	83.9	89.2
100 year	47.0	77.9	92.3	97.5

Notes: Data for Environment Canada weather station at Kingston Pumping Station (#6104175)

2.3 Hydrologic Modelling Input Data and Results

2.3.1 Substation Development

The following information is relevant to the development of the pre-development and post-development hydrologic simulation models for the proposed development Substation site.

- The substation is located on Property #4;
- The area proposed for the substation covers about 1.5 ha;
- Based on the substation layout, the development will be dominated by gravels under post development conditions representing about 41% of the developed lands. A pervious runoff curve number (CN) value of 84 has been applied for stormwater management modelling purposes recognizing activity at the site which will result in minor compaction and reduction in infiltration capacity across portions of the Site. An imperviousness of 13% of the total developed area (post-development) has been modeled with a CN value of 98. About 46% of the substation site footprint remains in a pre-development condition for modelling purposes;
- The substation will be constructed on a gravel pad underlain by a grounding grid. ;
- Gravel roads constructed as part of the development of the substation site will be at grade (i.e., not elevated);
- The substation development area drains to a drainage feature (as defined from Ontario Base Mapping) located about 50 m south of the southern boundary of Property #4;

- Surficial soils underlying the substation development area are generally comprised of Lyons loams, classified as Hydrologic Soil Group C[1];

- A base CN number of 79 was used for pervious areas for modelling purposes;

- For post development modelling, the rainfall on the solar panel will fall onto pervious ground and travel overland to the receiving water. As a result, the stormwater runoff from the solar panel arrays is considered to be clean; and

- Time of concentration was computed using the Hathaway equation. Overland flow length was abstracted from available topographic mapping (Ontario Base Maps) and Site plans.

The development of pre-development and post-development hydrologic models took into account the two primary considerations, previously noted, for the substation/array development on Property #4, namely:

The construction associated with installation of the solar panels will be on existing ground and the existing topography will be maintained to the extent reasonably and practically possible, and;

The solar panels are an impervious surface, however, the underlying soils and topography will not have changed from pre-development conditions. Rain water flowing off the solar panels will fall to the existing ground surface, runoff will travel an un-changed path therefore maintaining the opportunity to infiltrate in a manner equalling pre-development. Therefore, areas to be covered by solar panels are not considered to change in terms of their runoff potential between pre-development and post-development.

The substation will be housed on a gravel pad. The gravel pad is typically constructed with a minimum depth of 0.15 m or 6 inches on the upslope side of the substation development. The native material underlying the gravel pad is typically graded to provide a consistent slope for runoff. The grading of the native material results in some compaction of the soils reducing infiltration capacity (this effect is represented in the hydrologic modelling by an increase in CN number for the gravel pad areas of the development). The gravel pad is constructed with minimal surface grade to an approximate maximum depth of about 1 m. The typical specification used for the gravel material used for pad construction is crushed stone having a minimum size of 19 mm (or about 1 inch) with minimal fines. The purpose of the gravel pad is to avoid surface runoff ponding in the substation area. A result of the gravel pad, as constructed, is attenuation of stormwater runoff from the substation area although this effect cannot be effectively represented in the modelling.

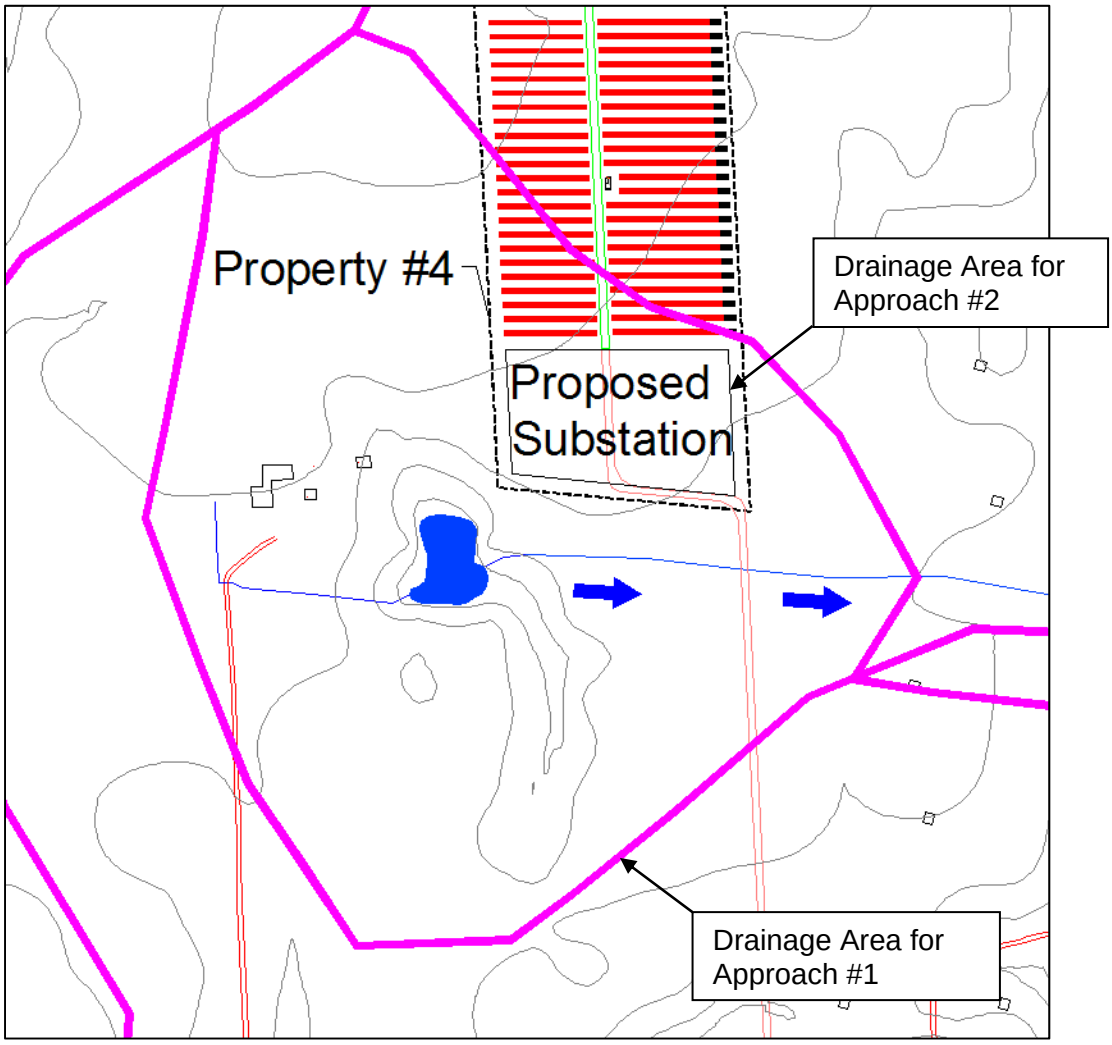
[1] Via http://66.212.167.150/LICO/CDSI_Potential_Mapping_Project.htm

Given the distributed nature of the proposed Project, two modelling approaches have been used to quantify the potential impact of development. Firstly (Approach #1), pre- and post-development models were constructed based on topographically defined drainage patterns to a location a distance downstream sufficient so that the upstream catchment area encompassed a Property. Secondly (Approach #2), pre- and post-development models were constructed based only on the development footprint to an arbitrary outlet, as in the case of the substation.

The pre- and post-development subcatchment model (Approach #1) encompassing the south draining portion of Property #4, including the substation, is illustrated in Figure 2-2. The subcatchment model based on Approach #2 is simply the 1.5 ha footprint of the substation.

Subcatchment parameterization, for both the pre-development and post-development conditions and both modelling Approaches, is outlined in Tables 2-4.

Figure 2-2: Pre- and Post-Development Subcatchment Model - Substation



The computed peak flows from the critical duration analysis are provided in Table 2-5. The results indicate that the 12 hour duration rainfall event is critical for the drainage area associated with the substation. This result is consistent for both modelling approaches and both rainfall distributions (AES and SCS) analyzed. The CRCA stormwater planning guidelines indicate a preference for the AES rainfall distribution, therefore, the 12 hour AES distribution will be used for further modelling analysis for SWM planning for this Project.

The pre- and post-development computed peak flows for the substation site are provided in Table 2-6.

Table 2-4: Catchment Parameterization

Catchment #	Area (ha)	Impervious Area (ha)	Imperviousness (%)	CN (AMC II)	Tp (hr)
Approach #1					
Pre	21.5	0	0	79	0.99
Post	21.5	0.2	1.1	79.3	0.98
Approach #2					
Pre	1.5	0	0	79	0.23
Post	1.5	0.2	13.3	83.6	0.20

Notes:
1. Tp Time to Peak
2. AMC Antecedent Moisture Condition
3. Imperviousness as a percentage of total catchment area

Table 2-5: Critical Duration Analysis Results

100 year Design Rainfall Event Duration	Peak Flow (m^3/s) at Outlet from Site			
	Approach #1		Approach #2	
	Pre	Post	Pre	Post
AES 1 hour	0.507	0.517	0.097	0.122
AES 12 hour	0.618	0.625	0.055	0.062
SCS Type II 6 hour	0.902	0.917	0.182	0.231
SCS Type II 12 hour	1.015	1.032	0.205	0.251
SCS Type II 24 hour	0.950	0.966	0.189	0.229

Notes:
Due to the very small computed flows, the peak flows have been documented above to three decimal places as a means of illustrating computed changes from pre-development to post-development. This level of detail is provided for information purposes only and should not be construed as an indication of the accuracy of the simulation model computations.

Table 2-6: Pre- and Post-Development Peak Flows – Substation

Design Rainfall Event (AES 12 hr)	Peak Flow (m^3/s) at Outlet from Site							
	Approach #1				Approach #2			
	Pre	Post	% Change	Absolute Change	Pre	Post	% Change	Absolute Change
2	0.157	0.160	1.9%	0.003	0.013	0.016	23.1%	0.003
5	0.263	0.267	1.5%	0.004	0.024	0.028	16.7%	0.004
10	0.341	0.346	1.5%	0.005	0.031	0.036	16.1%	0.005
25	0.448	0.454	1.3%	0.006	0.040	0.046	15.0%	0.006
50	0.532	0.538	1.1%	0.006	0.047	0.054	14.9%	0.007
100	0.618	0.625	1.1%	0.007	0.055	0.062	12.7%	0.007

Notes:
Due to the very small computed flows, the peak flows have been documented above to three decimal places as a means of illustrating computed changes from pre-development to post-development. This level of detail is provided for information purposes only and should not be construed as an indication of the accuracy of the simulation model computations.

As illustrated in Figure 2-2, the outlet of the drainage area associated with Approach #1 lies about 100 m downstream from the southern boundary of the substation development footprint. At this location increases in computed peak flows are less than 2% for all of the design rainfall events assessed. Absolute increases in computed peak flows are negligible.

The computed increases in peak flows associated with Approach #2 are significantly greater with larger percentage increases computed for the more frequent events with decreasing change from pre- to post-development through to the 100 year event. However, the absolute changes in computed peak flows are also negligible. Further, the influence of any change in computed peak flows is dissipated within the 100 m distance between the presumed outlet from the substation development footprint and the discharge point for the drainage area associated with Approach #1.

It is therefore concluded that the changes in computed peak flows demonstrate that the substation development has negligible impact on the nature of stormwater runoff from the proposed development.

2.3.2 Property/Array Developments

As noted previously, the array locations are distributed within the Project Location across 19 properties.

The following information is relevant to the development of the pre-development and post-development hydrologic simulation models for the proposed Property developments:

- Gravel roads constructed as part of the development of the substation site will be at grade (i.e., not elevated);

- Surficial soils within the Project developments have been defined based on Map 1-5a from [CRCA, 2011]. The associated hydrologic soil classification is based on available soil mapping for the area (Gillespie et al, 1963 and 1966) and information available at Land Improvement Contractors of Ontario website[2]; and,

- Time of concentration was computed using the Hathaway equation. Overland flow length was abstracted from available topographic mapping (Ontario Base Maps) and Site plans.

The development of pre-development and post-development hydrologic models took into account the two primary considerations, previously noted, for the array development on the Properties, namely:

- The construction associated with installation of the solar panel arrays will be on existing ground and the existing topography will be maintained to the extent reasonably and practically possible, and;

- The solar panels are an impervious surface, however, the underlying soils and topography will not have changed from pre-development conditions. Rain water flowing off the solar panels will fall to the existing ground surface, runoff will travel an un-changed path therefore maintaining the opportunity to infiltrate in a manner equalling pre-development. Therefore, areas to be covered by solar panel arrays are not considered to change in terms of their runoff potential between pre-development and post-development.

Given the distributed nature of the proposed Project, the two previously noted modelling approaches (Approach #1 and Approach #2) have been used to quantify the potential impact of the array developments.

A number of the Properties were evaluated for pre-development and post-development conditions, namely Properties 1, 2, 3, 4, 11, 14, 20, 21, 22, 23, and 24. These Properties were selected for specific hydrologic evaluation as they represent a varied range of change from pre-development and post-development. The full results of this modelling analysis, with drainage boundary illustrations, are provided in **Appendix A**. The average percentage change in computed peak flows is 1.06% using Approach #1 and 3.3% using Approach #2.

The subcatchment parameterization associated with all of the drainage areas associated with the Property developments is provided in **Appendix B**.

The results of the evaluations for these Properties are considered to be reflective of the anticipated results across the remaining Properties which were not specifically assessed with hydrologic modelling.

[2] Available at http://66.212.167.150/LICO/CDSI_Potential_Mapping_Project.htm

It is therefore concluded that the changes in computed peak flows, as indicated above, demonstrate that the array developments have negligible impact on the nature of stormwater runoff from the proposed development of the Properties.

2.4 Stormwater Management Plan

Based on the results of the hydrologic modelling, ”quantity” control is not considered necessary for this SWM Plan. Therefore, the focus of the SWM Plan becomes stormwater ”quality” control.

Grassed filter strips are a low-cost Best Management Practice (BMP) designed to improve the quality of stormwater runoff by using biological and chemical processes in soils and vegetation to filter out constituents. They function by slowing runoff velocities and filtering out sediment and other pollutants, and providing some infiltration into underlying soils. Filter strips were originally used as an agricultural treatment practice, and have more recently evolved into an urban practice.

As noted previously, after construction, the site for areas under and within the panel arrays blocks will be seeded with ‘pasture’ grass varieties. These plantings will essentially act as grassed filter strips for the site. The proposed plantings over a 10 m flow length will provide effective stormwater runoff quality control given the minimal contributing impervious area.

Also noted previously was the implementation of a “double containment system” for transformers at the site which will be an integral component of the quality control aspect of the SWM Plan.

3.0 MAINTENANCE AND MONITORING PROGRAM

The SWM works will be owned, maintained and monitored by the Proponent.

3.1 Maintenance

Proper maintenance is required for maximum filter-strip effectiveness. The maintenance requirements for the grass filter strips within this development will be based on information provided in MOE (2003). The following minimal maintenance items are recommended:

- Inspect the filter strip frequently, especially after intense rainfall events and runoff events of long duration. Small breaks in the sod and small erosion channels quickly become large problems;

- Minimize the development of erosion channels within the filter. Even small channels may allow much of the runoff from the field to bypass the filter. These areas should be repaired and reseeded immediately to help ensure proper flow of runoff through the filter;

- Reseed or inter-seed bare areas of the filter. Since it may be difficult to re-establish vegetation in an established filter strip, the use of mulch or sod can help to reduce some problems;

- Mow and remove hay as required to maintain moderate vegetation height;

- Soil test periodically and apply soil amendments according to test results and recommendations; and

- Control trees, brush, noxious weeds, and Canada thistle in the filter using either mechanical or other means.

3.2 Monitoring

Monitoring will consist of visual inspections of the vegetated areas adjacent to drainage ditches. The monitoring program will include regular inspections of the erosion and sediment control features described in the following section.

4.0 EROSION AND SEDIMENT CONTROL PROGRAM

Erosion and sedimentation are naturally occurring processes that involve particle detachment, sediment transport and deposition of soil particles. Construction activities commonly alter the landscapes where they are located, exacerbating these natural processes.

The transport of sediment overland and deposition into surrounding natural areas, including watercourses, woodlots, and wetlands as well as adjacent private lands, needs to be prevented. The erosion and sediment control measures described in this section are focused on the features of the SWM Plan only. The erosion and sediment control plan for the entire site, as documented in the Construction Plan Report, should be compliant with the MOE design manual (2003).

To minimize the potential operation and environmental impacts, the grass filter areas should be inspected frequently to identify any erosion areas and make timely repairs to the grade.

5.0 CONCLUSIONS

This Report demonstrates that the proposed conditions for the substation and array development, a component of the Project, satisfy the requirements for stormwater management established by MOE (2003), the CRCA, and the proposed changes to O.Reg. 359/09 and the proposed revisions to the Technical Guide. It has been demonstrated that the required targets will be met as follows:

Hydrological modelling completed for this assessment indicates no significant changes between pre-development condition and post-development stormwater runoff peak flow conditions. Therefore, quantity control of stormwater runoff is not considered to be a requirement of this SWM Plan. Further, no impacts to downstream flood conditions are anticipated.

As no significant changes between pre-development condition and post-development stormwater runoff peak flow conditions are anticipated, the recommended stormwater management plan focuses on stormwater runoff quality control. Pasture grass varieties, which will substantially cover the Site after construction, will provide water quality control through filtering (in a similar manner to grassed filter strips) for stormwater runoff from the Site.

A “double containment system” will be implemented for transformers at the substation proposed as a component of this Project. In addition to the “first stage” of containment, namely the transformer enclosures (conservator, tank, etc.), a “second stage” of containment will be in the form of a transformer containment pit system.

A preliminary Stormwater Management facility maintenance and monitoring strategy, based on the stormwater management plan, has also been provided.

A preliminary Stormwater Management facilities erosion and sedimentation control strategy, based on the stormwater management plan, has also been provided.

Sincerely,
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APPENDIX A

HYDROLOGY MODELLING OUTPUT - PROPERTIES

Property #1 Characteristics

	Approach #1	Approach #2
Property	1	
Property Area	8.66	
Road Area	0.508	
% Impervious	2.55	5.87
Longest Flow Path (m)	400	494.6
Slope (%)	1.40	1.40
CN (Existing)	81.0	81.8
Tp(hr)	0.36	0.42
CN (Post-Development)	81.4	82.7
Tp(hr)	0.36	0.40

Property #1 Peak Flow Rates (m^3/s)

Approach #1

Property	1			
Storm Duration	Existing	Proposed	Absolute Change	% Change
2	0.192	0.196	0.004	2.08
5	0.323	0.329	0.006	1.86
10	0.417	0.442	0.025	6.00
25	0.544	0.553	0.009	1.65
50	0.642	0.651	0.009	1.40
100	0.741	0.751	0.01	1.35

Approach #2

Property	1			
Storm Duration	Existing	Proposed	Absolute Change	% Change
2	0.085	0.089	0.004	4.71
5	0.141	0.147	0.006	4.26
10	0.183	0.19	0.007	3.83
25	0.238	0.247	0.009	3.78
50	0.281	0.29	0.009	3.20
100	0.324	0.334	0.01	3.09

Property #2 Characteristics

	Approach #1	Approach #2
Property	2	
Property Area	2.25	
Road Area	0.327	
% Impervious	0.42	14.5
Longest Flow Path (m)	1100	357.1
Slope (%)	0.20	1.40
CN (Existing)	74.0	76.3
Tp(hr)	2.65	0.38
CN (Post-Development)	74.1	79.4
Tp(hr)	2.64	0.35

Property #2 Peak Flow Rates (m^3/s)

Approach #1

Property	2			
Storm Duration	Existing	Proposed	Absolute Change	% Change
2	0.346	0.347	0.001	0.29
5	0.587	0.59	0.003	0.51
10	0.765	0.769	0.004	0.52
25	1.011	1.015	0.004	0.40
50	1.203	1.208	0.005	0.42
100	1.4	1.406	0.006	0.43

Approach #2

Property	2			
Storm Duration	Existing	Proposed	Absolute Change	% Change
2	0.018	0.02	0.002	11.11
5	0.03	0.035	0.005	16.67
10	0.04	0.045	0.005	12.50
25	0.053	0.059	0.006	11.32
50	0.063	0.069	0.006	9.52
100	0.073	0.08	0.007	9.59

Property #3 Characteristics

	Approach 1	Approach 2	Approach 1	Approach 2	Approach 1	Approach 2
Property	3a		3b		3c	
Property Area	2.88		10.34		1.60	
Road Area	0.271		0.538		0.00	
% Impervious	2.49	9.41	2.13	5.20	0.00	0.00
Longest Flow Path (m)	579.5	128.3	822.6	787.6	436	272.1
Slope (%)	0.89	1.17	1.32	1.02	0.01	0.37
CN (Existing)	81.0	82.0	81.0	81.9	84.5	81.0
Tp(hr)	0.61	0.15	0.66	0.71	4.08	0.52
CN (Post-Development)	81.4	83.5	81.4	82.7	84.5	81.0
Tp(hr)	0.60	0.15	0.65	0.69	4.08	0.52

Property #3 Peak Flow Rates (m^3/s)

Approach #1

Property	3a				3b				3c			
Storm Duration	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change
2	0.095	0.097	0.002	2.11	0.216	0.22	0.004	1.85	0.194	0.194	0	0.00
5	0.161	0.164	0.003	1.86	0.365	0.372	0.007	1.92	0.315	0.315	0	0.00
10	0.209	0.213	0.004	1.91	0.475	0.482	0.007	1.47	0.4	0.4	0	0.00
25	0.274	0.279	0.005	1.82	0.623	0.632	0.009	1.44	0.514	0.515	0.001	0.19
50	0.325	0.33	0.005	1.54	0.737	0.747	0.01	1.36	0.601	0.602	0.001	0.17
100	0.377	0.383	0.006	1.59	0.854	0.866	0.012	1.41	0.689	0.69	0.001	0.15

Approach #2

Property	3a				3b				3c			
Storm Duration	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change
2	0.03	0.032	0.002	6.67	0.091	0.095	0.004	4.40	0.014	0.014	0	0.00
5	0.049	0.052	0.003	6.12	0.153	0.159	0.006	3.92	0.025	0.025	0	0.00
10	0.063	0.065	0.002	3.17	0.198	0.205	0.007	3.54	0.032	0.032	0	0.00
25	0.081	0.084	0.003	3.70	0.259	0.268	0.009	3.47	0.042	0.042	0	0.00
50	0.095	0.098	0.003	3.16	0.307	0.317	0.01	3.26	0.049	0.049	0	0.00
100	0.109	0.112	0.003	2.75	0.355	0.365	0.01	2.82	0.057	0.057	0	0.00

Property #4 Characteristics

	Approach 1	Approach 2	Approach 1	Approach 2	Approach 1	Approach 2
Property	4a		4b		4c	
Property Area	3.07		7.53		1.75	
Road Area	0.14		0.24		0.34	
% Impervious	0.87	4.43	0.62	3.13	4.98	19.26
Longest Flow Path (m)	428.9	315.4	947.7	558.5	348.7	322.9
Slope (%)	0.64	0.54	0.48	0.47	0.72	0.68
CN (Existing)	85.7	84.3	84.5	88.3	88.0	88.2
Tp(hr)	0.48	0.43	1.10	0.63	0.35	0.34
CN (Post-Development)	85.8	84.9	84.6	88.6	88.5	90.1
Tp(hr)	0.48	0.42	1.09	0.63	0.35	0.31

Property #4 Peak Flow Rates (m^3/s)

Approach #1

Property	4a				4b				4c			
Storm Duration	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change
2	0.179	0.18	0.001	0.56	0.345	0.346	0.001	0.29	0.091	0.092	0.001	1.10
5	0.293	0.295	0.002	0.68	0.561	0.563	0.002	0.36	0.146	0.149	0.003	2.05
10	0.373	0.375	0.002	0.54	0.717	0.72	0.003	0.42	0.183	0.187	0.004	2.19
25	0.479	0.481	0.002	0.42	0.926	0.929	0.003	0.32	0.232	0.236	0.004	1.72
50	0.561	0.563	0.002	0.36	1.087	1.09	0.003	0.28	0.269	0.273	0.00	1.49
100	0.643	0.645	0.002	0.31	1.249	1.253	0.004	0.32	0.305	0.309	0.00	1.31

Approach #2

Property	4a				4b				4c			
Storm Duration	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change
2	0.034	0.035	0.001	2.94	0.093	0.095	0.002	2.15	0.024	0.027	0.003	12.50
5	0.055	0.057	0.002	3.64	0.15	0.152	0.002	1.33	0.038	0.042	0.004	10.53
10	0.071	0.073	0.002	2.82	0.19	0.192	0.002	1.05	0.048	0.052	0.004	8.33
25	0.091	0.094	0.003	3.30	0.242	0.245	0.003	1.24	0.061	0.065	0.004	6.56
50	0.107	0.11	0.003	2.80	0.282	0.285	0.003	1.06	0.07	0.074	0.004	5.71
100	0.123	0.126	0.003	2.44	0.321	0.325	0.004	1.25	0.079	0.084	0.005	6.33

Property #8 Characteristics

	Approach #1	Approach #2
Property	8b	
Property Area	1.940	
Road Area	0.110	
% Impervious	2.21	5.67
Longest Flow Path (m)	476.5	155.0
Slope (%)	0.54	0.64
CN (Existing)	81.0	82.3
Tp(hr)	0.67	0.24
CN (Post-Development)	81.4	83.2
Tp(hr)	0.66	0.23

Property #8 Peak Flow Rates (m^3/s)

Approach #1

Property	8b			
Storm Duration	Existing	Proposed	Absolute Change	% Change
2	0.042	0.043	0.001	2.38
5	0.072	0.073	0.001	1.39
10	0.093	0.095	0.002	2.15
25	0.122	0.125	0.003	2.46
50	0.145	0.147	0.002	1.38
100	0.168	0.171	0.003	1.79

Approach #2

Property	8b			
Storm Duration	Existing	Proposed	Absolute Change	% Change
2	0.021	0.022	0.001	4.76
5	0.0334	0.036	0.0026	7.78
10	0.044	0.045	0.001	2.27
25	0.057	0.058	0.001	1.75
50	0.067	0.068	0.001	1.49
100	0.076	0.078	0.002	2.63

Property #11 Characteristics

	Approach #1	Approach #2
Property	11a	
Property Area	0.433	
Road Area	0	
% Impervious	0	0
Longest Flow Path (m)	354.7	634.0
Slope (%)	1.97	1.26
CN (Existing)	81.4	82.6
Tp(hr)	0.27	0.52
CN (Post-Development)	81.4	82.6
Tp(hr)	0.27	0.52

Property #11 Peak Flow Rates (m^3/s)

Approach #1

Property	11a			
Storm Duration	Existing	Proposed	Absolute Change	% Change
2	0.129	0.129	0	0.00
5	0.215	0.215	0	0.00
10	0.276	0.276	0	0.00
25	0.358	0.358	0	0.00
50	0.421	0.421	0	0.00
100	0.484	0.484	0	0.00

Approach #2

Property	11a			
Storm Duration	Existing	Proposed	Absolute Change	% Change
2	0.004	0.004	0	0.00
5	0.007	0.007	0	0.00
10	0.009	0.009	0	0.00
25	0.012	0.012	0	0.00
50	0.014	0.014	0	0.00
100	0.016	0.016	0	0.00

Property #14 Characteristics

	Approach 1	Approach 2	Approach 1	Approach 2	Approach 1	Approach 2
Property	14AB-a		14AB-b		14C-b	
Property Area	67.14		3.33		0.525	
Road Area	3.27		0.21		0	
% Impervious	3.56	4.87	1.76	6.27	0	0
Longest Flow Path (m)	1452.6	1140.9	903.1	774.4	1227.7	113.9
Slope (%)	0.63	0.56	0.34	0.42	0.68	0.26
CN (Existing)	86.8	85.6	86.8	89.2	86.8	89.8
Tp(hr)	0.48	1.13	0.45	0.84	0.40	0.22
CN (Post-Development)	87.2	86.2	87.0	89.8	86.8	89.8
Tp(hr)	0.47	1.10	0.45	0.82	0.40	0.22

Property #14 Peak Flow Rates (m^3/s)

Approach #1

Property	14AB-a				14AB-b				14C-b			
Storm Duration	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change
2	1.11	1.136	0.026	2.34	0.145	0.147	0.002	1.38	0.804	0.804	0	0.00
5	1.799	1.833	0.034	1.89	0.235	0.237	0.002	0.85	1.305	1.305	0	0.00
10	2.278	2.317	0.039	1.71	0.298	0.301	0.003	1.01	1.654	1.654	0	0.00
25	2.918	2.967	0.049	1.68	0.382	0.385	0.003	0.79	2.113	2.113	0	0.00
50	3.406	3.457	0.051	1.50	0.445	0.448	0.003	0.67	2.459	2.459	0	0.00
100	3.893	3.947	0.054	1.39	0.508	0.514	0.006	1.18	2.804	2.805	0.001	0.04

Approach #2

Property	14AB-a				14AB-b				14C-b			
Storm Duration	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change
2	0.633	0.654	0.021	3.32	0.04	0.042	0.002	5.00	0.008	0.008	0	0.00
5	1.024	1.055	0.031	3.03	0.064	0.066	0.002	3.13	0.012	0.012	0	0.00
10	1.302	1.339	0.037	2.84	0.081	0.083	0.002	2.47	0.015	0.015	0	0.00
25	1.674	1.72	0.046	2.75	0.103	0.106	0.003	2.91	0.019	0.019	0	0.00
50	1.961	2.011	0.05	2.55	0.12	0.123	0.003	2.50	0.022	0.022	0	0.00
100	2.25	2.304	0.054	2.40	0.137	0.14	0.003	2.19	0.025	0.025	0	0.00

Property #20 Characteristics

	Approach #1	Approach #2
Property	20c	
Property Area	0.137	
Road Area	0.06	
% Impervious	2.67	314.6
Longest Flow Path (m)	733.8	59.0
Slope (%)	0.27	0.85
CN (Existing)	86.8	86.3
Tp(hr)	0.17	0.08
CN (Post-Development)	87.1	91.1
Tp(hr)	0.17	0.06

Property #20 Peak Flow Rates (m^3/s)

Approach #1

Property	20c			
Storm Duration	Existing	Proposed	Absolute Change	% Change
2	0.027	0.027	0.00	0
5	0.043	0.043	0.00	0
10	0.054	0.054	0.00	0
25	0.069	0.069	0.00	0
50	0.08	0.08	0.00	0
100	0.09	0.09	0.00	0

Approach #2

Property	20c			
Storm Duration	Existing	Proposed	Absolute Change	% Change
2	0.001	0.001	0.00	0
5	0.002	0.002	0.00	0
10	0.002	0.002	0.00	0
25	0.003	0.003	0.00	0
50	0.003	0.003	0.00	0
100	0.004	0.004	0.00	0

Property #22 Characteristics

	Approach 1	Approach 2	Approach 1	Approach 2
Property	22a		22b	
Property Area	1.45		3.58	
Road Area	0.16		0.19	
% Impervious	2.62	13.3	4.90	7.28
Longest Flow Path (m)	377.3	270.3	210.7	221.2
Slope (%)	0.47	0.19	0.50	0.14
CN (Existing)	86.8	87.1	86.8	81.8
Tp(hr)	0.19	0.59	0.11	0.70
CN (Post-Development)	87.4	88.3	87.3	82.7
Tp(hr)	0.18	0.56	0.11	0.68

Property #22 Peak Flow Rates (m^3/s)

Approach #1

Property	22a				22b			
Storm Duration	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change
2	0.082	0.084	0.002	2.44	0.046	0.047	0.001	2.17
5	0.13	0.133	0.003	2.31	0.073	0.073	0	0.00
10	0.163	0.166	0.003	1.84	0.091	0.091	0	0.00
25	0.205	0.209	0.004	1.95	0.115	0.115	0	0.00
50	0.238	0.241	0.003	1.26	0.132	0.132	0	0.00
100	0.27	0.273	0.003	1.11	0.15	0.15	0	0.00

Approach #2

Property	22a				22b			
Storm Duration	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change
2	0.017	0.018	0.001	5.88	0.031	0.003	0.002	6.45
5	0.028	0.029	0.001	3.57	0.053	0.055	0.002	3.77
10	0.035	0.035	0.002	5.71	0.068	0.071	0.003	4.41
25	0.045	0.045	0.002	4.44	0.09	0.093	0.003	3.33
50	0.053	0.053	0.002	3.77	0.106	0.11	0.004	3.77
100	0.06	0.06	0.003	5.00	0.123	0.126	0.003	2.44

Property #23 Characteristics

	Approach 1	Approach 2	Approach 1	Approach 2
Property	23A-b		23A-c	
Property Area	4.46		2.85	
Road Area	0.22		0.12	
% Impervious	2.24	2.62	2.82	4.31
Longest Flow Path (m)	209.3	217.2	382.4	199.1
Slope (%)	0.48	0.18	0.26	0.25
CN (Existing)	86.8	83.9	86.8	81.7
Tp(hr)	0.19	0.55	0.16	0.48
CN (Post-Development)	87.0	84.3	87.1	82.5
Tp(hr)	0.19	0.55	0.16	0.47

Property #23 Peak Flow Rates (m^3/s)

Approach #1

Property	23A-b				23A-c			
Storm Duration	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change
2	0.129	0.131	0.002	1.55	0.054	0.055	0.001	1.85
5	0.205	0.207	0.002	0.98	0.085	0.086	0.001	1.18
10	0.257	0.259	0.002	0.78	0.107	0.108	0.001	0.93
25	0.324	0.327	0.003	0.93	0.135	0.136	0.001	0.74
50	0.375	0.378	0.003	0.80	0.156	0.157	0.001	0.64
100	0.426	0.428	0.002	0.47	0.177	0.178	0.001	0.56

Approach #2

Property	23A-b				23A-c			
Storm Duration	Existing	Proposed	Absolute Change	% Change	Existing	Proposed	Absolute Change	% Change
2	0.045	0.047	0.002	4.44	0.027	0.028	0.001	3.7
5	0.076	0.078	0.002	2.63	0.046	0.047	0.001	2.17
10	0.097	0.1	0.003	3.09	0.059	0.061	0.002	3.39
25	0.126	0.13	0.004	3.17	0.077	0.079	0.002	2.60
50	0.149	0.152	0.003	2.01	0.09	0.093	0.003	3.33
100	0.171	0.175	0.004	2.34	0.105	0.107	0.002	1.90

APPENDIX B

SUBCATCHMENT PARAMETERIZATION

Table 1: Summary of Hydrologic Paramaters for Modelling Approach #1

Property	Catchment Area (ha)	Area of Proposed Access Road for Arrays (ha)	Average Distance to Outlet (m)	CN (Existing conditions)	Tp Existing Conditions (hr)	% Impervious	CN (Proposed Conditions)	Tp Proposed Condtions (hr)
1	19.93	0.51	82.00	81.0	0.36	2.55	81.4	0.36
2	77.73	0.33	117.00	74.0	2.65	0.42	74.1	2.64
3a	10.89	0.27	247.00	81.0	0.61	2.49	81.4	0.60
3b	25.20	0.54	113.00	81.0	0.66	2.13	81.4	0.65
3c	38.18	0.00	326.00	84.5	4.08	0.00	84.5	4.08
4a	15.63	0.14	175.00	85.7	0.48	0.87	85.8	0.48
4b	38.18	0.24	213.00	84.5	1.10	0.62	84.6	1.09
4c	6.77	0.34	300.00	88.0	0.35	4.98	88.5	0.35
6A-a	65.01	0.75	39.54	76.2	1.59	1.16	76.5	1.58
6A-b	15.79	0.00	34.95	82.6	0.09	0.00	82.6	0.09
7a	20.30	0.14	192.28	81.0	0.27	0.70	81.1	0.27
7b	18.80	0.11	338.50	72.4	0.66	0.56	72.5	0.65
8a	4.09	0.06	75.36	67.0	0.57	1.47	67.5	0.56
8b	4.97	0.11	142.80	81.0	0.67	2.21	81.4	0.66
11a	12.65	0.00	200.47	81.4	0.27	0.00	81.4	0.27
11b	31.75	0.41	260.02	81.4	0.71	1.28	81.6	0.71
12	68.31	0.88	283.89	88.0	0.89	1.28	88.1	0.88
14AB-a	91.80	3.27	164.35	86.8	0.48	3.56	87.2	0.47
14AB-b	11.89	0.21	84.49	86.8	0.45	1.76	86.9	0.45
14C-a	29.11	0.72	274.33	86.8	0.49	2.46	87.0	0.49
14C-b	64.90	0.00	160.32	86.8	0.40	0.00	86.8	0.40
19a	9.24	0.22	210.12	86.8	0.22	2.34	87.0	0.21
19b	10.64	0.29	155.50	86.8	0.23	2.72	87.1	0.23
20a	43.54	0.95	269.63	86.8	0.27	2.18	87.0	0.27
20b	13.84	0.18	323.40	86.8	0.20	1.28	86.9	0.20
20c	2.10	0.06	110.58	86.8	0.17	2.67	87.1	0.17
21a	20.54	0.43	108.65	86.8	0.34	2.10	87.0	0.34
21b	9.83	0.12	21.69	86.8	0.22	1.25	86.9	0.22
21c	6.72	0.16	40.57	86.8	0.23	2.31	87.0	0.23
21d	7.53	0.29	182.20	86.8	0.18	3.88	87.2	0.18
22a	6.18	0.16	117.81	86.8	0.19	2.62	87.0	0.19
22b	3.92	0.19	23.73	86.8	0.11	4.90	87.3	0.11
22c	3.88	0.26	22.00	86.8	0.14	6.73	87.5	0.13
22d	17.76	0.34	200.00	86.8	0.10	1.90	86.8	0.10
23A-a	7.21	0.05	112.98	86.8	0.09	0.75	86.8	0.09
23A-b	9.74	0.22	160.74	86.8	0.19	2.24	87.0	0.19
23A-c	4.14	0.12	36.09	86.8	0.16	2.82	87.1	0.16
23B	5.29	0.12	165.00	86.8	0.20	2.32	87.0	0.19
23C-a	5.78	0.02	180.98	86.8	0.24	0.40	86.8	0.24
23C-b	17.76	0.27	222.10	86.8	0.11	1.52	86.9	0.11
24a	17.76	0.33	222.00	86.8	0.10	1.83	86.9	0.10
24b	67.15	0.24	100.00	86.8	0.10	0.35	86.8	0.10

Table 2: Summary of Hydrologic Paramaters for Modelling Approach #2

Property	Area of Property (ha)	Area of Proposed Access Road for Arrays (ha)	CN (Existing conditions)	Tp Existing Conditions (hr)	% Impervious	CN (Proposed Conditions)	Tp Proposed Condtions (hr)
1	8.66	0.51	81.8	0.42	5.87	82.7	0.40
2	2.25	0.33	76.3	0.38	14.53	79.4	0.35
3a	2.88	0.27	82.0	0.15	9.41	83.5	0.15
3b	10.34	0.54	81.9	0.71	5.20	82.7	0.69
3c	1.60	0.00	81.0	0.52	0.00	81.0	0.52
4a	3.07	0.14	84.3	0.43	4.43	84.9	0.42
4b	7.53	0.24	88.3	0.63	3.13	88.6	0.63
4c	1.75	0.34	88.2	0.34	19.26	90.1	0.31
6A-a	14.51	0.75	83.2	0.53	5.19	83.9	0.52
6A-b	0.94	0.00	85.7	0.42	0.00	85.7	0.42
7a	1.54	0.14	85.4	0.21	9.31	86.5	0.20
7b	3.15	0.11	81.0	0.33	3.36	81.6	0.32
8a	2.02	0.06	68.5	0.24	2.98	69.4	0.24
8b	1.94	0.11	82.3	0.24	5.67	83.2	0.23
11a	0.43	0.00	82.6	0.52	0.00	82.6	0.52
11b	5.60	0.41	82.1	0.24	7.27	83.2	0.23
12	17.10	0.88	88.0	0.27	5.12	88.5	0.27
14AB-a	67.14	3.27	85.6	1.13	4.87	86.2	1.10
14AB-b	3.33	0.21	89.2	0.84	6.27	89.8	0.82
14C-a	10.57	0.72	89.0	0.67	6.77	89.6	0.66
14C-b	0.53	0.00	89.8	0.22	0.00	89.8	0.22
19a	1.36	0.22	85.9	0.50	15.88	87.8	0.46
19b	2.55	0.29	84.4	0.73	11.33	85.9	0.69
20a	14.08	0.95	85.0	0.76	6.74	85.9	0.74
20b	3.33	0.18	84.5	0.31	5.31	85.2	0.30
20c	0.14	0.06	86.3	0.08	40.88	91.1	0.07
21a	5.93	0.43	81.7	1.10	2.84	82.2	1.08
21b	4.34	0.12	81.6	0.69	2.84	82.1	0.68
21c	4.85	0.16	81.9	0.50	3.20	82.4	0.49
21d	8.08	0.29	82.1	0.48	3.62	82.7	0.47
22a	1.45	0.16	87.1	0.59	11.20	88.3	0.56
22b	3.58	0.19	81.8	0.70	5.36	82.6	0.68
22c	5.56	0.26	82.4	0.29	4.69	83.1	0.28
22d	4.94	0.34	82.1	0.52	6.92	82.8	0.50
23A-a	0.42	0.05	82.3	0.34	12.80	84.3	0.32
23A-b	4.46	0.22	83.9	0.55	4.89	84.6	0.54
23A-c	2.85	0.12	81.7	0.48	4.10	82.4	0.47
23B	3.19	0.12	80.1	0.15	3.85	80.8	0.14
23C-a	0.71	0.02	81.9	0.35	3.25	82.4	0.34
23C-b	6.12	0.27	82.1	0.53	4.41	82.8	0.52
24a	5.17	0.33	82.1	0.52	6.30	82.9	0.50
24b	3.22	0.24	82.1	0.19	7.40	83.3	0.18

APPENDIX C

HYDROLOGY MODELLING OUTPUT - SUBSTATION

```
V    V   I    SSSSS  U   U    A    L
V    V   I    SS     U   U   A A   L
 V  V    I     SS    U   U  AAAAA  L
 V  V    I      SS   U   U  A   A  L
  VV     I    SSSSS  UUUUU  A   A  LLLLL

 OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
O   O    T      T    H   H   Y Y   MM MM  O   O
O   O    T      T    H   H    Y    M   M  O   O

 OOO     T      T    H   H    Y    M   M   OOO
```


***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files\Visual OTTHYMO 2.2.4\voin.dat

Output filename: C:\AMEC\Projects\Samsung - SWM Plan\Hydrology\Samsung Wind 001\Substation Only - Pre to Post Analysis.out
Summary filename: C:\AMEC\Projects\Samsung - SWM Plan\Hydrology\Samsung Wind 001\Substation Only - Pre to Post Analysis.sum

DATE: 11/2/2011 TIME: 8:36:18 PM

USER:

COMMENTS: _____

****
** SIMULATION NUMBER: 1 **
****

MASS STORM	Filename: C:\AMEC\Projects\Samsung - SWM Plan\Hydrology\AES 12h-60min.mst
Ptotal= 41.20 mm	Comments: AES 12 HR MASS CURVE

Duration of storm = 11.00 hrs
Mass curve time step = 60.00 min
New Storm time step = 6.00 min

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.10	.62	2.90	9.19	5.70	3.79	8.50	.21
.20	1.24	3.00	9.06	5.80	3.63	8.60	.16
.30	1.85	3.10	8.73	5.90	3.46	8.70	.12
.40	2.47	3.20	8.40	6.00	3.30	8.80	.08

.50	3.09	3.30	8.08	6.10	3.09	8.90	.04
.60	3.71	3.40	7.75	6.20	2.88	9.00	.00
.70	4.33	3.50	7.42	6.30	2.68	9.10	.00
.80	4.94	3.60	7.09	6.40	2.47	9.20	.00
.90	5.56	3.70	6.76	6.50	2.27	9.30	.00
1.00	6.18	3.80	6.43	6.60	2.06	9.40	.00
1.10	6.59	3.90	6.10	6.70	1.85	9.50	.00
1.20	7.00	4.00	5.77	6.80	1.65	9.60	.00
1.30	7.42	4.10	5.69	6.90	1.44	9.70	.00
1.40	7.83	4.20	5.60	7.00	1.24	9.80	.00
1.50	8.24	4.30	5.52	7.10	1.15	9.90	.00
1.60	8.65	4.40	5.44	7.20	1.07	10.00	.00
1.70	9.06	4.50	5.36	7.30	.99	10.10	.00
1.80	9.48	4.60	5.27	7.40	.91	10.20	.00
1.90	9.89	4.70	5.19	7.50	.82	10.30	.00
2.00	10.30	4.80	5.11	7.60	.74	10.40	.00
2.10	10.18	4.90	5.03	7.70	.66	10.50	.00
2.20	10.05	5.00	4.94	7.80	.58	10.60	.00
2.30	9.93	5.10	4.78	7.90	.49	10.70	.00
2.40	9.81	5.20	4.61	8.00	.41	10.80	.00
2.50	9.68	5.30	4.45	8.10	.37	10.90	.00
2.60	9.56	5.40	4.28	8.20	.33	11.00	.00
2.70	9.43	5.50	4.12	8.30	.29		
2.80	9.31	5.60	3.96	8.40	.25		

CALIB			
NASHYD (0001)	Area (ha)= 21.50	Curve Number (CN)= 79.0	
ID= 1 DT= 5.0 min	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00	
	U.H. Tp(hrs)= .99		

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.083	.62	2.833	9.26	5.583	3.96	8.33	.27
.167	1.11	2.917	9.16	5.667	3.82	8.42	.24
.250	1.61	3.000	9.06	5.750	3.69	8.50	.21
.333	2.10	3.083	8.73	5.833	3.56	8.58	.16
.417	2.60	3.167	8.47	5.917	3.43	8.67	.13
.500	3.09	3.250	8.21	6.000	3.30	8.75	.10
.583	3.71	3.333	7.94	6.083	3.09	8.83	.07
.667	4.20	3.417	7.68	6.167	2.93	8.92	.03
.750	4.70	3.500	7.42	6.250	2.76	9.00	.00
.833	5.19	3.583	7.09	6.333	2.60	9.08	.00
.917	5.69	3.667	6.82	6.417	2.43	9.17	.00
1.000	6.18	3.750	6.56	6.500	2.27	9.25	.00
1.083	6.59	3.833	6.30	6.583	2.06	9.33	.00
1.167	6.92	3.917	6.03	6.667	1.90	9.42	.00
1.250	7.25	4.000	5.77	6.750	1.73	9.50	.00
1.333	7.58	4.083	5.69	6.833	1.57	9.58	.00
1.417	7.91	4.167	5.62	6.917	1.40	9.67	.00
1.500	8.24	4.250	5.55	7.000	1.24	9.75	.00
1.583	8.65	4.333	5.49	7.083	1.15	9.83	.00
1.667	8.98	4.417	5.42	7.167	1.09	9.92	.00
1.750	9.31	4.500	5.36	7.250	1.02	10.00	.00
1.833	9.64	4.583	5.27	7.333	.96	10.08	.00
1.917	9.97	4.667	5.21	7.417	.89	10.17	.00
2.000	10.30	4.750	5.14	7.500	.82	10.25	.00
2.083	10.18	4.833	5.08	7.583	.74	10.33	.00

2.167	10.08	4.917	5.01	7.667	.68	10.42	.00
2.250	9.98	5.000	4.94	7.750	.61	10.50	.00
2.333	9.88	5.083	4.78	7.833	.54	10.58	.00
2.417	9.78	5.167	4.65	7.917	.48	10.67	.00
2.500	9.68	5.250	4.52	8.000	.41	10.75	.00
2.583	9.56	5.333	4.38	8.083	.37	10.83	.00
2.667	9.46	5.417	4.25	8.167	.34	10.92	.00
2.750	9.36	5.500	4.12	8.250	.30	11.00	.00

Unit Hyd Qpeak (cms)= .829

PEAK FLOW (cms)= .157 (i)
TIME TO PEAK (hrs)= 5.000
RUNOFF VOLUME (mm)= 12.634
TOTAL RAINFALL (mm)= 41.200
RUNOFF COEFFICIENT = .307

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0002)	Area (ha)=	21.50	Curve Number (CN)=	79.3
ID= 1 DT= 5.0 min	Ia (mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=	.98		

Unit Hyd Qpeak (cms)= .838

PEAK FLOW (cms)= .160 (i)
TIME TO PEAK (hrs)= 5.000
RUNOFF VOLUME (mm)= 12.784
TOTAL RAINFALL (mm)= 41.200
RUNOFF COEFFICIENT = .310

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0003)	Area (ha)=	1.50	Curve Number (CN)=	79.0
ID= 1 DT= 5.0 min	Ia (mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=	.23		

Unit Hyd Qpeak (cms)= .249

PEAK FLOW (cms)= .013 (i)
TIME TO PEAK (hrs)= 3.417
RUNOFF VOLUME (mm)= 12.620
TOTAL RAINFALL (mm)= 41.200
RUNOFF COEFFICIENT = .306

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0004)	Area (ha)=	1.50	Curve Number (CN)=	83.6
ID= 1 DT= 5.0 min	Ia (mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=	.20		

Unit Hyd Qpeak (cms)= .286

PEAK FLOW (cms)= .016 (i)

2.167	10.08	4.917	5.01	7.667	.68	10.42	.00
2.250	9.98	5.000	4.94	7.750	.61	10.50	.00
2.333	9.88	5.083	4.78	7.833	.54	10.58	.00
2.417	9.78	5.167	4.65	7.917	.48	10.67	.00
2.500	9.68	5.250	4.52	8.000	.41	10.75	.00
2.583	9.56	5.333	4.38	8.083	.37	10.83	.00
2.667	9.46	5.417	4.25	8.167	.34	10.92	.00
2.750	9.36	5.500	4.12	8.250	.30	11.00	.00

Unit Hyd Qpeak (cms)= .829

PEAK FLOW (cms)= .157 (i)
TIME TO PEAK (hrs)= 5.000
RUNOFF VOLUME (mm)= 12.634
TOTAL RAINFALL (mm)= 41.200
RUNOFF COEFFICIENT = .307

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0002)	Area (ha)=	21.50	Curve Number (CN)=	79.3
ID= 1 DT= 5.0 min	Ia (mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=	.98		

Unit Hyd Qpeak (cms)= .838

PEAK FLOW (cms)= .160 (i)
TIME TO PEAK (hrs)= 5.000
RUNOFF VOLUME (mm)= 12.784
TOTAL RAINFALL (mm)= 41.200
RUNOFF COEFFICIENT = .310

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0003)	Area (ha)=	1.50	Curve Number (CN)=	79.0
ID= 1 DT= 5.0 min	Ia (mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=	.23		

Unit Hyd Qpeak (cms)= .249

PEAK FLOW (cms)= .013 (i)
TIME TO PEAK (hrs)= 3.417
RUNOFF VOLUME (mm)= 12.620
TOTAL RAINFALL (mm)= 41.200
RUNOFF COEFFICIENT = .306

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0004)	Area (ha)=	1.50	Curve Number (CN)=	83.6
ID= 1 DT= 5.0 min	Ia (mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=	.20		

Unit Hyd Qpeak (cms)= .286

PEAK FLOW (cms)= .016 (i)

TIME TO PEAK (hrs)= 3.333
RUNOFF VOLUME (mm)= 15.203
TOTAL RAINFALL (mm)= 41.200
RUNOFF COEFFICIENT = .369

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

****
** SIMULATION NUMBER: 2 **
****

MASS STORM Ptotal= 54.90 mm	Filename: C:\AMEC\Projects\Samsung - SWM Plan\Hydrology\AES 12h-60min.mst Comments: AES 12 HR MASS CURVE

Duration of storm = 11.00 hrs
Mass curve time step = 60.00 min

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
1.00	8.24	4.00	7.69	7.00	1.65	10.00	.00
2.00	13.73	5.00	6.59	8.00	.55	11.00	.00
3.00	12.08	6.00	4.39	9.00	.00		

CALIB NASHYD (0001) ID= 1 DT= 5.0 min	Area (ha)= 21.50 Curve Number (CN)= 79.0 Ia (mm)= 5.00 # of Linear Res.(N)= 3.00 U.H. Tp(hrs)= .99

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.083	8.24	2.833	12.08	5.583	4.39	8.33	.00
.167	8.24	2.917	12.08	5.667	4.39	8.42	.00
.250	8.24	3.000	12.08	5.750	4.39	8.50	.00
.333	8.24	3.083	7.69	5.833	4.39	8.58	.00
.417	8.24	3.167	7.69	5.917	4.39	8.67	.00
.500	8.24	3.250	7.69	6.000	4.39	8.75	.00
.583	8.24	3.333	7.69	6.083	1.65	8.83	.00
.667	8.24	3.417	7.69	6.167	1.65	8.92	.00
.750	8.24	3.500	7.69	6.250	1.65	9.00	.00
.833	8.24	3.583	7.69	6.333	1.65	9.08	.00
.917	8.24	3.667	7.69	6.417	1.65	9.17	.00
1.000	8.24	3.750	7.69	6.500	1.65	9.25	.00
1.083	13.72	3.833	7.69	6.583	1.65	9.33	.00
1.167	13.73	3.917	7.69	6.667	1.65	9.42	.00
1.250	13.73	4.000	7.69	6.750	1.65	9.50	.00
1.333	13.73	4.083	6.59	6.833	1.65	9.58	.00
1.417	13.73	4.167	6.59	6.917	1.65	9.67	.00
1.500	13.73	4.250	6.59	7.000	1.65	9.75	.00
1.583	13.73	4.333	6.59	7.083	.55	9.83	.00
1.667	13.73	4.417	6.59	7.167	.55	9.92	.00
1.750	13.73	4.500	6.59	7.250	.55	10.00	.00
1.833	13.73	4.583	6.59	7.333	.55	10.08	.00
1.917	13.73	4.667	6.59	7.417	.55	10.17	.00
2.000	13.72	4.750	6.59	7.500	.55	10.25	.00

2.083	12.08	4.833	6.59	7.583	.55	10.33	.00
2.167	12.08	4.917	6.59	7.667	.55	10.42	.00
2.250	12.08	5.000	6.59	7.750	.55	10.50	.00
2.333	12.08	5.083	4.39	7.833	.55	10.58	.00
2.417	12.08	5.167	4.39	7.917	.55	10.67	.00
2.500	12.08	5.250	4.39	8.000	.55	10.75	.00
2.583	12.08	5.333	4.39	8.083	.00	10.83	.00
2.667	12.08	5.417	4.39	8.167	.00	10.92	.00
2.750	12.08	5.500	4.39	8.250	.00	11.00	.00

Unit Hyd Qpeak (cms)= .829

PEAK FLOW (cms)= .263 (i)
TIME TO PEAK (hrs)= 4.250
RUNOFF VOLUME (mm)= 21.206
TOTAL RAINFALL (mm)= 54.900
RUNOFF COEFFICIENT = .386

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB NASHYD (0002) ID= 1 DT= 5.0 min	Area (ha)= 21.50	Curve Number (CN)= 79.3
	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00
	U.H. Tp(hrs)= .98	

Unit Hyd Qpeak (cms)= .838

PEAK FLOW (cms)= .267 (i)
TIME TO PEAK (hrs)= 4.167
RUNOFF VOLUME (mm)= 21.428
TOTAL RAINFALL (mm)= 54.900
RUNOFF COEFFICIENT = .390

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB NASHYD (0003) ID= 1 DT= 5.0 min	Area (ha)= 1.50	Curve Number (CN)= 79.0
	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00
	U.H. Tp(hrs)= .23	

Unit Hyd Qpeak (cms)= .249

PEAK FLOW (cms)= .024 (i)
TIME TO PEAK (hrs)= 3.000
RUNOFF VOLUME (mm)= 21.182
TOTAL RAINFALL (mm)= 54.900
RUNOFF COEFFICIENT = .386

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB NASHYD (0004) ID= 1 DT= 5.0 min	Area (ha)= 1.50	Curve Number (CN)= 83.6
	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00
	U.H. Tp(hrs)= .20	

Unit Hyd Qpeak (cms)= .286

PEAK FLOW (cms)= .028 (i)
TIME TO PEAK (hrs)= 3.000
RUNOFF VOLUME (mm)= 24.920
TOTAL RAINFALL (mm)= 54.900
RUNOFF COEFFICIENT = .454

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

****
** SIMULATION NUMBER: 3 **
****

MASS STORM	Filename: C:\AMEC\Projects\Samsung - SWM Plan\Hydrology\AES 12h-60min.mst
Ptotal= 63.90 mm	Comments: AES 12 HR MASS CURVE

Duration of storm = 11.00 hrs
Mass curve time step = 60.00 min

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
1.00	9.59	4.00	8.95	7.00	1.92	10.00	.00
2.00	15.97	5.00	7.67	8.00	.64	11.00	.00
3.00	14.06	6.00	5.11	9.00	.00		

CALIB NASHYD (0001) ID= 1 DT= 5.0 min	Area (ha)= 21.50	Curve Number (CN)= 79.0
	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00
	U.H. Tp(hrs)= .99	

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.083	9.59	2.833	14.06	5.583	5.11	8.33	.00
.167	9.59	2.917	14.06	5.667	5.11	8.42	.00
.250	9.59	3.000	14.06	5.750	5.11	8.50	.00
.333	9.59	3.083	8.95	5.833	5.11	8.58	.00
.417	9.59	3.167	8.95	5.917	5.11	8.67	.00
.500	9.59	3.250	8.95	6.000	5.11	8.75	.00
.583	9.59	3.333	8.95	6.083	1.92	8.83	.00
.667	9.59	3.417	8.95	6.167	1.92	8.92	.00
.750	9.59	3.500	8.95	6.250	1.92	9.00	.00
.833	9.59	3.583	8.95	6.333	1.92	9.08	.00
.917	9.59	3.667	8.95	6.417	1.92	9.17	.00
1.000	9.59	3.750	8.95	6.500	1.92	9.25	.00
1.083	15.97	3.833	8.95	6.583	1.92	9.33	.00
1.167	15.97	3.917	8.95	6.667	1.92	9.42	.00
1.250	15.97	4.000	8.95	6.750	1.92	9.50	.00
1.333	15.97	4.083	7.67	6.833	1.92	9.58	.00
1.417	15.97	4.167	7.67	6.917	1.92	9.67	.00
1.500	15.97	4.250	7.67	7.000	1.92	9.75	.00
1.583	15.97	4.333	7.67	7.083	.64	9.83	.00
1.667	15.97	4.417	7.67	7.167	.64	9.92	.00
1.750	15.97	4.500	7.67	7.250	.64	10.00	.00
1.833	15.97	4.583	7.67	7.333	.64	10.08	.00
1.917	15.97	4.667	7.67	7.417	.64	10.17	.00

2.000	15.97	4.750	7.67	7.500	.64	10.25	.00
2.083	14.06	4.833	7.67	7.583	.64	10.33	.00
2.167	14.06	4.917	7.67	7.667	.64	10.42	.00
2.250	14.06	5.000	7.67	7.750	.64	10.50	.00
2.333	14.06	5.083	5.11	7.833	.64	10.58	.00
2.417	14.06	5.167	5.11	7.917	.64	10.67	.00
2.500	14.06	5.250	5.11	8.000	.64	10.75	.00
2.583	14.06	5.333	5.11	8.083	.00	10.83	.00
2.667	14.06	5.417	5.11	8.167	.00	10.92	.00
2.750	14.06	5.500	5.11	8.250	.00	11.00	.00

Unit Hyd Qpeak (cms)= .829

PEAK FLOW (cms)= .341 (i)
TIME TO PEAK (hrs)= 4.167
RUNOFF VOLUME (mm)= 27.442
TOTAL RAINFALL (mm)= 63.900
RUNOFF COEFFICIENT = .429

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0002)	Area	(ha)=	21.50	Curve Number	(CN)= 79.3
ID= 1 DT= 5.0 min	Ia	(mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=		.98		

Unit Hyd Qpeak (cms)= .838

PEAK FLOW (cms)= .346 (i)
TIME TO PEAK (hrs)= 4.083
RUNOFF VOLUME (mm)= 27.709
TOTAL RAINFALL (mm)= 63.900
RUNOFF COEFFICIENT = .434

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0003)	Area	(ha)=	1.50	Curve Number	(CN)= 79.0
ID= 1 DT= 5.0 min	Ia	(mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=		.23		

Unit Hyd Qpeak (cms)= .249

PEAK FLOW (cms)= .031 (i)
TIME TO PEAK (hrs)= 3.000
RUNOFF VOLUME (mm)= 27.412
TOTAL RAINFALL (mm)= 63.900
RUNOFF COEFFICIENT = .429

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0004)	Area	(ha)=	1.50	Curve Number	(CN)= 83.6
ID= 1 DT= 5.0 min	Ia	(mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=		.20		

Unit Hyd Qpeak (cms)= .286

PEAK FLOW (cms)= .036 (i)
TIME TO PEAK (hrs)= 3.000
RUNOFF VOLUME (mm)= 31.846
TOTAL RAINFALL (mm)= 63.900
RUNOFF COEFFICIENT = .498

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

****
** SIMULATION NUMBER: 4 **
****

MASS STORM	Filename: C:\AMEC\Projects\Samsung - SWM Plan\Hydrology\AES 12h-60min.mst
Ptotal= 75.40 mm	Comments: AES 12 HR MASS CURVE

Duration of storm = 11.00 hrs
Mass curve time step = 60.00 min

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
1.00	11.31	4.00	10.56	7.00	2.26	10.00	.00
2.00	18.85	5.00	9.05	8.00	.75	11.00	.00
3.00	16.59	6.00	6.03	9.00	.00		

CALIB NASHYD (0001) ID= 1 DT= 5.0 min	Area (ha)= 21.50	Curve Number (CN)= 79.0
	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00
	U.H. Tp(hrs)= .99	

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.083	11.31	2.833	16.59	5.583	6.03	8.33	.00
.167	11.31	2.917	16.59	5.667	6.03	8.42	.00
.250	11.31	3.000	16.59	5.750	6.03	8.50	.00
.333	11.31	3.083	10.56	5.833	6.03	8.58	.00
.417	11.31	3.167	10.56	5.917	6.03	8.67	.00
.500	11.31	3.250	10.56	6.000	6.03	8.75	.00
.583	11.31	3.333	10.56	6.083	2.26	8.83	.00
.667	11.31	3.417	10.56	6.167	2.26	8.92	.00
.750	11.31	3.500	10.56	6.250	2.26	9.00	.00
.833	11.31	3.583	10.56	6.333	2.26	9.08	.00
.917	11.31	3.667	10.56	6.417	2.26	9.17	.00
1.000	11.31	3.750	10.56	6.500	2.26	9.25	.00
1.083	18.85	3.833	10.56	6.583	2.26	9.33	.00
1.167	18.85	3.917	10.56	6.667	2.26	9.42	.00
1.250	18.85	4.000	10.56	6.750	2.26	9.50	.00
1.333	18.85	4.083	9.05	6.833	2.26	9.58	.00
1.417	18.85	4.167	9.05	6.917	2.26	9.67	.00
1.500	18.85	4.250	9.05	7.000	2.26	9.75	.00
1.583	18.85	4.333	9.05	7.083	.75	9.83	.00
1.667	18.85	4.417	9.05	7.167	.75	9.92	.00
1.750	18.85	4.500	9.05	7.250	.75	10.00	.00
1.833	18.85	4.583	9.05	7.333	.75	10.08	.00

1.917	18.85	4.667	9.05	7.417	.75	10.17	.00
2.000	18.85	4.750	9.05	7.500	.75	10.25	.00
2.083	16.59	4.833	9.05	7.583	.75	10.33	.00
2.167	16.59	4.917	9.05	7.667	.75	10.42	.00
2.250	16.59	5.000	9.05	7.750	.75	10.50	.00
2.333	16.59	5.083	6.03	7.833	.75	10.58	.00
2.417	16.59	5.167	6.03	7.917	.75	10.67	.00
2.500	16.59	5.250	6.03	8.000	.75	10.75	.00
2.583	16.59	5.333	6.03	8.083	.00	10.83	.00
2.667	16.59	5.417	6.03	8.167	.00	10.92	.00
2.750	16.59	5.500	6.03	8.250	.00	11.00	.00

Unit Hyd Qpeak (cms)= .829

PEAK FLOW (cms)= .448 (i)
TIME TO PEAK (hrs)= 4.000
RUNOFF VOLUME (mm)= 35.935
TOTAL RAINFALL (mm)= 75.400
RUNOFF COEFFICIENT = .477

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0002)	Area (ha)=	21.50	Curve Number (CN)=	79.3
ID= 1 DT= 5.0 min	Ia (mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=	.98		

Unit Hyd Qpeak (cms)= .838

PEAK FLOW (cms)= .454 (i)
TIME TO PEAK (hrs)= 4.000
RUNOFF VOLUME (mm)= 36.255
TOTAL RAINFALL (mm)= 75.400
RUNOFF COEFFICIENT = .481

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0003)	Area (ha)=	1.50	Curve Number (CN)=	79.0
ID= 1 DT= 5.0 min	Ia (mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=	.23		

Unit Hyd Qpeak (cms)= .249

PEAK FLOW (cms)= .040 (i)
TIME TO PEAK (hrs)= 3.000
RUNOFF VOLUME (mm)= 35.895
TOTAL RAINFALL (mm)= 75.400
RUNOFF COEFFICIENT = .476

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0004)	Area (ha)=	1.50	Curve Number (CN)=	83.6
ID= 1 DT= 5.0 min	Ia (mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=	.20		

Unit Hyd Qpeak (cms)= .286

PEAK FLOW (cms)= .046 (i)
TIME TO PEAK (hrs)= 3.000
RUNOFF VOLUME (mm)= 41.144
TOTAL RAINFALL (mm)= 75.400
RUNOFF COEFFICIENT = .546

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

****
** SIMULATION NUMBER: 5 **
****

MASS STORM	Filename: C:\AMEC\Projects\Samsung - SWM Plan\Hydrology\AES 12h-60min.mst
Ptotal= 83.90 mm	Comments: AES 12 HR MASS CURVE

Duration of storm = 11.00 hrs
Mass curve time step = 60.00 min

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
1.00	12.59	4.00	11.75	7.00	2.52	10.00	.00
2.00	20.98	5.00	10.07	8.00	.84	11.00	.00
3.00	18.46	6.00	6.71	9.00	.00		

CALIB NASHYD (0001) ID= 1 DT= 5.0 min	Area (ha)= 21.50	Curve Number (CN)= 79.0
	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00
	U.H. Tp(hrs)= .99	

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.083	12.59	2.833	18.46	5.583	6.71	8.33	.00
.167	12.59	2.917	18.46	5.667	6.71	8.42	.00
.250	12.59	3.000	18.46	5.750	6.71	8.50	.00
.333	12.59	3.083	11.75	5.833	6.71	8.58	.00
.417	12.59	3.167	11.75	5.917	6.71	8.67	.00
.500	12.59	3.250	11.75	6.000	6.71	8.75	.00
.583	12.59	3.333	11.75	6.083	2.52	8.83	.00
.667	12.59	3.417	11.75	6.167	2.52	8.92	.00
.750	12.59	3.500	11.75	6.250	2.52	9.00	.00
.833	12.59	3.583	11.75	6.333	2.52	9.08	.00
.917	12.59	3.667	11.75	6.417	2.52	9.17	.00
1.000	12.59	3.750	11.75	6.500	2.52	9.25	.00
1.083	20.97	3.833	11.75	6.583	2.52	9.33	.00
1.167	20.98	3.917	11.75	6.667	2.52	9.42	.00
1.250	20.98	4.000	11.75	6.750	2.52	9.50	.00
1.333	20.98	4.083	10.07	6.833	2.52	9.58	.00
1.417	20.98	4.167	10.07	6.917	2.52	9.67	.00
1.500	20.98	4.250	10.07	7.000	2.52	9.75	.00
1.583	20.98	4.333	10.07	7.083	.84	9.83	.00
1.667	20.98	4.417	10.07	7.167	.84	9.92	.00
1.750	20.98	4.500	10.07	7.250	.84	10.00	.00

1.833	20.98	4.583	10.07	7.333	.84	10.08	.00
1.917	20.98	4.667	10.07	7.417	.84	10.17	.00
2.000	20.97	4.750	10.07	7.500	.84	10.25	.00
2.083	18.46	4.833	10.07	7.583	.84	10.33	.00
2.167	18.46	4.917	10.07	7.667	.84	10.42	.00
2.250	18.46	5.000	10.07	7.750	.84	10.50	.00
2.333	18.46	5.083	6.71	7.833	.84	10.58	.00
2.417	18.46	5.167	6.71	7.917	.84	10.67	.00
2.500	18.46	5.250	6.71	8.000	.84	10.75	.00
2.583	18.46	5.333	6.71	8.083	.00	10.83	.00
2.667	18.46	5.417	6.71	8.167	.00	10.92	.00
2.750	18.46	5.500	6.71	8.250	.00	11.00	.00

Unit Hyd Qpeak (cms)= .829

PEAK FLOW (cms)= .532 (i)
TIME TO PEAK (hrs)= 3.917
RUNOFF VOLUME (mm)= 42.516
TOTAL RAINFALL (mm)= 83.900
RUNOFF COEFFICIENT = .507

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB			
NASHYD (0002)	Area (ha)= 21.50	Curve Number (CN)= 79.3	
ID= 1 DT= 5.0 min	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00	
	U.H. Tp(hrs)= .98		

Unit Hyd Qpeak (cms)= .838

PEAK FLOW (cms)= .538 (i)
TIME TO PEAK (hrs)= 3.917
RUNOFF VOLUME (mm)= 42.872
TOTAL RAINFALL (mm)= 83.900
RUNOFF COEFFICIENT = .511

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB			
NASHYD (0003)	Area (ha)= 1.50	Curve Number (CN)= 79.0	
ID= 1 DT= 5.0 min	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00	
	U.H. Tp(hrs)= .23		

Unit Hyd Qpeak (cms)= .249

PEAK FLOW (cms)= .047 (i)
TIME TO PEAK (hrs)= 3.000
RUNOFF VOLUME (mm)= 42.469
TOTAL RAINFALL (mm)= 83.900
RUNOFF COEFFICIENT = .506

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB			
NASHYD (0004)	Area (ha)= 1.50	Curve Number (CN)= 83.6	
ID= 1 DT= 5.0 min	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00	
	U.H. Tp(hrs)= .20		

Unit Hyd Qpeak (cms)= .286

PEAK FLOW (cms)= .054 (i)
TIME TO PEAK (hrs)= 3.000
RUNOFF VOLUME (mm)= 48.267
TOTAL RAINFALL (mm)= 83.900
RUNOFF COEFFICIENT = .575

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

****
** SIMULATION NUMBER: 6 **
****

MASS STORM	Filename: C:\AMEC\Projects\Samsung - SWM Plan\Hydrology\AES 12h-60min.mst
Ptotal= 92.30 mm	Comments: AES 12 HR MASS CURVE

Duration of storm = 11.00 hrs
Mass curve time step = 60.00 min

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
1.00	13.85	4.00	12.92	7.00	2.77	10.00	.00
2.00	23.08	5.00	11.08	8.00	.92	11.00	.00
3.00	20.31	6.00	7.38	9.00	.00		

CALIB NASHYD (0001) ID= 1 DT= 5.0 min	Area (ha)= 21.50	Curve Number (CN)= 79.0
	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00
	U.H. Tp(hrs)= .99	

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.083	13.85	2.833	20.31	5.583	7.38	8.33	.00
.167	13.85	2.917	20.31	5.667	7.38	8.42	.00
.250	13.85	3.000	20.31	5.750	7.38	8.50	.00
.333	13.85	3.083	12.92	5.833	7.38	8.58	.00
.417	13.85	3.167	12.92	5.917	7.38	8.67	.00
.500	13.85	3.250	12.92	6.000	7.38	8.75	.00
.583	13.85	3.333	12.92	6.083	2.77	8.83	.00
.667	13.85	3.417	12.92	6.167	2.77	8.92	.00
.750	13.85	3.500	12.92	6.250	2.77	9.00	.00
.833	13.85	3.583	12.92	6.333	2.77	9.08	.00
.917	13.85	3.667	12.92	6.417	2.77	9.17	.00
1.000	13.85	3.750	12.92	6.500	2.77	9.25	.00
1.083	23.07	3.833	12.92	6.583	2.77	9.33	.00
1.167	23.08	3.917	12.92	6.667	2.77	9.42	.00
1.250	23.08	4.000	12.92	6.750	2.77	9.50	.00
1.333	23.08	4.083	11.08	6.833	2.77	9.58	.00
1.417	23.08	4.167	11.08	6.917	2.77	9.67	.00
1.500	23.08	4.250	11.08	7.000	2.77	9.75	.00
1.583	23.08	4.333	11.08	7.083	.92	9.83	.00
1.667	23.08	4.417	11.08	7.167	.92	9.92	.00

1.750	23.08	4.500	11.08	7.250	.92	10.00	.00
1.833	23.08	4.583	11.08	7.333	.92	10.08	.00
1.917	23.08	4.667	11.08	7.417	.92	10.17	.00
2.000	23.07	4.750	11.08	7.500	.92	10.25	.00
2.083	20.31	4.833	11.08	7.583	.92	10.33	.00
2.167	20.31	4.917	11.08	7.667	.92	10.42	.00
2.250	20.31	5.000	11.08	7.750	.92	10.50	.00
2.333	20.31	5.083	7.38	7.833	.92	10.58	.00
2.417	20.31	5.167	7.38	7.917	.92	10.67	.00
2.500	20.31	5.250	7.38	8.000	.92	10.75	.00
2.583	20.31	5.333	7.38	8.083	.00	10.83	.00
2.667	20.31	5.417	7.38	8.167	.00	10.92	.00
2.750	20.31	5.500	7.38	8.250	.00	11.00	.00

Unit Hyd Qpeak (cms)= .829

PEAK FLOW (cms)= .618 (i)
TIME TO PEAK (hrs)= 3.917
RUNOFF VOLUME (mm)= 49.227
TOTAL RAINFALL (mm)= 92.300
RUNOFF COEFFICIENT = .533

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0002)	Area	(ha)=	21.50	Curve Number (CN)=	79.3
ID= 1 DT= 5.0 min	Ia	(mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=		.98		

Unit Hyd Qpeak (cms)= .838

PEAK FLOW (cms)= .625 (i)
TIME TO PEAK (hrs)= 3.833
RUNOFF VOLUME (mm)= 49.617
TOTAL RAINFALL (mm)= 92.300
RUNOFF COEFFICIENT = .538

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0003)	Area	(ha)=	1.50	Curve Number (CN)=	79.0
ID= 1 DT= 5.0 min	Ia	(mm)=	5.00	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=		.23		

Unit Hyd Qpeak (cms)= .249

PEAK FLOW (cms)= .055 (i)
TIME TO PEAK (hrs)= 3.000
RUNOFF VOLUME (mm)= 49.173
TOTAL RAINFALL (mm)= 92.300
RUNOFF COEFFICIENT = .533

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB					
NASHYD (0004)	Area	(ha)=	1.50	Curve Number (CN)=	83.6
ID= 1 DT= 5.0 min	Ia	(mm)=	5.00	# of Linear Res.(N)=	3.00

---------- U.H. Tp(hrs)= .20

Unit Hyd Qpeak (cms)= .286

PEAK FLOW (cms)= .062 (i)
TIME TO PEAK (hrs)= 3.000
RUNOFF VOLUME (mm)= 55.472
TOTAL RAINFALL (mm)= 92.300
RUNOFF COEFFICIENT = .601

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

FINISH

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APPENDIX C

WATER ASSESSMENT AND WATER BODY REPORT

APPENDIX D

NOISE STUDY REPORT

APPENDIX E

SETBACKS AND SCREENING DEVICES