Charlottetown Diesel Generating Station

Reliability Improvement Project

Environmental Assessment Registration

November 2, 2023

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1.0 INTRODUCTION

1.1 **Name of Undertaking**

Charlottetown Generating Station Reliability Improvement Project (the "Project").

1.2 **Proponent Information**

Name:	Newfoundland and Labrador Hydro	
Address:	Hydro Place, 500 Columbus Drive, St. John's, NL A1B 0C9	
Company Representative:	Scott Crosbie, Vice President, Operations	
Website	hydro@nlh.nl.ca (general inquiries)	
Principal Proponent Contacts		
Name:	Ken Sparkes	Mark Howell, P. Eng.
Title:	Environmental Specialist, Environmental Services	Project Manager, Engineering Services
Telephone:	709-737-1204 | c. 709-690-8694	709-778-6693 | c. 709-687-9781
Email:	KenSparkes@nlh.nl.ca	MarkHowell@nlh.nl.ca

1.3 **Project Overview**

To ensure the continued provision of reliable power to the communities of Charlottetown and Pinsent's Arm, Labrador, Newfoundland and Labrador Hydro ("Hydro") is increasing installed generating capacity at the existing Charlottetown Diesel Generating Station. This undertaking will result in an increase in installed capacity of the generating station exceeding one (1) megawatt ("MW") and requires Registration under the Environmental Assessment Regulations.

1.4 **Project Background and Purpose/Need/Rationale**

Hydro operates a diesel generating station in Charlottetown to supply power to the communities of Charlottetown and Pinsent's Arm, Labrador (Figure 1).

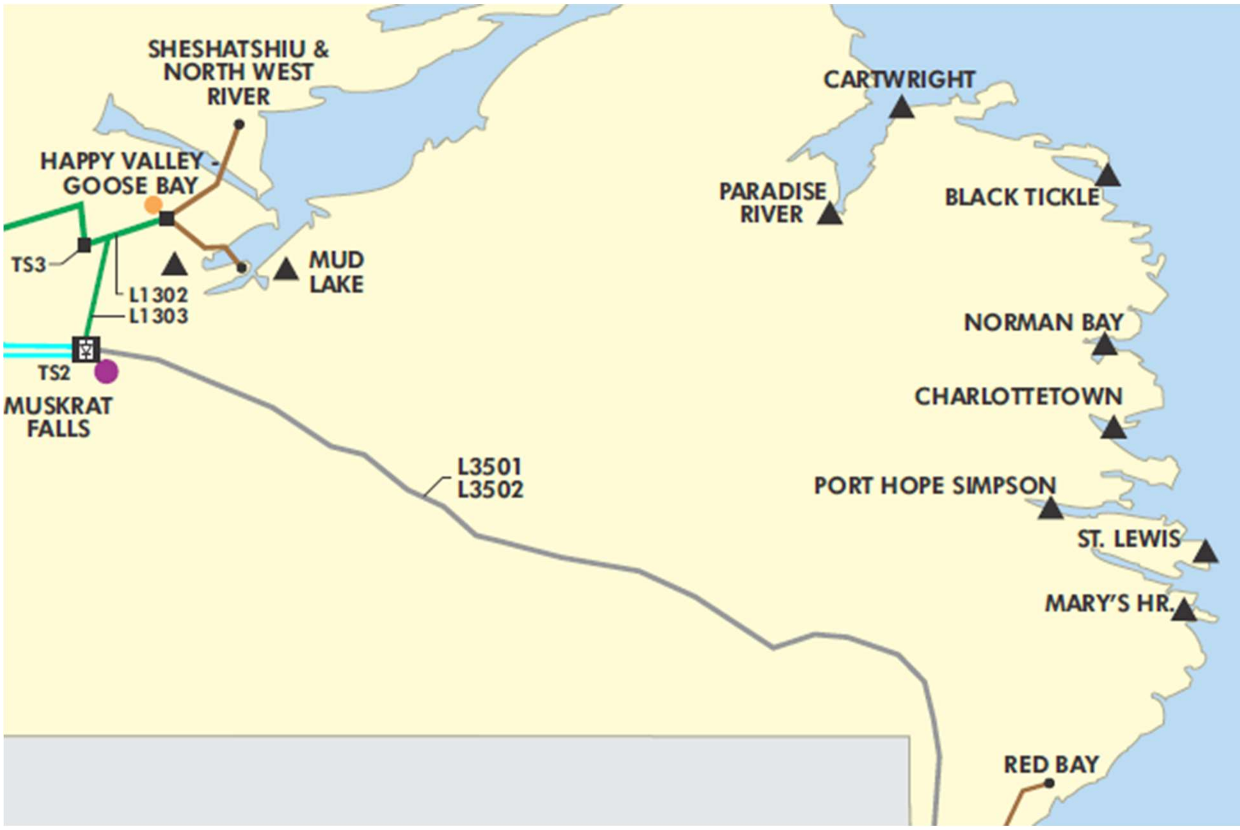

Figure 1. Project Location

On October 7, 2019, the Charlottetown Diesel Generating Station experienced a catastrophic fire that resulted in the total loss of the building and three diesel generating units ("gensets"). Since the 2019 fire, Hydro has provided power to the communities by utilizing mobile gensets. Hydro has not re-built the Charlottetown facility as it proposes to ultimately provide and distribute power to these, and other, communities following construction of a regional diesel generating station in Port Hope Simpson[1].

Utilizing mobile diesel generation as a source of firm capacity increases risk to reliability. Mobile gensets have limited protection and controls, lack condition monitoring capability, and require modifications to operate in winter conditions. Since the 2019 fire, Hydro has subsequently experienced:

- failure of the generator component of Unit 2102 on July 20, 2020;
- failure of Unit 2089 on July 2, 2022;

[1] This proposal is under review by the Public Utilities Board and Environmental Assessment registration is pending.

- failure of Unit 2088 on February 1, 2023 resulting in the unit being out of service for approximately 30 days;
- partial engine failure of Unit 2102 on May 4, 2023 resulting in the unit being out of service for approximately 30 days; and
- failure of the generator component of Unit 821 on May 9, 2023.

The reliability risk associated with the use of mobile gensets can be partially mitigated by ensuring a sufficient quantity of gensets are available to continue to meet demand in the event of an outage or failure of one or more units.

Hydro normally operates diesel generating stations utilizing "N-1" redundancy criteria - meaning the facility can satisfy the peak load requirements[2] with the largest genset unavailable. To mitigate the demonstrated reliability risk associated with continued[3] use of mobile generation, in 2022, Hydro increased the redundancy criteria for Charlottetown from N-1 to N-2, allowing Hydro to meet peak demand even if the two largest generating units are unavailable. In conjunction with this change in criteria, Hydro made application to the Public Utilities Board ("Board") to purchase an additional mobile genset, effectively increasing installed capacity for Charlottetown.

The least cost alternative identified to achieve N-2 capacity was to purchase an available, used 1825 kW mobile genset from the Muskrat Falls site. This was approved by the Board on November 7, 2022[4]. The 1825 kW mobile genset (Unit 2108) was transported to St. John's for maintenance and refurbishment in the spring of 2023 prior to deployment to Charlottetown in June. Unit 2108 has been commissioned and operated at reduced capacity on an interim basis, so as not to result in an increase in capacity exceeding 1 MW, until this undertaking is released.

This project is required to maintain reliable service to customers in the communities of Charlottetown and Pinsent's Arm, Labrador until an alternative power supply for the region is constructed and commissioned.

1.5 **Approval of the Undertaking**

The permits and authorizations, or amendments to existing permits and authorizations, required for the Project are provided in Table 1.

[2] The peak load occurs during operation of the shrimp plant, normally between May and November.
[3] Mobile generation is required until the long-term supply solution is established following commissioning of a proposed regional facility in Port Hope Simpson.
[4] Approved in Order No. PU.32(2022).

Table 1. Permits and Authorizations Required for the Project

Permit or Authorization	Agency	Notes
Release of the Undertaking under the EA Regulations	NLDECC – Environmental Assessment Division	The Environmental Registration document represents the "application" for this regulatory process
Amended Certificate of Approval for Operation of the Generating Station	NLDECC – Pollution Prevention Division	Existing Certificate of Approval (AA22-065674) to be amended

1.6 Stakeholder Engagement

Since the 2019 fire at the Charlottetown Diesel Generating Station, Hydro has extensively engaged with key stakeholders, including communities, government representatives, and regulatory stakeholders, to provide Hydro's interim solution for the communities of Charlottetown and Pinsent's Arm, as well as to outline Hydro's approach to the long-term supply plan for Southern Labrador communities.[5]

In a March 9, 2023 meeting with representatives from the communities of Charlottetown and Pinsent's Arm, Hydro committed to providing quarterly updates. The most recent update was provided on August 18, 2023 (Appendix A).

2.0 PROJECT DESCRIPTION

2.1 Location

The project is located within the community of Charlottetown, Labrador at the existing location of the Charlottetown Diesel Generating Station (Figure 2).

[5] The ongoing proceeding and correspondence related to the Long-term Supply Plan for Southern Labrador can be viewed at the Public Utilities Board website: http://www.pub.nf.ca/applications/NLH2021Capital/NLH2021Capital_SUPP_Phase1SouthernLabrador/index.htm

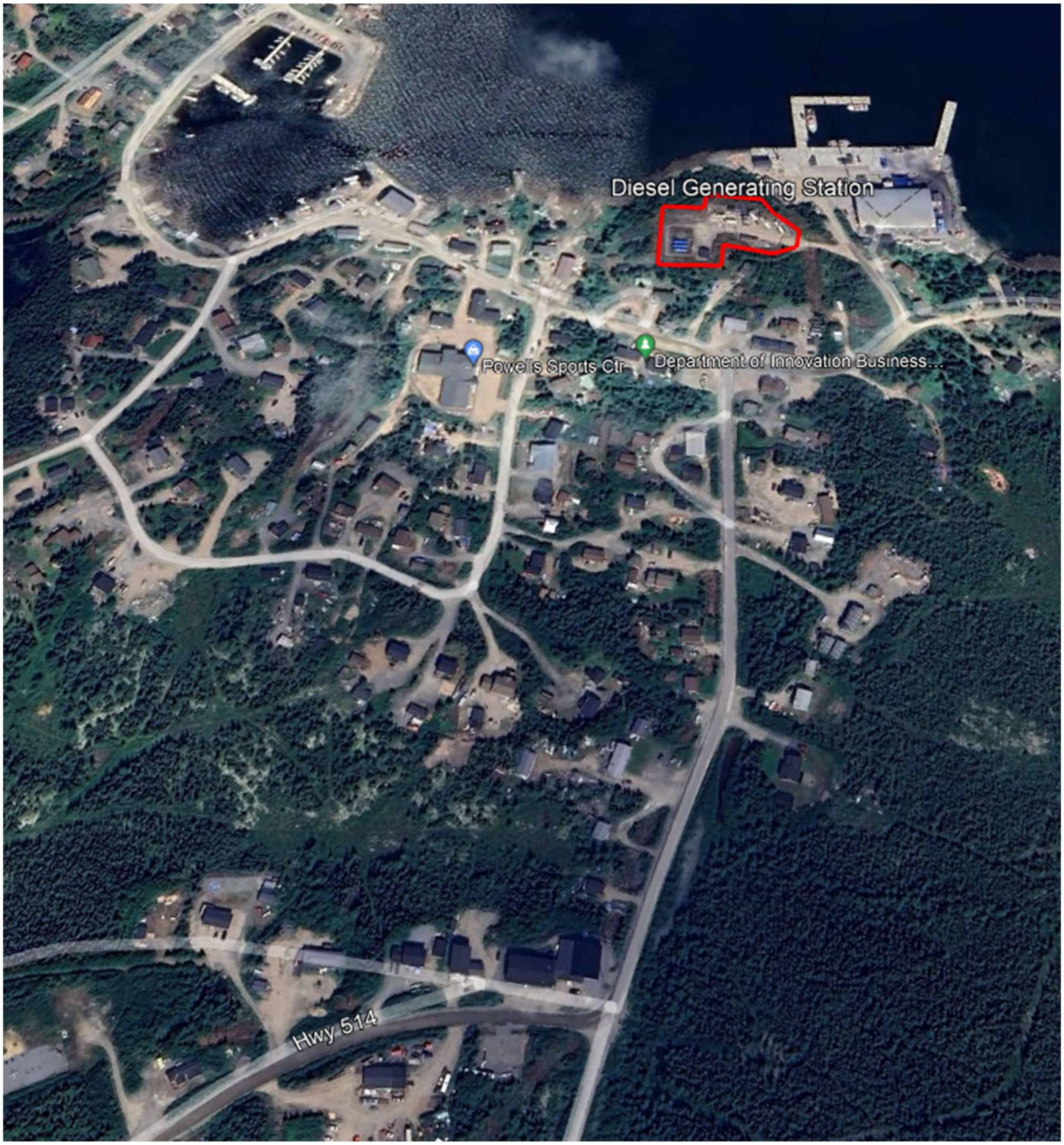

Figure 2. Community of Charlottetown

The community of Charlottetown is accessible by road via Route 514, off the Trans Labrador Highway. The site layout below shows the location of all mobile gensets at the Charlottetown Diesel Generating Station (Figure 3).

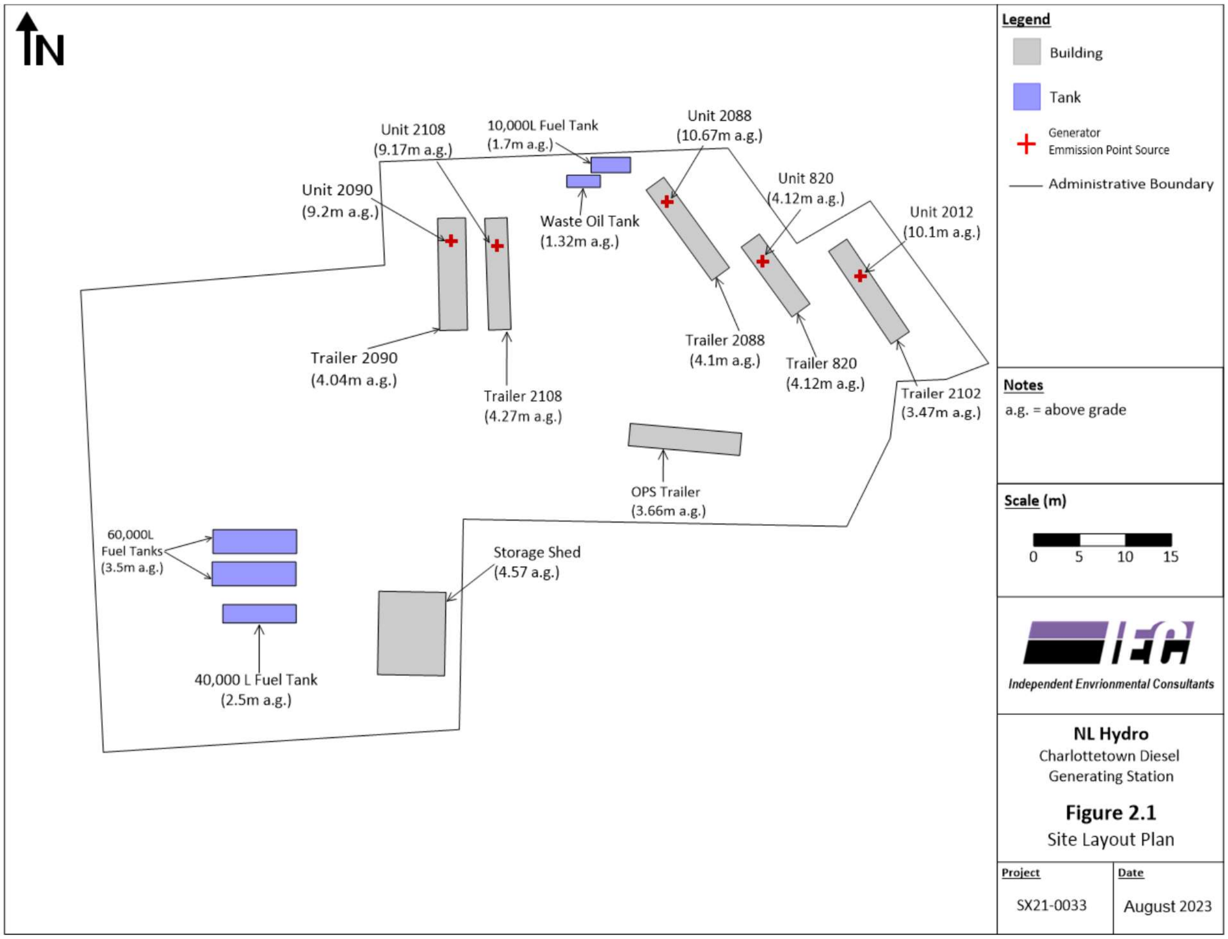

Figure 3. Charlottetown Generating Station Layout

2.2 Project Components and Activities

The project includes the purchase, installation, and commissioning of a used 1825 kW mobile genset (Unit 2108) at the Charlottetown Diesel Generating Station. The genset is installed on an existing concrete pad at the generating station, with no earthworks or site expansion required. Installation of the genset includes electrical and mechanical hook up, fuel system piping modifications, and exhaust stack modifications.

2.3 Wastes, Discharges and Emissions

During project activities, emission sources will include mobile equipment and temporary power generation as needed to support tool and equipment usage. Equipment will have exhaust systems regularly inspected and mufflers will be operating properly. Equipment will meet the requirements of the provincial *Air Pollution Control Regulations* under the Environmental Protection Act.

Hazardous waste materials will not be generated in large quantities and will be disposed of through conventional waste-oil and hazardous waste disposal streams in accordance with Hydro's standard environmental management processes.

Air dispersion modeling has been completed for the new configuration of the generating station, demonstrating compliance with Newfoundland and Labrador Ambient Air Quality Standards.

2.4 **Schedule and Unit Operation**

Unit 2108 has been installed in Charlottetown and was commissioned during the summer of 2023. Unit 2108 operated, at reduced capacity, for a period in 2023, but is not required to operate during the winter period[6]. It is anticipated that Unit 2108 will be operated at full capacity upon commencement of shrimp plant operations in May/June of 2024 until the end of the shrimp processing season in the fall of 2024. Unit 2108 will be utilized in this manner each year until an alternate power supply is established for the community.

2.5 **Alternatives**

To improve reliability (N-2 redundancy) and increase installed capacity of the Charlottetown Diesel Generating Station, the following two additional alternatives were considered:

2.5.1 Purchase a new mobile diesel genset.

This alternative required a procurement lead time exceeding 2 years. Given the history of mobile unit failures in Charlottetown since 2019, Hydro did not consider this option viable or prudent.

2.5.2 Rent a mobile diesel genset.

This alternative involved renting a mobile diesel genset until the interconnection of Southern Labrador communities is complete. No suitable rental units could be identified at the time. This alternative also proved cost prohibitive as rental fees would be in excess of $3,000,000, assuming that a long-term solution for southern Labrador was not in-service prior to 2026.

The alternative of purchasing a used, available genset (Unit 2108) from Muskrat Falls was selected based on technical viability, least cost ($1.6M), and implementation timeframe.

2.6 **Occupations**

Table 2 provides the occupations, including National Occupational Classification (NOC) code, required during the life of the Project.

[6] Unit 2108 has not been modified to allow use during winter conditions. During the winter period, other smaller units provide the necessary power and N-2 redundancy. Peak demand occurs during shrimp plant operation rather than during the winter period.

Table 2. Occupations for Undertaking

Position	NOC Code	Number of Positions
Mechanic	72401	1
Electrician	72201	1
Welder	72106	1
Pipe Fitter	72301	2
Truck Driver	73300	1
Supervisor	72014	2
P&C Technologist	22310	1
Power Line Technician	72203	3

3.0 PROJECT SETTING AND KEY ENVIRONMENTAL ASPECTS

The project is occurring within the boundaries of an existing industrial site within the community of Charlottetown, Labrador. Charlottetown is a coastal community, with the generating station located within 100 meters of the Atlantic Ocean. Private dwellings and commercial properties are in close proximity to the generating station to the south, east, and west. The project will not impact vegetation or water bodies and there are no known species of concern in the immediate area.

The key environmental aspects of the project include: air emissions, fuel management, and noise. These key environmental aspects are discussed below.

3.1 Air Emissions

Hydro completed air dispersion modelling for the new configuration[7] of mobile gensets for Charlottetown using the CALMET/CALPUFF modelling package in accordance with regulatory requirements. Modelled pollutant concentrations were compared against Newfoundland and Labrador Ambient Air Quality Standards ("AAQS"). Model results show that the maximum predicted ground level concentrations for all pollutants and averaging periods are below their respective provincial AAQS. The detailed report is included in Appendix B.

[7] The assessment considers the operation of five (5) mobile units (Units 2088, 2090, 2102, 820, and 2108) with a total installed capacity of 5,095 kilowatts (kW).

3.2 Fuel Management

The undertaking does not require an increase to the capacity of the bulk fuel storage system at the Charlottetown Diesel Generating Station. Unit 2108 has been connected to the existing bulk fuel supply. The undertaking adds redundant capacity to the generating station but does not result in a significant change to fuel usage at the site.

3.3 Noise

In July 2023, following installation of Unit 2108, Hydro completed a noise mapping assessment to gather baseline noise data for various mobile genset operating scenarios. Measurements were taken using a Casella – CEL633C Sound Level Meter at locations around the generating station site and within the community. The average reading at locations in the community was 58.8 dB, comparable to that of a normal conversation. Noise measurements ranging from 46.4 to 92.5 decibels (dB) were recorded during the assessment. Five of 56 readings exceeded 85 dB[8], all of which were on the generating station site near operating equipment.

Since completion of the noise mapping in July, Hydro has also installed sound barrier panels along a portion of the generating station property on a trial basis[9]. Hydro will gather feedback on this noise mitigation approach and is committed to ongoing consultation with the community should concerns arise.

4.0 FUNDING

The project is 100% funded by Hydro.

5.0 PROJECT RELATED DOCUMENTS

The most recent quarterly update provided to the communities of Charlottetown and Pinsent's Arm is found in Appendix A.

To support the requirement for an amended Certificate of Approval for operation of the Charlottetown Diesel Generating Station in its new configuation, air dispersion modeling has been completed and the report is included in Appendix B.

6.0 SIGNATURE

Nov. 2, 2023
Date

Company Representative
Scott Crosbie, Vice President, Operations

[8] Hearing protection is required at Hydro facilities when noise level exceeds 85 dB.
[9] This commitment originates from a previous meeting with Town Council where sound suppression was discussed.

APPENDIX A

Sample Quarterly Update to Communities

newfoundland labrador hydro

Newfoundland and Labrador Hydro
Hydro Place. 500 Columbus Drive
P.O. Box 12400. St. John's. NL
Canada A1B 4K7
t. 709.737.1400 | f. 709.737.1800
nlhydro.com

August 18, 2023

Charlottetown Town Council
P.O. Box 151
Charlottetown, NL A0K 5Y0

Attention: Rick Oram
Mayor, Town of Charlottetown

Dear Mayor Oram:

Newfoundland and Labrador Hydro ("Hydro") remains committed to the safety of the residents of Charlottetown and Pinsent's Arm, and to ensuring a safe and reliable electricity supply.

Safety is Hydro's top priority. We are committed to operating and maintaining our sites in a safe manner, and to work in partnership with the Town and the Volunteer Fire Department ("VFD") to ensure a safe and reliable supply of power to the communities.

As indicated in our letter to the Towns dated March 17, 2023, Hydro is honoring its commitments to meet with Town officials as needed, and providing written quarterly updates on our progress to address issues raised in the meetings. Please see below for the first update on site safety, the current electricity supply in Charlottetown, and Hydro's long-term electricity supply plan for the southern Labrador region.

1.0 Fire Safety Risk Assessment and Protocols

Commitment: In meetings with Town officials, Hydro committed to work with the VFD to develop protocols in the case of fire at Hydro's site.

It was agreed that these protocols would clarify the expectations of the VFD at Hydro's site, would provide a review of associated hazards, and ensure appropriate access to the site for public safety and protection of Town equipment and infrastructure. In May 2023, Hydro's Safety Advisor, Ron LeDrew, met with VFD's Fire Chief and Deputy Fire Chief and performed a site-specific safety and risk assessment at Hydro's diesel generating station in Charlottetown.

The following outlines the key risks from that assessment along with the progress on the respective recommendations:

Update: Emergency Response Plan (Site-Specific)

A draft Emergency Response Manual ("ERM") for the Charlottetown Mobile Diesel Generating Station has been developed for the VFD emergency response personnel and Hydro employees at the Charlottetown station. It serves as a reference for proper response procedures (fire-safety protocols) and to obtain pertinent information that will ensure a safe and effective emergency response is undertaken.

The goal of the document is to reduce the probability of emergency events escalating to catastrophic proportions and minimize losses, with the ultimate goal to return to normal operation as quickly and as safely as possible. The fire response protocols outlined in the draft ERM have been reviewed with Hydro employees and the VFD department members. A copy of the draft ERM was provided to the Fire Chief for review and to provide commentary. Hydro is now working with its internal safety and operations teams for sign-off and implementation of this document by the end August 2023.

Update: Fire Alarming and Emergency Notification

Hydro's Engineering Services group worked with Hydro Rural Operations in Labrador and external vendors to determine an appropriate tool to send automatic notifications to Hydro in the event of a mobile unit tripping due to fire or for some other reason. The chosen solution is an auto-dialer for each of the mobile units that will send a notification of a unit trip, due to fire or other reason, to a Hydro operator to ensure an appropriate and timely response, as required. The auto-dialers have been ordered and are expected to be received in September 2023 and installed in October 2023.

Update: Site Surveillance Systems

Site surveillance cameras were recommended for the site in Charlottetown for remote monitoring. Appropriate surveillance cameras have been selected and ordered, and optimal installation locations have been determined. Emergency lighting (flood lights), to be utilized in the event of a power outage, have been ordered and optimal locations have also been assessed for final installation. Both installations are scheduled for completion by the end of September 2023.

Update: Sound Suppression

Hydro is installing a sound panel along the fencing of the perimeter of the site to reduce noise from the mobile units as cited by some Charlottetown residents. Hydro's tender for the sound panel has closed. Hydro expects the sound panel materials to be received and installed by mid-September.

Update: Fire Safety Assessment and Training

Hydro's Safety Advisors, Ron LeDrew and Gus Loder, along with Production Supervisor, Cory Simms, travelled to Charlottetown during the week of June 5, 2023 to undertake fire safety initiatives with the VFD. Ron is a former Department of National Defence Fire Chief (9 Wing Gander) and Gus is the current Fire Chief with a VFD (Town of Badger).

A detailed site tour of the Charlottetown Mobile Diesel Generating Plant was provided to the Fire Chief and seven members of the Charlottetown VFD. High risk areas of the site were discussed and the fire response protocols in the draft ERM were reviewed.

In addition, Gus delivered an Electrical Safety for Fire Fighters course (Provincial Fire and Emergency Services certificate course) to the Charlottetown VFD members. The delivery of this course also provided the opportunity to discuss fire-fighting tactics and safe response protocols when approaching situations on Hydro's infrastructure.

Update: Modifications of Mobile Unit Layout

The mobile gensets on the former building concrete floor have been reconfigured to further mitigate the risks associated with fire spreading between units.

Update: Response Times

Hydro has staff strategically stationed in Labrador that are able to respond in a timely manner. Hydro will continue to ensure open communication with the Town and management personnel will continue to be available to support with enquiries.

Update: Additional Fire Safety Actions

Hydro continues to operate the mobile gensets with doors closed during operation to guard against the possibility of fire spreading outside the container. As well, **preliminary engineering solutions have been implemented to address cooling system issues** that are believed to be a contributing factor for previous fires. Hydro is also working with several vendors to determine whether a suitable fire suppression product is available on the market that could be placed inside the containers that house the generators.

2.0 Current Power Solution and Capacity

Commitment: Hydro is committed to ensuring that the Town, and their businesses, have a reliable supply of power today, and until a permanent solution is in place.

Hydro acknowledges that a fixed and permanent generating station is preferable to mobile generators; however, Hydro is ensuring that multiple redundant units, i.e. backups to backups, are available to minimize the risk of customer impact. As such, **there is sufficient excess capacity on site in Charlottetown to meet peak community load forecasts even if multiple units are unavailable**, as shown in Figure 1.

During winter 2023, with the units installed on site, there was enough generation to meet the forecasted peak community load (highest usage over this period in the community) of 756 kW if three of the largest units were out of service. Winter 2024 will be evaluated further throughout the upcoming months; however, generation availability should be similar to winter 2023.

During summer 2023 (i.e., June 2023 to October 2023), there will be enough generation to meet a forecasted peak community load of 1,545 kW if two of the largest units were out of service.

Hydro also engaged in discussions with the Town and the VFD to understand options for backup generation for critical facilities. Hydro will continue to work with the Town to support the Town with advancing options for a backup supply.

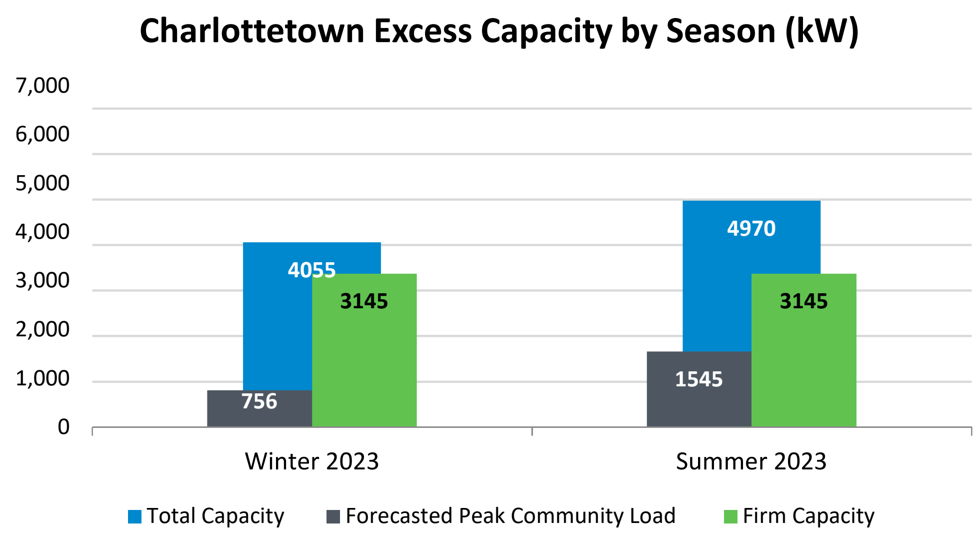

Figure 1: Charlottetown Excess Capacity by Season (kW)[1]

3.0 Status of Proposed Regional Diesel Generating Station and Regulatory Process Update

Commitment: Hydro has committed to providing updates to the Town on the status of the regulatory process in written updates and subsequent meetings with Town officials and continues to work through the regulatory process with the Board of Commissioners of Public Utilities ("Board") to support a decision as soon as possible.

Completed Actions:

- Midgard Consulting Inc.'s ("Midgard") independent assessment was completed at the end of March 2023, which provided detailed information and analysis of the recommended long-term solution for southern Labrador. Midgard's analysis confirmed Hydro's analysis and recommendation from the original project application to the Board. Midgard's overall recommendation was that Hydro proceed with the interconnection of the communities of southern Labrador with a regional diesel generating station; however, it recommended full interconnection immediately rather than a phased implementation.
- To enable the regulatory review process to proceed without delay, Hydro immediately began a review and analysis of Midgard's recommendation
- On March 31, 2023, Hydro met with representatives from the Town of Charlottetown to provide an overview of Midgard's Analysis and provided Town officials with a copy of its correspondence to the Board, which included a copy of Midgard's report.
- Hydro held an in-person meeting with council members in the Town of Charlottetown and held virtual meetings with the other towns in southern Labrador as well as the NunatuKavut Community Council ("NCC"). In these meetings, Hydro outlined its proposal to proceed with the regional diesel generating station, including immediate interconnection of all four systems as

[1] Total capacity is defined as the total available generation, while firm capacity is defined as the available generation with the largest unit out of service.

recommended by Midgard, solicited feedback and listening to concerns regarding the revised proposal.

- Hydro accepted Midgard's recommendation as the lowest possible cost, consistent with reliable service, and in an environmentally responsible manner and prepared an update to its application to the Board detailing revisions in cost, schedule, or scope resulting from consideration of Midgard's recommendations and the passage of time since the original application in 2021.
- Hydro filed this amended application with the Board on May 31, 2023 and provided a copy of its correspondence to the Town of Charlottetown, the NCC, and the other towns in southern Labrador on the same day.
- Hydro filed its responses to Requests for Information ("RFIs") from the Board and intervenors on July 7, 2023 .

Next Steps:

Generally, following this review process, the Board will consider all available information and evidence to come to a decision regarding project approval. After deliberation, the Board will then issue a "Board Order" outlining its decision. Since Hydro filed its responses to RFI's, it has received two additional information requests from the Board.

First, the Board requested that Hydro provide details with respect to its plans to provide safe and reliable power to Charlottetown while the Board reviews Hydro's revised application for southern Labrador, and if approved, throughout the construction period.

Second, the Board requested that Hydro file 'additional information' on several of the alternatives to supply southern Labrador as outlined and proposed in Midgard's report (the external consultant) from March 31, 2023. Hydro is disappointed and quite concerned that the Board continues to ask for more information on this file. Hydro feels it has demonstrated, through its analysis and evidence, that its recommended solution is the least-cost, reliable and environmentally responsible option to supply Charlottetown and southern Labrador. However, Hydro, in cooperation with Midgard, is preparing a fulsome response to the Board to demonstrate where and how Hydro has presented the evidence necessary for a decision in its filings with the Board.

However, it is important to note that when Hydro filed its amended application with the Board on May 31, 2023, we acknowledged the proposed schedule, with construction starting in 2024, was an aggressive timeline, and that certain aspects of the schedule, such as Board approval and environmental assessment approval, are outside of Hydro's control. We want to reiterate that our team is committed and focused on this file, and are doing everything we can to advance preparatory work in parallel with the approval processes. We have begun the Environmental Assessment process with the Province and are spending money on other work – that can be reasonably done in advance – despite not having approval on the file yet. Hydro is unable to speculate on the timeframe for a Board Order from the Board or release from the environmental assessment and is continuing to advocate for expediency. However, we are reaching a point where our ability to begin construction in 2024 is at risk. Hydro is committed to working with the Board, intervenors, and stakeholders to ensure timely approval of this project and allow Hydro to move forward with the implementation of a long-term solution for the residents of Charlottetown and Pinsent's Arm, as well as the southern Labrador region.

Following the Board's decision, Hydro will work to construct the proposed project as expeditiously as possible. The early stages of project execution mostly include procurement activities. The following project schedule is outlined in the amended project application:

Table 1: Project Schedule

Activity	Start Date	End Date
Planning:		
Front-end engineering and project approval	First Quarter 2020	Third Quarter 2023
Environmental assessment	Third Quarter 2023	Second Quarter 2024
Design:		
Detailed design of diesel generating station and distribution	Third Quarter 2023	Fourth Quarter 2024
Procurement:		
Major equipment and construction contracts	Third Quarter 2023	Second Quarter 2026
Construction:		
Regional diesel generating station and distribution	Second Quarter 2024	First Quarter 2027
Commissioning:		
Commissioning of equipment	Fourth Quarter 2026	Second Quarter 2027
Closeout:		
Contract and project closeout	Second Quarter 2027	Third Quarter 2027

In the event that the project is not approved, Hydro will work urgently with all stakeholders to propose an alternative solution that can be executed as quickly as possible. Hydro will continue to update the Town on the status of the regulatory process in its quarterly written updated and in any subsequent meetings with Town officials.

Appendix 1 provides an illustration of the timeline of activities.

4.0 Conclusion

Hydro will continue to provide a written update to the Town every quarter, or more frequent as may be required, as the project advances. The format and content will likely evolve as the file advances over time.

Hydro is confident that its proposed regional diesel generating station would result in the lowest total lifecycle cost for all generating assets in southern Labrador. Hydro will continue to work with the Board to get the proposed project approved as quickly as possible.

We sincerely appreciate the Town's continued willingness to engage with us as we work to manage this challenging situation.

NEWFOUNDLAND AND LABRADOR HYDRO

Jennifer Williams
President
JW/kd

Encl.

Appendix 1

Regional Diesel Generating Station Timeline

TOWN OF CHARLOTTETOWN

REGIONAL DIESEL GENERATING STATION TIMELINE

PHASE 1

- Charlottetown Diesel Generating Station fire
- Planning begins for long-term solution
- Labrador Interconnection Options Study completed

PHASE 2

- Hydro applies to PUB for project approval
- RFI Rounds 1 and 2
- PUB received correspondence from public/community stakeholders
- Regulatory review paused for additional stakeholder engagement
- PUB requested additional information
- Midgard Consulting engaged to complete analysis

PHASE 3

- Midgard Consulting filed
- Hydro filed amended project application with PUB
- Regulatory review has resumed
- Hydro anticipates project approval (issue tender for design contract, order long-lead equipment, and complete geotechnical testing)

PHASE 4

- Tender and award site works contract
- Complete detailed design
- Commence site work and foundations
- Tender and award distribution line contract
- Tender contract for building and equipment installation

PHASE 5

- Install pre-engineered building and begin equipment installation
- Complete distribution line construction

PHASE 6

- Complete equipment installation
- Complete substation work
- Begin equipment commissioning and testing

PHASE 7

- Complete commissioning and testing
- Regional diesel generating station in service

APPENDIX B

Dispersion Modelling Report

Final Report

CALPUFF Air Dispersion Modelling for the Charlottetown Diesel Generating Station – New Configuration (Fall 2023)

Prepared for:

newfoundland labrador hydro

4th Level Hydro Place, 500 Columbus Drive
St. John's, Newfoundland and Labrador
A1B 4K7

Prepared by:

IEC

Independent Environmental Consultants
582 St Clair Avenue West Suite 221
Toronto, Ontario
M6C 1A6

IEC Project No.: SX21-0033

October 2023

REPORT PREPARATION

Primary Authors:

Position	Name	Signature
Air Quality Scientist	Kim Theobald	[signature]

Technical Review:

Position	Name	Signature
Senior Environmental Engineer	Nick Shinbin	[signature]

Management Review:

Position	Name	Signature
Vice President	Paul Kirby	[signature]

EXECUTIVE SUMMARY

Newfoundland and Labrador Hydro (NL Hydro) operate a thermal (diesel) electricity generating station in Charlottetown, NL (the Facility). In 2019, a fire occurred at the plant, destroying the powerhouse and its three (3) permanent generating units. Since that time, the Facility has operated with mobile units. This assessment considers the operation of five (5) mobile units (units 820, 2088, 2090, 2102, and 2108) having a total capacity of 5,095 kilowatts (kW).

Independent Environmental Consultants (IEC), a division of SEN-X Environmental Consultants Inc., and its subcontractor Weather2Umbrella (W2U), were retained by NL Hydro to complete a CALPUFF air dispersion modelling assessment for the mobile units using updated meteorology and emissions based on NL Hydro's estimate of monthly peak power load forecasted for 2028. A meteorological data set was generated for the period 2019 to 2022 using the Weather Research and Forecasting Nonhydrostatic Mesoscale Model (WRF-NMM) with a horizontal resolution of about four (4) kilometres (km). The outputs from WRF-NMM were used to run the CALMET model over a 20 km by 20 km domain, having a fine horizontal resolution of 200 metres (m).

For each mobile unit, emission rates of nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), total suspended particulate (TSP), particulate matter less than 10 microns (PM_{10}), and particulate matter less than 2.5 microns ($PM_{2.5}$) were estimated using emissions profiles (e.g., power load vs. emissions) provided by NL Hydro and forecasted power loads. Using the updated meteorology and emission rates, the CALPUFF model was run to predict ground-level concentrations of air pollutants resulting from the operation of the Facility. The results were compared against Newfoundland and Labrador Ambient Air Quality Standards (AAQS).

The model results show that the maximum predicted ground level concentrations for all pollutants and averaging periods are below their respective provincial AAQS. The pollutant with the highest predicted concentration relative to its AAQS is NO_2. The maximum predicted 24-hour NO_2 concentration is 28.7% of the AAQS, and the maximum predicted 1-hour NO_2 concentration is 23.9% of the AAQS. The maximum predicted 24-hour $PM_{2.5}$ concentration is 10.4% of the AAQS, the maximum predicted 24-hour PM_{10} concentration is 5.2% of the AAQS, and the maximum 24-hour TSP concentration is predicted to be less than 2.5% of the AAQS. Both SO_2 and CO are less than 0.5% of their respective AAQS.

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1.0 INTRODUCTION

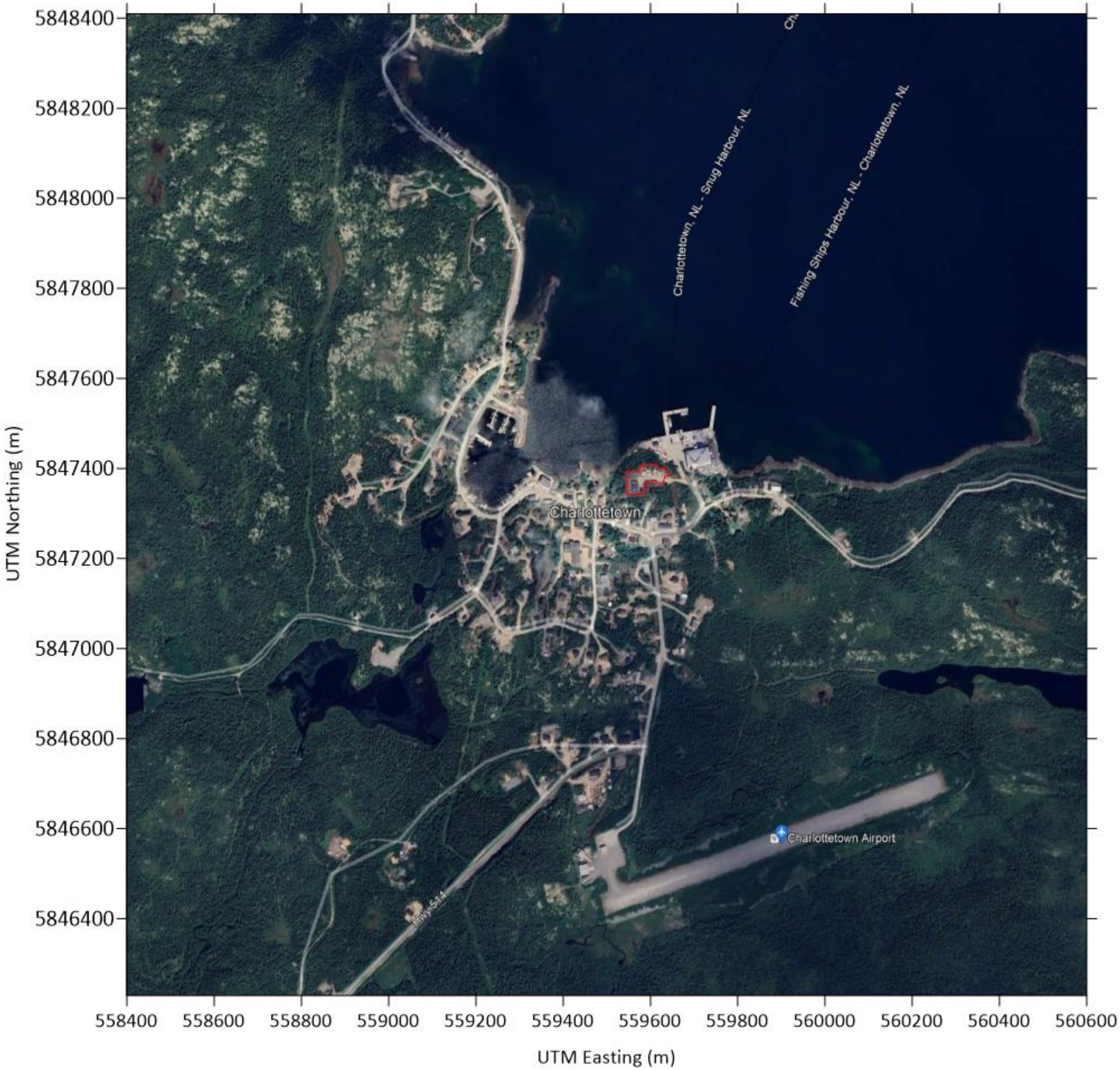
Newfoundland and Labrador Hydro (NL Hydro) own and operate a thermal (diesel) electricity generating station in the town of Charlottetown, NL (see Figure 1.1). Due to a fire in the main plant in 2019, three (3) stationary units were destroyed. Since that time, the Facility has operated with mobile units. This assessment considers the operation of five (5) mobile units (units 2088, 2090, 2102, 820 and 2108) based on a total capacity of 5,095 kilowatts (kW).

Independent Environmental Consultants (IEC), a division of SEN-X Environmental Consultants Inc., and its subcontractor Weather2Umbrella (W2U), were retained by NL Hydro to perform an air dispersion modelling assessment of the mobile units using the CALMET/CALPUFF modelling package. CALPUFF was used to predict ground-level concentrations of nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), total suspended particulate (TSP), particulate matter less than 10 microns (PM_{10}), and particulate matter less than 2.5 microns ($PM_{2.5}$). To determine the potential impact of the Facility on local air quality, modelled pollutant concentrations were compared to the ambient air quality standards (AAQS) outlined in Schedule A, Table I of the *Air Pollution Control Regulations, 2022 (NLR 11/22)*, which are summarized in Table 1.1.

The air dispersion modelling assessment and this report conform to the following documents published by the Newfoundland and Labrador Department of Environment and Climate Change (DOECC) (formerly the Department of Environment & Conservation [DOEC]):

- *Guideline for Plume Dispersion Modelling. GD-PPD-019.2*, Newfoundland & Labrador Department of Environment & Conservation (DOEC, 2012a) and
- *Determination of Compliance with the Ambient Air Quality Standards. GD-PPD-009.4*, Newfoundland & Labrador Department of Environment & Conservation (DOEC, 2012b).

Section 2.0 of this report provides a description of the Facility and the production/emissions scenarios modelled. The CALMET and CALPUFF methodologies are outlined in Section 3.0, and the results of the modelling assessment are summarized in Section 4.0. Lastly, Section 5.0 presents the conclusions of the study.



Legend

Administrative Boundary

Notes

Map Reference

Source: Google Earth 2023

WGS-84 UTM (km) Zone 21

Independent Envrionmental Consultants

NL Hydro

Charlottetown Diesel Generating Station

Figure 1.1

Site Location Plan

Project	Date
SX21-0033	July 2023

Table 1.1: Newfoundland and Labrador Ambient Air Quality Standards

Pollutant	Units	Ambient Air Quality Standards (AAQS)				
		1-hour	3-hour	8-hour	24-hour	Annual
TSP	µg/m³	--	--	--	120	60 [1]
PM_{10}	µg/m³	--	--	--	50	--
$PM_{2.5}$	µg/m³	--	--	--	25	8.8 [2]
SO_2	ppb	344	229		115	23
NO_2	ppb	213			106	53
CO	ppb	30,582		13,107		

Source: AAQS from Schedule A, Table I of the Air Pollution Control Regulations, 2022 (NLR 11/22)
Notes:
All values at reference conditions of 25°C and 101.325 kPa
[1] Geometric mean
[2] Arithmetic mean

2.0 FACILITY DESCRIPTION

The Facility will operate five (5) mobile diesel generators as follows:

- unit 2088 at 910 kW,
- unit 2102 at 910 kW,
- unit 820 at 725 kW,
- unit 2090 at 725, and
- unit 2108 at 1,825 kW.

Units 2088 and 2102 are currently installed on site, while the remaining units are planned installations.

Each unit will be housed in a separate trailer, with units 2088, 2090, 2102, and 2108 exhausting to the atmosphere via their own stack. Unit 820 will exhaust through a vent flush with the roof of the trailer. Building and stack information for the Facility is described below, followed by a description of the production scenario and air emissions used in the modelling assessment.

2.1 BUILDING AND DIESEL GENERATOR INFORMATION

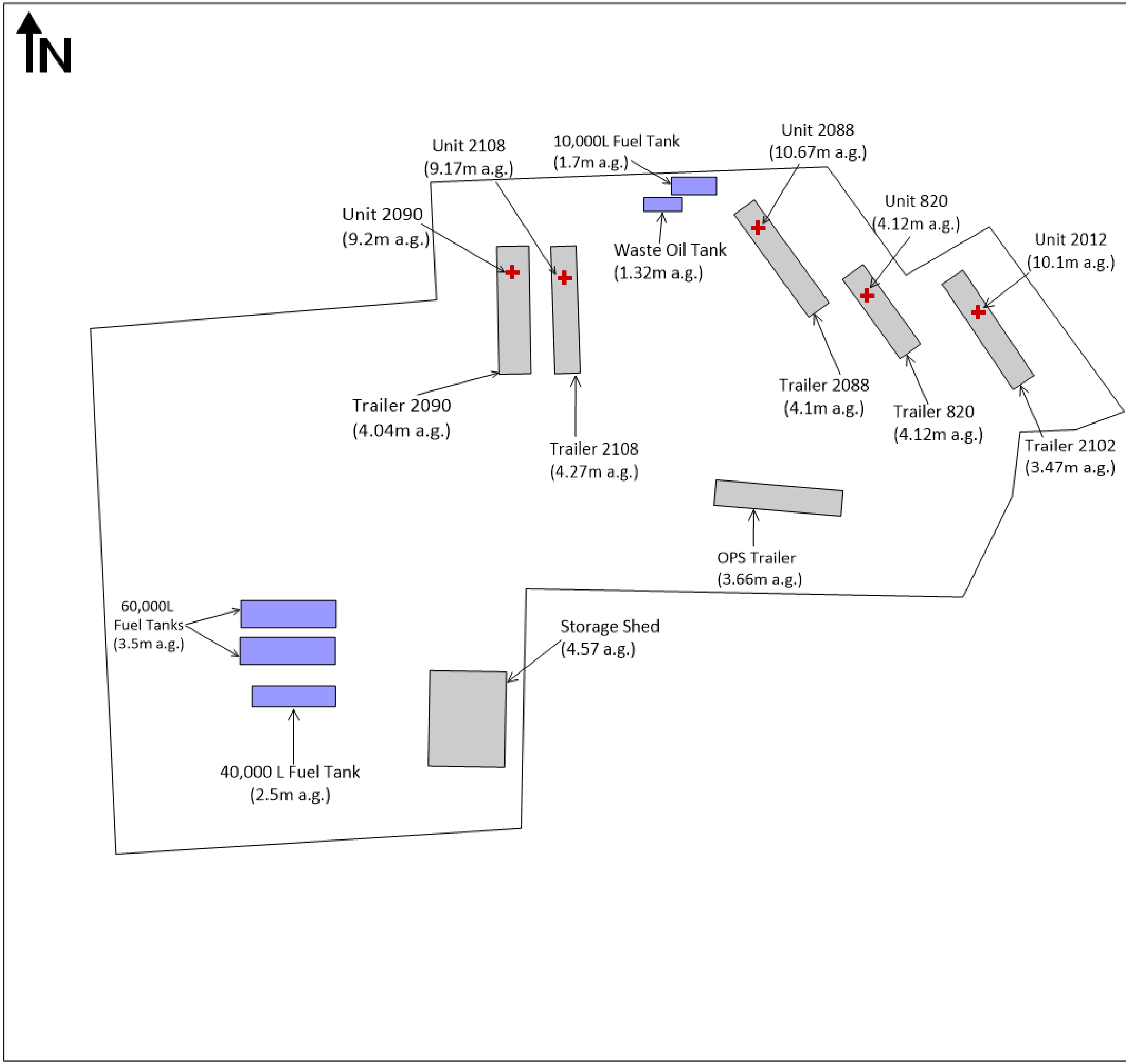
A scaled general layout of the site is illustrated in Figure 2.1, which shows the main buildings/structures at the Facility, the locations of the diesel generator stacks, and the administrative boundary. The BPIP-Prime building downwash calculations considered every structure at the Facility. The locations and heights of each structure are specified in Figure 2.1, and the corners and elevations of the structures are summarized in Table 2.1. As noted above, the four (4) fuel tanks (1 - 40,000 L, 2 - 60,000 L, 3 - 60,000 L, and 4 - 10,000 L), the waste oil tank (5,000 L), and the storage shed identified in Figure 2.1, were included in the BPIP calculations. Additional detail about the building downwash calculations is provided in Section 3.3.2.

Table 2.2 presents the stack parameters for each diesel generating unit. Note that temperature and flow rate vary by power load; however, for presentation purposes, the values shown in Table 2.2 are based on 80% engine load. It is also of note that the stacks for units 2090 and 2108 will have an outlet angled at 30 degrees from vertical. To account for the reduction in vertical momentum due to the outlet angle, the exit velocity was calculated using an effective diameter instead of the actual diameter (see Figure 2.2 for a schematic of the angled stacks and sample calculations for the effective diameter, “b” for unit 2108).

As noted above, unit 820 does not have a stack, but a vent in the roof of the trailer that measures 80 inches by 50 inches (or 27.8 ft^2). An equivalent diameter for unit 820 was calculated based on the vent area.

2.2 PRODUCTION SCENARIO

Table 2.3 outlines the production scenario used for the air dispersion modelling assessment. This scenario is based on NL Hydro’s forecast of monthly peak engine loads for 2028. The engine loads shown in Table 2.3 were used for all four years of meteorological data modelled. It was also conservatively assumed that the peak load for each month was constant for each hour of the day.



Legend

Building

Tank

Generator Emmission Point Source

Administrative Boundary

Notes

a.g. = above grade

Scale (m)

0 5 10 15

Independent Envrionmental Consultants

NL Hydro

Charlottetown Diesel Generating Station

Figure 2.1

Site Layout Plan

Project	Date
SX21-0033	August 2023

Figure 2.2: Example Schematic of Angled Stack Outlet for Unit 2108

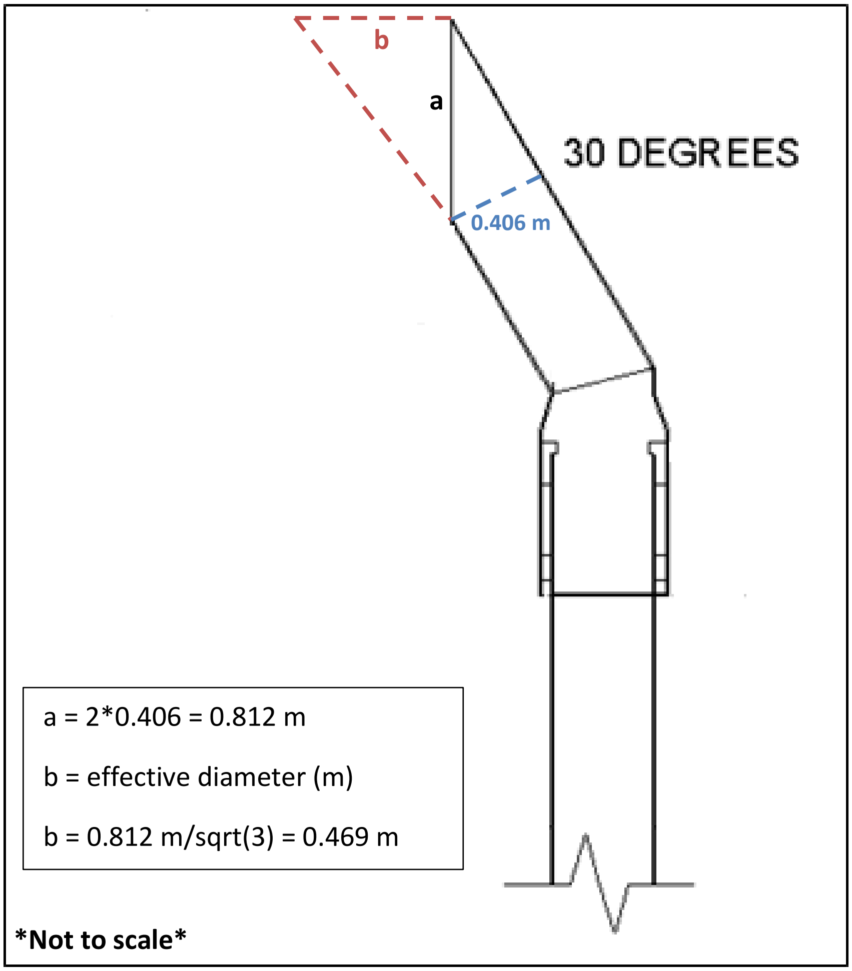


Table 2.1: Building Information for BPIP-Prime

Building	SE Corner		Base Elevation (m)	Height Above Grade (m)
	UTM Easting (m)	UTM Northing (m)		
Unit 2088 trailer	559602	5847383	4.5	4.1
Unit 820 trailer	559611	5847379	4.5	4.1
Unit 2102 trailer	559621	5847376	4.5	3.5
Waste oil tank	559588	5847392	4.3	1.3
60,000 L fuel tank	559545	5847354	5.7	3.5
60,000L fuel tank	559545	5847351	5.7	3.5
40,000L fuel tank	559547	5847346	5.7	2.5
Storage shed	559571	5847347	5.9	4.6
10,000 L fuel tank	559591	5847393	4.2	1.7
Unit 2090 trailer	559573	5847376	4.8	4.0
Unit 2108 trailer	559578	5847376	4.8	4.3
Operations trailer	559591	5847363	5.3	3.7

Table 2.2: Point Source Parameters

Generator Unit	Capacity (kW)	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height Above Grade (m)	Stack Diameter (m)	Average Stack Temperature (K) [1]	Average Exhaust Flow Rate (m^3/min) [1]
Mobile 2088	910	559595	5847390	4.5	10.7	0.254	712	192.3
Mobile 2090	725	559572	5847386	4.8	9.2	0.351 [3]	666	110.6
Mobile 2102	910	559617	5847382	4.5	10.1	0.304	709	188.8
Mobile 820	725	559606	5847384	4.5	4.1	1.813 [2]	666	1450.7
Mobile 2108	1825	559577	5847386	4.8	9.2	0.469 [3]	621	313.4

Notes:
[1] At 80% load
[2] Equivalent diameter calculated based on the vent area of 27.8 ft^2. d = sqrt(A/pi)*2 = sqrt(27.8/pi)*2 = 5.95 ft = 1.81 m.
[3] Effective diameter based on the stack configuration and calculations shown in Figure 2.2. Actual diameter of unit 2108 is 0.406 m and 0.304 m for unit 2090.

Table 2.3: Monthly Power Production Scenario

Month	2028 Month Load Forecast (Peaks)	Mobile 2088 (910 kW)	Mobile 2102 (910 kW)	Mobile 820 (725 kW)	Mobile 2108 (1825 kW)	Mobile 2090 (910 kW)
January	680	74.7%	0.0%	0.0%	0.0%	0.0%
February	685	0.0%	75.3%	0.0%	0.0%	0.0%
March	664	73.0%	0.0%	0.0%	0.0%	0.0%
April	640	0.0%	0.0%	0.0%	0.0%	88.3%
May	611	0.0%	0.0%	84.3%	0.0%	0.0%
June	1185	0.0%	0.0%	0.0%	61.6%	0.0%
July	1403	0.0%	0.0%	0.0%	76.9%	0.0%
August	1469	0.0%	0.0%	0.0%	80.5%	0.0%
September	1374	0.0%	0.0%	0.0%	75.3%	0.0%
October	1366	0.0%	0.0%	0.0%	74.8%	0.0%
November	761	83.6%	0.0%	0.0%	0.0%	0.0%
December	694	0.0%	76.3%	0.0%	0.0%	0.0%

2.3 AIR EMISSIONS

NL Hydro provided regression curves (i.e., power load vs. emissions), which are based on manufacturers' testing data, for each diesel generating unit. To develop hourly emission rates, the regression curves were applied to the production scenario outlined in Table 2.3. Regression curves were also provided for exit temperature and flow rate for each unit. The resulting emission rates for units 2088, 2102, 820, 2108, and 2090 are provided in Table 2.4, Table 2.5, Table 2.6, Table 2.7, and Table 2.8 respectively. Monthly stack exit temperatures and flow rates that were used in the model are also provided in these tables.

Emissions of sulphur dioxide were based on the mass of sulphur in diesel fuel. It was assumed that the fuel used by the Charlottetown generators meets the requirements set out in the *Sulphur in Diesel Fuel Regulations (CAN/CGSB-3.517-2007)* which specifies that sulphur must be less than 15 mg/kg.

Emissions of particulate matter from the diesel generators were assumed to be 100% $PM_{2.5}$. In other words, emissions of TSP = PM_{10} = $PM_{2.5}$. This assumption was recommended by the DOECC (B. Lawrence, personal communication, 4 Feb 2016). The ratios listed in U.S. EPA AP 42 documentation are considered outdated and more recent research suggests that all particulate matter from diesel generators is less than 2.5 microns.

Finally, emissions of NO_2 and NO were based on a NO_2/NOx ratio of 20%, which is the recommended ratio for generators outlined in Table A.1 of the *Plume Dispersion Guideline* (DOEC, 2012a). NO_2 and NO were calculated as follows:

$NO_2 = NOx \times 20\%$

and,

$NO = (NOx - NO_2) \times (MW\ of\ NO \div MW\ of\ NO_2) = (NOx - NO_2) \times (30 \div 46)$

where:

MW = Molecular Weight in g/mol.

Table 2.4: Unit 2088 Monthly Air Emissions, Temperature, and Flow Rate

Month	Stack Temperature (K)	Exhaust Flow Rate (m^3/min)	Average Emission Rate (g/s)					
			SO_2[1]	NOx	NO_2[2]	NO[2]	$PM_{2.5}$[3]	CO
January	707	183	0.00140	1.31	0.26	0.68	0.011	0.076
February	-	-	-	-	-	-	-	-
March	705	180	0.00137	1.27	0.25	0.66	0.012	0.081
April	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-
June	-	-	-	-	-	-	-	-
July	-	-	-	-	-	-	-	-
August	-	-	-	-	-	-	-	-
September	-	-	-	-	-	-	-	-
October	-	-	-	-	-	-	-	-
November	716	198	0.00154	1.57	0.31	0.82	0.011	0.061
December	-	-	-	-	-	-	-	-
Average	***709***	***187***	***0.00144***	***1.38***	***0.27***	***0.72***	***0.011***	***0.073***

Notes:
[1] Based on the mass of sulphur in diesel fuel. Assumes ultra-low sulphur fuel (15 mg/kg) based on CAN/CGSB-3.517-2007.
[2] Based on an in-stack NO_2 / NOx ratio of 0.2 as specified in Table A.1 of the *Guideline for Plume Dispersion Modelling*, *2nd Revision* (DOEC, 2012a).
[3] All particulate matter is assumed to be less than 2.5 µm such that $PM_{2.5}$ = PM_{10} = TSP (e-mail communication, B. Lawrence [DOECC], 4 Feb 2016).

Table 2.5: Unit 2102 Monthly Air Emissions, Temperature, and Flow Rate

Month	Stack Temperature (K)	Exhaust Flow Rate (m^3/min)	Average Emission Rate (g/s)					
			SO_2[1]	NOx	NO_2[2]	NO[2]	$PM_{2.5}$[3]	CO
January	-	-	-	-	-	-	-	-
February	705	180	0.00138	1.26	0.25	0.66	0.012	0.081
March	-	-	-	-	-	-	-	-
April	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-
June	-	-	-	-	-	-	-	-
July	-	-	-	-	-	-	-	-
August	-	-	-	-	-	-	-	-
September	-	-	-	-	-	-	-	-
October	-	-	-	-	-	-	-	-
November	-	-	-	-	-	-	-	-
December	706	182	0.00140	1.28	0.26	0.67	0.011	0.079
Average	***705***	***181***	***0.00139***	***1.27***	***0.25***	***0.66***	***0.011***	***0.080***

Notes:
[1] Based on the mass of sulphur in diesel fuel. Assumes ultra-low sulphur fuel (15 mg/kg) based on CAN/CGSB-3.517-2007.
[2] Based on an in-stack NO_2 / NOx ratio of 0.2 as specified in Table A.1 of the *Guideline for Plume Dispersion Modelling*, *2nd Revision* (DOEC, 2012a).
[3] All particulate matter is assumed to be less than 2.5 µm such that $PM_{2.5}$ = PM_{10} = TSP (e-mail communication, B. Lawrence [DOECC], 4 Feb 2016).

Table 2.6: Unit 820 Monthly Air Emissions, Temperature, and Flow Rate

Month	Stack Temperature (K)	Exhaust Flow Rate (m^3/min)	Average Emission Rate (g/s)					
			SO_2 [1]	NOx	NO_2 [2]	NO [2]	$PM_{2.5}$ [3]	CO
January	-	-	-	-	-	-	-	-
February	-	-	-	-	-	-	-	-
March	-	-	-	-	-	-	-	-
April	-	-	-	-	-	-	-	-
May	672	1458	0.00120	0.59	0.12	0.31	0.021	0.204
June	-	-	-	-	-	-	-	-
July	-	-	-	-	-	-	-	-
August	-	-	-	-	-	-	-	-
September	-	-	-	-	-	-	-	-
October	-	-	-	-	-	-	-	-
November	-	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-	-
Average	***672***	***1458***	***0.00120***	***0.59***	***0.12***	***0.31***	***0.021***	***0.204***

Notes:
[1] Based on the mass of sulphur in diesel fuel. Assumes ultra-low sulphur fuel (15 mg/kg) based on CAN/CGSB-3.517-2007.
[2] Based on an in-stack NO_2 / NOx ratio of 0.2 as specified in Table A.1 of the *Guideline for Plume Dispersion Modelling, 2nd Revision* (DOEC, 2012a)
[3] All particulate matter is assumed to be less than 2.5 µm such that $PM_{2.5}$ = PM_{10} = TSP (e-mail communication, B. Lawrence [DOECC], 4 Feb 2016).

Table 2.7: Unit 2108 Monthly Air Emissions, Temperature, and Flow Rate

Month	Stack Temperature (K)	Exhaust Flow Rate (m^3/min)	Average Emission Rate (g/s)					
			SO_2[1]	NOx	NO_2[2]	NO[2]	$PM_{2.5}$[3]	CO
January	-	-	-	-	-	-	-	-
February	-	-	-	-	-	-	-	-
March	-	-	-	-	-	-	-	-
April	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-
June	616	284	0.00204	1.65	0.33	0.86	0.037	0.284
July	625	334	0.00251	2.15	0.43	1.12	0.028	0.214
August	628	343	0.00262	2.31	0.46	1.21	0.028	0.210
September	624	329	0.00247	2.08	0.42	1.08	0.028	0.218
October	624	328	0.00245	2.06	0.41	1.07	0.028	0.219
November	-	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-	-
Average	***623***	***324***	***0.00242***	***2.05***	***0.41***	***1.07***	***0.030***	***0.229***

Notes:
[1] Based on the mass of sulphur in diesel fuel. Assumes ultra-low sulphur fuel (15 mg/kg) based on CAN/CGSB-3.517-2007.
[2] Based on an in-stack NO2 / NOx ratio of 0.2 as specified in Table A.1 of the DOEC *Guideline for Plume Dispersion Modelling, 2nd Revision* (2012)
[3] All particulate matter is assumed to be less than 2.5 µm such that PM2.5 = PM10 = TSP (personal communication, DOEC, 4 Feb 2016)

Table 2.8 Unit 2090 Monthly Air Emissions, Temperature, and Flow Rate

Month	Stack Temperature (K)	Exhaust Flow Rate (m^3/min)	Average Emission Rate (g/s)					
			SO_2[1]	NOx	NO_2[2]	NO[2]	$PM_{2.5}$[3]	CO
January	-	-	-	-	-	-	-	-
February	-	-	-	-	-	-	-	-
March	-	-	-	-	-	-	-	-
April	760	138	0.00113	0.99	0.20	0.52	0.008	0.095
May	-	-	-	-	-	-	-	-
June	-	-	-	-	-	-	-	-
July	-	-	-	-	-	-	-	-
August	-	-	-	-	-	-	-	-
September	-	-	-	-	-	-	-	-
October	-	-	-	-	-	-	-	-
November	-	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-	-
Average	***760***	***138***	***0.00113***	***0.99***	***0.20***	***0.52***	***0.008***	***0.095***

Notes:
[1] Based on the mass of sulphur in diesel fuel. Assumes ultra-low sulphur fuel (15 mg/kg) based on CAN/CGSB-3.517-2007.
[2] Based on an in-stack NO2 / NOx ratio of 0.2 as specified in Table A.1 of the DOEC *Guideline for Plume Dispersion Modelling, 2nd Revision* (2012)
[3] All particulate matter is assumed to be less than 2.5 µm such that PM2.5 = PM10 = TSP (personal communication, DOEC, 4 Feb 2016)

3.0 MODELLING METHODOLOGY

3.1 MODEL SELECTION

The CALMET/CALPUFF modelling system is the preferred regulatory model in Newfoundland and Labrador. At the request of the DOECC, Version 7.0 of the CALMET and CALPUFF models were used. CALMET is a meteorological model that produces hourly, three-dimensional gridded wind fields from available meteorological, terrain and land use data. CALPUFF is a non-steady state puff dispersion model that utilizes the CALMET wind fields and accounts for spatial changes in meteorology, variable surface conditions, and plume interactions with terrain. CALPUFF can handle both simple and complex terrain.

The Charlottetown Diesel Generating Station is in an area having complex terrain and is located near a water body, emphasizing the need to use CALPUFF.

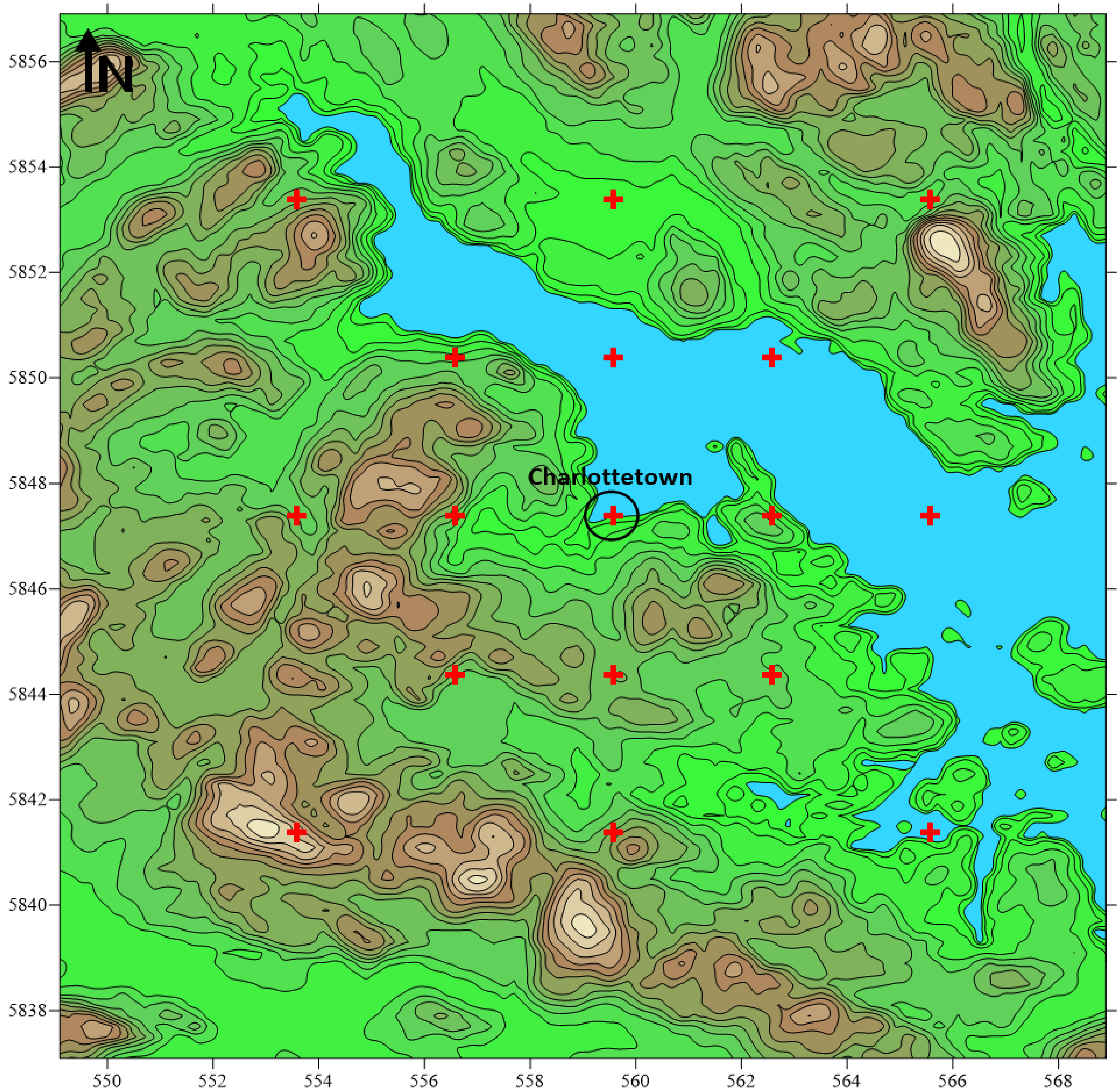
3.2 CALMET

The CALMET model was used to develop hourly meteorological data fields to use in CALPUFF. Four (4) years of meteorological data were developed covering the period 2016 to 2019. The CALMET model was run over a large 20 km by 20 km modelling domain having a grid spacing of 200 m. Figure 3.1 shows the CALMET modelling domain.

The outputs from the CALMET model were used to capture the regional wind flow pattern and were used as the inputs into CALPUFF's air dispersion calculations. Ten (10) vertical layers were included for the wind field. The layer heights are shown in Table 3.1.

Table 3.1: CALMET Wind Field Layer Heights

Vertical Height of Layer (m)	Layer Height of Top (m)	Notes
20	20	10-meter meteorology
20	40	30-meter meteorology
40	80	
80	160	
140	300	
300	600	
400	1,000	
500	1,500	
700	2,200	
800	3,000	



Legend

"Pseudo" Points

Terrain Elevations (m)

260
240
220
200
180
160
140
120
100
80
60
40
20
10
5
0

Notes

Map Reference

WGS-84 UTM (km) Zone 21

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NL Hydro

Charlottetown Diesel Generating Station

Figure 3.1

CALMET Domain, "Pseudo" Points and Terrain Contours

Project	Date
SX21-0033	Jul. 2023

3.2.1 Meteorology

As outlined in the modelling guidance (DOEC, 2012a), CALMET can accept inputs from mesoscale meteorological models. The mesoscale model outputs can be directly applied to CALMET or used to generate hourly surface and upper air data. The latter approach was used for this assessment. The mesoscale model used was the Weather Research and Forecast (WRF) Non-Hydrostatic Mesoscale Model (WRF-NMM). WRF-NMM was initialized using archived Global Forecast System (GFS) mesoscale analysis wind fields produced by the National Center for Environmental Prediction (NCEP). The GFS data is generated every 6 hours over a 25 km by 25 km grid and is based on all available surface and upper air observations. WRF-NMM modelling was used to cover a large area with a horizontal resolution of approximately 4 km by 4 km.

The output from the WRF-NMM model was used to generate hourly surface data in CD-144 format (wind speed, wind direction, temperature, cloud cover, etc.) as well as upper air profiles. Hourly surface and upper air data were generated for seventeen (17) locations in the CALMET modelling domain. The locations of the 17 "pseudo" stations are shown in Figure 3.1.

In place of WRF-NMM outputs, it was recommended by the DOECC to use sea surface temperature data from the NOAA Optimum Interpolation (OI) Sea Surface Temperature (SST) V2 database (NOAA, 2019). This data was used to create the sea surface file for input to CALMET.

3.2.2 Terrain Data

Terrain data inputs for CALMET were processed through the TERREL program. TERREL is a pre-processor program provided with the CALMET/CALPUFF modelling system that accepts surface elevation data in a variety of formats to produce grid-cell averaged terrain files for use in the MAKEGEO processor. For this modelling assessment, Canadian Digital Elevation Model (CDED) files were used. CDED files are available online from the Government of Canada (http://maps.canada.ca/czs/index-en.html).

The resulting gridded terrain file produced by TERREL is presented graphically in Figure 3.1. The outputs from TERREL were also used to assign ground elevations to the discrete receptors used in CALPUFF (see Section 3.3.1).

3.2.3 Land Use Data

Gridded land use classifications were provided by the DOECC for the CALMET meteorological domain. This land use data was further edited by IEC by recoding small inland water bodies (land use code 51) and large water bodies or (i.e., the ocean or land use code 55) to reflect times of the year when the water bodies are covered in ice. For such periods, the land use classification was changed to 90 (perennial snow or ice). Periods with sea ice were classified using data from the NOAA OI SST V2 database (NOAA, 2019). If ice coverage was greater than 40%, then the land use was classified as 90.

The different periods used to generate the CALMET land use files are outlined in Table 3.2, while the surface parameters used in CALMET are provided in the modelling guidance document (DOEC, 2012a). However, the surface parameters are reproduced in Table 3.3 for completeness.

The resulting gridded land use file produced by MAKEGEO for the 'non-winter' and 'winter without snow' period is provided in Figure 3.2, while the land use file for the 'winter with snow' period is provided in Figure 3.3.

Table 3.2: Seasonal Land Use Periods used in CALMET

Season	Julian Days			
	2019	2020 [1]	2021	2022
Non-winter	167-273	168-274	167-273	167-273
Winter **without** snow	136-166, and 274-304	137-167, and 275-305	136-166, and 274-304	136-166, and 274-304
Winter **with** snow	1-135, and 305-365	1-136, and 306-366	1-135 and 305-365	1-135 and 305-365
Frozen Ocean	1-148	1-169 and 322-366	1-142 and 352-365	1-162 and 330-365
Frozen Lakes	1-121, and 312-365	1-113, and 320-366	1-98, and 339-366	1-116, and 314-365

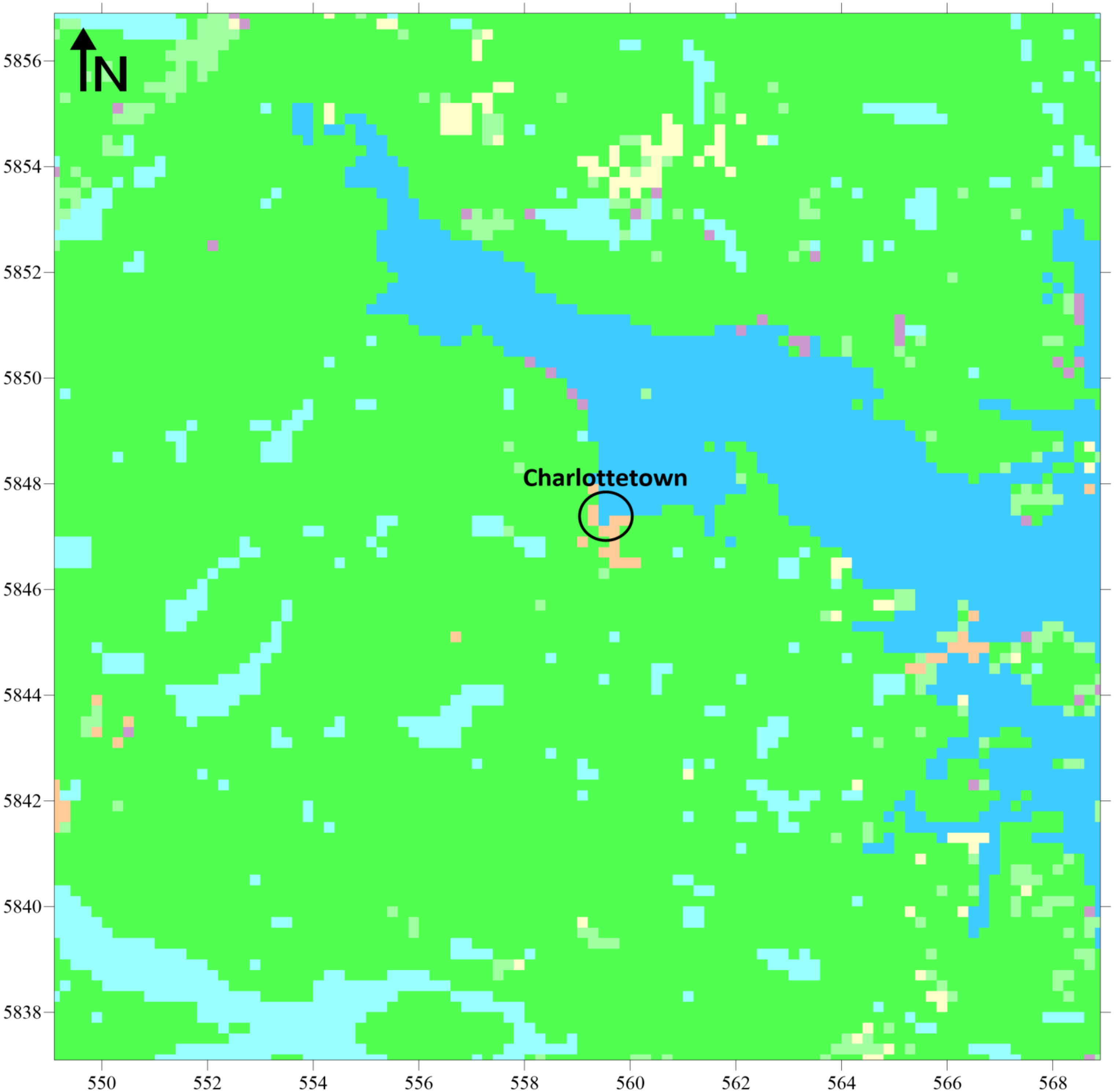
Notes:
n/a – not applicable
[1] Leap year with 366 days

Table 3.3: Season Land Use Parameters

Input Land Use Category	z_0 (m)	Albedo	Bowen Ratio	Soil Heat Flux Parameter	Anthropogenic Heat Flux (W/m²)	Leaf Area Index	Output Category ID
Non-Winter[1]							
31 - Herbaceous Rangeland	0.05	0.25	1.0	0.15	0.0	0.5	30
32 - Shrub and Brush Rangeland	0.05	0.25	1.0	0.15	0.0	0.5	30
41 - Deciduous Forest Land	1.0	0.1	1.0	0.15	0.0	7.0	40
42 - Evergreen Forest Land	1.0	0.1	1.0	0.15	0.0	7.0	40
43 - Mixed Forest Land	1.0	0.1	1.0	0.15	0.0	7.0	40
51 - Fresh Water	0.001	0.1	0.0	1.0	0.0	0.0	51
55 - Salt Water	0.001	0.1	0.0	1.0	0.0	0.0	55
61 - Forested Wetland	1.0	0.1	0.5	0.25	0.0	2.0	61
62 - Non-forested Wetland	0.2	0.1	0.1	0.25	0.0	1.0	62
74 - Bare Exposed Rock	0.05	0.3	1.0	0.15	0.0	0.05	70
77 - Mixed Barren Land	0.05	0.3	1.0	0.15	0.0	0.05	70
81 - Shrub and Brush Tundra	0.2	0.3	0.5	0.15	0.0	0.0	80
82 - Herbaceous Tundra	0.2	0.3	0.5	0.15	0.0	0.0	80
90 - Perennial Snow or Ice	0.05	0.7	0.5	0.15	0.0	0.0	90
Winter with Snow Cover[1]							
Input Land Use Category	**z_0 (m)**	**Albedo**	**Bowen Ratio**	**Soil Heat Flux Parameter**	**Anthropogenic Heat Flux (W/m²)**	**Leaf Area Index**	**Output Category ID**
31 - Herbaceous Rangeland	0.005	0.7	0.5	0.15	0.0	0.5	30
32 - Shrub and Brush Rangeland	0.005	0.7	0.5	0.15	0.0	0.5	30
41 - Deciduous Forest Land	0.5	0.5	0.5	0.15	0.0	0.0	40
42 - Evergreen Forest Land	1.3	0.35	0.5	0.15	0.0	7.0	40
43 - Mixed Forest Land	0.9	0.42	0.5	0.15	0.0	3.5	40
51 - Fresh Water	0.001	0.7	0.5	0.15	0.0	0.0	51
55 - Salt Water	0.001	0.7	0.5	0.15	0.0	0.0	55
61 - Forested Wetland	0.5	0.3	0.5	0.15	0.0	0.0	61
62 - Non-forested Wetland	0.2	0.6	0.5	0.15	0.0	0.0	62
74 - Bare Exposed Rock	0.002	0.7	0.5	0.15	0.0	0.0	70
77 - Mixed Barren Land	0.002	0.7	0.5	0.15	0.0	0.0	70
81 - Shrub and Brush Tundra	0.005	0.7	0.5	0.15	0.0	0.0	80
82 - Herbaceous Tundra	0.005	0.7	0.5	0.15	0.0	0.0	80
90 - Perennial Snow or Ice	0.05	0.7	0.5	0.15	0.0	0.0	90

Winter without Snow Cover[1]							
Input Land Use Category	**z_0 (m)**	**Albedo**	**Bowen Ratio**	**Soil Heat Flux Parameter**	**Anthropogenic Heat Flux (W/m²)**	**Leaf Area Index**	**Output Category ID**
31 - Herbaceous Rangeland	0.01	0.20	1.0	0.15	0.0	0.5	30
32 - Shrub and Brush Rangeland	0.01	0.20	1.0	0.15	0.0	0.5	30
41 - Deciduous Forest Land	0.6	0.17	1.0	0.15	0.0	7.0	40
42 - Evergreen Forest Land	1.3	0.12	0.8	0.15	0.0	7.0	40
43 - Mixed Forest Land	0.95	0.14	0.9	0.15	0.0	7.0	40
51 - Fresh Water	0.001	0.10	0.0	1.0	0.0	0.0	51
55 - Salt Water	0.001	0.10	0.0	1.0	0.0	0.0	51
61 - Forested Wetland	0.6	0.14	0.3	0.25	0.0	2.0	61
62 - Non-forested Wetland	0.2	0.14	0.1	0.25	0.0	1.0	62
74 - Bare Exposed Rock	0.05	0.20	1.5	0.15	0.0	0.05	70
77 - Mixed Barren Land	0.05	0.20	1.5	0.15	0.0	0.05	70
81 - Shrub and Brush Tundra	0.100	0.20	1.0	0.15	0.0	0.0	80
82 - Herbaceous Tundra	0.1	0.20	1.0	0.15	0.0	0.0	80
90 - Perennial Snow or Ice	0.002	0.70	0.50	0.15	0.0	0.0	90

Notes:
[1] For periods used in CALMET, see Table 3.2



Legend

Land Use Category

100
90
80
70
60
55
50
40
30
20
10

Notes

Map Reference

WGS-84 UTM (km) Zone 21

Independent Envrionmental Consultants

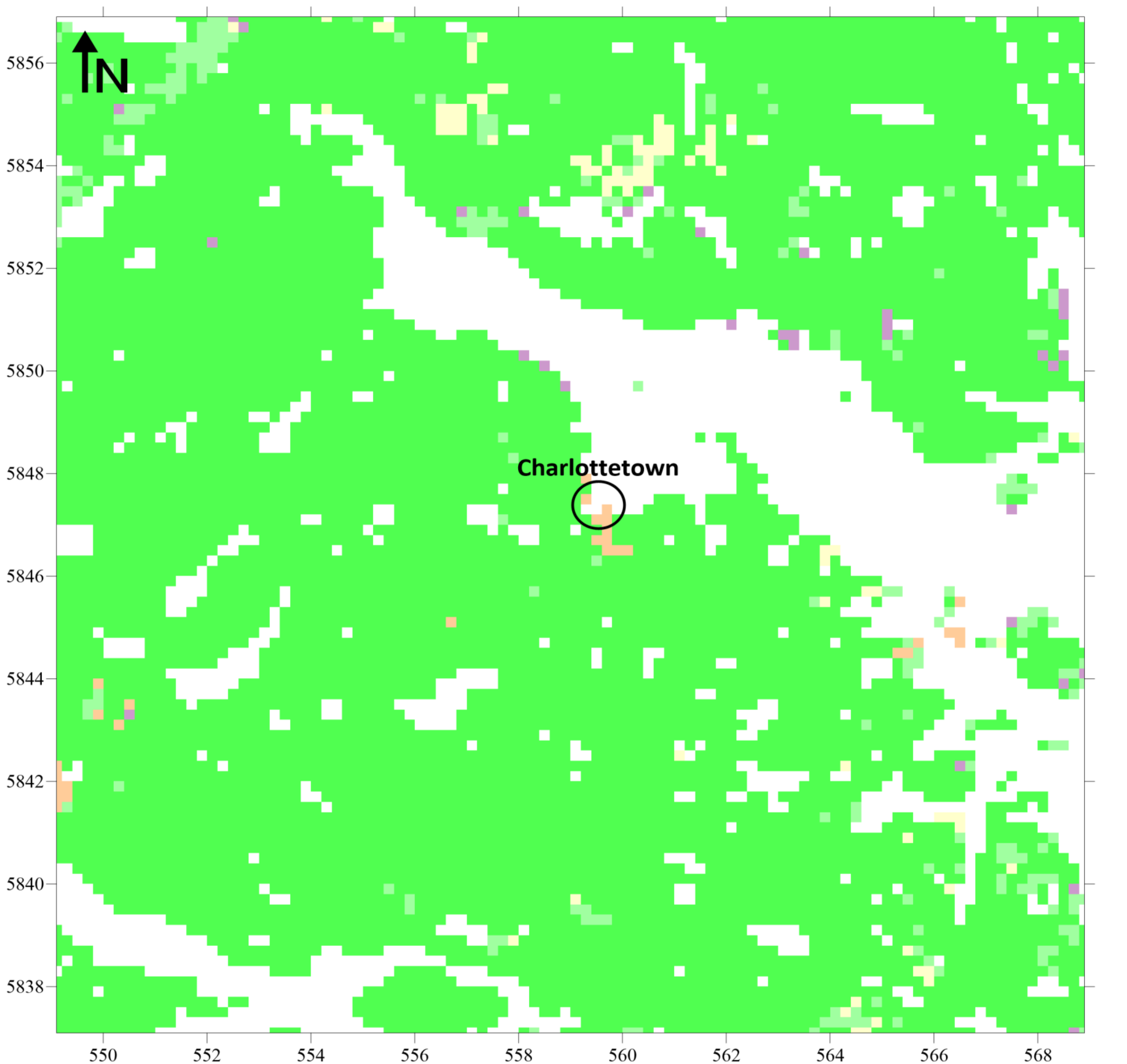
NL Hydro

Charlottetown Diesel Generating Station

Figure 3.2

CALMET Land Use (Non-Winter and Winter Without Snow)

Project	Date
SX21-033	Jul. 2023



Notes

Map Reference

WGS-84 UTM (km) Zone 21

Independent Envrionmental Consultants

NL Hydro

Charlottetown Diesel Generating Station

Figure 3.3

CALMET Land Use (Winter With Snow)

Project	**Date**
SX21-033	Jul. 2023

3.2.4 CALMET Options

Provincial modelling guidance (DOEC, 2012a) was followed when selecting the appropriate CALMET options. The main CALMET options used are summarized in Table 3.4.

Table 3.4: CALMET Options

CALMET Option	Selected Option	Explanation
No. of Vertical Layers	NZ = 10	10 vertical layers used: 0, 20, 40, 80, 160, 300, 600, 1000, 1500, 2200, 3000 m
No Observation Mode	NOOBS = 0	Use surface, overwater, or upper air observations
Method to compute cloud fields	ICLOUD = 0	Gridded clouds not used
Use varying radius of influence	LVARY = T	Use varying radius of influence
Maximum radius of influence over land in the surface layer	RMAX1 = 5	Maximum radius of influence of surface stations over land is 5 km
Maximum radius of influence over land in the layer aloft	RMAX2 = 5	Maximum radius of influence of upper air stations over land is 5 km
Maximum radius of influence over water	RMAX3 = 5	Maximum radius of influence of upper air stations over water is 5 km
Minimum radius of influence used in the wind field interpolation	RMIN= 0.1	Minimum radius of influence of stations is 0.1 km
Radius of influence of terrain features	TERRAD = 1 (no default)	Terrain effects are considered up to 1 km for each grid point
Relative weighting of the first guess field and observations in the surface layer	R1 = 1	Weighting used for surface layer is 1km
Relative weighting of the first guess field and observations in the layers aloft	R2 = 1	Weighting used for layers aloft is 1 km
Surface met. station to use for the surface temperature	ISURFT = -1	Use 2-D spatially varying surface temperatures
Option for overwater lapse rates used in convective mixing height growth	ITWPROG = 0	Use SEA.DAT lapse rates and deltaT (or assume neutral conditions if missing)
3D relative humidity from observations or from prognostic data	IRHPROG = 0	Use RH from SURF.DAT file
3D temperature from observations or from prognostic data	ITPROG = 0	Use Surface and upper air stations
Land use categories for temperature interpolation over water	JWAT1 = 999 JWAT2 = 999	Temperature interpolation disabled using 999

3.2.5 CALMET Results

Wind direction frequencies and the average wind speed (by direction) generated by CALMET are presented as a wind rose in Figure 3.4 for a grid point near the Facility. Figure 3.4 shows that the wind primarily blows from the southwest and has an average speed of 6.5 m/s.

In addition, Figure 3.5 shows the daily profile of mixing heights for a CALMET grid point near the Facility. For each modelling year, the Figure demonstrates a typical mixing height profile, which shows how the height grows after sunrise and collapses after sunset. These profiles demonstrate that CALMET can reproduce the physical parameters that are important for air dispersion modelling. Figure 3.6 presents daily temperature profile for the period.

Figure 3.4: CALMET Wind Rose (2019-2022)

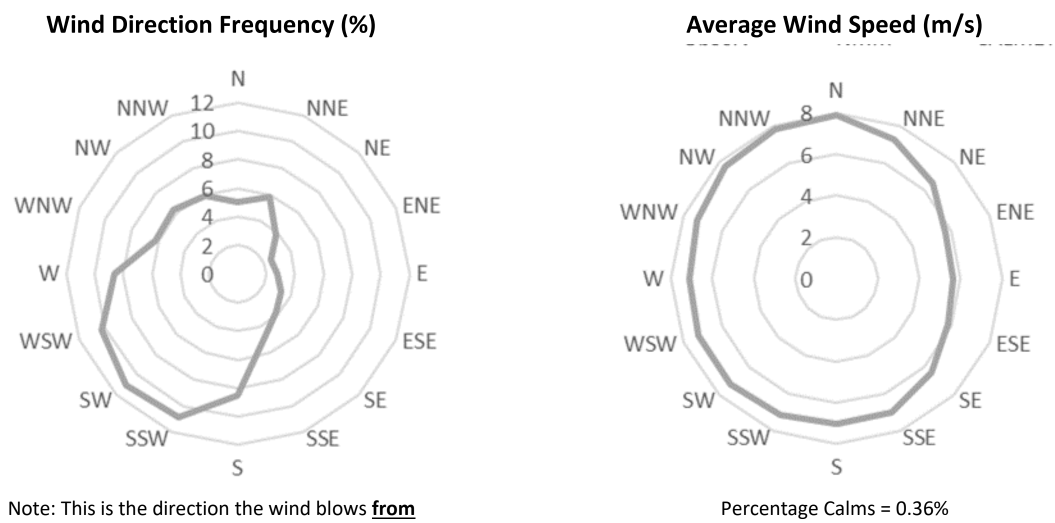


Figure 3.5: Daily Mixing Height Profile at Charlottetown from CALMET (2019-2022)

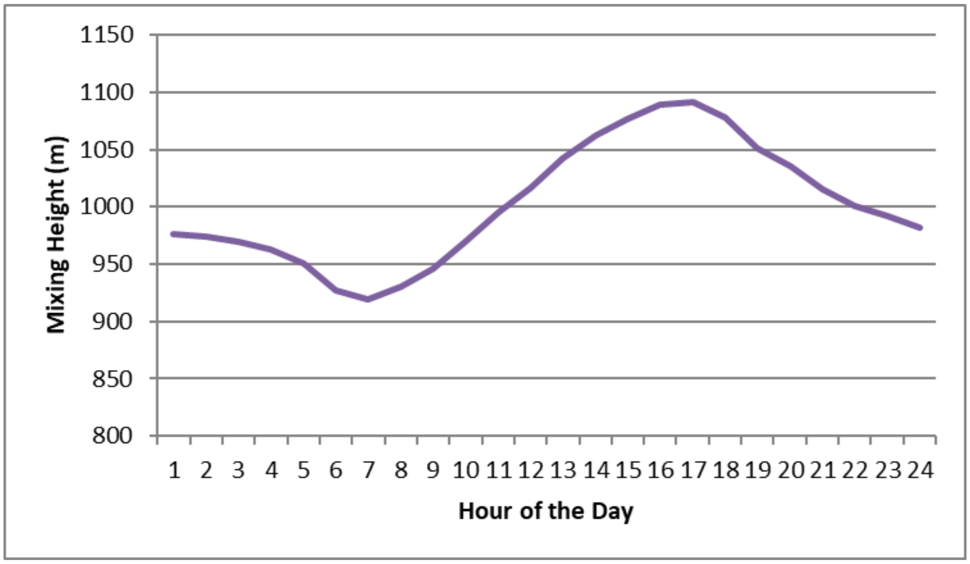
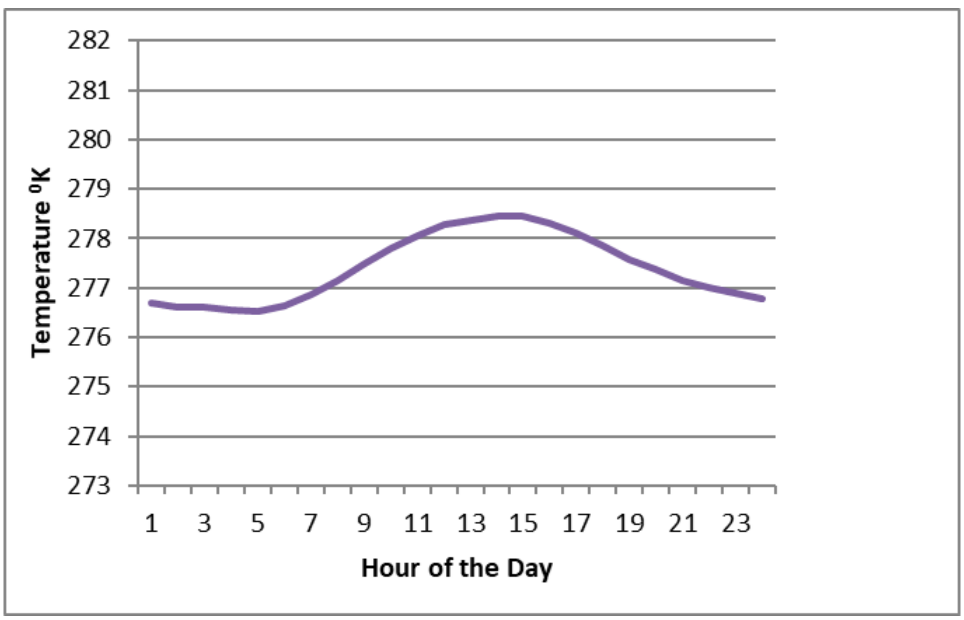


Figure 3.6: Daily Temperature Profile at Charlottetown from CALMET (2019-2022)



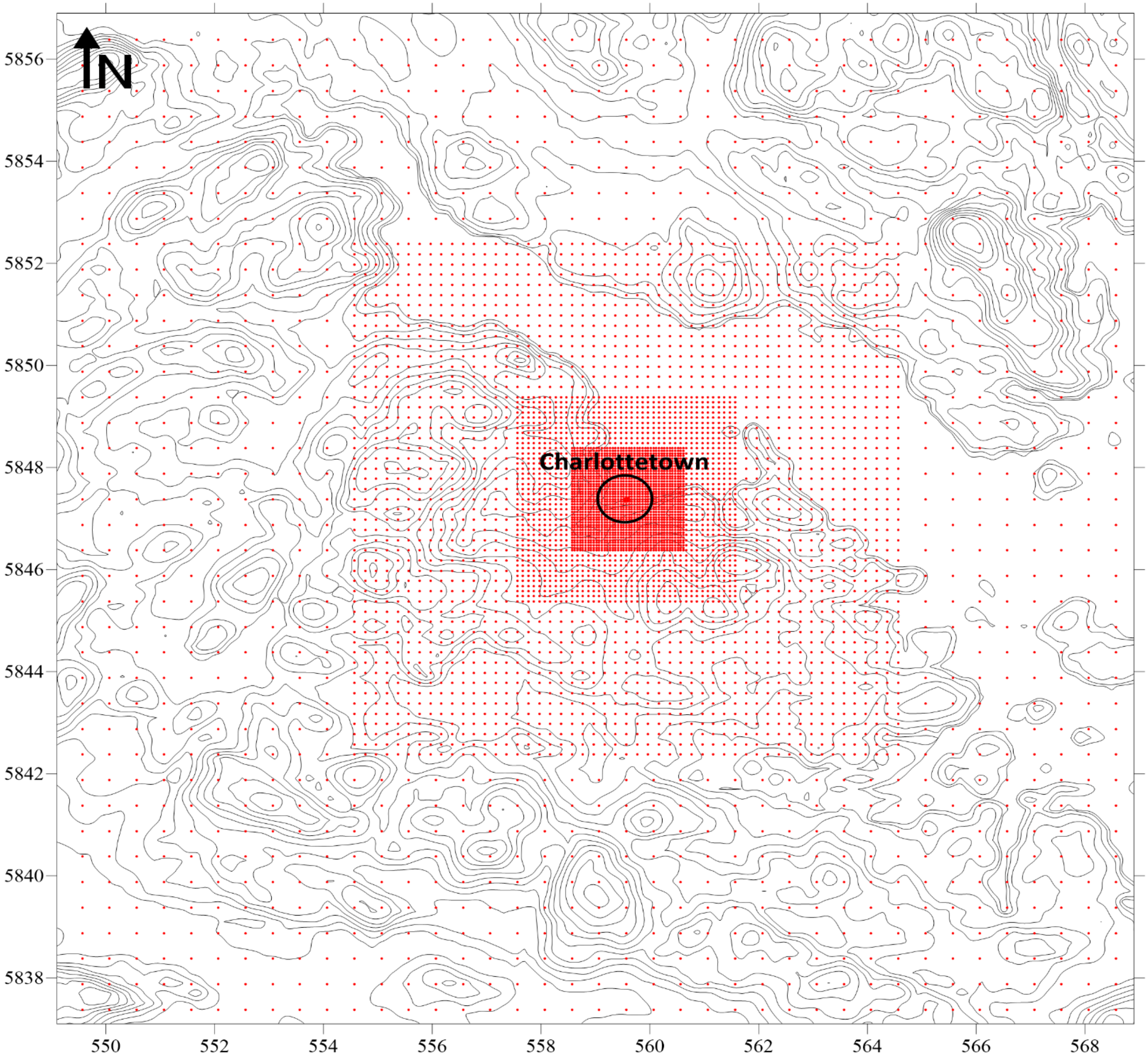
3.3 CALPUFF

3.3.1 Modelling Domain and Receptor Grid

A modelling domain of approximately 19 km by 19 km was used in the CALPUFF model runs. Receptors were chosen based on recommendations provided in section 2.4 of provincial modelling guidance (DOEC, 2012a). Specifically, a nested receptor grid, centered on the Charlottetown site, was placed as follows:

- 50 m spacing within 1 km of the site boundary;
- 100 m spacing within all areas located beyond 1 km from the site boundary, but less than 2 km from the site boundary;
- 200 m spacing within all areas located beyond 2 km from the site boundary; and
- 500 m spacing within all areas located beyond 5 km from the site boundary.

In addition, discrete receptors were placed every 10 m along the administrative boundary. The full receptor grid contains 6,237 receptors and is illustrated in Figure 3.7.



Legend

Discrete Receptor

Notes

Map Reference

WGS-84 UTM (km) Zone 21

Independent Envrionmental Consultants

NL Hydro

Charlottetown Diesel Generating Station

Figure 3.7

CALPUFF Receptors

Project	**Date**
SX21-033	Jul. 2023

3.3.2 Building Downwash

The effects of building wake on plume rise and dispersion were considered in the modelling assessment. Building dimensions and stack heights were processed with the Building Profile Input Program (BPIP) to generate the characteristic dimensions required by CALPUFF's PRIME building wake sub-model. As illustrated in Figure 2.1, all structures were considered in the PRIME sub-model. The corners, heights and elevations of the buildings/structures were provided previously in Table 2.1.

3.3.3 CALPUFF Options

Provincial modelling guidance (DOEC, 2012a) was followed when selecting the appropriate CALPUFF options. The options used in this assessment are presented in Table 3.5.

Table 3.5: CALPUFF Options

Parameter	Name of parameter and interpretation	Default value	Selected value	Selected value interpretation
NSE	Number of emitted species	8	8	Emitted species (8)
NSPEC	Number of chemical species	8	8	Emitted species and species implicated in chemical transformations (8)
MBDW	Method used to simulate building downwash	1	2	PRIME method
MSPLIT	Puff splitting allowed	0	1	Yes
MCHEM	Chemical mechanism	1	6	Updated RIVAD scheme with ISORROPIA equilibrium
MAQCHEM	Aqueous phase transformation	0	1	Transformation rates and wet scavenging coefficients adjusted for in-cloud aqueous phase reactions
MLWC	Liquid water content	1	0	Water content estimated from cloud cover and presence of precipitation
MDISP	Method used to compute dispersion coefficients	3	2	Dispersion coefficients from internally calculated micrometeorological variables
MPDF	Probability density function (PDF) used for dispersion under convective conditions	0	1	Yes
MREG	Test options specified to verify if they conform to (US-EPA) regulatory values	1	0	No checks are made
MOZ	Ozone data input option	1	0	Monthly background value
MH2O2	H2O2 data input option	1	0	Monthly background value
NINT	Number of particle size intervals	9	5	Used to evaluate effective particle deposition velocity
FMFAC	Vertical momentum flux factor	1	1	

3.3.4 Chemical Characteristics of Modelled Species

As required by provincial modelling guidance (DOEC, 2012a), the RIVAD/ISORROPIA chemical mechanism, inclusive of wet and dry deposition of particles as gases, was modelled. This mechanism requires a special sequence of pollutants: SO_2, SO_4, NO, NO_2, HNO_3 and NO_3. Since the diesel generators do not emit SO_4, HNO_3 or NO_3, their emission rates were set to zero in the model.

The dry and wet deposition parameters used were based on modelling guidance and are presented in Table 3.6 (dry deposition parameters for particles), Table 3.7 (dry deposition parameters for gases), and Table 3.8 (wet deposition parameters). Background concentrations of ozone (O_3), ammonia (NH_3), and hydrogen peroxide (H_2O_2) are required for the RIVAD/ISORROPIA chemical mechanism. In the absence of local monitoring data, default data from provincial modelling guidance was used, which is summarized in Table 3.9. The exception is ozone data, which was provided by the DOECC for Labrador (e-mail communication, B. Lawrence [DOECC], 5 November 2021).

Table 3.6: Dry Deposition Parameters for Particle Species

Species	Geometric Mass Mean Diameter (µm)	Geometric Standard Deviation (µm)
SO_4	0.48	2
NO_3	0.48	2
P1 (d < 2.5 µm)	1.25	1.242

Table 3.7: Dry Deposition Parameters for Gaseous Species

Species	Diffusivity (cm^2/s)	Alpha Star	Reactivity	Mesophyllic Resistance	Henry's Law Coefficient
SO_2	0.1509	1000	8	0	0.04
NO	0.1345	1	2	25	18
NO_2	0.1656	1	8	5	3.5
HNO_3	0.1628	1	18	0	8.0E-08
CO	0.186	1	2	61	44

Table 3.8: Wet Deposition Parameters for Modelling Species

Species	Scavenging Coefficient	
	Liquid Precipitation	Frozen Precipitation
SO_2	3.0E-05	0
SO_4	1.0E-04	3.0E-05
NO	0	0
NO_2	0	0
HNO_3	6.0E-05	0
NO_3	1.0E-04	3.0E-05
P1 (d < 2.5 µm)	1.0E-04	3.0E-05
CO	0	0

Table 3.9: Monthly Background Concentrations of O_3, NH_3, and H_2O_2

Month	Ozone (O_3) (ppb)	Ammonia (NH_3) (ppb)	Hydrogen Peroxide (H_2O_2) (ppb)
January	30	0.5	0.2
February	31	0.5	0.2
March	34	0.5	0.2
April	36	0.5	0.2
May	28	0.5	0.2
June	21	0.5	0.2
July	15	0.5	0.2
August	14	0.5	0.2
September	16	0.5	0.2
October	20	0.5	0.2
November	27	0.5	0.2
December	29	0.5	0.2

4.0 MODELLING RESULTS

The following sections outline the results of the air dispersion modelling assessment in accordance with section 5 of the *Plume Dispersion Modelling Guideline* (DOEC, 2012a). Compliance is assessed in Section 4.1, which compares the maximum predicted concentrations outside of the administrative boundary to applicable air quality standards. As stated in provincial guidance for the determination of compliance (DOEC, 2012b), meteorological anomalies may result in the over prediction of modelled concentrations. As a result, compliance for each modelled year is based on the following:

- 9th highest level at any given receptor for a 1-hour averaging period;
- 6th highest level at any given receptor for a 3-hour averaging period;
- 3rd highest level at any given receptor for an 8-hour averaging period;
- 2nd highest level at any given receptor for a 24-hour averaging period;
- 1st highest level at any given receptor for an annual averaging period.

Due to the remote setting of the Facility, background concentrations of the modelled air pollutants are expected to be negligible. As a result, a background concentration was not added to the predicted concentrations, and modelled results were directly compared to the air quality standards.

4.1 MAXIMUM PREDICTED CONCENTRATIONS

Table 4.1 provides the maximum predicted concentrations (meteorological anomalies removed) of NO_2, SO_2, CO, TSP, PM_{10}, and $PM_{2.5}$ for each modelled year (2019 to 2022). As can be seen in Table 4.1, all maximum pollutant concentrations are predicted to be below their respective ambient air quality standards (AAQS). The pollutant with the highest predicted concentration relative to its AAQS is NO_2. Maximum predicted concentrations of 24-hour NO_2 range from 18.9 ppb to 30.5 ppb (or 17.8% to 28.7% of the AAQS) and 1-hour NO_2 concentrations range from 43.2 ppb to 51.0 ppb (or 20.3% to 23.9% of the AAQS).

The pollutant with the next highest concentration relative to its AAQS is $PM_{2.5}$. Maximum predicted concentrations of 24-hour $PM_{2.5}$ range from 1.6 µg/m³ to 2.6 µg/m³ (or 6.3% to 10.4% of the AAQS of 25 µg/m³). As discussed in Section 2.3, it was assumed that all particulate matter emissions from the generators are less than 2.5 microns. As a result, predicted concentrations of TSP and PM_{10} are equal to predicted $PM_{2.5}$ concentrations. PM_{10} concentrations range from 3.1% to 5.2% of the AAQS of 50 µg/m³ while TSP predicted concentrations are less than 2.5% of their AAQS.

At less than 0.5%, SO_2 and CO have the lowest predicted concentrations relative to their AAQS.

Table 4.1: Summary of Maximum Predicted Concentrations for the Charlottetown Diesel Generating Station

Pollutant	Averaging Period	Units	AAQS	2019		2020		2021		2022	
				Conc.	% Of AAQS	Conc.	% Of AAQS	Conc.	% Of AAQS	Conc.	% Of AAQS
NO_2	1h	213	ppb	43.2	20.3%	51.0	23.9%	48.4	22.7%	46.4	21.8%
	24h	106	ppb	27.9	26.3%	18.9	17.8%	30.5	28.7%	21.8	20.6%
	Ann	53	ppb	1.6	3.0%	0.8	1.6%	1.2	2.3%	0.8	1.5%
SO_2	1h	344	ppb	0.1	0.03%	0.1	0.04%	0.1	0.03%	0.2	0.1%
	3h	229	ppb	0.1	0.04%	0.1	0.03%	0.1	0.04%	0.1	0.04%
	24h	115	ppb	0.1	0.05%	0.04	0.04%	0.1	0.05%	0.04	0.04%
	Ann	23	ppb	0.003	0.01%	0.001	0.01%	0.002	0.01%	0.001	0.01%
CO	1h	30,582	ppb	38.1	0.1%	53.0	0.2%	40.9	0.1%	67.2	0.2%
	8h	13,017	ppb	26.1	0.2%	27.1	0.2%	25.3	0.2%	20.5	0.2%
TSP	1h	N/A	µg/m³	4.5	N/A	6.3	N/A	4.9	N/A	8.0	N/A
	24h	120	µg/m³	2.6	2.2%	1.9	1.6%	2.0	1.7%	1.6	1.3%
	Annual	60	µg/m³	0.1	0.2%	0.04	0.1%	0.1	0.1%	0.0	0.1%
PM_{10}	1h	N/A	µg/m³	4.5	N/A	6.3	N/A	4.9	N/A	8.0	N/A
	24h	50	µg/m³	2.6	5.2%	1.9	3.8%	2.0	4.1%	1.6	3.1%
	Annual	N/A	µg/m³	0.1	N/A	0.04	N/A	0.1	N/A	0.0	N/A
$PM_{2.5}$	1h	N/A	µg/m³	4.5	N/A	6.3	N/A	4.9	N/A	8.0	N/A
	24h	25	µg/m³	2.6	10.4%	1.9	7.6%	2.0	8.2%	1.6	6.3%
	Ann	8.8	µg/m³	0.1	1.0%	0.04	0.4%	0.1	0.6%	0.0	0.5%

Notes:
N/A – not applicable
Compliance with AAQS based on the 9th hourly, 6th 3-hour, 3rd 8-hour and 2nd daily maximums.
Pollutants above an AAQS are in shaded and in **bold**.

4.2 Isopleths of Concentrations and Top-50 Tables

Provincial modelling guidance (DOEC, 2012a) requires that isopleths and Top-50 tables (without meteorological anomalies removed) be created for each pollutant and averaging time that has a modelled concentration which is more than 50% of the AAQS. As shown in Table 4.1, all pollutants and averaging periods are less than 50% of the AAQS in each modelled year. As a result, isopleths and Top-50 tables have not been created.

5.0 CONCLUSIONS

Air dispersion modelling using the CALMET/CALPUFF modelling system was performed to evaluate the impacts of the Charlottetown Diesel Generating Station on local air quality. NO_2, SO_2, CO, TSP, PM_{10} and $PM_{2.5}$ were modelled and predicted concentrations were compared to Newfoundland and Labrador Ambient Air Quality Standards (AAQS) in accordance with provincial guidance. A four-year modelling period (2019 to 2022) was used.

Based on the monthly forecasted peak power loads for 2028 and the operation of mobile units 820, 2088, 2090, 2102, and 2108, the main conclusions of this air dispersion modelling assessment are:

- For each year modelled, resulting concentrations of NO_2, SO_2, CO, TSP, PM_{10} and $PM_{2.5}$ are compliant with applicable AAQS for all averaging periods (1-hour, 3-hour, 8-hour, 24-hour and annual).
- The pollutant with the highest predicted concentration relative to its AAQS is NO_2. The maximum predicted concentration of 24-hour NO_2 is 30.5 ppb (or 28.7% of the AAQS) and the maximum predicted concentration of 1-hour NO_2 is 51.0 ppb (or 23.9% of the AAQS).
- The maximum predicted 24-hour concentration of $PM_{2.5}$ is 2.6 µg/m³ (or 10.4% of the AAQS).
- The maximum predicted 24-hour concentration of PM_{10} is 2.6 µg/m³ (or 5.2% of the AAQS).
- Maximum predicted 24-hour concentrations of TSP is less than 2.5% of the AAQS.
- Maximum predicted concentrations of SO_2 and CO are less than 0.5% of their corresponding AAQS.

6.0 REFERENCES

National Oceanic and Atmospheric Administration (NOAA), 2019. *Optimum Interpolation Sea Surface Temperature V2*. Developed by NOAA Oceanic and Atmospheric Research Division, Earth System Research Laboratory, Physical Sciences Division. Website: https://www.esrl.noaa.gov/psd/. Accessed on 26 April 2019.

Newfoundland and Labrador Department of Environment and Conservation (DOEC). 2012a. *Guideline for Plume Dispersion Modelling GD-PPD-019.2*. September.

Newfoundland and Labrador Department of Environment and Conservation (DOEC). 2012b. *Determination of Compliance with Ambient Air Quality Standards GD-PPD-009.4*. December.

Appendix A:

CALMET/CALPUFF Input Files