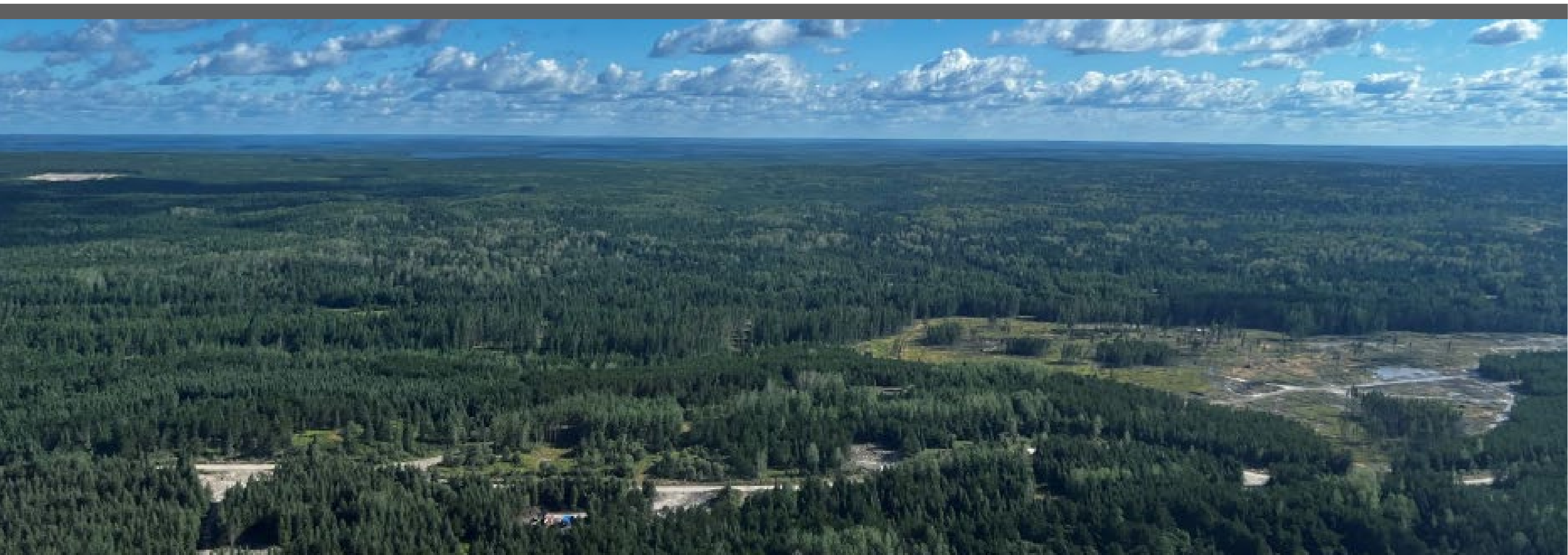
KINROSS Great Bear

Great Bear Gold Project Impact Statement

Appendix D-3:

Greenhouse Gas Assessment



GREAT BEAR RESOURCES

GREAT BEAR PROJECT
GREENHOUSE GAS ASSESSMENT

SEPTEMBER 2025

GREAT BEAR PROJECT

GREENHOUSE GAS ASSESSMENT

GREAT BEAR RESOURCES

PROJECT NO.: OMEMA2303
SEPTEMBER 2025

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ABBREVIATIONS

CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
D&C	decommissioning and closure
DOM	dead organic matter
g-CO_2e/kWh	grams of carbon dioxide equivalent per kilowatt hour
GHG	greenhouse gas
GWP	global warming potential
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
Great Bear Resources	Great Bear Resources Ltd.
km	kilometres
kt-CO_2e	kilotonnes of carbon dioxide equivalent
kW	kilowatt
kWh	kilowatt-hour
kWh/t	kilowatt hour per tonne
Mt	million tonnes (metric)
Mt-CO_2e	million tonnes of carbon dioxide equivalent
MW	megawatt
MWh	megawatt-hour
NPP	net primary production
N_2O	nitrous oxide
NIR	National Inventory Report
Project	Great Bear Project
SACC	Strategic Assessment of Climate Change
SACC Technical Guide	Draft Technical Guide Related to The Strategic Assessment of Climate Change
SOC	soil organic carbon
SSR	sources, sinks, and reservoirs
t-CO_2e/km	tonnes of carbon dioxide equivalent per kilometre
t-CO_2e/kg-gold	tonnes of carbon dioxide equivalent per kilogram of gold
TISG	Tailored Impact Statement Guidelines
US EPA	United States Environmental Protection Agency
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute
WSP	WSP Canada Inc.

GLOSSARY OF TERMS

Avoided Domestic Greenhouse Gas (GHG) Emissions	GHG emissions that are reduced or eliminated in Canada as a result of the project. The avoided GHG emissions only apply to a project's net GHG emissions.
Carbon Dioxide Equivalent (CO_2e)	A unit of measure used to allow the addition of, or the comparison between, gases that have different global warming potentials (GWPs). Since many GHGs exist and their GWPs vary, the emissions are added in a common unit, CO_2e. To express GHG emissions in units of CO_2e, the quantity of a given GHG (expressed in units of mass) is multiplied by its global warming potential.
Global Warming Potential (GWP)	Calculated as the ratio of the time-integrated radiative forcing (i.e., the amount of heat-trapping potential) that would result from the emission of 1 kilogram (kg) of a given GHG to that from the emission of 1 kg of CO_2.
Great Bear Project or the Project	The Great Bear Project is a proposed mine with supporting facilities that includes construction, operations, and closure and decommissioning phases.
Tailored Impact Statement Guidelines	Guidelines for the Preparation of an Impact Statement pursuant to the *Impact Assessment Act, 2019* for the Great Bear Project, dated August 1, 2024.

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APPENDICES

1 INTRODUCTION

1.1 OVERVIEW

Great Bear Resources Ltd. (Great Bear Resources) a wholly owned subsidiary of Kinross Gold Corporation, is planning to develop, operate, and reclaim a gold mine (the Project) on the Great Bear Property (the Property). The Project will consist of two open pits, underground mining activities, an onsite ore processing facility, and auxiliary operations and administrative activities will also take place on the Property. The Property is located approximately 25 kilometres (km) southeast of the Municipality of Red Lake (Figure 1-1) in northwestern Ontario.

An Impact Assessment pursuant to the *Impact Assessment Act* is required for the Project. This Greenhouse Gas (GHG) Assessment report is one of a series of technical support documents prepared by WSP Canada Inc. (WSP) on behalf of Great Bear Resources to describe the predicted environmental impact of the Project.

The methodologies, data, assumptions, and limitations that have been used to evaluate the net GHG emissions from the Project are detailed in Section 3.0 and Table 3-1.

The estimated total Project net GHG emissions is 5,018 kilotonnes of carbon dioxide equivalent (kt-CO_2e). This includes direct and acquired energy GHG emissions for the construction phase, a forecasted 26 year operations phase, and the closure and decommissioning phase. Construction of a transmission line to a nearby regional transmission line (E2R) will connect the Project to Ontario electrical grid to partially satisfy electric energy requirements of the Project. The electrical grid does not have sufficient supply to fully support the Project at this time. The regional transmission line can supply a maximum of 13 MW to the Project. The regional transmission line and connection to Ontario's electrical grid is key in decarbonizing the Project and engagement is ongoing to increase grid power supply to the region which would benefit the Project, to reduce (and eventually avoid if possible) the requirement for generation of power for the Project on the site.

The maximum annual GHG emissions from the operations phase will occur in Year +4, and are estimated to be 227 kt-CO_2e, representing 0.14% of Ontario's GHG inventory for 2022 (157 Mt-CO_2e) and 0.03% of the Canadian GHG inventory for that same year (708 Mt-CO_2e).

During full operations, the calculated average and maximum GHG intensities of the Project's operations are 13.8 and 19.5 t-CO_2e/kg-gold respectively. The global average carbon intensity for on-grid gold production, estimated at 27.7 t-CO2e/kg-gold, and for gold mines in Canada an intensity of 8.6 t-CO2e/kg-gold is reported (Ulrich, Trench, Hagemann, 2022). The projected GHG intensity for the operations phase is in line with other Canadian gold mining operations, considering the Project is only able to have a portion of its electricity needs provided by the Ontario electricity grid.

Great Bear Resources will implement a Net-Zero Plan to reduce their net GHG emissions to zero by 2050. Specific mitigation measures are discussed further in the Net-Zero Plan issued under separate cover.

1.2 OBJECTIVE

This GHG Assessment has been prepared to assess the potential GHG emissions of the construction, operation, and closure and decommissioning phases of the Project. This GHG Assessment will estimate the net GHG emissions and impact on carbon sinks from the Project in accordance with recognized standards, guidelines, and specifically to address the Tailored Impact Statement Guidelines (TISG) issued for the Project on August 1, 2024 (see Section 2.2).

Mitigation measures and plans to achieve net-zero emissions by 2050 will be discussed in the accompanying Net-Zero Plan and Best Available Technology / Best Environmental Practices (BAT/BEP) Determination issued under separate cover.

1.3 PROPOSED PROJECT

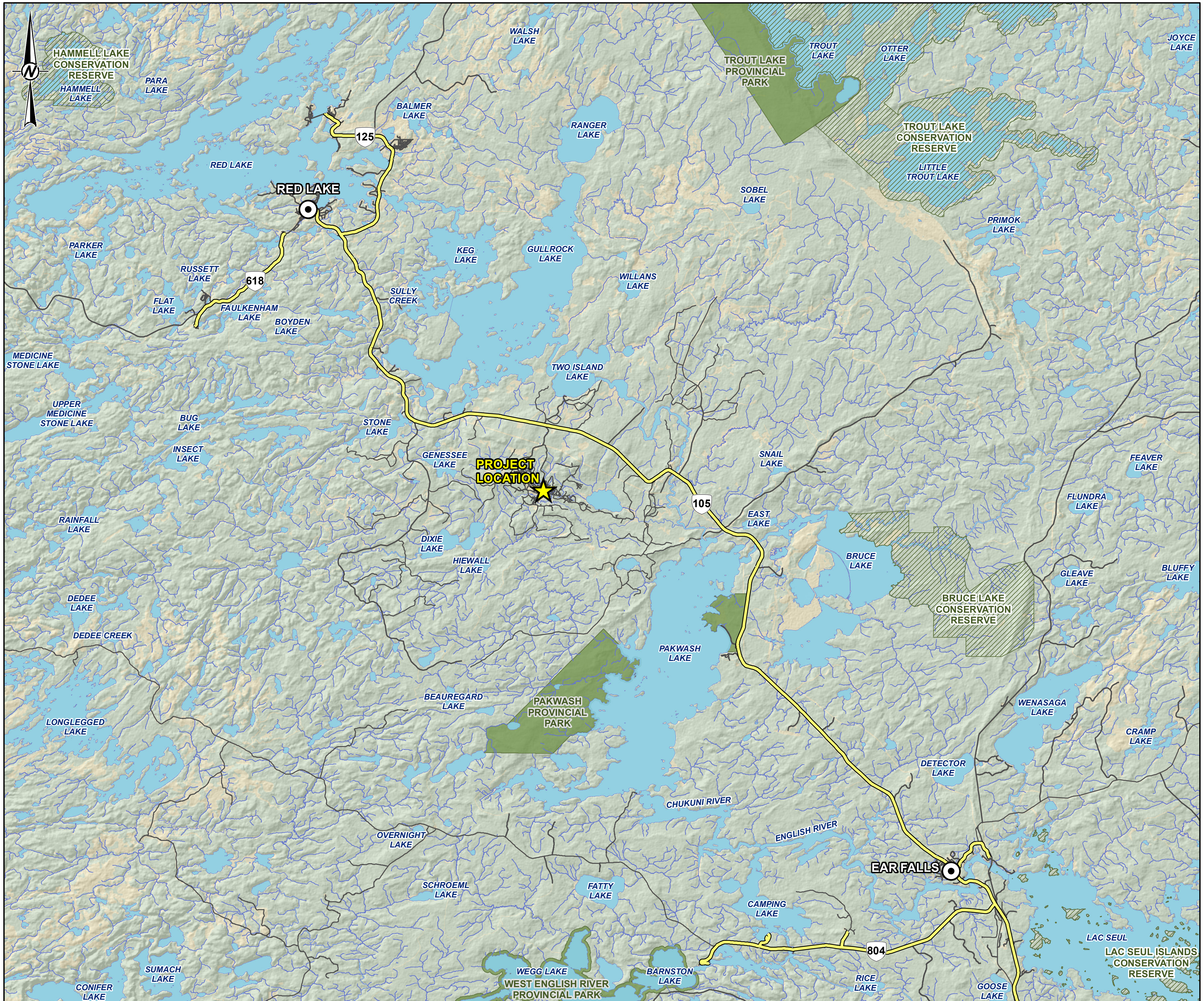
Great Bear Resources is planning to develop, operate, and eventually reclaim a gold mine comprised of underground workings and two open pits (LP Central pit and Viggo pit with associated stockpiles, ore processing facilities and infrastructure. To allow for the development and safe operation of the mine, onsite roads will be constructed with accompanying utilities and a water management and treatment system will be established to facilitate controlled dewatering of the mining area. Ore from the open pit will be processed in an onsite ore processing plant and tailings resulting from the processing of ore will be stored in a tailings management facility (TMF) and a re-purposed Viggo open pit (the Viggo management facility; VMF).

The main components of the Project are:

- LP Central pit, Viggo pit
- Underground mine, accessed via portals, ramps and shaft
- Flood protection berm
- TMF
- VMF
- Run of mine stockpile
- Low grade ore stockpile
- Mine rock stockpile
- Overburden stockpile
- Process plant
- Buildings and supporting infrastructure
- Water management and treatment facilities
- Construction and permanent camp
- Quarries, and sand and gravel pits

The expected duration of Project phases varies by activity, but is approximately described as follows:

- Construction (Year -3 to Year -1: three years in length)
- Operations (Year 1 to Year 26: twenty-six years in length)
- Decommissioning and Closure (Year 27 to Year 43: including three years of active closure).



KEY MAP

SCALE 1:30,000,000

LEGEND

- PROJECT LOCATION
- TOWN
- CONSERVATION RESERVE
- PROVINCIAL PARK
- HIGHWAY
- LOCAL ROAD
- RESOURCE/ RECREATION ROAD
- WATERCOURSE
- WATERBODY

0 2.5 5 10

1:250,000 KILOMETRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
2. WATERCOURSES AND WATERBODY ACQUIRED FROM LAND INFORMATION ONTARIO (MNRF) AND MODIFIED TO MATCH AERIAL IMAGERY AND LIDAR.
3. ROADS INFORMATION PROVIDED BY KINROSS, AUGUST 2022.
4. COORDINATE SYSTEM: NAD 1983 UTM ZONE 15N

CLIENT
GREAT BEAR RESOURCES

PROJECT
GREAT BEAR GOLD PROJECT

TITLE
PROJECT LOCATION

CONSULTANT

YYYY-MM-DD	2024-10-28
DESIGNED	----
PREPARED	MD
REVIEWED	----
APPROVED	----

PROJECT NO.	CONTROL	REV.	FIGURE
OMEMA2303	0001	A	1-1

2 FRAMEWORKS

The GHG Assessment has been prepared using the following guidance and the TISG:

- Strategic Assessment of Climate Change (ECCC 2020)
- Draft Technical Guide Related to the Strategic Assessment of Climate Change (ECCC 2021)
- ISO 14064-2 Specification (with guidance at the project level for quantification, monitoring, and reporting of greenhouse gas reductions and enhancements) (ISO 14064-2:2019)
- International GHG Protocol for Project Accounting (WRI 2004)
- Considering Climate Change in the Environmental Assessment Process (Government of Ontario 2017).

2.1 ENVIRONMENT AND CLIMATE CHANGE CANADA GUIDANCE

The Strategic Assessment of Climate Change (SACC) was developed by Environment and Climate Change Canada (ECCC) to enable consistent, predictable, efficient, and transparent consideration of climate changes throughout the Impact Assessment process for designated projects under the Impact Assessment Act. The Draft Technical Guide Related to the Strategic Assessment of Climate Change was also published by ECCC to be used as a more comprehensive basis for this GHG Assessment, it will be herein referred to as the SACC Technical Guide.

As the Project is being assessed under the *Impact Assessment Act* this GHG Assessment incorporated both the SACC and the SACC Technical Guide to assess the GHG emissions of the Project.

2.2 TAILORED IMPACT STATEMENT GUIDELINES

The TISG for the Project indicate that the Impact Statement must provide the following with respect to GHG emissions and carbon sink impacts:

TISG Requirement	**Report Section**
A description of each of the Project's main GHG emission sources and their estimated annual GHG emissions over the lifetime of the Project.	Sections 3.2 and 4.1 Tables 3-1, 4-1, A1 and A2
Net GHG emissions by year for each phase of the Project based on its maximum throughput or capacity.	Section 3 Tables 4-2 and A1
Each term of Equation 1 of the SACC Technical Guide (Net GHG emissions = Direct GHG emissions + Acquired energy GHG emissions - Avoided domestic GHG emissions - Offset credits measures), per year for each phase of the Project.	Section 3 Tables A1 and A2
Emissions intensity (Equation 4 of the SACC Technical Guide) for each year of the operation phase of the Project in terms of kt-CO_2e/tonne units produced.	Sections 3.3 and 4.3 Table A3
The quantity and a description of the "units produced" used in Equation 4 of the SACC Technical Guide for each year of the operation phase of the Project.	Sections 3.3 and 4.3 Table A3
Methodology, data, emission factors, and assumptions used to quantify each element of the net GHG emissions.	Section 3 Tables 3-1, A4 and A5
A discussion on the development of emissions estimates and uncertainty assessment.	Sections 3 and 3.5
Where applicable, a description of large sources of GHG emissions that may be the consequence of accidents or malfunctions.	Section 3.6
A quantitative and qualitative description of the Project's positive or negative impact on carbon sinks.	Sections 3.7 and 4.1
Any mitigation measures planned to restore disturbed carbon sinks.	Section 5

2.3 GREENHOUSE GAS PROTOCOL

The World Business Council for Sustainable Development and World Resources Institute GHG Protocol (WBCSD / WRI 2004) has been adopted by the United Nations Environment Programme which provides guidance for preparing corporate or project GHG inventories. The GHG Protocol was considered for this GHG Assessment.

The GHG Protocol defines six GHG Accounting Principles that were applied in the quantification for credibility and consistency:

Relevance	Use data, methods, criteria, and assumptions that are appropriate for the intended use of reported information.
Completeness	Consider all relevant information that may affect the accounting and quantification of GHG emissions and reductions, complete all requirements, and disclose any specific or intentional exclusions.
Consistency	Use of data, methods, criteria, and assumptions that allow for meaningful and valid comparisons.
Transparency	Provide clear and sufficient information for reviewers to assess the credibility and reliability of GHG estimates and reduction claims.
Accuracy	Reduce uncertainties as much as is practical, such that the quantification of GHG emissions is systemically neither over, nor under, actual emissions.
Conservativeness	Use conservative assumptions, values, and procedures when uncertainty is high.

3 METHODOLOGY

The methodologies, data, assumptions, and limitations (Table 3-1) that have been used to evaluate the net GHG emissions from the Project are described herein for the:

- Definition of the assessment boundaries
- Identification of the Project's main GHG emissions sources (Table 3-1)
- Quantification of the net GHG emissions associated with all phases of the Project, including an annual breakdown of each term of Equation 1 (Appendix A, Table A1 and Table A2) in the SACC Technical Guide
- Quantification of the Project emission intensity, as shown in Equation 4 of SACC Technical Guide (Appendix A, Table A3)
- Uncertainty assessment (Appendix D, Table D1)
- Large GHG emission sources that may be the consequence of potential accidents or malfunctions
- Carbon sink impacts (i.e., foregone carbon sequestration from land clearing operations).

In addition to the above, mitigation measures to reduce GHG emissions are briefly discussed in Section 5 and the accompanying Net-Zero Plan issued under separate cover.

3.1 ASSESSMENT BOUNDARIES

3.1.1 OPERATIONAL BOUNDARY

The operational boundary defines the scope of direct and indirect emissions for the Project, as well as carbon sink impacts. The Project boundary encompasses the activities within the leased claims where Great Bear Resources has operational control.

The assessment boundary excludes any upstream and downstream emissions such as transportation of product (doré bars) offsite, raw materials to site, employees to site and offsite waste disposal.

3.1.2 TEMPORAL BOUNDARY

The temporal boundaries for this assessment span the construction, operations, and decommissioning and closure phases of the Project. The expected duration of Project phases varies by activity, but is approximately described as follows:

- Construction phase: Year -3 to Year -1, 3 years in length
- Operations phase: Year 1 to Year 26, 26 years in length
- Decommissioning and closure (closure) phase: starting in Year 27 with a three year active reclamation period.

After active reclamation at the start of the decommissioning and closure phase, a period of passive closure and environmental monitoring will follow while the mine workings fill with water. Limited decommissioning of residual water treatment infrastructure will occur after that period. GHG emissions associated after the active closure period are expected to be limited and not material.

3.1.3 GREENHOUSE GASES

GHGs considered in the assessment include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). However, as the assessed emissions are all the result of fuel combustion (either directly or indirectly), CO_2 emissions are the dominant contributor to total equivalent GHGs (i.e., carbon dioxide equivalent – CO_2e).

The global warming potentials (GWPs) used for this assessment are those set forth by the Government of Canada in Schedule 3 of the *Greenhouse Gas Pollution Pricing Act* (2018) and are shown in Appendix A, Table A5. These are consistent with the most recent ECCC reporting requirements.

3.1.4 EMISSIONS SCENARIOS

The Project Emissions Scenario represents the GHG emissions when the Project proceeds as described and must consider announced measures and market conditions. The scenario can be represented using the direct and acquired energy GHG emissions but needs to account for predicted emission changes due to modified processes and transportation methods resulting from market conditions (e.g., policies, regulations, programs).

3.2 NET GREENHOUSE GAS EMISSIONS

The SACC introduces the concept of quantifying a project's net GHG emissions with Equation 1 from Section 2.1 of the SACC Technical Guide. This equation is included below for reference and each term is discussed in more detail in the following sections.

Net GHG Emissions = Direct Greenhouse Gas Emissions
+ Acquired Energy Greenhouse Gas Emissions
- Avoided Domestic Greenhouse Gas Emissions
- Offset Measures

Forecast data were provided by Great Bear Resources and were used to calculate the direct and indirect GHG emissions for all phases of the Project. This included use of fuels for the equipment fleets, blasting, generators, heating, electricity demand, and construction schedules.

Emission factors were primarily used to calculate the GHG emissions. The following subsections summarize the calculation methodologies used for this GHG assessment. Emission factors used in this methodology are included in the GHG Assessment as Appendix A, Table A5.

3.2.1 DIRECT GREENHOUSE GAS EMISSIONS

Direct greenhouse gas emission includes carbon emissions occurring from sources that are owned or controlled by Great Bear Resources at the Project. They are generated by activities that are within the defined scope of the Project. Examples of these GHG emissions include:

- Mobile combustion (e.g., diesel fuel combustion in haul trucks)
- Stationary combustion (e.g., natural gas camp heating)
- Blasting with emulsion and ammonia explosives
- Domestic waste landfill (if developed).
- Land use changes (e.g., land clearing deforestation and biomass decay). This excludes carbon sequestration (see Section 3.7) from land-use change which is included as carbon sinks quantification.

These emissions have been included in this GHG Assessment using estimates regarding onsite fleet operations, blasting and generators. These direct GHG emissions are also referred to as scope 1 emissions as per the GHG Protocol.

3.2.1.1 MOBILE COMBUSTION

Diesel equipment is used on site at the open pit, underground mine, aggregate (quarries, and sand and gravel pits termed borrows in this document) operations and tailings activities. A detailed forecast of diesel fuel usage for mobile combustion equipment was provided by Great Bear Resources for the life of the Project. The GHG emissions are calculated from the forecasted annual fuel consumption and a volume-based fuel emission factor for diesel.

The GHG emission factors for heavy-duty diesel vehicles with moderate control were obtained from Table A6.1-15 of the National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada (Government of Canada 2024). Once individual GHG emission are calculated, they are converted to CO_2e values using GWP values found in Appendix A, Table A5, and then summed.

The GHG emission were calculated as follows:

$$\text{GHG Emissions (t-}CO_2\text{e/yr)} = \sum V_{diesel} \times EF_{mc,\,y} \times GWP_y \times (1 \text{ tonne} / 1{,}000{,}000 \text{ g})$$

Where:

V_{diesel}	=	Volume of diesel (L/yr)
$EF_{mc,\,y}$	=	Emission factor for mobile combustion equipment for GHG “y” (g_y/L)
GWP_y	=	Global Warming Potential of GHG “y” (t-CO_2e/t_y)
y	=	Denotes the specific GHG (CO_2, CH_4 or N_2O)

A sample calculation for mobile combustion is included in Appendix A, Table A4.

3.2.1.2 STATIONARY COMBUSTION

Stationary combustion refers to the greenhouse gas emissions from the stationary natural gas and diesel equipment. This includes the natural gas heating equipment, the onsite natural gas electricity generation equipment, diesel generators used in the construction phase for transition power, and diesel generators used in operations phase for remote power. A detailed forecast of natural gas and diesel fuel usage was provided by Great Bear Resources for the life of the Project. The GHG emissions are calculated from the forecasted annual fuel consumption and a volume-based fuel emission factor for diesel. Once individual GHG emissions are calculated, they are converted to carbon dioxide equivalent values using GWP values found in Appendix A, Table A5 and then summed.

For diesel generators, the emission factors from Tables 2-2 and 2-7 of Canada’s Greenhouse Gas Quantification Requirements (ECCC 2024b) were used to estimate GHG emissions. For natural gas heating and generators, the emission factors from Tables A6.1-1 and A6.1-3 of the National Inventory Report (Government of Canada 2024) were used to estimate GHG emissions.

The GHG emission were calculated as follows:

$$\text{GHG Emissions (t-}CO_2\text{e/yr)} = \sum V_{fuel} \times EF_{sc,\,y} \times GWP_y \times (1 \text{ tonne} / 1{,}000{,}000 \text{ g})$$

Where:

V_{fuel}	=	Volume of fuel, natural gas (m^3/yr) or diesel (L/yr)
$EF_{sc,\,y}$	=	Emission factor for stationary combustion equipment for GHG “y”, natural gas (g/m^3) or diesel (g_y/L)
GWP_y	=	Global Warming Potential of GHG “y” (t-CO_2e/t_y)
y	=	Denotes the specific GHG (CO_2, CH_4 or N_2O)

A sample calculation for stationary combustion is included in Appendix A, Table A4.

3.2.1.3 BLASTING

An emulsion explosive will primarily be used for blasting at the Project. The emulsion includes compounds containing carbon, which are assumed to be oxidized to carbon dioxide during detonation.

The annual material movements were used in combination with an emulsion usage factor to estimate the annual mass of emulsion required for the Project. An emulsion usage factor of 0.351 kgemulsion/tonne-rock was used for the open pit, quarry and site development operations, whereas an emulsion usage factor of 1.2 kg-emulsion/tonne-rock was used for the underground mining operations. The emulsion usage factors were provided by Great Bear Resources.

The GHG emissions from blasting are based on the annual mass of emulsion required by the Project and an emission factor. The emission factor of 0.170 tonne-CO_2/tonne-emulsion was provided by an emulsion supplier (Dyno Nobel 2021).

The GHG emission were calculated as follows:

$$\text{GHG Emissions (t-CO}_2\text{e/yr)} = M_{em} \times EF_{em}$$

Where:
M_{em} = Projected mass of emulsion detonated (t-emulsion/yr)
EF_{em} = Emission factor (t-CO_2e/t-emulsion)

Blasting during decommissioning and closure phase, if any, was assumed to be limited and immaterial. A sample calculation for blasting is included in Appendix A, Table A4.

3.2.1.4 DOMESTIC WASTE LANDFILL

The GHG emissions from domestic waste from the landfill on site if developed, are considered a direct GHG emission and therefore were included in the assessment. The GHG emissions from the onsite landfill were predicted using the United States Environmental Protection Agency LandGEM model. LandGEM is a screening tool based on a first-order decay method for quantifying emissions from the decomposition of landfilled waste in municipal solid waste landfills (US EPA 2020).

The forecasted potential annual volume of waste and the total volume of the landfill was provided by Great Bear Resources. The landfill was assumed to be in operation during the construction, operation, and decommissioning and closure phases. An approximate waste density of 311 kg/m^3 was used to predict the annual waste landfilled (Thenmozhi and Hameed 2014). These projections, along with an estimated landfill capacity of 1000 m^3/year were input to LandGEM to produce the methane and carbon dioxide emissions.

3.2.1.5 LAND USE CHANGES

The GHG emissions from land-use conversions as a result of the Project construction are included in the direct GHG emissions. Note that this does not include foregone carbon sequestration from land-use change that is included as a part of the carbon sink impact discussed in Section 3.7.

As the Project area is greater than 100 hectares, Tier 2 methodology was used per the SACC Technical Guide. The use of the IPCC methodological framework for calculations is an acceptable approach if Tier 1 defaults are substituted with Tier 2 site- or regionally-specific data wherever practical (Government of Canada 2021).

Land uses were based on vegetation inventories completed by WSP for the Project with areas quantified according to the Boreal Ecological Land Classification with consideration of wildfire and logging activity. Wildfire and logging data were based on a 2020 Forest Management Plan which sourced information from the Ministry of Natural Resources and Forestry, Forest Resource Inventory. This information allows for the estimation of land use area (e.g., forest, swamp, fen) affected by the Project. Further details regarding the land use area summary are included in Appendix B, Table B1. The Generic Methodologies Applicable to Multiple Land-use Categories (IPCC 2006a) were used. Detailed assumptions related to the land use estimates can be found in Appendix B, Table B2.

- **Above-Ground Biomass Carbon Stocks Removed:** Forests, other vegetation, and soils sequester carbon from the atmosphere, and the amount of carbon sequestered is referred to as the stock. The total biomass stock removed was estimated by multiplying the land use area by the tonnes of dry mass per hectare from a representative tree stand (Payne et al., 2019). Detailed calculations are provided in Appendix B, Table B2. The tree coverage within each land use was estimated using the definitions in Ontario's (2014) Wetland Evaluation System. Assumptions regarding the above-ground biomass carbon stocks in the Project area are included in Appendix B, Table B2.
- **Dead Organic Matter (DOM) Removed:** The calculations for DOM are provided in Appendix B, Table B2. The method was the same as described for the above-ground biomass but applying the DOM carbon fraction to determine the change in carbon stock. Assumptions regarding the DOM in the Project area are included in Appendix B, Table B2.
- **Soil Organic Carbon (SOC) Removed:** The estimated quantity of SOC was determined by multiplying the area of wetland soils per the Ontario's Wetland Evaluation System definitions, and non-wetland soils by respective carbon content factors in tonnes of carbon per hectare (tC/ha); the calculations are presented in Appendix B, Table B2.

The carbon content factor for non-wetland soils was from a study for a representative tree stand (Payne et al. 2019). Tree stands were considered juvenile if less than or equal to 30 years and mature if greater than 30 years (Payne et al. 2019). The carbon content factor used for wetland soils was that published in the IPCC Volume 4, Chapter 2: Generic Methodologies Applicable to Multiple Land Use Categories, Table 2.3 for bogs, fens, marshes, and swamps (IPCC 2014a). It was assumed that any draining organic soils would be built over and remain anoxic.

The quantity of CO_2e absorption or release associated with land use changes were included in the net GHG emission determination, except for the foregone sequestration which is presented separately per the TISG. The carbon stock changes are presented both as carbon and an example CO_2e scenario, due to uncertainty around the final fate. During mine operation, and upon mine decommissioning and closure, reforestation will be carried out to restore much of the cleared area however the net GHG determination conservatively does not include consideration of reforestation.

A sample calculation for emissions resulting from land use changes is included in Appendix B, Table B2.

3.2.2 ACQUIRED ENERGY GREENHOUSE GAS EMISSIONS

Acquired energy GHG emissions include emissions from the generation of electricity, heat, steam, or cooling, purchased from a third party by Great Bear Resources for the Project. A typical example includes emissions generated offsite from third party electricity generation. These emissions have been included in this GHG Assessment using estimates for onsite electricity demands. The acquired energy GHG emission are referred to as scope 2 emissions as per the GHG Protocol.

A transmission line will connect the Project to the Ontario electrical grid to partially satisfy electric energy requirements of the Project. This regional transmission line is currently able to supply a maximum of 13 MW to the Project. The available grid capacity is assumed to be maximized with the balance of demand being supplied by onsite generation, as discussed in Section 3.2.1.2.

Electricity demand projections were provided by Great Bear Resources based on percent operating times and the below intensities for the various operations:

- Processing 45.04 kWh/tonne-mined
- Site administration 23,129 MWh/year
- Underground 50,143 MWh/year
- Underground hoist 36,512 MWh/year
- Open pit dewatering 2,796 MWh/year.

GHG emission intensity from grid supplied electricity was determined using the ECCC emission factors for Ontario's reference scenario (only includes fully implemented policies, in tonnes CO_2e/GWh) provided in the Canada's Greenhouse Gas Emissions Projections (excluding biomass & RNG), Ontario (ECCC 2023). The GHG emission intensity of electricity supplied assumed the first year of construction was 2027 and that intensities were as projected through to 2050 (the last projection available). Intensities past 2050 were assumed equal to the projected 2050 grid intensity. Based on these assumptions, the projected average grid intensity during the Project life was estimated as 28.5 g-CO_2e/kWh.

Ontario's supply mix will undergo substantial change over the next few decades as the available capacity from the nuclear fleet continues to be impacted by refurbishments, retirements, and by new capacity being brought online. This, along with political frameworks, will impact the emission factors used to determine the GHG emissions contribution from grid power. The Pathway to Decarbonization report published by the Independent Electricity System Operator provides pathways for Ontario to be net-zero by 2035 and zero-carbon by 2045 (IESO 2022).

The GHG emissions were calculated as follows:

$$\text{GHG Emissions (t-}CO_2\text{e/yr)} = D_{grid} \times EF_{grid} \times (1 \text{ tonne} / 1{,}000{,}000 \text{ g})$$

Where:

D_{grid} = Electricity demand of the Project (kWh/yr)

EF_{grid} = Ontario grid emission factor (g-CO_2e/kWh)

A sample calculation for electricity emissions is included in Appendix A, Table A4.

3.2.3 AVOIDED DOMESTIC GREENHOUSE GAS EMISSIONS

Avoided domestic GHG emissions are GHG emissions that are reduced or eliminated in Canada as a result of the Project (e.g., a less energy intensive facility replacing a more energy intensive facility).

These actions must not be required by law or be counted as offset credits (see Section 3.1.4). They must represent real, additional, quantified, verifiable, unique, and permanent reductions that can be assigned to the Project (the same avoided emissions cannot be claimed more than once).

These avoided domestic GHG emissions are not to be mistaken for offset measures; avoided GHG emissions are considered to reflect diverted emissions and not a counteractive measure, such as renewable energy credits / clean energy credits.

Avoided emissions can only be considered in terms of direct emissions or acquired energy emissions of a project and, therefore, cannot be applied to any upstream or downstream activities. This can include practices such as fuel switching, installing efficiencies, or limiting timber harvest levels.

The Project will not result in avoided domestic emissions.

3.2.4 OFFSET MEASURES

Offset measures aim to eliminate, minimize, or mitigate GHG emissions. These GHG emissions are the sum of the following constituents:

- **Offset Credits:** GHG emission reductions or removals generated from activities that are additional to what would have occurred in the absence of the offset project.
- **CO_2 Captured and Stored:** Emissions that are generated by the project and permanently stored in a storage project via CO_2 injection into a geological reservoir in accordance with federal and provincial regulations.
- **Corporate-Level Initiatives:** GHG emissions removed due to mitigation measures separate from the project and not reflected in a project's direct GHG emissions.

- **Other Mitigation Measures:** For example, land-use changes to mitigate carbon sink disturbance through restoration, afforestation, compensation, and conservation.

Potential offset measures are discussed in more detail in the accompanying Net-Zero Plan and Best Available Technologies / Best Environmental Practices Determination issued under separate cover.

3.3 PROJECT EMISSION INTENSITY

Once the Project's net GHG emissions are determined, the emissions intensity of the Project can be calculated using Equation 4 from Section 2.1 of the SACC Technical Guide. This equation is included below for reference, where the Units Produced term corresponds with the gold production (kg-gold) of the Project.

$$\text{Project Emission Intensity} = \frac{\text{Net GHG Emissions}}{\text{Units Produced}}$$

The Project's emission intensity estimate was calculated for each year (Appendix A, Table A3) of the Project's operation phase to provide both the maximum annual and average annual emissions intensity during operations.

3.4 UPSTREAM GREENHOUSE GAS ASSESSMENT

Carbon emissions or removals which are a consequence of the Project but occur at GHG sources or sinks not owned or controlled by Great Bear Resources are referred to as upstream of downstream emissions. Landfill gases generated and released at an offsite landfill are an example of indirect GHG emissions. These indirect upstream and downstream greenhouse gas emissions are also referred to as scope 3 emissions as per the GHG Protocol.

As per Section 5.0 of the SACC Technical Guide, upstream emissions from the Project are defined as the domestic and non-domestic emissions associated with all phases of the Project, such as extracting resources up to, but not including the activities on the Property.

Upstream and downstream GHG emissions are not required in the calculation of net GHG emissions in this GHG Assessment. However, per Section 5.0 of the SACC Technical Guide, consideration of indirect upstream emissions is described for the Project diesel usage, natural gas usage, and fuel oil in the explosives.

Annex F of the SACC provides the methodology for assessing upstream GHGs. The S&T Squared Consultants Inc. GHGenius tool (2023) was used as the reference for lifecycle fuel GHG emission factors (gCO_2e/fuel unit) but with fuel-end use portions removed as these are assessed as direct Project emissions. Petrol diesel (0.0015% sulphur content) from crude oil and compressed natural gas emission factors from the GHGenius tool were used to represent upstream emissions from onsite fuel oil usage (both diesel and fuel oil in explosives) and onsite natural gas combustion. The maximum annual fuel usages were multiplied by the respective factors assuming 5% of explosives are fuel oil (Dyno Nobel 2022) to estimate upstream GHG emissions.

The predicted upstream emissions are compared to the upstream GHG emission thresholds listed in Table 15 of the SACC Technical Guide to determine the requirement for a comprehensive upstream GHG emission assessment (Government of Canada 2021).

These calculations are included in the GHG Assessment as Appendix C, Table C1.

3.5 UNCERTAINTY ASSESSMENT

As per the TISG and following Section 2.3 of the SACC Technical Guide, a discussion on the development of emissions estimates and their associated uncertainty is included in this GHG Assessment as Appendix D, Table D1. It differentiates between qualitative and quantitative uncertainties associated with various parameters used in the GHG estimations.

Uncertainty in quantifying GHG emissions can be categorized into scientific and estimation uncertainty (WRI 2004).

3.5.1 SCIENTIFIC UNCERTAINTY

Scientific uncertainty arises when a process is not sufficiently understood. Examples relevant to this estimate are:

- **Global Warming Potentials (GWP):** These values reflect the potency of a GHG in terms of CO_2 equivalent and are regularly updated by IPCC as understanding of climate changes improves. The uncertainty around GWPs is approximately ±40% (US EPA 2024).
- **Region-Specific Carbon Sink Study:** Used to estimate sequestered carbon and CO_2 uptake, this study is one of many refining the understanding of carbon uptake and biomass growth. Mechanisms and uncertainty for carbon sequestration, storage, and release are not fully understood however parameter variability is discussed further in this section.

To reduce this uncertainty, future inventories should review the state of understanding to confirm the latest knowledge is being applied as applicable.

3.5.2 ESTIMATION UNCERTAINTY

Estimation uncertainty arises during emission calculations and can be further classified into model and parameter uncertainty.

3.5.2.1 MODEL

Model uncertainty is that which pertains to the equations used and the appropriateness of input parameters. Examples of this include:

- **Carbon Sequestration:** The applicability of net primary production as a reflection of atmospheric carbon uptake was confirmed with the author of the region-specific carbon sink white paper (Payne et al. 2019).
- **Fate of Biomass:** The fate of removed above-ground biomass was unknown and assumed to be 10% undisturbed, 20% stockpiled on site, and 70% merchantable material. The estimated emissions would range from 100% onsite stockpiling (upper range of emissions) to all trees being marketable with carbon remaining sequestered in wood-based products. The fate of removed DOM was unknown and assumed to be 10% undisturbed, 80% stockpiled on site, and 10% merchantable material. The estimated emissions would range from 100% onsite stockpiling (upper range of emissions) to all dead organic matter (litterfall) being undisturbed or merchantable with carbon remaining sequestered in the material.
- **Stand Age:** Due to logging activities in the area, a juvenile stand age of 25 years was assumed as an average (Payne et al. 2019). A juvenile stand can have 1.4 to 1.8 time more carbon sequestration potential when compared to a mature stand and foregone sequestration estimates in this regard are expected to be conservative. Further, an average age of 50 years was assumed for mature stands.

This uncertainty may be reduced in future estimates by refining calculation assumptions based on the latest Project information.

3.5.2.2 PARAMETER

Parameter uncertainty is that associated with the variability of parameter used as inputs into calculations. Examples include:

- **Fuel Combustion**: The uncertainty of emission factors differs based on the specific GHG and activity (e.g., mobile off-road versus stationary electricity production):

Emission Factor Activity	Gas	2022 Emission Factor Uncertainty [1]
Fuel Combustion - Off-Road (1.A.2-3-42)	CO_2	±0.10%
	CH_4	±7.00%
	N_2O	±78.00%
Fuel Combustion – Public Electricity and Heat Production[3,4] (1.A.1.a)	CO_2	±3.00%
	CH_4	±27.00%
	N_2O	±210.00%

Note:
1 ECCC 2024a, Table A2-2

Fuel oil use in explosives, onsite power generation, and Ontario's electrical grid GHG intensity were assumed to have a similar emission factor uncertainty to Fuel Combustion – Public Electricity and Heat Production.

- **Life of Mine Projections**: Decisions regarding energy usage and production will be influenced by factors such as commodity prices, funding resources, and regulatory instruments. The projections provided by Great Bear Resources are considered to be representative of magnitude but refinements to energy usage estimates are likely to be a main driver of changes to overall GHG emissions from the Project as the design progresses.
- **Land Use Changes**: Ecosite data was provided to WSP by Great Bear Resources. These data were based on a 2020 Forest Management Plan which sourced information from the Forest Resource Inventory. The recency of the data may contribute to the uncertainty of GHG emissions associated with the land use changes. Ontario's Wetland Evaluation System (2022) was used to define tree coverage. The level of uncertainty is unknown however value used are expected to be conservative. IPCC (2006a Table 2.3) provides an error estimate of ±90% in wetland carbon stock values. The uncertainty on carbon content in dry biomass was estimated at ±8%. The uncertainty for the ratio of below- to above-ground biomass is estimated at 40% (IPCC, 2006b). The uncertainty of the volume yield curve is unknown.
- **Foregone Carbon Sequestration:** Below-ground net primary production (NPP, biomass growth) ranges from 0% to 40% of total NPP (Bond-Lamberty 2004). As the region-specific study focused on above-ground NPP, it was assumed that underground NPP is two thirds of what above-ground NPP was and that an addition 5% of NPP is achieved from soil carbon uptake. The combined uncertainty for SOC, DOM, and above ground biomass is estimated at ±18%.

Uncertainty was reduced in the methodology by using emission factors derived from local studies as practical, rather than default values provided in the SACC Technical Guide or supporting documents. Where a range of values was provided, a value which would result in a conservative estimate was generally selected such that results presented are expected to over-estimate emissions.

While local emission factors were used where available, these factors and provincial, national, and international factors (ordered in what is typically decreasing levels of accuracy) all have inherent uncertainty. Additionally, a review of the Assumption and Limitations in Table 3-1, and those in the appended calculations, demonstrate the simplifications made in order to summarize GHG emissions.

An overall quantitative estimate of uncertainty is provided in Appendix D, Table D1 to support an understanding as practical range of outcomes.

3.6 POTENTIAL ACCIDENT OR MALFUNCTION

As per the TISG and following Section 2.2 of the SACC Technical Guide, a discussion of the main sources of GHGs and their emissions that may result from a potential accident or malfunction is included in this GHG Assessment. There are no known large sources of GHG emissions that could result as the consequence of potential accidents of malfunctions associated with the Project.

3.7 CARBON SINK IMPACTS

As per the TISG and Section 4.0 of the SACC Technical Guide, a quantitative assessment of the impact of the Project on the carbon sinks resulting from the land use change at the Property has been developed. Land use conversion for the construction of the Project results in foregone carbon sequestration (e.g., the uptake of carbon by vegetation that would have taken place in the absence of the Project). Potential mitigation measures are discussed as well.

The loss of carbon uptake was calculated (Appendix B, Table B3) by multiplying the annual carbon accumulation rate (tonnes-C/hectare/year) (Payne et al. 2022) of the land use and land cover by the area of each respective land use (e.g., forest, swamp, fen, bog, marsh, water). Land uses and areas were based on vegetation inventories completed by WSP for the Project and quantified according to the Boreal Ecological Land Classification.

Carbon accumulation rates were the summation of the carbon accumulation of the vegetated area (treed) and the soil-covered area.

The carbon sink impacts for a specific land use in a given year were calculated as follows:

$$CSI\ (t\text{-}C/yr) = [(NatFlux_{Vegetation} - PostDFlux) \times T \times A)] + [(NatFlux_{Soil} - PostDFlux) \times T \times A)]$$

Where:

$NatFlux_{Vegetation}$	=	Natural annual carbon accumulation rate of the vegetation being impacted (tC/ha/yr)
$NatFlux_{Soil}$	=	Natural annual carbon accumulation rate of the soil being impacted (t-C/ha/yr)
PostDFlux	=	Post-disturbance flux rate impacted by the Project (t-C/ha/yr)
T	=	Time interval (yr)
A	=	Land area (ha)

The carbon sink impacts for all land uses were summed and then converted to uptake as follows:

$$Total\ CO_2\ Uptake\ (t\text{-}CO_2e/yr) = Total\ CSI_{Vegetation} + Total\ CSI_{Soil}$$

Where:

Total $CSI_{Vegetation}$	=	Total carbon sink influence of vegetation at Property in a given year (t-C/yr)
Total CSI_{Soil}	=	Total carbon sink influence of soil at Property in a given year (t-C/yr)

Carbon accumulation rates of trees in forest and swamp lands, assumed to have 100% tree cover, were published in a study of representative tree stands (Payne et. al. 2019). The annual carbon accumulation for fens and bogs was based on 25% tree coverage (Ontario 2014).

Volume growth curves for mixed-wood stands in northwestern Ontario (Payandeh and Field 1986) were used to interpolate annual forgone sequestration between a juvenile and mature stand. Based on the vegetation inventories, it was assumed that the average stand age of trees for the Project was 25 years for juvenile and 50 years for mature.

Carbon accumulation rates of soil were obtained from Annex D, Table 31 of the SACC Technical Guide. Marshes, water, meadow, paved areas, and utility corridor land uses were assumed to have immaterial uptake relative to the other land-use types. Sample calculations are included in Appendix B, Table B3 for reference.

Table 3-1: Emission Sources, Assumptions, and Inclusion in Assessment

Emission Category	Emission Type	Emission Source / Sink	Applicable Project Phases	Assumptions	Inclusion in Assessment
Direct GHG Emissions	Mobile Combustion	Open Pit Mine Fleet Underground Mine Fleet, Quarry, Borrow and Tailings Fleet	Construction Operations Decommissioning and Closure	• Forecast of diesel distinguishes between stationary and mobile combustion. • Mobile combustion considered for fleet operations associated with the open pit, underground, and quarry / borrow / TMF sources.	Quantitative
	Stationary Combustion	Heating Onsite Electricity Generation	Construction Operations Decommissioning and Closure	• Natural gas is used to supply heat and electricity on site. • Diesel is used to supply electricity on site for small remote areas where electrical distribution is not feasible.	Quantitative
	Blasting	Open Pit Operations Underground Operations Quarry Operations	Construction Operations	• Release of CO_2 from emulsion explosive used in blasting operations. • Distinguished between explosive used for the open pit, underground, quarry, and site development sources.	Quantitative
	Waste Management	Onsite Domestic Waste Landfill (potential)	Construction Operations Decommissioning and Closure	• A domestic landfill is not proposed for the Project; the potential associated emissions from a landfill are considered in this document as a contingency should a landfill be required in the future. • Emissions from onsite landfill modelled using forecasted annual volume of waste and assumed waste density of 311 kg/m^3 (Thenmozhi and Hameed 2014).	Quantitative
	Biomass Removal	Land Clearing during Site Development	Construction	• Site clearing will result in the removal of carbon stored in the biomass. • 20% of the above-ground biomass cleared and 80% of the dead organic matter will be stockpiled on site; the stockpiles will act like passively aerated composting piles. • Based on wildfires and logging activity on the Property, the average forest is mature (i.e., stand age of 50 years). • Detailed assumptions are provided in Appendix B, Tables B1 and B2.	Quantitative
Indirect GHG Emissions	Acquired Energy	Purchased Electricity from Ontario Grid	Construction Operations Decommissioning and Closure	• Electricity supplied to the site that has been purchased from the Ontario grid. • The projected annual GHG intensity of Ontario's grid (ECCC 2023) for the Project lifetime	Quantitative
Carbon Sink Impacts	Foregone Carbon Sequestration	Forest Sink	Construction Operations Decommissioning and Closure	• Land use changes (i.e., land clearing, deforestation) will affect carbon uptake or release that would have been observed by the land without mining operations. • Detailed assumptions are provided in Appendix B, Tables B1 and B3.	Quantitative Presented separately per SACC guidance

4 RESULTS

The GHG assessment includes both a determination of the net GHG emissions over the life of the Project, the maximum annual GHG emissions, and the GHG emission intensity for the operations.

The net GHG emissions considered the direct GHG emissions, acquired energy, and the effect of land use changes on GHGs. There is no CO_2 capture and storage or avoided domestic GHG emissions associated with the Project.

In determining the GHG intensity of the Project, the GHG emissions were divided by the corresponding kilograms of gold equivalent produced in a given year and overall.

A year-by-year inventory of GHG emissions and supporting sample calculations are provided in Appendix A.

4.1 SUMMARY OF GREENHOUSE GAS EMISSIONS

The net GHG emissions from the Project are estimated at 5,018 kt-CO_2e of direct GHG emissions and acquired energy GHG emissions over the construction, operations, and decommissioning and closure phases of the Project.

The net GHG emissions for the Project include consideration of:

- Mobile Combustion – Equipment Fleets, Diesel Fuel (2,082 kt-CO_2e)
- Stationary Combustion – Heating and Electricity, Natural Gas (2,469 kt-CO_2e)
- Stationary Combustion – Electricity, Diesel Fuel (197 kt-CO_2e)
- Onsite Blasting (28 kt-CO_2e)
- Domestic Waste Landfill (17 kt-CO_2e; if developed in the future)
- Acquired Energy – Purchased Electricity (77 kt-CO_2e)
- Land Clearing – Biomass Removal (146 kt-CO_2e).

The Project GHG sources and emissions are summarized in Table 4-1 and Appendix A, Table A1 and Table A2. The largest source of GHG emissions during mine operations is the combustion of natural gas for electricity, contributing to 36% of the overall Project GHG emissions as shown in Figure 4-1. The GHG emissions for the maximum operating year are presented in Table 4-2.

The impact of the loss of carbon sinks with land use changes (foregone carbon sequestration) of 584 kt-CO_2e (159 kt of carbon) was not included in the net GHG emissions per the TISG and SACC Technical Guide.

The highest annual operations emissions occur in Year +4. After this year the annual amount of material moved from the open pit begins to diminish, as does the level of fleet activity.

4.2 UPSTREAM GREENHOUSE GAS ASSESSMENT

Upstream GHG emissions are domestic and non-domestic emissions associated with all stages of production from the point of extracting the resources up to, but not including, the activities within the operational boundary of Great Bear Resources for the Project.

As described in Table 15 of the SACC Technical Guide, any TISGs published between 2020 and 2029 will have a threshold for conducting an upstream GHG assessment of 500 kt-CO_2e/year for the maximum annual year during the operation phase.

The Project is anticipated to have upstream emissions of approximately 77 kt-CO_2e/year in the peak year; this equates 15% of the threshold for a detailed assessment and 0.02% of Canada's 2030 target. Since the Project's maximum year upstream emission are well below the upstream GHG threshold of 500 kt-CO_2e/year, no further assessment is required as a part of this GHG Assessment. Detailed calculations are provided in Appendix C, Table C1.

4.3 SUMMARY OF PROJECT EMISSION INTENSITY

The use of a GHG emission intensity allows for more meaningful comparison with other gold mining projects with different production rates. The emission intensity was calculated following Equation 4 of the SACC Technical Guide, which includes direct emissions, acquired energy emissions, and emissions from biomass removal.

4.3.1 COMPARISON WITH GREENHOUSE GAS BENCHMARKS AND INVENTORIES

The emission intensity (excluding carbon sink impacts) for each year of the Project operations phase is presented in Appendix A, Table A3 and is summarized as follows:

- Average Annual Operations: 13.8 t-CO2e/kg-gold (Year +1 to +26)
- Maximum Annual Year of Operations: 19.5 t-CO2e/kg-gold (Year +3).

As the GHG intensity of a mine will vary based on factors including the energy sources, the GHG intensity of the electricity grid and grid capacity, deposit grade, location of the processing facility, and the type of mine, it is difficult to find projects that are directly comparable for benchmarking. For this reason, two sources of potential benchmarking information were considered:

- The global average carbon intensity for on-grid gold production, estimated at 27.7 t-CO_2e/kg-gold, and for gold mines in Canada an intensity of 8.6 t-CO_2e/kg-gold is reported (Ulrich, Trench, Hagemann 2022).
- Publicly availably intensities via corporate environmental, social, and corporate governance (ESG) reporting for the larger Canadian and global mining companies. Emission intensities were reported for 20 gold mining operations (14 in Canada, six in the United States) with a range of 3.2 t-CO_2e/kg-gold to 50.8 t-CO_2e/kg-gold and an average of 16.8 t-CO_2e/kg-gold. The highest GHG intensities were for the six sites in the United States and two mines in Nunavut that do not have access to the electrical grid. Eleven Canadian mines that are powered from the electrical grid had GHG emission intensities of 3.2 t-CO_2e/kg-gold to 16.5 t-CO_2e/kg-gold, and the average intensity of these mines was 7.5 t-CO_2e/kg-gold.

Based upon the review of corporate ESG reporting, in general high-performing gold mining operations are those with access to low-carbon intensity electricity grids. Ulrich, Trench, and Hagemann (2022) support this finding noting that Canada's low carbon electricity supply is a contributing factor to lower GHG intensities relative to the global average.

The Project's average and maximum annual GHG intensities of 13.8 and 19.5 t-CO_2e/kg-gold, respectively, are in line with other Canadian gold mining operations, considering the mine will only have a portion of its onsite electricity provided by the Ontario electricity grid.

For additional context, for the Project's GHG emissions, the maximum annual emissions, excluding the foregone carbon sequestration, were compared with the Canadian and Ontario GHG inventories and the federal 2030 target to appreciate the relative magnitude of GHG emissions from the Project. In addition, the total emissions from onsite combustion and blasting were compared against the sector data for mining and heavy industry. Comparisons to inventories are provided in Appendix A, Table A6.

Table 4-1: Project GHG Emissions by Phase

Category	Phases			Total [1] (kt-CO_2e)	Percent of Total (%)
	Construction (kt-CO_2e)	Operations (kt-CO_2e)	Decommissioning and Closure (kt-CO_2e)		
Direct - Open Pit - Diesel Fuel	140.0	694.4	17.2	851.6	17%
Direct - Underground Mine Fleet - Diesel Fuel	11.5	956.6	2.9	971.0	19%
Direct - Quarry, Borrow and Tailings - Diesel Fuel	24.3	210.6	24.3	259.2	5%
Direct - Explosives	2.2	25.9	0.0	28.1	<1%
Direct - Heating - Natural Gas	40.4	613.0	18.9	672.3	13%
Direct - Electricity Generation - Natural Gas	0.2	1,796.2	0.0	1,796.4	36%
Direct - Construction Electricity Generation - Diesel Fuel	56.2	0.0	0.0	56.2	1%
Direct – Operations Electricity Generation - Diesel Fuel	13.2	114.4	13.2	140.8	3%
Direct – Domestic Waste Landfill [2]	0.2	14.3	2.5	17.0	<1%
Direct - Land Use Changes from Biomass Removal	146.2	0.0	0.0	146.2	3%
Indirect - Acquired Energy	7.6	69.4	0.4	77.4	2%
Net GHG Emissions	**442.1**	**4,496.2**	**79.6**	**5,017.9**	**—**
Foregone CO_2 Sequestration [3]	**59.7**	**474.3**	**49.8**	**583.8**	**—**

Notes:

1 *Subtotals may not add to totals due to rounding.*

2 *A domestic landfill is not proposed for the Project. The potential associated emissions from a landfill are considered in this document as a contingency should a landfill be required in the future.*

3 *Foregone CO_2 sequestration due to the loss of carbon sinks is not included in the net GHG emissions and is presented separately per TISG and SACC Technical Guide (ECCC 2021).*

Table 4-2: Project GHG Emissions for Maximum Operations Emission Year +4

Category	Maximum Annual GHG Emissions (kt-CO_2e) [1]
Direct GHG Emissions[2]	222.2
Acquired Energy	4.6
Total Annual GHG Emissions	226.9

Notes:

1 *Subtotals may not add to totals due to rounding.*

2 *Direct GHG Emissions include diesel and natural gas fuel usage from mobile and stationary combustion and blasting*

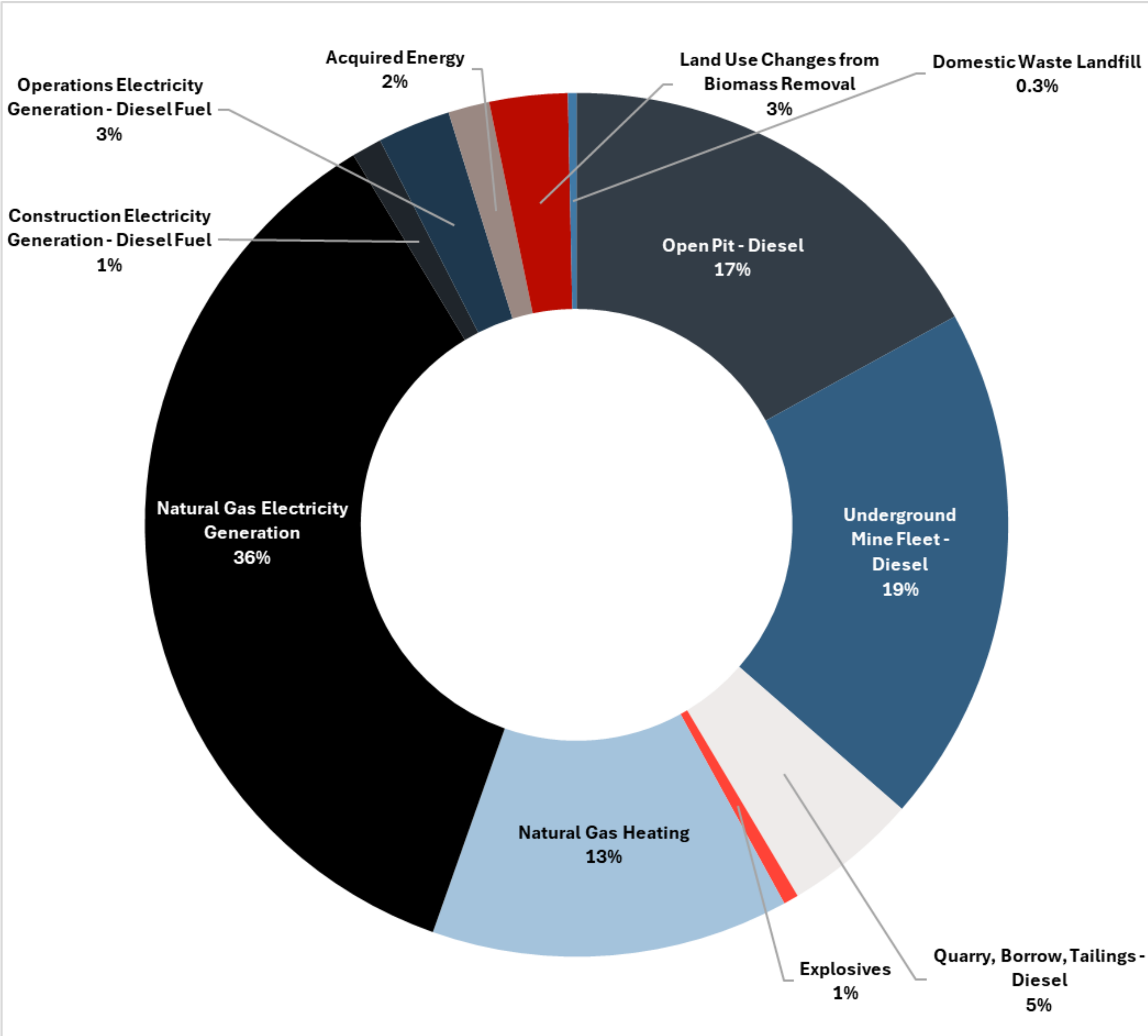


Figure 4-1: Greenhouse Gas Emissions by Source for the Project Lifetime

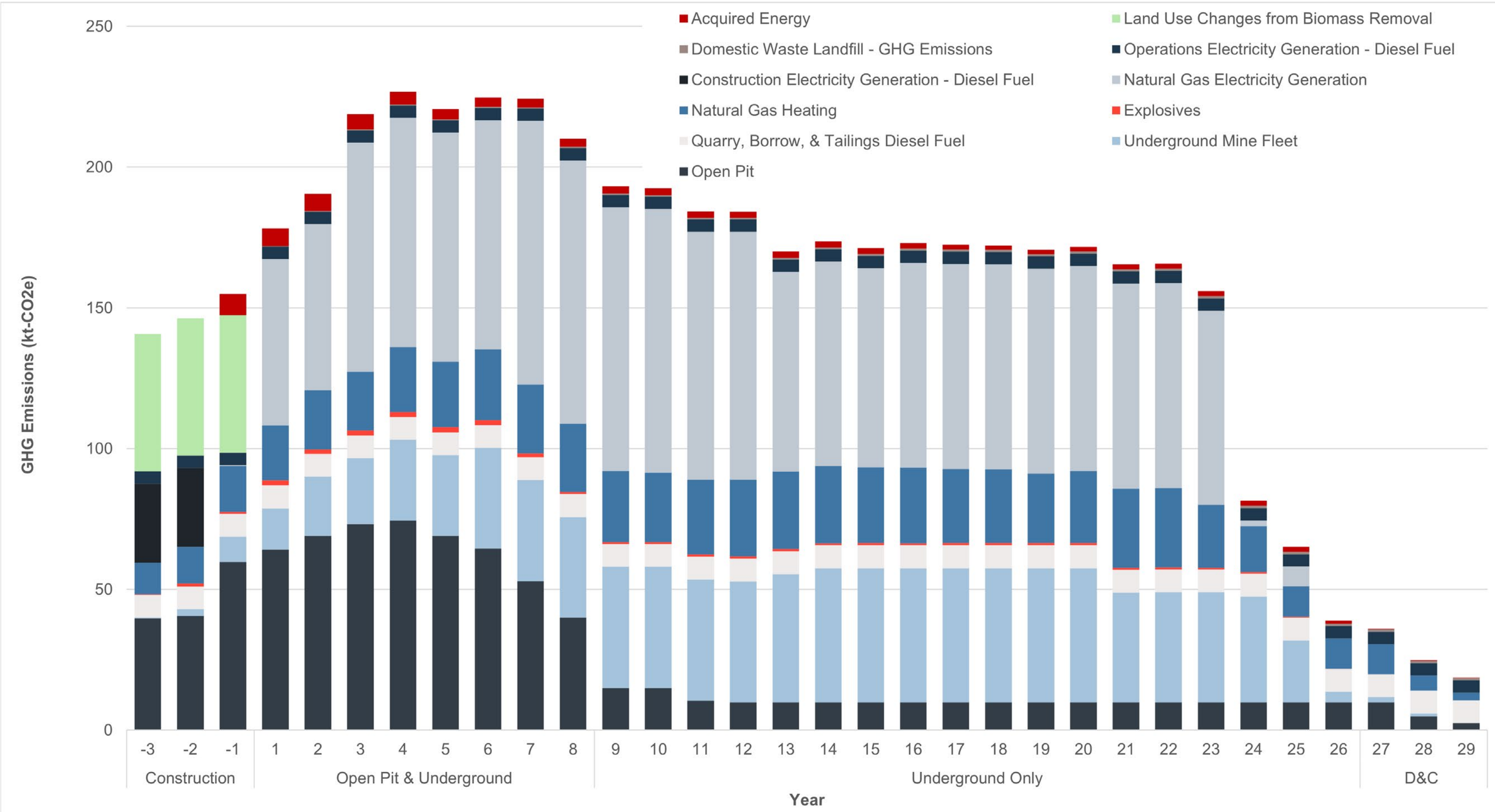


Figure 4-2: Annual Greenhouse Gas Emissions for the Project

5 GREENHOUSE GAS MITIGATIONS

5.1 MITIGATION MEASURES

The Project design has incorporated measures to mitigate GHG emissions. The following sections provide a high-level discussion on potential future mitigation measures not considered in the GHG calculations for each source of GHG emissions.

5.1.1 DIRECT GREENHOUSE GAS EMISSIONS – DIESEL USAGE

Onsite diesel use is the second largest source of GHG emissions for the Project, with the heavy-duty equipment fleet for the underground and open mines being the main sources. While current technology remains limited for the larger open pit equipment, there have been substantial advances in battery technology, trolley-assist, and other electrification options. Based on discussions with the major equipment providers, electrified options and not available for all equipment and some first-generation equipment is not expected to be commercially available for another five years or more. Other options for decarbonizing mobile equipment include the incorporation of biodiesel, renewable diesel, hydrogen, and other low-carbon fuels.

5.1.2 DIRECT GREENHOUSE GAS EMISSIONS – NATURAL GAS USAGE

Onsite natural gas usage is the largest source of the Project's GHG emissions as it includes the natural gas heating and electricity generation at the site. Strategies under consideration to reduce associated emissions include electrification, battery storage, heat recovery, heat pumps, hydrogen-fire boilers / furnaces, and renewable natural gas.

A key element of decarbonization at this Project will be accessibility of 100% grid power if and when the regional electrical grid is enhanced. Great Bear Resources is actively engaging with the regional grid supplier on the feasibility of securing this supply. If additional grid power is available and feasible, the project plans to utilize this power to decarbonize and reduce natural gas usage proportionally. This remains a key goal of the project. This is discussed further in the accompanying Net-Zero Plan issued under separate cover.

5.1.3 DIRECT GREENHOUSE GAS EMISSIONS – BLASTING

Onsite blasting throughout construction and operations phases is a small source of GHG emissions, accounting for roughly 1% of the net GHG emissions. In addition to decarbonizing their own operations, explosive manufacturers are committing to developing lower-carbon products to help their customers reduce their own direct emissions (Orica 2021). Great Bear Resources will continue to follow the development of these products in order to optimize explosive use.

5.1.4 DIRECT GREENHOUSE GAS EMISSIONS – DOMESTIC WASTE LANDFILL

The potential onsite domestic waste landfill is one of the smallest sources of GHG emissions, accounting for less than 1% of the net GHG emissions, and thus are not considered as a primary means to reduce the Project's net GHG emissions.

5.1.5 DIRECT GREENHOUSE GAS EMISSIONS – LAND USE CHANGES

Land clearing associated with site development during the construction phase is a small source of GHG emissions, accounting for roughly 3% of the net GHG emissions. Commitments to reduce associated emissions include merchantable timber recovery, progressive reforestation, and land reclamation. These commitments may also reduce the carbon sink impacts from the initial land clearing operations.

5.1.6 ACQUIRED ENERGY GREENHOUSE GAS EMISSIONS – ACQUIRED ELECTRICITY

The Project will be connected to a regional transmission line on the Ontario electrical grid, which will partially satisfy electric energy requirements of the Project (approximately 13 MW). Additional power line supply is not available from the existing grid and needs to be generated via natural gas. If and when capacity becomes available from the regional electrical grid, Great Bear proposes to access this source so that electricity demand for the Project may be fully or primarily supplied from the Ontario grid which is of low carbon intensity in comparison to onsite natural gas power generation. If a transmission line expansion proceeds, then the onsite natural gas usage (largest source of the Project's GHG emissions) will be reduced substantially. This is discussed further in the accompanying Net-Zero Plan issued under separate cover.

6 GREENHOUSE GAS MONITORING AND REPORTING

The Project is expected to have GHG reporting responsibilities under federal and provincial regulatory GHG Reporting Programs. These programs currently (2024) include:

- Ontario Greenhouse Gas Emissions: Quantification, Reporting and Verification Regulation (O. Reg. 390/18) under the *Canadian Environmental Protection Act*
- Government of Canada GHG Emissions Reporting Program (ECCC under *Canadian Environmental Protection Act*).

In addition to reporting, the Project would be subject to the requirements of the provincial Emissions Performance Standards Regulation 241/19.

Energy use and GHG emissions would be tracked and reported annually under these or subsequent programs as needed.

7 SUMMARY

This report documents the GHG regulatory framework, Project boundaries, GHG quantification methods, data, and assumptions that were used to estimate the net GHG emissions, emission intensity, and carbon sink changes for the Project. Based on the estimated GHG emissions, the following comparisons can be made:

- The net GHG emissions from the Project are estimated at 5,018 kt-CO_2e, which includes direct emissions (combustion, blasting, electricity, heating, landfilling and biomass removal) and acquired energy emissions.
- The maximum annual GHG emissions for operations are estimated to be 227 kt-CO_2e, representing 0.14% of Ontario's GHG inventory for 2022 (157 Mt-CO_2e) and 0.03% of the Canadian GHG inventory for that same year (708 Mt-CO_2e).
- Comparisons against the heavy industry inventory for Ontario and Canada are also relevant, and the annual GHG forecasts were found to be 0.2% of the Ontario inventory and 0.07% of Canada's total, respectively.
- The average and maximum GHG intensities of the Project's operations are 13.8 and 19.5 t-CO_2e/kg-gold, respectively. Compared to other gold mines in Canada the Project will have a GHG intensity in line with mines that operate using a hybrid of grid power and onsite power generation. Broadly, high-performing gold mining operations, from a GHG intensity perspective, are those that have access to, and maximize the use of, low-carbon intensity electrical grids. Accordingly, the Project's GHG intensity will be heavily dependent on the accessibility to a transmission line with increased capacity, the decarbonization of Ontario's electrical grid, and feasible electrified technologies.
- Foregone carbon sequestration as a result of land use changes at the Project are estimated at 584 kt-CO_2e.
- Onsite natural gas usage is the largest source of the Project's GHG emissions as it includes the natural gas heating and electricity generation at the site. A key element of decarbonization at this Project will be accessibility of 100% grid power if and when the regional electrical grid is enhanced. Great Bear Resources is actively engaging with the regional grid supplier on the feasibility of securing this supply. If additional grid power is available and feasible, the project plans to utilize this power to decarbonize and reduce natural gas usage proportionally. This remains a key goal of the project.

Although, the Project will result in a net increase in GHG emissions, the change will not have a notable effect on the Canadian and global GHG inventories. GHG mitigation opportunities will be reviewed and implemented to minimize the contribution of the Project to the overall provincial and federal inventories.

8 REFERENCES

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Appendix A
Emission Summary and Sample Calculations

Table A1: Summary of Emissions by Year and Source (kt-CO2e)

Phase / Year	Electricity Generation - Natural Gas	Heating - Natural Gas	Construction Electricity Generation - Diesel Fuel	Operations Electricity Generation - Diesel Fuel	Open Pit - Diesel Fuel	Underground Mine Fleet - Diesel Fuel	Quarry, Borrow, & Tailings - Diesel Fuel	Explosives	Domestic Waste Landfill	Land Use Changes from Biomass Removal	Direct GHG Emissions (Scope 1)	Acquired Energy (Scope 2)	Net GHG Emissions
Construction	**0.2**	**40.4**	**56.2**	**13.2**	**140.0**	**11.5**	**24.3**	**2.2**	**0.2**	**146.2**	**434.5**	**7.6**	**442.1**
Y -3	0.0	11.2	28.1	4.4	39.7	0.2	8.1	0.3	0.0	48.7	140.8	0.0	140.8
Y -2	0.0	12.9	28.1	4.4	40.6	2.3	8.1	1.1	0.1	48.7	146.3	0.0	146.3
Y -1	0.2	16.3	0.0	4.4	59.7	9.0	8.1	0.8	0.1	48.7	147.4	7.6	155.0
Open Pit & Underground	**631.0**	**181.5**	**0.0**	**35.2**	**507.0**	**224.0**	**64.8**	**12.8**	**2.4**	**0.0**	**1,659.0**	**35.2**	**1,694.3**
Y 1	59.1	19.6	0.0	4.4	64.1	14.7	8.1	1.8	0.2	0.0	172.0	6.3	178.3
Y 2	59.1	21.0	0.0	4.4	69.0	21.0	8.1	1.6	0.2	0.0	184.4	6.1	190.5
Y 3	81.4	20.8	0.0	4.4	73.2	23.4	8.1	1.8	0.2	0.0	213.4	5.5	218.8
Y 4	81.4	23.1	0.0	4.4	74.4	28.7	8.1	1.8	0.3	0.0	222.2	4.6	226.9
Y 5	81.4	23.2	0.0	4.4	69.0	28.7	8.1	1.8	0.3	0.0	217.0	3.6	220.6
Y 6	81.4	25.1	0.0	4.4	64.5	35.8	8.1	1.8	0.4	0.0	221.5	3.3	224.8
Y 7	93.6	24.5	0.0	4.4	52.9	35.9	8.1	1.4	0.4	0.0	221.2	3.0	224.3
Y 8	93.6	24.2	0.0	4.4	39.9	35.8	8.1	0.8	0.4	0.0	207.3	2.8	210.1
Underground Only	**1,165.2**	**431.5**	**0.0**	**79.2**	**187.4**	**732.6**	**145.8**	**13.1**	**11.9**	**0.0**	**2,767.6**	**34.2**	**2,801.9**
Y 9	93.6	25.2	0.0	4.4	15.0	43.0	8.1	0.8	0.5	0.0	190.6	2.7	193.3
Y 10	93.6	24.6	0.0	4.4	15.0	43.0	8.1	0.8	0.5	0.0	190.0	2.4	192.5
Y 11	88.0	26.6	0.0	4.4	10.4	43.1	8.1	0.8	0.5	0.0	182.0	2.4	184.3
Y 12	88.0	27.3	0.0	4.4	9.8	43.0	8.1	0.8	0.5	0.0	182.0	2.3	184.3
Y 13	71.0	27.5	0.0	4.4	9.8	45.6	8.1	0.8	0.6	0.0	167.8	2.2	170.0
Y 14	72.6	27.4	0.0	4.4	9.8	47.7	8.1	0.8	0.6	0.0	171.4	2.1	173.6
Y 15	70.7	26.9	0.0	4.4	9.8	47.7	8.1	0.9	0.6	0.0	169.2	2.0	171.2
Y 16	72.8	26.8	0.0	4.4	9.8	47.7	8.1	0.8	0.6	0.0	171.1	1.9	173.0
Y 17	72.8	26.3	0.0	4.4	9.8	47.7	8.1	0.9	0.7	0.0	170.7	1.7	172.4
Y 18	72.8	26.2	0.0	4.4	9.8	47.7	8.1	0.9	0.7	0.0	170.6	1.6	172.2
Y 19	72.8	24.6	0.0	4.4	9.8	47.7	8.1	0.9	0.7	0.0	169.1	1.5	170.6
Y 20	72.8	25.6	0.0	4.4	9.8	47.7	8.1	0.9	0.7	0.0	170.1	1.6	171.7
Y 21	72.8	28.1	0.0	4.4	9.8	39.1	8.1	0.7	0.7	0.0	163.8	1.7	165.5
Y 22	72.8	28.2	0.0	4.4	9.8	39.2	8.1	0.7	0.8	0.0	164.0	1.7	165.8
Y 23	69.0	22.3	0.0	4.4	9.8	39.2	8.1	0.6	0.8	0.0	154.2	1.7	156.0
Y 24	2.1	16.3	0.0	4.4	9.8	37.6	8.1	0.6	0.8	0.0	79.7	1.7	81.5
Y 25	7.0	10.8	0.0	4.4	9.8	22.1	8.1	0.3	0.8	0.0	63.4	1.7	65.1
Y 26	0.0	10.8	0.0	4.4	9.8	3.8	8.1	0.1	0.8	0.0	37.9	1.1	38.9
Decommissioning and Closure	**0.0**	**18.9**	**0.0**	**13.2**	**17.2**	**2.9**	**24.3**	**0.0**	**2.5**	**0.0**	**79.2**	**0.4**	**79.6**
Y 27	0.0	10.8	0.0	4.4	9.8	1.9	8.1	0.0	0.8	0.0	35.9	0.2	36.1
Y 28	0.0	5.4	0.0	4.4	4.9	1.0	8.1	0.0	0.8	0.0	24.7	0.1	24.8
Y 29	0.0	2.7	0.0	4.4	2.5	0.0	8.1	0.0	0.9	0.0	18.6	0.1	18.7
Grand Total	**1,796.4**	**672.3**	**56.2**	**140.8**	**851.6**	**971.0**	**259.2**	**28.1**	**17.0**	**146.2**	**4,940.3**	**77.4**	**5,017.9**

Table A2: Summary of Emissions by Phase

Emission Type	Emission Source	GHG Emissions (kt-CO2e)			
		Construction	Operations	Decommissioning and Closure	Grand Total
Direct (Scope 1)	Open Pit - Diesel Fuel	140.0	694.4	17.2	851.6
Direct (Scope 1)	Underground Mine Fleet - Diesel Fuel	11.5	956.6	2.9	971.0
Direct (Scope 1)	Quarry, Borrow, & Tailings - Diesel Fuel	24.3	210.6	24.3	259.2
Direct (Scope 1)	Explosives	2.2	25.9	0.0	28.1
Direct (Scope 1)	Heating - Natural Gas	40.4	613.0	18.9	672.3
Direct (Scope 1)	Electricity Generation - Natural Gas	0.2	1,796.2	0.0	1,796.4
Direct (Scope 1)	Construction Electricity Generation - Diesel Fuel	56.2	0.0	0.0	56.2
Direct (Scope 1)	Operations Electricity Generation - Diesel Fuel	13.2	114.4	13.2	140.8
Direct (Scope 1)	Domestic Waste Landfill	0.2	14.3	2.5	17.0
Direct (Scope 1)	Land Use Changes from Biomass Removal	146.2	0.0	0.0	146.2
Indirect (Scope 2)	Acquired Energy	7.6	69.4	0.4	77.4
—	Net GHG Emissions	442.1	4,496.2	79.6	5,017.9
Carbon Sink Impacts	Foregone Carbon Sequestration	59.7	474.3	49.8	583.8

Table A3: Summary of Project Emission Intensity

Year	Net GHG Emissions (t-CO_2e)	Gold Produced (kg Gold)	Project Emission Intensity (t-CO_2e/kg gold)
Y -3	140,800	0.0	0.0
Y-2	146,300	0.0	0.0
Y -1	155,000	3,486.4	0.0
Y 1	178,300	13,454.2	13.3
Y 2	190,500	14,638.3	13.0
Y 3	218,800	11,216.1	19.5
Y 4	226,900	12,816.5	17.7
Y 5	220,600	13,412.9	16.4
Y 6	224,800	13,980.8	16.1
Y 7	224,300	18,408.8	12.2
Y 8	210,100	19,156.4	11.0
Y 9	193,300	15,126.2	12.8
Y 10	192,500	12,860.1	15.0
Y 11	184,300	13,380.3	13.8
Y 12	184,300	12,909.1	14.3
Y 13	170,000	10,467.5	16.2
Y 14	173,600	12,866.2	13.5
Y 15	171,200	13,366.4	12.8
Y 16	173,000	14,162.6	12.2
Y 17	172,400	14,246.2	12.1
Y 18	172,200	13,467.5	12.8
Y 19	170,600	12,559.9	13.6
Y 20	171,700	13,422.8	12.8
Y 21	165,500	13,309.6	12.4
Y 22	165,800	12,711.0	13.0
Y 23	156,000	12,306.4	12.7
Y 24	81,500	11,291.9	7.2
Y 25	65,100	7,389.6	8.8
Y 26	38,900	1,726.7	22.5
Y 27	36,100	12.7	0.0
Y 28	24,800	0.0	0.0
Y 29	18,700	0.0	0.0
Grand Total	**5,017,900.0**	**338,153.1**	**357.7**
Average (Operations)	**—**	**—**	**13.8**
Max (Operations)	**—**	**—**	**19.5**

Table A4: Sample Calculations for Mobile Combustion, Stationary Combustion, Blasting, Acquired Electricity

Direct GHG Emissions - Mobile Combustion - Open Pit, Diesel Fuel

Maximum Year Fuel Consumption, V_{diesel} 27,480,500 L/yr

Parameter	CO_2	CH_4	N_2O	Units of Measure	Reference
Emission Factor, $EF_{mc,y}$	2,681	0.14	0.082	g/L	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Global Warming Potential, GWP_y	1	28	265	t-CO_2e/tonne	Government of Canada. 2018. Greenhouse Gas Pollution Pricing Act, Schedule 3
GHG Emissions	73,661	4	2	tonnes/yr	-
GHG Emissions	73,661	108	597	t-CO_2e/yr	-
Total GHG Emissions	74,366	—	—	t-CO_2e/yr	-

Direct GHG Emissions - Stationary Combustion - Heating, Natural Gas

Maximum Year Fuel Consumption, V_{fuel} 12,966,932 m^3/yr

Parameter	CO_2	CH_4	N_2O	Units of Measure	Reference
Emission Factor, $EF_{sc,y}$	1921	0.037	0.03	g/m^3	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-1 & A6.1-3 - Manufacturing Industries
Global Warming Potential, GWP_y	1	28	265	t-CO_2e/tonne	Government of Canada. 2018. Greenhouse Gas Pollution Pricing Act, Schedule 3
GHG Emissions	24,909	0.5	0.4	tonnes/yr	-
GHG Emissions	24,909	13	113	t-CO_2e/yr	-
Total GHG Emissions	25,036	—	—	t-CO_2e/yr	-

Direct GHG Emissions - Blasting

Maximum Year Explosive Used 10,348,414 kg-emulsion/yr

Parameter	CO_2	CH_4	N_2O	Units of Measure	Reference
Emission Factor, EF_{em}	0.17	—	—	t-CO_2/tonne-emulsion	Dyno Nobel. 2021. Personal Communication on May 19, 2021.
Global Warming Potential, GWP_y	1	28	265	t-CO_2e/tonne	Government of Canada. 2018. Greenhouse Gas Pollution Pricing Act, Schedule 3
GHG Emissions	1,759	—	—	tonnes/yr	-
GHG Emissions	1,759	—	—	t-CO_2e/yr	-
Total GHG Emissions	1,759	—	—	t-CO_2e/yr	-

Acquired Energy GHG Emissions - Purchased Electricity

Maximum Year Electricity Usage, D_{grid} 113,880,000 kWh/yr

Parameter	CO_2e	Units of Measure	Reference
Emission Factor, EF_{grid}	28.8	t-CO2e/GWh	Government of Canada. 2023b. Canada's Greenhouse Gas Emissions Projections (excluding biomass & RNG), Ontario.
GHG Emissions	3,280	t-CO2e/yr	-

Table A5: Emission Factors and Intensities

Global Warming Potentials

Substance	100-Year GWP		Reference
	AR4	AR5	
CO_2	1	1	Government of Canada. 2018. Greenhouse Gas Pollution Pricing Act, Schedule 3
CH_4	25	28	
N_2O	198	265	

Emission Factors

Fuel Type	CO_2	CH_4	N_2O	CO_2e	Unit	Category	Reference
Natural Gas	1,921.0	0.037	0.033	1,931	g/m^3	Stationary Combustion	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-1 & A6.1-3 - Manufacturing Industries
Propane	1,515.0	0.024	0.108	1,544	g/L	Stationary Combustion	ECCC. 2024. Canada's Greenhouse Gas Quantification Requirements Table 2-1, Propane and Table 2-6, Propane - Industry
Diesel	2,681.0	0.078	0.020	2,688	g/L	Stationary Combustion	ECCC. 2024. Canada's Greenhouse Gas Quantification Requirements Table 2-2, Diesel and Table 2-7, Diesel: All-Industry - Stationary Combustion
Gasoline	2,307.3	0.111	0.007	2,312	g/L	Gasoline Vehicles - LDGV - Tier 3	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.140	0.022	2,317	g/L	Gasoline Vehicles - LDGV - Tier 2	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.230	0.470	2,438	g/L	Gasoline Vehicles - LDGV - Tier 1	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.320	0.660	2,491	g/L	Gasoline Vehicles - LDGV - Tier 0	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.520	0.200	2,375	g/L	Gasoline Vehicles - LDGV - Oxidation Catalyst	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.460	0.028	2,328	g/L	Gasoline Vehicles - LDGV - Non-catalytic Controlled	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.111	0.007	2,312	g/L	Gasoline Vehicles - LDGT - Tier 3	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.140	0.022	2,317	g/L	Gasoline Vehicles - LDGT - Tier 2	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.240	0.058	2,329	g/L	Gasoline Vehicles - LDGT - Tier 1	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.210	0.660	2,488	g/L	Gasoline Vehicles - LDGT - Tier 0	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.430	0.200	2,372	g/L	Gasoline Vehicles - LDGT - OC	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.560	0.028	2,330	g/L	Gasoline Vehicles - LDGT - NCC	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.068	0.200	2,362	g/L	Gasoline Vehicles - HDGV - 3WC	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.290	0.047	2,328	g/L	Gasoline Vehicles - HDGV - NCC	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.490	0.084	2,343	g/L	Gasoline Vehicles - HDGV - Uncontrolled	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.770	0.041	2,340	g/L	Gasoline Vehicles - GM - NCC	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	0.230	0.048	2,326	g/L	Gasoline Vehicles - GM - U	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.051	0.220	2,740	g/L	Diesel Vehicles - LDDV - AC	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.068	0.210	2,738	g/L	Diesel Vehicles - LDDV - MC	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.100	0.160	2,726	g/L	Diesel Vehicles - LDDV - U	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.068	0.220	2,741	g/L	Diesel Vehicles - LDDT - AC	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.068	0.210	2,738	g/L	Diesel Vehicles - LDDT - MC	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.085	0.160	2,725	g/L	Diesel Vehicles - LDDT - U	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.110	0.015	2,688	g/L	Diesel Vehicles - HDDV - AC	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.140	0.082	2,706	g/L	Diesel Vehicles - HDDV - MC	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.150	0.075	2,705	g/L	Diesel Vehicles - HDDV - U	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Natural Gas	1.9	0.009	0.000	2.2	g/L	Natural Gas Vehicles	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Propane	1,515.0	0.640	0.028	1,540.3	g/L	Propane Vehicles	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	10.560	0.013	2,606.4	g/L	Off-road Gasoline 2-stroke	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Gasoline	2,307.3	5.080	0.064	2,466.5	g/L	Off-road Gasoline 4-stroke	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.073	0.022	2,688.4	g/L	Off-road Diesel < 19kW	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.073	0.022	2,688.4	g/L	Off-road Diesel ≥ 19kW, Tier 1 - 3	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Diesel	2,680.5	0.073	0.227	2,742.7	g/L	Off-road Diesel ≥ 19kW, Tier 4	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15

Fuel Type	CO_2	CH_4	N_2O	CO_2e	Unit	Category	Reference
Oil	2,705.0	12.690	0.016	3,064.6	g/L	Off-road Lubricating Oil 2-stroke	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Natural Gas	1.9	0.009	0.00006	2.2	g/L	Off-road Natural Gas	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Propane	1,515.0	0.640	0.087	1,556.0	g/L	Off-road Propane	ECCC. 2024. National Inventory Report 1990-2022 Part 2, Table A6.1-15
Hydrogenation Derived Renewable Diesel (HDRD)	—	—	—	55.0	g/L	Mobile Combustion	S&T Squared Consultants Inc. 2023. GHGenius.
Renewable Natural Gas (RNG)	—	—	—	200.0	g/kg	Mobile Combustion	S&T Squared Consultants Inc. 2023. GHGenius.
Natural Gas Volume-Energy Conversion	0.03724	—	—	—	GJ/m^3	—	Canada Energy Regulator. 2016. Energy Conversion Tables. Government of Canada.
Diesel Volume-Energy Conversion	38.68	—	—	—	GJ/m^3	—	Canada Energy Regulator. 2016. Energy Conversion Tables. Government of Canada.
Generator Thermal Efficiency	40%	—	—	—	—	—	Decker, C. T., et al. (2016), Opportunities for Waste Heat Recovery at Contingency Bases, US Army Corps of Engineers, Figure 5
Diesel Energy Density	0.0000441	—	—	—	TJ/kg	—	Donev, J.M.K.C., et al. 2024. Energy Education - Energy Density. University of Calgary.
Diesel Density	0.846	—	—	—	kg/L	—	Innovation, Science and Economic Development Canada. 2018. Volume Correction Factors - Diesel Fuel. Government of Canada.
Propane Volume-Energy Conversion	25.53	—	—	—	GJ/m^3	—	Canada Energy Regulator. 2016. Energy Conversion Tables. Government of Canada.
Blasting Emissions	0.17	—	—	—	$t\text{-}CO_2$/t-ANFO	—	Dyno Nobel. 2021. Personal Communication on May 19, 2021.

Underground Mining Diesel Emission Factor

Gold Mine Reference	Diesel (GJ)	Diesel (L)	Amount Mined (tonnes)	Underground Diesel Emission Factor (L/tonne)	Reference
Éléonore	261,970	6,772,755	1,588,000	4.3	Kinross
Musselwhite	336,575	8,701,537	934,000	9.3	Kinross
Young Davidson	231,154	5,976,060	2,883,241	2.1	Kinross
Island Mine	137,875	3,564,504	435,297	8.2	Kinross
Kettle-River	-	-	-	6.3	Kinross
Average	-	-	-	**6.0**	Kinross

Electricity Usage

Electricity Parameter	Power (MW)	Power (kWh/year)	Reference
Grid Availability	13.0	113,880,000	Kinross

Ontario Grid Emission Factor Projections

Year	Emission Factor - Reference Scenario ($t\text{-}CO_2e$/GWh)	Emission Factor - AM Scenario ($t\text{-}CO_2e$/GWh)	Reference
2024	63.1	65.5	Government of Canada. 2023b. Canada's Greenhouse Gas Emissions Projections (excluding biomass & RNG), Ontario.
2025	84.4	87.8	
2026	69.7	76.7	
2027	84.9	87.1	
2028	72.9	75.4	
2029	66.7	69.3	
2030	55.1	48.1	
2031	53.4	24.7	
2032	47.9	20.7	
2033	40.7	13.9	
2034	31.6	6.6	
2035	28.8	0.9	
2036	26.6	0.5	
2037	24.9	0.2	
2038	23.4	0.2	
2039	21.5	0.2	
2040	20.7	0.2	
2041	19.8	0.2	
2042	19.3	0.2	
2043	18.6	0.2	
2044	17.7	0.2	
2045	16.6	0.2	
2046	15.2	0.2	
2047	14.1	0.2	
2048	13.5	0.2	
2049	14.2	0.2	
2050	15.3	0.3	
2051	15.3	0.3	
2052	15.3	0.3	
2053	15.3	0.3	
2054	15.3	0.3	
2055	15.3	0.3	
2056	15.3	0.3	

Table A6: Comparison with National and Provincial Benchmarks

Parameter	Sources Included	GHG Emissions (Mt-CO_2e)		Maximum Annual Project GHG Emissions	Fraction of Benchmark		Reference	
		Canada	Ontario	(Mt-CO2e)	Canada	Ontario	Canada	Ontario
Total Inventory	Direct and Indirect (Scope 1 and 2)	708	157.0	0.227	0.03%	0.14%	ECCC. 2024. National Inventory Report 1990-2022 Executive Summary, Table ES-1, Total	ECCC. 2024. National Inventory Report 1990-2022 Executive Summary, Figure ES-7, Ontario
Mining	Direct (Scope 1)	11	1.7	—	—	—	ECCC. 2024. National Inventory Report 1990-2022 Part 3, Table A10-2, Ontario - Mining	ECCC. 2024. National Inventory Report 1990-2022 Part 3, Table A12-7, Ontario - Mining
Smelting and Refining (Non-Ferrous Metals)	Direct (Scope 1)	10	0.8	—	—	—	ECCC. 2024. National Inventory Report 1990-2022 Part 3, Table A10-2, Ontario - Smelting and Refining	ECCC. 2024. National Inventory Report 1990-2022 Part 3, Table A12-7, Ontario - Smelting and Refining
Mining, Smelting, and Refining	Direct (Scope 1)	21	2.5	0.222	1.06%	8.89%	—	—
Heavy Industry (including Mining)	Direct (Scope 1)	78	28.6	0.222	0.28%	0.78%	ECCC. 2024. National Inventory Report 1990-2022 Executive Summary, Table ES-1, Heavy Industry	EN_GHG_Econ_Can_Prov_Terr.xlsx
Comparison against 2030 Target	Direct and Indirect (Scope 1 and 2)	406	—	0.227	0.056%	—	Office of the Auditor General of Canada. 2021. Report 5 - Lessons Learned from Canada's Record on	

Appendix B
Land Use Changes and Carbon Sink Impact Calculations

Table B1: Land Use Summary

Ecosite Code	Ecosite Description [1]	Area (ha)								Estimated Tree Coverage [2,3]	Wetland = W Dryland = D	Ecosite Developed by Default?
		Undisturbed	Recency of Wildfires (yrs)	Recency of Logging (yrs)				Total				
			(41-50)	(11-20)	(21-30)	(31-40)	(41-50)					
B012	Very Shallow, Dry to Fresh: Pine - Black Spruce Conifer	—	22.9	—	—	—	—	22.9		100%	D	N
B033	Sandy Soil: Red Pine-White Pine	0.7	5.0	—	—	—	—	5.7		100%	D	N
B034	Dry, Sandy: Jack Pine – Black Spruce Dominated	—	59.7	—	—	—	—	59.7		100%	D	N
B035	Dry, Sandy: Pine - Black Spruce Conifer	1.1	11.4	—	—	—	—	12.5		100%	D	N
B040	Dry, Sandy: Aspen – Birch Hardwood	—	5.8	—	—	—	—	5.8		100%	D	N
B049	Dry to Fresh, Coarse: Jack Pine - Black Spruce Dominated	—	37.8	—	—	—	—	37.8		100%	D	N
B050	Dry to Fresh, Coarse: Pine - Black Spruce Conifer	13.3	48.0	—	—	—	—	61.3		100%	D	N
B055	Dry to Fresh, Coarse: Aspen - Birch Hardwood	0.8	232.6	4.0	—	—	—	237.4		100%	D	N
B065	Moist, Coarse: Pine - Black Spruce Conifer	0.4	9.4	—	—	—	—	9.8		100%	D	N
B070	Sandy, Coarse: Hardwood-Fir-Spruce Mixedwood	—	0.5	—	—	—	—	0.5		100%	D	N
B082	Fresh, Clayey: Jack Pine - Black Spruce Dominated	15.8	2.2	—	—	—	—	18.0		100%	D	N
B098	Fresh, Silty to Fine Loamy: Jack Pine - Black Spruce	1.6	15.9	—	—	22.8	32.2	72.5		100%	D	N
B099	Fresh, Silty to Fine Loamy: Pine - Black Spruce Conifer	20.8	42.9	—	0.2	11.5	13.5	88.8		100%	D	N
B101	Fresh, Silty to Fine Loamy: Spruce - Fir Conifer	1.1	0.0	—	—	—	—	1.1		100%	D	N
B104	Fresh, Silty to Fine Loamy: Aspen - Birch Hardwood	0.0	43.3	0.0	—	—	—	43.4		100%	D	N
B114	Moist, Fine: Pine - Black Spruce Conifer	9.4	145.6	—	5.5	—	27.6	188.1		100%	D	N
B119	Moist, Fine: Aspen - Birch Hardwood	—	10.1	—	—	—	—	10.1		100%	D	N
B126	Treed Bog	—	4.0	—	—	—	—	4.0		25%	W	N
B127	Organic Poor Conifer Swamp	0.0	0.0	—	—	—	—	0.0		100%	W	N
B128	Intermediate Conifer Swamp	1.4	219.0	—	—	—	7.4	227.8		100%	W	N
B133	Hardwood Swamp	—	3.5	—	—	—	—	3.5		100%	W	N
B135	Organic Thicket Swamp	2.7	30.1	—	—	—	—	32.8		100%	W	N
B136	Sparse Treed Fen	0.5	13.1	—	—	—	—	13.6		25%	W	N
B140	Open Moderately Rich Fen	—	1.5	—	—	—	—	1.5		25%	W	N
B142	Mineral Meadow Marsh	—	6.0	—	—	—	—	6.0		0%	W	N
B193	Active Course Clean Fill	—	0.2	—	—	—	—	0.2		0%	—	N
B197	Pavement / Concrete	0.1	2.0	—	—	—	—	2.1		0%	—	Y
WAT	Open Water	12.5	0.0	—	—	—	—	12.5		0%	—	Y

Parameter	Area (ha)
▲A, Total Area	1179
▲$A_{TO\_OTHERSI}$, Area of Tree Coverage	1144
▲$A_{TO\_OTHERSI}$, Total Area of Soil Disturbance	1165

Age [4]	Treed Area (ha)	% Area	Non-Wetland (ha)	% Area
Harvested	0	0%	0	0%
Juvenile	10	0.9%	4	0.5%
Mature	1135	99.1%	806	99.5%

Assumptions and Notes:

[1]Vegetation communities from Ontario's Forest Resources Inventory Dataset via WSP GIS Team.

[2]Percent tree coverage is a measure of area that is generally treed, not a measure of soil productivity.

[3]Bogs and fens assumed to be 25% treed (Ontario, 2014, Page 49-50). Marshes assumed to be 0% treed (Ontario, 2014, Page 52). Swamps and forests assumed fully treed (100%) (Ontario, 2014, Page 50).

[4]Harvested area includes disturbances in the last 0-10 years. Juvenile tree stand area includes disturbances in the last 11-30 years. Mature tree stand area includes undisturbed land and land where there were no disturbances for over 31 years (Payne et al., 2019)

Table B2: Carbon Stocks Determination

Parameter	tonnes of C	% Combusted	% Undisturbed	% Unmerchantable / Left Onsite	% Merchantable / Removed	tonnes of CO_2e	tonnes of CO_2e excluding biogenic combustion CO_2
Above-Ground Biomass Carbon Stocks Removed	118,701	0%	10%	20%	70%	46,721	46,721
Dead Organic Matter (DOM) Removed	30,897	0%	10%	80%	10%	48,645	48,645
Soil Organic Carbon (SOC) Disturbed	13,878	—	—	—	—	50,852	50,852
Total							**146,218**

Assumptions:

Direct GHG emissions from biomass combustion excludes biogenic CO2 (Canada, 2021, Section 2.1.1.1).

Burning DOM results in 90% CO_2, 9% CO, 1%CH^4 conversion (Canada, 2022a, Section A3.5.2.1.)

Burning DOM results in $N_2O = CO_2 x\ 0.00017$ (Canada, 2022a, Section A3.5.2.1.)

Where no other data was available, changes in C stocks involving transfers to the atmosphere were converted to CO_2 (Canada, 2021, Table 18).

Poor composting (e.g., only passive aeration) was assumed to represent stockpiled biomass. CH4 is formed in anaerobic sections of the compost, but it is oxidised to a large extent in the aerobic sections of the compost with N_2O formation also possible as a function of nitrogen content. Poorly working composts are likely to produce more both of CH4 and N2O (IPCC, 2006a).

- Assume the dry biomass is 50% carbon and 2% nitrogen content (IPCC, 2006b, Vol 5, Ch.4, Table 4.1).
- 20 gCH4/kg-dry biomass (IPCC, 2006b, Vol 5, Ch.4, Table 4.1 - upper range to rep. poor composting)
- 1.6 gN2O/kg-dry biomass (IPCC, 2006b, Vol 5, Ch.4, Table 4.1 - upper range to rep. poor composting)
- 0.5 Ratio of carbon to dry biomass (Payne et al., 2019)

Conservatively assuming no wetlands will be maintained as wetlands.

Did not assess annual loss of carbon from drained organic soils due to insufficient detail.

Assumed 70% of the above-ground biomass was merchantable or otherwise removed from site; 20% is in-situ (slash/mulch), and 10% was undisturbed.

Assumed 80% of the DOM was left in-situ unmerchantable (litter/mulch) with potential for anaerobic decomposition; 10% was removed from site and 10% was undisturbed.

Assumed undisturbed carbon stock have no GHG emissions.

Above-Ground Biomass Carbon Stocks Removed

IPCC, 2006a, Vol.4, Ch.2, Eqn. 2.15: ANNUAL CHANGE IN BIOMASS CARBON STOCKS ON LAND CONVERTED TO OTHER LAND-USE CATEGORY (TIER 2)

▲C_B =	▲C_G +	▲$C_{CONVERSION}$ -	▲C_L
-118,701	0	-118,701	0

Where:

▲C_B = Annual change in carbon stocks in biomass on land converted to other land-use category (tC/yr)

▲C_G = Annual increase in carbon stocks in biomass due to growth on land converted to another land-use category (tC/yr)

▲$C_{CONVERSION}$ = Initial change in carbon stocks in biomass on land converted to other land-use category (tC/yr)

▲C_L = Annual decrease in biomass carbon stocks due to losses from harvesting, fuel wood gathering and disturbances on land converted to other land-use category (tC/yr)

Assumptions:

▲C_G = 0 tC/yr, Assume no growth

▲C_L = 0 tC/yr, Assume no living biomass is removed from site as wood products

Biomass Stocks on Land Determination

Refer to Appendix B1

Parameter	Area (ha)
▲$A_{TO\_OTHERS\ treed}$, Area of Juvenile Biomass Clearing	10
▲$A_{TO\_OTHERS\ treed}$, Area of Mature Biomass Clearing	1135
▲$A_{TO\_OTHERS\ treed}$, Area of Land Use Biomass Clearing	**1144**

Change in Biomass Carbon Stock

IPCC, 2006a, Vol.4, Ch.2, Eqn. 2.16: INITIAL CHANGE IN BIOMASS CARBON STOCKS ON LAND CONVERTED TO ANOTHER LAND CATEGORY

Age	▲$C_{CONVERSION}$ =	Σ{(B_{AFTERi} -	$B_{BEFOREi}$) •	▲$A_{TO\_OTHERSi}$} •	CF
Juvenile	-338	0	34.6	10	1
Mature	-118,364	0	104.3	1135	1
Total	**-118,701**				

Where:

▲$C_{CONVERSION}$ = Initial change in carbon stocks in biomass on land converted to other land-use category (tC/yr)

$B_{BEFOREi}$ = Biomass stocks on land type i before the conversion (tC/ha)

B_{AFTERi} = Biomass stocks on land type i immediately after the conversion (tC/ha)

▲$A_{TO\_OTHERSi}$ = Area of land use i converted to another land-use category in a certain year (ha/yr)

CF = Carbon fraction of dry matter (tCdry/tCtotal)

i = Type of land converted to another land-use category

Assumptions:

$B_{BEFOREi, juvenile}$ =	34.6	tC/ha (Payne et al., 2019)
$B_{BEFOREi, mature}$ =	104.3	tC/ha (Payne et al., 2019)
B_{AFTERi} =	0	tC/ha, Assume all living biomass will be removed
▲$A_{TO\_OTHERSi}$ =	1144	ha, GIS estimation based on site plan
CF=	1	tC_{dry}/tC_{total} , already on the basis of dry mass

Assumptions:

Vegetation Communities from Ontario's Forest Resources Inventory Dataset, Via WSP GIS Team

[3]Bogs and fens assumed to be 25% treed (Ontario, 2014, Page 49-50). Marshes assumed to be 0% treed (Ontario, 2014, Page 52). Swamps and forests assumed fully treed (100%) (Ontario, 2014, Page 50).

Dead Organic Matter (DOM)

IPCC, 2006a, Vol.4, Ch.2, Eqn. 2.23: ANNUAL CHANGE IN CARBON STOCKS IN DEAD WOOD AND LITTER DUE TO LAND CONVERSION

Age	▲C_{DOM} =	[(C_n -	C_o) •	▲A_{on}] ÷	T_{on}
Juvenile	-368	0	37.7	10	1
Mature	-30,530	0	26.9	1135	1
Total	**-30,897**				

Where:

▲C_{DOM} = Annual change in carbon stocks in dead wood or litter (tC/yr)
C_n = Dead wood / litter stock under the old land-use category (tC/ha)
C_o = Dead wood / litter stock under the new land-use category (tC/ha)
▲A_{on} = Area undergoing conversion from old to new land-use category (ha)
T_{on} = Time period of the transition from old to new land-use category (yr)

Assumptions:

T_{on} = 1 yr, transition (i.e., clearing) assumed to take 1 year
C_n = 0 tC/ha (Canada, 2021, Table 18 - SACC default, all DOM is lost)
$C_{o\ juvenile}$ = 37.7 tC/ha (Payne et al., 2019)
$C_{o\ mature}$ = 26.9 tC/ha (Payne et al., 2019)

Soil Organic Carbon (SOC)

IPCC, 2006a, Vol.4, Ch.2, Eqn. 2.24: ANNUAL CHANGE IN CARBON STOCKS IN SOILS

▲C_{Soils} =	▲$C_{Mineral}$ -	$L_{Organic}$ +	▲$C_{Inorganic}$
-13,878	-13,878	0	0

Where:

▲C_{Soils} = Annual change in carbon stocks in soils (tC/yr)
▲$C_{Mineral}$ = Annual change in organic carbon stocks in mineral soils (tC/yr)
$L_{Organic}$ = Annual loss of carbon from drained organic soils (tC/yr)
▲$C_{Inorganic}$ = Annual change in inorganic carbon stocks from soils (tC/yr)

Assumptions:

▲$C_{Inorganic}$ = 0 tC/ha (Canada, 2021, Table 18 - Default based on depth of 30 cm)
$L_{Organic}$ = 0 tC/ha, Assume that drained organic soils will be left built over and remain anoxic
▲C_{Soils} , calculated at carbon lost from soils

IPCC 2006a, Vol.4, Ch.2, Eqn. 2.25: ANNUAL CHANGE IN ORGANIC CARBON STOCKS IN MINERAL SOILS

▲$C_{Mineral}$ =	[(SOC_0 -	$SOC_{(0-T)}$)] ÷	D
-13,878	0	13878	1

Mineral Soil	$SOC_{(0-T)}$ =	(SOC_{REF} •	F_{LU} •	F_{MG} •	F_I •	A)
Wetland Soils	8,445	146	0.2			289
Juvenile	30	37.7	0.2			4
Mature	5,403	33.5	0.2			806
Total	**13,878**					

Where:

▲$C_{Mineral}$ = Annual change in organic carbon stocks in mineral soils (tC/yr)
SOC_0 = Soil organic carbon stock in the last year of an inventory time period (tC)
T = Number of years over a single inventory time period (yr)
D = Time dependence of stock change factors which is the default time period for transition between equilibrium SOC values (yr)
c = represents the climate zones, s, the soil types, and I, the set of management systems that are present in a country
$SOC_{REF,wetland}$ = Reference carbon stock for wetlands (tC/yr)
$SOC_{REF,boreal}$ = Reference carbon stock for boreal (tC/yr)
F_{LU} = Stock change factor for land-use system or sub-system for a particular land-use
F_{MG} = Stock change factor for input of management regime
F_I = Stock change factor for input of organic matter
A = Land use of the stratum being estimated (ha)

Assumptions:

Note, ▲$C_{Mineral}$ is only for the first 30 cm
SOC_0 = 0 tC, assumed soil completely removed
D = 1 yr, assumed change occurs over 1 year
$SOC_{REF,wetland}$ = 146 tC/ha (IPCC, 2006a, Vol4, Ch.2, Table 2.3 - values for bogs, fens, marshes and swamps)
$SOC_{REF,boreal,\ juvenile}$ = 37.7 tC/ha (Payne et al., 2019)
$SOC_{REF,boreal,\ mature}$ = 33.5 tC/ha (Payne et al., 2019)
F_{LU} • F_{MG} • F_I = 0.2 (Canada, 2021, Table 18 - Default for Land to Settlement carbon loss)
Assumed WR, OVB stockpiles, and TMF soils are not disturbed based on KGC correspondence

Table B3: Foregone Carbon Sequestration

Land Type	Land Area (ha)				Assumed Tree Coverage
	Harvested	Juvenile	Mature	Total	
Forest	0	10	866	875	100%
Swamp	0	0	264	264	100%
Rich Fen	0	0	2	2	25%
Treed Fen	0	0	14	14	25%
Bog	0	0	4	4	25%
Marsh	0	0	6	6	0%
Water	0	0	13	13	0%
Pavement / Concrete	0	0	2	2	0%
Active Course Clean Fill	0	0	0	0.2	0%

Where:

CSI = Σ ((NatFlux - PostDFlux) • T • A (Canada, 2021, Annex D - Equation 5)
CSI = Carbon sink impact (tC)
NatFlux = Natural annual carbon accumulation rate of the land being impacted (tC/ha/yr), also referred to as uptake
PostDFlux = Post-disturbance (i.e., post conversion) flux rate impacted by the project (tC/ha/yr)
T = Time interval (yr)
A = Land area (ha)
i = Land-use class
j = Disturbance activity for each phase of the project (construction, operation, decommission including, for instance, site restoration or reclamation)

Assumptions:

$NatFlux_{RichFen, Soil}$ = 0.33 tC/ha/yr (Canada, 2021, Table 31 - defaults for Boreal Shield)
$NatFlux_{PoorFen, Soil}$ = 0.31 tC/ha/yr (Canada, 2021, Table 31 - defaults for Boreal Shield)
$NatFlux_{Bog, Soil}$ = 0.24 tC/ha/yr (Canada, 2021, Table 31 - defaults for Boreal Shield)
PostDFlux = 0 tC/ha/yr, Assumes all carbon uptake potential lost where project elements are built
T = 1 yr, Assumes a time interval of 1 year

Carbon uptake (NatFlux) for juvenile and mature tree stands was approximated using the stand age and the Net Primary Production (Payne et al., 2019). This is recognized as a good indicator of the natural carbon accumulation rate based on call with the author (N.J. Payne,
Predicted uptake of swamps and forests is proportional to the annual growth volume of the trees, assuming a basal area of 10 m (Payandeh & Field, 1986).
Marsh, water, and pavement / concrete have no carbon uptake (i.e., NatFlux = 0) because they do not host vegetation or soils.
All fens that are not stated as "Poor" are "Rich".
Treed areas (e.g., swamps, forests) with 100% tree coverage soil carbon accumulation assumed to be immaterial.
Average stand age of forests and swamps are 25 years for juvenile stand and 50 years for a mature stand.
No carbon uptake occurs once a tree is cut down.

Sample Calculation:

Determine the carbon uptake in year 2030 for the Rich Fen (Canada, 2021, Annex D - Equation 5)

CSI = [($NatFlux_{Vegetation}$ - PostDFlux) • T • Area)] + [($NatFlux_{Soil}$ - PostDFlux) • T • Area)]

$$CSI = \left(\frac{4.51\ tC}{ha \cdot year} - \frac{0\ tC}{ha \cdot year}\right) \cdot 1\ year \cdot 2\ ha \cdot 25\%\ treed + \left(\frac{0.33\ tC}{ha \cdot year} - \frac{0\ tC}{ha \cdot year}\right) \cdot 1\ year \cdot 2\ ha$$

CSI = 1.7 tC + 0.5 tC

CSI = 2.2 tC

Determine the total carbon dioxide uptake in year 2030 for all vegetation and soil using a molar conversion

Total CO_2 Uptake = (Total $CSI_{Vegetation}$ + Total CSI_{Soil}) • Conversion to CO_2

$$\text{Total } CO_2 \text{ Uptake} = (5349\ tC + 6\ tC) \cdot \frac{44.01\ g/mol\ CO_2}{12.01\ g/mol\ C}$$

Total CO_2 Uptake = 19,622 tCO_2 in 2030

Vegetation - Rate of Carbon Sequesteration and Carbon Sequestered

Year	$NatFlux_{Vegetation}$ (tC/ha)						$CSI_{Vegetation}$ (tC)						Total $CSI_{Vegetation}$
Land Type	Forest		Swamp	Rich Fen	Treed Fen	Bog	Forest		Swamp	Rich Fen	Treed Fen	Bog	
Tree Type	Juvenile	Mature	Mature	Mature	Mature	Mature	Juvenile	Mature	Mature	Mature	Mature	Mature	
Assumed Tree Coverage	100%	100%	100%	25%	25%	25%	—	—	—	—	—	—	
Land Area (ha)	10	866	264	2	14	4	—	—	—	—	—	—	(tC)
Y -3	5.27	4.59	5.27	4.59	4.59	4.59	51	3,976	1,393	1.7	16	5	**5,442**
Y -2	5.25	4.57	5.25	4.57	4.57	4.57	51	3,952	1,386	1.7	15	5	**5,411**
Y -1	5.22	4.54	5.22	4.54	4.54	4.54	51	3,929	1,378	1.7	15	5	**5,380**
Y 1	5.19	4.51	5.19	4.51	4.51	4.51	51	3,905	1,371	1.7	15	5	**5,349**
Y 2	5.16	4.48	5.16	4.48	4.48	4.48	50	3,882	1,364	1.7	15	5	**5,318**
Y 3	5.14	4.46	5.14	4.46	4.46	4.46	50	3,858	1,357	1.7	15	4	**5,286**
Y 4	5.11	4.43	5.11	4.43	4.43	4.43	50	3,835	1,350	1.7	15	4	**5,255**
Y 5	5.08	4.40	5.08	4.40	4.40	4.40	50	3,811	1,343	1.7	15	4	**5,224**
Y 6	5.06	4.38	5.06	4.38	4.38	4.38	49	3,788	1,335	1.6	15	4	**5,193**
Y 7	5.03	4.35	5.03	4.35	4.35	4.35	49	3,764	1,328	1.6	15	4	**5,162**
Y 8	5.00	4.32	5.00	4.32	4.32	4.32	49	3,740	1,321	1.6	15	4	**5,131**
Y 9	4.97	4.29	4.97	4.29	4.29	4.29	48	3,717	1,314	1.6	15	4	**5,100**
Y 10	4.95	4.27	4.95	4.27	4.27	4.27	48	3,693	1,307	1.6	14	4	**5,069**
Y 11	4.92	4.24	4.92	4.24	4.24	4.24	48	3,670	1,299	1.6	14	4	**5,037**
Y 12	4.89	4.21	4.89	4.21	4.21	4.21	48	3,646	1,292	1.6	14	4	**5,006**
Y 13	4.87	4.19	4.87	4.19	4.19	4.19	47	3,623	1,285	1.6	14	4	**4,975**
Y 14	4.84	4.16	4.84	4.16	4.16	4.16	47	3,599	1,278	1.6	14	4	**4,944**
Y 15	4.81	4.13	4.81	4.13	4.13	4.13	47	3,576	1,271	1.5	14	4	**4,913**
Y 16	4.78	4.10	4.78	4.10	4.10	4.10	47	3,552	1,263	1.5	14	4	**4,882**
Y 17	4.76	4.08	4.76	4.08	4.08	4.08	46	3,529	1,256	1.5	14	4	**4,851**
Y 18	4.73	4.05	4.73	4.05	4.05	4.05	46	3,505	1,249	1.5	14	4	**4,820**
Y 19	4.70	4.02	4.70	4.02	4.02	4.02	46	3,481	1,242	1.5	14	4	**4,788**
Y 20	4.67	3.99	4.67	3.99	3.99	3.99	46	3,458	1,235	1.5	14	4	**4,757**
Y 21	4.65	3.97	4.65	3.97	3.97	3.97	45	3,434	1,228	1.5	13	4	**4,726**
Y 22	4.62	3.94	4.62	3.94	3.94	3.94	45	3,411	1,220	1.5	13	4	**4,695**
Y 23	4.59	3.91	4.59	3.91	3.91	3.91	45	3,387	1,213	1.5	13	4	**4,664**
Y 24	4.57	3.89	4.57	3.89	3.89	3.89	45	3,364	1,206	1.5	13	4	**4,633**
Y 25	4.54	3.86	4.54	3.86	3.86	3.86	44	3,340	1,199	1.4	13	4	**4,602**
Y 26	4.51	3.83	4.51	3.83	3.83	3.83	44	3,317	1,192	1.4	13	4	**4,571**
Y 27	4.48	3.80	4.48	3.80	3.80	3.80	44	3,293	1,184	1.4	13	4	**4,539**
Y 28	4.46	3.78	4.46	3.78	3.78	3.78	43	3,270	1,177	1.4	13	4	**4,508**
Y 29	4.43	3.75	4.43	3.75	3.75	3.75	43	3,246	1,170	1.4	13	4	**4,477**

Soil - Rate of Carbon Sequestration and Carbon Sequestered

Year	$NatFlux_{Soil}$ (tC/ha/yr)					CSI_{Soil} (tC)					Total CSI_{Soil}
Land Type	Forest	Swamp	Rich Fen	Treed Fen	Bog	Forest	Swamp	Rich Fen	Treed Fen	Bog	
Land Area (ha)	875	264	2	14	4	—	—	—	—	—	(tC)
Y -3	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y -2	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y -1	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 1	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 2	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 3	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 4	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 5	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 6	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 7	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 8	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 9	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 10	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 11	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 12	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 13	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 14	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 15	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 16	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 17	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 18	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 19	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 20	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 21	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 22	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 23	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 24	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 25	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 26	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 27	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 28	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**
Y 29	—	—	0.33	0.31	0.24	—	—	0.5	4.2	1.0	**6**

Total Carbon Sequestered

Year	Total CSI (tC)	Total CO_2 Uptake (tCO_2e)
Y -3	5,448	19,963
Y -2	5,417	19,850
Y -1	5,386	19,736
Y 1	5,355	19,622
Y 2	5,323	19,508
Y 3	5,292	19,394
Y 4	5,261	19,279
Y 5	5,230	19,165
Y 6	5,199	19,051
Y 7	5,168	18,937
Y 8	5,137	18,823
Y 9	5,106	18,709
Y 10	5,074	18,595
Y 11	5,043	18,481
Y 12	5,012	18,367
Y 13	4,981	18,253
Y 14	4,950	18,139
Y 15	4,919	18,025
Y 16	4,888	17,911
Y 17	4,857	17,797
Y 18	4,825	17,683
Y 19	4,794	17,569
Y 20	4,763	17,455
Y 21	4,732	17,341
Y 22	4,701	17,227
Y 23	4,670	17,112
Y 24	4,639	16,998
Y 25	4,608	16,884
Y 26	4,576	16,770
Y 27	4,545	16,656
Y 28	4,514	16,542
Y 29	4,483	16,428

Appendix C
Upstream GHG Assessment

Table C1: Upstream GHG Assessment

Emission Type	Description	Max Annual Usage	Units	Density	Units	Upstream Emission Factor [1]	Emission Factor Units	Emissions (kt-CO_2e/year)	GHGenius Reference Fuel
Direct (Scope 1)	Diesel Fuel	42,655,839	L	—	—	821	gCO_2e/L	35	Petrol Diesel, 0.0015% S
Direct (Scope 1)	Natural Gas	61,486,665	m^3	0.71	kg/m^3	722	gCO_2e/kg	32	Natural Gas
Direct (Scope 1)	Blasting Explosive[2]	10,566	tonnes	840	kg/m^4	821	gCO_2e/L	10	Petrol Diesel, 0.0015% S
						Total Upstream GHG Emissions		77	—
						Canada's 2030 Target		406,000	40% reduction from 2005
						% of Canada's 2030 Target		0.02%	

Notes:

[1]GHGenius502b, Heavy-Dust ICE Vechicle - Fossil or Nuclear Foodstock (Year 2022), excluding net vehicle operation.

[2]Blasting Explosive contains 5% Fuel Oil based on Dyno Nobel (2022) Titan 2000 SDS.

Appendix D
Uncertainty Assessment

Table D1: Uncertainty Assessment

Forest Carbon Stock Study Factor Uncertainties

Parameter	Mg-C/ha	+/-	Uncertainty (±)	Reference
Above-Ground Vegetation Carbon Stock	34.6	4.5	13%	Payne et al., 2019, Table 5, 25-yr stand
Dead Organic Matter (DOM) Carbon Stock	37.3	3.8	10%	
Soil Organic Carbon (SOC) Carbon Stock	37.7	11.1	29%	
Total	109.6	19.4	18%	
	Mg-C/ha/yr			
Aboveground Net Primary Production	3.7	0.3	8%	Payne et al., 2019, Table 6, 20-25-yr stand

Other Carbon Stock Factor Uncertainties

Parameter			Uncertainty (±)	Reference
Wetland Carbon Stocks			90%	IPCC 2006a, Table 2.3
Tonne C/Tonne Dry-Biomass			8%	IPCC 2006b, Table 4.3, Boral Conifers
Ratio of below- to above-ground biomass			40%	IPCC 2006b, Table 4.4, Boral, <75 tonnes
Ecosite Area Determination			Unknown	—
Ecosite Tree Coverage			Unknown	Per definitions in Ontario's Wetland Evaluation System
Volume Yield Curve			Unknown	—

Combined Carbon Stock Uncertainties

Parameter			Uncertainty (±)	Method
Above-Ground Vegetation CO_2e			21%	Added Carbon Stock to Carbon Content Uncertainty
Dead Organic Matter (DOM) Carbon Stock			10%	Dead Organic Matter (DOM) Carbon Stock Uncertainty
Soil Organic Carbon (SOC) Carbon Stock			45%	Wetland and Boreal carbon stock uncertainties weighted by Project Area
Net Primary Production CO_2e			8%	Payne et al., 2019, Table 6, 20-25-yr stand

Fuel Combustion National Inventory Uncertainties

Emission Factor Activity	Gas		2022 Emission Factor Uncertainty (±)	Reference
Fuel Combustion - Off-Road (1.A.2-3-42)	CO_2		0.10%	ECCC 2024a, Table A2-2
	CH_4		7.00%	
	N_2O		78.00%	
	Weighted Average		1.24%	Weighted uncertainty based upon 2022 Emissions from ECCC 2024a, Table A2-2
Fuel Combustion – Public Electricity and Heat Production[3,4] (1.A.1.a)	CO_2		3.00%	ECCC 2024a, Table A2-2
	CH_4		27.00%	
	N_2O		210.00%	
	Weighted Average		4.43%	Weighted uncertainty based upon 2021 Emissions from ECCC 2024a, Table A2-2

Other Uncertainties and Assumptions

Assumed "Fuel Combustion - Off-Road" fo all fuel combustion onsite.
Assumed Payne's (2019) uncertainty for aboveground net primary production can be applied to SACC's carbon flux for bogs and fens.
For the purposes of estimating screening-level uncertainty, asymmetrical uncertainties were approximate as symmetrical.
Any parameters not mentioned had unknown levels of uncertainty. However, those assessed can provide a screening-level estimate of uncertainty.

Quantitative Uncertainty Estimate

Parameter	Emission Source	Emissions (t-CO2e)		
		Total Estimated	Lower Range	Upper Range
Direct (Scope 1)	Fuel Combustion	4,747,500	4,688,415	4,806,585
Direct (Scope 1)	Land Use Changes, Aboveground Biomass	46,721	40,644	52,797
Direct (Scope 1)	Land Use Changes, Dead Organic Matter	48,645	43,689	53,600
Direct (Scope 1)	Land Use Changes, Soil Organic Carbon	50,852	35,880	65,825
Direct (Scope 1)	Land Use Changes	146,218	120,213	172,223
Indirect (Scope 2)	Acquired Energy	77,433	74,006	80,860
—	Total	4,971,151	4,882,634	5,059,668
Carbon Sink Impacts	Foregone Carbon Sequestration	583,800	536,465	631,135