Maritime Launch Services Ltd

CANSO SPACEPORT FACILITY

Environmental Assessment Registration

June 2018

Prepared By:

Strum Consulting
Railside, 1355 Bedford Hwy.
Bedford, NS B4A 1C5
t. 902.835.5560
f. 902.835.5574
www.strum.com

CANSO SPACEPORT FACILITY - Environmental Assessment Registration Document

Prepared For:

Maritime Launch Services Limited
Suite 900, Purdy's Wharf Tower One
1959 Upper Water Street
Halifax, NS B3J 3N2
t. (505) 553-0822
e. Steve.matier@maritimelaunch.com
www.maritimelaunch.com

June 2018

June 27, 2018

Environmental Assessment Branch

Nova Scotia Environment

PO Box 442, Halifax, Nova Scotia

B3J 2P8

To Whom It May Concern:

Please find enclosed the Environmental Assessment Registration Document for the Canso Spaceport Project.

The undersigned approves and accepts the contents, as submitted to the Nova Scotia Environment Department, Environmental Assessment Branch. I am also confirming that we have not received any public funding for the development of the Project.

Yours Truly,

Stephen E. Matier

President and CEO

Maritime Launch Services

EXECUTIVE SUMMARY

Maritime Launch Services Ltd. (MLS) has proposed to construct and operate a private commercial space launch site near the communities of Little Dover, Hazel Hill, and Canso, within the Municipality of the District of Guysborough (MODG) of Nova Scotia. The purpose of the Project is to establish a commercially-controlled, commercially-managed, launch site that would provide launch site options in North America, in support of the growing commercial space transportation industry.

The Project will be situated on a portion of Crown Land designated by Property Identification Number (PID) 35096320 and consist of three components; the Launch Control Center (LCC), the Horizontal Integration Facility (HIF), and the Vertical Launch Area (VLA) connected by a transportation route. Access to the Project site is expected to coincide, in part, with the access road to the Sable Wind Farm, owned and operated by the MODG, in partnership with Nova Scotia Power.

The Project is considered a Class I undertaking under the Nova Scotia Environment Assessment Regulations and as such, requires a registered Environmental Assessment as identified under Schedule 'A' of the Regulations. The Environmental Assessment and the registration document have been completed according to the methodologies and requirements outlined in the document "A Proponent's Guide to Environmental Assessment", as well as accepted best practices for conducting environmental assessments.

A number of environmental components were evaluated for this assessment. Based on field data and associated research, mitigation strategies and best management practices were identified to avoid or mitigate potential effects of the Project for the majority of the components. Following the preliminary assessment, the valued ecosystem components determined for further assessment were:

- Atmospheric Environment
- Acoustic Environment
- Geologic Environment
- Freshwater Environment
- Terrestrial Habitat
- Avifauna
- Local Demographics
- Recreation and Tourism
- Cultural and Heritage Resources
- Aboriginal Resources
- Cumulative Effects

The effects assessment for these components determined that residual effects are expected to be of low significance or not significant. Cumulative effects were considered to be not significant.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF DRAWINGS

Drawing 1.1	Site Location
Drawing 1.2	Proposed Launch Site Layout
Drawing 1.3	Project Property
Drawing 5.1	Sound Monitoring Locations
Drawing 5.2	Surficial Geology
Drawing 5.3	Bedrock Geology
Drawing 5.4a-d	Wetland Survey Results
Drawing 5.5	NSDNR Moose Occurrence Data
Drawing 5.6	Mainland Moose Transects
Drawing 5.7	Bird and Bat Acoustic Monitoring
Drawing 5.8	Bird Survey
Drawing 6.1	Local Communities

LIST OF ACRONYMS

ACCDC	Atlantic Canada Conservation Data Centre
AFSS	Autonomous Flight Safety Systems
AQHI	Air Quality Health Index
ARD	Acid Rock Drainage
ASME	American Society of Mechanical Engineers
BSC	Bird Studies Canada
CAR	Canadian Aviation Regulations
CCG	Canadian Coast Guard
CCOHS	Canadian Center for Occupational Health and Safety
CEAA	Canadian Environmental Assessment Agency
CLC	Community Liaison Committee
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRI	Canadian Rivers Institute
CSA	Canadian Space Agency
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
DoD	Department of Defense
EA	Environmental Assessment
EC	Environment Canada
EPP	Environmental Protection Plan
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
FAA	US Federal Aviation Administration
FFS	Fuel Filling System Facility
GAC	Global Affairs Canada
GC	Government of Canada
GCIFA	Guysborough County Inshore Fisherman's Association
GTO	Geostationary Transfer Orbit
HIF	Horizontal Integration Facility
HPS	High Pressure Sodium
IBA	Important Bird Area
ILS	Integrated Launch Vehicle
ISS	International Space Station
LCC	Launch Control Center
LOX	Liquid Oxygen
LV	Launch Vehicle
MLS	Maritime Launch Services Ltd.

MMH	Monomethylhydrazin
MODG	Municipality of the District of Guysborough
MTCR	Missile Technology Control Regime
MTRI	Mersey Tobeatic Research Institute
NCC	Nature Conservancy of Canada
NEF	Noise Exposure Forecast
NEW	Net Explosive Weight
NSL	Nova Scotia Legislature
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NSDNR	Nova Scotia Department of Natural Resources
NSE	Nova Scotia Environment
NSEA	*Nova Scotia Environment Act*
NSESA	*Nova Scotia Endangered Species Act*
NSTIR	Nova Scotia Transportation and Infrastructure Renewal
NTO	Nitrogen Tetroxide
OFS	Oxidizer Filling System
PID	Property Identification Number
PL	Payload
PSPC	Public Services and Procurement
RCMP	Royal Canadian Mounted Police
RF	Radio Frequency
RoRo	Roll On, Roll Off
RP	Rocket Propellant / Refined Petroleum
RP-1	Rocket Propellant-1 / Refined Petroleum-1
RPA	Recovery Potential Assessment
RSSSA	*Remote Sensing Space Systems Act*
SARA	*Species at Risk Act*
SFOC	Special Flight Operating Certificate
SOCI	Species of Conservation Interest
TBD	To Be Determined
TODG	Transport Dangerous Goods
TOS	Television Observation System
TDS	Total Dissolved Solids
UDMH	Usymmetrical Dimethyl Hydrazine
VEC	Valued Ecosystem Component

1.0 INTRODUCTION

Maritime Launch Services Ltd. (MLS) has proposed to construct and operate a private commercial space launch site near the communities of Little Dover, Hazel Hill, and Canso, within the Municipality of the District of Guysborough (MODG) of Nova Scotia (the Project) (Drawing 1.1). The purpose of the Project is to establish a commercially-controlled, commercially-managed, launch site that would provide launch site options in North America, in support of the growing commercial space transportation industry.

The majority of the Project infrastructure will be situated on a leased portion of Crown Land designated by Property Identification Number (PID) 35096320, while access roads will coincide with the Sable Wind Farm, owned and operated by the MODG, in partnership with Nova Scotia Power. The facility will consist of three components; the Launch Control Center (LCC), the Horizontal Integration Facility (HIF), and the Vertical Launch Area (VLA) connected by a transportation route (Drawing 1.2).

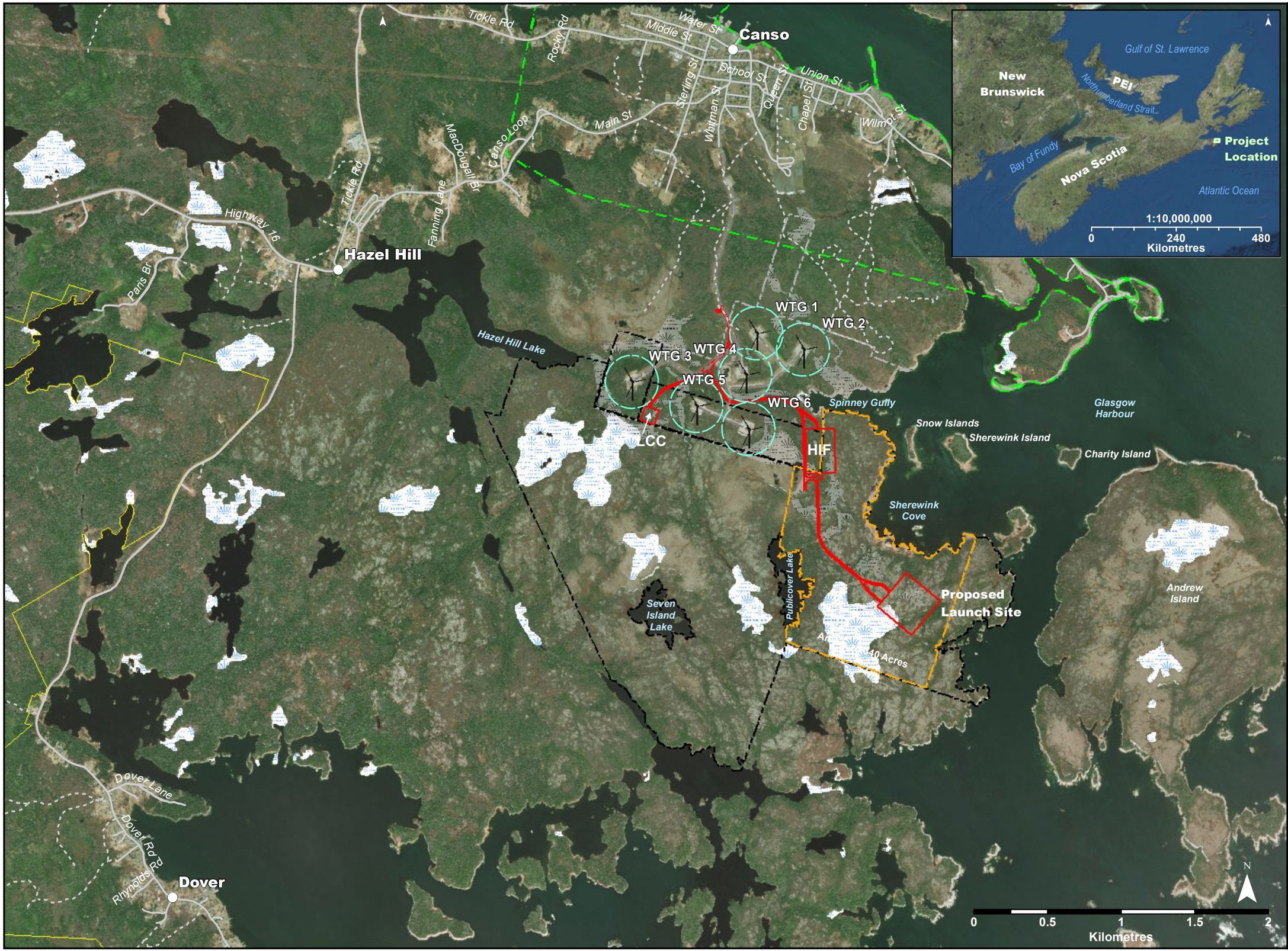
1.1 Proponent Information

MLS was formed in Nova Scotia, Canada in October 2016 with the intention of bringing together the necessary skills, assets, launch vehicle technology and infrastructure, to serve the growing commercial space needs for satellites. MLS will leverage from the highly reliable and proven launch vehicles designed by Yuzhnoye SDO in Ukraine to bring their latest model Cyclone 4M to the North American market. The Cyclone 4M occupies an underserved market segment which offers the most efficient lift capacity to address developing launch industry requirements. Constellation launch requirements dictate an optimum number of spacecraft be launched together. Both larger and smaller vehicle classes do not offer the most efficient mass utilization. The Cyclone 4M provided under the MLS launch services and launched to a polar and/or sun synchronous orbit from Canso, Nova Scotia will serve that market.

Proponent and consultant contact information is provided in Table 1.1. The Certificate of Incorporation for the Proponent company is included in Appendix A.

Table 1.1: Proponent Information

PROPONENT	
Name	Maritime Launch Services Ltd.
Address	1959 Upper Water Street Suite 900 Halifax, Nova Scotia B3J 3N2
Website	http://www.maritimelaunch.com/
Proponent Contact	
Name	Stephen Matier
Official Title	President and CEO for Spaceport Development
Address	Suite 900 Purdy's Wharf Tower One 1959 Upper Water St. Halifax, Nova Scotia B3J 3N2



Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Basemap: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.
3. Projection: NAD83(CSRS), UTM Zone 20 North.
4. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Place Names
- Existing Turbine Access Road
- Public Roads
- Access Roads / Trails
- Existing Transmission Lines
- Municipal Boundary
- Game Management Boundary

Project Location

- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Field Identified Wetland
- Mapped Wet Area

Maritime Launch Services - Project Location

Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date:	Project #:
June 2018	16-5903
Scale: 1:24,000	Drawing #: 1.1
Drawn By: M. Marriott	
Checked By: S. Duncan	

Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Existing Turbine Access Road
- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area

Canso Launch Site - Site Location

Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:12,500	Drawing #: 1.2
Drawn By: M. Marriott	
Checked By: S. Duncan	

Telephone	(505) 553-0822
Email	Steve.matier@maritimelaunch.com
ENVIRONMENTAL CONSULTANT CONTACT	
Name	Shawn Duncan
Title	Vice President
Address	1355 Bedford Hwy Bedford, Nova Scotia B4A 1C5
Telephone	(902) 835-5560
Fax	(902) 835-5574
Email	sduncan@strum.com

1.2 Project Information

Name of the Undertaking: Canso Spaceport Facility ('the Project')
Location of the Undertaking: Canso, Nova Scotia

The Project is located near the communities of Little Dover, Hazel Hill, and Canso, within the MODG (Drawing 1.1). The Project site includes a narrow strip of land totaling approximately 20 hectares, consisting of the properties listed in Table 1.2 (Drawing 1.3).

Table 1.2: Properties Comprising the Project Area

Property Identification Number (PID)	Land Owner	Facility Component	Total PID Area (ha)	Area to be Developed (ha)
35096320	NS Department of Natural Resources	Horizontal Integration Facility Launch Vehicle Railway Launch Site	960.6	13.5
35096700	Municipality of the District of Guysborough	Access Road	29.5	1.7
35204031	Municipality of the District of Guysborough	Launch Control Center Launch Vehicle Access Road Horizontal Integration Facility	33.9	4.5
35204049	Municipality of the District of Guysborough	Access Road	22.5	0.3

1.3 Purpose and Need for the Project

MLS proposes to construct and operate a private commercial space launch site for the purpose of establishing a commercially-controlled, commercially-managed, launch site that would provide launch site options in North America, in support of the commercial space transportation industry.

Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Existing Turbine Access Road
- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area

Canso Launch Site - Project Property

Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:12,500	Drawing #: **1.3**
Drawn By: M. Marriott	
Checked By: S. Duncan	

The proposed Project would allow MLS to offer the commercial space launch site for medium class orbital rockets designed and developed by Yuzhnoye SDO in Ukraine. The location proposed is from a point near Canso, Nova Scotia and is one that can achieve a polar and/or sun-synchronous trajectory. The proposed commercial space launch site near Canso would:

- Serve the robust market for space transportation services to promote and enable private sector science and exploration missions;
- Enable a stronger, more competitive commercial space transportation industry;
- Sustain Yuzhnoye's 60 year leadership and innovation in space launch activities though partnering with MLS and build on the strong relationship between Canada and Ukraine;
- Provide significant positive economic impact to the community and province hosting the launch site in terms of long term engineering and technician employment, infrastructure improvements, and tourism; and
- Improve Nova Scotia's attractiveness to the existing and evolving commercial space industry markets, resulting in new economic development opportunities and high-tech job creation.

The teamed effort between MLS, Yuzhnoye, and Nova Scotia augers for a space launch program conceived and timed to capitalize on the new opportunities in space. The global space industry is on the cusp of major change, one characterized by more frequent launches of smaller, short-lived, satellites, many of which will go into sun-synchronous polar orbits. The appetite for space-based services and information is growing asymptotically. This is especially true for internet-related developments and more precise information (agronomic, economic, meteorological, hydrological, etc.) about specific localities. Perhaps most important, space-based remote sensing is now much more dynamic, with information becoming more perishable and the demand for frequent resampling growing geometrically. Being able to support the new demands of the market will require low-cost solutions that can be rapidly tailored to individual customer preferences. Moving quickly will allow MLS to capitalize on this market in the area of space craft design and construction, launch services, and engineering, and expand those programs as they currently exist in Nova Scotia. Rapid establishment of a brand/reputation, within the context of the first Canadian spaceport initially and world-wide eventually, will cement the positioning of Nova Scotia as a pathfinder model in the emerging scientific, economic, commercial, and strategic global relationships.

Many countries, including Canada, have a need to develop satellites intended for low earth orbit for a range of applications as described above. As it stands today, there are very few launch locations globally that can serve this growing market and even fewer that serve the launch trajectory to a polar and sun-synchronous orbit. In most cases, they are restricted-use federal ranges, are expensive to launch from, and are antiquated. The business plan developed for the prospective launch site near Canso shows a strong case for an extremely efficient, safe, and cost-effective launch facility using the Yuzhnoye launch vehicles that will provide clients the orbital access needed.

1.4 Regulatory Framework

1.4.1 Federal

A federal Environmental Assessment (EA) is not required for the Project as it is not located on federal land or listed as a physical activity that constitutes a "designated project" as listed under the Regulations Designating Physical Activities of the *Canadian Environmental Assessment Act (*CEAA 2012).

The Project will be governed and administered by a number of Canadian federal departments. The following federal approvals/reviews are anticipated for the Project as the development unfolds and leading up to a first launch in 2021.

Table 1.3: Potential Federal Approvals and/or Applicable Acts

Permit/License/Approval/Notification/Lease Required	Government Agency
Review	Canadian Space Agency
Review/approval	Transport Canada – Nav Canada and Coast Guard
Review/approval	Public Services and Procurement Canada
Review/approval	Global Affairs Canada
Compliance – *Fisheries Act*, Section 35	Fisheries and Ocean Canada
Review	Department of National Defense
Compliance - *Migratory Birds Convention Act*	Environment Canada
Compliance - *Species at Risk Act (*SARA*)*	Environment Canada

MLS is currently working with a number of other federal government stakeholders to ensure the safe operation of the launch site that will allow the placement of satellites into space. The following sections provide an overview of these various federal permits and approvals.

Transport Canada

MLS is working under the oversight and regulations of the Canadian federal government with Transport Canada being responsible for rocket launch activities by virtue of the *Aeronautics Act*. This Act enabled the creation of the Canadian Aviation Regulations that establish regulations and standards for all aeronautical activities in Canada. This office is responsible for drafting the regulations, policies, and standards, and monitoring all operations, applicable to civil rocket launches in Canada. The intent of any regulation, standard, or policy governing rocket launch operations is the protection of people, property, and the environment. From a Civil Aviation safety point of view, the Canadian Aviation Regulation (CAR) 602.43 covers rocket launches. CAR 602.43 allows the Minister of Transport to issue an authorization for a rocket launch if it is in the public interest and is not likely to affect aviation safety. This authorization would likely take the form of a Special Flight Operating Certificate (SFOC).

Development must take into account domestic authorities, international treaties, and conventions to which Canada is a signatory, and other organizations' efforts to standardize and enhance the safety

of such operations. The global nature of the space industry also requires consideration be given to accepted industry practices in other launching states.

As such, MLS has been working with Transport Canada collaboratively since their first visit at the Transport Canada regional office in Moncton on November 3, 2016. MLS introduced the initiative to the Regional Director General, and two of her key staff in regulation and safety. This was followed by the submission of a comprehensive project description that was submitted the same day MLS initiated the Nova Scotia Crown land lease application on December 13, 2016.

Since the submission of the detailed project description, MLS has been meeting and corresponding with Transport Canada in Ottawa, with NavCanada, and with the Canadian Space Agency on a frequent and regular basis. MLS has been providing documentation for review dealing with flight safety and ground safety to these offices and working iteratively to modify the site layout and restricted airspace proposal to meet their requests and to adhere to international standards for safety setbacks and separation distances from the general public. For Example, the ground safety analysis that is required by Transport Canada, evaluates worst case scenarios from a blast and considers the appropriate safety setback distances for the general public from blast pressure waves as well as from fragments under the most severe circumstances. The site layout defined shows the nearest public location more than double the distance of the worst case scenario. Also, the mandatory initial flight safety assessment considers the launch trajectory and associated corridor that the launch vehicle will stay within, along with a number of other input parameters such as velocity, dwell time, population, and propellant quantities. These are input into an analysis that verifies the safety to the general public near the launch site and along the trajectory.

In August of 2017, Transport Canada provided MLS and NavCanada with their recommendations for the separation criteria necessary to support the launch activity proposed by MLS as it relates to restricted airspace near the launch site on the day of launch. The analysis of the proposed site layout developed by MLS was performed with the technical assistance of the Canadian Space Agency (CSA), and informed by contacts with the United States Federal Aviation Administration (FAA) Office of Commercial Space Transportation. The acceptance of the launch and ground safety proposals developed by MLS provided Transport Canada with the necessary information for NavCanada to commence a formal Aeronautical Study based on the proposed restricted airspace. This Aeronautical Study is necessary before the airspace structure can be formally changed to accommodate the activity proposed by MLS and a formalized Notice to Airmen (NOTAM) can be implemented.

The collaboration with Transport Canada will continue for the next two years plus and until such a time as the Minister of Transport has what is needed to approve a launch from Nova Scotia. No launch activity will ever commence without that written authorization, referred to as a Launch License. Included in the documentation required by Transport Canada are safety requirements based on risk management principles that provide for acceptance of certain risks based on comparison with other historically tolerated industries of similar benefit. Risk management requires use of qualitative and quantitative analyses to determine and evaluate risks that can occur during the testing, processing, launch, and flight phases of a space vehicle/rocket. The analyses include

descriptions of the consequences of a mishap (severity identification), probability of a mishap occurring (hazard event probability), and methodologies for elimination, control, or mitigation to avoid or reduce the impact of a mishap to an acceptable level.
MLS will also be generating extensive procedures and processes to operate the launch complex and integrate the launch vehicle, satellite payloads, and range operations into coordinated operational sequences. Included in this are scheduling and notification plans, public access controls, site user access controls, detailed launch operational sequences, ground safety plan, training plans, hazardous operations procedures, flight safety plans, launch and post-launch sequencing, etc. As they are produced by MLS they will be reviewed by Transport Canada. During this review process MLS will conduct table top exercises and field exercises, will go through planned and unplanned event responses and emergency response practices. These reviews and exercises will assist in refining all launch procedures and processes until they are accepted by the MLS management and Transport Canada launch authority. These documents will make up the Spaceport Operations Manual and will be subject to version control and update notifications within strict tolerances.

Transport Dangerous Goods Directorate (TODG)
In addition to Transport Canada's launch and site safety roles, there are other responsibilities within the ministry including with Transport Canada's Transport Dangerous Goods Directorate (TODG). The TODG Directorate is the focal point for the national program to promote public safety during the transportation of dangerous goods. The TODG Directorate serves as the major source of regulatory development, information, and guidance on dangerous goods transport for the public, industry, and government employees. The TODG office will be reviewing and approving all MLS transportation plans for the rocket propellants including kerosene, liquid oxygen, nitrogen tetroxide, and unsymmetrical dimethyl hydrazine.

Public Services and Procurement (PSPC)
Another key stakeholder that MLS is working with is Public Services and Procurement (PSPC). PSPC regulates the domestic possession, examination, and transfer of controlled goods and technologies in Canada. Controlled goods such as the launch vehicle stages to be brought from Ukraine to Canada may have military or national security significance and thus fall under that regulatory framework. The import of these materials and technologies into Canada will be reviewed, approved, and documented by PSPC.

Global Affairs Canada (GAC)
Global Affairs Canada (GAC) is also involved in the review and approval of all launches and deployment of satellites in Canada. Canada is one of the founding countries in the Missile Technology Control Regime (MTCR) implemented in 1987. MLS is working with GAC in its mission to strengthen international non-proliferation efforts and ensure there is no export of the rocket technology owned by the government of Ukraine once it comes to Canada. Similarly, Ukraine is also a signatory to the MTCR since 1998 following its separation from the former Soviet Union and abides by those same export control guidelines and procedures. GAC's Space Policy and Regulatory Affairs office is also responsible for licensing satellites that launch from Canada. For example, MLS's clients interested in remote sensing or earth imaging will be required to comply with the *Remote Sensing Space Systems Act (RSSSA)* that this office oversees. Further, some countries

such as the United States, which produce commercial satellites, will fall under their own government restrictions before export to Canada for launch and may require safeguard agreements between the two countries be put in place to confirm the international standards and commitments.

This overview is not intended to be fully inclusive of all the requirements MLS must meet before becoming operational in 2021. There are other important stakeholders within provincial agencies such as Occupational Health and Safety and within other federal agencies such as the RCMP that MLS is reaching out to. They range from the municipal, provincial, and federal to international and it is important to reiterate that all must be met before full operations of the site can begin and will continuously be required thereafter before each launch can proceed.

1.4.2 Provincial

The Project is subject to a Class 1 EA as defined by the Environmental Assessment Regulations under the *Nova Scotia Environment Act (NSEA)* due to the potential impact to greater than 2.0 hectares of wetland habitat. As such, the Proponent is required to register the Project with Nova Scotia Environment (NSE) and subsequently comply with the Class 1 registration process as defined by the document "A Proponent's Guide to Environmental Assessment" (NSE 2017a).

The following provincial approvals are anticipated for the Project.

Table 1.4: Potential Provincial Approvals

Permit/License/Approval/Notification/Lease Required	Government Agency/Relevant Laws
Wetland Alteration Approval	NSE
Notification of Blasting	NSE
EPP/Sediment and Erosion Control Plan	NSE
Work within Highway Right-of-Way	NSTIR
Use of Right-of-Way for Pole Lines	NSTIR
Electricity Standard Approval	NSDOE
Crown Lands Lease - *Crown Lands Act, S 16*	NSDNR
A Permit for Access Across Crown Land, A Right of Way, or Easement - *Crown Lands Act, S 16*	NSDNR
A letter of Authority or Time License for removal of trees on Crown Land - *Crown Lands Act, S 28*	NSDNR
Survey Order for establishing boundaries - *Crown Lands Act, S 13*	NSDNR
Review/approval – *Endangered Species Act*	NSDNR
Overweight/Special Move Permit	Service Nova Scotia
Resource Impact Assessment/Heritage Research Permit	Department of Communities, Culture, and Heritage
Elevator/Lift License	Nova Scotia Department of Labour and Advanced Education

All required provincial permits and approvals will be obtained prior to the appropriate phase of the construction and operations process.

1.4.3 Municipal

All development which falls within the Guysborough Municipal Planning area, must first obtain a municipal development permit under the By-law (MODG 2013). The Municipality recently underwent a regulated process for amending their planning documents, and as of May 2, 2018, the new amended land use planning documents have been approved and are now in effect. Copies of the new amended documents, as well as the zoning map, can be found on the MODG website at www.modg.ca under the Planning & Development section.

One of the changes in the documents that is most relevant to the Project is with respect to rocket launch facilities. The Municipality will now have the ability to permit rocket launch and related facilities by Development Agreement. MLS is in contact with the Municipality and will initiate the Development Agreement process. All required municipal permits and approvals will be obtained prior to their appropriate phase of construction.

1.5 Scope of the EA

EA is a planning tool used to predict the environmental effects of a proposed Project, identify measures to mitigate adverse environmental effects, and predict whether there will be significant adverse environmental effect after mitigation is implemented. The methodology used in this EA has been developed to meet the requirements of the *NSEA.* This framework is based on a structured approach that:

- focuses on issues of greatest concern;
- considers Aboriginal concerns as well as concerns raised by the public and other stakeholders; and
- integrates mitigative measures into Project design.

The EA provides an overview of the baseline conditions and individual Project components. Within the specified spatial and temporal boundaries, potential interactions between the Project and the environment are identified for the determination of Valued Ecosystem Components (VECs) that reflect key issues of concern. Project effects on individual VECs is assessed using the results of preliminary investigations, guidance from regulators, and the collective knowledge and expertise of the Project team. The ultimate focus of the assessment is on residual environmental effects that remain after planned mitigation has been applied.

1.5.1 Spatial and Temporal Boundaries

The spatial limitations of the EA vary based on the environmental criteria to be evaluated and are thus addressed in individual sections. However, in general, physical effects on environmental components are typically focused on the Project site, consisting of the Project footprint, with consideration taken into the surrounding environment, the Study area. Social impacts encompass a larger scope, including the communities of Little Dover, Hazel Hill, Canso and Guysborough County as a whole.

The temporal limitations of the EA extend from site preparation and construction, through operation and decommissioning. It is expected that the launch site's lifespan should exceed 40 years.

1.5.2 Species of Conservation Interest (SOCI)

Species observed or known to exist within 100 km of the Project site were screened against the criteria outlined in the document "Guide to Addressing Wildlife Species and Habitat in an EA Registration Document" (NSE 2009) to develop a list of priority species (i.e., SOCI), which are assessed further as a VEC.

In the context of this document, priority species include those that are:

- Listed under *Species at Risk Act (SARA)* as "Endangered", "Threatened", or "Special Concern";
- Listed by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as "Endangered", "Threatened", or "Special Concern"'
- Listed under the *NS Endangered Species Act (NSESA)* as "Endangered", "Threatened" or "Vulnerable";
- Listed by the Atlantic Canada Conservation Data Centre (ACCDC) as having a provincial status rank (GS-Rank) of "1 – At Risk", "2 – May be at Risk", or "3 – Sensitive", or "5 – Undetermined"; or
- Listed by the ACCDC as having a provincial status rank (S-Rank) of "S1", "S2", or "S3".

NS Department of Natural Resources (NSDNR) do not assess marine species and, therefore, are not given a conservation rank. The ACCDC only assesses specific species of marine mammals and fish, GS- and S-Ranks are not available for all the marine species assessed in this document.

2.0 PROJECT DESCRIPTION

The Project will involve the construction of a launch control center (LCC), horizontal integration facility (HIF), and the VLA to support its launch activities. All on-site facilities will be constructed on land owned by the Sable Wind Farm and undeveloped Crown land that will be leased by MLS (see Section 1.2). In addition, underground utility lines will be installed in a new transportation route between the LCC and HIF to the VLA. The actual Project footprint will consist of approximately 20 ha of the 160 ha lot.

Project components and activities are described in the following sections.

2.1 Project Components

MLS plans to construct facilities, structures, and utility connections in order to support the launch of the C4M launch vehicles. The facilities will consist of three areas: the LCC, HIF, and the VLA, linked by an access road. Between the HIF and VLA there will also be a rail specifically designed to transport the assembled launch vehicle to the launch pad.

2.1.1 Launch Control Center

The one-storey LCC building will be used for command and control of the launch vehicle, payload, and ground systems during launch and test operations (Figure 2.1). The control centre building will consist primarily of several large rooms for control consoles, conference rooms, and support rooms. In addition, each facility will house office areas for site personnel.

One or more antenna dishes will be required to receive data from the launch vehicle in flight and to communicate commands to the vehicle as needed. The antenna mounts will be approximately 8 m^2 and will be located within the site fence line at a location for optimal reception. Antenna dishes would be no larger than 7 m in diameter and 8 m high.

The combined parking areas of the vertical LCC would be designed to accommodate up to 50 personnel.

Figure 2.1: Rendering of the Launch Control Centre

2.1.2 Horizontal Integration Facility

The HIF is where the separate stages of the launch vehicle and payloads would be integrated in the weeks leading up to a launch into an Integrated Launch Vehicle (ILV). It is also where the upper stage propellants (NTO/UDMH) would be stored (apart from each other) and loaded onto the upper stage 2-3 days prior to the launch. These propellants would typically be brought into the site several weeks before launch.

The HIF is comprised of the following two main components described below.

Launch Vehicle Processing Facility

The launch vehicle processing facility serves to perform work with the launch vehicle (LV) including LV elements acceptance, LV test and assembly, mating of payload unit and LV, performance of LV integrated test prior to transportation to launch pad, as well as work performance in case of launch

cancellation (LV disassembly into elements, replacement of equipment, etc.). The LV facility building description is presented in Figure 2.2.

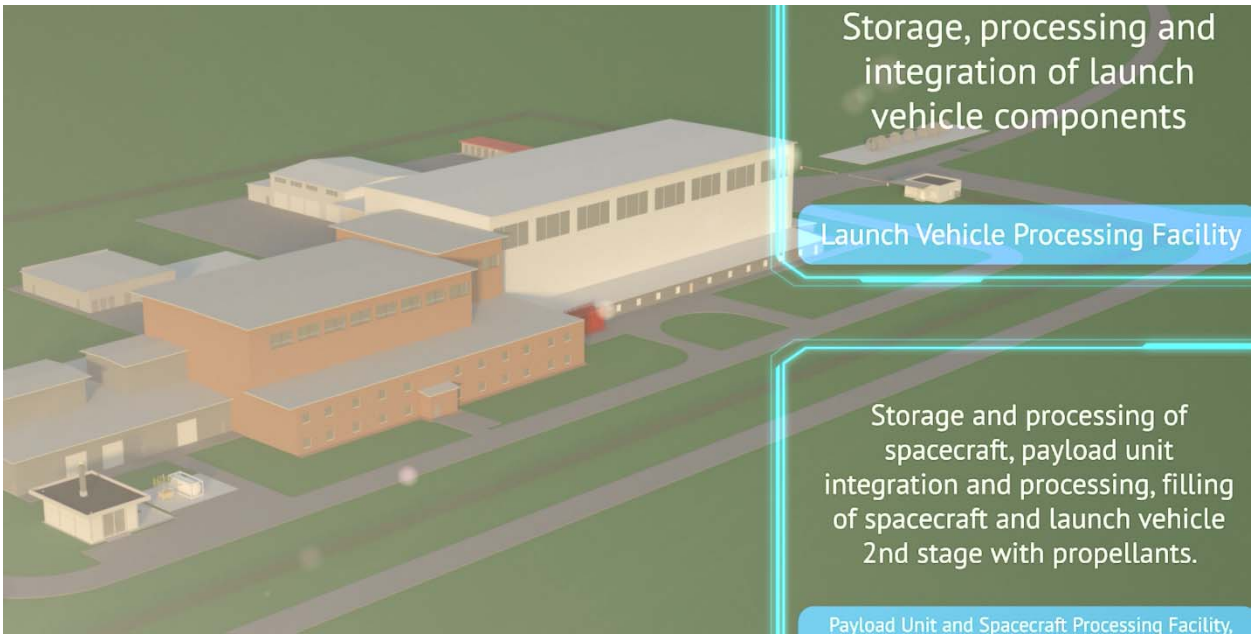


Figure 2.2: Rendering of the Launch Vehicle Processing Facility

Payload Processing Facilities

The payload processing facilities will be used to conduct final processing of payloads prior to integrating them with the launch vehicle. This processing will include final spacecraft checkouts, radio frequency (RF) checks, payload fueling, and other activities as required. The facilities will be designed to support the processing of two launch vehicles simultaneously to allow for a better throughput.

Table 2.1 Payload Processing Facilities

Facility Name	Dimensions (mm) or Building area (m^2)
Launch vehicle assembly, integration and test building (LV processing facility)	78,000 x 44,000 (mounting room: 78,000 x 20,000) h = 22,250
Launch vehicle storage (LV)	36,000 x 24,000 h = 3,800
Pyrodevices storage	15,000 x 6,000 h = 3,800
Diverters 16 m high	25 m^2
Compressed gases production facility	35,000 x 35,000 h = 8,000
Area with canopy for compressed gases supply system (receiving station)	8,000 x 15,000 h = 9,500
Area for storage of mass simulator	500 m^2
Fuel Storage Area	400 m^2
Oxidizer Storage Area	400 m^2

2.1.3 Vertical Launch Area

Proposed facility and infrastructure construction at the VLA will include the following:

- Launch pad and stand with its associated flame duct;
- Water suppression system (including water tower);
- Lightning protection towers (four total);
- Retention basin for deluge water;
- Propellant storage and handling areas;
- Propellant and gas run lines;
- Workshop and office area;
- Warehouse for parts storage; and
- Roads, parking areas, fencing, security, lighting, and utilities

The Launch Pad is where the ILV will be transported to the day before the launch. It is also where the first stage propellants [liquid oxygen/ rocket propellant or refined petroleum (LOX/RP)] would be stored (apart from each other) and loaded onto the first stage the day of the launch. The RP would typically be brought into the site several weeks before the launch. The LOX would be brought in 3-5 days prior to the launch.

The layout of the VLA is designed so that the launch pad is set back from the ocean, with a clear trajectory over water, launching south toward the Caribbean and as far away from populated areas as possible. The layout for the VLA is shown in Figure 2.3. The infrastructure list of facilities is shown in Table 2.2. The combined parking areas of the HIF would be designed to accommodate up to 100 personnel.

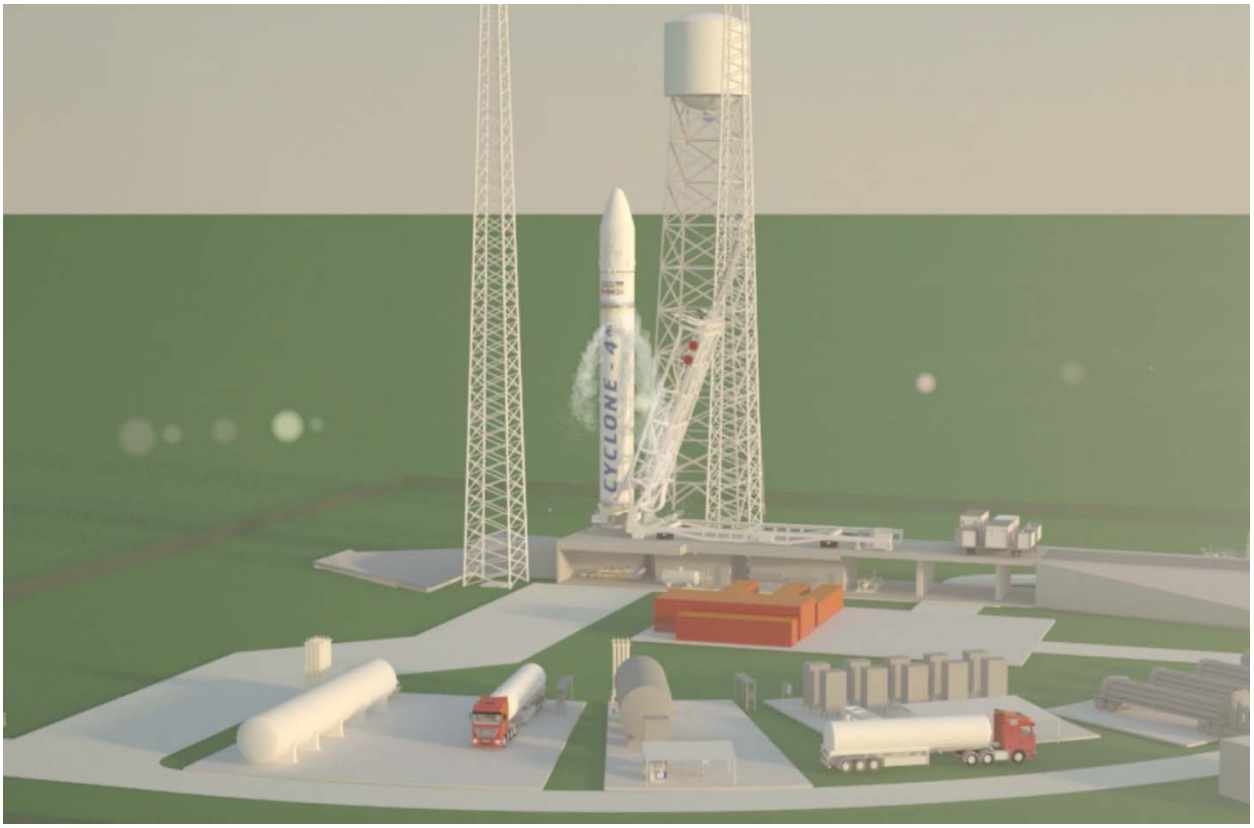


Figure 2.3: Rendering of the Vertical Launch Area

Table 2.2: Launch Site Facility Infrastructure

Facility Name	Dimensions or Building area
Launch facility	61,400 mm x 46,900 mm h = 3,600 mm
Fuel filling system facility (FFS)	60,000 mm x 24,000 mm h = 8,000 mm
Concrete pad	7,800 mm x 6,800 mm
Oxidizer filling system facility (OFS)	60,000 mm x 24,000 mm h = 8,000 mm
Concrete pad	7,800 mm x 6,800 mm
Area with canopy for fuel neutralization	100 m^2
Area with canopy for oxidizer neutralization	100 m^2
Masts 16 m high for television observation system (TOS) with electrical room	2,200 mm x 2,200 mm h = 16,000 mm
Special Railway track	Length is TBD, Width is 1520 mm
Diverters with height of 90 m	
Diverters with height of 25 m	
External fencing	TBD
Propellants vapour and spill collection and neutralization system facility	16,000 mm x 16,000 mm h = 3,500 mm
Area for installation of chilling machines	10,000 mm x 14,000 mm

Deluge Water System

One water tower will be installed at the VLA for sound and vibration suppression. The water tower will contain at least 950,000 litres and would be approximately 75 m high, which is required to provide sufficient pressure to the pad systems.

During a launch, the water tower will discharge up to 375,000 of water for the C4M. Approximately half of the water will be vapourized. Water not vapourized will be contained in a retention basin underneath the pad. This water will be sampled and analyzed to determine if the water contains any contaminants at levels that exceed water quality standards. Appropriate sampling protocols and water quality criteria will be developed in coordination with NSE and Environment Canada. Any contaminated water will be removed and transported to an approved industrial wastewater treatment facility outside of the VLA. Water which does not exceed guidelines will be pumped back to the water tower. The site deluge water would also be used for fire protection. All water (including deluge and potable water) will be either delivered by truck or withdrawn from a local source (i.e., well or lake) as approved by provincial authorities.

Propellant and Inert Gas Storage and Handling Areas

The propellant and inert gas storage areas will include storage and handling equipment for the propellants and gases that fuel the launch vehicle. There are four primary storage and handling areas: oxidizer area, fuel area, helium area, and nitrogen area.

Each area will include corrosion resistant storage tanks or vessels, including their supports and containment area where required, such as:

- Fluid pumps;
- Gas vapourizers; and
- Other components necessary to control flow to the launch vehicle.

In addition, each area will include a concrete or asphalt parking area for delivery trucks for refill of the storage tanks.

2.1.4 Access Roads and Infrastructure

The primary road access to the site and LCC will coincide with the current access road for the Sable Wind Farm. A road and specialized LV transport rail are proposed to connect the VLA to the HIF. The roadway is planned as one lane in each direction with a shoulder that is asphalt paved. The total width of the road is approximately 30 m wide by 2.4 km long for a total area of 7.2 hectares. The access road will also provide a transit route to connect utilities to the VLA from the LCC/HIF. Utilities at the site will include power, potable water, fire protection water, and septic.

The combined parking areas of the VLA would be designed to accommodate up to 50 personnel.

Primary power for the site will be provided by aboveground power lines to the main road access point to the facility from the commercial power through Nova Scotia Power. Power and data lines will then be split to the LCC and to the HIF/VLA via underground lines along the access roads. A total of approximately 1,000-3,000 kilowatts per hour (kW/hr) would be required by the vertical launch and control centre areas during launch operations. Generator operations are expected to be used as emergency power sources that could be required at any time due to a power outage, and as supplemental power for use during the final stages of the launch schedule. It is anticipated that the generators could be used continuously for the final 48-hours prior to launch.

Potable water would either be delivered by truck to the water tower at the VLA or pumped from a well. The septic system consists of either a mobile aboveground processing unit and holding tank, a standard below ground system, or Alternative Treatment Unit as permitted by NSE.

2.1.5 Launch Vehicle - Yuzhnoye C4M

The Yuzhnoye C4M (C4M) is a two-stage medium-lift class LV with a gross lift-off weight of approximately 272,000 kg and an approximate length of 40 m. The C4M uses LOX and highly refined kerosene, also known as rocket propellant-1 or refined petroleum-1 (RP-1), as propellants for its first stage. It uses nitrogen tetroxide (N_2O_4) and unsymmetrical dimethyl hydrazine (UDMH) as propellants for its upper stage to carry payloads into orbit. Figure 2.4 provides a depiction of the LV and Table 2.3 provides detailed specifications.

Figure 2.4: C4M Integrated Launch Vehicle (ILV)

Table 2.3: C4M ILV Specifications

	1st Stage	2nd Stage
ILV launch mass (without PL) (kg)	259460	12583
Engines	4xRD870	RD861K
Propellants	LOX + Kerosene	NT + UDMH
Stage thrust: Earth/Vacuum (tf)	317.6 / 353.8	- / 7.9
Thrust propellants reserves (kg)	224800	10700
Stage diameter (m)	3.9	3.98
Payload fairing diameter (m)	4.0	
ILV length (m)	38.9	
Performance: LEO, H_{cr}=200 km, i=45,3° (kg) SSO, H_{cr}=700 km (kg)	 5000 3350	

The C4M will have satellite payloads, typically designed for near earth imaging, communications, or scientific experiments (Figure 2.5). Most payloads will be commercial; however, some may be Canadian Space Agency or Canadian Department of Defense payloads, or a Federal contribution to a commercial payload. This contribution can be monetary (e.g., funding a technology demonstration) or physical (e.g., providing a second payload/instrument).

Many payloads will require some additional propellants on board, either for orbit maintenance or attitude control. Payload propellants may include hypergolic fuels such as hydrazine and nitrogen tetroxide (NTO). Hypergolic describes a propellant that ignites on contact with an oxidizer. Gaseous nitrogen will be used on the system for cleanliness purges, and liquid nitrogen will be used for cooling purges on an as-needed basis. Pressurized inert gases, including helium and nitrogen, and some solid propellants may also be included.

2.1.6 Propellant, Gas, Fuel, Oil, and Solvent Storage

Table 2.4 below provides the quantities in pounds (lbs) of the propellants.

Table 2.4: C4M Propellant Quantities

Cyclone – 4M ILV	1st Stage	2nd Stage	ILV
Propellant	LOX/Kerosene	UDMH/N_2O_4	LOX/Kerosene and UDMH/N_2O_4
Weight of Propellant	508,335 lbm	29,953 lbm	538,288 lbm

Source: Explosives Siting Report. Maritime Launch Services 2017. Proprietary and Confidential

LOX and Kerosene (RP-1) used for the first stage of the C4M launch would be stored in dedicated propellant storage areas within the VLA. The RP would typically be brought into the site several weeks before the launch while the LOX would be brought in 3 – 5 days prior to the launch. First stage fueling of LOX and RP-1 will be done with a quick disconnect fitting typically used in the aerospace industry. LOX storage will have a total capacity of 80,000 gal (~202,000 L). LOX will be sourced in Atlantic Canada by bulk tanker truck delivery. RP-1 tanks storage will have a total capacity of 30,000 gal (~115,000 L). Bulk RP-1 would likely be delivered by sea vessel to Port of Canso.

NTO and UDMH used in the second stage of a C4M launch will be stored in separate dedicated propellant storage areas near the HIF and loaded onto the upper stage 2 – 3 days prior to the launch. NTO and UDMH tanks will provide storage for 5,000 gal (~20,000 L) of each, which would provide adequate fuel for up to three launches. Exact tank dimensions will be determined with the final detailed design. Bulk UDMH and NTO sources include locations in the US, Europe, and China.

Payload fuel (UDMH, MMH, and NTO) will be stored at the LV Processing/Control Centre Area for each mission only; MLS does not intend to store bulk quantities of these propellants in large tanks at the LV Processing Area/Control Centre where the payloads are integrated. These propellants will be stored in aboveground storage tanks; a typical storage tank for these is 50 gal.

Helium will be used as a pressurant for the main tanks during flight. It will also be used as a purge during fueling operations. Helium will be obtained from commercial sources via a tanker and will be stored in aboveground storage tanks (high pressure tube banks). Gaseous nitrogen will be created from liquid nitrogen and delivered to the site by commercial truck. Approximately 200,000 L of inert gaseous helium and nitrogen, respectively, will be stored at the VLA. In addition, approximately 30,000 L of helium storage and 90,000 L of nitrogen storage will be required at the LV Processing/Control Centre Area. Typical storage of these gases would be six to eight tanks, approximately 1 m x 12 m in size each. Final storage tank dimensions will be determined during detailed design.

Additional storage for lesser quantities of materials will also be stored on site. Approximately 100 gal of isopropyl alcohol will be on site for each launch operation for additional cleaning, although only 20 gal will be required for cleaning operations during launch preparations. Solvent flushes will be performed during operation of the LV programs. Small volumes (less than 300 gal) of heavy gear oil, hydraulic oil, and cutting oil, and a limited supply of various solvents and adhesives will be stored in the shop areas of the LV Processing Area/Control Centre or the VLA for general use in the maintenance of ground equipment. An oxygen/acetylene torch with its associated gases [carbon dioxide (CO_2) and argon] may also be used on a limited basis. Welding gases and supplies will be stored in 10 K bottles each. Welding equipment will be maintained on site for occasional use. Approximately 10,000 gal of generator fuel (diesel/gasoline) will also be stored at the VLA.

All tanks and containments systems will be cleaned, tested, and certified before first use; all tanks will be tested to the Transport Canada regulations, American Society of Mechanic Engineers (ASME) Section VIII Pressure Vessel Code requirements, or American Petroleum Institute storage

tank requirements, as applicable. Permanent over-ground lines will be installed to connect both the LOX and the RP-1 storage areas to the launch pad. These piping systems will be designed, installed, and tested in accordance with ASME B31.3 Piping Code requirements.

2.2 Project Activities

2.2.1 Site Preparation and Construction

While the majority of the construction will occur during the day, small amounts of construction, such as pouring of concrete, may occur at night. All construction staging areas are planned to fall within the proposed Project boundaries and no additional areas would be required for staging.

The proposed schedule for all construction activities is an 18-month period from start to finish. Construction activities would not begin until after the environmental approval, NSDNR approval, and permitting requirements are complete.

Site clearing and grading will be undertaken to establish the proper grade for the various site facilities and roads within the Project footprint. This grading is not expected to require any blasting and is discouraged based on the relative nearness of the Sable Wind Farm. If it is absolutely required, it would be done with careful consideration and the use of blast blankets and other protective means to minimize potential impact to the wind farm turbine foundations. Explosives will not be stored on site, but rather will be transported to site on the day of the blast. Blast monitoring will be carried out where required. Overburden and underlying rock is planned to be retained and reused for landscaping and leveling of site to the required grade levels.

If the excess rock on the site is considered suitable, it may be processed to serve as construction aggregate for use in concrete or as fill on the site. Any aggregate material that will be brought to site from outside sources will be from approved quarries and pits only.

Near fish habitat, blasting activities will be conducted in compliance with the Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters (Wright and Hopky, 1998.)

Any structures such as wells, buildings, and foundations that are located outside of the facility boundaries and within a designated radius of the blasting site and that may experience damage or impact due to seismic vibrations or air concussion will be surveyed prior to any blasting activities (pre-blast survey).

Erosion and sediment control measures will be implemented to minimize the potential for increased erosion and siltation from site runoff while soils are exposed and un-stabilized, and from movement of construction vehicles. These requirements will be established in the construction of an Environmental Protection Plan (EPP) and measures will be specified in site-specific erosion and sediment control plans.

2.2.2 Launch Facilities

The construction period of the main launch facilities will span approximately 18 months. It has been assumed that the site will provide rock suitable for concrete and foundation backfill and will therefore become the principal source of such needs at the site. This will involve some heavy excavation equipment, crushing, and screening. A concrete batching plant will be established for the construction period. After site preparation, the activities will shift to installation of foundations and heavy haul roads linking the HIF to the VLA.

Prefabrication activities will proceed off-site in parallel with civil works, so that, as foundations are completed, phased delivery of prefabricated structures, equipment skids, subassemblies, and modules can progress. Deliveries will be sequenced to support the installation, hook-up, and commissioning program. Construction sequencing will be strongly focused on the testing and commissioning program that brings the facility into operation on schedule.

2.2.3 Construction Generated Waste

Construction activities will generate waste including:

- hazardous wastes arising from use of paints, oils, batteries etc.;
- sanitary waste;
- oily waste; and
- inert construction waste, including soil and rock.

Hazardous waste streams will be separated according to type (waste oils, paints, acid batteries, contaminated filters etc.) on-site and stored within suitable containment prior to transport off-site for disposal at an approved facility.

Accidental spills are also a potential source of petroleum-oil-lubricants (POL), and small quantities of other hazardous chemicals.

2.2.4 Construction Related Noise

During construction, noise will be generated through a variety of sources. Construction equipment includes a large number of types of machines and devices, varying widely in physical size, horsepower rating and principle of operation. Noise levels will vary with the equipment used. More information on construction related noise levels is included in Section 5.2 together with a discussion of proposed mitigation measures.

2.2.5 Operations and Maintenance

Proposed operations would consist of up to eight launch operations per year as well as associated pre-flight activities such as mission rehearsals. All launches would be expected to have commercial satellite payloads.

Launch times are subject to the satellite clients needs but the majority of launches would likely be conducted between the hours of 7:00 am and 12:00 pm. MLS will conduct all launches, including pre-flight activities, and all launches will be coordinated with Transport Canada and NavCanada.

The C4M launch trajectory would be specific to each particular mission, but they will all be conducted to the south over the Atlantic Ocean.

The Yuzhnoye C4M LV program is designed for minimal vehicle assembly and processing at the VLA. The goal is to launch within a few days to several weeks of vehicle and payload arrival at the site. The operational parameters for the Project are described below.

2.2.5.1 Launch Vehicle Delivery

The C4M stages will be prepared for shipment in Ukraine aboard flatbed trucks, loaded onto a RoRo (Roll On, Roll Off) vessel and carried across the North Atlantic for delivery to the Port of Mulgrave. They will then be barged to the Port of Canso as regulated by Transport Canada Marine Security requirements. Tractor trailers will then remove the flatbeds and drive them to the HIF where the stages will be offloaded.

Primary commercial payload processing will occur at the HIF. Primary payload processing activities include payload checkout, spacecraft propellant loading, and payload encapsulation in the fairing. Radiating, a common standard communication check before launch, of the payload will also occur during processing. Once primary payload processing is completed, the payload will be transported to the VLA.

2.2.5.2 Integrated Launch Vehicle Transport to the Vertical Launch Area

Ground transportation support during a launch campaign (preparation for and the actual launch event) will be minimal. This support will consist of a specialized transporter that delivers the LV to the VLA from the HIF via a rail system.

2.2.5.3 Pre-Launch Activities

This section describes the activities that may be conducted leading up to an actual launch, and include:

- Mission rehearsals;
- Coordination with governmental agencies and media outlets to provide notifications of launch operations; and
- Establishment of secure areas.

MLS will develop a Security Plan that will outline a process to prevent the public from accessing the area during hazardous operations.

<u>Mission Rehearsals</u>

The goal of mission rehearsals is to verify that all vehicle and ground systems are functioning properly and to verify that all procedures are properly written. Typical mission rehearsals will involve a final system checkout, followed by a mission rehearsal without propellants on board (referred to as a dry dress rehearsal) and a mission rehearsal with propellants on board (referred to as a wet dress rehearsal) to verify full launch readiness.

During a wet dress rehearsal, ground operators step through the flight procedures. The entire launch countdown is executed, with a pre-programmed abort just before the engine startup sequence, and before ignition. One dry and one wet dress rehearsal within 30 days of launch are typical in a launch preparation schedule to allow for team training and for coordination of activities between the mission-specific MLS crew and operations personnel.

Public Notification of Launch Operations

Launches and wet dress rehearsals require restricting public access in the vicinity of the VLA and securing land and water areas. These activities will require public notification.

At least two weeks in advance of a launch operation (i.e., actual launch or wet dress rehearsal), the Atlantic Region Office for Transport Canada, MODG, RCMP, Guysborough County Inshore Fisherman's Association (GCIFA), NavCanada, Coast Guard, the provincial government and others will be notified of the proposed date, the expected closure times, and backup closure dates and times. Written notices of the date, time, and the proposed closure area will be posted in several businesses and local offices in the area and within the Municipality, as well as an advertisement in local newspapers. In addition, MLS would file Notice to Airmen (NOTAM) with NavCanada and Notice to Mariners (NOTMAR) with the Coast Guard. Approximately 3-6 days prior to a launch operation that would require a closure, the public will be notified through local media, and through the use of NOTMARs and NOTAMs.

Security Plan Implementation

As part of the launch permitting process, MLS will develop a Security Plan that defines the process for ensuring that any unauthorized persons, vessels, aircraft, or other vehicles are not within the assessed hazard area (the Closure Area). The Security Plan will address safety and security personnel for each launch operation and roadblocks and other security checkpoints. MLS will also develop and implement agreements and plans with local authorities whose support is needed to ensure public safety during all launch processing and flight. The Security Plan will describe the procedures for securing the Closure Area, thus limiting public access in the area on the day of a launch operation and will be developed through coordination with Canada Customs and Border Protection, the RCMP, the MODG, and others, as identified by local authorities.

More details pertaining to the Security Plan are provided in Section 2.3.3.

2.2.5.4 Launch Day Activities

On the day of a launch operation, the LV will be moved from the HIF to the launch pad at the VLA. LVs may be erected and de-erected several times prior to launch; the transporter erector is designed to make this operation quick and simple. On the day of a launch operation, the LV will be erected and final system checks completed. Approximately 4 hours before engine ignition (or in the case of a wet dress rehearsal, an abort), the vehicle will be erected and loaded with propellant.

Nominal Trajectories

The majority of launches will be conducted between the hours of 7:00 a.m. and 12:00 p.m. MLS will conduct all launches, including pre-flight activities, and all launches will be coordinated with

Transport Canada and NavCanada. The exact C4M launch trajectory will be specific to each particular mission. However, all launches will be conducted to the south over the Atlantic Ocean, similar to what is depicted in Figure 2.9.

Figure 2.9: Depiction of the Launch Trajectory over the Atlantic Ocean

The first depiction shows the proposed restricted airspace for a typical launch. This restricted airspace reaches an altitude of 60,000 feet and air traffic would not be permitted in that airspace prior to and through the launch. The second depiction shows the typical Sun Synchronous Orbit trajectory planned through orbit insertion before reaching the Caribbean. The C4M LV drops the first stage and the upper stage fairing just over 2,000 km south of the launch site. The upper stage and satellite payload enter and remain in orbit. As is typical in the industry, the first stage and fairing are not recovered and sink to the bottom of the ocean.

2.2.6 Decommissioning

The facility is expected to be in operation for the foreseeable future with proper maintenance, according to market requirements. When permanent shut down of the facility is planned, the Proponent will work with NSE to prepare a final decommissioning and reclamation plan according to regulations at the time.

2.3 Safety and Security

2.3.1 Site Security

Security fencing will be maintained around the VLA in order to protect the general public from the potential hazards of the site and to prevent unauthorized access to the systems and materials on site. Security systems will include a security gate, a guard building, and fencing that extends around the perimeter of the VLA.

Fencing will consist of two 1.8 m tall chain-link fences, approximately 3 m apart. The outside perimeter fence will include a system to detect unauthorized access and will enclose approximately 4 ha. In addition, a 2 m wide dirt access road will be developed inside the inner fence line for security patrol.

Site lighting will be necessary for personnel safety but will be designed to protect the night sky and minimize light pollution. All site lighting will consist of high pressure sodium (HPS) light fixtures. The number of pole lights will be finalized during final detailed design.

2.3.2 Storage of Energetic Liquids

MLS plans are to ramp up launch operations from three in the first year to a launch frequency of eight times per year. Some of the launch operations at the facility are potentially hazardous because of the proximity of fuel and oxidizer to each other, the frequency of launches, lack of restraint of vehicle after liftoff, and the possibility of fallback with resultant dynamic mixing on impact. As a result, there are operational considerations that occur leading up to the launch that must be followed and access by the general public controlled.

The development areas which include the propellant storage tanks will have security fencing, signage, and 24/7 protective services. During normal operations in the weeks leading up to the launch, the general public will have full access to the Crown land PID overseen by the Department of Natural Resources, except inside the fenced area of the LCC, HIF, and VLA. This open access is due to the separation distances between the different kinds of propellants that precludes them from

mixing under any circumstances which could increase the potential hazard. These separation distances between propellants is defined by National Fire Protection Association (NFPA) standards and they fall within the fenced perimeter. The general public hikes, walks, fish, hunt deer and water fowl, and rides ATVs in that area and those activities will not be affected 95% of the time. Two to three days before the launch though, the HIF operations call for storing the upper stage propellants together inside the LV which will require a temporary clearance be maintained from the HIF of 1250 ft (380 m) especially during the propellant movement operations. Once that vehicle is moved by rail to the launch pad, that clearance radius also moves to the launch pad. On the day of launch, during the time leading up to the final launch commit countdown and when the LV first stage is fully fueled, non-essential personnel will be cleared back a minimum of 2700 ft (823 m) per accepted international standards and based on the total propellant quantities on the vehicle. As the launch countdown procedure continues into the final stages, all personnel will be cleared back behind a planned exclusion radius of 6560 ft (2 km) per international standards and as accepted by the launch regulatory body, Transport Canada. Should a launch hold or scrub occur, the non-essential personnel will remain outside the area until the LV is secured including offload of the propellants, if needed. The nearest residential home to the launch pad, is in the opposite direction of the launch trajectory and is 3 km away.

2.3.3 Security Plan and Closures

The Security Plan outlines the procedures and personnel involved for a closure preceding a launch or rehearsal. Closures will limit access to any unauthorized persons, vessels, aircraft, or other vehicles on the day of a launch operation with a pre-determined Closure Area, assessed for hazard potential. The Closure Area would begin at a checkpoint on the access road toward the Sable Wind Farm and offshore areas. The checkpoint north of the Sable Wind Farm will be a hard checkpoint which no one will be permitted to pass during launch operations. The proposed Closure Area will be fully vetted and tailored in consultation with Transport Canada and other local authorities and fisheries.

As described above, closure area distances around the launch pad increase the closer you get to the launch and coincide with the movement of propellants onto the LV. Over that time, the level of security sweeps and controls increase. During a closure, monitoring will be done by vehicle along existing roads as well as by video surveillance. High definition video cameras with zoom lenses will be placed well above ground level on the water tower and/or lightning towers. MLS and law enforcement will monitor the entire areas to ensure clearance by the general public. Unless there is an emergency, MLS will not conduct any ground sweeps in adjacent lands. Only in the case that video surveillance is insufficient will other monitoring methods be used, such as:

- Unmanned aerial surveillance;
- Manned aerial surveillance;
- Beach sweeps using suitable ground vehicles; and/or
- Sea vessels.

Closures and clearing of offshore areas will involve coordinating with the Canadian Coast Guard (CCG) and Fisheries Associations, issuing NOTMARs, and clearing the offshore area in order to ensure public safety. The CCG may conduct a boat patrol to sweep the offshore areas down range

to ensure the area is clear, continuing until MLS is ready to load propellant to the LV (approximately 3 hours prior to launch). MLS recognizes the Lobster Fishing Area 31a and 31b around Canso has a season running from Mid-April through the end of June and will closely coordinate with the local GCIFA to minimize impacts to the industry. The GCIFA already has radio contact capability with all local fisherman and MLS will coordinate with them well in advance of the launch date to notify people in the area.

After the launch operation is completed, MLS will notify law enforcement when the area has been deemed safe. Once deemed safe, the checkpoints will be raised and the area would re-open to the public.

Table 2.5 lists the actions that would be conducted to ensure the security of the Closure Area prior to an actual launch. The same actions/activities would occur for other launch operations requiring a closure (i.e., wet dress rehearsal), but the start time and durations will be different as these other launch operations are not expected to last as long as an actual launch.

Table 2.5: Launch Day Security Timeline

Action/Activity	Description	Start Time	Duration
Establish Soft Checkpoint	Begin notification of launch and secure times to all passing the checkpoint. Record names/destinations passing the checkpoint (TBD)	T-8 hrs	6 hrs
Lock down Soft Checkpoint	Restrict access to all but property owners and authorized personnel	T-6 hrs	Through Launch
Establish hard Checkpoint	Restrict access to all but authorized personnel	T-4 hrs	Through Launch
MLS and/or Coast Guard on Station	Vessels prohibit boaters from entering restricted areas	T-4 hrs	Through Launch
Beach security sweep	MLS security verifies no unauthorized presence	T-4 hrs	20 min
Land aerial sweep	Verify via video surveillance or unmanned aerial vehicle or ATV; no unauthorized presence	T-3 hrs	20 min
Trajectory sweep	Verify via visual sweep and/or aerial sweep no boaters in the safety zone	T-1 hrs	20 min
Final site sweep and evacuation	Verify all on-site work personnel are outside the closure area	T-1 hrs	15 min

2.4 Project Schedule

The first launch is planned for the summer of 2021. Following first launch, MLS will begin a launch pace that ramps up to an expected peak of eight launches per year beginning in 2024. Table 2.6 presents the Project schedule from EA registration to Project decommissioning.

Table 2.6: Project Schedule

Project Activity	Timeline
EA Registration	Summer 2018
Ground Breaking/Construction Stage	Fall 2018 – January 2021
Site Commissioning	January 2021
Operation – First Launch	July 2021
Decommissioning	40+ years

3.0 ENVIRONMENTAL MANAGEMENT

3.1 Environmental Protection Plan

An EPP will be developed following EA approval of the Project. The EPP will be approved by NSE prior to start of construction of the Project and will detail best practices and mitigative measures to be employed during construction to minimize potential environmental impacts. The EPP document is the primary mechanism for ensuring that mitigation is implemented, as determined through the EA process, to avoid or mitigate potential adverse environmental effects that might otherwise occur from construction activities, and as required by applicable agencies through permitting processes.

The EPP is a plan for all Project personnel, including contractors, and describes the responsibilities, expectations, and methods for environmental protection associated with Project activities. The EPP will incorporate:

- means to comply with requirements of relevant legislation;
- environmental protection measures identified as part of the EA; and
- environmental commitments made as part of the EA.

A site-specific erosion and sedimentation control plan (ESCP) will be developed for the Project and included in the EPP.

A suggested Table of Contents for the EPP is provided in Appendix B.

3.2 Setback Considerations

In accordance with the MODG Land Use By-law, for any Natural Resource (NR-1) Zone, no development permit shall be issued except in conformity with the following requirements:

Table 3.1: MODG Setbacks and Lot Requirements

Requirement	Standard
Minimum Lot Area	10,219 m^2 (110 000 ft^2)
Minimum Lot Frontage	100 m (330 ft)
Minimum Front Yard	7.62 m (25 ft)
Minimum Side Yard	4.57 m (15 ft)
Minimum Rear Yard	7.62 m (25 ft)

All permitted uses in a NR-1 Zone must be set back a minimum of 30.48 m (100 ft) of the ordinary high water mark of any watercourse.

Project related access roads are situated outside of the 180 m wind turbine setback zone for all Sable Wind Farm turbines, as required by the MODG Land Use By-Law for Large Scale Wind Turbines (MODG 2013).

4.0 ENVIRONMENTAL ASSESSMENT METHODOLOGY

The EA focuses on specific components of the biophysical and human environments called VECs that, if altered by the Project, may be of concern to stakeholders such as regulatory agencies, Aboriginal peoples, resource managers, scientists, and/or the general public. VECs incorporate biological systems as well as human, social, and economic conditions that are affected by changes in the biophysical environment. VECs can therefore relate to ecological, social, and/or economic systems that comprise the environment as a whole. Accidents and malfunctions are considered separately as a VEC.

Interactions between Project and environmental components are evaluated for potential environmental effects on VECs to determine potential effects and their significance. The determination of significance of adverse environmental effects is based on post-mitigation (residual) effects, rather than unmitigated potential effects. Therefore, the effects assessment considers the following:

- A review of potential Project interactions;
- Mitigation and environment protection measures proposed to reduce or eliminate adverse effects;
- The characterization of the residual environmental effects of the Project; and
- Any proposed follow-up monitoring to be completed post-construction.

The ultimate focus of the assessment is on residual environmental effects that remain after planned mitigation has been applied.

4.1 Selection of Valued Environmental Components (VECs)

The EA focuses on specific components of the biophysical and human environments called VECs that, if altered by the Project, may be of concern to stakeholders such as regulatory agencies, Aboriginal peoples, resource managers, scientists, and/or the general public. VECs incorporate biological systems as well as human, social, and economic conditions that are affected by changes in the biophysical environment. VECs can therefore relate to ecological, social, and/or economic systems that comprise the environment as a whole. Accidents and malfunctions are considered separately as a VEC.

A preliminary assessment of potential interactions between environmental components and Project activities was undertaken to identify VECs (Table 4.1).

Table 4.1: Environmental Component Interaction Assessment

PROJECT COMPONENTS	ENVIRONMENTAL COMPONENTS																	
	Biophysical												Socio-economic					
	Climate and Weather	Air Quality	Acoustic Environment	Geology	Hydrogeology and Groundwater	Waterbodies and Watercourses	Fish and Fish Habitat	Habitat and Vegetation	Wetlands	Mammals	Herpetofauna and Insects	Avifauna	Local Demographics	Land Use and Value	Recreation and Tourism	Cultural and Heritage Resources	Aboriginal Resources	Cumulative Effects
SITE PREPARATION AND CONSTRUCTION																		
Excavation and grading	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	✓	✓	✓
Blasting	✓	✓	✓	✓	✓	0	0	✓	0	✓	✓	✓	✓	0	0	✓	✓	✓
Installation of facilities and infrastructure	✓	✓	✓	✓	✓	0	0	0	0	✓	✓	✓	✓	✓	✓	✓	✓	✓
OPERATIONS AND MAINTENANCE																		
Daily Maintenance and Operations	✓	✓	✓	0	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	✓	✓	✓
Launch Vehicle Delivery	✓	✓	✓	0	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	✓	✓
Integrated Launch Vehicle Transport to Vertical Launch Area	✓	✓	✓	0	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	✓	✓
Pre-launch Activities	✓	✓	✓	0	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	✓	✓
Launch Activities	✓	✓	✓	0	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	✓	✓
ACCIDENTS AND MALFUNCTIONS																		
Accidental Release	0	✓	0	0	✓	✓	✓	✓	✓	✓	✓	✓	0	✓	✓	✓	✓	✓
Failure of Erosion and Control Measures	0	✓	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	✓	✓	✓	✓	✓
Notes: ✓ = Potential Interaction, 0 = No Interaction																		

The above assessment identified environmental components which would potentially interact with the Project. Based on this assessment, VECs to be addressed in this EA were determined as outlined in Table 4.2.

Table 4.2: Selected VECs for Further Assessment

VEC	Environmental Component
Atmospheric Environment	Climate and Weather
	Air Quality
Acoustic Environment	Acoustic Environment
Geologic Environment	Geology
	Hydrogeology and Groundwater
Freshwater Environment	Waterbodies and Watercourses
	Fish and Fish Habitat
Terrestrial Habitat	Habitat and Vegetation
	Wetlands
	Mammals
	Herpetofauna and Insects
Avifauna	Avifauna
Local Demographics	Local Demographics
Recreation and Tourism	Recreation and Tourism
Cultural and Heritage Resources	Cultural and Heritage Resources
Aboriginal Resources	Aboriginal Resources
Cumulative Effects	Cumulative Effects

4.2 Description of Baseline Conditions and Potential Negative Environmental Effects

For each VEC, an overview of the baseline conditions is described. In addition, potential negative effects resulting from interactions with Project activities are described and evaluated in detail for each VEC. Where there is potential for Project-related environmental effects, each effect is assessed using the results of preliminary investigations, guidance from regulators, and the collective knowledge and expertise of the Project team.

4.3 Specific Mitigative and Protective Measures

Where an adverse environmental effect on a VEC is identified, strategies for mitigation, avoidance, or compensation are proposed. Where possible, mitigation measures will be incorporated into Project design to eliminate or reduce potential adverse effects.

4.4 Effects Analysis

The determination and characterization of adverse environmental effects for each VEC is based on post-mitigation (residual) effects, rather than unmitigated potential effects in accordance with the criteria outlined in Table 4.3.

Table 4.3: Criteria for Identification and Definition of Environmental Effects

Attribute	Options	Definition
Scope (Geographic Extent)	Local	Effect restricted to area within 1 km of the Project site
	Regional	Effect extends up to several km from the Project site
	Provincial	Effect extends throughout Nova Scotia
Duration	Short-term	Effects last for less than 1 year
	Medium-term	Effects last for 1 to 10 years
	Long-term	Effects last for greater than 10 years
Frequency	Once	Occurs only once
	Intermittent	Occurs occasionally at irregular intervals
	Continuous	Occurs on a regular basis and regular intervals
Magnitude	Negligible	No measurable change from background in the population or resource; or in the case of air, soil, or water quality, if the parameter remains less than the standard, guideline, or objective
	Low	Effect causes <1% change in the population or resource (where possible the population or resource base is defined in quantitative terms)
	Moderate	Effect causes 1 to 10% change in the population or resource
	High	Effect causes >10% change in population in resource

4.5 Residual Effects Analysis

If, based on the criteria in Table 4.3, a residual effect is identified, the significance of the residual effect is then evaluated based on the criteria outlined in Table 4.4.

Table 4.4: Definition of Significant Residual Environmental Effect

Significance Level	Definition
High	Potential effect could threaten sustainability of the resource and should be considered a management concern. Research, monitoring, and/or recovery initiatives should be considered.
Medium	Potential effect could result in a decline in resource to lower-than-baseline but stable levels in the Study area after Project closure and into the foreseeable future. Regional management actions such as research, monitoring, and/or recovery initiatives may be required.
Low	Potential effect may result in slight decline in resource in Study area during life of the Project. Research, monitoring, and/or recovery initiatives would not normally be required.
Minimal/None	Potential effect may result in slight decline in resource in Study area during construction phase, but should return to baseline levels.

4.6 Recommended Monitoring and Follow-up

Follow-up and monitoring, in some cases developed in conjunction with regulators, may be recommended to assess effectiveness of measures implemented to mitigate adverse environmental effects.

5.0 ENVIRONMENTAL EFFECTS ASSESSMENT

5.1 Atmospheric Environment

5.1.1 Climate and Weather

Nova Scotia's climate is quite varied and is largely governed by coastal influences and elevation (Davis and Browne 1996). The Project site (centered at 45°18'37.40"N, 060°59'35.85"W) lies within the Eastern Shore Ecodistrict, which extends from the east side of the Halifax peninsula to the town of Canso (Neily *et al.* 2005). On the Canso peninsula, coastal influences extend inland to elevations of 150 m, where coastal forests are found. This region is characterized by short, cool summers and relatively mild, wet winters (Neily *et al.*, 2003). The typical growing season in the area of the Project site is 202 days (Webb and Marshall 1999).

Climate norms for a 30-year average were determined from the Deming weather station located 17.8 km from the Project site for average temperature and precipitation, including maximum and minimum values (EC 2016a).

Mean annual precipitation for the area is 1440.5 mm and is calculated by the total rainfall plus the equivalent of snowfall and other forms of frozen precipitation (Table 5.1). Monthly mean precipitation values range from 100.9 mm in August to 148.0 mm in November. The highest monthly mean rainfall levels occurred in October (144.2 mm), with mean monthly snowfall amounts greatest in January (30.4 cm). Rainfall occurs on average every month; however, snowfall does not occur during June, July, August, September, and October.

Table 5.1: Mean Precipitation Values for 1981-2010

Month	Mean Rainfall (mm)	Mean Snowfall (cm)	Total Precipitation (mm)
January	85.6	**30.4**	116.1
February	75.0	28.9	103.9
March	97.6	22.4	120.0
April	128.1	10.4	138.5
May	116.6	0.7	117.3
June	100.4	0.0	100.4
July	101.8	0.0	101.8
August	100.9	0.0	100.9
September	114.8	0.0	114.8
October	**144.2**	0.0	144.2
November	142.8	5.2	**148.0**
December	113.0	21.6	134.6
Annual Total	**1320.8**	**119.7**	**1440.5**

Source: EC 2016a

Annual average daily mean temperature is 6.1°C (Table 5.2). Average daily mean temperatures vary from -4.1°C in February to 17.4°C in August. Average daily temperatures ranged from -7.4°C in January to 20.2°C in June.

Table 5.2: Mean Temperature Values for 1981-2010

Month	Average Daily Mean (°C)	Average Daily Maximum (°C)	Average Daily Minimum (°C)	Extreme Maximum (°C)	Extreme Minimum (°C)
January	-4.0	-0.5	**-7.4**	10.5	**-25.0**
February	-4.1	-0.9	-7.3	10.0	**-25.0**
March	-1.5	1.3	-4.3	11.3	-19.0
April	2.6	5.3	-0.2	20.0	-11.0
May	6.6	9.7	3.5	24.0	-3.5
June	11.1	14.3	7.9	**31.1**	-0.6
July	15.1	17.9	12.2	30.0	4.4
August	**17.4**	**20.2**	14.6	28.5	4.4
September	15.2	18.1	12.2	26.1	2.0
October	10.1	12.8	7.3	21.7	-4.4
November	5.0	7.6	2.3	19.4	-12.0
December	-0.3	2.7	-3.3	12.2	-23.5
Annual	**6.1**	**9.1**	**3.1**	**-**	**-**

Bolded values represent the Average value (bottom of table) and the highest/lowest value in each column

Source: Environment Canada 1981-2010.

Wind data was determined from the Hart Island weather station located 3.5 km from the Project site. The average wind speed for the years 2011 – 2016 was 23 km/h (EC 2017), with gusts up to 139 km/h. Westerly winds are the predominant wind direction.

In Atlantic Canada, climate change is expected to bring warmer average temperatures, higher sea levels, more extreme rainfalls and storm flooding, and more frequent and extreme storms (Lemmen *et al.* 2008). Regional trends in seasonal temperatures for Atlantic Canada show an overall warming of 0.3 °C from 1948 to 2005 (Lewis 1997; Lines *et al.* 2003). Precipitation increased in Atlantic Canada by approximately 10% between 1948 and 1995 (Lewis 1997), and is anticipated to continue to increase in the future. The Atlantic region is subject to impacts from a wide range of seasonal and interannual events, including winter cyclonic storms, tropical cyclones, and other severe weather events; summer heat and drought; early or late season frost; winter rain and thaw events; and river ice jams and flooding. There is evidence of recent trends toward greater extremes and higher frequencies of such events (Zhang *et al.* 2001; Beltaos 2002; Bonsal and Prowse 2003; Bruce 2005; Webster *et al.* 2005).

5.1.2 Air Quality

The Government of Canada has established ambient air quality standards for fine particulate matter over two-time averaging periods, while the Government of Nova Scotia has legislated Air Quality Regulations under the *NSEA* (Table 5.3).

Table 5.3: Summary of Regulations Pertaining to Ambient Air Quality in Nova Scotia

Contaminant	Averaging Period	Regulatory Threshold (ug/m^3)	
		Federal[1]	Provincial[5]
Carbon Monoxide (CO)	1-hour	-	34,600
	8-hour	-	12,700
Nitrogen Dioxide (NO_2)	1-hour	-	400
	Annual	-	100
Sulphur Dioxide (SO_2)	1-hour	-	900
	24-hour	-	300
	Annual	-	60
Total Suspended Particulate (TSP)	24-hour	-	120
	Annual	-	70
Particulate Matter Less than 10 microns (PM_{10})	24-hour	-	-
Particulate Matter Less than 2.5 microns ($PM_{2.5}$)	24-hour[2]	28 (2015) 27 (2020)	-
	Annual[3]	10 (2015) 8.8 (2020)	-
Ozone (O_3)	1-hour	-	160
	8-hour[4]	135 (2015) 133 (2020)	-

Notes:

[1] Canadian Council of Ministers of the Environment Canada-Wide Standards for $PM_{2.5}$

[2] 3-year average of the annual 98th percentile of the daily 24-hour average concentrations

[3] 3-year average of the annual average concentrations

[4] 3-year average of the annual 4th highest daily maximum 8-hour average concentrations

[5] Nova Scotia Air Quality Regulations (NS Reg. 179/2014)

Nova Scotia monitors air quality at six stations throughout the province. Measured parameters include ground-level ozone (O3), particulate matter less than 2.5 microns in diameter (PM2.5), and nitrogen dioxide (NO2), and these values are used to calculate a score on the Air Quality Health Index (AQHI) (EC 2016b). The AQHI is a scale from 1-10+, in which scores represent the following health risk categories: Low (1-3), Moderate (4-6), High (7-10), and Very High (10+). The closest AQHI monitoring station to the Project site is located in Port Hawkesbury. The AQHI at this site is usually low at all times of the year (EC 2016b).

5.1.3 Potential Interactions and Effects

The proposed Project may adversely impact the atmospheric environment during construction, operation and decommissioning. Potential impacts include:

- Release of fugitive dust during construction and operations;
- Release of exhaust emissions during construction;
- Contributing greenhouse gas emissions to the atmosphere.

Fugitive Dust Emissions

Fugitive dust emissions consist of particulate matter generated from open air activities associated with both the construction (e.g. moving earth/disturbing soil, wind erosion) and operational phases (e.g. rocket launches) of the Project. They are composed mainly of soil minerals, but can also contain salt, pollen, spores, and tire particles. There are two forms of particulate matter that are of particular interest, as they pose the greatest concern for human health: particulate matter with a diameter of 10 microns (µm) or less (PM_{10}), and particulate matter with a diameter of 2.5 µm or less ($PM_{2.5}$). Particulate matter is measured by Total Suspended Particles (TSP) and is defined as the mass of airborne particles having a diameter of less than 44 microns (µm). Refer to Table 5.3 for the regulatory threshold, and to section 5.1.4 for mitigation measures and best management practices.

Tailpipe/Diesel Exhaust Emissions

Construction activities will result in an increase of combustion product, or tailpipe, emissions; primarily PM, NO_x, SO_2, and CO from vehicles (personal, delivery) and heavy equipment. These emissions are considered to be short-term, localized, and negligible. Refer to section 5.1.4 for mitigation measures and best management practices.

Rocket Launch Exhaust Emissions

As previously described, the Cyclone 4M rocket uses liquid propellants in the first stage, which is also commonly found in other modern U.S. built rockets. This first stage propellant is a refined form of kerosene known as RP-1 and the oxidizer is LOX which is considered more environmentally friendly compared to solid propellant exhaust (NASA 2009). According to NASA (2009), during the flight of a typical multi-stage rocket, several combustion products are released into the atmosphere. During the first stage of the launch, CO, CO_2, and H_2O are the primary combustion products of RP-1 and LOX (Figure 5.1). The primary chemical exhaust constituent of concern from an air quality perspective is carbon monoxide. The hazards associated with exposure to CO are well understood and regulated in legislation as well as several industry standard exposure criteria. As outlined above, the Nova Scotia Air Quality Regulations has set ambient air quality limits for CO.

Additional sources of emissions include outgassing from the rocket under low pressure conditions and from aerodynamic heating, as well as from a payload, which releases additional gaseous or liquid chemicals into the atmosphere in the higher reaches of the flight trajectory. These emissions are considered to be short-term and localized, with no substantial cumulative impacts based on eight launches per year.

Rocket Plume Emissions Modelling

As with other rocket launch facilities in the world, rocket plume emissions modeling will be completed prior to conducting any launches at the Canso Spaceport. The purpose of the modeling is to verify the duration, shape, and direction of the launch plume as well as the concentrations of CO in the launch plume as it disperses. This modeling will assist MLS and the regulatory agencies in developing an acceptable launch go-no go criteria based on prevailing wind speed and direction to ensure any cloud is well away and/or aloft from any populated areas up range.

The Rocket Exhaust Effluent Dispersion Model (REEDM) is an example of a model that has been used by other launch facilities to delineate large buoyant source clouds generated by rocket

launches. The REEDM model is based on the NASA Multi-Layer Diffusion Model, which was written initially to evaluate environmental effects associated with the Space Shuttle. These are categorized as "Gaussian puff" atmospheric dispersion models which are widely used by regulatory agencies for environmental and permitting studies, and by industries to predict accidental releases from their facilities.

MLS will be conducting modeling for any rockets that are launched from the Canso Spaceport. To complete this modeling, the rocket manufacturer will need to provide specific design details including the quantities of fuels, thrust, specific impulse, O/F ratios, and more to be used and the specific fuel ratios. This modeling will be completed well in advance of any launches and once completed will be provided to regulatory agencies for their review.

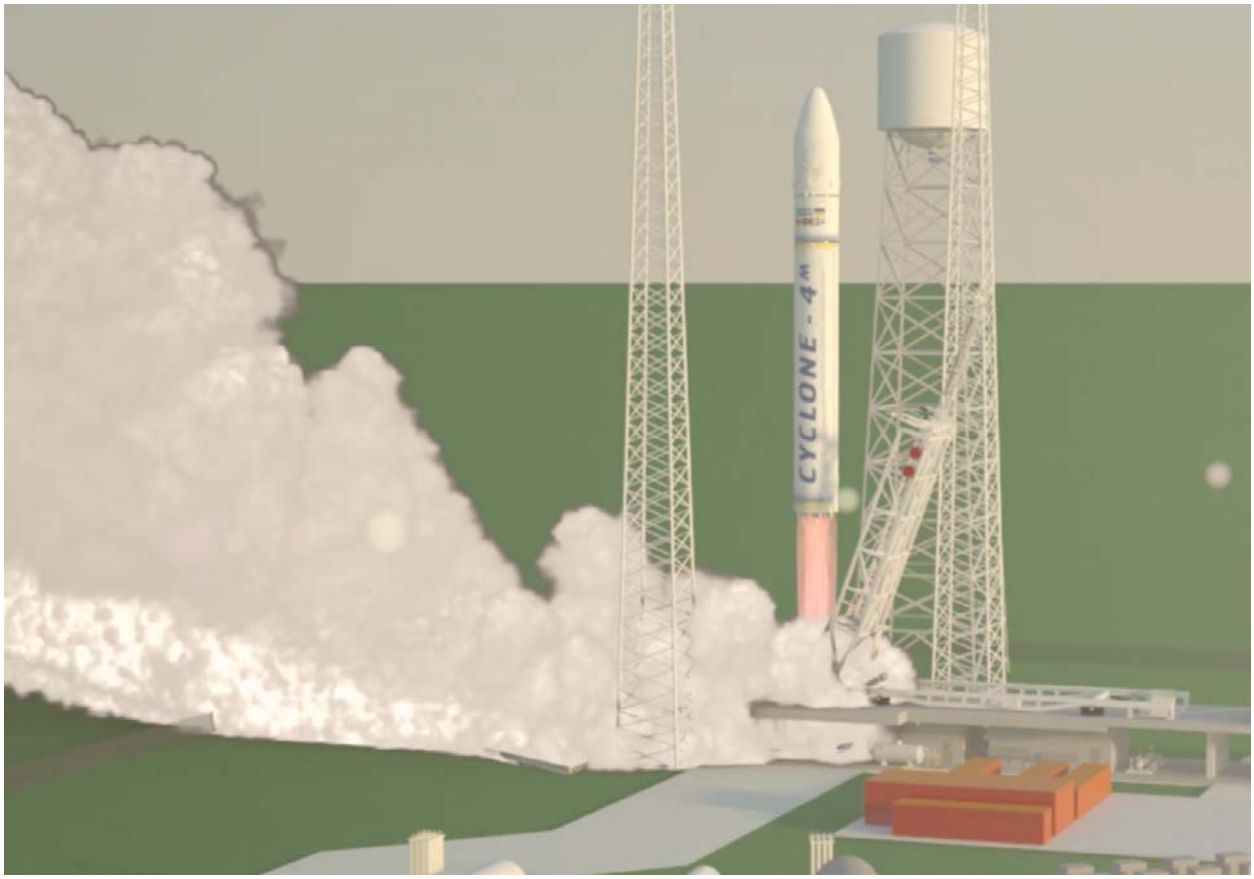


Figure 5.1: Rendering of the First Stage of a Rocket Launch

5.1.4 Specific Mitigative and Protective Measures

Mitigative measures to minimize the environmental effects of the Project on the atmospheric environment during construction, operation, and decommissioning activities include:

- Prior to excavation activities, erosion and sedimentation control measures will be deployed and assessed on a regular basis;
- All soils removed during the excavation phase will be stored according to provincial regulations and best practice guidelines;
- Exposed soils and stockpiles capable of producing particular matter will be covered;

- Where required, dust will be controlled using water or an approved dust suppressant;
- Unpaved road surfaces will be monitored during dry periods to ensure dust control is timely and effective;
- Engine idling and driving speeds will be restricted;
- All vehicles and construction equipment will be kept in good working order, and will be properly muffled;
- An ESCP will be developed as part of a site-specific EPP which will address the storage of stockpiled material;
- Implementation of the EPP, including the ESCP, spill prevention plan, and contingency plans (as necessary) will be implemented prior to construction;
- Control public access at and around the launch site prior to launch;
- Complete rocket plume emissions modeling once rocket design details are further defined;
- Provide outputs of modeling to regulatory agencies for review; and
- Adjust launch go-no go criteria based on results of the rocket plume emissions modeling.

5.1.5 Potential Residual Effects

An analysis of the residual effects on the atmospheric environment is provided in Table 5.4. It is anticipated that with the implementation of the recommended mitigation measures, Project activities will not have significant residual effects on the atmospheric environment.

Table 5.4: Determination of Residual Effects to the Atmospheric Environment

VEC	Potential Effect	Significance Criteria	Residual Effects	Significance of Residual Effects
Atmospheric Environment	Disruption in subsurface soils due to excavation (construction)	Scope: Local Duration: Short-term Frequency: Once Magnitude: Low	No	N/A
	Release of particulate matter (construction, operation)	Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Low	No	N/A
	Release of tailpipe exhaust emissions (construction, operation)	Scope: Local Duration: Short-term Frequency: Once Magnitude: Low	No	N/A
	Release of rocket exhaust emissions (operation)	Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Moderate	Yes	Low
	Accidents or Malfunctions resulting in unexpected emissions (construction, operation)	Scope: Local Duration: Short-term Frequency: Once Magnitude: Moderate	No	N/A

5.1.6 Recommended Monitoring and Follow-up

Air quality monitoring should be conducted during construction and while the Project is operational to ensure the Project maintains air quality standards outlined by both the provincial and federal governments.

An EPP, with an associated Erosion and Sedimentation Plan, should be developed for the site. Additional mitigative measures will be developed as necessary.

5.2 Acoustic Environment

5.2.1 Baseline Sound Monitoring

The proposed Project will be constructed in an undeveloped area where the acoustic environment is largely dominated by wind and rustling vegetation. Adjacent sources of sound include noise generated from the Sable Wind Farm turbines, waves crashing along the shoreline, and the occasional motor boat engine.

The standard measure of sound is in decibels (dB), weighted to the A-scale (dBA) to correspond with the human hearing range. Because sounds in the outdoor environment tend not to be continuous, averaging sound levels over an extended period of time (e.g. 1 hour – several days) is common practice. For the purposes of this report, L_{eq} is the time-averaged sound energy level, L_{50} is the median sound level, and L_{90} is the sound level exceeded 90 percent of the time (considered to be the background sound level).

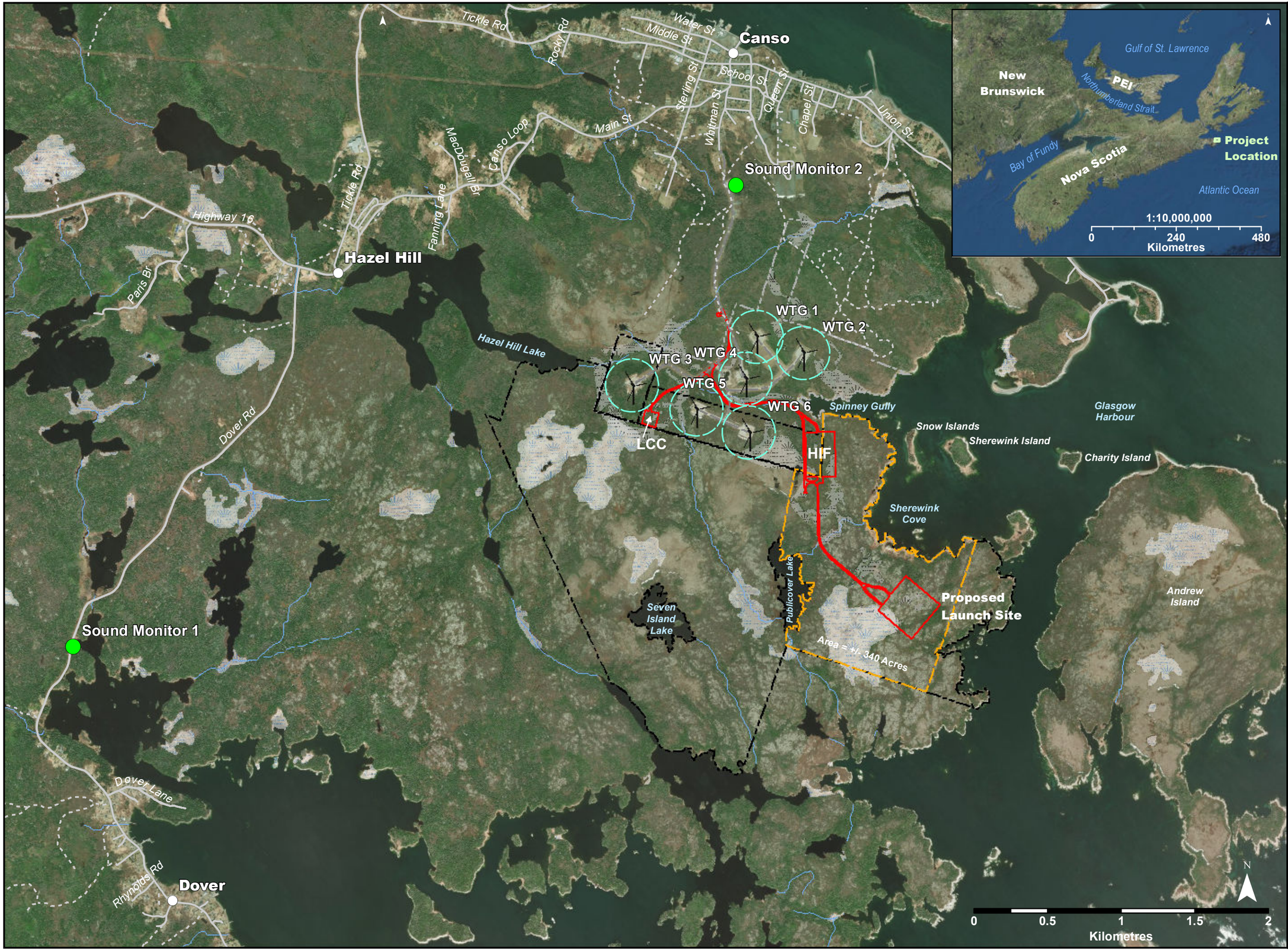
MODG has established the following criteria as acceptable noise levels in order to protect the health and welfare, as well as to maintain the peace and tranquility of the residences of the Municipality (MODG 2016):

$L_{eq} \leq 65$ dBA between 0600 to 2300 hours
$L_{eq} \leq 55$ dBA between 2300 to 0600 hours

Strum completed baseline sound monitoring throughout all seasons of 2017 with the purpose of assessing the baseline sound levels near the proposed Project site. During each assessment, sound level meters with data logging capabilities were deployed at two locations; one near the community of Little Dover and one near the community of Canso, for a minimum of two days (Table 5.5, Drawing 5.1).

Table 5.5: Sound Monitoring Locations, Deployment Dates and Run Times

Monitoring Location	Monitor Coordinates	Distance to Nearest Community	Deployment Dates	Run Time (d:hh:mm)
Sound Monitor Location #1 (near Little Dover)	45°18'08.09"N 63°03'16.99"W	1,870 m NW	May 23-26 July 12-14 October 19-24 December 14-19	2:21:37 2:01:02 5:00:58 4:23:23
Sound Monitor Location #2 (near Canso)	45°19'45.87"N 60°59'46.80"W	910 m S	May 16-23 July 12-14 October 19-24 December 14-19	2:20:19 2:00:02 5:01:01 4:23:09



Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Basemap: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.
3. Projection: NAD83(CSRS), UTM Zone 20 North.
4. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Sound Monitor Locations
- Place Names
- Existing Turbine Access Road
- Public Roads
- Access Roads / Trails

Project Location

- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Field Identified Wetland
- Mapped Wet Area

Maritime Launch Services - Sound Monitor Locations

MLS
Maritime Launch Services Ltd

Strum CONSULTING
*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:24,000	Drawing #: **5.1**
Drawn By: M. Marriott	
Checked By: S. Dickey	

The results show that the background sound levels (L_{90}), mean sound levels (L_{eq}) and median sound levels (L_{50}) near Little Dover were, on average, slightly lower than those near Canso; all of which did not exceed the noise limits set by MODG (Table 5.6). The discrepancy between sound levels is unclear; however, it is speculated that Sound Monitor #2 may have recorded slightly higher levels of sound due to its closer proximity to the Sable Wind Farm and the community of Canso (approximately 1 km closer than that of Sound Monitor #1 to the community of Little Dover) (Table 5.5). Regardless of the influence that the wind farm may have on the acoustic environment of the area, the baseline sound levels recorded are typical for a rural area at both locations.

Table 5.6: 2017 Sound Monitoring Results

Monitoring Period	Sound Monitor #1 Sound Level (dBA)			Sound Monitor #2 Sound Level (dBA)		
2017	**L_{eq}**	**L_{90}**	**L_{50}**	**L_{eq}**	**L_{90}**	**L_{50}**
May 23-26	47.4	43.8	44.7	51.9	47.0	48.1
July 12-14	39.1	22.3	25.6	46.5	45.5	45.5
October 19-24	46.0	45.2	45.2	47.2	45.2	45.2
December 14-19	47.2	45.2	45.2	46.4	44.2	44.2
Average	**44.9**	**39.1**	**40.2**	**48.0**	**45.5**	**45.8**

5.2.2 Launch Vehicle Noise and Sonic Boom Modelling

A Launch Noise Study was completed by Blue Ridge Research and Consulting and is provided in Appendix C. The potential for LV noise and sonic boom impacts is evaluated on a single-event and cumulative basis in relation to human annoyance, hearing conservation, and structural damage criteria. For a detailed acoustics overview and analysis methodology please refer to the full report provided in Appendix C. A summary of the results is provided below.

Single Event Results

Launch Vehicle Noise

The maximum A-weighted sound level ($L_{a,max}$) indicates the maximum sound level achieved over the duration of the event. An upper limit noise level of 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of noise-induced hearing loss. At a sound level of 115 dBA, the allowable exposure duration is 28 seconds for Canadian Center for Occupational Health and Safety (CCOHS) in Nova Scotia. Predicted noise levels for a single launch event at the Project site are less than the 115 dBA upper noise limit guideline at distances greater than 1.1 km of the launch pad, as shown by the central, red contour in Figure 5.2.

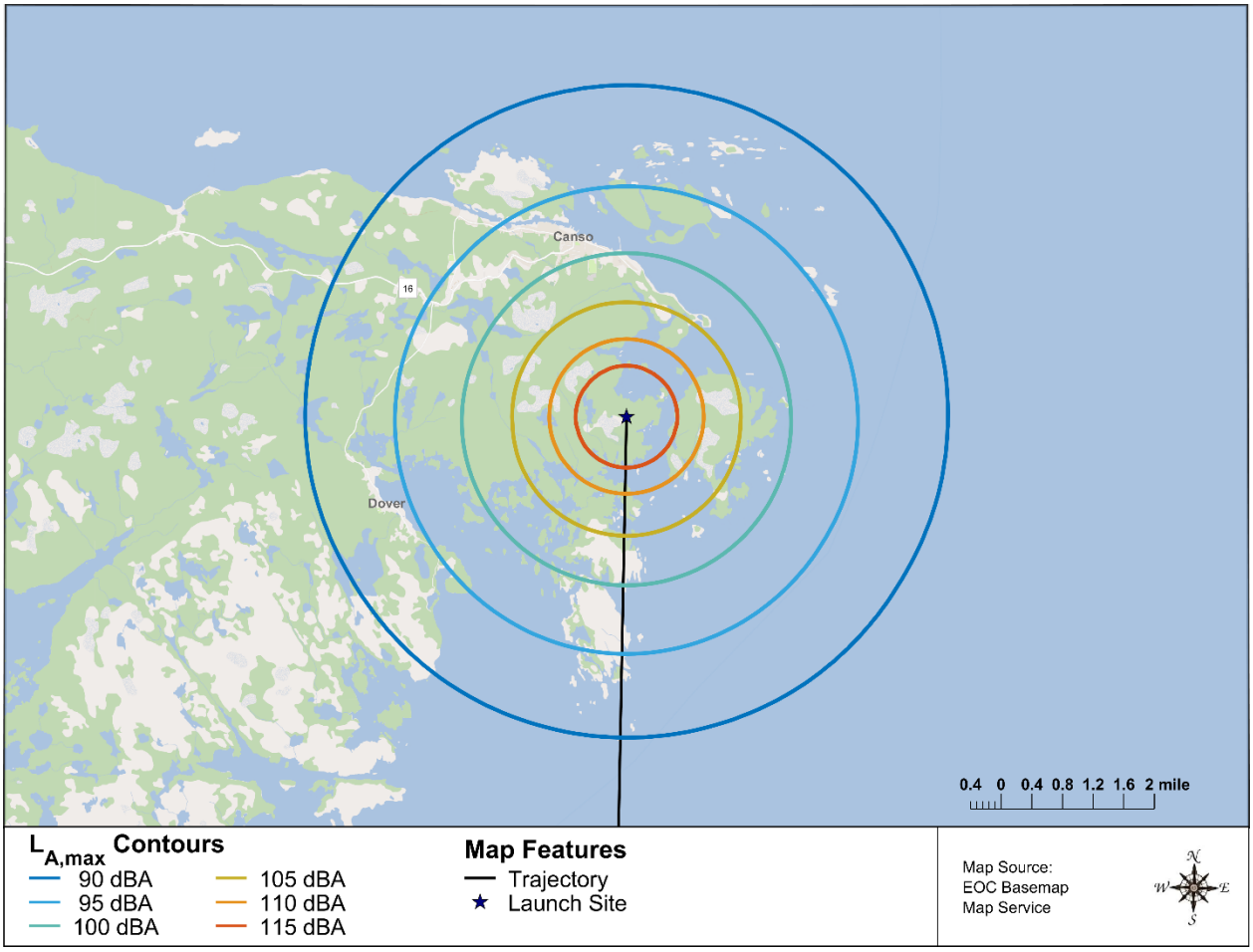


Figure 5.2: $L_{A,max}$ Contours Generated by Launch Event

A technical memorandum issued by NASA in 1972 found a relationship between structural damage claims and overall sound pressure level, where "the probability of structural damage [was] proportional to the intensity of the low frequency sound" (Guest and Sloan Jr. in BRRC 2017). Based on this relationship, it is estimated that one damage claim in 100 households exposed is expected at an average continuous sound level of 120 dB, and one in 1,000 households at 111 dB. Figure 5.3 shows the 111 dB and 120 dB L_{max} contours generated by a single launch event at the Project site. The communities of Canso and Little Dover fall within the 111 db contour, where it can be predicted that one in 1,000 households will make a damage claim. In Canso, a few properties along Union Street (and possibly Wilmot Street) fall within the 120 db contour, where it can be predicted that one in 100 households will make a damage claim.

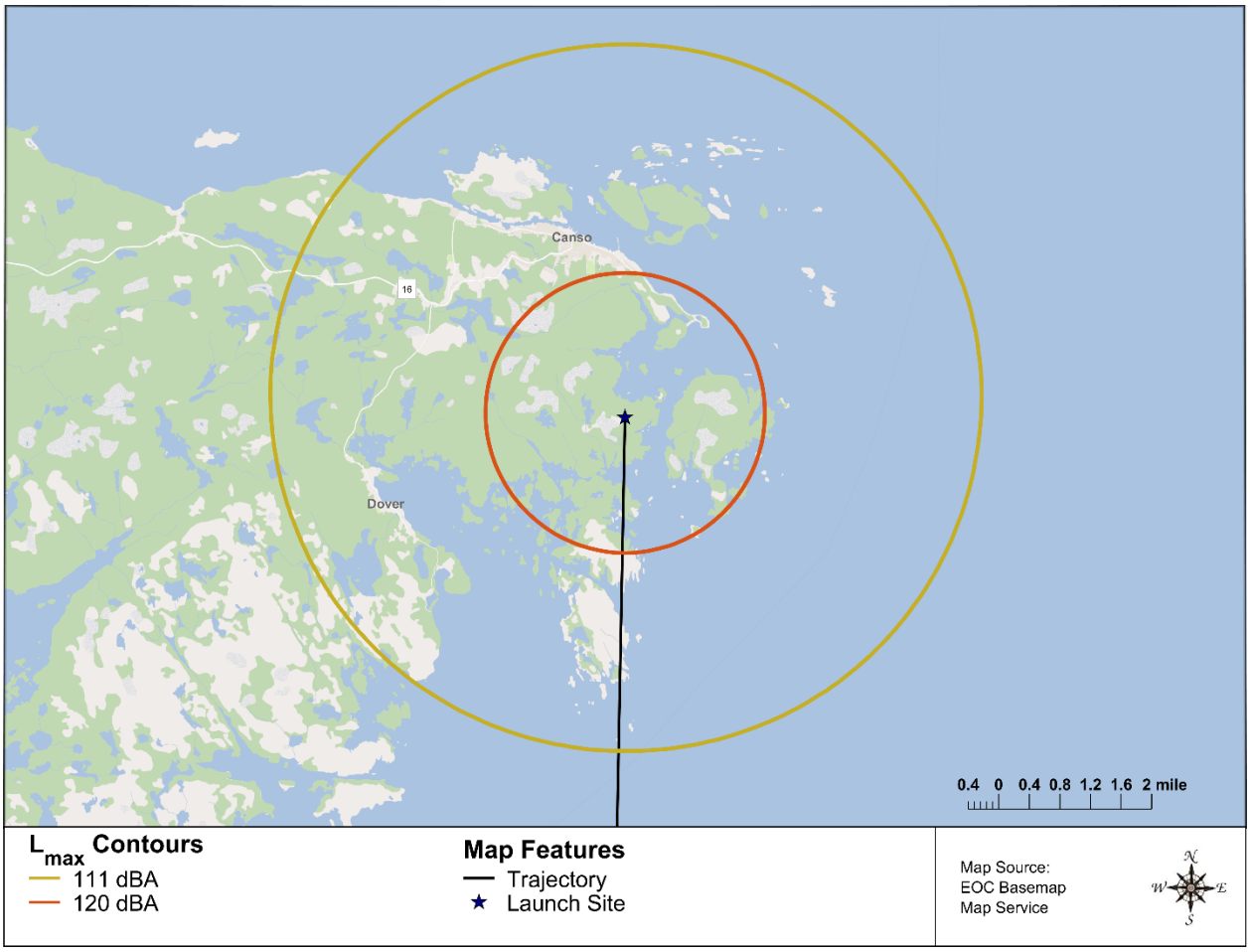


Figure 5.3: 111 dB and 120 dB L_{max} Contours Generated by Launch Event

Sonic Booms

According to BRRC (2017), "When a vehicle moves through the air, it pushes the air out of its way. At subsonic speeds, the displaced air forms a pressure wave that disperses rapidly. At supersonic speeds, the vehicle is moving too quickly for the wave to disperse, so it remains as a coherent wave. This wave is a sonic boom." The conformation of a sonic boom depends on the size, weight, shape, speed, and trajectory of the vehicle. For rocket trajectories, the boom is directed laterally until the rocket rotates significantly away from is vertical ascent, causing the sonic boom to propagate much further downrange and in relatively lower sonic boom levels when compared to sonic booms generated by aircraft. At the Project launch site, based on an approximate launch trajectory of 181° relative to true North, the sonic boom will propagate 60 km from the launch site, over the Atlantic Ocean (Figure 5.4), with a maximum overpressure of 6.9 psf (too small to be shown in Figure 5.4). The sonic boom is not predicted to intercept the mainland, and therefore, is not expected to cause structural damage or temporary hearing impairment.

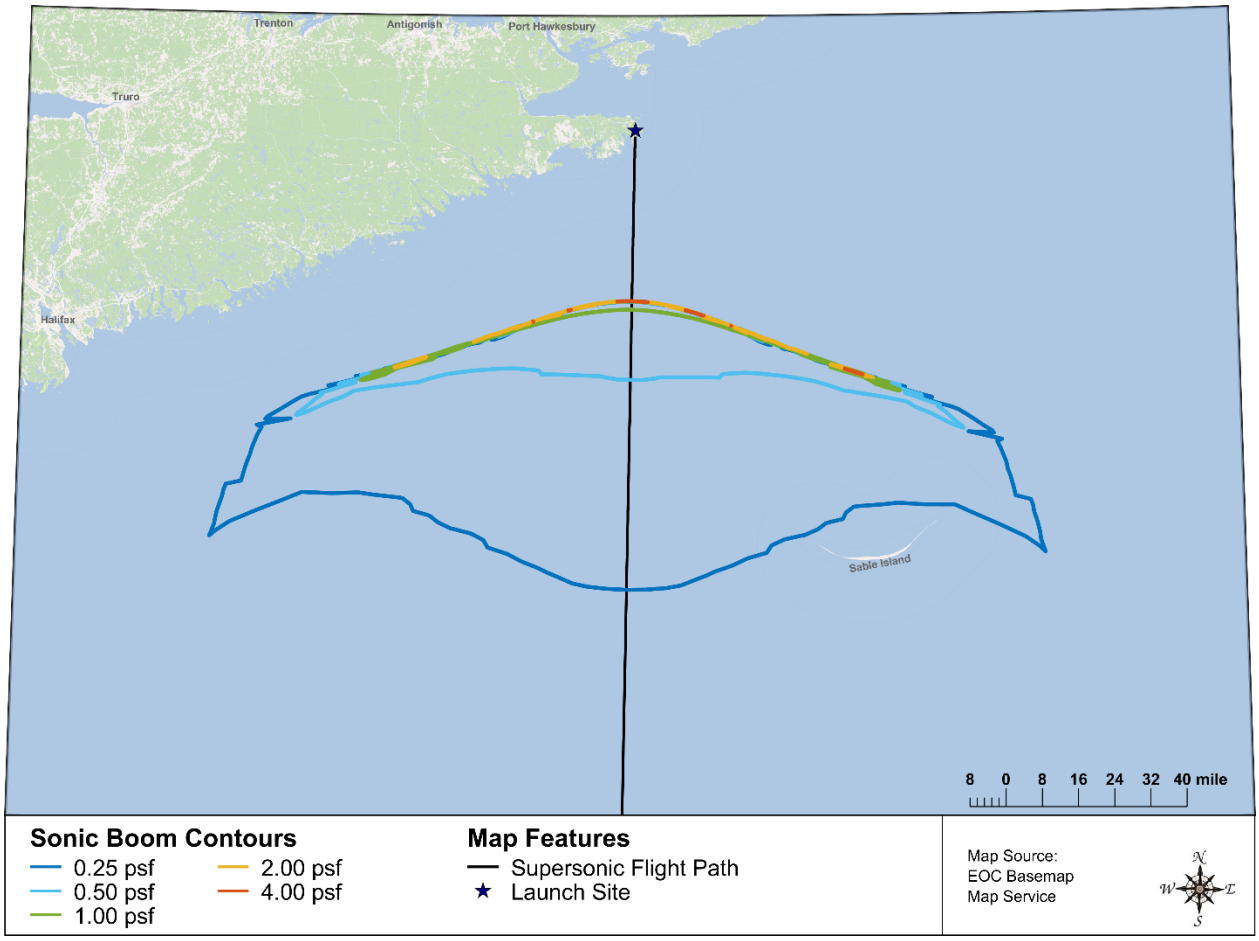


Figure 5.4: Sonic Boom Contours Generated by a Launch Event

Cumulative Noise Results

There are currently no regulations on how to evaluate the potential impacts of rocket noise, so the guidelines for the development of new aerodromes have been adopted for this purpose of this report. The Noise Exposure Forecast (NEF) is a metric based on the perceived noise level and effective perceived noise level, and is used to predict a community's response to a long-term noise environment. Transport Canada has developed a 'Community Response Prediction' table based on the analysis of noise complaints associated with 12 aerodromes, which is used to predict the level of annoyance experienced by humans within NEF areas (Table 5.7).

Table 5.7: Community Response Prediction

Response Area	Response Prediction
1 (> 40 NEF)	Repeated and vigorous individual complaints are likely. Concerted group and legal action might be expected.
2 (35 - 40 NEF)	Individual complaints may be vigorous. Possible group action and appeals to authorities.
3 (30 - 35 NEF)	Sporadic to repeated individual complaints. Group action is possible.
4 (< 30 NEF)	Sporadic complaints may occur. Noise may interfere occasionally with certain activities of the resident.

Source: Transport Canada 2017

Transport Canada (2017) recommends that below 25 NEF, all noise sensitive land uses are permissible without restrictions or limitations. Above 25 NEF, no new noise sensitive land uses (i.e. residential, schools, day care centers, nursing homes, and hospitals) are permitted. The NEF contours in Figure 5.5 show that there are no known permanent residences between the launch site and the 30 NEF contour, an area with a radius of 1.6 km around the launch site of low value for noise sensitive land uses mentioned above (refer to Section 6.2 for more details). The communities of Canso and Little Dover are beyond the 25 NEF contour, where only sporadic complaints are predicted based on Table 5.7.

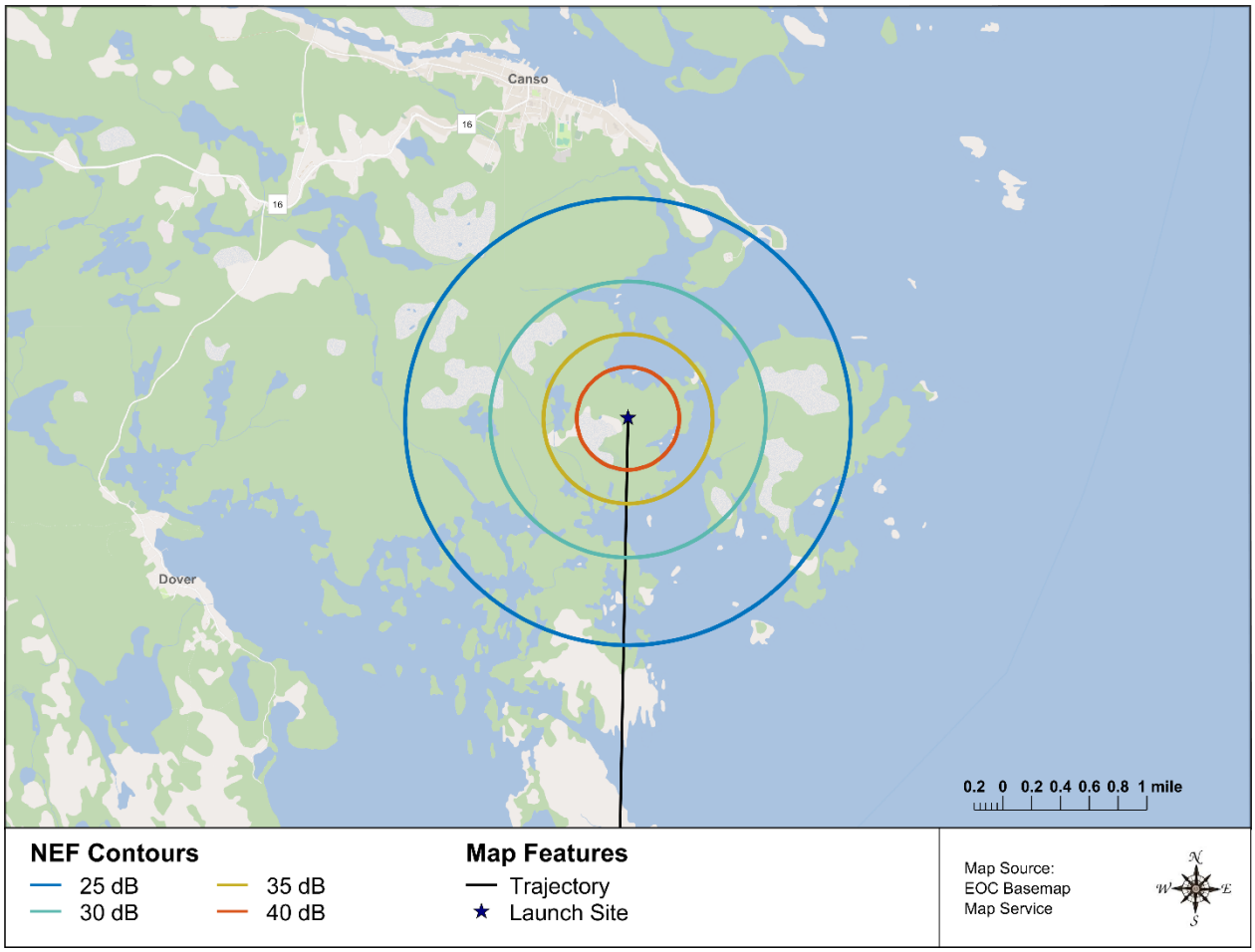


Figure 5.5: Noise Exposure Forecast (NEF)

5.2.3 Potential Interactions and Effects

The proposed Project may adversely impact the acoustic environment during construction, operation and decommissioning. Potential impacts include:

- Increased noise during construction and decommissioning phase;
- Increased noise during launch events;
- Annoyance and hearing impairment for local residents during launch event; and
- Structural damage associated with sonic booms during a launch event.

To provide more detail on potential impacts, two specific points of interest were selected for a more detailed analysis (Figure 5.6):

- The Canso Site located south of Canso at the end of Whitman Street along the east side of the road leading to the wind turbines, and
- The Little Dover Site located north of Little Dover along Dover Road on the west side of Dover Basin.

Figure 5.6: Specific Point Analysis

The results of the specific point analysis are presented in Table 5.8 and include the NEF, time above (TA) 66 dBA, $L_{A,max}$, and L_{max} received at the Canso and Little Dover sites from the launch of a medium class LV. The maximum sound level is expected to last for less than a second, based on the thrust profile, peak directivity angle, and distance between the source and the receiver used in this model. At the two specific points, the NEF levels are less than 30 (associated with sporadic community complaints), the TA 66 dBA (associated with not being able to understand/hear 95% of outdoor speech at 1 m) is expected to last less than two minutes, the $L_{A,max}$ values are less than the 115 dBA upper limit noise level associated with protecting human hearing, the L_{max} values are between 111 and 120 dB, which is associated with a potential risk of generating structural damage claims at a rate between one per 1,000 households and one per 100 households, respectively.

Table 5.8: Specific Point Noise Analysis Results (Table 5-1 in BRRC 2017)

Name	Location	NEF	TA 66 dBA	L_{Amax}	L_{max}
Canso	45.329133°N 60.996417°W	22 NEF	~90 seconds	102 dBA	120 dB
Little Dover	45.300276°N 61.055549°W	15 NEF	~110 seconds	92 dBA	114 dB

5.2.4 Specific Mitigative and Protective Measures

Mitigative measures to minimize the environmental effects of the Project on the acoustic environment during construction, operation, and decommissioning activities include:

- Equipment to be maintained in good working order and be properly muffled;
- Engine idling will be restricted;
- Noise control measures (e.g., sound barriers, shrouds, enclosures) will be used where warranted;
- Residents of nearby communities will be notified prior to any blasting activities;
- Residents of nearby communities will be notified prior to any launch activities;
- Implementation of the EPP, including the sound level monitoring (if required) and complaint response (as necessary).

5.2.5 Potential Residual Effects

An analysis of the residual effects on the acoustic environment is provided in Table 5.9. It is anticipated that with the implementation of the recommended mitigation measures, Project activities will not have significant residual effects on the acoustic environment.

Table 5.9: Determination of Residual Effects to the Acoustic Environment

VEC	Potential Effect	Significance Criteria	Residual Effects	Significance of Residual Effects
Acoustic Environment	Increased noise during construction activities (construction)	Scope: Local Duration: Short-term Frequency: Once Magnitude: Low	No	N/A
	Increased noise during launch events (operation)	Scope: Regional Duration: Short-term Frequency: Intermittent Magnitude: Low	Yes	Low
	Annoyance and hearing impairment for local residents during launch events (operation)	Scope: Regional Duration: Short-term Frequency: Intermittent Magnitude: Low	Yes	Low
	Structural damage associated with sonic booms during launch event (operation)	Scope: Regional Duration: Short-term Frequency: Intermittent Magnitude: Low	Yes	Low

5.2.6 Recommended Monitoring and Follow-up

An EPP, with a Sound Monitoring Plan, should be developed for the site. Additional mitigative measures will be developed as necessary.

Ongoing communication with the community and local fisheries organizations will be maintained throughout the Project life.

5.3 Geologic Environment

5.3.1 Geology

Physiography and Topography

The Project site lies within the Eastern Shore Ecodistrict of the Atlantic Coastal Ecoregion (Neily *et al.* 2005). This ecodistrict extends from the Halifax peninsula in the west to the Town of Canso in the east. Topography varies throughout the ecodistrict from the granite barrens of the Halifax peninsula in the west, sand beach and dunes give way to a proliferation of offshore islands, often drumlin in origin, to the coastal headlands of Guysborough County and granite barrens of the Canso peninsula. Nearly 21.6% of the ecodistrict (approximately 36,350 hectares) is comprised of exposed bedrock, the greatest of any ecodistrict (Neily *et al.* 2005).

Amongst areas of bogs/wetlands within the Project site, topography is undulating and hummocky ranging in elevation from 1 m to 20 m above sea level. Large boulders and bedrock protrude from the ground surface.

Surficial Geology

Surficial geology of the site is characterized by two different units: bedrock and silty drumlins (Drawing 5.2) (Stea *et al.* 1992). The bedrock is overlain by a silty material which is derived from both local and distant sources (Stea *et al.* 1992). This material creates a rolling topography with thicker till masking bedrock undulations. Drumlins appear throughout the site ranging from 4 – 30 m in depth (Stea *et al.* 1992).

Soils in the area are predominantly very thin or non-existent. Over the granitic bedrock, where soil cover is evident, the majority of the soils feature a well-drained sandy loam, interspersed with areas of bog habitat (Stea *et al.* 1992).

Bedrock Geology

The majority of the Project site is underlain by Middle-Late Devonian muscovite biotite monzogranite with the exception of the northern 150 m section of access road and a 200 m portion of road leading towards the HIF, which are underlain by the Goldenville Formation bedrock of the Meguma Group (Keppie 2000) (Drawing 5.3).

The geotechnical investigation completed as part of the Sable Wind Project revealed fair to good quality monzogranite bedrock beneath either a rootmat/topsoil layer or a thin zone of highly weathered (friable) bedrock. Groundwater levels measured as part of the December 2013 assessment were within 0.6 m of the ground surface (Stantec 2014).

N

PID 35204023
Crown Land

Hazel Hill Lake

PID 35204031
Crown Land

PID 35096320
Crown Land

Seven Island Lake

Publicover Lake

Spinney Gully

Glasdow Harbour

Snows Island

Sherewink Island

Sherewink Cove

0 200 400 600 800 1,000
Metres

Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area
- Water Bodies

Surficial Geology By Unit

- Bedrock
- Organic Deposits
- Silty Drumlin

Canso Launch Site - Surficial Geology

MLS Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:12,500	Drawing #: 5.2
Drawn By: M. Marriott	
Checked By: S. Duncan	

N

PID 35204023
Crown Land

Hazel Hill Lake

PID 35204031
Crown Land

PID 35096320
Crown Land

Seven Island Lake

Publicover Lake

Spinney Gully

Sherewink Cove

Snows Island

Sherewink Island

Glasdow Harbour

0 200 400 600 800 1,000
Metres

Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area
- Water Bodies

Bedrock Geology By Formation

- Goldenville Formation
- Middle - Late Devonian muscovite biotite monzogranite

Canso Launch Site - Bedrock Geology

MLS Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:12,500	Drawing #: **5.3**
Drawn By: M. Marriott	
Checked By: S. Duncan	

According to the NSE Well Log Database (NSE 2017b), there are no drilled wells identified within 1 km of the Project site. The closest drilled well is situated approximately 1.5 km northwest of the site in Hazel Hill. Within a 2.5 km radius of the site, a total of 26 drilled wells were identified, ranging in depths from 18.3 to 95.9 m. The majority of wells were drilled through granite (18) and quartzite (4) bedrock. Surficial material consisted of a mix of clay, boulders, sand, and gravel ranging from 0.6 to 56 m in thickness.

Bedrock containing sulphide bearing minerals (e.g., pyrite, pyrrhotite) can potentially generate acid run-off if fresh surfaces are exposed to oxygen and water. The physical disruption of such bedrock leads to oxidation of iron-sulphide minerals and the generation of acid rock drainage (ARD) (Fox *et al*. 1997). Construction activities in the presence of ARD can result in the acidification of surface and groundwater and promote the mobilization and leaching of toxic contaminants into the environment, including heavy metals. Sulphides occur in trace amounts throughout all granite rock units but concentrate locally near the contact with the sulphide-rich Meguma Group (Poulson *et al.* 1991; Samson and Clarke 2005). The only portion of the Meguma Group which is mapped within the Project site is at the northern extent of the existing access road. Therefore, impacts associated with ARD are not expected to occur however the likelihood of ARD will be determined following the results of the geotechnical evaluation.

Granitic regions in general are prone to higher levels of uranium in the subsurface that, when broken down naturally, form the radioactive gas, radon. When released to outdoor air, radon is diluted and is not a concern; however, in enclosed spaces the gas can sometimes accumulate to high levels (NSE 2009). Health Canada has established a guideline limit of 200 Bq/m^3 for the average annual radon level in the normal occupancy area of a building. In 2013, the Nova Scotia Department of Natural Resources (NSDNR) published updated mapping showing the potential for radon in indoor air in Nova Scotia. A section of the map details areas of the province designated as having high, moderate, and low potential to have indoor air concentrations that exceed Health Canada radon guidelines (GC 2017b). Based on the updated NSDNR mapping, the Project site is located in an area with “medium to high potential” to exceed the Health Canada Guideline of 200 Bq/m^3 for radon in air. According to the mapping, this is “based on the common presence of homes exceeding the Health Canada guideline for radon as well as having a bedrock known to contain occurrences of uranium and elevated levels of uranium and radon in groundwater”. However, radon guidelines are based on health risks for residential homes and public institutions (hospitals, retirement homes, penitentiaries, etc.) where occupants may spend up to 24 hours per day, 7 days per week inside the building. Land use at the facility will be designated as commercial, and therefore site buildings are expected to be occupied only up to 8 hours per day. As such, occupants of the buildings would not be expected to be subject to residential level exposures, and therefore the risk from radon gas exposure is significantly less.

5.3.2 Hydrogeology and Groundwater

Groundwater Quantity

The Wilkins Lake Watershed has been the sole source of drinking water for customers of the Canso Water Utility since 1965. Wilkins Lake has a water surface area of 83 acres with the total watershed area consisting of 368 acres. The utility serves 450 customers in the Town of Canso and in the

communities of Tickle and Hazel Hill. Wilkins Lake is located five miles outside the Town of Canso in the community of Fox Island and is situated along Highway 16.

Several individually drilled wells were also located within the area, including 12 drilled well records from the Hazel Hill area (approximately 1.5 km north/northwest of the Project) and 15 drilled well records from the Town of Canso (2.2 km north of the Project). A summary of the pertinent well properties (within 2.5 km of the Project site) included in the NSE Well Log Database (NSE 2017b) is presented in Table 5.10.

Table 5.10: Summary of Drilled Well Records

	Drilled Date (yr)	Well Depth (m)	Casing Length (m)	Estimated Yield (Lpm)	Water Level (m)	Overburden Thickness (m)	Water Bearing Fractures (m)
Minimum	1951	18.3	1.5	0.91	0.03	0.61	7.3
Maximum	1996	95.9	26.8	158.9	36.5	56	70.1
Average	1975	53.3	11.4	21.7	8.7	12.6	25.3
Number of well records	26	26	26	23	23	24	13

Source: NSE 2017b

Based on short term driller's estimates for the wells in Table 5.10, the average yield is approximately 21.7 Lpm (5.7 gpm) and average well depth is approximately 53.3 m (174.8 ft). These measurements represent very short-term yields estimated by the driller at the completion of well construction. Fracture depths ranged from 7.3 m (23.9 ft) to 70.1 m (229.9 ft).

The NSDNR Pump Test Database (NSDNR 2014) provides longer term yields for select wells throughout the province. One regional well, drilled through the Goldenville formation located within 8 km of the Project site, indicates a long term safe yield (Q_{20}) of 29.5 Lpm (7.8 gpm) and an apparent transmissivity of 2.5 m^2/day.

NSE maintains the Nova Scotia Groundwater Observation Well Network (NSE 2015b). The nearest observation well to the Project site is located approximately 58 km northwest, near Monastery, Antigonish County. This well was drilled to a depth of 158 m through sandstone bedrock of the Canso Group. The well was installed in 1974 as part of a groundwater resource evaluation study. A 50-hour pumping test was conducted at this well in 1974, indicating a transmissivity of 9.8 m^2/day and a 20-year safe yield of 439 m^3/day (67 igpm). In 2014, the average water elevation was 13.12 m above sea level and the annual water level fluctuation was 1.2 m.

Groundwater Quality

Groundwater within bedrock of the Goldenville formation tends to have a low degree of total dissolved solids (TDS), elevated manganese content, and is slightly hard and alkaline (The Canada-Nova Scotia Strait of Canso Environment Committee 1975).

Groundwater in contact with granitic rocks tends to have higher alkalinity, hardness, and TDS than the metamorphic rocks (Trescott 1968). Elevated concentrations of metals such as arsenic also

occur in some instances, associated with sulphides and base metal mineralization. Groundwater from drilled wells in granitic rocks is also at a risk of being contaminated with radioelements (e.g., radium, uranium, radon, and lead-210). Based on a review of local surficial and bedrock geology, and in consideration of anticipated site use and development associated with the Project, the likelihood of encountering bedrock mineralogy that would be harmful to human health or the environment is low.

Facility Water Supply

A 75 m high water tower will be installed at the VLA containing at least 950,000 L of water. During a launch the water tower will discharge up to 375,000 L of water for the C4M, half of which will vaporize and the remainder will be contained in a retention basin beneath the pad. This water will be sampled and analyzed to determine if the water contains controlled contaminants at levels that exceed water quality standards. Appropriate sampling protocols and water quality criteria will be developed in coordination with NSE. Contaminated water will be removed and hauled to an approved industrial wastewater treatment facility outside of the VLA. Water which does not exceed guidelines will be pumped back to the water tower.

Potable water will either be delivered by truck to the water tower or withdrawn from a local source (i.e., well or lake) as approved by provincial authorities.

5.3.3 Potential Interactions and Effects

The proposed Project may adversely impact the geologic environment during construction, operation, and decommissioning. Potential impacts include:

- Localized disturbances to surface soils and bedrock;
- Soil erosion and sedimentation of wetlands and/or watercourses;
- Deposition of particulates on soils near the launch pad;
- Effects of launch induced fires on soil characteristics;
- Impacts to shallow groundwater caused by launch failure; and
- Accidental release of deleterious substances (e.g. petroleum hydrocarbons, liquid propellants etc.).

Disturbance to surface soils and shallow bedrock from ground stripping, excavation, and heavy machinery during construction is expected to be localized in the areas of access roads and facility infrastructure construction. Mobilization of soils by wind or water may be transported to nearby wetlands/watercourses.

During launch events the potential for deposition of emission particulates could occur, however the launch pad will be constructed from concrete and would protect the underlying bedrock from the launch. Outside of the launch pad area soils contain a substantial amount of organic matter which creates a natural buffering capacity. Similar facilities have reported the deposition of metals immediately surrounding the launch pad and in the case of a launch failure in the immediate vicinity of the pad, could also result in petroleum products (derived from the first stag RP-1 fuel) or perchlorate (derived from the second stage ammonium perchlorate oxidizer) within the upper meter of soil.

The potential for launch-induced fires on site soils could result in increased soil temperature due to loss of vegetation and darkened soil coloring, increased pH, increased water repellence, reduced organic matter content, and an increased availability of soil nutrients.

Site infrastructure is located greater than 1.5 km from any likely domestic well location. While large scale blasting is not anticipated to occur, the potential for short term, localized blasting may arise during construction throughout the site. Impacts to shallow groundwater quality may arise should a launch failure occur in the immediate vicinity of the pad. Drinking water surrounding the site is largely supplied by a Designated Protected Water Area, with the occasional drilled well into deep bedrock.

The potential for accidental spills on the site exists during construction activities, though should be mitigated through adherence to the EPP. Processing activities would take place within closed structures, and precautions would be taken to prevent spills and control hazardous materials in accordance with facility operating plans. Spills of liquid propellants would be controlled through catchment systems and holding tanks in the processing facilities and would not impact surrounding soils or land resources.

Propellant spills could occur during propellant transfer to or from the processing facility or during spacecraft transport to the launch pad. Propellant spills onto soils occur as a result of spacecraft impact following a launch failure. Emergency response personnel would mitigate the impact of any spill. Spilled propellant would be collected and disposed of by a certified disposal contractor. Contaminated soils would be removed and treated as hazardous waste in accordance with municipal, provincial, and federal regulations. Short-term impacts on localized soils may result, but long-term impacts would not be substantial.

5.3.4 Specific Mitigative and Protection Measures

Mitigative measures to minimize the environmental effects of the Project on the geologic environment include:

- Development and implementation of an EPP for all phases of construction that will include specific sediment and erosion controls as well as provisions for the inspection and monitoring of erosion and sedimentation controls, handling of petroleum products and environmental protection measures. The EPP will be approved by NSE prior to the start of construction;
- Following results of the geotechnical assessment, the potential for environmental issues relating to ARD will be assessed if future disturbance or exposure of bedrock is anticipated. Any issues related to ARD will be completed in accordance with the NSE Sulphide Bearing Material Disposal Regulations (NSE 1995);
- A site specific ESCP will be completed for the Project to prevent soil erosion and sedimentation of wetlands and/or watercourses;
- Restoration of soils following the construction phase will occur;
- Pre-blast surveys will be completed (if required);
- Blasting will be conducted in accordance with provincial legislation and subject to terms and conditions of applicable permits;
- All blasts will be conducted and monitored by certified professionals;

- Testing of soils will be completed surrounding the launch pad for metals, petroleum products and percholate;
- Removal of soils exceeding applicable guidelines for disposal at a licensed facility;
- Spills of liquid propellants would be controlled through catchment systems and holding tanks in the processing facilities; and
- A spill contingency plan will be developed and included in the Project EPP.

5.3.5 Potential Residual Effects

An analysis of the residual effects on the geologic environment is provided in Table 5.11. It is anticipated that with the implementation of the recommended mitigation measures, significant adverse environmental effects on the geologic environment and groundwater are not likely to occur. The activities associated with construction and decommissioning of the facility will have limited to no interaction with the geologic environment. Launch activities may result in local, short term effects to

Table 5.11: Determination of Residual Effects to the Geologic Environment

VEC	Potential Effect	Significance Criteria	Residual Effects	Significance of Residual Effects
Geologic Environment	Disruption in subsurface soils and bedrock	Scope: Local Duration: Short-term Frequency: Once Magnitude: Low	No	N/A
	Soil erosion and sedimentation	Scope: Local Duration: Short-term Frequency: Once Magnitude: Low	No	N/A
	Deposition of particulates on soils near the launch pad	Scope: Local Duration: Intermittent Frequency: Once Magnitude: Low	Yes	Minimal/None
	Impacts to soil characteristics from launch induced fires	Scope: Local Duration: Intermittent Frequency: Once Magnitude: Low	Yes	Minimal/None
	Accidental release of deleterious substances	Scope: Local Duration: Short-term Frequency: Once Magnitude: Low	No	N/A

Significant adverse environmental effects are not likely to occur. No further assessment required.

5.3.6 Recommended Monitoring and Follow-up

An EPP and ESCP will be developed and approved by NSE prior to start of construction of the Project.

5.4 Freshwater Environment

5.4.1 Waterbodies and Watercourses

The Project site is located in the Shore Direct Secondary Watershed in the New Harbour/Salmon River Primary Watershed. The secondary watershed is a 30.8 km^2 area that flows directly into the Atlantic Ocean. There are 17 lakes within the secondary watershed (Table 5.12). The largest of which is Hazel Hill Lake located 0.15 km east of the proposed Project's access road. Publicover Lake and Seven Island Lake are located 0.37 km and 1.1 km, respectively, south of the transportation route (Drawing 1.3).

Table 5.12: Lakes Located in the Shore Direct Secondary Watershed

Name	Size (ha)
Eastern Lake	14.38
Unnamed	3.03
Hazel Hill Lake	50.70
Unnamed	3.80
Whistlehouse Lake	28.00
Ice Lake	5.91
Unnamed	0.21
Mud Hole	1.53
Unnamed	0.66
Unnamed	3.22
Blowdown Lake	12.66
Lumsden Lake	6.28
Unnamed	1.65
Seven Island Lake	8.80
Publicover Lake	8.30
Unnamed	2.11
Unnamed	0.52

Two watercourses have been identified within the Project footprint. Watercourse 1 consists of an intermittent channel, flowing from Publicover Lake into the ocean. Within the Project footprint it is a confined channel, becoming less confined as it approaches its outflow. Water depths were approximately 0.3 m with a channel width of 1.77 m. The banks were entirely vegetated with good stability and little evidence of streambank erosion. Watercourse 2 drains into Spinney Gully and consists of an intermittent channel flowing through a Black spruce grove. Water depths were 0.05 – 0.15 m and it has a channel width of 0.5 m (AMEC 2006).

5.4.2 Fish and Fish Habitat

A review of the ACCDC database for fish and aquatic invertebrate species recorded within a 100 km radius of the Project site was completed. All species, including status rankings, are provided in Table 5.13.

Table 5.13: Fish Species Recorded Within a 100 km Radius of the Project Site

Common Name	Scientific Name	SARA Status[1]	COSEWIC Status[2]	NSESA Status[3]	NS GS-Rank[4]	NS S-Rank[4]
Alewife	Alosa pseudoharengus	Not Listed	Not Listed	Not Listed	Sensitive	S3
American Eel	*Anguilla rostrate*	No Status	Threatened	Not Listed	Secure	S2
Atlantic Salmon - Eastern Cape Breton Population	*Salmo salar pop. 4*	No Status	Endangered	Not Listed	N/A	S1
Atlantic Sturgeon	*Acipenser oxyrhynchus*	No Status	Threatened	Not Listed	May Be At Risk	S2
Brook Floater	*Alasmidonta varicosa*	Special Concern	Special Concern	Threatened	Sensitive	S1S2
Brook Trout	*Salvelinus fontinalis*	Not Listed	Not Listed	Not Listed	Sensitive	S3
Eastern Pearlshell	*Margaritifera margaritifera*	Not Listed	Not Listed	Not Listed	Sensitive	S2
Eastern Lampmussel	*Lampsilis radiata*	Not Listed	Not Listed	Not Listed	Sensitive	S3S4
Striped Bass – Bay of Fundy pop.	*Morone sacatilis pop. 2*	No Status	Endangered	Not Listed	May Be At Risk	S1B
Striped Bass – Southern Gulf of St. Lawrence pop.	*Morone sacatilis pop. 1*	No Status	Special Concern	Not Listed	May Be At Risk	S2S3N
Tidewater Mucket	*Leptodea ochracea*	Not Listed	Not Listed	Not Listed	Sensitive	S1
Triangle Floater	*Alasmidonta undulata*	Not Listed	Not Listed	Not Listed	Secure	S2S3
Yellow Lampmussel	*Lampsilis cariosa*	Special Concern	Special Concern	Threatened	At Risk	S1

Source: ACCDC 2017; [1] GC 2017A; [2]COSEWIC 2017; [3]NSDNR 2017; [4]ACCDC 2017

A list of fish species within four lakes in the Shore Direct Secondary Watershed, in the vicinity of the Project site (Table 5.14) was compiled from previous studies. The lakes consisted of Hazel Hill Lake, Ice Lake, Round Lake, and Three Mile Lake. Previous studies included:

- The Natural History of Nova Scotia (Davis and Browne 1996); and
- Description of selected lake characteristics and occurrence of fish species in 781 Nova Scotia lakes (Alexander *et al.* 1986).

Table 5.14: Fish Species Recorded in Lakes Within 10 km of the Project Site

Species Name	Scientific Name	SARA Status[1]	COSEWIC Status[2]	NSESA Status[3]	NS GS-Rank[4]	NS S-Rank[4]
American Eel	*Anguilla rostrata*	No Status	Threatened	Not Listed	Secure	S2
Banded Killifish	*Fundulus diaphanus* (Mainland pop.)	Not Listed	Not at Risk	Not Listed	Secure	S5
Brook Trout	*Salvelinus fontinalis*	Not Listed	Not Listed	Not Listed	Sensitive	S3
Brown Bullhead	*Ameiurus nebulosus*	Not Listed	Not Listed	Not Listed	Secure	S5
Common Shiner	*Luxilus cornutus*	Not Listed	Not Listed	Not Listed	Secure	S5
Golden Shiner	*Notemigonus crysoleucas*	Not Listed	Not Listed	Not Listed	Secure	S4
Rainbow Trout	*Oncorhynchus mykiss*	Not Listed	Not Listed	Not Listed	Exotic	SNA
Ninespine Stickleback	*Pungitius pungitius*	Not Listed	Not Listed	Not Listed	Secure	S5
White Sucker	*Catostomus commersonii*	Not Listed	Not Listed	Not Listed	Secure	S5
Yellow Perch	*Perca flavescens*	Not Listed	Not Listed	Not Listed	Secure	S5

Source: ACCDC 2017; [1] GC 2017A; [2]COSEWIC 2017; [3]NSDNR 2017; [4]ACCDC 2017

Fish species that have been recorded within the Shore Direct Secondary Watershed, in the vicinity of the Project site, were screened against the criteria outlined in the document “Guide to Addressing Wildlife Species and Habitat in an EA Registration Document” (NSE 2009) to develop a list of priority species (i.e., SOCI), which may be assessed further.

A fish habitat assessment was completed on Watercourse 1 to determine its propensity to provide fish habitat. The stream provides fish habitat in the form of abundant overhanging vegetation and instream woody debris, with moderate levels of undercut banks and instream vegetation. The substrate was 100 percent fines and the banks were entirely vegetated. Due to the soft substrate, the watercourse does not provide spawning habitat, nor does the shallow water provide good overwintering habitat. Water quality data was not assessed, however, assessments completed on nearby Winter Creek and tributary to Winter Creek identified a pH of 4.5 and dissolved oxygen levels between 5.4 and 7.1 mg/L (AMEC 2006). As the watercourse flows from and through bogs, it is expected that the pH will also be acidic. As most fish species have tolerances higher than this (Lacoul et al. 2011), it is unlikely that Watercourse 1 is conducive to fish presence. A fish habitat assessment has not yet been completed on Watercourse 2.

Priority fish species include:

- Alewife (*Alosa pseudoharengus*) – "S3" (ACCDC);
- American eel (*Anguilla rostrata*) – "Threatened" (COSEWIC), "S2" (ACCDC);
- Atlantic Salmon (*Salmo salar*) – "Endangered" (COSEWIC), "May be at Risk" (ACCDC), "S1" (ACCDC);
- Atlantic Sturgeon (*Acipenser oxyrinchus*) – "Threatened" (COSEWIC), "May be at Risk" (ACCDC), "S2" (ACCDC);
- Brook Floater (*Alasmidonta varicosa*) - "Threatened" (COSEWIC), "Sensitive" (ACCDC), "S1S2" (ACCDC);
- Brook Trout (*Salvelinus fontinalis*) – "Sensitive" (ACCDC), "S3" (ACCDC);
- Eastern Pearlshell (*Margaritifera margaritifera*) – "Sensitive" (ACCDC), "S2" (ACCDC);
- Eastern Lampmussel (*Lampsilis radiata*) – "Sensitive" (ACCDC), "S3S4" (ACCDC);
- Striped Bass - Bay of Fundy pop. (*Morone sacatilis pop. 2*) – "Endangered" (COSEWIC), "May be at Risk" (ACCDC), "S2S3" (ACCDC);
- Striped Bass - Southern Gulf of St. Lawrence pop. (*Morone sacatilis pop. 1*) – "Special Concern" (COSEWIC), "May be at Risk (ACCDC), "S2S3N" (ACCDC);
- Tidewater Mucket (*Leptodea ochracea*) – "Sensitive" (ACCDC), "S1" (ACCDC);
- Triangle Floater (*Alasmidonta undulata*) – "S2S3" (ACCDC); and
- Yellow Lampmussel (*Lampsilis cariosa*) – "Special Concern" (SARA), "Threatened" (NSESA), "Special Concern" (COSEWIC), "At Risk" (ACCDC), "S1" (ACCDC).

Alewife

The Alewife, also referred to as the Gaspereau, is an anadromous schooling fish. They inhabit predominantly marine waters, returning to freshwater to spawn in the spring. Spawning occurs over sandy or gravel substrate where eggs are randomly scattered (CRI 2018). Adults return to sea shortly after spawning, where young-of-the-year will remain in freshwater for the summer, migrating to the sea in late autumn (DFO 2007). Gaspereau will remain in salt water until they mature, at around age 3, when they begin migrating again. Alewife are fished commercially and are a food source for other fish species and birds. Watercourse 1 does not provide spawning habitat and therefore is unlikely to support a migratory population of Alewife. Therefore, no further consideration of effects and mitigation specific to this species has been undertaken.

American Eel

The distribution of the American eel ranges from South America to Greenland in accessible freshwater systems that are connected to the Atlantic Ocean. This species is a catadromous fish which spawns in the Sargasso Sea, and juveniles drift in ocean currents, eventually migrating inland through freshwater rivers and their tributaries. In later life stages, American eels persist in a variety of freshwater and estuarine habitats (COSEWIC 2012).

American eels are most active at night, and hide in mud, sand, and graves, and under woody debris and rocks in shallow waters during the day. Eels are extremely mobile and can access seemingly inaccessible habitats through small channels and wet grass; small eels are even capable of climbing vertical barriers. Although listed as 'Threatened' by COSEWIC, the American eel can be considered declining in some locations and be stable elsewhere, such as in Nova Scotia where it is listed by the

provincial government as 'Secure'. Potential effects of the Project on this species, as well as other freshwater species are discussed further in Section 5.4.3.

Atlantic Salmon

Atlantic salmon is an anadromous species native to the North Atlantic Ocean and coastal rivers, which undertakes long feeding migrations to the ocean as older juveniles and adults and return to freshwater streams to reproduce. The species requires rivers that are clear, cool, and well oxygenated, with pools and shallow riffles and gravel, rubble, rock or boulder bottoms for reproduction (COSEWIC 2010a). The watercourses identified at the Project site form part of the New Harbour/Salmon River watershed, therefore any Atlantic salmon present would form part of the NS Southern Upland population (DFO 2008).

The Salmon River is known to support Atlantic Salmon from this population. The Recovery Potential Assessment (RPA) for the population indicates that abundance of the species is very low in the Southern Upland unit and has declined from levels observed in the 1980s and 1990s. Region-wide comparisons of juvenile density data from more than 50 rivers indicate significant ongoing declines between 2000 and 2009 and provide evidence for extirpations in some rivers. Twenty-two of 54 river systems surveyed in 2008-2009 were found to contain Atlantic salmon, including the Salmon River. Given the current status of the population and the reductions in freshwater habitat that have already occurred, all 22 of these rivers are considered important habitat for Southern Upland Atlantic salmon. The RPA identifies the Salmon River as a river of particular importance to the recovery potential of the population, with regards to within-river genetic variation (DFO 2013). Watercourse 1 does not provide habitat for the Atlantic salmon, and the likely acidity associated with the watercourse makes any habitat present undesirable. Therefore, no further consideration of effects and mitigation specific to this species has been undertaken.

Atlantic Sturgeon

Little is known about the habitat requirements for Atlantic sturgeon at the northern extent of its range, but important freshwater habitats for the species appear to be rivers with access to the sea, preferably with deep channels. Research suggests that the anadromous species spawns in freshwater over hard-bottom substrates at depths of 1-3 m in areas of strong currents, under waterfalls, and in deep pools just above the marine-freshwater demarcation (COSEWIC 2011). Juveniles remain in freshwater for the first summer before migrating to estuaries in winter. Juveniles remain in the freshwater-estuary system for 3 to 5 years before migrating to the near-shore marine environment as adults (COSEWIC 2011).

Occurring in rivers and estuaries near North Atlantic shore environments, the Atlantic sturgeon has been reported in the Annapolis, Avon, Shubenacadie, St. Croix and LaHave River systems, as well as the Minas Basin (Colligan *et al.* 1998; COSEWIC 2011). In Canada, the species is known to spawn only in two areas, the St. John River and middle St. Lawrence. Historically, the St. Croix River was also a known spawning area, although the current status of this population is unknown. The Project is not expected to have any impact on Atlantic sturgeon and no further consideration of effects and mitigation specific to this species has been undertaken.

Brook Floater

The vast majority of Brook floater populations occur in running water habitats with a range of flow conditions, from small creeks and streams to large rivers (COSEWIC 2009a). In Nova Scotia, Brook Floater also occurs locally in small and medium-sized lakes with no evident water flow (COSEWIC 2009a). Brook floater prefers waters with a pH greater than 5.4, indicating that acidity may be an important factor (COSEWIC 2009a). Brook Floater has a complex life cycle and relies on a fish host to complete its life cycle.

There is a known population of Brook Floater within the Salmon River, 40 km west from the Project site. A survey conducted in 2010, from the outflow of North Branch Lake in the Ogden Round Wilderness Area (approximately 53 km from the site) counted 19 individuals (COSEWIC 2009a). However, the likely acidity of any water on the Project site make it unlikely that Brook floaters are present and no further consideration of effects and mitigation specific to this species has been undertaken.

Brook Trout

Common throughout Nova Scotia and a popular sport fish, the brook trout occurs in river and lake environments as well as marine. The freshwater population prefers clear, cool lakes with good oxygen levels (Scott and Crossman 1985). In the fall (October – November) brook trout will migrate to a spawning location within riffled streams and fry will emerge in the spring (NSL 2017). Migrating individuals (sea-run) remain in freshwater until they are 2-3 years of age and begin migration to salt water in the spring. Non-migrating freshwater species travel a much shorter distance for migration (Macmillan and LeBlanc 2002; Mills 1971).

Brook trout are a poor competitor among other fish species and do well in areas where competition is lower. Competition with bass and perch, habitat loss, and overexploitation threaten this species, however, a management plan and stocking programs are established in Nova Scotia. Approximately two million brook trout are stocked annually. However, catch rate has declined 60% in the past 25 years (NSDAF 2005). Salmonids are acid-sensitive species, and therefore, it is unlikely that they are present at the Project site. Therefore, no further consideration of effects and mitigation specific to this species has been undertaken.

Eastern Pearlshell

The Eastern Pearlshell is an elongated shaped mussel, with a light brown to black coloured shell without rays (CDEP 2013). It is found in streams and small rivers that support trout or salmon populations and exist in a variety of substrate (CDEP 2013). Their thick shell allows them the ability to withstand fast flowing, rocking conditions unlike other mussel species. This species is not found in lakes or ponds (CDEP 2013). The Project site does not provide habitat in waterbodies or watercourses and it is unlikely that the Eastern Pearlshell is present. Therefore, no further consideration of effects and mitigation specific to this species has been undertaken.

Eastern Lampmussel

Eastern Lampmussel is a medium to large freshwater mussel. This species inhabits a variety of habitats, including small streams, large rivers, ponds and lakes and prefers sand or gravel substrate (NatureServe 2017). Eastern Lampmussel have a complex life cycle that relies on a fish host;

several fish have been confirmed as hosts including rock bass, bluegill, longear sunfish, smallmouth bass, largemouth bass, white perch, yellow perch and bluntnose minnow, among others (NatureServe 2017). Eastern Lampmussel is widely distributed across the northeastern United States and Canada, occurring in Nova Scotia, New Brunswick, Quebec, and Ontario (McAlpine and Smith 2010). Despite its wide distribution and varied habitats, the Eastern lampmussel is listed as "Sensitive" by NSDNR. The likely acidity of the waters in any on-site waterbodies makes it unlikely that the Eastern lampmussel would be present. Therefore, no further consideration of effects and mitigation specific to this species has been undertaken.

Striped Bass

The striped bass is an anadromous species typically associated with estuaries and coastal waters, which spawns and over-winters in fresh and occasionally brackish water.

In Nova Scotia, the Annapolis River and the Shubenacadie–Stewiacke River system in the Bay of Fundy historically supported spawning populations (Rulifson and Dadswell 1995, as cited in COSEWIC 2004). Today, the species is known to spawn only in two river systems in eastern Canada: the Miramichi and the Shubenacadie-Stewiacke systems. Catches have been recorded throughout the province, including in the Avon and Annapolis rivers, River Phillip, Shubenacadie (Grand) Lake, and the Minas Basin. ACCDC records in a 100 km radius from the Project site are limited to striped bass catches in the Bay of Fundy and the Southern Gulf of St. Lawrence (ACCDC 2017). It is unlikely that the Striped Bass is found in on-site waterbodies and watercourses. Therefore, no further consideration of effects and mitigation specific to this species has be undertaken.

Triangle Floater

Triangle floater has a wide range across the Atlantic Slope, from Nova Scotia west to the St. Lawrence River drainage, and south to Florida (Cordeiro 2011). Northern populations of this species avoid larger rivers, preferring small streams going far up towards the headwaters. This species favours a steady flow of water rather than riffles or rough water. Occasionally, it can be found in lakes, ponds, and canals. It lives mostly in a mixture of coarser or finer gravel with sand and mud, or in between large stones (Clarke 1981b). Southern populations are also found in big rivers in muddy sand with moderate current (Heard 1979). It is unlikely that the Triangle floater is present on the Project site and, therefore, no further consideration of effects and mitigation specific to this species has been undertaken.

Yellow Lampmussel

Yellow Lampmussel is a species of the Northeast Atlantic Slope, ranging from Georgia in the south to Nova Scotia in the north (COSEWIC 2004). Currently in Canada, the species is known from only two localities: the Sydney River, Cape Breton County, Nova Scotia, and the lower Saint John River and tributaries near Fredericton, New Brunswick. This species is typically found in faster flowing sections of larger rivers, especially on sand and gravel bottoms in riffles. However, in the north of its range it also occurs in lakes. The habitat in Sydney River includes a lake with wave-washed and vegetated shorelines and a lower river section dammed as a freshwater reservoir (COSEWIC 2004). Within this habitat the mussels live in water depths of 0.5 – 6.0 m preferring areas of sandy substrate with low macrophyte cover (COSEWIC 2004). Generally, they live in alkaline waters with pH above

7.0. The likely acidity of waters at the Project site does not make any watercourses or waterbodies in the Project site desirable habitat and, therefore, no further no further consideration of effects and mitigation specific to this species has been undertaken.

Tidewater Mucket

The tidewater mucket typically inhabits coastal freshwater habitats. The species occurs primarily in quiet waters, often in the lower tidal portions of rivers, on mud or sand bottoms (Clarke 1981; Johnson 1970). It is restricted to coastal regions in the Atlantic Slope drainage, from the Savannah River in Georgia to Cape Breton, Nova Scotia. It is often found in association with the yellow lampmussel in Maine, Nova Scotia, and New Brunswick (MDIFW *et al.* 2000; White 2001; Sabine *et al.* 2004), although it is not as limited to sand substrates as is the latter species. Although typically a species of coastal drainages, the tidewater mucket may occur well inland, including behind significant impoundments. As with the Yellow lampmussel, the Tidewater mucket is unlikely to be found at the Project site and, therefore, no further no further consideration of effects and mitigation specific to this species has been undertaken.

5.4.3 Potential Interactions and Effects

Project activities have the potential to impact the freshwater environment during construction and operation resulting in:

- Habitat loss/alteration;
- Release of sedimentation; and
- Accidental spills.

Project activities have the chance to result in habitat loss and alteration through the construction of the access road between the HIF and Launch Pad, which bisects Watercourse 1. Hydrologic flow will be maintained in Watercourse 1 through the installation of a culvert. All watercourse alterations associated with the project will receive provincial permitting approvals prior to construction activities.

Additional impacts may occur during construction and operation to waterbodies and watercourses not directly impacted by the Project footprint. Ground disturbance during construction activities may result in sedimentation of nearby waterbodies, impacting water quality and freshwater species habitat. During operation, sedimentation from cleared surfaces or emissions may impact water quality. Emissions from the rocket launches will include both sulphur and nitrogen dioxides which may have negative impacts to water quality if they deposit within watercourses and waterbodies, consequently impacting fish habitat and aquatic species. However, as launches will occur intermittently throughout the year, it is uncertain to what extent deposition may occur and whether this will impact the freshwater environment.

There is also a risk of accidental spills during construction and operation. Spills may occur from fueling and construction equipment during construction, or from fuels and propellants stored on site during operation.

5.4.4 Specific Mitigative and Protective Measures

Mitigative measures to minimize the environmental effects of the Project on the freshwater environment include:

- Implementation of the EPP, including the ESCP, spill prevention plan and contingency plans (as necessary) will be implemented prior to construction;
- ESC structures will be maintained and inspected regularly with particular emphasis before and after forecasted heavy rain events, and with consideration of the timing and types of activities involved;
- Where necessary, ESC measures will remain in place after work is completed until areas have stabilized and natural re-vegetation occurs;
- All overburden removed during the excavation phase will be stored according to provincial regulars and best practice guidelines;
- Exposed soils and stockpiles capable of producing sediment laden-runoff will continue to be stabilized and/or will be covered;
- The length of time stockpiled overburden will be left exposed, and the length without mitigation (e.g., mulching, seeding, rock cover) will be minimized through scheduled work progression;
- Work vehicles and/or heavy equipment will be cleaned and inspected prior to use to prevent the introduction of invasive species and deleterious substances into the water;
- Temporary storage of waste materials on-site will be located at least 30 m from known watercourses, wetlands, and waterbodies;
- Propellant and fuels will be contained in vessels to industry standards and checked regularly to ensure they are in good working condition;
- Appropriate fish salvage methods, if necessary, will be completed prior to in-water work;
- Fish passage, if appropriate, shall be maintained during all Project phases; and
- In-water work may not occur during October 1 to May 31, or as directed otherwise by government regulators, so as to not interfere with seasonal migration and spawning.

5.4.5 Potential Residual Effects

An analysis of residual effects on terrestrial habitat from the Project is provided in Table 5.15. It is anticipated that the only residual effects will be a result of the watercourse alteration on Watercourse 1. However, as the alteration will be confined to the bisection of the access road and hydrologic flow will be maintained, the significance of this effect will be minimal.

Table 5.15: Determination of Residual Effects to the Freshwater Environment

VEC	Potential Effect	Significance Criteria	Residual Effects	Significance of Residual Effects
Freshwater Environment	Habitat loss/alteration (construction, operation)	Scope: Local Duration: Long-term Frequency: Once Magnitude: Low	Yes	Minimal/None
	Release of sedimentation and deleterious substances (construction)	Scope: Local Duration: Short-term Frequency: Once Magnitude: Low	No	N/A
	Direct mortality (construction)	Scope: Local Duration: Short-term Frequency: Once Magnitude: Low	No	N/A

5.4.6 Recommended Monitoring and Follow-up

Prior to construction commencement, a fish survey and water quality assessment should be completed on Watercourse 1. Additionally, it is recommended that post-construction water quality monitoring is completed within Watercourse 1 as well as additional nearby waterbodies to monitor potential impacts of rocket emissions.

5.5 Terrestrial Habitat

5.5.1 Habitat and Vegetation

The Project site is located in the Eastern Shore Ecodistrict which consists of a coastal climate as a result of the influence of the Atlantic Ocean. On the Canso peninsula, the coastal influence extends further inland than in other areas of the Ecodistrict, and coastal forests are found on elevations of 150 m (Neily *et al.* 2003). Exposed bedrock and lakes comprise a large portion of the Ecodistrict, with a total of 9,734 ha covered by freshwater and 21.6% of the district covered by exposed bedrock (Neily *et al.* 2003).

The nearest protected area to the Project site is the Canso Coastal Barrens Wilderness Area, located 2.67 km west of the Project site. It is an 8,026 ha protected area consisting of a mix of islands, inlets, bays, small salt marshes, peninsulas, harbours, lagoons, headlands, and small beach (NSE 2017a). Its landscape is dominated by exposed granite barrens and patches of mature coastal coniferous forests (NSE 2017a).

Habitat on the Project site consists predominantly of coastal barrens and dense coniferous woodland forests, indicative of the Atlantic Coastal barrens. The habitat is strongly influenced by the proximity to the coast. Soils for the most part are shallow and nutrient deficient. Large trees are mainly absent, with the site dominated by early successional species and ericaceous and low-nutrient

tolerant shrubs and herbs. There are numerous dead standing trees (snags) throughout treed areas of the site. As the site slopes down towards the south, large bogs predominate. Closer to the coast, the bogs transition into granite outcroppings were vegetation is space, characteristic of coastal barrens.

Near the access road and between the LCC and HIF, coastal and spruce forest habitats predominate. The well-developed tree canopy consists of Balsam fir (*Abies balsamea*), Black spruce (*Picea mariana*) and White spruce (*Picea mariana*). Present in lesser abundance are White birch (*Betula papyrifera*) and Red maple (*Acer rubrum*). Absent are later successional species such as Red spruce (*Picea rubens*), Sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*) and Eastern white pine (*Pinus strobus*). There is a well-developed understory of regenerating softwoods, Rhodora (*Rhododendron canadense*), Mountain holly (*Nemopanthus mucronatus*), Wild raisin (*Viburnum nudum*) and Lambkill (*Kalmia angustifolia*). Soils are nutrient-poor resulting in low herbaceous diversity. Herbaceous species include Bunchberry (*Cornus canadensis*), Creeping snowberry (*Gaultheria hispidula*), Twinflower (*Linnaea borealis*), Canada mayflower (*Maianthemum canadensis*), Wild sarsaparilla (*Aralia nudicaulis*), wood ferns and Cinnamon fern (*Osmunda cinnamomea*). Schreber's moss (*Pleurozium schreberi*) is the most common bryophyte, with others present. Deadfall makes for an abundance of fallen woody debris and snags.

The proposed launch pad site and the access road connecting it to the HIF is composed largely of coastal barren habitat with granite outcrops, and undeveloped soils. Substrates consist of thin, acidic soils over top of granite with a high cover of reindeer lichen. Stunted Jack pine (*Pinus banksiana*) dominates, with a well-developed woody understory of Black huckleberry (Gaylussacia baccata), Black spruce, Rhodora and Lambkill. Interspersed throughout in areas with more cover and more developed soils are softwood stands, occasionally stunted due to coastal exposure. Nutrient poor wetlands have developed within depressions in the granite with drainage channels and wet areas forming in crevices, draining the larger bogs to the south.

A review of the ACCDC database for recorded observations of vegetative plants within a 100 km radius of the Project site was completed. The ACCDC database review identified 217 vascular plant SOCI, 33 nonvascular plant SOCI, and three lichen SOCI within a 100 km radius (ACCDC 2017).

A vegetative survey was completed July 13-14, 2017, at the Project site. A total of 163 vegetative species were identified during the survey. Of the species identified, 6 are considered SOCI:

- Slim-stemmed Reed Grass (*Calamagrostis stricta*): 'Sensitive' (ACCDC), 'S2' (ACCDC);
- Lesser brown sedge (*Carex adusta*): 'Sensitive' (ACCDC), 'S2S3' (ACCDC);
- Houghton's sedge (*Carex houghtoniana*): 'Sensitive' (ACCDC), 'S2S3' (ACCDC);
- Ovate spikerush (*Eleocharis ovata*): 'Sensitive' (ACCDC), 'S2' (ACCDC);
- Little curlygrass fern (*Schizaea pusilla*): 'S3S4' (ACCDC); and
- Entire-leaved nitrogen moss (*Tetraplodon mnioides*): 'S2S3' (ACCDC).

Noticeably absent from the site were species associated with late-successional and nutrient rich sites. Softwood species and ericaceous shrubs dominated the Project site. A complete list of plants identified at the Project site and a complete list of priority species is provided in Appendix D.

5.5.2 Wetlands

There are 14 wetlands of special significance (WSS) located within 5 km of the Project site (Table 5.16). The nearest WSS is a 1.67 ha salt marsh located 3 km east of the Project site by Betsey's Beach, on a small area of land connected to the mainland by a sand bar and causeway. The wetland is located near the outlet of Chapel Gully into the Atlantic Ocean. Ten of the other WSS are located within the Canso Coastal Barrens Wilderness Area.

Table 5.16: Wetlands of Special Significance located within 5 km of the Project site

Distance from Project Site	Wetland Size (ha)	Significance Category
2.14 km E	1.67	Salt Marsh
2.67 km W	7.08	Canso Coastal Barrens Wilderness Area
3.75 km SW	1.04	Salt Marsh
3.73 km W	0.62	Canso Coastal Barrens Wilderness Area
3.93 km W	0.30	Canso Coastal Barrens Wilderness Area
3.97 km SW	0.47	Canso Coastal Barrens Wilderness Area
4.02 km W	6.14	Canso Coastal Barrens Wilderness Area
4.04 km W	0.23	Canso Coastal Barrens Wilderness Area
4.34 km SW	0.83	Salt Marsh
4.35 km SW	1.51	Salt Marsh
4.35 km W	0.25	Canso Coastal Barrens Wilderness Area
4.69 km W	0.21	Canso Coastal Barrens Wilderness Area
4.41 km W	4.73	Canso Coastal Barrens Wilderness Area
4.93 km W	0.40	Canso Coastal Barrens Wilderness Area

A wetland field survey was completed within the Project site in summer 2017. Numerous wetlands were identified throughout the Project site (Drawings 5.4a - 5.4d). Within the Project footprint, a total of 3.09 ha of wetland habitat was identified in 11 wetlands within the Project footprint (Table 5.17). Wetlands identified on the Project site consist of treed swamps, shrub swamp, and bogs, with many existing as a complex of two or more wetland types. Of the wetlands to be impacted, most consist of partial infills with three wetlands being completely infilled.

Table 5.17: Wetlands Identified at the Project Site

Wetland ID	Wetland Type	Impact Area (m^2)	Impact Type	Project Component
1	Treed Swamp – Shrub Swamp – Bog Complex	0	N/A	N/A
2	Treed Swamp – Bog Complex	159.7	Partial infill	LCC
3	Treed Swamp	585.8	Partial infill	LCC
4	Treed Swamp	2,256.7	Partial infill	LCC/Access Road
5	Treed Swamp – Shrub Swamp Complex	369.7	Partial infill	Access Road
6	Treed Swamp – Shrub Swamp – Bog Complex	13,197.8	Partial infill	HIF/Access Road
7	Treed Swamp	0	N/A	N/A
8	Shrub Swamp	160.3	Partial infill	Access Road

Wetland ID	Wetland Type	Impact Area (m^2)	Impact Type	Project Component
9	Treed Swamp – Shrub Swamp – Bog Complex	159.5	Partial infill	Access Road
10	Bog	4,323.9	Partial infill	Launch Pad/Access Road
11	Shrub Swamp	599.2	Complete infill	Launch Pad/Access Road
12	Shrub Swamp – Bog Complex	8,067.1	Complete infill	Launch Pad/Access Road
13	Treed Swamp	269.7	Partial infill	Access Road
14	Tree Swamp	757.6	Complete infill	HIF
Total number of wetlands impacted				**12**
Total area of wetland habitat impacted				**3.09 ha (30,880 m^2)**

Wetland characteristics were relatively consistent for each wetland type. All wetlands had soils consisting of decomposing organic matter (histosols), predominantly with a *Sphagnum* base. Substrates were saturated to surface, and in some instances had intermittent standing water or an associated watercourse.

Treed swamps were dominated by Balsam fir, with Black spruce, Red maple and, occasionally, White birch also in the tree canopy. There was usually a well-developed subcanopy composed of regenerating tree species, as well as Mountain holly, Wild raisin, Lambkill and American mountain-ash (*Sorbus americana*). The herbaceous canopy was less densely vegetated, and consisted of Cinnamon fern, Wild sarsaparilla, Starflower (*Trientalis borealis*), Three-seeded sedge (*Carex trisperma*), Bunchberry, Whorled wood aster (*Oclemena acuminata*), Partridgeberry (*Mitchella repens*), Canadian mayflower (*Maianthemum canadensis*), Bluebead lily (*Maianthemum trifolium*), and Goldthread (*Coptis trifolia*). Substrates had a high cover of moss. Most wetlands had abundant deadfall which, combined with a dense subcanopy, made walking the wetlands difficult. However, the downed woody vegetation and abundant microtopography provided good cover for small mammals and amphibians.

Shrub swamps were dominated by ericaceous species, including Black spruce, Lambkill, Rhodora, Black huckleberry, blueberry (*Vaccinium angustifolium* and *V. myrtilloides*), Labrador tea (*Ledum groenlandicum*), Mountain holly, and Wild raisin. Shrub swamps were densely vegetated with only intermittent areas of herbaceous growth, which included Canadian mayflower, Cinnamon fern, Tawny cottongrass (*Eriophorum virginicum*), Bog aster (*Oclemena nemoralis*), and Pitcher plant (*Sarracenia purpurea*). Herbaceous vegetation was often similar to proximal bog or treed swamp habitat, although in lesser abundance. Soils were shallower than other wetland types, with some moss cover however often the substrate was covered with leaf litter.

Bogs were herbaceous dominated, with some ericaceous shrub species and blueberries. Herbaceous vegetation was dominated by Tawny cottongrass, Tufted clubsedge (*Trichophorum caespitosum*), Pitcher plant, cranberries (*Vaccinium macrocarpon* and *V. oxycoccos*), Cloudberry (*Rubus chamaemorus*), Bog rosemary (*Andromeda polifolia*), Bog laurel (*Kalmia polifolia*) and Bog aster. Most shrub species were stunted, rarely exceeding 1 m in height, and included Bog huckleberry, Leatherleaf, Lambkill, Labrador tea, Broom crowberry (*Corema conradii*), Eastern larch

Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Existing Sable Wind Farm Access
- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area

Water Features

- Field Identified Winter Creek
- Field Identified Watercourse
- Field Identified Drainage Channel
- Confirmed WL Bdy
- Approximate Wetland Boundaries
- Field Identified Wetland

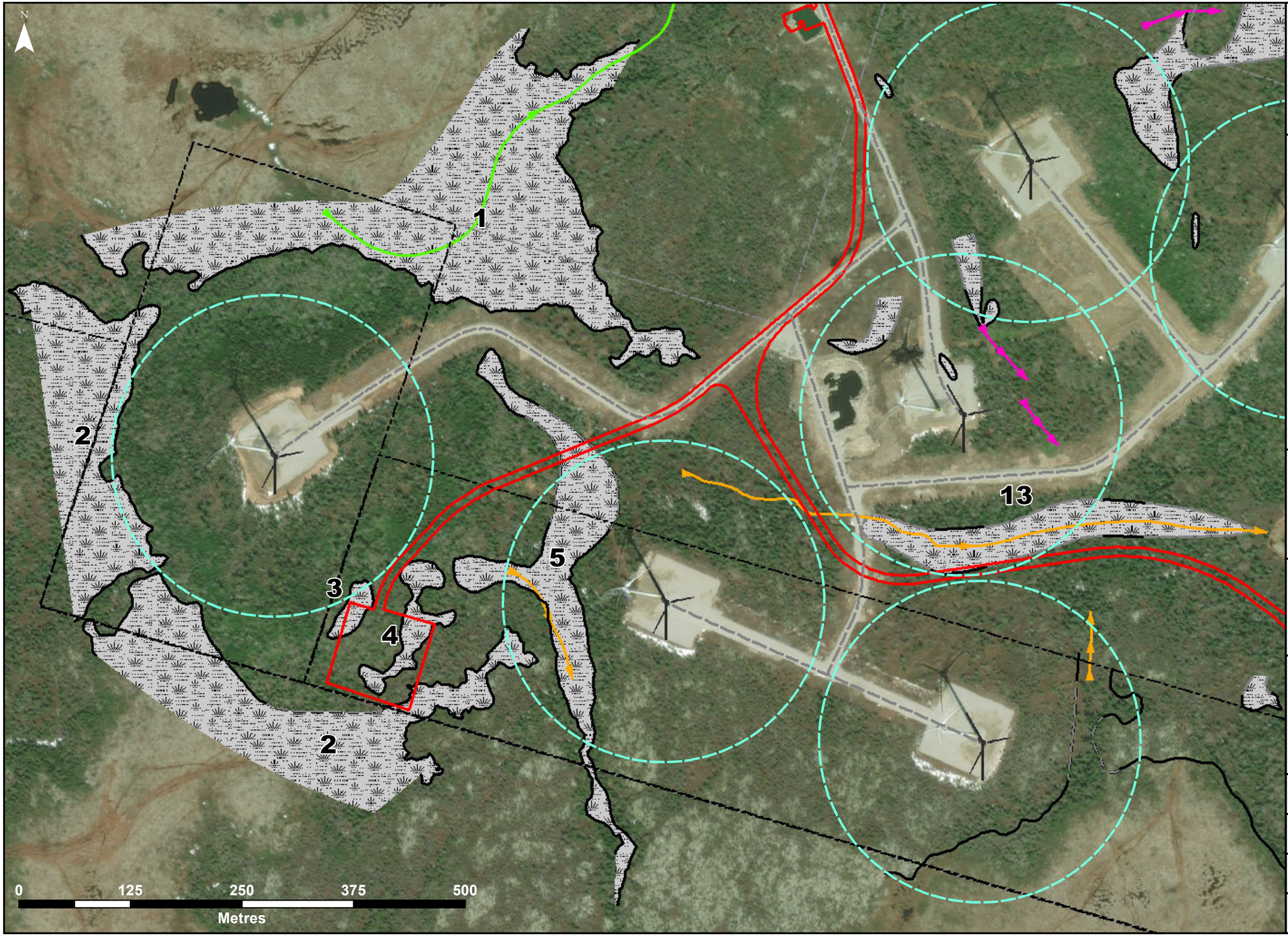
Canso Launch Site - Wetland Survey Results

MLS Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:9,000	Drawing #: **5.4a**
Drawn By: M. Marriott	
Checked By: H. Mosher	



Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Existing Sable Wind Farm Access
- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area

Water Features

- Field Identified Winter Creek
- Field Identified Watercourse
- Field Identified Drainage Channel
- Confirmed WL Bdy
- Approximate Wetland Boundaries
- Field Identified Wetland

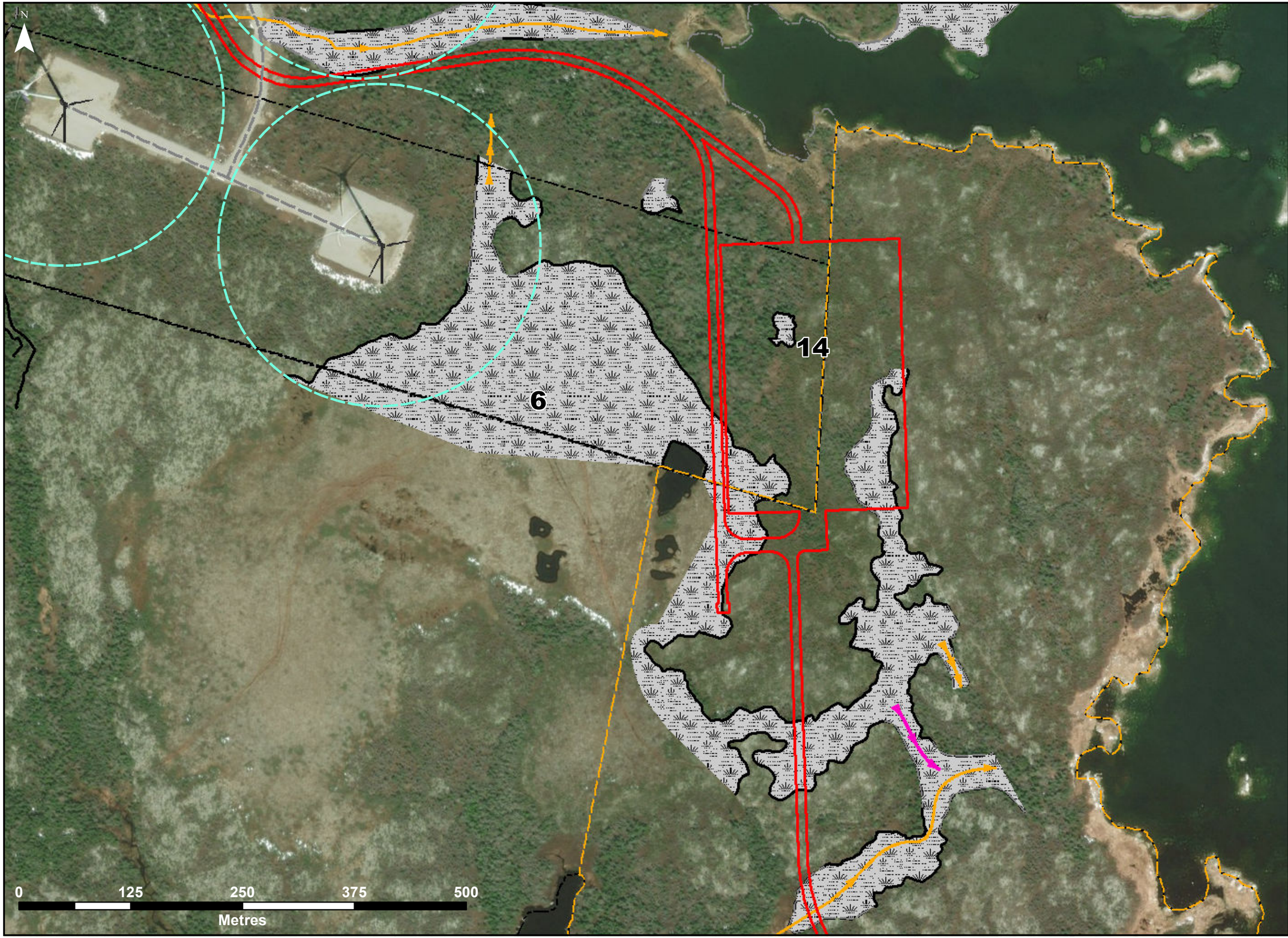
Canso Launch Site - Wetland Survey Results

MLS Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:4,000	Drawing #: **5.4b**
Drawn By: M. Marriott	
Checked By: H. Mosher	



Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Existing Sable Wind Farm Access
- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area

Water Features

- Field Identified Winter Creek
- Field Identified Watercourse
- Field Identified Drainage Channel
- Confirmed WL Bdy
- Approximate Wetland Boundaries
- Field Identified Wetland

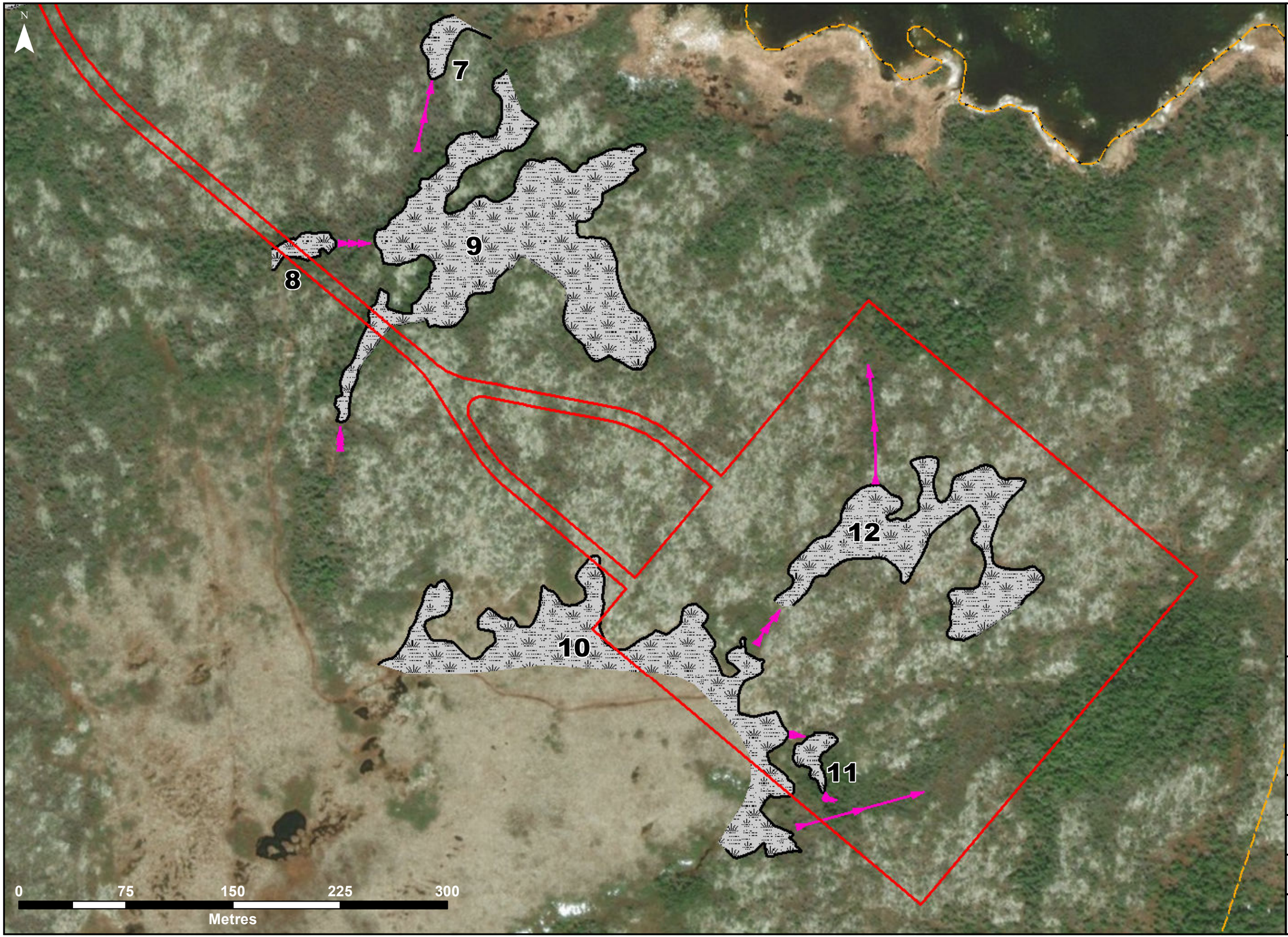
Canso Launch Site - Wetland Survey Results

MLS Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:4,000	Drawing #: **5.4c**
Drawn By: M. Marriott	
Checked By: H. Mosher	



Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Existing Sable Wind Farm Access
- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area

Water Features

- Field Identified Winter Creek
- Field Identified Watercourse
- Field Identified Drainage Channel
- Confirmed WL Bdy
- Approximate Wetland Boundaries
- Field Identified Wetland

Canso Launch Site - Wetland Survey Results

MLS Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:2,500	Drawing #: **5.4d**
Drawn By: M. Marriott	
Checked By: H. Mosher	

(*Larix laricina*), and Common juniper (*Juniperus communis*). Substrates were *Sphagnum* covered with deep peat accumulations (greater than 2 m in some areas). Reindeer lichen (*Cladonia* sp.) was also present on high hummocks throughout.

A complete wetland characteristics table is provided in Appendix E.

5.5.3 Mammals

The Nova Scotia Significant Species and Habitat Database (NSDNR 2014) contains 164 unique species and/or habitat records pertaining to terrestrial mammals within a 100 km radius of the Project site. These records include:

- 163 records that are classified as "Deer Wintering", which relate to known over-wintering habitat for White-tailed deer (*Odocoileus virginianus*); and
- One record classified as 'Other Habitat', relating to the North American River Otter (*Lontra canadensis*).

White-tailed Deer are common throughout Nova Scotia and are not considered SOCI but are valued by game hunters. They are usually solitary animals but will gather together in winter in mature softwood stands for survival. These wintering areas provide protection from the cold, wind, and snowfall.

The record relating to the North American River Otter is located 95 km NW of the Project site on Cape Breton Island, in Orangedale East. This habitat is located on the shores of McIver Pond. River Otters are common throughout North America and are not a SOCI. They are found anywhere there is a permanent water source and have on land dens in which to sleep and have their babies.

There are no records relating to significant terrestrial mammal habitat within 10 km of the Project site.

The ACCDC database (2017) indicates that six terrestrial mammal SOCI have been recorded within a 100 km radius of the Project site (Table 5.18).

Table 5.18: Mammal Species Recorded within a 100 km Radius of the Project Site

Common Name	Scientific Name	SARA Status[1]	COSEWIC Status[2]	NSESA Status[3]	NS GS-Rank[4]	NS S-Rank[4]
American Marten	*Martes americana*	Not Listed	Not Listed	Endangered	At Risk	S1
Canadian Lynx	*Lynx Canadensis*	No Listed	Not At Risk	Endangered	At Risk	S1
Little Brown Myotis	*Myotis lucifugus*	Endangered	Endangered	Endangered	At Risk	S1
Long-tailed Shrew	*Sorex dispar*	Not Listed	Not Listed	Not Listed	Sensitive	S2
Mainland Moose	*Alces alces americanus*	Not Listed	Not Listed	Endangered	At Risk	S1
Rock Vole	*Microtus chrotorrhinus*	Not Listed	Not Listed	Not Listed	Secure	S2

Common Name	Scientific Name	SARA Status[1]	COSEWIC Status[2]	NSESA Status[3]	NS GS-Rank[4]	NS S-Rank[4]
Southern Bog Lemming	*Synaptomys cooperi*	Not Listed	Not Listed	Not Listed	Secure	S3

Source: ACCDC 2017; [1] GC 2017a; [2]COSEWIC 2017; [3]NSDNR 2017; [4]ACCDC 2017

The NSDNR moose occurrence database (1900/01/01-2017/11/21) has 33 records within a 20 km radius of the Project site reported as animal sightings, track sightings, or unknown (inadequate information recorded at time of occurrence) (Drawing 5.5). Of the four occurrence records which are within 5 km of the Project site, all were animal sightings (two males, three females) made in the fall of the year; the most recent on 10 October 2009, south of the community of Little Dover. An additional five occurrence records were reported within 10 km of the Project site, of which, two were animal sightings and three were unknown, with four of five of these occurrences being reported in the fall. According to the NSDNR dataset, the most recent moose occurrence reported within 20 km of the Project site was a helicopter sighting that took place on August 12, 2014 somewhere between Fogherty Lake and Highway 16 (10-15 km from the Project Site).

Targeted surveys for Mainland Moose and Bats were completed, and incidental observations of mammals were made throughout other surveys.

Mainland Moose Surveys
Moose surveys consisted of two winter snow tracking surveys completed on January 23 and February 22, 2017, and one Pellet Groups survey completed on April 19, 2017. Efforts were also made to assess the Project site area for moose sign throughout much of the spring, summer, and fall of 2017 during other survey scopes. The moose surveys were conducted along 8.5 km of transects on and near the Project site (Drawing 5.6). Survey transects were routed through the variety of habitat types present in the Project site area, including mixedwood and coniferous forests of Balsam fir and Black spruce, regenerating cutovers, bogs and coastal barrens.

No evidence of mainland moose was observed during surveys, however, the following species were identified at the Project site:

- Coyote (*Canis latrans)*
- Muskrat (*Ondatra zibethicus*)
- North American Porcupine (*Erethizon dorsatum)*
- Raccoon (*Procyon lotor)*
- Red Fox (*Vulpes vulpes)*
- Red Squirrel (*Tamiasciurus hudsonicus)*
- Snowshoe Hare (*Lepus americanus)*
- White-tailed Deer (*Lepus americanus)*

These species are all common and ubiquitous throughout Nova Scotia, and none are considered SOCI.

Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Basemap: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.
3. Projection: NAD83(CSRS), UTM Zone 20 North.
4. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

NSDNR Moose Occurrence Data

Type of Occurrence

- Animal
- Tracks
- Unknown
- NSDNR Moose Occurrence Data >20 km from Project Site
- Place Names
- Public Roads
- Access Roads / Trails
- Project Location
- Project Site Boundary
- Crown Land Lease Area

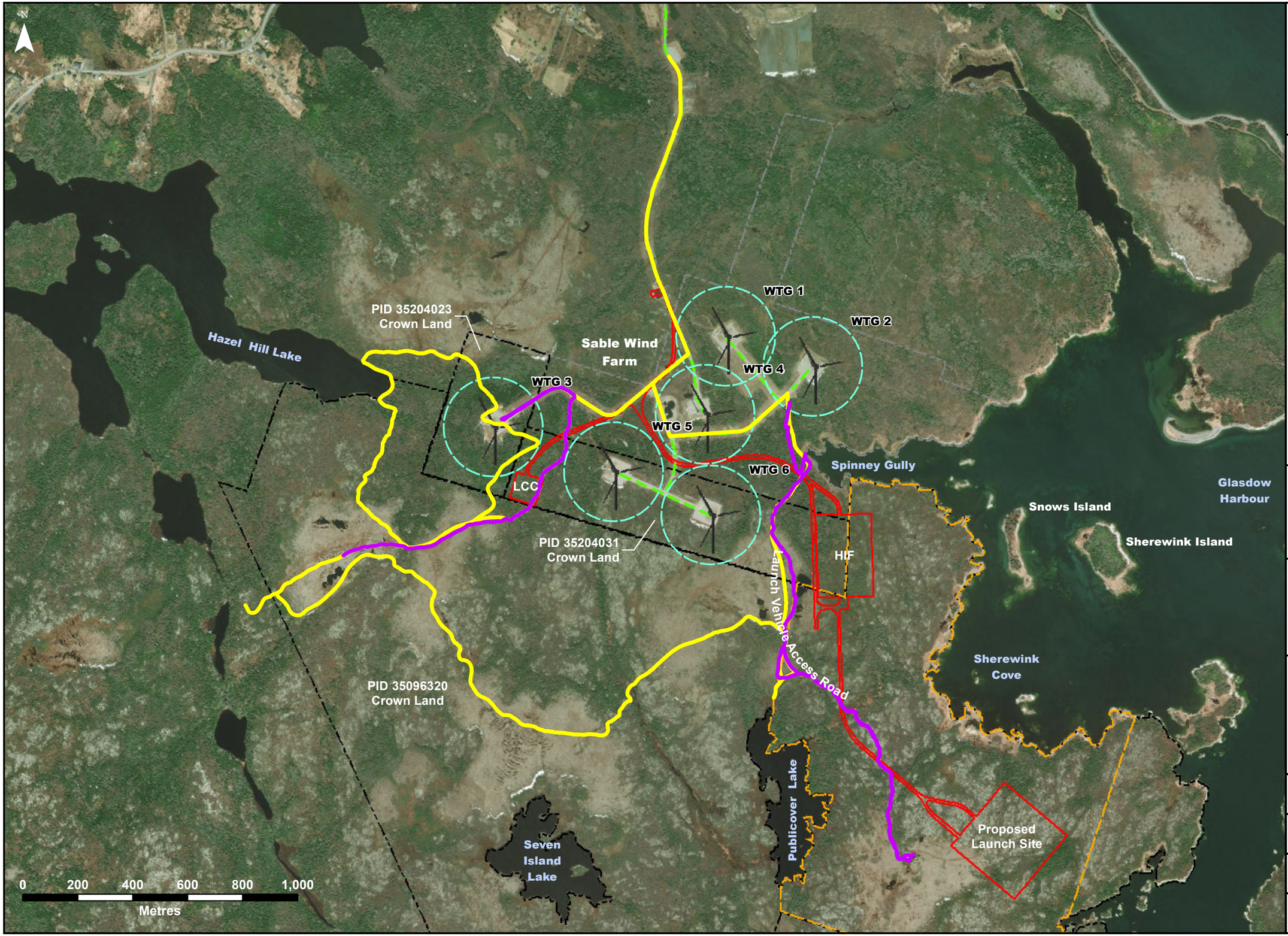
Maritime Launch Services - NSDNR Moose Occurrence Data 1900/01/01 to 2017/11/21

MLS Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:90,000	Drawing #: **5.5**
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Pellet Group Survey Transects
- Moose Survey Transects
- Existing Turbine Access Road
- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area

Canso Launch Site - Moose Survey Transects

Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:13,000	Drawing #: **5.6**
Drawn By: M. Marriott	
Checked By: S. Dickey	

Acoustic Bat Assessment

An acoustic bat assessment was conducted to evaluate the bat population in the area of the Project site during the migratory bat period (Mid-August to mid-September). ACCDC shows 24 records for bats within 100 km of the Project site, the nearest being from Little-Brown Myotis approximately 22km away. The nearest bat hibernacula is Hirschfield Galena Prospect (a mine), 85 km to the west.

Field surveys of bat migration/habitat use were carried out for 13 consecutive days from August 15 to August 28, 2017 using two AnaBat SD2 Ultrasound Bat Monitors (Titley Electronics, Columbia, Missouri). The bat monitors identify and log ultrasound signatures that may have emanated from bat echolocation calls. The bat monitors were programed to record all potential bat calls from 6 PM to 6 AM daily for the duration of the monitoring period. The stored files are then analyzed individually by a biologist with experience in identifying bat species by ultrasound spectrographs. The bat monitors were located in habitats representative of the Project site and that are expected to provide suitable foraging habitat for bats (i.e., forest edges and wetlands). Bat Monitor 1 was deployed on a softwood forest edge adjacent an open bog, on the Project site. Bat Monitor 2 was deployed on the boundary of a mature hardwood stand and an open bog (Drawing 5.7).

In total, 104 ultrasound files were recorded at the Bat Monitor 1 (BM1) location, and 212 files were recorded at the Bat Monitor (BM2) location. All 316 of these files were analyzed, and the results are summarized in Table 5.10 below.

Table 5.19: Results of the Acoustic Bat Assessment

Monitor	Number of Bat Calls	Date
BM1	0	-
BM2	1 (*Myotis sp.)*	August 22, 2017

Of the 104 ultrasound files recorded by BM1, none were generated by bats. Of the 212 files recorded by BM2 monitor, one was generated by a *Myotis* species on August 22, 2017.

The presence of a single bat indicates that the bat population is likely very low in the area of the Project site, although bats do appear to use the area during their migratory period. It is possible that a very small population of *Myotis sp.* resides in the area during the spring and summer months, but the lack of hybernacula within 85 km suggests that the bat population in the area is likely comprised of seasonal residents and possibly the occasional migrant.

While not identifiable to the species level, the *Myotis sp.* observed is most likely a Little-brown Myotis (*Myotis lucifugus*) but may possibly be a Northern Long-eared Myotis (*Myotis septentrionalis*).

The results of the desktop review and field surveys have revealed that mammalian SOCI that do or may occur near the Project site include:

- American Marten – “Endangered” (NS ESA), “At Risk” (NSDNR), “S1” (ACCDC);
- Canadian Lynx – “Endangered” (NS *ESA*), “At Risk” (NSDNR), “S1” (ACCDC);
- Little Brown Myotis – “Endangered” (NS ESA), “Endangered” (SARA), “Endangered” (COSEWIC), “At Risk” (NSDNR), “S1” (ACCDC);

Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Bat Acoustic Monitor
- Bird Acoustic Monitor
- Existing Sable Wind Farm Access
- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area
- Confirmed Wetland Boundries
- Approximate Wetland Boundaries
- Field Identified Wetland

Canso Launch Site - Bird and Bat Acoustic Monitor Locations

MLS Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:12,500	Drawing #: 5.7
Drawn By: M. Marriott	
Checked By: S. Dickey	

- Northern Long-eared Myotis – "Endangered" (NS ESA), "Endangered" (SARA), "Endangered" (COSEWIC), "At Risk" (NSDNR), "S1" (ACCDC);
- Long-tailed Shrew – "Special Concern" (SARA), "Sensitive" (NSDNR), "S2" (ACCDC);
- Mainland Moose – "Endangered" (NS *ESA*), "At Risk" (NSDNR), "S1" (ACCDC); and
- Rock Vole – "S2" (ACCDC); and
- Southern Bog Lemming – "S3" (ACCDC).

American Marten

American Marten prefer mature coniferous forests and have been more recently observed in mixed forests and cutovers (MTRI 2008). ACCDC data indicate that the closest observation of this species to the Project site was 83.9 km. Although these types of habitat are present at the Project site, the current known distribution of the American Marten in Nova Scotia is limited to Cape Breton and the southwestern part of the province, near Yarmouth (NSDNR 2013).

It is therefore unlikely that the Project will interact with American marten populations and no further consideration of effects and mitigation for this species has been undertaken.

Canadian Lynx

Although they can occur in a diversity of habitats, Canada Lynx are typically found in coniferous forests with snowshoe hare (their main prey). They require areas with interspersed forest types suitable for different activities, such as those found in previously disturbed forests (insect outbreaks and fire). Deep snow packs are a requirement for Canada Lynx. They are most commonly found in areas of high elevation, which can provide them necessary deep snow, around Cape Breton such as Cape Breton Highlands, North Mountain, Keppoch Mountain, and Boisdale Hills (MTRI 2008).

Canada Lynx were extirpated from the mainland during the 1950s but will travel province wide when food is scarce. ACCDC data indicate that the closest observation of Canada Lynx to the Project site was 44.8 km away. Due to their restricted range, it is unlikely that the Project will impact this species. No further consideration of effects and mitigation for this species has been undertaken.

Long-tailed Shrew

Long-tailed shrew are closely associated with steep, talus slopes, usually close to running water, and the presence of rocks is considered a principal habitat component (Kirkland 1981). Thought to be found only in the Cobequid Mountains (Scott 1987; Woolaver *et al*. 1998), more recent research has identified an additional population of Long-tailed Shrew near Wolfville at Stewart Mountain, approximately 250 km to the west of the Project site (Shafer and Stewart 2006). ACCDC data indicate that the closest observation of Long-tailed Shrew to the Project site was 75.6 ± 1 km away.

Although steep slopes and rocks are found in the Study area, due to the distance to known population sites it is unlikely that the Project will impact this species. No further consideration of effects and mitigation has been undertaken.

Mainland moose

Habitat requirements for mainland moose change throughout the year. Early successional growth, such as that provided by regenerating cutovers, offers quality foraging habitat for moose, and

interspersed wetlands provide suitable summer habitat for cows and calves (Parker 2003; Snaith & Beazley 2004). Mature softwood forest is used as escape cover throughout the year, and also provides thermal relief during the summer months (Broders *et al*. 2012) and relief from deep snows in winter (Telfer 1970).

Five significant concentration areas for mainland moose have been identified in Nova Scotia (NSDNR 2012a). The Project site is situated within the eastern extent of one such concentration area. This area encompasses 366 km^2 of land that stretches from Halfway Cove Lake (28 km west of the Project site) to the town of Canso. ACCDC records indicate that the closest observation of this species to the Project site was 94.2 ± 5.0 km away.

Despite the presence of relatively un-fragmented habitat that appears to provide for the varied requirements of Mainland Moose, no signs of this species were observed during targeted moose surveys. No evidence of moose was observed during surveys conducted in 2004, 2005, and 2012 for Sable Wind Farm (MODG 2012). This is indicative of a low population density of Mainland Moose in the area of the Project site. However, due to the proximity of the Project site to Mainland Moose concentration area, interaction with the Project cannot be ruled out. This species is therefore considered further through the residual effects analysis.

Little Brown Myotis and Northern Long-eared Myotis

The Little Brown Myotis and the Northern Long-eared Myotis are non-migratory bats, ubiquitous in Nova Scotia. They hibernate from September to early or mid-May in abandoned mines or caves (Fenton and Barclay 1980; Mosely 2007). Until relatively recently, they were a common occurrence throughout the province but have since gone in severe decline due to the outbreak of disease known as white-nose syndrome.

These species feed in open areas, such as over lakes or open bog along the forest edge and may roost in mature trees or trees in lower stages of decay. They overwinter in large hibernacula, which are not known to be present in the general area. It is possible that *Myotis* are present at the Project site in low abundance throughout the spring and summer, and they may pass through the area during their migration to their hibernacula in the late summer. These species are therefore considered further through the residual effects analysis.

Rock Vole

Rock Voles are typically found through central Quebec, central and eastern Ontario, and along the Appalachian Range. The Rock Vole prefers cool, damp, coniferous and mixed forests at higher elevations in the Appalachians; mossy rocky areas throughout Canada (Cassola 2016). Optimal habitat is ferns/mossy debris near flowing water in coniferous forests. Rock voles are usually found in areas of small clearings or wind-downed trees where exposed boulders and crevices are visible (Christian and Daniels 1985). Water, either in the form of surface or subsurface streams, is another key habitat component (Kirkland *et al.* 1979).

ACCDC data indicate that the closest observation of this species to the Project site was 75.7 km. No indication of Rock Vole was observed during field studies. Records within the Maritimes are restricted to the northern half of New Brunswick and Cape Breton Island (Roscoe and Majka 1976)

and the Gaspe. Although preferred habitats are found at the Project site, due to the distance to known population sites it is unlikely that the Project will impact this species. No further consideration of effects and mitigation has been undertaken.

Southern Bog Lemming
Southern Bog Lemming is widely distributed thought southeastern Canada from the maritime provinces to southeastern Manitoba. The prime habitat for lemmings is in moist, grassy areas around sphagnum bogs, swamps, and stream edges but can inhabit a wide range of less preferred habitats, such as shrubby grasslands, mixed forests, wet meadows, pasture lands, woodland clearings, and even clearcuts (Naughton 2014).

ACCDC data indicate that the closest observation of this species to the Project site was 75.7 km. No indication of Southern Bog Lemming was observed during field studies. However, there is abundant habitat on the site in the form of sphagnum bogs and swamps in which bog lemmings may occur. This species is therefore considered further through the residual effects analysis.

5.5.4 Herpetofauna

The Nova Scotia Significant Species and Habitat Database (NSDNR 2014) contains 323 unique species and/or habitat records pertaining to reptiles and amphibians within a 100 km radius of the Project site. All of these records are classified as 'Species at Risk' relating to the Wood Turtle (*Glyptemys insculpta*).

There are no records pertaining to herpetofauna within a 10 km radius of the Project site.

The ACCDC database identifies three terrestrial herpetofauna species within a 100 km radius of the Project area (Table 5.20).

Table 5.20: Reptile and Amphibian Species Recorded Within a 100 km Radius of the Project Site

Common Name	Scientific Name	SARA Status[1]	COSEWIC Status[2]	NSESA Status[3]	NS GS-Rank[4]	NS S-Rank[4]
Four-toed Salamander	*Hemidactylium scutatum*	Not Listed	Not at Risk	Not Listed	Secure	S3
Snapping Turtle	*Chelydra serpentina*	Special Concern	Special Concern	Vulnerable	Sensitive	S3
Wood Turtle	*Glyptemys insculpta*	Threatened	Threatened	Threatened	Sensitive	S2

Source: ACCDC 2017; [1]GC 2017a; [2]COSEWIC 2017; [3]NSDNR 2017; [4]ACCDC 2017

Of note is that sightings of many of the most common species are unreported to ACCDC and are therefore under-represented or absent from the database. Consequently, a review of the ACCDC data reveals predominantly rare or noteworthy species despite the fact that these species certainly represent a small fraction of the existing reptilian and amphibian community in the area.

Targeted herpetofauna surveys were not completed at the Project site. However, the following species were observed during other field surveys on site:

- Common Gartersnake (*Thamnophis sirtalis*): "Secure" (GS-Rank), "S5" (S-Rank).

Priority herpetofauna species include:

- Four-toed Salamander – "S3" (S-Rank);
- Snapping Turtle – "Special Concern" (SARA), "Vulnerable" (NSESA), "Special Concern" (COSEWIC); "Sensitive" (GS-Rank), "S3" (S-Rank);
- Wood Turtle – "Threatened" (SARA), "Threatened" (NSESA), "Threatened" (COSEWIC), "Sensitive" (GS-Rank), "S2" (S-Rank).

Four-toed Salamander

The Four-toed Salamander has a limited range in Canada (Desroches and Rodrigue 2004), with Nova Scotia situated near the species northern range limit. Although not believed to be sensitive or at risk in Nova Scotia, the Four-toed Salamander has been found at a relatively small number of widely separated localities (Gilhen 1984). The species is closely associated with sphagnum bogs. ACCDC data indicate that the closest observation of this species to the Project site was 38.7 km.

Four-toed Salamanders live in bogs, boggy streams, and flood plains in woodland areas. Adults prefer hardwood forests, while larvae live in water pools. The species requires both wetland and woodland habitats, so the protection of both is necessary to ensure their survival (NCC 2016). During the summer, the species lives in mossy forests and requires sphagnum bogs for reproduction. During the winter they burrow underground, sometimes in groups and occasionally with other amphibians such as Eastern Red-backed Salamanders (*Plethodon cinereus*) (NCC 2016).

No indication of Four-toed Salamander was observed during field studies. Although bog habitats are prevalent within the Project site, given the rarity of these species within Nova Scotia with the majority of sightings concentrated in south-central mainland it is unlikely that Four-toed Salamanders will be impacted by the Project and no further consideration of effects and mitigation has been undertaken.

Snapping Turtle

The Snapping Turtle, despite its conservation status, is considered relatively common in mainland Nova Scotia (Davis and Browne 1996). Snapping Turtle habitat is usually associated with slow moving water of moderate depth, with a muddy bottom and dense vegetation. Established populations are typically found in ponds, lakes, and river edges (COSEWIC 2009b).

The species has a widespread distribution across Nova Scotia, including the southeastern mainland region within which the Project site is located (COSEWIC 2009b). ACCDC records indicate that the closest observation of this species to the Project site was 81.4 km away. Although no indication of Snapping Turtles was observed on site, possible habitat is present. This species is considered further through the residual effects analysis.

Wood Turtle

Wood turtle requires three key habitat components: a watercourse, sandy substrate for nesting, and a forested area for thermal relief during the summer months (MacGregor and Elderkin 2003). Ideal streams have a clear, moderate flow, a hard bottom composed of sand or gravel, and are 7 to 100 feet wide (MacGregor and Elderkin 2003).

The species is found throughout the province but seems to be most abundant in central Nova Scotia (MacGregor and Elderkin 2003). ACCDC data indicate that the closest observation of this species to

the Project site was 35.2 ± 10 km away. No indication of Wood Turtles was observed during field studies nor was ideal habitat identified. The Project is unlikely to impact this species, and, therefore, no further consideration of effects and mitigation has been undertaken.

5.5.5 Insects

The Nova Scotia Significant Species and Habitats (NSDNR 2012c) database identifies one significant habitat feature relating to insects within a 100 km radius of the Project site. The record is classified as 'Species of Concern' and relates to Black meadowhawk (*Sympetrum danae*). The database contains no records of insects within a 10 km radius of the Project site.

The ACCDC database contains records of 38 unique taxa of insects within a 100 km radius of the Project site (Table 5.21).

Table 5.21: Unique Butterfly and Odonate Species Recorded Within a 100 km radius of the Project Site

Common Name	Scientific Name	SARA Status[1]	COSEWIC Status[2]	NSESA Status[3]	NS GS-Rank[4]	NS S-Rank[4]
Aphrodite Fritillary	*Speyeria aphrodite*	Not Listed	Not Listed	Not Listed	Secure	S3
Arctic Fritillary	*Boloria chariclea*	Not Listed	Not Listed	Not Listed	Sensitive	S2
Baltimore Checkerspot	*Euphydryas phaeton*	Not Listed	Not Listed	Not Listed	Secure	S2S3
Black Meadowhawk	*Sympetrum danae*	Not Listed	Not Listed	Not Listed	Sensitive	S3
Broadtailed Shadowdragon	*Neurocordulia michaeli*	Not Listed	Not Listed	Not Listed	Not Assessed	S1
Brook Snaketail	*Ophiogomphus aspersus*	Not Listed	Not Listed	Not Listed	May Be At Risk	S2S3
Compton Tortoiseshell	*Nymphalis l-album*	Not Listed	Not Listed	Not Listed	Secure	S1S2
Dorcas Copper	*Lycaena dorcas*	Not Listed	Not Listed	Not Listed	Not Assessed	S1?
Eastern Red Damsel	*Amphiagrion saucium*	Not Listed	Not Listed	Not Listed	Secure	S3
Elfin Skimmer	*Nannothemis bella*	Not Listed	Not Listed	Not Listed	Secure	S3
Forcipate Emerald	*Somatochlora forcipata*	Not Listed	Not Listed	Not Listed	May Be At Risk	S2S3
Green Comma	*Polygonia faunus*	Not Listed	Not Listed	Not Listed	Secure	S3
Grey Comma	*Polygonia progne*	Not Listed	Not Listed	Not Listed	Secure	S3S4
Grey Hairstreak	*Strymon melinus*	Not Listed	Not Listed	Not Listed	Secure	S1S2
Harlequin Darner	*Gomphaeschna furcillata*	Not Listed	Not Listed	Not Listed	Sensitive	S3
Harpoon Clubtail	*Gomphus descriptus*	Not Listed	Not Listed	Not Listed	Sensitive	S2S3
Henry's Elfin	*Callophrys henrici*	Not Listed	Not Listed	Not Listed	Secure	S3
Jutta Arctic	*Oeneis jutta*	Not Listed	Not Listed	Not Listed	May Be At Risk	S3
Juvenal's Duskywing	*Erynnis juvenalis*	Not Listed	Not Listed	Not Listed	Secure	S3S4
Maine Snaketail	*Ophiogomphus mainensis*	Not Listed	Not Listed	Not Listed	May Be At Risk	S2S3
Milbert's Tortoiseshell	*Aglais milberti*	Not Listed	Not Listed	Not Listed	Secure	S2

Common Name	Scientific Name	SARA Status[1]	COSEWIC Status[2]	NSESA Status[3]	NS GS-Rank[4]	NS S-Rank[4]
Monarch	*Danaus plexippus*	Special Concern	Endangered	Endangered	Sensitive	S2B
Mottled Darner	*Aeshna clepsydra*	Not Listed	Not Listed	Not Listed	Secure	S3
Northern Cloudywing	*Thorybes pylades*	Not Listed	Not Listed	Not Listed	Sensitive	S2S3
Northern Pygmy Clubtail	*Lanthus parvulus*	Not Listed	Not Listed	Not Listed	Secure	S3S4
Ocellated Darner	*Boyeria grafiana*	Not Listed	Not Listed	Not Listed	Sensitive	S3
Pepper and Salt Skipper	*Amblyscirtes hegon*	Not Listed	Not Listed	Not Listed	Secure	S2S3
Question Mark	*Polygonia interrogationis*	Not Listed	Not Listed	Not Listed	Secure	S3B
Rusty Snaketail	*Ophiogomphus rupinsulensis*	Not Listed	Not Listed	Not Listed	May Be At Risk	S2S3
Salt Marsh Copper	*Lycaena dospassosi*	Not Listed	Not Listed	Not Listed	At Risk	S2
Short-tailed Swallowtail	*Papilio brevicauda*	Not Listed	Not Listed	Not Listed	Sensitive	S1
Shy Cleg	*Haematopota rara*	Not Listed	Not Listed	Not Listed	Undetermined	S1S3
Spot-Winged Glider	*Pantala hymenaea*	Not Listed	Not Listed	Not Listed	Sensitive	S2?B
Vernal Bluet	*Enallagma vernale*	Not Listed	Not Listed	Not Listed	Undetermined	S3
Williamson's Emerald	*Somatochlora williamsoni*	Not Listed	Not Listed	Not Listed	May Be At Risk	S2
Yellow-banded Bumblebee	*Bombus terricola*	Not Listed	Special Concern	Vulnerable	Sensitive	S3

Source: ACCDC 2017; [1]GC 2017a; [2]COSEWIC 2017; [3]NSDNR 2017; [4]ACCDC 2017

All species listed above in Table 5.21 are considered priority insect species. The Monarch and the Yellow-banded bumblebee are the only species that have been granted a designated conservation status at either the provincial or federal level.

The Monarch can be found in open-habitats with abundant wildflower growth. Milkweed (*Asclepias* spp.) is a critical element of breeding habitat, whereas asters (*Asteraciae* spp.) and goldenrods (*Solidago* spp.) provide necessary food resources during migration (MTRI 2008).

Nova Scotia falls within the breeding range of this migratory species (COSEWIC 2010), and individuals can be found throughout the province from May to October (Maritime Butterfly Atlas 2012). Considering the widespread distribution of the species in Atlantic Canada, it is possible that the Monarch may transit through the Project site, particularly during the migratory period (late summer/early fall); however, it is unlikely that the Project site provides sufficient nectar resources to support a large congregation of migratory Monarchs.

The Yellow-banded Bumblebee can be found in various habitats throughout Nova Scotia, including mixed woodlands, agricultural habitats, and urban areas. It is a generalist species, feeding on both pollen and nectar from a wide range of plant genera. These bees usually nest and overwinter (queens) underground, often taking advantage of abandoned rodent burrows and rotting logs (COSEWIC 2015). In 2015, the Yellow-banded Bumblebee was listed of 'Special Concern' by

COSEWIC and in 2017, it was list as 'Vulnerable' by the *NSESA*. Considering this species was once widespread in Nova Scotia, it is possible that it could be present at the Project site, however, it is unlikely that the Project site provides sufficient pollen or nectar resources to meet the dietary requirements of this species as much of it is barren lands.

5.5.6 Potential Interactions and Effects

Project activities have the potential to impact the terrestrial environment during construction and operation resulting in:

- Habitat loss/alteration;
- Disturbance to mammals and herpetofauna through noise, and increased vehicular and human presence;
- Accidental release of sediment and hazardous materials; and
- Direct mortality.

Vegetation and Habitat

Terrestrial habitat loss and alteration will occur as a result of construction activities, which will involve excavation, infilling, and vegetation removal within the Project footprint. The impacts of habitat loss will be minimized through Project design with the avoidance of ecologically sensitive areas and by restricting impacts to as small of an area as possible.

Six vegetative species of conservational concern were identified at the Project site. Two sedge species were identified along the access roads of Sable Wind and are associated with disturbed habitats and roadways. Project activities are unlikely to seriously harm them and will possibly increase their habitat. The remainder of species are associated with acidic wet areas and were identified scattered throughout on-site bogs. Although the Project will impact some bog habitat, due to the relative abundance of bogs in the area, this should not represent a severe impact to their abundance in the region.

Wetlands

Impacts to wetland habitat are managed through the *NSEA.* Wetlands provide ecological functions and services within watersheds and provide an important link between aquatic and terrestrial habitat. The *Wetland Conservation Policy* (November 2011) follows a goal of 'no net loss' of wetland habitat, which is achieved through avoidance, mitigative design and compensation for the loss of habitat. All wetland alterations associated with the project will receive provincial permitting approvals prior to construction activities. Wetland hydrologic function will be maintained in existing habitat through the installation of culverts.

Mammals, Herpetofauna, and Insects

Disruption to mammals, herpetofauna, and insects as a result of noise generation, human presence, and vehicle traffic on the Project site may occur during the construction and the operational phases. During construction, noise guidelines will be maintained according to provincial and federal noise regulations. Construction related disturbances will be temporary, and although may cause some short-term disturbances, should not result in any long term behavioural shifts.

During operations, increased human presence and vehicular activity to and from the Project site may result in sensory disturbances to nearby mammals, herpetofauna and insects, including SOCI. This

may result in the displacement of these animals from the area. During launch activities, there will be a substantial increase in activity from day to day activities. As well, the noise produced from the actual launch will likely result in a temporary sensory disturbance lasting less than 10 minutes.

Direct mortality of mammals, herpetofauna, or insects may occur as a result of construction activities, such as excavation and infilling, or from vehicular movement on site during launch activities. During operation, fencing will be placed around the perimeter of the Project site which will aid in ensuring wildlife is not within the Project footprint, particularly the launch pad, when operational activities are ongoing. A wildlife management plan will be developed and included in the Project's EPP, and will include a SOCI identification guide, as well as a reporting protocol to report SOCI sightings during the construction and operation phases to the environmental manager, as well as NSDNR.

Accidental Spills
Propellants and fuels will be stored on site, as well as used in the rockets themselves. A spill contingency plan will be developed and incorporated into the EPP that would include information on emergency spill procedures.

5.5.7 Specific Mitigative and Protective Measures
Mitigative measures to minimize the environmental effects of the Project on the terrestrial environment include:

- Project personnel will report any evidence of Mainland Moose to NSDNR;
- Post-construction moose surveys will be completed;
- Should large congregations of Monarchs be found at the Project site, Project activities in the area should cease until the migrating group has left the Project site;
- General site restoration should be conducted following construction and should include the replanting of any vegetation removed or disturbed outside of the Project footprint;
- Damage and removal of vegetation will be minimized by establishing staging areas and site access routes away from existing trees/naturalized vegetation to the extent possible;
- Exposed soils will be stabilized and re-vegetated as soon as possible;
- Ensure that stockpiled material is secured and stabilized to prevent erosion and runoff;
- Implement temporary erosion and sediment control measures to prevent erosion/runoff from impacting adjacent vegetated lands and riparian areas;
- Areas for fuel storage, refuelling or lubrication of equipment should be located at least 30 m from any water body or wetland;
- Propellant and fuels will be contained in vessels to industry standards and checked regularly to ensure they are in good working condition;
- Washing and servicing of machinery and equipment should not be completed within 30 m of a waterbody or in an area where wash water will run into a wetland or waterbody; and
- Waste material will be properly stored and disposed of so as to not attract wildlife to the Project site.

5.5.8 Potential Residual Effects

An analysis of residual effects on terrestrial habitat from the Project is provided in Table 5.22. There is likely to be some impacts to terrestrial habitat, however these are expected to be short-term and impacting a minimal proportion of the local ecological community.

Table 5.22: Determination of Residual Effects to the Terrestrial Environment

VEC	Phase	Significance Criteria	Residual Effects	Significance of Residual Effects
Terrestrial Environment	Habitat loss/alteration (construction)	Scope: Local Duration: Long-term Frequency: Once Magnitude: Low	Yes	Low
	Disturbance (construction/operation)	Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Medium	Yes	Low
	Direct Mortality (construction/operation)	Scope: Local Duration: Short-term Frequency: Once Magnitude: Low	Yes	Low

5.5.9 Recommended Monitoring and Follow-up

Wetland monitoring should be conducted post-constructed, as stipulated by a Wetland Alteration Application Approval.

An EPP will be developed and implemented for the Project, including a spill prevention plan and contingency plans (as necessary). A wildlife management plan will be developed and included in the Project's EPP, and will include a SOCI identification guide, as well as a reporting protocol to report SOCI sightings during the construction and operation phases to the environmental manager, as well as NSDNR.

5.6 Avifauna

Avifauna in the area of the Project site as well as throughout the greater area of Canso and Little Dover was evaluated using a variety of assessment protocols including a desktop review of existing information and an extensive series of field programs.

The closest Important Bird Area (IBA) (IBA Canada 2012) is the Country Island Complex IBA located 26 km southeast of the Project site. The IBA consists of a series of small islands located off the Atlantic coast near Country Harbour and Tor Bay, in Guysborough County. The Country Island Complex IBA supports a large number of nesting Roseate Terns. The largest number are located on Country Island which is 68 km from the Project site, however additional islands within the complex are closer to the Project site, including Forster, Cooks, Dorts and Hog Islands.

Roseate Terns (*Sterna dougallii*)(identified as 'Threatened' by COSEWIC) have been recorded on Country Island since the 1980s, with an average of 30-35 pairs between 1987 and 1996 (IBA Canada, 2012). However, due to high predations by gulls, crows, and ravens resulted in almost complete breeding failure and in 1998 only three pairs nested on the island. In 1997 and 1998,

surveys identified numerous breeding pairs on islands throughout the complex (IBA Canada, 2012). In addition, over 50,000 pairs of Leach's Storm-petrels (*Oceanodroma leucorhoa*) were estimated in Country Island in 1998, representing about 2% of the estimated western population (IBA Canada, 2012). Arctic Terns (*Sterna paradisaea*) and Common Terns (*Sterna hirundo*) numbering in the hundreds are also found on the islands (IBA Canada 2012). Predation by gulls and corvids appear to be the most significant threat affecting nesting terns and, as a result, a Tern Restoration Plan for Country Island was developed (IBA Canada, 2012). The program involves non-lethal gull control by disrupting the early breeding season of both Herring Gulls (*Larus argentatus*) and Great Black-backed Gulls (*Larus marinus*). American Crow (*Corvus brachyrhynchos*) and Common Raven (*Corvus corax*) nests were also removed (IBA Canada, 2012).

The Project site is contained within map square 20PR52 of the Maritime Breeding Bird Atlas (MBBA 2012). In the most recent edition of the MBBA (covering the years 2006-2010), 77 species were identified as being possible, probable, or confirmed breeders within this area. The MBBA did not have any records of SOCI considered confirmed breeders; the following SOCI are considered probable breeders in the area:

- American Oystercatcher (*Haematopus palliatus*) – "S1B" (ACCDC);
- Brown-headed Cowbird (*Molothrus ater*) – "S2B" (ACCDC);
- Ruby-crowned Kinglet (*Regulus calendula*) – "3 - Sensitive" (NSDNR);
- Spotted Sandpiper (*Actitis macularius*) – "3 - Sensitive" (NSDNR), "S3S4B" (ACCDC); and
- Tennessee Warbler (*Vermivora peregrina*) – "3 - Sensitive" (NSDNR), "S3S4B" (ACCDC).

The NS Significant Species and Habitats database contains 383 unique records pertaining to birds and/or bird habitat within a 100 km radius of the Project site. These records include:

- 198 classified in the database as "Other Habitat", of which the majority relate to Bald Eagle (*Haliaeetus leucocephalus*) (162) and Osprey (*Pandion haliaetus*) (20), but also including records of Common Eider (*Somateria millissima*) (5), Great Blue Heron (*Ardea herodias*) (5), Great Horned Owl (*Bubo virginianus*) (3), Double-crested Cormorant (*Phalacrocorax auritus*) (1) and Barred Owl (*Strix varia*) (1);
- 101 records classified as "Species of Concern", of which the majority relate to Common Loon (*Gavia immer*) (33) and unclassified tern species (38), but also including records of Common Tern (13), Northern Goshawk (*Accipiter gentilis*) (4) and Arctic Tern (2), among others;
- 74 records classified as "Migratory Bird", relating to Common Eider (6), Double-crested Cormorant (9), unclassified waterfowl (11), Whimbrel (*Numenius phaeopus*) (8) and Willet (*Tringa semipalmata*) (21); and
- 11 records classified as "Species at Risk", primarily relating to Harlequin Duck (8), Roseate Tern (2) and unclassified tern species (1).

There are nine significant habitat features related to birds present within a 5 km radius of the Project site as summarized in Table 5.23.

Table 5.23: Significant Habitat Features Related to Birds Within a 10 km Radius of the Project Site

Feature Code	Species or Other Information	Location	Distance from Project Site (km)	Direction
GU858	Migratory Bird	Crow Island	4.6	North East
GU985	Bald Eagle	Snow Island	0.6	East
GU991	Harlequin Duck	Crow Island	4.6	North East
GU994	Double-crested Cormorant	Bald Rock	3.3	North
GU992	Harlequin Duck	Chebucto Bay	2	North
GU1007	Tern (unspecified)	Cranberry Islands	5	East
GU1008	Seagull (unspecified)	Spinney Gully Island	0.4	East
GU1009	Seagull (unspecified)	Gull Island	3.4	South East
GU1010	Seagull (unspecified)	Sheep Island	3.7	South West

Source: NSDNR 2014

The ACCDC database contains records of 102 bird SOCI within a 100 km radius of the Project site. Table F1 (Appendix F) lists these species as well as their respective provincial and national conservation status ranks. Of these species, the following are listed either by *SARA* or the *NSESA*:

- Barn Swallow (*Hirundo rustica*): 'Not Listed' (SARA), 'Endangered' (NS ESA), 'Threatened' (COSEWIC), 'At Risk' (NSDNR), 'S3B' (NS S-Rank)
- Bicknell's Thrust (*Catharus bicknelli*): 'Special Concern' (SARA), 'Endangered' (NS ESA), 'Threatened' (COSEWIC), 'At Risk' (NSDNR), 'S1S2B' (NS S-Rank)
- Bobolink (Dolichonyx oryzivorus): 'Not Listed' (SARA), 'Vulnerable' (NS ESA), 'Threatened' (COSEWIC), 'Sensitive' (NSDNR), 'S3S4B' (NS S-Rank)
- Canada Warbler (*Wilsonia Canadensis*): 'Threatened' (SARA), 'Endangered' (NS ESA), 'Threatened' (COSEWIC), 'At Risk' (NSDNR), 'S3S4B' (NS S-Rank)
- Chimney Swift (*Chaetura pelagica*): 'Threatened' (SARA), 'Endangered' (NS ESA), 'Threatened' (COSEWIC), 'At Risk' (NSDNR), 'S2B, S1M' (NS S-Rank)
- Common Nighthawk (*Chordeiles minor*): 'Threatened' (SARA), 'Threatened' (NS ESA), 'Threatened' (COSEWIC), 'At Risk' (NSDNR), 'S2S3B' (NS S-Rank)
- Eastern Wood-Pewee (*Contopus virens*): 'Not Listed' (SARA), 'Vulnerable' (NS ESA), 'Special Concern' (COSEWIC), 'Sensitive' (NSDNR), 'S3S4B' (NS S-Rank)
- Harlequin Duck – Eastern Pop. (*Histrionicus histrionicus pop. 1*): 'Special Concern' (SARA), 'Endangered' (NS ESA), 'Special Concern' (COSEWIC), 'At Risk' (NSDNR), 'S2N' (NS S-Rank)
- Olive-sided Flycatcher (*Contopus cooperi*): 'Threatened' (SARA), 'Threatened' (NS ESA), 'Threatened' (COSEWIC), 'At Risk' (NSDNR), 'S3B' (NS S-Rank)
- Peregrine Falcon – anatum/tundrius (*Falco peregrinus pop. 1*): 'Special Concern' (SARA), 'Vulnerable' (NS ESA), 'Special Concern' (COSEWIC), 'Sensitive' (NSDNR), 'S1B, SNAM' (NS S-Rank)
- Piping Plover melodus ssp. (*Charadrius melodus melodus*): 'Endangered' (SARA), 'Endangered' (NS ESA), 'Endangered' (COSEWIC), 'At Risk' (NSDNR), 'S1B' (NS S-Rank)
- Red Know rufa ssp (*Calidris canutus rufa*): 'Not Listed' (SARA), 'Endangered' (NS ESA), 'Endangered' (COSEWIC), 'At Risk' (NSDNR), 'S2M' (NS S-Rank)

- Roseate Tern (*Sterna dougallii*): 'Endangered' (SARA), 'Endangered' (NS ESA), 'Endangered' (COSEWIC), 'At Risk' (NSDNR), 'S1B' (NS S-Rank)
- Rusty Blackbird (*Euphagus carolinus*): 'Special Concern' (SARA), 'Endangered' (NS ESA), 'Special Concern' (COSEWIC), 'May Be At Risk' (NSDNR), 'S2B' (NS S-Rank)
- Savannah Sparrow princeps ssp (*Passerculus sandwichensis princeps*): 'Special Concern' (SARA), 'Not Listed' (NS ESA), 'Special Concern' (COSEWIC), 'Sensitive' (NSDNR), 'S1B' (NS S-Rank)
- Short-eared Owl (*Asio flammeus*): 'Special Concern' (SARA), 'Not Listed' (NS ESA), 'Special Concern' (COSEWIC), 'May Be At Risk' (NSDNR), 'S1B' (NS S-Rank)
- Whip-Poor-Will (*Caprimulgus vociferus*): 'Threatened' (SARA), 'Threatened' (NS ESA), 'Threatened' (COSEWIC), 'At Risk' (NSDNR), 'S1?B' (NS S-Rank)

Table F2 (Appendix F) lists the conservation status for NS species. Field surveys were completed throughout 2017 to gather data on the diversity, abundance, breeding status and habitat utilization of avifauna around the Project site, as well as in other areas in the general area of the Project site where birds are known to congregate (Drawing 5.8).

The avian field assessments included three programs:

- Passerine surveys;
- Shorebird surveys; and
- An avian acoustic study.

Field surveys employed a variety of methodologies, which will be described in each of the subsequent sections. Accompanying data for each program can be found in Appendix F.

5.6.1 Passerine Surveys

Passerine surveys were conducted to assess the diversity, abundance, habitat utilization and breeding status of terrestrial birds within and near the Project site throughout a full year [winter, spring, summer (breeding) and fall].

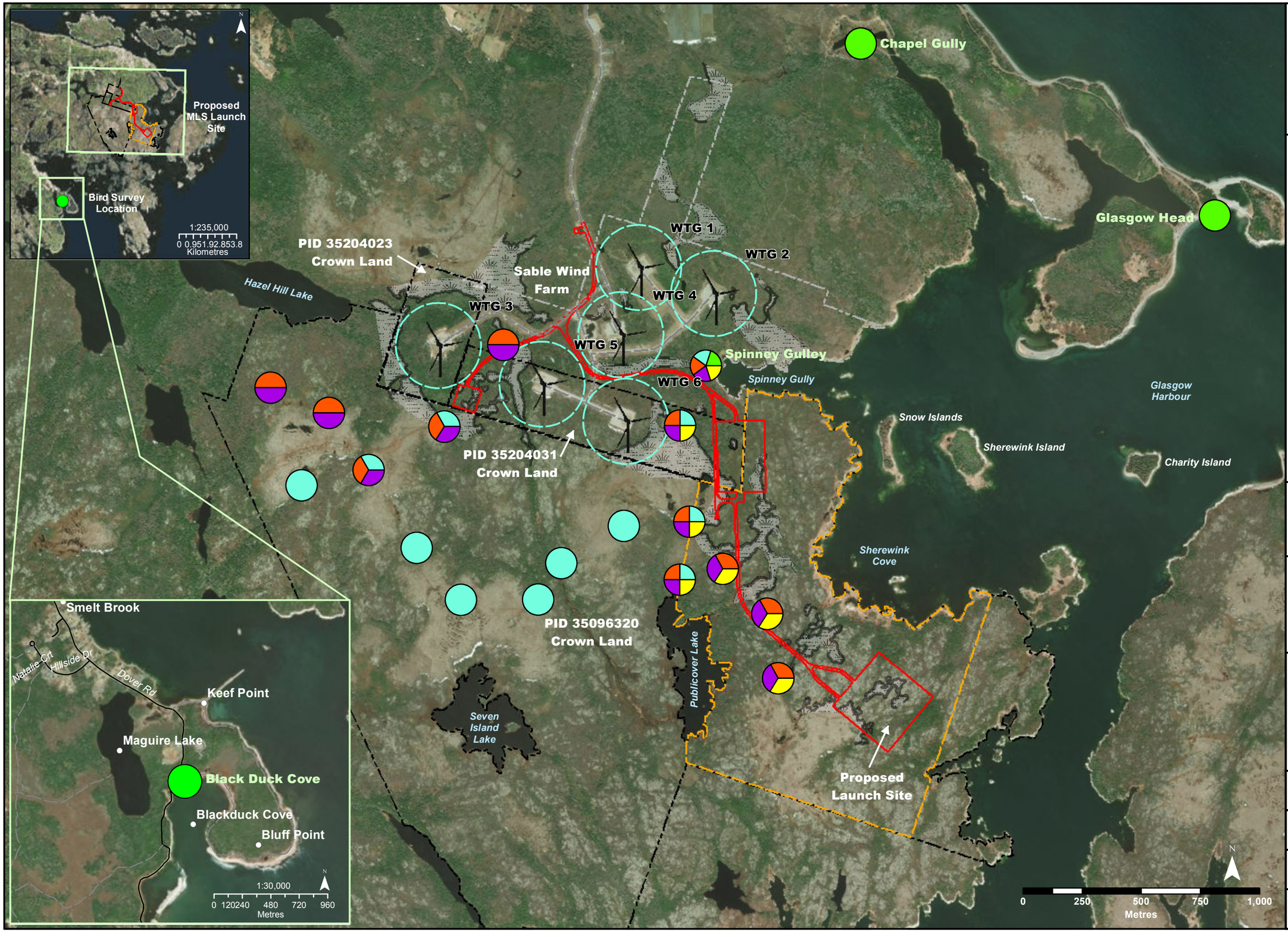
Passerine surveys employed the standard area search methodology (CWS 2007). Birds were inventoried over 10-minute point counts at a number of locations on and near the Project site (Drawing 5.8). Surveys were completed within four hours of sunrise. It total, ten surveys were conducted throughout 2017. Survey dates are summarized in Table 5.24 below. Breeding evidence was assessed using the methodology described in the Maritime Breeding Bird Atlas (BSC 2016).

Table 5.24: Passerine Survey Dates

Winter	Spring	Breeding	Fall
22-Feb-17	25-May-17	06-Jun-17	21-Sep-17
23-Jan-17	19-Apr-17	12-Jul-17	25-Oct-17
-	02-May-17	27-Jun-17	-

Winter Surveys

Two winter passerine surveys were conducted in January and February 2017 (Table 5.25) at 12-point count locations (Drawing 5.8) on and near the Project site in habitats representative of the



Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Existing Sable Wind Farm Access
- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area
- Confirmed Wetland Boundries
- Approximate Wetland Boundaries
- Field Identified Wetland

Bird Survey Locations

- Shorebird
- Passerine: Winter, Spring, Breeding, Fall

Canso Launch Site - Bird Survey

MLS Maritime Launch Services Ltd

Strum CONSULTING

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: June 2018	Project #: 16-5903
Scale: 1:15,000	Drawing #: 5.8
Drawn By: M. Marriott	
Checked By: S. Dickey	

area. A total of 95 individual birds were observed, comprised of five species (Table F3, Appendix F, attached).

The American Crow was the most commonly observed species during the winter bird surveys, followed by the Black-capped Chickadee (*Poecile atricapillus*), both of which appear to have a robust winter resident population in the area. Bald Eagles were also observed hunting above the open bog areas during the winter. Small numbers of the Common Raven and the Hairy Woodpecker (*Leuconotopicus villosus*) were also observed.

No SOCI species were observed during the winter surveys (Table F2, Appendix F).

Overall the wintering passerine bird population in the area appears to be low in both diversity and abundance, and comprised entirely of species known to be common winter residents in Nova Scotia.

Spring Migration Surveys
Three spring migration surveys were conducted in April and May (Table 5.25) at 12-point count locations (Drawing 5.8) on and near the Project site in habitats representative of the area. A total of 340 individual birds were observed, comprised of 37 species (Table F3, Appendix F).

Again, the American Crow was the most commonly observed species during the Spring Migration surveys owing to their robust resident population in the area. The same trend was observed for Black-capped Chickadees. Relatively high numbers of migratory songbirds were also observed [e.g. Common Yellowthroat (*Geothlypis trichas*), Magnolia Warbler (*Setophaga magnolia*), and Yellow-rumped Warbler (*Setophaga coronate*)], especially in areas of softwood forest cover and along forest edges. The predominant species observed in the more open bog and barren type habitat, which is prevalent in the Project site area, included a variety of sparrows [Dark-eyed Junco (*Junco hyemalis*), Savannah Sparrow (*Passerculus sandwichensis*), Song Sparrow (*Melospiza melodia*) and White-throated Sparrow (*Zonotrichia albicollis*)] and territorial warblers (e.g. Common Yellowthroat and Palm Warblers (*Setophaga palmarum*). Many of these species are early migrants and may have been establishing breeding territory as early as the April surveys. Seagulls (namely the Herring Gull and Greater Black-backed Gull) were observed making inland sorties over the Project site area, likely on foraging trips to the isolated pools in the nearby bogs or the various freshwater lakes in the area. The nearby Sherewink Cove appears to be a congregation area for various seagulls, as well as Double-crested Cormorants and Common Terns.

Six SOCI were observed in the spring migration surveys, listed in Table 5.25 below.

Of the six SOCI species observed, only the Common Tern was observed in relative abundance (21 individual birds). These species will be discussed further in Section 5.6.5.

The avian population in the Study area during the spring migration period is fairly robust and comprised largely of resident birds (e.g. crows, and resident gulls) as well as common songbird species, many of which are early migrants which began to establish their breeding territory shortly after arriving in early spring. It should be noted that the winter and spring of 2017 was particularly mild in the area, so the early establishment of breeding territories may not be typical. There was a

noteworthy trend of diurnal travel inland by seabirds, mainly gulls but also a few terns, during the spring migration period, possibly coinciding with the running of fish stocks into the inland lakes.

Breeding Passerine Surveys

Three breeding passerine surveys were conducted within the breeding season for most passerine birds (early June to late July) (Table 5.25). Surveys were conducted at 12-point count locations on and near the Project site in habitats representative of the area. A total of 610 individual birds were observed, comprised of 37 species (Table F3, Appendix F). Twenty four (24) species were assessed as 'possible' breeders, 12 were assessed as 'probable' breeders and one species was assessed as a 'confirmed' breeder (Table F4, Appendix F).

The most commonly observed species during the breeding passerine surveys were the Common Yellowthroat, the Dark-eyed Junco, the Hermit Thrush (*Catharus guttatus*), and the Savannah Sparrow, all of which were assessed as 'probable' breeders. Common woodland warblers (e.g. Magnolia Warbler, Palm Warbler and Yellow-rumped Warbler) were well represented in the surveys as well and were assessed for the most part as 'probable' breeders, indicating a relatively robust breeding population of these common species. A number of sparrow species, including Dark-eyed Junco, Savannah Sparrow, Song Sparrow, and White-throated Sparrow were assessed as 'probable' breeders, the latter of which was assessed as a 'confirmed' breeder, indicating a healthy sparrow population as well. Both the Black-capped Chickadee and Boreal Chickadee (*Poecile hudsonicus*) were also assessed as 'probable' breeders as well, likely owing to the abundance of coniferous and tundra-like habitat that is preferred by these species in the area. A number of breeding Willet pairs were also observed occupying the edges of bog type habitats near the Project site, indicating that important breeding habitat for this SOCI is abundant in the Area (SOCI will be discussed further in Section 5.6.5).

Areas where the breeding bird community is most concentrated coincides with coniferous forest habitat, which is where the largest diversity of songbirds that exhibited breeding behaviour were observed. Forest edges, particularly where open bogs met coniferous forest, were also areas of concentrated breeding activity, especially for aggressively territorial species like White-throated Sparrow, and the Common Yellowthroat, and to a lesser extent the Magnolia Warbler and Palm Warbler. The majority of the Project site, especially within the proposed impact area for the Project, was covered in rock-barren habitat comprised of exposed granite interspersed with areas of stunted jack-pine and spruce shrub cover. These areas were sparsely occupied by the breeding bird community, likely because of the lack of adequate cover. Open bog habitat is also prevalent within the Project site area (yet very little bog habitat would be impacted by the Project). This habitat was also sparsely occupied by the breeding bird community, with the exception of the Savannah Sparrow, were breeding pairs were common.

Six SOCI were observed during the breeding season surveys, listed in Table 5.25 below. Two of the six SOCI identified during the breeding season surveys were assessed as 'Possible' breeders (the Willet and the Boreal Chickadee), the rest were assessed as 'possible' breeders. SOCI will be discussed further in Section 5.6.5.

The avian population that occupies the Project site during the breeding season appears to be comprised largely of holdovers that were observed during spring migration, namely common sparrow and warbler species that arrived early in the spring and stayed in the area to nest and fledge their young. The breeding bird community was not observed to be especially diverse, and most species for which probable breeding evidence was observed are common throughout Nova Scotia. Habitat utilization by the breeding bird community was most concentrated in forested areas and forest edges. Open areas, such as rock barren (which is the most prevalent habitat type in the area) and open bog were under-utilized by all but a few species.

Fall Migration Surveys

Two fall migration passerine surveys were conducted in September and October 2017 (Table 5.25), at seven point count locations on and near the Project site in habitats representative of the area. A total of 308 individual birds were observed, comprised of 39 species (Table F3, Appendix F).

Resident American Crows were observed as the most abundant species during the fall migration surveys. Blue Jays (*Cyanocitta cristata*), Black-capped Chickadees, Common Ravens, and American Robins (*Turdus migratorius*), which also likely reside in the area throughout much of the winter were also observed. The majority of the breeding songbird species observed in the spring and breeding season surveys had left the area in the fall. Large numbers of finch species [mostly Pine Siskins (*Spinus pinus*), but American Goldfinch (*Spinus tristis*), Purple Finch (*Haemorhous purpureus*) and White-winged Crossbills (*Loxia leucoptera*) were also represented] were observed stopping near the Project site, likely foraging on the diverse berry crop on the bogs and scrubbed areas, where blueberry, cranberry, huckleberry, holly and Mountain ash berry crops were sustained throughout much of the late summer and fall. The berry crop also attracted a diverse array of other migrants, particularly Cedar Waxwing (*Bombycilla cedrorum*), Orange Crowned Warbler (*Vermivora celata*) and Lincoln's Sparrow (*Melospiza lincolnii*) to stopover in the area, albeit in relatively low numbers. A trend of various waterfowl species utilizing the isolated pools in the bogs, as well as the freshwater lakes in the area was noted. American Black Duck (*Anas rubripes*), Canada Goose (*Branta canadensis*), and Mallard (*Anas platyrhynchos*), were observed, within and flying over the bogs in the area, along with a few shorebird species such as Killdeer (*Charadrius vociferus*), and Spotted Sandpiper (*Actitis macularius*). While not observed during these surveys, Whimbrels (*Numenius phaeopus*) are also known to stopover suitable habitats in Nova Scotia to feed on berry crops (Morrison 1984). Ipswich Sparrow (a rare sub-species of the Savannah Sparrow endemic to Sable Island) was also observed foraging in bog habitat as well.

Six SOCI were observed during the fall migration surveys (Table 5.25). For the most part these species were observed in low numbers, with the exception of the Boreal Chickadee and the Pine Siskin. Nearly a dozen Boreal Chickadees were observed, all traveling in mixed migratory songbird flocks that were likely passing through the area. Likewise, for the Pine Siskin, which were observed in large flocks of several dozen strong, which appeared to use the area as a stopover location.

Overall, the data collected during the fall survey indicates a relatively constant population of common resident species, as well as an influx of a variety of passerine and shorebird species that utilize the area as a stopover location during their fall migration. The rich berry crop of the bogs and low scrubbed areas appears to be a significant attractor of these stopover migrants.

SOCI Observed During Passerine Surveys

Table 5.25 includes the list of SOCI that were observed throughout the Passerine Survey Program.

Table 5.25: SOCI Observed During Passerine Surveys

Common Name*	Scientific Name	Winter	Spring Migration	Breeding Season	Fall Migration
Boreal Chickadee	*Poecile hudsonica*	-	Yes	Yes	Yes
Common Loon	*Gavia immer*	-	-	Yes	-
Common Tern	*Sterna hirundo*	-	Yes	Yes	-
Golden-crowned Kinglet	*Regulus satrapa*	-	Yes	Yes	-
Greater Yellowlegs	*Tringa melanoleuca*	-	Yes	Yes	-
Killdeer	*Charadrius vociferus*	-	-	-	Yes
Pine Siskin	*Carduelis pinus*	-	-	-	Yes
Ruby-crowned Kinglet	*Regulus calendula*	-	Yes	Yes	-
Savannah Sparrow (Ipswich)	*Passerculus sandwichensis*	-	-	-	Yes
Semipalmated Sandpiper	*Charadrius semipalmatus*	-	-	-	Yes
Spotted Sandpiper	*Actitis macularius*	-	-	-	Yes
Willet	*Tringa semipalmata*	-	-	Yes	

* The conservation statuses for each of these species are presented in Table F2, Appendix F, attached.

These SOCI will be discussed in Section 5.6.5.

Passerine Surveys Summary

The data collected over the full season of passerine surveys can be summarized as follows:

- There is a relatively constant population of common terrestrial species as well as seagulls in the area.
- The avian population in the area over the winter period is low and un-diverse.
- Early songbird migrants begin to establish a robust breeding bird community early in the spring comprised of common migrant species that persists until late-summer.
- The most important terrestrial habitats for breeding birds are in areas of softwood forest cover and forest edges, whereas barren habitat (which is the most prevalent habitat type in the area) and bog habitat are scantly utilized by birds during the breeding season.
- The area appears to be a stopover location for a variety of migratory passerine, waterfowl and shorebird species during the fall, owing largely to the rich berry crop in bog and deciduous shrub dominated habitats.

5.6.2 Shorebird Surveys

The area is known to be utilized as a stopover point for a variety of seaducks, waterfowl, shorebirds and seabirds during the migratory periods. Seabird colonies are also known to be present and occupied by breeding seagulls and terns throughout the spring and summer (NSDNR 2014). Shorebird surveys were conducted to assess the diversity, abundance and habitat utilization of the marine and coastal bird population near the Project site throughout the year.

Shorebird surveys employed the standard area search methodology (CWS 2007). Birds were inventoried over 30-minute point counts at a number of locations on and near the Project site

(Drawing 5.8). Surveys were conducted within four hours of sunrise. It total, 14 surveys were conducted throughout 2017. Four survey areas were selected based on their habitat characteristics, and likelihood of being utilized by a variety of bird species. These four areas are described below:

- Spinney Gully – This small inlet is located immediately adjacent the Project site. It is a shallow sheltered inlet that may be suitable foraging habitat for shallow diving seabirds and waterfowl. There are a number of small islands nearby that may be utilized by colonies of gulls and other seabirds. A small saltwater marsh is present on the northern shore of the gully that may be suitable for foraging shorebirds and waterfowl.
- Chapel Gully – This is a long narrow sheltered gully that may be suitable foraging habitat for shallow diving seabirds and waterfowl. The gully is affiliated with a saltwater marsh that may be suitable foraging habitat for shorebirds and waterfowl. It is located approximately 1.5 km north of the Project site.
- Blackduck Cove – This is a sheltered inshore cove that may offer protection to sheltering seaducks and waterfowl. The cove has sand and cobbled beach segments that may be suitable foraging and nesting habitat for shorebirds. The cove opens to a relatively exposed area of surf that may be utilized by seaducks and shorebirds. This location is approximately 5 km southwest of the Project site.
- Glasgow Head – This peninsula is the most eastern point of Mainland Nova Scotia and may be a departure / arrival point for migrating birds. It has sand and cobble beaches that may be suitable foraging habitat for shorebirds, as well as a small sheltered cove that may shelter migrating waterfowl or foraging seabirds. This area is located approximately 2 km east of the Project site. Surveys were only conducted at Glasgow Head during the fall migration period when migrant birds were most likely to use the area as a stopover location.

The shorebird survey dates are summarized in Table 5.26 below.

Table 5.26: Shorebird Survey Dates

Season	Winter	Spring	Summer	Fall
Survey Locations	Spinney Gully, Chapel Gully, Blackduck Cove	Spinney Gully, Chapel Gully, Blackduck Cove	Spinney Gully, Chapel Gully, Blackduck Cove	Spinney Gully, Chapel Gully, Blackduck Cove, Glasgow Head
Survey Dates	22-Jan-17	18-Apr-17	27-Jun-17	28-Aug-17
	27-Feb-17	1-May-17	11-Jul-17	3-Oct-17
	13-Mar-17	24-May-17	1-Aug-17	24-Oct-17
	-	-	-	8-Nov-17
	-	-	-	15-Nov-17

Winter Shorebird Surveys

Standard area searches were repeated three times at three locations during the winter season (Table 5.7). Overall, 98 individual birds were observed across all three locations, comprised of eight species (Table F5, Appendix F).

Eight birds, all Common Eiders (*Somateria mollissima*), were observed at Spinney Gully.

The vast majority of birds (90 of 98) and species (seven of eight) were observed at Blackduck Cove. The abundance at this location was entirely due to large numbers of dabbling seabirds (Greater Scaup (*Aythya marila*) and the Surf Scoter (*Melanitta perspicillata*) observed in the cove in the early winter. Both of these species may overwinter in sheltered coastal bays in Nova Scotia. Small numbers of American Black Duck were also observed at this location, as well as transient species including Bald Eagle and Cliff Swallow (*Petrochelidon pyrrhonota*) foraging on and near the sand beach. Low numbers of resident seagulls are also present in the area.
Cliff Swallow was the only SOCI observed at this location, in late February. It was likely that the individuals observed here were early migrants moving through the area.

No species were observed at Chapel Gully.

The winter shorebird survey data shows that small to large groups of sea ducks likely overwinter in the many sheltered coastal bays in the general area of the Project site.

Spring Shorebird Surveys
Standard area searches were repeated three times at three locations during the spring season (Table 5.27). Overall, 145 individual birds were observed across all three locations, comprised of 16 species (Table F5, Appendix F).

Only three seagulls, one Great Black-backed Gull and two Herring Gulls, were observed at Spinney Gully in the spring.

Again, the majority of birds (100 birds comprised of 10 species) were observed at Blackduck Cove. The bulk of the bird abundance observed at this location were Herring Gulls (70 individual birds). Gulls were observed to congregate on a small island immediately to the northwest of Keef Point (Drawing 5.8) at the mouth of Dover Harbour where a mixed species seagull colony appears to be present. Small numbers of common waterfowl species, including American Black Duck, Double-crested Cormorant, Surf Scoter and Canada Goose were also observed sheltering and foraging on the cove.

Forty two (42) birds comprised of 8 species were observed at Chapel Gully. This included small numbers of common ducks (American Black Duck and Mallard) sheltering in the gully, and 24 Canada Geese, which were observed foraging in the saltwater marsh. A Snowy Egret (*Egretta thula*) was also observed, which according to local ornithologists, are known to stop in the marsh annually during the spring and fall.

Three SOCI were observed, two of which (Harlequin Duck and Greater Yellowlegs) were observed in low numbers sheltering or foraging in the marsh at Chapel Gully. A small group of Semipalmated Plovers (*Charadrius semipalmatus*) was also observed foraging on the beach at Blackduck Cove.

The spring shorebird surveys indicate that a variety of shorebird and waterfowl species use the sheltered bays and small saltwater marshes of the area as stopover locations during the spring migration period. The seagull population is also notably higher in coastal areas in the spring as it was in the winter as well.

Summer Shorebird Surveys
Standard area searches were repeated three times at three locations during the summer season (Table 5.27). Overall, 205 individual birds comprised of 11 species were observed across all three locations (Table F5, Appendix F).

Fifteen (15) birds comprised of four species were observed at Spinney Gully, two of which were common gulls (Herring Gull and Ring-billed Gull) foraging in the area, along with the Common Tern. A lone Willet was also observed foraging in a small salt marsh in the area.

Several common gull species, along with Double-crested Cormorants were observed flying from the north and following Chapel Gully to the southeast. This area was noted as a flight path during the 2004 and 2005 Avian assessment for the Sable Wind Project (Amec, 2006), and appears to continue to be used as such. At least three separate mated pairs of Willet were observed in the gully, indicating this species breeds in the area.

Once again, the greatest diversity and abundance of birds was observed at Blackduck Cove, with 169 birds comprised of nine species. The majority of birds were gulls loitering and flying around the sand beach, along with terns. Again, the gull colony near Keef point appeared to be active and occupied by several dozen gulls. There is likely also a colony of Common Terns nearby as well. A few species of shorebird were observed on the sand and rock beaches in the area, included Semipalmated Sandpiper (*Calidris pusilla*) and Spotted Sandpiper (*Actitis macularius*). A willet pair was also observed, likely nesting on the west bank of Blackduck Cove itself.

The summer shorebird surveys show that a number of species, namely Willet, breed in the sheltered coastal bays of the area. Mixed species seagull colonies and tern colonies (that may be mixed species as well, but only the Common Tern was observed) are likely present in the area. NSDNR's Significant Species Database shows tern colonies on the Cranberry Islands, approximately 5 km west of the Project site (NSDNR 2014). Observations of a number of sandpiper species were also consistently made, indicating small but probable breeding populations in the general area. Waterfowl were notably absent from the area during the summer period, with the exception of Canada Geese, which were observed in low numbers.

Fall Shorebird Surveys
Standard area searches were repeated five times at four locations during the summer season (Table 5.27). Overall, 296 individual birds comprised of 24 species were observed across all five locations, (Table F5, Appendix F).

Thirty one (31) birds comprised of six species were observed at Spinney gully during the fall. The majority of birds were common gulls (Herring Gull and Ring-billed Gull). Double-crested Cormorants were also observed foraging in the area. A Lesser Yellowlegs was observed in a small salt marsh, and a small group of Wood Duck were observed stopping over in the area, likely as they migrated from the north.

Thirty seven (37) birds comprised of nine species were observed at Chapel Gully throughout the fall. Most of which were common gulls (Great black-backed Gull, Herring Gull, and Ring billed gull) which

along with Double-crested Cormorant were observed flying down the Chapel Gully flyway, as was observed in the summer shorebird surveys. A few common waterfowl species (American Black Duck and Canada Goose) were observed foraging in the salt marsh, possibly as stopovers during their migration. Transient shorebird species, including Greater Yellowlegs, Great-blue Herron, and Snowy Egret were observed in the salt marsh, the latter of which may be the same individual known by locals to stop in the area in the spring and fall.

Again, Blackduck Cove showed the highest abundance of birds, with 151 observed comprised of nine species. Herring Gull and Great black-backed gull were again very numerous. A noteworthy abundance of waterfowl species was noted in the Cove, including numerous American Black Ducks and Mallards, but also Common Eiders and Common Loons. Small numbers of shorebirds including Semipalmated Plover and Spotted Sandpiper were observed foraging on the sand beach as well.

Only conducted in the fall, surveys at Glasgow head revealed that, like other areas, seagulls and terns patrol the area, and the small cove to the south of a sand beach appears to be a stopover point for a number common ducks. Double-crested Cormorant appears to consistently forage in the shallows near Glasgow head, as it likely does throughout much of Glasgow Harbour throughout the year. The sand beach on the peninsula is frequented by small numbers of shorebirds including Least Sandpiper and Semipalmated Sandpiper. A large group of Snow buntings were also observed in November foraging on the beach, likely as soon as they made landfall on Mainland Nova Scotia after migrating from farther north. In all, 77 individual birds comprised of 11 species were observed during the five surveys conducted at Glasgow Head.

The fall shorebird surveys show that common ducks become more abundant in the area later in the year. Additionally, a number of shorebird species appear in the area, likely as migratory stopovers.

SOCI Observed During Shorebird Surveys

Table 5.27 includes the list of SOCI that were observed throughout the Shorebird Survey Program. Spinney Gully was the only shorebird survey location located near (within 1 km) the Project site, so the SOCI observed at that location could be considered on the Project site. The other locations can be considered reference study locations.

Table 5.27: SOCI Observed During the Shorebird Surveys

Common Name	Winter		Spring		Summer		Fall	
	Spinney Gully (On-Site)	Other Locations	Spinney Gully (On-Site)	Other Locations	Spinney Gully (On-Site)	Other Locations	Spinney Gully (On-Site)	Other Locations
Cliff Swallow	-	Yes	-	-	-	-	-	-
Common Loon	-	-	-	-	-	-	-	Yes
Common Tern	-	-	-	-	Yes	Yes	-	Yes
Greater Yellowlegs	-	-	-	Yes	-	-	-	Yes
Harlequin Duck	-	-	-	Yes	-	-	-	-
Semipalmated Plover	-	-	-	Yes	-	-	-	Yes
Spotted sandpiper	-	-	-	-	-	Yes	-	Yes
Whimbrel	-	-	-	Yes	-	-	-	-
Willet	-	-	-	-	Yes	Yes	-	-

* The conservation statuses for each of these species are presented in Table F2, Appendix F, attached.

These SOCI will be discussed in in Section 5.6.5.

Shorebird Surveys Summary
The results of the full season of shorebird surveys can be summarized as follows:

- The many sheltered coves and bays, especially areas with sand beaches and saltmarsh habitat, in the greater area of the Project site likely host overwintering seaducks.
- The sheltered bays, sand beaches and saltmarsh habitats likely also serve as stopover locations for migrating waterfowl, shorebirds and even passerine species during the spring and fall migratory periods.
- Small to medium sized mixed species colonies of seagulls and terns that are occupied throughout most of the spring and summer exist in the general area.
- There is a healthy breeding population of Willet in the area, and possibly other shorebird species.

5.6.3 Avian Acoustic Study

An avian acoustic study was conducted to assess the bird community throughout the fall migration period. The area may be an important stopover point for birds migrating from the north in the fall, which has been demonstrated in recent studies (Kearney 2017), therefore a detailed assessment of bird movements through the area during the fall was warranted. Avian acoustic assessments have the advantage of being able to collect data for analysis much more frequently (e.g. daily) than in-person assessments, allowing for a more thorough assessment of how the avian community changes over the period of interest, allowing for patterns in migration to be inferred.

The acoustic study was conducted using two SM3 bird acoustic monitors (Wildlife Acoustics, Maynard, Massachusetts). The monitors were programed to record for 10 minutes starting at civil sunrise every day from their deployment on August 15, 2017, until they were taken down on November 16, 2017. Three days per week from August 17, 2017 until November 5, 2017 were selected at random, and the audio recordings made by each monitor were analyzed by a biologist experienced in assessing bird diversity and abundance through acoustic analysis. A total of 30 recordings were analyzed at each monitoring location. One of the monitors malfunctioned for two weeks between September 4 and 17, 2017, so that period was excluded from analysis for both monitoring locations.

While avian acoustic assessments are capable of collecting large amounts of relevant data over a long time period, there are a few limitations that should be addressed. The equipment records sound, including all vocalizations (songs, alarm calls, chip notes, flight calls, etc.) from birds, allowing for bird diversity and abundance to be estimated. However, the identification of birds to the species level is often not possible due to similarities in the recorded vocalizations or poor recording quality (due to environmental noise or large distances between the bird and the acoustic monitors). Furthermore, some groups of birds, such as waterfowl or seabirds, can be quiet, so their actual abundance in the area may not be reflected in the acoustic study dataset. Where possible, species were identified to the species level, but in some cases species could only be identified to the genus or order level. All species were compiled into ‘guilds’ to allow for a more concise analysis of the trends. The guild constituents are as follows:

- Passerines – This guild includes all perching birds, corvids, songbirds, etc.
- Raptors – This guild includes birds of prey, such as eagles, Osprey, owls and hawks
- Sea Birds and Gulls – This guild includes terns and gulls
- Seaducks and Waterfowl – This guild includes ducks, cormorants, geese and other waterfowl
- Shorebirds – This guild includes plovers, sandpipers and other wading birds

Avian acoustic monitors were deployed at the following two locations (Drawing 5.7):

- Spinney Gully Monitor – This monitor was deployed adjacent Spinney Gully, which is a small inlet located immediately adjacent the Project site. It is a shallow sheltered inlet that may be suitable foraging habitat for shallow diving seabirds and waterfowl. There are a number of small islands nearby that may be utilized by colonies of gulls and other seabirds. A small saltwater marsh is present on the northern shore of the gully that may be suitable for foraging shorebirds and waterfowl. The gully is surrounded by a mix of terrestrial habitats, including uneven aged coniferous forests, and deciduous shrub forests. This area should be a good reference for the variety of seabirds, shorebirds and passerine species that occur near the Project site.
- Glasgow Head Monitor – This monitor was deployed on the Glasgow Head peninsula, which is the most eastern point of Mainland Nova Scotia and may be a departure / arrival point for migrating birds. It has sand and cobble beaches that may be suitable foraging habitat for shorebirds, as well as a small sheltered cove that may shelter migrating waterfowl or foraging seabirds. There are also small areas of coniferous forest on the peninsula. This area is located approximately 2 km east of the Project site. This area should be an appropriate reference site where a variety of seabirds, shorebirds, waterfowl and passerine species should occur.

Overall, 490 birds constituted of at least 42 species were detected at the Spinney Gully Monitor, and 360 birds constituted of at least 29 species at Glasgow Head. A number of species (namely Passerines, but also ducks and Shorebirds) were unable to be identified at the species level, so the diversity of birds is likely slightly higher than reported. Passerines were by far the most numerous guild detected in the acoustic assessment, followed by Sea Birds and Gulls, and Shorebirds, with Raptors, and Seaducks and Waterfowl being detected in low numbers, the latter of which are difficult to detected in avian acoustic assessments, so their abundance is likely under-represented. Table 5.28 summarizes the abundance of birds broken down by guild detected at both locations. A full list the species detected during the acoustic assessment can be found in Table F6 (Appendix F).

Table 5.28 Diversity and Abundance of Birds Observed During the Acoustic Study

Guild	Spinney Gully	Glasgow Head
Passerines	368	265
Raptors	5	4
Sea Birds and Gulls	86	50
Seaducks and Waterfowl	9	8
Shorebirds	22	33
Total Number of Birds	490	360
Total Number of Species	42	29

Figure 5.7 (below) shows how the diversity and abundance of birds varied throughout the assessment period.

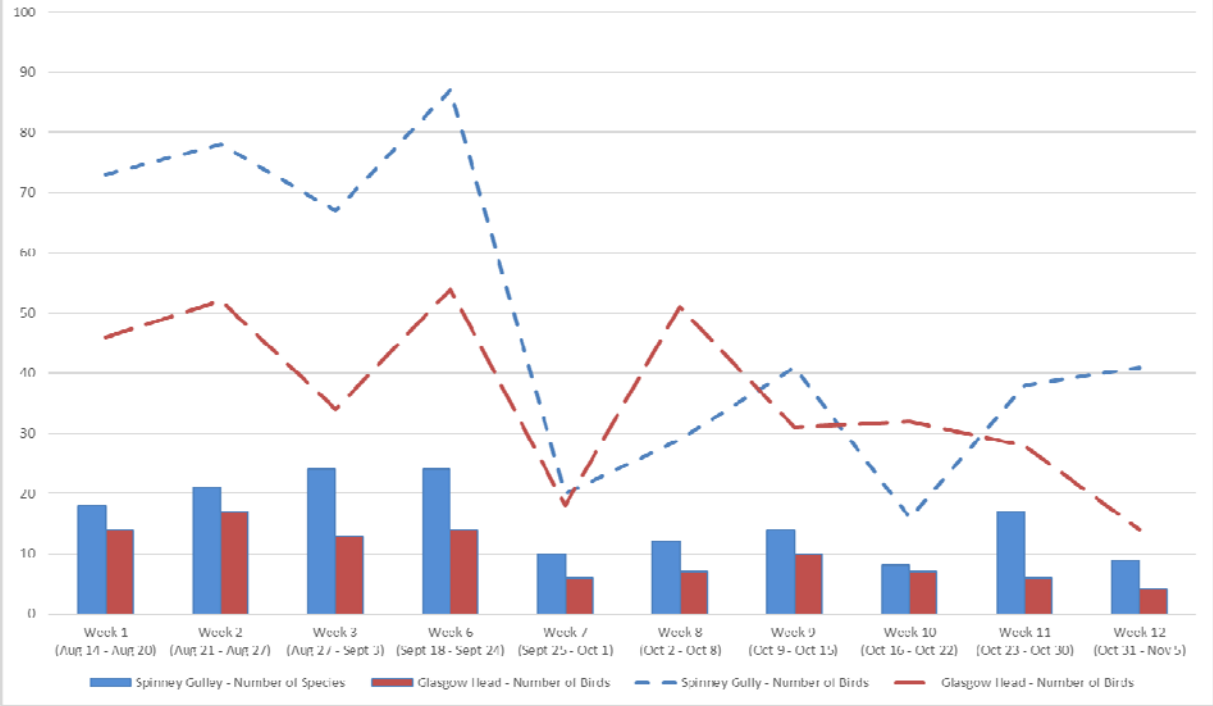


Figure 5.7: Avian Acoustic Study – Diversity and Abundance of Birds over Time

The assessment shows that diversity and abundance of birds detected was relatively high in late summer (mid-August through early September), and highest in early fall (Week 7 of the assessment from September 18 to 24, 2017), after which it remained relatively low at both locations as the fall progressed. The diversity of species detected tended to vary with abundance at both locations. The diversity of birds detected was consistently higher at the Spinney Gully location, likely owing to a greater diversity of fruitful foraging habitat (both terrestrial and marine) in the surrounding area. The abundance of birds was higher at Spinney brook in mid to late summer, and then the comparative abundance of birds detected alternated between the two locations for the duration of the fall.

Figure 5.8 (below) shows how the abundance and composition (by guild) of birds detected varied throughout the assessment period.

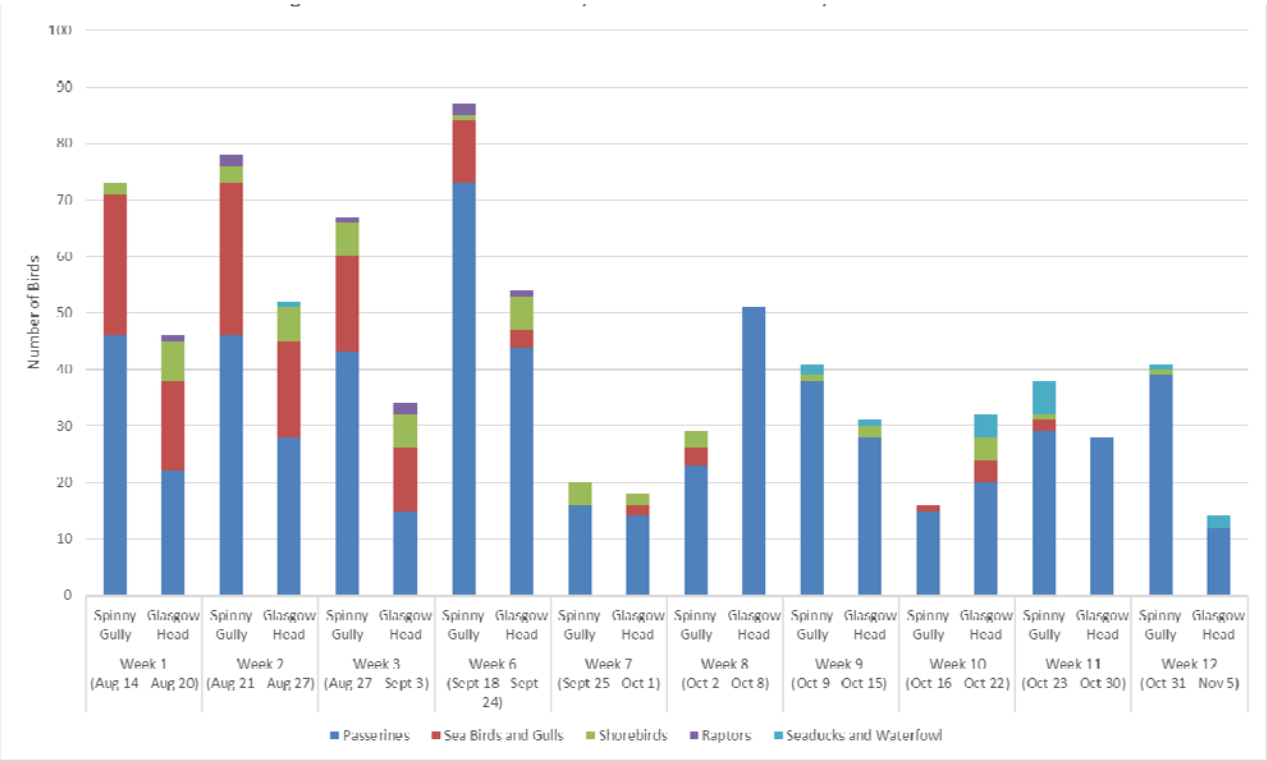


Figure 5.8: Avian Acoustic Study – Abundence of Birds by Guild over Time

Passerines constitute the vast majority of birds detected in the assessment and account for the bulk of variation in the abundance of birds detected over the assessment period. The abundance of passerines detected at Spinney Brook was consistently higher than at Glasgow Head, likely owing to the diversity of foraging habitat in the terrestrial areas around that location. American Crow (likely residents of the area) was the most consistently detected species of passerine. A variety of migratory warbler species were also detected, especially early in the fall. The consistent detection of small flocks of Black-capped Chickadees indicate mixed species groups of migratory songbirds passing through the area. Groups of migratory finches (namely White-winged Crossbill, but also Purple finch and American Goldfinch) were also detected on several occasions, indicating the passage of migratory finches. A number of sparrow species (e.g. Song Sparrow, Dark-eyed Junco, Savannah Sparrow and White-threated Sparrow) were also consistently detected throughout the period, many of these birds may have been passing through the area but some likely remained to over winter. Overall, the acoustic assessment revealed that passerines pass through the area in abundance during the fall migratory period and that that the movement of passerines remain strong well into the fall.

Sea Birds and Gulls were detected in the greatest abundance at both locations in mid-Summer, and their presence appeared to diminish gradually until early fall, with very few being detected beyond September 24. This coincides with the migration of Terns out of the area. Common species of seagulls persisted in the area throughout the assessment period, albeit in low detected abundance.

Shorebirds were detected in low but consistent abundance at both locations throughout the assessment period but were more present before September 24. These birds also appear to migrate through the area throughout much of the late summer and to a lesser extent, the fall.

A few species that constitute the guild Seaducks and Waterfowl were detected during the acoustic assessment, but in low abundance. As the species of this guild are not overly vocal, their detection in avian acoustic assessments is unreliable. The shorebird survey program revealed that many duck species pass through the area in the fall, and a few even over winter.

The only raptor detected was the Bald Eagle, which was detected on several occasions at both locations through the late summer. Eagles were observed in the winter passerine surveys, indicating that these birds reside in the area throughout the year.

Seven SOCI were detected at Spinney Gully, and four at Glasgow Head throughout the acoustic assessment, as summarized in Table 5.29.

Table 5.29: SOCI Detected in the Avian Acoustic Study

Species	Detected at Spinney Gulley	Detected at Glasgow Head
Boreal Chickadee	Yes	Yes
Common Tern	Yes	Yes
Golden-crowned Kinglet	Yes	-
Gray Jay	Yes	-
Greater Yellowlegs	Yes	Yes
Pine Siskin	Yes	-
Spotted Sandpiper	Yes	Yes
Willet	Yes	-

* The conservation statuses for each of these species are presented in Table F2, Appendix F, attached.

These SOCI will be discussed in Section 5.6.5.

The results of the Avian Acoustic Study can be summarized as follows:

- A number of passerine species move through the area during the fall migratory period, starting in mid to late summer and persisting until well into the fall.
- Terns appear to move out of the area by early fall.
- A small number of shorebird species moves through the area starting in mid-summer and persisting well into the fall.
- More birds of all varieties were detected at the Spinney Gully location on the Project site than at the Glasgow Head reference location, indicating that bird movement near the Project site is strong during the fall migratory period.

5.6.4 Avian SOCI

Table 5.30 summarizes the SOCI observed during the Avian Assessment programs.

Table 5.30: SOCI Observed on the Project Site during the Avian Assessment Programs

Species	Scientific Name	Passerine Surveys	Shorebird Surveys*	Avian Acoustic Assessment*
Boreal Chickadee	*Poecile hudsonica*	Yes	-	Yes
Cliff Swallow	*Petrochelidon pyrrhonota*	-	Yes*	-
Common Loon	*Gavia immer*	Yes	Yes	-
Common Tern	*Sterna hirundo*	Yes	Yes	Yes
Golden-crowned Kinglet	*Regulus satrapa*	Yes	-	Yes
Gray Jay	*Perisoreus canadensis*	-	-	Yes
Greater Yellowlegs	*Tringa melanoleuca*	Yes	Yes	Yes
Harlequin Duck	*Histrionicus histrionicus*	-	Yes*	-
Killdeer	*Charadrius vociferus*	Yes	-	-
Pine Siskin	*Carduelis pinus*	Yes	-	Yes
Ruby-crowned Kinglet	*Regulus calendula*	Yes	-	-
Savannah Sparrow (Ipswich)	*Passerculus sandwichensis princeps*	Yes	-	-
Semipalmated Plover	*Charadrius semipalmatus*	-	Yes*	-
Semipalmated Sandpiper	*Calidris pusilla*	Yes	-	-
Spotted Sandpiper	*Actitis macularius*	-	Yes	Yes
Whimbrel	*Numenius phaeopus*	-	Yes*	-
Willet	*Tringa semipalmata*	Yes	Yes	Yes

* Indicates that this species was not observed on the Project site, only at a reference site location.

The conservation status of each species listed are presented in Table F2, Appendix F. The impact of the Project on avifauna, included the SOCI below, will be discussed in Section 5.6.5.

Boreal Chickadee

This species was observed consistently throughout the season during the passerine surveys, as well as during the acoustic assessment in the fall. This species has an affinity for dense coniferous forests for both foraging and breeding, which are present on the Project site. Mated pairs of these birds were also observed on the Project site during breeding season, so it is highly likely that they breed on the Project site.

Cliff Swallow

This species was only observed incidentally at Black Duck Cove during a shorebird survey in the late winter. This species nests in colonies in exposed cliffs and steep slopes made up of loose substrates, typically near a marine environment. This habitat is not present on the Project site, but is abundant throughout much of Guysborough County and on Cape Breton Island. The individuals observed were likely passing through the area on their way to more suitable habitat elsewhere. As this species nests in conspicuous colonies that are usually comprised several hundred birds, their presence is would have been detected during more surveys if they utilized the Project site regularly. These birds are not likely to be impacted by the Project and will not be discussed further.

Common Loon
This species was observed during the passerine surveys during the breeding season, as well as during the shorebird surveys in the late fall. It is possible that these birds breed in the inshore lakes around the Canso area, as well as over-winter in marine environments in the area.

Common Tern
This species was observed in all bird survey programs and has a consistent presence throughout much of the spring and summer in coastal marine environments, including Spinney Gully and Sherwink Cover near the Project site. These birds also appear to make sorties overland above the Project site during the summer as well.

Golden-crowned Kinglet
This species was observed during the spring, summer and fall periods on the Project site, albeit in low abundance. This species has an affinity for mature coniferous forest interiors, which are present near the Project site, although very little of this habitat is likely to be disturbed by the Project.

Gray Jay
This species was only observed in the fall during the avian acoustic assessment. It too has an affinity for mature coniferous forest interiors, so it may be present near the Project site in the breeding season.

Greater Yellowlegs
This species was observed in coastal marine environments consistently throughout the survey assessment. While it is not likely to frequent terrestrial areas of the Project site, it may occupy coastal environments nearby throughout its breeding season.

Harlequin Duck
This species was observed at Chapel Gully during the spring migration period, probably as a stopover during its migration northward migration. The ACCDC dataset indicates that it was observed in January 2006 on the Cranberry Islands, approximately 5 km east of the Project site. This species may be present in marine during the migratory periods, and it may possibly overwinter in the area.

Killdeer
One Killdeer was observed on the Project site during the fall migratory period. This species is territorial and conspicuous and would likely have been observed on the Project site during other surveys if it utilized the area to any significant extent. These birds likely pass through the area during the migratory periods and may possibly feed on the rich berry crop in the open bog habitat in the fall.

Pine Siskin
This species was observed in relative abundance in the fall migratory period, but not during the spring or breeding season. T hey likely use the area as a stopover location during migration.

Ruby-crowned Kinglet
This species was observed in low numbers in the spring and breeding season passerine surveys, and has an affinity for coniferous forest interiors, which are present on the Project site.

Savannah Sparrow (Ipswich)
This species was observed in the fall in open bog habitat. It is endemic to Sable Island, and it is possible that the individual observed was displaced during migration. However, given Canso area`s relative proximity to Sable Island, it is possible that this species occupies the Project site area more frequently.

Semipalmated Plover
This species was observed at Black Duck Cove foraging on the sandy beach. It may occur on the marine coast near the Project site in isolated areas where suitable foraging habitat is present.

Semipalmated Sandpiper
This species was observed in relatively low abundance on a fairly consistent basis throughout much of the spring, breeding season and fall surveys in marine environments, including at Spinney Gully, and therefore is likely present in the coastal areas near the Project site throughout much of the year.

Spotted Sandpiper
This species was observed in relatively low abundance on a fairly consistent basis throughout much of the spring, breeding season and fall surveys in marine environments, including at Spinney Gully, and therefore is likely present in the coastal areas near the Project site throughout much of the year.

Whimbrel
This species was observed at Chapel Gully in the spring, but not on the Project site itself. The species, however, is known to stopover and feed on the berry crop in Nova Scotia (Morrison 1984) in the fall migration period, which may put it very near the Project site.

Willet
This species was observed in breeding pairs in several areas in the general area, including on the Project site itself. There is likely a healthy breeding Willet population in the general area.

5.6.5 Potential Interactions and Effects
Project activities have the potential to impact avifauna during construction and operation resulting in:

- Breeding or migration stopover habitat loss/alteration;
- Migration disruption;
- Sensory disturbance;
- Exposure to pollutants including unsymmetrical dimethylhydrazine (UDMH); and
- Direct mortality.

Increased human activity during operational activities may result in an increase in populations of species adapted to human environments, such as European Starlings (*Sturnus vulgaris*), American Robins, Rock Pigeons (*Columba livia*), etc. These species may out compete native bird species resulting in habitat loss for species less adapted to human presence.

Habitat loss and alteration may occur as a result of vegetation clearing and earthmoving during construction. Vegetation clearing for new access roads and laydown areas will result a small amount of habitat loss for passerine birds. Altered areas will be re-vegetated post-construction with non-invasive species. The majority of habitat that is expected to be altered is rocky barren habitat, which was not observed to be utilized by a diverse or abounded array of bird species during the breeding season, or any other period of the year. Small areas of important habitat, such as bog habitat that is utilized by Whimbrel and other species during migratory stopovers, and by Willet during the breeding season may be altered but will be avoided to the greatest extent possible.

The results of this assessment indicate that the general area of the Project site is likely a well utilized stopover location for a number of bird species during the spring and, especially, the fall migration period. Being located in the eastern-most area of Mainland Nova Scotia, the area may be a departure and arrival point for birds moving to or from Cape Breton Island and Newfoundland, especially under specific weather conditions during the migration periods (Kearney 2017). Furthermore, artificial lights are known to attract birds, often causing them to circle light sources continuously (Poot *et al*. 2008; van de Laar 2007; Marquenie *et al.* 2013), which may disrupt and disorientate birds during migration. It is possible that artificial lights from the project may disrupt migrating birds passing through the area. Additionally, the Cape Sable Wind Farm, consisting of six operating wind turbines, is located immediately to the north of the Project site. It is possible that migrating birds disorientated by the Project's lights may be put at an increased risk of interacting with the wind farm, resulting in injury or mortality.

The Launch vehicles are expected to generate high peak noise levels. This will cause a sensory disturbance to birds in the area, which may result in temporarily disorienting the birds, or scaring breeding birds off their nests, leaving the eggs or young vulnerable. Some birds may even be discouraged from foraging or nesting in the area. However, only eight to twelve launch events per year would likely make these disturbances too infrequent to result in a significant disturbance to the bird community.

There is a remote possibility that birds may be exposed to pollutants including UDMH if it is used as a propellant for the launch vehicles second stage. However, the second stage is not expected to fire until the launch vehicle is in the upper atmosphere and hundreds of kilometers away from the Canso area, so any direct localized effects of this substance on birds is extremely unlikely.

Direct mortalities may be caused during construction by the accidental destruction of the eggs, nests or young of birds nesting in areas where vegetation clearing and earthmoving may occur. There is also the remote possibility of bird mortalities occurring as a result of the flames and steam generated during vehicle launches.

5.6.6 Specific Mitigative and Protective Measures

Mitigative measures to minimize the environmental effects of the Project on avifauna include the following:

- Good sanitation and housekeeping protocols will be included in the EPP for the Project's construction and operation phases to limit the attraction of nuisance and invasive birds and other wildlife.

- An Avian Management Plan will be developed and incorporated into the Project's EPP to further categorize and manage the impact of the Project to Avifauna;
- All requirements as set out in the *Migratory Birds Convention Act* (*MBCA)* will be adhered to for Project activities;
- Planning and scheduling of clearing activities, on a best-efforts basis, to avoid key nesting periods (March 31 to August 31). Should vegetation clearing be required during nesting periods, searches for migratory bird nests will be undertaken within the area to be disturbed, in consultation with Canadian Wildlife Service (CWS), and all identified nests will be flagged and avoided;
- Vegetation clearing will be kept to a minimum;
- Disturbances to important bird habitats will be avoided to the greatest extent possible;
- A post-construction avian assessment will be conducted, and the collected data will be used to refine the mitigation strategies employed as part of the Avian Management Plan;
- Rigorous hazardous materials handling plans and spill cleanup plans will be incorporated into the Projects EPP to minimize the risk of pollutants to birds;
- A project lighting plan will be developed in consultation with NSE and CWS, and technologies will be used (such as downward shaded lamps and narrow spectrum bulbs) to light the facility in a manner that is minimally intrusive to migrating birds. A lighting curtailment schedule can also be implemented during key migratory periods.

5.6.7 Potential Residual Effects

An analysis of the residual effects on avifauna is provided in Table 5.31.

Table 5.31: Determination of Residual Effects to Avifauna

VEC	Proposed Effect	Significant Criteria	Residual Effect	Significance of Residual Effect
Avifauna	Habitat loss/ alteration (construction)	Scope: Local Duration: Long-term Frequency: Once Magnitude: Moderate	Yes	Minimal/None
	Migration disruption (operations)	Scope: Local Duration: Long-term Frequency: Intermittent Magnitude: Moderate	No	No
	Sensory disturbance (operations)	Scope: Regional Duration: Long-term Frequency: Intermittent Magnitude: Low	Yes	Minimal/None
	Exposure to pollutants (construction, operations)	Scope: Provincial Duration: Long-term Frequency: Intermittent Magnitude: Negligible	Yes	Minimal/None

It is anticipated that with the implementation of the recommended mitigation measures and proper planning, project activities will not have significant residual effects on avifauna.

5.6.8 Recommended Monitoring and Follow-up

An Avian Management Plan will be developed and incorporated into the Project's EPP to further categorize and manage the impact of the Project to Avifauna. It is recommended that a post-construction avian assessment be conducted, and the collected data used to refine the mitigation strategies employed as part of the Avian Management Plan.

6.0 SOCIO-ECONOMIC ENVIRONMENT

6.1 Local Demographics

The Project site is located within the MODG, with the Project centre located at 5019390.28 m N, 657302.80 m E (20T; NAD83). The nearest communities to the Property boundary, include the Town of Canso (1.3 km north), Hazel Hill (1.9 km west) and Little Dover (3.9 km southwest) (Drawing 6.1). The MODG had a population of 4,189 in 2011, having decreased from the 2006 population of 4,681 (Statistics Canada 2016a). A similar trend occurred within the Town of Canso, where the population decreased from 911 in 2006 to a population of 806 in 2011. Statistics Canada released population figures for 2016, for the MODG. The population appeared to have increased to 4,670 however the area underwent a boundary change since the 2011 Census which resulted in an adjustment to the 2011 population count from 4,189 to 4,995. Therefore, the District reported a 6.5% decrease in population from 2011 to 2016.

6.1.1 Demography

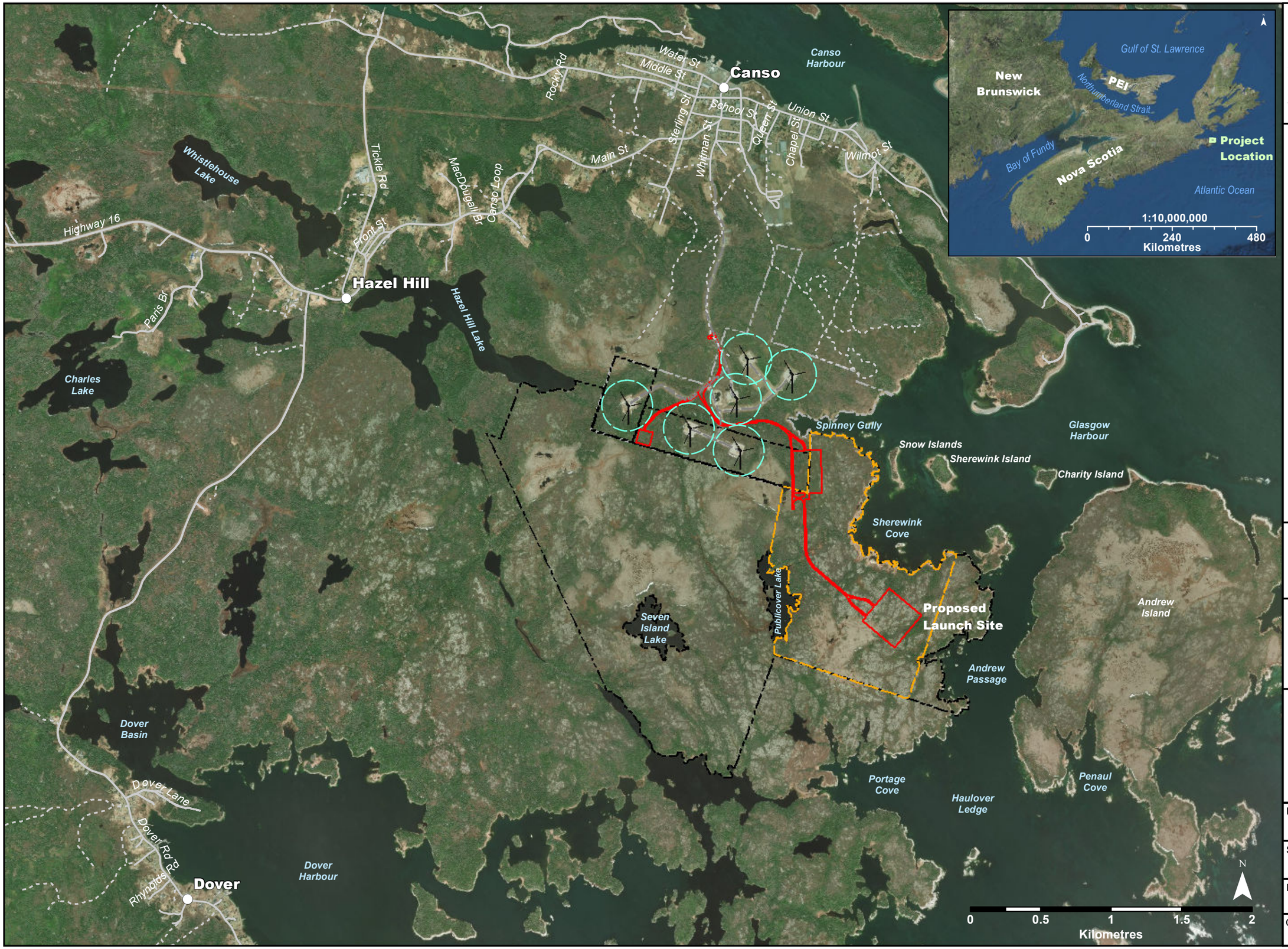
Population statistics for the Town of Canso and the MODG from the 2011 census are summarized in Table 6.1.

Table 6.1: Population in the Town of Canso and the MODG

Population Statistics	Town of Canso	MODG
Population in 2011	806	4,189
Population in 2006	911	4,681
Population change from 2006-2011 (%)	-11.5	-10.5
Total private dwellings in 2011	416	2,827
Land area (square km)	5.42	2,111.42
Population density per square kilometer	148.7	1.98

Source: Statistics Canada 2016a

The age distribution in the Town of Canso and the MODG reveals a median age of 51.0 and 53.9 years respectively, which is higher than the provincial median age (43.7) (Statistics Canada 2016a). An overview of age distribution for 2011 in Town of Canso and the MODG is outlined in Table 6.2 below.



Notes:

1. Reference: Digital Topographic Mapping & Property Management Unit MU0704 by Nova Scotia Geomatics Centre. Sable Wind Farm Environmental Assessment Completed by Strum Consulting in 2012.
2. Basemap: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.
3. Projection: NAD83(CSRS), UTM Zone 20 North.
4. All Features & Boundaries are Approximate. This Plan is Not Intended for Legal Use.

Legend:

- Place Names
- Existing Turbine Access Road
- Public Roads
- Access Roads / Trails

Project Location

- Approximate Location of Proposed Missile Launch Site & Access Road
- Wind Turbine Setback
- Sable Wind Farm Project Site Boundary
- Project Site Boundary
- Crown Land Lease Area

Maritime Launch Services - Local Communities

MLS Maritime Launch Services Ltd

Strum CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake

Date: June 2018	Project #: 16-5903
Scale: 1:25,000	Drawing #: 6.1
Drawn By: M. Marriott	
Checked By: S. Duncan	

Table 6.2: Age Distribution in in the Town of Canso and the MODG

Age Statistics	Town of Canso	MODG
0 - 14 years	115 (13.5 %)	450 (10.3 %)
15 - 64 years	560 (65.9 %)	2,800 (63.8 %)
65+ years	175 (20.6 %)	1,140 (25.9 %)
Total Population	**850 (100 %)**	**4,390 (100%)**

Source: Statistics Canada 2016a

In 2010, the average income for individuals in the Town of Canso and MODG was similar at $26,812 and $27,565, respectively, compared with the average of $35,478 for Nova Scotia (Statistics Canada 2016b). These averages are all lower than the Canadian average individual income of $40,650. The average value of dwellings the Town of Canso ($89,824) was lower than the MODG ($115,520), and significantly lower compared to the Nova Scotia ($201,991) (Table 6.3).

Table 6.3: Household Costs and Average Individual Income

Jurisdictions	Average Housing Value	Average Individual Income
Town of Canso	$89,824	$26,812
MODG	$115,520	$27,565
Province of Nova Scotia	$201,991	$35,478

Source: Statistics Canada 2016b

6.1.2 Health Care and Emergency Services

The nearest fire station to the Project site is the Canso/Hazel Hill Volunteer Fire Department located at 1134 Union Street in Canso (1.4 km to the north).
Emergency health services in the region include the Eastern Memorial Hospital located in Canso and the Guysborough Memorial Hospital located in Guysborough.

While the fire and emergency services run times to the launch site in the case of an emergency have adequate response times given the distances, being a volunteer department may cause less than desirable turn out times (the time it takes for the department staff to gear up and leave). Also, with the addition of liquid oxygen and other non-traditional fuels at the launch site, additional training and gear will be required. MLS envisions developing an agreement with MODG to place a paid staff that is able to respond to any possible responses needed at the site as well as those in the community they currently support. Likewise, MLS will evaluate the emergency medical response services capabilities in place at the hospital against potential response scenarios and address any necessary additional training or skill levels increases.

6.1.3 Industry and Employment

Statistics indicate that the unemployment rate in 2011 was 25.8% for the Town of Canso and 14.5% for the MODG, both of which are higher than the provincial average of 10% (Statistics Canada 2016b). With regard to employment rates, the Town of Canso employment rate was 37.4% and

MODG was 43.1%, which are both lower than the provincial rate of 56.8% (Statistics Canada 2016b).

A breakdown of the labour force within the Town of Canso and MODG is provided in Table 6.4. The highest proportions of workers in both the Town of Canso and MODG fall into the "agriculture, forestry, fishing, and hunting" category (22.7% and 21.0%, respectively). However, within this category, fishing is the primary component, dominated by the inshore lobster fishery which is discussed further in Section 6.1.3.1. Other significant industries for the Town of Canso include public administration, retail trade and manufacturing. Additional significant industries within the MODG include health care and social assistance, construction and educational services (Statistics Canada 2016b).

Table 6.4: Top Industries for the Employed Labour Force, Town of Canso, MODG

Industry	Town of Canso	MODG
Total employed labour force 15 years +	330	1,930
Agriculture, forestry, fishing and hunting	75 (22.7%)	405 (21.0%)
Public administration	55 (16.7%)	135 (7.0%)
Retail trade	40 (12.1%)	165 (8.5%)
Manufacturing	35 (10.6%)	140 (7.3%)
Construction	30 (9.1%)	205 (10.6%)
Health care and social assistance	25 (7.6%)	250 (13.0%)
Transportation and warehousing	15 (4.5%)	50 (2.6%)
Accommodation and food services	15 (4.5%)	80 (4.1%)
Educational Services	0 (0%)	180 (9.3%)

Source: Statistics Canada 2016b

A review of businesses located within close proximity to the Project site is provided in Table 6.5.

Table 6.5: Local Businesses and Proximity to Project Site

Business	Distance and direction from Site Boundary*	Distance and direction from Launch Pad*
AJ's Dining Room & Lounge, Main Street, Canso	1.1 km N	3.8 km NW
Bond and HARTS Market, Main Street, Canso	1.1 km N	3.7 km NW
NSLC, Main Street, Canso	1.2 km N	3.8 km NW
Wilson's Gas Stop, Main Street, Canso	1.2 km N	3.7 km NW
Canso Pharmacy (Guardian), Telegraph Street, Canso	1.2 km N	3.7 km NW
Choice Atlantic Seafoods, Queen Street, Canso	1.3 km N	3.5 km NW
BMO Bank of Montreal, Main Street, Canso	1.4 km N	3.9 km NW
Canso Co-Op Ltd, Water Street, Canso	1.8 km W	3.9 km NW
Avery's Your Independent Grocer, Paris Branch Road, Canso	2.8 km NW	4.6 km NW

Business	Distance and direction from Site Boundary*	Distance and direction from Launch Pad*
Last Port Motel, Paris Branch Road, Canso	3.0 km NW	5.6 km NW
Seabreeze Campground and Cottages, Fox Island Main Roaad, Canso	7.4 km N	9.9 km NW
Canso & Area Arena, Queen Street, Canso	7.4 km NW	3.7 km N
Canso RV Park & Marina, Union Street, Canso	2.4 km N	3.5 km N
**All distances measured from the nearest Property boundary, using the most direct route.*		

6.1.3.1 Inshore Lobster Fishery

The inshore fisheries is the main industry in the town of Canso, which is part of the DFO Maritime region. The Maritime region includes the entire Atlantic shoreline of Nova Scotia and the Bay of Fundy, and had a landed value of $1.28 billion in 2015, of which American lobster is the largest component, comprising 61% of the landings values, followed by molluscs and crustacean (28%), groundfish (7%), and pelagic/other (5%) (DFO 2017). The Maritime region lobster landings consist of 61% of the Canadian total of lobster landings and 34% of the North American totals (DFO 2017).

Canso is located in Lobster Fishing Area (LFA) 31A, which had 72 licenses in 2017 (DFO 2017). Nearby are LFA 31B and LFA 29, which have 71 and 63 licenses, respectively (DFO 2017). These LFAs have high total catch weights relative to other regions of Nova Scotia (Serdynska and Coffen-Smout, 2017). Particularly parts of LFA 31A which has a reported catch weight of 791, 608 kg in 2014, only surpassed in standardized catch rates by LFA grids in southwest Nova Scotia (Serdynska and Coffen-Smout, 2017). The fishing seasons for these 3 LFAs are:

- LFA29: May 10 – July 10
- LFA 31A: April 29 – June 30
- LFA 31B: April 19 – June 20

The inshore lobster industry has been growing steadily, with total North American landings doubling since between 1990 and 2016 (DFO 2017). Exports consist of a major component of the industry, and have increase 2.7 times since 2009, reaching a record $2.15 billion in 2016 (DFO 2017). The primary export market for both frozen/processed and live lobsters is the United States, however, exports to Asia have increased significantly, currently comprising 30% of the market share for live lobsters (DFO 2017).

6.1.4 Potential Interactions and Effects

No negative effects on local population and demographics are expected as a result of Project activities; therefore, this component is not addressed further through mitigation, monitoring or follow-up programs.

The proposed Project is expected to have a positive effect on the local economy, throughout the development of the Project via the use of local skills, labour, and suppliers.

Approximately 30 to 40 full-time MLS employees/contractors would be present at the VLA, HIF, and/or control centre area before the end of 2020. Full-time MLS employees/contractors are anticipated to work a single shift, between the hours of approximately 8:00 a.m. to 5:00 p.m. except

during the final launch preparations when the work schedules would likely increase. On a per-mission basis, launch campaigns (i.e., preparation for and conducting of a launch event) would be expected to last up to six weeks. During a launch campaign a staff is present to handle the rocket integration and a separate staff to handle the satellite integration and represent an additional 100 workers on site. During launch campaigns, the additional workers could work extended hours; however, 2 to 3 days prior to launch, full-time MLS employees/contractors and the rocket and satellite workers would need to be on-site for extended shifts but with programmed off shifts to sleep. Staffing on-site would return to normal levels (approximately 30 to 40 full-time MLS employees/contractors) within a day or two after the actual launch. Table 6.6 shows the number of full-time MLS employees/contractors working on site plus the local/transient workers necessary during launch campaigns that would be present between 2019 and 2028.

Table 6.6: Project Employment Projections

Year	Full-time MLS Employees/Contractors Working On-Site	Full-time MLS Employees/Contractors plus Additional Local/Transient Workers during Launch Campaigns	Full-time Construction Employees
2019			120
2020			120
2021	30	130	
2022	75	175	
2023	100	200	
2024	110	210	
2025	130	230	
2026	150	250	
2027	150	250	
2028	150	250	

The increased staffing levels will bring employment to the area. In addition, local business can expect to see spinoffs and the actual launch events are anticipated to draw crowds from near and far.

In addition to direct investments that the Project would bring to Nova Scotia's economy, several auxiliary economic benefits can also be expected. Workers that are directly involved with the development would contribute to local economies by redistributing wealth to a variety of goods and services such as hotels, restaurants, and grocery stores.

Indirect impacts on the local community could also include upgrades to infrastructure such as the fire department, roads and/or highways required for transporting goods and services. The costs of improvements to the fire department are to be burdened by MLS

6.1.5 Specific Mitigative and Protection Measures

Effects to the local/regional economy from the Project are anticipated to be positive in nature. Therefore, no mitigation is recommended.

6.1.6 Potential Residual Effects

Residual effects on local economy as a result of Project activities are expected to be positive in nature and include economic stimulation.

6.1.7 Recommended Monitoring and Follow Up

Ongoing communication with the community will be maintained throughout the Project life.

6.2 Land Use and Value

The majority of land surrounding the Project site is coastal or open woodland forests types, or undeveloped barren lands owned by the Crown, with only a few residential and recreational areas in the immediate vicinity. The adjoining land north of the Project site is owned by the MODG and contains the 13.8 MW Sable Wind Farm. Access to the launch site is expected to coincide, in part, with the access road to the Sable Wind Farm.

There are three licensed fish huts nearby that are legally used during the 63 day lobster season (LFS 31A, April 29 – June 30). Fishermen camp at these locations so they can work their nearby traps on a daily basis, bring their catch into port once or twice a week. In 2015, the landed value of Canada's lobster fisheries was approximately C$1.2 billion, with the lobster fisheries of Nova Scotia contributing nearly 60% this value (~C$696 million) (DFO 2015).

6.2.1 Potential Interactions and Effects

It is expected that Project activities will limit access for any unauthorized persons, vessels, aircraft, or other vehicles on part of the day of a launch operation with a pre-determined Closure Area, assessed for hazard potential. The Closure Area would begin at a checkpoint on the access road toward the Sable Wind Farm and offshore areas. The checkpoint north of the Sable Wind Farm will be a hard checkpoint which no one will be permitted to pass during launch operations. The proposed Closure Area will be fully vetted and tailored in consultation with Transport Canada and other local authorities and fisheries.

Closures will typically last up to 3 hours on launch day, and only an hour for a nominal launch scheduled for mid to late morning. A longer closure period may be required for potential aborts and contingencies due to weather or technical difficulties. The total number of closures and closure hours will fall within MLS's proposed 8 launch operations per year, or annual maximum of 24 hours of closure.

Closures and clearing of offshore areas will involve coordinating with the GCIFA, RCMP, and Canadian Coast Guard (CCG), issuing NOTMARs, and clearing the offshore area in order to ensure public safety. MLS and or CCG may conduct a boat patrol to sweep the offshore area to ensure the area is clear, continuing until MLS is ready to load propellant to the launch vehicle (approximately 3 hours prior to launch).

After the launch operation is completed, MLS and Transport Canada will notify law enforcement when the area has been deemed safe. Once deemed safe, the checkpoints will be raised and the area would re-open to the public.

6.2.2 Specific Mitigative and Protection Measures

The following mitigative measures will be implemented to avoid and mitigate any potential effects on land use and the inshore lobster fishery:

- Maintain access to lands where possible.
- Continued coordination with the NSDNR, the GCIFA in Canso as well as the fish hut owners to implement area clearances on the day of launch to adjust the launch schedule to allow for their work to complete for the day unimpeded, if there happens to be a launch scheduled during lobster season.
- Abstinence of any and all Project related activities at the port (e.g. deliveries) on the first and last days of the lobster fishery season (April 29 and June 30).

6.2.3 Potential Residual Effects

Construction and operation activities have the potential to interact with land use. Undeveloped areas presently accessible by trails will be bisected by the proposed Project. Limited access to previously accessible areas may create difficulties for recreational and fishing opportunities (i.e. hiking, bird watching, ATV trails).

6.2.4 Recommended Monitoring and Follow Up

Ongoing communication with the community and local fisheries organizations will be maintained throughout the Project life.

6.3 Recreation and Tourism

Recreational use in the area surrounding the Project includes ATV use, hiking, hunting and fishing. ATV trails were observed within the Project site which extended within and beyond the property boundaries.

There are a number of parks and protected areas in the Study area. Chapel Gully Trail is a popular attraction consisting of a short walking loop around a saltwater/freshwater estuary, a 43 m bridge over Chapel Gully, and a full 2 to 3 hour hike along shoreline and through beautiful woodland. The Canso Coastal Barrens Wilderness Area protects an 8,026 hectare stretch of rugged coastline consisting of a mix of islands, inlets, bays, small salt marshes, peninsulas, harbours, lagoons, headlands, and small beaches. Hiking or boating along the coastline can provide opportunities for siting rare plants, sea and land birds, seals and whales. This Wilderness Area is protected under the *Special Places Protection Act* (GC 2010). Sailor's Rest Park is a municipal park located in the middle of Canso, which is landscaped in the shape of a ship's steering wheel. Outside of the town, in Little Dover is the Black Duck Cove Provincial Park which provides a day use sandy beach park with a 3.5 km coastline walking trail.

The Study area has several museums and historic sites located throughout. Canso Islands National Historic Site is an interpretive centre located on Union Street in Canso, where visitors can learn about the history of Grassy Island. Boat trips to the island are provided by a Park's Canada vessel, between six to seven times daily. Trails on Grassy Island link eight designated sites. The Canso

Museum Whitman House is located on Union Street in Canso. The museum illustrates the history of Canso Town and eastern Guysborough Country, with exhibits from Canso Harbour.

A significant tourist attraction in Canso is the annual Stan Rogers Folk Festival typically now held during late July. This three day festival was established in 1997 and attracts thousands of music fans every year. During the second week of August, the Canso Regatta is held which consists of week-long event including boat races, a mid-way, parade, seaman's memorial, hootenannies as well as various activities for the youth.

6.3.1 Potential Interaction and Effects

During the construction phase of the Project an increase in noise, dust and air emissions with be temporary and localized. Clearing and construction of the access road and facility infrastructure will be isolated to Crown lands and the Sable Wind Farm property. Access to the immediate area during construction will be limited for safety reasons.

As detailed in Section 2.3.5, a Security Plan will be implemented limiting access to any unauthorized persons, vessels, aircraft or other vehicles on the day of a launch operation with a pre-determined Closure Area, assessed for hazard potential. The Closure Area would begin at a checkpoint on the access road toward the Sable Wind Farm and offshore areas. The checkpoint north of the Sable Wind Farm will be a hard checkpoint which no one will be permitted to pass during launch operations. The proposed Closure Area will be fully vetted and tailored in consultation with Transport Canada and other local authorities and fisheries.

Closures will last up to 3 hours on launch day, with a typical time of one hour for a nominal launch scheduled for mid to late morning. The 3 hour closure period allows for potential aborts and contingencies. The total number of closures and closure hours for wet dress rehearsals and actual launches will fall within MLS's proposed 8 launch operations per year, or annual maximum of 24 hours of closure.

During a closure, monitoring will be done by vehicle along existing roads as well as by video surveillance. High definition video cameras with zoom lenses will be placed well above ground level on the water tower and/or lightning towers. MLS and law enforcement will monitor the area to the north of the checkpoints to ensure that the area is clear. Unless there is an emergency, MLS will not conduct any ground sweeps in adjacent lands outside the Closure area. Only in the case that video surveillance is insufficient will other monitoring methods be used, such as:

- Unmanned aerial surveillance;
- Manned aerial surveillance;
- Beach sweeps using suitable ground vehicles; and/or
- Canadian Coast Guard vessels.

Closures and clearing of offshore areas will involve coordinating with the CCG and Fisheries Associations, issuing NOTMARs, and clearing the offshore area in order to ensure public safety. The CCG may conduct a boat patrol to sweep the offshore area to unsure the area is clear, continuing until MLS is ready to load propellant to the LV (approximately 3 hours prior to launch). MLS recognizes the Lobster Fishing Area 31A around Canso has a season running from Mid-April

through the end of June and will closely coordinate with the local fishery association to minimize impacts to the industry.

After the launch operation is completed, MLS and Transport Canada will notify law enforcement when the area has been deemed safe. Once deemed safe, the checkpoints will be raised and the area would re-open to the public.

6.3.2 Specific Mitigative and Protection Measures

The following mitigative measures will be implemented to avoid and mitigate any potential effects on recreation and tourism:

- Continued coordination with the NSDNR, the GCIFA in Canso as well as the fish hut owners to implement area clearances on the day of launch to adjust the launch schedule to allow for their work to complete for the day unimpeded.

6.3.3 Potential Residual Effects

Construction activities have the potential to interact with recreational land use. Undeveloped areas presently accessible by trails will be bisected by the proposed Project. Limited access to previously accessible areas may create difficulties for recreational opportunities (i.e. hiking, bird watching, ATV trails).

6.3.4 Recommended Monitoring and Follow Up

Ongoing communication with the community and local tourist/fisheries organizations will be maintained throughout the Project life.

7.0 CULTURAL AND HERITAGE RESOURCES

7.1 Archeological Screening and Reconnaissance

Boreas Heritage Consulting Inc. was retained by Strum Consulting, on behalf of MLS, to complete an Archaeological Screening and Reconnaissance for the proposed Project. The purpose of the assessment was to investigate the potential for encountering archaeological resources during the development of the facility and to ensure appropriate resource management strategies are devised before Project implementation. The archaeological investigation was conducted according to the terms of Heritage Research Permit A2017NS081 and submitted to Nova Scotia Communities, Culture, and Heritage – Special Places Program (SPP) December 2017 (Appendix G).

At the time of the assessment, a former version of the proposed development footprint was used however the main components (LCC, HIF, and Launch Compound) were located in the same areas as the current proposed layout. The access roads to the LCC and HIF have since been re-aligned but are not expected to alter the results presented by Boreas Heritage Consulting Inc. (2017).

The land within the Project area is part of the greater Mi'kmaw territory known as *Eskikewa'kik,* meaning 'skin dressers territory'. The Canso area provided a resource base for millennia prior to the arrival of European settlers and the Mi'kmaq seasonally moved throughout the greater region between areas where shelter and resources, including food and medicinal plants were available and annually migrated between hunting and fishing grounds (Chute 1999). Canso Harbour is likely one

of the earliest fishing ports in the Maritimes, known to have been frequented by French, Breton, and Basque fisherman as early as 1504. A review of historical mapping reveals an absence of settlement and no evidence of any historic structures within the immediate vicinity of the Project area. The economic mainstay of the community is still fishing, as it was in the eighteenth century.

The field component of the archaeological assessment was carried out on October 5, 2017 and consisted of systematic pedestrian transects walked across the property. No evidence of archaeological resources or areas of elevated archaeological potential were encountered and no indication of significant historic cultural modification was identified within the Project area.

Based on the results of the archaeological reconnaissance, the nature of the terrain, the distance to a significant water source, and the lack of evidence indicating significant cultural modification, the Project area is considered to exhibit low potential for encountering significant archaeological resources.

The following management recommendations were provided based on the archaeological screening and reconnaissance completed for the MLS launch facility:

1. It is recommended that the Project area, as identified in this report, be cleared of any requirement for further archaeological investigation.
2. In the event that archaeological resources and/or human remains are encountered, immediate contact should be made with Sean Weseloh McKeane, Coordinator of Special Places, Communities Culture and Heritage, at 902-424-6475.

Procedures related to potential discovery of archaeological items or sites during construction/ operation will be incorporated into the EPP.

8.0 MI'KMAQ ECOLOGICAL KNOWLEDGE STUDY

A Mi'kmaq Ecological Knowledge Study (MEKS) was completed by Membertou Geomatics Solutions (MGS) (Appendix H). The study consisted of two major components:

- Mi'kmaq Traditional Land and Resource Use Activities, both past and present; and
- A Mi'kmaq Significance Species Analysis, considering the resources that are important to Mi'kmaq use.

Interviews were undertaken from November 2017 to January 2018 with Mi'kmaq knowledge holders from the communities of Potlotek, Paqtnkek, Pictou Landing, and We'koqma'q. Information on past and present traditional use activities within the Project Site and Study Area were gathered. The Project Site included the planned launch site, a vehicle processing and control area, and the infrastructure to support these facilities (roads, etc.). The Study Area consists of areas within a 5 km radius of the Project Site boundaries.

Based on the data documented and analyzed, it was concluded that some Mi'kmaq use has been reported on the Project Site, or in the immediate vicinity. In the surrounding areas, trout fishing, deer, moose, rabbit, and partridge hunting were the predominant activities in the Project Site.

Within the Study Area it was concluded that the Mi'kmaq have historically undertaken traditional use activities and that this practice continues to occur today. These activities primarily involve harvesting of fish, but also include harvesting of animal, plant, and tree species; all of which occurs in varying locations throughout the Study Area and at varying times of the year. Mackerel, trout, and lobster were found to be the most fished species in the Study Area. Deer, partridge, and rabbits were found to be the most hunted species within the Study Area. With the small number of gathering areas identified, it is difficult to categorize the area as a particular gathering area type.

Due to the identification of Mi'kmaq Traditional Use Activities occurring in the Project Site, as well as activities that have occurred in the past and present in the Study Area, there is potential that the development of the Project may affect some Mi'kmaq traditional use.

It is recommended that the Proponent continue its communications with the Assembly of Nova Scotia Mi'kmaq Chiefs, through KMKNO, to discuss future steps, if required, with regards to Mi'kmaq use in the area.

9.0 SUMMARY OF EFFECTS ASSESSMENT

Table 9.1 summarizes the results of the effects assessment.

Table 9.1: Summary of Effects Assessments

Project Interaction and Phase	Mitigation Measures	Significant Residual Effect
Atmospheric Environment		
Disruption in subsurface soils due to excavation (construction)	• Prior to excavation activities, erosion and sedimentation control measures will be deployed and assessed on a regular basis; • All soils removed during the excavation phase will be stored according to provincial regulations and best practice guidelines; and • Exposed soils and stockpiles capable of producing particular matter will be covered.	None
Release of air-borne particles (construction)	• Where required, dust will be controlled using water or an approved dust suppressant; • Unpaved road surfaces will be monitored during dry periods to ensure dust control is timely and effective; • Engine idling and driving speeds will be restricted; • All vehicles and construction equipment will be kept in good working order, and will be properly muffled; • An ESCP will be developed as part of a site-specific EPP which will address the storage of stockpiled material; • Implementation of the EPP, including the ESCP, spill prevention plan, and contingency plans (as necessary) will be implemented prior to construction; • Control public access at and around the launch site prior to launch; • Complete rocket plume emissions modeling once rocket design details are further defined;	Low

Project Interaction and Phase	Mitigation Measures	Significant Residual Effect
	• Provide outputs of modeling to regulatory agencies for review; and • Adjust launch go-no go criteria based on results of the rocket plume emissions modeling.	
Acoustic Environment		
Increased noise during construction activities (construction)	• Equipment to be maintained in good working order and be properly muffled; • Engine idling will be restricted; • Residents of nearby communities will be notified prior to any blasting activities; and • Implementation of the EPP, including the sound level monitoring (if required) and complaint response (as necessary).	Minimal
Increased noise during launch events (operation)	• Noise control measures (e.g., sound barriers, shrouds, enclosures) will be used where warranted; • Residents of nearby communities will be notified prior to any launch activities; and • Implementation of the EPP, including the sound level monitoring (if required) and complaint response (as necessary).	None
Annoyance and hearing impairment for local residents during launch events (operation)	• Noise control measures (e.g., sound barriers, shrouds, enclosures) will be used where warranted; • Residents of nearby communities will be notified prior to any launch activities; and • Implementation of the EPP, including the sound level monitoring (if required) and complaint response (as necessary).	None
Structural damage associated with sonic booms during launch event (operation)	• Noise control measures (e.g., sound barriers, shrouds, enclosures) will be used where warranted; • Residents of nearby communities will be notified prior to any launch activities; and • Implementation of the EPP, including the sound level monitoring (if required) and complaint response (as necessary).	
Geologic Environment		
Disturbance to subsurface soils and bedrock, soil erosion and sedimentation (construction)	• Development and implementation of an EPP for all phases of construction that will include specific sediment and erosion controls as well as provisions for the inspection and monitoring of erosion and sedimentation controls, handling of petroleum products and environmental protection measures. The EPP will be approved by NSE prior to the start of construction; • Following results of the geotechnical assessment, the potential for environmental issues relating to ARD will be assessed if future disturbance or exposure of bedrock is anticipated. Any issues related to ARD will be completed in accordance with the NSE Sulphide Bearing Material Disposal Regulations (NSE 1995);	N/A

Project Interaction and Phase	Mitigation Measures	Significant Residual Effect
	• A site specific ESCP will be completed for the Project to prevent soil erosion and sedimentation of wetlands and/or watercourses; • Restoration of soils following the construction phase will occur; • Pre-blast surveys will be completed (if required). • Blasting will be conducted in accordance with provincial legislation and subject to terms and conditions of applicable permits; and • All blasts will be conducted and monitored by certified professionals.	
Deposition of particulates on soils near the launch pad (operation)	• Testing of soils will be completed surrounding the launch pad for metals, petroleum products and percholate; and • Removal of soils exceeding applicable guidelines for disposal at a licensed facility.	None
Impacts to soil characteristics from launch induced fires (operation)	No mitigation measures proposed.	Minimal/None
Accidental release of deleterious substances (construction, operation)	• Testing of soils will be completed surrounding the launch pad for metals, petroleum products and percholate; • Removal of soils exceeding applicable guidelines for disposal at a licensed facility; • Spills of liquid propellants would be controlled through catchment systems and holding tanks in the processing facilities; and • A spill contingency plan will be developed and included in the Project EPP.	N/A
Freshwater Environment		
Habitat loss/alteration (construction, operation)	• Appropriate fish salvage methods, if necessary, will be completed prior to in-water work; • Fish passage, if appropriate, shall be maintained during all Project phases; and • In-water work may not occur during October 1 to May 31, or as directed otherwise by government regulators, so as to not interfere with seasonal migration and spawning.	Minimal/None
Release of sedimentation and deleterious substances (construction)	• Implementation of the EPP, including the ESCP, spill prevention plan and contingency plans (as necessary) will be implemented prior to construction; • ESC structures will be maintained and inspected regularly with particular emphasis before and after forecasted heavy rain events, and with consideration of the timing and types of activities involved; • Where necessary, ESC measures will remain in place after work is completed until areas have stabilized and natural re-vegetation occurs; • All overburden removed during the excavation phase will be stored according to provincial regulars and best practice	N/A

Project Interaction and Phase	Mitigation Measures	Significant Residual Effect
	guidelines; • Exposed soils and stockpiles capable of producing sediment laden-runoff will continue to be stabilized and/or will be covered; • The length of time stockpiled overburden will be left exposed, and the length without mitigation (e.g., mulching, seeding, rock cover) will be minimized through scheduled work progression; • Work vehicles and/or heavy equipment will be cleaned and inspected prior to use to prevent the introduction of invasive species and deleterious substances into the water; • Temporary storage of waste materials on-site will be located at least 30 m from known watercourses, wetlands, and waterbodies; and • Propellant and fuels will be contained in vessels to industry standards and checked regularly to ensure they are in good working condition.	
Direct mortality (construction)	• Appropriate fish salvage methods, if necessary, will be completed prior to in-water work; • Fish passage, if appropriate, shall be maintained during all Project phases; and • In-water work may not occur during October 1 to May 31, or as directed otherwise by government regulators, so as to not interfere with seasonal migration and spawning.	N/A
Terrestrial Habitat		
Habitat loss/alteration (construction)	• General site restoration should be conducted following construction and should include the replanting of any vegetation removed or disturbed outside of the Project footprint; • Damage and removal of vegetation will be minimized by establishing staging areas and site access routes away from existing trees/naturalized vegetation to the extent possible; • Exposed soils will be stabilized and re-vegetated as soon as possible; • Ensure that stockpiled material is secured and stabilized to prevent erosion and runoff; and • Implement temporary erosion and sediment control measures to prevent erosion/runoff from impacting adjacent vegetated lands and riparian areas.	Low
Disturbance (construction/operation)	• Project personnel will report any evidence of Mainland Moose to NSDNR; • Post-construction moose surveys will be completed; • Should large congregations of Monarchs be found at the Project site, Project activities in the area should cease until the migrating group has left the Project site; and • Waste material will be properly stored and disposed of so as to not attract wildlife to the Project site.	Low

Project Interaction and Phase	Mitigation Measures	Significant Residual Effect
Direct Mortality (construction/operation)	• Areas for fuel storage, refuelling or lubrication of equipment should be located at least 30 m from any water body or wetland; • Propellant and fuels will be contained in vessels to industry standards and checked regularly to ensure they are in good working condition; and • Washing and servicing of machinery and equipment should not be completed within 30 m of a waterbody or in an area where wash water will run into a wetland or waterbody.	Low
Avifauna		
Habitat loss/ alteration (construction)	• An Avian Management Plan will be developed and incorporated into the Project's EPP o further categorize and manage the impact of the Project to Avifauna; • All requirements as set out in the *Migratory Birds Convention Act* (*MBCA)* will be adhered to for Project activities; • Planning and scheduling of clearing activities, on a best-efforts basis, to avoid key nesting periods (March 31 to August 31). Should vegetation clearing be required during nesting periods, searches for migratory bird nests will be undertaken within the area to be disturbed, in consultation with Canadian Wildlife Service (CWS), and all identified nests will be flagged and avoided; and • Vegetation clearing will be kept to a minimum; • Disturbances to important bird habitats will be avoided to the greatest extent possible.	Minimal/None
Migration disruption (operations)	• All requirements as set out in the *Migratory Birds Convention Act* (*MBCA)* will be adhered to for Project activities; • A post-construction avian assessment will be conducted, and the collected data will be used to refine the mitigation strategies employed as part of the Avian Management Plan; and • A project lighting plan will be developed in consultation with NSE and CWS, and technologies will be used (such as downward shaded lamps and narrow spectrum bulbs) to light the facility in a manner that is minimally intrusive to migrating birds. A lighting curtailment schedule can also be implemented during key migratory periods.	No
Sensory disturbance (operations)	• Good sanitation and housekeeping protocols will be included in the EPP for the Project's construction and operation phases to limit the attraction of nuisance and invasive birds and other wildlife; and • An Avian Management Plan will be developed and incorporated into the Project's EPP to further categorize and manage the impact of the Project to Avifauna. • A post-construction avian assessment will be conducted, and the collected data will be used to refine the mitigation strategies employed as part of the Avian Management Plan.	Minimal/None

Project Interaction and Phase	Mitigation Measures	Significant Residual Effect
Exposure to pollutants (construction, operations)	• An Avian Management Plan will be developed and incorporated into the Project's EPP to further categorize and manage the impact of the Project to Avifauna; • A post-construction avian assessment will be conducted, and the collected data will be used to refine the mitigation strategies employed as part of the Avian Management Plan; and • Rigorous hazardous materials handling plans and spill cleanup plans will be incorporated into the Projects EPP to minimize the risk of pollutants to birds.	Minimal/None
Local Demographics		
Residual effects on local economy as a result of Project activities are expected to be positive in nature and include economic stimulation.		
Land Use and Value		
Disturbance to fishing and recreational opportunities (construction, operation)	• Maintain access to lands where possible; • Continued coordination with the NSDNR, the GCIFA in Canso as well as the fish hut owners to implement area clearances on the day of launch to adjust the launch schedule to allow for their work to complete for the day unimpeded, if there happens to be a launch scheduled during lobster season; and • Abstinence of any and all Project related activities at the port (e.g. deliveries) on the first and last days of the lobster fishery season (April 29 and June 30).	Low
Recreation and Tourism		
Disturbance to recreational activities (construction, operation)	• Continued coordination with the NSDNR, the GCIFA in Canso, and fish hut owners to implement area clearances on the day of launch to adjust the launch schedule to allow for their work to complete for the day unimpeded.	Low

10.0 CONSULTATION AND ENGAGEMENT

10.1 Public Consultation

The MLS company founders conducted a research effort beginning in early 2016 to evaluate locations across North America that would suit the needs of the commercial space industry market demands and using the Cyclone 4M. One of the key criteria in that site selection process was to evaluate the community support for the initiative. The goal has always been to ensure that there was not just a site that met the safety and trajectory requirements but that the host location was open to the project. MLS narrowed down the potential sites being evaluated in mid-2016 and had a strong interest in the site in Nova Scotia. Following those technical evaluations and their positive results, MLS formed the company in October to be able to conduct the due diligence necessary to finalize the selection process. On November 2, 2016, MLS met with the Warden and Councillors for the MODG and gave a presentation outlining their initiative. The presentation was well received and MODG primary recommendation was to meet with the communities of Canso, Hazel Hill, and Little Dover to inform them and gauge their interest. Taking their advice, MLS arranged and held an open house at the Fire Hall in Canso on January 31, 2017 and met with the Guysborough County Inshore

Fisheries Association that same day. Since then, MLS has been following through with continuous engagement and consultation with them and numerous other groups including:

- Paqtnkek First Nations;
- Assembly of Nova Scotia Mi'kmaq Chiefs;
- Canso schools;
- Canso Area Development Association;
- Metis representative in Little Dover;
- St Francis Xavier University;
- Dalhousie;
- NS Community College;
- Community CLC; and
- Industry Day.

MLS has set up a mechanism through their website to be able to send out quarterly project updates to stakeholders, at large. These have been going out regularly to an email list of over 700 people. We have also provided written updates to the MODG and they have published them in their newsletters that go out to the residents in the entire District of Guysborough.

MLS has also been working with other provincial and federal authorities to provide information about our initiative, take feedback and adjust our plans to meet their requirements. These interfaces will be ongoing as the site design matures operational plans mature. T hose interfaces have included:

- MODG Warden and council;
- MLA for the Canso area;
- Nova Scotia Premier;
- MP for Cape Breton and Canso;
- Regional Director for Transport Canada;
- Senior Director, Aerospace, Defence and Marine Branch, ISED;
- Deputy Director Space Policy and Regulatory Affairs and ATT Non-Proliferation and Disarmament Division, Global Affairs;
- President and Director General for the Canadian Space Agency;
- Canadian Ambassador to Ukraine, Global Affairs;
- Policy Advisor, Office of the Hon. Marc Garneau, Transport Canada;
- Civil Aviation Inspector, General Flight Standards, Transport Canada; and
- Atlantic Desk to the Prime Minister's Office.

Based on the early responses to the proposed spaceport initiative, MLS formally selected the site for development on March 14, 2017. The Project team has been overwhelmed with the positive response and will continue to consult with the public regarding Project development. A summary of the direct and local consultations for this Project is provided in Table 10.1. Detailed information on key community events and the website is provided below.

Table 10.1: Consultation Meetings and Events

Date	Participants	Activity Summary
November 2, 2016	MODG	Presentation to Warden Vernon Pitts and the MODG Council.
January 30, 2017	NSE	Project introduction
January 30, 2017	Paqtnkek First Nations	Project introduction to Rose Julian and Daryl MadDonald in Afton
January 31, 2017	Community Open House	First Open House event held at the Canso Fire Hall and attended by approximately 140 members of the public. MLS shared Project details.
January 31, 2017	GCIFA	Presentation to GCIFA BOD
February 1, 2017	NS DNR	Project introduction
April 25, 2017	GCIFA	MLS representatives met with the association to discuss Project details and to learn about a year in the life for the fisherman.
April 27, 2017	Industry Day event hosted by St Francis Xavier	Presented project overview and business opportunity for local business to 67 businesses that attended
April 27, 2017	Academia presentation at STFX	Presentation to STFX, NSCC and other
October 14, 2017	Community Open House	Second Open House event held at the Canso Fire Hall and attended by approximately 110 members of the public. MLS and Strum representatives shared updates and details regarding the EA process.
December 13, 2017	CLC	The CLC met in December to discuss CLC guidelines, EA studies, health and safety concerns and benefits to the community.
December 14, 2017	Paqtnkek First Nations	Project description using poster boards to Chief PJ Prosper
December 14, 2017	Community Open House	Third Open House event was held at the Little Dover Parish Centre and attended by approximately 60 members of the public. MLS and Strum representatives shared Project updates and EA results.
December 14, 2017	Canso Schools	Presentation to the school children about satellites and their uses.

Date	Participants	Activity Summary
February 2, 2018	Assembly of Nova Scotia Mi'kmaq Chiefs	Presentation and overview of the spaceport development
May 16, 2018	CLC	Project update and near term plans

Community Liaison Committee

A CLC has been created for the Project, to act as an advisory body to the development team, to provide a forum for the two-way exchange of information, and to bring questions and concerns forward to the development team. The first CLC meeting was co-chaired by Steve Matier, MLS CEO, and Shawn Duncan, Strum Consulting, and is formed by 11 additional members, who represent the interests of local residents, landowners, recreational groups, fisherman, MODG and local businesses from the surrounding areas.

The first CLC meeting was held on December 13, 2017 at the Little Dover Parish Centre and was attended by 9 CLC members (in addition to the Chair and Co-Chair); 4 members of the Project team, and 2 guests which included local residents.

The second meeting of the CLC was held on May 16, 2018 at the GCIFA office in Canso and was attended by 9 members (in addition to the Chair) and 2 members from the project. A t all the meeting, the following topics were discussed:

- Project current status;
- Near term project plans;
- Key milestones; and
- Community questions received.

The CLC will continue to meet regularly and play a role throughout the development of the Project over the coming years.

Open House Events

Community open house events were held near the Project site in January, October, and December 2017. The events were held at the Canso Fire Hall (January and October) and the Little Dover Parish Centre (December) to inform the public about the Project and to hear local comments and concerns. The open house featured posters that provided information about the Project and associated studies that were underway. Copies of the posters are provided in Appendix I. Attendees had the opportunity to speak one-on-one with Project team members and submit written comments and/or questions.

Over 100 local community members attended each open house. The most common concerns raised during the open house included:

- Who will have fire mitigation responsibility;
- Does Canso have the appropriate infrastructure to deal with influx of visitors/residents;
- What is the geographical advantage of Canso;
- How many jobs will it create and in what sectors;
- How is the Project being funded;
- How will the Project impact the environment;

- Where will the equipment or infrastructure come from;
- What is the impact on inshore fishery;

The Project Team will continue to help address any concerns raised by local citizens over the duration of the Project's development.

Educational Groups
MLS had successful conversations with many post-secondary institutions in Nova Scotia including Saint Francis Xavier, Dalhousie University, and the Nova Scotia Community College. There would be opportunities for the Project to contribute to curriculum or offer employment partnerships for students, as well as provide schools the opportunity to visit and tour the Project site for educational purposes.

Website
A website for the Project has been developed and can be accessed at:
http://www.maritimelaunch.com/

The website provides an overview of the Project, Proponent information and shares information on upcoming events and Project news. The website is dedicated to providing information related to the Project and is intended for use by the general public and local residents to stay up to date on all aspects of project development. In the interest of transparency and public engagement, the Project team continues to add information to the website as it becomes available.

Posters from the October and December Open House events have been made available on Strum's website: https://strum.com/projects-portfolio/spaceport-environmental-assessment-and-civil-design#!Spaceport

10.2 Aboriginal Engagement
As shown in Table 10.1, MLS has placed a high priority on reaching out to the First Nations community to build a positive relationship much as has been done with the MODG, GCIFA, and the local community near the spaceport. Before the company was even formed in October 2016, the First Nations communities were listed as key stakeholders in our initiative. The nearest First Nation Reserve to the Project area is the Paq'tnkek band located near the community of Afton (66 km to the west). MLS initiated correspondence with their Director of Economic Development in November 2016 and arranged to provide them an overview of our Project in January 2017 when the MLS team was assembled in the province. Our goal was to ensure that they knew about the initiative and what the potential positive economic impact there could be. At that first meeting, MLS was apprised of the proposed highway interchange initiative being planned in Afton as well, which will see significant use during spaceport operations from spaceport users and from tourism.

MLS has continued to work with the First Nations community and in consultation with the Nova Scotia Office of Aboriginal Affairs. We have continued to meet with the Paq'tnkek including a meeting in Canso prior to the open house in December 2017 with Chief PJ Prosper. MLS was able to walk through the entire project layout and plans for construction and operations using poster

boards and to explain the planned employment for the site, the ancillary employment in the area and the significant increase in tourism.

The most recent direct interface with the First Nations was with the Benefits Committee in February of this year and is described in detail below.

Meeting Date: Friday, February 2, 2018
Meeting Location: KMKNO Offices, 75 Treaty Trail, Millbrook
Attendees:

- Chief Terry Paul - Membertou
- Chief Sidney Peters – Glooscap First Nation
- Chief Gerald Toney – Annapolis Valley First Nation
- Chief Wilbert Marshall – Chapel Island
- Chris Googoo - Ulnooweg Development Group
- Jennifer MacGillivary – KMKNO Benefits Officer

At the request of MLS, KMKNO included MLS on the agenda for their November 29, 2017 Benefits Committee meeting. On November 16, 2017, KMKNO informed MLS that due to a schedule change they had to be removed from the agenda. MLS was then rescheduled to present at the February 2, 2018 Benefits Committee meeting. Stephen Matier, CEO / Co-founder of MLS was unable to attend this meeting and appointed Harvey Doane of Nova Scotia Business Inc. to attend the meeting and present the Canso launch site project on their behalf.

The Benefits Committee were provided with slides outlining the project and the site layout prior to the meeting so that the material could be included in their meeting information package. During the meeting, Harvey Doane presented the Canso launch site project starting with an overview of the growing satellite market and the need for a commercial space port. The presentation also covered the basic concept of how satellites are launched, why Canso, Nova Scotia is an ideal location for a launch site, the geographic location of the proposed site, the size of the Cyclone 4M rocket compared to the existing wind towers, and the expected economic benefits to the region resulting from the establishment of the launch site. Discussion was held regarding the potential employment opportunities that could be created by the launch site. The construction of the site could span one and half years creating many employment opportunities. It was explained that there could be approximately 35 to 40 jobs directly associated with the operation of the launch site. There would then be many indirect opportunities for various services that would be required by the launch site and to accommodate the expected influx of tourists for launch events.

The discussion with the Benefits Committee was engaging and positive. There were questions regarding how KMKNO might potentially get involved as investors in the project. The Benefits Committee commented that the Canadian Space Agency was working with them on an initiative to promote a STEM program to First Nation students. It was explained that MLS was interested in getting engaged with students and would be pleased to work with KMKNO on this initiative.

10.3 Review of Public Concerns

Issues and concerns raised by the public and other stakeholders throughout the consultation process to date can be grouped into two broad categories which have been assessed throughout the EA and through MLS's work with the federal regulatory bodies.

Concerns include:
Ensure that MLS understands and respects the residents' livelihoods with respect to the fishing industry and ensures their design plans and operations provide the highest level of protection possible for the nearby oceans.

Helping the community understand any potential safety hazards and how they are being mitigated and minimized by MLS as the design and operations continue to be refined and to understand who in the federal government regulates and oversees the operations at the launch site.

11.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

Environmental factors that have the potential to have damaging effects on the facility infrastructure and operations include:

- Extreme wind;
- Extreme air temperature and relative humidity
- Clouds;
- Precipitation events;
- Fog;
- Droughts;
- Ice formation;
- Lightning strikes; and
- Fire.

The primary mitigative measure employed during the construction and operation of the Project will be to educate and train site personnel. Environmental and safety orientations will be conducted prior to the start of construction and all staff will be informed of the potential effects of the environment on the Project. Staff responsible for the operation and maintenance of the Project will be trained on the design and operation of the facility, including applicable operating procedures, safety protocols, and evacuation plans.

In addition to proper safety training, the development and adherence to launch weather guidelines will assure the avoidance of possibly adverse conditions during pre-launch, launch and post-launch activities.

Table 11.1: Effects of Environmental Events and Associated Mitigation

Event	Environmental Effect	Mitigation
Extreme wind	Headwinds, tailwinds, or turbulence impacting launch and flight path.	• Weather equipment used by forecasters to develop launch forecasts • Rocket weather launch commit criteria • Appropriate safety protocol
Extreme air temperatures & relative humidity	Higher humidity and air temperatures lower density of air, allowing for a higher flight and vice versa.	• Weather equipment used by forecasters to develop launch forecasts • Rocket weather launch commit criteria • Appropriate safety protocol
Clouds	Potential for hazardous electric fields, temperatures ranging into freezing zone, low ceiling, or low visibility	• Weather equipment used by forecasters to develop launch forecasts • Rocket weather launch commit criteria
Precipitation events	Any precipitation at the launch site or within the flight path will prohibit a launch. Flooding into the retention basin underneath the pad could compromise sampling protocols of controlled contaminants; release controlled contaminants into environment.	• Weather equipment used by forecasters to develop launch forecasts • Rocket weather launch commit criteria • Appropriate safety protocol
Fog	Reduced visibility will prohibit launch.	• Weather equipment used by forecasters to develop launch forecasts • Rocket weather launch commit criteria • Appropriate safety protocol
Droughts	Low water - inadequate suppression of sound and vibration associated with a launch, increased risk of fire and a decrease in ability to suppress.	• Weather equipment used by forecasters to develop launch forecasts • Rocket weather launch commit criteria • Appropriate safety protocol
Ice formation	Damage to aboveground power lines, hazardous conditions on access road or LV transport rail.	• Appropriate safety protocol
Lightning strike	Potential fire, damage to facilities or equipment, electrical field with triggering potential	• Appropriate safety protocol • Fire prevention plan • Evacuation plan • Local training of first responders
Fire	Damage to damage to facilities or equipment	• Appropriate safety protocol • Fire prevention plan • Evacuation plan • Local training of first responders

12.0 CUMULATIVE EFFECTS ASSESSMENT

Concerns are often raised about the long-term changes that may occur not only as a result of a single action but of the combined effects of each successive action on the environment (Hegman *et al.* 1999).
Cumulative effects have been assessed for the Project by taking into consideration the potential residual effects identified in Section 9, as well as potential effects associated with activities that have taken place in the past, those that currently exist, and those that will imminently take place in the surrounding area.

12.1 Activities Near the Project

The Project is located within a rural setting in Nova Scotia. The only existing project in the immediate vicinity of the Project site is the Sable Wind Farm. The Sable Wind Farm, owned and operated by the MODG, in partnership with Nova Scotia Power was constructed in 2015. The Sable Wind property adjoins the northern property boundary of the site and consists of six turbines generating a total of 13.8 MW. Access to the proposed Spaceport Launch site is expected to coincide, in part, with the access road to the Sable Wind Farm.

Several significant economic developments are proposed within Guysborough County, including the Melford Atlantic Gateway, Black Point Quarry, and Goldboro LNG. Melford Atlantic Gateway will include the construction of a 315 acre marine container terminal and logistics park in Melford, approximately 30 km northwest of the Project site. The terminal will become the closest North American port to Europe and Asia via the Suez Canal. Construction could start as early as July 2018.

The proposed Black Point Quarry consists of the development and operation of a construction aggregate quarry and marine terminal in Guysborough County. The quarry will be developed on a 355 hectare property, located approximately 11 km northwest of the Project site. The project is currently in the permitting stage, with site construction commencing as early as spring 2018.

Goldboro LNG is a proposed development that would include a natural gas liquefaction plant and facilities for the storage and export of LNG, including a marine jetty for loading. The facility would be located adjacent to the Maritimes and Northeast Pipeline, approximately 50 km southwest of the Project site.
Activities that could potentially interact cumulatively with the Project are evaluated in Table 12.1.

Table 12.1: Potential Interactions with the Project

Activity	Status of Activity	Location of Activity	Potential Cumulative Effect Expected	Cumulative Effect Interaction
Forestry/agricultural practices	Historical and ongoing	Land near the Project site and within the local community	Yes	• Loss or alteration of wildlife habitat • Wildlife mortality • Noise • Visual impacts

Small businesses and local economy	Historical and ongoing	Various locations within the local community	Yes	• Increase in jobs and economic opportunities
Sable Wind Farm	Ongoing	Adjoining parcel of land to the north	Yes	• Loss or fragmentation of wildlife habitat • Wildlife mortality (e.g. bird collisions with turbines) • Noise • Visual impacts
Black Point Quarry	Future	11 km northwest of the site	Yes	• Increase in jobs and economic opportunities
Melford Atlantic Gateway	Future	30 km northwest of the site	Yes	• Increase in jobs and economic opportunities
Goldboro LNG	Future	50 km southwest of the site	Yes	• Increase in jobs and economic opportunities

12.2 Significance of Cumulative Effects

The majority of the cumulative effects pertain to other current and future developments in eastern-Guysborough country that are near-enough to the Project site to bring commercial and economic impacts that would be compounded by the development of the Canso Spaceport. This would result in economic opportunities for the communities of Canso and Little Dover, as well as Guysborough County as a whole. However most of these other developments are not so close to the Project site to result in significant adverse cumulative effects to the environment (e.g. wildlife and habitat). As such the most significant cumulative effect of the Project with these developments would be the increase in employment and economic opportunities in the general area.

Forest and agricultural practices have occurred near the Project site area, which when combined with the land clearing that would be necessary to construct the Project, would result in the cumulative loss and fragmentation of habitat for the flora and fauna in the area. However, the Project's footprint is limited to a relatively small area (tolling approximately 20 ha), and the habitat within its footprint is of relatively low quality (comprised mostly of rock barrens). Therefore, the Project's contribution to habitat alteration and fragmentation would not be significant on a landscape level.

The Sable Wind Farm is the closest development to the Project site. The Canso Spaceport would also result in a cumulative effect with the Sable Wind Farm in the alteration and fragmentation of habitat for flora and fauna. As discussed above, the footprint of the Project would not result in a substantial change to the terrestrial habitat quality of the greater landscape. The cumulative effect of the Project with the wind farm on avifauna may result in increased bird mortality rates at the wind farm if the Project's lights were to attract more birds to the area. This, however, is highly mitigatable through the implementation of an avian management plan, which would include contingencies for using bird friendly lighting options, as well as providing a lighting curtailment plan for key periods of the year (e.g. in low visibility conditions during the fall bird migration period). Additionally, an avian monitoring plan will be developed to monitor the impacts of the Project on the bird population. Results of the avian monitoring plan would be used to revise the avian management plan as necessary. As such, the cumulative effect of the Project on bird mortality rates at the Sable Wind Farm is not expected to be significant.

13.0 CONCLUSION

In accordance with “A Proponent’s Guide to Environmental Assessment” (NSE 2017a), the studies, regulatory assessments, and VEC evaluations described within this document have been considered both singularly and cumulatively.

The results of this assessment indicate that there are no significant environmental concerns or impacts that may result from the Project that cannot be effectively mitigated. Best practices and standard mitigation methods will be implemented during all phases of the Project, to ensure methods and practices are comprehensive and are adhered to. Furthermore, an EPP will be developed and communicated to all employees working on the Project.

14.0 REFERENCES

ACCDC (Atlantic Canada Data Conservation Centre). 2016. Monarch (*Danaus plexippus*). Maritime Butterfly Atlas. Accessed on 11 January 2018 from: http://www.accdc.com/mba/profiles/danaus-plexippus.html.

ACCDC (Atlantic Canada Data Conservation Centre). 2017. Data Report 5805: Canso, NS. Atlantic Canada Data Conservation Centre, New Brunswick, Canada.

Alexander D.R., Kerekes, J.J. and B.C. Sabean. 1986. Description of selected lake characteristics and occurrence of fish species in 781 Nova Scotia Lakes. Proceedings of the Nova Scotia Institute of Science. 36(2): 63-106.

AMEC Earth and Environmental. 2006. Canso Wind Farm Environmental Impact Statement. Canso. Nova Scotia. 245 pp.

Beltaos, S. 2002. Effects of climate on mid-winter ice jams. Hydrological Processes. 16(4): 789-804.

BSC (Bird Studies Canada). 2016. Second atlas of breeding birds of the Maritime provinces. Available online from: http://www.mba-aom.ca/jsp/toc.jsp.

Bonsal, B.R. and T.D. Prowse. 2003. Trends and variability in spring and autumn 0°C-isotherm dates over Canada. Climatic Change. 57(3): 341-358.

Boreas Heritage Consulting Inc. 2017. Maritime launch services archaeological screening and reconnaissance. Boreas Heritage Consulting Inc., Nova Scotia, Canada.

Broders, H.G., Quinn, G.M., and G.J. Forbes. 2003. Species status, and the spatial and temporal patterns of activity of bats in southwest Nova Scotia, Canada. Northeastern Naturalist. 10: 383-398.

Broders, H.G., Coombs, A.B., and J.R. McCarron. 2012. Ecothermic responses of moose (Alces alces) to thermoregulatory stress on mainland Nova Scotia. Alces. 48: 53-61.

Bruce, J. 2005. Hurricanes and climate change. Canadian Meteorological and Oceanographic Society (CMOS) Bulletin. 33(5): 131.

Cassola, F. 2016. *Microtus chrotorrhinus*. The IUCN Red List of Threatened Species 2016: eT42626A115196387. Accessed on 10 January 2018 from: http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T42626A22347958.en.

CDEP (Connecticut Department of Environmental Protection). 2013. A field guide to the freshwater mussels of Connecticut. Bureau of Natural Resources / Wildlife Division, Department of Environmental Protection, Hartford, Connecticut, USA. Accessed on 10 January 2018 from: http://www.ct.gov/deep/cwp/view.asp?a=2723&q=325914&depNav_GID=1655.

CEAA (Canadian Environmental Assessment Agency). 2012. Canadian Environmental Assessment Act - regulations designating physical activities. Accessed on 10 January 2018 from: http://laws-lois.justice.gc.ca/eng/regulations/SOR-2012-147/page-1.html.

Christian, D. and J. Daniels. 1985. Distributional records of rock voles, *Microtus chrotorrhinus*, in Northeastern Minnesota. Canadian Field Naturalist. 99: 356-359.

Chute, J.E. 1999. Frank G. Speck's contributions to the understanding of Mi'kmaq land use, leadership, and land management. Ethnohistory. 46(3) 481-540.

Clarke, A. H. 1981a. The freshwater mollusks of Canada. National Museum of Natural Sciences, National Museums of Canada, Ottawa, ON. 446 pp.

Clarke, A.H. 1981b. The tribe Alasmidontini (Unionidae: Anodontinae), Part I: Pegias, Alasmidonta and Arcidens. Smithsonian Contributions to Zoology 326: 1-101.

Colligan, M., Collins, M., Hecht, A., Hendrix, M., Kahnle, A., Laney, W., St. Pierre, R., Santos, R. and T. Squiers. 1998. Status review of Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus). Atlantic Sturgeon Status Review Team, 124 p.

Cordeiro, J. 2011. Alasmidonta undulata. The IUCN Red List of Threatened Species 2011: eT189106A8683096. Accessed on 10 January 2018 from http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T189106A8683096.en.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2004. COSEWIC assessment and status report on the yellow lampmussel *Lampsilis cariosa* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 35 pp. (www.SARAregistry.gc.ca/status/status_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009a. COSEWIC assessment and status report on the Brook Floater Alasmidonta varicose in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 79 pp. (www.SARAregistry.gc.ca/status/status_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009b. COSEWIC assessment and update status report on the snapping turtle *Chelydra serpentina* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Vii + 47 pp. (www.SARAregistry.gc.ca/status/status_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010a. COSEWIC assessment and status report on the Atlantic Salmon *Salmo salar* (Nunavik population, Labrador population, Northeast Newfoundland population, South Newfoundland population, Southwest Newfoundland population, Northwest Newfoundland population, Quebec Eastern North Shore population, Quebec Western North Shore population, Anticosti Island population, Inner St. Lawrence population, Lake Ontario population, Gaspé-Southern Gulf of St. Lawrence population, Eastern

Cape Breton population, Nova Scotia Southern Upland population, Inner Bay of Fundy population, Outer Bay of Fundy population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xlvii + 136 pp. (www.SARAregistry.gc.ca/status/status_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010b. COSEWIC assessment and status report on the Monarch *Danaus plexippus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 43 pp. (www.SARAregistry.gc.ca/status/status_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2011. COSEWIC assessment and status report on the Atlantic *Sturgeon Acipenser oxyrinchus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiii + 49 pp. (www.SARAregistry.gc.ca/status/status_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012. COSEWIC assessment and status report on the American Eel *Anguilla rostrata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 109 pp. (www.registrelep-SARAregistry.gc.ca/default_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2015. COSEWIC assessment and status report on the Yellow-banded Bumble Bee *Bombus terricola* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 60 pp. (www.registrelep-SARAregistry.gc.ca/default_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2017. COSEWIC candidate wildlife species. Committee on the Status of Endangered Wildlife in Canada. Accessed on 10 January 2018 from: https://www.canada.ca/en/environment-climate-change/services/committee-status-endangered-wildlife/candidate-wildlife-species.html.

CRI (Canadian Rivers Institute). 2018. Alewife (Gaspereau), *Alosa pseudoharengus*. University of New Brunswick, Canada. Accessed on 10 January 2018 from: http://www.unb.ca/research/institutes/cri/links/inlandfishesnb/Species/alewifegasp.html.

CWS (Canadian Wildlife Service). 2007. Wind turbines & birds – monitoring protocols. Environment Canada. 33 pp. Accessed on 10 January 2018 from: http://publications.gc.ca/collections/collection_2013/ec/CW66-364-2007-eng.pdf.

Davis, D., and S. Browne. 1996. The Natural History of Nova Scotia. Nova Scotia Museum, Halifax, NS. 304 pp.

Dawson, W.R. 2014. Pine Siskin (Spinus pinus), version 2.0. In The Birds of North America (P.G. Rodewald, editor). Cornell Lab of Ornithology, Ithaca, New York, USA. https://doi.org/10.2173/bna.280. Accessed on 10 January 2018 from: https://birdsna.org/Species-Account/bna/species/pinsis.

Desroches, J., and Rodrigue, D. 2004. Amphibiens et reptiles du Québec et des Maritimes. Guides nature Quintin., Waterloo, Canada. 288 pp.

DFO (Fisheries and Oceans Canada). 2007. Assessment of Gaspereau River alewife. Canadian Science Advisory Secretariat Science Advisory Report. 2007/030. 8 pp. Accessed on 10 January 2018 from: http://waves-vagues.dfo-mpo.gc.ca/Library/329174.pdf.

DFO (Fisheries and Oceans Canada). 2008. Recovery potential assessment for Inner Bay of Fundy Atlantic salmon. Canadian Science Advisory Secretariat Science Report 2008/050. Accessed on 10 January 2018 from: http://waves-vagues.dfo-mpo.gc.ca/Library/335147.pdf.

DFO (Fisheries and Oceans Canada). 2013. Recovery potential assessment for Southern Upland Atlantic Salmon. Canadian Science Advisory Secretariat Science Advisory Report 2013/009. Accessed on 10 January 2018 from: http://waves-vagues.dfo-mpo.gc.ca/Library/348496.pdf.

DFO (Fisheries and Oceans Canada). 2015. 2015 Value of Atlantic & Pacific coasts commercial landings, by province (thousand dollars). Accessed on 9 January 2018 from http://www.dfo-mpo.gc.ca/stats/commercial/land-debarq/sea-maritimes/s2015pv-eng.htm.

DFO (Fisheries and Oceans Canada). 2017. Maritimes region lobster economic update. Presentation to the Regional Lobster Advisory Committee. September 26, 2017 Meeting.

EC (Environment Canada). 2016a. Canadian climate normals 1981-2010 station data. Accessed 10 January 2018 from: http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnName&txtStationName=Deming&searchMethod=begins&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=6336&dispBack=1.

EC (Environment Canada). 2016b. Port Hawesbury - Air Quality Health Index. Accessed on 10 January 2018 from: https://weather.gc.ca/airquality/pages/nsaq-005_e.html.

Elphick, C.S. and T.L. Tibbitts. 1998. Greater Yellowlegs (*Tringa melanoleuca*), version 2.0. In The Birds of North America (P.G. Rodewald, editor). Cornell Lab of Ornithology, Ithaca, New York, USA. https://doi.org/10.2173/bna.355. Accessed on 10 January 2018 from: https://birdsna.org/Species-Account/bna/species/greyel.

Evers, D.C., Paruk, J.D., McIntyre, J.W. and J.F. Barr. 2010. Common Loon (*Gavia immer*), version 2.0. In The Birds of North America (P.G. Rodewald, editor). Cornell Lab of Ornithology, Ithaca, New York, USA. https://doi.org/10.2173/bna.313. Accessed on 10 January 2018 from: https://birdsna.org/Species-Account/bna/species/comloo.

Fenton, M.B., and R.M.R. Barclay. 1980. *Myotis lucifugus*. Mammalian Species Account No. 142. 8 pp.

Fox, D., Robinson, C. and M. Zentilli. 1997. Pyrrhotite and associated sulphides and their relationship to acid rock drainage in the Halifax Formation, Meguma Group, Nova Scotia. Atlantic Geology. 33: 87-103. Accessed on 10 January 2018 from: https://journals.lib.unb.ca/index.php/ag/article/viewFile/2061/2425.

Gilhen, J. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum of Natural History, Nova Scotia, Canada. 162 pp.

GC (Government of Canada). 2010. *Special Places Protection Act*. Office of the Legislative Council. Accessed on 11 January 2018 from: https://nslegislature.ca/sites/default/files/legc/statutes/specplac.htm.

GC (Government of Canada). 2017a. A to Z species index. Species at Risk Public Registry. Accessed on 10 January 2018 from: http://www.registrelep-SARAregistry.gc.ca/sar/index/default_e.cfm.

GC (Government of Canada). 2017b. Guide for radon measurements in residential dwellings (homes). Health Canada, Publications – Health risks and safety. 24 pp. Accessed on 11 January 2018 from: https://www.canada.ca/en/health-canada/services/publications/health-risks-safety/guide-radon-measurements-residential-dwellings.html#a1_3.

Guest, G. and R.M. Slone Jr. 1973. Structural damage claims resulting from acoustic environments developed during static firing of rocket engines. NASA Space Shuttle Technology Conference – Dynamics and Aeroelasticity; Structures and Materials. San Antonio, Texas. pp. 45-70. Accessed on 17 January 2018 from: http://www.dtic.mil/dtic/tr/fulltext/u2/a307472.pdf.

Heard, W.H. 1979. Identification Manual of the Freshwater Clams of Florida. State of Florida Department of Environmental Regulation Technical Series. 4(2): 83 pp.

Hegmann, G., Cocklin, C., Creasey, R., Dupuis, S., Kennedy, A., Kingsley, L., Ross, W., Spaling, H. and D. Stalker. 1999. Cumulative Effects Assessment Practitioners' Guide. Environment Canada. Accessed on 10 January 2018 from: http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=43952694-1&printfullpage=true.

IBA (Important Bird Areas) Canada. 2012. Important Bird Areas in Canada. IBA Program. Accessed on 10 January 2018 from: http://www.ibacanada.ca/.

Johnson, R.I. 1970. The systematics and zoogeography of the Unionidae (Mullusca: Bivalvia) of the southern Atlantic Slope. Bulletin of the Museum of Comparative Zoology. 140: 263-450.

Kearney, J.F. 2017. Sable Wind, Breeding and Migrating Birds Post-Construction Monitoring, 2015-2016. John F. Kearney & Associates for the Municipality of the District of Guysborough and Nova Scotia Power Inc., March 2017.

Keppie, J.D. (compiler). 2000. Geological Map of the Province of Nova Scotia. Nova Scotia Department of Natural Resources, Minerals and Energy Branch, Map ME 2000-1, scale 1:500 000. Available online as DP ME 43, version 2, 2006 from: https://novascotia.ca/natr/meb/download/dp043.asp.

Kirkland, G.L. 1981. *Sorex dispar* and *Sorex gaspensis*. Mammalian Species. 155: 1-4.

Kirkland, G.L. and C.M. Knipe. 1979. The rock vole (Microtus chrotorrhinus) as a transition zone species. Canadian Field-Naturalist. 93(3): 319-321.

Lacoul, P., Freedman, B., and Clair, T. 2011. Effects of acidification on aquatic biota in Atlantic Canada. Environ. Rev. 19: 429-460.

Lemmen, D.S., Warren, F.J., Lacroix, J., and E. Bush. 2008. From Impacts to Adaptation: Canada in a Changing Climate 2007; Government of Canada, Ottawa, ON, 448 pp. Accessed on 11 January 2018 from: https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/assess/2007/pdf/full-complet_e.pdf.

Lewis, P.J. 1997. Trends In Abraham, J., Canavan, T. and R. Shaw (Eds), Climate Change and Climate Variability in Atlantic Canada – Volume VI of the Canada Country Study: Climate Impacts and Adaptations. Environment Canada, Atlantic Region. 18-20. Accessed on 11 January 2018 from: http://publications.gc.ca/collections/Collection/En56-119-4-1997E.pdf.

Lines, G., Pancura, M. and Landeer, C. 2003. Building climate change scenarios of temperature and precipitation in Atlantic Canada using the statistical downscaling model (SDSM); 14th Symposium on Global Change and Climate Variations, American Meteorological Society Annual Meeting, Long Beach, California. 25 pp. Accessed on 11 January 2018 from: https://ams.confex.com/ams/annual2003/webprogram/Paper52294.html.

MacGregor, M.K and M.F. Elderkin. 2003. Protecting and Conserving Wood Turtles: A Stewardship Plan for Nova Scotia. Published by the Biodiversity Program, Wildlife Division. 23 pp. Accessed on 11 January 2018 from: https://novascotia.ca/natr/wildlife/biodiversity/pdf/recoveryplans/finalwoodturtleplan.pdf.

MacMillan, J.L. and J.E. LeBlanc. 2002. Biological characteristics of sea-run salmonids from a spring angler creel survey on five Northumberland Strait river systems in Nova Scotia, and management implications. Manuscript and Technical Report Series. Nova Scotia Department of Agriculture and Fisheries, Inland Fisheries Division, P.O. Box 700, Pictou, Nova Scotia, B0K 1H0. Accessed on 11 January 2018 from: https://novascotia.ca/fish/documents/special-management-areas-reports/Sea_Run_Trout_Fisheries_in_Northumberland_Strait_Rivers_2002.pdf.

Maine Department of Inland Fisheries and Wildlife (MDIFW), Nedeau, E.J., McCollough, M.A., and B.I. Swartz. 2000. The Freshwater Mussels of Maine. Inland Fisheries and Wildlife Documents. 76.

Marquenie, J., Donners, M., Poot, H., Steckel, W. and B. De Wit. Bird-friendly light sources. 2013. Adapting the spectral composition of artificial lighting. IEEE Industry Applications Magazine Mar/Apr 2013: 56-62 pp.

McAlpine, D.F. and I.M. Smith. 2010. Assessment of Species Diversity in the Atlantic Maritime Ecozone. NRC Research Press, Ottawa, Canada. 785 pp.

Mills, D. 1971. Salmon and trout: a resource, its ecology, conservation and management. Oliver & Boyd, London, UK. 351 pp.

MODG (Municipality of the District of Guysborough). 2012. Sable wind farm project – environment assessment registration document. Accessed on 11 January 2018 from: https://www.novascotia.ca/nse/ea/sable-wind-guysborough.asp.

MODG (Municipality of the District of Guysborough). 2013. Municipality of the District of Guysborough land use bylaw. Accessed on 11 January 2018 from: http://www.municipality.guysborough.ns.ca/sites/default/files/pdfs/LAND%20USE%20BYLAW.pdf.

MODG (Municipality of the District of Guysborough). 2016. Municipality of the District of Guysborough noise control by-law. Accessed on 11 January 2018 from: http://www.municipality.guysborough.ns.ca/sites/default/files/pdfs/Noise%20Control%20By-Law.pdf.

Morrison, R.I.G. 1984. Migration systems of some New World shorebirds, in: Burger, J. et al. (Ed.) Shorebirds: migration and foraging behavior. Behavior of Marine Animals: Current Perspectives in Research, 6: pp. 125-202

Moseley, M. 2007. Records of bats (Chiroptera) at caves and mines in Nova Scotia. Curatorial Report Number 99, Nova Scotia Museum, Halifax, NS. 21 pp. Accessed on 11 January 2018 from: https://ojs.library.dal.ca/NSM/article/view/4030/3686.

MTRI (Mersey Tobeatic Research Institute). 2008. Species at risk in Nova Scotia: identification and information guide. 100 pp. Accessed on 11 January 2018 from: http://www.speciesatrisk.ca/SARGuide/download/SAR%20Guide.pdf.

NASA. 2005. Final site-wide environmental assessment, Wallops Flight Facility, Virginia. Prepared for NASA Goddard Space Flight Center. Prepared by URS-EG&G. January. Accessed on 11 January 2018 from: https://sites.wff.nasa.gov/code250/docs/Final%20Site-Wide%20EA.pdf.

NASA. 2009. Expansion of the Wallops Flight Facility launch range final environmental assessment, Wallops Flight Facility. Wallops Island, VA: WFF Environmental Office. Accessed on 11 January 2018 from: https://sites.wff.nasa.gov/code250/docs/expansion_ea/EWLR_FEA.pdf.

NatureServe. 2017. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Accessed on 11 January 2018 from: http://explorer.natureserve.org.

Naughton, D. 2012. The natural history of Canadian mammals. Canadian Museum of Nature. University of Toronto Press, Toronto, Ontario. 824 pp.

NCC (Nature Conservancy of Canada). 2016. Featured Species: Four-toed salamander. Accessed on 11 January 2018 from: http://www.natureconservancy.ca/en/what-we-do/resource-centre/featured-species/four-toed-salamander.html?referrer=https://www.google.ca/.

Neily, P.D., Quigley, E., Benjamin, L., Stewart, B., and T. Duke. 2005. Ecological land classification for Nova Scotia Volume 1 (Revised Edition) – mapping Nova Scotia's terrestrial ecosystems. Nova Scotia Department of Natural Resources, Renewable Resources Branch, Report DNR-2003-2. 75 pp. Accessed on 11 January 2018 from: https://novascotia.ca/natr/forestry/ecological/pdf/ELCrevised2.pdf.

Nisbet, I.C.T., Arnold, J.M., Oswald, S.A., Pyle, P. and M.A. Patten. 2017. Common tern (*Sterna hirundo*), version 3.0. In The Birds of North America (P. G. Rodewald, editor). Cornell Lab of Ornithology, Ithaca, New York, USA. https://doi.org/10.2173/bna.comter.03. Accessed on 11 January 2018 from: https://birdsna.org/Species-Account/bna/species/comter.

NSDAF (Nova Scotia Department of Agriculture and Fisheries). 2005. Nova Scotia trout management plan: Final Draft. Inland Fisheries Division. 45 pp. Accessed on 11 January 2018 from: https://novascotia.ca/fish/documents/special-management-areas-reports/NSTroutManplandraft05.pdf.

NSDNR (Nova Scotia Department of Natural Resources). 2012a. Endangered mainland moose special management practices. Wildlife and Biodiversity, Special Management Practices. Accessed on 11 January 2018 from: http://www.gov.ns.ca/natr/wildlife/habitats/terrestrial/pdf/SMP_Mainland_Moose.pdf.

NSDNR (Nova Scotia Department of Natural Resources). 2012b. Wet areas mapping and flow accumulation channels. Forestry, Forestry Program Areas. Accessed on 11 January 2018 from: http://novascotia.ca/natr/forestry/gis/wamdownload.asp.

NSDNR (Nova Scotia Department of Natural Resources). 2013. Wildlife and birds of Nova Scotia – kingdom Animalia: vertebrates. Wildlife and Biodiversity. Accessed on 11 January 2018 from: http://novascotia.ca/natr/wildlife/wns/wns7f.asp.

NSDNR (Nova Scotia Department of Natural Resources). 2014. Nova Scotia significant species and habitats database. Wildlife and Biodiversity. Accessed on 11 January 2018 from: http://www.gov.ns.ca/natr/wildlife/habitats/hab-data/.

NSDNR (Nova Scotia Department of Natural Resources). 2015. Wild Species – The General Status of Species in Nova Scotia. Retrieved from http://www.gov.ns.ca/natr/wildlife/genstatus/.

NSDNR (Nova Scotia Department of Natural Resources). 2017. Species at risk overview. *NS Endangered Species Act*: Legally Listed Species. Accessed on 11 January 2018 from: https://novascotia.ca/natr/wildlife/biodiversity/species-list.asp.

NSE (Nova Scotia Environment). 1995. Sulphide Bearing Material Disposal Regulations. Nova Scotia Environment Act, under Section 66. Accessed on 11 January 2018 from: https://novascotia.ca/just/regulations/regs/env5795.htm.

NSE (Nova Scotia Environment). 2009. Guide to addressing wildlife species and habitat in an EA registration document. Policy and Corporate Services Division Environmental Branch. 8 pp. Accessed on 11 January 2018 from: https://novascotia.ca/nse/ea/docs/EA.Guide-AddressingWildSpecies.pdf.

NSE (Nova Scotia Environment). 2017a. A proponent's guide to environmental assessment. Policy and Corporate Services Division Environmental Branch. 37 pp. Accessed on 11 January 2018 from: http://www.gov.ns.ca/nse/ea/docs/EA.Guide-Proponents.pdf.

NSE (Nova Scotia Environment). 2017b. Well logs database. Ground Water. Accessed on 11 January 2018 from: https://www.novascotia.ca/nse/welldatabase/wellsearch.asp.

NSL (Nova Scotia Legislature). 2017. Brook Trout. Accessed on 11 January 2018 from: http://nslegislature.ca/index.php/about/symbols/brook_trout.

Parker, G. 2003. Status report on the eastern moose (*Alces alces americana* Clinton) in mainland Nova Scotia. 77 pp. Accessed on 11 January 2018 from: https://novascotia.ca/natr/wildlife/biodiversity/pdf/statusreports/StatusReportMooseNSComplete.pdf.

Poot, H., Ens, B.J., de Vries, H., Donners, M.A.H., Wernand, M.R. and J.M. Marquenie. 2008. Green light for nocturnally migrating birds. Ecology and Society. 13: 47. Accessed on 2 January 2018 from http://www.ecologyandsociety.org/vol13/iss2/art47/

Poulson, S.R., Kubilius, W.P, and Ohmoto, H. 1991. Geochemical behavior of sulfur in granitoids during intrusion of the South Mountain Batholith, Nova Scotia, Canada. Geochim. Comoschim. Acta. 55: 3809-3830.

Reed, J.M., Oring L.W. and E.M. Gray. 2013. Spotted Sandpiper (*Actitis macularius*), version 2.0. In The Birds of North America (P.G. Rodewald, editor). Cornell Lab of Ornithology, Ithaca, New York, USA. https://doi.org/10.2173/bna.289. Accessed on 11 January 2018 from: https://birdsna.org/Species-Account/bna/species/sposan.

Roscoe, B. and C. Majka. 1979. First records of the rock vole (*Microtus chrotorrhinus*) and the Gaspe shrew (*Sorex gaspensis*) from Nova Scotia and a second for the Thompson's pygmy shrew (*Sorex thompsoni*) from Cape Breton Island. Canadian Field-Naturalist. 90: 497-498.

Sabine, D.L., Makepeace, S., and D.F. McAlpine. 2004. The yellow lampmussel (*Lampsilis cariosa*) in New Brunswick: a population of significant conservation value. Northeastern Naturalist, 11: 407-420.

Samson, H.R., and Clarke, D.B. 2005. Assimilation of country-rock sulphide minerals in the South Mountain Batholith, Nova Scotia, Canada. Geol. Assoc. Can. – Mineral. Assoc. Can., Program Abst. 30: 170.

Serdynska, A., and Coffen-Smout, S. 2017. Mapping inshore lobster landings and fishing effort on a Maritimes region statistical grid (2012-2014). Can. Tech. Rep. Fish. Aquat. Sci. 3177: 28 pp.
Scott, F.W. 1987. First record of the Long-tailed shrew, *Sorex dispar*, for Nova Scotia. Canadian Field Naturalist. 101: 404-407.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin. 184. 966 pp.

Shafer, A.B.A. and D.T. Stewart. 2006. A disjunct population of *Sorex dispar* (Long-tailed shrew) in Nova Scotia. Northeastern Naturalist 13(4): 603-608.

Snaith, T.V. and K.F. Beazley. 2004. The distribution, status, and habitat associations of moose in mainland Nova Scotia. Proceedings of the Nova Scotian Institute of Science 42(2): 263-317.

Statistics Canada. 2016a. Halifax, Nova Scotia (Code 1209034) and Canada (Code 01) (table). Census Profile. 2011 Census. Statistics Canada Catalogue no. 98-316-XWE. Ottawa. Released October 24, 2012. Accessed on 11 January 2018 from: http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E.

Statistics Canada. 2016b. Halifax, RGM, Nova Scotia (Code 1209034) (table). National Household Survey (NHS) Profile. 2011 National Household Survey. Statistics Canada Catalogue no. 99-004-XWE. Ottawa. Released September 11, 2013. Accessed on 11 January 2018 from: http://www12.statcan.gc.ca/nhs-enm/2011/dp-pd/prof/index.cfm?Lang=E.

Stea, R.R., Conley, H., and Y. Brown. 1992. Surficial geology map of the province of Nova Scotia. Nova Scotia Department of Natural Resources, Minerals and Energy Branch, Map ME 1992-3, scale 1:500 000. Available online as DP ME 36m version 36, 2006 at http://www.gov.ns.ca/natr/meb/download/dp036.asp.

Telfer, E.S. 1970. Winter habitat selection by moose and white-tailed deer. Journal of Wildlife Management 34(3):553-559.

The Canada-Nova Scotia Strait of Canso Environment Committee. 1975. Strait of Canso natural environment inventory: Water Resources. Earl Whynot & Associates Ltd., Halifax, Nova Scotia. 26 pp. Accessed on 12 January 2018 from: https://novascotia.ca/nse/groundwater/docs/GroundwaterResourcesReport_StraitofCanso.pdf.

Transport Canada. 2017. Part IV - aircraft noise. TP 1247 - Aviation - Land Use in the Vicinity of Aerodromes. Accessed on 16 January 2018 from: https://www.tc.gc.ca/eng/civilaviation/publications/tp1247-part4-1436.htm.

Trescott, Peter C. 1969. Groundwater resources and hydrogeology of the Windsor-Hantsport-Walton area, Nova Scotia. Province of Nova Scotia, Department of Mines Groundwater Section; Report 69-2. pp.65. Accessed on 12 January 2018 from: https://novascotia.ca/nse/groundwater/docs/GroundwaterResourcesReport_Windsor-Hansport-WaltonArea.pdf.

Van de Laar, F. 2007. Green Light to Birds: Investigation into the Effect of Bird-Friendly Lighting. pp 24. Accessed on 28 December 2017 from: http://www.waddenzee.nl/fileadmin/content/Dossiers/Energie/pdf/green_light_to_birdsNAM.pdf

Webb, K.T. and I.B. Marshall. 1999. Ecoregions and ecodistricts of Nova Scotia. Crops and Livestock Research Centre, Research Branch, Agriculture and Agri-Food Canada, Truro, Nova Scotia; Indicators and Assessment Office, Environmental Quality Branch, Environment Canada, Hull, Quebec. 39 pp. and 1 map. Accessed on 12 January 2018 from: http://sis.agr.gc.ca/cansis/publications/surveys/ns/nsee/nsee_report.pdf.

Webster, P.J., Holland, G.J., Curry, J.A. and H-R. Chang. 2005. Changes in tropical cyclone number, duration and intensity in a warming environment; Science. 309(5742): 1844 -1846. Accessed on 12 January 2018 from: http://science.sciencemag.org/content/309/5742/1844.full.

White, K. 2001. Assessment of the population status of freshwater mussels in Blacketts Lake, Nova Scotia. Atlantic Coastal Action Program, Cape Breton, NS.

Woolaver, L.G., Elderkin, M.F., and F.W. Scott. 1998. *Sorex dispar* in Nova Scotia. Northeastern Naturalist. 5(4): 323-330.

Zhang, X., Harvey, K.D., Hogg, W.D. and T.R. Yuzyk. 2001. Trends in Canadian streamflow. Water Resources Research. 37(4): 987-998. Accessed on 12 January 2018 from: http://onlinelibrary.wiley.com/doi/10.1029/2000WR900357/epdf.