Appendix H

Energy and Emissions Study

APPENDIX H
Energy & Emissions Study

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List of Abbreviations

Acronym	**Definition**
3-D	three-dimensional
APCR	Air Pollution Control Regulations
BPIP	Building Profile Input Program
Btu	British thermal unit
CAAQS	Canadian Ambient Air Quality Standards
CCME	Canadian Council of Ministers of the Environment
CDEM	Canadian Digital Elevation Model
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
dwt	deadweight tonnage
ECCC	Environment and Climate Change Canada
EF	emission factor
EOSD	Earth Observation for Sustainable Development of Forests
g	gram
GHG	greenhouse gas
GHGRP	Greenhouse Gas Reporting Program
GJ	gigajoule
GWP	global warming potential
hr	hour
hp	horsepower
ISR	in-stack ratio
kg	kilogram
km	kilometre
kWh	kilowatt hour
L	litre
LAA	Local Assessment Area
LPG	liquified petroleum gas
NH_3	ammonia
NL AQS	Newfoundland and Labrador Air Quality Standards
NL DECC	Newfoundland and Labrador Department of Environment and Climate Change
NLH	Newfoundland and Labrador Hydro
NL MGGA	Newfoundland and Labrador Management of Greenhouse Gas Act
nm	nautical mile

NOx	oxides of nitrogen
NO	nitrogen oxide
N_2O	nitrous oxide
NPRI	National Pollutant Release Inventory
NRCan	Natural Resources Canada
MW	megawatt
M	metres
m^2	square metres
m^3	cubic metres
OLM	ozone limiting method
PAH	polycyclic aromatic hydrocarbons
PM	particulate matter
PM_{10}	particulate matter less than 10 microns
$PM_{2.5}$	particulate matter less than 2.5 microns
POA	Port of Argentia
RAA	Regional Assessment Area
SEM	Sikumiut Environmental Management Ltd.
SO_2	sulfur dioxide
t	metric tonnes
TSP	total suspended particulate
US EPA	United States Environmental Protection Agency
VKT	vehicle kilometres travelled
VOC	volatile organic compound
WRF	Weather Research Forecasting

1.0 Introduction

The Argentia Renewables Project will produce green hydrogen using locally produced wind-generated electricity. Green hydrogen will be produced at the Green Fuels Facility on the Argentia Peninsula where it will also be converted to ammonia for shipment by vessels. The associated Argentia Wind Facility will be comprised of approximately 300 MW of installed capacity from up to 46 wind turbines located throughout private lands owned by the Port of Argentia (POA) (i.e., the POA Property) as described in Chapter 2. The current wind turbine design for the Project is expected to have a nominal power with an anticipated range of 6.8-7.2 megawatt (MW), a hub height of approximately 100 to 119 metres (m) and a rotor diameter of up to 170 m. For the purposes of this Environmental Assessment Registration, a nominal power of 6.8 MW and a hub height of 119 m is conservatively assumed. Electrical infrastructure will be required to connect wind power generated by the Argentia Wind Facility to the Argentia Green Fuels Facility, as well as to connect the Argentia Green Fuels Facility to the Newfoundland and Labrador Hydro (NLH) grid as described in Chapter 2. The Project is expected to produce up to 400 metric tonnes per day (tpd) of green ammonia, equivalent to up to 146,000 metric tonnes (t) of ammonia per year which will be stored and exported to international markets by ship from a marine terminal in the POA. The Project will require between 170 to 200 MW of renewable energy and 1,185 cubic metres (m^3) (313,045 US gallons) of freshwater daily.

1.1 Objectives

Argentia Renewables retained Sikumiut Environmental Management Ltd. (SEM) to develop greenhouse gas (GHG) and air release inventories for the construction and operation phases of the Project, as detailed below. Project decommissioning was not considered in this study.

1.1.1 Greenhouse Gas Inventory

The GHG inventory includes emissions produced from direct and indirect sources including, but not limited to, stationary combustion, mobile equipment, explosive use, electricity consumption, and marine transport. Annual operational phase emission estimates were compared to the threshold of 15,000 tonnes of carbon dioxide equivalents (CO_2e) set out in the **Newfoundland and Labrador Management of Greenhouse Gas Act** (NL MGGA) to determine whether Act and associated regulations, as well as the provincial carbon pricing system, are applicable to the Project. Furthermore, annual operational phase emission estimates were assessed to determine the applicability of the Greenhouse Gas Reporting Program (GHGRP), a mandatory reporting program for Canadian facilities that surpass the 10,000 tonnes of CO_2e emissions threshold

1.1.2 Air Release Inventory & Dispersion Modelling

The air release inventory includes emissions generated by combustion and non-combustion processes including, but not limited to, stationary combustion, mobile equipment, blasting, wind erosion of exposed surfaces, material handling, flare stacks, and marine transport. Air releases were computed in terms of annual emissions for the construction and operation phase, and as emission rates for the operation phase of the Project. Emission rates were used in an air dispersion modelling exercise via the CALPUFF dispersion modelling system. Modelling was performed to predict maximum ground level concentrations of air contaminants regulated by the **Air Pollution Control Regulations, 2022** (APCR) during operation of the Argentia Green Fuels Facility; steady air releases are not anticipated during operation of the Argentia Wind Facility. Concentrations, modelled as maximum hourly, maximum daily and annual average emissions, were predicted in relation to ambient air quality in the Local Assessment Area (LAA) and Regional Assessment Area (RAA) during normal operation of the Project. Modelled concentrations of air contaminants of interest were compared to the Newfoundland and Labrador Air Quality Standards (NL AQS) per the APCR, and the Canadian Ambient Air Quality Standards (CAAQS), as developed by the Canadian Council of Ministers of the Environment (CCME).

2.0 Greenhouse Gas Inventory

The GHG inventory for the Project was developed in consideration of requirements and recommendations of the NL Department of Environment and Climate Change (NL DECC) in place for reporting under the MGGA and its regulations (Newfoundland and Labrador Office of Climate Change, 2017), as well as federal guidance for reporting under the GHGRP. Requirements of NL DECC's Guidance for Registration of Onshore Wind Energy Generation and Green Hydrogen Production were also considered during GHG inventory development.

2.1 Methodology

2.1.1 GHG Emission Sources

The GHG inventory accounts for emissions from Scope 1, 2 and 3 sources during construction and operation of the Project. Scope 1 accounts for emissions from onsite sources (also referred to as direct emissions). Direct emissions typically arise from fuel combustion sources (e.g., mobile equipment, boilers, generators, etc.). Indirect emissions arise from Scope 2 and 3 sources. Scope 2 accounts for emissions that arise from onsite energy use that is generated offsite (e.g., purchased electricity), while Scope 3 accounts for all other indirect emissions. Such emissions occur as a result of Project activities but are generated by sources not associated with the Project (e.g., marine transportation of product). Scopes and sources of Project GHG emissions are outlined in Table H-2.1.1-1.

Table H-2.1.1-1 GHG Emission Scopes and Sources by Project Phase.

Phase	Scope	Source(s)
Construction	1 (Direct)	Blasting, Stationary Combustion, Mobile Equipment
	3 (Indirect)	Marine Transport of Supplies
Operation	1 (Direct)	Mobile Equipment, Flare Stacks, Stationary Combustion
	2 (Indirect)	Electricity Consumption
	3 (Indirect)	Marine Transport of Product

During Project construction, Scope 1 emissions will arise from explosive use to develop new roads and wind turbine foundations, as well as diesel equipment (both stationary and mobile) used to develop the Argentia Green Fuels Facility and Argentia Wind Facility. Indirect construction phase emissions will arise from marine transport of supplies such as wind turbine components (i.e., Scope 3 only). Scope 1 emissions during Project operation will arise from diesel equipment (both stationary and mobile) used to service the Argentia Green Fuels Facility and Argentia Wind Facility, and flare stacks to support the Argentia Green Fuels Facility. Indirect operation phase emissions will arise from electricity consumption (Scope 2) and marine transport of product to the global market (Scope 3).

Project emissions were estimated based on preliminary engineering details, publicly available emission factors and good practice guidelines. It is anticipated that Project details will change as engineering and procurement progress. The GHG inventory detailed herein serves as a conservative estimate of Project emissions.

2.1.2 GHG Inventory Development

The MGGA stipulates that GHG emissions are reported in terms of CO_2e, thus concentrations of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) were converted using global warming potentials (GWPs). The use of GWPs, which measure the amount of energy a GHG will absorb relative to CO_2, enables accurate comparison of emissions from different GHGs. Relevant GHGs and respective GWPs are provided in Table H-2.1.2-1.

Table H-2.1.2-1 Global Warming Potentials.

Greenhouse Gas	Global Warming Potential*
Carbon dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous Oxide (N_2O)	265
*100 year Source: Intergovernmental Panel on Climate Change, 2014	

In addition to GWPs, emissions were calculated using emission factors (EFs), which relate to a quantity of substance (e.g., CO_2, CH_4, N_2O) released and emitted per unit of energy. Relevant EFs by activity and phase are provided in Table H-2.1.2-2.

Project emissions were calculated by inputting GWPs (Table H-2.1.2-1), where required, and EFs in equations provided in Section 2.1.3. Data for the GHG inventory were retrieved from preliminary design specifications, reports, and email correspondence.

Table H-2.1.2-2 GHG Inventory Emission Factors.

Activity (Phase)	Units	Emission Factors			Source
		CO_2	CH_4	N_2O	
Blasting (Construction)					
Fossil-fuel based explosive use	$\frac{kg\ CO_2}{kg\ explosives}$	0.189	-	-	(The Mining Association of Canada, 2014)
Diesel Combustion (Construction, Operation)					
Stationary Combustion	$\frac{g}{L}$	2681	0.078	0.022	(Environment and Climate Change Canada, 2023b)
Mobile Equipment (off road diesel, ≥19 kW Tier 4)		2680.5	0.073	0.227	
Mobile Equipment (light-duty diesel trucks, advanced control)		2680.5	0.068	0.22	
Marine Transport (Construction, Operation)					
Origin to Port (5,000-9,999 dwt vessel)	$\frac{g\ CO_2e}{dwt \cdot nm}$	19.4	-	-	(International Maritime Organization, 2021)
Origin to Port (10,000-19,999 dwt vessel)		17.1	-	-	
Vessel Hotelling (marine diesel)	$\frac{g}{L}$	2680.5	0.25193	0.07198	(Environment and Climate Change Canada, 2023b)
Flare Stacks (Operation)					
Flaring [1]	$\frac{kg}{GJ}$	62.4	0.00083	0.0005	(Environment and Climate Change Canada, 2023a)
Electricity Consumption (Operation)					
NLH Grid Consumption	$\frac{g\ CO_2e}{kWh\ electricity}$	17	-	-	(Environment and Climate Change Canada, 2023c)

NOTES
kg=kilogram; g=gram; L=liter; dwt=deadweight tonnage; nm=nautical mile; GJ=gigajoule; kWh=kilowatt hour
[1] Flaring for continuously lit pilot flare

2.1.3 GHG Inventory Equations

Emissions were calculated based on the methodology set out in Equation H-2.1.3-1. However, slight deviations were required to suit data availability and perform sufficient unit conversions. Calculation methodology deviations were required to calculate emissions generated during marine transport (origin to port) and from flare stacks. Such deviations are detailed in Equations H-2.1.3-2 and H-2.1.3-3 through H-2.1.3-6, respectively.

Equation H-2.1.3-1: General Emissions

$$\text{Emissions}\left(\frac{\text{tonnes}}{\text{year}}\right) = A \times EF \times GWP$$

where: A = activity rate (e.g., fuel consumption, electricity use)

EF = emission factor

GWP = global warming potential

Equation H-2.1.3-2: Marine Transport Emissions

$$\text{Emissions}\left(\frac{\text{tonnes } CO_2e}{\text{year}}\right) = D\ (\text{nm}) \times VT\ (\text{tonnes}) \times TPY \times EF\left(\frac{\text{g } CO_2e}{\text{dwt}\cdot\text{nm}}\right) \times \frac{\text{tonne}}{10^6\ \text{g}}$$

where: D = shipping distance in nautical miles (nm)

VT = vessel tonnage

TPY = trips per year

EF = emission factor in units of grams of carbon dioxide equivalents (CO_2e) per deadweight tonnage nautical mile (dwt·nm)

Equation H-2.1.3-3: Flare Stack CO_2 Emissions

$$CO_2\left(\frac{\text{tonnes}}{\text{year}}\right) = \text{Fuel}\ (m^3) \times \frac{MW_{\text{flare gas}}\left(\frac{\text{kg}}{\text{kg}\cdot\text{mol}}\right)}{MWC\left(\frac{m^3}{\text{kg}\cdot\text{mol}}\right)} \times CC\left(\frac{\text{kg C}}{\text{kg flare gas}}\right) \times CE \times 3.664 \times \frac{\text{tonne}}{10^3\ \text{kg}}$$

where: Fuel = annual fuel consumption (m^3)

$MW_{\text{flare gas}}$ = average molecular weight of flare gas combusted at reference conditions (15 degrees Celsius (°C) and 101.325 kilopascals (kPa))

MWC = molar volume conversion factor at reference conditions [Equation H-2.1.3-4]

CC = average carbon content of flare gas

CE=combustion efficiency

3.664 = ratio of molecular weights, carbon dioxide (CO_2) to carbon (C)

Equation H-2.1.3-4: Molar Volume Conversion Factor at Reference Conditions

$$MVC\left(\frac{m^3}{kg \cdot mol}\right) = 8.3145 \times \left(\frac{[273.16 + \text{reference temperature } (°C)]}{[\text{reference pressure (kPa)}]}\right)$$

where: MWC = molar volume conversion factor at reference conditions

reference temperature = 15°C

reference temperature = 101.325 kPa, respectively.

Equation H-2.1.3-5: Flare Stack CH_4 Emissions

$$CH_4\left(\frac{\text{tonnes}}{\text{year}}\right) = \left(CO_2 \times \frac{EF_{CH4}}{EF}\right) + \left(CO_2 \times \frac{1 - CE}{CE} \times \frac{16}{44} \times f_{CH4}\right)$$

where: CO_2 = emissions of CO_2 from flared gas (tonnes; calculated from Equation H-2.1.3-3)

EF_{CH4} = emission factor for methane in units of kilograms per gigajoule (kg/GJ)

EF = CO_2 emission factor for flare gas in units of kg/GJ

CE=combustion efficiency

$\frac{16}{44}$ = ratio of molecular weights, CH_4 to CO_2

f_{CH4} = weight fraction of carbon in the flare gas prior to combustion that is contributed by methane

Equation H-2.1.3-6: Flare Stack N_2O Emissions

$$N_2O\left(\frac{\text{tonnes}}{\text{year}}\right) = \left(CO_2 \times \frac{EF_{N2O}}{EF}\right)$$

where: CO_2 = emissions of CO_2 from flared gas (tonnes; calculated from Equation H-2.1.3-3)

EF_{N2O} = emission factor for nitrous oxide in units of kg/GJ

EF = CO_2 emission factor for flare gas in units of kg/GJ

2.2 GHG Inventory Results

Annual Project construction and operation emission estimates are presented in Table H-2.2-1. Assumptions used in calculations are provided in Appendix H.1. Calculation details are provided in Appendix H.2.

Table H-2.2-1 Annual GHG Emissions Estimate Summary.

Phase	Source	Annual GHG Emissions (t CO_2e)			
		Scope 1 (Direct)	Scope 2 (Indirect)	Scope 3 (Other Indirect)	Total Scope 1 + Scope 2
Construction	Blasting	24			24
	Stationary Combustion	1,531			1,531
	Mobile Equipment	6,426			6,426
	Marine Transport of Supplies			172,616	0
	Total Annual Construction [1]	**7,981**	**0**	**172,616**	**7,981**
Operation	Mobile Equipment	48			48
	Flare Stacks	228			101
	Emergency Generator	826			860
	Marine Transport of Product			19,587	0
	Electricity Consumption		1,489		1,489
	Total Annual Operation [2]	**1,102**	**1,489**	**19,587**	**2,591**

NOTES
[1] Project construction scheduled to occur over a two-year period, marine transport of supplies to occur in a single calendar year.
[2] Operational lifetime of the Project is 30 years.

Scope 1 emissions were estimated to be 7,981 tonnes CO_2e per year across the two-year Project construction period. This estimate is considered conservative as it is anticipated that explosive use will be reduced upon completion of the geotechnical program, scheduled to commence in Spring 2024. Scope 3 emissions were estimated to be 172,616 tonnes CO_2e during the one-year supply delivery timeline. It was conservatively assumed that supplies would depart from the furthest port possible (in terms of nm) from Argentia.

Annual Scope 1 emissions were estimated to be 1,102 tonnes CO_2e per year over the 30-year operational lifetime of the Project. This estimate is conservative as emissions from emergency generator use calculated based on wort-case scenario of 100 hours of use per year. It is unlikely that the emergency generator will be used consistently throughout the year, if at all, thus annual emissions for emergency generator use are likely an overestimation. Annual Scope 2 emissions were estimated to be 1,489 tonnes CO_2e per year based on the current configuration of the NLH grid. It is possible that the NLH grid will become fully renewable during the operational lifetime of the Project. The eventual integration of Muskrat Falls is anticipated to eliminate the requirement of supplemental fossil-fuel fired infrastructure for electricity generation, thereby eliminating emissions associated with electricity consumption. Scope 3 emissions were estimated to be 19,587 tonnes CO_2e per year over the 30-year operational lifetime of the Project. It was assumed that product will be shipped to a major European port (i.e., Hamburg, Germany).

Scope 1 annual operational emissions do not exceed the threshold of 15,000 tonnes of CO_2e prescribed by the NL MGGA. As such, the Project is not anticipated to be subject to Section 4 and/ or 5 of the NL MGGA, the provincial carbon pricing system, nor the GHGRP. Although the Project is subject to the NL

MGGA, the Project will be subject to the Federal Fuel Charge, which is applicable regardless of annual operational GHG emissions. If at any point emissions generated at the Argentia Green Fuels Facility and Argentia Wind Facility surpass the emissions thresholds, the NL MGGA and/or GHGRP will apply, and the Project will be regulated.

3.0 Air Release Inventory

The air release inventory for the Project was developed in consideration of the APCR set forth by the NL DECC. Guidance and requirements of Environment and Climate Change Canada's (ECCC) National Pollutant Release Inventory (NPRI) and NL DECC's Guidance for Registration of Onshore Wind Energy Generation and Green Hydrogen Production were also considered.

3.1 Methodology

3.1.1 Air Emission Sources

The air release inventory accounts for emissions from combustion and non-combustion processes during construction and operation of the Project, as outlined in Table H-3.1.1-1.

Table H-3.1.1-1 Air Release Sources by Project Phase.

Phase	Source Type	Source(s)
Construction	Point	Stationary Combustion, Mobile Equipment
	Fugitive	Blasting, Stockpile Erosion, Aggregate Handling and Transfers, Crushing and Screening, Laydown Areas
	Unpaved Roads	Turbine Component Transportation
Operation	Point	Flare Stacks, Stationary Combustion, Mobile Equipment, Marine Transport of Product

During Project construction, point source emissions will arise from diesel equipment (both stationary and mobile) used to develop the Argentia Green Fuels Facility and Argentia Wind Facility. Fugitive releases will occur as a result of explosive use to develop new roads and wind turbine foundations as well as wind erosion of exposed surfaces and material handling. Transportation of turbine components on unpaved roads will generate particulate matter (PM) emissions within the Project Area. During Project operation, point source emissions will arise from diesel equipment (both stationary and mobile) used to service the Argentia Green Fuels Facility and Argentia Wind Facility, and flare stacks to support the Argentia Green Fuels Facility. Point source emissions will also be generated as a result of marine transport of end product to the global market.

Air releases were estimated based on preliminary engineering details, publicly available emission factors and good practice guidelines. It is anticipated that Project details will change as engineering and procurement progress. The air release inventory detailed herein serves as a conservative estimate of Project emissions.

3.1.2 Air Release Inventory Development

Point sources will generate emissions of carbon monoxide (CO), sulfur dioxide (SO_2), oxides of nitrogen (NOx), PM, volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs). Fugitive sources and unpaved roads will generate emissions of PM only. In the context of this study, PM refers to all three size fractions of PM: total suspended particulate (TSP), particulate matter less than 2.5 microns ($PM_{2.5}$), and particulate matter less than 10 microns (PM_{10}). Air contaminants included in the air release inventory are those on the NPRI substance list, which may pose a risk to the environment or to health.

Air releases were estimated based on the methodology set out in Equation H-3.1.2-1. Due to the wide range of air release sources considered, calculation methodology for emissions and EFs varied by source should the approach vary from Equation H-3.1.2-1. Calculation methodology by air release is provided in Sections 3.1.2.1 through 3.1.2.11. Relevant EFs by activity and phase are summarized in Section 3.1.3. Data for the air release inventory were retrieved from preliminary design specifications, reports, and email correspondence. It was assumed that diesel used for the Project will comply with **Sulphur in Diesel Fuel Regulations**, which stipulate that sulfur content in diesel will not exceed 0.1%.

Equation H-3.1.2-1: General Emissions

$$E\left(\frac{\text{tonnes}}{\text{year}}\right) = A \times EF \times \text{Conversion Factors}$$

where: E = emissions

A = activity rate (e.g., fuel consumption, electricity use)

EF = emission factor

3.1.2.1 Blasting

Approximately 200,000 m^3 of rock will be required to be blasted for construction of the Argentia Wind Facility. It was assumed that approximately 1.2 to 1.4 kilograms (kg) of pumped emulsion explosives will be required per m^3 of rock, thus the total explosive requirement for Argentia Wind Facility construction will be 250,000 kg. Blasting is not anticipated for construction of the Argentia Green Fuels Facility. It was assumed that the horizontal area of each blast will be 500 square metres (m^2), and that blasting will occur approximately once weekly for two years (i.e., 50 blasts per year, 100 blasts total). Emissions were estimated following Equation H-3.1.2-1, where the activity rate for PM is based on the number of blasts per year, while for other air releases, it is based on the quantity of explosives used (tonnes per year).

To facilitate calculation of air releases from blasting, PM EFs were calculated according to horizontal area of each blast (i.e., 500 m^2) (Environment and Climate Change Canada, 2017). EF calculation methodology for TSP, PM_{10} and $PM_{2.5}$ is provided in Equation H-3.1.2-2 (A-C).

Equation H-3.1.2-2 (A-C): Blasting PM EFs

(A) $EF_{TSP} = 0.00022(A)^{1.5}$

(B) $EF_{PM10} = \left(0.00022(A)^{1.5}\right) \times 0.52$

(C) $EF_{PM2.5} = (0.00022(A)^{1.5}) \times 0.03$

where: EF = emission factor for corresponding PM (kg/blast)
A = horizontal area (m^2) of the conical stockpile

3.1.2.2 Stockpile Erosion

Materials for construction of the Argentia Wind Facility and Argentia Green Fuels Facility will be stockpiled over the two-year construction period. Stockpiles will be subject to wind erosion, thereby resulting in the potential to emit fugitive PM emissions. It was assumed that stockpiles will be composed of gravel, conical and not exceed a pile height of 10 metres (m). Approximately 142,740 m^3 of material will be required for the Argentia Wind Facility while 5,831 m^3 will be required for the Argentia Green Fuels Facility during Project construction. Only PM will be released as a result of stockpile erosion. Per NPRI guidance, annual wind erosion emissions from stockpile surfaces were estimated using custom EFs using methodology outlined in Equation H-3.1.2-3 (Environment and Climate Change Canada, 2023h).

Equation H-3.1.2-3: Wind Erosion PM EFs

$$EF = 1.12 \times 10^{-4} \times J \times 1.7 \times \left(\frac{s}{1.5}\right) \times 365 \times \left(\frac{365 - P}{235}\right) \times \left(\frac{I}{15}\right)$$

where: EF = emission factor for corresponding PM (kg/m^2)
J = particulate aerodynamic factor

- $J_{TSP} = 1.0$
- $J_{PM10} = 0.5$
- $J_{PM2.5} = 0.075$

s = average silt loading of storage pile in percent (%)
P = number of days during the year with at least 0.254 mm of total precipitation (sum of total rainfall and the water equivalent of the total snowfall in mm) and days with snow on the ground.

I = percentage of time with unobstructed wind speed > 19.3 km·hr^{-1} in percent (%).

The average silt loading of storage piles was assumed to be 0.5% (limestone) (Mojave Desert Air Quality Management District, 2013). Values of P and I were obtained from historical weather data collected at the ECCC meteorological station in Argentia in 2023, as well as Canadian Climate Normals (Government of Canada, 2023b, 2023a).

3.1.2.3 Material Handling and Transfers

Handling and transferring of stockpiled materials will generate PM emissions during the construction period. It was assumed that each stockpile will contain 1,545 tonnes of gravel based on stockpile assumptions provided in Section 3.1.2.2. Per NPRI guidance, annual material handling and transfer emissions were estimated using custom EFs with methodology outlined in Equation H-3.1.2-4 (Environment and Climate Change Canada, 2017).

Equation H-3.1.2-4: Material Handling and Transfers PM EFs

$$EF = k \times (0.0016) \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where: EF = emission factor for corresponding PM (kg/tonne)

k = particle size multiplier

- k_{TSP} = 0.74
- k_{PM10} = 0.35
- $k_{PM2.5}$ = 0.053

U = mean wind speed (in metres per second, m·s^{-1})

M = material moisture content (%)

The mean wind speed was obtained from historical weather data collected at the ECCC meteorological station in Argentia in 2023 (Government of Canada, 2023). The material moisture content for crushed limestone (0.7%) for the stone quarrying and processing industry was used in calculations.

3.1.2.4 Crushing and Screening

Air release estimates due to crushing and screening were calculated using Equation H-3.1.2-1, where activity is annual throughput. As a conservative estimate, it was assumed that all required material (i.e., gravel) for the construction period will be crushed and screened on-site. The moisture content of crushed / screened materials will be less than 1.5%, thus emissions were assumed to be uncontrolled (Environment and Climate Change Canada, 2017).

3.1.2.5 Laydown Areas

Laydown areas will be required during construction of the Argentia Wind Facility and Argentia Green Fuels Facility. Two laydown areas will be required for the Argentia Wind Facility: (1) Port Laydown & Storage Area (60,000 m^2); and (2) Backlands Laydown (50,000 m^2). There will be four laydown areas during construction of the Argentia Green Fuels Facility: each covering an area of 2,400 m^2, 500 m^2, 840 m^2, and 3,000 m^2 respectively. Laydown areas are essentially flat stockpiles and will be subject to wind erosion. As such, custom EFs were calculated as per Equation H-3.1.2-3 (Section 3.1.2.2).

3.1.2.6 Unpaved Roads

Project roads, particularly in the Argentia Wind Facility, will be unpaved and thus fugitive dust (i.e., PM) will be emitted in the presence of vehicular traffic. Per NPRI guidance, annual unpaved road PM releases were estimated using custom EFs based on the methodology outlined in Equation H-3.1.2-5 (Environment and Climate Change Canada, 2017). EFs were calculated in units of kg per vehicle kilometres travelled (VKT). VKT was calculated using road segment distances, number of turbines accessed per segment, and estimates of annual trips required during Project operation and maintenance.

Equation H-3.1.2-5: Unpaved Road PM EFs

$$EF = k \left(\frac{s}{12} \right)^{a} \times \left(\frac{W}{2.72} \right)^{b}$$

where: EF = emission factor for corresponding PM (kg/VKT)

s = surface material silt content (8.5%)

W = mean vehicle weight (tonnes)

k, a, b = numerical constants [Table H-3.1.2-1]

Table H-3.1.2-1 Numerical Constants: Unpaved Road PM EF Calculations.

Species	Units	TSP	PM_{10}	$PM_{2.5}$
k	kg/VKT	1.381	0.423	0.042
a	-	0.700	0.900	0.900
b	-	0.450	0.450	0.450

Releases of PM associated with vehicular traffic on unpaved roads were estimated using methodology in Equation H-3.1.2-6. Equation H-3.1.2-6 considers control efficiency associated with dust control methods such as watering twice a day, watering more than twice a day, and chemical suppressants. It was assumed that unpaved roads will be watered twice per day, which provides a control efficiency of 55%, and a resulting control adjustment of 45%.

Equation H-3.1.2-6: Unpaved Road PM Emissions

$$E = EF\left(\frac{kg}{VKT}\right) \times VKT \times (1 - CE) \times \left(\left(\frac{\text{Operational Days - Days with Snow or Rain}}{\text{Operational Days}}\right) \times 100\right) \times \text{Conversion Factor}$$

where: E = emissions (tonnes per year)

VKT = vehicle kilometres travelled (km)

CE = control efficiency

Conversion Factor = kg to tonnes

3.1.2.7 Mobile Equipment

Air releases (NOx, CO, TSP, SO_2) will be generated from fossil fuel combustion (i.e., diesel) in mobile equipment during construction as well as operation and maintenance of the Project. Estimates of air releases from mobile equipment were developed using equipment lists provided in preliminary design specifications, reports, and email correspondence, and EFs according to engine tier and horsepower (hp). It was assumed that all engines in mobile equipment will be Tier 4, and that mobile equipment usage is evenly distributed across the entire construction period (i.e., two years) for the Argentia Wind Facility and Argentia Green Fuels Facility. Emissions were estimated using methodology in Equation H-3.1.2-7.

Equation H-3.1.2-7: Mobile Equipment Emissions

$$E = EF\left(\frac{g}{hp \cdot hr}\right) \times \text{Engine power (hp)} \times \text{Usage (hours)} \times \text{\# of units} \times \text{Conversion Factor}$$

where: E = emissions (tonnes per year)

EF = emission factor (grams (g) per hp·hour (hr))

Conversion Factor = g to tonnes

3.1.2.8 Stationary Combustion

Fossil fuel combustion in stationary equipment will generate air releases during Project construction. Estimates of air releases from mobile equipment were developed using fuel consumption estimates and equipment lists provided in preliminary design specifications, reports, and email correspondence, and EFs for diesel fuel generators up to 600 hp (Environment and Climate Change Canada, 2023d). Air releases, assumed to be evenly distributed across the two-year construction period, were estimated using Equation H-3.1.2-1.

3.1.2.9 Emergency Generator

Operation of the emergency generator will release air emissions should backup power be required. It was assumed that a single diesel-powered generator will be required to provide approximately 8 MW of emergency power for a maximum of 96 hours per year (i.e., 24 hours per quarter) over the operational lifetime of the Project. Air releases were estimated using Equation H-3.1.2-1 and EFs for large stationary diesel engines (> 600 hp) (Environment and Climate Change Canada, 2023f).

3.1.2.10 Flare Stacks

The Argentia Green Fuels Facility will be equipped with two flares: one for the ammonia plant (the "process flare") and one for the ammonia storage tank (the "tank flare"). Both flares will have continuously lit pilots using propane, ready to combust intermittent releases of gaseous streams in the event of process upsets. Air releases were estimated for continuous pilots and intermittent releases, as detailed further below.

Continuous Pilots

The combustion of propane in flare pilots will release thermal NOx, PM, CO, and residual propane. Fuel NOx releases are not anticipated since propane does not contain nitrogen. It was assumed that the volumetric flow rates of pilot will be 3% of the flare flow rate, as per preliminary design specifications and the United States Environmental Protection Agency's (US EPA) 'Parameters for Properly Designed and Operated Flares' (US EPA Office of Air Quality Planning and Standards (OAQPS), 2012). Emissions from continuous pilots were estimated per methodology outlined in Equation H-3.1.2-8 through H-3.1.2-10.

Equation H-3.1.2-8: Continuous Pilot NOx (thermal) and CO Emissions

$$E = \text{Flow}\left(\frac{\text{kg}}{\text{hr}}\right) \times \text{HHV}\left(\frac{\text{MJ}}{\text{kg}}\right) \times \text{EF}\left(\frac{\text{lb}}{\text{Btu}}\right) \times \text{Usage}\left(\frac{\text{hr}}{\text{yr}}\right) \times \text{Conversion Factors}$$

where: E = emissions (tonnes per year)
Flow = volumetric flow rate of pilot (kg per hr)
HHV = high heating value of pilot fuel (Megajoules (MJ) per kg))
EF = emission factor (pounds (lb) per British thermal unit (Btu))
Usage = annual operational hours (i.e., 8,760 hours)
Conversion factors = for lb to kg, MJ to Btu, and kg to tonnes.

Equation H-3.1.2-9: Continuous Pilot PM Emissions

$$E = \text{Flow}\left(\frac{kg}{hr}\right) \times \frac{1}{\rho_{fuel}}\left(\frac{m^3}{kg}\right) \times \text{EF}\left(\frac{kg}{10^3\ m^3\ fuel}\right) \times \text{Usage}\left(\frac{hr}{yr}\right) \times \text{Conversion Factor}$$

where: E = emissions (tonnes per year)

Flow = volumetric flow rate of pilot (kg per hr)

ρ_{fuel} = density of pilot fuel (kg per m^3)

EF = emission factor (kg per m^3 of pilot fuel)

Usage = annual operational hours (i.e., 8,760 hours)

Conversion factor = kg to tonnes.

Equation H-3.1.2-10: Continuous Pilot Residual Propane Emissions

$$E = \text{Flow}\left(\frac{kg}{hr}\right) \times (1 - DE) \times \text{Usage}\left(\frac{hr}{yr}\right) \times \text{Conversion Factor}$$

where: E = emissions (tonnes per year)

Flow = volumetric flow rate of pilot (kg per hr)

Usage = annual operational hours (i.e., 8,760 hours)

Conversion factors = kg to tonnes.

The destruction efficiency (DE) of the flare was assumed to be 98%, thus 0.98 was used in Equation H-3.1.2-10 (Texas Commission on Environmental Quality, 2023).

Intermittent Releases

The combustion of intermittently released ammonia (NH_3) will emit thermal and fuel NOx as well as residual NH_3. Thermal and fuel NOx were summed to estimate emissions of total NOx during intermittent releases. It was conservatively assumed that one hour worth of production will be released over a one-hour period annually (i.e., 16,667 kg per hour). Emissions from intermittent releases were estimated based on the methodology outlined in Equation H-3.1.2-11 and H-3.1.2-12.

Equation H-3.1.2-11: NOx Emissions from Intermittent Releases

E = [Thermal NOx] + [Fuel NOx]

$$E = \left[\text{Flow}\left(\frac{kg}{hr}\right) \times \text{HHV}\left(\frac{MJ}{kg}\right) \times \text{EF}\left(\frac{lb}{Btu}\right) \times \text{Usage}\left(\frac{hr}{yr}\right) \times \text{Conversion Factors}\right] + \left[\text{Flow}\left(\frac{kg}{hr}\right) \times \text{EF}\left(\frac{kg\ NO_x}{kg\ NH_3}\right) \times \text{Usage}\left(\frac{hr}{yr}\right) \times \text{Conversion Factors}\right]$$

where: E = emissions (tonnes per year)

Flow = volumetric flow rate of pilot (kg per hr)

EF = emission factor (thermal: lb per Btu; fuel: kg NOx per kg NH_3)

Usage = annual operational hours (i.e., 8,760 hours)

Conversion factors = for lb to kg, MJ to Btu, and kg to tonnes.

3.1.2.11 Marine Transport

The end product will be transported to the global market by marine shipping routes. Per preliminary design specifications, the end product will be shipped in a small to medium ammonia ship carrier, with offtake occurring once monthly for the 30-year operational lifetime of the Project. Based on offtake frequency, the ammonia carrier should have a capacity of approximately 20,000 m^3. It was assumed that the Clipper Eirene, a liquified petroleum gas (LPG) tanker with 21,220 m^3 NH_3 capacity will be used to transport end product to the global market (Solvag ASA, 1998). Air releases associated with marine transport will be generated when the Clipper Eirene maneuvers to the loading facility, as well as when the loading arms are filling the tanker (referred to as hotelling). It was assumed that maneuvering will take one hour per month and hotelling will take 15 hours. The main and auxiliary engines will be operational during maneuvering, while only the auxiliary engine will be operational during hotelling. The boiler unit on the Clipper Eirene will be operational for both maneuvering and hotelling. Air releases associated with marine transport will be the sum of emissions from the main and auxiliary engines (i.e., maneuvering and hotelling), as well as boilers. Emissions from marine transport were estimated using methodology outlined in Equation H-3.1.2-12 and H-3.1.2-13.

Equation H-3.1.2-12: Emissions from Maneuvering and Hotelling

$$E = \text{Engine Power (kW)} \times \text{Load Factor (\%)} \times EF \times \text{Usage} \left(\frac{hr}{yr}\right) \times \text{Conversion Factor}$$

where: E = emissions (tonnes per year)

Engine Power = power of engine (kilowatts (kW))

Load Factor = engine load factor during activity (i.e., maneuvering or hotelling)

EF = emission factor (g or kg per kilowatt hour (kWh))

Usage = time per mode (i.e., 12 hours maneuvering; 180 hours hotelling)

Conversion factor = g to tonnes

Equation H-3.1.2-13: Emissions from Boilers

$$E = \text{Fuel} \left(\frac{m^3}{hr}\right) \times EF \left(\frac{kg}{m^3}\right) \times \text{Usage} \left(\frac{hr}{yr}\right) \times \text{Conversion Factors}$$

where: E = emissions (tonnes per year)

Fuel = fuel consumption (m^3 per hour)

EF = emission factor (kg per m^3)
Usage = time per mode (i.e., 12 hours maneuvering; 180 hours hotelling)
Conversion factor = kg to tonnes.

3.1.3 Air Release Inventory Emission Factors

The emission factors used, and in some instances generated, for the calculations detailed in Section 3.1.2 are provided in Table H-3.1.3-1 (NOx, CO, SO_2 and PM) and Table H-3.1.3-2 (speciated organics and PAHs).

Table H-3.1.3-1 Air Release Inventory Emission Factors: NOx, CO, SO_2 and PM.

Activity (Phase)	Units	Emission Factors						Source
		NOx	CO	SO_2	TSP	PM_{10}	$PM_{2.5}$	
Blasting (Construction)								
Fossil-fuel based explosive use	$\frac{kg}{Mg}$	8	34	1	-	-	-	(Environment and Climate Change Canada, 2017)
	$\frac{kg}{Blast}$	-	-	-	2.46	1.28	0.07	
Wind Erosion (Construction)								
Stockpiles & Laydown Areas	$\frac{kg}{m^2}$	-	-	-	4.93E-02	2.46E-02	3.70E-03	(Environment and Climate Change Canada, 2023h; Mojave Desert Air Quality Management District, 2013)
Aggregate Handling & Transfers (Construction)								
Handling and transfer of stockpiled material	$\frac{kg}{tonne}$	-	-	-	0.02258	0.01068	0.00162	(Environment and Climate Change Canada, 2023e)
Crushing & Screening (Construction)								
Primary Crushing (Uncontrolled)	$\frac{kg}{tonne}$	-	-	-	0.0027	0.0012	0.0006	(Environment and Climate Change Canada, 2017)
Secondary Crushing (Uncontrolled)		-	-	-	0.0027	0.0012	0.0006	
Screening (Uncontrolled)		-	-	-	0.0125	0.0043	-	
Conveyor Transfer Point		-	-	-	0.0015	0.00055	-	
Unpaved Roads (Construction)								
Wind turbine component transportation	$\frac{kg}{VKT}$				3.642	1.043	0.104	(Environment and Climate Change Canada, 2024)
Stationary Combustion (Construction)								
Diesel fuel generator (≤600 hp)	$\frac{kg}{m^3}$	72.400	15.600	4.761	5.089	5.089	5.089	(Environment and Climate Change Canada, 2023d)
NOTES kg=kilogram; Mg=megagram; m^2=square metre; VKT=vehicle kilometre travelled; m^3=cubic metre; hp=horsepower; hr=hour; BTU=British thermal unit; kWh=kilowatt hour								
Mobile Equipment (Construction & Operation)								
≥75 to <100 hp engine	$\frac{g}{hp \cdot hr}$	0.3	-	0.00205	0.01	-	-	(United States Environmental Protection Agency, 2000, 2018)
≥100 to <175 hp engine		0.3	3.7	0.00205	0.01	-	-	

≥175 to <300 hp engine		0.3	2.6	0.00205	0.01	-	-	
≥300 to <600 hp engine		0.3	2.6	0.00205	0.01	-	-	
≥600 to <750 hp engine		0.3	2.6	0.004045	0.01	-	-	(United States Environmental Protection Agency, 1996, 2018)
≥750 hp engine		2.6	2.6	0.004045	0.03	-	-	
Stationary Combustion (Operation)								
Large Stationary Diesel Engines (>600 hp)	$\frac{kg}{m^3}$	52.532	13.954	1.658	1.018	0.814	0.786	(Environment and Climate Change Canada, 2023f)
Flare Stacks (Operation)								
Operation of continuous pilots and intermittent releases	$\frac{lb}{10^6 Btu}$	0.068 [1]	0.5496	-	-	-	-	(Texas Commission on Environmental Quality, 2023)
	$\frac{kg}{10^3 m^3 \text{ fuel}}$	-	-	-	0.82312	-	-	(McEwen & Johnson, 2012)
	$\frac{kg\ NO_x}{kg\ NH_3}$	0.005 [2]	-	-	-	-	-	(Texas Commission on Environmental Quality, 2021)
Marine Transport (Operation)								
Maneuvering - Main Engine	$\frac{g}{kWh}$	14.4	1.40	0.36	0.19	0.19	0.14	(ICF International, 2009)
Maneuvering - Auxiliary Engine		9.7	1.1	0.42	0.18	0.18	0.17	
Hotelling - Auxiliary Engine		9.7	1.1	0.42	0.18	0.18	0.17	
Boiler	$\frac{kg}{m^3}$	2.4	0.6	1.7	0.12	0.12	0.03	(United States Environmental Protection Agency, 2010)

NOTES

kg=kilogram; Mg=megagram; m^2=square meter; VKT=vehicle kilometre travelled; m^3=cubic metre; hp=horsepower; hr=hour; Btu=British thermal unit; kWh=kilowatt hour

[1] Thermal NOx calculation

[2] Fuel NOx calculation

Table H-3.1.3-2 Air Release Inventory Emission Factors: Speciated Organics and PAHs.

Air Contaminant	Emission Factors		
	Stationary Combustion (kg/m^3)		*Marine Transport – Boilers (g/kWh)*
	Construction [1]	**Operation [2]**	**Operation [3]**
1,3-Butadiene	3.21E-04	-	-
Acenaphthene	1.17E-05	7.68E-05	7.26E-09
Acenaphthylene	4.15E-05	1.52E-04	1.43E-08
Acetaldehyde	1.26E-02	4.14E-04	3.91E-08
Acrolein	7.59E-04	1.29E-04	1.22E-08
Anthracene	3.07E-05	2.02E-05	1.91E-09
Benz[a]anthracene	2.76E-05	1.02E-05	9.65E-10
Benzene	1.53E-02	1.27E-02	1.2E-06
Benzo[a]pyrene	1.54E-06	2.11E-06	3.99E-10
Benzo[b] fluoranthene	8.13E-07	1.82E-05	1.72E-09
Benzo[ghi]perylene	4.01E-06	4.56E-06	8.62E-10
Benzo[k]fluoranthene	1.27E-06	1.79E-06	3.38E-10
Chrysene	5.79E-06	2.51E-05	2.37E-09
Dibenz[a,h]anthracene	4.79E-06	2.84E-06	5.37E-10
Fluoranthene	1.25E-04	6.62E-05	6.25E-09
Fluorene	4.79E-04	2.10E-04	1.99E-08
Formaldehyde	1.94E-02	1.30E-03	1.22E-07
Inden[1,2,3-cd]pyrene	3.08E-06	3.40E-06	6.42E-10
Naphthalene	1.39E-03	2.13E-03	2.02E-07
Phenanthrene	4.83E-04	6.70E-04	6.33E-08
Propylene	4.24E-02	4.58E-02	4.33E-06
Pyrene	7.85E-05	6.09E-05	5.75E-09
Toluene	6.71E-03	4.61E-03	4.36E-07
Total PAHs	-	-	3.29E-07
Total VOCs	5.91E+00	1.34E+00	-
Xylene (all isomers)	4.68E-03	3.17E-03	2.99E-07

[1] Diesel fuel generator (up to 600 hp) (Environment and Climate Change Canada, 2023d)
[2] Large Stationary Diesel Engines (>600 hp) (Environment and Climate Change Canada, 2023f)
[3] Large Uncontrolled Stationary Diesel Engines (United States Environmental Protection Agency, 1996)

3.2 Air Release Inventory Results

Annual Project construction and operation air release estimates are presented in Table H-3.2-1. Air contaminants that were estimated to be less than 0.1 tonnes per year across all sources were omitted from Table H-3.2-1 and provided in Appendix H.3. Calculation details are provided in Appendix H.4.

The predominant air contaminant estimated to be released during Project construction is CO at 121.306 tonnes per year, the majority of which was estimated to arise from fossil fuel combustion in mobile equipment. Other notable emissions estimated to arise from fossil fuel combustion will be in the form of SO_2 (40.745 tonnes per year) and NOx (28.080 tonnes per year).

Project operation emissions are estimated to be significantly lower than construction emissions. NOx is estimated to be the predominant air contaminant released. Since the estimate of NOx is driven by emergency generator use, actual air releases during Project operation may be significantly less. It is unlikely that the emergency generator will be used consistently throughout the year, if at all, thus annual emissions for emergency generator use are likely an overestimation.

Table H-3.2-1 Annual Air Release Estimate Summary.

Phase	Source	Annual Air Releases (tonnes)								
		CO	SO_2	NOx	VOCs (total)	TSP	PM_{10}	$PM_{2.5}$	Propane	NH_3
Construction	Blasting	4.250	0.125	1.000		0.123	0.064	0.004		
	Stockpile Erosion					1.568	0.784	0.118		
	Aggregate Handling and Transfers					2.494	1.180	0.179		
	Crushing and Screening					2.126	0.794	0.131		
	Laydown Areas					5.754	2.877	0.432		
	Unpaved Roads					2.254	0.645	0.065		
	Mobile Equipment	114.204	39.749	13.842		0.426				
	Stationary Combustion	2.852	0.871	13.238	1.081	0.931	0.931	0.931		
	Total Annual Construction	**121.306**	**40.745**	**28.080**	**1.081**	**15.676**	**7.275**	**1.860**		
Operation	Emergency Generator	4.287	0.509	16.138	0.413	0.313	0.250	0.242		
	Flare Stacks	0.767		0.283		0.031			1.299	0.667
	Marine Transport	0.248	0.106	2.171			0.040	0.037		
	Mobile Equipment	1.885	0.676	0.218		0.007				
	Total Annual Operation	**7.187**	**1.291**	**18.810**	**0.413**	**0.351**	**0.290**	**0.279**	**1.299**	**0.667**

4.0 Air Dispersion Modelling

The CALPUFF dispersion modelling system ("the modelling system" or "CALPUFF") was used to predict maximum ground level concentrations of air contaminants during operation of the Argentia Green Fuels Facility. The modelling system is comprised of three main components: CALMET, CALPUFF, and CALPOST. CALMET is a meteorological model that processes meteorological and geophysical data to develop three-dimensional meteorological fields of wind speed, wind direction, temperature, and other meteorological variables. CALPUFF is a non-steady state Gaussian puff dispersion model that incorporates simple chemical transformations, coastal effects, overwater transport, building downwash and complex terrain. In conjunction with meteorological fields developed by CALMET, CALPUFF simulates the effect of time- and space-varying meteorological conditions on air contaminant transportation and removal. CALPOST, a post processor model, reports concentrations of air contaminants of interest using emission rates and CALPUFF results. CALPUFF was selected over other modelling systems (i.e., AERMOD) since it has better algorithms to handle complex terrain, changing weather patterns, and non-steady state scenarios (e.g., coastal interaction effects) that commonly occur in the province. Furthermore, CALPUFF is the preferred model by NL DECC.

4.1 Air Dispersion Modelling Methodology

4.1.1 CALMET

Meteorological modelling is an essential component of air dispersion modelling, mainly due to turbulence. The dispersion of atmospheric emissions is governed by turbulence that exists in the mixing layer. Both thermal (e.g., vertical temperature stratification) and mechanical effects (e.g., topography, surface roughness) can impact turbulence levels in the mixing layer. The extent of emission diffusion in the atmosphere is dictated by the height of the mixing layer (i.e., the mixed layer of air in contact with the ground surface).

The CALMET model ("CALMET") was initialized using three-dimensional (3-D) Weather Research Forecasting (WRF) modelled data at various levels of the atmosphere. WRF data incorporates surface meteorological parameters (i.e., wind speed and direction, temperature, cloud cover, ceiling height, pressure, relative humidity, precipitation rate) and upper air meteorological parameters (wind speed and direction, temperature, pressure, altitude) required by CALPUFF to predict plume dispersion and transport. Initialization was performed to generate an initial guess of meteorological conditions within the modelling domain prior to introducing terrain and geophysical surface characteristics (i.e., albedo, Bowen ratio, surface roughness).

The latest version of CALMET (version 6.5.0) was used for this study. The initial guess of meteorological conditions within the modelling domain were generated using WRF data purchased from Lakes Environmental (Environmental, 2024). WRF data can be supplemented with surface meteorological data to refine site-specific meteorology for use in the modelling system. Due to the sporadic nature of measurements collected at the meteorological station in Argentia, only WRF data were used. Ready for input to CALMET, the purchased WRF data covered a three-year period (2021-2023) to align with modelling requirements for environmental assessment as per the NL DECC Guideline for Plume Dispersion Modelling (Government of Newfoundland and Labrador Department of Environment and Conservation, 2012). The WRF data consisted of a 4 km resolution, 50 by 50 km grid centered on the Argentia Green Fuels Facility to allow for sufficient overlap with the LAA/RAA. A horizontal grid spacing of 500 m was selected for CALMET modelling. The WRF data contained 35 vertical levels of meteorological data, which was converted to 10 vertical layers by CALMET for model initialization. Land use data was obtained from the NL DECC, who derived a land use dataset from the Canadian Forest Service's Earth Observation for Sustainable Development of Forests (EOSD) to be compatible with the US Geological Survey Land Use and Land Cover Classification System. Terrain data was obtained from the Natural Resources Canada's (NRCan) Canadian Digital Elevation Model (CDEM).

The CALMET model predicted winds at the Argentia Green Fuels Facility between 2021 and 2023. The wind rose generated by CALMET (Figure H-4.1.1-1) indicates that winds were predicted to occur most frequently from the southwest direction, with less dominant occurrences from the southeast. The larger proportion of strong wind speeds were predicted to be from the southwest direction.

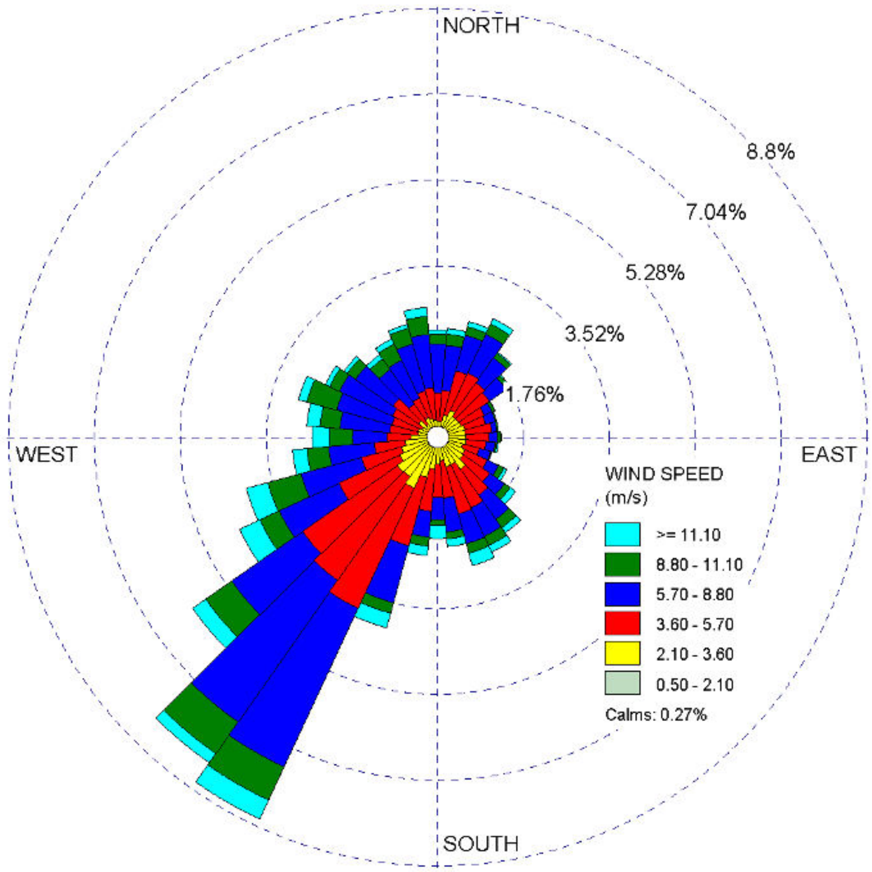

Figure H-4.1.1-1 CALMET Predicted Winds at the Argentia Green Fuels Facility (2021-2023).

Winds predicted by CALMET were compared to those measured in 2023 at the meteorological station in Argentia (Government of Canada, 2023b). The wind rose presented in Figure H-4.1.1-2 shows that wind speeds most frequently occurred from the southeast direction. Predominant wind directions were from the southeast and northwest, with a larger proportion of strong wind speeds occurring from the southeast.

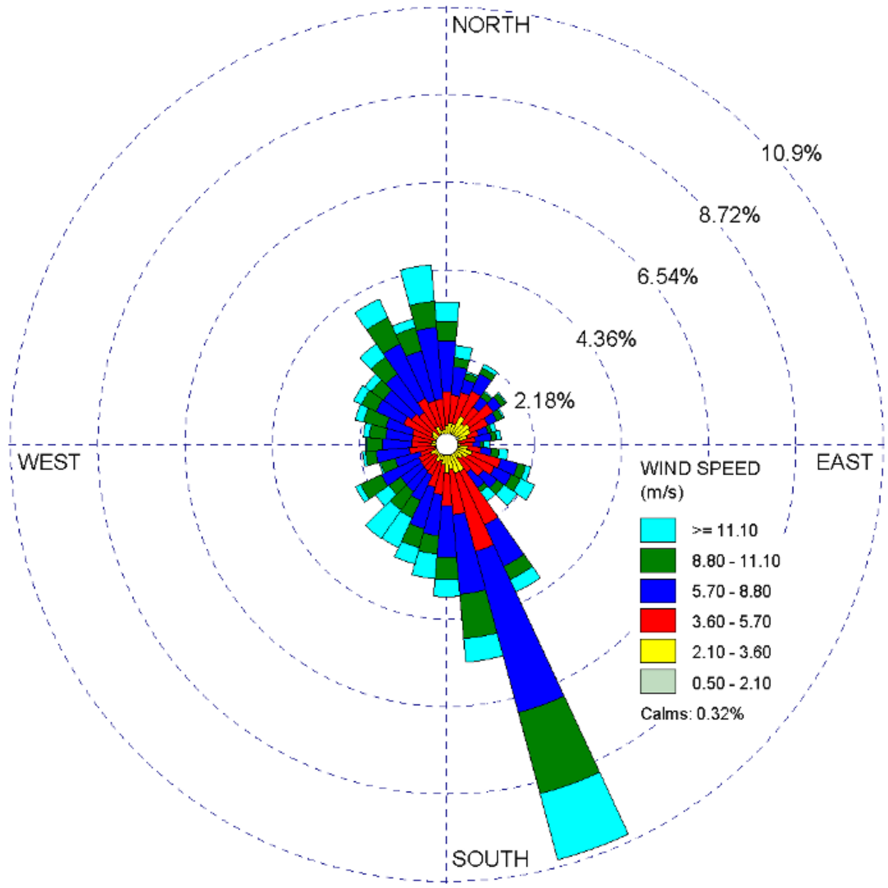

Figure H-4.1.1-2 Winds at the Meteorological Station in Argentia, NL (2023).

Wind speed and direction measured in Argentia in 2023 was partially consistent with that predicted by CALMET. Noted inconsistencies may be attributable to terrain differences and geographical features; the meteorological station site in Argentia is located in a less sheltered area of the Peninsula and at a slightly higher elevation than the Argentia Green Fuels Facility. Additionally, the data collected at the meteorological station in Argentia is for a single year, thus annual variability that may be incorporated in CALMET predictions is not captured.

4.1.2 CALPUFF

The latest version of the CALPUFF dispersion model (version 7.2.1) was used to predict ground-level concentrations of air contaminants anticipated to be released during Project operation. Modelling was conducted to assess annual and daily atmospheric discharges from the Argentia Green Fuels Facility, particularly those associated with emergency generator use, flare stacks, and ammonia ship carrier during offtake at the loading facility (referred to herein as marine transport). Emissions were predicted in relation to ambient air quality in the LAA and RAA during normal operation of the Project. The primary modelling area consisted of a 50 by 50 km area centered on the Argentia Green Fuels Facility. The modelling area was expanded to include discrete receptors in the RAA. To run the CALPUFF model, the following inputs were required:

- Emission rates of air contaminants (Section 4.1.2.1);
- Physical properties (e.g., release height, exit diameter) of emission sources (Section 4.1.2.2);
- Locations, and surrounding buildings and structures, of emission sources (Section 4.1.2.2); and
- Locations of receptors (Section 4.1.2.3).

Additional model inputs and parameters are provided in Section 4.1.2.4.

4.1.2.1 Emission Rates

Air releases were modelled as maximum hourly and daily, as well as annual average emissions to determine resulting maximum ground-level concentrations for the same averaging periods. This approach was used to facilitate comparison with relevant air quality standards (i.e., NL AQS, CAAQS). Furthermore, maximum emission rates were computed to determine the maximum possible concentration over a given hour or day (i.e., 24-hour period). Emission rates were prorated based on the projected operational time for activities occurring less than 24 hours per day. Maximum hourly, maximum daily, and annual average emission rate calculation methods are detailed by activity (i.e., emergency generator, flare stacks, marine transport) below. Emission rates used in CALPUFF are summarized in Appendix H.5. It should be noted that marine transport emissions were not modelled and are thus provided below for illustrative purposes.

Emergency Generator

As detailed in Section 3.1.2.9, it was conservatively assumed that emergency generator use will be limited to 96 hours per year, which equates to one 24-hour period per quarter. As such, maximum daily and hourly emission rates will be equivalent. Daily and hourly emission rates are calculated per methodology in Equation H-4.1.2-1 and H-4.1.2-2. The annual average emission rate was calculated per methodology in Equation H-4.1.2-3.

Equation H-4.1.2-1: Emergency Generator Daily and Hourly Emission Rate

$$ER_{daily,\ hourly} = EF\left(\frac{lb}{MMBtu}\right) \times HIR\left(\frac{MMBtu}{hr}\right) \times \text{Conversion Factors}$$

where: $ER_{daily,\ hourly}$ = daily / hourly emission rate (grams (g) per second (s))

EF = emission factor (pounds (lb) per one million British thermal units (MMBtu))

HIR = heat input rate of emergency generator (MMBtu per hour) [Equation H-4.1.2-2]

Conversion factors = for lb to g, and hr to s.

Equation H-4.1.2-2: Emergency Generator Heat Input Rate

$$HIR = Fuel\left(\frac{m^3}{yr}\right) \times HHV\left(\frac{GJ}{m^3}\right) \times \frac{1}{Usage}\left(\frac{yr}{hr}\right) \times \text{Conversion Factor}$$

where: HIR = heat input rate of emergency generator (MMBtu per hour)

Fuel = fuel consumption (m^3 per hour)

HHV = high heating value for diesel (gigajoules (GJ) per m^3)

Usage = operational hours per year (i.e., 96 hours)

Conversion factor = for GJ to MMBtu

Equation H4.1.2-3: Emergency Generator Annual Average Emission Rate

$$ER_{annual} = ER_{daily,\ hourly}\left(\frac{g}{s}\right) \times \frac{\text{operational time (hours)}}{\text{total time (hours)}}$$

where: ER_{annual} = annual average emission rate (grams (g) per second (s))

$ER_{daily,\ hourly}$ = daily / hourly emission rate (grams (g) per second (s))

Operational time = 96 hours

Total time = 8,760 hours

Flare Stacks

As detailed in Section 3.1.2.10, both flares required for safe and efficient operation of the Argentia Green Fuels Facility will generate emissions from continuous pilots and intermittent releases. Emission rate calculation details follow.

CONTINUOUS PILOTS

Pilots operate continuously, thus maximum hourly and daily, and average annual emission rates will be equivalent. Emission rates were calculated per methodology outlined in Equation H-4.1.2-4 (CO and NOx), H-4.1.2-5 (PM), and H-4.1.2-6 (residual propane).

Equation H-4.1.2-4: Continuous Pilots CO and NOx Emission Rate

$$ER = Flow\left(\frac{kg}{hr}\right) \times HHV\left(\frac{MJ}{kg}\right) \times EF\left(\frac{lb}{10^6\ Btu}\right) \times \text{Conversion Factors}$$

where: ER = daily / hourly / annual average emission rate (g per s)
Flow = flow rate of pilot (kg per hr)
HHV = high heating value for propane (MJ per kg)
EF = emission factor (lb per Btu)
Conversion factors = for MJ to Btu, lb to g, hr to s

Equation H-4.1.2-5: Continuous Pilots PM Emission Rate

$$ER = Flow\left(\frac{kg}{hr}\right) \times \frac{1}{\rho_{fuel}}\left(\frac{m^3}{kg}\right) \times EF\left(\frac{kg}{10^3\ m^3 fuel}\right) \times \text{Conversion Factors}$$

where: ER = daily / hourly / annual average emission rate (g per s)
Flow = flow rate of pilot (kg per hr)
ρ_{fuel} = density of propane (kg per m^3)
EF = emission factor (kg per 10^3 m^3 fuel)
Conversion factors = for kg to g, hr to s

Equation H-4.1.2-6: Continuous Pilots Residual Propane Emission Rate

$$ER = Flow\left(\frac{kg}{hr}\right) \times (1-DE) \times \text{Conversion Factors}$$

where: ER = daily / hourly / annual average emission rate (g per s)
Flow = flow rate of pilot (kg per hr)
DE = destruction efficiency of flare (unitless)
Conversion factors = for kg to g, hr to s

INTERMITTENT RELEASES

Intermittent releases will generate emissions of residual NH_3 and NOx (thermal and fuel). Hourly emission rates for residual NH_3 and NOx were calculated per methodology in Equation H-4.1.2-7 and H-4.1.2-8, respectively. Hourly emission rates were converted to daily and annual emission rates per methodology outlined in Equation H-4.1.2-9 and H-4.1.2-10, respectively.

Equation H-4.1.2-7: Intermittent Releases Hourly Residual NH_3 Emission Rate

$$ER_{hourly\ residual\ NH_3} = Flow\left(\frac{kg}{hr}\right) \times (1\text{-}DE) \times Conversion\ Factors$$

where: ER = hourly emission rate (g per s)
Flow = flow rate of intermittent release (kg per hr)
DE = destruction efficiency of flare (unitless)
Conversion factors = for kg to g, hr to s

Equation H-4.1.2-8: Intermittent Releases Hourly NOx Emission Rate

$$ER_{hourly\ NOx} = Thermal\ NO_x + Fuel\ NO_x$$

$$E = \left[Flow\left(\frac{kg}{hr}\right) \times HHV\left(\frac{MJ}{kg}\right) \times EF\left(\frac{lb}{Btu}\right) \times Conversion\ Factors\right] + \left[Flow\left(\frac{kg}{hr}\right) \times EF\left(\frac{kg\ NO_x}{kg\ NH_3}\right) \times Conversion\ Factors\right]$$

where: ER = hourly emission rate (g per s)
Flow = volumetric flow rate of pilot (kg per hr)
EF = emission factor (thermal: lb per Btu; fuel: kg NOx per kg NH_3)
Conversion factors = for lb to kg, MJ to Btu, kg to tonnes, and hr to s.

Equation H-4.1.2-9: Intermittent Releases Daily NH_3 and NOx Emission Rate

$$ER_{daily} = ER_{hourly} \times \frac{1\ hr}{24\ hr}$$

where: ER_{daily} = daily emission rate (g per s)
ER_{hourly} = hourly emission rate (g per s)

Equation H-4.1.2-10: Intermittent Releases Annual NH_3 and NOx Emission Rate

$$ER_{annual} = ER_{daily} \times \frac{1\ d}{365\ d}$$

where: ER_{annual} = annual emission rate (g per s)
ER_{daily} = daily emission rate (g per s)

Marine Transport

As detailed in Section 3.2.1.11, the end product will be transported to the global market once monthly via marine vessels. Maximum hourly and daily, as well as annual average emission rates were computed for when the marine vessel is at the loading facility. Hourly emission rates for marine transport were calculated per methodology in Equation H-4.1.2-11. Hourly emission rates were converted to daily and annual emission rates per methodology outlined in Equation H-4.1.2-12 and H-4.1.2-13, respectively.

Equation H-4.1.2-11: Marine Transport Hourly Emission Rate

$$ER_{marine\ vessel} = ER_{maneuvering} + ER_{hotelling} + ER_{boilers}$$

$$ER_{hotelling} = \text{Power (kW)} \times \text{Load Factor} \times EF\left(\frac{kg}{kWh}\right) \times \text{Conversion Factors}$$

$$ER_{maneuvering} = \text{Power (kW)} \times \text{Load Factor} \times EF\left(\frac{kg}{kWh}\right) \times \text{Conversion Factors}$$

$$ER_{boilers} = \text{Fuel}\left(\frac{m^3}{hr}\right) \times \text{Load Factor} \times EF\left(\frac{kg}{m^3}\right) \times \text{Conversion Factors}$$

where: ER= emission rate (g per s)

Power = main / auxiliary engine power (kW)

Load Factor = engine load factor during activity (i.e., maneuvering or hotelling)

EF = emission factor (kg per kWh or kg per m^3)

Fuel = fuel consumption (m^3 per hour)

Conversion Factors = hr to s, kg to g.

Equation H-4.1.2-12: Marine Transport Daily Emission Rate

$$ER_{daily} = ER_{hourly} \times \frac{16\ hr}{24\ hr}$$

where: ER_{daily} = daily emission rate (g per s)

ER_{hourly} = hourly emission rate (g per s)

16 hr = sum of hotelling and maneuvering time

Equation H-4.1.2-13: Marine Transport Annual Emission Rate

$$ER_{annual} = ER_{daily} \times \frac{12\ d}{365\ d}$$

where: ER_{annual} = annual emission rate (g per s)

ER_{daily} = daily emission rate (g per s)

4.1.2.2 Emission Source Details

Emission Source Characteristics

Emission source characteristics used to develop model inputs are provided in Table H-4.1.2-1. It was assumed that all releases occurred through vertical stacks.

Table H-4.1.2-1 Emission Source Characteristics.

Activity	Value
Emergency Generator	
Standby Power Requirement (MW)	8
Fuel Type	Diesel
Fuel Sulfur Content (%)	0.1
Annual Operating Hours	96
Flares	
Propane pilot flow rate (m3/hr)	2.18
NH_3 intermittent release (kg)	16,667
Duration of NH_3 intermittent release (hours)	1

Building Profile Input Program

Modelling the dispersion of air contaminants requires the consideration of buildings and structures. The presence of buildings and structures nearby emission sources can affect how air contaminants are dispersed. Building downwash, which occurs when wind flows over and around buildings, can limit plume rise and pull air contaminants towards the ground. This effect was considered in the Building Profile Input Program (BPIP) module of CALPUFF, which allowed for downwash of buildings to be modelled. Figure H-4.1.2-1 illustrates the building layout for the Argentia Green Fuels Facility, which was developed using a preliminary concept plot plan for the Project.

Pattern | Argentia Renewables

FIGURE NUMBER: H - 4.1.2 - 1

FIGURE TITLE: Argentia Green Fuels Facility Building Layout

PROJECT TITLE: Argentia Renewables

COORDINATE SYSTEM: NAD 1983 CSRS UTM Zone 22N

NOTES: The location of proposed project infrastructure is considered preliminary and is subject to change.

PREPARED BY: C. Burke

DATE: 24/07/25

REVIEWED BY:

APPROVED BY:

sem

SEM MAP ID: 238-005-GIS-147-Rev0

4.1.2.3 Receptor Grid

The receptor grid for the model was developed in consideration of the NL DECC Guideline for Plume Dispersion Modelling (Government of Newfoundland and Labrador Department of Environment and Conservation, 2012). Receptor grid spacing used in the model is as follows:

- 20 m spacing along the Project Area boundary;
- 50 m spacing from the centre of the Argentia Green Fuels Facility out to 500 m;
- 100 m spacing from 500 m out to 1,000 m;
- 200 m spacing from 1,000 m out to 2,000 m; and
- 500 m spacing from 2,000 m out to 12,000 m (to ensure coverage of the RAA).

Gridded receptors within the Project Area were removed from the model, thus maximum air contaminant concentrations for comparison with NL AQS and CAAQS were predicted outside of the Project Area. Sensitive receptors (e.g., hospitals, schools, recreational areas, etc.) were also included, as detailed in Table H-4.1.2-2. Modelling was conducted at a flagpole height of 0.0 m.

Table H-4.2.1-2 Sensitive Receptor Locations.

Receptor ID	Easting (m)	Northing (m)	Description
DR001	280777.37	5239322.59	St. Anne's Academy
DR002	275479.26	5236304.15	Laval High School
DR003	275376.92	5236170.49	CNA Placentia
DR004	275709.2	5236406.38	Registered Childcare Centre
DR005	275486.4	5236253.8	Beachside Manor
DR006	275870.3	5235886.2	Lions Club Manor Nursing Home
DR007	275877.29	5235804.02	Placentia Health Centre
DR008	274569.84	5240135.39	Sunset RV Park
DR009	275262.89	5235757.83	Unity Parc Arena
DR010	274680.64	5237733.03	Freshwater Skate Park
DR011	275420.54	5234650.16	Regatta Grounds
DR012	275702.21	5236088.86	Wayne John Searle Memorial Recreation Complex
DR013	275702.21	5236088.86	William Hatfield Memorial Ball Field
DR014	281009.53	5238892.11	William Hogan Ball Field
DR015	280854.55	5238836.67	Jeff Jones Memorial Soccer Pitch
DR016	276059.75	5238106.36	Coalyard Playground
DR017	277212.15	5238564.24	Ferndale Veterans' Park Playground
DR018	276130.99	5236611.84	Mount Pleasant Playground
DR019	281072.99	5239079.79	William Hynes Memorial Playground
DR020	276237.63	5236168.39	Great Beach Boardwalk
DR021	284146.9	5243360.19	Fox Harbour Trail & Park
DR022	275162.53	5237333.81	Castle Hill National Historic Site
DR023	276068.84	5235969.58	Mount Carmel RC Cemetery

DR024	280219.25	5244969.59	Fox Harbour Community Center
DR025	279487.28	5244151.69	Fox Harbour Cemetery
DR026	280204.4	5239263.57	Our Lady of Angels Parish & Cemetery
DR027	274369.45	5237592.22	Freshwater Cemetery

4.1.2.4 Additional Model Inputs and Parameters

Conversion of Oxides of Nitrogen to Nitrogen Dioxide

The ozone limiting method (OLM) was used to facilitate the prediction of ground level NO_2, the primary contaminant of concern of NOx (predominantly nitrogen oxide (NO) and NO_2). Since guidelines (i.e., NL AQS, CAAQS) only exist for NO_2, the conversion of NOx to NO_2 must be estimated for comparison purposes. The conversion can be estimated using the OLM since the formation of NO_2 is driven by ambient levels of ozone (O_3) in the atmosphere. This approach facilitates the prediction of ground-level concentrations based on the model results for NOx (i.e., the species for which emission rates were developed). The ozone concentrations used in the OLM are based on hourly concentrations measured at the Mount Pearl NAPS station between 2020 and 2022 (Environment and Climate Change Canada, 2023g). Concentrations of ground-level NO_2 were determined using the relationship identified in the Alberta Air Quality Model Guidance (Government of Alberta, 2021), which indicates that if the concentration of O_3 is greater than 0.8 times the concentration of NOx, then the concentrations of NO_2 and NOx are equal. Otherwise, the following methodology must be used: NO_2 concentration = O_3 concentration + 0.2 × NOx concentration. Values of 0.8 and 0.2 were derived from the in-stack ratio (ISR) for diesel power generating units (Government of Newfoundland and Labrador Department of Environment and Conservation, 2012). The ISR for diesel power generating units is 0.2, and the value of 0.8 is derived by subtracting the ISR from 1, as per the Alberta Air Quality Model Guidance (Government of Alberta, 2021).

Removal of Meteorological Anomalies

To ensure comparison with NL AQS and mitigation of model over-prediction, meteorological anomalies were removed per guidance developed by the NL Department of Environment and Conservation (now NL DECC) to determine compliance with ambient air quality standards (Newfoundland and Labrador Department of Environment and Conservation, 2012). Owing to overpredictions due to adverse meteorological conditions, some of the maximum modelled values at each receptor can be removed. As such, modelled impacts are based on the:

- 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; and
- 2nd highest level at any given receptor for a 24-hour averaging period.

4.2 Air Dispersion Modelling Results

CALPUFF was used to assess cumulative effects of the Project by predicting ground level concentrations of air contaminants of concern relative to background concentrations. This approach allowed for consideration of ambient air quality in addition to air releases generated by operation and maintenance of the Project. Concentrations of air contaminants processed to statistical metrics required by the CAAQS in the Atmospheric Environment Baseline Study (Appendix A) were considered to be representative background concentrations in the Project Area. Background concentrations were only available for SO_2, NO_2, CO, $PM_{2.5}$, and PM_{10} as they were obtained from monitoring data. Since TSP is not measured, it was assumed that background concentrations of TSP are equivalent to PM_{10} concentrations. Additionally, it was assumed that background concentrations of all other air contaminants of interest were negligible. For NO_2, CO, $PM_{2.5}$, and PM_{10}, 1-hour background concentrations used in dispersion modelling were based on the 90^{th} percentile of 1-hour average concentrations. The 24-hour background concentrations were maximum 24-hour concentrations excluding hourly values greater than the 90^{th} percentile. A different approach was used for CO, which has an 8-hour averaging period. The 8-hour CO background concentration is the maximum 8-hour rolling average following data refinement to exclude potentially anomalous values. This approach provides a more stable, representative background concentration without being skewed by extreme short-term spikes. Data refinement was conducted by removing values greater than the 90^{th} percentile of the 3-hour rolling average. The 3-hour rolling average captures peak pollution periods over a short duration that may not otherwise be detected in the 8-hour rolling average. The background concentration for annual average, where required, is the maximum annual average. Background concentrations used in dispersion modelling are provided in Table H-4.2-1 and H-4.2-2.

Table H-4.2-1 outlines results of air dispersion modelling (i.e., maximum predicted ground level concentrations) at the Argentia Green Fuels Facility boundary (i.e., fenceline), while Table H-4.2-2 presents results at the nearest sensitive receptor, Sunset RV Park. Predicted plus (+) background concentrations were compared to NL AQS and CAAQS, and the percentage of NL AQS were also computed. Air contaminants that do not have NL AQS guidelines or have negligible emission rates were omitted from modelling. Per results provided in Table H-4.2-1 and H-4.2-2, $PM_{2.5}$ was the only air contaminant with maximum ground level concentrations (annual) greater than 50% of the NL AQS. Results from air dispersion modelling are considered conservative, as estimates were based on assumptions detailed in Section 3.0.

Table H-4.2-1 Air Dispersion Modelling Results at Fenceline: Project Operation.

Air Contaminant	Averaging Period	Concentrations (µg/m³)			Guidelines (µg/m³)			% of NL AQS
		Background	Predicted	Predicted + Background	NL AQS	2020 CAAQS	2025 CAAQS	
CO	1-hour	263	43.3	306	35,000	-	-	0.88%
	8-hour	252	27.3	279	15,000	-	-	1.86%
SO_2	1-hour	0.8	5.1	5.9	900	183.4	170	0.66%
	3-hour	0.8	4.4	5.2	600	-	-	0.87%
	24-hour	0.5	2.3	2.8	300	-	-	0.93%
	Annual	0.8	0.2	1.0	60	13.1	10.5	1.59%
NO_2	1-hour	4	108	112	400	112.9	79	28.10%
	24-hour	2	64	66	200	-	-	32.83%
	Annual	2	6	8	100	32	28.2	7.61%
TSP	24-hour	16	1.4	17	120	-	-	14.46%
	Annual	11	0.11	11	60	-	-	18.51%
PM_{10}	24-hour	16	1.1	17	50	-	-	34.24%
$PM_{2.5}$	24-hour	8	1.1	9	25	27	27	36.40%
	Annual	5	8.42E-02	5	8.8	8.8	8.8	57.77%
NH_3	24-hour	NA	0.48	0	100	-	-	0.48%

NOTES
µg = microgram, m³=cubic metre; NL AQS = Newfoundland and Labrador Air Quality Standards; CAAQS = Canadian Ambient Air Quality Standards

Table H-4.2-2 Air Dispersion Modelling Results at Sensitive Receptor: Project Operation.

Air Contaminant	Averaging Period	Concentrations (µg/m³)			Guidelines (µg/m³)			% of NL AQS
		Background	Predicted	Predicted + Background	NL AQS	2020 CAAQS	2025 CAAQS	
CO	1-hour	263	1.45	264	35,000	-	-	0.76%
	8-hour	252	0.44	252	15,000	-	-	1.68%
SO_2	1-hour	0.8	0.14	1	900	183.4	170	0.10%
	3-hour	0.8	7.12E-02	1	600	-	-	0.15%
	24-hour	0.5	1.87E-02	1	300	-	-	0.18%
	Annual	0.8	8.44E-04	1	60	13.1	10.5	1.31%
NO_2	1-hour	4	5	9	400	112.9	79	2.30%
	24-hour	2	1	3	200	-	-	1.35%
	Annual	2	0	2	100	32	28.2	2.04%
TSP	24-hour	16	6.61E-03	16	120	-	-	13.34%
	Annual	11	5.12E-04	11	60	-	-	18.33%
PM_{10}	24-hour	16	1.10E-02	16	50	-	-	32.02%
$PM_{2.5}$	24-hour	8	1.12E-02	8	25	27	27	32.04%
	Annual	5	5.99E-04	5	8.8	8.8	8.8	56.82%
NH_3	24-hour	NA	1.70E-02	0	100	-	-	0.02%

NOTES
µg = microgram, m³=cubic metre; NL AQS = Newfoundland and Labrador Air Quality Standards; CAAQS = Canadian Ambient Air Quality Standards

5.0 References

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Appendix H.1
GHG Inventory Calculation Assumptions

Table H.1-1 List of Calculation Assumptions – Construction.

Phase	Activity	Assumptions
Construction	Blasting	No emissions of CH_4 or N_2O will be generated from blasting
		Explosive use (required for wind energy generation facility only) will be evenly distributed across the two-year construction period
	Stationary Combustion (Argentia Wind Facility)	Approximately 7.5% of total fuel burn anticipated for the construction period will be used in stationary combustion
		Stationary equipment fuel consumption will be evenly distributed across the two-year construction period
	Stationary Combustion (Argentia Green Fuels Facility)	Stationary equipment to be used on site shall be generators and vibratory hammers per FEL-1 noise analysis
		Stationary equipment fuel consumption will be evenly distributed across the two-year construction period
	Mobile Equipment (Argentia Wind Facility)	Approximately 92.5% of total fuel burn anticipated for the construction period will be used in stationary combustion
		Mobile equipment fuel consumption will be evenly distributed across the two-year construction period
	Mobile Equipment (Argentia Green Fuels Facility)	All mobile equipment is fueled by diesel
		All mobile equipment is Tier 4
	Marine Transport (Components)	All wind turbine components will be delivered in the same calendar year
		Wind turbine towers will be shipped in five segments
		Each shipment will contain eight units
		Empty weight is 50% of deadweight tonnage
		Components will be shipped from furthest port possible
	Marine Transport (Supplies)	All wind turbine components will be delivered in the same calendar year

Table H.1-2 List of Calculation Assumptions – Operation.

Phase	Activity	Assumptions
Operation	Mobile Equipment	Approximately half of the light vehicle requirement estimated for the construction phase will be required for operations (amounts to ~8 hr/day, 365 day/yr)
		All mobile equipment is fueled by diesel
	Flare Stacks	Mass flow rates for flare and tank flare are 3% of rates provided in FEL-1 study
		Combustion efficiency of pilot gas (propane) is 98%
	Stationary Combustion (Emergency Generator)	8 MW of standby power will be supplied by one emergency generator; usage will not exceed 100 hours per year (approx. one day per quarter)
		The diesel generator will consume 0.4 L of fuel per kWh
		Sulfur content of diesel will not exceed 0.1%
	Marine Transport (Product)	Ammonia will be transported by standard liquified petroleum/natural gas (LPG/LNG) capable vessels
		One vessel per month will be required
		Clipper Eirene gas carrier will transport product to global market
		Ammonia will be shipped to a major European port (assume Hamburg, Germany)
		During vessel hotelling (i.e., filling of vessel tanks), only one loading arm will be available to fill tanks (i.e., tanks will be filled consecutively)
		Vessel hotelling will take 15 hours per visit, 180 hours annually (12 visits per year assumed)
	Electricity Consumption	The requirement of 10 MW of firm power will be 24/7/365 (i.e., 8760 hours)

Appendix H.2
GHG Inventory Calculation Details

CONSTRUCTION - MOBILE EQUIPMENT

CPL - Argentia Wind Facility

CPL has indicated that approximately 4.5 million liters will be required for the construction period; approx. 7.5% (5-10% estimated) will be used in stationary equipment. The remaining 92.5% will be burned in mobile equipment

Per provided schedule, construction of the Argentia Wind Facility, inclusive of tree clearing and grubbing, road construction, foundation works, turbine installation, and mechanical completion, is scheduled to commence in Q2 2025 (June 2025) and is anticipated to finish in Q4 2026 (December 2026).

Assume that fuel burn is split evenly across the two years (i.e., 2025 and 2026)

Fuel Details

Fuel Type	Diesel
Total fuel burn (L)	4,500,000
Mobile fuel burn (L)	4,162,500
Annual mobile fuel burn	2,081,250

Emissions

Year	Consumption (L)	Emission Factors (g/L)			Actual GHG Emissions (tonnes)			GHG Emissions (tonnes CO2e)			Total GHG Emissions (tm/yr)
		CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	
Off-road Diesel (≥19 kW, Tier 4)											
Year 2 (2026)	2,081,250	2680.5	0.073	0.227	5578.79	0.15	0.47	5578.79	4.25	125.20	5,708
Year 3 (2026)	2,081,250	2680.5	0.073	0.227	5578.79	0.15	0.47	5578.79	4.25	125.20	5,708
Construction Period	4,162,500	2680.5	0.073	0.227	11157.58	0.30	0.94	11157.58	8.51	250.40	11,416

[1] As a conservative approach, it was assumed that all vehicles would be Tier 4 (EF for N2O is higher than Tier 1-3; all other EFs are equivalent)

[2] EFs retrieved from Canada's NIR (2021) Table A6.1–14 (part 2): Emission Factors for Energy Mobile Combustion Sources (Off-road)

SNC - Argentia Green Fuels Facility

Assume that all mobile equipment is fueled by diesel

Equipment Details

Equipment	Model	Net Power (output; hp)	Units	Operating Hours	Fuel Burn Rate	Units	Fuel Consumption (L)	Total	Per year
Backhoe	CAT 440	104	4	3,920	2.15	gal/hr	31,858	523,324	261,662
Compactor	CS56 Roller	157	4	1,960	2.91	gal/hr	21,560		
Bulldozers	D6 Dozer	215	2	3,920	5.9	gal/hr	87,424		
Pickup Truck		250	4	3,920	0.15	L/km	23,520		
Impact Pile Driver	Liebherr LRH 100.	335	2	1,960	2.56	gal/hr	18,967		
Hyd. Rock Breakers	PC490LC-11 w/ br	359	2	3,920	8.61	gal/hr	127,580		
Vibratory Hammer (HPSI 500)	PC490LC-11 w/ ha	359	2	1,960	8.61	gal/hr	63,790		
Flat Bed Truck		360	4	3,920	0.15	L/km	23,520		
Concrete Truck		425	10	3,920	4.5	gal/hr	66,679		
Concrete Pump Truck		485	2	1,960	4.5	gal/hr	33,340		
Crane*	Liebherr LTM 1250	544	4	1,568	16	L/hr	25,088		

[1] high fuel consumption selected, where available

[2] https://www.liebherr.com/en/deu/specials/fuel-savings-calculator/tool/calculator.html#page=3&catid=10&id=LRH%20100.1&v1=&v2=&v3=&ca=g&cu=EUR

[3] fuel burn for PC491LC-11 could not be found; Cat 340-08 used as comparable model

[4] *Not available. Comparable SANY SAC2500S burns <80 L/100 km. Assume that crane moves 20 km/hr (40 km/hr in transit; 0 km/hr while stopped)

[5] Based on Ready-Mix trucks, assume the same for concrete pump trucks

[6] Flat bed truck fuel burn = pickup truck fuel burn?

Emissions

Year	Consumption (L)	Emission Factors (g/L)			Actual GHG Emissions (tonnes)			GHG Emissions (tonnes CO2e)			Total GHG Emissions (tm/yr)
		CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	
Off-road Diesel (≥19 kW, Tier 4)											
Year 2 (2026)	261,662	2680.5	0.073	0.227	701.38	0.02	0.06	701.38	0.53	15.74	718
Year 3 (2026)	261,662	2680.5	0.073	0.227	701.38	0.02	0.06	701.38	0.53	15.74	718
Construction Period	523,324	2680.5	0.073	0.227	1402.77	0.04	0.12	1402.77	1.07	31.48	1,435

[1] As a conservative approach, it was assumed that all vehicles would be Tier 4 (EF for N2O is higher than Tier 1-3; all other EFs are equivalent)

CONSTRUCTION - WIND TURBINE COMPONENT TRANSPORTATION

These calculations were performed under the assumption that all wind turbine components will be delivered in the same calendar year.
This assumption aligns with the fact that Argentia Renewables' schedule: WTG delivery start (May 2026) and WTG delivery complete (July 2026).
What about deliveries for other components? Is it practical to assume that those will come by boat too?

Vessel	Vessel Type	Components	# Units	# trips per year [1]	Tonnage Deadweight (tonnes)	Tonnage Empty (tonne) [2]	Emission Factor (g CO2e/dwt·nm)
Rotra Vente	RoRo	Nacelles	45	6	8929	4465	19.4
Vestvind	Cargo	Hubs	45	6	10238	5119	17.1
Vestvind	Cargo	Blades	135	17	10238	5119	17.1
Boldwind	Cargo	Towers	225	29	10000	5000	17.1

[1] Assume 8 units per trip
[2] Assume empty weight is 50% of DWT
[3] Rotra Vente is a general cargo with 5,000-9,999 dwt while Vestvind and Boldwind are general cargo vessels with 10,000-19,999 dwt
[4] EFs retrieved from IMO 2020

Component	Origin	Probable Port	One-way trip (nm)	Emissions CO_2e (tonnes/yr)		
				FULL (one way)	EMPTY (one way)	Project
Nacelles	China	Tiajin, CN	11,453	11,904	5,952	17,855
Nacelles	Europe	Aarhus, DE	2,581	2,683	1,341	4,024
Hubs	China	Tiajin, CN	11,453	12,030	6,015	18,046
Hubs	Europe	Aarhus, DE	2,581	2,711	1,356	4,067
Hubs	India	Kandla, IMD	7,209	7,572	3,841	11,413
Blades	China	Tiajin, CN	11,453	34,086	17,043	51,129
Blades	Europe	Aarhus, DE	2,581	7,682	3,841	11,522
Blades	Mexico	Tampico, MX	2,838	8,446	4,223	12,670
Blades	India	Kandla, IMD	7,209	21,455	10,728	32,183
Towers	China	Tiajin, CN	11,453	56,795	28,398	85,193
Towers	Europe	Aarhus, DE	2,581	12,799	6,400	19,199

https://www.vestas.com/en/about/our-locations/production
https://sea-distances.org/
nm=nautical miles

Shipping Options

Nacelles	Hubs	Blades	Towers
Nacelles (China)	Hubs (China)	Blades (China)	Towers (China)
Nacelles (Europe)	Hubs (Europe)	Blades (Europe)	Towers (Europe)
	Hubs (India)	Blades (Mexico)	
		Blades (India)	

EMISSIONS [WORST CASE SCENARIO: Furthest Ports]

Component	Origin	Probable Port	One-way trip (nm)	Emissions CO_2e (tonnes/yr)		
				FULL (one way)	EMPTY (one way)	Project
Nacelles	China	Tiajin, CN	11453	11903.5106	5951.75531	17855.3
Hubs	China	Tiajin, CN	11453	12030.4465	6015.22326	18045.7
Blades	China	Tiajin, CN	11453	34086.2651	17043.1326	51129.4
Towers	China	Tiajin, CN	11453	56795.427	28397.7135	85193.1
					TOTAL	172,223

Fuel Consumption Estimate (includes hotelling [CONS 6])

Component	Origin	Probable Port	One-way trip		# Trips (return)	Total Transport (hrs)	Vessel	Main Engine			ρ_{MGO} (kg/L)	Fuel Burn Rate		Fuel Consumption (L)
			Days	Hours				Type	#	Power (kW)		g/kWh	(L/hr)	
Nacelles	China	Tiajin, CN	30	720	12	8,640	Rotra Vente	Wärtsilä 8L38	1	1,320	0.855	179	276	2,385,004
Hubs	China	Tiajin, CN	30	720	12	8,640	Vestvind	MAN-B&W 6L21/31	2	2,640	0.855	192	593	5,122,156
Blades	China	Tiajin, CN	30	720	34	24,480	Vestvind	MAN-B&W 6L21/31	2	2,640	0.855	192	593	14,512,775
Towers	China	Tiajin, CN	30	720	58	41,760	Boldwind*	MAN-B&W 6L21/31	4	5,280	0.855	192	1186	49,514,173
													TRANSPORT	71,534,107
													HOTELLING	145,152
													MARINE TOTAL	71,679,259

CONSTRUCTION - MARINE TRANSPORT OF SUPPLIES

Emissions include loading/unloading at port (hotelling)

These calculations were performed under the assumption that all wind turbine components will be delivered in the same calendar year.

This assumption aligns with the fact that Argentia Renewables' schedule: WTG delivery start (May 2026) and WTG delivery complete (July 2026).

Fuel Consumption Details

Vessel	Vessel Type	Components	AUX Engine Details			ρ_{MGO} (kg/L)	Fuel Burn Rate		Hotelling Time (hr/yr)	Annual Fuel Consumption (L/yr)
			Type	Number	Power (kW)		g/kWh	L/hr [4]		
Rotra Vente [1]	RoRo	Nacelles	Scandia D160 75M aux engine	2	511	0.855	201	240	180	43,247
Vestvind [2]	Cargo	Hubs/Blades	Volvo Penta D13 diesel genset	3	368	0.855	212	274	180	49,273
Boldwind [3]	Cargo	Towers	MAN 6L16/24 diesel generator	2	625	0.855	200	292	180	52,632

[1] Rotra Vente engine details here: https://shippingtandy.com/features/rotra-vente/

[2] Vestvind engine details here: https://www.scheepvaartwest.be/CMS/index.php/general-cargo/9787-vestvind-imo-9750579

[3] Boldwind detailed here: https://www.unitedwindlogistics.de/boldwind/#:~:text=The%20newbuilding%20(built%202020)%20combines,driven%20by%20high%20quality%20MDO; https://www.projectcargojournal.com/shipping/2020/05/12/united-wind-logistics-takes-delivery-of-first-new-deck-carrier/; https://www.scheepvaartwest.be/CMS/index.php/general-cargo/11740-boldwind-imo-9870018 AND https://www.ship-technology.com/news/united-wind-logistics-delivery-mv-boldwind/?cf-view

[4] Fuel burn rate in L/h includes # units

Emissions

Year	Consumption (L)	Emission Factors (g/L)			Actual GHG Emissions (tonnes)			GHG Emissions (tonnes CO2e)			Total GHG Emissions (tm/yr)
		CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	
Rotra Vente [1]	43,247	2680.5	0.25193	0.07198	115.92	0.01	0.00	115.92	0.31	0.82	117
Vestvind [2]	49,273	2680.5	0.25193	0.07198	132.08	0.01	0.00	132.08	0.35	0.94	133
Boldwind [3]	52,632	2680.5	0.25193	0.07198	141.08	0.01	0.00	141.08	0.37	1.00	142
										TOTAL	393

EF Source: NIR Part 3, Annex 6 https://publications.gc.ca/collections/collection_2023/eccc/En81-4-2021-2-eng.pdf

OPERATION - MOBILE EQUIPMENT

Mobile equipment during operation phase anticipated to be limited to light duty pickup trucks

Assume that approximately half of the hwy truck/light vehcile (LV) requirement estimated for the construction phase (provided by Dexter via CPL) will be used for the operation phase

LV Details

Annual LV use (hr)	2900
Daily LV used (hr)	8
Vehicle speed (km/hr)	40
Fuel rating (L/km) [1]	0.15
Annual fuel consumption (L)	17400

[1] Fuel rating retrieved from: https://fcr-ccc.nrcan-rncan.gc.ca/en?_gl=1*14vg18q*_ga*MzIzMzA2MjkxLjE3MDkwNTg1MTg.*_ga_C2N57Y7DX5*MTcwOTkwODUwNC40LjAuMTcwOTkwODUwNC4wLjAuMA..

Details	Consumption (L)	Emission Factors (g/L) [1]			Actual GHG Emissions (tonnes)			GHG Emissions (CO2e)			Total GHG Emissions (tm/yr)
		CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	
Operation - Mobile Equipment	17,400	2680.5	0.068	0.22	46.64	0.00	0.00	46.64	0.03	1.01	48

[1] EFs for mobile equipment retrieved from Canada NIR (2021) part 2, Table A6.1-14 (Road Transport, Light-duty Diesel Trucks, Advanced Control)

OPERATION - FLARE STACKS

INPUTS

NH_3 Process Flare Unit Details

Flare Volumetric Flow Rate (m3/hr) [1]	72.7
Pilot Volumetric Flow Rate (m3/hr) [2]	2.181
Pilot Mass Flow Rate (kg/hr)	3.7077
Density of propane (kg/m^3) [3]	1.7
Pilot operation (hr/yr)	8760
Annual fuel consumption (m^3/yr)	19,106
Annual fuel consumption (L/yr)	19,105,560

[1] As per SNC FEL-1 Heat & Materials Balance for Flare Gas
[2] Assumed to be 3% of volumetric flow rate of flare (USEPA 2012)
[3] Engineering toolbox

NH_3 Tank Flare Unit Details

Flare Volumetric Flow Rate (m3/hr) [1]	72.7
Pilot Volumetric Flow Rate (m3/hr) [2]	2.181
Mass Flow Rate (kg/hr)	3.7077
Density of propane (kg/m^3)	1.7
Pilot operation (hr/yr)	8760
Annual fuel consumption (m^3/yr)	19,106
Annual fuel consumption (L/yr)	19,105,560

Total annual fuel consumption (m^3)	38,211
Total annual fuel consumption (L)	38,211,120

EMISSIONS

CO_2

MW propane (kg/kg·mol)	44.097
MWC (m^3/kg·mol)	23.64575692
CC flare gas (kg C/kg propane) [1]	0.82
Combustion Efficiency [2]	0.98
CO_2 EMISSIONS (t/yr)	209.8171504

[1] https://www.engineeringtoolbox.com/co2-emission-fuels-d_1085.html
[2] Assumed 98% per TCEQ

CH_4

EF CH4 (kg/GJ)	0.00083
EF (kg CO2/GJ)	62.4
Combustion Efficiency [2]	0.98
f_{CH4}	0.4
CH_4 EMISSIONS (t/yr)	0.625624679

N2O

EF N2O (kg/GJ)	5.00E-04
EF (kg CO2/GJ)	62.4
N2O EMISSIONS (t/yr)	1.68E-03

Details	Consumption (L)	Actual GHG Emissions (tonnes)			GHG Emissions (CO2e)			Total GHG Emissions (tm/yr)
		CO2	CH4	N2O	CO2	CH4	N2O	
Operation - Flaring	38,211,120	209.82	0.63	0.00	209.82	17.52	0.45	228

OPERATION - EMERGENCY GENERATOR

One diesel generator will be required to generate approx. 8 MW of standby (i.e., emergency) power in the event of power loss, maintenance, start up/shut down, etc.
It was assumed that the emergency generator will be used for a maximum of 100 hours per year (i.e., approx 1 day per quarter)
The general rule of thumb that a diesel generator will use 0.4 L of fuel per kWh was applied here in the absence of equipment-specific fuel burn rate.
Default heating value and sulfur content used in calculations.

INPUTS: Generator & Fuel Details

Power Output (MW)	Operating Hours	Diesel Consumption (m^3/yr)	Heating Value (GJ/m^3)	S content (%)
8	96	307.2	38.184	0.1

Details	Consumption (L)	Emission Factors (g/L) [1]			Actual GHG Emissions (tonnes)			GHG Emissions (CO2e)			Total GHG Emissions (tm/yr)
		CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	
Operation - Emergency Generator	307,200	2681	0.078	0.022	823.60	0.02	0.01	823.60	0.67	1.79	826

[1] EFs for emergency generator retrieved from Canada NIR (2021) part 2, Table A6.1-5 (Emission Factors for Refined Pretroleum Products, Diesel)

OPERATION - MARINE TRANSPORT OF PRODUCT

Assumptions
Ammonia will be transported by standard liquified petroleum/natural gas (LPG/LNG) capabe vessels
One vessel per month will be required
Clipper Eirene gas carrier will transport product to global market
Ammonia will be shipped to a major european port (assume Hamburg, Germany)

EMISSIONS - TRANSPORT

Parameter	Value
Daily production (tonnes)	400
29-day production (tonnes)	11,600
Max production capacity (37.5 days; tonnes)	15,000
ρ_{NH3} (@ -32°C, kg·m^{-3})	696
29-day production (m^3)	16,667
Max production (m^3) [1]	21,552
Vessel [link below]	Clipper Eirene
Vessel capacity (m^3)	21220
Component	NH3 Product
# trips/year	12
Tonnage Deadweight (tonnes)	18056
Tonnage Empty (tonne)	9028
Emission Factor Category	Liquified gas tanker (0-49999 cbm)
Emission Factor (gCO2/dwt.nm)	23.4
One-way trip (nm)	2550

[1] Tanker should support close to max production

Vessel Status (Route)	Vessel Tonnage	# Trips/yr	Shipping Distance (nm)	Emissions (tonnes CO_2e/yr)
Empty (EUR-CAN)	9028	12	2,550	6,464
Full (CAN-EUR)	18056	12	2,550	12,929
			TOTAL	19,393

EMISSIONS - VESSEL HOTELLING
Vessel hotelling during operation is required for product loading at Port -- there will be two loading arms (i.e., cannot fill all three at once)

Species	Emission Factor (g/L)	GWP
CO_2	2680.5	1
CH_4	0.25193	28
N_2O	0.07198	265

EF Source: NIR Part 3, Annex 6 https://publications.gc.ca/collections/collection_2023/eccc/En81-4-2021-2-eng.pdf

Cargo Tank Capacities	Quantity (tonne)	Quantity (m^3)	Loading Time (hr)
1	3934	5652.3	4.0
2	5097	7323.3	5.2
3	5098	7324.7	5.2
Total	14129	20300.3	14.5

Average fuel consumption, AUX, loading (ton/day)	9
Hourly fuel consumption (L/hr) [1]	398
Hotelling time (hours) [2]	15
Loading Rate (m3/hr)	1400

[1] Marine gas oil density retrieved from https://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html
[1] Round up to 15 hrs hotelling time

Vessel Status	Annual Hotelling (hr/yr) [2]	Fuel Consumption (L/yr)	Emissions (tonnes CO_2e/yr)			Total Emissions (tonnes CO_2e/yr)
			CO_2	CH_4	N_2O	
Hotelling (Loading)	180	71620	191.98	0.51	1.37	194

[2] 12x24 hr periods over a calendar year

FUEL BURN ESTIMATE - TRANSIT (MAIN ENGINE ONLY)

Annual MGO Estimate					
Component	Fuel Cons (tonne/day)	Days in transit*	# trips/year	Fuel Burn (tonnes/year	Fuel Burn (L/year)
Main Engine	20.0	22	12	5268.9	61,624,918

OPERATION - ELECTRICITY CONSUMPTION

The wind farm will require 10 MW of firm power from NLH on an annual basis

EMISSIONS

Power requirement (MW)	10
Power requirement (kW)	10000
Hours required (h) [1]	8760
Megawatt-hours (MWh/year)	87600
kilowatt-hours (kWh/year)	87600000
EF (g CO_2/kWh)	17
Emissions (tonnes CO_2/year)	1,489

[1] Assumes that firm power will be required 24/7/365

Appendix H.3
Air Release Inventory Results

Table H.3-1 Air Release Inventory Results: Construction.

Substance Details			Annual Construction Emissions (tonnes per year)										CONSTRUCTION PERIOD (2 YRS)
Substance Name	CAS Number	NPRI Part	BLASTING	STOCKPILE EROSION	AGGREGATE HANDLING & TRANSFERS	CRUSHING & SCREENING	LAYDOWN AREAS	UNPAVED ROADS	MOBILE EQUIPMENT	STATIONARY COMBUSTION	TOTAL	
CO	630-08-0	4	4.250						114.204	2.852	121.306	242.612
SO_2	7446-09-5	4	0.125						39.749	0.871	40.745	81.489
NOx, expressed as NO_2	11104-93-1	4	1.000						13.842	13.238	28.080	56.161
Total VOCs	*	4								1.081	1.081	2.161
TSP	*	4	0.123	1.579	2.511	2.140	5.754	2.254	0.426	0.931	15.717	31.434
PM_{10}	*	4	0.064	0.790	1.188	0.800	2.877	0.645		0.931	7.294	14.587
$PM_{2.5}$	*	4	0.004	0.118	0.180	0.132	0.432	0.065		0.931	1.861	3.722
Acetaldehyde	75-07-0	1A								0.002	0.002	0.005
Acrolein	107-08-8	1A								0.000	0.000	0.000
Benzene	71-43-2	1A/5								0.003	0.003	0.006
1,3-Butadiene	106-99-0	1A/5								0.000	0.000	0.000
Formaldehyde	50-00-0	1A/5								0.004	0.004	0.007
Naphthalene	91-20-3	1A								0.000	0.000	0.001
Propylene	115-07-1	1A/5								0.008	0.008	0.015
Toluene	108-88-3	1A/5								0.001	0.001	0.002
Xylene (all isomers)	1330-20-7	1A/5								0.001	0.001	0.002
Mercury (and its compounds)	*	1B								0.000	0.000	0.000
Acenaphthene	83-32-9	2								0.000	0.000	0.000
Acenaphthylene	208-96-8	2								0.000	0.000	0.000
Anthracene	120-12-7	2								0.000	0.000	0.000
Benz[a]anthracene	56-55-3	2								0.000	0.000	0.000
Chrysene	218-01-9	2								0.000	0.000	0.000
Benzo[a]pyrene	50-32-8	2								0.000	0.000	0.000
Benzo[b] fluoranthene	205-99-2	2								0.000	0.000	0.000
Benzo[ghi]perylene	191-24-2	2								0.000	0.000	0.000
Benzo[k]fluoranthene	207-08-9	2								0.000	0.000	0.000
Dibenz[a,h]anthracene	53-70-3	2								0.000	0.000	0.000
Fluoranthene	206-44-0	2								0.000	0.000	0.000
Fluorene	86-73-7	2								0.000	0.000	0.000
Inden[1,2,3-cd]pyrene	193-39-5	2								0.000	0.000	0.000
Phenanthrene	85-01-8	2								0.000	0.000	0.000
Pyrene	129-00-0	2								0.000	0.000	0.000

Table H.3-2 Air Release Inventory Results: Operation.

Substance Details			Annual Operation Emissions (tonnes per year)					OPERATION PERIOD (30 YRS)
Substance Name	CAS Number	NPRI Part	EMERGENCY GENERATOR	FLARE STACKS	MARINE TRANSPORT	MOBILE EQUIPMENT	TOTAL	
CO	630-08-0	4	4.287	0.767	0.248	1.885	7.187	215.599
SO_2	7446-09-5	4	0.509		0.106	0.676	1.291	38.729
NO_x, expressed as NO_2	11104-93-1	4	16.138	0.283	2.171	0.218	18.809	564.276
Total VOCs	*	4	0.413				0.413	12.391
TSP	*	4	0.313	0.031		0.007	0.351	10.541
PM_{10}	*	4	0.250		0.040		0.291	8.718
$PM_{2.5}$	*	4	0.242		0.037		0.279	8.366
NH_3	NA-16	1A		0.667			0.667	20.000
Acetaldehyde	75-07-0	1A	0.000				0.000	0.004
Acrolein	107-08-8	1A	0.000				0.000	0.001
Benzene	71-43-2	1A/5	0.00391		0.000		0.004	0.127
1,3-Butadiene	106-99-0	1A/5					0.000	0.000
Formaldehyde	50-00-0	1A/5	0.000		0.000		0.000	0.013
Naphthalene	91-20-3	1A	0.001		0.000		0.001	0.021
Propylene	115-07-1	1A/5	0.014		0.001		0.015	0.458
Toluene	108-88-3	1A/5	0.001		0.000		0.002	0.046
Xylene (all isomers)	1330-20-7	1A/5	0.001		0.000		0.001	0.032
Mercury (and its compounds)	*	1B					0.000	0.000
Acenaphthene	83-32-9	2	0.000		0.000		0.000	0.001
Acenaphthylene	208-96-8	2	0.000		0.000		0.000	0.002
Anthracene	120-12-7	2	0.000		0.000		0.000	0.000
Benz[a]anthracene	56-55-3	2	0.000		0.000		0.000	0.000
Chrysene	218-01-9	2	0.000		0.000		0.000	0.000
Benzo[a]pyrene	50-32-8	2	0.000		0.000		0.000	0.000
Benzo[b] fluoranthene	205-99-2	2	0.000		0.000		0.000	0.000
Benzo[ghi]perylene	191-24-2	2	0.000		0.000		0.000	0.000
Benzo[k]fluoranthene	207-08-9	2	0.000		0.000		0.000	0.000
Dibenz[a,h]anthracene	53-70-3	2	0.000		0.000		0.000	0.000
Fluoranthene	206-44-0	2	0.000		0.000		0.000	0.001
Fluorene	86-73-7	2	0.000		0.000		0.000	0.002
Inden[1,2,3-cd]pyrene	193-39-5	2	0.000		0.000		0.000	0.000
Phenanthrene	85-01-8	2	0.000		0.000		0.000	0.007
Pyrene	129-00-0	2	0.000		0.000		0.000	0.001
Propane	74-98-6	5		1.299			1.299	38.975

Appendix H.4
Air Release Inventory Calculation Details

CONSTRUCTION - BLASTING

ASSUMPTIONS

Approximately 200,000 m3 of rock will be required to be blasted. Assume that 1.2-1.4 kg explosives per m3 of rock will be required therefore assume 250,000 kg of explosives will be required

Per FEL-1, no explosives shall be required during Argentia Green Fuels Facility construction

Assume that explosive consumption for wind farm construction is split evenly across the two years (i.e., 2025 and 2026)

Assume that minimum blast hole diameter is 65 mm

Blasting Details

Explosive type	Pumped emulsion
Quantity to blast (m^3)	200,000
Explosives per m^3 of rock (kg)	1.2-1.4
Total explosive requirement (kg)	250,000
Bench height (m)	4
Total blast area (m^2)	50,000
Per blast area (m^2)	500
# blasts per year	50

EMISSIONS

Substance	Quantity (tonnes/yr)	EF	Units	Emissions (tonnes/yr)
NOx	125	8	kg/Mg	1.00
CO	125	34	kg/Mg	4.25
SO_2	125	1	kg/Mg	0.125
TSP		2.46	kg/blast	0.123
PM_{10}		1.28	kg/blast	0.064
$PM_{2.5}$		0.07	kg/blast	0.004

https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/pits-quarries-guide.html

CONSTRUCTION - STOCKPILE EROSION

Emission Factor Calculations

$$EF = 1.12 \times 10^{-4} \times J \times 1.7 \times \left(\frac{s}{1.5}\right) \times 365 \times \left(\frac{365 - P}{235}\right) \times \left(\frac{I}{15}\right)$$

Where:
J = Particulate Aerodynamic Diameter
s = average silt loading of storage pile (%)
P = average number of days with at least 0.254 mm of precipitation and/or snow cover
I = time in year with unobstructed wind speed > 19.3 km/hr (%)

NPRI SOURCE
https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/tools-calculating-emissions/stockpiles-exposed-area-wind-erosion-calculator.html#toc5

Emission Factor Inputs

Constant	Value	Units	Source
J_{TSP}	1.0		NPRI Toolbox
J_{PM10}	0.5		NPRI Toolbox
$J_{PM2.5}$	0.075		NPRI Toolbox
s	0.5	%	Mojave Desert 2013
P	243	days/year	NPRI stockpile and exposed area wind erosion emission calculator and Argentia (AUT) daily and hourly data, 2023
I	61	%	

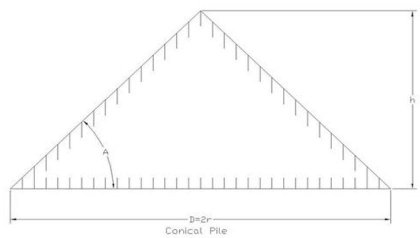
Emission Factors

Size Fraction	EF (kg/m^2)
TSP	4.93E-02
PM_{10}	2.46E-02
$PM_{2.5}$	3.70E-03

Stockpile Parameters

Details & Assumptions

Assume that height (h) of stockpiles will not exceed 10 m, and that stockpiles are conical and composed of gravel (bulk aggregate)
If the angle of repose (A) of gravel is 45°, then the diameter (D) will be 20 m (radius, r=10 m)



Calculations

$$V = \frac{1}{3}\pi r^2 h$$

Where: V = volume of stockpile
r = radius of stockpile
h = height of stockpile

$$f_s = \frac{1}{4}\pi D^2$$

f_s = footprint of stockpile
D = diameter

$$A = \pi r\sqrt{r^2 + h^2}$$

A = exposed surface area of stockpile
r = radius of stockpile
h = height of stockpile

$V_{stockpile}$ (m^3)	1,047
f_s (m^2)	315
A (m^2)	445

ρ_{gravel} (kg/m^3)	1,475

tonnes to m^3 conversion: $Quantity\,(m^3) = \dfrac{Quantity\,(tonnes)}{\rho\left(\frac{kg}{m^3}\right)} \times \dfrac{1000\,kg}{tonne}$

STOCKPILES

Inputs

Material	Quantity	Units	# of Stockpiles		
			Total	Year 2	Year 3
Argentia Wind Facility					
Road Base	98,320	m^3	94	47	47
Select Screened Cable Backfill	3,080	m^3	3	2	2
Substation Imported Fill	4,440	m^3	4	2	2
Surfacing Gravel	35,190	m^3	34	17	17
Washed Gravel	1,710	m^3	2	1	1
Argentia Green Fuels Facility					
Class A	6,000	tonnes	4	2	2
Class B	2,600	tonnes	2	1	1

* 0 to reflect that construction will occur across two calendar years rather than three

EMISSIONS

Emissions (tonnes)	Argentia Wind Facility					Argentia Green Fuels Facility		TOTAL (tonnes)
	Road Base	Select Screened Cable Backfill	Substation Imported Fill	Surfacing Gravel	Washed Gravel	Class A	Class B	
Year 2								
TSP	1.03	0.03	0.04	0.37	0.02	0.04	0.02	1.57
PM_{10}	0.52	0.02	0.02	0.19	0.01	0.02	0.01	0.78
$PM_{2.5}$	0.08	0.00	0.00	0.03	0.00	0.00	0.00	0.12
Year 3								
TSP	1.03	0.03	0.04	0.37	0.02	0.04	0.02	1.57
PM_{10}	0.52	0.02	0.02	0.19	0.01	0.02	0.01	0.78
$PM_{2.5}$	0.08	0.00	0.00	0.03	0.00	0.00	0.00	0.12

EMISSIONS - COMPONENT SUMMARY BY YEAR

Emissions (tonnes)	Argentia Wind Facility			Argentia Green Fuels Facility		
	Year 2	Year 3	Total	Year 2	Year 3	Total
TSP	1.50	1.50	3.00	0.07	0.07	0.13
PM_{10}	0.75	0.75	1.50	0.03	0.03	0.07
$PM_{2.5}$	0.11	0.11	0.23	0.00	0.00	0.01

EMISSIONS - PROJECT SUMMARY BY YEAR

Emissions (tonnes)	Year 2	Year 3
TSP	1.57	1.57
PM_{10}	0.78	0.78
$PM_{2.5}$	0.12	0.12

CONSTRUCTION - AGGREGATE HANDLING & TRANSFERS

STOCKPILES

Inputs from CONS 2 (Stockpile Erosion)

$V_{stockpile}$ (m^3)	1,047
f_s (m^2)	315
A (m^2)	445
ρ_{gravel} (kg/m^3)	1,475

Supplemental inputs required for aggregate handling calculations

Total qty stored in pile (tonnes)	1,545

Inputs from Stockpile Erosion

Material	Quantity	Units	# of Stockpiles Total	Year 2 (2025)*	Year 3 (2026)*
Argentia Wind Facility					
Road Base	98,320	m3	94	47	47
Select Screened Cable Backfill	3,080	m3	3	2	2
Substation Imported Fill	4,440	m3	4	2	2
Surfacing Gravel	35,190	m3	34	17	17
Washed Gravel	1,710	m3	2	1	1
Argentia Green Fuels Facility					
Class A	6,000	tonnes	4	2	2
Class B	2,600	tonnes	2	1	1

13.2.4-2 EMISSION FACTORS

Table 13.2.4-1. TYPICAL SILT AND MOISTURE CONTENTS OF MATERIALS AT VARIOUS INDUSTRIES[a]

Industry	No. Of Facilities	Material	Silt Content (%) No. Of Samples	Silt Content (%) Range	Silt Content (%) Mean	Moisture Content (%) No. Of Samples	Moisture Content (%) Range	Moisture Content (%) Mean
Iron and steel production	9	Pellet ore	13	1.3 - 13	4.3	11	0.64 - 4.0	2.2
		Lump ore	9	2.8 - 19	9.5	6	1.6 - 8.0	5.4
		Coal	12	2.0 - 7.7	4.6	11	2.8 - 11	4.8
		Slag	3	3.0 - 7.3	5.3	3	0.25 - 2.0	0.92
		Flue dust	3	2.7 - 23	13	1	—	7
		Coke breeze	2	4.4 - 5.4	4.9	2	6.4 - 9.2	7.8
		Blended ore	1	—	15	1	—	6.6
		Sinter	1	—	0.7	0	—	—
		Limestone	3	0.4 - 2.3	1.0	2	ND	0.2
Stone quarrying and processing	2	Crushed limestone	2	1.3 - 1.9	1.6	2	0.3 - 1.1	0.7
		Various limestone products	8	0.8 - 14	3.9	8	0.46 - 5.0	2.1
Taconite mining and processing	1	Pellets	9	2.2 - 5.4	3.4	7	0.05 - 2.0	0.9
		Tailings	2	ND	11	1	—	0.4
Western surface coal mining	4	Coal	15	3.4 - 16	6.2	7	2.8 - 20	6.9
		Overburden	15	3.8 - 15	7.5	0	—	—
		Exposed ground	3	5.1 - 21	15	3	0.8 - 6.4	3.4
Coal-fired power plant	1	Coal (as received)	60	0.6 - 4.8	2.2	59	2.7 - 7.4	4.5
Municipal solid waste landfills	4	Sand	1	—	2.6	1	—	7.4
		Slag	2	3.0 - 4.7	3.8	2	2.3 - 4.9	3.6
		Cover	5	5.0 - 16	9.0	5	8.9 - 16	12
		Clay/dirt mix	1	—	9.2	1	—	14
		Clay	2	4.5 - 7.4	6.0	2	8.9 - 11	10
		Fly ash	4	78 - 81	80	4	26 - 29	27
		Misc. fill materials	1	—	12	1	—	11

[a] References 1-10. ND = no data.

EMISSIONS

Emission Factors

Variable	Input	Units	Multiplier*	Substance	EF**	EF Units
Mean Wind Speed	6.860	m/s	0.74	TSP	0.02258	kg/tonne
Material Moisture content	0.700	%	0.35	PM_{10}	0.01068	kg/tonne
Total Quantity Stored in Pile	1544.616	tonnes	0.053	$PM_{2.5}$	0.00162	kg/tonne

* Particle Size Multiplier is constant for each specific particle size range (AP-42, chapter 13.2.4-1, Final report, November 2006).

** EF= Emission Factor for Aggregate Handling activities calculated using equation (1) in AP-42, chapter 13.2.4-1, Final report, November 2006.

Releases per Stockpile

Emissions (tonnes)	Per Stockpile
TSP	0.035
PM_{10}	0.016
$PM_{2.5}$	0.002

Phase	Argentia Wind Facility					Argentia Green Fuels Facility	
Material	Road Base	Select Screened Cable Backfill	Substation Imported Fill	Surfacing Gravel	Washed Gravel	Class A	Class B
# Stockpiles							
Year 2	47	2	2	17	1	2	1
Year 3	47	2	2	17	1	2	1

Emissions (tonnes)	Argentia Wind Facility Road Base	Select Screened Cable Backfill	Substation Imported Fill	Surfacing Gravel	Washed Gravel	Argentia Green Fuels Facility Class A	Class B	TOTAL (tonnes)
Year 2								
TSP	1.64	0.05	0.07	0.59	0.03	0.07	0.03	2.49
PM_{10}	0.78	0.02	0.03	0.28	0.02	0.03	0.02	1.18
$PM_{2.5}$	0.12	0.00	0.00	0.04	0.00	0.00	0.00	0.18
Year 3								
TSP	1.64	0.05	0.07	0.59	0.03	0.07	0.03	2.49
PM_{10}	0.78	0.02	0.03	0.28	0.02	0.03	0.02	1.18
$PM_{2.5}$	0.12	0.00	0.00	0.04	0.00	0.00	0.00	0.18

*assume that emissions in this table are both in tonnes and tonnes per year

TOTAL	TSP	4.99
	PM_{10}	2.36
	$PM_{2.5}$	0.36

CONSTRUCTION - CRUSHING & SCREENING

ASSUMPTIONS

All required materials will be crushed and screened on site as a conservative estimate

Moisture content of crushed/screened material will be <1.5% (i.e., 0.3-1.1%) therefore emissions assumed to be uncontrolled

https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/pits-quarries-guide.html#crushing

ρ_{gravel} (kg/m^3)	1475

Material	Quanity (tonnes)
Argentia Wind Facility	
Road Base	145,022
Select Screened Cable Backfill	4,543
Substation Imported Fill	6,549
Surfacing Gravel	51,905
Washed Gravel	2,522
Argentia Green Fuels Facility	
Class A	6,000
Class B	2,600
TOTAL	219,142
Annual Aggregate Requirement	109,571

Process	Substance	EF (kg/tonne)	Emissions (tonnes/yr)
Primary Crushing	TSP - Uncontrolled	0.0027	0.296
Primary Crushing	PM_{10} - Uncontrolled	0.0012	0.131
Primary Crushing	$PM_{2.5}$ - Uncontrolled	0.0006	0.066
Secondary Crushing	TSP - Uncontrolled	0.0027	0.296
Secondary Crushing	PM_{10} - Uncontrolled	0.0012	0.131
Secondary Crushing	$PM_{2.5}$ - Uncontrolled	0.0006	0.066
Screening	TSP - Uncontrolled	0.0125	1.370
Screening	PM_{10} - Uncontrolled	0.0043	0.471
Screening	$PM_{2.5}$ - Uncontrolled	0	0.000
Conveyor Transfer Point	TSP - Uncontrolled	0.0015	0.164
Conveyor Transfer Point	PM_{10} - Uncontrolled	0.00055	0.060
Conveyor Transfer Point	$PM_{2.5}$ - Uncontrolled	0	0.000

Total Release

Substance	Emissions (tonnes/yr)	Total (tonnes)
TSP - Uncontrolled	2.126	4.251
PM_{10} - Uncontrolled	0.794	1.589
$PM_{2.5}$ - Uncontrolled	0.131	0.263

CONSTRUCTION - LAYDOWN AREAS

ASSUMPTIONS

Turbine laydown areas and crane pads assume just in time blade delivery, allowance for single blade offload only

Size Fraction	TSP	PM_{10}	$PM_{2.5}$
Emission Factors (kg/m^2)	4.93E-02	2.46E-02	3.70E-03

Laydown Area	Area		Annual Emissions (t/yr)		
	ha	m^2	TSP	PM_{10}	$PM_{2.5}$
Argentia Wind Facility					
Port Laydown & Storage Area	6	60000	2.96	1.48	0.22
Backlands Laydown	5	50000	2.46	1.23	0.18
Argentia Green Fuels Facility					
Laydown 1	0.24	2400	0.12	0.06	0.01
Laydown 2	0.05	500	0.02	0.01	0.00
Laydown 3	0.084	840	0.04	0.02	0.00
Laydown 4	0.3	3000	0.15	0.07	0.01
		TOTAL	5.754	2.877	0.432

CHECK	TOTAL	116740	5.75	2.88	0.43

CONSTRUCTION - UNPAVED ROADS

EMISSION FACTOR

Species	TSP	PM_{10}	$PM_{2.5}$
k (kg/VKT)	1.381	0.423	0.042
a	0.700	0.900	0.900
b	0.450	0.450	0.450

Where
k - constant in kg/VKT from AP-42 Table 13.2.2-2
a & b - constants from AP-42 Table 13.2.2-2 (unitless)
s - surface material silt content (%)
W - mean vehicle weight (metric tons)

Vehicle	Empty (tonnes)	Full (tonnes)	Average	Average
Blade Transport	15	38	26.5	
Other Component Transport*	15	90	52.5	39.5

*Assumes heaviest component

EF	TSP	PM_{10}	$PM_{2.5}$
kg/VKT	3.642	1.043	0.104

EMISSIONS

Project Work Area*	Area Location	Wind Turbine Site Numbers	# Turbines	# components	# blades	# other components
1**	Within the PoA	1-7	6	60	18	42
2	PoA Privately owned land, known as the Backlands	8 - 43	36	360	108	252
3	South from PoA, Moll Point area	44 - 46	3	30	9	21
4	Hilltop, west of the community of Freshwater	47	1	10	3	7
		Total	46	460	138	322

*As defined in Appendix "E" - Transportation Impact Study and Traffic Mgmt Plan
**Turbine 3 does not exist

Area	Segment	Length (km)	# Turbines	# Blade Trips Total	# Blade Trips Annual	Annual Blade VKT	# Other Trips Total	# Other Trips Annual	Annual Other VKT	Total Annual VKT	Dust Control Method (H2O 2x)	Natural Adjustment	TSP Emissions (t/y)	PM10 Emissions (t/y)	PM2.5 Emissions (t/y)
Area 1	1	5.891	6	120	60	353.434	36	18	106.030	459.464	55%	33%	0.308	0.088	0.009
Area 2	1	8.628	8	48	24	207.072	112	56	483.168	690.240	55%	33%	0.462	0.132	0.013
	2	8.767	10	60	30	263.021	200	100	876.735	1139.756	55%	33%	0.763	0.218	0.022
	3	3.559	4	24	12	42.707	56	28	99.651	142.358	55%	33%	0.095	0.027	0.003
	4	3.677	4	24	12	44.130	56	28	102.970	147.099	55%	33%	0.098	0.028	0.003
	5	1.840	3	18	9	16.556	42	21	38.632	55.188	55%	33%	0.037	0.011	0.001
	6	9.261	7	42	21	194.491	98	49	453.812	648.302	55%	33%	0.434	0.124	0.012
Area 3	1	2.340	3	18	9	21.063	42	21	49.148	70.211	55%	33%	0.047	0.013	0.001
Area 4	1	1.385	1	6	3	4.155	14	7	9.696	13.851	55%	33%	0.009	0.003	0.000
												Annual (t/y)	2.254	0.645	0.065

CONSTRUCTION - MOBILE EQUIPMENT

ASSUMPTIONS

Assume 10 hour work days

Assume that usage is across entire construction period, estimated to be 140 weeks/35 months per FEL-1 Section 9.0 (Schedule)

Models selected to estimate rated engine power, conservative assumptions made

Where unit numbers were not specified, assume that usage includes sum of all units required to complete the work

EQUIPMENT DETAILS - Argentia Wind Facility

Type	Net Power (output; hp)	Units	Usage (hrs)
Excavator	108	1	4,500
Support	111	1	1500
Backfill Equip	157	1	7800
Support	160	1	5500
Backfill Equip	162	1	2100
Trucks	173	1	15000
Excavator	188	1	4,200
Excavator	188	1	1,000
Backfill Equip	215	1	8600
Drills	225	1	3600
Trucks	250	1	5,800
Excavator	300	1	6,000
Support	360	1	2000
Trucks	370	1	1,500
Crushing	393	1	2300
Excavator	424	1	12,500
Concrete	425	1	7500
Drills	431	1	3800
Trucks	473	1	10,000
Concrete	485	1	7500
Crushing	541	1	2300
Cranes	544	2	2800
Support	544	1	1200
Cranes	687	2	2450
Trucks	700	1	1,500

Argentia Green Fuels Facility

Equipment	Net Power (output; hp)	Units	Operating Hours	Usage Factor
Backhoe	104	4	3,920	40%
Compactor	157	4	1,960	20%
Bulldozers	215	2	3,920	40%
Pickup Truck	250	4	3,920	40%
Impact Pile Driver	335	2	1,960	20%
Hyd. Rock Breakers	359	2	3,920	40%
Vibratory Hammer	359	2	1,960	20%
Flat Bed Truck	360	4	3,920	40%
Concrete Truck	425	10	3,920	40%
Concrete Pump Truck	485	2	1,960	20%
Crane	544	4	1,568	16%

EMISSION DETAILS - Argentia Wind Facility

Emission Factors

Engine Power [1]	g/hp-hr			lb/hp-hr
	NOx	CO	TSP	SO_2 [2,3]
≥75 to <100	0.3	0	0.01	2.05E-03
≥100 to <175	0.3	3.7	0.01	2.05E-03
≥175 to <300	0.3	2.6	0.01	2.05E-03
≥300 to <600	0.3	2.6	0.01	2.05E-03
≥600 to <750	0.3	2.6	0.01	0.004045
≥750	2.6	2.6	0.03	0.004045

[1] Assume all engines are Tier 4

[2] Diesel fuel EF for SOx for engines < 600 hp retrieved from AP-42 Gasoline and Diesel Industrial Engines, Table 3.3-1

[3] Diesel fuel EF for SOx for engines >600 hp retrieved from AP-42 Large Stationary Diesel and All Stationary Dual-fuel Engines, Table 3.4-1; %S assumed to be 0.5%

** assumes all SOx converted to SO2

Type	Net Power (output; hp)	Units	Usage (hrs)	Emissions (tonnes) NOx	CO	TSP	SO_2
Excavator	108	1	4500	0.1	1.8	0.00	0.45
Support	111	1	1500	0.0	0.6	0.00	0.16
Backfill Equip	157	1	7800	0.4	4.5	0.01	1.14
Support	160	1	5500	0.3	3.3	0.01	0.82
Backfill Equip	162	1	2100	0.1	1.3	0.00	0.32
Trucks	173	1	15000	0.8	9.6	0.03	2.42
Excavator	188	1	4200	0.2	2.1	0.01	0.74
Excavator	188	1	1000	0.1	0.5	0.00	0.18
Backfill Equip	215	1	8600	0.6	4.8	0.02	1.72
Drills	225	1	3600	0.2	2.1	0.01	0.75
Trucks	250	1	5800	0.4	3.8	0.01	1.35
Excavator	300	1	6000	0.5	4.7	0.02	1.68
Support	360	1	2000	0.2	1.9	0.01	0.67
Trucks	370	1	1500	0.2	1.4	0.01	0.52
Crushing	393	1	2300	0.3	2.4	0.01	0.84
Excavator	424	1	12500	1.6	13.8	0.05	4.94
Concrete	425	1	7500	1.0	8.3	0.03	2.97
Drills	431	1	3800	0.5	4.3	0.02	1.53
Trucks	473	1	10000	1.4	12.3	0.05	4.41
Concrete	485	1	7500	1.1	9.5	0.04	3.39
Crushing	541	1	2300	0.4	3.2	0.01	1.16
Cranes	544	2	2800	0.9	7.9	0.03	2.84
Support	544	1	1200	0.2	1.7	0.01	0.61
Cranes	687	2	2450	1.0	8.8	0.03	6.19
Trucks	700	1	1500	2.7	2.7	0.03	1.93
			TOTAL	15.2	117.0	0.4	43.7
			Annual	7.6	58.5	0.2	21.9

EMISSION DETAILS - Argentia Green Fuels Facility

Engine Power [1]	g/hp-hr			lb/hp-hr
	NOx	CO	TSP	SO_2 [2,3]
≥75 to <100	0.3	0	0.01	2.05E-03
≥100 to <175	0.3	3.7	0.01	2.05E-03
≥175 to <300	0.3	2.6	0.01	2.05E-03
≥300 to <600	0.3	2.6	0.01	2.05E-03
≥600 to <750	0.3	2.6	0.01	0.004045
≥750	2.6	2.6	0.03	0.004045

[1] Assume all engines are Tier 4

[2] Diesel fuel EF for SOx for engines < 600 hp retrieved from AP-42 Gasoline and Diesel Industrial Engines, Table 3.3-1

[3] Diesel fuel EF for SOx for engines >600 hp retrieved from AP-42 Large Stationary Diesel and All Stationary Dual-fuel Engines, Table 3.4-1; %S assumed to be 0.5%

** assumes all SOx converted to SO2

Equipment	Net Power (output; hp)	Units	Operating Hours	Emissions (tonnes) NOx	CO	TSP	SO_2
Backhoe	104	4	3920	0.489	6.034	0.016	1.520
Compactor	157	4	1960	0.369	4.554	0.000	1.147
Bulldozers	215	2	3920	0.506	4.383	0.017	1.571
Pickup Truck	250	4	3920	1.176	10.192	0.039	0.659
Impact Pile Driver	335	2	1960	0.394	3.414	0.013	1.224
Hyd. Rock Breakers	359	2	3920	0.844	7.318	0.028	2.623
Vibratory Hammer	359	2	1960	0.422	3.659	0.014	1.311
Flat Bed Truck	360	4	3920	1.693	14.676	0.056	5.260
Concrete Truck	425	10	3920	4.998	43.316	0.167	15.524
Concrete Pump Truck	485	2	1960	0.570	4.943	0.019	1.772
Crane	544	4	1568	1.024	8.871	0.034	3.179
			TOTAL	12.5	111.4	0.4	35.8
			Annual	6.2	55.7	0.2	17.9

ANNUAL EMISSIONS - Construction Period

Project Component	Annual Emissions (tonnes) NOx	CO	TSP	SO_2
Argentia Wind Facility	7.6	58.5	0.2	21.9
Argentia Green Fuels Facility	6.2	55.7	0.2	17.9
Total	13.8	114.2	0.4	39.7

CONSTRUCTION - STATIONARY COMBUSTION

Argentia Wind Facility

Approximately 4.5 million liters will be required for the construction period; approx. 7.5% (5-10% estimated) will be used in stationary equipment. The remaining 92.5% will be burned in mobile equipment

Assume that fuel burn is split evenly across the two years of construction for the Argentia Wind Facility

Fuel Details

Fuel Type	Diesel
Total fuel burn (L)	4,500,000
Stationary fuel burn (L)	337,500

Argentia Green Fuels Facility

Assume that only stationary equipment to be used on site shall be generators and vibratory hammers.

Assumptions will likely result in an overestimate of diesel consumption, which shall account for any diesel used for other small stationary equipment

Generator Details

Equipment [1]	Power Output (kW) [1]	Quantity	Usage Factor	Operating Hours	Diesel Consumption (L)	Annual Diesel Consumption (L)
6 kW light tower generator	6	8	50%	11,760	28,224.00	14,112

[1] Assume comparable to light tower generator (https://www.unitedrentals.com/marketplace/equipment/lighting-equipment/towable-light-towers/towable-light-tower-6kw-generator-4200w-30-ft-vertical-mast-diesel-powered)

EMISSIONS - Argentia Green Fuels Facility & Argentia Wind Facility

Emissions calculation method(s) derived from the Diesel Fuel Generator - Fuel Usage (Up to 600 hp) calculation spreadsheet developped by the NPRI (https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/tools-calculating-emissions/diesel-fuel-generator-fuel-usage.html)

Total fuel burn (L)	365,724
Annual fuel burn (L; 2 yrs)	182,862
HHV_{Diesel} ($GJ \cdot m^{-3}$)	38.184

Substance Name	CAS Number	Emission Factor	EF** Units	EF Rating	Activity Rate (m^3)	Total Release to 3 decimals	Units
Carbon Monoxide (CO)	630-08-0	1.560E+01	kg/m^3	D	182.862	2.852	tonnes
Sulphur Dioxide (SO_2)	7446-09-5	4.761E+00	kg/m^3	D	182.862	0.871	tonnes
NOx, expressed as NO_2	11104-93-1	7.240E+01	kg/m^3	D	182.862	13.238	tonnes
Total VOCs	*	5.910E+00	kg/m^3	D	182.862	1.081	tonnes
Total Suspended Particulate (TSP)	*	5.089E+00	kg/m^3	D	182.862	0.931	tonnes
PM10	*	5.089E+00	kg/m^3	D	182.862	0.931	tonnes
PM2.5	*	5.089E+00	kg/m^3	D	182.862	0.931	tonnes
Acetaldehyde	75-07-0	1.259E-02	kg/m^3	E	182.862	0.002	tonnes
Acrolein	107-08-8	7.592E-04	kg/m^3	E	182.862	0.000	tonnes
Benzene	71-43-2	1.532E-02	kg/m^3	E	182.862	0.003	tonnes
1,3-Butadiene	106-99-0	3.209E-04	kg/m^3	E	182.862	0.000	tonnes
Formaldehyde	50-00-0	1.937E-02	kg/m^3	E	182.862	0.004	tonnes
Naphthalene	91-20-3	1.392E-03	kg/m^3	E	182.862	0.000	tonnes
Propylene	115-07-1	4.235E-02	kg/m^3	E	182.862	0.008	tonnes
Toluene	108-88-3	6.714E-03	kg/m^3	E	182.862	0.001	tonnes
Xylene (all isomers)	1330-20-7	4.679E-03	kg/m^3	E	182.862	0.001	tonnes
Mercury (and its compounds)	*	4.948E-06	kg/m^3	U	182.862	0.000	tonnes
Acenaphthene	83-32-9	1.166E-05	kg/m^3	E	182.862	0.000	tonnes
Acenaphthylene	208-96-8	4.153E-05	kg/m^3	E	182.862	0.000	tonnes
Anthracene	120-12-7	3.070E-05	kg/m^3	E	182.862	0.000	tonnes
Benz[a]anthracene	56-55-3	2.758E-05	kg/m^3	E	182.862	0.000	tonnes
Chrysene	218-01-9	5.795E-06	kg/m^3	E	182.862	0.000	tonnes
Benzo[a]pyrene	50-32-8	1.543E-06	kg/m^3	E	182.862	0.000	tonnes
Benzo[b] fluoranthene	205-99-2	8.134E-07	kg/m^3	E	182.862	0.000	tonnes
Benzo[ghi]perylene	191-24-2	4.014E-06	kg/m^3	E	182.862	0.000	tonnes
Benzo[k]fluoranthene	207-08-9	1.272E-06	kg/m^3	E	182.862	0.000	tonnes
Dibenz[a,h]anthracene	53-70-3	4.785E-06	kg/m^3	E	182.862	0.000	tonnes
Fluoranthene	206-44-0	1.249E-04	kg/m^3	E	182.862	0.000	tonnes
Fluorene	86-73-7	4.794E-04	kg/m^3	E	182.862	0.000	tonnes
Inden[1,2,3-cd]pyrene	193-39-5	3.078E-06	kg/m^3	E	182.862	0.000	tonnes
Phenanthrene	85-01-8	4.826E-04	kg/m^3	E	182.862	0.000	tonnes
Pyrene	129-00-0	7.847E-05	kg/m^3	E	182.862	0.000	tonnes

OPERATION - EMERGENCY GENERATOR

One diesel generator will be required to generate approx. 8 MW of standby (i.e., emergency) power in the event of power loss, maintenance, start up/shut down, etc.
It was assumed that the emergency generator will be used for a maximum of 100 hours per year (i.e., approx 1 day per quarter)
The general rule of thumb that a diesel generator will use 0.4 L of fuel per kWh was applied here in the absence of equipment-specific fuel burn rate.
Default heating value and sulfur content used in calculations.
The default value for sulfur (S) corresponds with Maximum Limits for large stationary engines under the Sulphur in Duesel Fuel Regs (noted in 2022 calculator from NPRI).

INPUTS: Generator & Fuel Details

Power Output (MW)	Operating Hours	Diesel Consumption (m^3)	Heating Value (GJ/m^3)	S content (%)	Heat Input rate (MMBtu/hr)
8	96	307.2	38.184	0.1	115.8

Large Stationary Diesel Engines (>600 hp) [Source: NPRI] NPRI
Emissions AP-42 Ch 3.4

Substance	Emission Factor (kg/m^3)	Annual Emissions (tonnes/year)
Acetaldehyde	4.137E-04	0.000
Acrolein	1.294E-04	0.000
Benzene	1.274E-02	0.004
Formaldehyde	1.295E-03	0.000
Naphtalene	2.134E-03	0.001
Propylene	4.580E-02	0.014
Toluene	4.613E-03	0.001
Xylene (all isomers)	3.168E-03	0.001
Acenaphthene	7.683E-05	0.000
Acenaphthylene	1.515E-04	0.000
Anthracene	2.019E-05	0.000
Benz[a]anthracene	1.021E-05	0.000
Benzo[b]fluoranthene	1.822E-05	0.000
Benzo[k]fluoranthene	1.789E-06	0.000
Benzo[a]pyrene	2.109E-06	0.000
Chrysene	2.512E-05	0.000
Benzo[ghi]perylene	4.564E-06	0.000
Dibenz[a,h]anthracene	2.840E-06	0.000
Fluoranthene	6.616E-05	0.000
Fluorene	2.101E-04	0.000
Indeno[1,2,3-cd]pyrene	3.398E-06	0.000
Phenanthrene	6.698E-04	0.000
Pyrene	6.090E-05	0.000
CO	13.954	4.287
SO_2	1.658	0.509
NOx (expressed as NO_2)	52.532	16.138
Total VOCs	1.344	0.413
TSP	1.018	0.313
PM_{10}	0.814	0.250
$PM_{2.5}$	0.786	0.242

Emission Rates

Substance	Emission Factor (lb/mmBtu)	Emission Rate (g/s) Hourly	Daily	Annual
Acetaldehyde	2.520E-05	3.677E-04	3.677E-04	4.030E-06
Acrolein	7.880E-06	1.150E-04	1.150E-04	1.260E-06
Benzene	7.760E-04	1.132E-02	1.132E-02	1.241E-04
Formaldehyde	7.890E-05	1.151E-03	1.151E-03	1.262E-05
Naphtalene	1.300E-04	1.897E-03	1.897E-03	2.079E-05
Propylene	2.790E-03	4.071E-02	4.071E-02	4.462E-04
Toluene	2.810E-04	4.100E-03	4.100E-03	4.494E-05
Xylene (all isomers)	1.930E-04	2.816E-03	2.816E-03	3.086E-05
Acenaphthene	4.680E-06	6.829E-05	6.829E-05	7.484E-07
Acenaphthylene	9.230E-06	1.347E-04	1.347E-04	1.476E-06
Anthracene	1.230E-06	1.795E-05	1.795E-05	1.967E-07
Benz[a]anthracene	6.220E-07	9.076E-06	9.076E-06	9.947E-08
Benzo[b]fluoranthene	1.110E-06	1.620E-05	1.620E-05	1.775E-07
Benzo[k]fluoranthene	1.090E-07	1.591E-06	1.591E-06	1.743E-08
Benzo[a]pyrene	1.285E-07	1.875E-06	1.875E-06	2.055E-08
Chrysene	1.530E-06	2.233E-05	2.233E-05	2.447E-07
Benzo[ghi]perylene	2.780E-07	4.057E-06	4.057E-06	4.446E-08
Dibenz[a,h]anthracene	1.730E-07	2.524E-06	2.524E-06	2.767E-08
Fluoranthene	4.030E-06	5.881E-05	5.881E-05	6.445E-07
Fluorene	1.280E-05	1.868E-04	1.868E-04	2.047E-06
Indeno[1,2,3-cd]pyrene	2.070E-07	3.021E-06	3.021E-06	3.310E-08
Phenanthrene	4.080E-05	5.954E-04	5.954E-04	6.524E-06
Pyrene	3.710E-06	5.414E-05	5.414E-05	5.933E-07
CO	0.8500	12.403	12.403	0.136
SO_2 (expressed as SOx)	0.1010	1.474	1.474	0.016
NOx (expressed as NO_2)	3.2000	46.695	46.695	0.512
Total VOCs	0.0900	1.313	1.313	0.014
TSP	0.0620	0.905	0.905	0.010
PM_{10}	0.0496	0.724	0.724	0.008
$PM_{2.5}$	0.0479	0.699	0.699	0.008

OPERATION - FLARE STACKS

INPUTS

Flare Details

	Process Flare	Tank Flare
Destruction Efficiency (%)	0.98	0.98
Flare Volumetric Flow Rate (m^3/hr) [1]	72.7	72.7
Pilot Volumetric Flow Rate (m^3/hr) [2]	2.18	2.18
Pilot Mass Flow Rate (kg/hr)	3.71	3.71
Density of propane (kg/m^3) [3]	1.7	1.7
Pilot operation (hr/yr)	8760	8760
Annual fuel consumption (m^3/yr)	19,106	19,106
Annual fuel consumption (L/yr)	19,105,560	19,105,560

[1] As per FEL-1 Heat & Materials Balance for Flare Gas
[2] Assumed to be 3% of volumetric flow rate of flare (USEPA 2012)
[3] Engineering toolbox

Emission Factors - Thermal NOx

Species	EF	Units	EF Source
NOx	0.068	lb/10^6 Btu	TCEQ 2022
CO	0.5496	lb/10^6 Btu	TCEQ 2022
TSP	0.82312	kg/10^3 m^3 fuel	M&J 2012

Emission Factors - Fuel NOx

Species	EF	Units	EF Source
NOx	0.005	kg NOx/kg NH_3	TCEQ 2021

[1] EF retrieved from TCEQ 2021 sample calculations

Supplementary Data

Destruction Efficiency	0.98
Uncombusted	0.02
BTU/MJ (conversion)	947.82

Fuel Details

Species	HHV (MJ/kg)
C_3H_8	50.4
NH_3	22.5

EMISSIONS

Flare	Species Combusted	Flow Rate (kg/hr)[1]	Annual Operating Hours	Annual Emissions (tonnes/year)				
				NOx	CO	TSP	C_3H_8	NH_3
Continuous Pilots								
NH_3 Flare Unit (Process Flare)	C_3H_8	3.71	8,760	4.75E-02	3.84E-01	1.57E-02	0.650	
NH_3 Tank Flare Unit (Tank Flare)	C_3H_8	3.71	8,760	4.75E-02	3.84E-01	1.57E-02	0.650	
Intermittent Releases [3]								
NH_3 Flare Unit (Process Flare)	NH_3	16,667	1	9.42E-02				0.333
NH_3 Tank Flare Unit (Tank Flare)	NH_3	16,667	1	9.42E-02				0.333

[1] Continous pilot flow rates and intermittent releases from FEL-1
[2] Assume that both flows are comprised of 100% species combusted
[3] Assume that 1-hour worth of production could be released over a 1-hour period

EMISSION RATES

Flare	Species Combusted	Flow Rate (kg/hr)[1]	Annual Operating Hours	Emission Rate (g/s)														
				Hourly					Daily					Annual				
				NOx	CO	TSP	C_3H_8	NH_3	NOx	CO	TSP	C_3H_8	NH_3	NOx	CO	TSP	C_3H_8	NH_3
Continuous Pilots																		
NH3 Flare Unit (Process Flare)	C_3H_8	3.71	8,760	1.51E-03	1.22E-02	4.99E-01	2.06E-02		1.51E-03	1.22E-02	4.99E-01	2.06E-02		1.51E-03	1.22E-02	4.99E-01	2.06E-02	
NH3 Tank Flare Unit (Tank Flare)	C_3H_8	3.71	8,760	1.51E-03	1.22E-02	4.99E-01	2.06E-02		1.51E-03	1.22E-02	4.99E-01	2.06E-02		1.51E-03	1.22E-02	4.99E-01	2.06E-02	
Intermittent Releases [3]																		
NH3 Flare Unit (Process Flare)	NH_3	16,667	1	26.2				92.6	1.09				3.86	2.99E-03				1.06E-02
NH3 Tank Flare Unit (Tank Flare)	NH_3	16,667	1	26.2				92.6	1.09				3.86	2.99E-03				1.06E-02

[1] Continous pilot flow rates and intermittent releases from FEL-1
[2] Assume that both flows are comprised of 100% species combusted
[3] Assume that 1-hour worth of production could be released over a 1-hour period

OPERATION - MARINE TRANSPORT

SNC FEL assumes that ship loading for NH3 off takers occurs once a month using a small-medium ammonia ship carrier
AQ releases are estimated for within-project area impacts rather than entire marine shipping route (Guidance Doc does not stipulate the requirement of AQ release accounting outside of the project boundary)
Calculations conducted for emissions on a tonnes per year basis; emission rates were not used.

INPUTS, PARAMETERS & EMISSION FACTORS

Fuel Details

Type	Marine Gas Oil (MGO)
Density (kg/L)	0.855
Sulfur content (%)	0.10
HHV (kWh/kg) [1]	12.75

[1] Source: https://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html

Vessel Details

Type	LPG Tanker Clipper Eirene
Main Engine RPM	112.7
Engine Speed Designation	Slow (<130 RPM)
NH3 Capacity (tonnes)	14129
Main Engine Power (kW)	7100
AUX Engine Power (kW)	4200
Boiler Engine Power (kW)	482
Maneuvering Time (hr) [1]	1
Hotelling Time (hr) [2]	15

[1] Maneuvering time assumed to be 1 hour based on the short distance the vessel is required to travel from the Marine Entrance/Port Authority (MEPA) to the offtake jetty
[2] Hotelling time (rounded to nearest integer) based on tank capacities and loading rate of LPG Tanker

Vessel Time Details

Vessels per trip	1
Trips per year	12
Maneuvering Time per year	12
Hotelling Time per year	180
Total Vessel Time per year	192

Fuel Consumption - Clipper Eirene

Component	Fuel Consumption			
	ton/day	tonne/hr	L/hr	m^3/hr
Main Engine	22	0.8316	972.6	0.9726
AUX, Loading	9	0.3402	397.9	0.3979
SO_2	6	0.2268	265.3	0.2653
NOx (expressed as NO_2)	4	0.1512	176.8	0.1768
Boiler	1	0.0378	44.2	0.0442

[1] Equivalent to average consumption for loaded condition; assume that idle consumption=maneuvering consumption

Emission Factors (g/kWh)	Maeuvering		Hotelling	Boiler
	Main Engine	AUX Engine		(kg/m^3)
Time per mode (hr/yr)	12	12	180	192
Tanker Load Factor	0.07	0.33	0.26	0.6
NOx	14.4	9.7	9.7	2.4
CO	1.40	1.1	1.1	0.6
SO2	0.36	0.42	0.42	1.7
PM10	0.19	0.18	0.18	0.12
PM2.5	0.14	0.17	0.17	0.03
HC	0.60	0.40	0.40	-
TSP	0.19	0.18	0.18	0.12

[1] Tier II NOx limit used as a conservative estimate
[2] Hotelling auxiliary engine EFs retrieved from Table 2-16 (MGO, 0.10% S) of Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories: Ocean Going Vessels (https://www.epa.gov/sites/default/files/2016-06/documents/2009-port-inventory-guidance.pdf)
[3] EF for SOx, assume 100% SO2
[4] No EF for TSP, assume equal to PM10
[5] Main engine EFs retreived from Table 2-9 (EFs for Ocean Going Vessel Main Engines, slow-speed diesel (SSD))
[6] AUX Engine Load Factors retreived from Table 2-7 (Auxiliary Engine Load Factor Assumptions, Tanker)
[7] Boiler EFS retrieved from AP-42 Chapter 1.3 Fuel Oil Combustion (External Combustion Sources) Tables 1.3-1 & 1.3-6. Boilers < 100 MBtu/hr, distillate oil fired
[8] No Load Factor for main engine during hotelling as main engine is not in use

Emission Factors - Speciated Organics & PAHs - Clipper Eirene (w/ 0.1% S MGO)

Contaminant	EF (lb/MMBtu)	EF (kg/kWh)
Benzene	7.76E-04	1.20E-06
Toluene	2.81E-04	4.36E-07
Xylenes	1.93E-04	2.99E-07
Propylene	2.79E-03	4.33E-06
Formaldehyde	7.89E-05	1.22E-07
Acetaldehyde	2.52E-05	3.91E-08
Acrolein	7.88E-06	1.22E-08
Naphthalene	1.30E-04	2.02E-07
Acenaphthylene	9.23E-06	1.43E-08
Acenaphthene	4.68E-06	7.26E-09
Fluorene	1.28E-05	1.99E-08
Phenanthrene	4.08E-05	6.33E-08
Anthracene	1.23E-06	1.91E-09
Fluoranthene	4.03E-06	6.25E-09
Pyrene	3.71E-06	5.75E-09
Benz(a)anthracene	6.22E-07	9.65E-10
Chrysene	1.53E-06	2.37E-09
Benzo(b)fluoranthene	1.11E-06	1.72E-09
Benzo(k)fluoranthene	2.18E-07	3.38E-10
Benzo(a)pyrene	2.57E-07	3.99E-10
Indeno(1,2,3-cd)pyrene	4.14E-07	6.42E-10
Dibenz(a,h)anthracene	3.46E-07	5.37E-10
Benzo(g,h,l)perylene	5.56E-07	8.62E-10
Total PAH	2.12E-04	3.29E-07

SOURCE: USEPA AP-42 Table 3.4-3 & 4 Efs for Large Uncontrolled Stationary Diesel Engines (https://www.epa.gov/sites/default/files/2020-10/documents/c03s04.pdf)

ANNUAL & DAILY EMISSIONS

Emission calculations followed methodology set out in the DRAFT TECHNICAL GUIDE RELATED TO THE STRATEGIC ASSESSMENT OF CLIMATE CHANGE (Equation 3)

ANNUAL EMISSIONS - CACs

Contaminant	Emissions (tonnes/yr)				Total Annual Emissions (t/yr)	Total Annual Emissions (kg/yr)
	Maeuvering		Hotelling	Boiler		
	Main Engine	AUX Engine	AUX Engine			
NOx	0.082	0.161	1.907	0.020	2.171	2170.6
CO	0.008	0.018	0.216	0.005	0.248	247.6
SO2	0.002	0.007	0.083	0.014	0.106	106.1
PM10	0.001	0.003	0.035	0.001	0.040	40.5
PM2.5	0.001	0.003	0.033	0.000	0.037	37.3
HC (hydrocarbons)	0.003	0.007	0.079	-	0.089	88.7

DAILY EMISSIONS - CACs

Contaminant	Emissions (tonnes/day)				Total Daily Emissions (t/yr)	Total Daily Emissions (kg/yr)	CHECK
	Maeuvering		Hotelling	Boiler			
	Main Engine	AUX Engine	AUX Engine				
NOx	0.007	0.013	0.159	0.002	0.181	180.9	2170.6
CO	0.001	0.002	0.018	0.000	0.021	20.6	247.6
SO2	0.000	0.001	0.007	0.001	0.009	8.8	106.1
PM10	0.000	0.000	0.003	0.000	0.003	3.4	40.5
PM2.5	0.000	0.000	0.003	0.000	0.003	3.1	37.3
HC	0.000	0.001	0.007	-	0.007	7.4	88.7

ANNUAL EMISSIONS - Speciated Organics & PAHs

Contaminant	Emissions (tonnes/yr)				Total Annual Emissions (t/yr)	Total Annual Emissions (kg/yr)
	Maeuvering		Hotelling	Boiler		
	Main Engine	AUX Engine	AUX Engine			
Benzene	6.875E-06	2.002E-05	2.366E-04	6.682E-05	3.303E-04	3.303E-01
Toluene	2.490E-06	7.248E-06	8.566E-05	2.420E-05	1.196E-04	1.196E-01
Xylenes	1.710E-06	4.978E-06	5.884E-05	1.662E-05	8.214E-05	8.214E-02
Propylene	2.472E-05	7.197E-05	8.505E-04	2.402E-04	1.187E-03	1.187E+00
Formaldehyde	6.990E-07	2.035E-06	2.405E-05	6.794E-06	3.358E-05	3.358E-02
Acetaldehyde	2.233E-07	6.500E-07	7.682E-06	2.170E-06	1.073E-05	1.073E-02
Acrolein	6.981E-08	2.033E-07	2.402E-06	6.785E-07	3.354E-06	3.354E-03
Naphthalene	1.152E-06	3.353E-06	3.963E-05	1.119E-05	5.533E-05	5.533E-02
Acenaphthylene	8.177E-08	2.381E-07	2.814E-06	7.948E-07	3.928E-06	3.928E-03
Acenaphthene	4.146E-08	1.207E-07	1.427E-06	4.030E-07	1.992E-06	1.992E-03
Fluorene	1.134E-07	3.302E-07	3.902E-06	1.102E-06	5.448E-06	5.448E-03
Phenanthrene	3.615E-07	1.052E-06	1.244E-05	3.513E-06	1.737E-05	1.737E-02
Anthracene	1.090E-08	3.173E-08	3.750E-07	1.059E-07	5.235E-07	5.235E-04
Fluoranthene	3.570E-08	1.040E-07	1.229E-06	3.470E-07	1.715E-06	1.715E-03
Pyrene	3.287E-08	9.570E-08	1.131E-06	3.195E-07	1.579E-06	1.579E-03
Benz(a)anthracene	5.511E-09	1.604E-08	1.896E-07	5.356E-08	2.647E-07	2.647E-04
Chrysene	1.356E-08	3.947E-08	4.664E-07	1.317E-07	6.512E-07	6.512E-04
Benzo(b)fluoranthene	9.834E-09	2.863E-08	3.384E-07	9.558E-08	4.724E-07	4.724E-04
Benzo(k)fluoranthene	1.931E-09	5.623E-09	6.646E-08	1.877E-08	9.278E-08	9.278E-05
Benzo(a)pyrene	2.277E-09	6.629E-09	7.835E-08	2.213E-08	1.094E-07	1.094E-04
Indeno(1,2,3-cd)pyrene	3.668E-09	1.068E-08	1.262E-07	3.565E-08	1.762E-07	1.762E-04
Dibenz(a,h)anthracene	3.065E-09	8.925E-09	1.055E-07	2.979E-08	1.473E-07	1.473E-04
Benzo(g,h,i)perylene	4.926E-09	1.434E-08	1.695E-07	4.788E-08	2.366E-07	2.366E-04
Total PAH	1.878E-06	5.469E-06	6.463E-05	1.825E-05	9.023E-05	9.023E-02

DAILY EMISSIONS - Speciated Organics & PAHs

Contaminant	Emissions (tonnes/yr)				Total Annual Emissions (t/yr)	Total Annual Emissions (kg/yr)	CHECK
	Maeuvering		Hotelling	Boiler			
	Main Engine	AUX Engine	AUX Engine				
Benzene	5.729E-07	1.668E-06	1.971E-05	5.568E-06	2.752E-05	2.752E-02	3.303E-01
Toluene	2.075E-07	6.040E-07	7.139E-06	2.016E-06	9.966E-06	9.966E-03	1.196E-01
Xylenes	1.425E-07	4.149E-07	4.903E-06	1.385E-06	6.845E-06	6.845E-03	8.214E-02
Propylene	2.060E-06	5.997E-06	7.088E-05	2.002E-05	9.896E-05	9.896E-02	1.187E+00
Formaldehyde	5.825E-08	1.696E-07	2.004E-06	5.662E-07	2.798E-06	2.798E-03	3.358E-02
Acetaldehyde	1.861E-08	5.417E-08	6.402E-07	1.808E-07	8.938E-07	8.938E-04	1.073E-02
Acrolein	5.818E-09	1.694E-08	2.002E-07	5.654E-08	2.795E-07	2.795E-04	3.354E-03
Naphthalene	9.598E-08	2.794E-07	3.303E-06	9.328E-07	4.611E-06	4.611E-03	5.533E-02
Acenaphthylene	6.814E-09	1.984E-08	2.345E-07	6.623E-08	3.274E-07	3.274E-04	3.928E-03
Acenaphthene	3.455E-09	1.006E-08	1.189E-07	3.358E-08	1.660E-07	1.660E-04	1.992E-03
Fluorene	9.450E-09	2.751E-08	3.252E-07	9.185E-08	4.540E-07	4.540E-04	5.448E-03
Phenanthrene	3.012E-08	8.770E-08	1.036E-06	2.928E-07	1.447E-06	1.447E-03	1.737E-02
Anthracene	9.081E-10	2.644E-09	3.125E-08	8.826E-09	4.363E-08	4.363E-05	5.235E-04
Fluoranthene	2.975E-09	8.663E-09	1.024E-07	2.892E-08	1.429E-07	1.429E-04	1.715E-03
Pyrene	2.739E-09	7.975E-09	9.425E-08	2.662E-08	1.316E-07	1.316E-04	1.579E-03
Benz(a)anthracene	4.592E-10	1.337E-09	1.580E-08	4.463E-09	2.206E-08	2.206E-05	2.647E-04
Chrysene	1.130E-09	3.289E-09	3.887E-08	1.098E-08	5.427E-08	5.427E-05	6.512E-04
Benzo(b)fluoranthene	8.195E-10	2.386E-09	2.820E-08	7.965E-09	3.937E-08	3.937E-05	4.724E-04
Benzo(k)fluoranthene	1.609E-10	4.686E-10	5.538E-09	1.564E-09	7.732E-09	7.732E-06	9.278E-05
Benzo(a)pyrene	1.897E-10	5.524E-10	6.529E-09	1.844E-09	9.115E-09	9.115E-06	1.094E-04
Indeno(1,2,3-cd)pyrene	3.057E-10	8.899E-10	1.052E-08	2.971E-09	1.468E-08	1.468E-05	1.762E-04
Dibenz(a,h)anthracene	2.555E-10	7.438E-10	8.790E-09	2.483E-09	1.227E-08	1.227E-05	1.473E-04
Benzo(g,h,l)perylene	4.105E-10	1.195E-09	1.412E-08	3.990E-09	1.972E-08	1.972E-05	2.366E-04
Total PAH	1.565E-07	4.557E-07	5.386E-06	1.521E-06	7.519E-06	7.519E-03	9.023E-02

EMISSION RATES

Emission Rates - CACs

Contaminant	Hourly Emission Rates (g/s)				Total Hourly Maximum Emissions (g/s)
	Maeuvering		Hotelling	Boiler	
	Main Engine	AUX Engine	AUX Engine		
NOx	1.904	3.735	2.942	0.018	8.599
CO	0.185	0.424	0.334	0.004	0.947
SO2	0.048	0.162	0.127	0.013	0.349
PM10	0.025	0.069	0.055	0.001	0.150
PM2.5	0.019	0.065	0.052	0.000	0.136
HC	0.079	0.154	0.121	-	0.355

Emission Rates - Speciated Organics & PAHs

Contaminant	Hourly Emission Rates (g/s)				Total Hourly Maximum Emissions (g/s)
	Maeuvering		Hotelling	Boiler	
	Main Engine	AUX Engine	AUX Engine		
Benzene	2.180E-08	1.951E-08	3.458E-08	8.868E-09	8.476E-08
Toluene	7.894E-09	7.065E-09	1.252E-08	3.211E-09	3.069E-08
Xylenes	5.422E-09	4.852E-09	8.602E-09	2.206E-09	2.108E-08
Propylene	7.838E-08	7.014E-08	1.243E-07	3.188E-08	3.048E-07
Formaldehyde	2.217E-09	1.984E-09	3.516E-09	9.016E-10	8.618E-09
Acetaldehyde	7.080E-10	6.336E-10	1.123E-09	2.880E-10	2.753E-09
Acrolein	2.214E-10	1.981E-10	3.512E-10	9.005E-11	8.607E-10
Naphthalene	3.652E-09	3.268E-09	5.794E-09	1.486E-09	1.420E-08
Acenaphthylene	2.593E-10	2.321E-10	4.114E-10	1.055E-10	1.008E-09
Acenaphthene	1.315E-10	1.177E-10	2.086E-10	5.348E-11	5.112E-10
Fluorene	3.596E-10	3.218E-10	5.705E-10	1.463E-10	1.398E-09
Phenanthrene	1.146E-09	1.026E-09	1.818E-09	4.663E-10	4.457E-09
Anthracene	3.456E-11	3.092E-11	5.482E-11	1.406E-11	1.344E-10
Fluoranthene	1.132E-10	1.013E-10	1.796E-10	4.605E-11	4.402E-10
Pyrene	1.042E-10	9.327E-11	1.653E-10	4.240E-11	4.052E-10
Benz(a)anthracene	1.747E-11	1.564E-11	2.772E-11	7.108E-12	6.794E-11
Chrysene	4.298E-11	3.847E-11	6.819E-11	1.748E-11	1.671E-10
Benzo(b)fluoranthene	3.118E-11	2.791E-11	4.947E-11	1.268E-11	1.212E-10
Benzo(k)fluoranthene	6.124E-12	5.481E-12	9.716E-12	2.491E-12	2.381E-11
Benzo(a)pyrene	7.220E-12	6.461E-12	1.145E-11	2.937E-12	2.807E-11
Indeno(1,2,3-cd)pyrene	1.163E-11	1.041E-11	1.845E-11	4.731E-12	4.522E-11
Dibenz(a,h)anthracene	9.720E-12	8.699E-12	1.542E-11	3.954E-12	3.779E-11
Benzo(g,h,l)perylene	1.562E-11	1.398E-11	2.478E-11	6.354E-12	6.073E-11
Total PAH	5.956E-09	5.330E-09	9.448E-09	2.423E-09	2.316E-08

OPERATION - MOBILE EQUIPMENT

Mobile equipment during operation phase anticipated to be limited to light duty pickup trucks
Assume that approximately half of the hwy truck/light vehcile (LV) requirement estimated for the Argentia Wind Facility construction phase will be used for the operation phase

LV Details

Annual LV use (hr)	2900
Daily LV used (hr)	8
Vehicle speed (km/hr)	40
Fuel rating (L/km) [1]	0.15
Annual fuel consumption (L)	17400
Engine power (hp) [2]	250

[1] Fuel rating retrieved from: https://fcr-ccc.nrcan-rncan.gc.ca/en?_gl=1*14vg18q*_ga*MzIzMzA2MjkxLjE3MDkwNTg1MTg.*_ga_C2N57Y7DX5*MTcwOTkwODUwNC40LjAuMTcwOTkwODUwNC4wLjAuMA.

[2] Assume all engines are Tier 4; Diesel fuel for SOx for engines < 600 hp retrieved from AP-42 Gasoline and Diesel Industrial Engines, Table 3.3-1

EMISSIONS

Vehicle Type	Engine Power (hp)	Annual LV Use (hr)	Emission Factors				Annual Emissions			
			g/hp-hr			lb/hp-hr	tonnes			
			NOx	CO	TSP	SO_2	NOx	CO	TSP	SO_2
Highway Truck	250	2900	0.3	2.6	0.01	2.05E-03	0.218	1.885	0.007	0.676

** assumes all SOx converted to SO2

Appendix H.5
Air Dispersion Modelling Emission Rates

Table H.5-1 Air Dispersion Modelling Emission Rates: Operation

Air Contaminant	Hourly (g/s)					Daily (g/s)					Annual (g/s)				
	Tank Flare - Pilot	NH_3 Flare - Pilot	Emergency Generator	Tank Flare - NH_3 Release	NH_3 Flare - NH_3 Release	Tank Flare - Pilot	NH_3 Flare - Pilot	Emergency Generator	Tank Flare - NH_3 Release	NH_3 Flare - NH_3 Release	Tank Flare - Pilot	NH_3 Flare - Pilot	Emergency Generator	Tank Flare - NH_3 Release	NH3 Flare - NH_3 Release
Modelled [subject to APCR]															
CO	1.217E-02	1.22E-02	12.403			1.217E-02	1.217E-02	12.403			1.217E-02	1.217E-02	1.359E-01		
SO_2			1.474					1.474					1.615E-02		
NOx	1.505E-03	1.51E-03	46.695	26.200	26.200	1.505E-03	1.505E-03	46.695	1.090	1.090	1.505E-03	1.505E-03	5.117E-01	2.990E-03	2.990E-03
TSP	4.987E-01	4.99E-01	9.047E-01			4.987E-01	4.987E-01	0.905			4.987E-01	4.987E-01	9.915E-03		
PM_{10}			7.238E-01					0.724					7.932E-03		
$PM_{2.5}$			6.990E-01					0.699					7.660E-03		
NH_3				92.600	92.600				3.860	3.860				1.060E-02	1.060E-02
Not Modelled [not subject to APCR; provided for illustrative purposes]															
Benzene			1.132E-02					1.132E-02					1.241E-04		
Acetaldehyde			3.677E-04					3.677E-04					4.030E-06		
Acrolein			1.150E-04					1.150E-04					1.260E-06		
Formaldehyde			1.151E-03					1.151E-03					1.262E-05		
Naphthalene			1.897E-03					1.897E-03					2.079E-05		
Propylene			4.071E-02					4.071E-02					4.462E-04		
Benzo[a]pyrene			1.875E-06					1.875E-06					2.055E-08		
Acenaphthene			6.829E-05					6.829E-05					7.484E-07		
Acenaphthylene			1.347E-04					1.347E-04					1.476E-06		
Anthracene			1.795E-05					1.795E-05					1.967E-07		
Benz[a]anthracene			9.076E-06					9.076E-06					9.947E-08		
Chrysene			2.233E-05					2.233E-05					2.447E-07		
Benzo[b]fluoranthene			1.620E-05					1.620E-05					1.775E-07		
Benzo[ghi]perylene			4.057E-06					4.057E-06					4.446E-08		
Benzo[k]fluoranthene			1.591E-06					1.591E-06					1.743E-08		
Dibenz[a,h]anthracene			2.524E-06					2.524E-06					2.767E-08		
Fluoranthene			5.881E-05					5.881E-05					6.445E-07		
Fluorene			1.868E-04					1.868E-04					2.047E-06		
Inden[1,2,3-cd]pyrene			3.021E-06					3.021E-06					3.310E-08		
Phenanthrene			5.954E-04					5.954E-04					6.524E-06		
Pyrene			5.414E-05					5.414E-05					5.933E-07		
Propane	2.060E-02	2.060E-02				2.060E-02	2.060E-02				2.060E-02	2.060E-02			