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Bio-Resources | Building Systems | Environmental | Geotechnical | Project Management

VIOLET SOLAR FARM

ENVIRONMENTAL IMPACT ASSESSMENT

Brunswick Mills, New Brunswick

Prepared for:

C2 Solar Ltd.
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C2 Solar

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16 July 2019

Project No: 12316

SAINT JOHN CLYDE RIVER HALIFAX

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ENGINEERS & GEOSCIENTISTS BRITISH COLUMBIA

OQM CERTIFIED

EXECUTIVE SUMMARY

C2 Solar Ltd., a renewable energy start-up company, is proposing to build and operate Atlantic Canada's first utility-scale solar farm. The 10 MW + Violet Solar Farm will occupy 40 ha of a 112 ha appropriately zoned land parcel in Brunswick Mills, which is located in the Bathurst Mining Camp region of New Brunswick. This clean, renewable energy project will help New Brunswick in its transition to a low-carbon economy.

Site's average solar radiation incident on a horizontal surface is 3.93 kWh · m^{-2} · yr^{-1}

Atlantic Canada's first utility-scale (10 MW +) solar farm and comprise 31 200, 320 W panels over 40 ha

Will generate enough clean, renewable energy to supply at least 2 000 homes

Net CO_{2eq} offset of 82 474 tonnes over 25 years

Estimated capital cost of $18 million

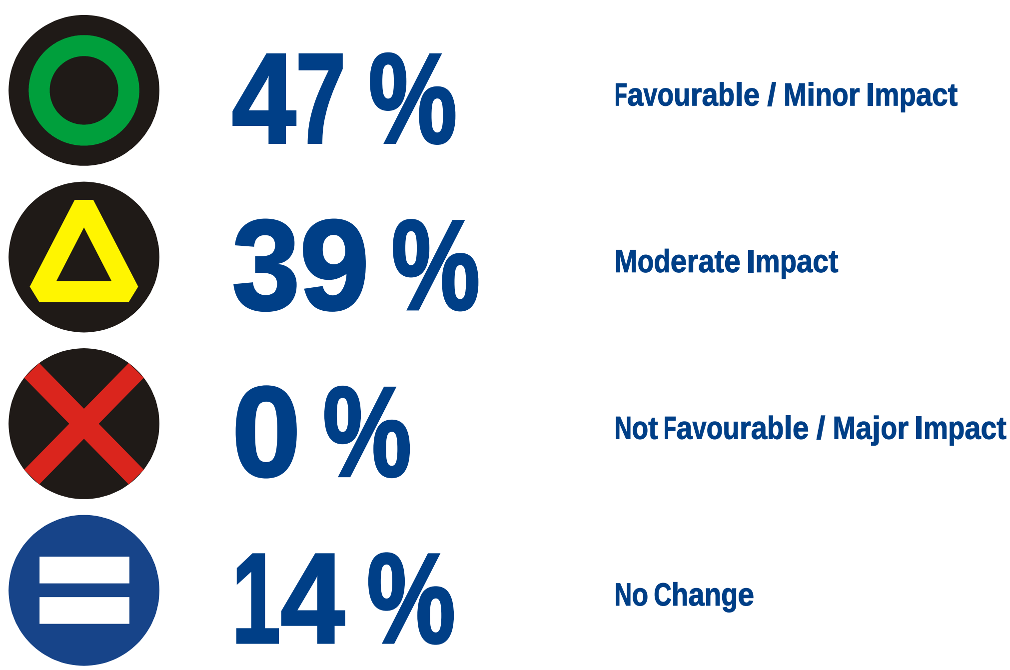
Require 40 to 60 people to construct and several (part-time) to operate and maintain

As per the Environmental Impact Assessment (EIA) Regulation **[87-83]** of the New Brunswick *Clean Environment Act*, the solar farm triggers EIA review. An EIA is a planning tool used by the proponent and regulatory authorities. The purpose of an EIA is to identify and evaluate the potential impacts that a project may have on the environment and vice versa. Best-management practices are presented to mitigate any identified potential environmental impacts. In New Brunswick, the Department of Environment and Local Government oversees the EIA process.

This EIA document provides a detailed description of the solar farm and a narrative on the baseline environment. Components of the existing environment that are described include the physio-chemical environment, the biological environment, and the socio-economic environment. The baseline environment was overlain by five Project stages (*i.e.*, environmental permitting, construction, operation and maintenance, decommissioning, and mishaps, errors, and / or unforeseen events) to assess potential environmental interactions. Based on that process, 10 Valued Environmental Components (VECs) were identified and included:

- physio-chemical environment:
  - air quality;
  - sound emissions;
  - surface water quantity and quality; and
  - groundwater quantity and quality;
- biological environment:
  - terrestrial flora and fauna; and
- socio-economic environment:
  - labour and economy;
  - land-use;
  - transportation network;
  - aesthetics; and
  - health and safety.

Within this EIA document, a visual impact assessment process analogous to a traffic light was used for characterizing potential environmental impacts. All told, 128 specific potential impacts were assessed. In many instances, there are no changes or minor impacts anticipated as a result of the Project. Where there are potential moderate impacts, they are primarily associated with construction. Overall, the assessment yielded a favourable to moderate environmental impact. The solar facility should proceed as detailed within this EIA document.



An Environmental Protection Plan (EPP) specific to the Violet Solar Farm will be developed to mitigate identified potential impacts. The EPP will dictate the importance of best-management practices that will be undertaken by all those associated with the Project to ensure environmental protection. It will be a dynamic document to be used by Project personnel in the field and at the corporate level for ensuring commitments made in the EIA are implemented and monitored.

The EIA process is open and transparent. As such, there is a consultation process that ensures those individuals and / or groups that may be potentially affected by the Project are made aware of the registration, are able to obtain information on the project, and are able to express any and / or all concerns they may have. This EIA document is available for public comment until 6 September 2019. Following that, a Public Involvement report will be submitted to the NBDELG for consideration during Project approval.

Comments, questions, and concerns regarding this EIA document can be forwarded to the Environmental Consultant:

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ACRONYMS

AAS: Aboriginal Affairs Secretariat

AC: Alternating Current

ACCDC: Atlantic Canada Conservation Data Centre

ACOA: Atlantic Canada Opportunities Agency

AM: (Ante Meridiem) before midday

ATV: All-Terrain Vehicle

B.A.: Bachelor of Arts

BMP: Best Management Practice

c-Si: polycrystalline silicon

CA: Census Agglomeration

CAD: Canadian

CAPEX: CAPital EXpenditure

CDD: Canadian Disaster Database

CdTe: cadmium telluride

CDWQG: Canadian Drinking Water Quality Guideline

CH: Caledonia Highlands

cm: centimetres

CO_2: carbon dioxide

CO_{2eq}: carbon dioxide equivalents

COSEWIC: Committee On the Status of Endangered Wildlife In Canada

cSi-PV: crystalline silicon PhotoVoltaic

CSIA: Canadian Solar Industries Association

DC:	Direct Current
DDT:	DichloroDiphenylTrichloroethane
DEWA:	Dubai Electricity and Water Authority
e.g.:	(*exempli gratia*) for example
EIA:	Environmental Impact Assessment
EP:	Environmental Professional
et al.:	(*et alii* / *et aliae* / *et alia*) and others
EPP:	Environmental Protection Plan
ESA:	Environmentally Sensitive Area
etc.:	(*et cetera*) and so forth
FID:	Final Investment Decision
FIT:	Feed-In-Tariff
f*SARA*:	federal *Species At Risk Act*
GC:	Government of Canada
GHG:	GreenHouse Gas
GHGRP:	GreenHouse Gas Reporting Program
GW:	GigaWatts
GWh:	GigaWatts per hour
ha:	hectare
hrs:	hours
i.e.:	(*id est*) namely / that is
IBOF:	Inner Bay Of Fundy
ICLR:	Institute for Catastrophic Loss Reduction
NBIF:	New Brunswick Innovation Foundation
IFC:	International Finance Corporation
IPCC:	Intergovernmental Panel on Climate Change
IRAP:	Industrial Research Assistance Program
ISO:	International Standards Organization
ITK:	Indigenous Traditional Knowledge
kg:	kilograms
km:	kilometre
kt:	kilotonnes
km^2:	square kilometres
kPa:	kiloPascals
kVA:	kiloVolt Amps

kW:	kiloWatt
kWh:	kiloWatt hours
L:	Litre
LSD:	Local Service District
Ltd.:	Limited
m:	metres
m^2:	square metres
m^3:	cubic metres
min:	minutes
mm:	millimetres
MO:	MOncton
MTI:	Mi'gmawe'l Tplu'taqnn Inc.
MVA:	MilliVolt Amps
MW:	MegaWatt
mya:	million years ago
N:	North
NASA:	North American Space Agency
n:	statistical symbol for sample size
n.b.:	(*nota bene*) note well / take note
NAP:	Northern Appalachians
NB:	New Brunswick
NB Power:	New Brunswick Power
NBDELG:	New Brunswick Department of Environment and Local Government
NBDJPS:	New Brunswick Department of Justice and Public Safety
NBDTHC:	New Brunswick Department of Tourism, Heritage, and Culture
NBIF:	New Brunswick Innovation Foundation
NGO:	Non-Government Organization
NRC:	National Research Council
O&M:	Operation and Maintenance
ONB:	Opportunities New Brunswick
OPEX:	OPerational EXpense
OWLS:	Online Well Log System
P.Eng.:	Professional Engineer
P.Geo.:	Professional Geoscientist

PB:	Passamaquoddy Bay
PDF:	Portable Document Format
PhD:	Doctorate of Philosophy
PID:	Property Identifier
PM:	(Post Meridiem) after midday
PO:	Post Office
pop.:	population
PPA:	Power Purchase Agreement
p*SARA*:	provincial *Species At Risk Act*
PSC:	Public Safety Canada
PV:	PhotoVoltaic
RA:	Regulatory Authority
RDC:	Regional Development Corporation
ROW:	Right-Of-Way
s:	second
SCADA:	Supervisory Control And Data Acquisition
t:	tonne
TBD:	To Be Determined
TRC:	Technical Review Committee
US:	United States
W:	Watt
W:	West
WAWA:	Watercourse And Wetland Alteration
WNNB:	Wolastoqey Nation in New Brunswick
yr:	year
%:	Care Of
%:	Percent
$:	dollars
¢:	cents
°:	degrees
°C:	degrees Celsius
° ' ":	degrees minutes seconds
>:	greater than
≥:	greater than or equal to

<: less than

≤: less than or equal to

×: multiplication symbol

®: Registered

~: Approximately

±: plus or minus

1.0 PROPONENT

1.1 PROPONENT NAME

The proponent for this Project is C2 Solar Ltd. (C2 Solar). C2 Solar is a company deeply-rooted in New Brunswick that was founded to foster local investment in renewable energy and other innovative technologies, all with the aim of driving economic development and furthering New Brunswick's reputation as a regional energy leader.

1.2 PROPONENT ADDRESS

2151 Sandy Point Road
Saint John, New Brunswick
E2K 5H4

1.3 PROPONENT CONTACT

Mr. Fraser Forsythe, *P.Eng.*
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C2 Solar Ltd.

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1.4 PRINCIPAL CONTACT FOR PURPOSES OF ENVIRONMENTAL IMPACT ASSESSMENT

Fundy Engineering & Consulting Ltd. (Fundy Engineering) prepared this Environmental Impact Assessment (EIA) Registration Document. The principal contact at Fundy Engineering with respect to this EIA is:

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1.5 PROPERTY OWNERSHIP

Construction and operation of the Project will occur on the 112 hectare (ha) land parcel identified in the New Brunswick Geographical Corporation's database as Property IDentifier (PID) 20557021 (Figure 1). The property, located in Brunswick Mills, is owned by the Regional Development Corporation (RDC). C2 Solar currently has a land-use agreement in place with the RDC to investigate the property for developing and operating a solar farm. A PID map and reports for the property are included in Appendix I as is a letter from the RDC indicating that C2 Solar has an agreement in place to investigate use of the lands for a solar farm.

Figure 1. Aerial photograph circa 2015 showing the property in Brunswick Mills, New Brunswick that is the subject of C2 Solar's proposed Violet Solar Farm.

2.0 PROJECT DESCRIPTION

2.1 PROJECT NAME

For the purposes of this EIA, the Project is referred to as:

VIOLET SOLAR FARM

2.2 PROJECT OVERVIEW

The sun is the central star of our solar system. It radiates light and heat, which makes it possible for life to exist on Earth. Annually, about 3.4 × 10^{24} Joules of solar energy reach the Earth's surface [*WEC*, 2013]. That is about 7 500 times global primary energy consumption required annually. Despite there being an abundance of potential energy to harvest from the sun, as shown in Figure 2, less than 0.5 % of today's energy consumption for societal needs is generated from the sun [*WEC*, 2016]. Society remains highly dependent on fossil fuels to generate energy; more than 85 % is derived from the burning of fossil fuels [*WEC*, 2016]. This is a growing concern because electricity generation is the largest individual contributor to GreenHouse Gas (GHG) emissions globally [*IPCC*, 2014]. Not only is fossil fuel derived electricity generation harmful to the present and future environment, but it is unsustainable.

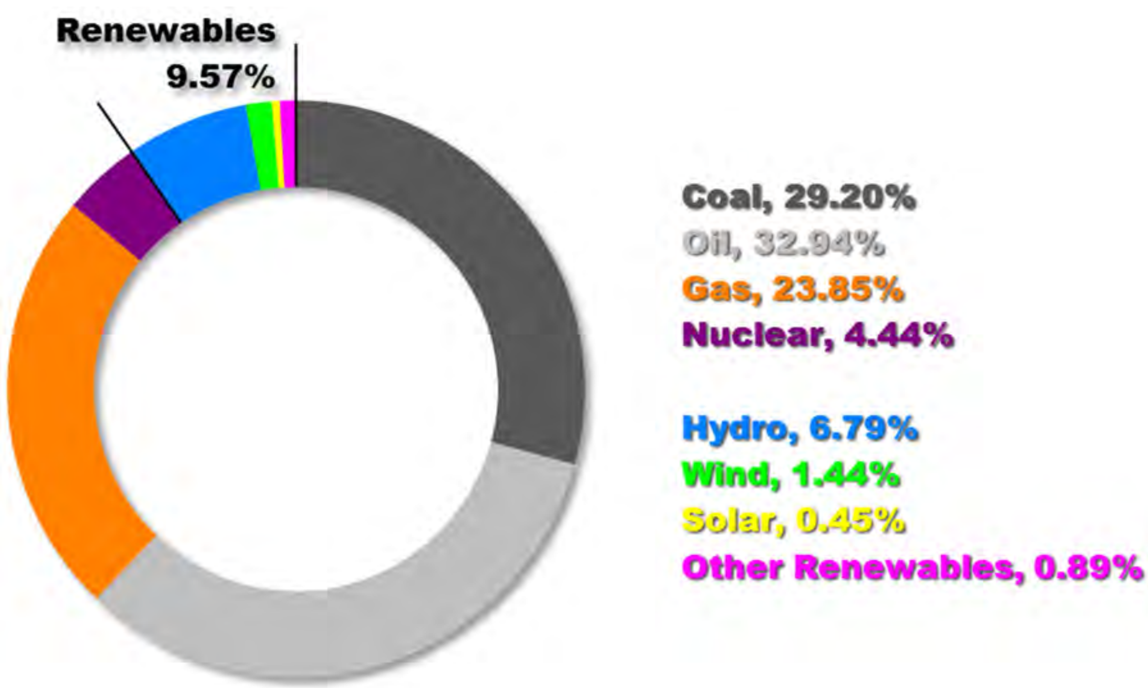


Figure 2. Composition of primary global energy consumption in 2015. Data from *WEC* [2016].

In 1839, while experimenting with silver coated platinum electrodes immersed in an electrolyte, French physicist Alexandre Edmond Becquerel observed a physical phenomenon allowing conversion of solar light to electricity [*Becquerel*, 1839]. By 1884, Charles Fritts, an American inventor, was able to produce a small amount of electricity by placing a layer of selenium coated with gold leaf atop a metal plate [*Nelson*, 2007]. Soon thereafter, the first United States (US) patent for a solar cell was issued to Chemist Edward Weston [*Weston*, 1888]. Although solar cells had been developed, they were only capable of producing very small amounts of electricity (*i.e.*, < 1 % efficient). Because of this, cheaper and more efficient forms of electricity generation, such as oil and gas, were focused on for many years to follow.

On 25 April 1954, Bell Labs announced that they had developed the first practical solar cell using silicon instead of selenium [*Chodos*, 2009]. Their silicon cells were about 6 % efficient at converting sunlight to electricity, which meant that they were practical for use; however, because of their high cost, their use was primarily restricted to aerospace applications (*i.e.*, satellites). Their high cost prohibited wide-scale use for many years.

On 15 December 1982, ARCO Solar Inc. commissioned the world's first solar farm. The 1 MegaWatt (MW) grid-connected PhotoVoltaic (PV) installation in Hesperia, California comprised 256 monocrystalline solar cell modules in an 8 ha array (*n.b.*, refer to Figure 3 for a schematic of a solar cell, module / panel, and array) [*Arnett et al.*, 1984].

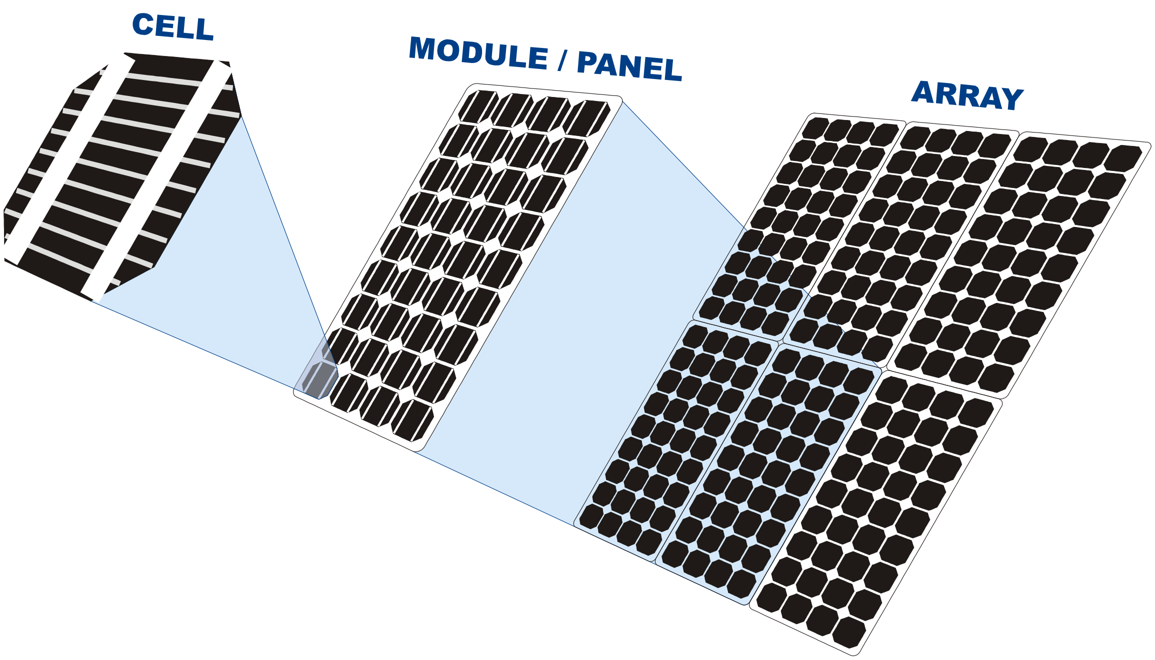


Figure 3. Definition of a solar cell, solar module / panel, and a solar array.

Today, PV arrays are used for both standalone and grid-connected electricity systems. When sunlight hits a PV module, a percentage of the light energy is absorbed by the solar cell. Technology within the solar cell then converts the light energy into Direct Current (DC) electricity, which is then converted to Alternating Current (AC) electricity for use on-site (*i.e.*, standalone electrical systems) or transmission to the electrical grid.

Since ARCO Solar Inc.'s success, PV technology and electricity generating conversion efficiency have markedly improved. This, coupled with reduced installation costs per watt (*n.b.*, the cost of PV modules has continued to fall to where they are now well below \$1 · Watt^{-1} (W) as shown in Figure 4) and reduced energy payback periods, have made solar energy attractive for utility-scale energy systems. Furthermore, PV technology passively generates electricity; there are no GHG emissions during operation. Skypower Ltd. opened Canada's first utility-scale PV farm (*i.e.*, the 9.1 MW First Light I) in 2009 outside Stone Mills, Ontario (Figure 5). In 2015, Phase II of China's Longyangxia Dam Solar Park opened as the world's largest solar farm with a capacity of 850 MW. We will continue to see the development of solar farms across the globe.

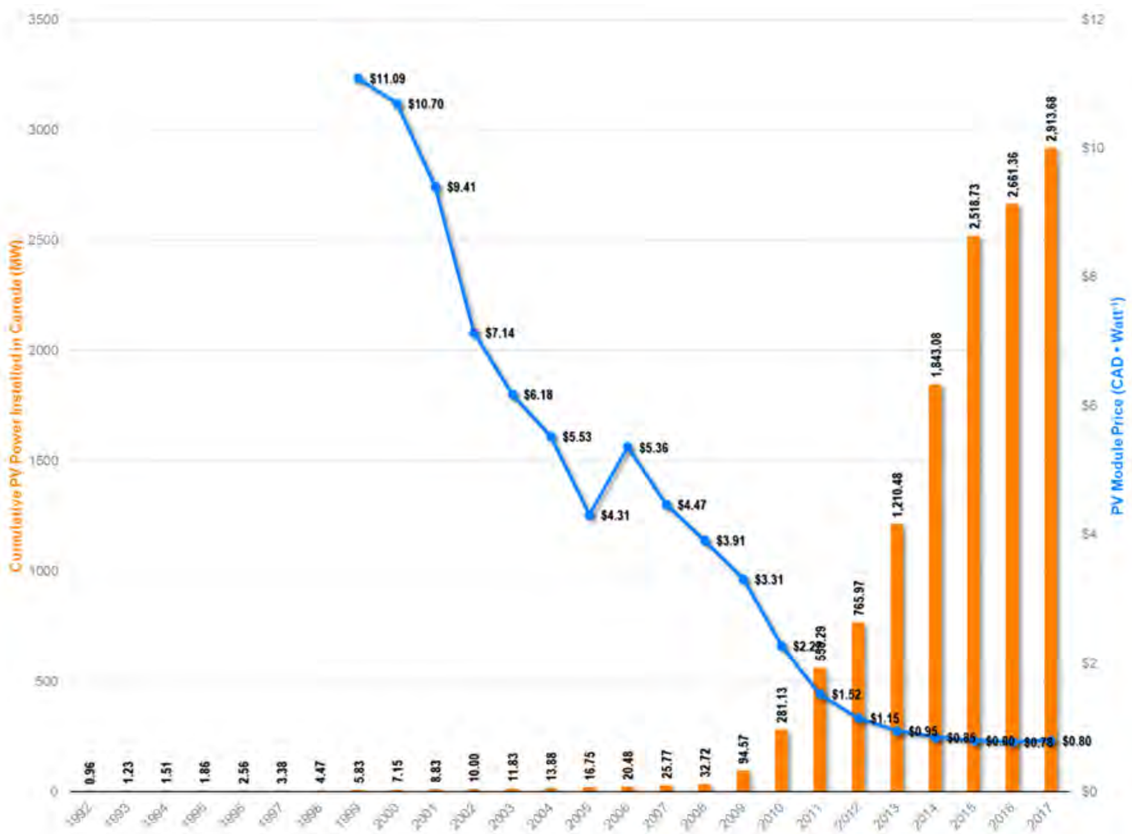


Figure 4. Cumulative photovoltaic power and module price for photovoltaic power installed in Canada between 1992 and 2015. Data from *Poissant and Luukkonen* [2014], *Poissant and Bateman* [2015], *Poissant et al.* [2016], *Poissant et al.* [2017] and *Baldus-Jersen et al.* [2018].

Canada's solar industry has seen consistent and rapid growth (Figure 4). In 1992, only 960 kiloWatts (kW) of installed PV capacity existed in Canada whereas in 2017 it had grown to 2 914 MW. There has been considerable variability in growth of Canada's solar industry because electricity generation falls under provincial jurisdiction. In 2017, 97.3 % of Canada's total installed PV capacity was located in Ontario (Figure 6). PV growth in Ontario is a result of the PV-focused procurement programs launched there in 2006, including the Renewable Energy Standard Offer Program, the Feed-In-Tariff (FIT) program (*i.e.*, for projects > 10 kW), and the microFIT program (*i.e.*, projects ≤ 10 kW). To date, there are > 100 utility-scale PV farms across Ontario, though the majority tend to be clustered around large southern metropolitan areas (Figure 7). The Province's, and Canada's largest, is the 100 MW Cayuga Grand Renewable Solar Project along the shores of Lake Erie.

Figure 5. Google Earth image showing Skypower's First Light I solar farm outside Stone Mills, Ontario, which opened as Canada's first solar farm in 2009.

It is interesting to note that in 2017, New Brunswick ranked eleventh in terms of installed PV capacity for provinces and territories (Figure 6; *n.b.*, its ranking has dropped in recent years as other regions move ahead). There were 98 utility interconnected PV systems in New Brunswick with a combined capacity of 0.730 MW [*Baldus-Jeursen et al.*, 2018]. Those systems were restricted to small residential and commercial roof-top units. One of the largest, at 15 kW, is located in Fredericton on the roof of the Association of Professional Engineers and Geoscientists New Brunswick office (Figure 8). In 2017, a 100 kW ground-mounted system was installed at the Auenland Farm in Mount Pisgah (Figure 9). As previously mentioned, there are currently no utility-scale PV systems in New Brunswick.

The Violet Solar Farm will be a utility-scale (*i.e.*, 10 MW +) renewable energy project capable of generating enough electricity to service approximately 2 000 residences. The Project will provide a secure supply of energy, enhance New Brunswick's energy diversity portfolio, and hedge against the price volatility often experienced with fossil fuel-based generating systems. This Project aligns with New Brunswick's Climate Change Action Plan for transitioning to a low-carbon economy [*PNB*, 2016].

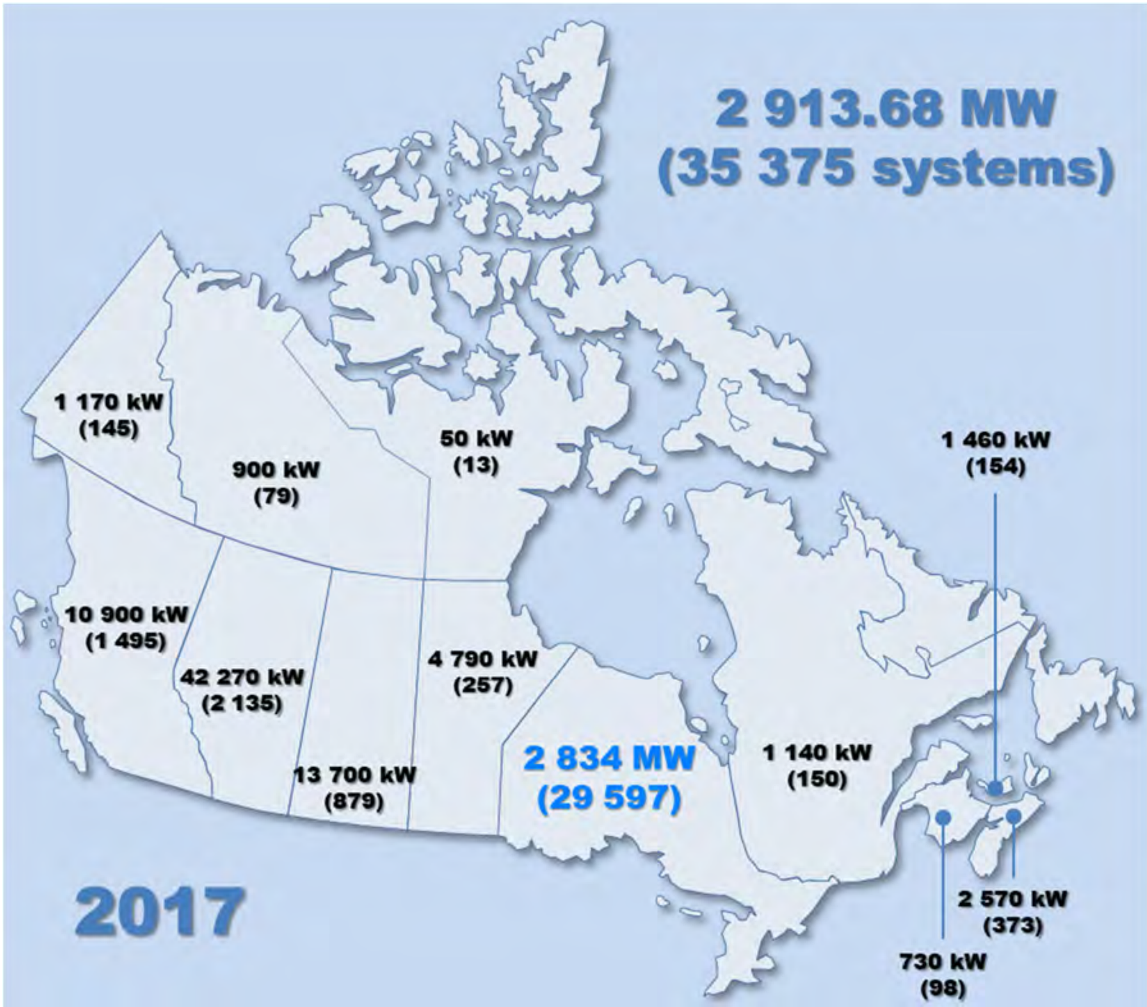


Figure 6. Map showing installed photovoltaic capacity and the number of utility interconnected systems as of 31 December 2017 across Canada. Data from *Baldus-Jeursen et al.* [2018]. Note: Ontario's installed capacity, shown in MW, dwarfs that of all other provinces and territories combined, which are shown in kW.

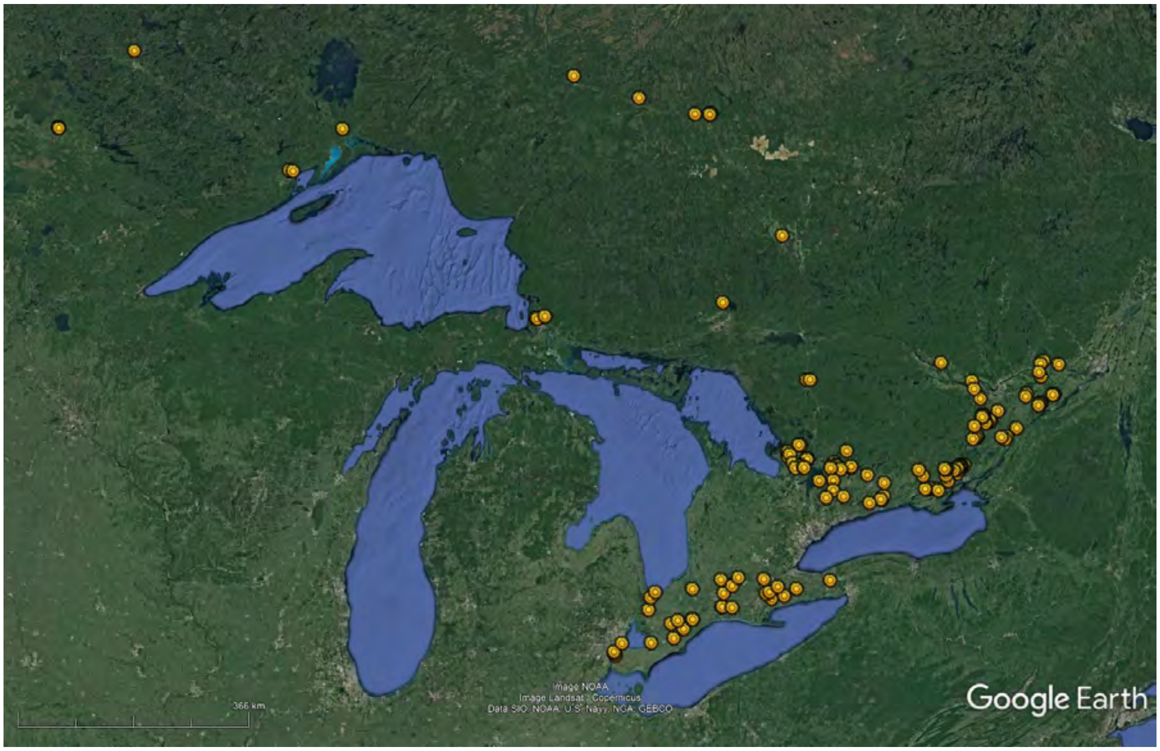


Figure 7. Google Earth image showing operational utility-scale photovoltaic farms across Ontario as of 31 December 2017. Data from multiple sources including scanning of Google Earth.

Figure 8. Photograph showing the solar panels on the roof of the Association of Professional Engineers and Geoscientists of New Brunswick office building in Fredericton, New Brunswick.

Figure 9. Photograph showing some of the ground-mounted tiltable solar panels at the Auenland Dairy Farm in Mount Pisgah, New Brunswick.

2.3 PURPOSE OF THIS ENVIRONMENTAL IMPACT ASSESSMENT

The purpose of an EIA is to identify and evaluate the potential impacts that the proposed Project may have on the environment. As per Schedule A, item b) (*i.e.*, all electric power generating facilities with a production rating of three megawatts or more…) of the Environmental Impact Assessment Regulation **[87-83]** of the New Brunswick *Clean Environment Act*, the Project triggers EIA review. This EIA was prepared by Fundy Engineering & Consulting Ltd. (Fundy Engineering) on behalf of C2 Solar (% Mr. Fraser Forsythe). The EIA identifies potential environmental impacts this Project may pose and presents measures to mitigate those potential environmental impacts. This EIA meets the requirements of the *New Brunswick Department of the Environment and Local Government* (*NBDELG)* [2018] guide to EIAs.

2.4 PROJECT PURPOSE / RATIONALE / NEED / RATIONALE

The purpose of the Project is to increase the availability of electricity generated from renewable energy sources by developing the first utility-scale solar farm in Atlantic Canada. This important milestone will enhance New Brunswick's reputation as a regional energy leader and help the Province achieve necessary reductions in energy-related carbon dioxide (CO_2) emissions.

In 2016, the Province of New Brunswick issued *Transitioning to a Low-Carbon Economy* action plan (*i.e.*, the Plan), which represents the provincial Climate Change Action Plan [*PNB*, 2016]. The Plan notes that New Brunswick will phase out coal as a source of electricity as soon as possible. The document goes further and notes that transitioning to new sources of electricity will include many opportunities for New Brunswickers to be more efficient and competitive by creating new business opportunities. Actions 42 and 43 of the Plan, which are highlighted below, support C2 Solar's development of renewable and low-emission energy.

> *42. Support the uptake of increased renewables for both electricity generation and residential/business heating in New Brunswick, through financial incentives, policy and legislation.*

> *43. Investigate and remove existing barriers to achieving greater implementation of renewable power generation, distributed energy generation, and net metering.*

2.4.1 Provincial Electricity Generation Portfolio

New Brunswick Power (NB Power), the public electric utility in New Brunswick, owns and operates 13 electricity generating stations throughout the Province. Those stations, which are summarized in Figure 10, provide a net generating capacity of 3 513 MW [*NB Power*, 2018]. NB Power also has electricity generating contracts in place third-parties. In 2017, those agreements provided for a net generating capacity of 736 MW [*NB Power*, 2018] as shown in Figure 11. In 2017, 17.3 % of NB Power's net generating capacity comprised third-party renewable energy sources (Figure 12).

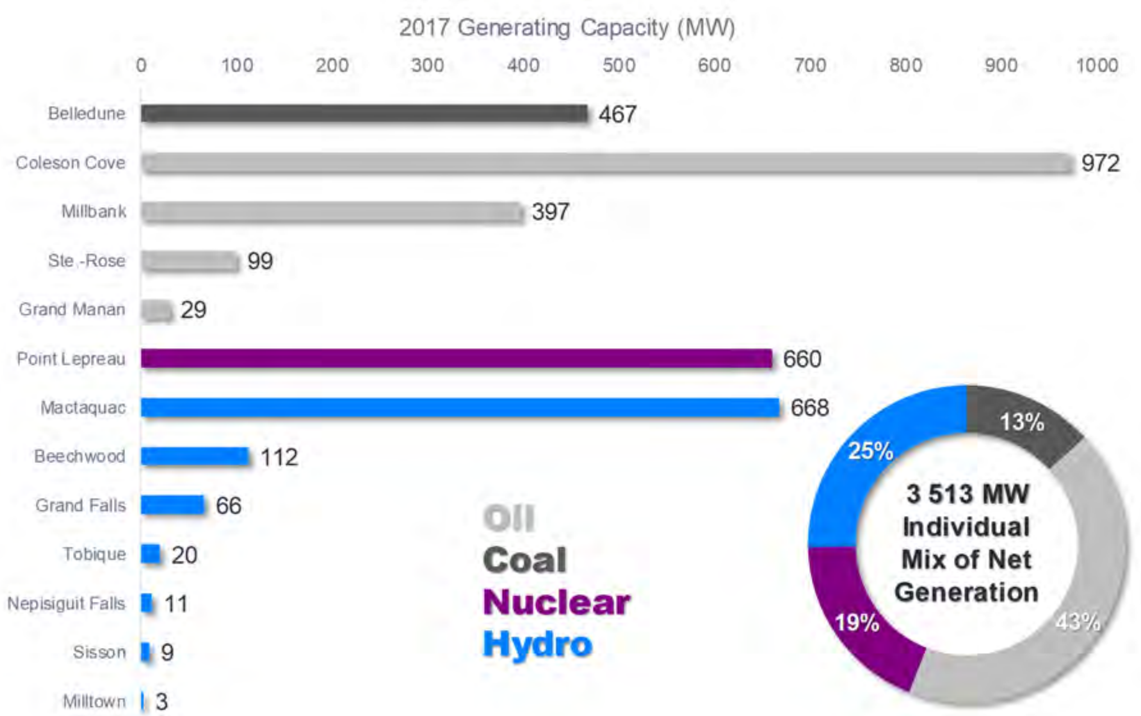


Figure 10. NB Power's 2017 net generating capacity and generation mix. Data from *NB Power* [2018].

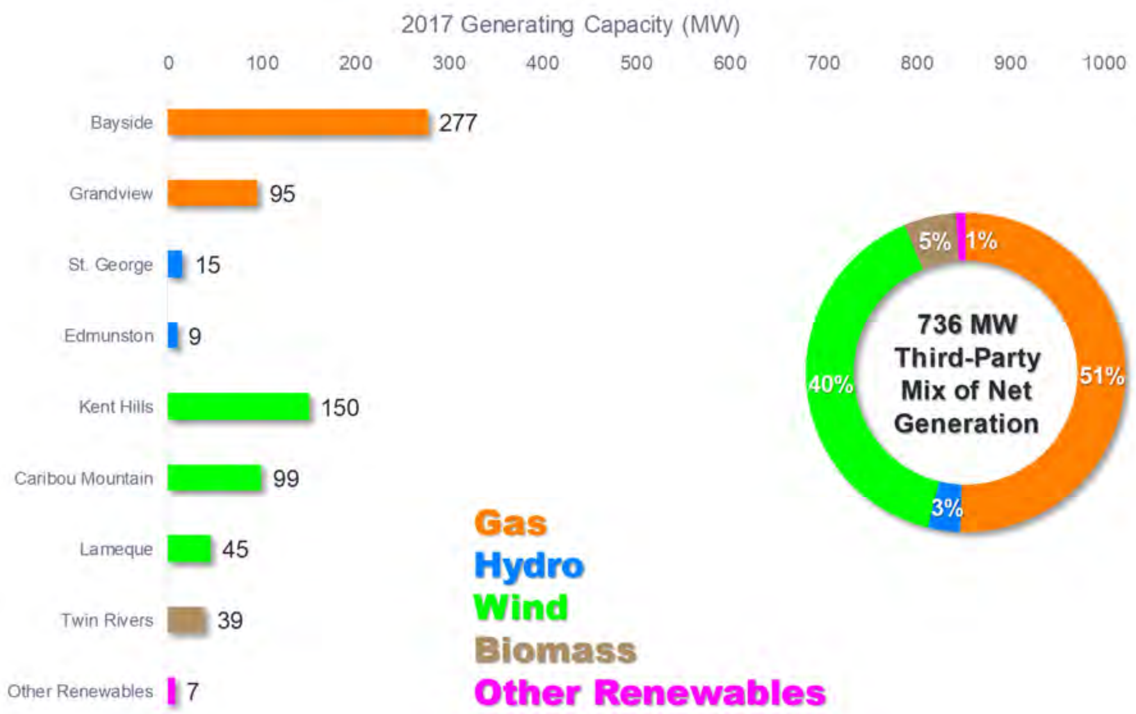


Figure 11. NB Power's 2017 third-party net generating capacity and generation mix. Data from *NB Power* [2018].

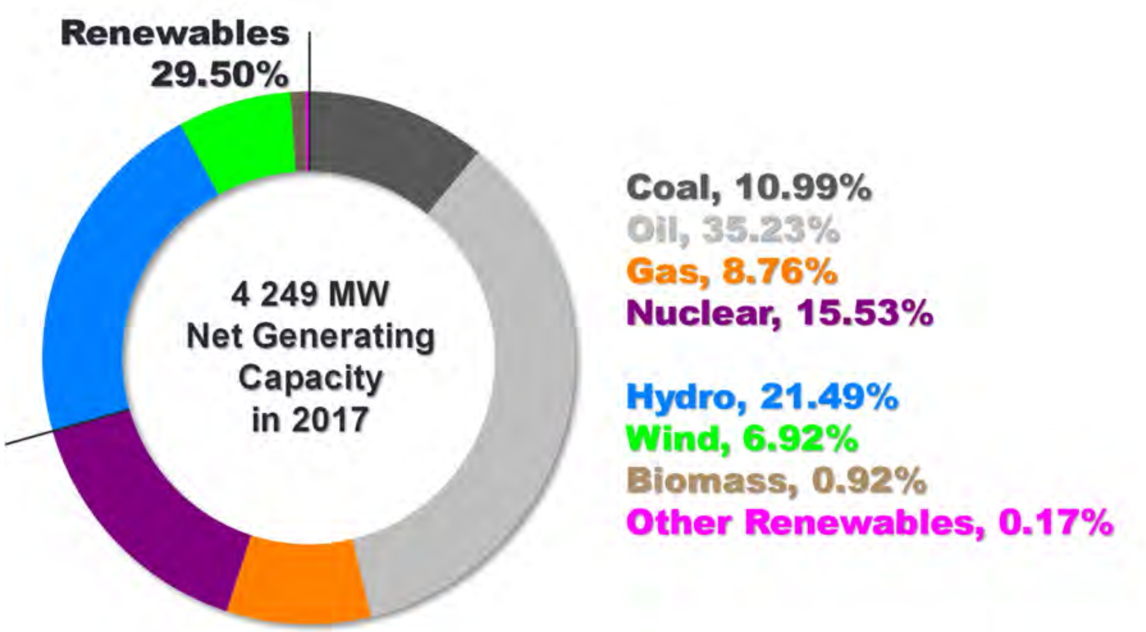


Figure 12. NB Power's 2017 total and third-party net generation mix. Data from *NB Power* [2018].

NB Power is committed to supporting the development of renewable energy resources while balancing the utility's supply requirements [*NB Power*, Undated]. Their corporate objective is to have 40 % renewables by 2020. Although they achieved this goal in 2015-

2016 when the in-province electricity generation from renewables was 42 %, there is a possibility that objective could be non-attainable in the near-term with the federal government's December 2016 release of the *Pan-Canadian Framework on Clean Growth and Climate Change*. This is because under the government's *Transitioning to a Low-Carbon Economy* action plan, NB Power will have to eliminate its Belledune coal-fired electricity generation stations from its portfolio by 2030 (*n.b.*, coal-fired generation plants have a 45 year to 50 year regulatory end-of-life, which for Belledune would be 2043).

Canada is a signatory to various international agreements, conventions, and protocols. Some, including *The Paris Agreement* of the United Nations Framework Convention on Climate Change, involve commitments requiring action relating to climate change and GHG emissions. *The Paris Agreement* affects all Canadian Provinces and Territories. As New Brunswick, and other Canadian Provinces and Territories, shifts to low-carbon emission energy solutions, generating electricity from the sun presents a promising opportunity.

Additionally, consumers want electricity generators to increase their generation via renewables and have a variety of sources in their renewables mix. Although New Brunswick generates electricity using hydro, wind, and biomass, consumers are still looking for solar to be added to the mix because it is believed to be the safest and cleanest energy source for the future. A public opinion research survey by *IRG* [2012] notes that solar has some the highest levels of social acceptance among available energy options.

2.4.2 New Brunswick's Solar Resource

Cyr et al., [2012] developed a solar energy atlas for New Brunswick using a parametric model based on correlation and regression statistics between the fractional bright sunshine and atmospheric transmissivity. Results show that the annual average solar radiation incident on a horizontal surface for New Brunswick is 3.72 kiloWatt hours per square metre per day ($kWh \cdot m^{-2} \cdot day^{-1}$) (Figure 13). As expected, New Brunswick's solar energy resource varies by season; maximum values occur during the early summer (*i.e.*, June) and minimum values exist during the early winter (*i.e.*, December).

Natural Resources Canada [2016a] has a publicly-accessible database that provides estimates of the electricity that can be generated from PV arrays and the mean daily global insolation for over 3 500 Canadian municipalities. Based on the data available for 244 New Brunswick municipalities, Grand Harbour on Grand Manan has the lowest annual insolation at 2.91 $kWh \cdot m^{-2} \cdot day^{-1}$ and Belledune along the Bay of Chaleur has the highest at 5.89 $kWh \cdot m^{-2} \cdot day^{-1}$.

At 39.6 GigaWatts (GW) in 2015, Germany had the second most installed solar capacity in the world [*IRENA*, 2016]. The annual average solar radiation incident on a horizontal surface in Germany is 2.8 $kWh \cdot m^{-2} \cdot day^{-1}$, which is considerably less than that for New Brunswick. Solar maps for New Brunswick show that there is considerable potential for the solar industry to grow (Figure 13).

New Brunswick's diverse and robust electricity generating mix allows it to be energy independent. Currently, New Brunswick is a leader in supplying secure, reliable, and competitive electricity to the northeastern United States. That region is increasingly looking at greener sources of electricity generation so this Project would likely enhance the Province's position as an energy exporter to the region.

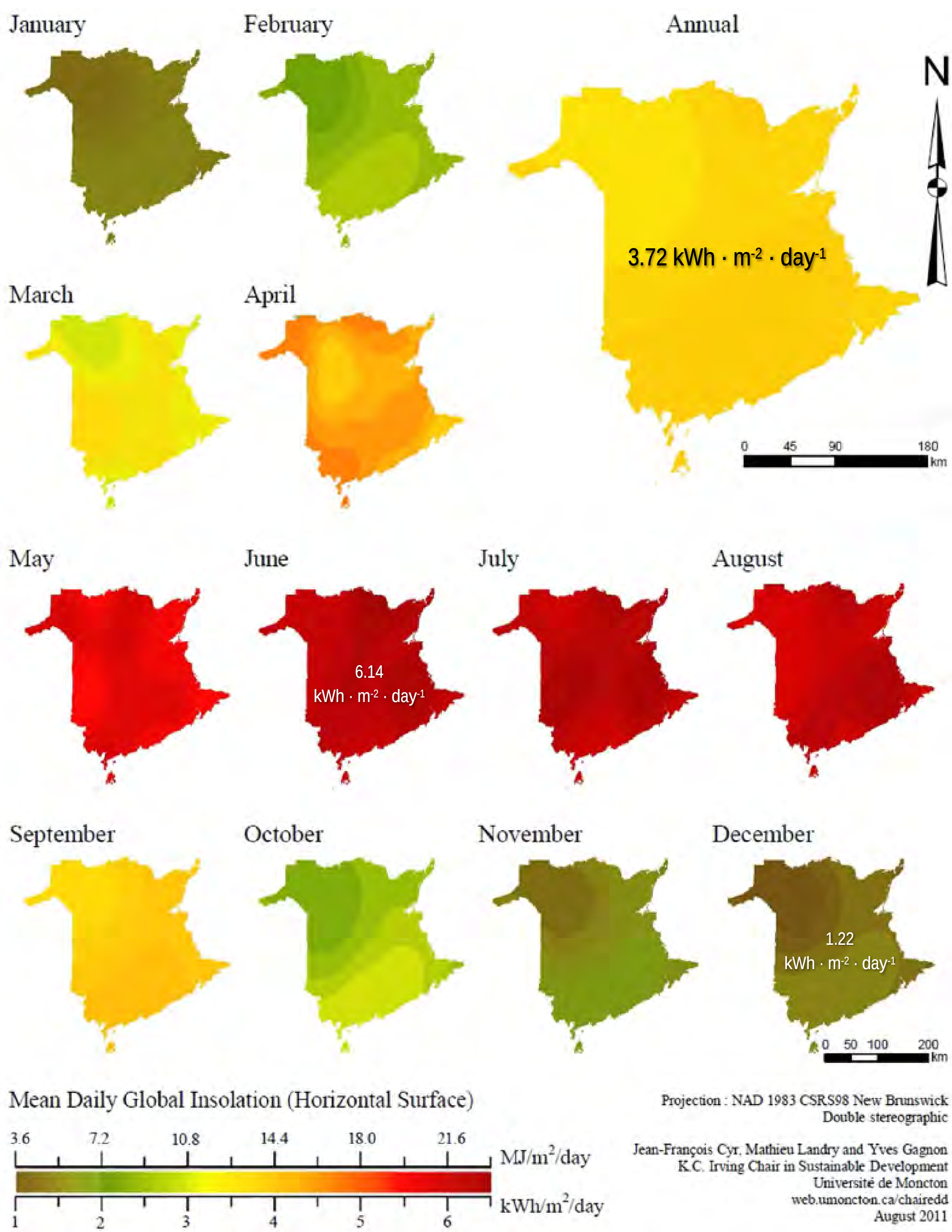


Figure 13. Monthly and annual average solar radiation incident on a horizontal surface across New Brunswick. From *Cyr et al.* [2012].

2.4.2.1 Solar Photovoltaic Systems

PV technology used to generate electricity has rapidly grown over the past decade [*IEA*, 2015]. Solar cells are used to directly generate electricity from the sun's energy, an infinite renewable resource. PV technology is modular, scalable, has no moving parts, generates no noise or GHG emissions when in operation, the majority of parts can be recycled at the end of life, and it has little impact on land, wildlife, and ecosystems. Solar cells are attractive because they can be installed almost anywhere so long as the location has southern sky exposure and is not subject to intense shading.

The silicon wafer of the solar cell facing the sun is coated with an anti-reflective coating that helps efficiently absorb the sunlight. Electrical contacts within the solar cell provide the connection between the semiconductor material and the external electrical load (*i.e.*, on the electrical transmission network). When sunlight shines on the photovoltaic cell, photons of light strike the surface of the semiconductor material and liberate electrons from the material's atomic structure. Certain doping chemicals are added to the semiconductors composition to help to establish a path for the freed electrons.

The flow of electrons forms an electrical current over the surface of the solar cell. Metallic strips placed across the surface of the PV cell collect those electrons and form the positive connection. The back of the PV cell, the side opposite of the incoming sunlight consists of a layer of aluminium or molybdenum metal that forms the negative connection to the cell. Then a photovoltaic solar cell has two electrical connections, one positive, on the top, and one negative, at the bottom.

Essentially, thin sheets of crystalline silicon are layered to create a single solar PV cell. As sunlight strikes the surface of the PV cell, the solar energy causes the silicon to release electrons. The release and the subsequent flow of electrons creates useable electricity as illustrated in Figure 14. Variations within the crystalline silicon structures of the PV cells are used by various manufacturers to improve conversion efficiency of solar energy.

In Figure 14, sunlight strikes the surface of the photovoltaic cell. When this happens, electrons are knocked loose from the N-layer. In this example, silicon in the N-layer was doped with phosphorous to yield a negative charge (*i.e.*, due to the extra electron). The electrons from the N-layer are transferred via conductors to the P-layer. In this example, silicon in the P-layer was doped with boron to yield a positive charge (*i.e.*, due to the electron deficiency). As electrons flow from the N-layer to the P-layer, they pass through a circuit, thus generating electricity. The EN-layer is electrically neutral (*i.e.*, due to the stable crystal bond), which allows electrons to move from the P-layer to the N-layer, but not back.

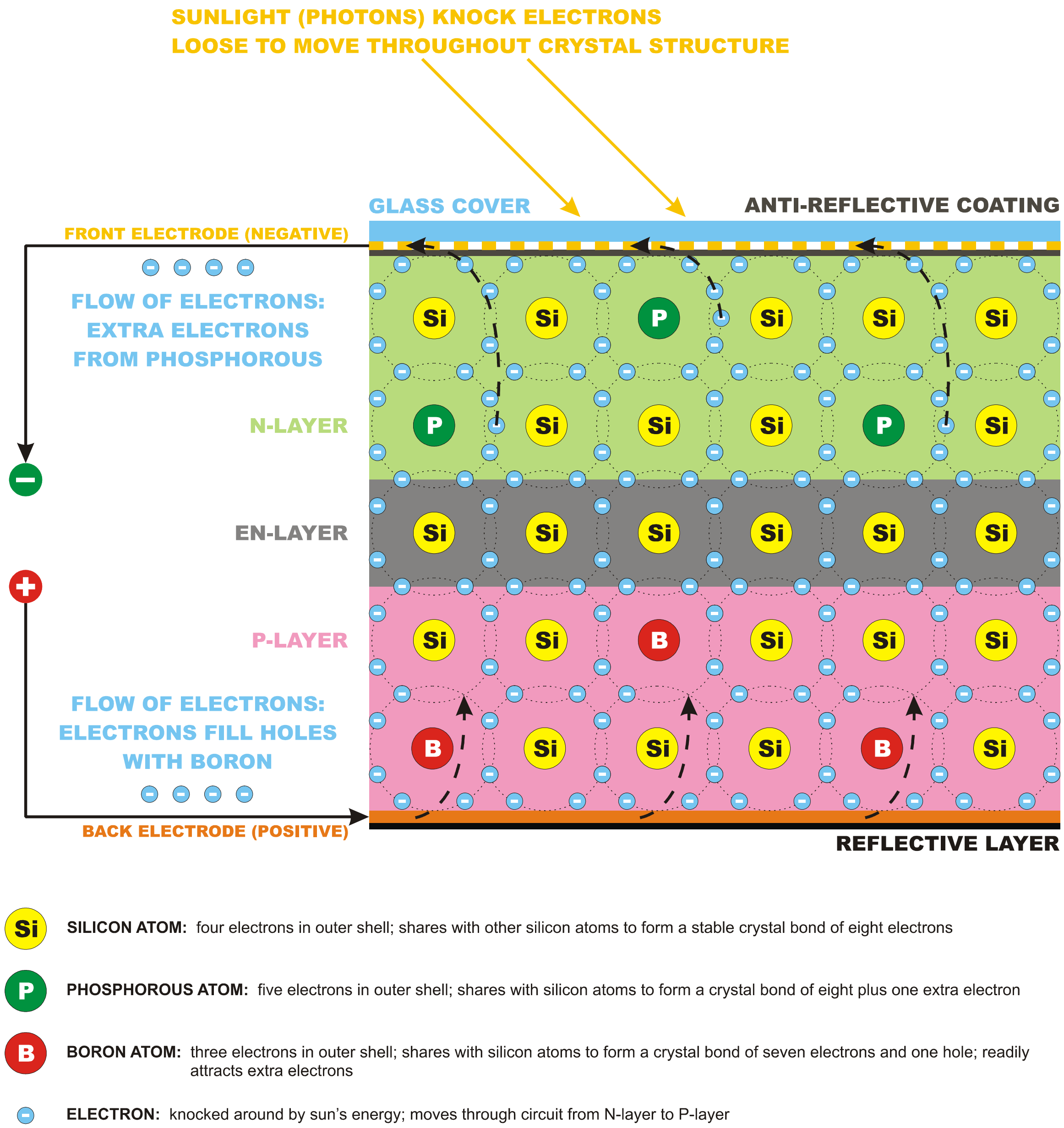


Figure 14. Illustration showing the function of a photovoltaic cell.

2.4.3 Economics of Solar

PV technology is gaining ground and considerable effort is being made to make the technology more affordable. Currently, solar is competitive in areas where electricity costs are > 20 ¢ · kWh^{-1}; however, some jurisdictions are promoting and subsidizing the development of solar. As noted in Section 2.2, Ontario implemented several subsidy programs to kick start the solar industry.

The cost of PV will continue to fall as electricity rates continue to rise. The vision of the Canadian Solar Industries Association (CSIA) is that by 2025, solar energy will be widely deployed throughout Canada [*CSIA*, 2010]. Going forward, the increased competitiveness of PV technology will present a promising opportunity for meeting energy needs while transitioning to a low-carbon economy.

A recent study completed by *Hydro Québec* [2016] indicates that residential electricity rates in New Brunswick are still some of the lowest in North America. Figure 15 shows how Moncton's residential rates in 2016 compared to 21 other North American cities (*i.e.*, Moncton ranked 9th out of 21 for the lowest residential rate).

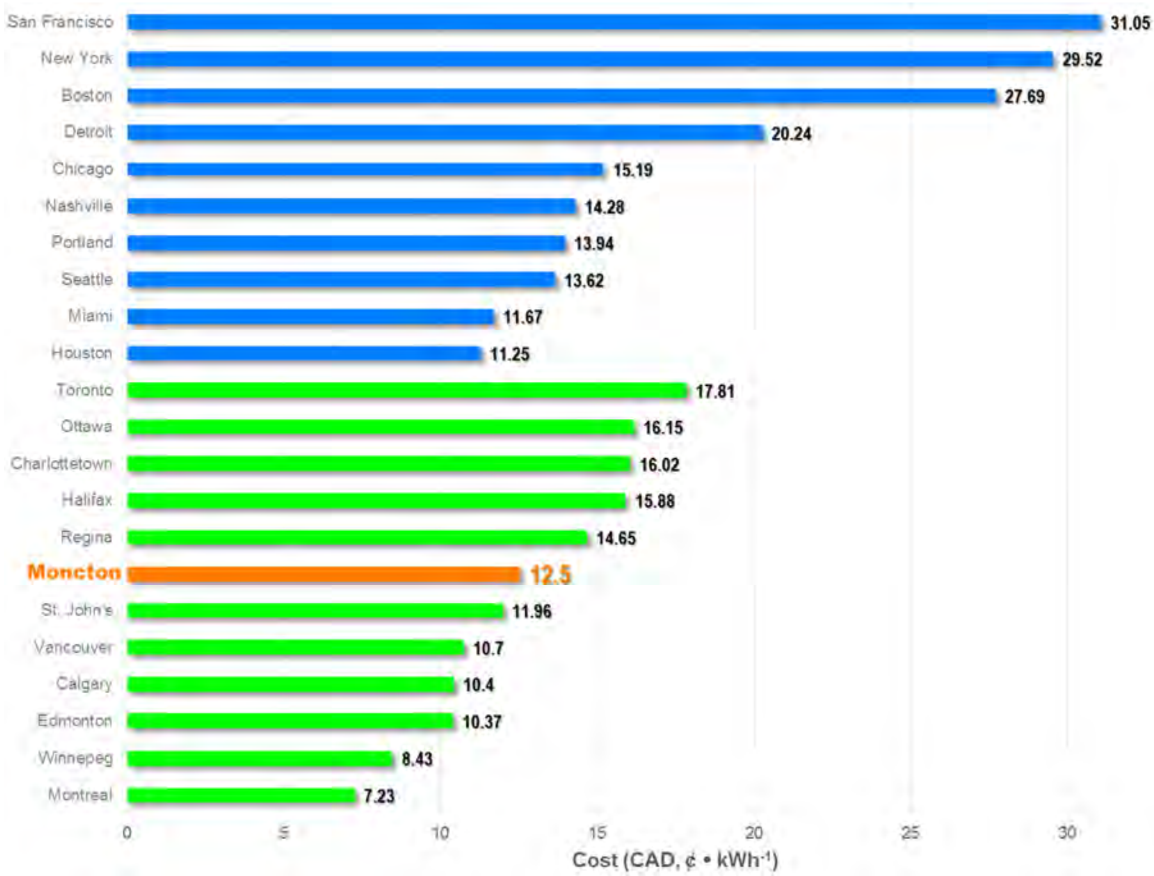


Figure 15. Average cost of residential electricity for some major American cities, shown in blue, and Canadian cities, shown in green, as of 1 April 2016. Data from [*Hydro Québec*, 2016].

In April 2016, the Dubai Electricity and Water Authority (DEWA) announced an 800 MW third phase for the Mohammed bin Rashid Al Maktoum Solar Park in Seih Al-Dahal, Dubai. The 2.99 US ¢ · kWh^{-1} power project is the cheapest international solar announcement to date [*Hirtenstein*, 2016]. Although the DEWA project is an outlier, it represented the first time that solar has undercut coal for an electricity generating facility.

Electricity from renewable energy in New Brunswick is considerably increasing. The Provincial Government is committed to increasing the amount of electricity from new renewable sources to 40 % by 2020. The potential for solar to provide affordable and environmentally responsible electricity to meet provincial electricity needs is at the leading edge and the power generated by this Project would locally help NB Power reach its renewable energy portfolio standard obligations.

2.4.4 Environmental Benefits of Solar

Solar energy is a clean source of energy, especially when compared to traditional forms of electricity generation. When compared to conventional fossil-fuel derived electricity generation, PV technology generates considerably less life-cycle air emissions per GWh [*Fthenakis et al.*, 2008]. Life cycle emissions take into account emissions produced during the manufacture, construction, operation and maintenance, and decommissioning of electricity generation technologies. Southern Environmental Law Center's Solar Initiative's March 2017 report [*SELCSI*, 2017] note that solar energy generation produces < 5 % the emissions of coal energy generation when the two lifecycles are compared.

2.5 PROJECT LOCATION

The basic operational requirement for a solar farm is daylight, so the range of sites in New Brunswick is fairly limitless. Planning for the proposed Project began in early 2016. There were many criteria that were considered for siting the solar farm. After considering several locations, C2 Solar settled on an undeveloped forested property (*i.e.*, Figure 1) in Brunswick Mills near Bathurst, New Brunswick in the Bathurst Local Service District. The lands are located in Bathurst Parish of Gloucester County (Figure 17).

Figure 16. General location of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

2.5.1 Project Siting Considerations

In determining the most appropriate site for the construction and operation of a solar farm, various criteria were considered. General and environmental siting considerations included those listed in Table 1.

Table 1. General and environmental criteria used for siting the C2 Solar's proposed Violet Solar Farm in New Brunswick.

Criterion	Details
Solar resource	At or above New Brunswick's annual average solar radiation incident on a horizontal surface of 3.72 kWh · m^{-2} · day^{-1}
Electrical grid connection	In close proximity to the electrical transmission gird with available capacity
Land ownership	Available for long-term lease and / or ownership
Land size	A minimum of 40 ha and includes opportunities for expansion on the same property and / or adjacent properties
Land cost	Suitable for business model
Geography	Relatively flat site that is free from shading from buildings and hills / mountains
Access	Easily accessible site from existing transportation corridors and can be easily secured
Economy	Can strengthen the local economy through construction and long-term operation and maintenance
Zoning	Zoned appropriately or solar farm development (*i.e.*, heavy industrial) or could likely be rezoned appropriately
Use	Not currently in use for other productive uses (*e.g.*, agriculture, silviculture, hunting / trapping, quarry, *etc.*) or existing resources could benefit by development (*i.e.*, timber harvesting); a brownfield meeting all other criteria would be preferred
Protected areas	Is not part of a protected watershed / wellfield, environmentally significant area, municipal, provincial, or federal park, national wildlife areas and / or migratory bird sanctuaries
Species at risk	Does not impact species at risk and / or their habitat
Watercourses and wetlands	Has no impact, or minimal impact, on watercourses and / or wetlands
Migratory birds	Away from important migratory bird nesting sites and migration routes and important water-bird breeding colonies
Archaeological sites	Does not impact archaeological resources or cultural heritage sites
Residential areas	Setback from residential areas in order to limit any interference
Aerodromes	Setback at least 5 km from an aerodrome to limit glare / glint from solar panels
Soils	Sufficient to install helical anchors to support the solar arrays
Visual	Does not intrude upon the overall visual nature of the area

Originally, the preferred site was one located in Middle River, New Brunswick about 14 kilometres (km) from the selected site. That site met many of the criteria at the outset; however, when it was put through an environmental constraints mapping process it was noted that the site was located almost entirely within the Middle River protected watershed (Figure 17).

Due to limitations on building within a protected watershed, the Project could not move forward at that site. This was confirmed through discussions with NBDELG personnel. Therefore, desktop work on the Middle River site was halted and a new site was sought.

After considerable effort, a new site, the one located in Brunswick Mills, was identified for locating the Project. Two other sites in addition to the Middle River and Brunswick Mills sites were also considered for the Project. For business reasons, the other two sites are not described in detail here; however, one is located in Charlotte County and the other is located in Albert County.

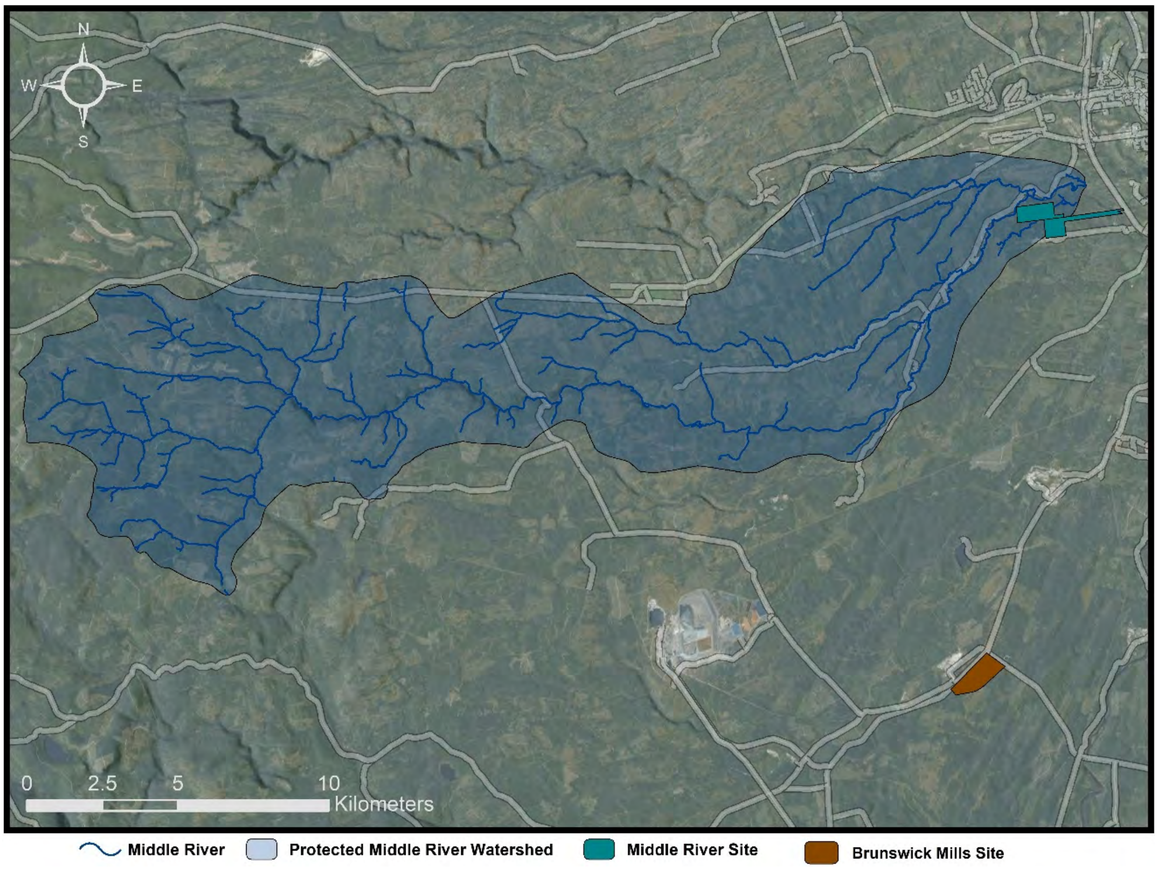


Figure 17. Map showing the general location of the properties within Middle River, New Brunswick protected watershed that were originally identified for siting the Violet Solar Farm.

2.5.2 Project Alternatives

2.5.2.1 Null Alternative

The null alternative (*i.e.*, the do-nothing approach) was considered in order to provide a baseline against which to compare other alternatives for the various Project components (*n.b.*, the baseline environment represents the null alternative). Under this alternative, the Project would not be undertaken.

New Brunswick currently relies on fossil fuel derived energy sources for about 55 % of its electrical generating capacity (*n.b.*, this includes individual and third-party sources; refer to Section 2.4.1). The burning of fossil fuels is one of the main contributors to carbon dioxide emissions, which is the main greenhouse gas that has been linked to climate change [*IPCC*, 2014]. The coal-fired Belledune Generation Station is the second largest contributor to GHG emissions in the Province (*n.b.*, refer to Section 3.1.3), which is one of the primary reasons it will likely be shuttered on or before 2030.

In Canada, there has been a renewed emphasis of securing future power supply through the diversification of power generation sources. Not completing this Project may compromise the use of this type of renewable option for electrical generation in the future. This could potentially have significant negative impacts on the environment and social well-being of New Brunswickers and Canadians now and in the future. If the Project is not undertaken, it would be a lost opportunity to reduce GHG emissions and move further ahead at generating electricity with cleaner and greener options.

Doing nothing would avoid environmental impacts associated with the development and operation of the Project, such as vegetation clearing, construction sounds, traffic and dust, visual impacts, *etc.*; however, those impacts are considered to be manageable and would not result in a significant impact to the environment.

Because of the above, the null alternative is not considered environmentally and socially responsible. Therefore, the null alternative was not considered further.

2.5.2.2 Alternative Technologies

There are several different PV technologies on the market. Crystalline silicon photovoltaics (cSi-PV), or first generation technology, include mono-crystalline and multi-crystalline solar cells. Thin-film solar cells (thin-PV) are a second generation technology. The main types of commercially-available thin-film solar cells include amorphous silicon, cadmium telluride (CdTe), copper-indium-selenide, and copper-indium-gallium-diselinide. Third-generation technology, organic PV materials, is still early in research and development.

C2 Solar selected cSi-PV solar cells because they are the most prevalent technology in use throughout the world [*IFC*, 2015]. There are numerous manufacturers of cSi-PV technologies throughout North America and manufacturing lead times are minimal. Although the manufacture of thin-PV solar cells yield the least amount of GHGs [*Fthenakis et al.*, 2008], electricity conversion efficiency of cSi-PV technology is equal to, if not better than, thin-PV technology (*i.e.*, 14 % to 19 % for cSi-PV versus 4 % to 16 % for thin-PV) [*Groszko and Butler*, 2014]. The extra conversion efficiency is important based on the lower insolation rates experienced in northern latitudes, such as New Brunswick. Also, because cSi-PV solar cells have been in use for many years, their installation, operation, and maintenance is well understood.

Other solar energy technologies, such as low-temperature solar thermal power and concentrating solar power plants, were deemed not financially-viable for this Project. Therefore, they were not considered further.

2.6 PROJECT DETAILS

The first of C2 Solar's bouquet of Solar Farms, the Violet Solar Farm, will be a grid-connected system, which negates the need for on-site electrical storage systems (*i.e.*, batteries). The Solar Farm will comprise a multi-hectare, fixed tilt or manual variable tilt (*n.b.,* for New Brunswick, the tilt varies between 36.5 ° and 39.6 °), ground-mounted field of PV arrays. A schematic showing the key electrical components of a solar farm is provided in Figure 18. The overall site plan for C2 Solar's Project is shown in Figure 19 and a listing of the key components is summarized in Table 2. More details on the layout for the C2 Solar Project are included in Appendix II.

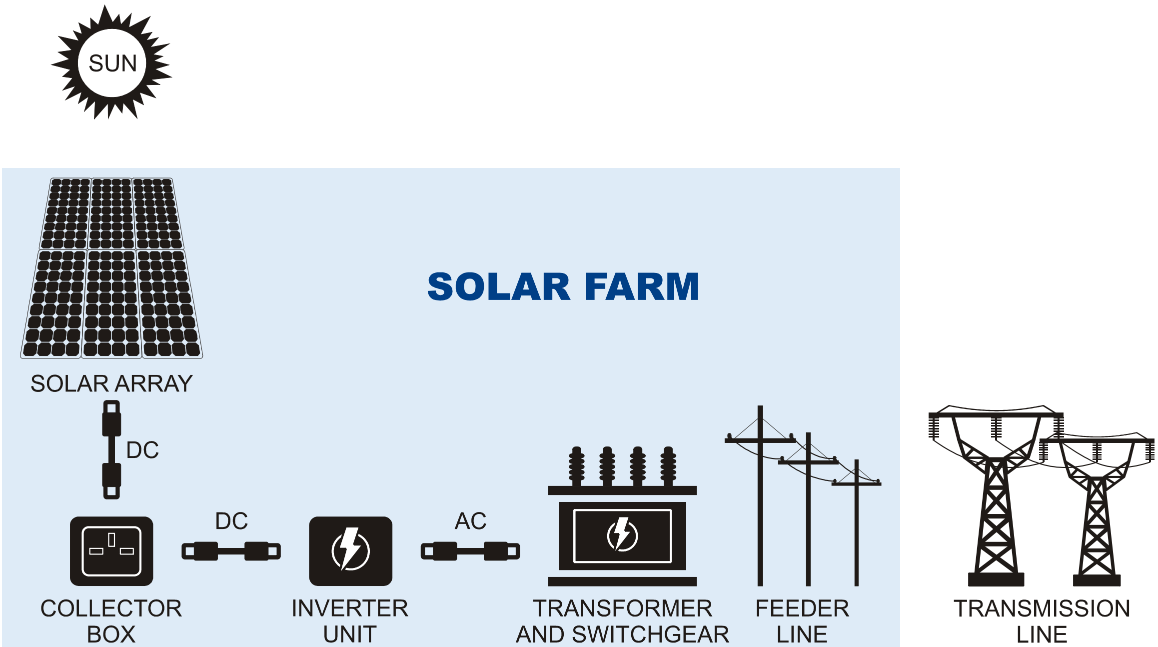


Figure 18. Schematic showing the key electrical components of a solar farm.

Table 2. Key components of the Violet Solar Farm proposed for Brunswick Mills, New Brunswick.

Component	Number	Details
Solar cells	2 246 400	72 cells per module
Modules	31 200	320 W
Arrays	312	100 modules per array
Collector boxes	312	1 collector box per array
Inverters	11	1 inverter per cluster
Transformers	1	
Switching station	1	
Trenched cables	TBD	TBD during detailed engineering
Feeder line	1	~ 750 m long
Meteorological tower	1	25 m tall

Grid-connected systems require inverters to transform DC power to AC power. The balance of the system includes inverters, transformers, wiring, monitoring equipment, and structural components.

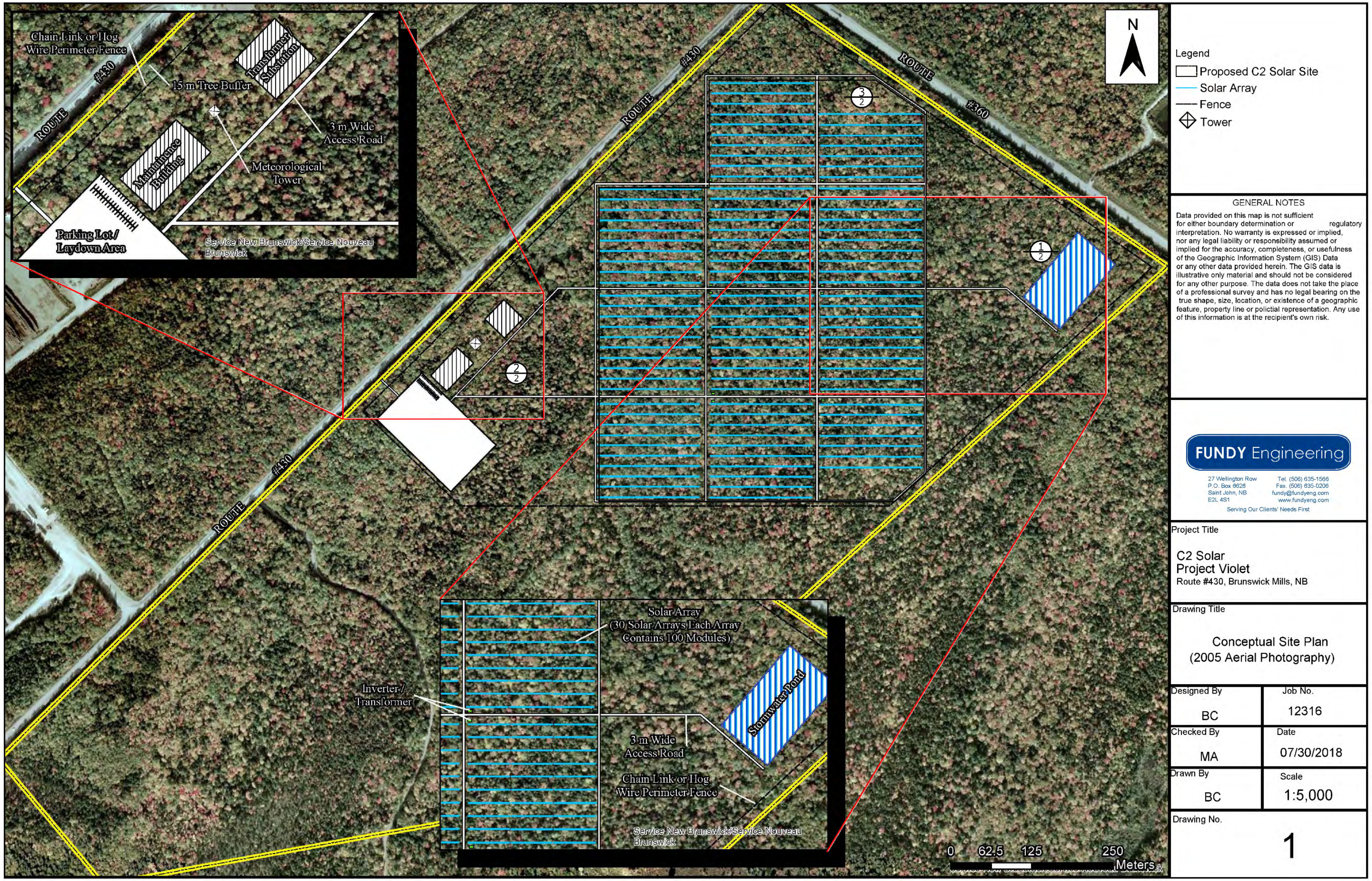


Figure 19. Overall site layout for the Violet Solar Farm proposed for Brunswick Mills, New Brunswick.

While the asset life of the solar panels is expected to be 35 years, the solar farm is expected to have a design life of about 25 years and may require refurbishment to match the useful life of the solar modules. Although the Project is a 10 MW utility-scale solar farm, C2 Solar has access to adjacent RDC lands for an additional 10 MW (*i.e.*, Phase 2) if markets and demand exists.

The solar field has been laid out to minimize cable runs and associated electrical losses. It provides adequate distance between arrays, clusters, and other structures to prevent shading. It also incorporates access routes throughout for maintenance staff and vehicles at appropriate intervals.

2.6.1 Access Roads and Parking

PID 20557021 is located adjacent to NB Route 430 (*i.e.*, Mines Road) at the intersection with NB Route 360. The Mines Road is a 40 km long two-lane asphalt north-south secondary highway extending between Newcastle and Bathurst. NB Route 360 is a 13 km long two-lane asphalt east-west secondary highway extending from Allardville to Brunswick Mines. Both roadways are maintained by the New Brunswick Department of Transportation and Infrastructure.

A 3 m wide internal gravel roadway network will be constructed within the solar field (*i.e.*, between the clusters and along the perimeter of the solar field) for undertaking long-term maintenance activities. Provision of this roadway network will allow vehicle access directly to all major electrical equipment (*i.e.*, inverters and substation). A gravel parking lot of sufficient size will be located near the entrance of the solar field and will be of sufficient capacity for all staff vehicles and equipment during peak construction and long-term operation and maintenance.

Access tracks will be located between the solar arrays. Native grasses will be allowed to grow up on these access tracks, which will assist with overall surfacewater management on the Project site.

2.6.2 Temporary Construction Area

During Project construction, it will be necessary to designate temporary storage / laydown areas for equipment and components as well as areas for construction trailers and parking. Overall, it is anticipated that about 1 ha of space will be required for temporary storage and laydown during construction. Those areas are as designated in Figure 19.

2.6.3 Security Fence

For the safety of the public, to prevent vandalism, and to keep animals out, a security fence will be erected at the Project perimeter (Figure 19). A gate will be located in the fencing to allow entrance / exit from NB Route 430 (*i.e.*, Mines Road). The security fence will either be chain link or 10.2 cm hog wire sufficiently tall enough (*i.e.*, ~ 2.5 m) to keep coyotes, bears, deer, moose, and other large animals out of the solar farm.

A chain link fence topped with three strands of barbed wire will be erected around each of the inverter units, the transformer, and the meteorological / communications tower.

Video cameras will be installed at specific locations along the perimeter security fence, at each inverter unit, at the transformer, and the control building. Motion-sensored lighting will be installed as necessary across the site.

A buffer strip, a minimum of 5 m wide, will be retained between the security fence and the Project site boundary. This will be done to screen the site from adjoining properties even though they are currently forested. A 15 m wide buffer strip, at a minimum, should be retained adjacent to NB Route 430 and NB Route 360 in order to limit glint / glare to users of those roadways and to help limit roadway dusts from landing on the solar panels.

2.6.4 Stormwater Collection System

A site access road will be constructed from NB Route 430. Ditches exist adjacent to NB Route 430 for conveying surfacewater runoff. Therefore, a culvert will be placed in the ditch where the access road meets NB Route 430.

Internally, a network of access roads between the arrays and clusters will exist. If necessary, ditches and culverts will be installed adjacent to and beneath the access road at locations where conveyance of surface water runoff is required.

Precipitation falling on the solar panels will runoff onto the ground in front of the solar arrays. Although water infiltration will still occur across the majority of the site following construction (*i.e.*, impervious surfaces, such as concrete pads and buildings, will be limited), a system of swales, ditches, and culverts will be constructed to collect and convey stormwater runoff generated within the site to an on-site stormwater pond. The swales and ditches will generally be constructed adjacent to the proposed internal roadways. The stormwater retention pond will be constructed in the area proposed for laydown at the tail end of construction.

During detailed design, a more comprehensive stormwater management plan will be developed.

2.6.5 Solar Field

For preliminary design purposes, 320 W Suntech polycrystalline silicon (c-Si) solar modules were selected (*n.b.*, each module comprises 72 solar cells). These modules:

- have an excellent price-to-performance ratio;
- produce high energy output (*i.e.*, up to 16.5 % conversion efficiency) across a wide range of climatic conditions (*n.b.*, they are certified to withstand extreme wind and snow loads and they are tested in harsh environments) with excellent temperature response coefficients; and
- are manufactured in highly-automated, state-of-the-art facilities certified to International Standards Organization (ISO) 9001:2008, ISO 140001:2004, and ISO 17025:2005 quality and environmental management standards.

A module product datasheet is provided in Appendix III. The PV modules are 1 956 mm × 992 mm × 40 mm and weigh 25.8 kg. The modules are framed in anodized aluminum alloy and have a 4.0 mm thick tempered front glass. These modules are able to withstand extreme wind (*i.e.*, 2.5 kPa), snow loads (*i.e.*, 3.6 kPa), and extreme temperature fluctuations (*i.e.*, - 40 °C to 85 °C).

Based on preliminary design estimates, a 26.8 ha solar field will be required to yield 10 MW. The solar field will comprise 31 200 modules distributed throughout 312 arrays (*n.b.*, each array will typically comprise 100 modules). The solar arrays will be distributed across the solar field in 11 clusters whereby an inverter unit is dedicated to each cluster. Subject to detailed design, the arrays will be installed facing due south and fixed at a site-specific tilt angle from horizontal of 38.9 °. The arrays will be spaced a minimum of 5.7 m apart in order to eliminate overshadowing during all times of the year (Figure 20).

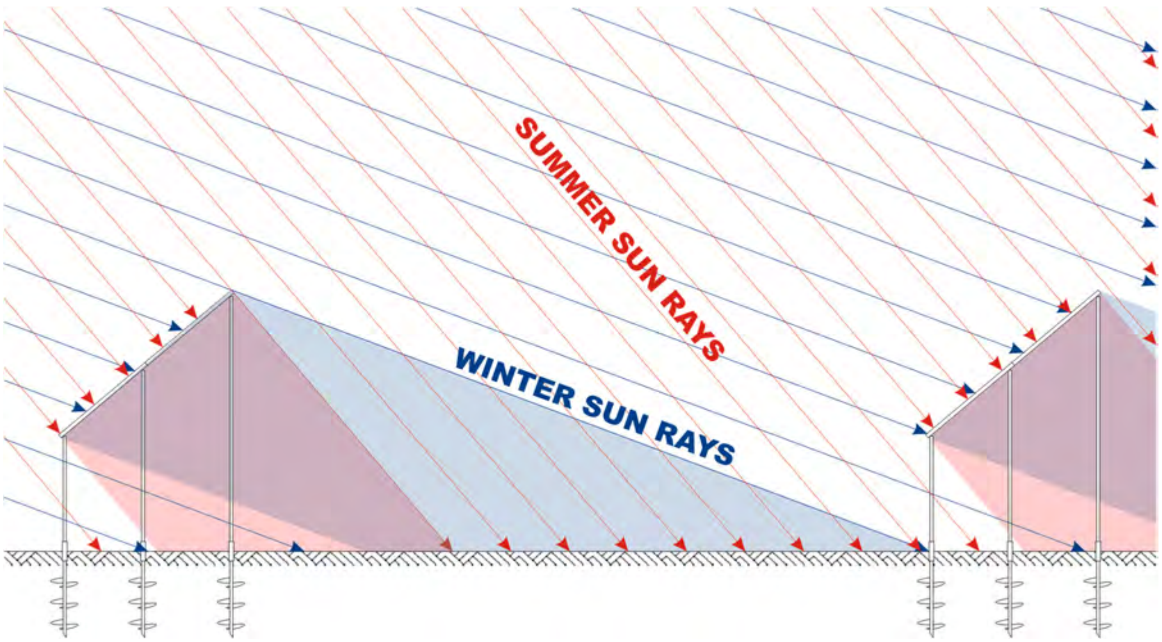


Figure 20. Schematic showing the summer and winter shading produced by the panels and racking tables for the Violet Solar Farm proposed for Brunswick Mills, New Brunswick.

The modules will be mounted on aluminum racking tables. The tables will be installed on vertical steel posts driven approximately 1 m to 1.5 m into the ground. The front of each table will be approximately 2 m above grade while the rear would be about 4.5 m above grade, but those heights may vary depending on local topography.

The PV modules will be electrically connected via wiring harnesses running along the bottom of the racking table for each array. Those wires will feed to a frame-mounted combiner box located at the end of each array. The combiner boxes will feed DC power from the arrays to the cluster's 1 000 kiloVolt Amp (kVA) inverter unit via underground cables. The inverter units will convert the DC electric input into AC electric output. The inverter units will have an internal cooling fan and a step-up transformer (*i.e.*, low-voltage of 1 kV to medium voltage of 27.6 kV).

Each solar array will be electrically isolated from the others. The AC power output from the inverter units will feed to an on-site 10 MegaVolt Amp (MVA) transformer (*i.e.*, substation) via underground cables. The transformer will step up the current to 69 kV for input to NB Power's transmission grid. The output will be connected to the grid through a feeder line and various marshalling and switchgear, protection devices, and meters.

All underground cabling will be installed in trenches about 0.5 m wide and 1 m deep. A sand or pea gravel layer will surround the electrical conduits to safely house the cabling, and a warning tape will be placed above the wires within the trench. A thin layer of native soils will be placed on top once the cables have been installed. The inverter units and transformer will be mounted on concrete pads and appropriate grounding systems will be installed where necessary.

2.6.6 Control Building

A slab-mounted Control Building will be constructed inside the security fence (Figure 19). The 60 m^2 building will house general office space, a small lunch room, a washroom, and an equipment / spare parts storage area. Potable water will be supplied by drilling an on-site groundwater well. Wastewater will be collected and treated within an on-site septic tank and infiltration field.

2.6.7 Monitoring Systems

A Supervisory Control And Data Acquisition (SCADA) system will be installed to continuously collect data for analysis and system monitoring remotely. The SCADA system will include a network of dataloggers and programmable logic controllers. Remote monitoring will also include data collected from the on-site meteorological station. Data collected from all of these systems will be used to assist with operational decisions. No personnel will be on-site during a normal operational day as it will operate remotely.

2.6.8 Electrical Interconnection

Electricity generated from the Project will be fed into NB Power's transmission and distribution system. An NB Power transformer is located about ~ 750 m to the northwest of the property line adjacent to NB Route 430 on PID 20379624. That transformer is used to feed electricity to the Fornebu Lumber Company Inc.'s framing lumber sawmill located on PID 20325163 and shown in Figure 1 and Figure 21. Currently, there is 12 kV power line that crosses over the Canadian National Railway tracks (*i.e.*, PID 20525408) and runs along PIDs 20391520 and 20378915 from the transformer to NB Route 430. The power line is installed on standard wooden poles (*n.b.*, typically 13.7 m long installed 1.8 m into the ground and spaced about 76 m apart). A photograph showing the power line easement and the power line crossing NB Route 430 is provided in Figure 22 and Figure 23, respectively. From that location, the power line extends southwest along NB Route 430.

Figure 21. Photograph looking northwest from NB Route 430 at Brunswick Mills, New Brunswick towards the entrance gate to the Fornebu Lumber Company Inc.'s framing sawmill.

There is a 69 kV transmission line in the immediate vicinity of the Project site (Figure 24). Preliminary discussions with NB Power Transmission staff indicate that no additional line or upgrades would be required of the existing 69 kV line. Details will be worked out with NB Power or others as part of long-term Power Purchase Agreement (PPA).

Figure 22. Photograph looking northwest showing the 12 kV power line easement between an NB Power transformer and NB Route 430 at Brunswick Mills, New Brunswick.

Figure 23. Google Earth Street View image looking northeast showing the power line crossing NB Route 430 at Brunswick Mills, New Brunswick.

Figure 24. NB Power's systems map. From *NB Power* [2016].

2.7 PROJECT STAGES

The proposed Project will proceed in several Stages. Each of those Stages is described below. Environmental permitting, monitoring, and compliance are a necessary component for all Stages of the proposed Project.

2.7.1 Power Purchase Agreement

Prior to advancing the Project through the Stages noted below, a long-term PPA will have to be developed between C2 Solar and NB Power or others. Although New Brunswick's public utility already has several PPAs in place as noted in Section 2.4.1, none currently exist for the purchase of power from a solar farm. Solar installations in New Brunswick with excess power operate on a net metering program, which is not an option for this utility-scale Project (*n.b.*, the net metering program is designed to allow customers to generate their own electricity to offset their consumption while remaining connected to the grid and they cannot exceed 100 kW). A PPA would need to be in place in order for a Final Investment Decision (FID) to be made on breaking ground for the Project.

2.7.2 Stage I - Project Environmental Permitting, Monitoring, and Compliance

C2 Solar is committed to environmental excellence. To ensure environmental protection and preservation, the Proponent will strive to have all Project personnel implement and follow a Project-specific Environmental Protection Plan (EPP). Procedures within the Project-specific EPP are expected to include:

- environmental incident procedures;
- spill response;
- environmental incident reporting guidelines;
- waste management; and
- contingency procedures related to site-specific tasks.

All employees and contractors working at the Project site will be required to participate in a safety and environmental orientation program. Standard operating procedures, basic care procedures, and contingency procedures will be developed for the solar farm. On a go-forward basis, C2 Solar will ensure all Project personnel implement, comply with, and follow those procedures.

2.7.3 Stage II - Project Construction

Several activities are associated with Project construction, including clearing and grubbing, structural foundations, array assembly, *etc.* Those activities are briefly described in the sections below. The heavy equipment anticipated for use during each of those activities is also identified; however, the equipment types and quantities required will depend on the contractor's requirements and equipment availability.

2.7.3.1 Surveying, Clearing, Grubbing, and Levelling

Prior to any construction activities, a surveyor will be contracted to layout the perimeter of the solar farm shown in Figure 19. This will be done to ensure that the boundaries are clearly marked before construction. A buffer strip of vegetation at least 5 m wide will be retained between the perimeter of the solar farm and any property boundaries. It is recommended that a buffer at least 15 m wide be retained adjacent to NB Route 430 and NB Route 360.

Currently, the timberland where the solar farm will be constructed is under a state of regrowth. All standing timber will be harvested by a fuelwood contractor to make way for the Project. Where practicable, all merchantable timber will be salvaged and non-merchantable timber will be shredded / mulched using appropriate equipment and will be spread in appropriate areas on-site at the end of construction during site cleanup. Heavy equipment anticipated for use during these activities is summarized in Table 3.

Table 3. Heavy equipment anticipated for use during surveying, clearing, grubbing, and levelling activities associated with construction of the Violet Solar Farm in Brunswick Mills, New Brunswick.

Equipment Use / Type	Typical Task
Semi-trailer truck and float	Floating equipment to and from the site
Rubber- tired mechanical harvester	Felling of trees and delimbing
Rubber-tired skidder / forwarder	Yarding of felled merchantable timber
Shredder	Shredding and mulching of non-merchantable timber
Tractor and trailer equipped with a grappler	Transport of trees off-site
Bull dozer with root rake	Removal of stumps and roots and material movement
Tracked excavator	Loading and movement of material
Back-hoe crawler	Removal of stumps and roots
Dump truck	Material movement
Scrapper-pan	Material movement
Pick-up support truck or van	Transport of equipment and personnel

All clearing activities will adhere to relevant regulatory requirements and will only be done to the extent required. Where possible, all clearing activities will be done outside of the migratory birds breeding season (*i.e.*, annually from 1 May to 31 August). Where this is not possible, a qualified biologist will be contracted to survey the area and identify and delineate any active nesting sites (*i.e.*, by flagging off a 30 m buffer zone around the nest).

Although no watercourses and / or wetlands have been identified within the footprint of the solar field, flora removal within 30 m of any and all watercourses and / or wetlands will be minimized to the extent possible and will not occur prior to permit / authorization issuance by the Regulatory Authority (RA). When vegetation is removed, it will be done in accordance with the permit / authorization conditions.

Once clearing activities are complete, the area will be grubbed to remove stumps and roots. Where possible and practical, root rakes will be used so that only roots and stumps are removed and topsoil and organic matter is left behind. It is anticipated that the stumps and roots removed from the surface will be shredded / mulched on-site using appropriate equipment. Alternatively, the material will be transported off-site for disposal within a nearby pit / quarry.

The lands proposed for the solar field are relatively flat; however, some levelling may be required. In those instances, topographically high areas will be cut down and topographically low areas will be filled in.

2.7.3.2 Security Fence, Internal Roadways, and Parking

Before bringing any of the solar farm equipment to the site, a security fence will be erected at the site perimeter. A locking gate installed at the entrance from NB Route 430 will provide controlled entry to the Project site. For safety and security purposes, motion-sensor activated lights will be installed on either side of the locking gate. Construction of the internal roadways and parking lot will involve minor grading and placement of granular materials. If additional parking is required during construction, it can be accommodated within the laydown area (Figure 19).

It is possible that the security fence can be erected and internal roadways and parking lot can be constructed concurrent with site levelling exercises. The heavy equipment anticipated for use during these activities is summarized in Table 4.

Table 4. Heavy equipment anticipated for use during erection of the security fence and building the internal roadways and parking area associated with construction of the Violet Solar Farm in Brunswick Mills, New Brunswick.

Equipment Use / Type	Typical Task
Semi-trailer truck and float	Floating equipment to and from the site
Bobcat fitted with post hole driller	Drilling holes for fence posts
Semi-trailer truck and trailer	Transport of fencing materials to the site
Bulldozer	Material movement
Dump truck	Hauling granular material to the site
Compactor / roller	Fill compaction
Loader	Material movement
Pick-up support truck or van	Transport of equipment and personnel

2.7.3.3 Temporary Infrastructure and Supporting Facilities

Prior to assembling the solar arrays, several contractor trailers will be brought to the site. Those trailers will serve as offices / lunch rooms / equipment storage (*i.e.*, for valuables that can be secured when personnel are absent) throughout construction. Temporary power for construction will be obtained utilizing the existing 69 kV and 12 kV feeder lines. Temporary washroom facilities will also be brought on-site for the duration of Project construction. Those temporary washrooms will be maintained by a licensed and approved third-party contractor who will be required to regularly service the facilities. Minimal heavy equipment will be required for these activities as summarized in Table 5. Once the solar farm has been commissioned, the temporary infrastructure and supporting facilities will be removed from the site.

Table 5. Heavy equipment anticipated for use during temporary infrastructure and supporting facilities activities associated with construction of the Violet Solar Farm in Brunswick Mills, New Brunswick.

Equipment Use / Type	Typical Task
Semi-trailer truck and float	Moving trailers and portable washrooms to site
Pumper truck	Cleaning of portable washrooms
Pick-up support truck or van	Transport of equipment and personnel

2.7.3.4 Structural Anchors and Foundations

Vertical steel posts will be used to support the aluminum racking tables. It is expected that the steel posts will either be driven approximately 1 m to 1.5 m into the ground or be attached to screw piles / helical anchors that are installed 1 m to 1.5 m in the ground; however, if geotechnical testing indicates that either of those anchoring systems is not sufficient, the steel posts may be attached to Sonotube® concrete forms installed in the ground (*n.b.*, this is a support system of last resort). Table 6 lists the heavy equipment that is anticipated for use during these activities.

Table 6. Heavy equipment anticipated for use during installation of structural anchors and foundations associated with construction of the Violet Solar Farm in Brunswick Mills, New Brunswick.

Equipment Use / Type	Typical Task
Semi-trailer truck and float	Floating equipment to and from the site
Tracked excavator	Excavation for footings and foundations
Welding truck	Base-stations for welding equipment
Forklift / loader	Movement of structural anchors and rebar
Pile driving rig (*i.e.*, tracked excavator fitted with appropriate gear)	Installing structural anchors
Concrete truck	Hauling concrete to the site
Concrete pumper truck	Movement of concrete about the site
Concrete pumps and vibratory equipment	Placing and compacting of concrete
Pick-up support truck or van	Transport of equipment and personnel

The control building, the meteorological / communications tower, the 11 inverter stations, and the transformer will all be founded on cast-in-place concrete pads reinforced with structural rebar.

2.7.3.5 Array Assembly

The fixed-tilt aluminum racking tables will be constructed atop the vertical steel posts. Following this, the modules will be unpackaged, laid out on the racking tables, and secured in place. The modules of each array will then be wired in series from the back and wires will gather at the base of the racking table where they will run to the end of the array and enter the collector box (Figure 18). Although minimal heavy equipment will be required for carrying out these activities (Table 7), much of it will be done at height and construction personnel require fall-arrest systems where applicable. Racking tables and modules delivered to the site will be stored in the laydown area until assembly.

Table 7. Heavy equipment anticipated for use during solar array assembly activities associated with construction of the Violet Solar Farm in Brunswick Mills, New Brunswick.

Equipment Use / Type	Typical Task
Semi-trailer truck and float	Floating equipment to and from the site an material delivery
Telehandler (9 t)	Movement of heavy equipment about the site
Forklift / loader	Movement of modules about the site
Scissor lift	Safely positioning personnel in above-ground areas
Air compressor	Operating pneumatic tools for array assembly
Pick-up support truck or van	Transport of equipment and personnel

2.7.3.6 Cable Trenching

All electrical cables running between the collector boxes and inverters and between the inverters and substation will be buried. A common trench will be excavated along each side of the internal access road running down the centre of the solar field. The output from each collector box will feed to the cluster's inverter and output from the inverter of each cluster will feed to the solar farm's substation. This trenching design, constructed using the heavy equipment summarized in Table 8, will limit the overall length of electrical runs within the solar field.

Table 8. Heavy equipment anticipated for use during cable trenching activities associated with construction of the Violet Solar Farm in Brunswick Mills, New Brunswick.

Equipment Use / Type	Typical Task
Semi-trailer truck and float	Floating equipment to and from the site
Tracked excavator	Trench excavation
Dump truck	Hauling sand to the site
Loader	Material movement
Pick-up support truck or van	Transport of equipment and personnel

2.7.3.7 Inverters, Substation, and Ancillary Electrical Gear

The inverters, substation, and ancillary electrical gear (*e.g.*, conductors, switchgear, meters, disconnect switches, meteorological / communications tower, *etc.*) will be delivered to the site on flatbed trucks and lifted into place using a crane (Table 9). Once the equipment is in place, the chain link security fences will be erected around the inverters and substation. The switchgear yard will be gravel and the various ancillary electrical gear will be founded on concrete piles.

Table 9. Heavy equipment anticipated for installing the inverters, substation, and ancillary electrical gear for the Violet Solar Farm in Brunswick Mills, New Brunswick.

Equipment Use / Type	Typical Task
Semi-trailer truck and float	Floating equipment to and from the site
Truck crane (40 t to 90 t)	Movement and placement of inverters and transformer
Telehandler (9 t)	Movement of heavy electrical equipment about the site
Scissor lift	Safely positioning personnel in above-ground areas
Dump truck	Hauling gravel to the site
Loader	Material movement
Pick-up support truck or van	Transport of equipment and personnel

2.7.3.8 Control Building

A wood-framed control building will be built on-site and founded on a concrete pad. A septic tank with an infiltration field and a potable groundwater well will be drilled alongside the control building (*n.b.*, siting of the infiltration field and potable groundwater well will adhere to setback requirements as per the applicable Regulations). The heavy equipment anticipated for use during these activities is summarized in Table 10.

Table 10. Heavy equipment anticipated for constructing the control building for the Violet Solar Farm in Brunswick Mills, New Brunswick.

Equipment Use / Type	Typical Task
Semi-trailer truck and float	Floating equipment to and from the site
Tracked excavator	Septic tank excavation and lifting tank in place and installing the infiltration field
Well drilling rig	Drilling potable groundwater well
Welding truck	Base-stations for welding equipment
Scissor lift	Safely positioning personnel in above-ground areas
Pick-up support truck or van	Transport of equipment and personnel

2.7.3.9 Feeder Line

The Right-Of-Way (ROW) for the feeder line, extending from the solar field to NB Power's transmission line, will be cleared using the same heavy equipment summarized in Table 3. The clearing of the ROW will likely be done coincident with the clearing work for the solar field and done by the same contractor using the same processes described in Section 2.7.3.1. Once the ROW is cleared, a tracked all-terrain cherry picker and pole drilling / standing machine will be used to install any extra wooden poles required and to string the electrical wires (Table 11).

Table 11. Heavy equipment anticipated for use in constructing the feeder line for the Violet Solar Farm in Brunswick Mills, New Brunswick.

Equipment Use / Type	Typical Task
Semi-trailer truck and float	Floating equipment to and from the site
All-terrain cherry picker pole drilling / standing machine	Installing utility poles and stringing wires
Pick-up support truck, van, or ATV	Transport of equipment and personnel

2.7.3.10 Stormwater Collection System and Site Clean-up

To mitigate sediment leaving the site during surface water runoff events, a drainage swale will be constructed between the perimeter security fence and the internal perimeter roadway. Water collected within that drainage swale will be directed to an on-site stormwater retention pond. Save for extreme precipitation events, it is expected that the retention pond will be empty. The internal drainage swales, which will also direct water to the stormwater retention pond, will only be constructed after the electrical trenches have been backfilled.

Once all of the construction equipment and materials have been removed from the site it will be left to naturally re-vegetate (*i.e.*, no hydroseeding will be undertaken). Should routine monitoring show issues related to erosion and sedimentation then remedial measures will be undertaken.

2.7.3.11 Commissioning

Commissioning will occur when the solar farm has been inspected and is ready for energizing. Commissioning will be done to ensure the Project is structurally and electrically safe, it is sufficiently robust to operate over the anticipated lifespan, it operates as designed, and its performance falls in line with pre-determined parameters.

Once the Project has been commissioned and is ready for operation, all of the temporary infrastructure will be dismantled and taken off-site.

2.7.3.12 Workforce and Work Hours

It is expected that approximately 40 to 60 construction personnel will be required on-site during the peak construction period. The construction workforce will likely be recruited from the Bathurst region. Project construction is anticipated to occur over 10 to 12 months. During that period, on-site construction activities will normally be completed Monday through Saturday from 7 AM to 7 PM. A reduced construction crew may be used when working on Sundays and evenings, if required. The remote location means that there will likely be minimal to no impacts to the public as a result of construction hours.

2.7.4 Stage III - Project Operation and Maintenance

The Solar Farm will operate daily during daylight hours only (*i.e.*, ~ 4 467 hrs $\cdot$ yr^{-1}) for the duration of the Project lifespan (*i.e.*, 25 years). There will be no permanent on-site employees because PV facilities generally require little maintenance throughout the year [*El-Sharkwai*, 2009; *IFC*, 2013]. Instead, the Project will be continuously monitored and operated remotely in real time using the SCADA system. Most issues will be remotely diagnosed and, when required, maintenance personnel will be dispatched to correct any problems.

It is expected that routine Operation and Maintenance (O&M) activities will be contracted out locally. Typical scheduled maintenance activities are summarized in Table 12, but a detailed description can be found in *Haney and Burstein* [2013]. Wherever possible, planned shutdowns for maintenance activities will occur during the early morning or evening when light levels are low and energy production is minimal. All personnel involved in O&M activities will be made aware of the Project-specific EPP and they will be required to adhere to the procedures in that document. They will also be required to undertake Project-specific health and safety training.

Table 12. Typical scheduled operational and maintenance activities for a solar farm.

Activity	Frequency	Description
Security check	Weekly	Site visits will be conducted to ensure that the perimeter security fence is intact and that the security fences surrounding the inverter units, transformer, and meteorological / communications tower have not been compromised. When snowpack is absent, the security checks will be done by vehicle; however, when snowpack is present, the security checks will most likely be done via snowmobile.
Electrical tests and inspections*	Monthly	Electrical testing will be conducted to verify connections and to ensure proper voltages and currents. Visual inspections will be done on the modules, module racks, combiner boxes, inverter units, and transformer.
Module cleaning	Biannually	Normally, panel cleaning will occur via natural rainfall; however, there may be a need, depending on site conditions, to clean the panels (*e.g.*, due to dust / pollen build-up, excessive bird droppings, *etc.*). Panels will be inspected during the spring and fall and if panel cleaning is required, it will be done using clean water obtained from the on-site potable well. No cleaning solutions of any type will be used for washing the modules.
Landscaping	Annually	Vegetation will grow under and between the solar arrays. This will require management to avoid the site becoming overgrown with noxious weeds and trees. Mowing, trimming, and mulching will likely be done using farm equipment; however, there may be an opportunity to allow cows, sheep, or other livestock to graze on the lands as solar arrays pose no risk to livestock. No herbicides will be used for the control and maintenance of vegetation. The ROW will be cleared as required using mechanical equipment, such as an excavator mounted brush cutter.

NOTES:
*Only qualified personnel should conduct electrical inspections and the work should be done by at least two people using appropriate personal protective equipment and proper safety procedures

Corrective maintenance (*i.e.*, unplanned activities and shutdowns) will occur on an as-needed basis and may include activities such as replacing broken modules or repairing inverters. Cleaning of snow from the solar arrays is not anticipated. The modules will be tilted at about 38.9 °. Normally, snow should slide off the modules, but under heavy snow events, snow may stick to the modules and clearing could be necessary.

A sufficient stock of spare parts, such as mounting structures, combiner boxes, fuses, DC and AC cabling components, modules, and inverters, will be kept on-site and stored in the control building.

During operation, the panels will release no emissions to the environment, they will generate no sound, and they will produce no pollution.

2.7.5 Stage IV - Project Decommissioning

The solar farm will be a temporary land-use, albeit for approximately 25 years. Over time, the performance of solar panels decreases as a result of degradation due to environmental conditions (*i.e.*, humidity, temperature, solar irradiation, and voltage bias) and module technology (*e.g.*, quality of materials used, lamination defects, cell contact breakdown, *etc.*). Typically there is a 3 % conversion efficiency loss in the first year and about a 0.5 % to 0.8 % loss in conversion efficiency each year thereafter. Therefore, 25 year old panels will still be about 80 % to 85 % efficient [*Jordan and Kurtz*, 2013].

Key elements of the decommissioning will include:

- disconnecting the solar farm from the electrical grid;
- disconnecting the transformer, inverters, and solar arrays;
- breaking down the solar arrays;
- breaking down the tables and pulling the steel supports out of the ground;
- removing underground cabling;
- tearing down the on-site building and security fence;
- recycling all materials at appropriate facilities, where practical and feasible;
- disposing of non-recyclable materials at appropriate facilities; and
- site reclamation.

Essentially, decommissioning will be similar to construction, only in reverse. A team of workers will be brought to the site where the arrays will be dismantled. Ideally, the majority of materials will be recycled, but will depend on markets. PV panels contain some toxic substances, like cadmium and arsenic. Those can be controlled through the recycling and proper disposal.

Recycling companies have only recently begun to take an interest in PV panels because they have realized there will be a significant increase in waste starting about 2030 [*Cu-PV*, 2016]. Currently, PV panels can be recycled by crushing them in a hammer mill. The panel falls apart into glass cullets, back sheet pieces, wiring, and silicon solar cells. Although the waste volumes are relatively low, the recycling process is expensive; however, this may change between now and the time that the panels are recycled. For example, thermal and chemical processing to extract module components intact from the end-of-life PV modules for recycling or reassembly into new PV modules is showing promise.

It is anticipated that a detailed plan will be developed in the months prior to decommissioning the Project. That plan will identify how the various materials will be handled once removed from the site. It will also characterize how the site will be left (*e.g.*, graded and left to re-develop as forested land, planted with trees, *etc.*).

2.7.6 Stage V - Mishaps, Errors, and / or Unforeseen Events

With any Project, there is always the possibility of a mishap, errors, and / or unforeseen events. Those instances may happen during this Project and the Proponent will mitigate them by taking a systematic approach to safeguarding public and personnel health and safety by establishing a safe culture during Project implementation. An EPP will be specifically developed for this Project. That Project-specific EPP will include emergency response and contingency measures in the event that mishaps, errors, and / or unforeseen events occur.

2.8 PROJECT SCHEDULE

It is expected that construction will take about 20 months once an FID is made regarding the solar farm as shown in Figure 25. Depending on business and market conditions, the Project schedule could be shifted out by up to two years.

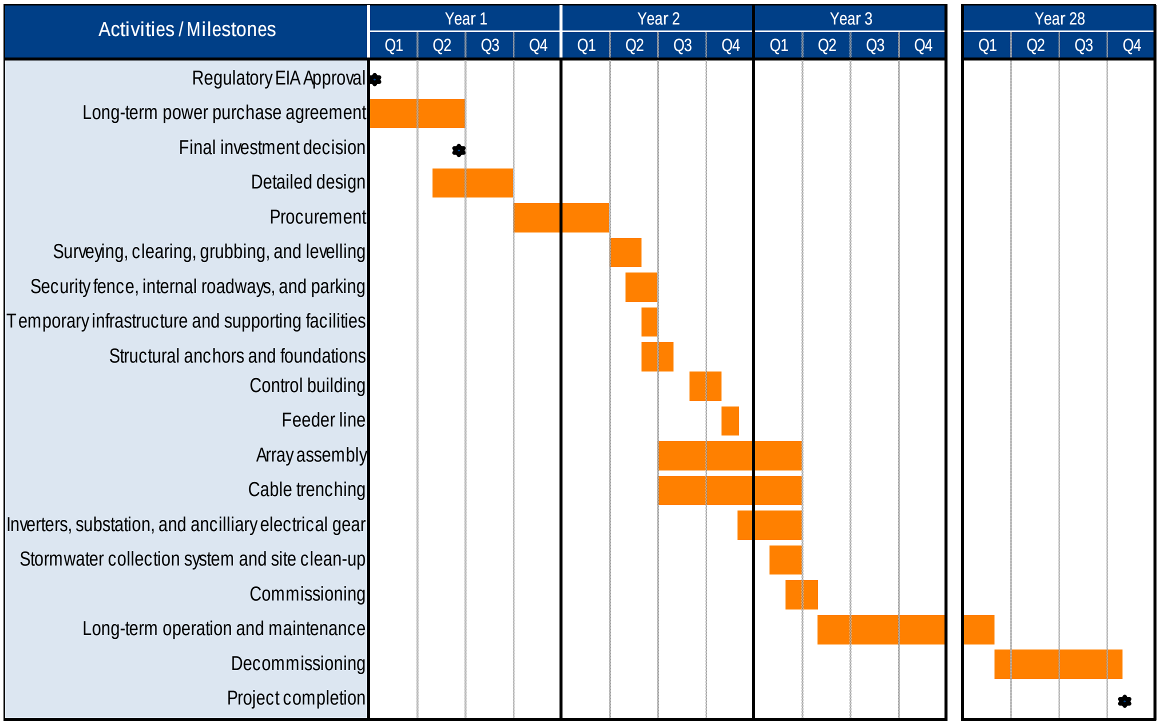


Figure 25. High-level Gantt chart for the construction of the Violet Solar Farm in Brunswick Mills, New Brunswick.

3.0 DESCRIPTION OF THE EXISTING / BASELINE ENVIRONMENT

This section describes the existing environment, pre-Project, at and in the vicinity of Brunswick Mills. The information contained in this section is considered to be baseline information for this Project and can be used for comparison to post-Project data to assess any potential impacts. Within this section, "regional" refers to Gloucester County New Brunswick, which includes the rural areas (*e.g.*, Middle River, Sainte-Anne, Big River, *etc.*) and urban centres (*e.g.*, Bathurst, *etc.*) around the Project site. Where specifically defined, the term "local" refers to the Project site proper and the area immediately surrounding the site (*i.e.*, a 500 m buffer with a particular focus on Brunswick Mills).

3.1 PHYSIO-CHEMICAL ENVIRONMENT

3.1.1 Climate

Brunswick Mills exists within the Nicolas Denys Ecodistrict of the Northern Uplands Ecoregion of New Brunswick [*Hinds*, 2000]. That Ecodistrict is a narrow, gently sloping strip of land that lies along the shores of the Bay of Chaleur stretching from the Dalhousie Peninsula to the mouth of the Nepisiguit River. According to the Köppen-Geiger climate classification, the region is characterized by a humid continental climate [*Peel et al.*, 2007]. The Bay of Chaleur, which is a large heat sink, influences the climate and generally provides a cool and dry climate.

Monthly climate data between 1981 and 2010 are available for the meteorological station at the Bathurst Airport (*n.b.*, this is the most recent 'climate normal' period). That station is located at latitude 47°37'45.05"N, latitude 65°44'54.02"W, and at an elevation of 58.80 m. During that period, the mean annual temperature was 4.8°C ± 1.20 °C (Figure 26) with a monthly daily minimum of – 16.2 °C in January to a monthly daily maximum of 24.8 °C in July [*Environment Canada*, 2017]. The extreme minimum mean daily temperature of – 35.6 °C was measured on 20 January 1994. In contrast, the extreme maximum mean daily temperature of 37.4 °C was measured on 27 June 2003.

Precipitation (*i.e.*, rain, drizzle, freezing drizzle, hail, snow, *etc.*) is generally well distributed throughout all months and the majority (> 70 %) falls in the form of rain. On average, 157 days each year experience some form of precipitation. Mean annual precipitation between 1981 and 2010 (Figure 26) was 1 110 mm with a mean monthly low of 66.5 mm in February to a mean monthly high of 122.9 mm in October [*Environment Canada*, 2017]. The most extreme daily rainfall of 96.3 mm was measured on 28 October 2008. The greatest snowfall of 56.0 cm was recorded on 7 March 1999. Snow generally occurs during eight months of the year and there is generally a snowpack for about 144 days each year.

Prevailing winds are generally from the west and southwest (*i.e.*, they blow from the west or southwest) [*Environment Canada*, 2017]. The maximum hourly wind speed of 65 km · hr^{-1} occurred on 20 December 1996 and winds were from the southwest. The maximum wind gust speed of 87 km · hr^{-1} occurred on 29 December 2009 and winds were from the west.

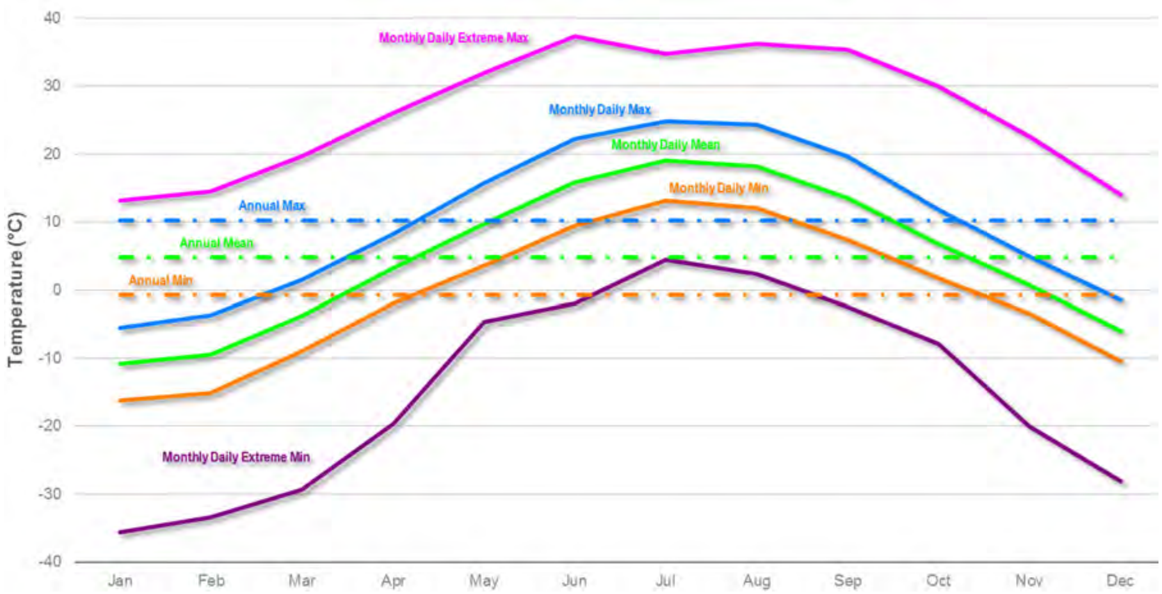


Figure 26. Compilation of mean daily temperatures measured at the Bathurst Airport meteorological station between 1981 and 2010.

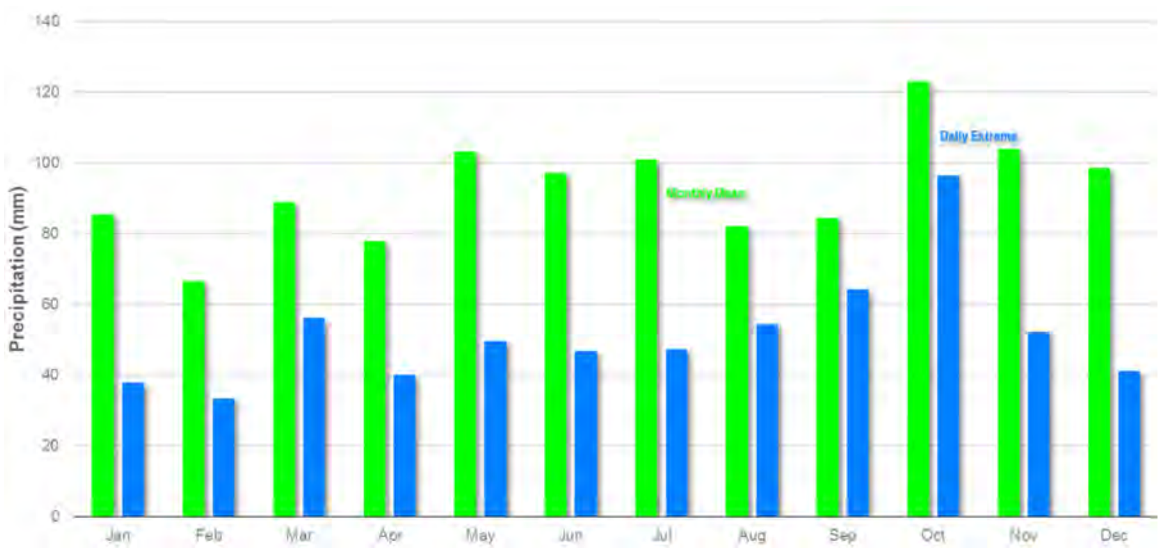


Figure 27. Compilation of mean daily precipitation measured at the Bathurst Airport meteorological station between 1981 and 2010.

3.1.2 Solar Energy

Surface solar energy data were generated using the North American Space Agency's (NASA) renewable energy resource website [*NASA*, 2017]. The data, summarized in Table 13, are based on satellite-derived monthly data for a grid of 1 ° latitude × 1 ° longitude (*i.e.*, 100 km × 100 km at the equator) for a 22 year period between July 1983 and June 2005. The data are considered reasonable for preliminary studies of solar energy projects. A complete copy of the meteorological and solar energy data generated are included in Appendix IV.

Table 13. Monthly average radiation (kWh · m^{-2} · day^{-1}) for latitude 47.46597 °N and longitude -65.75176 °W incident on a solar array with an azimuth of 180 ° and tilted at various angles. Data from *NASA* [2017].

Parameter*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
SSE HRZ†	1.32	2.29	3.64	5.17	6.09	6.62	6.27	5.66	4.53	2.76	1.62	1.14	3.93
K§	0.44	0.50	0.53	0.56	0.56	0.57	0.56	0.58	0.60	0.52	0.47	0.44	0.53
Diffuse‡	0.78	1.18	1.75	2.09	2.44	2.59	2.51	2.21	1.90	1.32	0.91	0.69	1.70
Direct¥	1.97	3.12	4.12	5.61	6.10	6.58	6.21	6.02	5.28	3.67	2.41	1.81	4.41
Tilt 0 °	1.27	2.26	3.60	5.15	6.10	6.65	6.30	5.63	4.45	2.68	1.61	1.11	3.91
Tilt 32 °	1.93	3.18	4.44	5.67	6.07	6.32	6.10	5.96	5.33	3.65	2.46	1.77	4.41
Tilt 47 °	2.10	3.37	4.50	5.48	5.63	5.75	5.60	5.66	5.33	3.82	2.68	1.95	4.32
Tilt 62 °	2.16	3.38	4.34	5.02	4.93	4.92	4.84	5.09	5.06	3.80	2.75	2.03	4.03
Tilt 90 °	1.98	2.95	3.50	3.63	3.28	3.17	3.17	3.53	3.91	3.24	2.50	1.88	3.06
OPT**	2.16	3.40	4.51	5.67	6.24	6.71	6.38	6.01	5.36	3.84	2.75	2.03	4.59
OPT ANG††	63.0	56.0	44.0	29.0	14.0	9.00	11.0	24.0	39.0	53.0	62.0	65.0	38.9

NOTES:
*All values are at the Earth's surface and are based on the monthly data averaged over a 22 year period (*i.e.*, July 1983 to June 2005) and are for a surface with a 180 °azimuth
†Monthly average amount of the total solar radiation incident on a horizontal surface
§Clearness index, which is dimensionless, and is the monthly average amount of insolation at the top-of-atmosphere that reaches the Earth's surface
‡The monthly average amount of solar radiation on a horizontal surface under all-sky conditions with the direct radiation from the sun's beam blocked by a shadow band or tracking disc
¥The monthly average amount of direct normal radiation incident on a surface oriented normal to the solar radiation
**The monthly average amount of total solar radiation incident on a surface titled at the optimal angle
††The optimal tilt angle

As expected, the average solar radiation is greatest during the summer and the least during winter (Table 13). Based on the model, the optimal tilt for yielding maximum power production (

Figure 28) for a fixed solar array with a 180 ° azimuth at the Project site is 38.9 °.

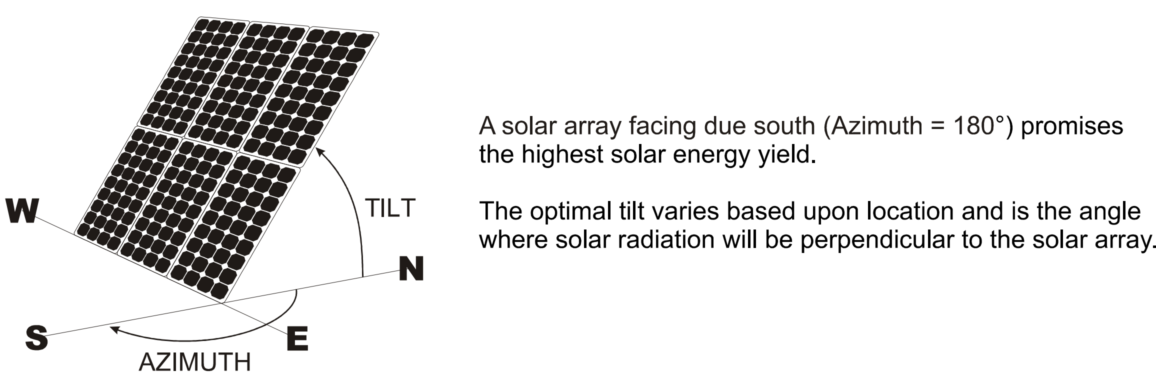


Figure 28. Illustration showing the definition of azimuth and tilt for a solar array.

3.1.3 Greenhouse Gas Reporting

GHG emissions (*i.e.*, carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride, and nitrogen trifluoride) are believed to be contributors to accelerated climate change. Greenhouse gas emissions summaries are available between 1990 and 2015 for all provinces and territories, Canada, and the World. The emissions summaries comprise total emissions from: energy activities (*i.e.*, stationary combustion sources, transportation, and fugitive sources); industrial processes (*e.g.*, mineral products, chemical industry, metal production, *etc.*); solvent and other product use; agriculture (*i.e.*, fermentation, manure management, soils management, and field burning); and waste activities (*i.e.*, wastewater handling, incineration, and landfills) [*ECCC*, 2016]. The data are summarized in Table 14.

Table 14. Provincial and territorial, national, and global greenhouse gas emissions data for 1994, 1999, 2004, and 2010 to 2015. Data from *ECCC* [2016] and *CAIT* [2017].

Region	Kilotonnes of Carbon Dioxide Equivalent Units (kt CO_{2eq})									Change*
	1994	1999	2004	2010	2011	2012	2013	2014	2015	
AB	199 000	225 000	235 000	242 000	246 000	260 000	272 000	274 000	274 100	138%
BC	56 800	64 400	67 400	60 900	61 100	62 700	63 100	62 900	60 900	107%
MB	19 100	20 700	21 200	19 700	19 500	20 800	21 500	21 500	20 800	109%
NB	17 100	19 800	22 200	18 600	18 900	16 900	15 000	14 900	14 100	82%
NL	7 410	9 590	10 900	10 300	10 300	9 760	9 570	10 600	10 300	139%
NS	19 400	21 000	24 200	20 400	21 100	19 200	18 400	16 600	16 200	84%
NT	1 850	1 230	1 410	1 360	1 430	1 490	1 380	1 530	1 400	76%
NU		263	644	424	232	235	227	269	600	228%
ON	177 000	202 000	207 000	179 000	175 000	171 000	171 000	170 000	166 200	94%
PE	1 910	2 010	2 160	1 990	2 050	2 060	1 770	1 800	1 800	94%
QC	87 400	89 200	93 600	82 400	84 400	81 800	82 900	82 700	80 100	92%
SK	58 300	66 700	69 900	69 900	69 300	71 700	73 900	75 500	75 000	129%
YK	494	566	479	344	384	393	351	268	300	61%
Canada	645 764	722 459	756 093	707 318	709 696	718 038	731 098	732 567	721 800	112%
NB†	2.65%	2.74%	2.94%	2.63%	2.66%	2.35%	2.05%	2.03%	1.95%	
World	30 372 307	32 445 919	37 067 575	42 778 969	44 067 058	44 534 645	45 261 252			149%
Canada‡	2.13%	2.23%	2.04%	1.65%	1.61%	1.61%	1.62%			

NOTES:
*Percentage change between 1994 emissions and 2015 emissions except for Nunavut, which is between 1999 and 2015, and the World, which is between 1999 and 2013
†New Brunswick's emissions contribution to Canada's emissions
‡Canada's emissions contribution to the World's emissions

Although there have been efforts to curb and reduce GHG emissions, global GHG emissions continue to steadily increase (Table 14 and Figure 29). This is largely due to the increase in emissions from developing countries. Comparatively, Canadian emissions exhibited a sharp downward trend between 2007 and 2009, which was likely due to increased awareness and the implementation of newer technologies nationally to reduce GHG emissions; however, since 2009, emissions have been on the upswing. All provinces, with the exception of Alberta, British Columbia, Manitoba, Saskatchewan, and

Newfoundland, all large fossil fuel extracting provinces, have shown a decrease in GHG emissions. Between 1994 and 2015, New Brunswick's GHG emissions decreased by about 18 % while Canada's overall emissions have increased.

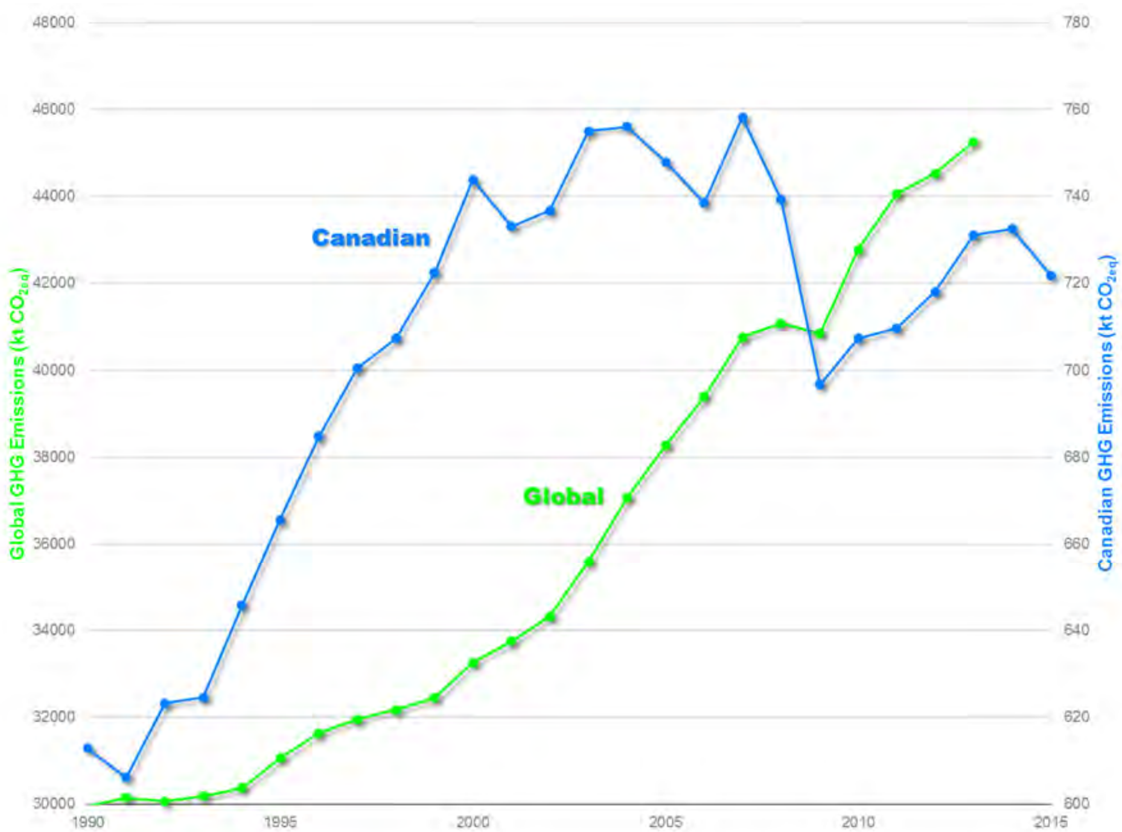


Figure 29. Global and Canadian annually reported greenhouse gas emissions, in kilotonnes (kt) of carbon dioxide equivalent units (CO_{2eq}).

In order to assess Canada's overall environmental performance and contribution to GHG emissions, the Canadian Government announced the introduction of the Greenhouse Gas Emissions Reporting Program (GHGRP) in March 2004. Through the GHGRP, all facilities that emit the equivalent of 50 000 tonnes or more of GHGs in carbon dioxide equivalent units (CO_{2eq}) per year from stationary combustion, industrial processes, venting, flaring, fugitives, and on-site transportation, waste, and wastewater sources are required to report. Facilities falling below the threshold are not obligated to report, but they may voluntarily do so.

Since 2004, several industrial facilities in New Brunswick have reported to the GHGRP. During that time, GHG emissions reporting in the Province have collectively decreased by 36 % from about 22 000 kt · yr^{-1} CO_{2eq} in 2004 to about 14 100 kt · $year^{-1}$ CO_{2eq} in 2015 (Table 14). Industrial emissions reductions, which are a significant amount of overall emissions, have resulted from the implementation of improved technology and the phasing out of coal-fired power generating stations (*i.e.*, Grand Lake Generating Station and Dalhousie Generating Station) [*ECCC*, 2016].

For the six years between 2011 and 2016, the same dozen industrial facilities in New Brunswick reported to the GHGRP and the total CO_{2eq} emissions are plotted in Figure 30.

The three largest contributors to total CO_{2eq} emissions, which represent > 80 % of the reported emissions, are Bayside Power, the Belledune Generating Station, and the Irving Oil Refinery. As previously noted, Belledune is a coal-fired electricity generating station that will have to be shuttered by 2030 if a phase-out agreement to end-of-life is not approved by the Federal Government.

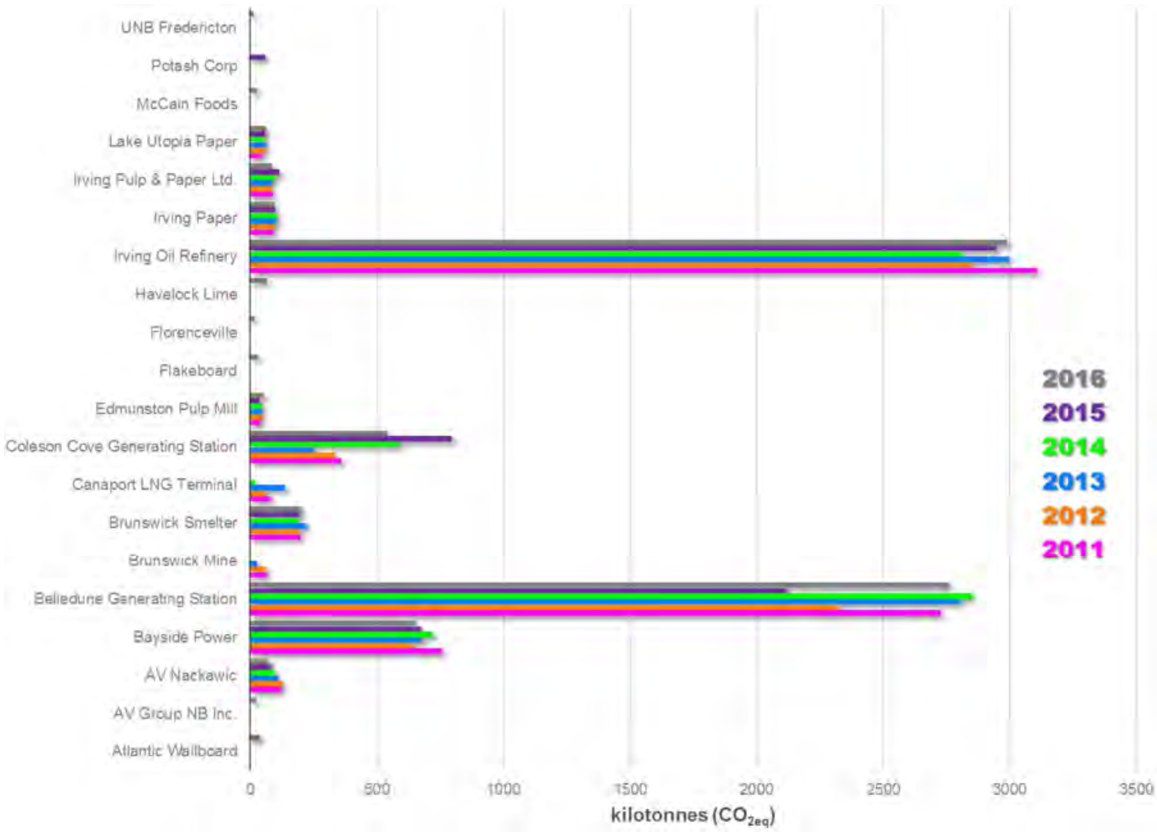


Figure 30. Reported total carbon dioxide equivalents (CO_{2eq}), in kilotonnes, for New Brunswick facilities that reported to the Greenhouse Gas Emissions Reporting Program between 2011 and 2016.

3.1.4 Sound Levels

The Bathurst Local Service District (LSD) has small pockets of light and heavy industrialized areas (*i.e.*, two industrial parks). The local area is mostly timberland with some current and former mining operations (*i.e.*, Brunswick Mine, Bathurst Mines, and Heath Steele Mines), a timber processing facility (*i.e.*, The Fornebu Lumber Company Inc.'s sawmill), and some pits and quarries. There are likely loud sounds associated with those operations. The nearest residential developments to the Project site are about 5 km to the northeast along NB Route 430 (*i.e.*, Blue Mountain Settlement) and 7 km to the southwest along the Nepisiguit Falls Road (*i.e.*, Bathurst Mines).

There are no sound-sensitive receptors (*i.e.*, homes, hospitals, schools, libraries, park, and recreational areas) or land-uses in the local area (*i.e.*, within 5 km).

3.1.5 Topography

The local area is relatively flat, but does slope south towards the Nepisiguit River. Site elevations range from about 80 m to 120 m. Regionally, elevations range from sea level along the Bay of Chaleur coastline to about 150 m in the highlands.

3.1.6 Hydrology

The Project site is located within the 3 092 km^2 Nepisiguit River watershed, which discharges to the Bay of Chaleur at Bathurst. Headwaters of the Nepisiguit River are north of the Christmas Mountains between Mount Carleton and Big Bald Mountain. Several falls exist along the River, including Indian Falls, Nepisiguit Falls, and Pabineau Falls.

There are no mapped watercourses and wetlands on the Project site (Figure 31). During ground-truthing exercises, no watercourses and wetlands were identified. The nearest watercourse is Pabineau River, which is located about 150 m to the east of the Project site at its closest location to PID 20557021.

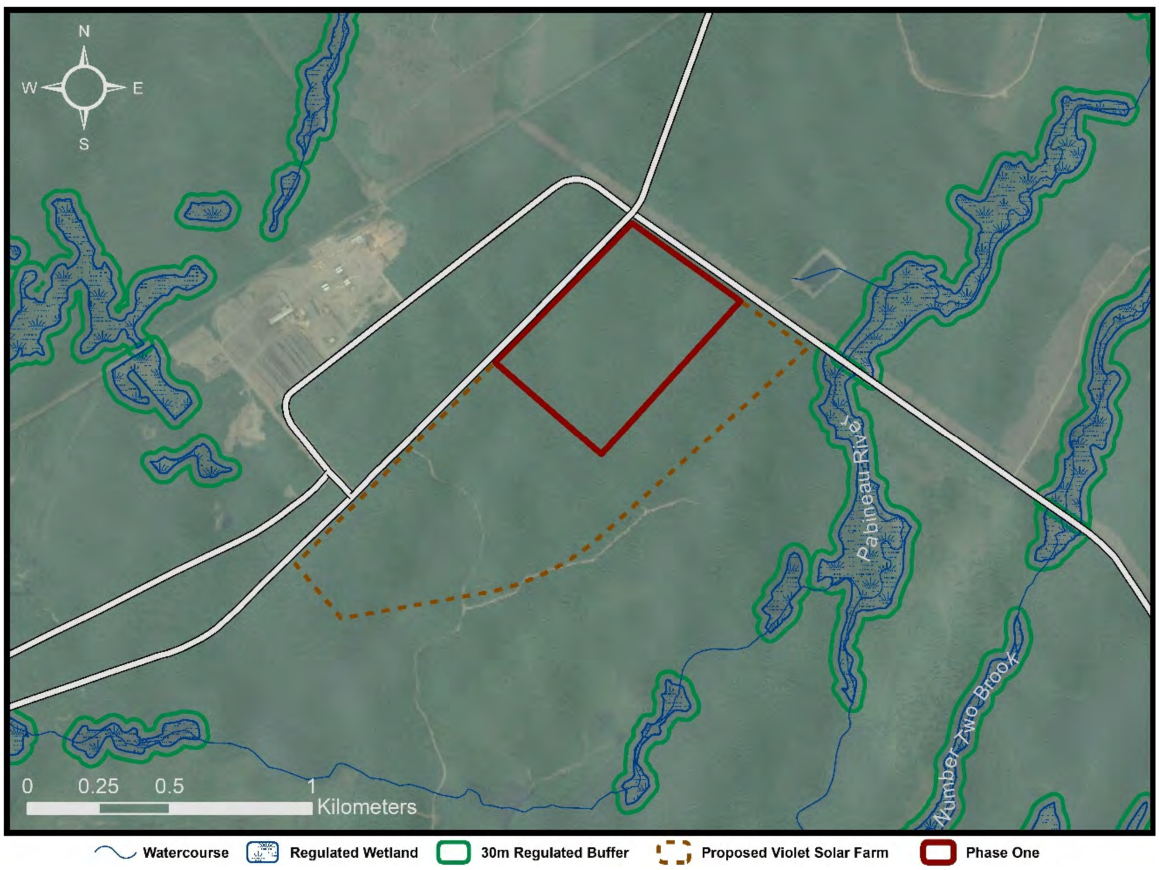


Figure 31. Aerial photograph, circa 2015, showing watercourses and wetlands in the immediate vicinity of the Violet Solar Farm proposed for Brunswick Mills, New Brunswick.

Environment Canada operates a hydrometric station on the Middle River near Bathurst (*i.e.*, station 01BJ010). Although the Project site is not located within the Middle River watershed, it is relatively close to the site and the Nepisiquit River likely responds in a similar fashion. Mean daily water stream discharge data were obtained for the Middle

River from Environment Canada [*GC*, 2017]. Figure 32 shows the minimum, mean, and maximum mean daily data between 1981 and 2012. Generally, Middle River exhibits two hydrograph peaks, one in spring during snowmelt and ice-out and one in fall. During the 32 years, the mean daily flow was 4.44 $m^3 \cdot s^{-1} \pm 7.765$ $m^3 \cdot s^{-1}$ (n = 11 445). The greatest mean daily flow of 114 $m^3 \cdot s^{-1}$ occurred on 4 May 1991 and the lowest mean daily flow of 0.09 $m^3 \cdot s^{-1}$ occurred on 2 and 3 September 2010.

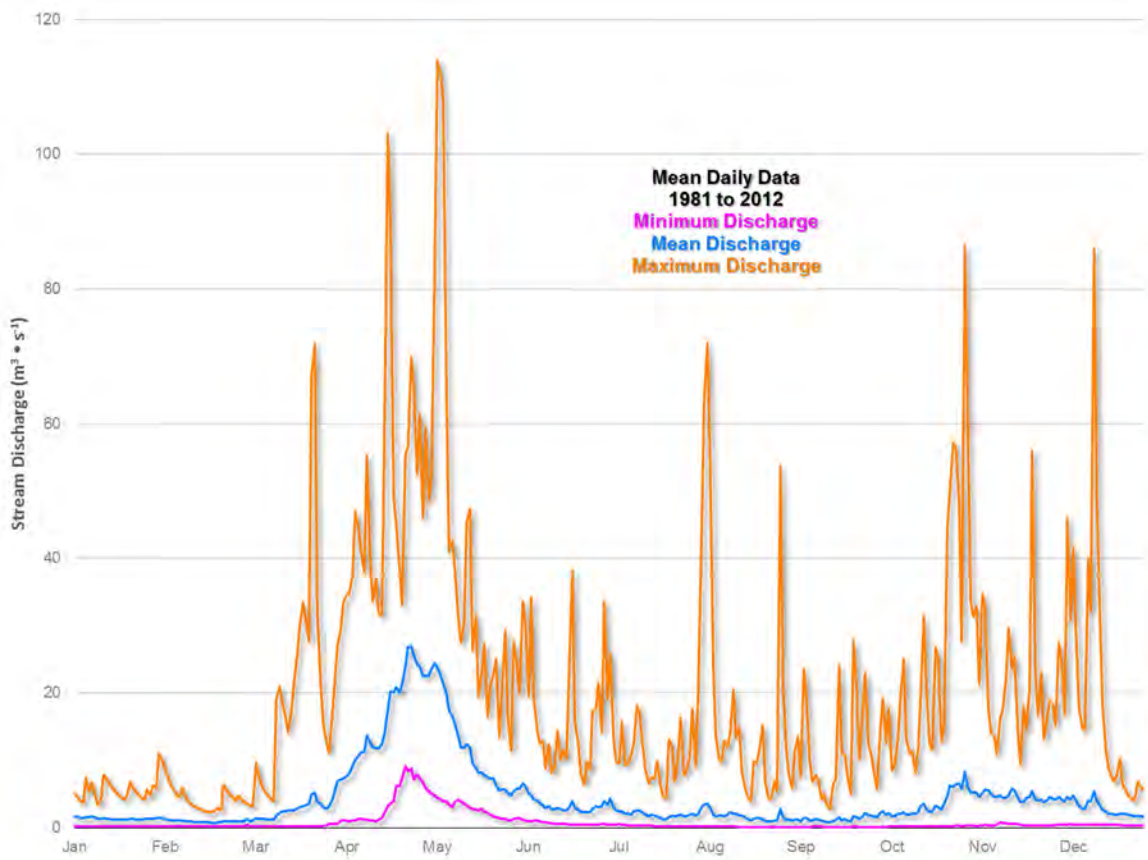


Figure 32. Mean daily stream discharge for Middle River, New Brunswick from 1981 to 2012 as measured by Environment Canada at hydrometric station 01BJ010 [*GC*, 2017].

3.1.7 Geology

3.1.7.1 Bedrock

The Project site lies within the Eastern Miramichi Highlands of the Miramichi Highlands physiographic region of New Brunswick [*Rampton et al.*, 1984]. Bedrock geology of the immediate area, which is shown in Figure 33, is primarily comprised of igneous rock that is early Devonian in age (*i.e.*, 358 mya to 416 mya). The pink, coarse-grained, equigranular to subporyphyritic biotite granite belongs to the Pabineau Falls Granite [*Wilson*, 2013].

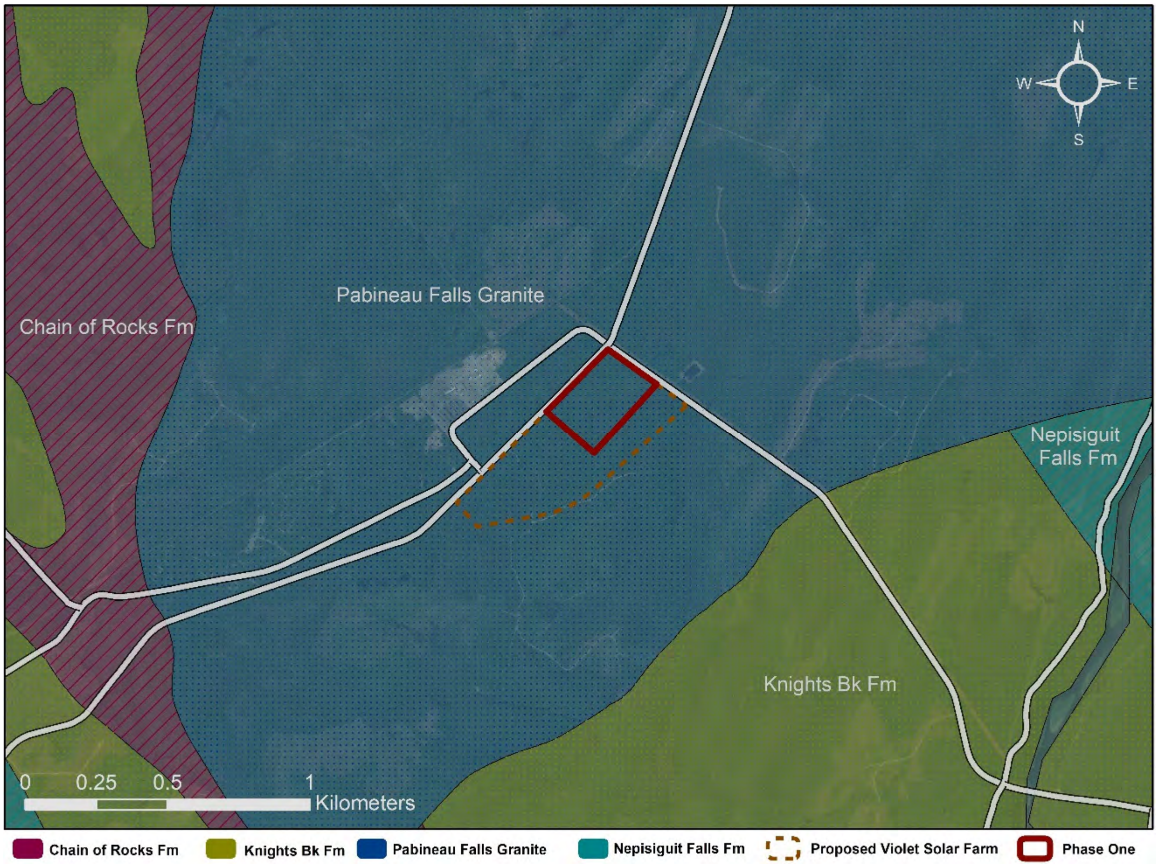


Figure 33. Bedrock geology map showing the location of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

3.1.7.1.1 Local Mining

The Bathurst Mining Camp is one of the most prolific base metal mining camps in the world and is located in northeast New Brunswick centred in the Nepisiguit River valley near Bathurst. The mining district hosts 45 known volcanogenic massive sulfide deposits (*i.e.*, camps as summarized in Table 15) and 95 significant occurences that are typical of the Appalachian Mountains [*McCutcheon et al.*, 2003; *Goodfellow*, 2007]. Although the primary mineral mined is zinc, the ore bodies are also mined for lead, zinc, copper, silver, gold, bismuth, antimony, and cadmium. Several mines have existed in the district over the years, beginning with the discovery of the Brunswick No. 6 deposit in 1952 (Figure 34). Because the area is well known for its deposits, mineral claims are held on many of the properties.

In New Brunswick, the landowners do not own mineral rights, the Crown does (*n.b.*, in some specific instances, minerals were granted with the land and each conveyance since the granting has preserved the ownership of those minerals). As per the New Brunswick *Mining Act* **[M-14.1]**, Crown-owned minerals are available for exploration and development. Prospectors, claims holders, and mining lease holders have the right to prospect, explore, mine, and produce those minerals whether they are on Crown-owned or privately-owned lands. They also have the right of access to the minerals.

Table 15. Summary of the Bathurst Mining Camps of New Brunswick.

ID	Mining Camp	Production			
		Started	Ceased	Minerals Mined*	Tonnage Extracted (to 2003)§
1	Key Anacon				
2	Key Anacon East				
3	Brunswick No. 12	1964	2013	Ag, Cu, Pb, Zn	88 806 500
4	Brunswick Northend				
5	Headway				
6	Pabineau				
7	Brunswick No. 6	1966	1983	Ag, Cu, Pb, Zn	12 197 000
8	Austin Brook				
9	Flat Landing Brook				
10	Captain North Extension (CNE)			Ag, Cu, Pb, Zn	39 000
11	Captain				
12	Louvicourt				
13	Taylor Brook				
14	Nepisiguit "A"				
15	Nepisiguit "B"				
16	Nepisiguit "C"				
17	Heath Steele B-5 Zone				
18	Heath Steele B Zone	1957	1999	Ag, Cu, Pb, Zn	20 723 000
19	Health Steele ACD Zones	1957	1999	Ag, Cu, Pb, Zn	2 649 900
20	Heath Steele C North				
21	Heath Steele E Zone				
22	Heath Steele HC-4				
23	Heath Steele West Grid				
24	Heath Steele H-2 Zone				
25	Heath Steele N-5	1957	1999	Ag, Cu, Pb, Zn	1 137 000
26	Stratmat Main				
27	Stratmat Central				
28	Stratmat Boundary	1957	1999	Ag, Cu, Pb, Zn	INCLUDED IN 25
29	Stratmat S-1				
30	Stratmat West Stringer				
31	Canoe Landing Lake				
32	Rocky Turn				
33	Armstrong B				
34	Armstrong A				
35	Wedge	1962	1968	Ag, Cu, Pb, Zn	1 503 500
36	Orvan Brook				
37	Chester			Cu, Zn	3 000
38	McMaster				
39	Caribou	1970	Present	Ag, Au, Cu, Pb., Zn	4 122 500
40	Camel Back				
41	Halfmile North Lake				
42	Halfmile Lake				
43	Murray Brook	1989	1992	Ag, Au	1 014 000
44	Devil's Elbow				
45	Restigouche			Ag, Pb, Zn	230 700

NOTES:
*Ag = Silver; Au = Gold; Cu = Copper; Pb = Lead; Zn = Zinc
§From *McCutcheon et al.*, [2003]

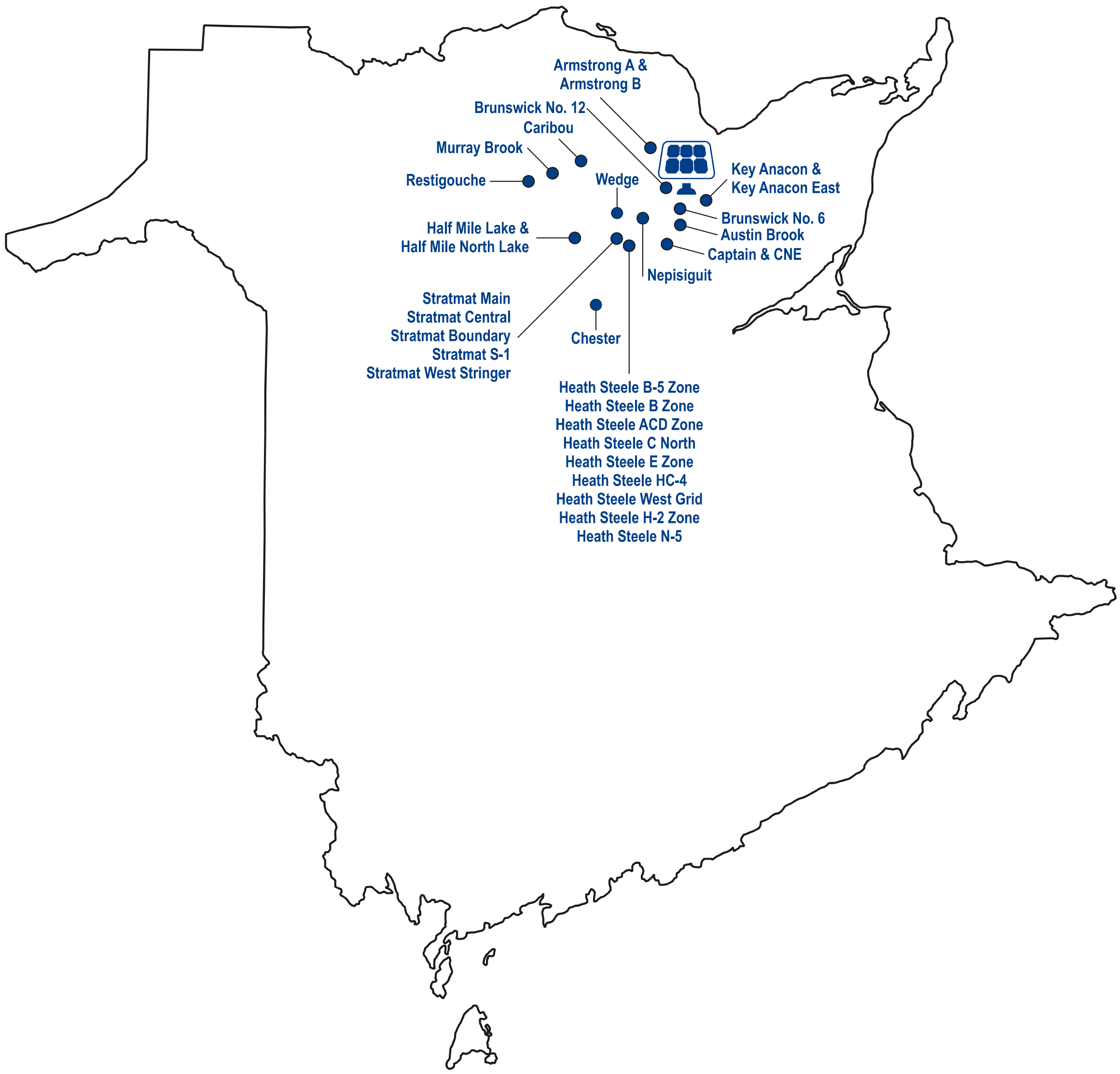


Figure 34. Mines that have operated within the Bathurst Mining Camp of northern New Brunswick.

The New Brunswick Department of Energy and Resource Development databases were queried for existing mineral claims in the vicinity of the Project. Figure 35 shows the mineral claims in the vicinity of the Project site and Table 16 summarizes those claims. None of the claims are located within the boundaries of the proposed Project, though Claim 8012 does extend on to the PID.

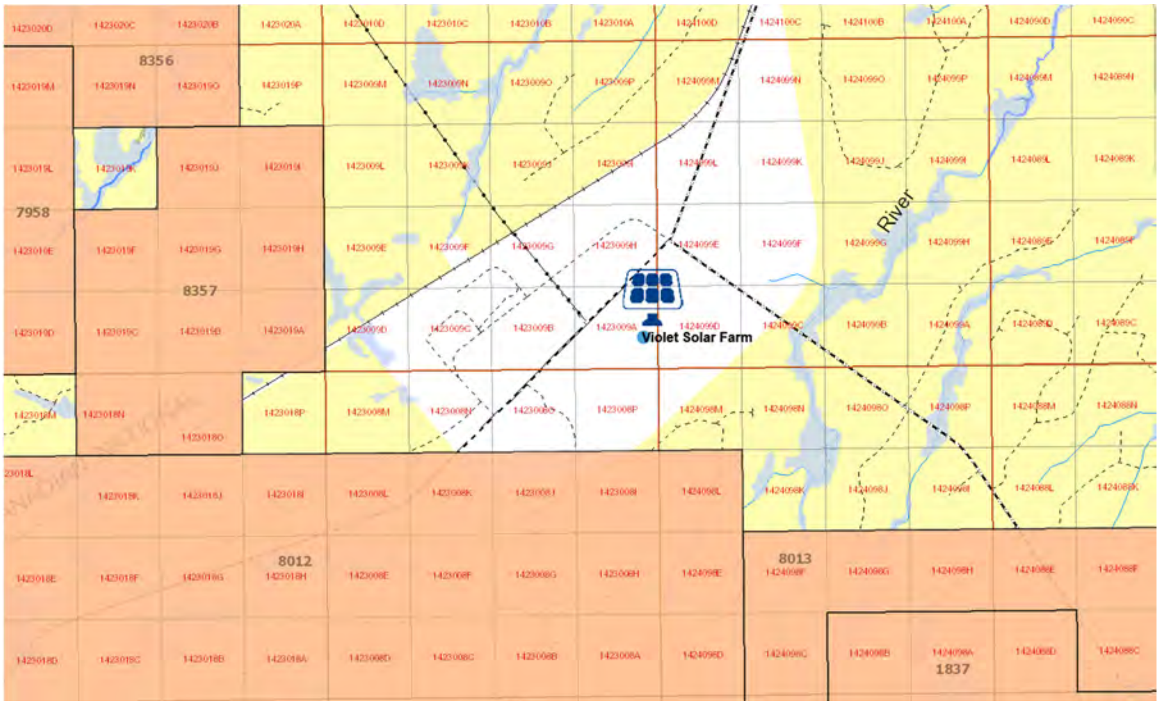


Figure 35. Map showing the mineral claims in the vicinity of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick. Data from NB e-CLAIMS.

Table 16. Information regarding the mineral claims in the vicinity of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick. Data from NB e-CLAIMS.

Right Number	Claim Name	Claim Type	Issue Date	Expiry Date	Owners
8012	Bathurst Mines A	Mineral	16 Jan 2017	16 Jan 2019	Osisko Metals Incorporated
8013	Bear Island	Mineral	16 Jan 2017	16 Jan 2019	Osisko Metals Incorporated
8357	Flemming Brook	Mineral	21 Aug 2017	21 Aug 2019	S. Nikki Lovesey
8356	Flemming Brook	Mineral	21 Aug 2017	21 Aug 2019	Kim David
1837	Key Anacon Mine	Mineral	28 Oct 1984	28 Oct 2019	Osisko Metals Incorporated
7958	Gilmour West	Mineral	27 Dec 2016	27 Dec 2018	Ossiko Metals Incorporated

3.1.7.2 Surficial

Surficial geology of the area (Figure 36) is described by *Pronk and Allard* [2003] as being glaciofluvial sediments of sand, gravel, minor silt, and till deposited in front of, at the margin of, within, or under retreating Late Wisconsinan ice. The blanket of loamy lodgment till, minor ablation till, silt, sand, gravel, and rubble is generally 0.5 m to 3 m thick. According to *Rees et al.* [2005], morainal till in the area is about 1 m to 2 m thick. The poorly drained till comprises acidic, olive brown, coarse loamy compact material with 20 % to 40 % coarse fragments of slate, siltstone, argillite, schist, and miscellaneous quartzite and greywacke.

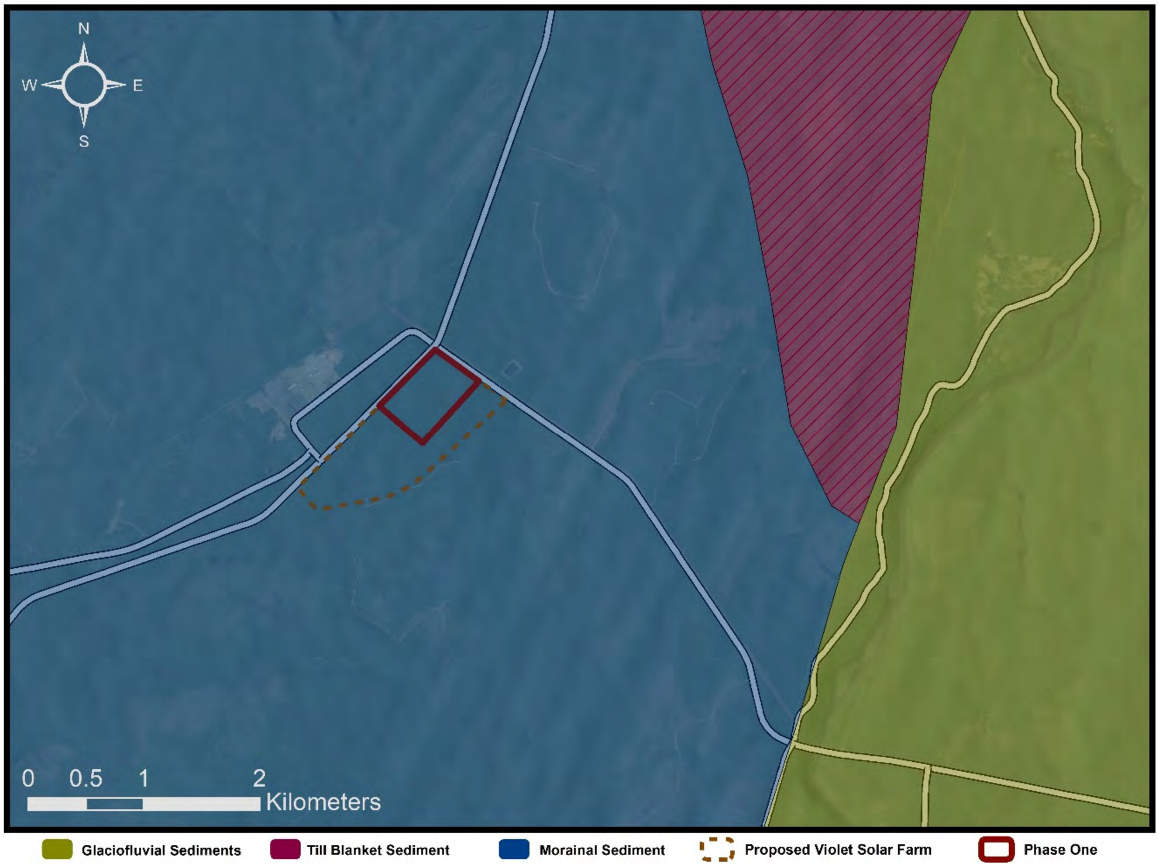


Figure 36. Surficial geology map showing the location of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

3.1.8 Hydrogeology

3.1.8.1 Use

Approximately 64 % of New Brunswick's population is reliant on groundwater for supplying domestic freshwater [*Natural Resources Canada*, 2005]. Regional groundwater availability maps exist for most of Canada and are generalizations of large quantities of data collected for a region [*Natural Resources Canada*, 2005]. In the Brunswick Mills area, aquifers are typically able to supply a flow rate > 24 $L \cdot min^{-1}$ (Figure 37); however, localized groundwater availability can only be determined through on-site investigations.

The Fornebu Lumber Company Inc.'s nearby sawmill likely obtains potable water from an on-site well; however, search of the Province's Online Well Log System (OWLS) did not reveal any records for that facility (*n.b.*, it is not known if groundwater or surface water are used to supply any process water at the facility). The nearest residential community, Blue Mountain Settlement, is located about 5 km distant. A search for available well logs was completed within a 5 km radius of PID 20557021 for characterizing groundwater quantity and quality.

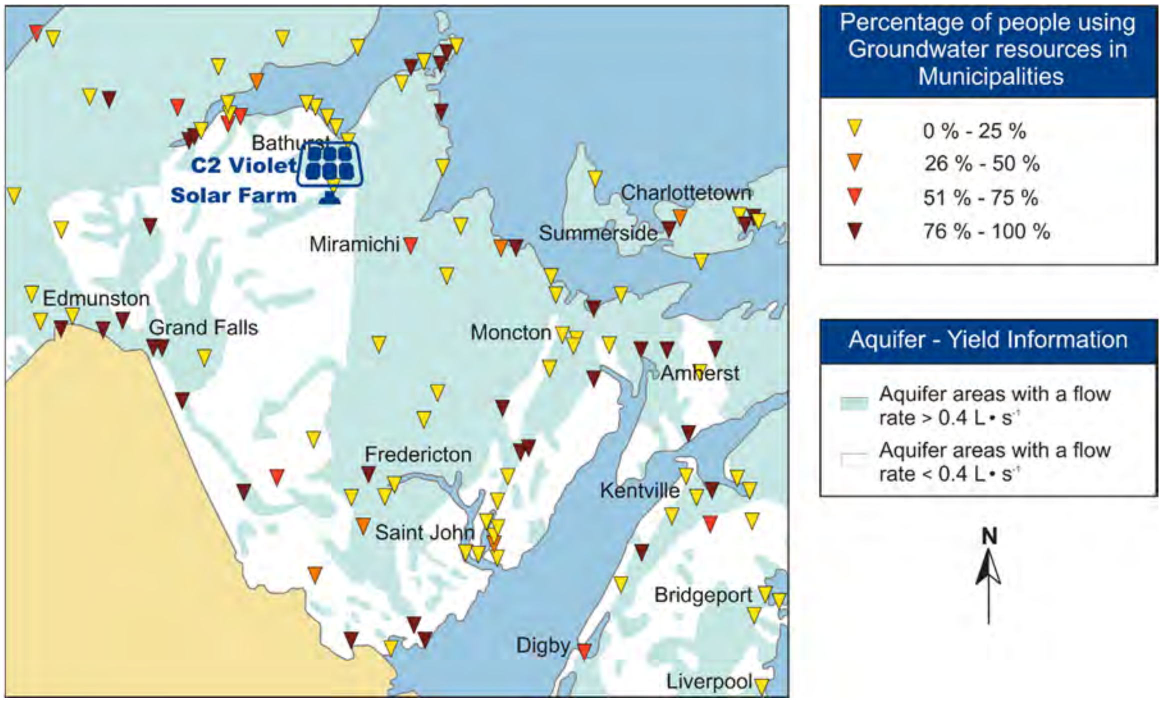


Figure 37. Groundwater availability map for New Brunswick.

Residential, commercial, and industrial properties outside of Bathurst City proper are reliant on groundwater for supplying potable water. There are no known large potential groundwater users in the immediate area. The adjacent sawmill likely only uses groundwater for supplying potable and sanitary systems.

3.1.8.2 Quantity

A potable groundwater well records search returned 6 well logs from the NBDELG's OWLS database. Refer to Appendix V for a copy of the OWLS records search. Those data were used for characterizing the local groundwater quantity.

Based on the records, the average well depth is 23.4 m ± 8.97 m (n = 6). Depths range from as shallow as 12.2 m to as deep as 36.6 m. Casing length for this group of wells ranges from 5.8 m to 21.0 m and averages 9.8 m ± 6.01 m (n = 6). According to the well logs, where data are available, bedrock is found at a depth of 11.1 m ± 14.36 m (n = 6). The shallowest depth that bedrock was encountered is 0.3 m and the greatest depth is 57.9 m. The average safe yield for the six wells with available data, as estimated by the well driller(s), is 20.1 L $\cdot$ min^{-1} ± 21.2 L $\cdot$ min^{-1}. The safe yield is estimated to be a low as 2.3 L $\cdot$ min^{-1} and as great as 45.5 L $\cdot$ min^{-1} from individual wells. Static water levels are generally 21.9 m ± 9.24 m below the top of casing and typically range from 12.2 m to 36.6 m (n = 5).

Figure 38. Map showing groundwater wells on file with the NBDELG within a 5 km radius of Brunswick Mills, New Brunswick. The well logs and water quality records were obtained for characterizing local groundwater quantity and quality.

3.1.8.3 Quality

There were no water quality records (*i.e.*, microbiology, general chemistry, and trace metals) available for potable water wells within a 5 km radius of PID 20557021. Based on data within the New Brunswick Groundwater Chemistry Atlas [*NBDENV*, 2008], arsenic exceedances are generally common in groundwater supplies of the area.

3.2 BIOLOGICAL ENVIRONMENT

3.2.1 Federal Species At Risk

Federally listed species at risk that exist in New Brunswick and could potentially be impacted by the Project are noted in Table 17. Those terrestrial and aquatic species identified under the federal *Species At Risk Act* (f*SARA*) and by the Committee On Status of Endangered Wildlife In Canada (COSEWIC) as being at risk in New Brunswick are listed. Listing of a species in Table 17 does not indicate that it is either present or absent at the Project site. Presence and absence information is provided below. The order of risk level under the f*SARA* and by the COSEWIC is as follows:

- special concern;
- threatened;
- endangered;
- extirpated; and
- extinct.

Table 17. Terrestrial and aquatic flora and fauna listed as being species at risk under the f*SARA* and by the COSEWIC that could potentially be affected by the proposed Project in Brunswick Mills, New Brunswick.

Common Name	Scientific Name	f*SARA* Status	COSEWIC Status
Vascular Plants, Mosses, and Lichens			
Vole ears lichen	*Erioderma mollissimum*	Endangered	Endangered
Boreal felt lichen	*Eridoerma pedicellatum*	Endangered	Endangered
Prototype quillwort	*Isoetes prototypus*	Special concern	Special concern
Butternut	*Juglans cinerea*	Endangered	Endangered
Beach pinweed	*Lechea maritime*	Special concern	Special concern
Furbish's lousewort	*Pedicularis furishiae*	Endangered	Endangered
Anticosti aster	*Symphyotrichum anticostense*	Threatened	Threatened
Gulf of St. Lawrence aster	*Symphyotrichum laurentianum*	Threatened	Threatened
Bathurst aster (Bathurst pop.)	*Symphyotrichum subulatum*	Special concern	Special concern
Molluscs			
Dwarf wedgemussel	*Alasmidonta heterodon*	Extirpated	Extirpated
Brook floater	*Alasmidonta varicosa*	Special concern	Special concern
Yellow lampmussel	*Lampsilis cariosa*	Special concern	Special concern
Reptiles			
Snapping turtle	*Chelydra serpentina*	Special concern	Special concern
Wood turtle	*Glyptemys insculpta*	Threatened	Threatened
Birds			
Eastern whip-poor-will	*Antrostomus vociferus*	Threatened	Threatened
Short-eared owl	*Asio flammeus*	Special concern	Special concern
Barrow's goldeneye (Eastern pop.)	*Bucephala islandica*	Special concern	Special concern
Red knot *rufa* subspecies	*Calidris canutus rufa*	Endangered	Endangered
Canada warbler	*Cardellina canadensis*	Threatened	Threatened
Bicknell's thrush	*Catharus bicknelli*	Threatened	Threatened
Chimney swift	*Chaetura pelagica*	Threatened	Threatened
Piping plover *melodus* subspecies	*Charadrius melodus melodus*	Endangered	Endangered
Common nighthawk	*Chordeiles minor*	Threatened	Threatened
Olive-sided flycatcher	*Contopus cooperi*	Threatened	Threatened
Yellow rail	*Coturnicops noveboracensis*	Special concern	Special concern
Rusty blackbird	*Euphagus carolinus*	Special concern	Special concern
Peregrine falcon	*Falco peregrinus anatum / tundrius*	Special concern	Special concern
Harlequin duck (Eastern pop.)	*Histrionicus histrionicus*	Special concern	Special concern
Least bittern	*Ixobrychus exilis*	Threatened	Threatened

Common Name	Scientific Name	f*SARA* Status	COSEWIC Status
Eskimo curlew	*Numenius borealis*	Endangered	Endangered
Roseate tern	*Sterna dougallii*	Endangered	Endangered
Arthropods			
Cobblestone tiger beetle	*Cicindela marginipennis*	Endangered	Endangered
Maritime ringlet	*Coenonympha nipisiquit*	Endangered	Endangered
Monarch butterfly	*Danaus plexippus*	Endangered	Special concern
Pygmy snaketail	*Ophiogomphus howei*	Special concern	Special concern
Fishes			
Shortnose sturgeon	*Acipenser brevirostrum*	Special concern	Special concern
Rainbow smelt (Lake Utopia)	*Osmerus mordax*	Threatened	Threatened
Atlantic salmon (IBOF pop.)	*Salmo salar*	Endangered	Endangered
Terrestrial Mammals			
Little brown bat	*Myotis lucifugus*	Endangered	Endangered
Northern bat	*Myotis septentrionalis*	Endangered	Endangered
Tri-colored bat	*Perimyotis subflavus*	Endangered	Endangered

The Atlantic Canada Conservation Data Centre (ACCDC) databases were queried for known observation data of federally protected species within a 5 km radius of the Project site (*i.e.*, refer to Appendix VI). According to the ACCDC data, five species listed under the f*SARA* and by the COSEWIC have been observed (Figure 39) and include:

- Canada warbler;
- chimney swift;
- common nighthawk;
- olive-sided flycatcher; and
- rusty blackbird.

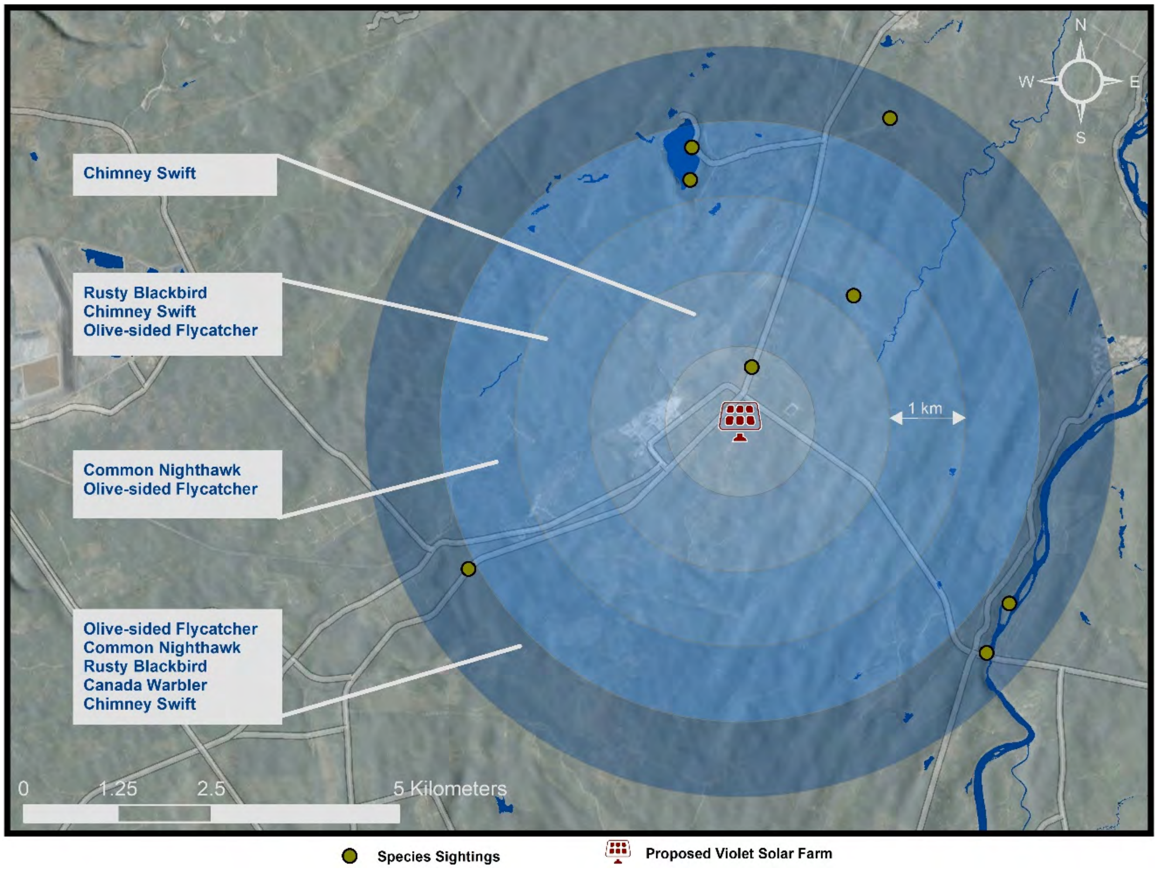


Figure 39. Map showing the recorded observations of species listed under the f*SARA* and by the COSWEIC within a 5 km radius of the Project site in Brunswick Mills, New Brunswick. Data obtained from the ACCDC.

3.2.1.1 Snapshots of Federal Species At Risk Locally Present

Detailed information provided below on the protected species was obtained from the species profiles on the f*SARA* [*SARA*, 2018] and COSWEIC [*COSEWIC*, 2018] websites.

The Canada warbler is a small (12 cm to 15 cm), brightly coloured songbird (Figure 40). Their numbers have plummeted in the majority of their nesting areas. Although most abundant in wet, mixed deciduous-coniferous forests with a well-developed shrub layer, it is found in a variety of forest types. It also prefers riparian shrub forests on slopes and in ravines and in old-growth forests with canopy openings and a high density of shrubs, as well as in regenerating forest stands. Because their habitat is being lost and degraded, their numbers continue to be vulnerable to decline and hence the reasoning for their threatened ranking under the f*SARA* and by the COSEWIC (Table 17).

The chimney swift is a small (*i.e.*, 12 cm to 15 cm), sooty gray bird with very long, slender wings and very short legs. There are no subspecies of the chimney swift, but like all swifts, it is incapable of perching and can only cling vertically to surfaces (Figure 40). They build nests of twigs, stuck together with salvia, in chimneys and other vertical surfaces in dim, enclosed areas including air vents, wells, hollow trees, and caves. They forage over all urban and suburban areas, rivers, lakes, forest, and fields in search of flying insects. Although the global population of chimney swifts is relatively healthy, they have been impacted in Atlantic Canada due to severe storm events and the reduction in nesting habitat (*i.e.*, chimneys are not as prevalent as they once were). This has caused them to be listed as threatened under the f*SARA* and by the COSEWIC (Table 17).

Figure 40. Photographs of species listed under the f*SARA* and by the COSEWIC that have been observed within a 5 km radius of the Project site in Brunswick Mills, New Brunswick.

The common nighthawk is a medium-sized bird with long, narrow, pointed wings and a slightly notched long tail (Figure 40). It is ranked as a threatened species under the f*SARA* and by the COSEWIC (Table 17). While in flight, their distinguishing feature is a wide white stripe across the long feathers at the edge of their wings. They nest in a wide variety of open, vegetation-free habitats, including dunes, beaches, recently harvested forests, burnt-over areas, logged areas, rocky outcrops, rocky barrens, grasslands, pastures, peat bogs, marshes, lakeshores, and river banks. They are also known to inhabit mixed and coniferous forests. Causes of population decline are unknown, but it may be partly attributed to the decline of insect populations, which they largely feed upon.

The olive-sided flycatcher (Figure 40) is a small (*i.e.*, 18 cm to 20 cm long), but stout songbird ranked as a threatened species under the f*SARA* and by the COSEWIC (Table 17). They breed in scattered locations throughout most coniferous and mixed forests of Canada. Considerable declines in population have occurred due to habitat loss and alteration. These birds are most often found in open areas containing tall living trees or snags for perching. Those vantage points are required to suit their foraging habits. Open areas used comprise forest clearings, forest edges located near natural openings, such as rivers and swamps, logged areas, and burned forest, or open areas within old-growth forests.

The rusty blackbird (Figure 40) is a thrush-sized passerine with narrow and pointed wings, and a slightly rounded tail that is almost as long as the wings. *Euphagus carolinus* has pale yellow eyes and a slightly curved black bill. They nest in the forest and favour the shores of wet areas, such as slow-moving streams, peat bogs, marshes, swamps, beaver ponds, and pasture edges. In Canada, the rusty blackbird occurs in all provinces and territories, and is believed to have declined by approximately 85 % since the mid-1960s due to habitat alteration. As a result, they are listed as a species of special concern under the f*SARA* and by the COSEWIC (Table 17).

3.2.2 Provincial Species At Risk

Provincially listed species at risk that exist in New Brunswick and could potentially be impacted by the Project are noted in Table 18. Those terrestrial and aquatic species identified under the provincial *Species At Risk Act* (f*SARA*) as being at risk in New Brunswick are listed. Listing of a species in Table 18 does not indicate that it is either present or absent at the Project site. Presence and absence information is provided below. The order of risk level under the p*SARA* is as follows:

- special concern;
- threatened;
- endangered; and
- extirpated.

Table 18. Terrestrial and aquatic flora and fauna listed as being at risk in New Brunswick under the p*SARA* that could potentially be affected by the proposed Project in Brunswick Mills, New Brunswick.

Common Name	Scientific Name	p*SARA* Status
Vascular Plants, Mosses, and Lichens		
Blue felt lichen	*Degelia plumbea*	Special concern
Parker's pipewort	*Eriocaulon parkeri*	Endangered
Vole ears lichen	*Erioderma mollissimum*	Endangered
Boreal felt lichen (Atlantic pop.)	*Erioderma pedicellatta*	Endangered
Prototype quillwort	*Isoetes prototypus*	Endangered
Butternut	*Juglans cinerea*	Endangered
Beach pinweed	*Lechea maritima*	Special concern
Southern twayblade	*Listera australis*	Endangered
Furbish's lousewort	*Pedicularis furbishiae*	Endangered
Van Brunt's Jacob's-ladder	*Polemonium vanbruntiae*	Threatened
Pinedrops	*Pterospora andromedea*	Endangered
Anticosti aster	*Symphyotrichum anticostense*	Endangered
Gulf of St. Lawrence aster	*Symphyotrichum laurentianum*	Endangered
Bathurst aster (Bathurst pop.)	*Symphyotrichum subulatum*	Endangered
Molluscs		
Dwarf wedgemussel	*Alasmidonta heterodon*	Extirpated
Brook floater	*Alasmidonta varicosa*	Special concern
Yellow lampmussel	*Lampsilis cariosa*	Special concern
Reptiles		
Loggerhead sea turtle	*Caretta caretta*	Endangered
Snapping turtle	*Chelydra serpentina*	Special concern

Common Name	Scientific Name	p*SARA* Status
Leatherback sea turtle (Atlantic pop.)	*Dermochelys coriacea*	Endangered
Wood turtle	*Glyptemys insculpta*	Threatened
Birds		
Short-eared owl	*Asio flammeus*	Special concern
Barrow's goldeneye (Eastern pop.)	*Bucephala islandica*	Special concern
Red knot *rufa* subspecies	*Calidris canutus rufa*	Endangered
Whip-poor-will	*Caprimulgus vociferus*	Threatened
Bicknell's thrush	*Catharus bicknelli*	Threatened
Chimney swift	*Chaetura pelagica*	Threatened
Piping Plover *melodus subspecies*	*Charadrius melodus melodus*	Endangered
Common nighthawk	*Chordeiles minor*	Threatened
Olive-sided flycatcher	*Contopus cooperi*	Threatened
Eastern wood-pewee	*Contopus virens*	Special concern
Yellow rail	*Coturnicops noveboracensis*	Special concern
Bobolink	*Dolichonyx oryzivorus*	Threatened
Rusty blackbird	*Euphagus carolinus*	Special concern
Peregrine falcon *anatum / tundrius*	*Falco peregrinus anatum/tundrius*	Endangered
Bald eagle	*Haliaeetus leucocephalus*	Endangered
Barn swallow	*Hirundo rustica*	Threatened
Harlequin duck (Eastern pop.)	*Histrionicus histrionicus*	Endangered
Wood thrush	*Hylocichla mustelina*	Threatened
Least bittern	*Ixobrychus exilis*	Threatened
Eskimo curlew	*Numenius borealis*	Endangered
Horned grebe (Western pop.)	*Podiceps auritus*	Special concern
Roseate tern	*Sterna dougallii*	Endangered
Eastern meadowlark	*Sturnella magna*	Threatened
Canada warbler	*Wilsonia canadensis*	Threatened
Arthropods		
Cobblestone tiger beetle	*Cicindela marginipennis*	Endangered
Maritime ringlet	*Coenonympha nipisiquit*	Endangered
Monarch	*Danaus plexippus*	Special concern
Skillet clubtail	*Gomphus ventricosus*	Endangered
Pygmy snaketail	*Omphiogomphus howei*	Special concern
Fishes		
Shortnose sturgeon	*Acipenser brevirostrum*	Special concern
Atlantic sturgeon (Maritimes pop.)	*Acipenser oxyrinchus*	Threatened
Thorny skate	*Amblyraja radiata*	Special concern
Atlantic wolffish	*Anarhichas lupus*	Special concern
American eel	*Anguilla rostrata*	Threatened
Cusk	*Brosme brosme*	Endangered
White shark (Atlantic pop.)	*Carcharodon carcharias*	Endangered

Common Name	Scientific Name	p*SARA* Status
Atlantic cod (Laurentian south pop.)	*Gadus morhua*	Endangered
Atlantic cod (southern pop.)	*Gadus morhua*	Endangered
American plaice (Maritime pop.)	*Hippoglossoides platessoides*	Threatened
Mako shortfin (Atlantic pop.)	*Isurus oxyrinchus*	Threatened
Porbeagle	*Lamna nasus*	Endangered
Winter skate (southern Gulf of St. Lawrence pop.)	*Leucoraja ocellata*	Endangered
Winter skate (Georges Bank-Western Scotian Shelf-pop.)	*Leucoraja ocellata*	Special concern
Smooth skate (Laurentian-Scotian pop.)	*Malacoraja senta*	Special concern
Striped bass (Bay of Fundy pop.)	*Morone saxitilis*	Endangered
Striped bass (southern Gulf of St. Lawrence pop.)	*Morone saxitilis*	Special concern
Rainbow smelt (Lake Utopia large-bodied pop.)	*Osmerus mordax*	Threatened
Rainbow smelt (Lake Utopia small-bodied pop.)	*Osmerus mordax*	Threatened
Blue shark (Atlantic pop.)	*Prionace glauca*	Special concern
Atlantic salmon (Inner Bay of Fundy pop.)	*Salmo salar*	Endangered
Atlantic salmon (Outer Bay of Fundy pop.)	*Salmo salar*	Endangered
Atlantic salmon (Gaspe-Southern Gulf of St. Lawrence pop.)	*Salmo salar*	Special concern
Acadian redfish Atlantic population	*Sebastes fasciatus*	Threatened
Spiny dogfish Atlantic population	*Squalus acanthias*	Special concern
Atlantic bluefin tuna	*Thunnus thynnus*	Endangered
Mammals		
Blue whale (Atlantic pop.)	*Balaenoptera musculus*	Endangered
Fin whale (Atlantic pop.)	*Balaenoptera physalus*	Special concern
Gray wolf	*Canis lupus*	Extirpated
North Atlantic right whale	*Eubalaena glacialis*	Endangered
Wolverine	*Gulo gulo*	Extirpated
Canada lynx	*Lynx canadensis*	Endangered
Little brown *Myotis*	*Myotis lucifugus*	Endangered
Northern *Myotis*	*Myotis septentrionalis*	Endangered
Atlantic walrus	*Odobenus rosmarus rosmarus*	Extirpated
Tri-colored bat	*Perimyotis subflavus*	Endangered
Harbour porpoise (Northwest Atlantic pop.)	*Phocoena phocoena*	Special concern
Woodland caribou (Atlantic (Gaspesie) pop.)	*Rangifer tarandus caribou*	Extirpated

The ACCDC databases were queried for known observation data of provincially protected species within a 5 km radius of the Project site (*i.e.*, refer to Appendix VI). According to the ACCDC data, seven species listed under the p*SARA* have been observed (Figure 41):

- barn swallow;
- Canada warbler;
- chimney swift;
- common nighthawk;
- eastern wood-pewee;

- rusty blackbird; and
- olive-sided flycatcher.

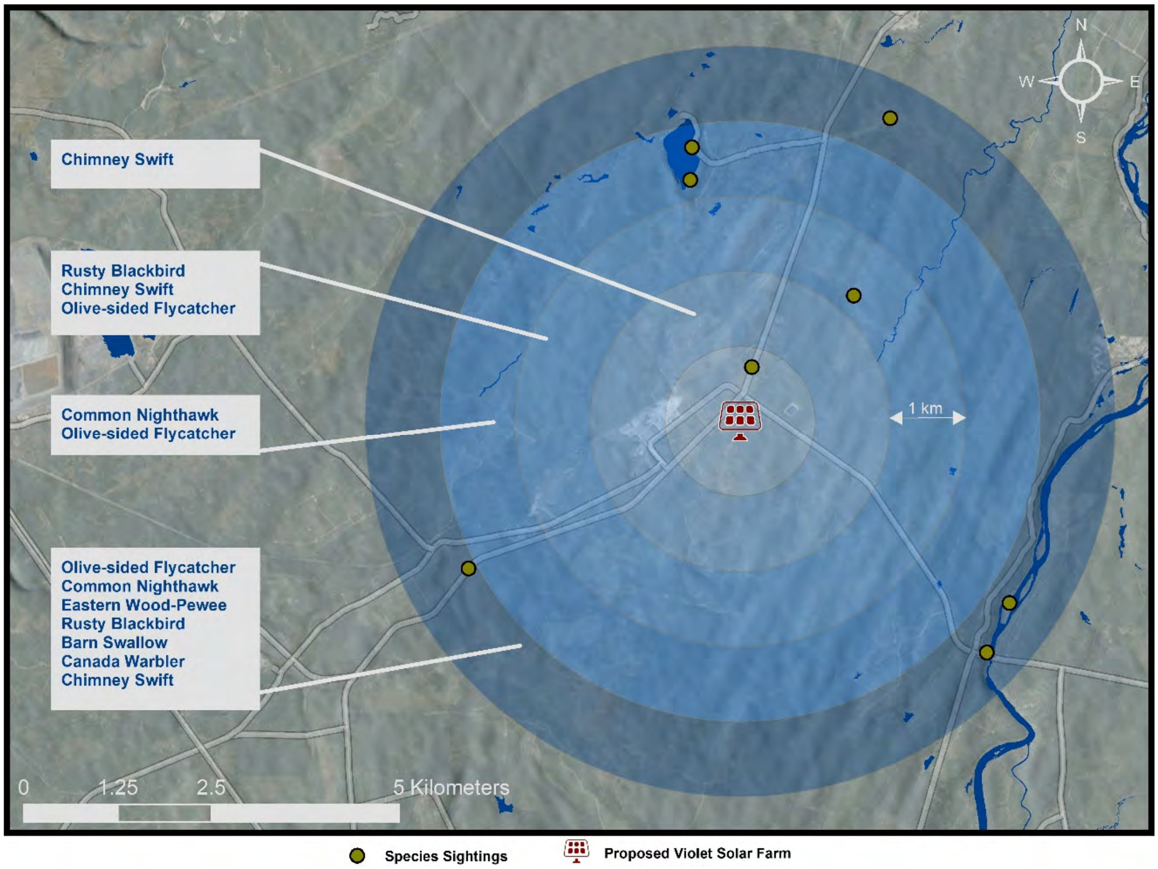


Figure 41. Map showing the recorded observations of species listed under the p*SARA* within a 5 km radius of the Project site in Brunswick Mills, New Brunswick. Data obtained from the ACCDC.

3.2.2.1 Snapshots of Provincial Species At Risk Locally Present

Those seven species listed under the p*SARA* that have been observed within 5 km of the Project site in Brunswick Mills, New Brunswick are shown in Figure 42. Descriptions of those species are provided below if not previously described in Section 3.2.1.1. Detailed information provided below on the protected species was obtained from the species profiles on the p*SARA* [*SARA*, 2018], COSWEIC [*COSEWIC*, 2018], and regulatory agency websites.

Figure 42. Photographs of species listed under the p*SARA* that have been observed within a 5 km radius of the Project site in Brunswick Mills, New Brunswick.

The barn swallow (Figure 42) is the most widespread swallow species in the world. The population of over 190 million individuals globally is considered stable [*BirdLife*, 2014]. Because there have been considerable declines in the presence for the past several decades, the barn swallow species is listed as threatened under the p*SARA* (Table 18). It is a distinctive passerine that has blue upperparts, a long, deeply forked tail that is curved, and pointed wings. This 17 cm to 19 cm long bird is commonly found in open areas with low vegetation, such as pastures, meadows, and farmland. They build a cup nest from mud pellets in barns or other similar structures and feeds on insects caught while in flight.

The eastern wood-pewee (Figure 42) is a small forest flycatcher that grows to about 15 cm long. It was once thought to be a single species of the olive-sided flycatcher, but was later identified as a separate species. Adults are generally greyish-olive on their upper parts and pale on the under parts with pale bars on their wings. Males and females are similar in appearance. They have a distinctive, clear, three-part song, usually heard as “pee-ah-wee”. It is generally found in the mid-canopy layer of forest clearings and at the edges of deciduous and mixed forests. Its habitat is threatened through various land-use activities, which is why it is listed as a species of special concern under the p*SARA* (Table 18).

The Department of Natural Resources in each Maritimes province considers several species “location sensitive” and concern about exploitation of location sensitive species precludes inclusion of precise coordinates in the ACCDC report. Those species have been included here as being locally present (*n.b.*, only the bald eagle is known to be within the local area).

The bald eagle (Figure 78) is a large bird of prey with a distribution across North America and generally found near large bodies of open water that are near an abundant food supply and old-growth trees for nesting. Between the 1940s and 1970s, their numbers considerably declined due to intense hunting, unintentional poisonings (*e.g.*, Dichloro-Diphenyl-Trichloroethane (DDT) and lead shot), and habitat destruction. Juveniles are dark brown with white streaking throughout, while adults sport the white head and tail. At maturity, the bald eagle has a wingspan between 1.8 m and 2.3 m and can weigh up to 6 kg. Although the number of bald eagles has drastically increased over the past few decades to the point where they are no longer a species listed under the f*SARA*, they are still listed as being endangered under the p*SARA* (Table 18).

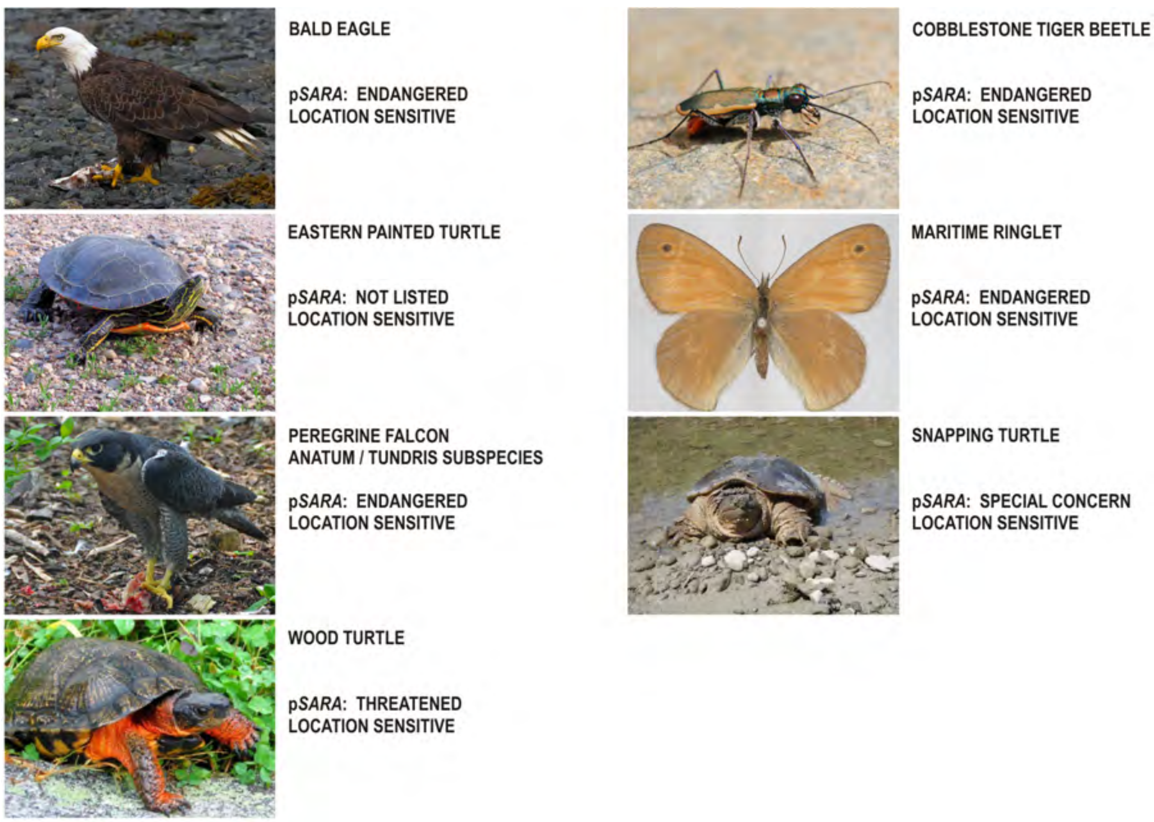


Figure 43. Photographs of location sensitive species listed under the p*SARA* that may be present at the Project site in Brunswick Mills, New Brunswick.

The cobblestone tiger beetle has two distinctive identification features: a bright red-orange abdomen; and a narrow and continuous cream-coloured border along the margin of its wing coverings (Figure 78). Individuals are between 11 mm and 14 mm long. Although endemic to the eastern United States, they are only known to exist at eight locations in Canada, which are all located in New Brunswick within the Saint John River basin. Because of this, the species is ranked as endangered under the p*SARA* (Table 18).

The eastern painted turtle is a subspecies of the painted turtle. Although the COSEWIC has not assessed the status of this turtle and it is not listed under the f*SARA* or p*SARA*, it is identified as being a location sensitive species by the NBDERD. This turtle has the widest range of any freshwater turtle in Canada. Painted turtles, which are easily identified with head and limbs that are black to green with yellow and red stripes, inhabit shallow aquatic habitats with slow-moving water, soft bottoms, aquatic vegetation, and abundant basking sites. The painted turtle is typically active from April until early October and in the winter they are dormant and burrow into bottom sediments. Wetland loss has resulted in their decline and extirpation, primarily in southern parts of their range, and ongoing habitat loss continues to threaten them. They are especially susceptible to mortality on roads, particularly during the nesting period when females make overland movements.

The Maritime ringlet is a small (*i.e.*, 4 cm wingspan), beige in colour marsh butterfly (Figure 78). It lives its entire life within saltwater wetlands where its habitat is influenced by flooding during high tides. Adults (*i.e.*, butterflies) are only visible for three to four weeks from mid-July to mid-August. The global distribution of this species is confined to the Bay of Chaleur region, which is why it is classified as an endangered species under p*SARA* (Table 18).

The *anatum* subspecies of the peregrine falcon (Figure 78) is a high-speed bird of prey slightly smaller and more streamlined than a hawk. Great declines in peregrine populations were observed following the introduction of the pesticide DDT; however, their populations began to increase following DDT restrictions that were established in 1970. It is estimated that there are 500 pair in Canada. Because of this low number, they are listed as a threatened species under the f*SARA* and by the COSEWIC (Table 18). Peregrine nests are usually scrapes made on cliff ledges near wetlands. Their nesting territory is about a 1 km radius around the nest and their home range extends to a radius of up to 27 km. They prefer open habitats such as wetlands, but they are known to hunt over open forest.

Canada's largest freshwater turtle, with a carapace up to 40 cm long, is the snapping turtle (Figure 78). The turtle's carapace, which can be brown, black, or olive, has three prominent keels. A distinctive characteristic is the turtle's large head with a hooked upper jaw and relatively long neck. Although they live in shallow water of almost every kind, they prefer slow-moving water with a soft mud bottom and dense aquatic vegetation (*e.g.*, ponds, sloughs, shallow bays, river edges, *etc.*). Because they are prone to illegal harvesting, persecution, and road mortality, the snapping turtle has been ranked as a species of special concern under the p*SARA* (Table 18).

The wood turtle (Figure 78) inhabits a broad range of habitats. They prefer to be near areas of moderately flowing water (*e.g.*, streams, creeks, and rivers), and they favour riparian areas with open canopy. During the summer, the wood turtle prefers to be on the ground in forested areas. In spring and fall they prefer to be near water and they overwinter in the water. Wood turtles appear to select habitats, rather than randomly using areas. The damming of watercourses, loss and degradation of riparian habitat, road mortality, and the pet trade all threaten the wood turtle population. They are considered sensitive to pollution as evidenced by their disappearance from low-quality watercourses. Pesticides and insecticides also threaten the population. No New Brunswick population is known to exceed 100 individuals. Although evidence suggests that populations are common and stable, the wood turtle is ranked as a threatened species under the f*SARA* and by the COSEWIC (Table 18).

3.2.3 Other Locally Observed Species

ACCDC databases were also queried for known observation data of provincially ranked flora and fauna within a 5 km radius of the Project site. Those species identified in the sections above are not included here. The full list of the flora (n = 11 unique species) and fauna (n = 19 unique species) within 5 km of the site is provided in Table 18 and the ACCDC report can be found in Appendix VI. Interpretation of the ACCDC S-rank system is provided in Table 20.

A visual representation of the 11 observed flora species is provided in Figure 44. Similarly, a visual representation of the 19 observed fauna species is provided in Figure 45.

Table 19. List of provincially ranked flora and fauna identified by the ACCDC as being observed within a 5 km radius of the Project site in Brunswick Mills, New Brunswick.

Common Name	Scientific Name	S-rank	NB GS Rank
Flora			
Northern bent grass	*Agrostis mertensii*	S2	May be at risk
Tower mustard	*Arabis glabra*	S3	Undetermined
Longbeak sedge	*Carex sprengelii*	S2	Sensitive
Alpine sweet-vetch	*Hedysarum alpinum*	S3	Secure
Stiff aster	*Ionactis linariifolius*	S2	Sensitive
Vasey rush	*Juncus vaseyi*	S2	Secure
Field locoweed	*Oxytropis campestris var johannensis*	S2	Sensitive
Small headed beakrush	*Rhynchospora capitellata*	S3	Secure
Prickly rose	*Rosa acicularis ssp. Sayi*	S2	May be at risk
Clinton's clubrush	*Trichophorum clintonii*	S3	Secure
Thyme-leaved speedwell	*Veronica serpyllifolia ssp. humifusa*	S3	Secure
Fauna			
Spotted sandpiper	*Actitis macularius*	S3S4B,S5M	Secure
Pine siskin	*Carduelis pinus*	S3	Secure
Chimney swift	*Chaetura pelagica*	S2S3B,S2M	Secure
Killdeer	*Charadrius vociferus*	S3B,S3M	Sensitive
Common nighthawk	*Chordeiles minor*	S3B,S4M	At risk
Evening grosbeak	*Coccothraustes vespertinus*	S3B,S3S4N,SUM	Sensitive
Olive-sided flycatcher	*Contopus cooperi*	S3B,S3M	At risk
Eastern wood-peewee	*Contopus virens*	S4B,S4M	Secure
Cape may warbler	*Dendroica tigrina*	S3B,S4S5M	Secure
Rusty blackbird	*Euphagus carolinus*	S3B,S3M	May be at risk
Wilson's snipe	*Gallinago delicate*	S3S4B,S5M	Secure
Barn swallow	*Hirundo rustica*	S2B,S2M	Sensitive
Red-breasted merganser	*Mergus serrator*	S3B,S5M,S4S5N	Secure
Brown-headed cowbird	*Molothrus ater*	S3B,S3M	May be at risk
Cliff swallow	*Petrochelidon pyrrhonota*	S2S3B,S2S3M	Sensitive
Bank swallow	*Riparia riparia*	S2S3B,S2S3M	Sensitive
Forcipate emerald	*Somatochlora forcipata*	S3	Secure
Eastern kingbird	*Tyrannus tyrannus*	S3S4B,S3S4M	Sensitve
Canada warbler	*Wilsonia Canadensis*	S3B,S3M	At risk

Table 20. The Atlantic Canada Conservation Data Centre's Sub-national (*i.e.*, provincial) rarity rank (S-rank) of species and S-rank definitions.

ACCDC S-rank	Definition
S1	Extremely rare: may be especially vulnerable to extirpation; typically five or fewer occurrences or very few remaining individuals.
S2	Rare: may be vulnerable to extirpation due to rarity or other factors; six to 20 occurrences or few remaining individuals.
S3	Uncommon: found only in a restricted range, even if abundant at some locations; 21 to 100 occurrences.
S4	Usually widespread, fairly common: apparently secure with many occurrences, but of longer-term concern (*e.g.*, watch list); 100 + occurrences).
S5	Abundant: widespread and secure under present conditions.
S#S#	Numeric range rank: a range between two consecutive ranks for a species / community; denotes uncertainty about the exact rarity (*e.g.*, S1S2).
SH	Historical: previously occurred in the province but may have been overlooked during the past 20 years to 70 years; presence is suspected and will likely be rediscovered.
SU	Unrankable: possibly in peril, but status is uncertain; need more information.
SX	Extinct / Extirpated: believed to be extirpated from its former range.
S?	Unranked: not yet ranked.
SA	Accidental: accidental or casual, infrequent and far outside usual range; includes species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds, or even thousands of miles outside their usual range.
SE	Exotic: an exotic established in the province (*e.g.*, Purple Loosestrife or Coltsfoot); may be native in nearby regions.
SE#	Exotic numeric: an established exotic that has been assigned a rank.
SP	Potential: potentially occurs, but no occurrences have been reported.
SR	Reported: no persuasive documentation (*e.g.*, misidentified specimen).
SRF	Reported falsely: erroneously reported and the error has persisted in the literature.
SZ	Zero: not of practical conservation concern because there are no definable occurrences, although the species is native and appears regularly; an SZ rank is generally used for occasional long distance migrants.

Although not included in the sightings, it is expected that other wildlife common to the area would frequent the proposed Project site. Those species would likley include black bear (*Ursus americanus*), moose (*Alces alces*), white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), varying hare (*Lepus americanus*), bobcat (*Lynx rufus*), lynx (*Lynx canadensis*), raccoon (*Procyon lotor*), porcupine (*Erethizon dorsatum*), ruffed grouse (*Bonasa umbellus*), and skunk (*Mephitis mephitis*).

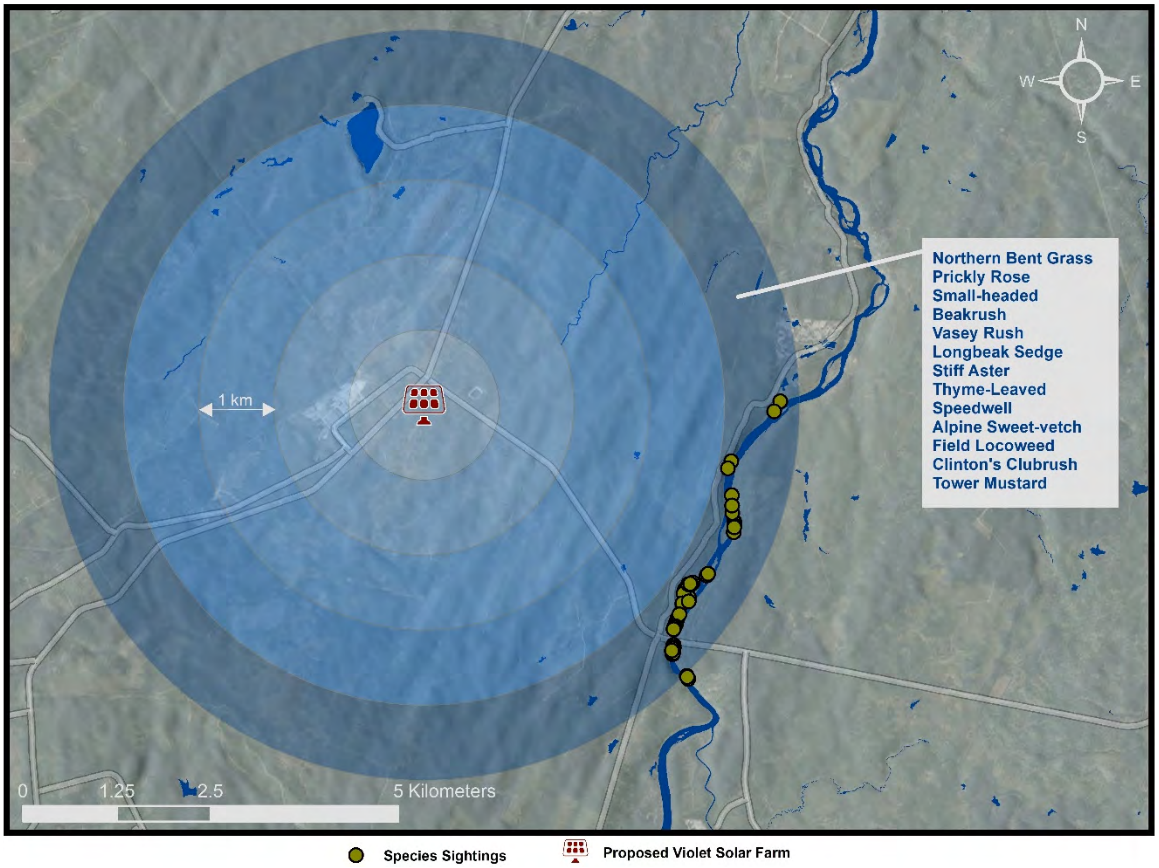


Figure 44. Map showing the recorded observations of flora listed provincially as being rare and / or endangered within a 5 km radius of the Project site in Brunswick Mills, New Brunswick. Data obtained from the ACCDC.

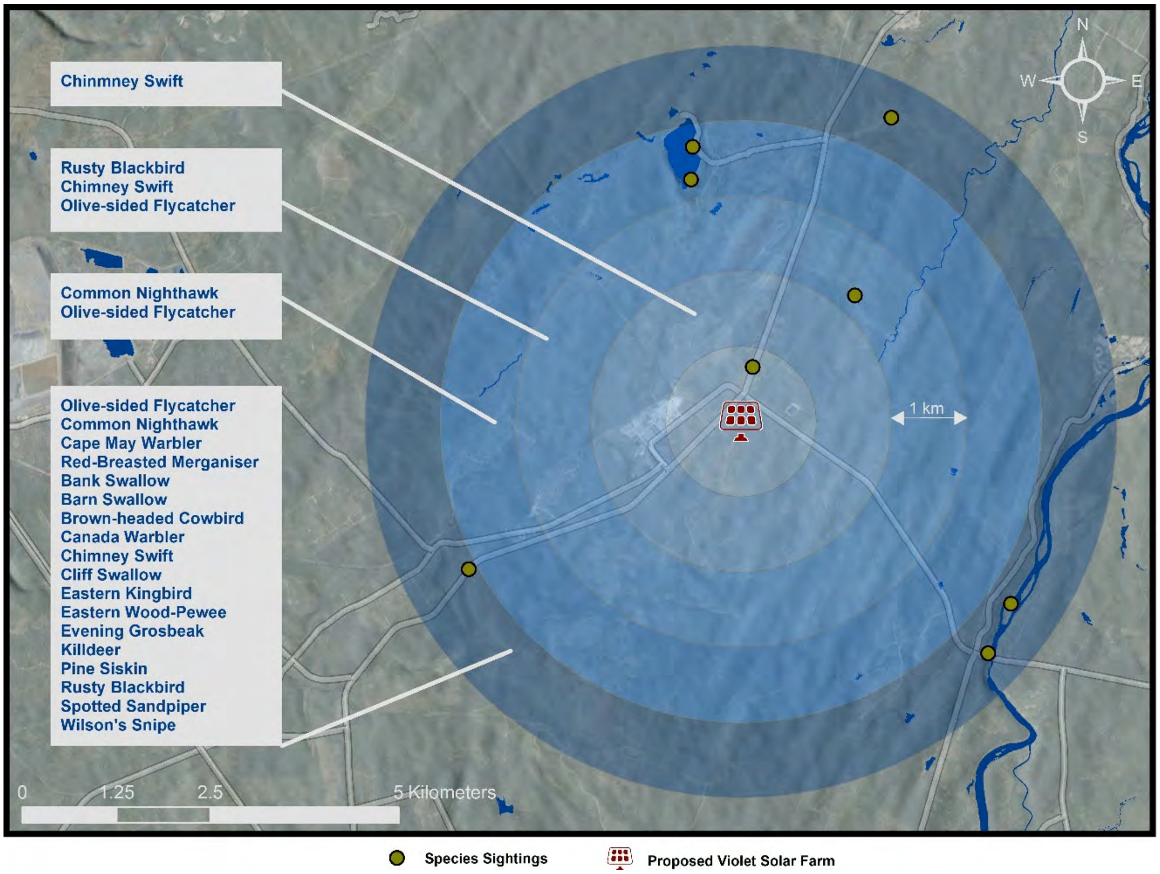


Figure 45. Map showing the recorded observations of fauna listed provincially as being rare and / or endangered within a 5 km radius of the Project site in Brunswick Mills, New Brunswick. Data obtained from the ACCDC.

3.2.4 Environmentally Significant and Managed Areas

The ACCDC query yielded one Environmentally Significant Area (ESA), but no managed areas within 5 km of the Project site (Figure 46).

The Pabineau Lake ESA was officially recognized on 10 May 1995 because of the significance for fish forest birds. The 26.5 ha Pabineau Lake (Figure 47) is fairly shallow (*i.e.*, < 4 m) and was originally acidic, but in 1975 lime was introduced to the lake. Annually, it is stocked in the spring with yearling brook trout (*Salvelinus fontinalis*) and in the fall with 25 cm brook trout. Pabineau Lake is a popular locale for ice fishing, there are several cottages located at its perimeter, and it is in close proximity to the Pabineau First Nation. According to *Chiasson and Crighton* [1994], there is a very good stand of mature red pine (*Pinus resinosa*) located on a steep bank at the east side of the lake and common loon (*Gavia immer*) have been reported to nest in the area.

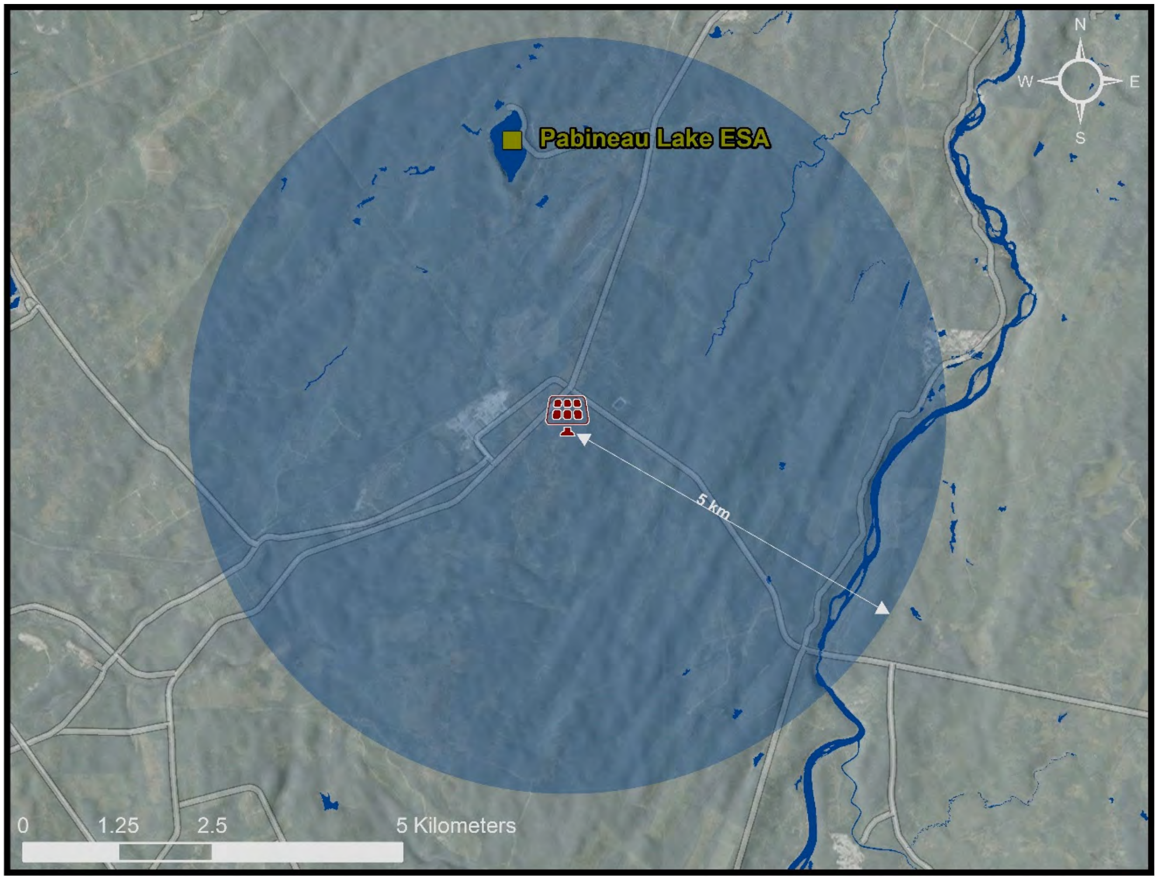


Figure 46. Map showing the environmentally significant area within a 5 km radius of the C2 Violet Solar Farm in Brunswick Mills, New Brunswick. Data obtained from the ACCDC.

Figure 47. Google Earth image showing Pabineau Lake near Brunswick Mills, New Brunswick.

3.3 SOCIO-ECONOMIC ENVIRONMENT

3.3.1 Demographics and Labour

The Project site straddles the City of Bathurst and the Bathurst LSD. The Bathurst LSD lies within Bathurst Parish. In 2016, the population of Bathurst and Bathurst Parish was 11 897 [*Statistics Canada*, 2017a] and 4 797 [*Statistics Canada*, 2017b], respectively. The City of Bathurst has a land size of 92.04 km^2 while Bathurst Parish has an overall area of 1 504.87 km^2. In 2016, the population density was 129.3 people · km^{-2} in the City of Bathurst and 3.2 people · km^{-2} within Bathurst Parish. Population in both areas has been in decline.

The Bathurst Census Agglomeration (CA) used by Statistics Canada (*i.e.*, City of Bathurst, Beresford, Bathurst Parish, Town of Beresford, Village of Petit-Rocher, Village of Nigadoo, Village of Pointe-Verte, and Pabineau First Nation) had a population in 2011 and 2016 of 31 936 and 31 110, respectively (*i.e.*, a 2.6 % decline in population) [*Statistics Canada*, 2017c]. In 2016, there were 13 970 private dwellings in the CA. The population density across the 2104.04 km^2 CA was 14.8 people · km^{-2}.

In 2011, the employment rate in the Bathurst CA was 45.7 % while the unemployment rate was at 11.3 % [*Statistics Canada*, 2017d]. The majority of people's occupations were characterized as sales and service (28.6 %), business, finance, and administration (14.7 %), trades, transport, and equipment operators (13.5 %), health occupations (11.5 %), and education, labour, and social, community, and government services (11.0 %). Median total income of economic families in 2015 was $67 029 while the median after-tax income of economic families was $59 296.

The Bathurst Mining Camp (*i.e.*, a region of 45 known volcanogenic massive sulfide deposits) has fallen on tough economic times in the past few decades, which has significantly affected employment rates in the region. Trevali Mining Corporation's Heath Steele copper, lead, and zinc mine closed in 1999 after 43 years of operation and Xstrata Zinc's Brunswick Mine closed in 2013 after 49 years of operation. Xstrata Zinc also closed its smelter in Belledune. The Smurfit-Stone Paper Mill ceased operations in 2009. Collectively, those closures resulted in an unemployment rate of over 20 % [*CBC*, 2013]. The economy does have some bright spots.

Trevali Mining Corporation continues to employ about 270 people at the zinc-copper-lead-silver-gold Caribou Mine. The adjacent Fornebu Lumber Bathurst Sawmill employs more than 125 people.

3.3.2 Archaeological and Cultural Features

Jacques Cartier was the first European to visit the Chaleur Region in 1534. Permanent settlement dates to around 1620 when missionaries began arriving and established Récollet Mission on the shore of Nepisiguit Bay [*Ganong*, 1899]. In 1652, the famous trader and explorer Nicholas Denys, then Governor of Acadia, established his headquarters at Ferguson Point [*Zelazny*, 2007]. The settlement was abandoned a few years later, but resettled in 1755 by Acadians during expulsion from Nova Scotia.

Bathurst became of the hub of trading in the Chaleur Region during the 1800s. Rural farming and fishing communities relied on the Village of Bathurst for essential services.

When the Bathurst Power and Paper Company constructed a pulp mill in 1914, the pulp and paper industry became the region's economic generator. In the 1950s, several large deposits of lead and zinc were discovered south of Bathurst and by the 1960s, mining gradually replaced pulp and paper as the major industry in the region.

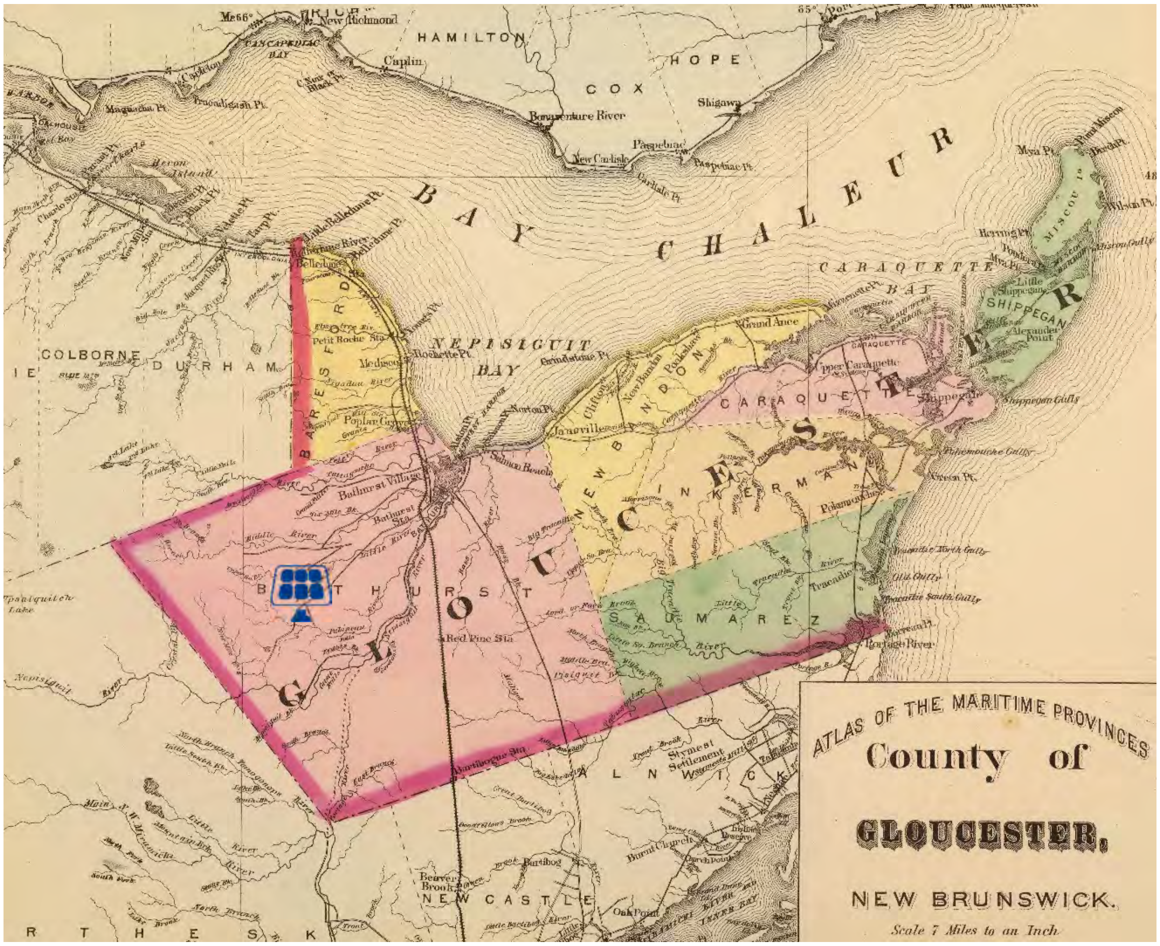


Figure 48. Historical map of Gloucester County, New Brunswick showing the general location of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick. From *Campbell and Fowler* [1878].

Archaeological predictive modelling obtained from the New Brunswick Department of Tourism, Heritage, and Culture (NBDTHC) is presented in Figure 49. The information shows that no historic archaeological sites are located within the vicinity of the Project site. Further, the modelling does not suggest that there is a high potential to encounter historic artifacts.

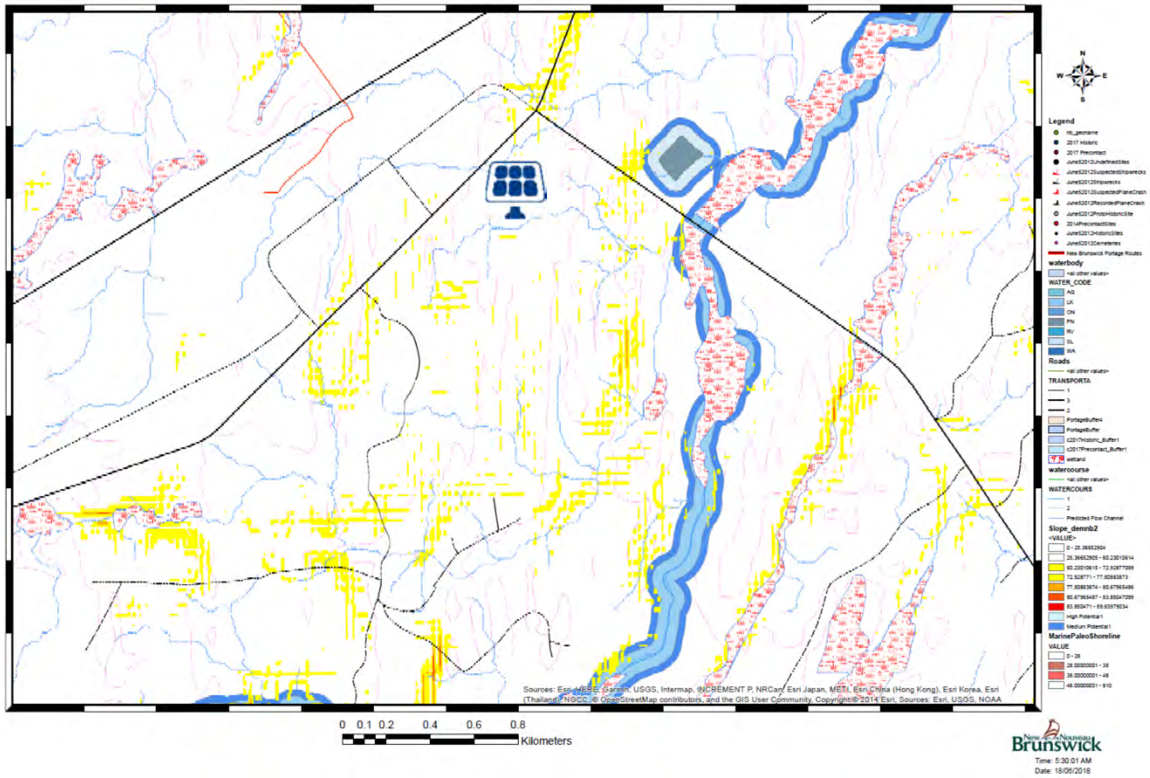


Figure 49. Archaeological predictive modelling in the vicinity of the Project site in Brunswick Mills, New Brunswick. Source: New Brunswick Department of Tourism, Heritage, and Culture.

3.3.3 Traditional Uses by First Nations

The Project is located within the traditional Mi'kmaq territory of Gespegeoag [*Hinds*, 2000] (Figure 50). Since First Nations lacked a written history, not much is known prior to the arrival of Europeans. Archaeologists have found abundant evidence of early use by First Nations (*i.e.*, dating back 4 000 years), particularly along the shoreline and lower Nepisiguit River [*Zelazny*, 2007]. Oinpegitjoig, the most important First Nation village, was located in Bathurst Harbour. The Nepisiguit River not only supplied sustenance in the form of salmon, but also served as a major overland transportation route to the Saint John River and Maliseet territory [*Ganong*, 1899] as shown in Figure 51.

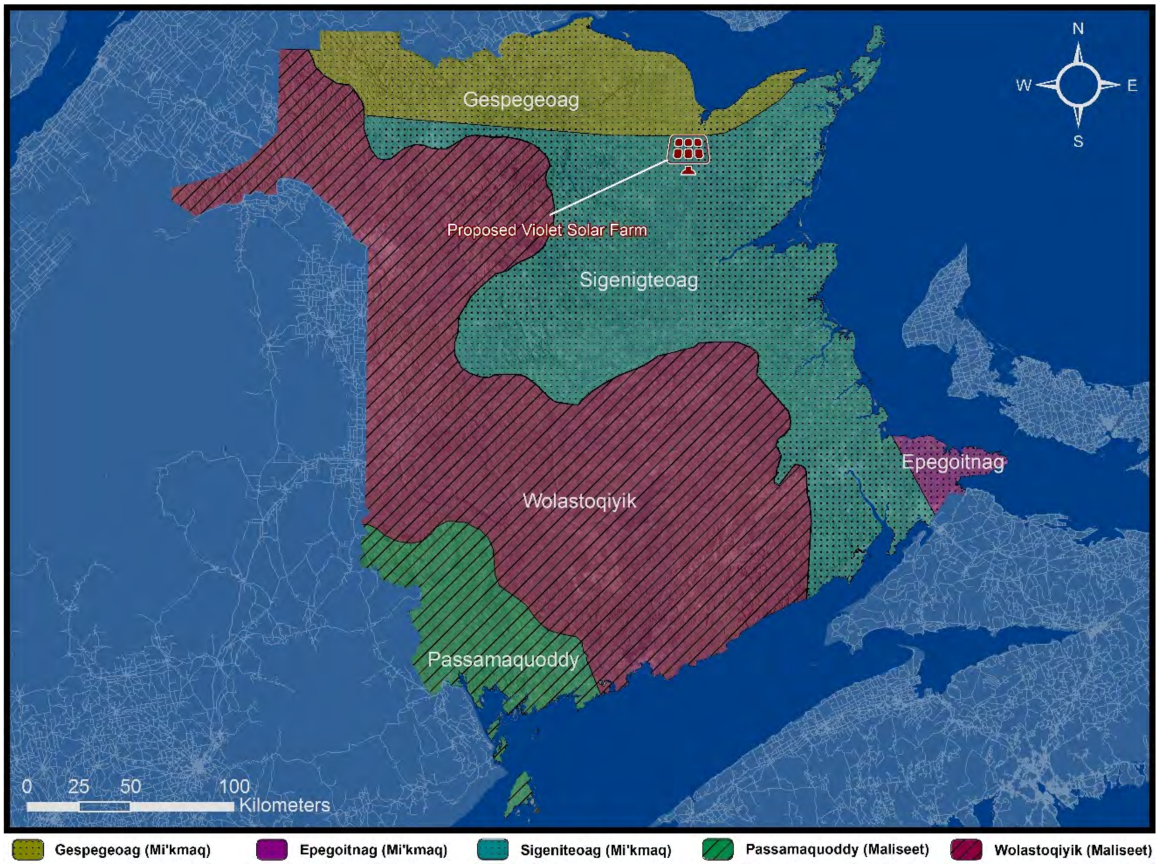


Figure 50. Traditional Maliseet and Mi'kmaq territory in New Brunswick.

The Pabineau First Nation community (Oinpegitjoig L'Noeigati) is located about 9 km northeast of the Project site near Pabineau Falls (Figure 52). The community has a land base of 426 ha. There are 280 registered band members with an on-reserve population of about 200 including 120 band members, 40 non-status Indians, and 40 non-Indians.

The Pabineau Mi'kmaq First Nation has a long history of hunting, fishing, trapping, and gathering. The lands and waters surrounding the Nepisiguit (Oinpegitjoig) River and Pabineau (Oasapegel) River hold a special significance to members of the Pabineau First Nation. It is likely that members use or have used the Project lands in the past for various activities.

Figure 51. Map showing the ancient portage routes used by First Nations to travel overland between river systems in northern New Brunswick. From *CanoeKayakNB* [2017].

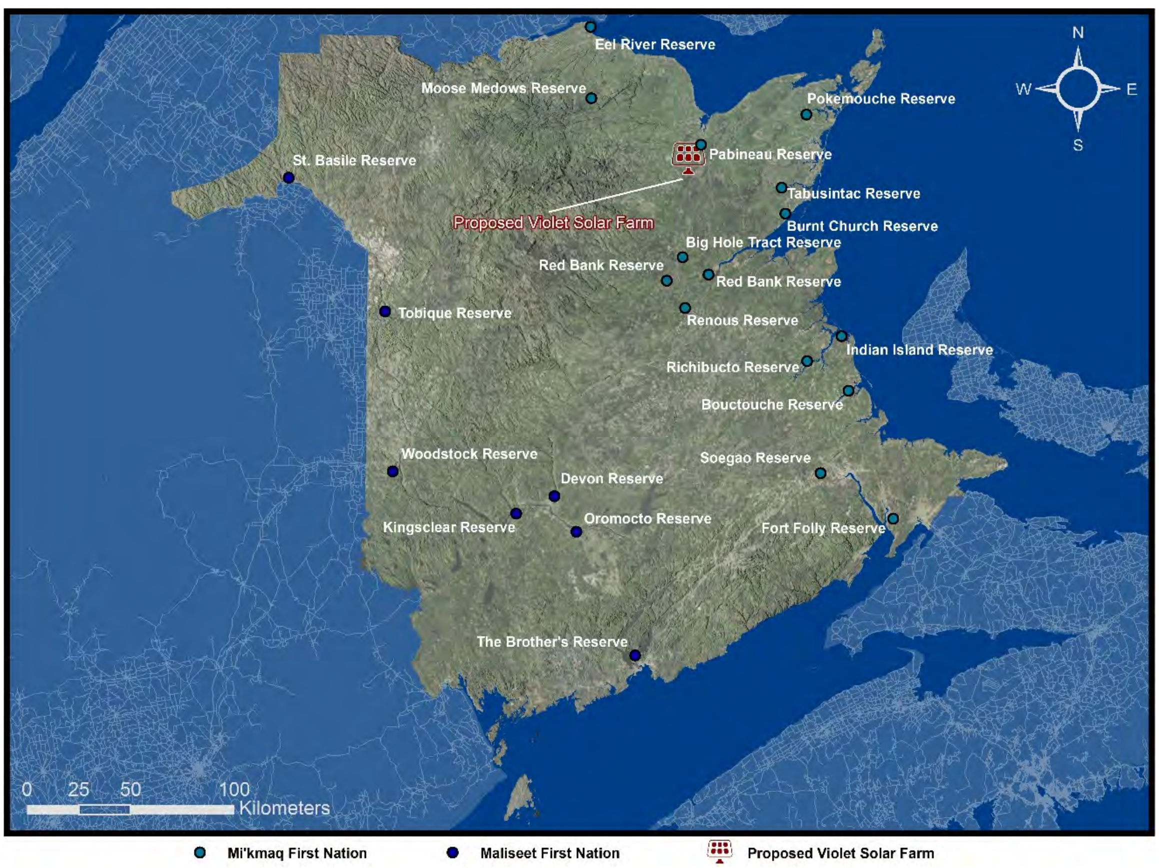


Figure 52. Map of New Brunswick's Mi'kmaq and Maliseet First Nations.

3.3.4 Historical Land-Use

Historical aerial photographs for the Project site are shown in Figure 53 through Figure 56. Based on these photographs, the property has not been previously developed; however, it was previously set aside for development as a forest industry complex subdivision (Figure 57). It is believed that the existing sawmill was constructed around 1974 as Phase I of the forest industry complex. The Project site was slated for Phase 4 of the overall complex. It is not known why the site was not fully built out, but is likely a result of economic and political factors.

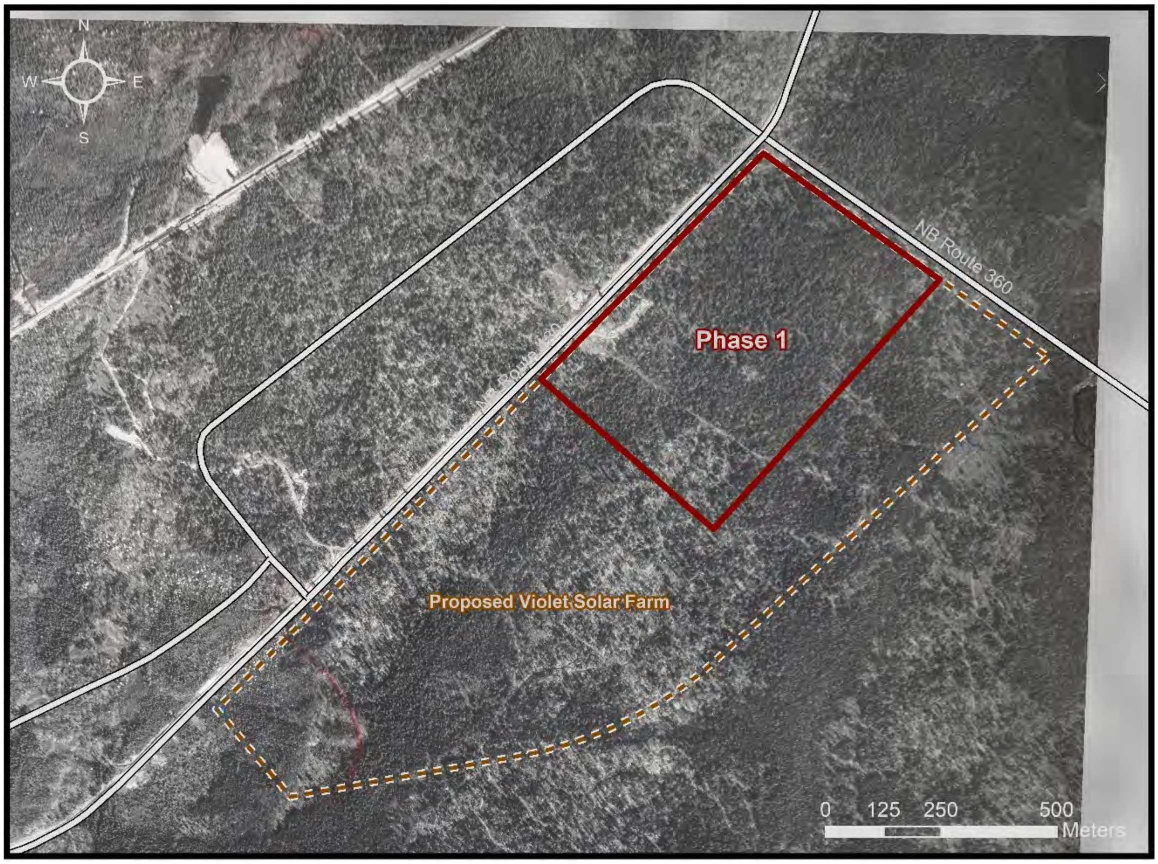


Figure 53. Aerial photograph showing the Project site in Brunswick Mills, New Brunswick in 1963.

Figure 54. Aerial photograph showing the Project site in Brunswick Mills, New Brunswick in 1974.

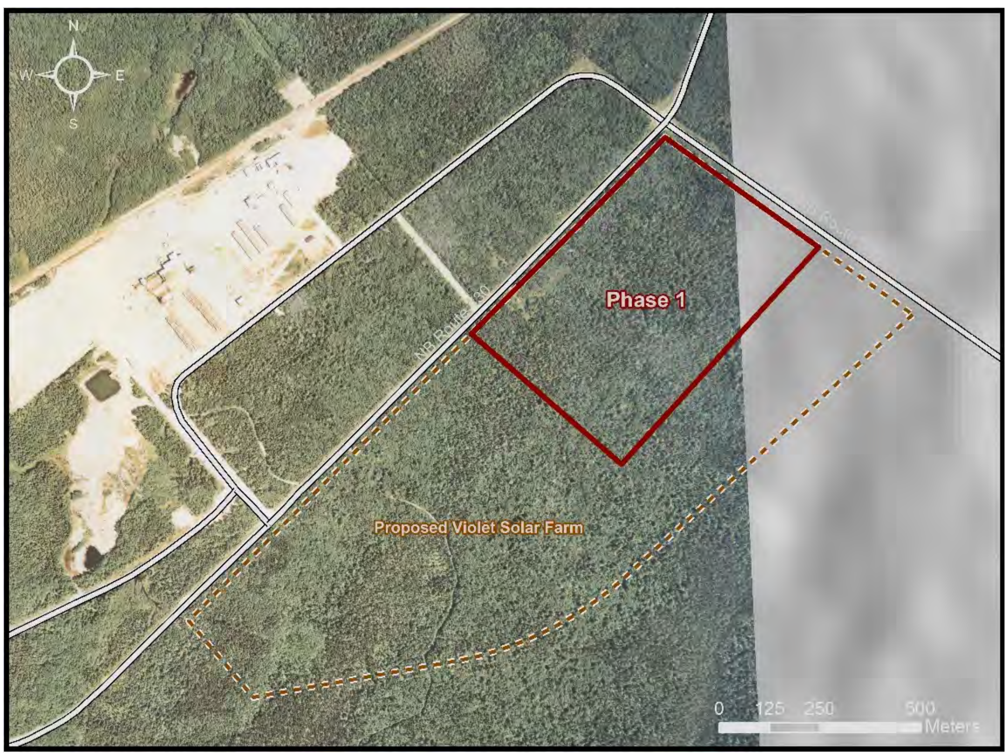


Figure 55. Aerial photograph showing the Project site in Brunswick Mills, New Brunswick in 1984.

Figure 56. Aerial photograph showing the Project site in Brunswick Mills, New Brunswick in 2012.

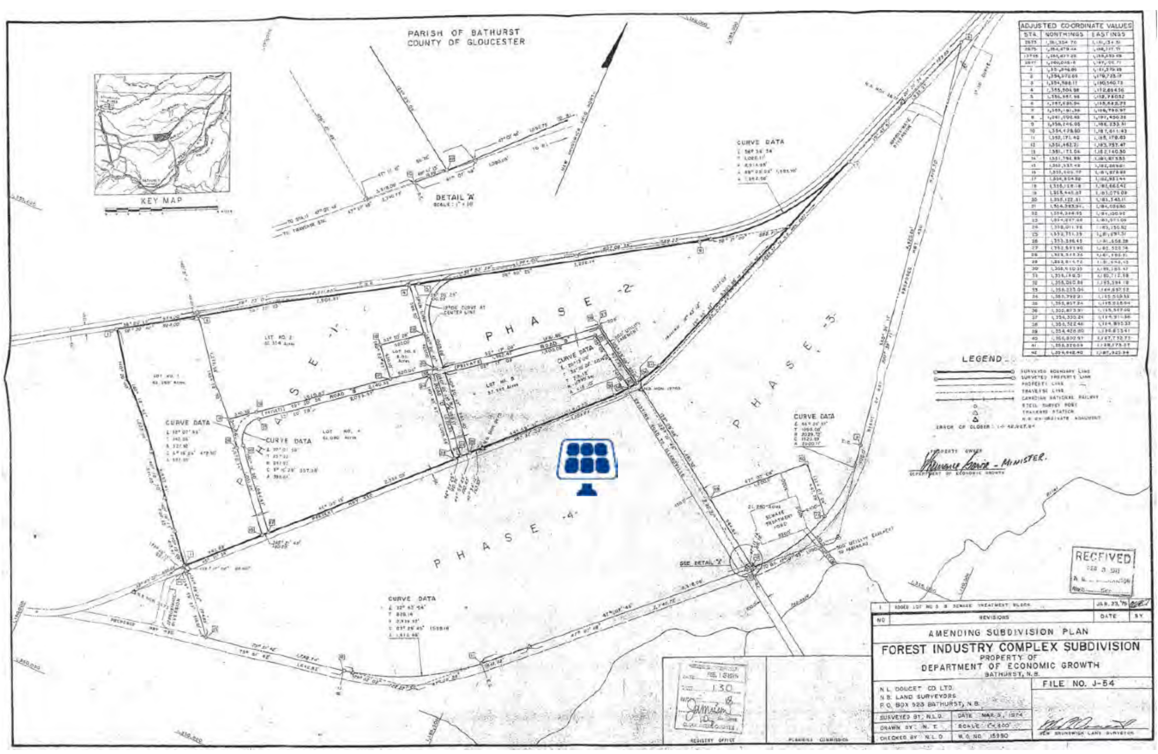


Figure 57. Forest Industry Complex Subdivision survey for Brunswick Mills, New Brunswick circa March 1974.

Metallic mineral deposits are known to occur in the region, including copper, lead, and zinc. Several former mines, such as Heath Steele, Brunswick Mines, and Bathurst Mines are located within 30 km of the Project site. There are also several pits and quarries in the region Figure 58. Although the Project site is not known to have valuable extractable minerals, exploration licenses issued by the Province permit holders to carry out exploration and prospecting for minerals in the area.

Figure 58. Google Earth image showing locations of former mines (pink points) and pits and quarries (turquoise points) in the vicinity of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

3.3.5 Current Land-Use

Currently, the land proposed for the Project is undeveloped. The vegetative community on the property is comprised of an open second-growth Acadian forest (Figure 59 and Figure 60). Tree species include: white birch (*Betula papyrifera*), yellow birch (*B. alleganiensis*), American beech (*Fagus grandifolia*), red maple (*Acer rubrum*), balsam poplar (*Populus balsamifera*), trembling aspen (*P. tremuloides*), eastern white pine (*Pinus strobus*), white spruce (*Picea glauca*), black spruce (*P. mariana*), and balsam fir (*Abies balsamea*). Typical woody understory species include moosewood (*Acer pensylvanicum*) and specked alder (*Alnus rugosa*). The herbaceous layer includes several mosses, lichens, and ferns.

Figure 59. Photograph taken on 20 September 2018 showing the typical second-growth Acadian forest at the Project site in Brunswick Mills, New Brunswick.

Figure 60. Photograph taken on 20 September 2018 showing the typical second-growth Acadian forest canopy at the Project site in Brunswick Mills, New Brunswick.

3.3.6 Health and Safety

Health and safety on work sites in New Brunswick are governed by municipal, provincial, and federal legislation. That legislation is designed to protect the health and safety of employees and the general public.

3.3.7 Transportation

The Project site is located adjacent to NB Route 430, which has direct access to NB Route 11 and the City of Bathurst. NB Route 11 is a two-lane asphalt controlled access highway. NB Route 430, connects with NB Route 360 at the northern corner of the Project site. NB Route 360 has direct access to NB Route 8. Both NB Route 430 and NB Route 360 are two-lane asphalt highways. All of the roadways described are designed for heavy truck traffic and / or are truck routes.

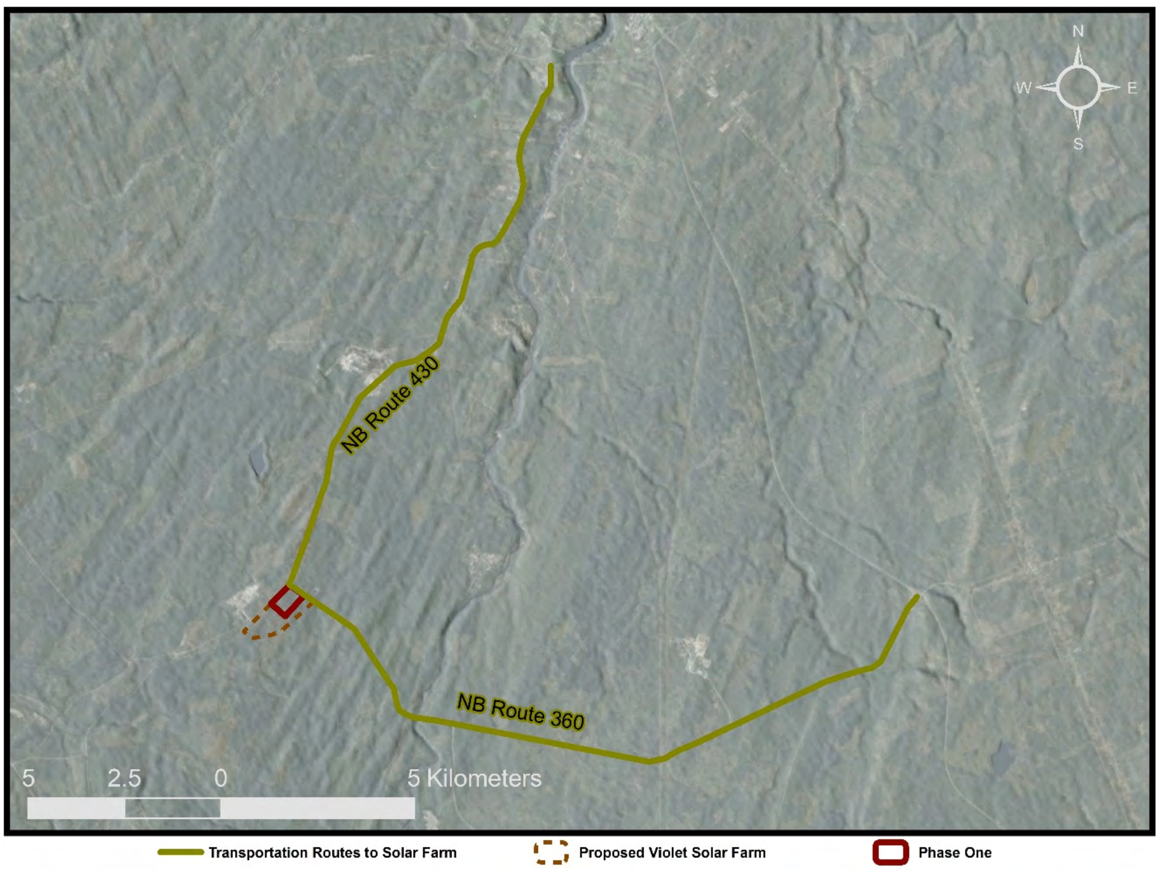


Figure 61. Map showing roads within the vicinity of the Project site in Brunswick Mills, New Brunswick.

A rail line exists about 750 m north of the Project site and connects Bathurst to Brunswick Mines. The rail line used to be operated by the New Brunswick East Coast Railway but Canadian National took over the line following the closure of the Smurfit-Stone mill in 2005. From Bathurst, the railway connects to eastern and western North American destinations. The Bathurst airport lies about 18 km north of the Project site. Annually, about 50 000 passengers travel through the airport.

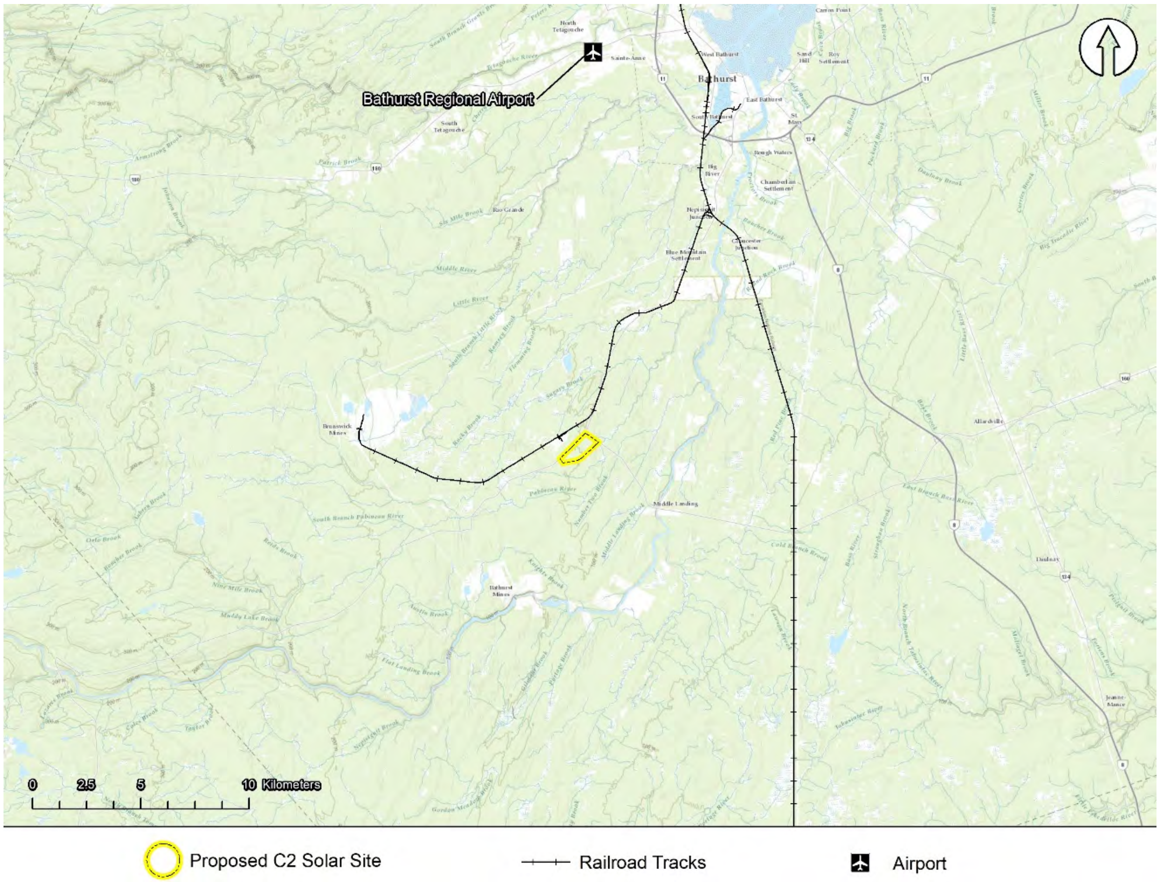


Figure 62. Map showing railroads and the Bathurst Airport in relation to the Project site in Brunswick Mills, New Brunswick.

3.3.8 Municipal Services and Infrastructure

The lands are unserviced for water and sewer. The Fornebu Lumber Company Inc.'s sawmill and nearby mines likely rely on groundwater wells for potable water and septic tanks and / or individual wastewater treatment facilities for on-site sewage treatment. Solid waste collected in the region is transported and disposed of at the Red Pine Solid Waste Management Site (*i.e.*, located in Allardville; Figure 58) via a private contractor.

There are no electrical services on the Project site, but there are power lines at the boundary between the Project site and NB Route 430. Electricity in the area is distributed via a 69 kV NB Power line (Figure 24). A substation from that line is located ~ 750 m northwest of the Project site.

3.3.9 Aesthetics

As noted above, the Project site is surrounded by a predominantly second-growth Acadian forest. The forested lands around the Project site, which are relatively flat, are in various stages of regrowth (Figure 63).

Figure 63. Bird's eye view of the lands surrounding the Project site in Brunswick Mills, New Brunswick.

3.3.10 Recreation and Tourism

The Project site comprises Crown lands. Those lands are not part of any International, National, Provincial, or Municipal park. They do not comprise a migratory bird sanctuary, ecological reserve, wildlife management area, wildlife refuge, game sanctuary, or deer wintering area. The site is not in a wellfield protection zone, in a protected watershed, and / or protected natural area. This was confirmed through information reviewed within the ACCDC databases and mapping available from the NBDERD, and the NBDELG.

There are a few formalized attractions that tourists visit in the vicinity of the Project site as shown in Figure 64. Pabineau Falls (Figure 65) is likely the most visited tourist attraction in the area. The Sentier Nepisiguit Mi'kmaq Trail, which follows the Nepisiguit River (Winpegigewig), extends through the Pabineau Falls area from the Daly Point Nature Reserve in Bathurst to the Nepisiguit Lakes at Mount Carleton Provincial Park. The ~ 128 km trail highlights the rich cultural and natural heritage of the Winpegigewig (troubled river) basin. The Sentier Nepisiguit Mi'kmaq Trail and its associated camping spots and lookouts do not traverse the Project site.

Hundreds of people annually attend the Pabineau First Nation's Pow-wow, which is held throughout the first weekend of July at the Flying Eagle Memorial Pow-wow Grounds (Figure 64). The event is a celebration of Aboriginal culture. The Oasapegal (flowing brightly) Heritage Park is a small park near the mouth of the Pabineau River where it flows into the Nepisiguit River. The site has been a sacred spot of the Mi'kmaq for centuries.

In New Brunswick, there are a multitude of formalized trails overseen by the New Brunswick All-Terrain Vehicle (ATV) Federation and the New Brunswick Federation of Snowmobile Clubs. There are no formalized trails that traverse the Project site. The nearest formalized trail, snowmobile trail 19, is about 4 km distant. Snowmobile trail 19 is 36 km long and extends from Middle Landing to North Tetagouche.

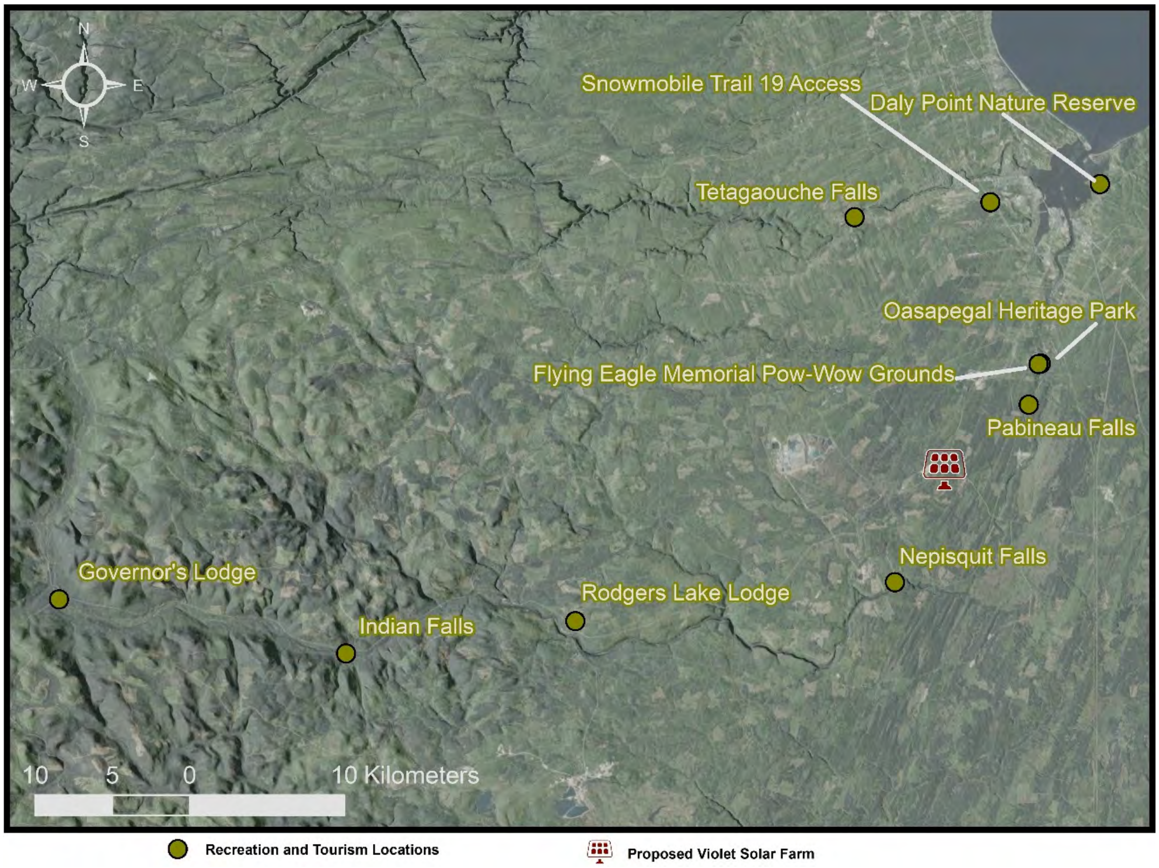


Figure 64. Tourist attractions in the vicinity of the Project site in Brunswick Mills, New Brunswick.

The Governors Lodge / Wilderness Resort is located in the valley of Popple Depot along the Nepisiguit River. It is an area used by many to view wildlife, hike, fish, hunt, snowmobile, ATV, and to learn about the region's rich cultural heritage. Indian Falls is located in the Popple Depot area. Popple Depot was historically one of the areas where lumber companies would store food and supplies for workers.

Between 1919 and 1921, a hydroelectric power dam was constructed at Nepisiguit Falls [*Stantec*, 2011]. It was constructed to provide power to the Bathurst Power and Paper Company's pulp mill. The station has the capacity to generate 10.8 MW of power via three turbines. NB Power purchased the facility in 2007 from the Smurfit-Stone Corporation.

Rogers Lake Lodge is located along Provincial Snowmobile Trial 23. It is a wilderness outpost that offers all-season services for outdoor enthusiasts.

The 40 ha Daly Point Nature Reserve is located in Bathurst just northeast of Bathurst Harbour. The park has about 7.5 km of nature trails along which visitors can view hundreds of species of flowers, plants and animals. The Reserve's saltmarsh is home to the endangered Maritime Ringlet Butterfly. There is an interpretive centre located at the Reserve that operates educational and recreational programs.

Tetagouche Falls is located on the Tetagouche River. There is a short nature trail that takes visitors from NB Route 180 to the Falls.

Figure 65. Photograph showing Pabineau Falls on the Nepisiguit River, New Brunswick.

4.0 POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION

4.1 PROJECT INTERACTIONS / SCOPING

As noted in Section 2.7, there are five Project stages. Different activities are associated with each stage and not all stages interact with the environment. For this EIA, environmental interactions are strictly limited to the spatial and temporal boundaries of this Project. For example, interactions are not considered in the fabrication of panels by the manufacturer.

A high-level assessment of the Project stages and potential environmental interaction is summarized in Table 21. Accordingly, only Stages II, III, and V require further assessment herein as they are the only stages that have potential interactions with the environment that can be identified.

Table 21. Project stages for the proposed Violet Solar Farm in Brunswick Mills, New Brunswick. Included are the activities associated with each stage and whether or not there is an interaction with the environment.

Stage	Activities	Interaction
I – Environmental permitting, monitoring, and compliance	• Desktop reviews • Non-intrusive field investigations • Permit applications • Site reviews and inspections • Development and review of best management practices	No
II – Construction	• Tree clearing, grubbing, and levelling • Access road development • Erecting security fence • Installing structural anchors and foundations • Excavating electrical cable trenches • Constructing and erecting arrays • Installing electrical infrastructure • Constructing buildings • Commissioning infrastructure	Yes
III – Operation and maintenance	• Generating electricity • Performing security checks • Conducting electrical tests and inspections • Cleaning modules and landscaping	Yes
IV – Decommissioning	• Removing equipment and infrastructure • Reclaiming the site	Yes, but will be defined at a later date
V – Mishaps, errors, and / or unforeseen events	• Potential for spills and / or contaminant releases	Yes

Fundy Engineering's Project Team, based on previous environmental impact assessment experience and professional judgment, assessed potential interactions between Stages II, III, and V (*i.e.*, those with an environmental interaction as identified in Table 21) and all of the environmental components described in Section 3.0. Through that exercise, it was determined that there are 10 environmental components that require detailed assessment with respect to the solar farm (*i.e.*, those with a potential Project interaction). Those environmental components are identified below as Valued (socially, economically, culturally and / or scientifically) Environmental Components (VECs).

Table 22. Assessment of potential interactions of various stages for the proposed Violet Solar Farm in Brunswick Mills, New Brunswick and the environment. Check marks indicate that there is potential for interaction and requires further assessment.

Environmental Component	Stage and Environmental Interaction		
	II: Construction	III: Operation and Maintenance	V: Mishaps, Errors and Unforeseen Events
PHYSIO-CHEMICAL ENVIRONMENT			
Air quality	✓	✓	✓
Sound emissions	✓	✓	✓
Surface water quantity and quality	✓	✓	✓
Groundwater quantity and quality	✓	✓	✓
BIOLOGICAL ENVIRONMENT			
Terrestrial flora and fauna	✓	✓	✓
Aquatic flora and fauna	✗	✗	✗
SOCIO-ECONOMIC ENVIRONMENT			
Labour and economy	✓	✓	✓
Archaeological and cultural features	✗	✗	✗
Land-use	✓	✓	✓
Transportation network	✓	✓	✓
Aesthetics	✓	✓	✓
Protected areas	✗	✗	✗
Recreation and tourism	✗	✗	✗
Health and safety	✓	✓	✓

4.2 OVERVIEW OF VALUED ENVIRONMENTAL COMPONENT ANALYSIS

Fundy Engineering employs a visual method of impact level when assessing VECs through the EIA process. Our proven method (Table 23) is a way for reviewers (*i.e.*, Regulator(s), stakeholders, and the general public) to quickly and easily review the impacts without having to understand a complex environmental assessment process. In the analysis of Project impacts on the environment, there are several terms that must be considered.

Table 23. Fundy Engineering's Valued Environment Component Assessment visual coding method, which is analogous to a traffic light.

Assessment Symbol	Description
	*Favourable or little to no impact*: criteria receiving this impact level have no significant problems associated with them; they are green lights for the Project.
	*Potential impacts that may require some degree of mitigation*: criteria receiving this impact level do not appear to have significant problems associated with them; they are yellow lights for the Project and should be approached with caution.
	*Not favorable or a major impact*: criteria receiving this impact level rating would be difficult to implement; they are red lights for the Project.
	*No change in existing impact*: criteria receiving this impact level have no additional potential impact from the Project than already currently exists.

Project impact green lights are considered those activities that may yield short-term impacts (Table 23). Those impacts would be experienced for a brief period of the Project (*i.e.*, a day or week during a Project Stage). For example, a green light may be applied to sound emissions if a pile driver were to be used for a one week period over a year-long construction period where the only loud activity anticipated is the driving of piles. Green lights are also applied to activities that have a positive outcome. Creating long-term employment through the development of a recreational facility, for example, would be a positive impact that would be assigned a green light in our analysis. If the impact is not entirely positive, then mitigation measures are likely required for green lights.

Project yellow lights (Table 23) are considered to be those activities that extend between the short-term and long-term. Impacts considered long-term are those that may be experienced for a prolonged period of time, such as during the entire duration of the Project. With yellow lights, long-term impacts are not permanent (*i.e.*, they are reversible and with environmental protection methods, the impact may be further reduced). An example of a yellow light would be increased erosion along a linear corridor resulting from the clearing and grubbing of a forest. The impact is reversible (*i.e.*, replanting of vegetation to return to pre-impact conditions) or can be mitigated (*i.e.*, through the implementation of best-management practices, such as silt fences and sedimentation basins). Mitigation measures are required for yellow lights.

Red lights (Table 23) are applied when long-term impacts are considered to be permanent. That is they may cause irreversible change in the environment. An example would be a large and persistent oil spill to a major drinking water aquifer. After halting the spill, considerable effort may be required to remediate the contamination. During remediation, which would likely be prolonged, a new source of drinking water would be required. Red lights require that mitigation measures be developed.

When there is no anticipated change to the component as a result of the project, a blue light (Table 23) is applied. Blue lights do not require mitigation because there is no change.

Residual effects are also considered in the assessment of potential project environmental impacts. A residual effect is any measurable or demonstrable environmental impact that remains following the implementation of mitigation measures. Each Project activity, component, and associated mitigation measure is assessed on different attributes of the potential for environmental impact (*i.e.*, intensity, spatiotemporal extent, frequency, and reversibility). The potential for residual effects is described for each VEC below. In the instance where a residual effect is expected to occur, the potential impact is further assessed to determine whether any cumulative effects may arise through the interaction between the Project-specific impacts and similar effects from past, present, and / or reasonably foreseeable activities.

4.3 POTENTIAL PROJECT IMPACTS ON THE ENVIRONMENT

4.3.1 Valued Environmental Components Assessed

The following VECs were assessed for the proposed Violet Solar Farm in Brunswick Mills, New Brunswick:

- physio-chemical environment:

- air quality;
- sound emissions;
- surface water quantity and quality; and
- groundwater quantity and quality;

➢ biological environment:
- terrestrial flora and fauna; and

➢ socio-economic environment:
- labour and economy;
- land-use;
- transportation network;
- aesthetics; and
- health and safety.

The identified VECs were assessed with consideration given to risks associated with the construction and commissioning stage, the operation and maintenance stage, and any mishaps, errors, and / or unforeseen events (*i.e.*, malfunctions or accidents) that may occur as a result of the proposed Project. The assessment of the VECs listed above is described in detail in the sections that follow.

4.3.2 Physio-Chemical Environment

4.3.2.1 Air Quality

Air quality was selected as a VEC because it has the potential to be affected during all aspects of the Project (*e.g.*, construction and commissioning, operation and maintenance, and mishaps, errors, and / or unforeseen events). The following potential impacts associated with air quality were assessed:

- micro-climate (*i.e.*, temperature and precipitation) of the local area;
- emissions of CO;
- emissions of NO_X;
- emissions of SO_2;
- emissions of VOCs; and
- emissions of PM (*i.e.*, from exhausts and dusts).

4.3.2.1.1 Potential Impacts

The complete assessment of potential impacts of the Project on air quality is provided in Table 24 (*n.b.*, the table can be found several pages ahead). Overall, the assessment yielded six green lights, 10 yellow lights, and two no change lights.

Because solar panels have a low reflectivity and absorb photons from direct sunlight thereby converting it to electricity, there have been concerns of previous solar farms creating a heat island effect. *Nemet* [2009] noted that PVs would need to be deployed on the scale of multiple terrawatts in order to significantly contribute to climate modification. For a solar farm of the size proposed for the Project (*i.e.*, 10 MW), there could be some micro-climate changes that result.

Fthenakis and Yu [2013] studied in detail the micro-climate for a 1 MW section of a large solar farm in North America. In that study, the solar modules had a fixed tilt of 25 °, the bottom edge of each module was raised 0.5 m off the ground, and the arrays were spaced 4 m apart. Overall, they found that the annual average air temperature at 2.5 m off the ground in the center of the solar farm was 1.9 °C warmer than the ambient temperature. Despite being warmer, they also found that temperature differentials were not detectable between 5 m and 18 m off the ground and about 300 m from the perimeter of the field. Computer modelling done by *Fthenakis and Yu* [2013] showed that developing access roads between solar fields allows for substantial cooling and can mitigate micro-climate variations.

For this Project, there will be several more access roads within the solar field (*i.e.*, separating the solar clusters) than compared to the study site of *Fthenakis and Yu* [2013] and the arrays here will have a greater spacing (*i.e.*, a minimum of 5.7 m apart compared to 4 m) in order to eliminate panel shading. Furthermore, the modules for this Project will be set higher above the ground surface (*i.e.*, 2 m versus 0.5 m) to account for winter snowpack depth. All of these Project features should aid in an overall reduction in temperature changes / micro-climate impacts resulting from the presence of the solar panels.

Armstrong et al. [2016] reported that the ground below solar panels (*i.e.*, within the shadow) was cooler and less moist than ambient conditions (*i.e.*, refer to Figure 20). They noted that those conditions could affect important plant-soil processes, such as productivity and decomposition. The inclusion of several access roads within the solar field should aid in reducing the overall micro-climate variations across the site.

It is anticipated that heavy equipment used during construction of the Project and vehicle use related to workers travelling to and from the site will produce about 2 643 tonnes of GHG emissions (*i.e.*, CO_{2eq}) during the ~ 11 month construction period. After construction is complete, those emissions will cease to exist. That is the reason why yellow lights were applied to the majority of potential impacts during Project construction. Project-related GHG emission estimates are provided in Appendix VII.

Solar is the way of the future and receives high social acceptance because operationally, the physical solar farm will not emit any GHGs; however, there will be some GHG emissions related to the routine maintenance activities listed in Table 12. It is estimated that over the lifespan of the Project, those routine activities will result in about 331 tonnes of CO_{2eq} emissions (*i.e.*, refer to Appendix VII).

Adding more renewables to NB Power's generation mix will result in GHG emission reductions related to energy purchases by customers from fossil fuel generated electricity. As calculated in Appendix VII, it is estimated that the Project will yield a total lifespan GHG emissions offset of 85 148 tonnes CO_{2eq}. This results in a net GHG emissions offset for the Project of 82 474 tonnes CO_{2eq}.

Should a mishap, error, and / or unforeseen event occur, there is a potential that impacts could be realized to air quality. Therefore, yellow lights were applied to the majority of potential impacts. Overall, the potential impacts identified for air quality related to this Project can be reduced or eliminated using the mitigation measures described below.

4.3.2.1.2 Proposed Mitigation

At a minimum, the mitigation measures outlined below should be undertaken by Project personnel to ensure that potential impacts to air quality are minimized.

- Heavy equipment should only be operated at optimum loading rates.
- Heavy equipment should be turned off when not in use and / or when practical.
- The number of vehicle kilometers traveled should be kept to a minimum (*i.e.*, there should be no unnecessary operation of equipment in and around the site).
- Heavy equipment should be operated at moderate and steady speeds and when travelling on surfaces where dusts are generated (*i.e.*, local gravel roadways).
- Heavy equipment should be operated using clean fuels (*i.e.*, ultra-low sulphur diesels), where available and practical.
- Heavy equipment exhaust systems should meet the recommended standards.
- Equipment should be maintained according to manufacturer recommended servicing periods.
- Heavy equipment should only be refueled using a protocol designed to mitigate any risk to the environment.
- No solid waste should be burned on-site.
- If the application of water as a dust suppressant is deemed necessary on local gravel roadways (*n.b.*, this is the preferred method of dust suppression), it should be applied using suitable equipment (*e.g.*, a tanker truck equipped with spray bars and methods of controlling water flow, *etc.*).
- Material stock piles (*e.g.*, soil, sand, aggregate, *etc.*) and spoils piles should be sited in locations that minimize the impact from prevailing winds.
- Allowing vegetation, such as grasses and shrubs, to re-establish itself should reduce impacts to air quality, especially those associated with fugitive dusts generate from wind blowing over bare soils.

4.3.2.1.3 Potential Post-Mitigation Residual and Cumulative Impacts

Overall, this Project is expected to have a minimal impact on local air quality as summarized in Table 24. There are no residual and / or cumulative impacts anticipated to air quality as a result of this Project.

4.3.2.2 Sound Emissions

Sound is emitted by the majority of construction equipment and that sound is often above ambient sound levels. When they become too high, sound levels may be a nuisance to nearby residents and may cause disturbance to local wildlife. Additionally, sound levels can be a hazard to Project personnel if appropriate precautions are not taken. Because of this, sound emissions were selected as a VEC. The following potential impacts were assessed for the Project:

- sound levels (*i.e.*, intensity);
- sound duration;
- sound repetition; and
- ground vibration.

Sound waves generate ground vibration hence the reason for assessing the impact of the Project on ground vibrations.

4.3.2.2.1 Potential Impacts

Table 25 is the complete assessment of potential impacts conducted for sound emissions associated with the Project. Of the 12 potential impacts, 11 were assigned green lights. A distance of about 6.8 km and 7 km, respectively, separates the Project footprint and the nearest residential receptors along Nepisiguit Falls Road and NB Route 430. It is believed that sound emission levels during construction will considerably dissipate over that distance to a level that no sounds will be heard by residents in those areas. The only apparent change that residents along NB Route 430 may experience is sound associated with increased traffic going to and from the site during construction. Those residents should be accustomed to heavy vehicle traffic going to and from the former Brunswick Mine and Bathurst Mine, various pits and quarries, forest harvesting operations, the Fornebu Lumber Company Inc.'s Mill, *etc.*

There are very few moving parts associated with the operational Project. Some sound emissions will occur from the cooling fans associated with the inverters and transformers, but those will likely only occur during peak sunlight hours of the day when the system is generating electricity (*i.e.*, the system does not operate overnight during dark hours). As noted in *MASSCEC* [2015], those common sounds dissipate relatively quickly from the source (*i.e.*, within 15 m to 45 m). Retaining a vegetated buffer strip between the solar field and the property line will aid in mitigating sound emissions from the operational site. Sound emissions related to security checks, electrical tests and inspections, module cleaning, and landscaping will be infrequent (*i.e.*, refer to Table 12). Therefore, it is believed, due to the relatively remote location of the Project site, that any sound emitted above background levels will not be audible to the nearest sensitive receptors.

Although it is difficult to determine what type(s) of equipment would be required during a mishap, error, and / or unforeseen event, the site is distant enough from residential receptors that any sound emissions should not be audible at those locations. For that reason, green lights were applied.

4.3.2.2.2 Proposed Mitigation

The mitigation measures provided below should be implemented by Project personnel to minimize the potential impact of sound emissions to nearby receptors (*i.e.*, residents and the general public), particularly during Project construction and operation and maintenance.

- All heavy equipment should be equipped with the appropriate manufacturer designed sound emission abatement equipment (*i.e.*, mufflers).
- Shrouding on equipment should be inspected regularly to ensure that it is in good condition and limits the level of sound emitted.
- The exhaust systems of all heavy equipment should be inspected regularly to ensure that mufflers are operating properly.
- Heavy equipment should be maintained according to manufacturer recommended servicing periods.
- The idling of all heavy equipment should be kept to a minimum.

- Any loud equipment (*i.e.*, > 90 dBA at the source) should be sited as far away as possible from the nearest sensitive receptor (*i.e.*, residents).
- Loud construction activity should be scheduled / planned to occur during normal workday / daylight hours (*i.e.*, 7 AM through 7 PM Monday through Saturday), where possible.
- Contractor(s) / subcontractor(s) should ensure that all equipment has proper functioning noise abatement equipment.

4.3.2.2.3 Potential Post-Mitigation Residual and Cumulative Impacts

Project construction may result in some short-term loud sounds. Those potential impacts can be mitigated as noted above. During operation, it is anticipated that there will be no apparent change in sound emissions.

4.3.2.3 Surface Water Quantity and Quality

There are no watercourses and / or wetlands located within the proposed footprint of the Project; however, there are some watercourses and wetlands located nearby, including Pabineau River. Therefore, surface water quantity and quality was selected as a VEC. The following potential impacts were assessed for the Project:

- surface water quantity (*i.e.*, change in runoff regime);
- surface water quality (*i.e.*, change in general chemistry and trace metals); and
- hydrocarbon / hazardous chemical contamination.

4.3.2.3.1 Potential Impacts

Table 26 provides a summary of the impact assessment on surface water quantity and quality. Overall, the assessment yielded six yellow lights and three green lights.

Although the panels will create a rain shadow (Figure 66), precipitation will still reach the ground surface in the presence of the solar panels; rainwater and snow, in normal circumstances, will runoff the panels and fall to the ground where it will be available for surface water runoff and / or groundwater recharge. Initially, there may be somewhat a greater amount of runoff across the site, but once vegetation is re-established, it should be no greater than the undeveloped site. Implementation of a surface water management plan, which includes the construction of drainage ditches and a stormwater pond, should mitigate any impacts.

Depending on the nature of a mishap, error, and / or unforeseen event, there is a possibility that the impact to a surface water feature could be long-lasting. Therefore, mitigation measures should be developed.

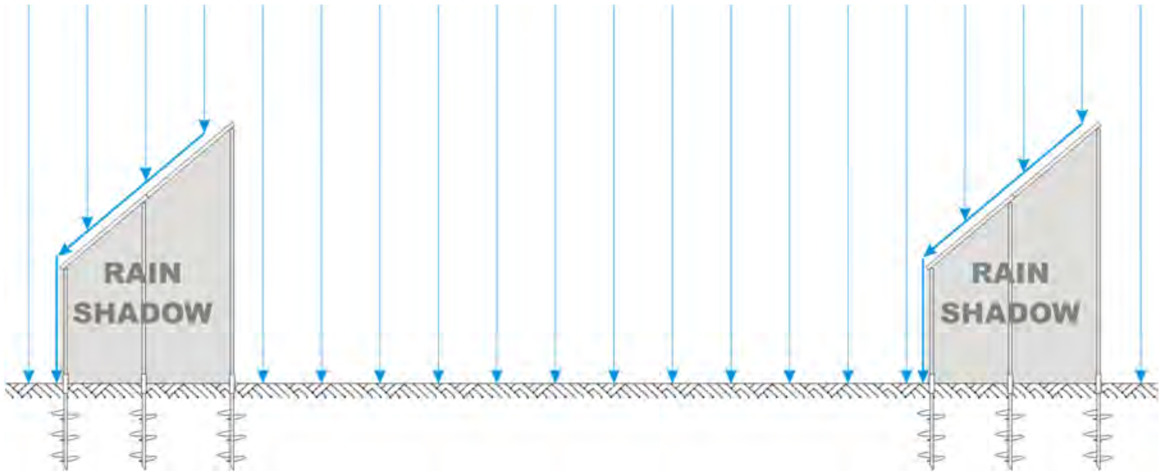


Figure 66. Schematic showing the rain shadow produced by the panels and racking tables for the Violet Solar Farm proposed for Brunswick Mills, New Brunswick.

4.3.2.3.2 Proposed Mitigation

The mitigation measures listed below should be employed to minimize the chance of activities related to the Project from affecting surface water environs through the introduction of hydrocarbons and hazardous chemicals and contaminants.

- All Project personnel should be briefed on the potential impacts that the Project could have on surface water quality and quantity.
- An erosion and sediment control plan should be developed and implemented prior to initiating the Project in order to limit and control erosion and sedimentation.
- After the Project site has been cleared, grubbed, and levelled, the stormwater collection system will be installed to manage surface water runoff across the site throughout the lifespan of the Project.
- During construction, all sanitary / septic waste should be collected, handled, and disposed of by a licensed waste disposal operator.
- Mitigation measures developed for this Project should be adhered to in order to adequately address potential issues (*e.g.*, not storing hydrocarbons on-site, fueling equipment > 30 m from the edge of a watercourse, *etc.*).

4.3.2.3.3 Potential Post-Mitigation Residual and Cumulative Impacts

No residual and cumulative effects are likely to occur to the surface water environment so long as the mitigation measures provided here are followed.

4.3.2.4 Groundwater Quantity and Quality

Groundwater was identified as a VEC because surface water and groundwater systems used for potable water supplies in the area can have strong communication networks. The specific potential impacts assessed were:

- groundwater quality (*i.e.*, change in general chemistry and trace metals);
- groundwater quantity (*i.e.*, decreased well yields);

- hydrocarbon / hazardous chemical contamination; and
- groundwater recharge areas.

4.3.2.4.1 Potential Impacts

Results of the groundwater quantity and quality impact assessment are provided in Table 27. Three green lights, three yellow lights, and six blue lights were applied to the potential impacts. It is realized that contamination may occur to the groundwater system and potential impacts could be long-lasting depending on the degree of the spill and the initial clean-up efforts, which is why yellow lights were applied to those aspects.

4.3.2.4.2 Proposed Mitigation

The mitigation measures listed below should be employed to minimize the chance of Project activities from impacting the groundwater regime by eliminating the potential pathways where hydrocarbons and other pollutants may enter the system (*n.b.*, the mitigation measures are nearly identical to those provided for surface water protection and is because the two systems are often interconnected).

- All Project personnel should be briefed on the potential impacts that the Project could have on groundwater quantity and quality.
- Mitigation measures developed for this Project should be adhered to in order to adequately address potential impacts on groundwater quantity and quality.
- During construction, all sanitary / septic waste should be collected, handled, and disposed of by a licensed waste disposal operator.
- Mitigation measures developed for this Project should be adhered to in order to adequately address potential issues (*e.g.*, not storing hydrocarbons on-site, fueling equipment > 30 m from the edge of a watercourse, *etc.*).

4.3.2.4.3 Potential Post-Mitigation Residual and Cumulative Impacts

If a spill migrates to the groundwater system, the potential impacts could be long lasting because groundwater environments are complex and often difficult to remediate. This is an extremely remote possibility because of the limited use of hydrocarbons and hazardous chemicals throughout the Project lifecycle; however, environmental protection measures should be developed and included in the Project-specific EPP.

Table 24. Assessment of potential impacts on air quality of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Potential Impact	Stage II: Construction and Commissioning			Stage III: Operation and Maintenance			Stage V: Mishaps, Errors, and / or Unforeseen Events		
	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation
Micro-climate (*i.e.*, temperature and precipitation)					4	O			
CO emissions		1, 2	A to L		5, 6, 7	A to L, P		1, 2, 8	A to L, P
NO_x emissions		1, 2	A to L		5, 6, 7	A to L, P		1, 2, 8	A to L, P
SO_2 emissions		1, 2	A to L		5, 6, 7	A to L, P		1, 2, 8	A to L, P
VOC emissions		1, 2	A to L		5, 6, 7	A to L, P		1, 2, 8	A to L, P
PM emissions (*e.g.*, exhausts, dusts, *etc.*)		1, 2, 3	A to L		5, 6, 7	A to N, Q		1, 2, 3, 8	A to N, P

COMMENTS

1 An increase in personal and construction vehicles could impact the local air quality.
2 Construction equipment is a major source of combustion emissions which potentially will have an effect on local air quality; during the ~ 11 month construction period, it is estimated that about 2 643 tonnes CO_{2eq} of greenhouse gases will be emitted.
3 Fugitive dusts may be generated while clearing trees, moving materials, and operating vehicles on the local gravel roadways.
4 Research suggests that only minor micro-climate changes result from the presence of a solar farm and those minor impacts do not extend considerably beyond the farm's three-dimensional perimeter.
5 Planting vegetation or allowing vegetation, including grasses and shrubs to regenerate / grow, can increase the air quality of the Project site.
6 The solar farm will generate clean and green electricity for feeding to NB Power's transmission grid and it is estimated that indirect greenhouse gas emissions related to electricity generation in New Brunswick will be reduced by 85 148 tonnes CO_{2eq} over the 25 year lifespan of the solar farm.
7 It is estimated that operation and maintenance equipment will generate about 331 tonnes CO_{2eq} of greenhouse gases over the Project's lifespan (*i.e.*, 25 years).
8 The net lifespan benefit of the solar farm is anticipated to be a reduction of indirect reduction of greenhouse gas emissions related to electricity generation in New Brunswick of 82 174 tonnes CO_{2eq}.
9 In the event of an emergency, equipment with pollutant reduction technologies may not be readily available; however, it will be more important to correct the mishap, error, and / or unforeseen event.

MITIGATING MEASURES

A A Project-specific environmental protection plan will be developed to provide best-management practices that all Project personnel should follow in order to limit the potential for impacts to air quality to occur.
B All Project personnel should be briefed on the potential impacts that equipment emissions can have on the quality of the local airshed and briefing information should range from describing emissions that are released from equipment during operation to how those emissions can be reduced.
C Mitigation measures developed and included in the Project-specific environmental protection plan should be adhered to in order to adequately address potential impacts.
D Construction, operation, and maintenance equipment should only be operated at optimum loading rates.
E Heavy equipment should be turned off when not in use.
F The number of vehicle kilometers travelled should be kept to a minimum (*i.e.*, there should be no unnecessary operation of equipment in and around the site).
G Construction, operation, and maintenance vehicles should comply with the posted / recommended speed limits and, as appropriate, reduce speed when travelling on surfaces where dusts are generated (*i.e.*, local gravel roadways).
H Heavy equipment should be operated using clean fuels (*i.e.*, ultra-low sulphur diesels), where available and practical.
I Heavy equipment exhaust emission systems should meet the recommended standards.
J Equipment should be maintained according to manufacturer recommended servicing periods.
K Heavy equipment should be refueled using a protocol designed to mitigate environmental risks.
L No solid waste should be burned on site.
M If the application of water as a dust suppressant is deemed necessary on local gravel roadways (*n.b.*, this is the preferred method of dust suppression), it should be applied using suitable equipment (*e.g.*, a tanker truck equipped with spray bars and methods of controlling water flow, *etc.*).
N Material stock piles (*e.g.*, soil, sand, aggregate, *etc.*) and spoils piles should be sited in locations that minimize the impact from prevailing winds.
O Solar panels used for the Project will have anti-reflective coatings to limit reflection, which should help mitigate micro-climate impacts.
P Emergency response and contingency plans should be designed to prevent any major and / or sustained environmental damage during any errors, mishaps, and / or unforeseen events.
Q Allowing vegetation to re-establish itself should reduce impacts to air quality, especially those associated with fugitive dusts generated from wind blowing over bare soils.

Table 25. Assessment of potential impacts on sound emissions of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Potential Impact	Stage II: Construction and Commissioning			Stage III: Operation and Maintenance			Stage V: Mishaps, Errors, and / or Unforeseen Events		
	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation
Sound levels (*i.e.*, intensity)		1, 2, 3	A to H		4	A to H		1, 2, 5	A to I
Sound duration		1, 2, 3	A to H		4	A to H		1, 2, 5	A to I
Sound repetition		1, 2, 3	A to H		4	A to H		1, 2, 5	A to I
Ground vibration		1, 2, 3	A to H					1, 2, 5	A to I

COMMENTS

1 Heavy construction equipment will emit sounds and may cause ground vibrations.
2 The heavy equipment planned for Project construction may emit sounds at levels exceeding ambient levels and although back-up alarms on heavy equipment emit sounds at 120 dBA, their use will be temporary and intermittent.
3 Tree clearing, grubbing, and grading may affect the attenuation of sounds from the Project site; however, there will still be considerable forested lands between the Project site and the nearest residential receptor.
4 Very little sound will be emitted from the Project site during operation and maintenance considering the only loud emitters will be cooling fans on the insulated enclosures used for housing the inverters and substation and the temporary and infrequent operation of farm equipment (*i.e.*, once or twice annually for up to a week at a time) to mow the vegetation between the solar arrays.
5 In the event of an emergency, equipment with sound abatement technologies may not be readily available; however, it will be more important to correct the mishap, error, and / or unforeseen event.

MITIGATING MEASURES

A A Project-specific environmental protection plan will be developed to provide best-management practices that all Project personnel should follow in order to limit the potential for impacts to the sound environment to occur.
B All Project personnel should be briefed on the potential impacts the Project may have on sound and sound levels; this could range from explaining that daily inspections and regular maintenance should be done on all heavy equipment to ensure they running as designed and are not unnecessarily contributing to construction noise.
C Mitigation measures developed and included in the Project-specific environmental protection plan should be adhered to in order to adequately address potential impacts.
D Project personnel should ensure that all equipment is equipped with the appropriate manufacturer designed sound level abatement equipment (*i.e.*, mufflers and shrouds).
E The exhaust systems of all Project equipment should be inspected regularly (*i.e.*, daily or weekly) to ensure that sound level abatement equipment is operating properly.
F Equipment should be maintained according to manufacturer's recommended servicing periods.
G The idling of all heavy equipment should be kept to a minimum.
H Loud construction activity should be scheduled / planned to occur during normal workday / daylight hours (*i.e.*, 7 AM through 7 PM Monday through Saturday), where possible, to limit any potential annoyance to residential receptors.
I Any additional mitigation measures developed for this Project should be adhered to in order to adequately address any potential impacts.

Table 26. Assessment of potential impacts on surface water quantity and quality of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Potential Impact	Stage II: Construction and Commissioning			Stage III: Operation and Maintenance			Stage V: Mishaps, Errors, and / or Unforeseen Events		
	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation
Surface water quantity (*i.e.*, change in runoff regime)		1, 2	A, B		7, 8	A, C		9	E
Surface water quality (*i.e.*, change in general chemistry and trace metals)		3, 4	B, C, D		7, 8	A		9	E
Hydrocarbon / hazardous chemical contamination		5, 6	D, E		5, 6	A		9	E

COMMENTS

1 There are no watercourses and / or wetlands located within the Project footprint and the majority of the water that falls on the ground will likely continue to infiltrate the ground before making it to any off-site watercourses and / or wetlands (*n.b.*, Pabineau River, the nearest waterbody, is at least 300 m from the Project footprint).
2 Clearing and grubbing the site may lead to altered surface conditions and affect surface water flow across the site.
3 Clearing and grubbing the site may affect the nutrient loading of the surface water flowing on the site and infiltrating the ground surface.
4 Exposure of rock and sediment during Project construction may alter the quality of surface water flowing from the Project site.
5 There is a potential that hydrocarbons, through their storage and use on-site, could be introduced to surface water systems.
6 There is a potential that hazardous chemicals, through their storage and use on-site, could be introduced to surface water systems.
7 A stormwater collection system will be used to manage runoff across the site and the majority of surface water runoff will return to pre-construction conditions.
8 Once the Project is operational, there will be little additional impact to the surface water environment (*i.e.*, new steady-state conditions will be created).
9 Depending on the mishap, error, and / or unforeseen event, there is a possibility the impact could be long-lasting and could yield any one or all of the potential impacts identified.

MITIGATING MEASURES

A All Project personnel should be briefed on the potential impacts that the Project could have on surface water quality and quantity.
B An erosion and sediment control plan should be developed and implemented prior to initiating the Project in order to limit and control erosion and sedimentation.
C After the Project site has been cleared, grubbed, and levelled, the stormwater collection system will be installed to manage surface water runoff across the site throughout the lifespan of the Project.
D During construction, all sanitary / septic waste should be collected, handled, and disposed of by a licensed waste disposal operator.
E Mitigation measures developed for this Project should be adhered to in order to adequately address potential issues (*e.g.*, not storing hydrocarbons on-site, fueling equipment > 30 m from the edge of a watercourse, *etc.*).

Table 27. Assessment of potential impacts on groundwater quantity and quality of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Potential Impact	Stage II: Construction and Commissioning			Stage III: Operation and Maintenance			Stage V: Mishaps, Errors, and / or Unforeseen Events		
	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation
Groundwater quality (*i.e.*, change in general chemistry and trace metals)								3	A, B, D
Groundwater quantity (*i.e.*, decreased well yields)									
Hydrocarbon / hazardous chemical contamination		1	A, B, C		1, 5	A, B		1	A, B
Groundwater recharge areas		2	A		2	A			

COMMENTS

1 If a hydrocarbon or hazardous chemical spill migrates to the groundwater system, the potential impacts could be long lasting because groundwater systems are complex and often difficult to remediate once contaminated.
2 There may be additional water available to recharge the groundwater system due to the reduction in evapotranspiration from terrestrial flora.
3 There is a potential that hydrocarbons, through their storage and use on-site, could be introduced to groundwater systems.
4 There is a potential that hazardous chemicals, through their storage and use on-site, could be introduced to groundwater systems.
5 During operation and maintenance, there will be minimal use of hydrocarbon / hazardous chemicals on the site.

MITIGATING MEASURES

A All Project personnel should be briefed on the potential impacts that the Project could have on groundwater quantity and quality.
B Mitigation measures developed for this Project should be adhered to in order to adequately address potential impacts on groundwater quantity and quality.
C During construction, all sanitary / septic waste should be collected, handled, and disposed of by a licensed waste disposal operator.
D Mitigation measures developed for this Project should be adhered to in order to adequately address potential issues (*e.g.*, not storing hydrocarbons on-site, fueling equipment > 30 m from the edge of a watercourse, *etc.*).

4.3.3 Biological Environment

4.3.3.1 Terrestrial Flora and Fauna

Based on information obtained from the ACCDC, some COSEWIC and *SARA* ranked species of terrestrial fauna do exist within a 5 km radial buffer surrounding the Project site (*i.e.*, refer to Section 3.2.1.1 and Section 3.2.2.1 for a description of those species, Appendix VI for the ACCDC data report, and Figure 39 and Figure 41 for distribution maps). The following potential impacts were evaluated with respect to terrestrial flora and fauna:

- *SARA*, COSEWIC, and / or ACCDC listed species;
- existing vegetation and habitat;
- plant associations and biodiversity;
- wildlife species and habitat;
- wildlife species and habitat fragmentation; and
- natural wildlife migration, nesting, and food chains.

4.3.3.1.1 Potential Impacts

The Project will be secured via a perimeter security fence and access for large land mammals (*e.g.*, deer, moose, coyote, *etc.*) will be limited or restricted. The number of direct animal mortalities at solar farms as reported by *Katzner* [2013] is believed to be negligible. Small animals, such as mice, squirrels, and chipmunks, will still be able to access the site by going under, over, or through the spaces in the chain link fence. *McDonald et al.* [2009], calculated land-use intensity for 16 different energy production / conservation methods. Solar photovoltaics ranked in the middle at 37 $km^2 \cdot TW \cdot hr^{-1} \cdot yr^{-1}$. Overall impact of fencing off the site (*i.e.*, 40 ha) is considered minimal when compared to the size of surrounding undeveloped lands (*i.e.*, tens of thousands of hectares).

To facilitate construction of the solar farm, the lands will have to be cleared, grubbed, and levelled. This will temporarily result in the loss of the vegetative community, however, once the solar farm is in operation, vegetation will be permitted to re-establish itself on the bare ground. It likely will not take long, a growing season or two, for a vegetative community to re-establish itself at the site. The vegetation, which will most likely comprise grasses and shrubs, will be mowed once or twice a year to keep it from becoming unmanageable and / or growing above the panels where it could cast shadows and interfere with the generation of electricity.

Migratory birds are afforded special protection under the *Migratory Birds Convention Act. S*everal species of migratory birds are known to migrate through the region. Some sightings of ACCDC ranked migratory birds have been observed within a 5 km radial buffer around the site (*i.e.*, refer to Figure 39 and Figure 41); however, none of those species are known to inhabit or frequent the site. Instead, they may be transient visitors.

Loud sounds emitted by construction equipment may limit use of the immediate area by birds. Clearing of the native vegetation would remove habitat features, such as food sources and habitat connectivity. Once construction is complete, birds will return. The panels may present a low risk of collision to those birds and actually, the presence of the solar farm may be an appealing feature to them. For example, the panel racking systems may provide perches and sheltered nesting areas, the warm air immediately above the panels may be an attractant to flying insects that birds feed on, and the racking systems may provide ample areas for spiders to spin their webs and catch insects [*Suuronen*, 2017; *Peschel*, 2010]. A downside of having birds attracted to the solar farm would be droppings on the panels [*Harrison et al.*, 2016]. If droppings become frequent and wide-spread, maintenance would likely include panel washing with the frequency dependent on the amount of droppings.

Lake effects have been identified as an issue at very large solar PV sites in southern California [*Black and Veatch*, 2018; *Upton*, 2014]. There, thousands of solar panels have fooled birds into thinking they are lakes. As a result, some migrating water birds have altered their flight paths and died or have been critically injured upon impact with the panels (*i.e.*, the birds realize too late in their descent that the solar panels are not water). This is not expected to be an issue for the Project as there are large water features in the region that would likely be more attractive to migrating water birds.

Walston et al. [2016] provided the first preliminary assessment of avian mortality at utility-scale solar energy facilities in the United States. Of the various causes of avian mortality, such as buildings and windows, vehicles, communication towers, fossil fuel power plants, and wind farms, they reported solar farms to be the least impactful. For instance, mortality rates are likely 160 times lower for a solar facility than compared to a fossil fuel power plant. With respect to solar farms, they noted that concentrated solar plants would have a much higher mortality rate than a solar PV farm.

The solar farm may pose a threat to bats; however, the presence of solar PVs may also present benefits to bats similar to those identified for birds. There are no known bat hibernacula in the local area so there are not anticipated to be any considerable impacts on bats.

In their biodiversity comparative study at 11 utility-scale solar farms and paired control sites in the United Kingdom, *Montag et al.* [2016] reported higher biodiversity at solar farms. Their study revealed that solar farms can lead to an increase in the diversity and abundance of broad leaved plants, grasses, butterflies, bumblebees, birds, and bats; however, the level of benefit to biodiversity is highly dependent on the management of the site during operation.

The impact assessment for terrestrial flora and fauna is summarized in Table 28. The overall impact of the solar farm on terrestrial flora and fauna is expected to be less than other land disturbances, such as agriculture and forest harvesting. As noted above, there are expected to be some minor impacts to terrestrial flora and fauna, but those impacts will most likely be restricted to the construction of the solar farm. The impact assessment yielded 10 yellow lights, five green lights, and one blue light (Table 28).

4.3.3.1.2 Proposed Mitigation

The mitigation measures listed below should be employed to minimize the probability of activities related to the Project from affecting surrounding terrestrial flora and fauna.

- Any sensitive flora should be salvaged and relocated from the Project site prior to construction activity and tree clearing should be undertaken outside of the migration and breeding season for migratory birds (*i.e.*, May to August).
- Extremely loud, intrusive, or otherwise potentially harassing activities should be avoided or limited during periods of the year when wildlife are under severe environmental and physiological stress, such as the spring breeding season for birds.
- The perimeter fence should be erected at the outset of construction to keep larger animals from entering the site.
- Project personnel should properly dispose of food scraps and garbage in the appropriate receptacles provided by the contractor.
- Waste stored on-site should be stowed in an appropriate manner and should be transported to an appropriate disposal facility (*e.g.*, Red Pine Station Waste Management Facility, *etc.*) on a regular basis.
- Project personnel should be advised, prior to working on the Project site, to not feed or harass nuisance wildlife (*e.g.*, varmint, sea gulls, rodents, *etc.*).
- No attempt should be made to chase, catch, divert, follow, or otherwise harass wildlife by vehicle or on foot.
- If injured or diseased wildlife are encountered, then the Department of Natural Resources and the Canadian Wildlife Service should be contacted to determine the appropriate course of action.
- If deceased animals are encountered, they should be removed and disposed of, as soon as possible, in consultation the Department of Natural Resources and the Canadian Wildlife Service.
- No Project personnel should affect wildlife populations by either hunting or trapping and firearms should be strictly prohibited on the Project site.
- If an active nest, den, *etc.* is encountered, it should be immediately reported to the Project manager / supervisor(s) who should ensure that a no-disturbance buffer zone is established.
- Emergency response and contingency plans should be designed to prevent any sustained environmental damage during any errors, mishaps, and / or unforeseen events.

4.3.3.1.3 Potential Post-Mitigation Residual and Cumulative Impacts

No residual and cumulative effects are likely to occur to terrestrial flora and fauna over the duration of the construction and operation of the Project assuming the above mitigation measures are implemented.

Table 28. Assessment of potential impacts on terrestrial flora and fauna of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Potential Impact	Stage II: Construction and Commissioning			Stage III: Operation and Maintenance			Stage V: Mishaps, Errors, and / or Unforeseen Events		
	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation
SARA, COSWEIC and / or ACCDC listed species	△	**1, 2, 3**	**A, B, C**	◯	**1, 2**	**A, B**	△	**11, 12**	**A, B, N**
Existing vegetation and habitat	△	**4, 5**	**A, B, C**	◯	**9**	**A, B**	△	**11, 12**	**A, B, N**
Plant associations and biodiversity	=			=			=		
Wildlife species and habitat	△	**3, 6, 7, 8**	**A, B, D to M**	◯	**9**	**A, B, F to N**	△	**11, 12**	**A, B, N**
Wildlife species and habitat fragmentation	△	**3, 6, 7, 8**	**A, B, D to M**	◯	**9**	**A, B, F to N**	△	**11, 12**	**A, B, N**
Natural wildlife migration, nesting and food chains	△	**1, 3, 6, 7, 8**	**A, B, C to M**	◯	**10**	**A, B, F to N**	△	**11, 12**	**A, B, N**

COMMENTS

1 No terrestrial flora and fauna species of special concern are believed to exist on the Project site; however, ACCDC records suggest that some flying transient / vagrant / migrant species of special conservation concern, such as the Canada warbler, common nighthawk, or the chimney swift, or rare species do exist within a 5 km radius of the site. Therefore, there is a possibility that they could pass through the site on occasion.
2 Some flying fauna could seek out areas of the Project site during construction and or when it is in operation. For example, the racking for the panels could present an attractive nesting spaces for birds.
3 Sound emitted from heavy equipment could scare away / displace wildlife.
4 Almost the entire Project footprint will be cleared and grubbed of vegetation and then levelled to facilitate construction of the solar farm, which will eliminate existing flora and fauna habitat within the boundaries of the Project site.
5 Increased overland flow due to clearing and grubbing the vegetative cover may reduce the amount of water available, captured, and stored for vegetation.
6 Loss of vegetation may result in loss of wildlife habitat.
7 During clearing and grubbing, injury or death of invertebrates, amphibians, reptiles, small mammals, and / or vegetation may occur.
8 If refuse from Project personnel is not stored properly, it may be an attraction for wildlife, which could result in unwanted interactions between humans and wildlife.
9 Once the solar farm is in operation, some vegetation (*i.e.*, grasses and shrubs) will regrow across the site creating some habitat for small animals and birds that are able to access the site.
10 Once the site has been established and in operation, new wildlife migration patterns, nesting sites, and food chains should be created.
11 Depending on the mishap, error, and / or unforeseen event, there is a possibility the impact could be long-lasting and could extend off-site to affect a species of special conservation concern.
12 Ground spills of hydrocarbons during refueling operations of heavy equipment (*i.e.*, gasoline and diesel) may contaminate food and water sources for wildlife.

MITIGATING MEASURES

A All Project personnel should be briefed on the potential impacts that the Project could have on terrestrial flora and fauna.
B Mitigation measures developed for this Project should be adhered to in order to adequately address those potential issues (*e.g.*, limiting Project lighting during normal bird migration season, *etc.*).
C Any sensitive flora should be salvaged and relocated from the Project site prior to construction activity and tree clearing should be undertaken outside of the migration and breeding season for migratory birds (*i.e.*, May to August).
D Extremely loud, intrusive, or otherwise potentially harassing activities should be avoided or limited during periods of the year when wildlife are under severe environmental and physiological stress, such as the spring breeding season for birds.
E The perimeter fence should be erected at the outset of construction to keep larger land animals from entering the site.
F Project personnel should properly dispose of food scraps and garbage in the appropriate receptacles provided by the contractor.
G Waste stored on-site should be stowed in an appropriate manner and be transported to an appropriate disposal facility (*e.g.*, Red Pine Station Waste Management Facility, *etc.*) on a regular basis.
H Project personnel should be advised, prior to working on the Project site, to not feed or harass nuisance wildlife (*e.g.*, varmint, sea gulls, rodents, *etc.*).
I No attempt should be made to chase, catch, divert, follow, or otherwise harass wildlife by vehicle or on foot.
J If injured or diseased wildlife are encountered, then the Department of Natural Resources and the Canadian Wildlife Service should be contacted to determine the appropriate course of action.
K If deceased animals are encountered, they should be removed and disposed of, as soon as possible, in consultation with the Department of Natural Resources and the Canadian Wildlife Service.
L No Project personnel should affect wildlife populations on the Project site by either hunting or trapping and firearms should be strictly prohibited on the Project site.
M If an active nest, den, *etc.* is encountered, it should be immediately reported to the Project manager / supervisor(s) who should ensure that a no-disturbance buffer zone is established.
N Emergency response and contingency plans should be designed to prevent any sustained environmental damage during any errors, mishaps, and / or unforeseen events.

4.3.4 Socio-Economic Environment

4.3.4.1 Labour and Economy

As described in Section 2.7.3.12, this Project has the potential to positively affect the local labour market and economy. Therefore those parameters were chosen as VECs to assess. The potential impacts, positive and negative, that were assessed with respect to labour and economy for the Project were:

- employment / workforce retention;
- skills training;
- local spending; and
- livelihood.

4.3.4.1.1 Potential Impacts

This Project will create economic development in an otherwise high unemployment and economically depressed area of the Province (*i.e.*, unemployment is typically at or above 10 % in the Bathurst region). Furthermore, it has the potential to stimulate and diversify local economic development opportunities (*i.e.*, spur development of other solar farms and / or solar panel / component manufacturers). Although jobs will primarily be during the short-lived construction period, there will be some long-term operation and maintenance jobs in the form of security, property maintenance, electrical testing and inspections, engineering, and accounting.

Construction of a solar farm is not an overly complex process. Therefore, the training required for traditional trades, such as welders, electricians, labourers, and heavy equipment operators, will be minimal; however, the development of a utility-scale solar farm may pique the interest of other developers and be a springboard for training programs to develop in trade schools.

Currently, the industrial lands are undeveloped and have a minimal annual tax levy (*i.e.*, $555; refer to Appendix I). Development of the Violet Solar Farm will increase the overall assessment of the property thereby generating more taxes for the Bathurst LSD over a period of at least 25 years.

The impact assessment for labour and economy is summarized in Table 29. The assessment yielded 11 green lights and one no change light.

4.3.4.1.2 Proposed Mitigation

This Project is positive for the local labour market and economy because it will provide much needed construction jobs in the region, albeit short-term, and some long-term operation and maintenance jobs. No negative impacts are anticipated. Therefore, no additional mitigation measures, other than those highlighted in Table 29, are required.

4.3.4.1.3 Potential Post-Mitigation Residual and Cumulative Impacts

No residual and cumulative effects are likely to be incurred within the local labour market and economy due to this Project.

4.3.4.2 Land-Use

The Project footprint exists entirely on vacant Crown timberland. Although the property is undeveloped, it is identified as being unimproved land for industrial purposes (*i.e.*, refer to Appendix I). The potential impacts, positive and negative, that were assessed with respect to land-use for the Project were:

- traditional uses by First Nations;
- land-use conflicts (*i.e.*, zoning);
- land value (*i.e.*, developed and undeveloped land); and
- use of natural resources (*e.g.*, timber, agriculture, *etc.*)

4.3.4.2.1 Potential Impacts

The PID proposed for this Project is suitably located for industrial development and was actually set aside in 1974 for industrial purposes (*i.e.*, refer to Section 3.3.4). No land-use conflicts are likely during construction with respect to rural residential development or land managed for forestry purposes. At the outset, a woodlands contractor would likely be hired to harvest the standing timber on the site allowing for use of existing natural resources. The extraction of any valuable extractable mineral resources would be restricted during construction and operation; however, the Project is highly reversible and the lands could be used for mineral extraction in the long-term.

The impact assessment for land-use is provided in Table 30. Overall, the assessment yielded seven green lights and five yellow lights.

4.3.4.2.2 Proposed Mitigation

The mitigation measures provided below should be adhered to in order to reduce the likelihood of impacts being realized to land-use.

- Members of the Pabineau First Nation should be consulted regarding potential traditional uses of the land and if uses are identified then appropriate mitigation measures should be established.
- A vegetated buffer should be retained between the development and NB Route 430 and NB Route 360 in order to minimize views of the solar farm (*i.e.*, provide camouflage for the site).
- A woodlands contractor (*i.e.*, fuelwood and / or pulpwood contractor) should be hired to harvest the standing timber on the portion of the site the solar farm will occupy.

4.3.4.2.3 Potential Post-Mitigation Residual and Cumulative Impacts

No residual and cumulative effects are likely to be incurred with respect to local land-use due to this Project.

4.3.4.3 Transportation Network

Through this Project, the local transportation network will see a moderate increase in heavy equipment traffic (*e.g.*, floating construction equipment to and from the site, importing Project infrastructure, *etc.*). Additionally, during peak construction, dozens of workers are expected to be working on the Project. The potential impacts that were assessed with respect to the local transportation network were:

- traffic hazards;
- damage to infrastructure; and
- conflict with existing traffic.

4.3.4.3.1 Potential Impacts

Heavy construction equipment and Project components will be transported to the site via the existing road network. It is expected that the majority of heavy equipment will come from the Bathurst area and the solar panels will most likely come from a manufacturer in Ontario. NB Route 430, which is expected to be the route most likely used to access the Project site, is a public, two lane asphalt roadway (*n.b.*, in the vicinity of the Project site the speed limit is 90 km $\cdot$ hr^{-1}) designed for heavy truck traffic as it is the primary route for getting to and from Fornebu Lumber Company Inc.'s framing lumber sawmill, timber blocks managed by various forestry companies, and the former mining sites of Health Steele, Brunswick Mines, and Bathurst Mines. Depending on various economic factors, traffic along NB Route 430 ebbs and flows (*e.g.*, in response to commodity prices, biomass demand, *etc.*). The short-term increase in traffic along the roadway associated with the Project is not anticipated to have any major impacts on the transportation network.

The proposed entrance to the Project site from NB Route 430 would allow adequate sightlines for vehicles entering and exiting the site (*i.e.*, > 750 m from the intersection with NB Route 360 and the nearest turn on NB Route 430). The site is sufficiently large enough to allow suitable areas for equipment laydown and for heavy equipment and personal vehicles to be parked.

The impact assessment for the local transportation network yielded three green lights and six no change lights (Table 31). No change lights were applied to Project operation and maintenance and mishaps, errors, and / or unforeseen events because there are not expected to be any large increases in traffic once Project construction is complete.

4.3.4.3.2 Proposed Mitigation

The measures provided below should be implemented by all Project personnel to minimize the potential impact on the local transportation network.

- All vehicles permitted on local roadways should be maintained according to provincial regulations with respect to registration, licensing, insurance, and safety inspection.
- No vehicles associated with Project work (*i.e.*, personnel vehicles, construction vehicles, heavy equipment, *etc.*) should be allowed to park along roadways; parking should only occur in safe and identified locations.
- All Project personnel operating vehicles permitted on local roadways should obey the posted speed limits and other posted signs, such as weight restrictions.
- Any additional mitigation measures developed for this Project should be adhered to in order to adequately address any potential impacts.

4.3.4.3.3 Potential Post-Mitigation Residual and Cumulative Impacts

No residual and cumulative effects are likely to be incurred to the local transportation network due to this Project.

4.3.4.4 Aesthetics

The Project has the potential to affect aesthetics of the area, which is why it was selected as a VEC for assessment. The following potential impacts to aesthetics were assessed:

- visual pollution;
- light pollution (*i.e.*, light trespass, glint, and glare);
- local compatibility; and
- odour.

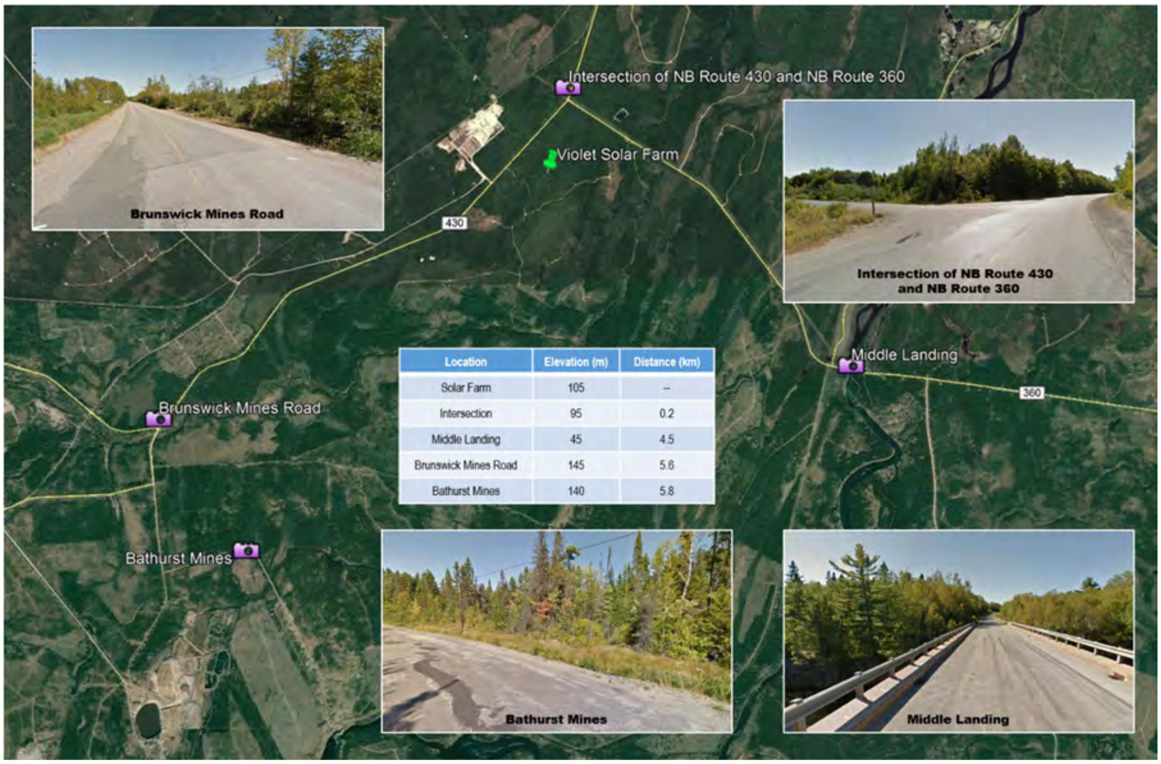
4.3.4.4.1 Potential Impacts

It is believed that the Project can be successfully accommodated and assimilated into the surrounding landscape without causing any significant harm to the landscape character, visual amenity, or landscape setting of the area. Given the maximum height of the PV arrays is 4.5 m, the Project is only expected to be visible within the immediate vicinity and there are no known sensitive visual receptors nearby. The existing standing forest, which is at least 10 m tall, will conceal the solar arrays from surrounding areas (*i.e.*, Middle Landing, NB Route 360, NB Route 430, and Bathurst Mines; Figure 67) thereby not affecting viewsheds from those areas (*n.b.*, there are very few wide-open areas and the forest canopy is close to the edge of all major roadways in the area).

Portions of the solar farm will likely be visible by employees of Fornebu Lumber Company Inc.'s adjacent framing lumber; however, the views will be minimal and likely far less obtrusive than that facility itself. Users of local snowmobile / ATV trails are exposed to various viewscapes along their length and the presence of the solar farm may draw trail users to the area in order to see a unique site first-hand. In this instance, riders may travel along NB Power's transmission corridor to access the site.

There may be a slight possibility that the meteorological tower, which is anticipated to be 25 m tall (*n.b.*, the height is subject to detailed design), may be seen from NB Route 430 and NB Route 360; however, it is not expected to cause any negative impacts to the overall aesthetics of the area. Power poles and pylons within NB Power's transmission corridors would be of a similar height. Also, this tower would not be any higher than some of the infrastructure that still exists at the Brunswick Mines site.

A commonly expressed concern with solar farms is whether glint or glare will negatively affect aircraft flying above. The direct reflection of the sun on the surface of a PV module is referred to as glint; it is a momentary flash of bright light. Glare is the continuous source of brightness; it is the refection of the bright sky around the sun. Glare is significantly less intense than glint.



Location	Elevation (m)	Distance (km)
Solar Farm	105	–
Intersection	95	0.2
Middle Landing	45	4.5
Brunswick Mines Road	145	5.6
Bathurst Mines	140	5.8

Figure 67. Google Earth Street View images showing a ground-level viewing perspective for four view planes selected for the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Solar systems have successfully been implemented at many airports worldwide [*Kandt and Romero*, 2014]. In Ontario, there are currently at least three operational solar farms on airport properties (*i.e.*, the 8.5 MW Thunder Bay YQT Solar Farm, the 10 MW Belleville North Solar Farm, and the 50 MW Windsor YQG Solar Farm shown in Figure 68) and one approved for another airport property (*i.e.*, Lake Simcoe YLK Solar Farm). There are also many Ontario solar farms in close proximity (*i.e.*, < 5 km) to airports. Aircraft accident databases from the Canada, the US, and UK include no accidents attributed to glint from a solar farm [*TSBC*, 2018; *MASSCEC*, 2015].

Solar modules comprise silicon-based PV cells that are encased in glass, which does not have a true glint, but does cause glare. Reflection of sunlight by PV modules is undesirable; lower glare results in a greater amount of light captured thus a higher amount of electricity produced. Therefore, module manufacturers use anti-reflective coatings on the glass to reduce the overall glare, which can be as little as 2 % and far less than other common surfaces [*FAA*, 2010] (Figure 69). As a result, most of the sunlight reaching the surface of PV panel is transmitted to the solar cell beneath the glass with only a small amount lost to glare. The amount of glare from the Project is expected to be less than currently occurs from the natural coniferous and deciduous forest currently present (*i.e.*, 10 % to 20 %).

Figure 68. Google Earth image showing the 50 MW YQG Solar Farm in Windsor, Ontario.

The US Federal Aviation Administration (FAA) released a policy document about implementing solar technologies at airports in the US [*Kandt and Romero*, 2014]. It was determined that PV farms can be constructed on and within the vicinity (*i.e.*, < 15 km) of airports because they have a low profile and a low potential to impact flight operations. This Project's solar panels will be fixed with a southerly aspect. Even if there should be glint and glare from them, they will face away from the Bathurst Regional Airport (*i.e.*, ZBF) and would probably only be a nuisance to pilots approaching the airport from the south (*n.b.*, the runway has a true bearing of 262 ° / 82 °). Nuisance glare can be mitigated by pilots using darkened visors, sunglasses, and glare shields [*Riley and Olson*, 2011].

Although there are no other solar farms in the area, or in New Brunswick, and compatibility for this Project is perhaps low (*i.e.*, the surrounding lands are largely undeveloped and the solar farm is unique for the visual catchment), it is not expected to have any major impact. That is primarily because it will largely be hidden from view at ground level and most people in the area will never even know the Project exists. Any glint and glare caused by the solar panels will be interrupted by existing natural vegetation before ever reaching Bathurst Mines, the nearest residential community. There are no high points of ground or tourist outlooks that the Project site can be seen from. The only portion of the Project that will likely be visible is the feeder line. Although it will be seen from NB Route 430, it is not unique as NB Power has several transmission lines running parallel to highways in the area.

During the short Project construction period (*i.e.*, 10 to 12 months; Figure 25), there will be one or two truck cranes on-site in order to conduct aerial lifting and erecting, particularly for the inverters, substation, and meteorological tower. Those cranes may extend above the tree line and may be seen from NB Route 430 and NB Route 360. For personnel safety during construction, there will be requirements to light equipment and work areas during low-light conditions and evening hours, but those periods are expected to be minimal. Construction equipment will emit exhausts; however, the associated odours should dissipate before reaching any nearby residential properties. There will be no odours released during long-term O&M, save for those associated with security vehicles and any O&M equipment.

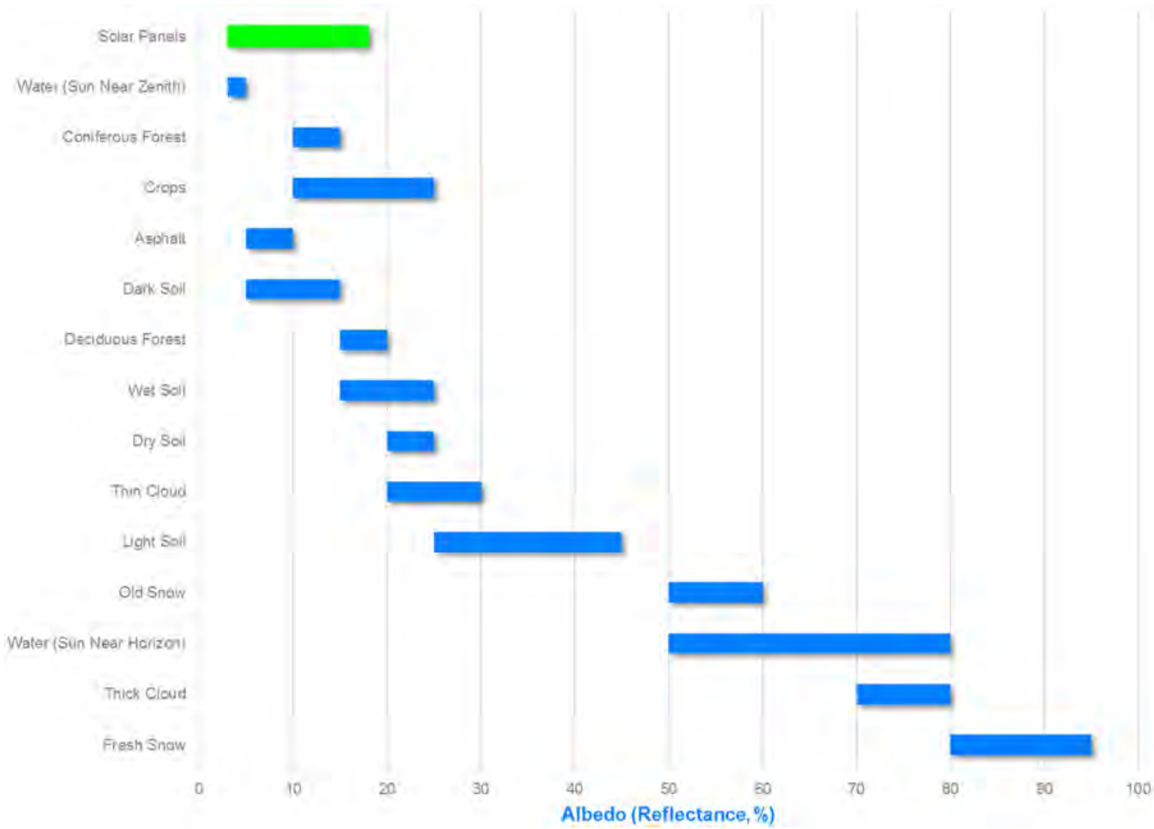


Figure 69. Range of albedo (*i.e.*, reflectance) for common surfaces, including solar photovoltaics. Data from *Avery and Berlin* [1992].

As noted in Section 2.6.3, motion-sensored lighting will be installed, as necessary, across the site primarily for health and safety and security considerations. The delays on those lights will be set low to limit the amount of time the lights may be turned on.

The impact assessment for aesthetics, which is summarized in Table 32, yielded one green light and 11 yellow lights. Although yellow lights were applied to the majority of potential impacts, those impacts are expected to be short-lived and implementation of the mitigation measures identified below will help reduce the potential impact.

4.3.4.4.2 Proposed Mitigation

The mitigation measures provided below should be undertaken to ensure that the potential impacts to aesthetics are minimized.

- Solar panels used for the Project will have anti-reflective coatings to limit reflection similar to or less than existing conditions.

- During Project construction, if work is required during low-light and night-time conditions, lighting should be oriented such that it does not shine upwards.
- Permanent Project lighting should be down-shielded, directed away from nearby receptors, such as residences, and be motion-activated with short delays.
- Heavy equipment should be turned off when not in use and / or when practical in order to limit the amount of exhaust and associated nuisance odours that has the potential to migrate off-site.
- It is recommended, and has been incorporated in the conceptual design, that a natural vegetated buffer strip of at least 5 m be maintained between the perimeter security fence and the land lease boundary to help conceal the solar farm.
- Operators should ensure that switchable, non-motion-activated lights, are turned off when not required for performing their duties and / or for safety reasons.

4.3.4.4.3 Potential Post-Mitigation Residual and Cumulative Impacts

No residual and cumulative effects are likely to occur to local aesthetics throughout the duration of Project assuming the above mitigation measures are implemented.

4.3.4.5 Health and Safety

The solar farm has the potential to affect the health and safety of Project personnel, as well as the general public and visitors. For this reason, health and safety was selected as a VEC. The following potential impacts pertaining to health and safety were assessed for the Project:

- occupational and personal hazards;
- local airshed contamination;
- solid waste and sanitary waste generation;
- traffic hazards; and
- electromagnetic fields.

4.3.4.5.1 Potential Impacts

Maintaining a safe work site is of paramount importance to C2 Solar. The impact assessment for health and safety is summarized in Table 33. Overall, the assessment yielded 10 green lights and five yellow lights suggesting that there will be very little impact, if any, to health and safety throughout all stages of the Project. The yellow lights were applied primarily to potential impacts during construction and commissioning when there are likely to be more risks. For example, as discussed in 4.3.2.1, construction equipment will emit exhausts that are essentially absent at the Project site today thereby impacting the airshed over the short-term. During a potential mishap, error, and / or unforeseen event, there is a possibility that the local airshed could also be impacted due to the presence of heavy equipment; however, it is anticipated that any impacts would be short-lived and be essentially eliminated once the event has been rectified.

ElectroMagnetic Fields (EMFs) consist of electric and magnetic fields and are generated whenever and wherever electricity is used. Electric fields are produced by voltage and magnetic fields are created by current. EMFs exist close to lines transmitting electricity and around electrical devices, such as appliances and cellphones, but their strength rapidly decreases with distance from the source. Although natural and anthropogenic materials provide some shielding against electric fields, most do not obstruct magnetic fields. Exposure to magnetic fields is considered more serious because some epidemiological studies have linked it to increased cancer risk [*NIEHS*, 2002; *WHO*, 2007].

During operation, the Project will emit extremely low frequency EMFs in the daytime when electricity is being generated. Sources of those EMFs include the solar arrays, the inverters, the substation, the feeder line, and the transmission line. Research by *Chang and Jennings* [1994] found that human exposure to EMFs from utility-scale solar farms in California is significantly less than compared to exposure from common household appliances. *Sheppard* [2014] notes that solar farm EMFs are highly localized, considerably weaker than limits found in all safety guidelines, and generally indistinguishable from background levels at the perimeter security fence. Considering the distance to the nearest residential receptors there should be no concerns related to human health and EMF exposure from the Project.

The transmission line connected to the Violet Solar Farm would be the largest source of EMFs (*n.b.*, EMFs would be generated from the transmission line at all times that it is charged, not just when the Project is operational). Electric fields (Figure 70) and magnetic fields (Figure 71), from that line, in the absence of any barriers, would be almost negligible at a distance of about 60 m [*NIEHS*, 2002].

During maintenance activities at the Project site, workers will be exposed to generic occupational health and safety risks, such as exposure to falls from heights, electric shock hazards, *etc.* Therefore, the work should only be completed by trained and / or certified / licensed persons. Some maintenance workers will also be intermittently exposed to EMFs, but again, the effects are likely to be negligible.

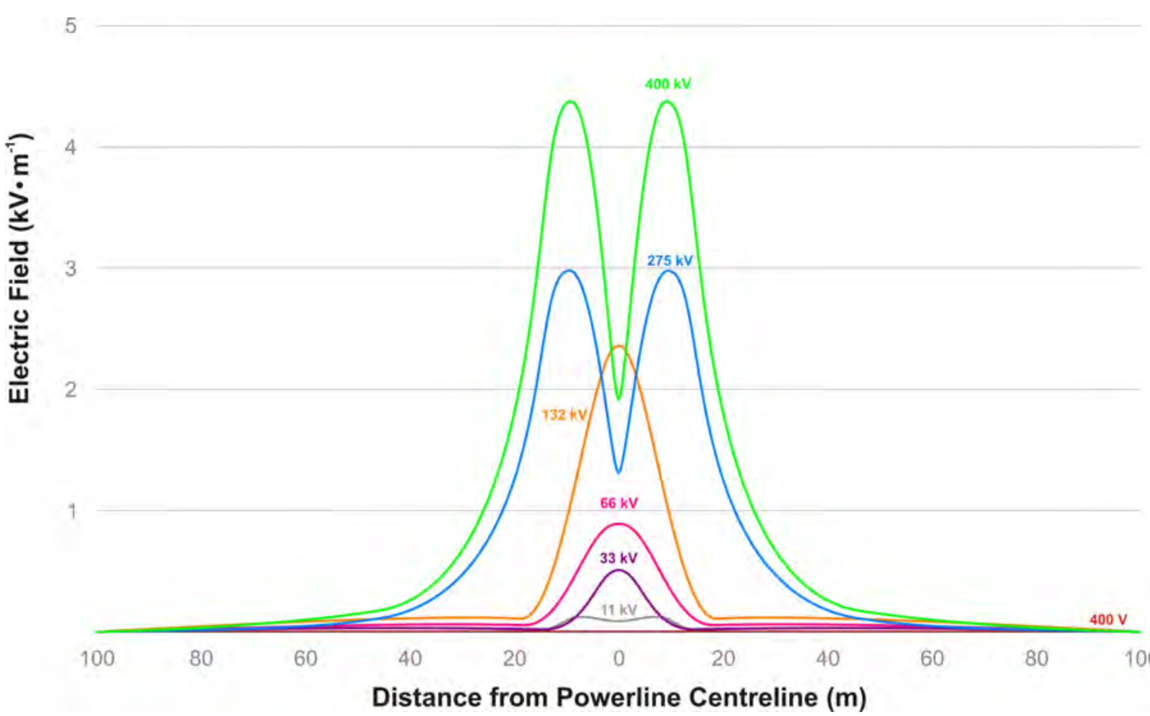


Figure 70. Typical electric fields generated from overhead powerlines of varying voltages. Adapted from *EMFI* [2018].

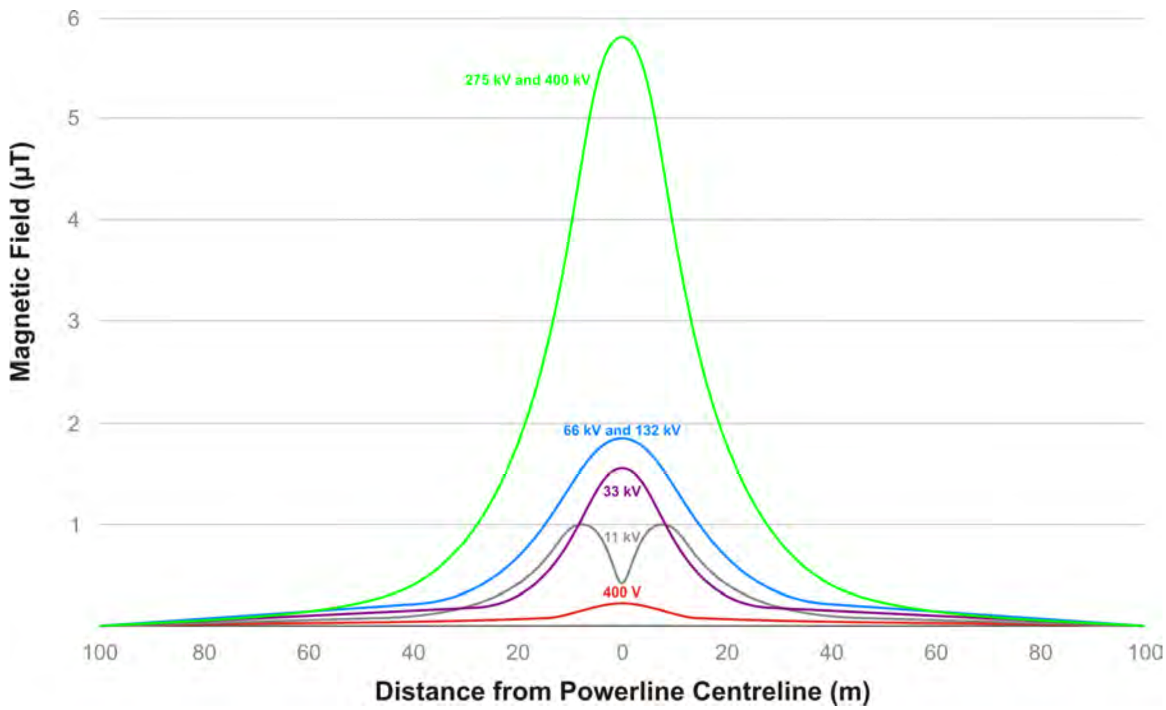


Figure 71. Typical magnetic fields generated from overhead powerlines of varying voltages. Adapted from *EMFI* [2018].

4.3.4.5.2 Proposed Mitigation

Various safety procedures and protocols should be put in place, not only to protect those working on the site, but also used to protect the general public and visitors from any harm. The mitigation measures provided below should be undertaken by all Project personnel to ensure that the potential risks to Project personnel and public health and safety are minimized.

- All Project personnel should make occupational health and safety and public health and safety a primary objective in all of their activities related to the Project.
- All laws and regulations related to health and safety should be followed and all of those laws and regulations are applicable to all Project personnel, with no exceptions.
- All Project personnel should be adequately trained to do their job so that they conform to the occupational health and safety standards and public health and safety standards.
- The Proponent should ensure that occupational health and safety standards and general public health and safety standards are part of the Project working environment.
- All Project personnel should wear appropriate personal protective equipment (PPE) for the tasks they are performing.
- The Proponent should ensure that Project personnel wear appropriate PPE for the tasks they are performing.
- All Project personnel should report any fatal or serious incident that results in lost time or property damage and those reports should be submitted promptly by the Proponent to the appropriate regulatory authorities.

- All hazardous materials (*e.g.*, paints, solvents, *etc.*) should be labelled appropriately and stored as per the manufacturer's recommendations.
- Project personnel working with hazardous chemicals should be trained appropriately for their safe use, handling, and storage, and they should have access to the Material Safety Data Sheet information.
- Project personnel working at heights should be trained appropriately for working at heights and should be provided with the appropriate PPE for working at heights.
- A perimeter security fence should be erected to protect against non-authorized persons circulating within the Project site, additional security fences should be erected around the inverters and substation, and appropriate signage should be erected on the fences (*e.g.*, no trespassing, high voltage, *etc.*) at regular intervals along the security fences to warn the general public of potential risks from entering the Project site.
- Electrical work should only be completed by trained and certified / licensed professionals.
- Electrical wires should be buried, where possible, and electrical components like the inverters and substation should be enclosed in shelters, where possible, to limit EMFs.

4.3.4.5.3 Potential Post-Mitigation Residual and Cumulative Impacts

No residual and cumulative effects are anticipated, with respect to health and safety, over the construction and operation of the Project, if the above mitigation measures are implemented

Table 29. Assessment of potential impacts on labour and economy of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Potential Impact	Stage II: Construction and Commissioning			Stage III: Operation and Maintenance			Stage V: Mishaps, Errors, and / or Unforeseen Events		
	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation
Employment / worker retention	●	**1, 2, 3, 4**	**A**	●	**6**	**A**	●	**9**	**E**
Skills training	●	**3, 4**	**B, C, D**	●	**6**	**B, C**	●	**3, 4**	**E**
Local spending	●	**3, 4, 5**	**C**	●	**7, 8**	**C**	●	**10**	**E**
Livelihood	●	**3**	**B, C**	⊜			●	**10**	**E**

COMMENTS

1 Engineers, environmental scientists, and other professionals are being paid wages to secure permits for the Project.
2 Engineers, scientists, and other professionals will be engaged to conduct detailed design for the Project.
3 Skilled labour (*e.g.*, surveyors, carpenters, engineers, electricians, heavy equipment operators, *etc.*) will be required to build the Project and some of their wages will likely be used to purchase goods and services, thereby boosting the local economy.
4 This Project will generate and promote economic development, albeit short-term, in an otherwise high unemployment area of New Brunswick.
5 This Project has an anticipated capital expenditure of $18 million, which should result in moderate spending in the local economy for goods and services (*e.g.*, workers will likely patronize local businesses, eateries, *etc.*).
6 Long-term operation and maintenance of the solar farm will be contracted out and will require a minor amount of skilled labour (*i.e.*, electricians).
7 Annual property taxes will be paid to the local service district (*i.e.*, Bathurst Local Service District).
8 Some goods and services will be required to operate and maintain the solar farm.
9 Errors, mishaps, and / or unforeseen events could result in a short-term or long-term stoppage in operation of the solar farm.
10 Depending on the error, mishap, and / or unforeseen event, employment may be generated (*e.g.*, cleanup of a spill, *etc.*), which could be more than that required to operate and maintain the Project.

MITIGATING MEASURES

A Data indicate that there is ample room to grow employment in the local labour market (*i.e.*, unemployment rate in the Bathurst region is often > 10 %).
B Special apprenticeship and related programs may be available to contractors that target and assist skills gaps, such as heavy equipment operators, electricians, *etc.*
C Subject to skills, availability, costs, and quality, hiring from the local workforce should be a priority for contractors to the maximum extent possible before going outside the region.
D Local labour unions may have to coordinate the amount of available workers with the various contractors to ensure there is sufficient skilled labour available.
E Mitigation measures developed for this Project should be adhered to in order to adequately address any potential impacts and to minimize the amount of time the solar farm is inoperable.

Table 30. Assessment of potential impacts on land-use of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Potential Impact	Stage II: Construction and Commissioning			Stage III: Operation and Maintenance			Stage V: Mishaps, Errors, and / or Unforeseen Events		
	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation
Traditional uses by First Nations	△	**1**	**A**	△	**1**	**A**	△	**1**	**A**
Land-use conflicts (*i.e.*, zoning)	●	**2**	**B, C**	●	**2**	**B, C**	●	**2**	**B**
Land value (*i.e.*, developed and undeveloped land)	●	**3**	**B**	●	**3**	**B**	△	**7**	**E**
Use of natural resources (*e.g.*, timber, agriculture, *etc.*)	●	**4**	**D**	●	**5, 6**	**E**	△	**7**	**E**

COMMENTS

1 There are no known traditional uses by First Nations of the land parcel.
2 Heavy industry exists on adjacent lands (*i.e.*, Fornebu Lumber Company Inc.'s framing lumber sawmill) and the land parcel proposed for the development was identified for part of a forest industry complex subdivision in 1974.
3 Improvements will be made to the land, such as installing a potable water well, an on-site septic system, levelling the site, *etc.*, which will also increase the annual tax levy on the property.
4 The standing timber on the site is likely at an age that it can be harvested. There are no known valuable extractable mineral resources on the site.
5 Use of the site will be altered during the operation and maintenance of the solar farm, but the site will still be used to harvest natural resources (*i.e.*, solar energy versus timber). Any valuable extractable minerals that are present at the site would still be available in the long-term.
6 The forest road that extends on the proposed site from NB Route 430 and on to lands further south could be severed by the perimeter fence causing another access road to lands further south to be developed.
7 In the event of a major mishap, error, and / or unforeseen event, there may be impacts to land-use that could create conflicts, affect land value (*e.g.*, contamination of lands, *etc.*), and / or impact use of natural resources.

MITIGATING MEASURES

A Members of the Pabineau First Nation should be consulted regarding potential traditional uses of the land and if uses are identified then appropriate mitigation measures should be established.
B The site is ideal because it allows for concentrating heavy industrial activities instead of scatterizing them.
C A vegetated buffer should be retained between the development and NB Route 430 and NB Route 360 in order to minimize views of the solar farm (*i.e.*, provide camouflage for the site).
D A woodlands contractor (*i.e.*, fuelwood and / or pulpwood contractor) should be hired to harvest the standing timber on the portion of the site the solar farm will occupy.
E Mitigation measures developed for this Project should be adhered to in order to adequately address any potential impacts and to minimize the amount of time the solar farm is inoperable.

Table 31. Assessment of potential impacts on the transportation network of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Potential Impact	Stage II: Construction and Commissioning			Stage III: Operation and Maintenance			Stage V: Mishaps, Errors, and / or Unforeseen Events		
	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation
Traffic hazards		1, 2	A to D					4	D
Damage to infrastructure		3, 4	C, D					2	B
Conflict with existing traffic		5	A to D					4	D

COMMENTS

1 There will be an increase in heavy equipment traffic along local roadways.
2 There may be an increase in traffic accidents as a result of increased traffic associated with Project construction and commissioning.
3 Damage to road surfaces (*i.e.*, potholes) and associated infrastructure (*e.g.*, bridges, *etc.*) due to wide and / or heavy loads or traffic volumes.
4 Existing infrastructure is designed to standards capable of supporting the movement of heavy equipment to and from the Project site (*e.g.*, specific load limits, turning radii, *etc.*).
5 There may be an increase in traffic volumes along local roadways.

MITIGATING MEASURES

A All Project vehicles used on local roadways should be maintained according to provincial regulations with respect to licensing, insurance, and safety inspection.
B No vehicles associated with Project work (*i.e.*, personnel vehicles, construction vehicles, heavy equipment, *etc.*) should be allowed to park along roadways; parking should only occur in safe and identified locations on the Project site.
C All Project personnel operating vehicles permitted on local roadways should obey the posted speed limits and other posted signs, such as weight restrictions.
D Any additional mitigation measures developed for this Project should be adhered to in order to adequately address any potential impacts.

Table 32. Assessment of potential impacts on aesthetics of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Potential Impact	Stage II: Construction and Commissioning			Stage III: Operation and Maintenance			Stage V: Mishaps, Errors, and / or Unforeseen Events		
	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation
Visual pollution		1	A		5, 6, 7, 8	C		12, 13	I
Light pollution (*i.e.*, light trespass, glint and glare)		2	B		9, 10	E, F, G		13	I
Local compatibility		3	C		3	H		12	I
Odour		4	D		11	D		13	I

COMMENTS

1 Truck cranes or heavy lift cranes will be required for aerial lifting and erecting of the inverters, substation, and meteorological station and may possibly be seen from distant locations.
2 For personnel safety, equipment and work areas will require lighting during low-light conditions and evening hours and that light might extend beyond the Project site, but will not likely reach any distant residential areas.
3 Clearing land and constructing a solar farm will be drastically different than the surrounding lands, which are largely undeveloped and mostly forested.
4 Construction equipment will generate odours (*e.g.*, exhausts, *etc.*) that can migrate beyond the Project site; however, the separation distance between the Project site and the nearest residential receptor (*i.e.*, located at 695 Nepisiguit Falls Road, which is about 6.8 km distant) should allow any odours to naturally dissipate.
5 The meteorological tower, which is anticipated to be 25 m tall, may be visible from NB Route 430 and NB Route 360; however, it will be no more intrusive than NB Power's transmission poles and pylons or some of the remaining tall infrastructure at Brunswick Mines.
6 The existing standing forest, which is at least 10 m tall, will conceal the solar farm from all surrounding areas.
7 The solar farm is at a higher elevation than most surrounding areas, which will help in its concealment.
8 There are no formal snowmobile trails or ATV trails that pass by the site, but there is an NB Power transmission line corridor that could be used by riders and the solar farm may draw riders to the area in order to see the unique site first-hand.
9 Permanent Project lighting could spill beyond the Project site; however, it is not expected to be seen from the nearest residential receptor.
10 Glint and glare could negatively affect aircraft flying above; however, solar panels incorporate anti-reflective coatings to eliminate glint and glare and because of this solar farms have been successfully implemented at many airports worldwide.
11 Emissions associated with operations and maintenance equipment are expected to be minimal and infrequent (*e.g.*, weekly security checks, once or twice annual landscaping, *etc.*).
12 If a major mishap, such as a forest fire on the surrounding lands occurred, there is a potential that concealment of the solar farm could be diminished; however, natural regeneration would likely limit the amount of time the solar farm is visible.
13 In the event of a major mishap, error, and / or unforeseen event, there may be short-lived impacts to aesthetics (*e.g.*, the use of additional temporary lighting, the use of additional heavy equipment, *etc.*).

MITIGATING MEASURES

A Truck cranes or heavy lift cranes should be lowered when no longer required.
B Construction lighting required for personnel safety during low-light conditions and evening hours should be confined to areas actively being worked, be downshielded, and extinguished when not in use.
C A natural / treed buffer of at least 5 m will be maintained between the perimeter security fence and the land lease boundary to help screen the solar farm.
D Heavy equipment and vehicles should be turned off when not in use and / or when practical in order to limit the amount of exhaust and associated nuisance odours that have the potential to migrate off-site.
E Permanent Project lighting should be down-shielded, directed away from nearby receptors, such as residences, and be motion-activated with short delays.
F Operations and maintenance staff should ensure that switchable non-motion-activated lights are turned off when not required for performing their duties and / or for safety reasons.
G Solar panels used for the Project will have anti-reflective coatings to limit reflection similar to or less than existing conditions.
H Cleared areas between the solar arrays should be allowed to naturally regenerate with grasses and shrubs and be monitored to ensure that regeneration occurs and where natural regeneration is unsuccessful within the first two years, revegetation should be undertaken.
I Mitigation measures developed for this Project should be adhered to in order to adequately address any potential impacts.

Table 33. Assessment of potential impacts on health and safety of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Potential Impact	Stage II: Construction and Commissioning			Stage III: Operation and Maintenance			Stage V: Mishaps, Errors, and / or Unforeseen Events		
	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation	Degree of Impact	Comment	Mitigation
Occupational and personal hazards	△	1, 2, 3	A to K	○	1, 2, 3	A to K	○	1, 2, 3, 11	A to K, O
Local airshed contamination	△	4	B, L	○	8	B, L	△	4, 11	B, L, O
Solid waste and sanitary waste generation	△	5	B	○	5	B	○	5, 11	B, O
Traffic hazards	△	6	B, M	○	6	B, M	○	6, 11	B, M, O
Electromagnetic fields	○	7	B, N	○	9, 10	B, N	○	9, 10, 11	B, N, O

COMMENTS

1 Workers may be involved in activities that will include the potential exposure to dust, noise, hazardous chemicals (*e.g.*, paints, solvents, *etc.*) excavations, and working at height.
2 Accidents could cause personal injury and infrastructure damage (*e.g.*, if back up alarms are not used, if inattentiveness occurs during operation, *etc.*).
3 The general public could be harmed if adequate precautions are not taken to keep them from accessing the Project site.
4 As noted in the Air Quality Valued Environmental Component Impact Assessment Worksheet, there is expected to be a moderate, though localized, impact on air quality during construction and / or mishaps, errors, and / or unforeseen events as a result of increased operation of heavy equipment emitting pollutants to the airshed.
5 Sanitary and solid wastes generated during Project construction and operation and maintenance activities will be handled appropriately (*e.g.*, sanitary waste will be collected and disposed of using a licensed wastewater hauler and / or via an on-site septic system, approved construction debris will be sent to the Red Pine Station Waste Management Facility, *etc.*).
6 As noted in the Transportation Network Valued Environmental Component Impact Assessment Worksheet, there is expected to be a minimal increase in potential traffic hazards throughout all Project Phases, but it will be greater during construction.
7 The Project will not be energized until construction is complete and the commissioning portion of the work is only expected to take a few weeks so exposure to electromagnetic fields will be minimal during this Project Phase.
8 As noted in the Air Quality Valued Environmental Component Impact Assessment Worksheet, there is expected to be little impact on air quality during the operation and maintenance Phase of the Project.
9 The strength of electromagnetic fields around the Project site are expected to be much less than those humans are normally exposed to daily and considerably less than the electromagnetic field limit identified as being potentially adverse to public health.
10 There is considerable separation distance between the solar farm and the nearest residential receptor (*i.e.*, > 6.8 km), which will cause any electromagnetic fields generated by the solar farm to be negligible.
11 All mishaps, errors, and / or unforeseen events by their nature pose potential impacts to health and safety of Project personnel.

MITIGATING MEASURES

A All Project personnel should make occupational health and safety and public health and safety a primary objective in all their activities related to the Project.
B All Project personnel should be instructed on what personal protective equipment is required to be worn, what guards should be in place, what measures should be taken to protect other workers and the general public, and how rules and regulations with respect to the environment, roadways, and equipment should be strictly adhered to, with no exceptions.
C All Project personnel should be adequately trained to do their job so that they conform to the occupational health and safety standards and public health and safety standards.
D The Proponent should ensure that occupational health and safety standards and general public health and safety standards are part of the Project working environment and should ensure that Project personnel have available appropriate personal protective equipment to wear for the tasks they are performing.
E All hazardous materials (*e.g.*, paints, solvents, *etc.*) should be labelled appropriately and stored as per the manufacturer's recommendations.
F Project personnel working with hazardous chemicals should be trained appropriately for their safe use, handling, and storage, they should be provided with the appropriate personal protective equipment for their safe use, handling, and storage, and they should have access to the Material Safety Data Sheet information.
G Project personnel working at heights should be trained appropriately for working at heights and should be provided with the appropriate personal protective equipment for working at heights.
H Project personnel should immediately report any serious accident that results in lost time or property damage and those reports should be submitted promptly by the Proponent to the appropriate regulatory authority.
I A perimeter security fence should be erected to protect against non-authorized persons circulating within the Project site, additional security fences should be erected around the inverters and substation, and appropriate signage should be erected on the fences (*e.g.*, no trespassing, high-voltage, *etc.*) at regular intervals along the security fences to warn the general public of potential risks from entering the Project site.
J Electrical work should only be completed by trained and certified / licensed professionals.
K The electrical systems of the solar farm should not be energized until construction is complete and the facility is ready to be commissioned.
L Mitigation measures noted in the assessment of the Air Quality Valued Environmental Component should be implemented and followed.
M Mitigation measures noted in the assessment of the Transportation Network Valued Environmental Component should be implemented and followed.
N Electrical wires should be buried, where possible, and electrical components like the inverters and substation should be enclosed in shelters, where possible, to limit electromagnetic fields.
O Emergency response and contingency plans should be designed to prevent any major and / or sustained environmental damage.

4.3.5 Summary of Potential Environmental Impacts

Overall, this Project aids NB Power in attaining its renewable portfolio standard obligations with locally-sourced simple and safe renewable energy and assists the Province of New Brunswick with transitioning to a low-carbon economy. Solar panels produce electricity with no air or water pollution, no GHG emissions, nor the use of finite fossil fuels.

As described above, 10 VECs were assessed for potential impacts to the environment by the proposed Project. An overall VEC impact assessment summary is provided in Table 34. The results indicate that in many instances, there are minimal or positive impacts anticipated as a result of this Project.

Table 34. Summary of the potential impacts for the proposed Violet Solar Farm in Brunswick Mills, New Brunswick on selected valued environmental components.

VEC	Number of Lights For Stage II / III / V				Overall VEC Impact Assessment*
	Green	Yellow	Red	No Change	
PHYSIO-CHEMICAL ENVIRONMENT					
Air quality	0 / 6 / 0	5 / 0 / 5	0 / 0 / 0	1 / 0 / 1	
Sound emissions	4 / 3 / 4	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	
Surface water quantity and quality	0 / 3 / 0	3 / 0 / 3	0 / 0 / 0	0 / 0 / 0	
Groundwater quantity and quality	1 / 2 / 0	1 / 0 / 2	0 / 0 / 0	2 / 2 / 2	
BIOLOGICAL ENVIRONMENT					
Terrestrial flora and fauna	0 / 5 / 0	5 / 0 / 5	0 / 0 / 0	1 / 1 / 1	
SOCIO-ECONOMIC ENVIRONMENT					
Labour and economy	4 / 3 / 4	0 / 0 / 0	0 / 0 / 0	0 / 1 / 0	
Land-use	3 / 3 / 1	1 / 1 / 3	0 / 0 / 0	0 / 0 / 0	
Transportation network	3 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 3 / 3	
Aesthetics	0 / 1 / 0	4 / 3 / 4	0 / 0 / 0	0 / 0 / 0	
Health and safety	1 / 5 / 4	4 / 0 / 1	0 / 0 / 0	0 / 0 / 0	
TOTALS	60	50	0	18	

NOTES: *No change lights are excluded from the determination of the overall VEC impact; the coloured light that received the greatest number of assignments in the environmental assessment determines the ultimate VEC impact

All told, 128 specific possible impacts were assessed (Table 34). Of those, 14 % (*n* = 18) yielded no change lights. As an ultimate overall VEC potential impact assessment (*i.e.*, based on the summation of all possible impacts for the 10 VECs), the proposed Project is expected to have little to no impact on the environment, especially in light of the mitigation measures developed. The ultimate VEC yielded a green light. **Therefore, the Project should proceed as detailed within this EIA document.**

4.4 POTENTIAL ENVIRONMENT IMPACTS ON THE PROJECT

As part of the NBDELG's EIA process, the environment's impact on a project should also e assessed (*e.g.*, seasonal flooding and extreme events, such as maximum precipitation, wind, and climate change scenarios, which may be pertinent to long-term facilities). No government agency provides specific guidance on how to properly assess the impacts of the environment on a project, but instead it is left up to the proponent. Several impacts of the environment on the proposed Project are considered here including: temperature; precipitation; floods; wind; erosion; forest fires; and seismic events. One particular theme of interest in assessing the impact of the environment on a project is climate change.

4.4.1 Notes on Climate Change

The international scientific community generally agrees that climate change is occurring and that the impacts are currently being felt globally [*GC*, 2004]. Since the 1950s, observations have been made with regards to the warming of the atmosphere, the warming of the ocean, the decrease in the amounts and duration of snow and ice cover, the increase in sea level, and the increased concentrations of greenhouse gasses present in the atmosphere. Changes observed in recent years are unprecedented when compared with historical data over similar timeframes in the past [*IPCC*, 2013]. For example, the period between 1983 and 2012 in the northern hemisphere was likely the warmest 20 year period of the last 1 400 years [*IPCC*, 2013]. As the phenomena of climate change continues, the effects are predicted to increase at an accelerating rate.

The Intergovernmental Panel on Climate Change (IPCC), through climate modeling scenarios, estimates that mean global temperatures are likely to increase 1.1 °C to 6.4 °C during the twenty-first century [*IPCC*, 2013], depending on the GHG emission scenario used. Warming is anticipated to be most prominent over land and at high northern latitudes [*IPCC*, 2013], which means that Canada, because it is a high latitude country, is expected to have more pronounced warming [*Bruce et al.*, 2000]. Although temperatures are predicted to increase over time, seasonal variations are still expected. According to the *IPCC* [2013], recent climate warming has already shown to have had an effect on terrestrial biological systems such as the timing of spring events (*e.g.*, bird migration and egg laying, leaf unfolding, and northern shifts in the habitable ranges of various flora and fauna, *etc.*).

The rate of sea level rise since the mid-nineteenth century has been larger than the mean rate during the previous two millennia. Sea levels increased by 0.17 m to 0.21 m between 1901 and 2010 and a 0.26 m to 0.82 m increase in global mean sea level is predicted by the year 2100 [*IPCC*, 2013]. Rising sea levels and the increased rate in change can be attributed to thermal expansion resulting from an increase in ocean temperatures and a loss of frozen ice mass from glaciers and ice sheets [*IPCC*, 2013]. Water levels along the southeastern coast of New Brunswick could increase by 50 cm to 70 cm by the end of this century [*Parkes et. al.*, 2006].

Climate changes will not be homogenous, but instead vary regionally. In Atlantic Canada, inland areas may be subject to drier summers where increased evaporation of water may exceed increased precipitation. Coastal regions may be subjected to frequent flooding caused by a rising sea level coupled with an anticipated increase of high intensity weather systems [*Vasseur and Catto*, 2008]. *Zweirs and Kharn* [1998] speculate that the most acute effects under a changing climate may be the increased intensity and frequency of extreme events, and in particular precipitation events.

Bruce et al. [2000] predict climate changes for Atlantic Canada if a doubled CO_2 atmosphere is attained by 2050. Under a doubled CO_2 atmosphere summer temperatures are likely to be 4 °C warmer than current, while winter temperatures may increase by about 6 °C. *Vasseur and Catto*, [2008] estimate that Atlantic Canada temperatures will increase by 2 °C to 4 °C in the summer and 1.5 °C to 6 °C in the winter by 2050. In Charlo, the nearest New Brunswick modelled location, the maximum and minimum temperatures are expected to increase by 2.9 °C to 3.9 °C and 2.1 °C to 3.1 °C, respectively [*Lines et. al.*, 2006].

Precipitation amounts under a doubled CO_2 atmosphere may increase by 20 % in the winter, and although unpredictable, summer precipitation amounts are also expected to increase. Studies by *Lewis* [1997] show that precipitation in Atlantic Canada between 1948 and 1995 increased by about 10 % [*Vasseur and Catto*, 2008]. Predictions by *Lines et. al.*, [2006] suggest that by 2080, precipitation for Saint John could increase by as much as 12 % in the winter and 35 % in the summer. Extreme precipitation events are expected, according to *Zweirs and Kharn* [1998], to increase and may result in decreasing return periods by half (*e.g.*, a 100 year event will become a 50 year event under a doubled CO_2 environment).

The following guidance is offered by the *Canadian Environmental Assessment Agency* [2003] for assessing climate change:

> *The objective [of the guidance document] is to help practitioners assess, reduce, and manage the adverse impacts that climate change may have on projects and ensure that these impacts will not pose a risk to the public or the environment. The consideration of climate change impacts on a project is a component of the standard EA practice of considering possible changes to a project caused by the environment. The consideration of climate change impacts in EA should reflect regional variations in climate and environment, and jurisdictional practices.*

Design engineers and architects generally follow specific guidelines with respect to design criteria. Those design criteria consider the environmental effects of climate change and the potential cumulative effects on the structures (*e.g.*, increased streamflow through a culvert, increased snow loads on a roof, *etc.*). Engineers will account for impacts of climate change on the proposed solar farm in their design. Mitigation of potential effects of the environment on the proposed Project are also inherent in the planning (*i.e.*, the EIA document), construction (*e.g.*, environmental protection / management plans), and planned operation of the Project (*e.g.*, capture and handling of surface water runoff).

The information contained in this section of the document provides information on how the environment will affect the Project. A considerable adverse effect of the environment on the proposed development is considered one that would result in:

- a long-term interruption in schedule (*i.e.*, a construction season) or in service (*i.e.*, several days);
- damage to infrastructure that is not economically feasible to repair (*i.e.*, > 150 % of the total original cost); and / or
- causes a considerable negative effect on an established VEC for the Project as per the criteria established for that VEC.

Many planning, designing, and construction strategies are available to minimize the potential effects of the environment on the Project so that risk of serious damage to infrastructure, human health, or interruption of service can be reduced to acceptable levels. The National Codes of Canada, which will be strictly adhered to for this Project, identify many codes and standards that address environmental considerations during all aspects of a project.

The scope of the assessment of the environment on the Project is limited by spatial and temporal boundaries. Analysis is done only for inside the Project boundaries. All seasons were analyzed. Consideration was given to construction, operation, maintenance, and errors, mishaps, and / or unforeseen events.

4.4.2 Notes on Extreme Weather

The frequency and severity of extreme weather is on the rise globally (Figure 72) and it appears to be a product of climate change [*Carey*, 2012]. The number of extraordinary severe floods, storms, and other weather related events that have occurred during the previous few decades seems to suggest that extreme weather events are becoming more common [*Francis and Hengeveld*, 1998]. Over the past few decades in Atlantic Canada, the most costly extreme weather events have been hurricanes [*ICLR*, 2012].

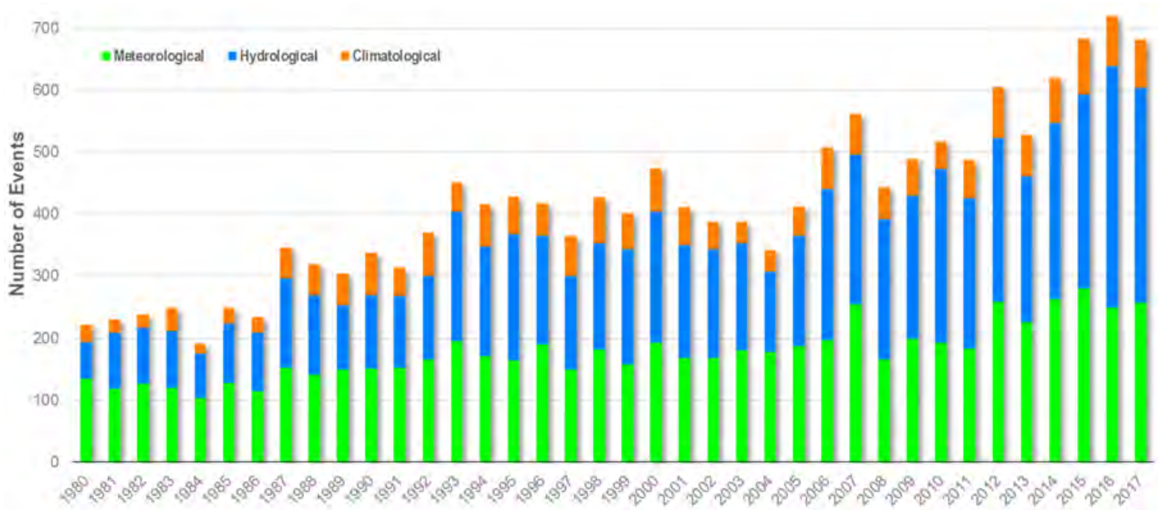


Figure 72. Global natural loss extreme weather related events between 1980 and 2017 with at least one fatality and / or produced normalized losses over the threshold assigned by the World Bank [*NatCatSERVICE*, 2018].

Public Safety Canada (PSC) maintains the Canadian Disaster Database (CDD). The CDD contains detailed disaster information for 84 natural disasters that have occurred in New Brunswick since 1900. About 45 % of those natural disasters have occurred in the past 25 years. The events are broken down as shown in Figure 73. The most costly event on record was the 1998 Ice Storm (*n.b.*, the event extended across Ontario, Quebec, and Atlantic Canada).

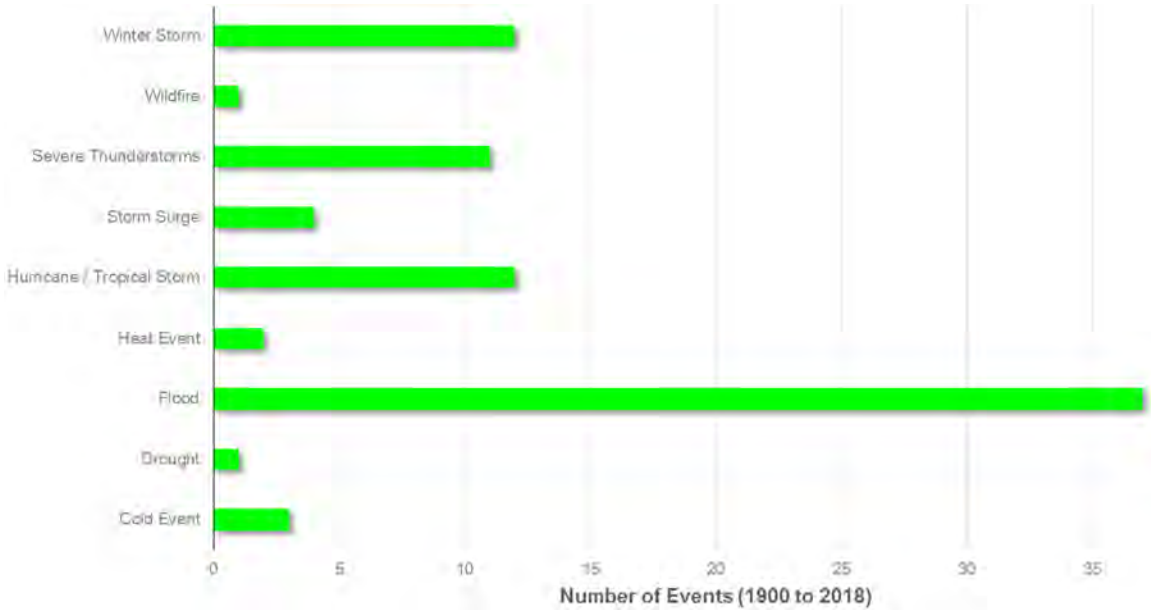


Figure 73. Characterization of the 83 natural disasters for New Brunswick between 1900 and 2018 as recorded in the Canadian Disaster Database [*PSC*, 2018].

4.4.3 Precipitation

Occasionally, tropical storms and hurricanes pass through the region bringing with them extreme precipitation. Heavy bursts of rain during thunderstorms are typically short-lived and occur on an infrequent basis in the Bathurst region. Heavy snowfalls are common in New Brunswick, but they do not typically cause any considerable impacts. As noted above, climate change is expected to increase the amount of annual precipitation in the Bathurst region. Increased temperatures from a changing climate could increase the frequency and intensity of thunderstorms.

In Atlantic Canada, increased precipitation in the winter, coupled with expected elevated temperatures, may result in the increased frequency of rain on snow events resulting in larger volumes of precipitation being discharged as runoff and a smaller percentage of precipitation infiltrating the surface and recharging groundwater systems [*Vasseur and Catto*, 2008]. This phenomenon also increases the risk of flooding due to the reduced lag time associated with runoff entering watercourses verses groundwater infiltrating watercourses after precipitation events. Contamination of flood waters may pose further damage to the environment, should they come into contact with sewage, domestic or industrial waste, or agricultural pesticides and fertilizers [*Vasseur and Catto*, 2008].

Design engineers will use appropriate codes and standards for planning the Project, which has an estimated operational lifespan of 25 years. Best design practices dictate that those professionals consider a changing climate, which is being completed for this Project.

The following is a list of concerns associated with increased precipitation events that could result under a changing climate:

- unsafe work conditions;
- unsafe travel conditions;

- increased overland flow;
- increased erosion;
- localized flooding;
- increased insurance costs; and
- increased stress and strain on structures (*e.g.*, snow loads).

Because potential impacts are being planned for in the design, considerable impacts are not expected to occur; however, the mitigation measures provided below should be followed to reduce the likelihood of impacts being realized.

- Work should be halted when extreme precipitation causes unsafe working conditions (*i.e.,* > 50 mm events).
- Workers should use their own discretion for safety concerns when travelling to and from the site during unfavourable weather conditions (*i.e.*, extreme rainfall events or snowstorms).
- As much as practicable, the Proponent should retain or develop green spaced in order to mitigate localized flooding.
- A surface water management plan, which includes an erosion and sedimentation control plan during construction, should be developed for the Project site.
- Structures that could be impacted by overland flow and / or flooding, should be located well above ground-level.
- Structural engineers should account for increased snow loads in their design to accommodate increased potential snow loads under a changing climate.

4.4.4 Winds

Winds are weaker at the ground surface compared to higher up in the atmosphere because of increased resistance afforded by vegetation and structures [*Henry and Heinke*, 1996; *Lutgens and Tarbuck*, 2001]. No predictions that the authors are aware of have been made with respect to wind directions and speeds under a changing climate; however, it is likely that winds could increase / decrease in speed as a result of changing temperature patterns. The following is a list of concerns related to wind:

- increased stress and strain on structures; and
- blowing and drifting snow;

Below are mitigation measures offered for changing winds.

- Structural engineers should account for increased wind stress and strain in their design to accommodate increased potential snow loads under a changing climate.
- Although the Project site is large and wide open, the placement of panels on racking tables well above the ground should reduce snow drifting on to the panels.
- A treed buffer strip retained adjacent to the perimeter security fence should create a wind break at the edge of the development.

4.4.5 Wet and Dry Acid Deposition

An estimated 21 % to 75 % of Atlantic Canada's landmass receives an amount of acid deposition that exceeds critical loads where adverse environmental effects are evident [*Meteorological Service of Canada*, 2004]. Fossil fuel combustion in power generating plants, smelting operations, petroleum refining, and motor vehicles produce large quantities of sulfur and nitrogen oxides that are emitted to the atmosphere [*Sawyer et al.*, 1994; *Craig et al.*, 1996]. Those oxides (*i.e.*, acid gases) are often emitted through tall stacks that introduce the pollutants to areas of the atmosphere where there are stronger and more persistent winds [*Lutgens and Tarbuck*, 2001]. This helps reduce local pollution, but through the process of long-range transport it can aggravate downwind regional pollution problems [*Langmuir*, 1997].

Once in the atmosphere, those acid gas emissions can be scavenged by water droplets and fall to the earth's surface as acid precipitation (*i.e.*, having a pH < 5.0 and in the form of dew, drizzle, fog, sleet, snow, and rain) in the form of sulfuric and nitric acid [*Murphy and Nance*, 1998]. Dry deposition (*i.e.*, particulates, gases, and aerosols) can also occur and once on the ground surface those deposits can be entrained by water to also form acids [*Henry and Heinke*, 1996].

Wet and dry deposition of acids can be problematic in New Brunswick. That is because fallout from the heavy industrialized areas of Michigan, Indiana, Ohio, western Pennsylvania, and southern Ontario and Quebec generally occurs in the region. Those emissions can wreak havoc on the region's environment. Because the deposition is sourced from far away, there is little that can be done locally to curb the potential impacts. Instead, design and mitigation measures must be developed to account for the potential impacts.

In October 1998, federal, provincial, and territorial Energy and Environment Ministers signed *The Canada-Wide Acid Rain Strategy for Post 2000* [*CCME*, 2006]. Part of that strategy called for reducing domestic acidifying emissions in New Brunswick. In that vein, emissions caps and stack emissions limits were introduced for existing facilities. Air emissions from new major sources became regulated through the issuance of ATOs under the *Clean Air Act*. A facility's ATO stipulates emissions limits and conditions under which reporting is required. Similar programs to New Brunswick's have been applied to emissions in other Atlantic provinces. Overall, implementation of those programs has yielded a reduction in emissions (Figure 74) and the subsequent decline in the production of sulfuric and nitric acid formation from those pollutants; however, progress can still be made.

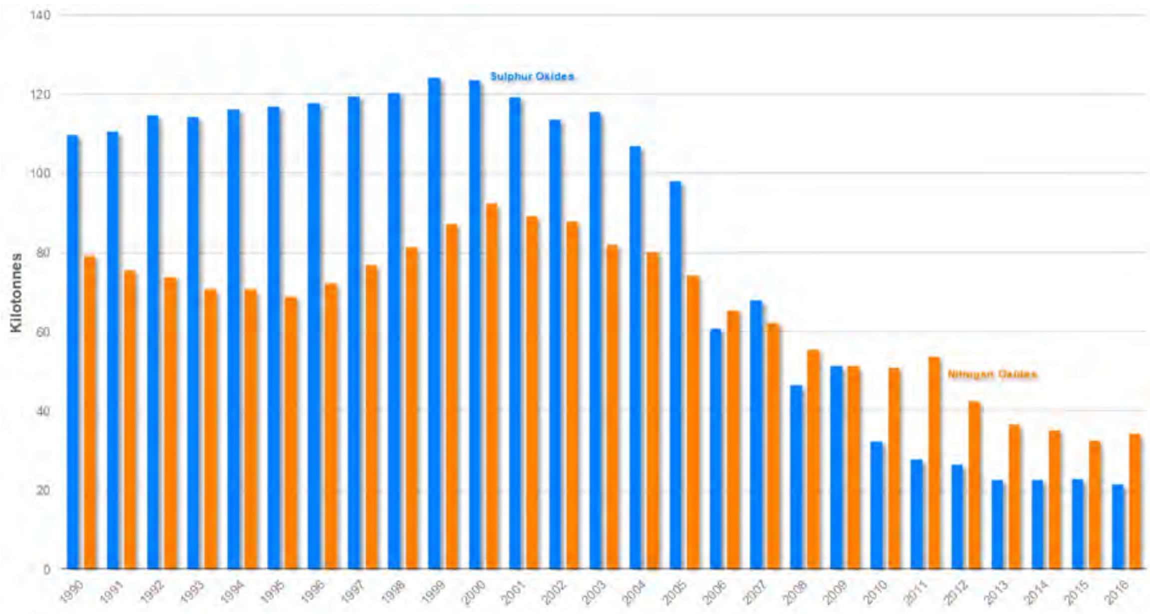


Figure 74. Historical sulphur oxide and nitrous oxide emissions for New Brunswick as reported by the *ECCC* [2018].

It is possible that wet and dry acid deposition will have an impact on the proposed Project. Although it is likely that some structures (*e.g.*, concrete foundations, etching on the glass surface of the panels, *etc*.) will be affected, the damage is expected to be minimal or occur in a manner that is not mechanically or operationally destructive to the structure during its expected lifetime. Climate change could have a negative impact on the amount of acid precipitation contacting the Project. For example, predicted increases in precipitation could yield more wet acid deposition leading to increased destruction to the facilities. Therefore, it is important that design professionals use sound engineering practices to provide mitigation and ensure that those concerns are addressed.

4.4.6 Forest Fires

Forests cover almost 85 % (61 000 km^2) of New Brunswick [*New Brunswick Forest Products Association*, 2014] and more than 7 million hectares of forested lands are managed throughout the Province. Forest fires set by lightning strikes and people are a major threat to the management of New Brunswick's forests [*Bates et al.*, 1957]. For example, the Great Miramichi Fire in October 1825 destroyed more than 19 300 km^2 of forest [*Morison*, 1938; *Brown*, 1950] and the Kedgwick Fires in June 1919 destroyed 25.9 km^2 of forest [*Prince*, 1919]. Between 1998 and 2016, there were about 261 ± 88 forest fires annually (Figure 75), destroying approximately 3.45 km^2 ± 2.69 km^2 of forest each year [*NBDNR* and *NBDERD* Annual Reports].

Because forest fires are somewhat of a common occurrence in New Brunswick, there is potential for one to affect the construction and / or operation of the Violet Solar Farm. The Forest Fire Management Section of the New Brunswick Department of Energy and Resources Development (NBDERD) is tasked with protecting provincial forest resources and personal property from fire. That group forecasts and tracks fire weather at 28 stations across the province according to the Canadian Forest Fire Weather Index System. If a forest fire occurred, they have at their disposal ground attack and air attack units, which drastically aid in knocking down the fire and preventing its spread. Those resources would be available should a forest fire occur near the solar facility at any time, thereby considerably reducing the magnitude and extent of a forest fire on the Project.

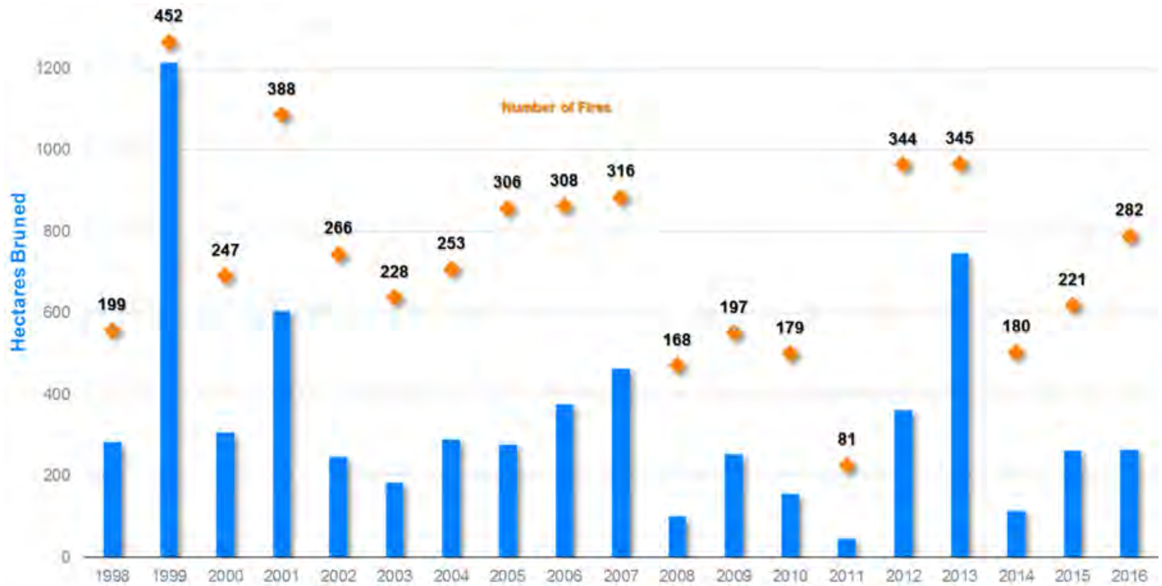


Figure 75. Annual New Brunswick forest area burned and number of fires as reported by the *NBDNR* and *NBDERD* [Annual Reports].

Increased incidence of forest fires under a changing climate may be realized due to warmer temperatures, drier conditions, higher winds, *etc*. The occurrence of forest fire activity is anticipated to increase 25 % by 2030 in Canada [*ICLR*, 2012]. Setting the solar arrays back from the perimeter security fence and having the panels on racking tables above the ground should limit the threat of all but the largest of forest fires. The site is easily accessible from roadways and is not very remote. The Fornebu Lumber Company Inc.'s framing lumber sawmill has round-the-clock security, so if a fire were to break out in the local area, it would likely be quickly noticed and called in for response. Therefore, it is not likely that a forest fire will have a considerable effect on the proposed Project.

4.4.7 Seismic Activity

New Brunswick lies within the northeastern corner of the Northern Appalachians seismic zone (NAP; Figure 76). According to the *Geological Survey of Canada* [2014], approximately 330 earthquakes greater than magnitude (M) 2.5 occurred within the NAP between 1764 and 2001 (*n.b.*, pre-1960s, the M was estimated based on newspaper articles and historical documents while post-1960s, Earthquakes Canada's seismograph network has been used to detect earthquakes whose M > 2.5). On average, approximately three events greater than an M 5 occur each decade (*i.e.*, those earthquakes that are potentially damaging to structures).

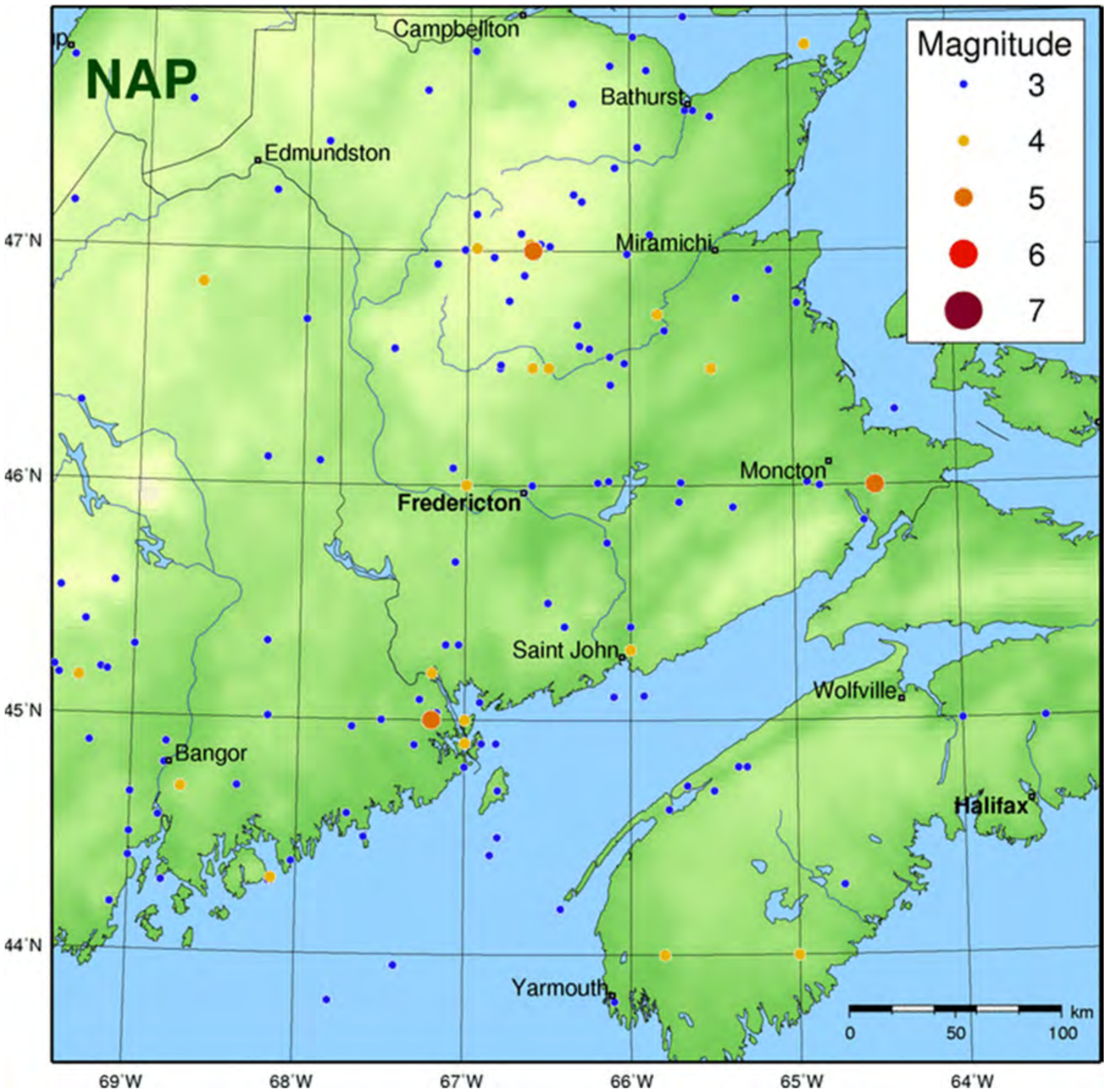


Figure 76. Map showing the Northern Appalachian Seismic Zone (NAP) from Geological Survey of Canada [2016].

Burke [1984] noted that the epicentres of recent earthquakes in the NAP coincide with larger historical earthquakes; those regions that were lively in the past remain active today. The New Brunswick earthquake records show a clustering of earthquake epicentres in three sub-zones: Passamaquoddy Bay (PB); Central Highlands (CH); and MOncton (MO) [*Burke*, 2004]. *Halchuk et al.* [2004] calculated the maximum likelihood probability estimates for the three subzones with respect to the entire NAN. Activity rates were higher by a factor of two for the CH, higher by a factor of two to three for PB, and lower by a factor of 0.5 for MO (*n.b.*, MO was identified by *Burke* [1984] as a sub-zone because an earthquake with an M > 5 was recorded there). The intraplate earthquakes in those three sub-zones are thought to be a result of either old fault line reactivation, the concentration of stress at pluton boundaries, or glaciostatic movements.

Significant Canadian earthquakes for the period 1600 to 2006 were catalouged by *Lamontagne et al.* [2007]. Of the 160 significant events, seven occurred within the NAP

(Table 35). The largest historically reported event for the NAP struck the PB sub-zone on 21 March 1904. Foreshocks and aftershocks accompanied that earthquake, which reportedly caused minor building damage (*e.g.*, throwing of chimneys) and was felt throughout the Maritimes [*Burke*, 2013]. The 9 January 1982 Miramichi earthquake, which produced two sizeable aftershocks (*i.e.*, an M 5.1 and an M 5.4, respectively, 3.5 hours and 2.5 days after the mainshock), was the most recent significant event and was also the most comprehensively studied in the NAP [*Broster and Burke*, 2011].

Table 35. Significant earthquakes recorded in New Brunswick between 1600 and 2006 as reported by *Lamontagne et al.* [2007].

Date	Sub-Zone*	Latitude (° N)	Longitude (° W)	Magnitude	Magnitude Type†
22 May 1817	PB	45.0	67.2	4.8	m_N
8 February 1855	MO	46.0	64.5	5.2	m_N
22 October 1869	CH	46.5	66.5	5.7	M_f (IV)
21 March 1904	PB	45.0	67.2	5.9	M_f (IV)
22 July 1922	CH	46.5	66.6	4.9	M_{FA}
30 September 1937	CH	47.4	66.3	4.8	M_{FA}
9 January 1982	CH	47.0	66.6	5.8	m_N

NOTES:
*PB = Passamaquoddy Bay, MO = MOncton, and CH = Caledonia Highlands
†m_N = Nuttli or body wave magnitude, M_{FA} = felt area magnitude, and M_f (IV) = magnitude based on the Modified Mercalli Intensity IV area

Seismic threat studies for the NAP place most of New Brunswick in the moderate hazard range [*Burke*, 1984 and *Broster and Burke*, 2011]. When significant earthquakes strike, they can cause minor damage to buildings and some effects on natural features (*e.g.*, floods from embankment failure, alteration to flow of rivers and springs, mass movements, tsunami along coasts, seiches in lakes, ground disturbance, *etc.*).

The Brunswick Mills region is not considered to be within a defined active seismic zone. Statistics indicate that all of the recent earthquakes in the region have resulted in little significant damage (*i.e.*, no considerable damage to structures). There is no evidence in the region to support any surface displacement in recent geologic time. It is likely that recent earthquakes in the region were a result of deep geological activity rather than shallow surface fault systems. Potential for disturbance and seismic activity within the region is considered low.

Standards dictate that all structures be designed and built to withstand earthquakes in the area (*i.e.*, based on the probability of specific magnitude earthquakes within a specific return period). Those criteria ensure the integrity of the structure based on the level of earthquake risk in the area. If a minor earthquake were to occur in the area, construction on and / or operation of the solar facility could be moderately affected. It is unlikely that a minor earthquake would cause extensive damage to Project structures. In the event of an extreme earthquake, the solar facility could receive damage such that it would not be economically feasible to repair; however, this is an unlikely event. An earthquake in between minor and extreme could cause moderate damage to Project structures, but it is likely that they could be repaired.

The Geological Survey of Canada regularly updates seismic hazard maps for Canada. The most recent edition of those maps was produced for the 2015 National Building Code Canada (NBCC; Figure 77). To determine the 2015 NBCC seismic hazard values at Brunswick Mills, Natural Resources Canada's seismic hazard calculator was used (http://www.seismescanada.rncan.gc.ca/hazard-alea/interpolat/index_2015-en.php). The ground motion probabilities are summarized in Table 6.

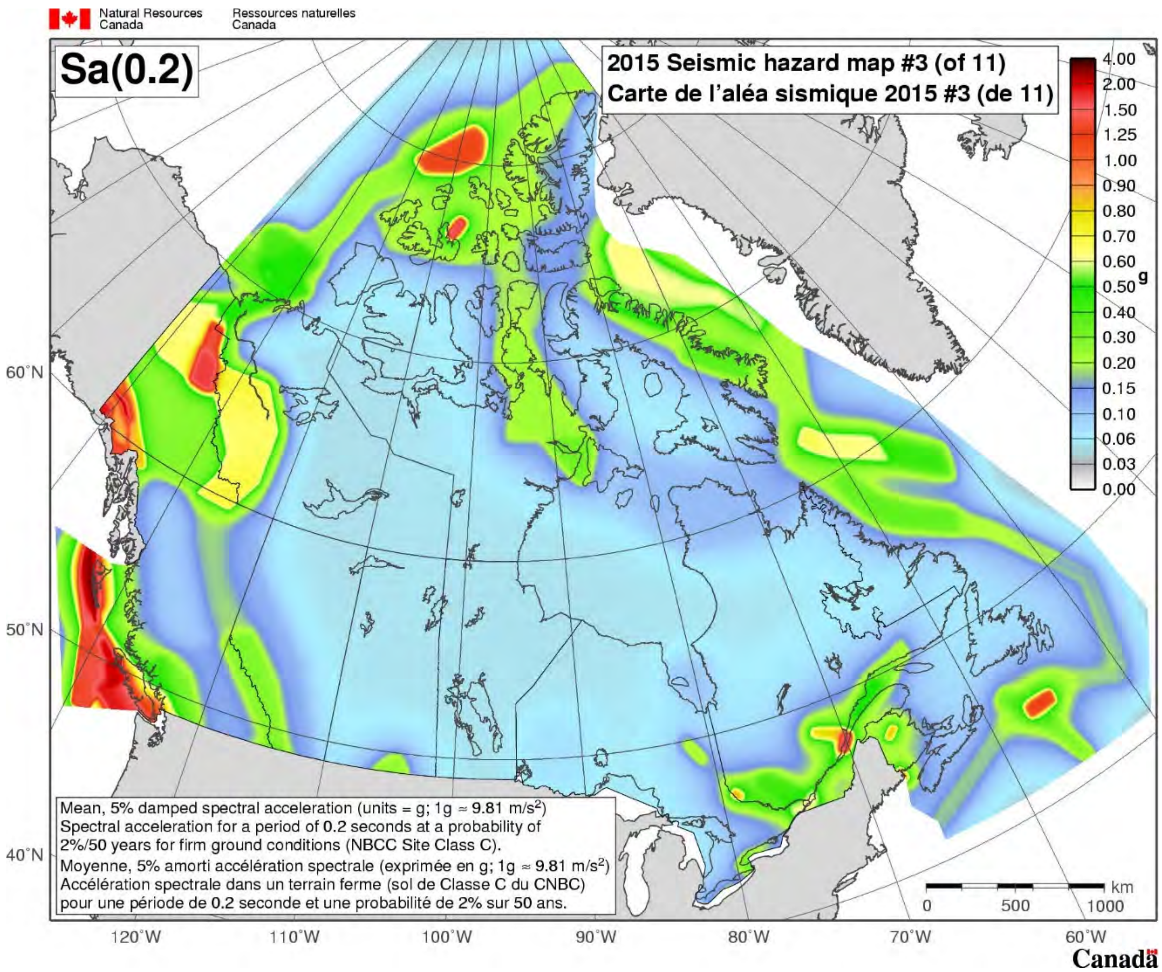


Figure 77. Spectral acceleration (Sa) for a period of 0.2 s at a probability of 2 % · 50 yr^{-1} for firm ground conditions (*i.e.*, NBCC soil class C) from *Natural Resources Canada* [2016b].

Table 36. 2015 National Building Code interpolated ground motions calculated for Brunswick Mills, New Brunswick using Natural Resources Canada's seismic hazard calculator.

Probability of exceedance per annum	0.010	0.0021	0.001	0.000404
Probability of exceedance in 50 years	40 %	10 %	5 %	2 %
Sa(0.2 s)	0.041 g	0.107 g	0.158 g	0.248 g
Sa(0.5 s)	0.025 g	0.063 g	0.091 g	0.140 g
Sa(1.0 s)	0.013 g	0.035 g	0.050 g	0.075 g
Sa(2.0 s)	0.0053 g	0.017 g	0.025 g	0.037 g
Sa(5.0 s)	0.0011 g	0.0039 g	0.0059 g	0.0099 g
Sa(10.0 s)	0.0006 g	0.0016 g	0.0025 g	0.0038
Peak Ground Acceleration	0.023 g	0.066 g	0.100 g	0.159 g
Peak Ground Velocity	0.017 g	0.048 g	0.073 g	0.166 g

NOTES:
Spectral and peak hazard values are determined for firm ground (*NBCC* 2015 soil class C – average shear wave velocity of 450 m · s^{-1}). The values were interpolated from a 10 km spacing grid of points. More than 95 % of the interpolated values yielded by the seismic hazard calculator are within 2 % of the calculated values.

4.4.8 Summary

The Proponent will ensure design of the Project is in accordance to strict standards and codes. Through application of those criteria and implementation of the mitigation measures noted, the Project should withstand all impacts of the environment on it, even under a changing climate. Detailed mitigation strategies for potential impacts of the environment on the Project should be further discussed in the Project-specific EPP. In particular, the Project-specific EPP should ensure that there is:

- no long-term interruption in construction activities;
- no long-term interruption in scheduling of the Project;
- no long-term interruption in operation of the Project;
- no damage to infrastructure such that public health and safety are put and risk; and
- no change to infrastructure that would not be economically feasible to repair.

4.5 PROJECT-SPECIFIC ENVIRONMENTAL PROTECTION PLAN

A Project-specific environmental protection plan will be developed. The EPP will be an important component to the overall Project because it will dictate the importance of Best-Management Practices (BMPs) that shall be undertaken by all those associated with the Project to ensure environmental protection. The EPP will provide a practical means for conveying BMPs to C2 Solar for ensuring the implementation of the outlined standards and regulations throughout the entire Project. It will be a dynamic document that will be used by Project personnel in the field and at the corporate level for ensuring commitments made in the EIA are implemented and monitored.

More specifically, the purpose of the EPP will be to:

- outline C2 Solar's commitments to minimize potential Project environmental impacts, including commitments made during the regulatory review process of the EIA;
- comply with conditions and requirements of an "EIA Approval", if and when issued;
- comply with the conditions of any authorization(s), license(s), and / or permit(s) issued to complete the project;
- provide a reference document for C2 Solar and all contractor personnel to use when planning and / or conducting specific Project activities; and
- provide a summary of environmental issues and protection measures to be implemented during the Project.

The EPP will be developed in accordance with applicable federal and provincial environmental protection legislation and regulations. C2 Solar will continue to take a proactive approach toward creating a safe and secure work environment and maintain a system to manage environmental effects of the Project. They will identify health, safety, environmental, and security issues as part of the execution planning and manage the environmental effects of the Project and work in ways that are environmentally, economically, and socially justified and legally compliant. Specific health, environmental, safety, and security issues will be addressed in the execution plans and procedures for the Project.

5.0 FIRST NATION AND PUBLIC INVOLVEMENT

The NBDELG has a prescriptive process for undertaking First Nation and public involvement with respect to EIAs. This section describes the work that has been and will be done to involve First Nations, the public, and stakeholders in the EIA process. It identifies the meetings that have been held and who was consulted.

First Nation and public involvement is an important component of the Project. C2 Solar's goal is to notify and inform the right-holders, the public, and stakeholders about the Project. As such, the public consultation plan is designed to inform and engage all the right-holders and all stakeholder groups about the Project in order to encourage participation and gather feedback from all interested parties, including questions and concerns about the Project. The overall goal is to ensure that those potentially affected by the Project are aware of the Project, able to obtain additional information and able to express any concerns they may have. The goal of the consultation process is to gather input, identify potential issues, and ensure understanding of the Project among stakeholder groups.

On-going First Nation, public, and stakeholder involvement will occur throughout the regulatory review process to collect feedback and enhance the Project's development.

5.1 PARTIES TO INCLUDE

5.1.1 First Nations

The Project site is located within the traditional Mi'kmaq territory of Gespegeoag (Figure 50). It is also relatively close to the Pabineau First Nation. Section 35 of the *Constitution Act, 1982* "recognizes and affirms" the "existing" Aboriginal and treaty rights in Canada and the duty to consult. In New Brunswick, First Nation communities are right-holders as opposed to stakeholders. As such, they require engagement.

Engagement with New Brunswick's First Nations communities must be done both early and often to ensure a true partnership or accession from them. Although the provincial government will consult with First Nation communities during the EIA review process, C2 Solar must also engage with them.

To begin the engagement process, members of the First Nations will be contacted as per the New Brunswick Aboriginal Affairs Secretariat protocol. Since 1 April 2016, Mi'gmawe'l Tplu'taqnn Inc. (MTI) has been designated to hold the mandate of consultation and accommodation and rights implementation for its Mi'kmaq member communities. The MTI member communities include:

- Amlamgog (Fort Folly);
- Esgenoôpetitj (Burnt Church);
- L'nui Menikuk (Indian Island);
- Metepenagiag (Red Bank);
- Natoaganeg (Eel Ground);
- Tjipõgtõtjg (Bouctouche);

- Ugpi'ganjig (Eel River Bar); and
- Oinpegitjoig L'Noeigati (Pabineau).

The Elsipogtog First Nation is not a member of MTI and consults directly with the government. Each of the Chiefs of the above communities are to be sent correspondence as part of the consultation process. Table 37 lists those individuals who will be sent formal notification of the Project registration document (*i.e.*, in the form of an information letter).

Table 37. Chiefs and Consultation Directors of New Brunswick's First Nations who will be sent information regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

First Nation	Chief	Consultation Coordinator(s)	Address
Mi'kmaq			
*Mi'gmawe'l Tplu'tagnn, Inc. Mi'gmaq members**			
Amlamgog (Fort Folly)	Rebecca Knockwood	Jesse Simon, Tanya McGraw	38 Bernard Trail, PO Box 971, Dorchester, NB, E4K 3V5
Esgenoôpetitj (Burnt Church)	Alvery Paul	Jesse Simon, Tanya McGraw	620 Bayview Drive, Burnt Church, NB, E9G 2A8
L'nui Menikuk (Indian Island)	Kenneth Barlow	Jesse Simon, Tanya McGraw	61 Island Drive, Indian Island, NB, E4W 1S9
Metepenagiag (Red Bank)	William (Bill) Ward	Jesse Simon, Tanya McGraw	PO Box 293, Metepenagiag Mi'kmaq Nation, NB, E9E 2P2
Natoaganeg (Eel Ground)	George Ginnish	Jesse Simon, Tanya McGraw	47 Church Road, Eel Ground, NB, E1V 4E6
Tjipõgtõtjg (Bouctouche)	Ann Mary Steele	Jesse Simon, Tanya McGraw	9 Reserve Road, Bouctouche, NB, E4S 4G2
Ugpi'ganjig (Eel River Bar)	Thomas (Everett) Martin	Jesse Simon, Tanya McGraw	11 Main Street, Unit 201, Eel River Bar, NB, E8C 1A1
Oinpegitjoig L'Noeigati (Pabineau)	David Peter-Paul	Jesse Simon, Tanya McGraw	1290 Pabineau Falls Road, Pabineau First Nation, NB, E2A 7M3
Indpendent Mi'gmaq			
Elsipogtog	Arren Sock	Kenneth Francis	Kopit Lodge, 33 Riverside Drive, Elsipogtog, NB, E4W 2Y6

NOTES:
*When corresponding with MTI member Chiefs, carbon copy Jesse Simon, Executive Director of MTI, and Tanya McGraw, Administration and Office Assistant at MTI; PO Box 296, Station A, Fredericton, NB, E3B 4Y9
§When corresponding with WNNB member Chiefs, carbon copy their consultation coordinator

5.1.2 Local Residents, NGOs, and Community Groups

Fundy Engineering and C2 Solar will continue to reach out to the First Nation leaders and their community members as well as reaching out to local residents, applicable Non-Government Organizations (NGOs), community groups (*i.e.*, Bathurst Chamber of Commerce, Bathurst Sustainable Development), and local MLAs. Generally, those groups are direct conduits to the community. Relayed Project information will include:

- who is involved;
- what is the purpose of the proposed Project;

- where the proposed Project will occur;
- when the proposed Project will occur;
- why the proposed Project is being considered;
- how the proposed Project will be undertaken; and
- how questions / comments / concerns can be submitted for disposition.

5.1.3 Regulatory Agencies

The NBDELG, through the EIA regulation of the *Clean Environment Act*, has regulatory jurisdiction over this Project.

5.2 PRE-REGISTRATION CONSULTATION

5.2.1 New Brunswick Aboriginal Affairs Secretariat

A teleconference was held between representatives of the New Brunswick Aboriginal Affairs Secretariat (AAS), C2 Solar, and Fundy Engineering on 15 November 2018. The teleconference was conducted between AAS's Fredericton office and Fundy Engineering's Saint John office. The proposed Project was reviewed and discussed with respect to introducing and developing First Nations engagement and, more specifically, an introduction and meeting with Pabineau Band Council and representatives of MTI. A summary of those who participated in the teleconference is provided in Table 38.

Table 38. Teleconference participants held on 15 November 2018 regarding the proposed Violet Solar Farm in Middle River, New Brunswick.

Name	Affiliation
Mary Ann Mann	AAS, Project Executive
Sophie Jensen	AAS, Consultant
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

Another teleconference was held between representatives of AAS, C2 Solar, and Fundy Engineering on 4 December 2018. A debrief of the meeting held with the Pabineau Band Council and MTI representatives on 30 November 2018 was conducted in order to further develop First Nations engagement. A summary of those who participated in the teleconference is provided in Table 39.

Table 39. Teleconference participants held on 4 December 2018 regarding the proposed Violet Solar Farm in Middle River, New Brunswick.

Name	Affiliation
Mary Ann Mann	AAS, Project Executive
Chief David Peter-Paul	Pabineau First Nation
Terry Richardson	Pabineau First Nation, Councilor
Kristie Halka-Glazier	MTI
Karen Narvie	MTI
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

5.2.2 First Nations

Proponents are encouraged to reach out to First Nations early in the EIA process. To initiate discussions with First Nations, individual introductory letters were emailed on 19 November 2018 to the recipients noted in Table 40. The letters introduced C2 Solar, described "Project Violet", and provided contact information for C2 Solar to allow for further discussions.

Table 40. Recipients of the project description introduction letter sent via email on 19 November 2019 regarding the proposed Violet Solar Farm in Middle River, New Brunswick.

Name	Affiliation
Chief Bill Ward	Red Bank First Nation
Chief David Peter-Paul	Pabineau First Nation
Jesse Simon	Burchills Legal Counsel
Chief Kenneth Barlow	Indian Island First Nation
Chief Rebecca Knockwood	Fort Folly First Nation
Chief Arren Sock	Elsipogtog First Nation
Chief George Ginnish	Eel Ground First Nation
Chief Everett Martin	Eel River Bar First Nation
Chief Alvery Paul	Burnt Church First Nation
Chief Ann Mary Steele	Bouctouche First Nation

C2 Solar representatives had a meeting with members of Oinpegitjoig L'Noeigati prior to registering the Project for EIA review with the NBDELG. A summary of who attended the meeting, which was held on 30 November 2018 at the Pabineau Band Council office in Bathurst, is provided in Table 41. That initial meeting was conducted to introduce "Project Violet" to the Pabineau Band. First Nations engagement and potential involvement in the Project were discussed at the meeting.

Table 41. Attendees of the pre-registration consultation meeting on 30 November 2018 regarding the proposed Violet Solar Farm in Middle River, New Brunswick.

Name	Affiliation
Chief David Peter-Paul (attended via phone)	Pabineau First Nation
Terry Richardson	Pabineau Band Council
Kristie Halka-Glazier	Assistant Energy and Mines Coordinator
Marsha Somerville	Esgenoopetitj Liaison, ITK Team Lead
Karen Narvie	Eel River Bar Liaison
Cecelia Brooks (attended via phone)	Director of Indigenous Knowledge
Derek Simon (attended via phone)	Legal Counsel
Mary Ann Mann	AAS, Project Executive
Bill Meehan	Local Resident
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

On 26 and 27 February 2019, C2 Solar representatives attended the "Energizing Atlantic First Nations – Clean Energy Conference" hosted by the Atlantic Policy Congress of First Nations Secretariat in Fredericton, New Brunswick. During the conference, many informal conversations occurred regarding the Project. For example, C2 Solar representatives made introductions with Chief Rebecca Knockwood of Fort Folly First Nation.

On 28 February 2019, further discussions were held between C2 Solar representatives and the Fort Folly First Nation. This was done to provide an overview of the Project. Table 42 provides a summary of the meeting attendees.

Table 42. Attendees of the pre-registration consultation meeting on 28 February 2019 regarding the proposed Violet Solar Farm in Middle River, New Brunswick.

Name	Affiliation
Chief Rebecca Knockwood	Fort Folly First Nation
Tina Milner	Fort Folly First Nation Liaison
Tim Ryan	Fundy Engineering, Environmental Engineering Director
Tom Mann	C2 Solar First Nation Engagement

Representatives of C2 Solar met with members of the Pabineau First Nation on 22 March 2019 to review the Project and discuss collaborative opportunities. A summary of those in attendance at the meeting is provided in Table 43 below.

Table 43. Attendees of the pre-registration consultation meeting on 22 March 2019 regarding the proposed Violet Solar Farm in Middle River, New Brunswick.

Name	Affiliation
Chief David Peter-Paul	Pabineau First Nation
Tim Ryan	Fundy Engineering, Environmental Engineering Director

On 6 May 2019, C2 Solar representatives presented the Project to the larger body of MTI at the Sheraton Four Points hotel in Moncton, New Brunswick. Several First Nations Chiefs and First Nations representatives were in attendance as summarized in Table 44.

As a result of the various meetings and First Nations engagement as described above, a letter of intent between C2 Solar and Pabineau First Nation Mi'gmawe'l Tplu'Tagn Ltd. Was signed on 12 June 2019 to codify an agreement to:

- maintain and foster sustainable long-term relationships that are transparent and respectful;
- support the revitalization of the Mi'gmaq communities while encouraging greater opportunities for Mi'gmaq participation in sustainable, lawful, and respectful economic development;
- facilitate strong economic links between the Mi'gmaq communities in the region of the Project; and
- acknoweledge C2 Solar's filing of an EIA submission to the NBDELG.

A copy of the Letter of Intent is included in Appendix VIII.

Table 44. Attendees of the pre-registration consultation meeting on 6 May 2019 regarding the proposed Violet Solar Farm in Middle River, New Brunswick.

Name	Affiliation
Chief Roger Augustine	Assembly of First Nations Regional Chief
Chief Alvery Paul	Burnt Church First Nation
Chief Ken Barlow	Indian Island First Nation
Chief George Ginnish	Eel Ground First Nation
Chief Bill Ward	Red Bank First Nation
Chief David Peter-Paul	Pabineau First Nation
Chief Rebecca Knockwood	Fort Folly First Nation
Gordon LaBillois (Chief's Proxy)	Eel River First Nation
Stuart Gilby	MTI Legal Counsel
Derek Simon	MTI Legal Counsel
Jennifer Coleman	MTI Administrator
Kristie Halka-Glazier	MTI Energy Coordinator
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

C2 Solar is committed to the principles of the Relationship, Engagement, and Consultation Protocol signed by the Pabineau First Nation and Eel River Bar First Nation with MTI and the Belledune Port Authority on 31 May 2018 (see Appendix VIII).

5.2.3 New Brunswick Department of the Environment and Local Government

Prior to registering a project, the NBDELG recommends discussing it with Project Assessment Branch representatives in order to:

- obtain advice and guidance on the submission of the EIA registration document and the review process;
- obtain information with respect to the possible timing and duration of the review for the EIA document; and
- provide the NBDELG personnel with advance notice of the anticipated timing for preparation and submission of the EIA document.

On 31 March 2017, a pre-registration consultation meeting was held between representatives of the NBDELG, C2 Solar, and Fundy Engineering (Table 45). The meeting was held at the NBDELG's head office (*i.e.*, in Fredericton, New Brunswick). At that time, the project was being proposed for a collection of properties in Middle River, New Brunswick; however, because a portion of the lands were located within a protected watershed, the site was later switched to the Brunswick Mills site.

Table 45. Attendees of the pre-registration consultation meeting on 31 March 2017 regarding the proposed Violet Solar Farm in Middle River, New Brunswick.

Name	Affiliation
Sheila Goucher	NBDELG, Environment Assessment Section Project Manager
Shawn Hamilton	NBDELG, Environment Assessment Section Project Manager
Jason Bower	NBDELG, Drinking Water Source Protection Technician
Tim Ryan	Fundy Engineering, Environmental Engineering Director
Matt Alexander	Fundy Engineering, Senior Environmental Scientist

A meeting was held between representatives of the NBDELG, C2 Solar, and Fundy Engineering on 11 September 2018 at NBDELG's Fredericton head office (Table 46). The proposed Project was introduced and discussed. Reviewed during the meeting were: First Nations Engagement; an approval timeline; NBDELG Project Manager assignment; and review of the Climate Change Directorate mandate.

Table 46. Attendees of the pre-registration consultation meeting on 11 September 2018 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
David Maguire	NBDELG, Environment Assessment Section Branch Manager
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

On 4 October 2018, a pre-registration consultation meeting was again convened with representatives of the NBDELG. That meeting was held with employees at the NBDELG regional office in Saint John. The proposed Project was introduced and discussed with respect to initiatives under the New Brunswick Climate Change Secretariat and reviewed with the NBDELG Project Manager that had been assigned to the Project. A list of those who attended the meeting is provided in Table 47.

Table 47. Attendees of the pre-registration consultation meeting on 4 October 2018 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Susan Atkinson	NBDELG, Climate Change Secretariat Director
Cassandra Colwell	NBDELG, Environment Assessment Section Project Manager
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

An additional pre-registration consultation meeting was held with the NBDELG at the head office in Fredericton. In attendance at that meeting, held on 25 October 2018, were potential members of the TRC (Table 48). The proposed Project was introduced to all participants and reviewed with respect to the mandates of the individual departments.

Table 48. Attendees of the pre-registration consultation meeting on 25 October 2018 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Cassandra Colwell	NBDELG, Environment Assessment Section Project Manager
Sophie Jensen	Aboriginal Affairs Secretariat, Consultant
Mary Ann Mann	Aboriginal Affairs Secretariat, Project Executive
Brent Corey	NB Power, Generation and Planning Senior Advisor
Denis Gallant	RDC, Infrastructure and Development Director
Arielle Demerchant	NBDELG, Source and Surface Water Management Biologist
Sara Smith	NBDELG, Climate Change Secretariat Officer
Vincent Balland	NBDTI, Environmental Section Engineer
Scott King	NBDTI, Bridge Design Unit Technologist
Stephen Zwicker	ECCC, Environmental Assessment Coordinator
Paul Fournier	NBDELG, Bathurst Regional Director
Colette Lemieux	NBDERD, Planning Section Coordinator
Hubert Askanas	NBDERD, Biodiversity Section Biologist
James Dickie	NBDERD, Approvals Section Project Manager
Pascal Giasson	NBDERD, Energy Division Process Improvement Facilitator
David Swallows	NBDERD
Ben Newman	NBDERD, Crown Lands Operations Unit Manager
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

5.2.4 Stakeholders

C2 Solar undertook several pre-registration meetings with various stakeholders in order to apprise them of the potential Project. Below is a summary of those meetings.

On 5 December 2016, C2 Solar representatives met with NB Power executives in Fredericton, New Brunswick. The purpose of the meeting was to introduce the Project's concepts and siting and to gauge the interest level and support. Table 49 below lists those in attendance at the meeting.

Table 49. Attendees of the pre-registration consultation meeting on 5 December 2016 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Gatean Thomas	NB Power, President and CEO
Keith Cronkite	NB Power, Senior VP Business Development
Neil Larlee	NB Power, VP Renewables
Gord Mouland	Fundy Engineering, President
Tim Ryan	Fundy Engineering, Environmental Engineering Director

Additional meetings were held with NB Power in Fredericton on 10 April 2017 to discuss grid connection details and on 6 June 2017 to discuss to land options. Table 50 and Table 51 list the attendees of those meetings.

Table 50. Attendees of the pre-registration consultation meeting on 10 April 2017 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Neil Larlee	NB Power, VP Renewables
Brent Corey	NB Power, Generation and Planning Senior Advisor
Scott Brown	NB Power, Technical Department
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

Table 51. Attendees of the pre-registration consultation meeting on 6 June 2017 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Brad Coady	NB Power, Technical Department
Brent Corey	NB Power, Generation and Planning Senior Advisor
Scott Brown	NB Power, Technical Department
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

On 2 February 2018, C2 Solar met with a representative at RDC to review a land option license agreement, which was later signed on 6 February 2018. Table 52 lists the meeting attendees.

Table 52. Attendees of the RDC pre-registration consultation meeting on 2 February 2018 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Denis Gallant	RDC, Director of Infrastructure Development
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

Also on 2 February 2018, a meeting was held via teleconference with Renewable and Alternate Energy personnel at Emera to discuss Atlantic Link projects and Emera Inc.'s solar business.

Table 53. Attendees of the pre-registration consultation meeting on 2 February 2018 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Dan Muldoon	Emera Inc., Renewable & Alternate Energy
Wayne O'Connor	Emera Inc., VP Business Development & Strategy
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

On 22 June 2018, a pre-registration meeting was held between representatives of NB Power, C2 Solar, and Fundy Engineering (Table 54). The meeting was held at NB Power's head office in Fredericton. The proposed Project was introduced at the meeting and discussed with respect to technical and regulatory issues that could impact the overall Project.

Table 54. Attendees of the pre-registration consultation meeting on 22 June 2018 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Brad Cody	NB Power, Energy Projects Director
Brent Corey	NB Power, Generation and Planning Senior Advisor
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

An additional meeting was held with RDC on 3 August 2018. A representative with Opportunities New Brunswick was also at the meeting to discuss potential land opportunities. A list of the meeting attendees is provided in Table 55.

Table 55. Attendees of the pre-registration consultation meeting on 3 August 2018 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Denis Gallant	RDC, Director of Infrastructure Development
Rick Lloyd	Opportunities New Brunswick, Strategic Accounts Director
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

Another meeting occurred on 25 October 2018 with Brent Corey to provide a Project update and to review the draft EIA document.

A teleconference meeting was held between representatives of TransAlta, C2 Solar, and Fundy Engineering on 26 September 2018 (Table 56). The teleconference was conducted between Fundy Engineering's Saint John office TransAlta's Montreal office. The proposed Project was introduced and discussed with respect to technical issues of conceptual design, capital expenditure, and power purchase potential.

Table 56. Attendees of the pre-registration consultation meeting on 26 September 2018 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Simon Belanger	TransAlta, Project Developer
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

A meeting was convened with a representative of Saint John Energy on 26 October 2018 (Table 57). The meeting was held at Fundy Engineering's Saint John office. The proposed Project was introduced and discussed with respect to technical and regulatory issues that could impact the Project.

Table 57. Attendees of the pre-registration consultation meeting on 26 October 2018 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Ryan Mitchell	Saint John Energy, Engineering and Operations Vice President
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

On 14 November 2018, a meeting was held with Repsol personnel to introduce the Project and identify any potential opportunities. A summary of the meeting attendees is provided in Table 58.

Table 58. Attendees of the pre-registration consultation meeting on 14 November 2018 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Adolfo Azcarraga	Repsol, LNG Project Manager
Fraser Forsythe	C2 Solar
Tim Ryan	Fundy Engineering, Environmental Engineering Director

C2 Solar personnel met with an additional Emera representative on 22 November 2018. The purpose of the meeting was to provide a Project update. A list of attendees is provided in Table 59.

Table 59. Attendees of the pre-registration consultation meeting on 22 November 2018 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Rob Belliveau	Emera Inc., NB General Manager
Fraser Forsythe	C2 Solar

5.2.5 Elected Officials / Political Party Representatives

C2 Solar undertook several pre-registration meetings with various elected officials and / or political party representatives. This was done in order to apprise them of the potential Project. A summary of those meetings is provided below.

On 14 February 2019, C2 Solar representatives met with members of the New Brunswick Green Party in Fredericton. Table 60 summarizes those in attendance at the meeting.

Table 60. Attendees of the pre-registration consultation meeting on 14 February 2019 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
David Coon	NB Green Party, Leader
Amanda Wildeman	NB Green Party, Chief of Staff
Fraser Forsythe	C2 Solar

Representatives of C2 Solar met with members of the New Brunswick Liberal Caucus on 16 May 2019. The meeting was convened to introduce the Project prior to registering the

EIA and to discuss challenges with existing legislation. A summary of the meeting attendees is provided in Table 61.

Table 61. Attendees of the pre-registration consultation meeting on 16 May 2019 regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Affiliation
Gerry Lowe	NB Liberal Party, Saint John MLA
Rob McKee	NB Liberal Party, Moncton Centre MLA
Jacques LeBlanc	NB Liberal Party, Shediac-Beaubassin-Cap-Pele MLA
Keith Chiasson	NB Liberal Party, Tracadie Sheila MLA
Guy Arsenault	NB Liberal Party, Campbellton-Dalhousie MLA
JC D'Amours	NB Liberal Party, Edmunston-Madawaska MLA
Francine Landry	NB Liberal Party, Madawaska Les Lacs-Edmunston MLA
Stephen Horseman	NB Liberal Party, Fredericton North MLA
Monique LeBlanc	NB Liberal Party, Moncton East MLA
Lisa Harris	NB Liberal Party, Miramichi Bay-Neguac MLA
Brian Kenny	NB Liberal Party, Bathurst West-Beresford MLA
Andrew Harvey	NB Liberal Party, Carleton-Victoria MLA
Chuck Chiasson	NB Liberal Party, Victoria La Vallée MLA
Benoît Bourque	NB Liberal Party, Kent South MLA
Gille Lepage	NB Liberal Party, Restigouche West MLA
Roger Melanson	NB Liberal Party, Dieppe MLA
Daniel Guitard	NB Liberal Party, Restigouche-Chaleur MLA
Denis Landry	NB Liberal Party, Bathurst East-Nepisiquit-Saint-Isidore MLA
Fraser Forsythe	C2 Solar

5.3 PROJECT REGISTRATION PUBLIC CONSULTATION PROCESS PLAN

It is the Proponent's responsibility to demonstrate that the potentially affected public and other stakeholders are given the opportunity to actively participate in the EIA review process. Fundy Engineering has developed an organized information dissemination program, whereby relevant, sufficient, and credible information is presented.

The public consultation plan for this Project was developed in accordance with the process described in Appendix C of *A Guide to Environmental Impact Assessment in New Brunswick* [*NBDELG*, 2012]. The step-wise process proposed for the public consultation plan for this EIA is described in detail below. Our process satisfies the component of the NBDELG EIA Determination Review Summary highlighted in Figure 78.

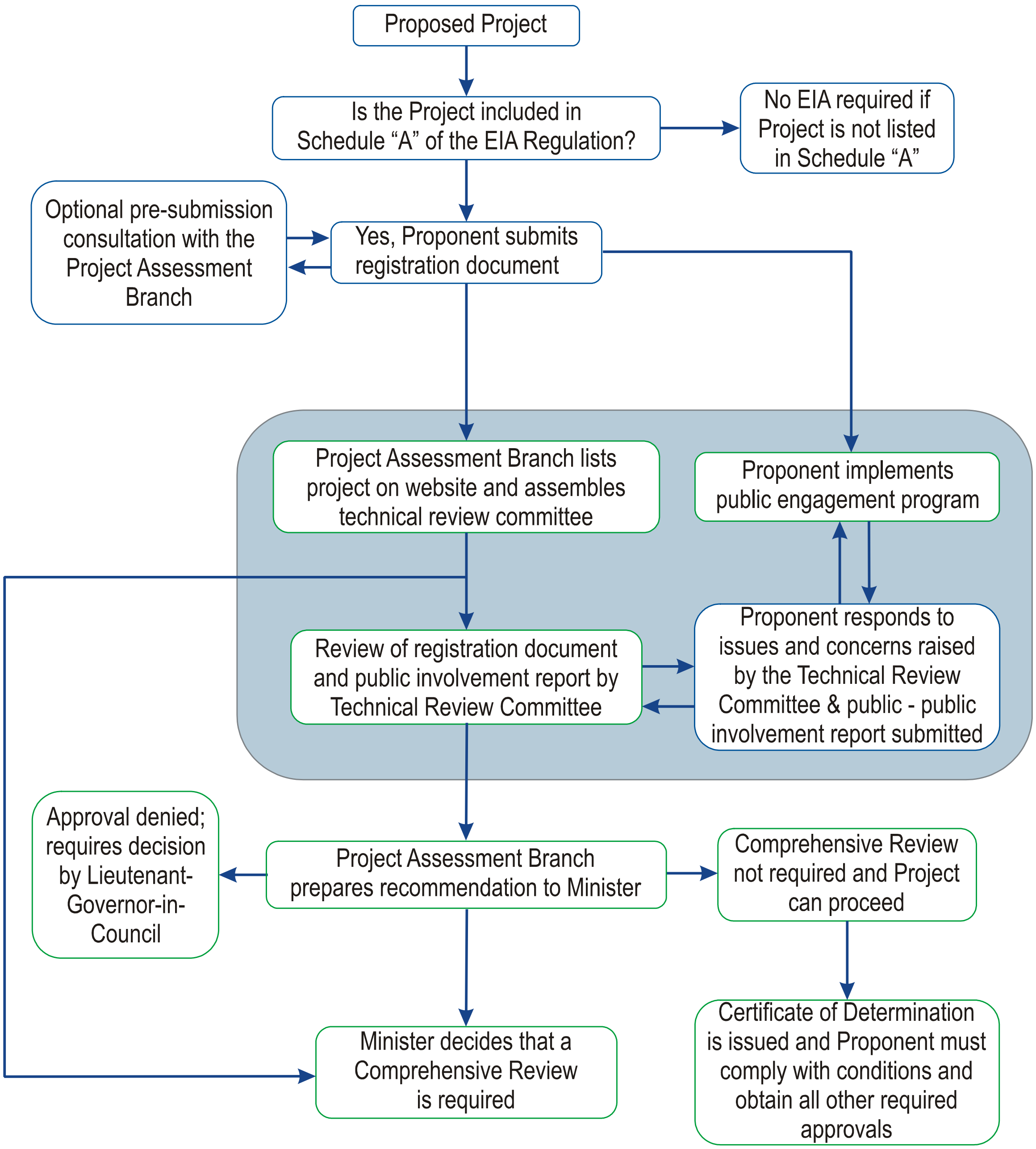


Figure 78. The NBDELG EIA Determination Review process highlighting the public consultation component of the process (*i.e.*, the blue box).

The public will be informed of this Project and the EIA registration document will be made available for review. Questions, comments, and concerns regarding the document will be collected and addressed as part of this process (*i.e.*, there is a two way flow of information between the proponent and the public with opportunities for the public to express their views).

5.3.1 Step 1: Direct Communication with Elected Officials and Service Groups

Formal notification of the Project registration document (*i.e.*, in the form of an information letter) will be sent to elected officials, local service groups and community groups, environmental groups (*i.e.*, Bathurst Sustainable Development and the Conservation Council of New Brunswick), and other potential stakeholder groups (*e.g.*, Federation of Snowmobile Clubs and the ATV Federation). Direct communication will enable those individuals and groups (*i.e.*, Table 62) to become more familiar with the Project, ask questions, and / or raise any and all issues / concerns.

Table 62. Elected officials, service groups, environmental groups, and stakeholders who will be sent information regarding the proposed Violet Solar Farm in Brunswick Mills, New Brunswick.

Name	Association	Address
Minister Hon. Jeff Carr	Environment and Local Government	189A Sunbury Drive, Fredericton Junction, NB, E5L 1R5
MLA Brian Kenny	Bathurst West-Beresford Constituency	325 Vanier Boulevard, Suite 5, Bathurst, NB, E2A 3N1
MLA Hon. Daniel Guitard	Restigouche-Chaleur Constituency and Speaker of the Legislative Assembly	691 Principale Street, Petit-Rocher, NB, E8J 1G1
MLA Denis Landry	Bathurst East-Nepisiguit Constituency	4024 Boulevard des Fondateurs, Saint-Isidore, NB, E8M 1G2
Mayor Paolo Fongemie	City of Bathurst / Chaleur Regional Service Commission (CRSC)	150 St. George Street, Bathurst, NB, E2A 1B5
Deputy Mayor Rickey Hondas	City of Bathurst	150 St. George Street, Bathurst, NB, E2A 1B5
Councillor Penny Anderson	City of Bathurst	150 St. George Street, Bathurst, NB, E2A 1B5
Councillor Kim Chamberlain	City of Bathurst	150 St. George Street, Bathurst, NB, E2A 1B5
Councillor Jeff Glendenning	City of Bathurst	150 St. George Street, Bathurst, NB, E2A 1B5
Councillor Samuel Daigle	City of Bathurst	150 St. George Street, Bathurst, NB, E2A 1B5
Councillor Lee Stever	City of Bathurst	150 St. George Street, Bathurst, NB, E2A 1B5
Councillor Katherine Lanteigne	City of Bathurst	150 St. George Street, Bathurst, NB, E2A 1B5
City Manager Todd Pettigrew	City of Bathurst	150 St. George Street, Bathurst, NB, E2A 1B5
Ms. Jocelyne Hachey, Executive Director	CRSC	702 Principale Street, Petit-Rocher, NB, E8J 1V1
Mayor Joseph Noel	Village of Belledunne / CRSC	PO Box 1006, 2471 Main Street, Belledune, NB, E8G 2X9
Mayor Jean-Guy Grant	Town of Beresford / CRSC	855-2 Principale Street, Beresford, NB, E8K 1T3
Mayor Luc Desjardins	Village of Petit-Rocher / CRSC	582 Rue Principale, Petit-Rocher, NB, E8J 1S5
Mayor Charles Doucet	Village of Nigadoo / CRSC	385 Rue Principale, Unit 1, Nigadoo, NB, E8K 3R6
Mayor Normand Doiron	Village of Pointe-Verte / CRSC	52 Rue du Quai, Pointe-Verte, NB, E8J 2T9
Ms. Carole Caron	CRSC	702 Principale Street, Petit-Rocher, NB, E8J 1V1
Mr. Charles Comeau	CRSC	702 Principale Street, Petit-Rocher, NB, E8J 1V1

Name	Association	Address
Mr. Normand Plourde	CRSC	702 Principale Street, Petit-Rocher, NB, E8J 1V1
Mr. Donald Gauvin	CRSC	702 Principale Street, Petit-Rocher, NB, E8J 1V1
Ms. Brenda Kelley, Executive Director	Bathurst Sustainable Development	PO Box 20047, 1047 St. Peter Avenue, Bathurst, NB, E2A 4V7
Ms. Lois Corbett, Executive Director	Conservation Council of New Brunswick	180 St. John Street, Fredericton, NB, E3B 4A9
Mr. Ross Antworth, General Manager	NB Federation of Snowmobile Clubs Inc.	147-B Houlton Road, Woodstock, NB, E7M 1Y4
Mr. Jacques Poirier, General Manager	NB ATV Federation	1925 Hanwell Road, Unit C, Hanwell, NB, E3C 1M4
Ms. Jennifer Henry, Executive Director	Bathurst Regional Airport	2929 Route 180, Tetagouche sud, NB, E2A 7B9
Mr. Chris Daigle	Bathurst Economic Development	150 St. George Street, Bathurst, NB, E2A 1B5

5.3.2 Step 2: Direct Written Communication with Nearby Residents

A limited mail out comprising a project information sheet will be sent to local residents and businesses (*i.e.*, those included within a 10 km radius shown in Figure 79).

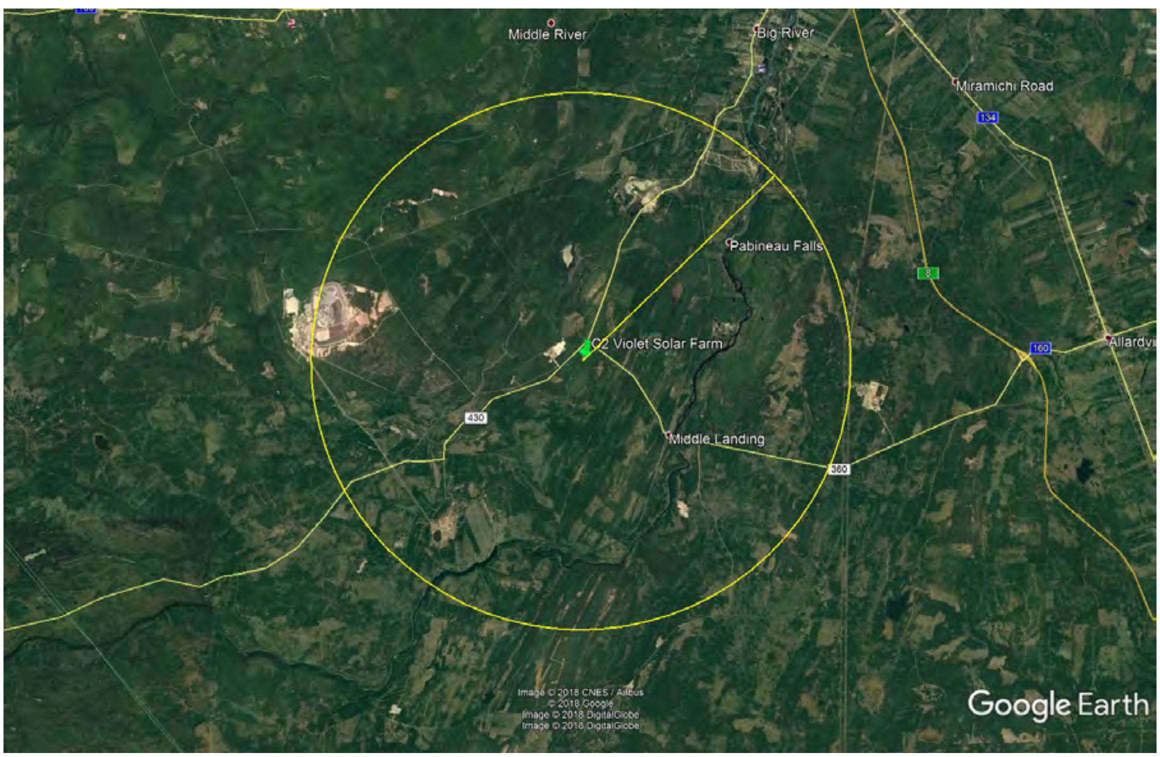


Figure 79. Neighbouring properties (*i.e.*, within 10 km) of the proposed Violet Solar Farm in Brunswick Mills, New Brunswick that will be notified of the Project.

5.3.3 Step 3: Notifications on the NBDELG Website and at the Head Office

The NBDELG shall place notice of the EIA registration on its website (*i.e.*, http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/environmental_impactassessment/

registrations.html) and shall have the EIA document available for public review at the Project Assessment Branch head office located on the second floor of 20 McGloin Street in Fredericton, New Brunswick. To satisfy this requirement, C2 Solar will provide an electronic version of the registration document (*i.e.*, as a PDF document) and two hard copies to the NBDELG.

5.3.4 Step 4: Documentation Availability with Stakeholder and NBDELG Offices

Copies of the Project registration document, and any subsequent submissions made in response to issues raised by the Technical Review Committee (TRC), will be made available at the local NBDELG office. A copy of the EIA document along with any subsequent revision(s) will be placed at the Bathurst NBDELG regional office at 159 Main Street where it will be made available to the public.

Because of the close proximity to the Pabineau First Nation, a copy of the registration document will be placed at the Administration Office located at 1290 Pabineau Falls Road.

5.3.5 Step 5: Public Notice Announcement

As required, a public notice will be placed in at least one local newspaper that has general circulation in Gloucester County (*i.e.*, *The Northern Light*) and / or at least one provincial daily newspaper (*i.e.*, *Telegraph Journal*). The standard notice for an EIA registration document, which will be used for publicly announcing the proposed Project is presented in Figure 80.

NOTICE

Registration of Undertaking
Environmental Impact Assessment Regulation
Clean Environment Act, Opportunity for Public Comment

On 16 July 2019, C2 Solar Ltd. submitted for registration the following activity with the Department of Environment and Local Government in accordance with Section 5(1) and Schedule "A" of the Environmental Impact Assessment Regulation: "Violet Solar Farm".

This EIA examines developing New Brunswick's first utility-scale photovoltaic solar farm. The 10 MW solar farm will be located on 40 ha of rural industrial land in Brunswick Mills, New Brunswick. Renewable electricity generated from the solar farm will be enough to service 2 000 homes. The Project will be an important clean and green addition to New Brunswick's portfolio of electricity generating infrastructure. It will also assist in the reduction of greenhouse gas emissions common in electrical generation. Overall, this Project will yield positive socio-economic and environmental impacts.

The Proponent's registration document can be examined at:

Fundy Engineering 27 Wellington Row Saint John, NB	Bathurst Public Library 150 St. George Street Bathurst, NB

and at:

NBDELG Regional Office 159 Main Street, Room 202 Bathurst, NB	NBDELG Head Office 20 McGloin Street, 2nd floor Fredericton, NB

Any comments should be submitted directly to the Proponent at:

C2 Solar Ltd.
% Fundy Engineering
27 Wellington Row
Saint John, N.B., E2L 4S1

matt.alexander@fundyeng.com

Receipt of comments is requested on or before 6 September 2019. Additional information about the proposal and the public involvement process is available at:

http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/environmental_impactassessment/registrations.html

Notice placed by: C2 Solar Ltd.

Figure 80. Example of the public notice announcement that will be placed by the Proponent in at least one local newspaper and / or at least one provincial daily newspaper.

5.3.6 Step 6: Local Area Availability of the Registered Document

Copies of the Project registration document, and any subsequent submissions made in response to issues raised by the TRC, will be made available in at least two locations local to the Project. Locations proposed for viewing the document locally include the Bathurst Public Library (*i.e.*, 150 St. George Street) and the Bathurst Regional NBDELG Office (*i.e.*, 159 Main Street, Room 202). A copy of the Project registration document and any subsequent information will be made available to any member of the public, stakeholder, and / or First Nation upon request.

5.3.7 Step 7: Open House and / or Public Meeting

As there is no requirement for public open houses under a Determination Review, and given the considerable communications and consultations with First Nations and stakeholders that have already occurred, it is believed that an open house for the Project is unnecessary and redundant.

5.3.8 Step 8: Documentation of Public Consultation Activities

The NBDELG Minister (*i.e.*, the Honourable Jeff Carr) will only provide an EIA determination once sufficient information has been received. This includes documentation of public and stakeholder concerns and Proponent responses. Within 60 days of registering the proposed Project, a report documenting the above public consultation process will be submitted to the NBDELG. In addition, this report will be made available for public review. The report will:

- describe the public consultation activities including copies of newspaper notices, and letters distributed;
- identify the key public and private stakeholders including First Nations that were directly contacted during the public consultation process;
- include copies of any and all correspondence received from and sent to stakeholders and the general public;
- describe any issues or concerns received during the public consultation program, which includes the names and affiliations of the person(s) providing the comments;
- indicate how those issues and concerns were, or will be, considered and / or addressed; and
- describe any proposed future public consultation with respect to the Project.

C2 Solar will adhere to the report requirements listed above. Given the Registration date of 16 July 2019 and the deadline of 6 September 2019 for public comments, the report documenting the public consultation process will be released prior to 18 September 2019.

6.0 PROJECT APPROVALS

6.1 LOCAL / MUNICIPAL APPROVALS

6.1.1 Re-Zoning

Currently, the lands proposed for the Project are zoned Industrial, Unimproved, and Unserviced (*i.e.*, Appendix I). The lands do not require re-zoning to permit the construction and operation of the Project as per the New Brunswick *Community Planning Act*.

A copy of the *Community Planning Act* can be found at:

<http://laws.gnb.ca/en/ShowPdf/cs/C-12.pdf>.

6.1.2 Building Permit

Pursuant to Section 59 of the New Brunswick *Community Planning Act*, a building permit must be obtained prior to the construction, relocation, demolition, and / or altering of any structures on land within a municipality. A building permit can be obtained from the Chaleur Regional Service Commission.

A copy of the *Community Planning Act* can be found at:

<http://laws.gnb.ca/en/ShowPdf/cs/C-12.pdf>.

Contact information for the Planning Department of the Chaleur Regional Service Commission is as follows:

Planning Department
Chaleur Regional Service Commission
702 Principale Street
Petit-Rocher, New Brunswick
E8J 1V1

✆ 506.542.2688
🖷 506.542.2642
🖱 http://www.csrchaleurrsc.ca
✉ info@csrchaleurrsc.ca

6.2 PROVINCIAL APPROVALS

6.2.1 Environmental Impact Assessment Approval

As per Schedule A, item *b)* (*i.e.*, all electric power generating facilities with a production rating of three megawatts ore more…) of the Environmental Impact Assessment Regulation **[87-83]** of the New Brunswick *Clean Environment Act*, this Project triggers EIA review. As previously noted, the purpose of an EIA is to identify and evaluate the potential impacts that the proposed Project will have on the environment. The EIA also identifies and presents measures to mitigate those potential environmental impacts. There are no sector-specific EIA guidelines for solar farms. The fee for registering this Project for EIA review would be $5 500.

A copy of the *Clean Environment Act* can be found at:

<http://laws.gnb.ca/en/showfulldoc/cs/C-6//20130718>; and

a copy of the EIA Regulation can be found at:

<http://laws.gnb.ca/en/showfulldoc/cr/87-83//20130718>.

Contact information for the NBDELG's Environmental Assessment Section of the Sustainable Development and Impact Evaluation Branch is as follows:

NBDELG
Environmental Assessment
Sustainable Development and Impact Evaluation
PO Box 6000
Fredericton, NB
E3B 5H1

506.444.5382
506.453.2627
www.gnb.ca/environment
eia-eie@gnb.ca

6.2.2 Watercourse and Wetland Alteration Permit

New Brunswick's watercourses and wetlands are afforded protection under the Watercourse and Wetland Alteration (WAWA) Regulation **[90-80]** of the New Brunswick *Clean Water Act*. Any proposed alterations within watercourses and / or wetlands, or within their 30 m regulated buffer, require permitting through the NBDELG's WAWA program. The fee for registering for a single permit respecting one alteration is $25. No watercourses and / or wetlands exist on the property and this was confirmed through ground-truthing exercises; however, if a watercourse and / or wetland or its regulated 30 m buffer is impacted, a WAWA permit will be required.

A copy of the *Clean Water Act* can be found at:

<http://laws.gnb.ca/en/ShowPdf/cs/C-6.1.pdf>;

a copy of the WAWA Regulation can be found at:

<http://laws.gnb.ca/en/ShowPdf/cr/90-80.pdf>;

the WAWA application portal can be found at:

<https://www.elgegl.gnb.ca/WAWAG/en/Home/Site>; and

a copy of the WAWA technical guidelines can be found at:

<http://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Water-Eau/WatercourseWetlandAlterationTechnicalGuidelines.pdf>.

Contact information for the NBDELG WAWA program is as follows:

NBDELG
Surface Water Protection
Sustainable Development and Impact Evaluation
Marysville Place
PO Box 6000
Fredericton, NB
E3B 5H1

✆ 506.457.4850
🖷 506.453.6862
🖰 http://www2.gnb.ca/content/gnb/en/departments/elg/environment.html
✉ elg/egl-info@gnb.ca

6.2.3 On-Site Sewage Disposal System Approval

All on-site sewage disposal system installations, constructions, repairs, and replacements require approval from the Department of Justice and Public Safety. As per the On-Site Sewage Disposal System Regulation **[2009-137]** of the New Brunswick *Public Health Act*, only licensed installers can install, construct, repair, or replace on-site sewage disposal systems after receiving approval from the Department of Justice and Public Safety. Inspectors with that Department assess applications to ensure the proposed systems will not contaminate groundwater resources and/or cause health hazards.

A copy of the *Public Health Act* can be found at:

<http://laws.gnb.ca/en/showpdf/cs/P-22.4.pdf>;

a copy of the Sewage Disposal System Regulation can be found at:

<http://laws.gnb.ca/en/showpdf/cr/2009-137.pdf>; and

a copy of the on-site sewage system application can be found at:

<https://www.pxw1.snb.ca/snb7001/e/1000/CSS-FOL-35-1631E.pdf>.

Contact information for the New Brunswick Department of Justice and Public Safety's (NBDJPS) Bathurst Technical Inspection Services:

NBDJPS
Technical Inspection Services
Regional Office
360 St. George Street
Bathurst, NB
E2A 1B9

✆ 506.547.2087
🖷 506.659.3222

http://www2.gnb.ca/content/gnb/en/departments/public_safety.html
DPS-MSP.Information@gnb.ca

6.2.4 *Electrical Installation and Inspection Act and Regulations*

The solar farm is classified as a Type III installation as per the General Regulation **[84-165]** of the New Brunswick *Electrical Installation and Inspection Act*. In New Brunswick, as per Section 17 of the General Regulation, electrical design must be approved by the Chief Electrical Inspector before a wiring permit for the solar farm can be issued. Furthermore, electrical inspections must be conducted to ensure that electrical work meets minimum regulated standards prior to operation of the Project.

A copy of the *Electrical Installation and Inspection Act* can be found at:

<http://laws.gnb.ca/en/ShowPdf/cs/2011-c.144.pdf>;

a copy of the General Regulation can be found at:

<http://laws.gnb.ca/en/ShowPdf/cr/84-165.pdf>; and

a copy of the electrical wiring permit application can be found at:

<https://www.pxw1.snb.ca/snb7001/e/1000/CSS-FOL-SNB-78-0020E.pdf>.

Contact information for the New Brunswick Department of Justice and Public Safety's (NBDJPS) Bathurst Technical Inspection Services:

NBDJPS
Technical Inspection Services
Regional Office
360 St. George Street
Bathurst, NB
E2A 1B9

506.547.2087
506.659.3222
http://www2.gnb.ca/content/gnb/en/departments/public_safety.html
DPS-MSP.Information@gnb.ca

6.3 FEDERAL APPROVALS

There are no known permits, licenses, and / or authorizations required to be issued by any federal government department and / or agency for the Project to be carried out.

7.0 FUNDING

Although CAPital EXpenditure (CAPEX) and OPerational EXpenditure (OPEX) costs are site-specific, data are available for the mature North American, European and Asian solar markets. Those data are useful for benchmarking this Project. In 2015, the International Finance Corporation (IFC) reported variations for CAPEX and OPEX costs for those mature markets and the data are summarized in Table 63. *Compass Renewable Energy Consulting* [2015] estimated similar costs for utility-scale solar farms in British Columbia. A typical breakdown of CAPEX costs for a utility-scale solar farm are shown in Figure 81.

Table 63. Variations in capital expenditures and operational expenditures circa 2013 / 2014 for ground-mounted utility-scale photovoltaic solar farms. Data from *IFC* [2015].

Value (CAD · MW^{-1})*	Minimum	Mean	Maximum	Variability
CAPEX	$1.6 million	$1.7 million	$2.3 million	47 %
OPEX (Annually)	$2 300	$4 500	$8 000	241 %

NOTES:
*Values were presented in USD and a conversion rate to CAD of 1.064 was used for 2013 / 2014

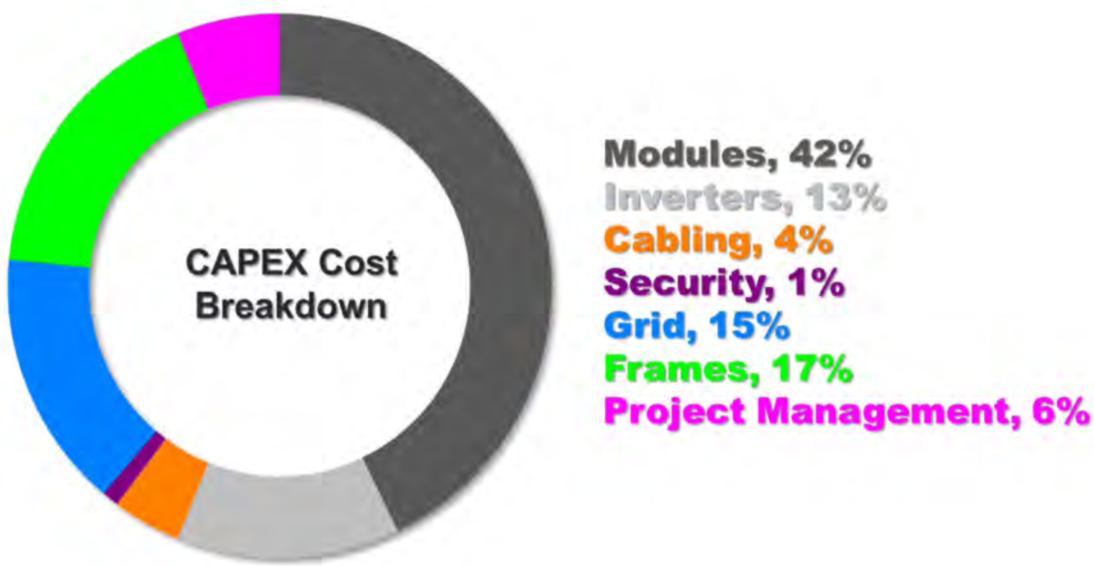


Figure 81. Typical breakdown of capital expenditure costs circa 2014 for a ground-mounted utility-scale solar farm. Data from *IFC* [2015].

The CAPEX for this Project is estimated at $18 million (CAD). Currently, C2 Solar is looking for private equity investors for constructing and operating the Project. C2 Solar may seek funding support from government agencies in the form of loans or grants to support technology development and capital funds. Applications may be submitted to funding agencies, such as the National Research Council (NRC) Industrial Research Assistance Program (IRAP), the Atlantic Canada Opportunities Agency (ACOA), Opportunities New Brunswick (ONB), and the New Brunswick Innovation Foundation (NBIF) and training agencies, such as the Department of Post-Secondary Education, Training, and Labour.

8.0 SIGNATURES

This Project Environmental Impact Assessment was prepared in accordance with the Environmental Impact Assessment Regulation **[87-83]** under the New Brunswick *Clean Environment Act* and on the advice of and in consultation with the various Regulators. Fundy Engineering & Consulting Ltd. prepared the document on behalf of C2 Solar Ltd. The Proponent has reviewed the document and understands the information contained within. C2 Solar Ltd. commits to undertaking all environmental mitigation measures described within this Environmental Impact Assessment document.

Respectfully submitted,

Proponent Signature:

Mr. Fraser Forsythe, *P.Eng.*
Director
C2 Solar Ltd.

Environmental Consultant Signature:

Dr. Matt Alexander, *P.Geo., EP*
Senior Environmental Scientist
Fundy Engineering & Consulting Ltd.

16 July 2019

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10.0 GLOSSARY

Aboriginal Peoples: are the indigenous peoples recognized in the *Canadian Constitution Act*, 1982.

aerodrome: any area of land, water (*n.b.*, including the frozen surface thereof) or other supporting surface used or designed, prepared, equipped or set apart for use either in whole or in part for the arrival, departure, movement or servicing of aircraft and includes any buildings, installations and equipment situated thereon or associated therewith.

airshed: a geographical area that shares the same air mass due to topography, meterology, and / or climate and as a result, it behaves in a coherent way with respect to the dispersion of emissions.

Alternating Current (AC): an electric current that reverses its direction at regular intervals many times in a second.

anthropogenic: caused by human activity.

aquifer: a saturated permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic conditions.

archaeological and cultural features: all evidence of human occupation that comes out of the ground or underwater or on the ground, including shell middens, fishing stations, large First Nation villages, sugar-bush camps, shipbuilding yards, trading posts, shipwrecks, cemeteries, military forts, and a variety of other locations where humans, both long ago and more recently.

avian: a bird.

azimuth: the angle between the projected vector and a reference vector on the reference plane.

baseline: background or pre-activity data that can be used for comparison when conducting further analyses.

bedrock: solid rock encountered below the soil or any other unconsolidated cover that occurs on the Earth's surface.

Best Management Practices (BMPs): techniques used to guide design and construction of an Undertaking to minimize adverse environmental impacts.

biological environment: considers the flora and fauna components of the environment and their interaction.

biomass: waste material from plants or animals that is not used for food or feed and instead can be used in various industrial processes, such as energy production or as raw materials for manufacturing chemicals.

bylaw: a law made by municipal government.

carbon dioxide (CO_2): an atmospheric gas, composed of carbon and oxygen, that is a major component of the carbon cycle and the predominant gas contributing to the greenhouse effect and is therefore known as a contributor to climate change. It is produced through natural processes, but is also released through anthropogenic activities, such as the combustion of fossil fuels to produce electricity.

carbon monoxide (CO): a colourless, odourless, and highly toxic gas that is a byproduct of combustion.

circa (ca): makes reference to an approximate date when the actual date is unknown.

Clean Water Act: a provincial *Act* administered by the New Brunswick Department of the Environment, which deals with protecting the overall water environment for all New Brunswicker's to enjoy.

Clean Environment Act: a provincial *Act* administered by the New Brunswick Department of the Environment, which deals with protecting the overall environment for all New Brunswicker's to enjoy.

climate: a description of aggregate weather conditions or the sum of all statistical weather information that is used to describe a place or region.

climate normal: a data period, typically 30 years in duration, used by Environment Canada to summarize or describe the average climatic conditions of a particular location.

Committee On the Status of Endangered Wildlife In Canada (COSEWIC): a committee of experts that assesses and designated which wild species are in some danger of disappearing from Canada.

cultural resources: archaeological and historic resources that are eligible for or listed by the government including buildings, sites, districts, structures, or objects having historical, architectural, archaeological cultural, or scientific importance.

Direct Current (DC): the unidirectional flow of an electric current.

ecodistrict: used to reference communities of interacting plants or animals or species or groups in relation to their biophysical or geographic context.

Electromagnetic Fields (EMFs): electric and magnetic fields that are generated whenever and wherever electricity is used.

emission: a form of pollution discharged into a receiving body from smokestacks, pipes, vents, surface areas of commercial or industrial facilities, from motor vehicles, locomotives, aircrafts, *etc.*

endangered: a species that is facing imminent extirpation.

Environmental Impact Assessment (EIA): a study undertaken to assess the effect on a specified environment of the introduction of any new factor that may upset the current ecological balance and includes the social and physical environment of the surrounding area.

Environmental Protection Plan (EPP): a description of what will be done to minimize the environmental effects pre-, during, and post-construction of the Undertaking. The plan also includes mitigation measures.

Environmentally Significant Area (ESA): spaces that are provided special protection because they represent a habitat that is integral to the overall ecological health of the region.

equivalent carbon dioxide (CO_{2eq}): is a comparative measure used for emissions from various greenhouse gases based upon the concentration of carbon dioxide that would cause the same level of radiative forcing.

erosion: the wearing away of land surface by wind or water, which naturally occurs from weather or runoff but can be intensified by land-clearing practices related to farming, residential or industrial development, road building, timber cutting, *etc.*

fauna: the collective animal life occurring in an area or time period, especially the naturally occurring indigenous animal life.

Feed-In Tariff (FIT): a policy mechanism designed to accelerate investment in renewable energy technologies.

Final Investment Decision (FID): when the project execution phase begins and money starts being spent on project procurement and construction.

First Nations: a collective group of Aboriginals that are living on a reserve.

flora: the collective plant life occurring in an area or time period, especially the naturally occurring indigenous plant life.

fossil fuels: a naturally occurring fuel, such as coal or gas, that formed in the geological past as a result of organic material being buried.

fugitive emissions: pollutants released to the atmosphere but not through stacks, vents, pipes, or any other confined air stream.

geology: the science that studies Earth by looking at its composition and the processes past and present that shaped it, both on the surface and within.

glacial: pertaining to an interval of geologic time that was marked by an equatorward advance of ice during an ice age.

glaciomarine: deposits consisting of sediments that were transported by glacial ice and marine water.

glass cullet: glass that is crushed and ready to be remelted.

greenfield: a previously undeveloped open space, such as agricultural fields or forests, that has not been used for commercial or industrial activities and is presumed to be free of contamination.

greenhouse gas: a gas (*e.g.*, carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorcarbons, sulphur hexafluoride, nitrogen trifluoride, *etc.*) that contributes to the greenhouse effect by absorbing radiation.

GreenHouse Gas Reporting Program (GHGRP): a Canada-wide single reporting system that tracks direct emissions from industrial, government, commercial, and other facilities that meet or exceed the reporting threshold for 26 greenhouse gases and gas species that are subject to mandatory reporting.

ground truth: the process of verifying the correctness of remote sensing information by use of ancillary information, such as field studies.

groundwater: subsurface water that occurs beneath the water table in soils and geologic formations that are fully saturated.

hazardous materials: a solid, liquid, or gaseous material that, upon exposure, constitutes an identifiable risk to human health or the natural environment. Hazardous material criteria are established with regard to appropriate regulatory requirements.

hibernaculum: an over-wintering area used to hibernate and survive the winter; bats typically seek out caves to hibernate.

hydrocarbons: a broad family of organic compounds that are comprised predominantly of carbon and hydrogen in various combinations; crude oil, natural gas, petroleum products, etc. are all various forms of hydrocarbons.

hydrogeology: the scientific study of groundwater geology and the geological environments that control the occurrence, movement, production, and characteristics of groundwater.

hydrology: an earth science that encompasses the occurrence, distribution, movement, and properties of water.

impermeable: not allowing water to pass through.

Important Bird Area (IBA): an area recognized as being globally important for the conservation of bird populations. There are about 10 000 sites globally.

land parcel: an area of land for which rights or ownership can be purchased.

land use: the way that land is developed and used in terms of the kinds of activities allowed (*e.g.*, agriculture, residences, industries, *etc.*).

lithology: a description of the physical character of a rock as determined by eye or with a low-power magnifier, and based on colour, structures, mineralogic components, and grain size.

long-term impacts: those that are experienced for a prolonged period, such as during the entire duration (*i.e.*, operation) of the Undertaking.

lubricants: a substance used to reduce the friction between surfaces or as process materials either incorporated into other materials used as processing aids in the manufacturing of other products, or as carriers for other materials.

micro-climate: an area influenced by natural or human-made features that alter the climatic conditions from the general regional climate.

micro Feed-In Tariff (microFIT): a policy mechanism intended to encourage the development of small-scale renewable energy projects.

migratory birds: land birds that migrate very long distances to breed or escape temperatures outside their normal optimum temperature range.

morainal sediments: glacial drift materials deposited mainly by direct glacial action and possessing initial constructional form independent of the material beneath it.

n: see sample size.

null alternative: assessing the impacts if the Undertaking is not to proceed (*a.k.a.*, the do nothing alternative).

Parcel / Property IDentification (PID) number: a unique number given to a land parcel for tracking information, such as deed holders, size, environmental issues, *etc.*

Parcel Information: Service New Brunswick (SNB) maintains a network of registries across the province where legal plans and documents related to the ownership of real property can be registered and made available for public scrutiny.

The records in the Registries provide land ownership information dating back to the issuance of the original crown grants. Instruments registered or filed in the registry include deeds, mortgages, wills, subdivision plans, *etc*.

permanent impacts: those that cause irreversible change to the environment.

Personal Protective Equipment (PPE): safety clothing, helmets, goggles, earplugs, steel-toe boots, or other garments or equipment designed to protect the wearer from body injury or infection.

petroleum hydrocarbons: a family of naturally occurring liquid organic compounds,

photovoltaic effect: the creation of voltage and electric current between two dissimilar materials in close contact upon exposure to light; it is a physical and chemical phenomenon.

physiochemical environment: considers the chemical and physical components of the environment and their interaction.

physiographic region: an area having a pattern of relief features or landforms that differ significantly from that of adjacent areas.

Power Purchase Agreement (PPA): a contract between two parties, one which generates electricity and one which purchases the electricity, that defines all commercial terms for the sale of electricity between the two parties, including when the project will begin commercial operation, schedule for delivery of electricity, penalties for under delivery, payment terms, and termination.

precipitation: any kind of water that falls from the sky (*i.e.*, snow, rain, freezing rain, sleet, hail, virga, *etc.*) as part of the weather at a specified place within a specified period of time.

pre-cast: a concrete unit, structure, or member that is cast and cured in an area other than its final position or place.

receptor: a sensitive component of the ecosystem that reacts to or is influenced by environmental stressors.

Regional Development Corporation (RDC): the provincial Crown Corporation in New Brunswick that plans, coordinates, and implements regional and economic development initiatives.

Regulator / Regulatory Authority(RA): the agency / department that oversees and applies the *Act* and regulations governing the environment.

renewables: sources of energy that are not depleted as they are used, such as water, wind, or solar power.

sanitary waste: liquid or solid waste originating solely from humans and human activities, such as wastes collected from toilets, showers, wash basins, sinks used for cleaning domestic areas, sinks used for food preparation, clothes washing operations, and sinks or washing machines where food and beverage serving dishes, glasses, and utensils are cleaned, but does not include hazardous or radioactive materials.

short-term impacts: those that are only experienced for a brief period or during a portion of the Undertaking (*i.e.*, during the pre-construction, construction, or commissioning).

socioeconomic environment: considers the social and economic components of the environment and their interaction.

solar array: a group of connected solar panels / modules used to convert light energy directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon.

solar cell: an electrical device that converts light energy directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon.

solar farm: a large area of land that has solar panels setup to generate electricity; generally connected to a utility of multiple users.

solar panel / module: a packaged, connected assembly of solar cells used to convert light energy directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon.

solid waste: non-liquid or gaseous waste that can be accepted for disposal in a landfill or incinerator and includes food waste, paper and cardboard, yard waste, metals, plastics, *etc.*, but does not typically include industrial waste, medical waste, or hazardous waste.

special concern: a species that may become threatened or endangered because of a combination of biological characteristics and identified threats.

Species At Risk Act (SARA): a federal *Act* administered by Environment Canada with the goal of protecting Canada's wildlife.

Supervisory Control And Data Acquisition (SCADA): a control system architecture that uses computers, networked data communications, and graphical user interfaces for high-level process supervisory management, but uses other peripheral devices, such as programmable logic controllers and discrete proportional integral derivative controllers to interface with a process plant or machinery.

surfacewater: all water that flows in watercourses and wetlands or is held in reservoirs above the Earth's surface.

surficial sediments: unconsolidated alluvial (*i.e.*, formed by running water), residual, or glacial deposits overlying bedrock or occurring on or near the surface of the earth.

terrestrial: relating to or inhabiting the land (*e.g.*, terrestrial plants live on the land as opposed to in the water).

The Paris Agreement: an agreement within the United Nations Framework Convention on Climate Change dealing with greenhouse gas emissions mitigation, adaptation, and finance, starting in the year 2020.

threatened: a species that is likely to become endangered if nothing is done to the factors leading to its extirpation or extinction.

till: unsorted and unstratified drift consisting of a heterogeneous (*i.e.*, non-uniform) mixture of clay, sand, gravel, and boulders that is deposited by and underneath a glacier.

topography: the physical features of a geographical area including relative elevations and the position of natural and anthropogenic features.

Transitioning to a Low-Carbon Economy: a bold vision developed for New Brunswick to intensify efforts to combat climate change.

utility-scale solar facility: one that generates solar power and feeds it into the grid.

Valued Environmental Component (VEC): components of the human and physical environment that are considered important and therefore require evaluation through an environmental impact assessment.

varmint: small nuisance animals, such as raccoons, foxes, and coyotes.

vermin: small nuisance pests, such as flies, spiders, mice, and rats.

wastewater: liquid or waterborne wastes polluted or fouled from household, commercial, or industrial applications along with any surfacewater, stormwater, or groundwater infiltration.

watershed: an area of land that drains to a single outlet and is separated from other watersheds by a divide.

Watercourse and Wetland Alteration (WAWA) permit: in New Brunswick, watercourses and wetlands are afforded protection under the *Clean Water Act* (Regulation 90-80) with respect to a temporary or permanent change made at, near, or to a watercourse or wetland or to the water flow in a watercourse or wetland. The permits are administered by the New Brunswick Department of the Environment.

watercourse: the full width and length, including the bed, banks, sides and shoreline, or any part of a river, creek, stream, spring, brook, lake, pond, reservoir, canal, ditch, or other natural or artificial channel open to the atmosphere, the primary function of which is the conveyance or containment of water whether the flow be continuous or not.

weather: the state of the atmosphere at any given time.

wetland: land that either periodically or permanently, has a water table at, near, or above the land's surface or that is saturated with water and sustains aquatic processes as indicated by the presence of hydric soils, hydrophytic vegetation, and biological activities adapted to wet conditions.

11.0 REPORT DISCLAIMERS AND DISCLOSURES

The sole purpose of this report and the associated services performed by Fundy Engineering & Consulting Ltd. is to complete an Environmental Impact Assessment document for a utility-scale solar farm at C2 Solar's site in Brunswick Mills, New Brunswick. The scope of services was defined by the New Brunswick Department of the Environment and Local Government's guidelines to Environmental Impact Assessment in New Brunswick [*NBDELG*, 2018].

This report was prepared on behalf of and for the exclusive use of the Client. The report expresses the professional opinion of Fundy Engineering experts and is based on their technical / scientific knowledge. Fundy Engineering & Consulting Ltd. accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report or data by any third-party. Fundy Engineering makes no guarantee that the Client will be successful in the regulatory approval.

Appendix I:

Property Maps and Reports and Authorization for Proposed Land Use by Regional Development Corporation

Map Scale / Échelle cartographique 1 : 13102

While this map may not be free from error or omission, care has been taken to ensure the best possible quality. This map is a graphical representation of property boundaries which approximates the size, configuration and location of properties. It is not a survey and is not intended to be used for legal descriptions or to calculate exact dimensions or area.

Même si cette carte n'est peut-être pas libre de toute erreur ou omission, toutes les précautions ont été prises pour en assurer la meilleure qualité possible. Cette carte est une représentation graphique approximative des terrains (limites, dimensions, configuration et emplacement). Elle n'a aucun caractère officiel et ne doit donc pas servir à la rédaction de la description officielle d'un terrain ni au calcul de ses dimensions exactes ou de sa superficie.

Parcel Information

PID:	20557021	**County:**	Gloucester
Status:	Active	**Active Date/Time:**	1984-02-13 00:00:00
Land Related Description:	Land	**Management Unit:**	NB0423
Area:	112	**Area Unit:**	Hectares
Date Last Updated:	2016-03-24 12:59:58	**Harmonization Status:**	Harmonized
Land Titles Status:	Not Land Titles	**Land Titles Date/Time:**	
Date of Last CRO:		**Manner of Tenure:**	Not Applicable
Land Gazette Information:	NO		
Description of Tenure:			

Public Comments:

MAP / CARTE 21P05Y

Parcel Interest Holders

Owner	Qualifier	Interest Type
Regional Development Corporation/Société de développement régional		Owner
Regional Development Corporation/Société de développement régional		Owner
Société de développement régional /Regional Development Corporation		Owner
Société de développement régional /Regional Development Corporation		Owner

Assessment Reference

PAN	PAN Type	Taxing Authority Code	Taxing Authority
5025437		824	L.S.D. of/D.S.L. de Bathurst

Parcel Locations

Civic Number	Street Name	Street Type	Street Direction	Place Name
	430	Route		Brunswick Mills

County Parish

County	Parish
Gloucester	Bathurst

Documents

Number	Registration Date	Book	Page	Code	Description
35784454	2016-03-23			4600	Other Notices

Plans

No Records Returned

Parcel Relations

No Records Returned

Non-Registered Instruments

Number	Date	Code	Description	Plan Name	Filing Reference	Office	Surveyor Name
273	1974-01-01	9000	Administration Plan			NB Commerce and Tech (was 9G)	

PAN Information

Service Nouveau-Brunswick

PAN:	5025437	**Status:**	Open
Assessed Owner(s):	REGIONAL DEVELOPMENT CORP/ SOCIÉTÉ DE DÉVELOPMENT	**Mailing Address:**	PO BOX/C.P. 6000 FREDERICTON NB
Assessment Year:	2018	**Postal Code:**	E3B 5H1
Current Assessment:	$ 29,400	**Current Levy:**	$ 555.22
Location:	MINES ROAD	**County:**	Gloucester
Property Description:	ABANDONED DUMP	**Tax Class:**	Fully Taxable
Property Type Code:	301	**Property Type Name:**	Industrial Land - Unimproved Unserviced
Taxing Authority Code:	824	**Neighbourhood Code:**	02
Taxing Authority Description:	L.S.D. of/D.S.L. de Bathurst	**Neighbourhood Description:**	GRAND FALLS
Sequence Number:	Z180	**Sub Unit:**	0
Harmonization:	COMPLETED (PAN consists of Assessment amalgamated parcels except those for building stradding parcels)	**Farm Land Identifiation Program:**	No
PID:	20557047	**PID (2nd):**	20557021
More PID(s):	Yes		

Sale Price Information

Price: $1 **Date:** 2016-03-23

LICENSE AGREEMENT

THIS LICENSE AGREEMENT (the "***Agreement***") is made as of February 6, 2018 (the "***Effective Date***")

BETWEEN:

REGIONAL DEVELOPMENT CORPORATION ("***Owner***")

- and -

C2 SOLAR LIMITED., a company duly incorporated under the laws of New Brunswick (the "***Licensee***").

(each, a "***Party***")

RECITALS:

A. Owner is the owner of record, as reported on the Service New Brunswick Planet land records system, of the lands identified by the New Brunswick Parcel Identifiers 20395778, 20396040, 20395786, 20557021, 20557047, and 20395760 in Gloucester County, New Brunswick (the "***Licensed Lands***");

B. Licensee wishes to obtain Owner's permission to enter onto the Licensed Lands to conduct environmental and geotechnical testing;

IN CONSIDERATION of the mutual undertakings in this Agreement, and other good and valuable consideration, the receipt and sufficiency of which are acknowledged, the Parties agree as follows:

1. Nothing in this Agreement will be construed as authorizing Licensee to, and Licensee will not (i) alter the Licensed Lands in any manner other than as authorized in this Agreement; or (ii) construct, erect, place or affix any building, structure or fixture upon the Licensed Lands except as authorized under this Agreement. No easement, lease, fee simple or any other interest in the Licensed Lands is granted by this Agreement.

2. Owner grants to Licensee a non-exclusive, non-perpetual license (the "***License***") for a period of 2 years from the Effective Date, to enter the Licensed Lands on foot and by vehicle, with machinery and equipment as may be necessary to carry out only the following activities (the "Permitted Activities") at the sole cost of Licensee:

   Environmental Impact Assessment Work

   - Visual observation of the property by various Scientist and Environmental Professionals;
   - Sample collection of plant species;
   - GPS mapping of wetlands and watercourses with corresponding placement of survey ribbon;

- site photos;

Geotechnical Work

- Geotechnical investigation to confirm soils and depth to bedrock through test pit or borehole investigation, with minimal clearing as required to access test locations.

3. The rights granted under this Agreement to Licensee extend to and are exercisable by Licensee's employees, agents, contractors and subcontractors (the "***Licensee Parties***"). Licensee will cause all of the Licensee Parties to comply with the provisions of this Agreement applicable to them.

4. The Parties may by mutual agreement renew the License for one further 6 month renewal period on the same terms and conditions, except that any renewal period must be agreed to in writing no less than 60 days before the end of the initial term.

5. Either party may at any time terminate this Agreement immediately upon written notice to the other party.

6. Licensee will not enter upon or exit from the Licensed Lands except in accordance with this Agreement. Licensee will access the Licensed Lands only at such locations as agreed to by Owner, acting reasonably.

7. Licensee will, at its sole cost and expense, repair or remedy all damage, including but not limited to environmental damage, to the Licensed Lands caused by or arising out of the acts or omissions of Licensee or one or more of the Licensee Parties all to the satisfaction of Owner, acting reasonably.

8. Licensee will be solely responsible for (i) obtaining any locates of buried cables, pipelines, power lines or other underground structures, objects or apparatus on the Licensed Lands (each, a "***Buried Structure***") and (ii) conducting all such other investigations and examinations as may be necessary or desirable to carry out the Permitted Activities. At the reasonable request of Licensee, Owner will provide information that may be at its disposal concerning the location of any Buried Structures (the "***Owner Locates***"), provided that Owner does not warrant and will not be responsible for the accuracy or completeness of the Owner Locates. If Licensee discovers on any of the Licensed Lands any Buried Structure of which it was previously unaware or uninformed, or any Buried Structure in a location not corresponding to the location specified in any locate obtained by Licensee, then Licensee will (a) immediately cause all work on the affected area of the Licensed Lands to cease, and (b) notify Owner. Licensee will not carry out any work close enough, in the opinion of Owner, acting reasonably, to a Buried Structure to create a risk of damage to the Buried Structure until Licensee has made arrangements acceptable to Owner and to the third party owner, if any, of the Buried Structure to allow the work to continue.

9. Licensee will exercise the rights granted under this Agreement so as to cause the least damage to, and interference with, the use and enjoyment of the Licensed Lands by Owner.

10. Licensee will comply with all applicable federal, provincial and municipal laws, statutes, codes, ordinances, orders, decrees, by-laws, rules, regulations, permits, licenses, authorizations and directives in exercising its rights and carrying out its obligations under this Agreement.

11. Licensee will:

a) be liable to Owner and his employees and agents (the "***Owner Parties***") for any losses, costs, damages, expenses, charges, fines, penalties, legal fees and other liabilities that may be incurred by Owner arising out of any act or omission by Licensee or the Licensee Parties; and

b) indemnify and defend the Owner Parties from and against:

(i) any losses, costs, damages, expenses, charges, fines, penalties, legal fees and other liabilities ("***Losses***"), and

(ii) the assertion of a legal right by any method, whether arising out of contract, from common law or statute, in tort, in equity, in property or otherwise ("***Claim***")

that may be incurred by the Owner Parties or that may be made or brought by any third party against the Owner Parties, arising from any act or omission of the Licensee or the Licensee Parties, except to the extent that the Claim or Loss arises from Owner's negligence or wrongdoing.

12. Licensee acknowledges and agrees that Owner makes no representation as to Owner's title to the Licensed Lands. Any rights granted under this Agreement by Owner to Licensee are limited to the extent of Owner's interest in the Licensed Lands. Licensee remises, releases and forever discharges Owner from all Claims that Licensee has now, ever had or ever will have arising from or relating to title to the Licensed Lands or any adverse claim by a third party to title to the Licensed Lands. Licensee will obtain at its sole expense any other consent, license or interest in land that may be are required from a third party with respect to the exercise by Licensee of the rights granted under this Agreement.

13.

a) Licensee will procure and maintain at its sole cost a policy of comprehensive general liability insurance (the "***Policy***") in an amount not less than $2,000,000.

b) The Policy will:

i) include Owner as an additional insured;

ii) provide that thirty (30) days' written notice will be given to Owner prior to any material change adversely affecting Owner, or cancellation of the Policy;

iii) be endorsed to provide to Owner revised certificates of insurance immediately upon renewal of or any amendment to the Policy.

14. Licensee will provide to Owner copies of the Policies and certificates of insurance evidencing compliance with the provisions of this Schedule. If such copies and certificates of insurance have not been received by Owner within 48 hours of the commencement of the Operating Season, Owner may, by notice in writing, immediately terminate this Agreement.

15. Licensee will obtain and maintain in good standing any permits, licenses and consents necessary to carry out the Permitted Activities.

16. Any demand, notice or other communication ("***Notice***") to be given in connection with this Agreement will be in writing and will be given by personal delivery, commercial courier service, registered mail (postage prepaid) or by electronic transmission and addressed to the applicable Party as follows:

To Licensee	C2 Solar Limited c/o Fundy Engineering Saint John, NB E2L 4S1 Facsimile: 506-635-0206 e-mail: forsythe@rogers.com Attention: Fraser Forsythe, Director
To Owner	Regional Development Corporation P.O. Box 6000 Fredericton, NB E3B 5H1 Facsimile: 506-453-7988 e-mail: cade.libby@gnb.ca Attention: Cade Libby, Vice-President

For the purpose of this Section 16, a Notice will be considered validly given at the following times:

Delivery Method	Time of Notice
- by personal delivery or commercial courier service	day of actual delivery
- by registered mail	the 5th business day following the deposit in the mail, except that in the event of an actual or threatened disruption of regular

	postal service, notice will not be effective if given by mail.
- By electronic transmission	on the day of transmission

If the time of delivery is not a business day or if the Notice is received after ordinary office hours at the place of receipt, the Notice will be considered received on the next Business Day. Either Party may change its address for Notice by giving Notice to the other Party.

17. Either Party (the "***Waiving Party***") may, at its option, waive in whole or in part any failure by the other Party (the "***Obligated Party***") to perform any of the obligations under this Agreement. A waiver applies only to the specific matter it addresses, extends only to the Waiving Party and will not prejudice the right of the Waiving Party to require the subsequent performance by the Obligated Party of any obligation under this Agreement, including the waived obligation on subsequent occasions.

18. This Agreement is a complete and self-contained record of the agreement between the Parties. No promise, representation, commitment, agreement, negotiation or discussion by either Party in any form, express or implied, that occurred before the execution of this Agreement is of any effect with respect to the subject matter of this Agreement. The Parties acknowledge that in entering into this Agreement they have not relied on any promise, representation, commitment, agreement, discussion or information, express or implied, that is not written in this Agreement.

19. Licensee may not assign this Agreement or any part of it without Owner's written consent.

20. This Agreement may not be amended except by an agreement in writing signed by the Parties or by their successors or permitted assignees.

21. Despite any other provision of this Agreement, Sections and all others which by their nature would continue beyond the termination or expiry of this Agreement will survive and remain in force until the Parties agree to their termination.

22. If any term of this Agreement (the "***Invalidated Term***") is found by a court of competent jurisdiction to be invalid or unenforceable for any reason, the Invalidated Term will not affect the remainder of this Agreement. The Invalidated Term will be treated as being modified to the extent necessary to make it enforceable while preserving as much as possible the intent of the Parties expressed in this Agreement.

23. Identical copies of this Agreement may be signed separately by the Parties and combined to form fully executed originals. A signed Agreement delivered by electronic means is as valid as if delivered physically and will be treated as an executed original of this Agreement.

24. Compliance with provisions of this Agreement that establish deadlines is vital to this Agreement and mandatory.

25. This Agreement will be governed by the laws of New Brunswick and Canada. In any legal proceeding, this Agreement will be treated as having been performed in New Brunswick. Each Party submits to the exclusive jurisdiction of the courts of New Brunswick for all matters arising from this Agreement.

26. This Agreement is in English by agreement of the Parties. Les Parties s'accorde et consente que cette entente est en anglais seulement.

27. This Agreement is for the benefit of and binds the Parties and their successors and permitted assignees.

THE PARTIES enter into this agreement by signing below.

REGIONAL DEVELOPMENT CORPORATION

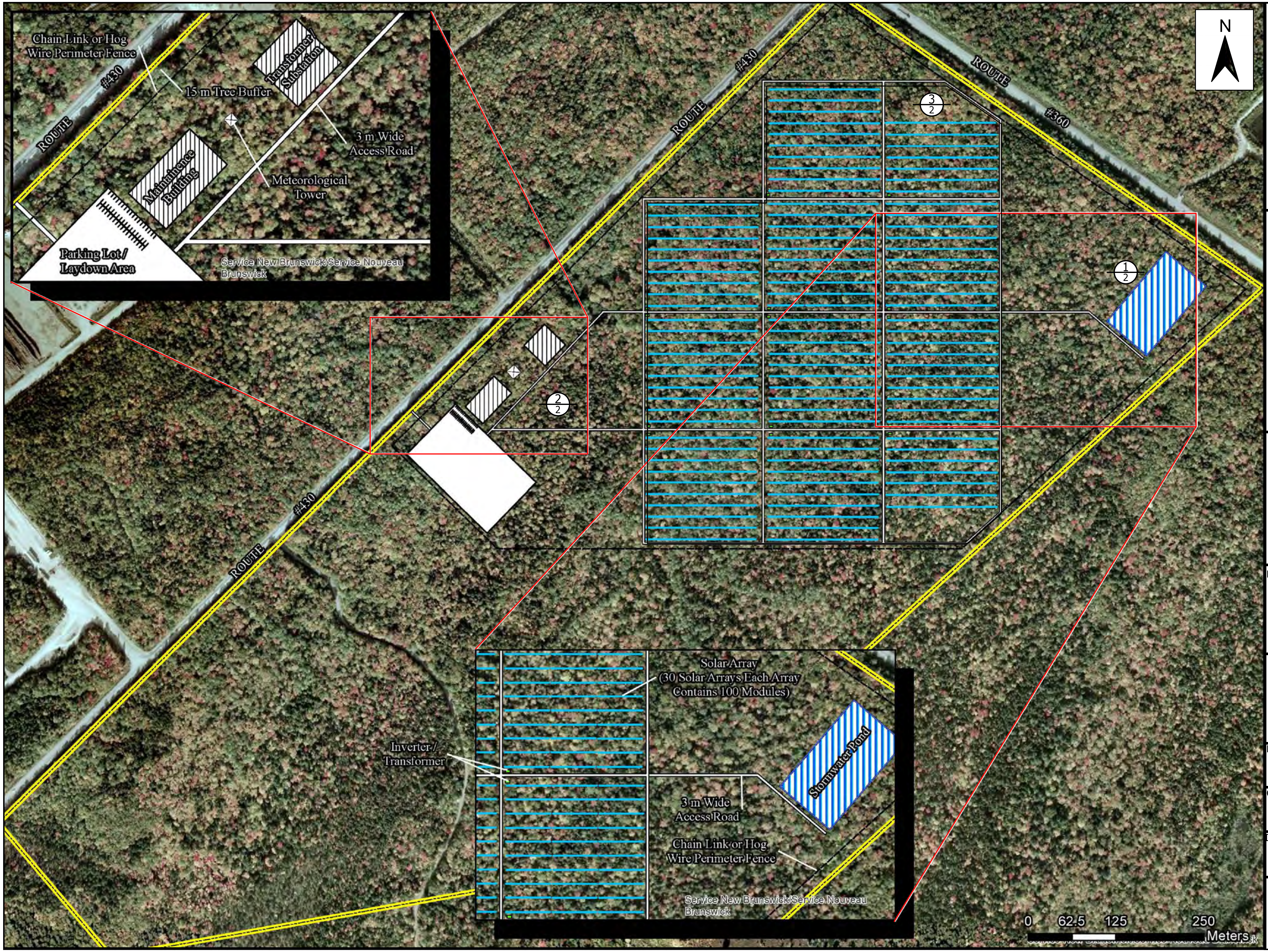
for Bill Levesque, President

C2 SOLAR LIMITED

Name: Fraser Forsythe
Title: Director

Appendix II:

Violet Solar Farm Conceptual Plans



Legend
- Proposed C2 Solar Site
- Solar Array
- Fence
- Tower

GENERAL NOTES

Data provided on this map is not sufficient for either boundary determination or regulatory interpretation. No warranty is expressed or implied, nor any legal liability or responsibility assumed or implied for the accuracy, completeness, or usefulness of the Geographic Information System (GIS) Data or any other data provided herein. The GIS data is illustrative only material and should not be considered for any other purpose. The data does not take the place of a professional survey and has no legal bearing on the true shape, size, location, or existence of a geographic feature, property line or policial representation. Any use of this information is at the recipient's own risk.

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Fax. (506) 635-0206
fundy@fundyeng.com
www.fundyeng.com
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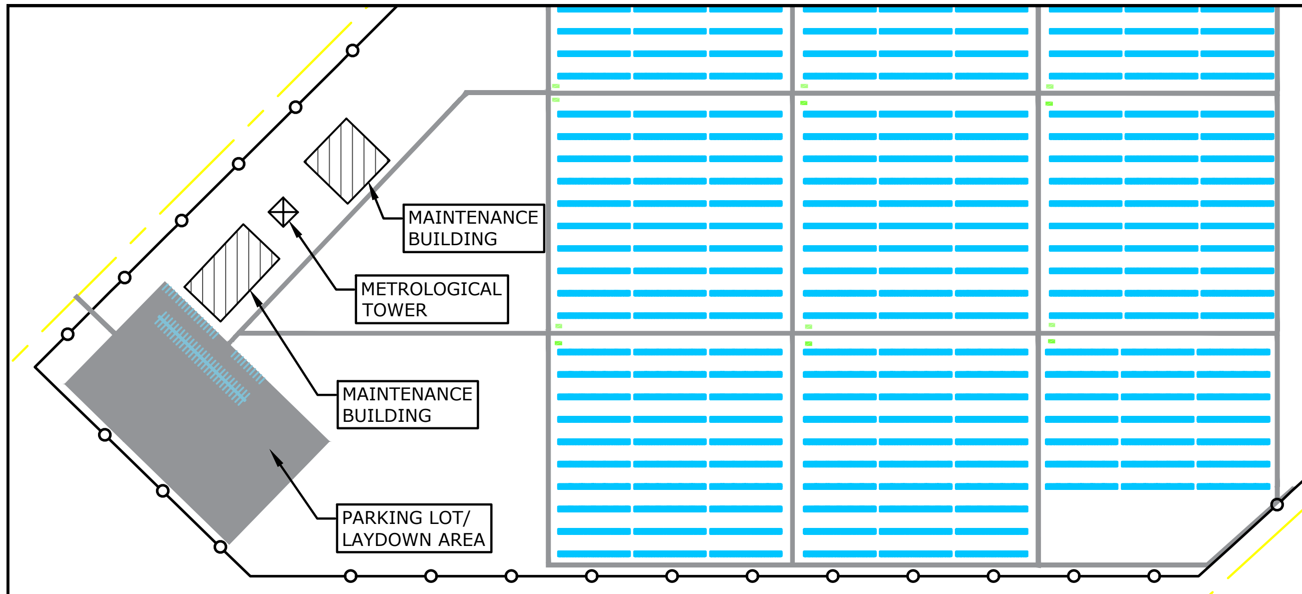
Project Title
C2 Solar
Project Violet
Route #430, Brunswick Mills, NB

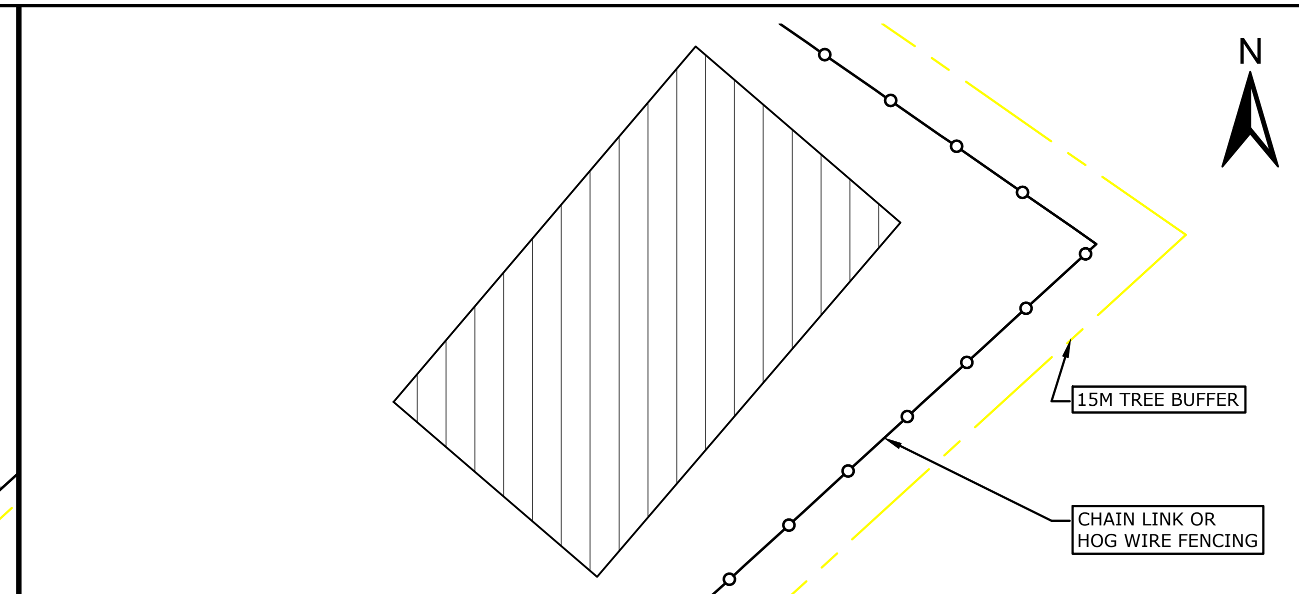
Drawing Title
Conceptual Site Plan
(2005 Aerial Photography)

Designed By: BC	Job No.: 12316
Checked By: MA	Date: 07/30/2018
Drawn By: BC	Scale: 1:5,000

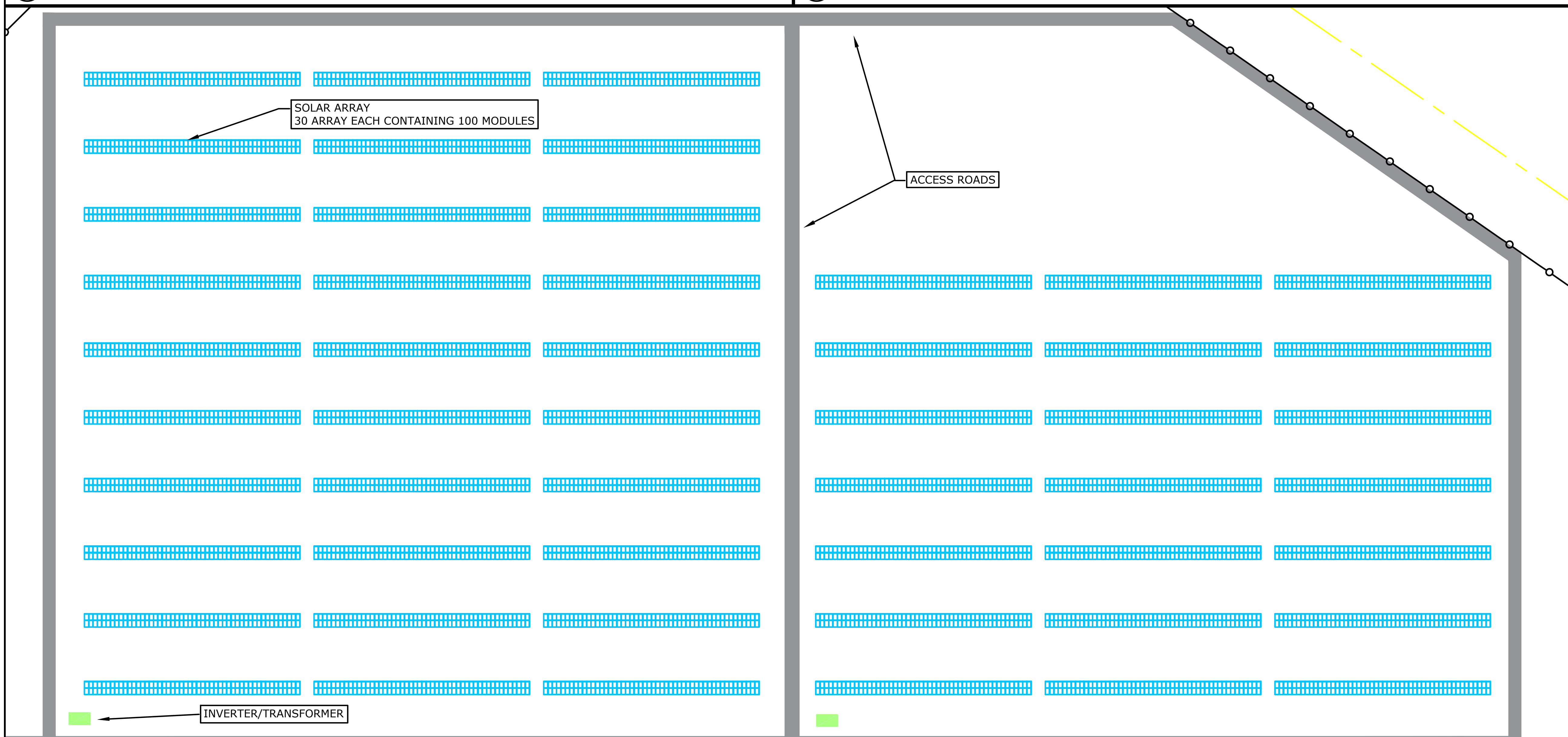
Drawing No.
1



1 / 2 BUILDING LAYOUT
SCALE: 1:2000



2 / 2 STORMWATER POND
SCALE: 1:2000



3 / 2 PANNEL ARRAY SPACING
SCALE: 1:1000

KEY PLAN
N.T.S

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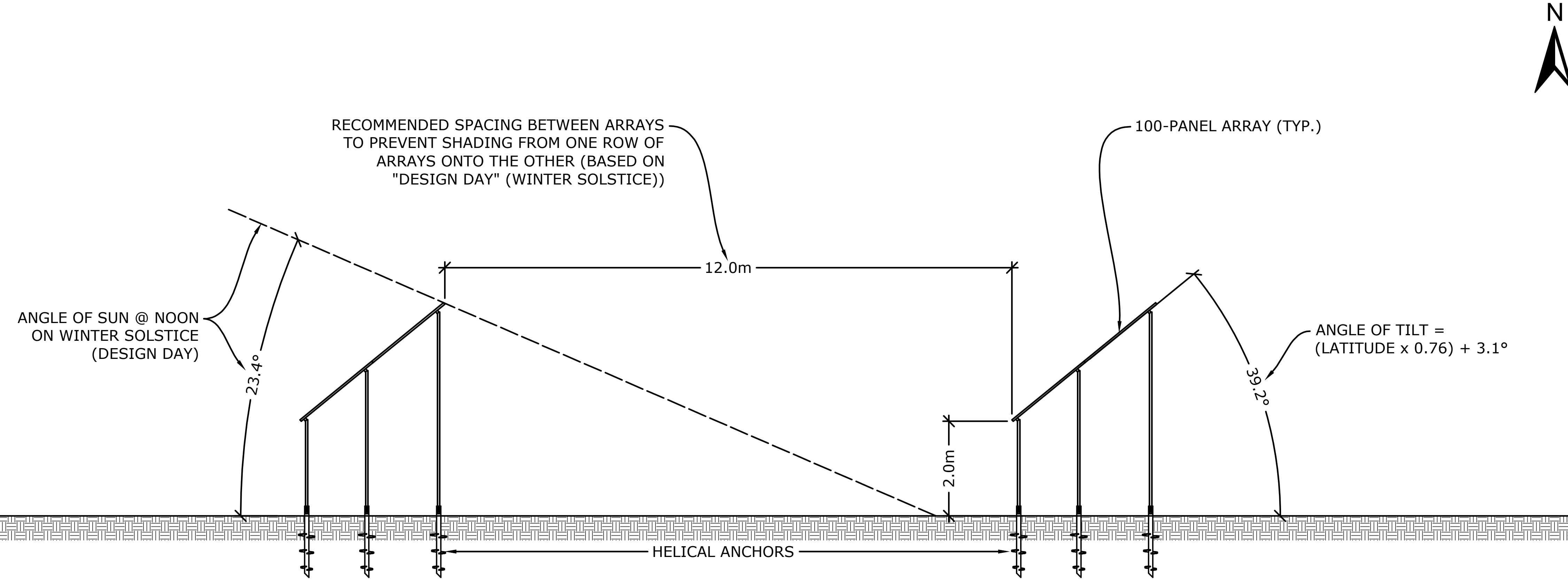
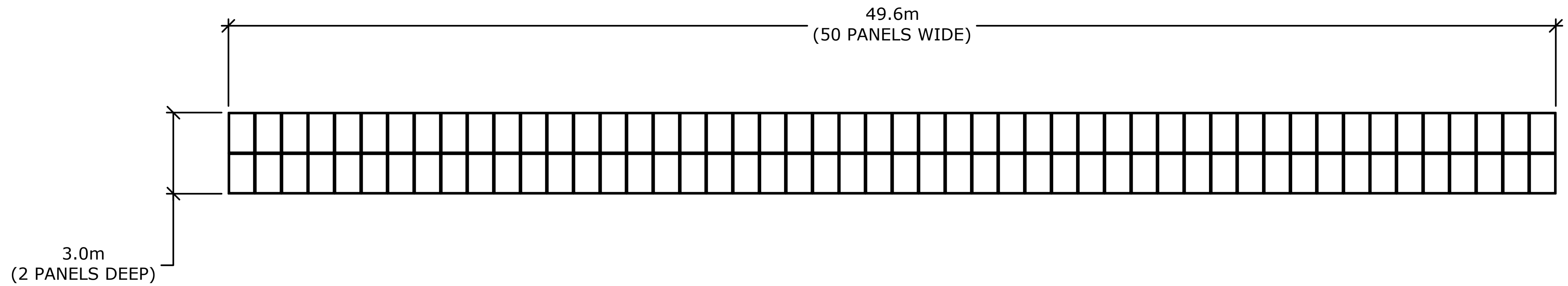
Project Title: C2 Solar Project Violet, Route #430, Brunswick Mills, NB	
Drawing Title: Conceptual Site Plan Array Arrangement	
Designed By: BC	Job No.: 12316
Checked By: MA	Date: 11/15/2018
Drawn By: BC	Scale: AS NOTED
Drawing No.: 2	



SOLAR ARRAYS - TILT ANGLE & SPACING

1/3 SCALE: 1:100



TYPICAL SOLAR PANEL ARRAY (100 PANELS) - PLAN VIEW

2/3 SCALE: 1:200

KEY PLAN
N.T.S

GENERAL NOTES

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Project Title

C2 Solar
Project Violet
Route #430, Brunswick Mills, NB

Drawing Title

Conceptual Site Plan
Array Details

Designed By: BC	Job No.: 12316
Checked By: MA	Date: 07/30/2018
Drawn By: BC	Scale: AS NOTED

Drawing No.

3

Appendix III:

SUNTECH Product Information Sheets

STP320 - 24/Vem
STP315 - 24/Vem
STP310 - 24/Vem

SUNTECH
BE UNLIMITED

320 Watt
POLYCRYSTALLINE SOLAR MODULE

Features

16.5% **High module conversion efficiency**
Module efficiency up to 16.5% achieved through advanced cell technology and manufacturing capabilities

PID Resistant **High PID resistant**
Advanced cell technology and qualified materials lead to high resistance to PID

0/+5W **Positive tolerance**
Positive tolerance of up to 5W delivers higher output reliablity

2% **Suntech current sorting process**
System output maximized by reducing mismatch losses up to 2% with modules sorted & packaged by amperage

3800Pa 5400Pa **Extended wind and snow load tests**
Module certified to withstand extreme wind (3800 Pascal) and snow loads (5400 Pascal) *

Harsh environment **Withstanding harsh environment**
Reliable quality leads to a better sustainability even in harsh environment like desert, farm and coastline

Certifications and standards:
IEC 61215, IEC 61730, conformity to CE

**

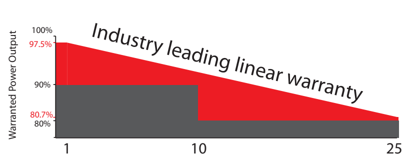
Trust Suntech to Deliver Reliable Performance Over Time

- World-class manufacturer of crystalline silicon photovoltaic modules
- Unrivaled manufacturing capacity and world-class technology
- Rigorous quality control meeting the highest international standards: ISO 9001: 2008, ISO 14001: 2004 and ISO17025: 2005
- Regular independently checked production process from international accredited institute/company
- Tested for harsh environments (salt mist, ammonia corrosion and sand blowing testing: IEC 61701, IEC 62716, DIN EN 60068-2-68)***
- Long-term reliability tests
- 2 x 100% EL inspection ensuring defect-free modules

Special 4 busbar design

The unique cell design leads tremendous reduction in electrodes resistance and raise in conversion efficiency. Less residual stress, less cell micro-cracks and hotspot risks.

Industry-leading Warranty based on nominal power



- 97.5% in the first year, thereafter, for years two (2) through twenty-five (25), 0.7% maximum decrease from MODULE's nominal power output per year, ending with the 80.7% in the 25th year after the defined WARRANTY STARTING DATE.****
- 12-year product warranty
- 25-year linear performance warranty

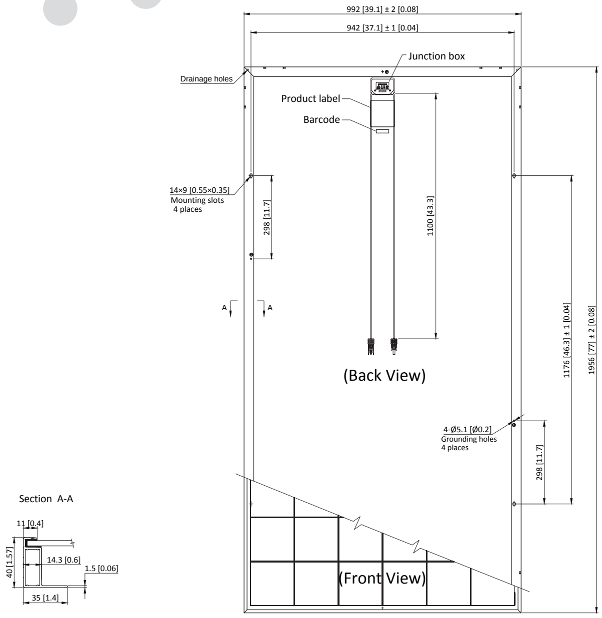
IP68 Rated Junction Box

The Suntech IP68 rated junction box ensures an outstanding waterproof level, supports installations in all orientations and reduces stress on the cables. High reliable performance, low resistance connectors ensure maximum output for the highest energy production.

* Please refer to Suntech Standard Module Installation Manual for details. **PV Cycle only for EU market.
*** Please refer to Suntech Product Near-coast Installation Manual for details. **** Please refer to Suntech Product Warranty for details.

STP320 - 24/Vem
STP315 - 24/Vem
STP310 - 24/Vem

SUNTECH
BE UNLIMITED



Electrical Characteristics

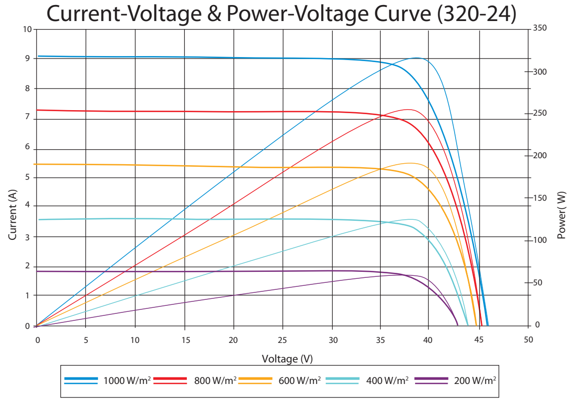
STC	STP320-24/ Vem	STP315-24/ Vem	STP310-24/ Vem
Maximum Power at STC (Pmax)	320 W	315 W	310 W
Optimum Operating Voltage (Vmp)	37.1 V	36.8 V	36.5 V
Optimum Operating Current (Imp)	8.63A	8.56 A	8.50 A
Open Circuit Voltage (Voc)	45.6 V	45.1 V	44.9 V
Short Circuit Current (Isc)	9.14A	9.02 A	8.96 A
Module Efficiency	16.5%	16.2%	16.0%
Operating Module Temperature	-40 °C to +85 °C		
Maximum System Voltage	1000 V DC (IEC)		
Maximum Series Fuse Rating	20 A		
Power Tolerance	0/+5 W		

STC: Irradiance 1000 W/m², module temperature 25 °C, AM=1.5;
Best in Class AAA solar simulator (IEC 60904-9) used, power measurement uncertainty is within +/- 3%

NOCT	STP320-24/ Vem	STP315-24/ Vem	STP310-24/ Vem
Maximum Power at NOCT (Pmax)	235W	229 W	226 W
Optimum Operating Voltage (Vmp)	34.0V	33.2 V	32.8 V
Optimum Operating Current (Imp)	6.90 A	6.91 A	6.88 A
Open Circuit Voltage (Voc)	41.8V	41.5 V	40.9 V
Short Circuit Current (Isc)	7.40 A	7.30 A	7.26 A

NOCT: Irradiance 800 W/m², ambient temperature 20 °C, AM=1.5, wind speed 1 m/s;
Best in Class AAA solar simulator (IEC 60904-9) used, power measurement uncertainty is within +/- 3%

Current-Voltage & Power-Voltage Curve (320-24)



Excellent performance under weak light conditions: at an irradiation intensity of 200 W/m² (AM 1.5, 25 °C), **96.5%** or higher of the STC efficiency (1000 W/m²) is achieved

Temperature Characteristics

Nominal Operating Cell Temperature (**NOCT**)	45±2°C
Temperature Coefficient of Pmax	-0.41 %/°C
Temperature Coefficient of Voc	-0.33 %/°C
Temperature Coefficient of Isc	0.067 %/°C

Mechanical Characteristics

Solar Cell	Polycrystalline silicon 156 × 156 mm (6 inches)
No. of Cells	72 (6 × 12)
Dimensions	1956 × 992 × 40mm (77.0 × 39.1 × 1.6 inches)
Weight	25.8 kgs (56.9 lbs.)
Front Glass	4.0 mm (0.16 inches) tempered glass
Frame	Anodized aluminium alloy
Junction Box	IP68 rated (3 bypass diodes)
Output Cables	TUV (2Pfg1169:2007)
	4.0 mm² (0.006 inches²), symmetrical lengths (-) 1100mm (43.3 inches) and (+) 1100 mm (43.3 inches)
Connectors	MC4 compatible

Dealer information

Packing Configuration

Container	20' GP	40' GP	40' HC
Pieces per pallet	25	25	25
Pallets per container	5	12	24
Pieces per container	125	300	600

SUNTECH
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Global Installation Guide for Suntech Power Photovoltaic Module

Version 20170101

Table of Contents

*** Please read carefully. This document is binding for any warranty case.**

*** Any installed PV system less than 500m from coastline, please refer to the Near-coast installation manual.**

- This guide contains information regarding the installation and safe handling of Wuxi Suntech Power Co., Ltd photovoltaic module (hereafter referred to as "module"). Wuxi Suntech Power Co., Ltd referred to as "Suntech".
- Installers must read and understand this guide prior to installation. For any questions, please contact Suntech's Global Quality & Customer Support department or our local representatives for more detailed information. Installers must follow all safety precautions as described in this guide as well as local requirement and regulations by law or authorised organisations.
- Before installing a solar photovoltaic system, installers should familiarize themselves with its mechanical and electrical requirements. Keep this guide in a safe place for future reference (care and maintenance) and in case of sale or disposal of the modules.
- Suntech modules are tested and certified for installation worldwide. Different regions may have different regulations for solar PV installations. In this guide, hereafter "IEC Only" is used to refer to regions where IEC standard applies, e.g. Europe, Middle East, most of Asia Pacific countries; " UL Only " is used to refer to regions where UL standard applies, e.g. United States, Canada; all other references are global.

General safety

- Modules that fall under this application class may be used in system operation at more than 50V DC or 240W, where general contact access is anticipated. Modules qualified for safety under IEC 61730-2 and within this application class are considered to meet the requirements for Safety Class II. (IEC Only)
- Installing solar photovoltaic systems requires specialized skills and knowledge. Installation must only be performed by qualified personnel.
- Installers must assume all risks of injury that might occur during installation, including, but not limited to, the risk of electric shock.
- One single module may generate more than 30V DC when exposed to direct sunlight. Contact with a DC voltage is potentially hazardous and should be always avoid.
- Do not disconnect the modules or any electrical part under load.
- PV modules generate electricity when exposed to sunlight. Number of modules string connected can cause lethal shock and burn hazards. Only authorized and trained person should have access to the modules.
- Photovoltaic solar modules convert light energy to direct current electrical energy. They are designed for outdoor use. Modules can be ground mounted, mounted on rooftops, vehicles or boats. The proper design of support structures lies within the responsibility of the system designers and installers.
- When installing the system, abide to all local, regional and national statutory regulations. Obtain a building permit if necessary.
- The electrical characteristics are within ±10 percent of the indicated values of Isc, Voc and Pmax under standard test conditions (irradiance of 1000 W/m², AM 1.5 spectrum, and a cell temperature of 25°C (77°F)).

- Only use equipment, connectors, wiring and support frames suitable for solar electric systems.
- Do not use mirrors, other magnifiers or antifically concentrated sunlight onto the modules.
- Always use fall protection equipment when working from heights of 6 feet (183cm) or above. Follow Occupational Safety and Health Act (OSHA) or local governing safety regulations regarding Fall Protection. (UL Only)
- Do not sit, stand, step or walk on any side of the module, including the frames.
- Do not permit any part of the module(s) to be submerged or allow for constant water to soil the module(s) unless it's natural rain fall or periodic cleaning.
- Do not permit constant dew on any part of backsheet of the module.

Handling safety

- Do not lift the module by grasping the module's junction box or electrical leads.
- Do not drop the module or allow objects to fall on the module.
- Do not place any heavy or sharp objects on the module.
- Be cautious when placing the module down onto a surface, particularly when placing it in a corner.
- Inappropriate transport and installation may break the module and void the warranty.
- Do not attempt to disassemble the modules, and do not remove any attached nameplates or components from the modules.
- Do not apply paint or adhesive to the module top surface or backsheet.
- To avoid damage to the backsheet and cells, do not scratch, dent or hit the backsheet. During the transportation, do not to apply direct pressure on the backsheet or front glass.
- Do not drill holes in the frame. This may compromise the frame strength, cause corrosion of the frame and void the warranty.
- Do not scratch the anodized coating of the frame (except for grounding connections at the grounding connection point on the back side of the module). It may cause corrosion of the frame or compromise the frame strength.
- A module with broken glass or torn backsheet cannot be repaired and must not be used since contact with any module surface or the frame can cause an electric shock.
- Work only under dry conditions, and use only dry tools. Do not handle modules under wet conditions unless wearing appropriate protective equipment.
- When storing uninstalled modules outdoors for any period of time, always cover the modules and ensure that the glass faces down on a soft flat surface to prevent water from collecting inside the module and causing damage to exposed connectors.

Installation safety

- Never open electrical connections or unplug connectors while the circuit is under load.
- Contact with electrically charged parts of the modules, such as terminals, can result in burns, sparks and lethal shock whether or not the module is connected.
- Do not touch the PV module unnecessarily during installation. The glass surface and the frame may be hot; there is a risk of burns and electric shock.
- Do not work in the rain, snow or in windy conditions.
- Avoid exposing cables and connectors to direct sunlight and scratches or cuts in order to prevent insulation degradation.
- Use only insulated tools that are approved for working on electrical installations.
- Keep children well away from the system while transporting and installing mechanical and electrical components.
- Completely cover the module with an opaque material during installation to prevent electricity from being generated.
- Do not wear metallic rings, watchbands, earrings, nose rings, lip rings or other metallic objects while installing or troubleshooting photovoltaic systems.
- Follow the safety regulations(eg. safety rules for working on electrical power plant stations) of your regions and for all other system components, including wires and cables, connectors, charging regulators, inverters, storage batteries, rechargeable batteries, etc.
- Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions. Accordingly, the values of Isc and Voc marked on this module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor current ratings, minimum factor of fuse sizes, and size of controls connected to the PV output.
- Only use same connectors to connect modules to form a string, or connect to another device. Removing the connectors will void the warranty.

Fire Safety

- Consult your local authority for guidelines and requirements for building or structural fire safety.
- Roof constructions and installations may affect the fire safety of a building; improper installation may create hazards in the event of a fire.
- Use components such as ground fault circuit breakers and fuses as required by local authority.
- Do not use modules near equipment or in places where flammable gases may be generated.
- The modules have been rated Fire Class C, and are suitable for mounting on to a Class A roof.

Each module has three labels providing the following information:

1. **Nameplate:** describes the product type; rated power, rated current, rated voltage, open circuit voltage, short circuit current, all as measured under standard test conditions; weight, dimensions etc.; the maximum system voltage is 600 volts or 1000 volts depending on the product family DC for UL standard and 1000 volts DC for IEC standard. Depending on the products some are UL/IEC listed to 1 000 volts while other UL products are 600 volts. Check your nameplate or contact your local representative for details.

2. **Barcode:** each individual module has a unique serial number. The serial number has 18 digits. The 15th and the 16th digits are the week code, and the 17th and the 18th digits are the year code. For example, STP xxxxxxxxxxxxxx2414 means the module was assembled and tested in the 24th week of 2014. Each module has only one bar code. It is permanently attached to the interior of the module and is visible from the top front of the module. This bar code is inserted prior to laminating.

STP 0B2314304281712414

Typical serial number barcode label

3. **Sorting label:** four different marks are shown on this sticker. "QC Pass" assures that the module has passed the quality control examination. "HIPOT" means that it has passed the insulation test. Finally modules are sorted out according to their output current, referred as a corresponding symbol "Ix" attached, in which x takes the value 1, 2 or 3. To get optimal performance out of a string of modules it is recommended to connect only modules of the same "Ix" class (for example only I2 modules) in one given string. The function of the "Barcode" please refer to the "Barcode" instruction mentioned above.

STP 0B2314304281712414

I3	HIPOT	QC Pass

Sorting label

Do not remove any labels. Removing a label will make the Suntech warranty void.

Selecting the location

- Select a suitable location for installing the modules.
- The modules should face south in northern latitudes and north in southern latitudes.
- For detailed information on the best installation angle, refer to standard solar photovoltaic installation guides or consult a reputable solar installer or systems integrator.
- Modules should not be shaded at any time. If a module is shaded or even partially shaded, it will fail to perform at ideal conditions and result in lower power output. A permanent and/or regular shade on the module voids the warranty.
- This installation manual is applicable for all pv system of 500 m or more away from the coastline. If you need to install your system less than 500m from the coast line please refer to Near-coast installation manual (www.suntech-power.com) or contact Suntech's Customer Support department or our regional representatives.
- Do not use modules near equipment or in locations where flammable gases may be generated or collected.

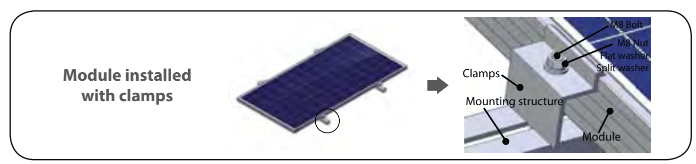
General Installation

- Before installing modules check for any optical deviations. Any optical deviations noticed after system installed may void warranty. Any potential costs for labor, material or other cost such as documentation, safety or performing the (de/ re-) installation will not be covered.
- The module mounting structure must be made of durable, corrosion-resistant and UV-resistant material. Always use a tested and certified mounting structure approved for your system design.
- In regions with heavy snowfall in winter, select the height of the mounting system so that the lowest edge of the module is not covered by snow for any length of time. In addition, ensure that the lowest portion of the module is placed high enough so that it is not shaded by plants, trees or damaged by ground soil moved by or through the air.
- For ground mounting systems, the minimum distance Suntech recommend from the ground to the bottom of the module is at least 24 inches (60cm).
- Modules must be securely attached to the mounting structure. For Clamping System installation methods, the recommended maximum compression for each clamp is 2900 PSI (20 Mpa) in order to avoid potential damages to module frames. Follow the instruction of the clamping system supplier.
- Provide adequate ventilation under the modules in conformity to your local regulations. A minimum distance of 10 cm between the roof plane and the frame of the module is generally recommended.
- Always observe the instructions and safety precautions included with the module support frames.

- Before installing modules on a roof, always ensure the roof construction is suitable. In addition, any roof penetration required to mount the module must be properly sealed to prevent leaks.
- Dust building up on the surface of the module can impair with the module performance. The modules shall be installed with a tilt angle no less than 10 degrees, making it easier for dust to be removed by rain. A flat angle requires more frequent cleaning.
- Observe and take into account the linear thermal expansion of the module frames (the recommended minimum distance between two modules is 2 cm).
- Always keep the front and backsheet of the module free from foreign objects, plants and vegetation, structural elements, which could come into contact with the module, especially when the module is under mechanical load.
- When installing a module on a pole, select a pole and module mounting structure that will withstand the anticipated wind load and snow load for the area.
- Ensure modules are not subjected to wind or snow loads exceeding the maximum permissible loads, and are not subject to excessive forces due to the thermal expansion of the support structures. Never allow modules overlap or exceeds the rooftop: Refer to the following installation methods for more detailed information.

Installation methods

- Modules can be installed on the frame using mounting holes, clamps* or an insertion system. Modules must be installed according to the following examples. Not mounting the modules according to these instructions may void the warranty.



** The minimum recommended length for each clamp is 50 mm.*

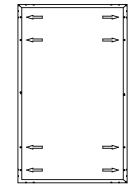
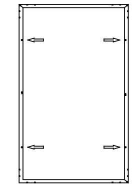
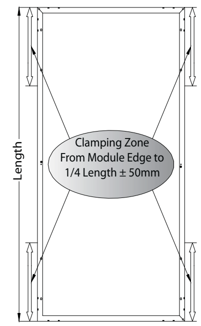
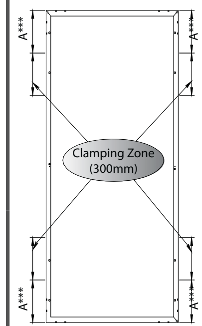
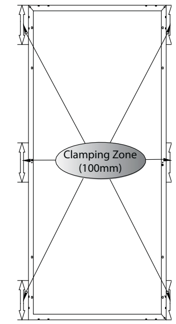
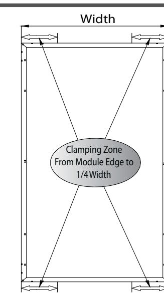
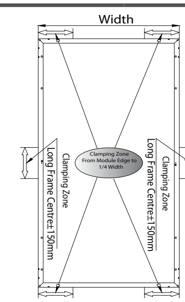
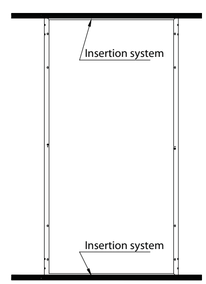
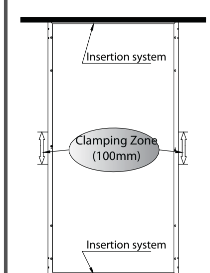
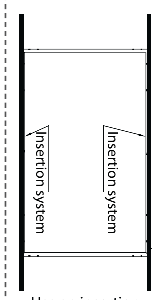
- Module can be installed in both landscape and portrait modes.
- The modules must be properly secured to their support so that they can withstand live load conditions, including wind uplift, to the pressure they have been certified for. It is the installer's responsibility to ensure that the clamps used to secure the modules are strong enough.

Attachment guidelines

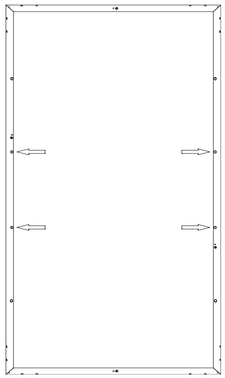
- Select the proper installation method depending on the load(See below for more detailed information).
- With different installation methods, the modules have been tested to withstand the loads of 2400 Pa, 3800 Pa and 5400 Pa according to IEC 61215 standard, equivalent of 1600 Pa(0.232psi), 2500 Pa(0.363psi) and 3600 Pa(0.522psi) respectively under UL 1703 standard.
- The diagrams in the tables below are designed for illustration purpose. For each installation, modules can be installed either in portrait or landscape mode. If you integrate our obsolete products and need advice, please contact Suntech Global Customer Support Department for installation instructions based on older manuals.

Suntech Module Type	Module Dimension Length×Width×Thickness
T Series	1324 mmx992 mmx 35 mm
W Series	1640 mm×992 mm×35 mm 1650 mm×992 mm×35 mm
V Series	1956 mm×992 mm×40 mm 1960 mm×992 mm×40 mm

Suntech T series, W series, V series module

	2400 Pa Load * *2400 Pa Wind Load* *2400 Pa Snow Load*	**3800 Pa Load *** *3800 Pa Wind Load* *3800 Pa Snow Load*	**5400 Pa Load *** *5400 Pa Snow Load* *3800 Pa Wind Load*
Mounting system			 Use eight mounting holes (Exclude Ve)  Use four mounting hole
Clamping system ** Attachment to the long frame	 Use four clamps		 Use four clamps  Use six clamps
Clamping system ** Attachment to the short frame	 Use four clamps on short frame		 Use four clamps on the short frame and two clamps at the center of each long frame
Insertion System	 Use insertion system on short frame		 Use insertion system on a short frame and two clamps at the center of each long frame  Use an insertion system on a long frame

Suntech T series, W series, V series module

	2400 Pa Load * *2400 Pa Wind Load* *2400 Pa Snow Load*	**3800 Pa Load *** *3800 Pa Wind Load* *3800 Pa Snow Load*	**5400 Pa Load *** *5400 Pa Wind Load* *3800 Pa Snow Load*
NEXTracker **** Mounting system			

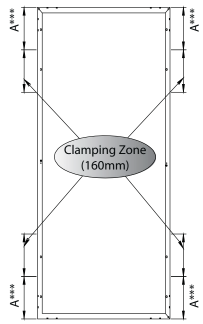
* *The loads of 2400 Pa, 3800 Pa and 5400 Pa are under IEC standard. The installation methods applicable for 5400 Pa are also relevant for 3800 Pa and 2400 Pa. The installation methods applicable for 3800 Pa are also relevant for 2400 Pa.*

** *The module clamps must not come into contact with the front glass or deform the frame in any way. Avoid shading effects from the module clamps and insertion systems. Drainage holes in the module frame must not be closed or obscured by the clamps.*

*** *Measurement A stands for the distance from the module edge to the clamping zone. Measurement A is 150mm for T series 35 mm thickness, 180mm for W series 35mm thickness, 280mm for V series 40mm thickness. The clamping zone defines the range for the middle point of the clamp.*

**** *The mounting holes reserved for Nextracker mounting system with special accessories.*

Suntech W series AC module

	5400 Pa Load * *5400 Pa Snow Load* *3800 Pa Wind Load*
Clamping system ** Attachment to the long frame	 Use four clamps

* *The loads of 3800 Pa and 5400 Pa are under IEC standard. The installation methods applicable for 5400 Pa are also relevant for 3800 Pa and 2400 Pa. The installation methods applicable for 3800 Pa are also relevant for 2400 Pa.*
** *The module clamps must not come into contact with the front glass or deform the frame in any way. Avoid shading effects from the module clamps and insertion systems. Drainage holes in the module frame must not be closed or obscured by the clamps.*
*** *Measurement A stands for the distance from the module edge to the clamping zone. Measurement A is 320 mm for AC module. The clamping zone defines the range for the middle point of the clamp.*

Electrical Installation

General installation

- Any hardware used must be compatible with any other used material to avoid galvanic corrosion. Defects caused by corrosions void the warranty.
- It is not recommended to use modules with different configurations (grounding, wiring) in the same system.
- Excessive cables must be organized or fixed in an adequate way, e.g. attached to the mounting structure by using non-metallic cable ties. Solar cables, connectors and juction boxes should not be exposed to water exposure, and snow, and rain or water submersion for a long period of time(IP65/67/68).
- For applications requiring high operating voltage several modules can be connected in series to form a string of modules; the system voltage is then equal to the sum of the voltage of each module.
- For applications requiring high operating currents several strings of modules can be connected in parallel; the system current is then equal to the sum of the current of each string of modules.
- The maximum system voltage is 600 volts or 1000 volts depending on the product family DC according to standards.
- The maximum number of series connected modules depends on system design, the type of inverter used and environmental conditions.
- Based on the maximum series fuse rating of module and local electrical installation code, always make sure Suntech PV modules are assembled with the appropriate string fuse for circuit protection.
- There is no specific limitation on the number of modules that can be connected in parallel, the number of modules is determined by system design parameters such as current or power output.
- To prevent the cables and the connectors from overheating, the cross section of the cables and the capacity of the connectors must be selected to suit the maximum system short circuit current. The recommended cable is PV wire with a cross section of at least 4mm^2.
- Caution: do not secure the cables too tight. Any cable damage caused by cable management system is not covered under Suntech's warranty.
- Always refer to the cable manufacturer's bending radius which includes the radius just behind the connectors.
- When designing large modules arrays connected to a single inverter, always take into accout the resulting isolation resistance (Riso), which decrease increasing the number of modules in the array. A too low Riso can results in inverter faults.
- Please refer to local regulations to determine the system wires size, type and temperature.
- Suntech modules are supplied with connectors used for system electrical connections. The recommended connectors are Amphenol H4 connectors, Multi Contact MC4 connectors etc. Suntech strongly recommends using the genuine connector type specified by Suntech's product data sheet. Any choice of a different connector type other than specified may void the warranty of the module.
- To ensure reliable electric connection and to prevent possible intrusion of humidity, two Amphenol H4 or two Multi Contact MC4 connectors must be mated and locked together until a click can be heard.
- Long-term exposure to wet environments may cause connectors' poor connectivity, resulting in current leakage and poor conductivity which voids the warranty. Suntech recommends proper connector/cable/wire management to prevent moisture intrusion. Depending on the amount of humidity, Suntech recommends periodic inspections of the installation system to maintain optimal module performance.
- The DC current generated by photovoltaic systems can be converted into AC and fed into a public Grid. As local utilities' policies on connecting renewable energy systems to the Grids vary from region to region. Always seek the advice from a qualified system designer or integrator. Building permits, inspections and approvals by the local utility are generally required.
- Especially for larger installations Suntech recommends lightning protection following the local requirements and regulations.
- When the installation is finished and after connection to the grid please do a professional hand over to the owner including an installation protocol is required. Provide a clear documentation of the system to the owner consisting of following minimum data such as: user guide, system layout, data sheets, performance expectations, electrical system data e.g. a copy of the installation test report following minimum requirements of IEC 62446 / IEC 60364-6.

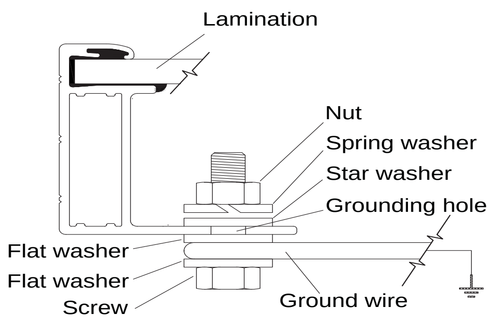
Grounding

- For grounding and bonding requirements, please refer to regional and national safety and electricity standards. If grounding is required, use a recommended connector type for the grounding wire.
- For grounding, this guide refers to module frame grounding. If grounding is required, make sure module frames (metal exposed to touch) are always grounded.
- Suntech recommends always refer to local state and national code requirements for PV module grounding. Suntech highly recommends negative grounding if it's allowed by local authorities.

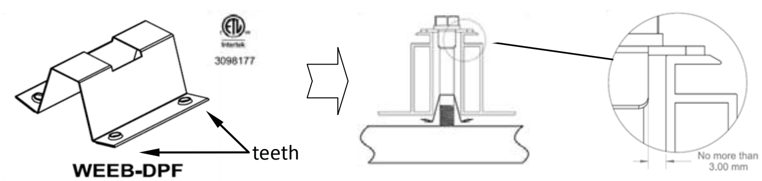
• When attaching the frame grounding hardware and wire to the frame it must be placed corresponding to the ground symbol stamped location to ensure proper electrical connection.

• Suntech recommends one of the following parts for grounding:

1) Use M5 bolt and washer to bond the ground wire and aluminum frame through the grounding hole (as shown below). The tightening torque is 3-7Nm. All nuts and washers should be made of stainless steel. 4-14 mm2 (AWG 6-12) exposed copper wire is recommended as ground wire.



2) Use WEEB-DPF to bond solar modules to module mounting brackets (grounding part is tested to UL467)

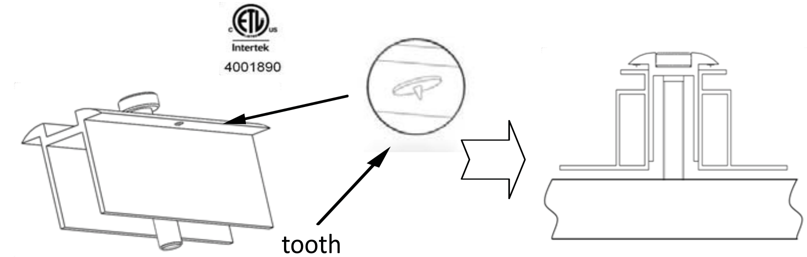


• Notice that WEEB teeth is positioned completely under the edge of the module frame.

• When position of solar module is finalized, torque fasteners to 20.5 N-m/15 ft-lb using general purpose anti-seize on threads.

• For more information, please contact supplier: BURNDY, http://www.we-llc.com

3) Use Schletter clamps to bond solar module to module mounting brackets (grounding part is tested to UL467).



• Recommend fastening torque is 20.5N-m/15 ft-lb.

• For more information, please contact supplier: Schletter, http://www.solar.schletter.eu

Maintenance

To ensure optimum module performance, Suntech recommends the following maintenance measures:

• Clean the module minimum once a year or more often when required depending of the pollution. Remove all organic from the surface. Module with soiling or contamination may reduce the power generation of the system. Always use clean water and a soft non-abrasive sponge or cloth for cleaning. A mild, non-abrasive cleaning agent may be used to remove stubborn dirt.

• Uncontrolled pollution is voiding the warranty or not cleaning the modules in time voids the warranty.

• Check the electrical, grounding and mechanical connections every six months to verify that they are clean, secure,undamaged and free of corrosion. Or else the warranty may be voided.

• In the event of a ground fault condition, NEVER wash or spray modules with water until ground fault has been identified, corrected by an authorized solar inverter service technician and the inverter is fully operational. This can cause electrocution or a serious safety issue.

• If any problem arises, consult a professional solar service providers for suggestions.

• Caution: observe solar manufacturers' maintenance instructions for all components used in the system, such as support frames, charging regulators, inverters, batteries etc.

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E-mail: services@suntech-power.com, serviceUS@suntech-power.com
Or please contact our local representatives, details at www.suntech-power.com

Appendix IV:

North American Space Agency Surface Meteorology and Solar Energy Tables

A new POWER home page with enhanced responsive GIS-enabled web data services and mapping capabilities will soon replace the current SSE home page with a target date of June 13, 2018. This current set of SSE web applications and website will no longer be accessible after that date. The new POWER will include improved solar and meteorological data with all parameters available on a 0.5-degree global grid. The beta version of the new home page, featuring the updated parameters, schedule updates and FAQ, can be accessed at POWER. Please direct any questions to POWER Project Team.

SSE Homepage | Find A Different Location | Accuracy | Methodology | Parameters (Units & Definition)

NASA Surface meteorology and Solar Energy - Available Tables

Latitude 47.466 / Longitude 65.752 was chosen.

Geometry Information

Elevation: **234** meters
taken from the
NASA GEOS-4
model elevation

Northern boundary **48**

Western boundary **65**

Center
Latitude **47.5**
Longitude **65.5**

Eastern boundary **66**

Southern boundary **47**

Parameters for Solar Cooking:

Monthly Averaged Insolation Incident On A Horizontal Surface (kWh/m^2/day)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year Average	1.32	2.29	3.64	5.17	6.09	6.62	6.27	5.66	4.53	2.76	1.62	1.14

Parameter Definition

Monthly Averaged Midday Insolation Incident On A Horizontal Surface (kW/m^2)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year Average	0.22	0.34	0.47	0.57	0.63	0.65	0.65	0.62	0.53	0.37	0.25	0.18

Parameter Definition

Monthly Averaged Clear Sky Insolation Incident On A Horizontal Surface (kWh/m^2/day)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year Average	2.06	3.34	5.18	6.45	7.39	7.63	7.13	6.23	5.03	3.49	2.25	1.72

Parameter Definition

Monthly Averaged Clear Sky Days (days)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year Average	2	3	3	3	2	3	4	4	5	5	4	3

Parameter Definition

Parameters for Sizing and Pointing of Solar Panels and for Solar Thermal Applications:

Monthly Averaged Insolation Incident On A Horizontal Surface (kWh/m^2/day)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average

22-year Average	1.32	2.29	3.64	5.17	6.09	6.62	6.27	5.66	4.53	2.76	1.62	1.14	3.93

Minimum And Maximum Difference From Monthly Averaged Insolation (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	-25	-26	-23	-20	-13	-14	-12	-11	-10	-21	-13	-19
Maximum	29	16	24	14	7	15	13	11	10	17	16	36

Parameter Definition

Monthly Averaged Diffuse Radiation Incident On A Horizontal Surface ($kWh/m^2/day$)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	0.78	1.18	1.75	2.09	2.44	2.59	2.51	2.21	1.90	1.32	0.91	0.69	1.70
Minimum	0.94	1.31	1.98	2.23	2.47	2.82	2.61	2.36	2.03	1.45	1.02	0.86	1.84
Maximum	0.65	0.97	1.59	2.14	2.49	2.64	2.55	2.22	1.81	1.13	0.83	0.60	1.64
22-year Average K	0.44	0.50	0.53	0.56	0.56	0.57	0.56	0.58	0.60	0.52	0.47	0.44	0.53
Minimum K	0.33	0.37	0.41	0.45	0.48	0.49	0.49	0.52	0.54	0.41	0.41	0.35	0.44
Maximum K	0.56	0.58	0.66	0.64	0.60	0.65	0.63	0.64	0.66	0.61	0.55	0.60	0.62

NOTE:	*Diffuse radiation, direct normal radiation and tilted surface radiation are not calculated when the clearness index (K) is below 0.3 or above 0.8.*

Parameter Definition

Monthly Averaged Direct Normal Radiation ($kWh/m^2/day$)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	1.97	3.12	4.12	5.61	6.10	6.58	6.21	6.02	5.28	3.67	2.41	1.81	4.41

Minimum And Maximum Difference From Monthly Averaged Direct Normal Radiation (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	-92	-64	-55	-37	-22	-28	-22	-21	-22	-49	-44	-88
Maximum	97	52	53	21	10	23	19	17	21	45	49	114

NOTE:	*Diffuse radiation, direct normal radiation and tilted surface radiation are not calculated when the clearness index (K) is below 0.3 or above 0.8.*

Parameter Definition

Monthly Averaged Insolation Incident On A Horizontal Surface At Indicated GMT Times (kW/m^2)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average@00	n/a	n/a	0.00	0.00	0.02	0.03	0.02	0.01	0.00	n/a	n/a	n/a
Average@03	0.01	0.03	0.11	0.24	0.32	0.36	0.31	0.26	0.19	0.09	0.03	0.01
Average@06	0.17	0.27	0.41	0.57	0.65	0.69	0.65	0.62	0.54	0.37	0.25	0.17
Average@09	0.22	0.34	0.47	0.57	0.63	0.65	0.65	0.62	0.53	0.35	0.22	0.18
Average@12	0.03	0.09	0.19	0.27	0.33	0.37	0.36	0.30	0.20	0.08	0.02	0.01
Average@15	n/a	n/a	0.00	0.01	0.02	0.04	0.04	0.02	0.00	n/a	n/a	n/a
Average@18	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Average@21	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Parameter Definition

Monthly Averaged Insolation Clearness Index (0 to 1.0)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average K	0.44	0.50	0.53	0.56	0.56	0.57	0.56	0.58	0.60	0.52	0.47	0.44	0.53

Minimum K	0.33	0.37	0.41	0.45	0.48	0.49	0.49	0.52	0.54	0.41	0.41	0.35	0.44
Maximum K	0.56	0.58	0.66	0.64	0.60	0.65	0.63	0.64	0.66	0.61	0.55	0.60	0.62

Parameter Definition

Monthly Averaged Insolation Normalized Clearness Index (0 to 1.0)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year Average	0.40	0.46	0.49	0.52	0.51	0.52	0.51	0.53	0.54	0.48	0.43	0.40

Parameter Definition

Monthly Averaged Clear Sky Insolation Incident On A Horizontal Surface ($kWh/m^2/day$)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	2.06	3.34	5.18	6.45	7.39	7.63	7.13	6.23	5.03	3.49	2.25	1.72	4.83

Parameter Definition

Monthly Averaged Clear Sky Insolation Clearness Index (0 to 1.0)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year Average	0.69	0.73	0.76	0.70	0.68	0.65	0.63	0.64	0.66	0.66	0.66	0.67

Parameter Definition

Monthly Averaged Clear Sky Insolation Normalized Clearness Index (0 to 1.0)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year Average	0.63	0.67	0.69	0.64	0.62	0.60	0.58	0.58	0.60	0.61	0.60	0.61

Parameter Definition

Monthly Averaged Downward Longwave Radiative Flux ($kWh/m^2/day$)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	5.62	5.49	5.95	7.10	8.14	8.86	9.09	8.69	7.77	6.98	6.17	5.75	7.14

Parameter Definition

Solar Geometry:

Monthly Averaged Solar Noon (GMT time)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	0747	0752	0746	0738	0734	0737	0744	0742	0733	0723	0722	0730

Parameter Definition

Monthly Averaged Daylight Hours (hours)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	8.94	10.3	11.9	13.6	15.1	15.9	15.5	14.2	12.6	10.9	9.38	8.53

Parameter Definition

Monthly Averaged Daylight Average Of Hourly Cosine Solar Zenith Angles (dimensionless)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	0.23	0.32	0.40	0.47	0.53	0.54	0.56	0.52	0.47	0.35	0.27	0.22

Parameter Definition

Monthly Averaged Cosine Solar Zenith Angle At Mid-Time Between Sunrise And Solar Noon (dimensionless)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Lat 47.466 Lon 65.752												
Average	0.26	0.35	0.45	0.54	0.58	0.60	0.59	0.56	0.49	0.39	0.29	0.24

Parameter Definition

Monthly Averaged Declination (degrees)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	-20.7	-12.3	-1.79	9.71	18.8	23.0	21.2	13.7	3.08	-8.46	-18.1	-22.8

Parameter Definition

Monthly Averaged Sunset Hour Angle (degrees)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	65.5	76.1	88.0	100	111	117	115	105	93.3	80.6	69.0	62.5

Parameter Definition

Monthly Averaged Maximum Solar Angle Relative To The Horizon (degrees)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	21.7	30.1	40.7	52.2	61.3	65.6	63.7	56.3	45.6	34.0	24.3	19.6

Parameter Definition

Monthly Averaged Hourly Solar Angles Relative To The Horizon (degrees)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0000 GMT	n/a	n/a	n/a	n/a	n/a	1.96	n/a	n/a	n/a	n/a	n/a	n/a
0100 GMT	n/a	n/a	n/a	0.87	8.29	10.9	8.60	3.37	n/a	n/a	n/a	n/a
0200 GMT	n/a	n/a	0.99	10.9	18.1	20.6	18.2	13.2	7.00	0.02	n/a	n/a
0300 GMT	n/a	2.09	10.9	21.0	28.2	30.6	28.3	23.3	17.0	9.64	2.22	n/a
0400 GMT	4.87	11.1	20.4	30.8	38.2	40.7	38.4	33.3	26.4	18.4	10.4	5.37
0500 GMT	12.1	19.0	28.8	39.7	47.6	50.4	48.0	42.5	34.8	25.7	17.1	12.0
0600 GMT	17.6	25.2	35.5	47.0	55.6	58.9	56.5	50.2	41.3	31.1	21.8	16.8
0700 GMT	20.9	29.0	39.7	51.4	60.5	64.5	62.3	55.2	45.0	33.8	24.1	19.3
0800 GMT	21.7	30.1	40.6	51.9	60.8	65.1	63.5	56.0	45.2	33.4	23.7	19.3
0900 GMT	19.8	28.2	38.1	48.3	56.3	60.4	59.5	52.5	41.7	30.0	20.7	16.7
1000 GMT	15.5	23.6	32.7	41.7	48.6	52.4	51.9	45.6	35.3	24.1	15.3	11.9
1100 GMT	9.20	16.9	25.1	33.1	39.4	42.9	42.6	36.8	27.0	16.3	8.11	5.25
1200 GMT	1.36	8.65	16.1	23.5	29.4	32.9	32.7	27.1	17.6	7.30	n/a	n/a
1300 GMT	n/a	n/a	6.41	13.4	19.3	22.8	22.5	17.0	7.66	n/a	n/a	n/a
1400 GMT	n/a	n/a	n/a	3.37	9.45	13.0	12.6	6.94	n/a	n/a	n/a	n/a
1500 GMT	n/a	n/a	n/a	n/a	0.14	3.88	3.35	n/a	n/a	n/a	n/a	n/a
1600 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1700 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1800 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1900 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2000 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2100 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2200 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2300 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Parameter Definition

Monthly Averaged Hourly Solar Azimuth Angles (degrees)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0000 GMT	n/a	n/a	n/a	n/a	n/a	57.1	n/a	n/a	n/a	n/a	n/a	n/a
0100 GMT	n/a	n/a	n/a	76.6	71.2	67.7	67.8	73.0	n/a	n/a	n/a	n/a
0200 GMT	n/a	n/a	93.8	87.6	81.7	77.9	78.1	83.8	92.9	102	n/a	n/a
0300 GMT	n/a	111	105	98.8	92.6	88.4	88.7	94.9	104	113	120	n/a
0400 GMT	128	122	117	111	104	100	100	107	116	126	131	132
0500 GMT	140	135	130	125	119	114	114	121	131	140	144	145
0600 GMT	153	149	146	143	138	133	132	139	148	155	159	158
0700 GMT	168	165	165	165	163	160	157	162	168	173	174	172
0800 GMT	183	182	184	189	193	192	188	188	189	191	190	187
0900 GMT	198	199	203	211	219	221	217	212	209	208	205	201
1000 GMT	212	214	221	230	238	242	238	232	227	223	218	215
1100 GMT	224	228	235	245	253	257	253	247	242	236	231	227
1200 GMT	236	240	248	258	266	269	266	260	254	248	n/a	n/a
1300 GMT	n/a	n/a	260	269	277	279	277	271	266	n/a	n/a	n/a
1400 GMT	n/a	n/a	n/a	280	287	290	287	282	n/a	n/a	n/a	n/a
1500 GMT	n/a	n/a	n/a	n/a	298	300	298	n/a	n/a	n/a	n/a	n/a
1600 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1700 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1800 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1900 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2000 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2100 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2200 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2300 GMT	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Parameter Definition

Parameters for Tilted Solar Panels:

Monthly Averaged Radiation Incident On An Equator-Pointed Tilted Surface (kWh/m²/day)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
SSE HRZ	1.32	2.29	3.64	5.17	6.09	6.62	6.27	5.66	4.53	2.76	1.62	1.14	3.93
K	0.44	0.50	0.53	0.56	0.56	0.57	0.56	0.58	0.60	0.52	0.47	0.44	0.53
Diffuse	0.78	1.18	1.75	2.09	2.44	2.59	2.51	2.21	1.90	1.32	0.91	0.69	1.70
Direct	1.97	3.12	4.12	5.61	6.10	6.58	6.21	6.02	5.28	3.67	2.41	1.81	4.41
Tilt 0	1.27	2.26	3.60	5.15	6.10	6.65	6.30	5.63	4.45	2.68	1.61	1.11	3.91
Tilt 32	1.93	3.18	4.44	5.67	6.07	6.32	6.10	5.96	5.33	3.65	2.46	1.77	4.41
Tilt 47	2.10	3.37	4.50	5.48	5.63	5.75	5.60	5.66	5.33	3.82	2.68	1.95	4.32
Tilt 62	2.16	3.38	4.34	5.02	4.93	4.92	4.84	5.09	5.06	3.80	2.75	2.03	4.03
Tilt 90	1.98	2.95	3.50	3.63	3.28	3.17	3.17	3.53	3.91	3.24	2.50	1.88	3.06
OPT	2.16	3.40	4.51	5.67	6.24	6.71	6.38	6.01	5.36	3.84	2.75	2.03	4.59
OPT ANG	63.0	56.0	44.0	29.0	14.0	9.00	11.0	24.0	39.0	53.0	62.0	65.0	38.9

NOTE:	*Diffuse radiation, direct normal radiation and tilted surface radiation are not calculated when the clearness index (K) is below 0.3 or above 0.8.*

Parameter Definition

Minimum Radiation Incident On An Equator-pointed Tilted Surface (kWh/m²/day)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average

SSE MIN	0.99	1.71	2.82	4.15	5.30	5.71	5.53	5.05	4.08	2.18	1.41	0.92	3.32
K	0.33	0.37	0.41	0.45	0.48	0.49	0.49	0.52	0.54	0.41	0.41	0.35	0.44
Diffuse	0.65	0.97	1.59	2.14	2.49	2.64	2.55	2.22	1.81	1.13	0.83	0.60	1.64
Direct	0.15	1.12	1.82	3.50	4.73	4.72	4.81	4.72	4.12	1.86	1.33	0.21	2.76
Tilt 0	0.95	1.68	2.79	4.13	5.31	5.74	5.55	5.03	4.01	2.12	1.40	0.90	3.31
Tilt 32	1.36	2.27	3.30	4.43	5.25	5.46	5.37	5.29	4.76	2.81	2.09	1.36	3.65
Tilt 47	1.46	2.39	3.31	4.26	4.87	4.96	4.93	5.02	4.74	2.93	2.26	1.49	3.56
Tilt 62	1.49	2.38	3.17	3.90	4.28	4.28	4.28	4.51	4.50	2.90	2.32	1.53	3.30
Tilt 90	1.35	2.06	2.54	2.84	2.90	2.83	2.86	3.15	3.48	2.46	2.10	1.41	2.50
OPT	1.49	2.40	3.33	4.45	5.42	5.78	5.62	5.33	4.78	2.94	2.32	1.53	3.79
OPT ANG	60.0	54.0	40.0	27.0	14.0	9.00	11.0	23.0	39.0	51.0	61.0	63.0	37.5

NOTE:	*Diffuse radiation, direct normal radiation and tilted surface radiation are not calculated when the clearness index (K) is below 0.3 or above 0.8.*

Parameter Definition

Maximum Radiation Incident On An Equator-pointed Tilted Surface ($kWh/m^2/day$)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
SSE MAX	1.70	2.67	4.50	5.87	6.53	7.61	7.06	6.27	5.00	3.22	1.88	1.55	4.49
K	0.56	0.58	0.66	0.64	0.60	0.65	0.63	0.64	0.66	0.61	0.55	0.60	0.62
Diffuse	0.94	1.31	1.98	2.23	2.47	2.82	2.61	2.36	2.03	1.45	1.02	0.86	1.84
Direct	3.90	4.77	6.35	6.80	6.76	8.12	7.44	7.07	6.42	5.35	3.60	3.89	5.88
Tilt 0	1.63	2.63	4.45	5.84	6.54	7.65	7.09	6.23	4.92	3.13	1.87	1.51	4.47
Tilt 32	2.59	3.76	5.60	6.47	6.52	7.27	6.88	6.62	5.91	4.33	2.92	2.54	5.12
Tilt 47	2.84	4.00	5.70	6.26	6.04	6.61	6.31	6.29	5.92	4.56	3.19	2.83	5.05
Tilt 62	2.94	4.03	5.52	5.74	5.28	5.64	5.44	5.65	5.62	4.55	3.29	2.97	4.73
Tilt 90	2.71	3.53	4.45	4.15	3.50	3.61	3.53	3.91	4.35	3.89	3.01	2.78	3.62
OPT	2.94	4.04	5.71	6.48	6.70	7.71	7.19	6.67	5.95	4.58	3.29	2.98	5.36
OPT ANG	64.0	57.0	45.0	30.0	15.0	9.00	11.0	24.0	40.0	54.0	63.0	67.0	39.8

NOTE:	*Diffuse radiation, direct normal radiation and tilted surface radiation are not calculated when the clearness index (K) is below 0.3 or above 0.8.*

Parameter Definition

Parameters for Sizing Battery or other Energy-storage Systems:

Minimum Available Insolation Over A Consecutive-day Period (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min/1 day	3.78	4.34	18.4	13.5	15.2	19.1	26.3	13.4	23.3	7.24	3.70	3.50
Min/3 day	5.55	27.9	38.1	35.2	47.5	50.0	49.6	45.6	42.2	30.0	22.6	28.0
Min/7 day	30.8	45.3	48.3	53.2	63.8	61.0	70.4	63.2	69.1	40.6	49.3	40.1
Min/14 day	47.5	52.9	71.1	68.2	72.4	67.3	80.1	80.2	76.8	57.6	66.5	59.5
Min/21 day	66.4	63.5	76.2	70.8	80.3	83.0	82.2	85.2	82.2	72.7	73.4	66.4
Min/Month	75.0	74.3	77.4	80.2	87.0	86.2	88.1	89.3	90.0	78.9	87.0	80.7

Parameter Definition

Solar Radiation Deficits Below Expected Values Incident On A Horizontal Surface Over A Consecutive-day Period (kWh/m^2)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 day	1.27	2.20	2.97	4.47	5.16	5.35	4.62	4.90	3.47	2.56	1.56	1.10
3 day	3.74	4.97	6.75	10.0	9.59	9.93	9.47	9.23	7.85	5.79	3.76	2.46

7 day	6.39	8.80	13.1	16.9	15.4	18.0	12.9	14.5	9.77	11.4	5.74	4.78
14 day	9.69	15.1	14.7	22.9	23.4	30.2	17.4	15.6	14.6	16.3	7.59	6.46
21 day	9.30	17.6	18.1	31.6	25.0	23.6	23.4	17.5	16.8	15.7	9.02	8.02
Month	10.2	16.5	25.4	30.6	24.4	27.3	22.9	18.6	13.5	17.9	6.30	6.82

Parameter Definition

Equivalent Number Of NO-SUN Or BLACK Days (days)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 day	0.96	0.95	0.81	0.86	0.84	0.80	0.73	0.86	0.76	0.92	0.96	0.96
3 day	2.83	2.16	1.85	1.94	1.57	1.50	1.51	1.63	1.73	2.09	2.32	2.15
7 day	4.84	3.82	3.61	3.27	2.52	2.72	2.06	2.57	2.15	4.15	3.54	4.19
14 day	7.34	6.58	4.04	4.44	3.85	4.57	2.77	2.76	3.23	5.92	4.68	5.66
21 day	7.04	7.66	4.99	6.11	4.11	3.56	3.73	3.10	3.72	5.71	5.56	7.03
Month	7.75	7.18	6.98	5.91	4.02	4.12	3.65	3.28	2.98	6.51	3.88	5.98

Parameter Definition

Parameters for Sizing Surplus-product Storage Systems:

Available Surplus Insolation Over A Consecutive-day Period (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max/1 day	198	190	174	151	142	135	137	137	151	169	178	178
Max/3 day	188	179	166	149	135	132	133	135	142	164	166	175
Max/7 day	181	161	155	138	124	129	127	128	139	152	155	156
Max/14 day	154	145	144	125	117	124	118	121	122	143	133	155
Max/21 day	139	130	140	119	112	121	117	117	117	128	126	137
Max/Month	129	116	124	114	107	115	113	111	110	117	116	136

Parameter Definition

Cloud Information:

Monthly Averaged Daylight Cloud Amount (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	58.3	54.4	57.2	58.1	56.7	48.8	47.0	44.8	44.6	53.7	54.8	59.0	53.1

Parameter Definition

Monthly Averaged Cloud Amount At Indicated GMT Times (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average@00	n/a	n/a	29.0	43.1	45.7	32.0	31.5	28.9	31.8	n/a	n/a	n/a
Average@03	63.4	58.0	54.3	53.3	53.0	40.6	39.5	35.3	41.9	51.2	50.7	60.3
Average@06	62.1	56.1	59.6	56.1	52.4	44.7	42.4	37.8	40.5	52.1	53.1	59.0
Average@09	57.2	53.4	60.2	61.6	66.3	62.1	59.3	50.5	45.7	55.1	59.9	58.9
Average@12	55.7	50.1	54.6	61.6	66.5	62.5	61.5	56.3	50.3	56.5	55.6	57.7
Average@15	n/a	n/a	49.2	54.7	56.0	50.7	48.0	44.3	42.1	n/a	n/a	n/a
Average@18	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Average@21	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Parameter Definition

Monthly Averaged Frequency Of Clear Skies At Indicated GMT Times (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

< 10% @0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
< 10% @3	n/a	n/a	23.1	25.7	24.3	36.8	38.7	44.8	37.2	n/a	n/a	n/a
< 10% @6	14.6	17.2	17.0	23.9	27.2	31.5	35.0	40.9	38.0	31.2	25.6	18.1
< 10% @9	17.7	17.5	15.6	16.6	15.2	15.6	17.0	25.9	32.5	29.6	21.3	17.4
< 10% @12	n/a	n/a	22.2	17.5	16.1	15.9	14.2	21.1	28.9	n/a	n/a	n/a
< 10% @15	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
< 10% @18	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
< 10% @21	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Monthly Averaged Frequency Of Broken-cloud Skies At Indicated GMT Times (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10 - 70% @0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10 - 70% @3	n/a	n/a	29.2	27.1	30.3	31.2	29.3	27.4	28.1	n/a	n/a	n/a
10 - 70% @6	31.3	36.3	29.4	25.7	27.5	33.9	31.0	29.1	29.3	21.1	27.7	28.3
10 - 70% @9	33.4	38.9	31.6	28.4	24.6	29.2	31.6	30.3	30.3	18.7	22.7	30.3
10 - 70% @12	n/a	n/a	30.7	26.9	21.7	27.8	32.9	29.4	28.1	n/a	n/a	n/a
10 - 70% @15	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10 - 70% @18	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10 - 70% @21	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Monthly Averaged Frequency Of Near-overcast Skies At Indicated GMT Times (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
>= 70% @0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
>= 70% @3	n/a	n/a	47.6	47.1	45.3	31.9	31.9	27.7	34.5	n/a	n/a	n/a
>= 70% @6	53.9	46.4	53.5	50.3	45.1	34.5	33.8	29.9	32.5	47.6	46.6	53.5
>= 70% @9	48.8	43.5	52.6	54.8	60.1	55.1	51.3	43.7	37.1	51.6	55.9	52.2
>= 70% @12	n/a	n/a	46.9	55.4	62.1	56.2	52.7	49.4	42.8	n/a	n/a	n/a
>= 70% @15	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
>= 70% @18	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
>= 70% @21	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Parameter Definition

Meteorology (Temperature):

Monthly Averaged Air Temperature At 10 m Above The Surface Of The Earth (°C)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	-9.71	-9.68	-3.72	8.36	17.7	24.1	25.3	22.9	16.2	7.35	-1.48	-7.65	7.59
Minimum	-13.8	-14.3	-7.41	3.35	11.7	18.1	19.8	17.4	11.3	3.27	-4.38	-11.4	2.90
Maximum	-6.28	-5.8	-0.24	13.3	22.4	28.5	29.4	27.6	21.1	11.4	1.10	-4.49	11.6

Parameter Definition

Average Daily Temperature Range (°C)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year Average	7.54	8.56	7.16	9.96	10.6	10.4	9.53 *	10.2	9.84	8.16	5.48	6.95

*** Warmest month**

Parameter Definition

Monthly Averaged Cooling Degree Days Above 18 °C

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	

Lat 47.466 Lon 65.752													Annual Sum
22-year Average	0	0	0	3	39	167	206	147	30	0	0	0	592

Parameter Definition

Monthly Averaged Heating Degree Days Below 18 °C

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Sum
22-year Average	869	793	676	292	67	6	0	6	83	330	588	804	4514

Parameter Definition

Monthly Averaged Arctic Heating Degree Days Below 10 °C

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Sum
22-year Average	621	567	428	101	4	0	0	0	5	112	348	556	2742

Parameter Definition

Monthly Averaged Arctic Heating Degree Days Below 0 °C

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Sum
22-year Average	311	285	143	6	0	0	0	0	0	2	87	248	1082

Parameter Definition

Monthly Averaged Earth Skin Temperature (°C)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	-10.7	-10.5	-3.92	9.76	20.5	27.6	28.3	24.9	17.5	7.67	-1.94	-8.51	8.50

Parameter Definition

Average Minimum, Maximum and Amplitude Of The Daily Mean Earth Temperature (°C)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Amplitude
Minimum	-15.7	-16.3	-8.98	1.87	10.2	16.7	18.7	15.9	9.74	1.85	-5.61	-13.0	
Maximum	-5.71	-4.63	1.83	19.7	31.9	39.5	38.9	35.4	27.9	15.5	2.29	-3.91	
Amplitude	5.00	5.85	5.40	8.94	10.8	11.3	10.1	9.76	9.11	6.84	3.95	4.58	27.9

Parameter Definition

Monthly Averaged Frost Days (days)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Sum
22-year Average	30	28	27	9	0	0	0	0	0	7	23	30	154

Parameter Definition

Dew/Frost Point Temperature At 10 m (°C)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Average	-12.7	-12.9	-7.57	-1.51	1.45	5.12	8.57	5.91	1.19	-1.65	-5.98	-11.0

Parameter Definition

Meteorology (Wind):

Monthly Averaged Wind Speed At 50 m Above The Surface Of The Earth (m/s)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	5.17	5.26	5.11	5.65	5.47	5.41	5.53	5.40	5.44	5.37	5.05	4.91	5.31

Minimum And Maximum Difference From Monthly Averaged Wind Speed At 50 m (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Minimum	-14	-11	-15	-10	-10	-9	-9	-10	-9	-9	-12	-19	-11
Maximum	8	17	18	8	16	10	12	10	11	9	11	13	12

It is recommended that users of these wind data review the SSE Methodology. The user may wish to correct for biases as well as local effects within the selected grid region.

All height measurements are from the soil, water, or ice/snow surface instead of "effective" surface, which is usually taken to be near the tops of vegetated canopies.

Parameter Definition Units Conversion Chart

Monthly Averaged Percent Of Time The Wind Speed At 50 m Above The Surface Of The Earth Is Within The Indicated Range (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
0 - 2 m/s	9	12	11	8	10	10	9	10	9	10	13	12	10
3 - 6 m/s	65	58	62	55	57	58	57	55	54	57	61	66	59
7 - 10 m/s	25	28	27	35	32	32	34	34	36	32	24	22	30
11 - 14 m/s	0	2	1	2	1	1	1	1	1	1	1	0	1
15 - 18 m/s	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 25 m/s	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter Definition

Monthly Averaged Wind Speed At 50 m Above The Surface Of The Earth For Indicated GMT Times (m/s)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Average@0130	5.66	5.80	5.66	5.68	5.34	5.09	5.15	5.62	6.01	5.79	5.53	5.39	5.55
Average@0430	5.25	4.88	4.16	3.98	3.53	3.35	3.38	3.17	3.78	4.50	4.92	5.07	4.16
Average@0730	3.56	3.48	3.81	5.22	5.41	5.32	5.31	4.99	4.59	3.90	3.41	3.41	4.37
Average@1030	3.74	4.11	4.63	5.90	5.82	5.58	5.84	5.53	5.53	5.30	3.93	3.38	4.94
Average@1330	5.41	5.32	5.09	5.87	5.78	5.68	6.02	5.68	5.47	5.30	5.04	5.13	5.48
Average@1630	6.05	6.30	5.90	6.07	5.79	5.93	6.19	5.95	5.83	5.99	5.90	5.78	5.97
Average@1930	5.95	6.22	5.88	6.31	6.10	6.25	6.28	6.17	6.19	6.21	5.91	5.65	6.09
Average@2230	5.76	6.02	5.74	6.14	6.02	6.05	6.08	6.10	6.16	5.99	5.74	5.47	5.93

Parameter Definition Units Conversion Chart

Monthly Averaged Wind Direction At 50 m Above The Surface Of The Earth (degrees)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10-year Average	155	135	112	101	93	78	61	50	48	48	53	65

Parameter Definition

Monthly Averaged Wind Direction At 50 m Above The Surface Of The Earth For Indicated GMT Times (degrees)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average@0130	151	101	74	74	72	68	48	65	92	148	116	133
Average@0430	147	103	73	72	67	48	23	48	91	150	126	134
Average@0730	149	108	74	76	339	7	316	316	300	247	137	135
Average@1030	163	110	74	40	317	351	316	318	298	270	171	141
Average@1330	161	95	68	15	336	1	331	332	317	277	119	141
Average@1630	160	96	74	40	13	25	354	0	3	264	114	145
Average@1930	158	103	81	62	52	50	18	33	69	191	117	146
Average@2230	157	102	80	74	70	65	37	54	91	156	112	139

Parameter Definition

Monthly Averaged Wind Speed At 10 m Above The Surface Of The Earth For Terrain Similar To Airports (m/s)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	4.08	4.16	4.04	4.46	4.32	4.26	4.37	4.26	4.30	4.24	3.99	3.88	4.19

It is recommended that users of these wind data review the SSE Methodology. The user may wish to correct for biases as well as local effects within the selected grid region.	***All height measurements are from the soil, water, or ice/snow surface instead of "effective" surface, which is usually taken to be near the tops of vegetated canopies.***

Parameter Definition Units Conversion Chart

Difference Between The Average Wind Speed At 10 m Above The Surface Of The Earth And The Average Wind speed At 50 m Above The Surface Of The Earth (%)
Vegetation type **"Airport": flat rough grass**

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	-21	-20	-21	-20	-21	-20	-20	-20	-21	-21	-20	-20	-20

Parameter Definition

Monthly Averaged Wind Speed Adjusted For Height And Vegetation Type (m/s)
Height **100 meters**
Vegetation type **"Airport": flat rough grass**

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	5.73	5.83	5.66	6.26	6.06	6.00	6.13	5.99	6.03	5.95	5.60	5.44	5.89

Parameter Definition

Monthly Averaged Wind Speed At 50, 100, 150 and 300 m Above The Surface Of The Earth (m/s)
Vegetation type **"Airport": flat rough grass**

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
50m	5.17	5.26	5.11	5.65	5.47	5.41	5.53	5.40	5.44	5.37	5.05	4.91	5.31
100m	5.73	5.83	5.66	6.26	6.06	6.00	6.13	5.99	6.03	5.95	5.60	5.44	5.89
150m	6.09	6.20	6.02	6.66	6.44	6.37	6.52	6.36	6.41	6.33	5.95	5.78	6.26
300m	6.76	6.88	6.68	7.39	7.15	7.07	7.23	7.06	7.11	7.02	6.60	6.42	6.95

Parameter Definition

Monthly Averaged Wind Speed For Several Vegetation And Surface Types (m/s)
Height **100 meters**

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
35-m broadleaf-evergreen trees (70% coverage)	7.16	7.28	7.07	7.82	7.57	7.49	7.65	7.47	7.53	7.43	6.99	6.80	7.36
20-m broadleaf-deciduous trees (75% coverage)	6.54	6.70	6.55	7.30	7.16	7.23	7.50	7.22	7.12	6.93	6.48	6.25	6.92
20-m broadleaf and needleleaf trees (75% coverage)	7.36	7.28	6.88	7.50	7.16	7.04	7.19	7.17	7.32	7.38	7.04	6.94	7.19
17-m needleleaf-evergreen trees (75% coverage)	6.96	6.89	6.55	7.15	6.97	6.94	7.14	6.97	7.03	6.98	6.61	6.52	6.89
14-m needleleaf-deciduous trees (50% coverage)	6.86	6.89	6.60	7.20	6.97	6.84	6.99	7.02	7.27	7.28	6.85	6.61	6.95
Savanna:18-m broadleaf trees (30%) & groundcover	6.86	6.98	6.78	7.50	7.26	7.18	7.34	7.17	7.22	7.13	6.70	6.52	7.06
0.6-m perennial groundcover (100%)	6.23	6.34	6.16	6.81	6.59	6.52	6.66	6.51	6.55	6.47	6.08	5.92	6.40
0.5-m broadleaf shrubs (variable %) & groundcover	6.23	6.34	6.16	6.81	6.59	6.52	6.66	6.51	6.55	6.47	6.08	5.92	6.40
0.5-m broadleaf shrubs (10%) with bare soil	6.23	6.34	6.16	6.81	6.59	6.52	6.66	6.51	6.55	6.47	6.08	5.92	6.40
Tundra: 0.6-m trees/shrubs (variable %) & groundcover	6.23	6.34	6.16	6.81	6.59	6.52	6.66	6.51	6.55	6.47	6.08	5.92	6.40
Rough bare soil	6.02	6.12	5.95	6.58	6.37	6.30	6.44	6.28	6.33	6.25	5.88	5.71	6.18

Crop: 20-m broadleaf-deciduous trees (10%) & wheat	6.27	6.47	5.99	7.20	6.97	6.89	7.04	6.88	6.93	6.75	6.26	6.00	6.64
Rough glacial snow/ice	6.58	6.61	6.29	6.86	6.64	6.56	6.71	6.55	6.69	6.75	6.39	6.25	6.57
Smooth sea ice	5.85	5.83	5.55	6.01	5.82	5.75	5.88	5.86	6.03	6.12	5.76	5.60	5.84
Open water	5.54	5.63	5.47	6.05	5.86	5.79	5.92	5.78	5.83	5.75	5.41	5.26	5.69
"Airport": flat rough grass	5.73	5.83	5.66	6.26	6.06	6.00	6.13	5.99	6.03	5.95	5.60	5.44	5.89

Parameter Definition

Meteorology (Other):

Monthly Averaged Relative Humidity (%)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	78.8	77.8	75.6	54.9	37.7	33.3	39.1	36.5	39.2	56.7	72.8	77.5	56.6

Parameter Definition

Monthly Averaged Specific Humidity At 10 m Above The Surface Of The Earth (kg/kg)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year Average	0.001707	0.001708	0.002532	0.003865	0.004868	0.006278	0.007938	0.006526	0.004666	0.003762	0.002858	0.001968

Parameter Definition

Monthly Averaged Atmospheric Pressure (kPa)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	99.7	99.7	99.5	99.1	98.7	98.2	98.0	98.3	98.9	99.4	99.7	99.8	99.1

Parameter Definition

Monthly Averaged Total Column Precipitable Water (cm)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	0.61	0.57	0.75	1.05	1.48	1.94	2.34	1.98	1.47	1.12	0.90	0.69	1.24

Parameter Definition

Monthly Averaged Precipitation (mm/day)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	1.11	0.92	0.81	0.77	0.72	0.49	0.56	0.31	0.24	0.56	0.97	1.04	0.70

Parameter Definition

Supporting Information:

Monthly Averaged Top-of-atmosphere Insolation (kWh/m^2/day)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	3.00	4.55	6.78	9.09	10.8	11.5	11.1	9.69	7.55	5.24	3.39	2.56	7.13

Parameter Definition

Monthly Averaged Surface Albedo (0 to 1.0)

Lat 47.466 Lon 65.752	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	0.43	0.44	0.30	0.16	0.19	0.20	0.20	0.20	0.20	0.20	0.19	0.33	0.25

Parameter Definition

Back to SSE Data Set Home Page

Responsible > Data: Paul W. Stackhouse, Jr., Ph.D.
Officials > Archive: John M. Kusterer
Site Administration/Help: NASA Langley ASDC User Services (Contact Us)
[Privacy Policy and Important Notices]
Document generated on Thu May 3 12:41:20 EDT 2018

Appendix V:

Online Well Log System Records

Environment

Report Number 5141

Well Driller's Report

Date printed 5/3/2018

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Domestic	New Well	Rotary	05/26/2006

Casing Information

Casing above ground 0.30m   Drive Shoe Used? Yes

Well Log	Casing Type	Diameter	From	End	Slotted?
5141	Steel	15.24cm	0m	11.89m	

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	36.58m	2.28 lpm	0hr 30min	9.14m	2.28 lpm	No	0 lpm

(BTC - Below top of casing)

Well Grouting

There is no Grout information.

Drilling Fluids Used
None

Disinfectant
Bleach (Javex)

Qty 0L

Pump Installed
N/A

Intake Setting (BTC)
33.53m

Driller's Log

Well Log	From	End	Colour	Rock Type
5141	0m	5.79m	Brown	Gravel
5141	5.79m	9.75m	Brown	Slate and Clay
5141	9.75m	11.28m	Brown	Gravel
5141	11.28m	15.85m	Red	Granite
5141	15.85m	22.86m	Grey	Granite
5141	22.86m	27.74m	Brown	Granite
5141	27.74m	36.58m	Grey	Granite

Overall Well Depth
36.58m

Bedrock Level
0m

Water Bearing Fracture Zone

Well Log	Depth	Rate
5141	15.24m	2.28 lpm

Setbacks

Well Log	Distance	Setback From
5141	30.48m	Right of any Public Way Road

Environment

Report Number 7055

Well Driller's Report

Date printed 5/3/2018

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Domestic	New Well	Rotary	09/09/2002

Casing Information

Casing above ground 0.30m   Drive Shoe Used? Yes

Well Log	Casing Type	Diameter	From	End	Slotted?
7055	Steel	15.24cm	0m	21.03m	

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	0m	45.5 lpm	0hr 30min	0m	45.5 lpm	No	0 lpm

(BTC - Below top of casing)

Well Grouting

There is no Grout information.

Drilling Fluids Used
Water

Disinfectant
Bleach (Javex)

Qty 0L

Pump Installed
N/A

Intake Setting (BTC)
22.86m

Driller's Log

Well Log	From	End	Colour	Rock Type
7055	0m	10.67m	Brown	Gravel
7055	10.67m	11.89m	Brown	Slate and Clay
7055	11.89m	18.29m	Brown	Till
7055	18.29m	19.81m	Brown	Slate and Clay
7055	19.81m	30.48m	Grey	Granite

Overall Well Depth
30.48m

Bedrock Level
19.81m

Water Bearing Fracture Zone

Well Log	Depth	Rate
7055	27.43m	45.5 lpm

Setbacks

Well Log	Distance	Setback From
7055	16.76m	Septic Tank
7055	23.77m	Leach Field
7055	38.10m	Right of any Public Way Road

Environment

Report Number 8716

Well Driller's Report

Date printed 5/3/2018

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Domestic	New Well	Rotary	08/15/2006

Casing Information

Casing above ground 0.30m   Drive Shoe Used? Yes

Well Log	Casing Type	Diameter	From	End	Slotted?
8716	Steel	15.24cm	0m	8.23m	

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	12.19m	45.5 lpm	0hr 30min	3.66m	45.5 lpm	No	0 lpm

(BTC - Below top of casing)

Well Grouting

There is no Grout information.

Drilling Fluids Used
None

Disinfectant
Bleach (Javex)
Qty 0L

Pump Installed
N/A
Intake Setting (BTC)
9.14m

Driller's Log

Well Log	From	End	Colour	Rock Type
8716	0m	7.32m	Brown	Gravel
8716	7.32m	7.92m	Grey	Slate and Clay
8716	7.92m	10.36m	Red	Granite
8716	10.36m	12.19m	Grey	Granite

Overall Well Depth
12.19m

Bedrock Level
0m

Water Bearing Fracture Zone

Well Log	Depth	Rate
8716	9.14m	45.5 lpm

Setbacks

Well Log	Distance	Setback From
8716	16.76m	Septic Tank
8716	24.08m	Leach Field

Environment

Report Number 31395

Well Driller's Report

Date printed 5/3/2018

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Domestic	New Well	Rotary	07/04/2013

Casing Information

Casing above ground 0.30m

Drive Shoe Used? Yes

Well Log	Casing Type	Diameter	From	End	Slotted?
31395	Steel	15.24cm	0m	5.79m	

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	24.38m	2.28 lpm	0hr 30min	3.66m	2.28 lpm	No	0 lpm

(BTC - Below top of casing)

Well Grouting

Well Log	Grout Type	From	End
31395	Bentonite	3.05m	4.27m

Drilling Fluids Used
Water

Disinfectant
Bleach (Javex)
Qty 0L

Pump Installed
N/A
Intake Setting (BTC)
0m

Driller's Log

Well Log	From	End	Colour	Rock Type
31395	21.95m	24.38m	Grey	Slate
31395	0m	0.30m	Brown	Till
31395	0.30m	3.66m	Brown	Shale
31395	3.66m	6.40m	Grey	Slate
31395	6.40m	6.71m	Brown	Slate
31395	6.71m	21.34m	Grey	Slate
31395	21.34m	21.95m	Brown	Slate

Overall Well Depth
24.38m

Bedrock Level
0m

Water Bearing Fracture Zone

Well Log	Depth	Rate
31395	22.86m	2.28 lpm

Setbacks

Well Log	Distance	Setback From
31395	31.09m	Center of road

New Nouveau Brunswick

Environment

Report Number 31397

Well Driller's Report

Date printed 5/3/2018

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Domestic	New Well	Rotary	09/04/2013

Casing Information

Casing above ground 0.30m

Drive Shoe Used? Yes

Well Log	Casing Type	Diameter	From	End	Slotted?
31397	Steel	15.24cm	0m	5.79m	

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	18.29m	22.75 lpm	0hr 30min	3.05m	22.75 lpm	No	0 lpm

(BTC - Below top of casing)

Well Grouting

Well Log	Grout Type	From	End
31397	Bentonite	3.66m	4.88m

Drilling Fluids Used
Water

Disinfectant
Bleach (Javex)
Qty 0L

Pump Installed
N/A
Intake Setting (BTC)
0m

Driller's Log

Well Log	From	End	Colour	Rock Type
31397	0.91m	18.29m	Grey	Slate
31397	0m	0.91m	Brown	Till

Overall Well Depth
18.29m

Bedrock Level
0m

Water Bearing Fracture Zone

Well Log	Depth	Rate
31397	12.19m	4.55 lpm
31397	15.24m	13.65 lpm

Setbacks

Well Log	Distance	Setback From
31397	30.48m	Right of any Public Way Road

Environment

Report Number 31398

Well Driller's Report

Date printed 5/3/2018

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Domestic	New Well	Rotary	09/30/2013

Casing Information

Casing above ground 0.30m   Drive Shoe Used? Yes

Well Log	Casing Type	Diameter	From	End	Slotted?
31398	Steel	15.24cm	0m	5.79m	

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	18.29m	2.28 lpm	0hr 30min	3.35m	2.28 lpm	No	0 lpm

(BTC - Below top of casing)

Well Grouting

Well Log	Grout Type	From	End
31398	Bentonite	3.66m	4.88m

Drilling Fluids Used
Water

Disinfectant
Bleach (Javex)

Qty 0L

Pump Installed
N/A

Intake Setting (BTC)
0m

Driller's Log

Well Log	From	End	Colour	Rock Type
31398	0m	1.52m	Brown	Boulders
31398	1.52m	18.29m	Grey	Slate

Overall Well Depth
18.29m

Bedrock Level
0m

Water Bearing Fracture Zone

Well Log	Depth	Rate
31398	7.62m	2.28 lpm

Setbacks

Well Log	Distance	Setback From
31398	16.76m	Septic Tank
31398	23.77m	Leach Field
31398	30.48m	Center of road

Appendix VI:

Atlantic Canada Conservation Data Centre Report

Atlantic Canada Conservation Data Centre
Centre de données sur la conservation du Canada atlantique

DATA REPORT 6081: Bathurst Mines, NB

Prepared 14 May 2018
by J. Churchill, Data Manager

CONTENTS OF REPORT

Map 1. A 100 km buffer around the study area

1.0 PREFACE

The Atlantic Canada Conservation Data Centre (ACCDC) is part of a network of NatureServe data centres and heritage programs serving 50 states in the U.S.A, 10 provinces and 1 territory in Canada, plus several Central and South American countries. The NatureServe network is more than 30 years old and shares a common conservation data methodology. The ACCDC was founded in 1997, and maintains data for the jurisdictions of New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador. Although a non-governmental agency, the ACCDC is supported by 6 federal agencies and 4 provincial governments, as well as through outside grants and data processing fees. URL: www.ACCDC.com.

Upon request and for a fee, the ACCDC queries its database and produces customized reports of the rare and endangered flora and fauna known to occur in or near a specified study area. As a supplement to that data, the ACCDC includes locations of managed areas with some level of protection, and known sites of ecological interest or sensitivity.

1.1 DATA LIST

Included datasets:

Filename	Contents
BathurstMineNB_6081ob.xls	All Rare and legally protected *Flora and Fauna* in your study area
BathurstMineNB_6081ob100km.xls	A list of Rare and legally protected *Flora and Fauna* within 100 km of your study area
BathurstMineNB_6081sa.xls	All *Significant Natural Areas* in your study area
BathurstMineNB_6081ff.xls	Rare and common *Freshwater Fish* in your study area (DFO database)

1.2 RESTRICTIONS

The ACCDC makes a strong effort to verify the accuracy of all the data that it manages, but it shall not be held responsible for any inaccuracies in data that it provides. By accepting ACCDC data, recipients assent to the following limits of use:

a) Data is restricted to use by trained personnel who are sensitive to landowner interests and to potential threats to rare and/or endangered flora and fauna posed by the information provided.
b) Data is restricted to use by the specified Data User; any third party requiring data must make its own data request.
c) The ACCDC requires Data Users to cease using and delete data 12 months after receipt, and to make a new request for updated data if necessary at that time.
d) ACCDC data responses are restricted to the data in our Data System at the time of the data request.
e) Each record has an estimate of locational uncertainty, which must be referenced in order to understand the record's relevance to a particular location. Please see attached Data Dictionary for details.
f) ACCDC data responses are not to be construed as exhaustive inventories of taxa in an area.
g) The absence of a taxon cannot be inferred by its absence in an ACCDC data response.

1.3 ADDITIONAL INFORMATION

The attached file DataDictionary 2.1.pdf provides metadata for the data provided.

Please direct any additional questions about ACCDC data to the following individuals:

Plants, Lichens, Ranking Methods, All other Inquiries
Sean Blaney, Senior Scientist, Executive Director
Tel: (506) 364-2658
sblaney@mta.ca

Animals (Fauna)
John Klymko, Zoologist
Tel: (506) 364-2660
jklymko@mta.ca

Plant Communities
Sarah Robinson, Community Ecologist
Tel: (506) 364-2664
srobinson@mta.ca

Data Management, GIS
James Churchill, Data Manager
Tel: (902) 679-6146
jlchurchill@mta.ca

Billing
Jean Breau
Tel: (506) 364-2657
jrbreau@mta.ca

Questions on the biology of Federal Species at Risk can be directed to ACCDC: (506) 364-2658, with questions on Species at Risk regulations to: Samara Eaton, Canadian Wildlife Service (NB and PE): (506) 364-5060 or Julie McKnight, Canadian Wildlife Service (NS): (902) 426-4196.

For provincial information about rare taxa and protected areas, or information about game animals, deer yards, old growth forests, archeological sites, fish habitat etc., in New Brunswick, please contact Stewart Lusk, Natural Resources: (506) 453-7110.

For provincial information about rare taxa and protected areas, or information about game animals, deer yards, old growth forests, archeological sites, fish habitat etc., in Nova Scotia, please contact Sherman Boates, NSDNR: (902) 679-6146. To determine if location-sensitive species (section 4.3) occur near your study site please contact a NSDNR Regional Biologist:

Western: Duncan Bayne
(902) 648-3536
Duncan.Bayne@novascotia.ca

Western: Jason Power
(902) 634-7555
Jason.Power@novascotia.ca

Central: Shavonne Meyer
(902) 893-6353
Shavonne.Meyer@novascotia.ca

Central: Kimberly George
(902) 893-5630
Kimberly.George@novascotia.ca

Eastern: Lisa Doucette
(902) 863-7523
Lisa.Doucette@novascotia.ca

Eastern: Terry Power
(902) 563-3370
Terrance.Power@novascotia.ca

For provincial information about rare taxa and protected areas, or information about game animals, fish habitat etc., in Prince Edward Island, please contact Garry Gregory, PEI Dept. of Communities, Land and Environment: (902) 569-7595.

2.0 RARE AND ENDANGERED SPECIES

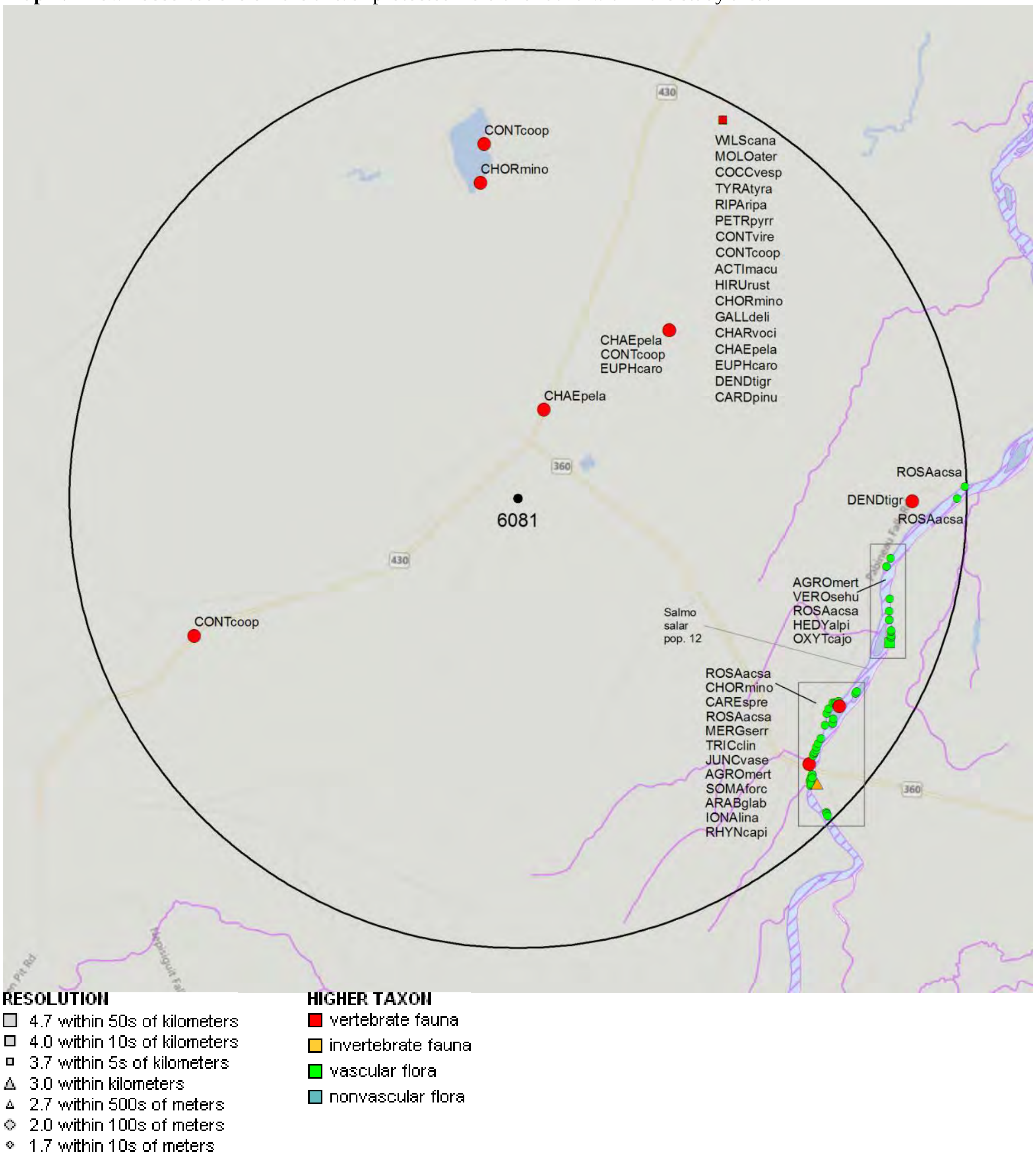
2.1 FLORA

The study area contains 52 records of 11 vascular, no records of nonvascular flora (Map 2 and attached: *ob.xls).

2.2 FAUNA

The study area contains 52 records of 18 vertebrate, 1 record of 1 invertebrate fauna (Map 2 and attached data files - see 1.1 Data List). Please see section 4.3 to determine if 'location-sensitive' species occur near your study site.

Map 2: Known observations of rare and/or protected flora and fauna within the study area.

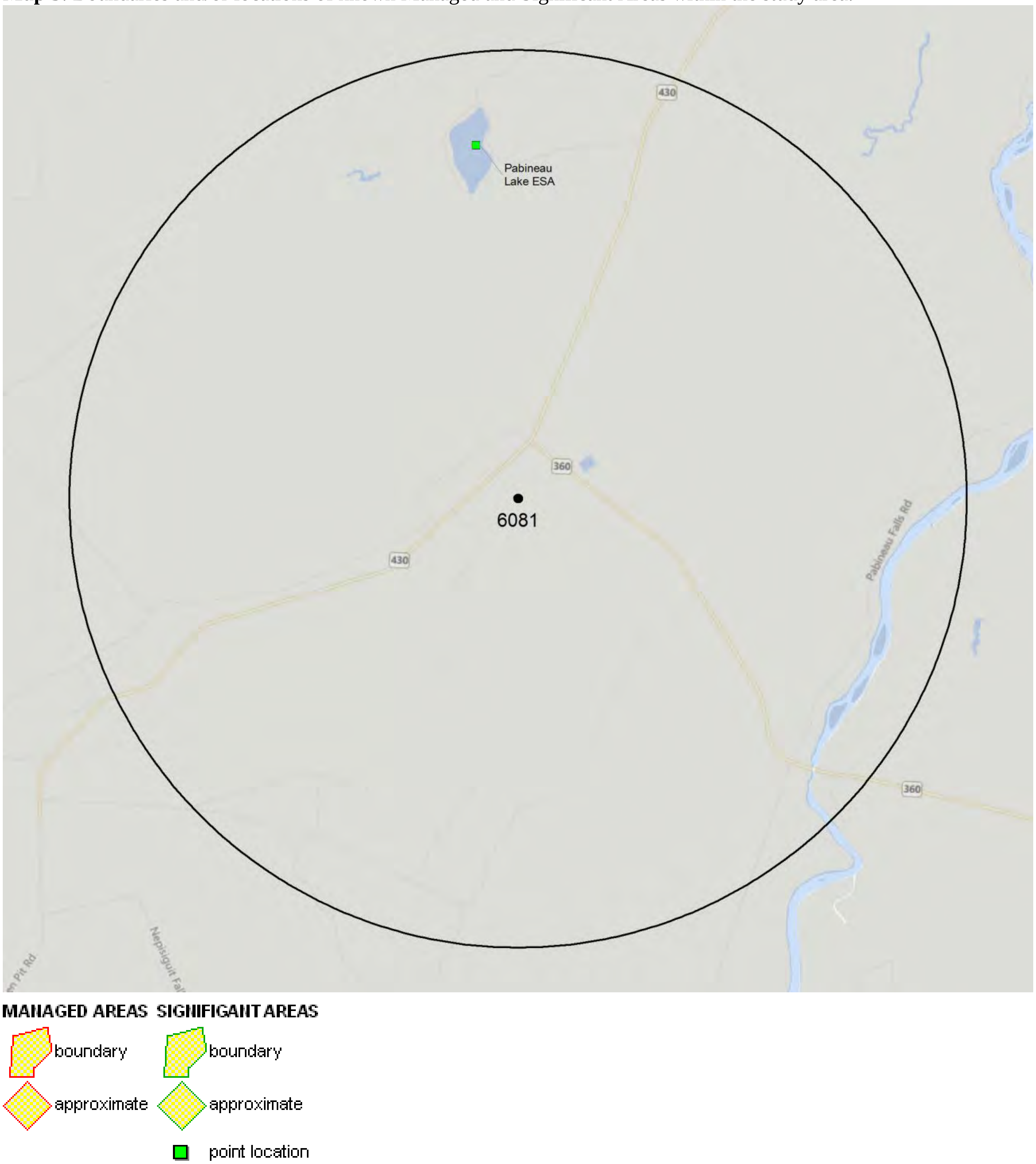


3.0 SPECIAL AREAS

3.1 MANAGED AREAS
The GIS scan identified no managed areas in the vicinity of the study area (Map 3).

3.2 SIGNIFICANT AREAS
The GIS scan identified 1 biologically significant site in the vicinity of the study area (Map 3 and attached file: *sa*.xls).

Map 3: Boundaries and/or locations of known Managed and Significant Areas within the study area.



4.0 RARE SPECIES LISTS

Rare and/or endangered taxa (excluding “location-sensitive” species, section 4.3) within the study area listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record). [P] = vascular plant, [N] = nonvascular plant, [A] = vertebrate animal, [I] = invertebrate animal, [C] = community. Note: records are from attached files *ob.xls/*ob.shp only.

4.1 FLORA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)
P	*Ionactis linariifolius*	Stiff Aster				S2	3 Sensitive	11	4.3 ± 0.0
P	*Oxytropis campestris var. johannensis*	Field Locoweed				S2	3 Sensitive	1	4.4 ± 10.0
P	*Rosa acicularis ssp. sayi*	Prickly Rose				S2	2 May Be At Risk	20	4.2 ± 0.0
P	*Carex sprengelii*	Longbeak Sedge				S2	3 Sensitive	1	4.3 ± 0.0
P	*Juncus vaseyi*	Vasey Rush				S2	3 Sensitive	3	4.2 ± 0.0
P	*Agrostis mertensii*	Northern Bent Grass				S2	2 May Be At Risk	5	4.2 ± 0.0
P	*Arabis glabra*	Tower Mustard				S3	5 Undetermined	1	4.6 ± 0.0
P	*Hedysarum alpinum*	Alpine Sweet-vetch				S3	4 Secure	4	4.4 ± 0.0
P	*Veronica serpyllifolia ssp. humifusa*	Thyme-Leaved Speedwell				S3	4 Secure	1	4.3 ± 0.0
P	*Rhynchospora capitellata*	Small-headed Beakrush				S3	4 Secure	4	4.2 ± 0.0
P	*Trichophorum clintonii*	Clinton's Clubrush				S3	4 Secure	1	4.5 ± 0.0

4.2 FAUNA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)
A	*Hirundo rustica*	Barn Swallow	Threatened	Threatened	Threatened	S2B,S2M	3 Sensitive	3	4.8 ± 7.0
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Threatened	S2S3B,S2M	1 At Risk	7	1.0 ± 0.0
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened		S2S3B,S2S3M	3 Sensitive	3	4.8 ± 7.0
A	*Contopus cooperi*	Olive-sided Flycatcher	Threatened	Threatened	Threatened	S3B,S3M	1 At Risk	7	2.5 ± 0.0
A	*Wilsonia canadensis*	Canada Warbler	Threatened	Threatened	Threatened	S3B,S3M	1 At Risk	1	4.8 ± 7.0
A	*Chordeiles minor*	Common Nighthawk	Threatened	Threatened	Threatened	S3B,S4M	1 At Risk	6	3.5 ± 0.0
A	*Euphagus carolinus*	Rusty Blackbird	Special Concern	Special Concern	Special Concern	S3B,S3M	2 May Be At Risk	4	2.5 ± 0.0
A	*Coccothraustes vespertinus*	Evening Grosbeak	Special Concern			S3B,S3S4N,SUM	3 Sensitive	1	4.8 ± 7.0
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Special Concern	S4B,S4M	4 Secure	2	4.8 ± 7.0
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2S3B,S2S3M	3 Sensitive	1	4.8 ± 7.0
A	*Carduelis pinus*	Pine Siskin				S3	4 Secure	3	4.8 ± 7.0
A	*Charadrius vociferus*	Killdeer				S3B,S3M	3 Sensitive	3	4.8 ± 7.0
A	*Molothrus ater*	Brown-headed Cowbird				S3B,S3M	2 May Be At Risk	1	4.8 ± 7.0
A	*Dendroica tigrina*	Cape May Warbler				S3B,S4S5M	4 Secure	3	4.4 ± 0.0
A	*Mergus serrator*	Red-breasted Merganser				S3B,S5M,S4S5N	4 Secure	1	4.4 ± 0.0
A	*Tyrannus tyrannus*	Eastern Kingbird				S3S4B,S3S4M	3 Sensitive	1	4.8 ± 7.0
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S5M	4 Secure	2	4.8 ± 7.0
A	*Gallinago delicata*	Wilson's Snipe				S3S4B,S5M	4 Secure	3	4.8 ± 7.0
I	*Somatochlora forcipata*	Forcipate Emerald				S3	4 Secure	1	4.6 ± 1.0

4.3 LOCATION SENSITIVE SPECIES

The Department of Natural Resources in each Maritimes province considers a number of species “location sensitive”. Concern about exploitation of location-sensitive species precludes inclusion of precise coordinates in this report. Those intersecting your study area are indicated below with “YES”.

New Brunswick

Scientific *Name*	Common Name	SARA	Prov Legal Prot	Known within the Study Site?
Chrysemys picta picta	Eastern Painted Turtle			No
Chelydra serpentina	Snapping Turtle	Special Concern	Special Concern	No
Glyptemys insculpta	Wood Turtle	Threatened	Threatened	No
Haliaeetus leucocephalus	**Bald Eagle**		**Endangered**	**YES**
Falco peregrinus pop. 1	Peregrine Falcon - anatum/tundrius pop.	Special Concern	Endangered	No
Cicindela marginipennis	Cobblestone Tiger Beetle	Endangered	Endangered	No
Coenonympha nipisiquit	Maritime Ringlet	Endangered	Endangered	No
Bat Hibernaculum		[Endangered][1]	[Endangered][1]	No

1 *Myotis lucifugus* (Little Brown Myotis), *Myotis septentrionalis* (Long-eared Myotis), and *Perimyotis subflavus* (Tri-colored Bat or Eastern Pipistrelle) are all Endangered under the Federal Species at Risk Act and the NB Species at Risk Act.

4.4 SOURCE BIBLIOGRAPHY

The recipient of these data shall acknowledge the ACCDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

# recs	CITATION
51	Blaney, C.S.; Mazerolle, D.M. 2010. Fieldwork 2010. Atlantic Canada Conservation Data Centre. Sackville NB, 15508 recs.
34	Lepage, D. 2014. Maritime Breeding Bird Atlas Database. Bird Studies Canada, Sackville NB, 407,838 recs.
17	Erskine, A.J. 1992. Maritime Breeding Bird Atlas Database. NS Museum & Nimbus Publ., Halifax, 82,125 recs.
2	Dept of Fisheris & Oceans. 2001. Atlantic Salmon Maritime provinces overview for 2000. DFO.
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5.0 RARE SPECIES WITHIN 100 KM

A 100 km buffer around the study area contains 19789 records of 133 vertebrate and 606 records of 54 invertebrate fauna; 5028 records of 299 vascular, 383 records of 107 nonvascular flora (attached: *ob100km.xls).

Taxa within 100 km of the study site that are rare and/or endangered in the province in which the study site occurs. All ranks correspond to the province in which the study site falls, even for out-of-province records. Taxa are listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record).

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
A	*Myotis lucifugus*	Little Brown Myotis	Endangered	Endangered	Endangered	S1	1 At Risk	2	86.0 ± 1.0	NB
A	*Charadrius melodus melodus*	Piping Plover melodus ssp	Endangered	Endangered	Endangered	S1B,S1M	1 At Risk	1843	21.9 ± 0.0	NB
A	*Dermochelys coriacea (Atlantic pop.)*	Leatherback Sea Turtle - Atlantic pop.	Endangered	Endangered	Endangered	S1S2N	1 At Risk	4	56.4 ± 1.0	NB
A	*Calidris canutus rufa*	Red Knot rufa ssp	Endangered		Endangered	S2M	1 At Risk	312	20.6 ± 0.0	NB
A	*Empidonax virescens*	Acadian Flycatcher	Endangered	Endangered		SNA	8 Accidental	1	75.4 ± 0.0	NB
A	*Delphinapterus leucas*	Beluga Whale - St Lawrence Estuary pop.	Endangered	Threatened		SNA		2	76.2 ± 1.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
A	*Rangifer tarandus pop. 2*	Woodland Caribou (Atlantic-Gasp├⌐sie pop.)	Endangered	Endangered	Extirpated	SX	0.1 Extirpated	6	51.8 ± 5.0	NB
A	*Sturnella magna*	Eastern Meadowlark	Threatened	Threatened	Threatened	S1B,S1M	2 May Be At Risk	4	53.2 ± 7.0	NB
A	*Ixobrychus exilis*	Least Bittern	Threatened	Threatened	Threatened	S1S2B,S1S2M	1 At Risk	1	61.8 ± 0.0	NB
A	*Hylocichla mustelina*	Wood Thrush	Threatened	Threatened	Threatened	S1S2B,S1S2M	2 May Be At Risk	48	15.0 ± 1.0	NB
A	*Caprimulgus vociferus*	Whip-Poor-Will	Threatened	Threatened	Threatened	S2B,S2M	1 At Risk	40	37.8 ± 7.0	NB
A	*Hirundo rustica*	Barn Swallow	Threatened	Threatened	Threatened	S2B,S2M	3 Sensitive	529	4.8 ± 7.0	NB
A	*Catharus bicknelli*	Bicknell's Thrush	Threatened	Special Concern	Threatened	S2B,S2M	1 At Risk	553	43.4 ± 7.0	NB
A	*Glyptemys insculpta*	Wood Turtle	Threatened	Threatened	Threatened	S2S3	1 At Risk	322	21.2 ± 1.0	NB
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Threatened	S2S3B,S2M	1 At Risk	225	1.0 ± 0.0	NB
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened		S2S3B,S2S3M	3 Sensitive	379	4.8 ± 7.0	NB
A	*Contopus cooperi*	Olive-sided Flycatcher	Threatened	Threatened	Threatened	S3B,S3M	1 At Risk	397	2.5 ± 0.0	NB
A	*Wilsonia canadensis*	Canada Warbler	Threatened	Threatened	Threatened	S3B,S3M	1 At Risk	408	4.8 ± 7.0	NB
A	*Dolichonyx oryzivorus*	Bobolink	Threatened	Threatened	Threatened	S3B,S3M	3 Sensitive	482	14.4 ± 7.0	NB
A	*Chordeiles minor*	Common Nighthawk	Threatened	Threatened	Threatened	S3B,S4M	1 At Risk	319	3.5 ± 0.0	NB
A	*Anguilla rostrata*	American Eel	Threatened		Threatened	S4	4 Secure	11	39.5 ± 0.0	NB
A	*Vermivora chrysoptera*	Golden-winged Warbler	Threatened	Threatened		SNA	8 Accidental	1	64.3 ± 1.0	NB
A	*Coturnicops noveboracensis*	Yellow Rail	Special Concern	Special Concern	Special Concern	S1?B,SUM	2 May Be At Risk	2	78.5 ± 0.0	NB
A	*Histrionicus histrionicus pop. 1*	Harlequin Duck - Eastern pop.	Special Concern	Special Concern	Endangered	S1B,S1S2N,S2M	1 At Risk	8	30.7 ± 7.0	NB
A	*Falco peregrinus pop. 1*	Peregrine Falcon - anatum/tundrius	Special Concern	Special Concern	Endangered	S1B,S3M	1 At Risk	9	62.5 ± 20.0	NB
A	*Asio flammeus*	Short-eared Owl	Special Concern	Special Concern	Special Concern	S2B,S2M	3 Sensitive	12	27.5 ± 0.0	NB
A	*Bucephala islandica (Eastern pop.)*	Barrow's Goldeneye - Eastern pop.	Special Concern	Special Concern	Special Concern	S2M,S2N	3 Sensitive	39	16.6 ± 5.0	NB
A	*Euphagus carolinus*	Rusty Blackbird	Special Concern	Special Concern	Special Concern	S3B,S3M	2 May Be At Risk	150	2.5 ± 0.0	NB
A	*Coccothraustes vespertinus*	Evening Grosbeak	Special Concern			S3B,S3S4N,SUM	3 Sensitive	414	4.8 ± 7.0	NB
A	*Phalaropus lobatus*	Red-necked Phalarope	Special Concern			S3M	3 Sensitive	4	64.3 ± 1.0	NB
A	*Phocoena phocoena (NW Atlantic pop.)*	Harbour Porpoise - Northwest Atlantic pop.	Special Concern	Threatened		S4		2	84.6 ± 5.0	NB
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Special Concern	S4B,S4M	4 Secure	323	4.8 ± 7.0	NB
A	*Podiceps auritus*	Horned Grebe	Special Concern		Special Concern	S4N,S4M	4 Secure	3	64.5 ± 3.0	NB
A	*Tryngites subruficollis*	Buff-breasted Sandpiper	Special Concern			SNA	8 Accidental	3	59.8 ± 0.0	NB
A	*Odobenus rosmarus rosmarus*	Atlantic Walrus	Special Concern		Extirpated	SX		4	56.4 ± 1.0	NB
A	*Bubo scandiacus*	Snowy Owl	Not At Risk			S1N,S2S3M	4 Secure	12	16.6 ± 5.0	NB
A	*Accipiter cooperii*	Cooper's Hawk	Not At Risk			S1S2B,S1S2M	2 May Be At Risk	3	88.8 ± 0.0	NB
A	*Fulica americana*	American Coot	Not At Risk			S1S2B,S1S2M	3 Sensitive	5	54.7 ± 1.0	NB
A	*Aegolius funereus*	Boreal Owl	Not At Risk			S1S2B,SUM	2 May Be At Risk	12	34.1 ± 7.0	NB
A	*Sorex dispar*	Long-tailed Shrew	Not At Risk	Special Concern		S2	3 Sensitive	20	68.8 ± 1.0	NB
A	*Buteo lineatus*	Red-shouldered Hawk	Not At Risk	Special Concern		S2B,S2M	2 May Be At Risk	9	43.4 ± 1.0	NB
A	*Chlidonias niger*	Black Tern	Not At Risk			S2B,S2M	3 Sensitive	4	93.8 ± 7.0	NB
A	*Globicephala melas*	Long-finned Pilot Whale	Not At Risk			S2S3		1	54.3 ± 1.0	NB
A	*Lynx canadensis*	Canadian Lynx	Not At Risk		Endangered	S3	1 At Risk	49	7.6 ± 0.0	NB
A	*Sterna hirundo*	Common Tern	Not At Risk			S3B,SUM	3 Sensitive	510	17.7 ± 0.0	NB
A	*Podiceps grisegena*	Red-necked Grebe	Not At Risk			S3M,S2N	3 Sensitive	7	52.3 ± 0.0	NB
A	*Haliaeetus leucocephalus*	Bald Eagle	Not At Risk		Endangered	S4	1 At Risk	326	4.4 ± 0.0	NB
A	*Canis lupus*	Gray Wolf	Not At Risk		Extirpated	SX	0.1 Extirpated	1	98.4 ± 100.0	NB
A	*Puma concolor pop. 1*	Eastern Cougar	Data Deficient		Endangered	SNA	5 Undetermined	39	17.8 ± 1.0	NB
A	*Morone saxatilis*	Striped Bass	E,E,SC			S3	2 May Be At Risk	12	44.7 ± 10.0	NB
A	*Salvelinus alpinus*	Arctic Char				S1	3 Sensitive	9	55.3 ± 1.0	NB
A	*Synaptomys borealis sphagnicola*	Northern Bog Lemming				S1		4	52.1 ± 1.0	NB
A	*Tringa melanoleuca*	Greater Yellowlegs				S1?B,S5M	4 Secure	624	16.5 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
A	*Aythya americana*	Redhead				S1B,S1M	8 Accidental	1	64.3 ± 1.0	NB
A	*Grus canadensis*	Sandhill Crane				S1B,S1M	8 Accidental	2	65.3 ± 1.0	NB
A	*Bartramia longicauda*	Upland Sandpiper				S1B,S1M	3 Sensitive	6	52.5 ± 7.0	NB
A	*Phalaropus tricolor*	Wilson's Phalarope				S1B,S1M	3 Sensitive	13	53.2 ± 1.0	NB
A	*Leucophaeus atricilla*	Laughing Gull				S1B,S1M	3 Sensitive	1	94.3 ± 0.0	NB
A	*Progne subis*	Purple Martin				S1B,S1M	2 May Be At Risk	4	59.9 ± 7.0	NB
A	*Thryothorus ludovicianus*	Carolina Wren				S1B,S1M	8 Accidental	3	52.5 ± 0.0	NB
A	*Oxyura jamaicensis*	Ruddy Duck				S1B,S2S3M	4 Secure	12	54.1 ± 0.0	NB
A	*Uria aalge*	Common Murre				S1B,S3N,S3M	4 Secure	3	52.0 ± 0.0	NB
A	*Aythya affinis*	Lesser Scaup				S1B,S4M	4 Secure	39	16.6 ± 5.0	NB
A	*Aythya marila*	Greater Scaup				S1B,S4M,S2N	4 Secure	14	56.8 ± 1.0	NB
A	*Eremophila alpestris*	Horned Lark				S1B,S4N,S5M	2 May Be At Risk	105	43.5 ± 0.0	NB
A	*Sterna paradisaea*	Arctic Tern				S1B,SUM	2 May Be At Risk	35	22.3 ± 0.0	NB
A	*Branta bernicla*	Brant				S1N, S2S3M	4 Secure	66	23.1 ± 10.0	NB
A	*Chroicocephalus ridibundus*	Black-headed Gull				S1N,S2M	3 Sensitive	6	64.3 ± 1.0	NB
A	*Butorides virescens*	Green Heron				S1S2B,S1S2M	3 Sensitive	2	61.2 ± 0.0	NB
A	*Nycticorax nycticorax*	Black-crowned Night-heron				S1S2B,S1S2M	3 Sensitive	274	10.2 ± 1.0	NB
A	*Empidonax traillii*	Willow Flycatcher				S1S2B,S1S2M	3 Sensitive	14	51.6 ± 7.0	NB
A	*Stelgidopteryx serripennis*	Northern Rough-winged Swallow				S1S2B,S1S2M	2 May Be At Risk	5	17.7 ± 0.0	NB
A	*Troglodytes aedon*	House Wren				S1S2B,S1S2M	5 Undetermined	6	52.5 ± 7.0	NB
A	*Rissa tridactyla*	Black-legged Kittiwake				S1S2B,S4N,S5M	4 Secure	23	43.3 ± 0.0	NB
A	*Calidris bairdii*	Baird's Sandpiper				S1S2M	3 Sensitive	7	57.2 ± 0.0	NB
A	*Microtus chrotorrhinus*	Rock Vole				S2?	5 Undetermined	25	81.5 ± 1.0	NB
A	*Mimus polyglottos*	Northern Mockingbird				S2B,S2M	3 Sensitive	59	14.4 ± 7.0	NB
A	*Toxostoma rufum*	Brown Thrasher				S2B,S2M	3 Sensitive	32	32.9 ± 7.0	NB
A	*Pooecetes gramineus*	Vesper Sparrow				S2B,S2M	2 May Be At Risk	57	27.2 ± 7.0	NB
A	*Anas strepera*	Gadwall				S2B,S3M	4 Secure	51	52.3 ± 0.0	NB
A	*Alca torda*	Razorbill				S2B,S3N,S3M	4 Secure	9	51.0 ± 14.0	NB
A	*Pinicola enucleator*	Pine Grosbeak				S2B,S4S5N,S4S5M	3 Sensitive	78	7.7 ± 7.0	NB
A	*Tringa solitaria*	Solitary Sandpiper				S2B,S5M	4 Secure	73	19.3 ± 0.0	NB
A	*Oceanodroma leucorhoa*	Leach's Storm-Petrel				S2B,SUM	3 Sensitive	1	83.8 ± 0.0	NB
A	*Chen caerulescens*	Snow Goose				S2M	4 Secure	9	54.9 ± 0.0	NB
A	*Phalacrocorax carbo*	Great Cormorant				S2N,S2M	4 Secure	5	18.5 ± 0.0	NB
A	*Somateria spectabilis*	King Eider				S2N,S2M	4 Secure	2	64.6 ± 1.0	NB
A	*Larus hyperboreus*	Glaucous Gull				S2N,S2M	4 Secure	17	16.6 ± 5.0	NB
A	*Asio otus*	Long-eared Owl				S2S3	5 Undetermined	13	42.2 ± 1.0	NB
A	*Picoides dorsalis*	American Three-toed Woodpecker				S2S3	3 Sensitive	68	12.8 ± 7.0	NB
A	*Salmo salar*	Atlantic Salmon				S2S3	2 May Be At Risk	1933	18.3 ± 1.0	NB
A	*Anas clypeata*	Northern Shoveler				S2S3B,S2S3M	4 Secure	74	44.3 ± 7.0	NB
A	*Myiarchus crinitus*	Great Crested Flycatcher				S2S3B,S2S3M	3 Sensitive	25	24.3 ± 7.0	NB
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2S3B,S2S3M	3 Sensitive	260	4.8 ± 7.0	NB
A	*Pluvialis dominica*	American Golden-Plover				S2S3M	3 Sensitive	47	21.9 ± 0.0	NB
A	*Calcarius lapponicus*	Lapland Longspur				S2S3N,SUM	3 Sensitive	8	55.7 ± 0.0	NB
A	*Cepphus grylle*	Black Guillemot				S3	4 Secure	64	35.3 ± 0.0	NB
A	*Loxia curvirostra*	Red Crossbill				S3	4 Secure	86	26.4 ± 7.0	NB
A	*Carduelis pinus*	Pine Siskin				S3	4 Secure	279	4.8 ± 7.0	NB
A	*Prosopium cylindraceum*	Round Whitefish				S3	4 Secure	2	91.7 ± 0.0	NB
A	*Salvelinus namaycush*	Lake Trout				S3	3 Sensitive	4	87.3 ± 0.0	NB
A	*Sorex maritimensis*	Maritime Shrew				S3	4 Secure	32	72.6 ± 0.0	NB
A	*Cathartes aura*	Turkey Vulture				S3B,S3M	4 Secure	17	48.3 ± 5.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
A	*Rallus limicola*	Virginia Rail				S3B,S3M	3 Sensitive	14	27.2 ± 7.0	NB
A	*Charadrius vociferus*	Killdeer				S3B,S3M	3 Sensitive	707	4.8 ± 7.0	NB
A	*Tringa semipalmata*	Willet				S3B,S3M	3 Sensitive	359	16.5 ± 0.0	NB
A	*Coccyzus erythropthalmus*	Black-billed Cuckoo				S3B,S3M	4 Secure	57	14.4 ± 7.0	NB
A	*Vireo gilvus*	Warbling Vireo				S3B,S3M	4 Secure	58	14.4 ± 7.0	NB
A	*Piranga olivacea*	Scarlet Tanager				S3B,S3M	4 Secure	55	18.8 ± 7.0	NB
A	*Passerina cyanea*	Indigo Bunting				S3B,S3M	4 Secure	15	40.6 ± 7.0	NB
A	*Molothrus ater*	Brown-headed Cowbird				S3B,S3M	2 May Be At Risk	138	4.8 ± 7.0	NB
A	*Icterus galbula*	Baltimore Oriole				S3B,S3M	4 Secure	69	14.4 ± 7.0	NB
A	*Somateria mollissima*	Common Eider				S3B,S4M,S3N	4 Secure	160	17.7 ± 0.0	NB
A	*Dendroica tigrina*	Cape May Warbler				S3B,S4S5M	4 Secure	217	4.4 ± 0.0	NB
A	*Anas acuta*	Northern Pintail				S3B,S5M	3 Sensitive	184	19.9 ± 1.0	NB
A	*Mergus serrator*	Red-breasted Merganser				S3B,S5M,S4S5N	4 Secure	227	4.4 ± 0.0	NB
A	*Arenaria interpres*	Ruddy Turnstone				S3M	4 Secure	589	20.6 ± 0.0	NB
A	*Phalaropus fulicarius*	Red Phalarope				S3M	3 Sensitive	4	59.8 ± 0.0	NB
A	*Melanitta nigra*	Black Scoter				S3M,S1S2N	3 Sensitive	147	16.6 ± 5.0	NB
A	*Bucephala albeola*	Bufflehead				S3M,S2N	3 Sensitive	31	16.6 ± 5.0	NB
A	*Calidris maritima*	Purple Sandpiper				S3M,S3N	4 Secure	17	21.9 ± 0.0	NB
A	*Synaptomys cooperi*	Southern Bog Lemming				S3S4	4 Secure	11	72.6 ± 0.0	NB
A	*Tyrannus tyrannus*	Eastern Kingbird				S3S4B,S3S4M	3 Sensitive	219	4.8 ± 7.0	NB
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S5M	4 Secure	1037	4.8 ± 7.0	NB
A	*Gallinago delicata*	Wilson's Snipe				S3S4B,S5M	4 Secure	321	4.8 ± 7.0	NB
A	*Larus delawarensis*	Ring-billed Gull				S3S4B,S5M	4 Secure	409	16.6 ± 5.0	NB
A	*Dendroica striata*	Blackpoll Warbler				S3S4B,S5M	4 Secure	209	22.3 ± 7.0	NB
A	*Pluvialis squatarola*	Black-bellied Plover				S3S4M	4 Secure	458	20.5 ± 1.0	NB
A	*Limosa haemastica*	Hudsonian Godwit				S3S4M	4 Secure	210	21.9 ± 0.0	NB
A	*Calidris pusilla*	Semipalmated Sandpiper				S3S4M	4 Secure	730	16.5 ± 0.0	NB
A	*Calidris melanotos*	Pectoral Sandpiper				S3S4M	4 Secure	73	53.6 ± 0.0	NB
A	*Calidris alba*	Sanderling				S3S4M,S1N	3 Sensitive	407	16.5 ± 0.0	NB
A	*Morus bassanus*	Northern Gannet				SHB,S5M	4 Secure	177	16.6 ± 5.0	NB
I	*Coenonympha nipisiquit*	Maritime Ringlet	Endangered	Endangered	Endangered	S1	1 At Risk	38	16.6 ± 1.0	NB
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Special Concern	S3B,S3M	3 Sensitive	12	53.4 ± 0.0	NB
I	*Ophiogomphus howei*	Pygmy Snaketail	Special Concern	Special Concern	Special Concern	S2	2 May Be At Risk	21	80.7 ± 0.0	NB
I	*Alasmidonta varicosa*	Brook Floater	Special Concern		Special Concern	S2	3 Sensitive	11	94.3 ± 0.0	NB
I	*Bombus terricola*	Yellow-banded Bumblebee	Special Concern			S3?	3 Sensitive	17	25.7 ± 0.0	NB
I	*Erora laeta*	Early Hairstreak				S1	2 May Be At Risk	1	97.7 ± 7.0	NB
I	*Somatochlora septentrionalis*	Muskeg Emerald				S1	2 May Be At Risk	3	92.3 ± 0.0	NB
I	*Leucorrhinia patricia*	Canada Whiteface				S1	2 May Be At Risk	8	45.0 ± 1.0	NB
I	*Plebejus saepiolus*	Greenish Blue				S1S2	4 Secure	25	16.6 ± 1.0	NB
I	*Satyrium calanus*	Banded Hairstreak				S2	3 Sensitive	1	97.4 ± 7.0	NB
I	*Strymon melinus*	Grey Hairstreak				S2	4 Secure	8	21.2 ± 0.0	NB
I	*Aeshna juncea*	Rush Darner				S2	3 Sensitive	12	60.3 ± 1.0	NB
I	*Somatochlora brevicincta*	Quebec Emerald				S2	5 Undetermined	1	97.9 ± 0.0	NB
I	*Somatochlora tenebrosa*	Clamp-Tipped Emerald				S2	5 Undetermined	3	32.0 ± 0.0	NB
I	*Coenagrion interrogatum*	Subarctic Bluet				S2	3 Sensitive	8	10.0 ± 1.0	NB
I	*Callophrys henrici*	Henry's Elfin				S2S3	4 Secure	4	27.3 ± 5.0	NB
I	*Desmocerus palliatus*	Elderberry Borer				S3		2	20.4 ± 5.0	NB
I	*Carabus maeander*	a Ground Beetle				S3	5 Undetermined	1	84.1 ± 1.0	NB
I	*Hippodamia parenthesis*	Parenthesis Lady Beetle				S3	4 Secure	1	94.7 ± 1.0	NB
I	*Xylotrechus*	a Longhorned Beetle				S3		1	63.4 ± 1.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
	quadrimaculatus									
I	*Xylotrechus undulatus*	a Longhorned Beetle				S3		2	63.4 ± 1.0	NB
I	*Calathus gregarius*	a Ground Beetle				S3	4 Secure	1	27.3 ± 1.0	NB
I	*Hyperaspis disconotata*	a Ladybird Beetle				S3	5 Undetermined	1	43.0 ± 5.0	NB
I	*Hesperia sassacus*	Indian Skipper				S3	4 Secure	4	84.0 ± 1.0	NB
I	*Euphyes bimacula*	Two-spotted Skipper				S3	4 Secure	5	14.0 ± 0.0	NB
I	*Papilio brevicauda*	Short-tailed Swallowtail				S3	4 Secure	45	18.8 ± 7.0	NB
I	*Papilio brevicauda bretonensis*	Short-tailed Swallowtail				S3	4 Secure	12	21.2 ± 0.0	NB
I	*Lycaena hyllus*	Bronze Copper				S3	3 Sensitive	5	53.5 ± 0.0	NB
I	*Lycaena dospassosi*	Salt Marsh Copper				S3	4 Secure	106	16.6 ± 1.0	NB
I	*Satyrium acadica*	Acadian Hairstreak				S3	4 Secure	3	18.8 ± 7.0	NB
I	*Callophrys polios*	Hoary Elfin				S3	4 Secure	8	18.2 ± 0.0	NB
I	*Callophrys eryphon*	Western Pine Elfin				S3	4 Secure	10	27.3 ± 7.0	NB
I	*Plebejus idas*	Northern Blue				S3	4 Secure	30	54.4 ± 7.0	NB
I	*Plebejus idas empetri*	Crowberry Blue				S3	4 Secure	8	76.2 ± 1.0	NB
I	*Speyeria aphrodite*	Aphrodite Fritillary				S3	4 Secure	3	20.2 ± 1.0	NB
I	*Boloria eunomia*	Bog Fritillary				S3	5 Undetermined	5	17.5 ± 0.0	NB
I	*Boloria chariclea*	Arctic Fritillary				S3	4 Secure	17	20.2 ± 1.0	NB
I	*Boloria chariclea grandis*	Purple Lesser Fritillary				S3	4 Secure	4	17.4 ± 10.0	NB
I	*Polygonia satyrus*	Satyr Comma				S3	4 Secure	18	27.3 ± 7.0	NB
I	*Polygonia gracilis*	Hoary Comma				S3	4 Secure	27	16.6 ± 1.0	NB
I	*Nymphalis l-album*	Compton Tortoiseshell				S3	4 Secure	9	53.9 ± 10.0	NB
I	*Gomphus abbreviatus*	Spine-crowned Clubtail				S3	4 Secure	4	56.0 ± 0.0	NB
I	*Somatochlora albicincta*	Ringed Emerald				S3	4 Secure	29	41.1 ± 1.0	NB
I	*Somatochlora cingulata*	Lake Emerald				S3	4 Secure	19	19.4 ± 1.0	NB
I	*Somatochlora forcipata*	Forcipate Emerald				S3	4 Secure	10	4.6 ± 1.0	NB
I	*Williamsonia fletcheri*	Ebony Boghaunter				S3	4 Secure	1	77.8 ± 0.0	NB
I	*Lestes eurinus*	Amber-Winged Spreadwing				S3	4 Secure	13	19.4 ± 1.0	NB
I	*Stylurus scudderi*	Zebra Clubtail				S3	4 Secure	1	72.7 ± 0.0	NB
I	*Alasmidonta undulata*	Triangle Floater				S3	3 Sensitive	1	93.5 ± 1.0	NB
I	*Neohelix albolabris*	Whitelip				S3		1	88.3 ± 1.0	NB
I	*Satyrium liparops*	Striped Hairstreak				S3S4	4 Secure	13	20.2 ± 1.0	NB
I	*Satyrium liparops strigosum*	Striped Hairstreak				S3S4	4 Secure	3	21.9 ± 0.0	NB
I	*Cupido comyntas*	Eastern Tailed Blue				S3S4	4 Secure	1	96.5 ± 1.0	NB
I	*Coccinella transversoguttata richardsoni*	Transverse Lady Beetle				SH	2 May Be At Risk	9	17.2 ± 1.0	NB
N	*Arctoa fulvella*	a Moss				S1	2 May Be At Risk	2	86.0 ± 1.0	NB
N	*Aulacomnium heterostichum*	One-sided Groove Moss				S1	2 May Be At Risk	1	91.4 ± 0.0	NB
N	*Campylostelium saxicola*	a Moss				S1	2 May Be At Risk	1	89.4 ± 0.0	NB
N	*Grimmia donniana*	Donn's Grimmia Moss				S1	2 May Be At Risk	4	85.5 ± 0.0	NB
N	*Grimmia incurva*	Black Grimmia				S1	2 May Be At Risk	4	85.5 ± 0.0	NB
N	*Kiaeria starkei*	Starke's Fork Moss				S1	2 May Be At Risk	1	86.0 ± 1.0	NB
N	*Pseudoleskeella tectorum*	Rooftop Leskea Moss				S1	2 May Be At Risk	1	89.5 ± 1.0	NB
N	*Syntrichia ruralis*	a Moss				S1	2 May Be At Risk	1	43.5 ± 0.0	NB
N	*Zygodon viridissimus var. viridissimus*	a Moss				S1	2 May Be At Risk	1	89.7 ± 0.0	NB
N	*Lathagrium auriforme*	a tarpaper lichen				S1		1	43.4 ± 0.0	NB

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N	*Ephebe hispidula*	Dryside Rockshag Lichen				S1		1	66.4 ± 0.0	NB
N	*Ephebe perspinulosa*	Thread Lichen				S1		2	65.9 ± 0.0	NB
N	*Leptogium intermedium*	Forty-five Jellyskin Lichen				S1		4	66.0 ± 0.0	NB
N	*Phaeophyscia hispidula*	Whiskered Shadow Lichen				S1		1	43.7 ± 0.0	NB
N	*Anastrophyllum saxicola*	Curled Notchwort				S1?	6 Not Assessed	1	91.4 ± 0.0	NB
N	*Bryum blindii*	a Moss				S1?	2 May Be At Risk	1	53.3 ± 1.0	NB
N	*Cinclidium stygium*	Sooty Cupola Moss				S1?	2 May Be At Risk	1	35.1 ± 0.0	NB
N	*Tortula cernua*	Narrow-Leafed Chain-Teeth Moss				S1?	2 May Be At Risk	2	53.3 ± 1.0	NB
N	*Dicranum bonjeanii*	Bonjean's Broom Moss				S1?	2 May Be At Risk	2	83.8 ± 1.0	NB
N	*Homomallium adnatum*	Adnate Hairy-gray Moss				S1?	2 May Be At Risk	1	89.9 ± 0.0	NB
N	*Paludella squarrosa*	Tufted Fen Moss				S1?	2 May Be At Risk	1	35.1 ± 0.0	NB
N	*Seligeria recurvata*	a Moss				S1?	2 May Be At Risk	5	66.0 ± 0.0	NB
N	*Rhizomnium pseudopunctatum*	Felted Leafy Moss				S1?	2 May Be At Risk	2	89.3 ± 1.0	NB
N	*Leptogium burnetiae*	Long-bearded Jellyskin Lichen				S1?		1	43.8 ± 0.0	NB
N	*Peltigera venosa*	Fan Pelt Lichen				S1?	5 Undetermined	1	66.3 ± 0.0	NB
N	*Lophozia heterocolpos*	Whip Notchwort				S1S2	6 Not Assessed	2	80.0 ± 0.0	NB
N	*Metacalypogeia schusterana*	Schuster's Pouchwort				S1S2	6 Not Assessed	1	83.8 ± 0.0	NB
N	*Odontoschisma sphagni*	Bog-Moss Flapwort				S1S2	6 Not Assessed	1	86.8 ± 0.0	NB
N	*Pallavicinia lyellii*	Lyell's Ribbonwort				S1S2	6 Not Assessed	1	95.8 ± 1.0	NB
N	*Reboulia hemisphaerica*	Purple-margined Liverwort				S1S2	6 Not Assessed	2	43.1 ± 0.0	NB
N	*Calliergon richardsonii*	Richardson's Spear Moss				S1S2	2 May Be At Risk	1	89.4 ± 1.0	NB
N	*Campylium radicale*	Long-stalked Fine Wet Moss				S1S2	5 Undetermined	1	90.7 ± 10.0	NB
N	*Distichium inclinatum*	Inclined Iris Moss				S1S2	2 May Be At Risk	2	53.3 ± 1.0	NB
N	*Drummondia prorepens*	a Moss				S1S2	2 May Be At Risk	1	89.7 ± 0.0	NB
N	*Platydictya confervoides*	a Moss				S1S2	3 Sensitive	1	66.0 ± 0.0	NB
N	*Seligeria brevifolia*	a Moss				S1S2	3 Sensitive	5	66.3 ± 0.0	NB
N	*Timmia norvegica var. excurrens*	a moss				S1S2	2 May Be At Risk	2	80.0 ± 0.0	NB
N	*Calypogeia neesiana*	Nees' Pouchwort				S1S3	6 Not Assessed	1	56.6 ± 1.0	NB
N	*Lophozia badensis*	Dwarf Notchwort				S1S3	6 Not Assessed	1	53.3 ± 1.0	NB
N	*Lophozia obtusa*	Obtuse Notchwort				S1S3	6 Not Assessed	2	87.4 ± 1.0	NB
N	*Hypnum pratense*	Meadow Plait Moss				S2	3 Sensitive	1	89.7 ± 0.0	NB
N	*Isopterygiopsis pulchella*	Neat Silk Moss				S2	3 Sensitive	1	66.3 ± 0.0	NB
N	*Meesia triquetra*	Three-ranked Cold Moss				S2	2 May Be At Risk	1	40.5 ± 10.0	NB
N	*Platydictya jungermannioides*	False Willow Moss				S2	3 Sensitive	1	94.7 ± 1.0	NB
N	*Pohlia elongata*	Long-necked Nodding Moss				S2	3 Sensitive	4	89.2 ± 0.0	NB
N	*Pohlia sphagnicola*	a moss				S2	3 Sensitive	2	79.5 ± 1.0	NB
N	*Sphagnum lindbergii*	Lindberg's Peat Moss				S2	3 Sensitive	1	17.8 ± 0.0	NB
N	*Sphagnum flexuosum*	Flexuous Peatmoss				S2	3 Sensitive	2	89.5 ± 1.0	NB
N	*Tayloria serrata*	Serrate Trumpet Moss				S2	3 Sensitive	1	89.0 ± 0.0	NB
N	*Tetrodontium brownianum*	Little Georgia				S2	3 Sensitive	5	89.2 ± 0.0	NB
N	*Tortula mucronifolia*	Mucronate Screw Moss				S2	3 Sensitive	3	53.3 ± 1.0	NB
N	*Anomobryum filiforme*	a moss				S2	5 Undetermined	1	53.3 ± 1.0	NB
N	*Fuscopannaria leucosticta*	Rimmed Shingles Lichen				S2	2 May Be At Risk	123	33.0 ± 0.0	NB

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N	*Nephroma laevigatum*	Mustard Kidney Lichen				S2	2 May Be At Risk	3	66.0 ± 0.0	NB
N	*Peltigera lepidophora*	Scaly Pelt Lichen				S2	5 Undetermined	5	44.6 ± 0.0	NB
N	*Barbilophozia lycopodioides*	Greater Pawwort				S2?	6 Not Assessed	2	72.2 ± 1.0	NB
N	*Anacamptodon splachnoides*	a Moss				S2?	3 Sensitive	1	87.4 ± 0.0	NB
N	*Hygrohypnum montanum*	a Moss				S2?	3 Sensitive	2	87.1 ± 0.0	NB
N	*Sphagnum angermanicum*	a Peatmoss				S2?	3 Sensitive	1	88.5 ± 0.0	NB
N	*Trichodon cylindricus*	Cylindric Hairy-teeth Moss				S2?	3 Sensitive	2	87.3 ± 0.0	NB
N	*Plagiomnium rostratum*	Long-beaked Leafy Moss				S2?	3 Sensitive	1	91.2 ± 0.0	NB
N	*Collema leptaleum*	Crumpled Bat's Wing Lichen				S2?	5 Undetermined	1	91.2 ± 0.0	NB
N	*Bryum uliginosum*	a Moss				S2S3	3 Sensitive	2	51.6 ± 9.0	NB
N	*Campylium polygamum*	a Moss				S2S3	3 Sensitive	2	89.0 ± 0.0	NB
N	*Orthotrichum speciosum*	Showy Bristle Moss				S2S3	5 Undetermined	6	51.6 ± 9.0	NB
N	*Pohlia proligera*	Cottony Nodding Moss				S2S3	3 Sensitive	8	89.2 ± 0.0	NB
N	*Saelania glaucescens*	Blue Dew Moss				S2S3	3 Sensitive	3	43.0 ± 0.0	NB
N	*Scorpidium scorpioides*	Hooked Scorpion Moss				S2S3	3 Sensitive	3	35.1 ± 0.0	NB
N	*Sphagnum subfulvum*	a Peatmoss				S2S3	2 May Be At Risk	3	89.0 ± 0.0	NB
N	*Zygodon viridissimus*	a Moss				S2S3	2 May Be At Risk	1	89.9 ± 0.0	NB
N	*Cyrtomnium hymenophylloides*	Short-pointed Lantern Moss				S2S3	3 Sensitive	1	66.3 ± 0.0	NB
N	*Dendriscocaulon umhausense*	a lichen				S2S3	3 Sensitive	1	89.1 ± 0.0	NB
N	*Schistidium maritimum*	a Moss				S3	4 Secure	1	94.2 ± 0.0	NB
N	*Collema nigrescens*	Blistered Tarpaper Lichen				S3	3 Sensitive	2	66.0 ± 0.0	NB
N	*Solorina saccata*	Woodland Owl Lichen				S3	5 Undetermined	19	43.5 ± 0.0	NB
N	*Ahtiana aurescens*	Eastern Candlewax Lichen				S3	5 Undetermined	1	94.2 ± 0.0	NB
N	*Leptogium lichenoides*	Tattered Jellyskin Lichen				S3	5 Undetermined	4	43.1 ± 0.0	NB
N	*Nephroma resupinatum*	a lichen				S3	3 Sensitive	4	46.6 ± 0.0	NB
N	*Peltigera membranacea*	Membranous Pelt Lichen				S3	5 Undetermined	1	73.0 ± 0.0	NB
N	*Aulacomnium androgynum*	Little Groove Moss				S3?	4 Secure	4	91.4 ± 0.0	NB
N	*Dicranella rufescens*	Red Forklet Moss				S3?	5 Undetermined	1	58.8 ± 7.0	NB
N	*Anomodon rugelii*	Rugel's Anomodon Moss				S3S4	3 Sensitive	1	85.0 ± 8.0	NB
N	*Dicranella varia*	a Moss				S3S4	4 Secure	2	51.6 ± 9.0	NB
N	*Dicranum majus*	Greater Broom Moss				S3S4	4 Secure	4	91.6 ± 0.0	NB
N	*Dicranum leioneuron*	a Dicranum Moss				S3S4	4 Secure	1	80.9 ± 10.0	NB
N	*Encalypta ciliata*	Fringed Extinquisher Moss				S3S4	3 Sensitive	1	45.1 ± 0.0	NB
N	*Fissidens bryoides*	Lesser Pocket Moss				S3S4	4 Secure	2	51.6 ± 9.0	NB
N	*Heterocladium dimorphum*	Dimorphous Tangle Moss				S3S4	4 Secure	3	54.1 ± 1.0	NB
N	*Isopterygiopsis muelleriana*	a Moss				S3S4	4 Secure	2	43.0 ± 0.0	NB
N	*Myurella julacea*	Small Mouse-tail Moss				S3S4	4 Secure	3	45.1 ± 0.0	NB
N	*Pogonatum dentatum*	Mountain Hair Moss				S3S4	4 Secure	1	89.8 ± 0.0	NB
N	*Sphagnum compactum*	Compact Peat Moss				S3S4	4 Secure	1	89.5 ± 1.0	NB
N	*Tetraphis geniculata*	Geniculate Four-tooth Moss				S3S4	4 Secure	2	97.5 ± 0.0	NB
N	*Tetraplodon angustatus*	Toothed-leaved Nitrogen Moss				S3S4	4 Secure	1	91.4 ± 0.0	NB
N	*Abietinella abietina*	Wiry Fern Moss				S3S4	4 Secure	3	43.7 ± 0.0	NB
N	*Rauiella scita*	Smaller Fern Moss				S3S4	3 Sensitive	1	94.5 ± 0.0	NB

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N	*Leptogium teretiusculum*	Beaded Jellyskin Lichen				S3S4	5 Undetermined	2	66.1 ± 0.0	NB
N	*Cladonia floerkeana*	Gritty British Soldiers Lichen				S3S4	4 Secure	2	47.5 ± 0.0	NB
N	*Vahliella leucophaea*	Shelter Shingle Lichen				S3S4	5 Undetermined	9	43.0 ± 0.0	NB
N	*Nephroma parile*	Powdery Kidney Lichen				S3S4	4 Secure	4	43.2 ± 0.0	NB
N	*Protopannaria pezizoides*	Brown-gray Moss-shingle Lichen				S3S4	4 Secure	15	43.1 ± 0.0	NB
N	*Pseudocyphellaria perpetua*	Gilded Specklebelly Lichen				S3S4	3 Sensitive	4	91.2 ± 0.0	NB
N	*Stereocaulon paschale*	Easter Foam Lichen				S3S4	5 Undetermined	1	17.7 ± 1.0	NB
N	*Pannaria conoplea*	Mealy-rimmed Shingle Lichen				S3S4	3 Sensitive	2	92.1 ± 0.0	NB
N	*Dermatocarpon luridum*	Brookside Stippleback Lichen				S3S4	4 Secure	8	45.2 ± 0.0	NB
N	*Hennediella heimii*	Long-Stalked Beardless Moss				SH	2 May Be At Risk	1	90.7 ± 10.0	NB
N	*Leucodon brachypus*	a Moss				SH	2 May Be At Risk	9	89.0 ± 0.0	NB
P	*Juglans cinerea*	Butternut	Endangered	Endangered	Endangered	S1	1 At Risk	14	92.6 ± 0.0	NB
P	*Symphyotrichum laurentianum*	Gulf of St Lawrence Aster	Threatened	Threatened	Endangered	S1	1 At Risk	34	65.0 ± 5.0	NB
P	*Symphyotrichum anticostense*	Anticosti Aster	Threatened	Threatened	Endangered	S2S3	1 At Risk	28	95.7 ± 0.0	NB
P	*Symphyotrichum subulatum (Bathurst pop)*	Bathurst Aster - Bathurst pop.	Special Concern	Special Concern	Endangered	S2	1 At Risk	252	15.8 ± 0.0	NB
P	*Lechea maritima var. subcylindrica*	Beach Pinweed	Special Concern			S2	3 Sensitive	152	62.5 ± 0.0	NB
P	*Eriocaulon parkeri*	Parker's Pipewort	Not At Risk		Endangered	S2	1 At Risk	82	55.1 ± 0.0	NB
P	*Pterospora andromedea*	Woodland Pinedrops			Endangered	S1	1 At Risk	14	44.6 ± 0.0	NB
P	*Cryptotaenia canadensis*	Canada Honewort				S1	2 May Be At Risk	1	99.5 ± 1.0	NB
P	*Arnica lonchophylla*	Northern Arnica				S1	2 May Be At Risk	3	65.6 ± 0.0	NB
P	*Bidens eatonii*	Eaton's Beggarticks				S1	2 May Be At Risk	7	54.8 ± 0.0	NB
P	*Erigeron acris ssp. politus*	Bitter Fleabane				S1	2 May Be At Risk	1	98.1 ± 100.0	NB
P	*Pseudognaphalium obtusifolium*	Eastern Cudweed				S1	2 May Be At Risk	1	64.0 ± 0.0	NB
P	*Betula glandulosa*	Glandular Birch				S1	2 May Be At Risk	26	45.5 ± 0.0	NB
P	*Betula michauxii*	Michaux's Dwarf Birch				S1	2 May Be At Risk	3	82.0 ± 0.0	NB
P	*Cynoglossum virginianum var. boreale*	Wild Comfrey				S1	2 May Be At Risk	4	26.4 ± 0.0	NB
P	*Hackelia deflexa var. americana*	Nodding Stickseed				S1	2 May Be At Risk	3	77.0 ± 10.0	NB
P	*Arabis x divaricarpa*	Limestone Rockcress				S1	2 May Be At Risk	12	77.2 ± 5.0	NB
P	*Cardamine parviflora var. arenicola*	Small-flowered Bittercress				S1	2 May Be At Risk	1	13.6 ± 0.0	NB
P	*Descurainia incana ssp. incana*	Gray Tansy Mustard				S1	2 May Be At Risk	4	94.4 ± 0.0	NB
P	*Draba glabella*	Rock Whitlow-Grass				S1	2 May Be At Risk	7	49.0 ± 0.0	NB
P	*Draba incana*	Twisted Whitlow-grass				S1	2 May Be At Risk	2	60.2 ± 0.0	NB
P	*Moehringia macrophylla*	Large-Leaved Sandwort				S1	2 May Be At Risk	5	43.7 ± 0.0	NB
P	*Stellaria crassifolia*	Fleshy Stitchwort				S1	2 May Be At Risk	2	63.7 ± 10.0	NB
P	*Stellaria longipes*	Long-stalked Starwort				S1	2 May Be At Risk	10	49.1 ± 0.0	NB
P	*Chenopodium capitatum*	Strawberry-blite				S1	2 May Be At Risk	1	78.8 ± 1.0	NB
P	*Triadenum virginicum*	Virginia St John's-wort				S1	2 May Be At Risk	1	70.0 ± 0.0	NB
P	*Vaccinium boreale*	Northern Blueberry				S1	2 May Be At Risk	18	45.5 ± 0.0	NB

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P	*Vaccinium uliginosum*	Alpine Bilberry				S1	2 May Be At Risk	5	45.5 ± 0.0	NB
P	*Chamaesyce polygonifolia*	Seaside Spurge				S1	2 May Be At Risk	4	66.4 ± 5.0	NB
P	*Bartonia virginica*	Yellow Bartonia				S1	2 May Be At Risk	3	84.5 ± 0.0	NB
P	*Polygonum viviparum*	Alpine Bistort				S1	2 May Be At Risk	1	83.9 ± 0.0	NB
P	*Ranunculus lapponicus*	Lapland Buttercup				S1	2 May Be At Risk	1	39.2 ± 0.0	NB
P	*Ranunculus sceleratus*	Cursed Buttercup				S1	2 May Be At Risk	9	53.8 ± 0.0	NB
P	*Amelanchier fernaldii*	Fernald's Serviceberry				S1	2 May Be At Risk	1	84.8 ± 0.0	NB
P	*Salix serissima*	Autumn Willow				S1	2 May Be At Risk	4	34.4 ± 0.0	NB
P	*Saxifraga paniculata ssp. neogaea*	White Mountain Saxifrage				S1	2 May Be At Risk	4	44.3 ± 0.0	NB
P	*Agalinis paupercula var. borealis*	Small-flowered Agalinis				S1	2 May Be At Risk	9	70.2 ± 0.0	NB
P	*Limosella aquatica*	Water Mudwort				S1	2 May Be At Risk	18	94.2 ± 0.0	NB
P	*Carex backii*	Rocky Mountain Sedge				S1	2 May Be At Risk	2	81.7 ± 0.0	NB
P	*Carex bigelowii*	Bigelow's Sedge				S1	2 May Be At Risk	7	59.2 ± 0.0	NB
P	*Carex glareosa var. amphigena*	Gravel Sedge				S1	2 May Be At Risk	5	73.5 ± 1.0	NB
P	*Carex rariflora*	Loose-flowered Alpine Sedge				S1	2 May Be At Risk	2	91.4 ± 0.0	NB
P	*Carex saxatilis*	Russet Sedge				S1	2 May Be At Risk	6	88.3 ± 0.0	NB
P	*Carex viridula var. elatior*	Greenish Sedge				S1	2 May Be At Risk	14	34.4 ± 0.0	NB
P	*Cyperus diandrus*	Low Flatsedge				S1	2 May Be At Risk	2	56.8 ± 0.0	NB
P	*Cyperus bipartitus*	Shining Flatsedge				S1	2 May Be At Risk	14	48.2 ± 0.0	NB
P	*Schoenoplectus smithii*	Smith's Bulrush				S1	2 May Be At Risk	18	55.2 ± 0.0	NB
P	*Juncus greenei*	Greene's Rush				S1	2 May Be At Risk	1	57.4 ± 1.0	NB
P	*Juncus stygius*	Moor Rush				S1	2 May Be At Risk	1	90.4 ± 0.0	NB
P	*Juncus subtilis*	Creeping Rush				S1	2 May Be At Risk	8	68.6 ± 1.0	NB
P	*Juncus trifidus*	Highland Rush				S1	2 May Be At Risk	9	59.2 ± 0.0	NB
P	*Allium canadense*	Canada Garlic				S1	2 May Be At Risk	1	70.6 ± 1.0	NB
P	*Zigadenus elegans ssp. glaucus*	Mountain Death Camas				S1	2 May Be At Risk	10	49.1 ± 0.0	NB
P	*Malaxis brachypoda*	White Adder's-Mouth				S1	2 May Be At Risk	2	34.5 ± 0.0	NB
P	*Calamagrostis stricta ssp. inexpansa*	Slim-stemmed Reed Grass				S1	2 May Be At Risk	1	95.5 ± 0.0	NB
P	*Catabrosa aquatica var. laurentiana*	Water Whorl Grass				S1	2 May Be At Risk	2	79.3 ± 5.0	NB
P	*Dichanthelium xanthophysum*	Slender Panic Grass				S1	2 May Be At Risk	4	7.3 ± 0.0	NB
P	*Elymus hystrix var. bigeloviana*	Spreading Wild Rye				S1	2 May Be At Risk	2	94.6 ± 0.0	NB
P	*Puccinellia ambigua*	Dwarf Alkali Grass				S1	5 Undetermined	1	59.5 ± 0.0	NB
P	*Zizania aquatica var. brevis*	Indian Wild Rice				S1	2 May Be At Risk	16	48.1 ± 0.0	NB
P	*Stuckenia filiformis ssp. occidentalis*	Thread-leaved Pondweed				S1	2 May Be At Risk	1	95.9 ± 1.0	NB
P	*Potamogeton friesii*	Fries' Pondweed				S1	2 May Be At Risk	8	79.5 ± 0.0	NB
P	*Potamogeton nodosus*	Long-leaved Pondweed				S1	2 May Be At Risk	2	70.2 ± 0.0	NB
P	*Cystopteris laurentiana*	Laurentian Bladder Fern				S1	2 May Be At Risk	1	17.6 ± 0.0	NB
P	*Dryopteris filix-mas*	Male Fern				S1	2 May Be At Risk	2	99.9 ± 0.0	NB
P	*Gymnocarpium robertianum*	Limestone Oak Fern				S1	2 May Be At Risk	1	84.2 ± 0.0	NB
P	*Polystichum lonchitis*	Northern Holly Fern				S1		3	65.6 ± 0.0	NB
P	*Huperzia selago*	Northern Firmoss				S1	2 May Be At Risk	3	59.3 ± 0.0	NB
P	*Bidens heterodoxa*	Connecticut Beggar-Ticks				S1?	2 May Be At Risk	3	89.3 ± 1.0	NB
P	*Cuscuta campestris*	Field Dodder				S1?	2 May Be At Risk	3	71.0 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
P	*Galium trifidum ssp. subbiflorum*	Three-petaled Bedstraw				S1?	5 Undetermined	2	78.3 ± 0.0	NB
P	*Carex laxiflora*	Loose-Flowered Sedge				S1?	5 Undetermined	1	58.9 ± 2.0	NB
P	*Rumex aquaticus var. fenestratus*	Western Dock				S1S2	2 May Be At Risk	7	26.7 ± 0.0	NB
P	*Carex crawei*	Crawe's Sedge				S1S2	2 May Be At Risk	1	53.4 ± 0.0	NB
P	*Thelypteris simulata*	Bog Fern				S1S2	2 May Be At Risk	1	66.0 ± 1.0	NB
P	*Cuscuta cephalanthi*	Buttonbush Dodder				S1S3	2 May Be At Risk	25	15.8 ± 0.0	NB
P	*Scirpus atrovirens*	Dark-green Bulrush				S1S3	5 Undetermined	26	79.4 ± 0.0	NB
P	*Listera australis*	Southern Twayblade			Endangered	S2	1 At Risk	25	85.2 ± 0.0	NB
P	*Osmorhiza depauperata*	Blunt Sweet Cicely				S2	3 Sensitive	6	33.0 ± 0.0	NB
P	*Osmorhiza longistylis*	Smooth Sweet Cicely				S2	3 Sensitive	2	68.7 ± 0.0	NB
P	*Pseudognaphalium macounii*	Macoun's Cudweed				S2	3 Sensitive	1	98.4 ± 5.0	NB
P	*Solidago simplex*	Sticky Goldenrod				S2	2 May Be At Risk	2	65.6 ± 0.0	NB
P	*Ionactis linariifolius*	Stiff Aster				S2	3 Sensitive	53	4.3 ± 0.0	NB
P	*Symphyotrichum subulatum*	Annual Saltmarsh Aster				S2	1 At Risk	152	24.7 ± 0.0	NB
P	*Betula minor*	Dwarf White Birch				S2	3 Sensitive	21	58.8 ± 0.0	NB
P	*Arabis drummondii*	Drummond's Rockcress				S2	3 Sensitive	5	7.1 ± 1.0	NB
P	*Sagina nodosa*	Knotted Pearlwort				S2	3 Sensitive	5	23.8 ± 1.0	NB
P	*Stellaria longifolia*	Long-leaved Starwort				S2	3 Sensitive	1	10.2 ± 0.0	NB
P	*Atriplex franktonii*	Frankton's Saltbush				S2	4 Secure	6	64.4 ± 0.0	NB
P	*Chenopodium rubrum*	Red Pigweed				S2	3 Sensitive	10	62.3 ± 0.0	NB
P	*Hypericum dissimulatum*	Disguised St John's-wort				S2	3 Sensitive	1	85.2 ± 1.0	NB
P	*Shepherdia canadensis*	Soapberry				S2	3 Sensitive	2	66.3 ± 1.0	NB
P	*Astragalus eucosmus*	Elegant Milk-vetch				S2	2 May Be At Risk	2	70.2 ± 0.0	NB
P	*Oxytropis campestris var. johannensis*	Field Locoweed				S2	3 Sensitive	3	4.4 ± 10.0	NB
P	*Gentiana linearis*	Narrow-Leaved Gentian				S2	3 Sensitive	9	61.8 ± 0.0	NB
P	*Myriophyllum humile*	Low Water Milfoil				S2	3 Sensitive	1	68.6 ± 1.0	NB
P	*Nuphar lutea ssp. rubrodisca*	Red-disked Yellow Pond-lily				S2	3 Sensitive	4	51.1 ± 0.0	NB
P	*Orobanche uniflora*	One-Flowered Broomrape				S2	3 Sensitive	2	72.7 ± 10.0	NB
P	*Polygonum amphibium var. emersum*	Water Smartweed				S2	3 Sensitive	1	70.2 ± 0.0	NB
P	*Podostemum ceratophyllum*	Horn-leaved Riverweed				S2	3 Sensitive	8	70.5 ± 1.0	NB
P	*Anemone multifida*	Cut-leaved Anemone				S2	3 Sensitive	1	82.0 ± 10.0	NB
P	*Hepatica nobilis var. obtusa*	Round-lobed Hepatica				S2	3 Sensitive	4	46.9 ± 0.0	NB
P	*Ranunculus longirostris*	Eastern White Water-Crowfoot				S2	5 Undetermined	3	39.5 ± 1.0	NB
P	*Crataegus scabrida*	Rough Hawthorn				S2	3 Sensitive	2	7.2 ± 1.0	NB
P	*Rosa acicularis ssp. sayi*	Prickly Rose				S2	2 May Be At Risk	103	4.2 ± 0.0	NB
P	*Galium kamtschaticum*	Northern Wild Licorice				S2	3 Sensitive	5	76.7 ± 5.0	NB
P	*Salix candida*	Sage Willow				S2	3 Sensitive	23	20.7 ± 0.0	NB
P	*Castilleja septentrionalis*	Northeastern Paintbrush				S2	3 Sensitive	7	80.5 ± 1.0	NB
P	*Sagittaria calycina var. spongiosa*	Long-lobed Arrowhead				S2	4 Secure	78	48.0 ± 0.0	NB
P	*Carex concinna*	Beautiful Sedge				S2	3 Sensitive	2	92.2 ± 0.0	NB
P	*Carex granularis*	Limestone Meadow Sedge				S2	3 Sensitive	17	66.9 ± 5.0	NB

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P	*Carex gynocrates*	Northern Bog Sedge				S2	3 Sensitive	14	34.3 ± 0.0	NB
P	*Carex hirtifolia*	Pubescent Sedge				S2	3 Sensitive	12	57.2 ± 0.0	NB
P	*Carex prairea*	Prairie Sedge				S2	3 Sensitive	1	69.8 ± 1.0	NB
P	*Carex rostrata*	Narrow-leaved Beaked Sedge				S2	3 Sensitive	5	31.0 ± 0.0	NB
P	*Carex salina*	Saltmarsh Sedge				S2	3 Sensitive	11	19.6 ± 5.0	NB
P	*Carex sprengelii*	Longbeak Sedge				S2	3 Sensitive	1	4.3 ± 0.0	NB
P	*Carex tenuiflora*	Sparse-Flowered Sedge				S2	2 May Be At Risk	3	66.8 ± 10.0	NB
P	*Carex albicans var. emmonsii*	White-tinged Sedge				S2	3 Sensitive	9	62.4 ± 0.0	NB
P	*Eriophorum gracile*	Slender Cottongrass				S2	2 May Be At Risk	4	73.8 ± 0.0	NB
P	*Blysmus rufus*	Red Bulrush				S2	3 Sensitive	43	18.9 ± 1.0	NB
P	*Elodea nuttallii*	Nuttall's Waterweed				S2	3 Sensitive	2	87.5 ± 0.0	NB
P	*Juncus vaseyi*	Vasey Rush				S2	3 Sensitive	29	4.2 ± 0.0	NB
P	*Allium tricoccum*	Wild Leek				S2	2 May Be At Risk	17	95.9 ± 5.0	NB
P	*Amerorchis rotundifolia*	Small Round-leaved Orchis				S2	2 May Be At Risk	13	34.5 ± 0.0	NB
P	*Calypso bulbosa var. americana*	Calypso				S2	2 May Be At Risk	7	43.6 ± 0.0	NB
P	*Coeloglossum viride var. virescens*	Long-bracted Frog Orchid				S2	2 May Be At Risk	3	38.9 ± 1.0	NB
P	*Cypripedium parviflorum var. makasin*	Small Yellow Lady's-Slipper				S2	2 May Be At Risk	3	45.5 ± 2.0	NB
P	*Goodyera oblongifolia*	Menzies' Rattlesnake-plantain				S2	3 Sensitive	32	30.2 ± 10.0	NB
P	*Spiranthes lucida*	Shining Ladies'-Tresses				S2	3 Sensitive	5	70.8 ± 1.0	NB
P	*Agrostis mertensii*	Northern Bent Grass				S2	2 May Be At Risk	80	4.2 ± 0.0	NB
P	*Dichanthelium linearifolium*	Narrow-leaved Panic Grass				S2	3 Sensitive	3	7.4 ± 0.0	NB
P	*Piptatherum canadense*	Canada Rice Grass				S2	3 Sensitive	5	7.0 ± 0.0	NB
P	*Poa glauca*	Glaucous Blue Grass				S2	4 Secure	6	17.6 ± 0.0	NB
P	*Puccinellia laurentiana*	Nootka Alkali Grass				S2	3 Sensitive	2	66.1 ± 0.0	NB
P	*Zizania aquatica var. aquatica*	Indian Wild Rice				S2	5 Undetermined	6	55.3 ± 10.0	NB
P	*Piptatherum pungens*	Slender Rice Grass				S2	2 May Be At Risk	9	7.0 ± 1.0	NB
P	*Asplenium trichomanes*	Maidenhair Spleenwort				S2	3 Sensitive	6	43.3 ± 0.0	NB
P	*Woodwardia virginica*	Virginia Chain Fern				S2	3 Sensitive	9	80.1 ± 0.0	NB
P	*Woodsia alpina*	Alpine Cliff Fern				S2	3 Sensitive	19	65.9 ± 0.0	NB
P	*Lycopodium sitchense*	Sitka Clubmoss				S2	3 Sensitive	2	59.0 ± 0.0	NB
P	*Botrychium minganense*	Mingan Moonwort				S2	3 Sensitive	5	85.1 ± 1.0	NB
P	*Selaginella selaginoides*	Low Spikemoss				S2	3 Sensitive	16	34.5 ± 0.0	NB
P	*Toxicodendron radicans*	Poison Ivy				S2?	3 Sensitive	2	93.0 ± 0.0	NB
P	*Humulus lupulus var. lupuloides*	Common Hop				S2?	3 Sensitive	4	57.4 ± 0.0	NB
P	*Crataegus macrosperma*	Big-Fruit Hawthorn				S2?	5 Undetermined	1	7.2 ± 0.0	NB
P	*Galium obtusum*	Blunt-leaved Bedstraw				S2?	4 Secure	9	35.3 ± 1.0	NB
P	*Salix myricoides*	Bayberry Willow				S2?	3 Sensitive	6	36.2 ± 5.0	NB
P	*Carex vacillans*	Estuarine Sedge				S2?	3 Sensitive	4	52.4 ± 10.0	NB
P	*Platanthera huronensis*	Fragrant Green Orchid				S2?	5 Undetermined	3	5.6 ± 0.0	NB
P	*Solidago altissima*	Tall Goldenrod				S2S3	4 Secure	5	68.6 ± 0.0	NB
P	*Barbarea orthoceras*	American Yellow Rocket				S2S3	3 Sensitive	12	63.5 ± 1.0	NB
P	*Ceratophyllum echinatum*	Prickly Hornwort				S2S3	3 Sensitive	1	55.6 ± 0.0	NB

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P	*Callitriche hermaphroditica*	Northern Water-starwort				S2S3	4 Secure	13	52.4 ± 0.0	NB
P	*Elatine americana*	American Waterwort				S2S3	3 Sensitive	15	45.5 ± 0.0	NB
P	*Bartonia paniculata ssp. iodandra*	Branched Bartonia				S2S3	3 Sensitive	2	85.7 ± 0.0	NB
P	*Epilobium coloratum*	Purple-veined Willowherb				S2S3	3 Sensitive	3	86.6 ± 0.0	NB
P	*Rumex maritimus var. persicarioides*	Peach-leaved Dock				S2S3	5 Undetermined	1	83.4 ± 0.0	NB
P	*Rumex pallidus*	Seabeach Dock				S2S3	3 Sensitive	6	15.7 ± 17.0	NB
P	*Amelanchier sanguinea var. gaspensis*	Round-Leaved Serviceberry				S2S3	5 Undetermined	2	91.5 ± 0.0	NB
P	*Rubus pensilvanicus*	Pennsylvania Blackberry				S2S3	4 Secure	1	53.3 ± 2.0	NB
P	*Galium labradoricum*	Labrador Bedstraw				S2S3	3 Sensitive	18	34.4 ± 0.0	NB
P	*Valeriana uliginosa*	Swamp Valerian				S2S3	3 Sensitive	10	34.5 ± 0.0	NB
P	*Carex adusta*	Lesser Brown Sedge				S2S3	4 Secure	8	7.2 ± 0.0	NB
P	*Juncus brachycephalus*	Small-Head Rush				S2S3	3 Sensitive	2	34.5 ± 0.0	NB
P	*Corallorhiza maculata var. occidentalis*	Spotted Coralroot				S2S3	3 Sensitive	2	52.9 ± 1.0	NB
P	*Corallorhiza maculata var. maculata*	Spotted Coralroot				S2S3	3 Sensitive	5	47.3 ± 10.0	NB
P	*Listera auriculata*	Auricled Twayblade				S2S3	3 Sensitive	21	25.6 ± 0.0	NB
P	*Spiranthes cernua*	Nodding Ladies'-Tresses				S2S3	3 Sensitive	1	94.1 ± 0.0	NB
P	*Stuckenia filiformis*	Thread-leaved Pondweed				S2S3	3 Sensitive	2	66.5 ± 1.0	NB
P	*Stuckenia filiformis ssp. alpina*	Thread-leaved Pondweed				S2S3	3 Sensitive	9	87.6 ± 0.0	NB
P	*Potamogeton praelongus*	White-stemmed Pondweed				S2S3	4 Secure	5	57.4 ± 0.0	NB
P	*Isoetes acadiensis*	Acadian Quillwort				S2S3	3 Sensitive	1	79.4 ± 0.0	NB
P	*Panax trifolius*	Dwarf Ginseng				S3	3 Sensitive	8	26.8 ± 0.0	NB
P	*Arnica lanceolata*	Lance-leaved Arnica				S3	4 Secure	36	5.5 ± 0.0	NB
P	*Artemisia campestris ssp. caudata*	Field Wormwood				S3	4 Secure	6	49.2 ± 0.0	NB
P	*Bidens hyperborea*	Estuary Beggarticks				S3	4 Secure	105	24.5 ± 0.0	NB
P	*Bidens hyperborea var. hyperborea*	Estuary Beggarticks				S3	4 Secure	20	52.2 ± 1.0	NB
P	*Erigeron hyssopifolius*	Hyssop-leaved Fleabane				S3	4 Secure	115	17.6 ± 0.0	NB
P	*Prenanthes racemosa*	Glaucous Rattlesnakeroot				S3	4 Secure	2	95.5 ± 0.0	NB
P	*Symphyotrichum boreale*	Boreal Aster				S3	3 Sensitive	5	8.6 ± 5.0	NB
P	*Betula pumila*	Bog Birch				S3	4 Secure	107	34.5 ± 0.0	NB
P	*Arabis glabra*	Tower Mustard				S3	5 Undetermined	11	4.6 ± 0.0	NB
P	*Arabis hirsuta var. pycnocarpa*	Western Hairy Rockcress				S3	4 Secure	8	43.2 ± 0.0	NB
P	*Subularia aquatica var. americana*	Water Awlwort				S3	4 Secure	1	76.2 ± 1.0	NB
P	*Stellaria humifusa*	Saltmarsh Starwort				S3	4 Secure	13	18.9 ± 0.0	NB
P	*Hudsonia tomentosa*	Woolly Beach-heath				S3	4 Secure	71	23.1 ± 0.0	NB
P	*Crassula aquatica*	Water Pygmyweed				S3	4 Secure	46	44.1 ± 0.0	NB
P	*Penthorum sedoides*	Ditch Stonecrop				S3	4 Secure	5	94.1 ± 0.0	NB
P	*Elatine minima*	Small Waterwort				S3	4 Secure	5	40.3 ± 1.0	NB
P	*Astragalus alpinus var. brunetianus*	Alpine Milk-Vetch				S3	4 Secure	4	96.7 ± 1.0	NB
P	*Hedysarum alpinum*	Alpine Sweet-vetch				S3	4 Secure	9	4.4 ± 0.0	NB
P	*Gentianella amarella ssp. acuta*	Northern Gentian				S3	4 Secure	7	67.2 ± 0.0	NB

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P	*Geranium bicknellii*	Bicknell's Crane's-bill				S3	4 Secure	7	44.3 ± 0.0	NB
P	*Myriophyllum farwellii*	Farwell's Water Milfoil				S3	4 Secure	3	47.6 ± 0.0	NB
P	*Myriophyllum verticillatum*	Whorled Water Milfoil				S3	4 Secure	5	51.2 ± 1.0	NB
P	*Teucrium canadense*	Canada Germander				S3	3 Sensitive	41	55.2 ± 5.0	NB
P	*Nuphar lutea ssp. pumila*	Small Yellow Pond-lily				S3	4 Secure	7	41.0 ± 1.0	NB
P	*Epilobium hornemannii*	Hornemann's Willowherb				S3	4 Secure	32	12.3 ± 0.0	NB
P	*Epilobium strictum*	Downy Willowherb				S3	4 Secure	3	41.3 ± 0.0	NB
P	*Polygala sanguinea*	Blood Milkwort				S3	3 Sensitive	21	88.0 ± 0.0	NB
P	*Polygonum arifolium*	Halberd-leaved Tearthumb				S3	4 Secure	25	77.9 ± 5.0	NB
P	*Polygonum punctatum*	Dotted Smartweed				S3	4 Secure	2	93.3 ± 0.0	NB
P	*Polygonum punctatum var. confertiflorum*	Dotted Smartweed				S3	4 Secure	33	42.9 ± 0.0	NB
P	*Polygonum scandens*	Climbing False Buckwheat				S3	4 Secure	21	57.1 ± 0.0	NB
P	*Littorella uniflora*	American Shoreweed				S3	4 Secure	1	56.8 ± 1.0	NB
P	*Primula mistassinica*	Mistassini Primrose				S3	4 Secure	2	66.3 ± 10.0	NB
P	*Samolus valerandi ssp. parviflorus*	Seaside Brookweed				S3	4 Secure	128	43.5 ± 2.0	NB
P	*Pyrola minor*	Lesser Pyrola				S3	4 Secure	21	33.6 ± 0.0	NB
P	*Clematis occidentalis*	Purple Clematis				S3	4 Secure	11	26.3 ± 1.0	NB
P	*Ranunculus gmelinii*	Gmelin's Water Buttercup				S3	4 Secure	14	34.8 ± 1.0	NB
P	*Thalictrum venulosum*	Northern Meadow-rue				S3	4 Secure	5	54.9 ± 0.0	NB
P	*Amelanchier canadensis*	Canada Serviceberry				S3	4 Secure	2	89.2 ± 0.0	NB
P	*Rosa palustris*	Swamp Rose				S3	4 Secure	2	57.5 ± 1.0	NB
P	*Sanguisorba canadensis*	Canada Burnet				S3	4 Secure	49	18.8 ± 5.0	NB
P	*Galium boreale*	Northern Bedstraw				S3	4 Secure	5	56.0 ± 1.0	NB
P	*Salix pedicellaris*	Bog Willow				S3	4 Secure	26	64.0 ± 5.0	NB
P	*Comandra umbellata*	Bastard's Toadflax				S3	4 Secure	50	21.2 ± 1.0	NB
P	*Comandra umbellata ssp. umbellata*	Bastard's Toadflax				S3	4 Secure	6	77.2 ± 0.0	NB
P	*Parnassia glauca*	Fen Grass-of-Parnassus				S3	4 Secure	45	34.5 ± 0.0	NB
P	*Limosella australis*	Southern Mudwort				S3	4 Secure	85	16.0 ± 0.0	NB
P	*Veronica serpyllifolia ssp. humifusa*	Thyme-Leaved Speedwell				S3	4 Secure	13	4.3 ± 0.0	NB
P	*Boehmeria cylindrica*	Small-spike False-nettle				S3	3 Sensitive	7	55.4 ± 0.0	NB
P	*Pilea pumila*	Dwarf Clearweed				S3	4 Secure	6	55.4 ± 0.0	NB
P	*Viola adunca*	Hooked Violet				S3	4 Secure	8	51.5 ± 0.0	NB
P	*Viola nephrophylla*	Northern Bog Violet				S3	4 Secure	12	34.5 ± 0.0	NB
P	*Carex arcta*	Northern Clustered Sedge				S3	4 Secure	8	74.4 ± 0.0	NB
P	*Carex atratiformis*	Scabrous Black Sedge				S3	4 Secure	18	23.0 ± 0.0	NB
P	*Carex capillaris*	Hairlike Sedge				S3	4 Secure	21	34.5 ± 0.0	NB
P	*Carex chordorrhiza*	Creeping Sedge				S3	4 Secure	1	81.6 ± 0.0	NB
P	*Carex conoidea*	Field Sedge				S3	4 Secure	1	24.1 ± 10.0	NB
P	*Carex eburnea*	Bristle-leaved Sedge				S3	4 Secure	62	43.1 ± 0.0	NB
P	*Carex garberi*	Garber's Sedge				S3	3 Sensitive	28	5.5 ± 0.0	NB
P	*Carex haydenii*	Hayden's Sedge				S3	4 Secure	3	46.0 ± 0.0	NB
P	*Carex michauxiana*	Michaux's Sedge				S3	4 Secure	6	62.6 ± 0.0	NB
P	*Carex ormostachya*	Necklace Spike Sedge				S3	4 Secure	10	26.3 ± 1.0	NB
P	*Carex rosea*	Rosy Sedge				S3	4 Secure	1	77.8 ± 5.0	NB
P	*Carex tenera*	Tender Sedge				S3	4 Secure	2	52.3 ± 0.0	NB
P	*Carex tuckermanii*	Tuckerman's Sedge				S3	4 Secure	15	15.0 ± 0.0	NB
P	*Carex vaginata*	Sheathed Sedge				S3	3 Sensitive	15	34.5 ± 0.0	NB
P	*Carex wiegandii*	Wiegand's Sedge				S3	4 Secure	34	5.6 ± 2.0	NB
P	*Carex recta*	Estuary Sedge				S3	4 Secure	14	20.6 ± 0.0	NB

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P	*Cyperus dentatus*	Toothed Flatsedge				S3	4 Secure	1	30.8 ± 10.0	NB
P	*Cyperus esculentus*	Perennial Yellow Nutsedge				S3	4 Secure	2	71.7 ± 0.0	NB
P	*Eleocharis intermedia*	Matted Spikerush				S3	4 Secure	35	43.0 ± 0.0	NB
P	*Rhynchospora capitellata*	Small-headed Beakrush				S3	4 Secure	60	4.2 ± 0.0	NB
P	*Rhynchospora fusca*	Brown Beakrush				S3	4 Secure	5	65.3 ± 1.0	NB
P	*Trichophorum clintonii*	Clinton's Clubrush				S3	4 Secure	68	4.5 ± 0.0	NB
P	*Schoenoplectus torreyi*	Torrey's Bulrush				S3	4 Secure	7	56.2 ± 0.0	NB
P	*Lemna trisulca*	Star Duckweed				S3	4 Secure	1	64.4 ± 2.0	NB
P	*Triantha glutinosa*	Sticky False-Asphodel				S3	4 Secure	7	59.8 ± 0.0	NB
P	*Cypripedium reginae*	Showy Lady's-Slipper				S3	3 Sensitive	17	34.5 ± 0.0	NB
P	*Liparis loeselii*	Loesel's Twayblade				S3	4 Secure	7	43.8 ± 3.0	NB
P	*Platanthera blephariglottis*	White Fringed Orchid				S3	4 Secure	133	41.8 ± 0.0	NB
P	*Platanthera grandiflora*	Large Purple Fringed Orchid				S3	3 Sensitive	13	11.6 ± 0.0	NB
P	*Bromus latiglumis*	Broad-Glumed Brome				S3	3 Sensitive	5	26.0 ± 0.0	NB
P	*Dichanthelium depauperatum*	Starved Panic Grass				S3	4 Secure	23	7.1 ± 0.0	NB
P	*Muhlenbergia richardsonis*	Mat Muhly				S3	4 Secure	1	100.0 ± 0.0	NB
P	*Potamogeton obtusifolius*	Blunt-leaved Pondweed				S3	4 Secure	15	31.4 ± 1.0	NB
P	*Potamogeton richardsonii*	Richardson's Pondweed				S3	3 Sensitive	7	56.4 ± 1.0	NB
P	*Xyris montana*	Northern Yellow-Eyed-Grass				S3	4 Secure	80	61.5 ± 0.0	NB
P	*Zannichellia palustris*	Horned Pondweed				S3	4 Secure	68	15.5 ± 1.0	NB
P	*Adiantum pedatum*	Northern Maidenhair Fern				S3	4 Secure	3	68.7 ± 0.0	NB
P	*Cryptogramma stelleri*	Steller's Rockbrake				S3	4 Secure	35	17.5 ± 0.0	NB
P	*Asplenium trichomanes-ramosum*	Green Spleenwort				S3	4 Secure	98	17.5 ± 0.0	NB
P	*Dryopteris fragrans var. remotiuscula*	Fragrant Wood Fern				S3	4 Secure	51	42.6 ± 0.0	NB
P	*Dryopteris goldiana*	Goldie's Woodfern				S3	3 Sensitive	11	98.4 ± 0.0	NB
P	*Woodsia glabella*	Smooth Cliff Fern				S3	4 Secure	14	43.9 ± 0.0	NB
P	*Equisetum palustre*	Marsh Horsetail				S3	4 Secure	6	46.8 ± 0.0	NB
P	*Isoetes tuckermanii*	Tuckerman's Quillwort				S3	4 Secure	4	63.7 ± 0.0	NB
P	*Lycopodium sabinifolium*	Ground-Fir				S3	4 Secure	11	45.4 ± 0.0	NB
P	*Huperzia appalachiana*	Appalachian Fir-Clubmoss				S3	3 Sensitive	18	29.7 ± 1.0	NB
P	*Botrychium lanceolatum var. angustisegmentum*	Lance-Leaf Grape-Fern				S3	3 Sensitive	6	38.0 ± 0.0	NB
P	*Botrychium simplex*	Least Moonwort				S3	4 Secure	9	39.8 ± 0.0	NB
P	*Polypodium appalachianum*	Appalachian Polypody				S3	4 Secure	1	86.2 ± 1.0	NB
P	*Mertensia maritima*	Sea Lungwort				S3S4	4 Secure	8	48.9 ± 2.0	NB
P	*Lobelia kalmii*	Brook Lobelia				S3S4	4 Secure	34	17.6 ± 0.0	NB
P	*Suaeda calceoliformis*	Horned Sea-blite				S3S4	4 Secure	35	22.3 ± 1.0	NB
P	*Myriophyllum sibiricum*	Siberian Water Milfoil				S3S4	4 Secure	22	46.0 ± 0.0	NB
P	*Stachys pilosa*	Hairy Hedge-Nettle				S3S4	5 Undetermined	6	7.0 ± 0.0	NB
P	*Utricularia gibba*	Humped Bladderwort				S3S4	4 Secure	1	79.1 ± 1.0	NB
P	*Rumex maritimus*	Sea-Side Dock				S3S4	4 Secure	29	62.9 ± 0.0	NB
P	*Rumex maritimus var. fueginus*	Tierra del Fuego Dock				S3S4	4 Secure	20	64.9 ± 0.0	NB
P	*Potentilla arguta*	Tall Cinquefoil				S3S4	4 Secure	7	7.2 ± 0.0	NB
P	*Rubus chamaemorus*	Cloudberry				S3S4	4 Secure	147	43.1 ± 0.0	NB
P	*Geocaulon lividum*	Northern Comandra				S3S4	4 Secure	65	15.2 ± 1.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
P	*Juniperus horizontalis*	Creeping Juniper				S3S4	4 Secure	2	16.6 ± 1.0	NB
P	*Cladium mariscoides*	Smooth Twigrush				S3S4	4 Secure	2	64.5 ± 0.0	NB
P	*Eriophorum russeolum*	Russet Cottongrass				S3S4	4 Secure	68	42.8 ± 0.0	NB
P	*Triglochin gaspensis*	Gasp├⌐ Arrowgrass				S3S4	4 Secure	65	18.5 ± 1.0	NB
P	*Corallorhiza maculata*	Spotted Coralroot				S3S4	3 Sensitive	16	41.3 ± 0.0	NB
P	*Calamagrostis stricta*	Slim-stemmed Reed Grass				S3S4	4 Secure	14	53.3 ± 0.0	NB
P	*Distichlis spicata*	Salt Grass				S3S4	4 Secure	38	24.6 ± 0.0	NB
P	*Potamogeton oakesianus*	Oakes' Pondweed				S3S4	4 Secure	7	43.4 ± 0.0	NB
P	*Polygonum raii*	Sharp-fruited Knotweed				SH	0.1 Extirpated	6	19.6 ± 10.0	NB
P	*Montia fontana*	Water Blinks				SH	2 May Be At Risk	2	54.8 ± 1.0	NB
P	*Aquilegia canadensis*	Red Columbine				SH	2 May Be At Risk	1	81.8 ± 10.0	NB
P	*Gymnocarpium jessoense ssp. parvulum*	Asian Oak Fern				SH	2 May Be At Risk	1	97.7 ± 1.0	NB
P	*Botrychium campestre*	Prairie Moonwort				SH	2 May Be At Risk	1	49.2 ± 0.0	NB

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The recipient of these data shall acknowledge the ACCDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

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Appendix VII:

Greenhouse Gas Emissions Estimates

ESTIMATED DIRECT GHG EMISSIONS FOR CONSTRUCTION OF THE VIOLET SOLAR FARM

General Construction Information

Total construction period:	11	months
Total work days*:	231	days
Hours worked per day:	12	hours
Productive hours worked per day†:	8	hours

Emissions for Construction Workers Travelling To And From Site

Average workforce:	50	#
Vehicle occupants:	2	Workers per vehicle
Average round trip distance:	150	km
Total distance travelled:	866,250	km

Emission Equipment	LDGTs (#)	Fuel Consumption (L/100km) ‡	Equipment Details	Emission Factors (g/L) §			Assumptions	Emission Estimates (tonnes)			
				CO_2	CH_4	N_2O		CO_2	CH_4	N_2O	CO_{2eq}
Light-Duty Gasoline Trucks (LDGTs)	25	15	Medium usage for least efficient LDGTs	2316	0.14	0.022	Table A6-12 Tier 2 LDGTs (2004-2013)	301	1.82E-02	2.86E-03	302
							TOTALS	301	1.82E-02	2.86E-03	302

Emissions for Surveying, Clearing, Grubbing, and Levelling while using Heavy-Duty Diesel Vehicles (HDDVs)

Surveying, clearing, grubbing, and levelling timeline:	2	Months
Total work days*:	42	days
One-way trip distance for semi-tractor trailers:	100	km

Emission Equipment	#	Fuel Consumption (L/h) ‖	Equipment Details	Emission Factors (g/L) §			Assumptions	Emission Estimates (tonnes)			
				CO_2	CH_4	N_2O		CO_2	CH_4	N_2O	CO_{2eq}
Dump truck	4	49.2	775D medium load factor	2690	0.14	0.082	Table A6-12 HDDVs with moderate control (2004-2013)	178	9.26E-03	5.42E-03	180
Tracked mechanical harvester	1	19.5	325B medium load factor (equipped for forestry)	2690	0.14	1	Table A6-12 off-road diesel	18	9.17E-04	6.55E-03	20
Rubber-tired skidder	1	21	528B medium load factor	2690	0.14	1	Table A6-12 off-road diesel	19	9.88E-04	7.06E-03	21
Shredder	1	18.5	3600 Family Diesel Generator Set	2690	0.14	1	Table A6-12 off-road diesel	17	8.70E-04	6.22E-03	19
Bull dozer with root rake	1	33	D8R medium load factor	2690	0.14	1	Table A6-12 off-road diesel	30	1.55E-03	1.11E-02	33
Tracked excavator	2	19.5	325B medium load factor (equipped for forestry)	2690	0.14	1	Table A6-12 off-road diesel	35	1.83E-03	1.31E-02	39
Back-hoe crawler	1	17	953C medium load factor	2690	0.14	1	Table A6-12 off-road diesel	15	8.00E-04	5.71E-03	17
Scrapper-pan	4	43	623F medium load factor	2690	0.14	1	Table A6-12 off-road diesel	155	8.09E-03	5.78E-02	173
							TOTALS	467	2.43E-02	1.13E-01	501

Emission Equipment	Trips	Weight (tonnes)	Equipment Details	Emission Factors (g/tonne-km travelled) ¶ CO_{2eq}	Assumptions	Emission Estimates (tonnes) CO_{2eq}
Long-haul semi-tractor trailer (15t to 30t)	10	30	Loaded semi-tractor trailer - floating equipment	114	Truck transportation emissions from CN	3
Long-haul semi-tractor trailer (15t to 30t)	10	5	Empty semi-tractor trailer	114	Truck transportation emissions from CN	1
Long-haul semi-tractor trailer (15t to 30t)	50	5	Empty semi-tractor trailer	114	Truck transportation emissions from CN	3
Long-haul semi-tractor trailer (15t to 30t)	50	30	Loaded semi-tractor trailer - hauling timber away	114	Truck transportation emissions from CN	17
					TOTALS	24

Emissions for Security Fence, Internal Roadways, and Parking while using HDDVs

Security fence, internal roadways, and parking timeline:	2	Months
Total work days*:	42	days
One-way trip distance for semi-tractor trailer rigs:	100	km

Emission Equipment	#	Fuel Consumption (L/h) ‖	Equipment Details	Emission Factors (g/L) §			Assumptions	Emission Estimates (tonnes)			
				CO_2	CH_4	N_2O		CO_2	CH_4	N_2O	CO_{2eq}
Dump truck	4	49.2	775D medium load factor	2690	0.14	0.082	Table A6-12 HDDVs with moderate control (2004-2013)	178	9.26E-03	5.42E-03	180
Bobcat	2	7.4	416C medium load factor	2690	0.14	1	Table A6-12 off-road diesel	13	6.96E-04	4.97E-03	15
Telehandler	1	16	TH82 continuous operation	2690	0.14	1	Table A6-12 off-road diesel	14	7.53E-04	5.38E-03	16
Bull dozer	1	33	D8R medium load factor	2690	0.14	1	Table A6-12 off-road diesel	30	1.55E-03	1.11E-02	33
Compactor	1	14	CS-563C medium load factor	2690	0.14	1	Table A6-12 off-road diesel	13	6.59E-04	4.70E-03	14
Loader	2	20	962G medium load factor	2690	0.14	1	Table A6-12 off-road diesel	36	1.88E-03	1.34E-02	40
							TOTALS	284	1.48E-02	4.50E-02	298

Emission Equipment	Trips	Weight (tonnes)	Equipment Details	Emission Factors (g/tonne-km travelled) ¶ CO_{2eq}	Assumptions	Emission Estimates (tonnes) CO_{2eq}
Long-haul semi-tractor trailer (15t to 30t)	2	30	Loaded semi-tractor trailer - floating equipment	114	Truck transportation emissions from CN	1
Long-haul semi-tractor trailer (15t to 30t)	2	5	Empty semi-tractor trailer	114	Truck transportation emissions from CN	0
Long-haul semi-tractor trailer (15t to 30t)	15	30	Delivery of fencing material	114	Truck transportation emissions from CN	5
Long-haul semi-tractor trailer (15t to 30t)	15	5	Empty semi-tractor trailer	114	Truck transportation emissions from CN	1
					TOTALS	7

Emissions for Temporary Infrastructure and Supporting Facilities while using HDDVs

Total construction hours#:	2,772	hours
One-way trip distance for semi-tractor trailer rigs:	100	km
Average round-trip distance for pumper truck:	150	km
Number of pumper truck cleanouts**:	44	#

Emission Equipment	#	Fuel Consumption (L/h) ‖	Equipment Details	Emission Factors (g/L) §			Assumptions	Emission Estimates (tonnes)			
				CO_2	CH_4	N_2O		CO_2	CH_4	N_2O	CO_{2eq}
Genset	1	18.5	3600 Family Diesel Generator Set	2690	0.14	1	Table A6-12 off-road diesel	138	5.74E-02	4.10E-01	262
							TOTALS	138	5.74E-02	4.10E-01	262

Emission Equipment	LDGTs (#)	Fuel Consumption (L/100km) ‡	Equipment Details	Emission Factors (g/L) §			Assumptions	Emission Estimates (tonnes)			
				CO_2	CH_4	N_2O		CO_2	CH_4	N_2O	CO_{2eq}
Porta-potty pumper truck	1	15	Medium usage for least efficient LDGTs	2316	0.14	0.022	Table A6-12 Tier 2 LDGTs (2004-2013)	2	1.39E-04	2.18E-05	2
							TOTALS	2	1.39E-04	2.18E-05	2

Emission Equipment	Trips	Weight (tonnes)	Equipment Details	Emission Factors (g/tonne-km travelled) ¶ CO_{2eq}	Assumptions	Emission Estimates (tonnes) CO_{2eq}
Long-haul semi-tractor trailer (15t to 30t)	10	30	Delivery of temporary infrastructure	114	Truck transportation emissions from CN	3
Long-haul semi-tractor trailer (15t to 30t)	10	5	Empty semi-tractor trailer	114	Truck transportation emissions from CN	1
					TOTALS	4

Emissions for Structural Anchors and Foundations while using HDDVs

Structural anchors and foundations timeline:	2	Months
Total work days*:	42	days
One-way trip distance for semi-tractor trailer rigs:	100	km

Emission Equipment	#	Fuel Consumption (L/100km) ‡	Equipment Details	Emission Factors (g/L) §			Assumptions	Emission Estimates (tonnes)			
				CO_2	CH_4	N_2O		CO_2	CH_4	N_2O	CO_{2eq}
Tracked excavator	1	19.5	325B medium load factor	2690	0.14	1	Table A6-12 off-road diesel	18	9.17E-04	6.55E-03	20
Bobcat	2	7.4	416C medium load factor	2690	0.14	1	Table A6-12 off-road diesel	13	6.96E-04	4.97E-03	15
Telehandler	1	16	TH82 continuous operation	2690	0.14	1	Table A6-12 off-road diesel	14	7.53E-04	5.38E-03	16
Concrete truck / concrete pumper truck	4	49.2	Assumed same as dump truck	2690	0.14	0.082	Table A6-12 HDDVs with moderate control (2004-2013)	178	9.26E-03	5.42E-03	180
							TOTALS	223	1.16E-02	2.23E-02	230

Emission Equipment	Trips	Weight (tonnes)	Equipment Details	Emission Factors (g/tonne-km travelled) ¶ CO_{2eq}	Assumptions	Emission Estimates (tonnes) CO_{2eq}
Long-Haul semi-tractor trailer (15t to 30t)	20	30	Loaded semi-tractor trailer - delivery of anchors	114	Truck transportation emissions from CN	7
Long-Haul semi-tractor trailer (15t to 30t)	20	5	Empty semi-tractor trailer	114	Truck transportation emissions from CN	1
					TOTALS	8

Emissions for Array Assembly while using HDDVs

Array assembly timeline: 9 Months
Total work days*: 189 days
One-way trip distance for semi-tractor trailer rigs††: 1,500 km

Emission Equipment	#	Fuel Consumption (L/100km) ‡	Equipment Details	Emission Factors (g/L) § CO_2	Emission Factors (g/L) § CH_4	Emission Factors (g/L) § N_2O	Assumptions	Emission Estimates (tonnes) CO_2	Emission Estimates (tonnes) CH_4	Emission Estimates (tonnes) N_2O	Emission Estimates (tonnes) CO_{2eq}
Telehandler	2	16	TH82 continuous operation	2690	0.14	1	Table A6-12 off-road diesel	130	6.77E-03	4.84E-02	145
							TOTALS	130	6.77E-03	4.84E-02	145

Emission Equipment	Trips	Weight (tonnes)	Equipment Details	Emission Factors (g/tonne-km travelled) ¶ CO_{2eq}	Assumptions	Emission Estimates (tonnes) CO_{2eq}
Long-Haul semi-tractor trailer (15t to 30t)	25	30	Loaded semi-tractor trailer - delivery of modules	114	Truck transportation emissions from CN	128
Long-Haul semi-tractor trailer (15t to 30t)	25	5	Empty semi-tractor trailer	114	Truck transportation emissions from CN	21
					TOTALS	150

Emissions for Cable Trenching while using HDDVs‡‡

Cable trenching timeline: 9 Months
Total work days*: 189 days

Emission Equipment	#	Fuel Consumption (L/100km) ‡	Equipment Details	Emission Factors (g/L) § CO_2	Emission Factors (g/L) § CH_4	Emission Factors (g/L) § N_2O	Assumptions	Emission Estimates (tonnes) CO_2	Emission Estimates (tonnes) CH_4	Emission Estimates (tonnes) N_2O	Emission Estimates (tonnes) CO_{2eq}
Tracked excavator	1	19.5	325B medium load factor	2690	0.14	1	Table A6-12 off-road diesel	79	4.13E-03	2.95E-02	88
Dump truck	1	49.2	775D medium load factor	2690	0.14	0.082	Table A6-12 HDDVs with moderate control (2004-2013)	200	1.04E-02	6.10E-03	202
Loader	1	20	962G medium load factor	2690	0.14	1	Table A6-12 off-road diesel	81	4.23E-03	3.02E-02	90
							TOTALS	361	1.88E-02	6.58E-02	381

Inverters, Substation, and Ancillary Electrical Gear while using HDDVs‡‡

Inverters, substation, and ancillary electrical gear timeline: 4 Months
Total work days*: 84 days
One-way trip distance for semi-tractor trailer rigs: 150 km

Emission Equipment	#	Fuel Consumption (L/100km) ‡	Equipment Details	Emission Factors (g/L) § CO_2	Emission Factors (g/L) § CH_4	Emission Factors (g/L) § N_2O	Assumptions	Emission Estimates (tonnes) CO_2	Emission Estimates (tonnes) CH_4	Emission Estimates (tonnes) N_2O	Emission Estimates (tonnes) CO_{2eq}
Telehandler	1	16	TH82 continuous operation	2690	0.14	1	Table A6-12 off-road diesel	29	1.51E-03	1.08E-02	32
Dump truck	1	49.2	775D medium load factor	2690	0.14	0.082	Table A6-12 HDDVs with moderate control (2004-2013)	89	4.63E-03	2.71E-03	90
Loader	1	20	962G medium load factor	2690	0.14	1	Table A6-12 off-road diesel	36	1.88E-03	1.34E-02	40
Truck crane (40t to 90t)	1	49.2	Assumed same as dump truck	2690	0.14	0.082	Table A6-12 HDDVs with moderate control (2004-2013)	89	4.63E-03	2.71E-03	90
							TOTALS	243	1.26E-02	2.96E-02	252

Emission Equipment	Trips	Weight (tonnes)	Equipment Details	Emission Factors (g/tonne-km travelled) ¶ CO_{2eq}	Assumptions	Emission Estimates (tonnes) CO_{2eq}
Long-Haul semi-tractor trailer (15t to 30t)	5	30	Loaded semi-tractor trailer - delivery of electrical gear	114	Truck transportation emissions from CN	3
Long-Haul semi-tractor trailer (15t to 30t)	5	5	Empty semi-tractor trailer	114	Truck transportation emissions from CN	0
					TOTALS	3

Control Building while using HDDVs‡‡

Control building timeline: 2 Months
Total work days*: 42 days
One-way trip distance for semi-tractor trailer rigs: 150 km

Emission Equipment	#	Fuel Consumption (L/100km) ‡	Equipment Details	Emission Factors (g/L) § CO_2	Emission Factors (g/L) § CH_4	Emission Factors (g/L) § N_2O	Assumptions	Emission Estimates (tonnes) CO_2	Emission Estimates (tonnes) CH_4	Emission Estimates (tonnes) N_2O	Emission Estimates (tonnes) CO_{2eq}
Tracked excavator	1	19.5	325B medium load factor	2690	0.14	1	Table A6-12 off-road diesel	18	9.17E-04	6.55E-03	20
Well drilling rig	1	49.2	Assumed same as dump truck	2690	0.14	0.082	Table A6-12 HDDVs with moderate control (2004-2013)	44	2.31E-03	1.36E-03	45
							TOTALS	62	3.23E-03	7.91E-03	65

Emission Equipment	Trips	Weight (tonnes)	Equipment Details	Emission Factors (g/tonne-km travelled) ¶ CO_{2eq}	Assumptions	Emission Estimates (tonnes) CO_{2eq}
Long-Haul semi-tractor trailer (15t to 30t)	5	30	Loaded semi-tractor trailer - delivery of building materials	114	Truck transportation emissions from CN	3
Long-Haul semi-tractor trailer (15t to 30t)	5	5	Empty semi-tractor trailer	114	Truck transportation emissions from CN	0
					TOTALS	3

Feeder Line while using HDDVs

Feeder line erection timeline: 0.33 Months
Total work days*: 7 days
One-way trip distance for semi-tractor trailer rigs: 150 km

Emission Equipment	#	Fuel Consumption (L/100km) ‡	Equipment Details	Emission Factors (g/L) § CO_2	Emission Factors (g/L) § CH_4	Emission Factors (g/L) § N_2O	Assumptions	Emission Estimates (tonnes) CO_2	Emission Estimates (tonnes) CH_4	Emission Estimates (tonnes) N_2O	Emission Estimates (tonnes) CO_{2eq}
All-terrain cherry picker pole drilling / standing machine	1	21	Assumed same as a rubber-tired skidder	2690	0.14	1	Table A6-12 off-road diesel	3	1.65E-04	1.18E-03	4
							TOTALS	3	1.65E-04	1.18E-03	4

Emission Equipment	Trips	Weight (tonnes)	Equipment Details	Emission Factors (g/tonne-km travelled) ¶ CO_{2eq}	Assumptions	Emission Estimates (tonnes) CO_{2eq}
Long-Haul semi-tractor trailer (15t to 30t)	5	30	Loaded semi-tractor trailer - delivery of poles	114	Truck transportation emissions from CN	3
Long-Haul semi-tractor trailer (15t to 30t)	5	5	Empty semi-tractor trailer	114	Truck transportation emissions from CN	0
					TOTALS	3

Total construction emissions: 2,643 tonnes CO_{2eq}

NOTES:

*Assumed 21 working days per month
†Actual hours equipment is in operation; accounts for personnel breaks, machine downtime (*i.e.* , maintenance and refueling), *etc.*
‡Assumed gasoline consumption as medium usage for the least efficient vehicle (http://oee.nrcan.gc.ca/fcr-rcf/public/index-e.cfm)
§Data obtained from ECCC [2016], National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 2
‖Data obtained from Caterpillar Performance Handbook, Edition 29, Tables on pages 21-12 to 21-19
¶Data obtained from CN's greenhouse gas calculator for truck transportation - based on data from Statistics Canada
#Assumed Genset runs all hours workers are at site throughout the construction period (*i.e.* , 12 hours per day)
**Assumed porta-pottys pumped out once per week (*i.e.* , 4 weeks per month)
††Assumed delivery from manufacturing facility in Ontario; based on module dimensions, about 22 × 115 m^3 trailers are required for shipping
‡‡Assumed equipment is already on-site; does not require floating in/out as it is already accounted for in other construction work streams

ESTIMATED DIRECT GHG EMISSIONS FOR THE OPERATION AND MAINTENANCE OF THE VIOLET SOLAR FARM

Security Checks - Light-Duty Gasoline Trucks (LDGTs)

Annual security checks:	52	#
Average round trip distance*:	100	km
Number of LDGTs used:	1	#
Total distance travelled:	5,200	km
Gasoline consumption†:	15	L/100km
Gasoline consumed:	780	L

Electrical Tests and Inspections - LDGTs

Annual tests and inspections:	12	#
Average round trip distance‡:	500	km
Number of LDGTs used:	1	#
Total distance travelled:	6,000	km
Gasoline consumption†:	15	L/100km
Gasoline consumed:	900	L

Module Cleaning - LDGTs

Annual module cleaning events:	2	#
Days per cleaning:	7	days
Average round trip distance*:	100	km
Number of LDGTs used:	2	#
Total distance travelled:	2,800	km
Gasoline consumption†:	15	L/100km
Gasoline consumed:	420	L

Landscaping - LDGTs

Landscaping events:	1	#
Days per landscaping event:	5	days
Average round trip distance*:	100	km
Number of LDGTs used:	1	#
Total distance travelled:	500	km
Gasoline consumption†:	15	L/100km
Gasoline consumed:	75	L

Landscaping - Off-Road Diesel (ORD)

Landscaping events:	1	#
Days per landscaping event§:	6	days
Hours worked per day:	10	hours
Diesel consumption‖:	46	L/h
Diesel consumed:	2,730	L

Emissions Estimates

Emission Equipment	Total Fuel Consumed (L)	Emission Factors (g/L)¶			Assumptions	Emission Estimates (tonnes)			
		CO_2	CH_4	N_2O		CO_2	CH_4	N_2O	CO_{2eq}
Light-Duty Gasoline Trucks (LDGTs)	2,175	2316	0.14	0.022	Table A6-12 Tier 2 LDGTs (2004-2013)	5	3.05E-04	4.79E-05	5
Off-Road Diesel (ORD)	2,730	2690	0.15	1	Agricultural Tractor Challenger 65E Medium Usage	7	4.10E-04	2.73E-03	8
					TOTALS	12	7.14E-04	2.78E-03	13

NOTES:

*Assumed security personnel/cleaners could live outside Bathurst, which is only about 10 km from the site; includes travel about the site for security checks; assumes all safety checks are completed using LDGTs, although snowmobiles may be used during the winter

†Assumed gasoline consumption as medium usage for the least efficient vehicle (http://oee.nrcan.gc.ca/fcr-rcf/public/index-e.cfm)

‡Assumed electrical testing and inspection personnel may have to come from one of New Brunswick's major centres (*i.e.* , Fredericton, Moncton, or Saint John); assumes all testing and inspections are completed using LDGTs

§Assumed an agricultural tractor can drive to the site (*i.e.* , does not have to be floated in and out), which is why there is an extra day for use of tractor

‖Data obtained from Caterpillar Performance Handbook, Edition 29, Table on page 21-12

¶Data obtained from ECCC [2016], National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 2

C2 Solar farm lifespan: 25 years

Total lifespan O&M emissions: 331 tonnes CO_{2eq}

ESTIMATED INDIRECT GHG EMISSION REDUCTIONS DUE TO REDUCED ELECTRICITY PURCHASES FROM NB POWER FOR THE VIOLET SOLAR FARM

NB Power consumption intensity factor*:	280	g CO_{2eq} per kWh
C2 Solar annual electrical contribution to NB Power grid†:	12,164,000	kWh
NB Power electricity generation emissions offset‡:	3,406	tonnes CO_{2eq} annually
C2 Solar farm lifespan:	25	years

Total lifespan electrical emissions offset: 85,148 tonnes CO_{2eq}

NOTES:

*Data obtained from ECCC [2016], National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 3

†Modelled using the National Renewable Energy Laboratory's System Advisor Model (SAM): https://sam.nrel.gov/

‡Assumed the Middle River C2 Solar farm operates uninterrupted 365 days per year during daylight hours

Appendix VIII:

Letter of Intent between C2 Solar and Pabineau First Nation Mi'gmawe'l Tplu'Taqn Ltd.

Mi'gmawe'l Tplu'taqnn

LETTER OF INTENT

Among

C2 Solar Inc.

And

MI'GMAWE'L TPLU'TAQNN INC. (Mi'gmawe'l Tplu'taqnn) representing for the purposes of this Letter of Agreement 6 of its member First Nations: Amlamgog (Fort Folly); Esgenoöpetitj; L'nui Menikuk (Indian Island); Natoaganeg (Eel Ground); Metepenagiag Mi'kmaq; Tjipögtötjg (Buctouche), Ugpi'ganjig First Nation (Eel River Bar)

And

Oinpegitjoig First Nation (Pabineau)

Each a Party and Collectively the Parties

C2 Solar Inc. an incorporated body in the Province of New Brunswick is intent in developing an initial 10 mega watt solar panel farm situated on the unceded territory of the Mi'gmaq People on Crown Land situated on Crown Land in proximity to Pabineau First Nation. (the Property)

The Mi'gmaq communities of OinpegitJoig (Pabineau First Nation) and Mi'gmawe'l Tplu'taqnn and C2 Solar Inc. are committed in good faith to:

1) maintain and foster sustainable long-term relationships that are transparent and respectful.
2) support the revitalization of the Mi'gmaq communities while encouraging greater opportunities for Mi'gmaq participation in sustainable, lawful, and respectful economic development.
3) Facilitate strong economic links between the Mi'gmaq communities in the region and the Project.

40 Micmac Rd
Eel Ground, NB E1V 7M1

Phone: 506. 627.4696
Fax: 506 627 4605

This Letter of Interest is designed to:

1) Enable the Parties to explore the development of a framework for a variety of Agreements and Understandings including but not limited to; 1) Indigenous Knowledge Study,2) Cooperation and Relationship Agreement, 3) Impact and Benefit Agreement, 4) Environmental Protection Agreement.

2) Acknowledge C2 Solar's filing of an Environmental Impact Assessment submission to the NB Department of Environment and Local Government.

The Parties agree that the "Relationship, Engagement and Consultation Protocol" (Protocol) signed by the Belledune Port Authority and First Nation communities and MTI on May 31, 2018 will guide and direct the activities by the Parties to this Letter of Agreement.

The subject Agreements shall:

a) Define the roles and responsibilities of the Parties in the various aspects of their relationship(s).
b) Prescribe the steps for a practical, transparent and respectful approach to the jointly determined subject matter for the agreements and Understandings.
c) Create a joint steering committee to oversee the development and adoption of the proposed Agreements and Understandings.

The resulting Agreements and Understandings are intended to form a part of the documentation of the developing long- term relationship.

This Letter of Intent is non-binding and shall not be interpreted as consent to or a letter of support for the Project.

Agreed to and signed this day of June, 2019.

Chief David Peter-Paul

Chief David Peter-Paul
Oinpegitjoig First Nation

F. R. Fyffe

C2 Solar Inc.

Chief George Ginnish

Chief George Ginnish, Co-Chair
Mi'gmawe'l Tplu'taqnn Incorporated

Chief Rebecca Knockwood

Chief Rebecca Knockwood, Co-Chair
Mi 'gmawe'l Tplu 'taqnn Incorporated

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