nalcor energy

Labrador – Island Transmission Link

Marine Emissions
Environmental Effects Monitoring Plan

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REVISION LOG

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1.0 PURPOSE

The purpose of this Labrador-Island Transmission Link (L-ITL) (the Project) Marine Emissions Environmental Effects Monitoring Plan (MEEEMP) is to comply with regulatory requirements and commitments made in the L-ITL Environmental Impact Statement (EIS) (Nalcor 2012). The MEEEMP outlines how Nalcor Energy will monitor emissions from the operation of the submarine cables in the Strait of Belle Isle and the grounding stations at L'Anse au Diable and Dowden's Point.

This MEEEMP has been prepared to detail the monitoring and follow up program to confirm the predictions for the grounding station and the cable.

2.0 SCOPE

This plan addresses the required aspects of chemical, electromagnetic emissions and effects monitoring for the operation phase of the submarine cables in the Strait of Belle Isle and the grounding stations at L'Anse au Diable and Dowden's Point for the L-ITL (described in Section 5.0).

3.0 DEFINITIONS

Environmental Assessment: An evaluation of a project's potential environmental risks and effects before it is carried out and identification of ways to improve project design and implementation to prevent, minimize, mitigate, or compensate for adverse environmental effects and to enhance positive effects.

Environmental Management: The management of human interactions with the environment (air, water and land and all species that occupy these habitats including humans).

Environmental Protection Plan: Document outlining the specific mitigation measures, contingency plans and emergency response procedures to be implemented during the construction or operations of a facility.

Environmental Effects Monitoring: Monitoring of overall Project effects to confirm the predictions of EA and to fulfill EA commitments.

Environmental Compliance Monitoring: Monitoring of Project activities to confirm compliance with regulatory requirements and commitments made through the EA process.

4.0 ABBREVIATIONS AND ACRONYMS

CEAA	Canadian Environmental Assessment Act
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
EA	Environmental Assessment
EEMP	Environmental Effects Monitoring Plan
EMF	Electromagnetic Field
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPP	Environmental Protection Plan
ERC	Environment and Regulatory Compliance
FPP	Fisheries Protection Program – Fisheries and Oceans Canada
HVdc	High voltage direct current
LCP	Lower Churchill Project
L-ITL	Labrador-Island Transmission Link
NL	Newfoundland and Labrador
RCP	Regulatory Compliance Plan
ROW	Right of Way

5.0 LABRADOR-ISLAND TRANSMISSION LINK PROJECT DESCRIPTION

As described in the L-ITL EIS, the Project consists of the Construction and Operations of a ± 350 kilovolt (kV) High Voltage direct current (HVdc) electricity transmission system from Central Labrador to the Avalon Peninsula on the Island of Newfoundland (the Island) (Figure 5-1).

The transmission system includes the following key components:

- An alternating current (ac) to direct current (dc) converter station at Muskrat Falls;
- Approximately 400 km overhead HVdc transmission line from Muskrat Falls to Forteau Point;
- A 60 m wide right of way (ROW);
- Three, approximately 35 km long, submarine cables across the Strait of Belle Isle (i.e., between Forteau Point and Shoal Cove), with associated onshore infrastructure (transition compounds and land cables at both cable landings);
- Approximately 700 km of overhead HVdc transmission line from Shoal Cove to the Avalon Peninsula;

- A dc to ac converter station at Soldiers Pond;
- Shoreline grounding stations at L'Anse au Diable and Dowden's Point (described in more detail in Section 5.1)
- An overhead, wood pole line
  - o Near Forteau Point and L'Anse au Diable; and
  - o Between Soldiers Pond and Dowden's Point.

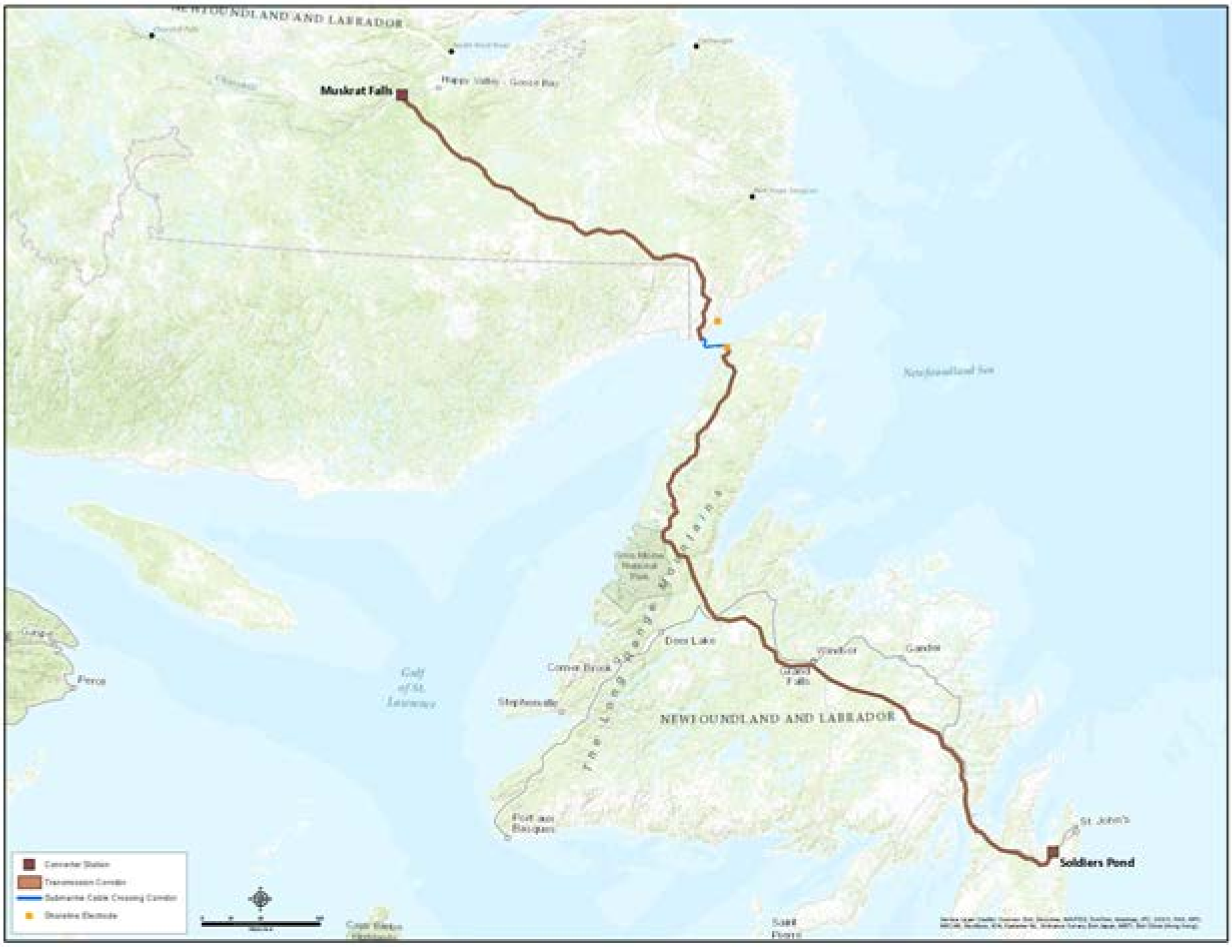

Figure 5-1 Labrador-Island Transmission Link (Nalcor 2012)

5.1 Submarine Cables - Description

Three subsea cables were installed across the Strait of Belle Isle to connect the transmission line between Labrador and Newfoundland. The three subsea cables were protected by installing rock berms on each of the cables. The rock berms were designed to protect the three subsea cables, and each subsea cable is protected by a berm with a base measuring 11.4 m wide at each conduit exit and 4.7 m for the remainder of the berm. Each berm is approximately

26 km long and has a side slope ratio of 1:3 (rise : run). The diameter of the rock used to construct the protective rock berms was between ¾ and 6 inches in diameter. The subsea cable protective rock berms were constructed using a fallpipe vessel. The fall pipe was equipped with a remotely operated vehicle (ROV) to ensure accurate placement of the rocks over each cable.

5.2 Shoreline Grounding Stations – Description

5.2.1 L'Anse au Diable

The shoreline grounding station at L'Anse au Diable is located in a natural cove which is separated from the Strait of Belle Isle by an engineered, water-permeable rock breakwater that extends beyond the mouth of the cove into the Strait of Belle Isle. The breakwater is designed to withstand the expected worst-case conditions associated with wave action, tidal effects, pack ice and freezing of the saltwater pond inside the berm. The depth of water at the inner berm toe (4 m at low tide) was designed to be sufficient to submerge the 80 vertically-oriented silicon cast iron electrode elements, and to accommodate changes in water level within the pond due to tides and ice formation.

The area of the saltwater pond is designed to be 16 160 m^2 and the area of the permeable breakwater in water is 10 000 m^2. The permeable breakwater is a rubble mound structure consisting of embankment materials sourced from nearby quarries. The breakwater has a pit run (mixed grade) core and is lined with a filter stone for stabilization, with armoring on the seaward side consisting of large rock (6 to 10 tonne pieces). Filter stone was placed at the eastern and western edges of the breakwater. The breakwater is permeable along its entire length for the exchange of seawater, with a design porosity of 20%.

While the length of the structure is 124 m, the length of the breakwater along its centre line is approximately 200 m. The crest of the breakwater is about 10 m above the sea floor and approximately 30 m wide. The approximate seaward side slope ratio was designed to be 1:1.5 (rise:run).

5.2.2 Dowden's Point

The shoreline grounding stations at Dowden's Point have a breakwater design to withstand expected worst-case site conditions (e.g., wave action, tide, and pack ice). The breakwater extends into Conception Bay such that the depth of water at the inner berm toe (4 m at low tide) is sufficient to submerge 80 vertically-oriented silicon cast iron electrode elements.

The permeable breakwater is a rubble mound structure consisting of embankment materials sourced from nearby quarries. The breakwater has a pit run (mixed grade) core and is lined with a filter stone for stabilization, with armoring on the seaward side of large armour stone (5 to 8 tonne pieces; size and dimension remain variable for detailed design). The breakwater is permeable along its entire length for the exchange of seawater, with an expected porosity of 20%. This inside area of the berm is filled with quarry run rock fill.

While the length of the electrode itself is approximately 120 m, the entire length of the breakwater along its centre line is approximately 250 m; 190 m in length and 30 m width on both sides. The crest of the breakwater is approximately 10 m above the sea floor and approximately 30 m wide. The approximate seaward side slope ratio was designed to be 1:1.5 (rise:run).

5.3 Operations and Maintenance

The Project has been designed as a bipolar system with a converter station at each end of the HVdc transmission line, and a shoreline grounding station connected to each converter station via an electrode line, providing a ground return path. The shoreline grounding stations were constructed at two locations: L'Anse au Diable, Labrador (connected to the Muskrat Falls converter station) and Dowden's Point, Newfoundland (connected to the Soldiers Pond converter station).

5.3.1 Grounding Stations

During normal balanced bipolar operation, the two poles (one positive and one negative with respect to ground) provide a path for the current, and small amounts of electrical current due to voltage imbalances will flow through the electrode (i.e., less than 1% of the system's total capacity). The grounding station provides a return path for the small amount of current due to voltage imbalances. If both poles are in service, the system can operate at its full rated capacity. If a transmission conductor failure or a pole fault were to occur, the grounding station can provide a temporary ground return path for the current for the duration of the fault. The grounding station may be used during a pole outage if metallic return is not available. This is expected to occur for less than 6 days per year (the design for the shoreline grounding station includes approximately 2 days for forced outages and approximately 4 days for scheduled outages). Additionally, an entire year of monopole operation has been assumed in the design. The total design for monopole operation is approximately 1.75 years out of 50 years. The use of the grounding stations to provide a long-term return path for the full current is expected to occur only under specific circumstances, such as the failure of two of the three subsea cables or the overhead conductor. The likelihood of a conductor failure is reduced through corridor and final ROW selection of the overhead line, cable protection planning, use of a spare cable across the Strait of Belle Isle, and reliable design of the transmission towers and conductors.

The grounding station can be continuously operated for 3.5 years before the elements may need to be replaced. Switches located in the termination structure can be used to turn off a series of electrode elements during maintenance activities. The road constructed along the crest of the permeable berm will allow safe access to the electrode elements.

Studies completed during the environmental assessment suggest that the operations and maintenance of the grounding station will not cause serious harm to fish or fish habitat (Nalcor 2012).

During the Operations Phase, certain emissions from the shoreline grounding station are anticipated. They are as follows:

- electric fields;
- electromagnetic fields (EMFs); and
- electrolysis products, principally chlorine and oxygen

5.3.2 Cable

During normal operations, the subsea cable design (i.e., the shielding and the rock berm covering) will result in no electric field around the subsea cables. There may be a weak electric field if there is any current leakage or stray current from various parts of the transmission system.

A static magnetic field will be generated around the cables and a weak electrical current (induced current) will be generated by any conductor moving through this field (e.g., fish) (Faraday's Law). The specific size of the field will depend on local conditions but would be in the order of 150 m as calculated by the Biot-Savart Formula (Worzyk 2009). The magnetic field strength attenuates rapidly from 260 µT (260,000 nT) at 1 m from the cable to 26 µT (26,000 nT) at 10 m as calculated using the Biot-Savart Formula using a maximum current of 1,286 amperes (A).

6.0 PROJECT SCHEDULE FOR COMMISSIONING

Energization of L-ITL will occur in phases. First power delivery from Churchill Falls to the Island is scheduled to occur this summer. The amount of power that will be transmitted will be dependent on the recall power available from Churchill Falls. For this phase of energization, the grounding stations will not be operational.

Full energization of L-ITL, including the use of the grounding stations is planned for 2019.

7.0 REGULATORY COMPLIANCE

The Fisheries Protection Program (FPP) of Fisheries and Oceans Canada reviewed the Lower Churchill Project's request for project review for the grounding stations at L'Anse au Diable and Dowden's Point and the submarine cables in the Strait of Belle Isle to determine whether either of these projects were likely to result in serious harm to fish, which is prohibited under subsection 35(1) of the *Fisheries Act.* The proposals were also reviewed to determine whether it would adversely impact listed aquatic species at risk and contravene Sections 32, 33 and 58 of the *Species at Risk Act.* Based on the mitigations proposed, FPP was of the view that the proposal would not result in serious harm to fish. FPP was also of the view that the proposal will not contravene Sections 32, 33 or 58 of the *Species at Risk Act.* No formal approval was required from the Program under the *Fisheries Act* or the *Species at Risk Act* in order to proceed with the construction and operation of the grounding stations and the submarine cables.

FPP did state that Nalcor should implement an aquatic effects monitoring program acceptable to Fisheries and Oceans Canada for the operation of the grounding stations at Dowden's Point and L'Anse au Diable and measure the electromagnetic field generated by the submarine cables during its various operational modes in a manner that enables confirmation of the predictions.

8.0 ENVIRONMENTAL EFFECTS MANAGEMENT

Environmental effects management employed for the grounding stations and the cables are described in Section 8.1 and 8.2.

8.1 Grounding Stations

The mitigation measures that will be employed during the operations and maintenance phase include:

- rock breakwater berm at each electrode site will act as a barrier for invertebrates and fish, therefore reducing any impacts the EMF or electrolysis would create;
- electrodes are designed to minimize electric and magnetic fields (e.g., through electrode design, electrode materials, electrode surface area, low resistivity surroundings);

- operation of electrodes under normal conditions as a bi-pole system will involve only very low levels of electric current flowing through the electrodes (<1%);
- HVdc system is designed to require less than 6 days per year of monopolar operations (100%) using the electrode, therefore there will be minimal creation of electrolysis by-products or EMFs resulting in negligible impact to fish;
- minimization of contact area between the shoreline saltwater pond and the breakwater to ensure a safe voltage gradient on the sea side of the breakwater, thereby ensuring no electrification effects on fish

8.2 Cables

The mitigation measures that have been employed for the operations and maintenance phase include:

- visual inspections of the subsea cable will be completed with an ROV;
- screen / armouring of the cable is on the same electric potential as the outside ambient so that the electric field is confined to the inside of the cable;
- subsea cable armour and protective rock berm minimizes electric fields;
- rock berm serves as a partial barrier to the EMF generated by the cable

9.0 ENVIRONMENTAL EFFECTS MONITORING – FOLLOW UP

9.1 Grounding Stations

The follow-up activities are intended to validate predictions made in the L-ITL EIS (Nalcor 2012) related to various emissions. Specifically, the follow-up work related to predictions on emissions during the operations phase of the Project are:

- Electric fields emitted from the shoreline electrode sites;
- Electromagnetic fields (EMFs) emitted from the shoreline electrode site; and
- Electrolysis products, primarily chlorine and hydrogen emitted from the shoreline electrode site.

The follow-up measurements of electric fields, EMFs, and chemical emissions will be carried out in situ (with the exception of chlorine which will be measured by collecting samples and measuring at a laboratory). Specifics on each parameter and the studies to be conducted are described below.

As stated in Section 6, the grounding stations will not be operational until 2019, and therefore, monitoring of the emissions associated with the grounding stations is planned for 2019.

9.1.1 Electric Field Measurements

The grounding sites have been designed to achieve below the maximum gradient of 1.25 V/m in the water on the sea side of the breakwater, which has historically been adapted as the safe limit for fish and humans. Therefore, no further assessment of electric fields for the grounding stations is proposed.

9.1.2 Chemical Emissions

Hydrogen production is associated with the operation of a grounding site as a cathode. This hydrogen production may decrease the pH of the sea water and therefore it is proposed to monitor pH as the chemical emission. The monitoring program will measure pH using an in-situ pH sensor, spatially around the breakwater and the use of a nearby control site.

Chlorine production will be measured by collecting water samples spatially around the breakwater during operations and from a nearby control site. Samples will be analyzed for free chlorine and compared to the predictions made during the EA.

9.1.3 Magnetic Emissions

The field work for monitoring magnetic emissions will be conducted during the same time period as the chemical emissions field monitoring program.

A spatial analysis of the area around the grounding stations will be conducted under baseline conditions and during load conditions to determine the difference in magnetic fields as a result of the operation of the grounding stations.

9.2 Submarine Cables

The follow-up activities are intended to validate predictions made in the L-ITL EIS (Nalcor 2012) related to the operation of the cables. Specifically, the focus of the follow-up work during the operations phase of the Project will be on the EMFs emitted by the subsea cable which is in compliance with DFO's recommendations (see Section 7 – Regulatory Compliance).

Operation of the submarine cables is planned for the summer of 2018. The follow up studies described below are planned for the summer of 2018. These studies will be repeated again at a later date, when the power generated at the Muskrat Falls hydro development increases the amount of power being transmitted to the load predictions used in the EA.

9.2.1 Magnetic Emissions

The field work for monitoring magnetic emissions will be conducted prior to the operation of the cables and during operation of the cables.

A spatial analysis of the area around a section of the cable will be conducted under baseline conditions and during load conditions to determine the difference in magnetic fields as a result of the operation of the subsea cables.

9.3 Reporting

Following the completion of the follow up programs described above, the reports will be made available to DFO and published on Nalcor Energy's website.

Two reports will be prepared, one following the completion of the monitoring and follow up study of the operation of the cables in 2018, and a second report following full energization of the line, and the operation of the grounding stations in 2019.

9.4 Contingency Plan

At this time, contingency plans are not anticipated for this EEM program.

10.0 REFERENCES

10.1 INTERNAL REFERENCES

LCP-PT-ED-0000-EA-SY-0002-01	Environmental Impact Statement and Supporting Documentation for the Labrador-Island Transmission Link
LCP-PT-MD-0000-EV-PL-0009-01	LCP HVdc Overland Transmission and HVdc Specialties Environmental Protection Plan
LCP-PT-MD-0000-RT-PL-0001-01	Regulatory Compliance Plan
LCP-PT-MD-0000-HS-PL-0001-01	Health and Safety Plan
LCP-PT-MD-0000-HS-PL-0004-01.	LCP Emergency Response Plan

LCP-PT-MD-0000-EA-PL-0001-01	LCP Integrated Environmental Assessment Commitment Management Plan

10.2 EXTERNAL REFERENCES

Nalcor. 2012. Labrador-Island Transmission Link. Environmental Impact Statement. April 2012.

Worzyk, T. 2009. Subsea Power Cables. Chapter 10 Environmental Issues. Springer-Verlag. Berlin. p. 249-268.