Appendix S1

Final Greenhouse Gases Technical Support Document

MARTEN FALLS FIRST NATION
COMMUNITY ACCESS ROAD

Air Quality and Greenhouse Gas Technical Support Document: Existing Conditions & Effects Assessment

February 2026

Volume 2 – Greenhouse Gases

Disclaimer: Dillon Consulting Limited

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Revision History

Revision Number	Date	Revised By:	Revision Description

Executive Summary

Marten Falls First Nation, a First Nation community in northern Ontario, has proposed an all-season Community Access Road that will connect the Marten Falls First Nation community to Ontario's provincial highway network (Highway 463) to the south via the existing Painter Lake Road.

Located at the junction of the Albany and Ogoki rivers, approximately 430 km from Thunder Bay, Ontario, Marten Falls First Nation is a remote community surrounded by natural landscapes and resources. Currently, Marten Falls First Nation is accessible by land only in the winter via an ice road (i.e., winter road). The proposed Community Access Road would allow year-round access to the community, providing greater connectivity for residents and visitors.

Volume 1 of this report provides results of the Air Quality study and Volume 2 provides results of the Greenhouse Gas study. Greenhouse Gas existing conditions as well as potential changes and contributions of Greenhouse Gases resulting from this project are discussed in this report.

Direct Greenhouse Gases from the project's construction and operation phases were quantified which mainly include emissions from construction mobile equipment, blasting operations, and vehicular traffic expected on the roadway. In addition to Greenhouse Gas emissions, carbon sink impacts due to land use changes were also assessed. The quantification of Greenhouse Gas emissions and carbon sink changes followed the *Technical Guide Related to the Strategic Assessment of Climate Change*, published by Environment and Climate Change Canada in August 2021 (SACC, 2021).

During the Project's 20-year assessment period, the total Greenhouse Gas emissions from construction activities, including mobile equipment and blasting, is approximately 83 kilotonnes of carbon dioxide equivalent. This accounts for approximately 5% of the Project's total Greenhouse Gas emissions.

The total Greenhouse Gas emissions from the operation phase traffic emissions are approximately 401 kilotonnes of carbon dioxide equivalent. This accounts for approximately 20% of the Project's total Greenhouse Gas emissions.

Land use changes from the Project contributed to a total of 1,485 kilotonnes of carbon dioxide equivalent. This accounts for 75% of the of the Project's total Greenhouse Gas emissions.

The maximum annual Greenhouse Gas emissions from construction, operation, and land use changes are 19 kilotonnes, 27 kilotonnes, and 277 kilotonnes of carbon dioxide equivalent, respectively.

Annual emissions were compared against provincial transportation sectoral totals for the purpose of defining magnitude and to assess the significance of residual effects. Annual emissions from construction and operation are both below 0.1% of Ontario's Road Transportation total Greenhouse Gases. Greenhouse Gas emissions from both construction and operation phases were assessed as negligible in magnitude and residual effects associated with both construction and operation phases were assessed as not significant.

Annual emissions from land use changes account for 0.18% of Ontario's total Greenhouse Gas emissions. Magnitude was assessed as low, and as such, residual effects associated with land use changes were assessed as not significant.

Table of Contents

List of Figures

List of Tables

1 Introduction

This Report presents the existing conditions and effects assessment for the Air Quality and Greenhouse Gas Discipline and is being prepared in support of the Marten Falls Community Access Road Environmental Assessment / Impact Statement Report. This Report (Volume 2) is specific to the Greenhouse Gas Assessment. Volume 1 is specific to the Air Quality Assessment.

Marten Falls First Nation (Marten Falls) is a remote First Nation community in northern Ontario, approximately 430 km from Thunder Bay, Ontario, located at the junction of the Albany and Ogoki rivers. Marten Falls is proposing a multi-purpose all-season Community Access Road (the Project) that will connect the community to the Ontario provincial highway network. The Project includes the construction and operation of an all-season road with the following key characteristics:

- Approximately 190 km of two-lane gravel all-season road on a new right-of-way;
- Approximately 100 m wide right-of-way cleared to a width of 60 m; and
- Proposed designated speed limit of 80 km per hour.

Marten Falls is currently accessible year-round by air transportation out of Thunder Bay, Ontario and Nakina, Ontario, and by a winter access road constructed on an annual basis, if winter conditions permit. Since the 1990s, Marten Falls has received provincial funding to maintain the 140 km of winter road to the community.

1.1 Project Overview

The Project consists of a new all-season road from Painter Lake Road located approximately 57 km north of Nakina, Ontario to the community of Marten Falls First Nation, a remote First Nation community in northern Ontario located at the junction of the Albany and Ogoki rivers. The Community Access Road will serve community access and industrial supply needs for both the community (e.g., fuel, construction supplies, water treatment supplies) and industrial proponents (e.g., mining, forestry), thereby minimizing infrastructure corridors in the Far North. Therefore, the Project will be for a multi-purpose road built to meet industrial use specifications.

In April 2018, Marten Falls First Nation signed an agreement with the Ministry of the Environment, Conservation and Parks to prepare an environmental assessment under the *Ontario Environmental Assessment Act*, 1990 to support the development of the Community Access Road. A study under the *Ontario Environmental Assessment Act* was formally initiated by Marten Falls First Nation in March 2019 when the Notice of Commencement for a Terms of Reference for the Project was published.

1.2 Qualifications of Individuals

A list of names and qualifications of the authors and technical reviewers of this Report is presented in **Table 1-1**.

Table 1-1: Qualifications of Individuals

Name	Title / Role	Years of Experience	Qualifications
David Diemer	Senior Environmental Engineer / Senior Review	31	P. Eng
Robert Morgan	Senior Environmental Engineer / Senior Review	12	P. Eng
Ryan Chen	Environmental Engineer / Technical Staff	10	P. Eng
Doug Gay	Environmental Engineer / Technical Discipline Lead	10	P. Eng

Notes:

P.Eng = Professional Engineer

2 Project Description

The Project will be executed in three main phases:

- Planning and design, which includes the preparation of the Environmental Assessment / Impact Statement Report, obtaining regulatory approvals and detailed engineering design.
- Construction, which is anticipated to last between three and ten years; and
- Operation and maintenance, for a permanent road.

2.1 Project Components

2.1.1 Roads

The Project will consist of a 190 km to 230 km (depending on the chosen route) all-season road within a 100 m wide right-of-way, 60 m of which will be cleared. Additional temporary clearing occurring in certain locations to accommodate construction activities, access, borrow areas, aggregate source areas, quarry sites, and temporary infrastructure such as staging areas, camps and debris and / or timber stockpiles will be required. It has a roadway approximately 11 m in width to accommodate a two-lane gravel road with culverts and two-lane bridges at water crossing locations. Traffic levels for the Project have been estimated at 700 vehicles per day for the north-south section and 100 vehicles a day for the east-west section of the Marten Falls First Nation Community Access Road. These volumes are reflective of the anticipated peak traffic in 2046.

The predominant building materials will be, blasted rockfill and composite excavation material capped with granular surface material. The majority of blasted rockfill will be obtained from rock outcrops within and / or adjacent to the right-of-way. Building materials will be primarily obtained through the pits and quarries developed specifically to support construction of the project.

Excavation within permafrost areas will be avoided, whenever possible, as cutting into surface vegetation can disturb the permafrost regime resulting in thaw and unstable ground. Permafrost studies indicate that alignment is in the sporadic discontinuous permafrost zone, instead of the discontinuous permafrost zone as previously thought, so permafrost occurrences are few, with known locations documented and monitored. At the time of drafting, no areas of known permafrost have been found within the Construction Disturbance Area. As a precaution, the design will primarily use fill to minimize any permafrost degradation and will follow the recommendations outlined in Permafrost Management Plan. For information on the Preferred Route Alternative please refer to **Section 6**.

2.1.2 Bridges and Culverts

Bridges will be required over the various waterways to provide grade separation with sizes ranging from single span to multi-span bridges to carry two lanes of traffic with appropriate shoulder widths. The foundation support for the bridge abutments are expected to consist of driven steel piles, drilled concrete piles or concrete spread footings.

Equalization culverts will be installed at locations where it is determined that spring-melt or storm runoff needs to pass from one side of the Project to the other to prevent flooding and / or erosion. The purpose of equalization culverts is to maintain the existing surface water drainage patterns in the area. Culverts will be put in place as construction progresses along the Project.

2.1.3 Quarries, Borrow Areas and Aggregate Source Areas

Quarries, borrow areas and aggregate source areas will be developed to provide crushed rock and granular materials for the construction of the Project and temporary access roads. Most of the rock required for construction is expected to come from quarry sites adjacent to the Project. Temporary access roads will be established to connect the various Project components as required and will be limited in length to the extent feasible. All materials will be subject to a geotechnical verification process in order to ensure they possess the desired physical properties for use in construction. The development and operation of all Pits and Quarries will be subject to the Aggregate Licensing process under the *Aggregate Resources Act*.

Only material that has been cleared through a geochemical verification process will be utilized for the road surface to avoid acid rock drainage or metal leaching. Monitoring of runoff will be conducted from an erosion and sediment control perspective; further details about this specific type of monitoring will be available in the Erosion and Sediment Control Plan.

2.1.4 Temporary Infrastructure for Construction

Temporary access roads may be required to access the right-of-way during construction. The purpose of the temporary access roads is to facilitate emergency access, equipment and personnel access, and to provide access to and from quarries, borrow sites and aggregate source areas. The temporary access roads will be cleared, but not grubbed, to approximately 10 m wide to accommodate equipment movement.

Upon completion of construction temporary access roads will be decommissioned, and entrances to temporary quarry, borrow or aggregate areas will be abandoned and / or blocked to discourage public use.

Temporary construction camps, staging areas and stockpile areas are anticipated to be established at various locations along the right-of-way and / or near other Project components. These components are proposed to support crews, store equipment, vehicles, materials, and supplies.

3 Information Shared by Indigenous Peoples & Other Interested Persons Which Informed This Report

In the course of completing the description of baseline conditions and effects assessment for this report, information provided by Indigenous knowledge holders, Indigenous community members, regulators and public stakeholders was used to develop the approach and assessment conducted for this study. This information and how it informed the development of this report are described below. This section does not detail all the information, comments or questions received related to the Project and is limited to only the information which informed this Report. For a full description of all consultation and engagement related to the Community Access Road refer to the Record of Consultation and Engagement for the Environmental Assessment / Impact Statement Report. Information related to the Indigenous Knowledge Program can be found in the *Marten Falls Community Access Road: Aboriginal and / or Treaty Rights and Interests Draft Existing Conditions Report* (Dillon, 2024).

3.1 Indigenous Knowledge

Indigenous Knowledge refers to Indigenous systems of knowledge as well as cultural practices related to the production of knowledge based on traditional belief systems, relationships to the environment, and community practices. It is the accumulated and living knowledge built upon the historic experiences of Peoples living on the land and adapting to social, economic, environmental, spiritual and political change (Chiefs of Ontario, n.d.) It includes knowledge about the natural environment (e.g., locations of caribou seasonal use and calving areas), the relationships between environmental changes and species or ecosystems, and how potential effects to the environment can be avoided or reduced.

Indigenous Land and Resource Use refers to specific areas and resources used for traditional purposes when Indigenous peoples learn and practice their Indigenous Knowledge (Garvin & Northern Forestry Centre (Canada), 2001). This includes the areas and sites used for hunting, trapping, fishing, and gathering and the resources harvested, as well as cultural sites, features and practices. Sometimes referred to as Traditional Land Use.

In 2019, the Marten Falls First Nation Community Access Road Project Team launched a program to collect Indigenous Knowledge. The Indigenous Knowledge Program is a critical component of the information base upon which the assessments will rely. The information generated through the Indigenous Knowledge Program has been woven with scientific approaches, and both knowledge systems will be given equal consideration in forming the foundation for existing conditions, predicting potential project effects, and determining appropriate mitigation and monitoring methods.

The Indigenous Knowledge Program occurs in two concurrent phases:

1. Collecting existing Indigenous Knowledge and information on Indigenous land and resource use to help inform the early stages of the assessments; and
2. Completing project-specific Indigenous Knowledge and Lands & Resource Use studies.

The protection and confidentiality of Indigenous Knowledge and information on Indigenous land and resource use is of the utmost importance to the Project Team. To honour and respect this important information, Indigenous Knowledge Sharing Agreements were established with interested communities prior to the use of community information. The Sharing Agreement outlines how confidential and sensitive information will be woven into the Project's environmental / impact and design processes.

All Indigenous communities and groups identified by the Ministry of the Environment, Conservation and Parks and the Impact Assessment Agency of Canada (the Agency) through the Indigenous Engagement and Partnership Plan have had the opportunity to participate in the Indigenous Knowledge Program. The Indigenous Knowledge Program provides interested Indigenous communities an opportunity to: share existing Indigenous Knowledge and information on Indigenous land and resource use and cultural values that may be relevant to the Project, and / or complete Project-specific studies to collect and share Indigenous Knowledge and information on Indigenous land and resource use and cultural values. The Indigenous Knowledge Program included opportunities for Indigenous communities and groups to meet with the Proponent to discuss the program, ask questions, and share concerns and interests. In support of this, the Proponent created an Indigenous Knowledge Program Guidance Document (the Guidance Document) that provides:

- An overview of the Indigenous Knowledge Program and information on how Indigenous Knowledge, Indigenous land and resource use, and cultural values and practices can be collected and / or shared.
- Information on how Indigenous Knowledge and information on Indigenous land and resource use, and cultural values and practices may be used in the planning and design processes; and
- A suite of guidance materials was developed based on the information requirements of both the federal and provincial assessment processes, including; question guides to support the collection of information on historical and current community context; Indigenous Knowledge that may be relevant to the various technical disciplines; information on Indigenous land and resource use, cultural values and practices and

associated spatial data, and perspective on potential Project-related effects and associated mitigation and / or enhancement measures.

The Guidance Document supported participating Indigenous communities in providing Project-specific information in a manner that facilitates meaningful incorporation into the Environmental Assessment / Impact Statement Report.

The Proponent strove to respectfully collaborate with Indigenous communities on how Indigenous Knowledge and information on Indigenous land and resource use and cultural values were considered in reporting, and how potential effects to Aboriginal and Treaty Rights and Interests were assessed. Measures to support this included but were not limited to: engaging Indigenous communities to solicit information on Indigenous Knowledge and Indigenous land and resource use and cultural values; to inform baseline conditions, providing Indigenous communities with draft sections of the Environmental Assessment / Impact Statement Report; to illustrate how Indigenous Knowledge and information on Indigenous land and resource use and cultural values has been integrated, and to confirm it has been presented appropriately. The proponent aims to complete collaborative working sessions with Indigenous communities to inform the effects assessment on Aboriginal and Treaty Rights and Interests. Further information on how potential effects on Indigenous rights were assessed is provided in the *Aboriginal and Treaty Rights and Interests Study Plan* (Dillon, 2021).

Information provided by Indigenous knowledge holders, recognized as such by their Indigenous Community, has been, obtained through literature review and shared directly by Indigenous nations in support of this Project through face-to-face meetings or receipt of Indigenous knowledge reports. The information, some of which is confidential, that has been used to inform this reporting is described in **Table 3-1** below.

Table 3-1: Indigenous Knowledge

Valued Component	Indigenous Community	Details	Section Reference
■ **Greenhouse Gas Emissions**	■ Marten Falls First Nation	■ Provided traffic estimates and operating windows for the existing winter road to inform estimates of existing greenhouse gas emissions	■ **Section 4.3**

3.2 Regulator and Public Stakeholder Input

The Proponent engaged with Regulators and Public Stakeholders with technical knowledge related to the Valued Components in order to inform aspects of this report. The information and how it informed the development of this report are described in **Table 3-2** below.

Table 3-2: Public, Agency, and Other Input

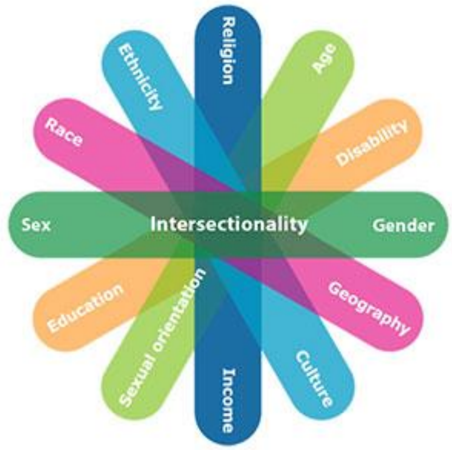
Valued Component	Provided By	Details	Section Reference
■ **Greenhouse Gases**	■ Ministry of the Environment, Conservation, and Parks ■ The Agency ■ Health Canada ■ Environment and Climate Change Canada ■ Northern Development and Mines ■ NRCan ■ Marten Falls First Nation Community Access Road Project Team	■ Discuss comments submitted by the Federal Review Team on the draft atmospheric environment study plan. ■ Relevant assessment standards and guidelines	■ **Section 4**

3.3 Gender-Based Analysis Plus

The *Impact Assessment Act* of Canada (Government of Canada, 2019) requires Gender-Based Analysis Plus to be applied to Impact Assessments in Canada. Gender-Based Analysis Plus is not a specific set of methods for Impact Assessments, but rather an approach that is adapted to the Project and the communities potentially impacted and / or being engaged.

Gender-Based Analysis Plus is an approach to assessing inequalities and impacts of policies, programs, projects on diverse groups and identities. These identities could include (but are not limited to): gender, sexual orientation, age, race, ethnicity, class, religion, and mental or physical disability (Women and Gender Equality Canada, 2022). These identities can also intersect or overlap; for example, where an individual identifies as being both Indigenous and an Elder or youth.

Figure 3-1: Gender-Based Analysis Plus Intersecting Identity Factors



Source: (Canadian Institutes of Health Research, 2022)

The Gender-Based Analysis Plus approach involves understanding how certain vulnerable groups such as Indigenous peoples, women, Elders, youth, and could Two-Spirit, Lesbian, Gay, Bisexual, Transgender, Queer, Questioning, Intersex, and Asexual persons experience, and could be disproportionately impacted by a project. Understanding how these groups could be affected by projects allow for more targeted, sensitive, and appropriate enhancement measures, mitigations, monitoring, and follow-up (Impact Assessment Agency of Canada, 2021).

It is important to understand that vulnerability in impact assessment is understood primarily, but not solely, as a structural vulnerability. This means that in many cases it is the systems and power structures that make certain groups more vulnerable (Impact Assessment Agency of Canada, 2021). For Indigenous peoples this includes historic and ongoing colonialism, loss of lands and culture, intergenerational trauma, and the residential school system that have resulted in significant social, economic, health and well-being disparities relative to the non-Indigenous Canadian population (Kim, 2019). Exceptions to this are where vulnerability may be associated with biological sex, pregnancy, or age in relation to environmental determinants of health and exposure to contaminants, for example.

For each discipline of the Impact Assessment, a Gender-Based Analysis Plus approach was employed. This approach and extent of its application also varied, however, depending on the type of study, and the relevance of Gender Based Analysis Plus to that study. The details of the approach for the discipline are outlined below.

3.3.1 Greenhouse Gases Gender-Based Analysis Plus Approach

The Gender-Based Analysis Plus approach for the Greenhouse Gases study involved a more limited, but still important application of Gender-Based Analysis Plus. This approach varied from the Gender-Based Analysis Plus approach in other disciplines, for example, within the socio-economic disciplines, in that it primarily involved identifying how vulnerable groups that could be disproportionately impacted by the Project informed the study which included:

- Weaving Project specific Indigenous Knowledge from Indigenous Elders that has been provided, verified, and made available through the Indigenous Knowledge program into the Greenhouse Gases Assessment (see **Section 3.1**); and
- Identifying and including interests and concerns specific to this study through the Consultation and Engagement program from groups who could be more vulnerable to, and disproportionately impacted by the Project which include Indigenous communities (see **Section 3.3**).

4 Study Methods and Assessment Scope

This section contains excerpts from the *Draft Community Access Road: Air Quality and Greenhouse Gases Study Plan* (AECOM, 2021). The original Draft Study Plan, including comments from regulators, can be found in **Attachment A**.

This section provides a summary of the study methods and assessment scope for the existing conditions and effects assessment for the Greenhouse Gases assessment.

4.1 Study Plan Purpose, Objectives, and Deviations

As required by the *Impact Assessment Act* (Government of Canada, 2019) and referenced *in the Tailored Impact Statement Guidelines* (Impact Assessment Agency of Canada, 2020), Study Plans and Work Plans were developed for disciplines as required. For the Air Quality and Greenhouse Gases discipline, only a Study Plan was developed.

The purpose of the Study Plan is to explain:

- An Existing Conditions study methodology that will result in a comprehensive description of the existing environment potentially impacted by the Project;
- The process for ensuring efficient and transparent data management and analysis was completed; and
- Developing the discipline-specific Effects Assessment methodology.

In some instances, through the execution of this study the approach deviated from what was described in the original Draft Study Plan; these deviations are outlined in **Table 4-1**.

Deviations were required as the Project evolved due to challenges encountered in the field, alternative methodologies being developed, comments from regulators, and as updated guidance became available. General changes such as changes to section headings, organization of sections and subsections and, changes to phrasing and tense have been made throughout. These administrative changes have not been documented in **Table 4-1.**

Table 4-1: Deviations from Draft Study Plan

Section Reference	Description of Change	Rationale
Section 7 Potential Effects	■ The original Draft Study Plan indicated following the Strategic Assessment of Climate Change (Environment and Climate Change Canada, 2020) for assessing Greenhouse Gas emissions from the project. ■ The methods for assessing Greenhouse Gas emissions, particularly from land use changes, are updated to follow the Technical Guide Related to the Strategic Assessment of Climate Change (Environment and Climate Change Canada, 2021).	■ The specific requirements and guidance for the assessment of Greenhouse Gas emissions, particularly from land use changes, are detailed in the Technical Guide Related to the Strategic Assessment of Climate Change (August 2021) which was published after the preparation of the original Draft Study Plan (April 2021). ■ The publication of the Technical Guide Related to the Strategic Assessment of Climate Change triggered requirements for an in-depth analysis of carbon stock and greenhouse gas changes associated with land use conversion.
Section 7 Potential Effects	■ A quantitative assessment of carbon sink changes is undertaken instead of the previously required qualitative assessment of carbon sinks.	■ The original Draft Study Plan proposed a qualitative description of the Project's positive or negative effects on carbon sinks following the Strategic Assessment of Climate Change (July 2020). ■ The Technical Guide Related to the Strategic Assessment of Climate Change (August 2021), released after the preparation of the Draft Study Plan, requires providing a quantitative assessment of the impact to carbon sinks resulting from land-use change, in addition to the qualitative assessment already described in the Strategic Assessment of Climate Change (July 2020).

Section Reference	Description of Change	Rationale
Section 7 Potential Effects	■ The original Draft Study Plan proposes to quantify the reductions in Greenhouse Gas emissions due to the full or partial displacement of air travel with road vehicle traffic. ■ The potential effects of avoided air travel on Greenhouse Gas emissions are qualitatively discussed, as compared to the previously proposed quantitative assessment of Greenhouse Gas reductions.	■ Given the sensitivity of airport flight data, limited information was made available which prevented a meaningful and confident assessment of Greenhouse Gas changes. Therefore, the reductions of Greenhouse Gas emissions due to avoided air travel are qualitatively assessed.

4.2 Study Scoping

4.2.1 Temporal Boundaries

Project phases, which are temporal boundaries, are developed to establish the timeframes within which potential effects of the Project will be considered. The Project is planned to occur in three phases, which are briefly described below.

- **Construction Phase:** The time from start of construction, including site preparation activities, to the start of operations and maintenance of the Community Access Road. Decommissioning of construction works is included in the construction phase. The construction phase is anticipated to take approximately three to ten years to complete.
- **Operations and Maintenance Phase:** The operations and maintenance phase starts once construction activities are complete and lasts for the life of the Project. The operations and maintenance phase of the Project is considered to be permanent based on the expected timeline for when major refurbishment of road components (e.g., bridges), is anticipated.
- **Decommissioning Phase:** There are currently no plans to decommission the Community Access Road as there is no expected / known end date for its need. Therefore, future suspension, decommissioning, and eventual abandonment will not be considered in this report. It will be considered if and when a decommissioning or abandonment application is made for the road.

In determining the temporal boundaries, in particular the long duration of operations and maintenance phase, consideration was given to the long-term effects on the well-being of present and future generations.

4.2.2 Valued Components and Indicators

The Agency describes **Valued Components** as the environmental, health, social, economic, or additional elements or conditions of the natural and human environment that may be impacted by a proposed project and area of concern or value to the public, Indigenous peoples, federal authorities and interested parties (Impact Assessment Agency of Canada, 2021).

Indicators represent the resource, feature, or issue related to the Valued Component that, if changed, may demonstrate an effect on the environment. Indicators may be characterized quantitatively or qualitatively. For example, effects from changes to the availability and distribution of Valued Components are often expressed through quantitative assessment of direct vegetation removals as well as predicted indirect effects on retained vegetation.

The Draft Study Plan presented indicators and rationale for selection known to the Proponent at the time of drafting. The draft table and the factors that influenced it can be found in Section 9.2 of the *Draft Community Access Road: Air Quality and Greenhouse Gas Study Plan (AECOM 2021)* in **Attachment A**.

An updated list of Greenhouse Gas indicators can be found in **Table 4-2** below.

Table 4-2: Greenhouse Gases Indicators

Valued Component	Indicators	Rationale for Selection	Measures of Change
Greenhouse Gases	▪ Quantification of Greenhouse Gas emissions (CO_2, CH_4, N_2O) expressed as CO_2 equivalent	▪ The Greenhouse Gases chosen for the indicators are those prescribed by the *National Inventory Report* (Environment and Climate Change Canada, 2023) and *Technical Guide Related to the Strategic Assessment of Climate Change* (Environment and Climate Change Canada, 2021)	▪ Net change in Greenhouse Gas emissions expressed as tonnes of CO_2 equivalent

4.2.3 Spatial Boundaries

4.2.3.1 Project Study Areas

Study areas identify the geographic extent within which potential effects of the Project are likely to occur and will be considered in the Environmental Assessment / Impact Statement Report. General project boundaries were established for the scoping of field programs, and to delineate study areas for discipline specific surveys. These general project boundaries are described in **Table 4-3** below.

Table 4-3: Project Study Areas Definition and Description

Study Area	Definition	Description
Construction Disturbance Area	■ Area of expected direct disturbance	■ 100 metre wide Community Access Road right-of-way, temporary construction access roads, work areas, worker camps, and pits, quarries, and associated access roads.
Project Study Area	■ The area where most of the direct effects of the Project are likely to occur	■ The area within 2.5 km (total of 5 km) of the centreline of the route alternatives.

4.2.3.2 Greenhouse Gases Study Areas

Discipline-specific Local Study Areas and Regional Study Areas have been defined for the Project. In defining these areas, the following was considered:

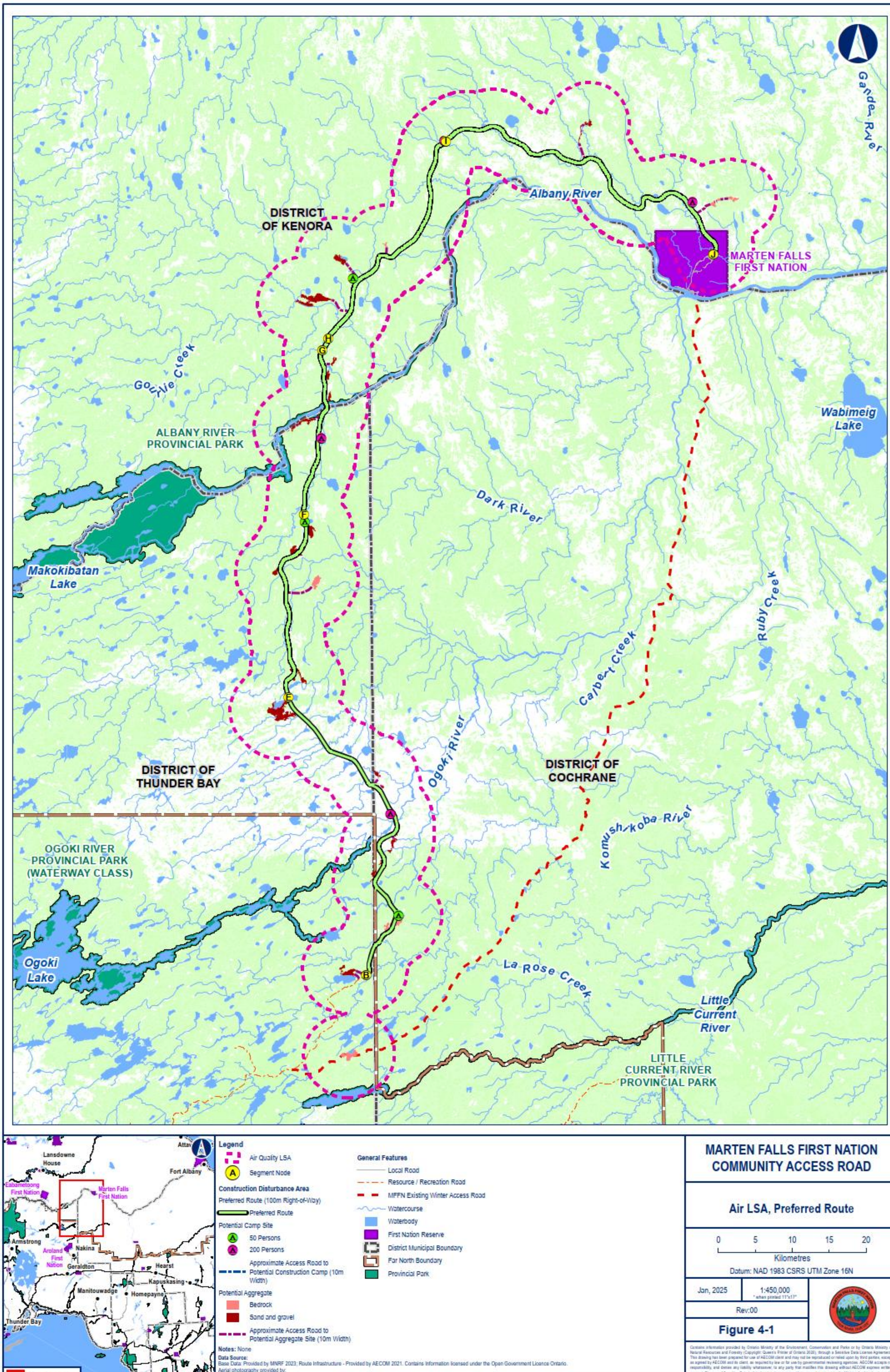
- Location and other characteristics of the discipline relative to the Project;
- The anticipated extent of the potential Project effects;
- Federal, provincial, regional, and local government administrative boundaries;
- Input from Indigenous Communities;
- Community knowledge and Indigenous Knowledge;
- Current or traditional land and resource use by Indigenous communities;
- Exercise of Aboriginal and Treaty Rights of Indigenous peoples, including cultural and spiritual practices; and
- Physical, ecological, technical, social, health, economic, and cultural considerations.

The Local and Regional Study Areas for Greenhouse Gases and the rationale for their selection are described in **Table 4-4** and shown in **Figure 4-1**.

Table 4-4: Discipline-Specific Study Areas Description and Rationale

Study Area	Geographic Extent	Rationale
Local Study Area	▪ Greenhouse Gases: Physical footprint of the project during construction and operations, which is equal to the Construction Disturbance Area.	▪ Direct Greenhouse Gas emissions impacts of the project will be limited to the Construction Disturbance Area.
Regional Study Area	▪ Greenhouse Gases: Province (Ontario).	▪ Greenhouse Gases will be assessed against provincial-scale emissions as well as federal and sectoral totals documented within the most current National Inventory Report prepared by Environment and Climate Change Canada.

Figure 4-1: Discipline Local and Regional Study Area



The study areas included in this document cover the extent to which readily available information suggests the Project may have noticeable effects on the environment. The size, nature and location of past, present, and reasonably foreseeable projects will be taken into consideration in the development of the cumulative effects assessment study area(s) and are further discussed in **Section 8**.

4.2.4 Tailored Impact Statement Guidelines Requirements Mitigation and Enhancement Measures

The Tailored Impact Statement Guidelines (Impact Assessment Agency of Canada, 2020) Section 20 requirements for Greenhouse Gases are provided below. The applicability of these requirements has been evaluated and will be adapted to the needs of the site, environment, and Project activities.

Table 4-5: Tailored Impact Statement Guidelines Section 20 Requirements

TISG Requirement Section 20 Requirement	Section Addressed In
▪ Describe measures included in the design of the Project to mitigate its Greenhouse Gas emissions. These could include design decisions such as the use of low-emitting technologies, the use of low-carbon or renewable fuel or carbon capture and storage	▪ **Section 7.4** to **Section 7.6**.
▪ Describe practices that will be taken to mitigate the Project's Greenhouse Gas emissions, such as anti-idling practices for mobile equipment, or continuous monitoring systems	▪ **Section 7.4** to **Section 7.6**.
▪ Identify and describe the use and application of best available technology and best environmental practice, including its effectiveness on the contaminants of concern, to prevent adverse effects on the receiving environment other than for Greenhouse Gas reduction purposes;	▪ **Section 7.4** to **Section 7.6**.
▪ To inform potential mitigation measures, a comparison of the Project's projected Greenhouse Gas emission intensity of similar projects in Canada and internationally that are a good example of energy efficiency or low emissions intensity projects. The comparison should explain why the emissions intensity may be different.	▪ **Section 7.4** to **Section 7.6**.

TISG Requirement Section 20 Requirement	Section Addressed In
■ Describe the standard mitigation practices, policies and commitments that constitute proven technically and economically feasible mitigation measures and that are to be applied as part of standard practice regardless of location as well as any new or innovative mitigation measures being proposed. Mitigation measures must be specific, achievable, measurable, and verifiable, and must be described in a manner that avoids ambiguity in intent, interpretation, and implementation.	■ **Section 7.4** to **Section 7.6**.
■ Describe mitigation measures that are specific to each environmental, health, social or economic effect identified. Mitigation measures are to be written as specific commitments that clearly describe when and how the Proponent intends to implement them, what decision-making criteria will be used, and the outcome these mitigation measures are designed to address.	■ **Section 7.4** to **Section 7.6**.

4.3 Existing Conditions Study Design and Methods

4.3.1 Desktop Assessment

A desktop review was completed to identify existing information and data sources that are available to inform the existing Greenhouse Gases within the Project's Local Study Area and identify information gaps that needed to be addressed for further analysis of the Project’s effects on Greenhouse Gases. The desktop review involves the collection and/or processing of data available from other disciplines that interact with Greenhouse Gases (e.g., Vegetation) as well as data unavailable from other disciplines while needed for the Greenhouse Gases assessment (e.g., carbon stocks).

In addition to the information and data sources required for the Greenhouse Gases assessment, the desktop assessment also included a review of applicable regulations and guidelines for Greenhouse Gas quantifications.

4.3.1.1 Greenhouse Gas Assessment Guidelines

A preliminary list of applicable information sources including federal and provincial guidance was reviewed in the development of this approach. The assessment of Greenhouse Gases mainly followed the guidance provided in the *Strategic Assessment of Climate Change* (July 2020) and the *Technical Guide Related to the Strategic Assessment of Climate Change* (August 2021; also referred to as the Strategic Assessment of Climate Change Technical Guide), both published by Environment and Climate Change Canada.

The assessment of Greenhouse Gases, especially for quantifying Greenhouse Gas emissions from land use changes, also followed relevant Intergovernmental Panel on Climate Change (IPCC) guidelines (2006) and the National Inventory Report (2020). Below are the Greenhouse Gas guidelines that were followed during the assessment.

- Strategic Assessment of Climate Change. July 2020.
- Technical Guide related to the Strategic Assessment of Climate Change - Guidance on quantification of net Greenhouse Gas emissions, impact on carbon sinks, mitigation measures, net-zero plan and upstream Greenhouse Gas assessment. August 2021.
- 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (LULUCF), Section 3.2 Forest Land.
- 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (LULUCF), Annex 3A.1 Biomass Default Tables for Section 3.2 Forest Land.
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other land Use, Chapter 2 Generic Methodologies Applicable to Multiple Land-Use Categories.
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 4 - Forest Land.
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 7 – Wetlands.
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 8 – Settlements.
- National Inventory Report (NIR), 2020. Greenhouse Gas Sources and Sinks in Canada- Part 1.
- UNFCCC, 2011. Estimation of non-CO_2 Greenhouse Gas emissions resulting from burning of biomass attributable to an A/R CDM project activity.

4.3.1.2 Existing Greenhouse Gas Sources

The environment surrounding the Project is considered to be a pristine setting due to the remote location of the Project, and there are no major anthropogenic sources of emissions (e.g., large industries) except community transportation. Therefore, the existing Greenhouse Gases are expected to be dominated by naturally occurring processes (e.g., Greenhouse Gases from vegetation) and emissions due to current community transportation (e.g., winter road traffic). Other Greenhouse Gas sources within the Local Study Area are unlikely affected by the Project such as emissions from community fuel usage. Those are not accounted as existing emissions for evaluating net Greenhouse Gas emissions resulting from the Project as the emissions are expected to be the same for the existing and project scenario. As such, existing Greenhouse Gases for the Project include emissions from winter road travel, air travel, and land use.

4.3.1.2.1 Existing Greenhouse Gases from Winter Road Travel

The Marten Falls First Nation Community is currently served by a winter road throughout the Project Area which is operated and maintained annually for less than two months between January and March. The use of the winter road has been further restricted in recent years due to increasingly warmer winters. Like most remote and First Nation communities, the Marten Falls First Nation Community relies on small commercial carriers for transport and access to essential goods and services.

Existing Greenhouse Gases from winter road traffic include emissions resulting from on-road vehicular travel as well as road maintenance. The annual Greenhouse Gases from the existing winter road travel can be estimated based on the sum of annual Greenhouse Gases for different vehicle types. Vehicle types on the winter road mainly consist of passenger cars, light-duty commercial trucks, heavy-duty transport trucks, and road maintenance vehicles.

The annual Greenhouse Gases resulting from each vehicle type can be estimated based on the annual distance travelled and vehicle emission rates per distance. Vehicle type distributions on the winter road were best estimated based on traffic data collected for a similar winter road project in Manitoba. For each vehicle type, the annual vehicle kilometre travelled was estimated based on the average daily traffic volume, operation window (on average six weeks per year), and the full winter road length (about 139 kilometres).

As Greenhouse Gas emission rates can vary significantly by vehicle type (e.g., heavy-duty trucks versus passenger cars), the United States Environmental Protection Agency Motor Vehicle Emission Simulator was used to determine Greenhouse Gas emission rates for each vehicle type.

The estimations of the existing winter road traffic and resulting Greenhouse Gas emissions are presented in **Section 5.1.1** and **Attachment B**.

4.3.1.2.2 Existing Greenhouse Gases from Existing Air Travel

The Project is expected to partially displace air travel with road vehicle traffic. Emissions as a result of the existing air flights, that may be fully or partially displaced by the proposed Community Access Road, are considered as existing Greenhouse Gases from air travel.

Greenhouse Gas emissions from existing air flights depend on the number and type of aircraft operations and engines, the fuel used, the length of flight, and other factors. For the flight routes likely to be affected after the completion of the Community Access Road, the aircraft types, fuel types (e.g., jet fuel), and consumption rates will be required to assess Greenhouse Gas emission changes.

Greenhouse Gas emissions from existing and avoided air travel are not quantitatively assessed due to the limited flight data available and the high uncertainties involved in the estimates of aircraft operations.

4.3.1.2.3 Existing Greenhouse Gases from Land Use

Land use changes due to Project construction result in carbon stock changes and subsequent direct Greenhouse Gas emissions. The change of carbon stocks for land uses within the Project Disturbance Area is assessed as an emission to the atmosphere as carbon dioxide. The land uses outside of the Project Disturbance Area are not directly impacted by construction activities, and; therefore, are not included in estimating existing carbon stock or Greenhouse Gas emissions.

To quantify the carbon stock and Greenhouse Gas emission changes resulting from land use conversions, the existing carbon stock before the undertaken of the proposed Project must be quantified. The quantifications of the existing (initial) carbon stocks and subsequent changes during the construction phase followed the assessment methods and guidance in the Strategic Assessment of Climate Change Technical Guidance (Environment and Climate Change Canada, 2021) and relevant Intergovernmental Panel on Climate Change guidelines (Intergovernmental Panel on Climate Change, 2006). The methods for quantifications of carbon stocks, including existing and post-construction, are detailed in **Attachment B**.

4.3.1.2.4 Existing Carbon Sinks from Land Use

Similar to the assessment of carbon stock changes, the changes in carbon sequestration capabilities (i.e., carbon sinks) due to the land use conversions were qualitatively and quantitatively assessed.

Note the impact on carbon sequestrations is assessed separately from the Project's net Greenhouse Gas emissions, as required in the Strategic Assessment of Climate Change Technical Guide. The method for assessing changes in carbon sinks due to land use conversions is summarized in **Section 4.4.2.1.1.4** and detailed in **Attachment B**.

4.3.2 Field Investigations

Ambient air quality data was collected through a field monitoring program to characterize the existing air quality. No field survey was required for the Greenhouse Gases study.

Field data and information from other disciplines (e.g., vegetation and peatland) were used to inform the Greenhouse Gas study. For instance, soil data collected for the peatland baseline study was used for estimating Greenhouse Gas emissions due to land use changes.

4.4 Effects Assessment

The following is a high-level overview of the approach for the identification, assessment, and evaluation of the potential effects:

- Review construction and operations activities to identify potential interaction(s) that could result in environmental effects;
- Characterize the existing environment for the preferred route;
- Identify potential environmental effects of the Preferred Route Alternative and recommend mitigation measures to avoid or minimize identified effects, as well as identify opportunities to enhance benefits to the environment;
- Predict and assess potential environmental effects remaining after taking into consideration the recommended mitigation measures (i.e., residual effects) using direction, magnitude, geographic extent, duration, frequency, reversibility, and likelihood;
- Predict cumulative effects that may result from a combination of the residual effects of the Preferred Route Alternative with the effects of other past, present, and reasonably foreseeable projects; and
- Identify a follow-up program for the Preferred Route Alternative that includes monitoring to verify the prediction of the effects assessment and effectiveness of the mitigation measures, and a requirement for monitoring of the commitments made in the Terms of Reference and Environmental Assessment / Impact Statement Report.

The following sections provide discipline-specific input and considerations as they pertain to the methodology for effects assessment. For detailed descriptions of the methodology used to inform this study refer to the Environmental Assessment / Impact Statement Report. Refer to **Section 6** for details related to the Preferred Route Alternative, including revised Study Areas which have been used in the Effects Assessment.

4.4.1 Project-Environment Interactions

The Project activities that may result in changes to the environment are described within the identified temporal and spatial boundaries (**Section 4.2**). This includes identification of both direct and indirect changes to the environment by comparing the existing condition to the effects anticipated to occur as a result of the Project. The likely Project-environment interactions were identified based on professional judgment, activities planned to occur, and as described in the *Marten Falls Community Access Road Project Tailored Impact Statement Guidelines* (Impact Assessment Agency of Canada, 2020) as well as projects of similar magnitude and / or location.

An analysis of Project-environment interactions for Greenhouse Gases that are likely to have a potential effect is provided in **Table 4-6** below.

Table 4-6: Project – Environment Interactions

Project Phases	Project Activities	Greenhouse Gases
Construction Phase	*Mobilization of Equipment and Supplies*	X
	Temporary Construction Staging Areas	X
	Temporary Access Roads and Trails	X
	Temporary Construction Camps	X
	ROW Clearing and Grubbing	X
	Brush and Timber Disposal	X
	Pits and Quarries	X
	Temporary Concrete Batch Plants	X
	Drilling / Blasting / Aggregate Production	X
	Road Construction (stripping, subgrade excavation, embankment fill placement, grading, ditching)	X
	Bridge and Culvert Installation (approach embankments, foundations, substructures, superstructures, traffic protection, erosion controls)	X
	Construction Site Restoration	
Construction Phase: Decommissioning	*Pits and Quarries*	X
	Temporary Camps, Roads / Trails, and Staging Areas	X
Operations and Maintenance Phase	*Road Usage*	X
	Maintenance	X

4.4.2 Assessing Residual Effects

4.4.2.1 Potential Effects

Following the identification of the Project–environment interactions, the existing conditions for the Preferred Route Alternative were reviewed to determine the potential effects of the Project. The potential effects on the Greenhouse Gases were described as either direct or indirect, and the potential effects on other disciplines were described as Discipline Interactions. The potential direct and indirect effects resulting from the Project–environment interactions were based on input received through the Indigenous Knowledge Program and Consultation and Engagement Program, regulatory agency guidance, and professional judgement.

Discipline interactions occur when a change to one Valued Component resulting from a project activity causes a change to another Valued Component in another discipline.

A **direct effect** occurs when there is a change due to a project activity. The potential direct effects resulting from the Project-environment interactions have been based on input received through the Indigenous Knowledge Program and Consultation and Engagement Program, regulatory agency guidance, and professional judgment.

An **indirect effect** occurs when there is a change due to a project activity that results in indirect effects on a Valued Component.

Residual effects are the effects remaining after the application of mitigation and enhancement measures. Where a potential effect has been identified, but implementation of mitigation measures is likely to avoid or sufficiently minimize the potential for an effect, the result is no residual effect, and no further analysis is required.

Table 4-7 provides a preliminary identification of potential discipline interactions with Greenhouse Gases. Greenhouse Gas emissions may be indirectly affected by changes to other environmental disciplines. Changes in Greenhouse Gases can in turn cause indirect changes to other disciplines. Examples of indirect Greenhouse Gas effects from and on other disciplines are provided during Effects Assessment in **Section 7.9**.

Table 4-7: Potential Indirect Interactions Between the Greenhouse Gases and Other Discipline

Discipline and Associated Valued Components	Aboriginal Treaty Rights and Interests	Atmospheric Environment and GHG	Acoustic and Vibration	Physiography, Geology, Terrain and Soils	Surface Water	Groundwater and Geochemistry	Vegetation	Wildlife	Fish and Fish Habitat	Social	Economy	Land and Resource Use	Human Health and Community Safety	Visual Aesthetics	Archaeological and Cultural Heritage
■ **Greenhouse Gases**	-		-	X	X	X	X	X	-	X	X	X	X	-	-

4.4.2.1.1 Construction Phase Effects

Greenhouse Gas emissions will be estimated for the construction phase based on the projected types of construction activities and duration. The effects of the project's construction on Greenhouse Gases include direct emissions from construction activities (e.g., construction mobile equipment emissions and blasting) and land use changes.

4.4.2.1.1.1 Greenhouse Gas Effects of Construction Activities

Anticipated construction activities, such as land clearing, blasting, aggregate extraction, material hauling, and road construction will be included in the estimate of Greenhouse Gas emissions. Emissions will be estimated based on emission factors generated from the United States Environmental Protection Agency Motor Vehicle Emission Simulator or those found in the United States Environmental Protection Agency's AP-42 emission factor database, if available. In the absence of detailed equipment operation data (e.g., capacity and duration), conservative assumptions were made during the assessment of Greenhouse Gas emissions. The detailed Greenhouse Gas calculations for construction mobile equipment and blasting are provided in **Attachment B**.

4.4.2.1.1.2 Greenhouse Gas Effects of Land Use Changes

The Project's construction is expected to convert different land uses (e.g., forest land) into settlements (i.e., roads and bridges) and thus impact the carbon stocks and carbon sequestration capabilities (i.e., carbon sink) of land uses within the Construction Disturbance Area.

The assessment of carbon changes and subsequent Greenhouse Gas emissions due to land use conversions followed the methods in the *Technical Guide Related to the Strategic Assessment of Climate Change* (Environment and Climate Change Canada, 2021). The methods for assessing carbon stock changes for each land use category are discussed in detail below.

4.4.2.1.1.2.1 Assessment Approach for Land Use Changes

The Strategic Assessment of Climate Change Technical Guide follows the Intergovernmental Panel on Climate Change tiered approach in determining the quantification method for Greenhouse Gases from land use changes. The requirement to use a Tier 1 approach versus a higher-tiered approach, which demands either site-specific data or a country-specific model, is based on the area of the project converted to land classified as settlements. The Construction Disturbance Area of the Project is larger than 100 hectares and therefore a Tier 2 or Tier 3 approach is required. As such, a review of Tier 2 and Tier 3 approaches was undertaken to determine the appropriate approach for the Project.

A Tier 2 approach uses the same methodological framework for calculations as in Tier 1 while requiring the use of site or region-specific data (e.g., carbon stock factors or emission factors), when appropriate, obtained through either field sampling or scientific literature.

A Tier 3 approach involves using a process-based model such as the *Carbon Budget Model of the Canadian Forest Sector* to track the relevant carbon stocks and transfers through time. It is the most demanding in terms of complexity and data requirements which requires the gathering of spatiotemporal data on activities and relevant environmental conditions that are needed for model input, calibration, and validation. The Environment and Climate Change Canada has been using the *Carbon Budget Model of the Canadian Forest Sector* for estimating Greenhouse Gas emissions from land use changes and the associated national and provincial total emissions are reported under the Land Use, Land-Use Change and Forestry (LULUCF) sector in the National Inventory Report.

Taking into consideration the lack of specific environmental and project data and the considerable resources required to develop, calibrate, and validate a Tier 3 model, a Tier 2 approach is considered to be more suitable for the Project and therefore is used for assessing Greenhouse Gas emissions from land use changes.

Note the Intergovernmental Panel on Climate Change Tier 1 approach assumes instant oxidation of all biomass (i.e., 100% loss) in the year of excavation. A Tier 2 approach can choose to use a site-specific decay curve, obtained from scientific literature or site survey, for each key carbon pool (e.g., biomass) to estimate annual carbon changes. As the project's land use conversion is anticipated to occur progressively throughout the construction phase, instant oxidation of carbons and subsequent Greenhouse Gases are assumed to occur in the year that land is disturbed (i.e., Tier 1 assumption).

Although the Tier 1 assumption is used for assessing annual carbon and Greenhouse Gas changes, the Tier 2 approach is followed by using site-specific parameters when possible. The detailed analysis of land uses and review of representative site or region-specific parameters (e.g., carbon stock value) are presented in **Attachment B**.

4.4.2.1.1.3 Effects on Carbon Stocks

The assessment of Greenhouse Gas Changes requires an estimate of the Project Disturbance Area that falls within each Intergovernmental Panel on Climate Change land-use category including forest land, wetlands, cropland, and grassland.

For each land use category, carbons can be stored in carbon pools including living biomass, dead organic matter, and soil organic carbon. For land uses converted to settlements (roads and bridges), potential carbon changes within each carbon pool are evaluated.

The methods for quantifying carbon stock changes for all carbon pools are described in the below sections.

4.4.2.1.1.3.1 Effects on Living Biomass

Living biomass includes organic material both aboveground and belowground, such as trees, shrubs, roots, and grasses. The calculation of the biomass carbon stock changes follows the Intergovernmental Panel on Climate Change method (equation 2.16, Intergovernmental Panel on Climate Change, 2006). The Intergovernmental Panel on Climate Change methodology assumes any living biomass being cleared from road construction will be instantly oxidized and considered as immediate direct Greenhouse Gas emissions, regardless of whether the biomass is left on-site, piled, or spread into adjacent areas.

The biomass carbon change is calculated as the difference in biomass stocks before (i.e., existing condition) and after the conversion (i.e., post-disturbance). The post-disturbance carbon stock is assumed zero for any living biomass on lands being cleared for road construction and therefore the biomass carbon stock change, as a result of the Project's construction, equals the existing biomass carbon stock for each land use category. As such, the loss of biomass carbons in forest land and others equals the initial carbon biomass before the conversion.

Note that annual biomass growth is assumed equal to zero for any lands-to-settlement conversions as per the Strategic Assessment of Climate Change Technical Guide (Environment and Climate Change Canada, 2021).

During the conversion of land uses, the Project is anticipated to burn about half of the wood collected from forest land, including living biomass, deadwood, and litter. As such, emissions resulting from wood burning are accounted in the Greenhouse Gas emissions from land use changes.

4.4.2.1.1.3.2 Effects on Dead Organic Matter

Dead organic matter comprises dead wood and litter. The deadwood contains carbon in coarse woody debris, dead coarse roots, standing dead trees, and other dead material not included in the litter or soil carbon pools. Within the Construction Disturbance Area, forest land and forested wetlands are determined as the key land use categories containing dead organic matter. Other land use categories (e.g., open wetlands) are expected to have little to no carbon stocks in the dead organic matter pool.

The dead organic matter within forest land and forested wetlands is expected to be disturbed through land clearing and wood burning. The carbon changes in dead organic matter within each land use category and the resulting Greenhouse Gas emissions are assessed in **Attachment B**.

4.4.2.1.1.3.3 Effects on Soil Organic Carbon

The carbons in soil are stored in organic and inorganic forms. Mineral soils are formed from the weathering of rocks and are primarily composed of inorganic material. Organic soils are formed from sedimentation and are primarily composed of organic matter. In general, the organic soil has a minimum of 12% to 20% organic matter by mass and the mineral soils have relatively low amounts of organic matter (Intergovernmental Panel on Climate Change, 2006). The Project's construction activities are anticipated to influence soil carbon storage by changing erosion and decomposition rates and subsequent loss of carbon from a site.

For mineral soils, the carbon stock is generally assessed to a default depth of 30 centimetres for Intergovernmental Panel on Climate Change Tier 1 and 2 methods and a default stock change factor (20%) in the Intergovernmental Panel on Climate Change Guidelines (Intergovernmental Panel on Climate Change, 2006) Section 8.3.3.2 is used. This assumes, for the land area that is covered (paved or gravel), 20% of the soil carbon relative to the previous land use will be lost as a result of disturbance, removal, or relocation.

Within the Construction Disturbance Area, forest land is identified as the key land use category containing the mineral soils. The initial carbon stock in mineral soils within the forestland is determined following the method in the Intergovernmental Panel on Climate Change Guidelines Section 8.3.3.2.

The wetlands within the Construction Disturbance Area mainly have organic soils (i.e., peat) for which the initial carbon stock and changes are assessed in the below section.

For organic soils, emissions of carbon vary depending on the previous land use and level of drainage. Generally, conversion from wetlands to settlements will likely increase carbon emissions from organic soils. This is because when the site is excavated and left in place, the soil profile is disturbed (e.g., mixed, spread or stored) and carbon is emitted due to the soil's accelerated decomposition.

For the project, the disturbance of organic soils in wetlands (i.e., peatland) is minimized by using the floating road technique which does not require excavation of underlying soils. In addition, large blast rock with significant porosity will be used to maintain the soil hydrology and therefore the organic soil is not expected to be drained after the construction. Therefore, zero carbon loss and subsequent Greenhouse gas emissions are assumed for organic soils within wetlands.

Nevertheless, the Project's construction is expected to remove some organic soil in the form of peat from forest land. Although the majority of forest land contains mineral soils, a small percentage (about 10%) of forest land is on organic soil, based on an analysis of land uses for the Construction Development Area.

As per the Strategic Assessment of Climate Change Technical Guide, changes in soil organic carbon are generally assumed not to be instantaneous, as in changes to biomass and dead organic matter stocks, but they are instead calculated as emissions from soil stocks for a certain time period. As such, the loss of organic soils in forest land is estimated and the associated change in the carbon storage and subsequent Greenhouse Gas emissions are evenly distributed into a default 20-year duration.

The estimations of existing carbon stock in organic soils in wetlands followed the technical method in "*A simple field method for estimating the mass of organic carbon stored in undisturbed wetland soils*" (Magnan et al., 2023; referred to as the wetland study hereafter). The wetland study developed linear regression equations between soil/peat thickness and soil organic carbon mass for different wetland classes, based on a large dataset of peat and soils collected from temperate and boreal regions of eastern Canada. More specifically, the following regression equations were developed for each wetland class.

Table 4-8: Soil Organic Carbon Mass Estimations

Wetland Class	Wetland Subclass	Equations(1)
Peatlands	Open bog	Y= 0.455x +1.543
	Open fen	Y= 0.398x +11.952
	Forested peatland	Y= 0.485x +13.532
Swamps	Hardwood swamp	Y= 0.6942x -5.2546
	Coniferous swamp	Y= 0.3044x +4.5083
Marshes	Freshwater marsh	Y= 0.2588x +0.7974
	Saltwater marsh	Y= 0.123x +4.9354

Notes:

(1). Y= soil organic carbon mass (kg/m^2), x= peat or organic-rich soil thickness (cm)

The regressions for carbon mass estimations for the peatlands including open bog, open fen, and forested peatland, are found close to the linear regression for all peatlands from a peat carbon vulnerability study (McLaughlin and Packalen, 2021). The vulnerability study produced the following regression equation for estimating carbon stocks based on a large peat dataset assembled for the Hudson Bay Lowlands.

Carbon mass (kg/m^2) = 0.4 x peat depth (m) +17

The method in the wetland study is considered more appropriate for estimating the initial soil organic carbon mass for various wetland types within the Construction Disturbance Area.

As the same method (Magnan, 2023) was used in the Peatland Baseline Study (AECOM, 2024) for estimating carbon stocks in all peatland groups, the analysis results of the Peatland Baseline Study, including the area of each peatland group within the Construction Disturbance Area, peat thickness, and estimated organic soil carbon storage, were used to inform the assessment of carbon stock changes and subsequent Greenhouse Gas emissions. The calculations of organic soil carbon storage are detailed in **Attachment B** and the Peatland Baseline Study (AECOM, 2024).

Although the Project is not anticipated to impact the soil carbon storage within wetlands due to the use of the floating road technique, the soil's carbon sequestration capacities are expected to be impacted. The assessment of the Project's impact on carbon sequestration capacities is provided in **Section 7.3**.

4.4.2.1.1.3.4 Summary of Methods for Assessing Carbon Stocks

A review of the available Geographic Information System mapping data (e.g., WSP vegetation community map, FarNorth Land Cover, and Landcover 2000 Classes) shows the key Intergovernmental Panel on Climate Change land use categories within the Construction Disturbance Area comprise forest land and wetlands.

Table 4-9 summarizes the impacted carbon pool due to land use conversions, quantification methods, assumptions, and required inputs for assessing carbon stock changes. The detailed methods and equations for calculating carbon stock changes in each carbon pool of land use due to land use conversions are provided in **Attachment B**.

Table 4-9: Assessing Carbon Stock Changes from Land Use Conversions

Intergovernmental Panel on Climate Change land use category	Carbon Pools	Calculation Method	Notes and Assumptions	Reference	Required Inputs/Parameters
Forest Land	**Living Biomass** (above and below ground)	■ Initial change in carbon stocks C (conversion) = Biomass after conversion (C_{after}) – Biomass before conversion (C_{before}). ■ C_{before} = Area (A) * Biomass stock value * Carbon Fraction.	■ Biomass after the conversion is zero. ■ Biomass growth is assumed to equal zero for lands converted to settlements per Strategic Assessment of Climate Change guidance Annex B-Step 4.1. ■ Use a carbon fraction of 0.5 to convert dry matter to carbon.	■ Intergovernmental Panel on Climate Change Equation 2.16 ■ Intergovernmental Panel on Climate Change Section 4.3. ■ Intergovernmental Panel on Climate Change Table 8.4.	■ Major forest types (i.e., leading tree species) within the Construction Disturbance Area identified through site survey and available databases. ■ Disturbed area and average age class for each forest type. ■ Representative biomass stock value or carbon storage for forest types obtained from the literature review for similar ecosystems.
	Dead Organic Matter	■ Annual change in dead organic matter ΔC_{DOM} = Area x (C_n – C_o)/T. ■ C_o= dead wood/litter stock under the old land-use category, tonnes C/ha.	■ Dead organic matter after the conversion is assumed as zero. ■ Deadwood carbon stock value is estimated based on the major forest types within the construction disturbance area and the default value of deadwood carbon for each forest type.	■ Intergovernmental Panel on Climate Change Section 2.3.2.2.	■ Disturbed forested area ■ Representative dead organic matter stock value for forest types obtained from the literature review for similar ecosystems.
	Soil Organic Carbon	■ ΔC_{soils} = $\Delta C_{Mineral}$ - $L_{organic}$ **Where,** ■ $\Delta C_{Mineral}$ = Annual change in organic carbon stocks in mineral soils, tonnes C/yr. ■ $L_{organic}$ = annual loss of carbon from organic soils due to drainage and other disturbances, tonnes C/yr. **Organic Soils:** ■ - $L_{Organic}$ =▲$SOC_{excavation}$ + ▲$SOC_{drainage}$. ■ ▲SOC excavation = ($SOC_{excavation-after}$ - $SOC_{excavation-Initial}$) /T.	**Organic Soils:** ■ Note the $L_{organic}$ in the IPCC Equation 2.24 has been revised to include organic carbon losses due to other disturbances (e.g., soil excavation) in addition to the soil drainage, following Step 4.3 of the Strategic Assessment of Climate Change Technical Guide. ■ Assumed no significant drainage of soil in wetlands due to the floating road construction technique and therefore the carbon loss from soil drainage is zero (▲$SOC_{drainage}$ =0). ■ The initial carbon stock in forest land ($SOC_{excavation-Initial}$) is estimated based on the average organic soil thickness for each forest type, obtained from provincial terrain soil mapping data, and the linear regression for estimating peat carbon stocks (McLaughlin and Packalen, 2021).	■ Equations 2.24, 2.25 (mineral soil), and 2.26 (organic soil). ■ Intergovernmental Panel on Climate Change Section 8.3.3.2. ■ Strategic Assessment of Climate Change Technical Guide Step 4.3.	■ Forested area with mineral and organic soils determined through available terrain and soil mapping data. ■ Estimates of carbon stock for organic soils in forest land.

Intergovernmental Panel on Climate Change land use category	Carbon Pools	Calculation Method	Notes and Assumptions	Reference	Required Inputs/Parameters
		Mineral Soils: ■ $\Delta C_{Mineral}$= (SOC_o - soil organic carbon$_{(0-T)}$)/D. ■ soil organic carbon= SOC_{REF} x Area x F_{lu}. **Where,** ■ SOC_0 = soil organic carbon stock at the end of conversion ■ soil organic carbon$_{(0-T)}$ = soil organic carbon stock before conversion ■ D = Duration, year ■ SOC_{REF} = the reference carbon stock, tonnes C/ha ■ F_{lu}= stock change factor for land use systems	**Mineral Soils:** ■ For mineral soils, a typical loss of carbon from soils (20%) is assumed ■ SOC_{REF}, the reference carbon stock for mineral soils will be determined based on mineral soil samples collected within the Construction Disturbance Area. ■ D = 20-year, default period for assessing soil carbon stock changes ■ F_{lu} =0.8 (assume 20% soil carbon loss due to disturbance or relocation of soil, per Intergovernmental Panel on Climate Change guide Section 8.3.3.2)		
Wetland	**Living biomass**	■ Same as Forest Land above	■ Assume all living biomass will be removed and instantly oxidized from road construction. ■ Biomass after the conversion is zero. ■ Forested wetlands (e.g., conifers swamps) are treated as forest land for calculating biomass carbon stock changes.	■ Intergovernmental Panel on Climate Change Equation 2.16.	■ Disturbed area for each wetland type ■ Literature search for biomass carbon stocks for each wetland class for a comparable ecological system
	Dead Organic Matter	■ Assume zero dead organic matter for open wetlands (i.e., non-forested wetlands) as per the SACC Technical Guidance	■ The change in dead organic matter can be assumed zero for open wetlands as there will be little to no tree litter at the site (except for forested wetlands) ■ Forested wetlands (e.g., conifers swamps) are treated as forest land for calculating deadwood carbon stock changes. ■ Dead organic matter in each type of forested wetlands is estimated based on the typical deadwood carbon stock value for each wetland class (e.g., treed bog and treed fen).	■ Strategic Assessment of Climate Change Annex B Step 4.2.	■ Review of dead organic matter carbon stocks for forested wetlands
	Soil Organic Carbon	■ For each wetland class, soil organic carbon = A x SOC_{mass} ■ SOC_{mass} = mass of soil organic carbon in each wetland class (kg/m^2)	■ No removal or excavation of soil on wetlands is required due to the floating road technique ■ No soil drainage on wetlands is planned due to the floating road technique.	■ G.Megnan et.al, 2023. A simple field method for estimating the mass of organic carbon stored in undisturbed wetland soils.	■ Disturbed area for each wetland class ■ Average peat thickness or carbon storage for each wetland class

4.4.2.1.1.4 Effects on Carbon Sinks

To align with the latest Strategic Assessment of Climate Change Technical Guide (2021) for Greenhouse Gas quantifications, the effects assessment includes qualitative and quantitative assessments of the Project's impacts on the carbon sinks. An impact to the carbon sinks implies interruption or alteration of the land area's ability to absorb carbon dioxide from the atmosphere.

Note the impact on carbon sinks due to land use changes is quantified separately from the net Greenhouse Gas emissions, as required in the Strategic Assessment of Climate Change Technical Guide. The changes in land's carbon sinks are estimated following the methodology in **Section 4.1** and Annex D of the *Strategic Assessment of Climate Change Technical Guide*.

In general, the natural carbon sink capacity for each land use class, before and after the land conversion, was determined based on a review of published data. The change in total sink capacities before and after the land conversion was determined as the carbon sink loss due to the project.

Detailed calculations of carbon sinks are provided in **Attachment B**.

4.4.2.1.2 Operating Phase Effects

Greenhouse Gas emissions during the operation phase mainly include direct emissions from future road traffic and emissions resulting from the loss of carbons in organic soils which were distributed over 20 years during the construction and operation phase.

The assessment of Greenhouse Gas emissions for the operation phase also considers the expected reductions in emissions from existing sources (e.g., aircraft, winter road usage) as a result of the project (i.e., avoided domestic Greenhouse Gas emissions).

Although the expected lifetime of the road is 75 years, Greenhouse Gas emissions from the Project are evaluated for 20 years starting from the anticipated first year of construction. This provides consistency with the future-build scenario as prescribed by the Ontario Ministry of Transportation (MTO, 2020). The average per-annum Greenhouse Gas contribution as a result of the project is compared to provincial, federal, and sector totals where applicable.

4.4.2.1.2.1 Greenhouse Gas Emissions from Road Traffic

The Greenhouse Gas emissions from vehicular traffic on the proposed Community Access Road are estimated based on the anticipated peak traffic data in 2046. An average annual daily traffic volume of 700 is assumed for the north-south section of the Community Access

Road. An average annual daily traffic volume of 100 is assumed for the east-west section of the Community Access Road (AECOM, 2024).

Routine road maintenance activities such as snow clearing are expected to be captured in the roadway vehicle data (traffic volumes and vehicle types) within the roadway operation scenario, and therefore will be included in the Greenhouse Gas assessment. Minor roadway maintenance activities, such as re-grading, are expected to have a lower impact than the roadway construction scenario; therefore, the impact of these activities would have been assessed within that bounding scenario.

4.4.2.1.2.2 Greenhouse Gas Changes due to Reduced Winter Road Travel

The vehicular traffic and the resulting Greenhouse Gas emissions from the existing winter road are expected to be negligible once the Community Access Road is in operation. Therefore, the reductions of Greenhouse Gas emissions due to the avoided winter road travel can be assumed to equal the Greenhouse Gas emissions resulting from the existing winter road travel.

4.4.2.1.2.3 Greenhouse Gas Changes due to Reduced Air Travel

The Project's effects on Greenhouse Gas emissions associated with air travel will be qualitatively discussed in the Effects Assessment of the Project – **Section 7.3.2**.

4.4.2.2 Mitigation and Enhancement Measures

Following the identification of potential effects, the effects assessment has explored technically and economically feasible mitigation measures to avoid or minimize the identified negative effects. In addition, enhancement measures to increase positive effects beyond those that are already inherent to the design have been considered where appropriate. These measures consist of industry-standard practices, federal and provincial standard specifications, regulator-mandated measures, best management practices, Indigenous and community recommendations and recommendations from environmental professionals based on expertise, scientific publications, experience, and judgement.

It is important that mitigation and enhancement measures are achievable, measurable, verifiable, and monitored for compliance and effectiveness during all temporal phases as part of the Project follow-up monitoring plan. Recommended environmental monitoring will verify the potential environmental effects predicted, evaluate the effectiveness of mitigation and enhancement measures, and identify the process the Proponent will follow if mitigation and enhancement measures are not effective.

The *Tailored Impact Statement Guidelines* (Impact Assessment Agency of Canada, 2020) Section 20 requirements for Atmospheric Environment are provided in **Table 4-5**. The applicability of these requirements has been evaluated and will be adapted to the needs of the site, environment, and Project activities.

4.4.2.3 Predicting Residual Effects

Following the identification of direct and indirect effects and the identification of mitigation and enhancement measures, residual effects are predicted. Once predicted, residual effects were characterized by residual effects characteristics, which are described in the below section. Any predicted residual effects are also carried forward into the cumulative effects assessment which is described in **Section 8**.

4.4.2.3.1 Characterization of Predicted Residual Effects

The characteristics used to complete the effects assessment are described in detail in the Environmental Assessment / Impact Assessment Report. The section that follows outlines how these characteristics were applied and provides discipline specific definitions where applicable. The effects assessment characteristics have been described in **Table 4-10** below.

Table 4-10: Residual Effects Characteristics

Effects Characteristic	Definition	Description
Context	■ Ecological Context	■ See description in **Section 4.4.2.3.2.1**
Direction	■ Direction of change from existing conditions	■ Positive: net gain or positive effect ■ Neutral: no change to existing conditions ■ Negative: net loss or adverse effect
Magnitude	■ Magnitude is the expected change from existing conditions	■ Negligible, low, medium, high. ■ See description in **Section 4.4.2.3.2.2**
Geographic Extent	■ The spatial area that the effect is expected to occur	■ Construction Disturbance Area: effect is confined within the direct physical disturbance of the Project. ■ Local: effect extends into the Local Study Area. ■ Regional: effect extends into the Regional Study Area. ■ Beyond Regional: effect extends beyond the Regional Study Area.
Duration	■ The period of time that the effect is expected to occur	■ Short-term: effect ends before the end of construction. ■ Medium-term: the effect occurs during construction and ends soon after operation begins and / or

Effects Characteristic	Definition	Description
		maintenance ends soon after the activity causing the effect ends. ■ Long-term: the effect occurs during construction and persists into operation and / or the effect is considered permanent, or the likelihood of reversibility is low or uncertain.
Frequency	■ How often the effect is expected to occur	■ Infrequent: The effect is expected to occur rarely. ■ Frequent: The effect is expected to occur intermittently. ■ Continuous: the effect is expected to occur continuously.
Reversibility	■ The ability to return to existing conditions	■ Reversible: the effect is not permanent. ■ Irreversible: the effect is permanent.
Likelihood	■ Probability that the effect will occur	■ Unlikely: the effect is not likely to occur. ■ Possible: the effect may occur but is not likely. ■ Probable: the effect is likely to occur. ■ Certain: the effect will occur.
Uncertainty	■ The potential for observed results to deviate from predictions made	■ Further details provided below

4.4.2.3.2 Discipline Specific Characteristics

In addition to the residual effects characteristics described in **Table 4-10**, characterizations of the following discipline-specific characteristics are required to characterize residual effects to determine the significance of those effects from the Project on Greenhouse Gases.

4.4.2.3.2.1 Ecological Context

The ecological context within which potential environmental, health, social and economic effects may occur has been taken into account when considering the effects criteria, such as species sensitivity and resilience, and includes Indigenous Knowledge where it was available. The ecological context of the effect includes a discussion of the environmental consequences of the predicted effect. For the Greenhouse Gas assessment ecological context is directly related to changes in Greenhouse Gas emissions.

4.4.2.3.2.2 Magnitude

Magnitude refers to the amount of change in a measurable parameter relative to the baseline conditions of a valued component, with and without the project in place, or to other standards or guidelines. When evaluating the magnitude of effects, this study considers both the proportion of the Valued Component affected within identified spatial boundaries and the relative effect.

For magnitude, environmental discipline-specific definitions are required and are provided below in **Table 4-11** below. The magnitudes of the Project's Greenhouse Gas contributions from construction and operation are assessed through comparison to the total Provincial transportation emissions (i.e., road transportation sector). As per the most recent National Inventory Report (Environment and Climate Change Canada, 2024), a total of 40,907 kilotonnes of carbon dioxide equivalent was emitted from Ontario's road transportation sector, and a total of 156,994 kilotonnes of carbon dioxide equivalent was emitted from all Ontario sectors which exclude emissions from land use changes.

Table 4-11: Greenhouse Gases Magnitude Definition

Magnitude Level	Magnitude Definition[1,2]	Annual Emission Thresholds (CO_2 eq)	Rationale
Negligible	Up to 0.1% of Provincial Road Transportation Greenhouse Gas Totals	under 41 kt	Releases of Greenhouse Gases and their accumulation in the atmosphere influence regional, national, and global climate and may affect emission reduction targets for Greenhouse Gases that have been set or are being developed federally and provincially. The magnitude has therefore been established as a percent contribution to provincial totals to assess the significance of Project emissions and hence potential effect on provincial reduction targets that may exist.
Low	0.1% to 0.5% of Provincial Road Transportation Greenhouse Gas Totals	41 to 205 kt	
Medium	0.5% to 1% of Provincial Road Transportation Greenhouse Gas Totals	205 to 409 kt	

Magnitude Level	Magnitude Definition[1,2]	Annual Emission Thresholds (CO_2 eq)	Rationale
High	>1% of Provincial Road Transportation Greenhouse Gas Totals	Above 409 kt	

Notes:

1. *The annual emission thresholds are determined based on the magnitude definition and Ontario's total Greenhouse Gases for transportation and all sectors for the 2022 inventory year obtained from the most recent National Inventory Report (Environment and Climate Change Canada, 2024).*

Magnitude thresholds defined in **Table 4-11** are specific to Greenhouse Gas emissions associated with the construction and operation phases of the Project. These Greenhouse Gas emission totals do not include emissions associated with Land Use Changes.

For the purpose of providing context of the magnitude of Greenhouse Gas emissions resulting from land use changes, the Greenhouse Gas emissions from land use changes spanning across the full project lifetime are compared against Ontario's total Greenhouse Gas emissions. The percentage of total emissions remains the same for each magnitude level as described in **Table 4-11**.

4.4.2.3.2.3 Duration

Duration refers to the period of time in which effects are expected to occur. When Greenhouse Gases are emitted their potential impact on climate change is considered long term.

4.4.2.3.2.4 Frequency

Frequency refers to how often the effect is expected to occur. Specific to residual effects with respect to Greenhouse Gas emissions, frequency is directly correlated to the continuousness of Greenhouse Gas emission generating activities which will result in the predicted effect.

As the emissions are reviewed over an annual basis, it can be assumed that regardless of the construction or operational activity (e.g., intermittently blasting, consistent hauling, and vehicle traffic) during the project, all activities would occur on a continuous basis.

4.4.2.3.2.5 Reversibility

Reversibility refers to the ability for conditions to return to existing conditions. The impact of Greenhouse Gas emissions on the environment are considered to be irreversible on a human lifespan timescale.

For the purpose of effects characterization, it is assumed that once Greenhouse Gases are emitted their potential impact on climate change is irreversible.

4.4.2.3.2.6 Uncertainty/Likelihood

All impact assessments involve some level of uncertainty, often over many geographic, biophysical, and social dimensions, and observed results may deviate, to some degree, from predictions made in the assessment. Uncertainty could be related to a number of factors, such as project design and components, existing conditions, spatial and temporal scope, valued component response, effectiveness of mitigation measures, overall scope of factors considered, cumulative effects, and natural and human causes of accidental events. Note that all uncertainties related to the effectiveness of mitigation measures must be considered when determining residual effects. Transparency in describing sources of uncertainty is critical to understanding the confidence that can be attributed to the analysis of effects and is important to decision-making. Efforts to address uncertainties has been focused on those uncertainties that are most meaningful to decision-making, such as how the biophysical and human environment will respond to changes and the efficacy of mitigation measures.

A level of uncertainty exists due to conservative methodologies used in the preparation of the Greenhouse Gas emission calculations; however, emission estimates were based on worst-case construction/operating scenarios. By using the worst-case scenarios, the predicted impacts are not likely to be exceeded and presents an upper-bound for the potential residual effects.

4.4.2.3.2.7 Prediction Confidence

Prediction confidence refers to the degrees of certainty in the predicted residual effects and associated determination of significance. All Impact Assessments involve some level of uncertainty, often over many geographic, biophysical, and social dimensions, and observed results may deviate, to some degree, from predictions made in the assessment. Therefore, the residual effects predictions vary in their level of certainty, which could be related to a number of factors, such as project design and components, existing conditions, spatial and temporal scope, Valued Component response, effectiveness of mitigation measures, overall scope of factors considered, and natural and human causes of accidental events.

Transparency in describing sources of uncertainty is critical to understanding the confidence that can be attributed to the analysis of effects and is important to decision-making. Efforts to address uncertainties have been focused on those uncertainties that are most meaningful to decision-making, such as how the biophysical and human environment will respond to changes and the efficacy of mitigation measures. The confidence levels are defined as:

- **Low:** Confidence levels were considered to be low if there were no representative emission factors or calculation methodologies and the operating activities/conditions or land use changes associated with the Greenhouse Gas emission estimates are poorly understood;
- **Moderate**: Confidence levels were considered to be moderate if there are representative emission factors or calculation methodologies available and the operating activities/conditions or land use changes associated with the Greenhouse Gas emission estimates are moderately understood; and
- **High**: Confidence levels were considered to be high if there are representative emission factors or calculation methodologies available and the operating activities/conditions or land use changes associated with the Greenhouse Gas emission estimates are highly understood.

4.4.2.3.3 Determination of Significance

A conclusion on significance regarding the predicted net effect on Greenhouse Gases will be made using the characteristics described in **Table 4-10**.

Significance of residual effects was determined using the effects characteristics described above. The assessment of significance of the residual effects of the Project was informed by the interaction between the residual effects characteristics, with magnitude and reversibility and geographic extent being the most important factors, along with consideration of context.

To evaluate significance of potential residual effects, the Greenhouse Gas results discussed in **Section 7** were used in conjunction with the effects characteristics defined in **Table 4-10**.

The determination of significance was generally as follows:

- **Significant:** Residual effects were generally considered as significant if the residual effect was assessed as a medium or high magnitude with irreversible effects.
- **Not Significant:** Residual effects were generally considered Not Significant if they demonstrate any other combination.

An assessment of significance was completed for the construction scenario, operation scenario, and land use change. Magnitude for construction and operating phases were assessed based on comparison to a sectoral (Ontario transportation) Greenhouse Gas totals. Magnitude for land use changes were compared against Ontario's total Greenhouse Gas emissions.

5 Existing Environment Description

The Existing conditions are described based on a combination of information obtained through engagement and consultation and desktop assessment.

5.1 Existing Greenhouse Gases

The environment surrounding the Project is considered to be pristine due to the remote location of the Project, and there are no major anthropogenic sources of emissions (e.g., major industries) except community transportation. Therefore, the existing Greenhouse Gases are expected to be dominated by naturally occurring processes (e.g., Greenhouse Gases from vegetation) and emissions due to current community transportation (e.g., air travel and winter road traffic). Other Greenhouse Gas sources within the Local Study Area are unlikely affected by the Project such as emissions from community fuel usage. Those are not accounted for as existing emissions for evaluating net greenhouse gases resulting from the project as the emissions are expected to be similar for the existing and project scenarios. As such, the existing sources of Greenhouse Gases for the project are expected to mainly include emissions from the existing winter road travel, air travel, and land uses.

5.1.1 Existing Greenhouse Gas from Winter Road Travel

Vehicle travel on the winter road contributes to existing Greenhouse Gases within the Local Study Area. Vehicle types on the winter road mainly consist of passenger cars, light-duty commercial trucks, heavy-duty transport trucks, and road maintenance vehicles. The subsections below present the assessment of Greenhouse Gas emissions from the existing winter road travel.

5.1.1.1 Traffic Volume

The volume of traffic on the winter road is generally low. The average daily traffic for passenger travel is about eight vehicles, which include passenger cars and commercial trucks. Transportation trucks are estimated to include approximately 30 loads in and out per winter.

Roadway maintenance activities are difficult to quantify and resulting emissions are anticipated to be insignificant in comparison to on-road travel emissions. As such, an additional 1% was added to the local traffic volume to account for traffic due to road maintenance.

Therefore, an average daily traffic of 9.5 vehicles was estimated including passenger cars, commercial trucks, heavy-duty transportation trucks, and road maintenance vehicles. The estimations of traffic volume, vehicle type distribution, and vehicular emission factors are provided in detail in **Attachment B**.

5.1.1.2 Vehicle Type Distribution

Greenhouse Gas emission rates from vehicle travel are dependent on factors such as vehicle types, fuel types, and the average travel speed. For example, a commercial diesel truck generates more Greenhouse Gases than a gasoline passenger car. Therefore, a representative vehicle type distribution for community winter roads is needed to estimate the traffic volume for each vehicle type (i.e., passenger cars and commercial trucks). Unlike local roads, winter roads are primarily used by truck traffic for delivering fuel, freight, and groceries.

In the absence of traffic survey data for the existing winter road, the vehicle type distribution and daily traffic distribution from a Greenhouse Gas Assessment Study completed for Manitoba Infrastructure Remote Road Operations in 2017 which quantified Greenhouse Gas emissions associated with an all season road development project on the east side of Lake Winnipeg was used.

5.1.1.3 Vehicle Emission Factors

The Motor Vehicle Emissions Simulator model (MOVES) predicts vehicle emissions based on extensive emission testing performed by the agency and accounts for local meteorology, fuel formulation, improving emissions technology, vehicle speed, road type, and other factors to estimate vehicle emissions (United States Environmental Protection Agency, 2024).

Average meteorology in January, including temperature and humidity, from the nearest weather station - Ogoki Post Airport (Station ID 6075786) is used for modelling vehicle emissions. Typical vehicle types on the winter road, including passenger cars, light-duty trucks, and heavy-duty transportation trucks, are predicted for Greenhouse Gases emission rates for the existing 2023 year.

Vehicle fleet generally travels at a lower speed on winter roads due to safety concerns and therefore have different emissions from the average fleet emission factors published by regulatory authorities which are generally derived from vehicular running on highways at a posted speed limit. The Winter Roads Technical Backgrounder recommended roads over land should be designed to travel safely at an average speed of at least 35 kilometres per hour and a speed limit for trucks over ice crossing is 15 kilometres per hour (IBI Group, 2016). Similarly, the Manitoba Ministry of Transportation and Infrastructure requires all vehicles on winter roads not to exceed a maximum speed of 40 kilometres per hour when travelling on a land road and 15 kilometres per hour on any ice road. For the purpose of Greenhouse Gas quantifications, all vehicles are assumed to travel at an average speed of 35 kilometres per hour for estimating greenhouse gases.

Major inputs for the Motor Vehicle Emissions Simulator model are provided in **Table 5-1** and the output emission factors are summarized in **Table 5-2**.

Table 5-1: Motor Vehicle Emissions Simulator Model Inputs

Key Motor Vehicle Emissions Simulator Parameters	Motor Vehicle Emissions Simulator Emission Rate Run for Winter Road Traffic
Time Span	■ 2023 existing year
Selected representative County	■ Niagara County, NY
Vehicle Miles Travelled fraction	■ County default
Age Distribution of vehicles	■ County default
Meteorology	■ Marten Falls First Nation OGOKI POST Airport station (ID 6075786) ■ 2021 Meteorology - January: Avg Temp 9.3°F, humidity 96%
Vehicle types	■ Passenger Vehicles (SourcetypeID=21) ■ Light Duty Commercial Trucks (SourcetypeID=32) ■ Heavy Duty Long-Haul Trucks (SourcetypeID=53)
Road types	■ Rural Unrestricted Access (Road type 3)
Pollutants	■ Greenhouse Gases (CO_2e) including CO_2, CH_4, and N_2O.
Average Speed	■ 35 kilometres per hour (Bin 5)
Fuel	■ County default fuel formulation ■ Passenger car uses gasoline ■ All trucks use diesel

Table 5-2: Motor Vehicle Emissions Simulator Emission Factors

Vehicle Types	Emission Factors[1] (g/VKT)			
	Methane (CH_4)	Nitrous Oxide (N_2O)	Carbon Dioxide (CO_2)	CO_2 Equivalent
Passenger Vehicles	0.0082	0.0016	222.8	223.5
Light Duty Commercial Trucks	0.0128	0.0030	308.0	309.1
Heavy Duty Transport Trucks	0.0272	0.0062	757.1	759.5

Notes:

1. Vehicle running exhaust emission factors from the United States Environmental Protection Agency Motor Vehicle Emissions Simulator model.

5.1.1.4 Winter Road Emission Summary

Table 5-3 summarizes the annual Greenhouse Gas emissions from the existing winter road traffic. The existing traffic on the winter road is estimated to generate approximately 21.1 tonnes of carbon dioxide equivalent (CO_2 e), as a part of the total existing Greenhouse Gases for the Marten Falls First Nation Community Access Road Project.

Table 5-3: Greenhouse Gases from Winter Road Traffic

	Passenger Car	LD Commercial Truck	HD Transport and Maintenance Truck	Total
Vehicle Type Distribution	0.7%	83.3%	16.0%	100%
Distance Driven (VKT/yr.)	366	46,271	8,878	55,514
CO_2 e EF (g/VKT)	223.5	309.1	759.5	-
Annual CO_2 e (t)	**0.1**	**14.3**	**6.7**	**21.1**

5.1.2 Existing Greenhouse Gas Emissions from Air Travel

As indicated in **Section 4.3.1**, Greenhouse Gas emissions from existing and avoided air travel are not quantitatively assessed due to the limited flight data available and the high uncertainties involved in the estimates of flight data. However, the Project's effects on Greenhouse Gas emissions associated with air travel are discussed in the Effects Assessment – **Section 7.3.2**.

5.1.3 Existing Greenhouse Gas Sequestration from Land Use

The methods for assessing existing and post-construction carbon stocks and subsequent Greenhouse Gas emissions followed the Strategic Assessment of Climate Change Technical Guidance and relevant Intergovernmental Panel on Climate Change guidelines.

Existing living biomass, deadwood/litter, and organic soils associated with different land uses (e.g., forest lands and wetlands) constitute a significant carbon stock which will be impacted by the Project's construction activities such as land clearing and soil excavation. The potential effects on carbon storage in existing land uses are described in **Section 7.3.3**.

The existing (initial) carbon storage in each carbon pool (e.g., soil) of land uses (e.g., forest land) is estimated in **Attachment B**. The initial carbon stocks associated with the existing land use were used to determine the changes in carbon stock and subsequent Greenhouse Gas emissions due to the Project.

The carbon sequestrations from the existing land uses within the Construction Disturbance Area, mainly including forest land and wetlands, are determined following the *Strategic Assessment of Climate Change Technical Guidance* Section 4 and Annex D- Further guidance on the methodology used to quantify the impact to carbon sinks.

The forests within the Construction Disturbance Area are generally old-growth forests which have either reached or surpassed the age for the maximum carrying capacity (maturity). Those forests have the lowest carbon sequestration rates compared to younger forests and therefore the total carbon flux of forest land is assumed zero.

The wetlands within the Construction Disturbance Area mainly consist of Fen (33.4%) and Swamp (63.8%). Bog and Marsh account for 1.2% and 1.6% of the total construction disturbance area. The majority of the wetlands (91.4%) within the Construction Disturbance Area are peatlands and a small percentage (8.6%) of the wetlands (e.g., mineral marshes) contain mineral soil. As such, the analysis of carbon sinks in wetlands has been focused on the peatlands.

The natural carbon sink capacities of each peatland class, during both growing and non-growing seasons, are determined based on reviewing published literature for carbon fluxes in a comparable ecosystem. For each peatland class, the annual carbon accumulation rate is determined using the sum of annual carbon dioxide and methane flux approach.

Peatlands within the Construction Disturbance Area are determined as carbon sources instead of carbon sinks based on the carbon sink analysis in **Appendix B6**. Bog and Fens are carbon sink sources during the growing season while the sequestrated carbons are completely offset by the carbon releases from the non-growing season. The peatland groups within the Construction Disturbance Area include Bog, Fen, and Swamp which emit 14 tonnes, 551 tonnes, and 1,080 tonnes of carbon annually.

Overall, the existing land uses within the Construction Disturbance Area emit about 1,646 tonnes of carbon annually.

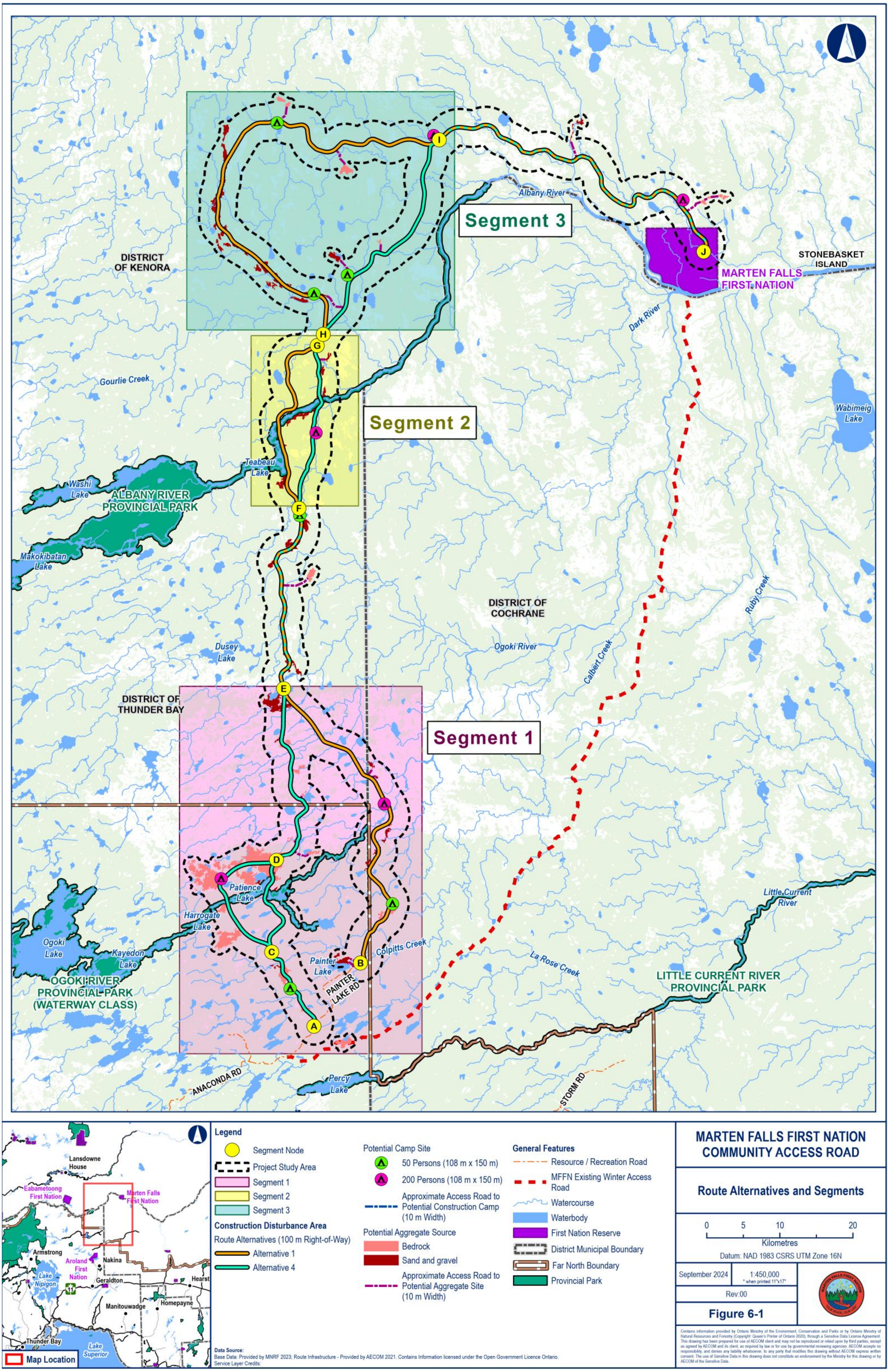
6 Selection of the Preferred Route Alternative

Following the collection of existing condition information on the two alternative route alignments described in **Section 4**, the Project undertook an exercise to select a Preferred Route Alternative. The methodology and detailed results of this exercise are described in the Environmental Assessment / Impact Assessment Report and are summarized at a high level below. The Preferred Route Alternative includes the footprint of any ancillary features such as pits and quarries, temporary access roads, and worker camps associated with the construction of that route. The Effects Assessment will be completed using the identified preferred route.

6.1 Alternative Segments and Routes Within Each Segment

In order to simplify the evaluation of the alternatives, the alternatives were divided into three separate segments based on their geographical locations. The segments were also determined so that any alternative route in one segment could connect with any alternative route in the next segment, allowing for decisions to be made based on the environment in each segment, and not based on the whole. This approach considers the variable environmental conditions within the project area, allowing for flexibility to avoid sensitive natural features encountered within the project disturbance area for each segment instead of requiring decision makers to balance trade offs of one long route versus the other.

Figure 6-1: Route Alternatives and Segments



6.2 Preferred Route Alternative

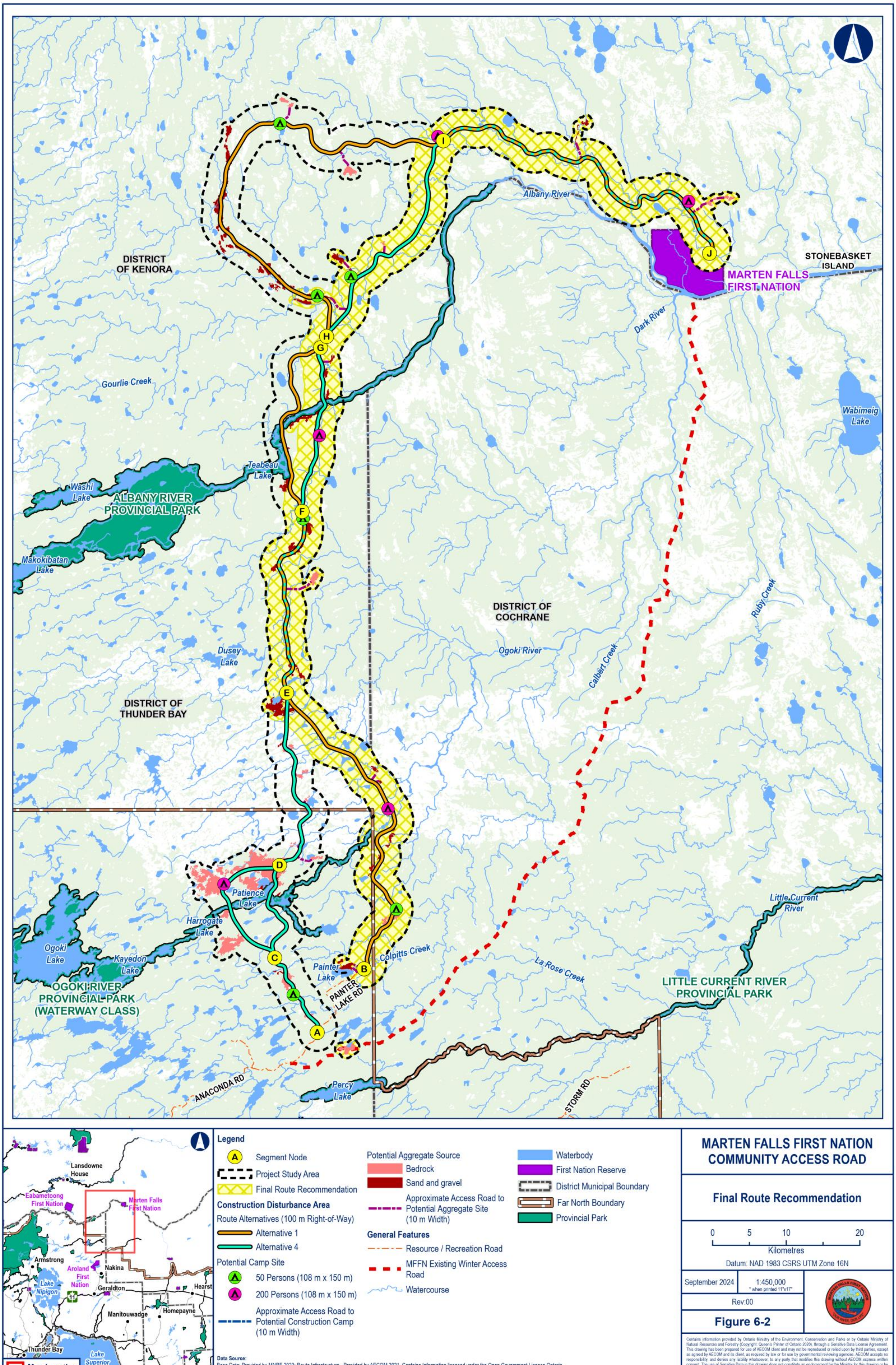
The selection of the preferred route within each segment involved a thorough analysis of technical, economic, natural, social, and cultural factors. The route alternative evaluation took into account the potential impacts and standard or known mitigation approaches to determine the net positive or negative effects of each alternative and was completed using the reasoned argument (trade-off) method. The reasoned argument method qualitatively compares the advantages and disadvantages of each alternative including the relative significance of the potential net effects.

Following the completion of the steps outlined above, and direction from the community of Marten Falls First Nation, Aroland First Nation, and input from the public and regulators, the Proponent identified a preferred route alignment for each segment.

- Segment 1 – Ogoki Crossing: Alternative 1
- Segment 2 – Albany Crossing: Alternative 4
- Segment 3 – North of the Albany: Alternative 4

The combination of Segments 1, 2, and 3 creates the final Preferred Route Alternative.

Figure 6-2: Preferred Route



7 Effects Assessment of the Project

Effects assessment results are provided for the preferred route alternative, by each temporal phase of the Project as described in **Section 4.2**. This includes the potential effects (positive and negative), mitigation measures, residual effects, and indirect effects. Where applicable Gender-Based Analysis Plus has been considered within the assessment for each Valued Component.

The methodologies for assessing the Project's potential effects were described in **Section 4**. The sections below summarize the assessment results of the potential effects.

7.1 Greenhouse Gas Emissions by Source Types

The Project's direct Greenhouse Gas emissions by source types with and without land use changes are summarized in **Table 7-1**.

Greenhouse Gas emissions from construction activities including mobile equipment and blasting account for a relatively small percentage of the Project's total Greenhouse Gas emissions. More specifically, the maximum annual Greenhouse Gas emissions released from construction mobile equipment and blasting during the project's assessment period is about 18 and 0.4 kilotonnes of carbon dioxide equivalent, respectively.

The total emission from construction mobile and blasting during the Project's assessment period is about 83 kilotonnes of carbon dioxide equivalent which accounts for approximately 5% of the Project's total Greenhouse Gas emissions.

Greenhouse Gases from future road traffic during the 20-year assessment period starting from the first construction year account for approximately 20% of the Project's total direct emissions. Greenhouse Gases from land use changes constitute approximately 75% of the Project's total direct emissions.

Table 7-1: Summary of Project Direct Greenhouse Gas Emissions by Source Types

Direct Greenhouse Gas Source Types	Maximum Annual Greenhouse Gas Emissions by Source Type [1,2,3] (kt CO_2 eq)	Total Direct Greenhouse Gas Emissions[4] (kt CO_2 eq)	Percentages of Total Greenhouse Gas Emissions (%)
Construction mobile	18	81	4%
Quarry and road blasting	0.4	1.8	< 1%
Operation traffic emissions	27	401	20%

Direct Greenhouse Gas Source Types	Maximum Annual Greenhouse Gas Emissions by Source Type [1,2,3] (kt CO_2 eq)	Total Direct Greenhouse Gas Emissions[4] (kt CO_2 eq)	Percentages of Total Greenhouse Gas Emissions (%)
Land use change	277	1,485	75%
Project's Total Direct Greenhouse Gas Emissions without Land Use Change	**27**	**484**	**24%**
Project's Total Direct Greenhouse Gas Emissions (with Land Use Change)	**295**	**1,969**	**100%**

Notes:

1. *Annual Greenhouse Gas emissions can vary by project phase and year. The Maximum annual Greenhouse Gas emissions for each source type throughout the assessment period, including the construction and operation phases, are presented.*
2. *kt CO_2 eq means kilotonnes of carbon dioxide equivalent.*
3 *The total Greenhouse Gases with and without Land Use Change are based on a worst-case year during the assessment period. As such, the total Greenhouse Gases are not equal to the sum of the max annual Greenhouse Gases by source types which may occur in different years. For example, the max annual Greenhouse Gas emissions for construction mobile occur during a typical construction year while the max Greenhouse Gas emissions for the operation traffic occur after the construction phase.*
4. *The project's total Greenhouse Gas emissions are assessed for a total of 20 years starting from the first year of construction, including approximately 5 years of construction and 15 years of operation.*

7.2 Greenhouse Gas Emission Intensity

The Project's Greenhouse Gas emissions from road construction were assessed for emission intensity (i.e., emissions per kilometre of road length built). The Project's construction is estimated to generate approximately 83 kilotonnes of carbon dioxide equivalent, excluding Greenhouse Gas emissions from land use changes. The Project's road construction emission intensity is estimated to be approximately 0.45 kilotonnes of carbon dioxide equivalent per kilometre of road length built.

The Project's emission intensity for road construction is estimated to satisfy the requirements in Section 2.1.5 of the Strategic Assessment of Climate Change Technical Guide. However, the estimated emission intensity was not used to inform the assessment of the Project's residual effects due to the lack of a comparable emission intensity from regulatory guidance documents for road construction projects.

Table 7-2: Project's Greenhouse Gas Emission Intensity

Road Construction (construction mobile and blasting)	Road Construction Greenhouse Gas Emissions (kt CO_2 eq)	Approximate Road Length (km)	Road Construction Emission Intensity (kt CO_2 eq/km)
	83	184	0.45

7.3 Potential Effects by Project Phases

The Project's direct Greenhouse Gas emissions by Project phases, with and without land use changes, are summarized in **Table 7-3**. The calculated Greenhouse Gas Emissions for each Project year and supporting assumptions are detailed in **Attachment B**.

Greenhouse Gas emissions from the construction phase, with land use changes, account for 67% of the Project's total direct Greenhouse Gas emissions. Greenhouse Gas emissions from the operation phase which include future traffic emissions and emissions resulting from the accelerated decomposition of disturbed soils account for approximately 33% of the Project's total emissions. Overall, the Project generates approximately 484 kilotonnes of carbon dioxide equivalent emissions without land use change and 1,969 kilotonnes of carbon dioxide equivalent emissions with land use change.

It should be noted that changes in land use during the construction phase will result in changes that may not be instantaneous and may occur during the operation phase of the project (e.g., accelerated soil carbon loss over a 20-year period).

Table 7-3: Summary of Direct Greenhouse Gas Emissions by Project Phase

Direct Greenhouse Gas Emissions	Project Construction [1,2,3,4,5]			Project Operation [1,2,3,4,5]			Project-Total
	Maximum Annual Emissions (kt CO_2 eq)	Total Emissions (kt CO_2 eq)	Percentage of Total Emissions by Project-Total with Land Use Change (%)	Maximum Annual Emissions (kt CO_2 eq)	Total Emissions (kt CO_2 eq)	Percentage of Total Emissions by Project-Total with Land Use Change (%)	Total Emissions (kt CO_2 eq)
Total Direct Greenhouse Gas without Land Use Change	19	83	4%	27	401	20%	484
Land Use Change	277	1,227	62%	17	258	13%	1,485
Total Direct Greenhouse Gas (with Land Use Change)	295	1,310	67%	44	658	33%	1,969

Notes:

1. *Annual Greenhouse Gas emissions for the construction phase are based on an estimate of 40 km of road built each year.*
2. *Some of the numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.*
3. *kt CO_2 eq means kilotonnes of carbon dioxide equivalent.*
4. *Annual carbon sequestrations of land use are separated from direct Greenhouse Gas emission estimations as per the SACC Technical Guide.*
5. *The project's total Greenhouse Gas emissions are assessed for a total of 20 years starting from the first year of construction. This includes approximately 5 years of construction and 15 years of operation.*

7.3.1 Potential Effects – Construction

As described in **Section 4.2.1** the construction phase encompasses the commencement of construction activities, including site preparation, to the start of operations and maintenance of the Marten Falls First Nation Community Access Road. Decommissioning of construction works (temporary pits and quarries, worker camps, temporary access roads) is included in the construction phase. The construction phase is anticipated to take approximately three to ten years to complete.

The potential effects of the Project's construction on Greenhouse Gases include direct emissions from construction mobile equipment, blasting operations, and land use changes. Emissions due to land use changes will be described separately in detail in **Section 7.3.3**.

Annual emissions for each source category were estimated for a typical construction year (i.e., 40 kilometres of road built in a year). Detailed calculations and supporting information/assumptions are provided in **Attachment B**.

Construction mobile equipment, including nonroad construction machinery and onroad construction vehicles (e.g., rock trucks), are estimated to generate approximately 18 kilotonnes of carbon dioxide equivalent per year and 81 kilotonnes of carbon dioxide equivalent for the entire construction phase.

Quarry and road blasting are expected to generate approximately 0.4 kilotonnes of carbon dioxide equivalent per year and 1.8 kilotonnes of carbon dioxide equivalent for the entire construction phase.

During a typical construction year, the project's annual Greenhouse Gas emissions, without land use changes, are estimated to be approximately 19 kilotonnes of carbon dioxide equivalent.

7.3.2 Potential Effects - Operation Phase

The operations and maintenance phase starts once construction activities are complete and lasts for the life of the Project. The operations and maintenance phase of the Project is considered to be permanent. This is based on the expected timeline for when major refurbishment of road components (e.g., bridges), is anticipated.

The direct Greenhouse Gas emissions during the operation phase of the Project include emissions from the future road traffic and land use change (i.e., emissions resulting from carbon loss in organic soils distributed over a 20-year period). Emissions due to land use changes are described separately in **Section 7.3.3**.

The road traffic on the proposed Community Access Road is anticipated to generate approximately 27 kilotonnes of carbon dioxide equivalent per year and a total of

401 kilotonnes of carbon dioxide equivalent for the entire 20-year assessment period. A 20-year assessment period is recommended in the Ontario Ministry of Transportation guideline for assessing air quality and Greenhouse Gases for Ontario transportation projects (MTO, 2020). The 20-year assessment period includes approximately 5 years of construction and 15 years of operation.

Greenhouse Gas emission estimates for the future road traffic were conservatively based on the projected peak traffic volume on the proposed Community Access Road in the 2046 year (AECOM, 2024). The actual Greenhouse Gas emissions each year are expected to vary depending on factors such as the actual traffic volume in the year. Improvements in vehicle emission controls and fuel efficiencies may also lead to variations in reported annual Greenhouse Gas emissions.

The Project’s operation is expected to reduce Greenhouse Gas emissions from existing air travel and winter road travel. As per the Strategic Assessment of Climate Change Technical Guide, the reduced Greenhouse Gas emissions due to the shift of travel forms can be accounted as avoided domestic emissions in calculating the Project’s net Greenhouse Gas Emissions.

The Project’s operation is expected to reduce approximately 0.02 kilotonnes of carbon dioxide equivalent per year and a total of 0.3 kilotonnes of carbon dioxide equivalent for the assessment period for Project operation. The low Greenhouse Gas emissions from the existing winter travel are attributed to low traffic volume and road accessibility.

Note the existing Greenhouse Gas emissions from winter road travel were estimated based on the current traffic volume and are assumed to remain constant for the no-build scenario. Vehicular travel on the existing road is anticipated to be negligible once the Community Access Road becomes operational and therefore the Greenhouse Gas emissions will be zero from the operation year of the Project.

The Project is anticipated to partially displace existing air travel with road vehicle traffic and result in Greenhouse Gas reductions due to avoided air travel. However, the Project's effects on existing air travel are not quantitatively assessed due to the limited information on existing flights and high uncertainties associated with estimates of avoided or increased air travel.

7.3.3 Potential Effects – Land Use Changes

Land use changes due to Project construction result in carbon stock changes and subsequent direct Greenhouse Gas emissions. The Project’s construction is expected to convert different land uses (e.g., forest land) into settlements (i.e., roads and bridges) and thus impact the carbon stocks and carbon sequestration capabilities (i.e., carbon sink) of land uses within the Construction Disturbance Area. The change of carbon stocks for land uses within the Project Disturbance Area is assessed as an emission to the atmosphere as carbon dioxide. In addition, half of the wood in forest land will be, stockpiled and burned, resulting in releases of Greenhouse gas emissions. The assessment of Greenhouse Gas emissions from land use changes is detailed in **Appendix B4** and below provides a summary of the associated effects of Greenhouse Gas.

As presented in **Table 7-3**, the land use changes resulting from the road construction are expected to generate approximately 277 kilotonnes of carbon dioxide equivalent per construction year and 17 kilotonnes of carbon dioxide equivalent per operation year due to the delayed, gradual loss of carbon stock in soil and subsequent carbon dioxide emissions. During the 20-year project assessment period, the land use changes due to road construction resulted in total Greenhouse Gas emissions of 1,485 kilotonnes of carbon dioxide equivalent, as shown in **Table 7-1** and **Table 7-3**.

Table 7-4 presents the carbon stock changes in carbon pools of land uses and subsequent total Greenhouse Gas emissions. The estimated losses of carbon storage in biomass, dead organic matter, and soil organic matter for the entire project period are 171 kilotonnes, 136 kilotonnes, and 94 kilotonnes, respectively. Following the Strategic Assessment of Climate Change Technical Guide, the losses of carbon stocks in carbon pools are treated as carbon dioxide emissions to the atmosphere, which resulted in total Greenhouse Gas emissions of 1,485 kilotonnes from land use change.

Table 7-4: Carbon Stock Change and Greenhouse Gas Emissions from Land Use Change

Carbon Pool	Unit	Construction and Operation
Living Biomass	tonnes C	- 171,161
Dead Organic Matter	tonnes C	- 135,948
Soil Organic Matter	tonnes C	- 93,773
Total CO2 (except wood burning)	tonnes CO2	1,469,902
Non-CO2 from Wood Burning	tonnes CO2	15,428
Total Emissions from Land Use Change	tonnes CO2	1,485,331

The annual changes of carbon stocks in carbon pools for each land use (i.e., forest land and wetlands) and subsequent carbon dioxide emissions are also estimated and detailed in summary tables in **Attachment B**. During a typical construction year, a total loss of 75 kilotonnes of carbon stocks are estimated from all carbon pools in both forest land and wetlands.

The land use changes due to Project construction also have potential effects on carbon sinks. As discussed in **Section 5.1.3**, the existing land uses within the Construction

Disturbance Area mainly include forest land and wetlands. The carbon sink of forest land is assumed zero as the forests within the Construction Disturbance Area have either reached or surpassed the age for the maximum carrying capacity. Wetlands within the Construction Disturbance Area are dominated by peatland classes such as Fen (33.4%) and Swamp (63.8%) which act as sources of carbon emissions rather than carbon sinks. Overall, the existing land uses within the Construction Disturbance Area are estimated to release 1,646 tonnes of carbon annually.

The project construction will change the existing land uses into settlements (i.e., road and bridges) which are assumed to have zero carbon sinks after the construction. Following the method for estimating carbon sink impact in the Strategic Assessment of Climate Change technical guide (Equation 5), the estimated carbon sink impact for the Project is an estimated lost potential to release about 165 kilotonnes of carbon into the atmosphere. From the carbon sink analysis perspective, the Project has positive impacts on carbon sinks as the disturbed land acted as a source of carbon emissions. However, the land use changes due to the Project's construction will cause a loss of carbon storage in carbon pools and result in subsequent Greenhouse Gas emissions to the atmosphere.

7.4 Mitigation – Construction

Best management practices that are typically employed during construction activity can be implemented to help reduce overall project impacts on the surrounding environment during periods of construction.

The Ontario Ministry of Transportation identifies potential mitigation measures that may be taken, if feasible, for transportation-related projects in the Ontario Ministry of Transportation *Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions for Provincial Transportation projects* (Ontario Ministry of Transportation, 2020). However, the public traffic on the proposed Community Access Road and resulting Greenhouse Gas emissions are beyond the control of the Project. The future improvement in emission control technology for vehicles is expected to reduce the potential effects of road operation.

It is recommended to develop a construction management plan after the final design and before construction begins. This plan should detail the selected mitigation measures with respect to Greenhouse Gas emissions, allowing for a more refined and efficient approach to controls, costing, and project scheduling. The specifics of the mitigation measures and best management practices will be clearer during the detailed design and construction submittal process. **Table 7-5** provides examples of these practices and measures. It is suggested that mitigation measures incorporate Ontario Ministry of Transportation recommendations as well as construction industry best practices. Where feasible, the following mitigation measures are suggested to help reduce overall residual effects.

Additionally, a construction monitoring plan should be created during the final design and construction submittal periods to ensure best management practices are being followed.

Table 7-5: Suggested Mitigation Measures for Construction

Mitigation Measure	Potential Reduction
■ **Development of a Construction Best Management Practice Plan prior to construction. Examples of best management practices that may be included are:** ○ **Implement anti-idling policies or procedures to reduce total vehicle idling times** ○ **Strategic haul planning to reduce the overall number of haul trips required for aggregate material demands. Consider sourcing material from the closest available material transfer points** ○ **Maintain equipment as per manufacturer specifications** ○ **Use fuel-efficient vehicles with low emissions**	■ Products of fuel combustion including Greenhouse Gas emissions
■ **Development of a construction monitoring plan. This plan may be used to validate that best management practices are being implemented and that mitigation actions taken are effective. Where mitigation is not providing a reduction to overall impacts, mitigation options should be re-assessed.**	■ Products of fuel combustion including Greenhouse Gas emissions

7.5 Mitigation – Operation

Unlike the construction phase of the project mitigation measures to reduce Greenhouse Gas emissions are less in control of the project owner and more directly related to the road user and regional governing body. There are a number of provincial and federal actions in place or proposed to reduce vehicle Greenhouse Gas emissions. The following regulations are outlined in the MTO Air Quality and Greenhouse Gas Guide (MTO, 2020), all of which aim to reduce vehicle related Greenhouse Gas emissions:

- The federal Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations (SOR/2010-201)
- Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations (SOR/2014-207)
- Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations (SOR/2013-24)

- Regulations Amending the Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations and Other Regulations Made Under the Canadian Environmental Protection Act, 1999 (SOR/2018-98)

It is expected that as time progresses and more fuel-efficient vehicles are used on the roadway, annual Greenhouse Gas emissions on a per-vehicle basis will decrease over the lifespan of the project during the operational phase.

7.6 Mitigation – Land Use Changes

Carbon loss due to land use change (e.g., converting forests into roads) and subsequent effects on Greenhouse Gas changes are inevitable. Mitigation measures can be taken to preserve existing carbon stocks as much as possible but can not fully eliminate the residual effect.

Where possible / feasible, considerations may be taken during route planning to avoid high-carbon stock areas such as dense forests. Although reforestation and afforestation of the land areas beyond the Right-of-Way are not planned, natural growth of vegetation (e.g., grasses) are anticipated after the construction.

Preserving and reusing the topsoil removed during construction helps to preserve the existing soil structure and thus reduces the loss of carbon in soils. Using advanced construction techniques and processes also reduces soil carbon loss. For instance, the Project will be using a “floating road” technique for road construction on wetlands which reduces the need for extensive soil excavation and disturbance.

7.7 Characterization of Residual Effects

An assessment of significance was completed for the construction and operating phases of the Project. Greenhouse Gas emission sources and annual emissions differ during each phase.

It should be noted that the duration of the Project’s construction phase is much less than that of the operating phase. Therefore, emissions associated with construction activity will be short-lived considering the entire project lifespan, however, effects of construction-related Greenhouse Gas emissions will remain. Residual effects for the construction and operational phases were characterized based on the criteria defined in **Section 4.4.2.3.1**.

Greenhouse Gas effects from land use changes associated with the Project have also been characterized. The land use changes occur during the construction phase include cascading effects on the operation phase (i.e., delayed and gradual loss of soil carbon stock). Therefore, the Greenhouse Gas effects associated with land use changes are characterized in **Section 7.7.3**, separated from residual effect characterization for the construction and operation phase.

In general, the determination of significance was as follows:

- **Significant:** Residual effects were generally considered as significant if the residual effect was assessed as a medium or high magnitude with irreversible effects.
- **Not Significant:** Residual effects were generally considered not Significant if they demonstrate any other combination.

7.7.1 Residual Effect Characterization – Construction

7.7.1.1 Magnitude

To evaluate the magnitude of the Project's emissions from construction, the maximum annual construction emissions were compared to Ontario's total Greenhouse Gas emissions and Ontario's road transportation sector total Greenhouse Gas emissions in 2022 (most current available data) from the *National Inventory Report* (Environment and Climate Change Canada, 2024). Note the magnitude of the Project's Greenhouse Gas emissions are assessed based on Ontario's Road Transportation sector total and the comparison to Ontario's total for all sectors is provided for additional context.

Table 7-6 provided a summary of the annual emissions from construction, without land use changes. Project phase emission totals are compared to the provincial totals. Provincial totals (i.e., Ontario's total and Ontario's Road Transportation sector total) excluded the emissions associated with land use changes. Further reasoning on the exclusion of land use change from this comparison is provided in **Section 7.7.2**.

A summary of Greenhouse Gas emissions from construction is provided in **Table 7-6**. Construction emissions account for approximately 0.05% of Ontario's road transportation sector total and 0.01% of Ontario's total.

Table 7-6: Assessment of Annual Greenhouse Gases from Construction

Annual Greenhouse Gases from Construction [1,2] (kt CO_2 eq)	Ontario Road Transportation Total Emissions in 2022 (kt CO_2 eq)	Percentage of Ontario's Road Transportation Total Emissions (%)	Ontario's Total Emissions in 2022 (kt CO_2 eq)	Percentage of Ontario's Total Emissions (%)
19	40,907	0.05%	156,994	0.01%

Notes:

1. *Project Direct Greenhouse Gas emissions from Construction Phase do not include Greenhouse Gas emissions from land use changes. The Project Greenhouse Gas emissions are compared against*

Ontario's Road Transportation sector total and Ontario's total Greenhouse Gas emissions (for all sectors) without land use changes.

2. *The maximum Annual Greenhouse Gas emissions are estimated based on construction activities and equipment usage in a typical construction year (i.e., 40 km road distance built in a year).*

As shown in **Table 7-6**, the Project's annual construction emissions, excluding land use changes, are below 0.1% of Ontario's road transportation total Greenhouse Gas emissions. Per the magnitude definition in **Table 4-11**, Greenhouse Gas emissions from the construction phase are considered to be of a negligible magnitude.

7.7.1.2 Duration and Frequency

The duration of residual effects of Greenhouse Gas emissions on climate change is considered long-term mainly due to the long atmospheric lifetime of Greenhouse Gases and long-lasting effects on the climate. For instance, the prevalent Greenhouse Gas-Carbon Dioxide can stay in the atmosphere for up to thousands of years.

Regarding the residual effects of Greenhouse Gas emissions from construction, the frequency is directly linked to the ongoing nature of construction activities that produce these emissions, ultimately leading to the anticipated effects. During the assessment of annual Greenhouse Gas emissions, emission-generating activities were assumed to occur at a continuous frequency throughout the construction phase.

7.7.1.3 Reversibility

Through the construction phase of the Project, Greenhouse Gas emissions will be emitted through the use of fuel-combusting equipment. The potential impact on climate change from these Greenhouse Gas emissions is considered to be irreversible on a human lifespan timescale.

7.7.1.4 Likelihood and Prediction Confidence

There is some likelihood / uncertainty in estimating Greenhouse Gas emissions from construction due to the conservative methods used. As emission estimates for construction were based on the worst-case equipment usage, the predicted effects are unlikely to be surpassed, providing an upper limit for the potential residual effects. During actual construction phases, equipment usage and type may differ from what was considered in this assessment and the overall Greenhouse Gas emissions may change from the estimations presented. As such, the likelihood of Greenhouse Gas residual effects was considered to be probable and the prediction confidence was ranked as low to moderate for construction scenarios.

7.7.2 Residual Effect Characterization – Operation

7.7.2.1 Magnitude

To evaluate the magnitude of the Project's emissions from operation, the maximum operation annual emissions were compared to Ontario's total Greenhouse Gas emissions and Ontario's road transportation sector total Greenhouse Gas emissions in 2022 (most current available data) from the *National Inventory Report* (Environment and Climate Change Canada, 2024). Note the magnitude of the Project's Greenhouse Gas emissions are assessed based on Ontario's Road Transportation sector total and the comparison to Ontario's total for all sectors is provided for additional context.

Table 7-7 provided a summary of the annual emissions from operation, without accounting for the cascading effects of the land use changes from construction (i.e., delayed, gradual loss of soil carbon stock and resulting Greenhouse Gas emissions). Project phase emission totals are compared to the provincial totals. Provincial totals (i.e., Ontario's total and Ontario's Road Transportation sector total) excluded the emissions associated with land use changes. Further reasoning on the exclusion of land use change from this comparison is provided in **Section 7.7.2**.

A summary of Greenhouse Gas emissions from the operation phase is provided in **Table 7-7**. During the operation phase, the Project's annual Greenhouse Gases account for approximately 0.07% of Ontario's road transportation total emissions and 0.02% of Ontario's Total Greenhouse Gas emissions.

Table 7-7: Assessment of Annual Greenhouse Gases from Operation

Annual Greenhouse Gases from Operation [1,2] (kt CO_2 eq)	Ontario Road Transportation Total Greenhouse Gases in 2022 (kt CO_2 eq)	Percentage of Ontario's Road Transportation Total Greenhouse Gases (%)	Ontario Total Greenhouse Gases in 2022 (kt CO_2 eq)	Percentage of Ontario's Total Greenhouse Gases (%)
27	40,907	0.07%	156,994	0.02%

Notes:

1. *Project Direct Greenhouse Gas emissions from Operation Phase does not include Greenhouse Gas emissions from land use changes. The Project Greenhouse Gas emissions are compared against Ontario's Road Transportation sector total Ontario's Total (for all sectors) without land use changes.*
2. *The annual Greenhouse Gas emissions for the Operation Phase are conservatively estimated based on the traffic volume in 2046 and assumed to remain constant throughout the operation period.*

As shown in **Table 7-7**, the Project's annual operation emissions, excluding land use changes, are below 0.1% of Ontario's road transportation total Greenhouse Gas emissions. Per the magnitude definition in **Table 4-11**, Greenhouse Gas emissions from the operation phase are considered to be of a negligible magnitude.

7.7.2.2 Duration and Frequency

The duration of residual effects of Greenhouse Gas emissions from the operation is considered long-term given the long atmospheric lifetime of Greenhouse Gases and long-lasting effects on the climate. Through the operation phase of the Project, Greenhouse Gas emissions are expected to be continuously emitted from vehicular traffic during the lifetime of the proposed road.

7.7.2.3 Reversibility

Through the operation phase of the Project, Greenhouse Gas emissions will be emitted through the use of fuel-combusting equipment. The potential impact on climate change from these Greenhouse Gas emissions is considered to be irreversible on a human lifespan timescale.

7.7.2.4 Likelihood and Prediction Confidence

When assessing the operating scenario of the Project, more certainty was present for the likelihood of residual effects due to the reduced number of variables to consider in emission calculations as well as a more well-defined future traffic loading projection; however, traffic loading estimates still carry uncertainty. Therefore, the likelihood of Greenhouse Gas residual effects from operation is considered probable and the prediction confidence is considered moderate.

7.7.3 Residual Effect Characterization – Land Use Changes

7.7.3.1 Magnitude

To provide a better context of Greenhouse Gas emissions from land use changes, the maximum annual emissions from land use changes, during the construction and operation phases are compared with the Ontario’s Total Greenhouse Gas emissions in 2022 (most current available data) from the National Inventory Report (Environment and Climate Change Canada, 2024).

Note Ontario’s Total Greenhouse Gas emissions presented in the Canada’s National Inventory Report exclude emissions from land use changes. The Canadian and Ontario Greenhouse Gas emissions from land use changes are reported in the National Inventory Report under the emission category of Land Use, Land-Use Change and Forestry (LULUCF); however, these emissions are excluded from the provincial and national total Greenhouse Gas emissions in the *National Inventory Report*.

The National Inventory Report only accounts for land use conversions from managed forest and unmanaged grassland to settlements. In the context of national Greenhouse Gas emissions inventories, managed forest land refers to areas where human interventions influence ecological processes, such as logging, forest management practices, and restoration activities. However, unmanaged forests are those that are left to natural processes without direct human intervention. The determination of managed and unmanaged forests is described in Section A3.5.2.5 of the *National Inventory Report*. Unmanaged forests are not considered and Greenhouse Gas emissions resulting from wetlands converted to settlements are also not accounted for in the *National Inventory Report*. Wetlands constitute a significant portion of direct Greenhouse Gas emissions from land use changes for the Project. As the majority of the land within the Project's construction disturbance area falls within unmanaged forest as well as wetlands, a direct comparison of Greenhouse Gas emissions under the emission category of Land Use, Land-Use Change and Forestry is not appropriate.

In addition to the above discrepancies, Greenhouse Gas emissions from land use changes in the National Inventory Report are estimated based on different approaches and methods (e.g., the Intergovernmental Panel on Climate Change Tier 3 method - Carbon Budget Model is used for most land use sectors and carbon dioxide emissions removals due to forest growth are accounted) as compared to this project which used the Tier 2 method following the Strategic Assessment of Climate Change Technical Guide.

Despite the above-mentioned, the maximum annual Greenhouse Gas emissions from land use changes, during construction and operation phases, are compared against the Ontario total to provide a context on the magnitude of the Greenhouse Gas effect associated with land use changes. As shown in **Table 7-8**, the Project's maximum annual Greenhouse Gas emissions from land use changes account for approximately 0.18% of Ontario's total. Per the magnitude definition described in **Table 4-11**, the magnitude of Greenhouse Gas emissions from land use changes is considered low (i.e., from 0.1% to 0.5% of Ontario's Total).

Table 7-8: Assessment of Annual Greenhouse Gases with Land Use Changes

Project Phase	Maximum Annual Greenhouse Gases from Land Use Changes (kt CO_2 eq)	Ontario Total Greenhouse Gases in 2022[1] (kt CO_2 eq)	Percentage of Ontario's Total Greenhouse Gases (%)
Construction and Operation	277	156,994	0.18%

Notes:

1. *Ontario's Total Greenhouse Gas emissions do not include emissions associated with land use change.*

7.7.3.2 Duration and Frequency

Similar to construction and operation, the duration of Greenhouse Gas residual effects from land use changes is considered long-term and the frequency is considered as continuous.

7.7.3.3 Reversibility

During construction, the land within the disturbance area will be permanently transformed from its current uses (such as forests or wetlands) into roads and related infrastructure (like bridges). Consequently, these land use changes and the associated Greenhouse Gas effects are deemed irreversible.

7.7.3.4 Likelihood and Prediction Confidence

Baseline data relied on for land use change calculations was informed by site-specific data collection as well as estimations from literature reviews and recognized study methods. Due to the uncertainty associated with using surrogate data to inform baseline conditions, particularly when considering land use changes of a project with a large project footprint, the likelihood associated with land use change was assessed as probable and the prediction confidence is assessed as low.

7.8 Summary of the Effects Assessment

Table 7-9 provides a summary of residual effects characteristics for both construction and operating phases of the project. Characteristics of residual effects and significance of Greenhouse Gases from land use changes were also assessed.

For determining the emission magnitude, the construction and operation emissions are compared to Ontario's sectoral-specific emission totals (Ontario's road transportation emissions). The project's emissions from land use changes are compared to regional emissions (Ontario's total emissions from all sectors).

Despite the potential implementation of mitigation measures, the road construction and subsequent vehicle traffic on the road will continue to produce Greenhouse Gases. Although improvement in future emission control technologies for construction mobile equipment and vehicles may reduce total Greenhouse Gas emissions, the residual emissions from the Project's construction and operation are unavoidable. When comparing to provincial transportation sector greenhouse gas totals, the magnitude of both construction and operation emissions are assessed as negligible and the significance of residual effects is assessed as not significant.

The project's construction will lead to changes in land uses (e.g., deforestation) which release carbons stored in vegetation and soil. Although the project is planned to use improved construction techniques (e.g., floating road) to minimize disturbances on wetlands, the residual effects of Greenhouse Gases from land use changes can not be fully eliminated. The project's emissions from land use changes are assessed as low magnitude when compared to Ontario's total Greenhouse Gases and therefore the significance of emissions from land use changes are determined as not significant.

Over the operational life of the road, traffic emissions are expected to contribute a large percentage to the Project's total emissions. Mitigation measures such as using fuel-efficient vehicles can reduce emissions but not entirely eliminate the residual effects.

Table 7-9: Characterization of Greenhouse Gases Residual Effects

Discipline / Valued Component	Predicted Residual Effect	Context	Direct / Indirect	Direction	Magnitude	Geographic Extent [1]	Duration	Frequency	Reversibility	Likelihood / Probability of Occurrence	Significance	Prediction Confidence
Greenhouse Gases	Greenhouse Gas Emissions - Construction Phase	Change in Greenhouse Gas Emissions	Direct	Negative	Negligible	Sectoral	Long Term	Continuous	Irreversible	Probable	Not Significant	Low to Moderate
	Greenhouse Gas Emissions - Operation Phase	Change in Greenhouse Gas Emissions	Direct	Negative	Negligible	Sectoral	Long Term	Continuous	Irreversible	Probable	Not Significant	Moderate
	Greenhouse Gas Emissions - Land Use Change	Change in Greenhouse Gas Emissions	Direct	Negative	Low	Regional	Long Term	Continuous	Irreversible	Probable	Not Significant	Low

Notes:

[1] Regional refers to the province of Ontario's total Greenhouse Gas emissions. Sectoral refers to the province of Ontario's transportation sector emissions.

7.9 Indirect Effects – Construction and Operation

Indirect effects may occur when a change to one valued component resulting from a Project activity causes a change to another valued component.

7.9.1 Indirect Effects from Changes In Other Disciplines

Table 7-10 provides some examples of Indirect effects on Greenhouse Gases as a result of changes in other disciplines.

Table 7-10: Examples of Indirect effects on Greenhouse Gases as a result of changes in other disciplines

Other Disciplines	Examples Of Changes in Other Disciplines and Indirect Effects on Greenhouse Gases
Physiology, Terrain, and Soil	■ Changes in terrain and soil may affect carbon stock and sequestration. For instance, steeper slopes often experience more erosion, leading to the loss of surface soil and organic matter, thus reducing carbon stocks. Changes in soil texture, structure, and organic matter may affect the soil's ability to hold carbon and sequestrate CO2 from the atmosphere.
Surface water and Groundwater	■ Changes in surface water and groundwater can influence soil carbon stocks and sequestration capabilities and thus impact Greenhouse Gas emissions. For instance, surface water and groundwater can influence soil moisture content and oxygen availability, thus affecting organic matter decomposition rates and carbon storage.
Vegetation	■ Increases or decreases in quantity, or changes to vegetation type (e.g., forest and wetlands) may affect the quantity of carbon storage and carbon sequestration capabilities, which can result in changes to Greenhouse Gas emissions and capture.
Social	■ Changes in transportation mode (vehicle type) and volume (traffic loading) will result in either an increase or decrease in community Greenhouse Gas emissions. ■ Changes in population and demographics can result in either an increase or decrease in fuel usage for transportation, heating, and community services. This change in fuel usage may result in either an increase or decrease in community Greenhouse Gas emissions.
Land and Resource Use	■ Changes in land use compatibility, parks and protected areas, local industries and linear infrastructure may affect emission

Other Disciplines	Examples Of Changes in Other Disciplines and Indirect Effects on Greenhouse Gases
	sources and quantities that may result in either an increase or decrease in community Greenhouse Gas emissions. ■ Changes to linear infrastructure may result in changes in fuel type and usage quantities that may result in either an increase or decrease in community Greenhouse Gas emissions. ■ Changes in recreation and tourism quantities can affect traffic loading and energy consumption within the community and may result in either an increase or decrease in community Greenhouse Gas emissions.

7.9.2 Indirect Effects of Greenhouse Gases on Other Disciplines

Greenhouse Gas emissions can have potential, indirect impacts on other disciplines, including Climate Change Adaptation and Economy. Examples of Greenhouse Gas indirect impacts on other disciplines are provided in **Table 7-11**.

Table 7-11 : Examples of Greenhouse Gas Indirect Impacts on Other Disciplines

Other Disciplines	Examples Of Greenhouse Gas Indirect Impacts on Other Disciplines
Climate Change	■ Changes in Greenhouse Gas emissions indirectly contribute to climate change through their influence on various environmental, atmospheric, and ecological processes, which necessitates a broad range of climate change adaptation strategies to mitigate the adverse effects. Adaptation refers to adjustments in systems, practices, and policies to minimize harm or exploit beneficial opportunities associated with climate change. Examples of climate change adaptation measures include crop diversification, flood management, and climate-resilient building codes.
Economy	■ Changes in Greenhouse Gas emissions can have indirect impacts on the economy, which range from increased costs associated with natural disasters and health care to potential benefits from new market opportunities in green technologies. Addressing these challenges requires coordinated efforts across sectors and often significant investment in adaptation and mitigation measures. ■ Changes in Greenhouse Gas emissions can also have potential impacts on carbon pricing, a market-based mechanism aimed at reducing Greenhouse Gas emissions by assigning a cost to emitting Greenhouse Gases. This can take the form of carbon taxes, cap-and-trade systems, or emissions trading schemes

7.10 Decommissioning Phase

There are currently no plans to decommission the Project as there is no expected/known end date for its need. Therefore, future suspension, decommissioning, and eventual abandonment are not considered in this report. Should a future need to decommission or abandon the road arise, a separate study will be required to assess those effects due to the change in environment over time around the roadway.

8 Cumulative Effects of the Project

The *Canadian Environmental Assessment Act, 2012* (Government of Canada, 2019) requires that each environmental assessment of a project take into account any cumulative environmental effects that are likely to result from the project in combination with the environmental effects of other physical activities that have been or will be carried out.

This section presents the assessment of potential cumulative effects completed as part of the Project. The effects of past and present activities on the Study Area and Valued Components identified for the Project were assessed and results are described in the following sections.

The cumulative effects assessment builds on the results of the effects assessment described in **Section 7** and will consider the incremental changes that are predicted to have a likely residual adverse effect on a Valued Component.

8.1 Cumulative Effects Assessment

Unlike other disciplines (vegetation, and surface water) cumulative effects of Greenhouse Gas emissions from this project as well as both existing and future project developments within the study area must be looked at with a different lens. In the context of Greenhouse Gas emissions, impacts to climate change are not bounded by geographic region. Cumulative effects should not be assessed on a local scale and be specifically limited to existing or future projects within a defined spatial boundary (i.e., within 5 km, 10 km, and 50 km from the project).

A project's Greenhouse Gas emissions have the potential to influence climate change on a global scale. Cumulative effects may be assessed through a lens of contribution to provincial total emissions and their impact on provincial or country specific emission reduction targets/commitments. A climate change specific study may comment further on potential impacts to climate change that may be influenced by Greenhouse Gas emissions resulting from this project.

If this project is completed, Greenhouse Gas emissions will be unavoidable and will contribute to Ontario's overall total emissions. As discussed in **Section 7.7,** Greenhouse Gas emissions resulting from this project were considered not significant due to their assessed magnitude which was based on their overall percentage of Ontario's transportation sectoral and provincial emissions. Although Greenhouse Gas emissions were assessed as not significant, emissions resulting from this project will negatively impact provincial and federal emission reduction targets.

9 Monitoring Programs and Future Commitments

A monitoring program verifies the accuracy of the effects assessment and evaluates the effectiveness of mitigation measures. Monitoring programs also include future commitments related to mitigating residual effects.

9.1 Pre-Construction Monitoring Program

Pre-construction monitoring is not applicable to Greenhouse Gases emissions. Calculations were competed to inform baseline conditions of Greenhouse Gas emissions.

9.2 Construction Monitoring Programs

As outlined in Volume 1 – Air Quality, a construction monitoring program is recommended as a mechanism to help mitigate and / or identify potential conditions that may lead to air quality impacts from construction related activities. Air quality impacts can include Greenhouse Gas emissions. Although not specifically an air quality concern in the context of human health, Greenhouse Gas emissions resulting from construction activities may also be reduced if construction best management practices are followed. Where feasible a construction activity monitoring program may be implemented to verify that construction best management practices are being applied or identify where additional efforts / mitigation techniques may be necessary to help reduce greenhouse gas emissions.

9.3 Operations Monitoring Program

No monitoring programs have been identified with respect to Greenhouse Gas emissions for the operation phase of this project at this time.

9.4 Future Commitments

No future commitments have been identified with respect to Greenhouse Gas emissions at this time.

10 Summary and Recommendations

Table 10-1: Potential Effects Summary and Recommendations

ID	Valued Component	Environmental Concern and Potential Effect	Project Phase	Concerned Agencies	Mitigation, Protection, Monitoring, and Study Commitments to be carried forward to Detail Design	Mitigation, Protection, Monitoring, and Study Commitments to be carried forward to Construction / Operation
	Greenhouse Gases	Increase in Greenhouse Gas Emissions due to Project activities	Construction	Environment and Climate Change Canada; Ministry of Environment, Conservation and Parks	N/A	Development of construction Best Management Practice Plan which will provide a summary of recommended best practices that may lead to reductions in Greenhouse Gas emissions. Some examples of best practices that may be included are as follows: ■ Reduce vehicle idling ■ Strategic haul planning to reduce haul trips for aggregates ■ Use fuel-efficient vehicles and maintain equipment regularly ■ Preserve and reuse topsoil to reduce carbon loss Development of a construction monitoring plan to validate that best management practices are being performed.
	Greenhouse Gases	Increase in Greenhouse Gas Emissions due to Project activities	Operation	Environment and Climate Change Canada; Ministry of Environment, Conservation and Parks	N/A	■ N/A

Notes:

N/A= Not Applicable

11 References

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12 Attachment A – Draft Study Plan, Workplan and Regulator Comments

MARTEN FALLS FIRST NATION
ALL SEASON COMMUNITY ACCESS ROAD

FINAL

Atmospheric Environment and Greenhouse Gases (GHG) Study Plan

June 2021

Distribution List

# Hard Copies	PDF Required	Association / Company Name
	✓	Marten Falls First Nation
	✓	AECOM Canada Ltd.

Revision History

Rev #	Date	Revision Description
Draft	*May* 2020	Submitted "\DRAFT Study Plan – Atmospheric Environment" to the Agency.
Final	May 2021	Revised to address federal and provincial agency comments.

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Table of Contents

List of Figures

List of Tables

Appendices

Acronyms

Agency, the ... Impact Assessment Agency of Canada
CAR .... Community Access Road
CAAQS .... Canadian Ambient Air Quality Standards
BTEX .... Benzene, Toluene, Ethylbenzene, and Xylene

CO .... Carbon Monoxide
DPM .... Diesel Particulate Matter
EA.................. Environmental Assessment
ECCC .... Environment and Climate Change Canada
GHG .... Greenhouse Gases
IA .... Impact Assessment
IAA................. Impact Assessment Act
IAAC .... Impact Assessment Agency of Canada
IS .... Impact Statement
km.................. kilometre
LSA................ Local Study Area
MECP .... Ontario Ministry of the Environment, Conservation and Parks
MFFN .... Marten Falls First Nation
MOVES .... Motor Vehicle Emission Simulator
NAPS............. National Air Pollution Surveillance Program
NIR .... National Inventory Report
NOx .... Nitrogen Oxides
O3.................. Ozone
PDA .... Project Development Area
PM .... Particulate Matter
ROW.............. Right of Way
RSA .... Regional Study Area
SAR .... Species at Risk
SO2 .... Sulphur Dioxide
TISG .... Tailored Impact Statement Guidelines
ToR................ Terms of Reference
TSP .... Total Suspended Particulate Matter
US EPA .... United Stated Environmental Protection Agency
VC .... Valued Component
VOC............... Volatile Organic Compounds
WRF .... Weather Research and Forecasting model

1. Introduction

The Proponent of the Community Access Road (CAR or the Project) is Marten Falls First Nation (MFFN), a remote First Nation community in northern Ontario located at the junction of the Albany and Ogoki rivers, approximately 430 kilometres (km) from Thunder Bay, Ontario. The MFFN community is proposing an all-season Community Access Road that will connect the MFFN community to Ontario's provincial highway network (Highway 643) to the south via the existing Painter Lake Road. MFFN, as the Proponent of the Project, has formed a MFFN CAR Project Team that includes MFFN CAR Community Member Advisors and MFFN CAR Project Consultants who act with input, guidance and direction from the MFFN Chief and Council.

This document outlines the study plan for the Atmospheric Environment and Greenhouse Gases (GHGs) discipline to support a co-ordinated Impact Assessment (IA) required for Project review by the Impact Assessment Agency of Canada (the Agency) under the federal *Impact Assessment Act* (IAA) and Environmental Assessment (EA) required for Project review by the Ontario Ministry of the Environment, Conservation and Parks (MECP) under the Ontario *Environmental Assessment Act*.

1.1 Federal and Provincial Terminology

The study plans have been prepared using federal terminology, however, the respective provincial terminology has been provided in **Table 1-1** for reference. The terms can be used interchangeably.

Table 1-1: Equivalent Federal and Provincial Terms

Provincial Term	Federal Term
Criteria	Valued Component
Impact Management Measure	Mitigation Measure
Net Effects	Residual Effects
Record of Consultation	Record of Engagement

1.2 Project Study Plans

This Study Plan is one of a group of study plans created for the Project. **Table 1-2** includes the study plans for each environmental[1] discipline currently planned for the Project and the valued components (VCs) covered by the study plans where applicable.

Table 1-2: Project Study Plans and Valued Components

Environmental Discipline	Study Plan Name	Valued Component(s)
Aboriginal and Treaty Rights and Interests	■ Aboriginal and Treaty Rights and Interests Study Plan	■ Indigenous Current Use of Lands and Resources for Traditional Purposes ■ Cultural Continuity (ability to practice and transmit cultural traditions)
Atmospheric Environment	■ Atmospheric Environment and Greenhouse Gases Study Plan	■ Air Quality ■ Greenhouse Gas Emissions
Climate Change	■ Climate Adaptation and Resiliency Study Plan	■ Climate Change
Acoustic and Vibration Environment	■ Acoustic and Vibration Environment Study Plan	■ Noise ■ Vibration
Physiography, Geology, Terrain and Soils	■ Physiography, Terrain and Soils Study Plan	■ Physiography, Terrain and Soils
Surface Water	■ Surface Water Study Plan	■ Surface Water
Groundwater and Geochemistry	■ Groundwater and Geochemistry Study Plan	■ Groundwater
Vegetation	■ Vegetation Study Plan	■ Wetland and Riparian Ecosystems ■ Upland Ecosystems ■ Designated Areas (Areas of Natural and Scientific Interest, Environmentally Significant Areas, Significant Woodlands, Critical Landform / Vegetation Associations) ■ Traditional Use Plants and SAR Plant Populations (including species with special conservation status or rarity in the province)
	■ Peatlands Study Plan	■ Peatland Ecosystems (bogs and fens)

1. *The use of the term environment in this document is inclusive of the components of the environment that are included in the Ontario Environmental Assessment Act definition, which includes a general description of the social, cultural, built and natural environments.*

Environmental Discipline	Study Plan Name	Valued Component(s)
Wildlife	■ Wildlife Study Plan	■ Bats (including SAR-bats such as: Little Brown Myotis [*Myotis lucifugus*], Northern Myotis [*Myotis septentrionalis*] and Tricolored Bat [*Perimyotis subflavus*]) ■ Fur Bearers (proxy VC[2] American Marten [*Martes americana*], Beaver [*Castor canadensis*] and Wolverine [*Gulo gulo*]) ■ Amphibians and Reptiles ■ Pollinating Insects
	■ Ungulates (Moose and Caribou) Study Plan	■ Moose (*Alces alces*) ■ Caribou, boreal population (*Rangifer tarandus*)
	■ Bird Study Plan	■ Forest Birds (proxy VC of Red-eyed Vireo [*Vireo olivaceus*] for deciduous forest, Ovenbird [*Seirus aurocapilla*] for mixedwood forest, Dark-eyed Junco [*Junco hyemalis*] for coniferous forest and disturbed forest ■ Raptors (proxy VC of Osprey [*Pandion haliaetus*] for diurnal raptors and Boreal Owl [*Aegolius funereus*] for nocturnal raptors ■ Shorebirds (proxy VC of Wilson's Snipe [*Gallingo delicata*]) ■ Waterfowl (proxy VC of Mallard [*Anas* platyrhynchos]) ■ Bog / Fen Birds and Other Wetland Birds (proxy VC of Palm Warbler [*Setophaga palmarum*] for bogs, Common Yellowthroat [*Geothlypis trichas*] for fens; and Northern Waterthrush [*Parkesia noveboracensis*] for swamps . ■ SAR birds: Canada Warbler (*Cardellina canadensis*), Chimney Swift (*Chaetura pelagica*), Common Nighthawk (*Chordeiles minor*), Eastern Whip-poor-will (*Antrostomus vociferous*), Eastern Wood-Pewee (*Contopus virens*), Evening Grosbeak (*Coccothraustes vespertinus*), Olive-sided Flycatcher (*Contopus cooperi*), Bald Eagle (*Haliaeetus leucocephalus)*, Peregrine Falcon (*Falco peregrinus*), Short-eared Owl (*Asio flammeus)*, Bank Swallow (*Riparia riparia*), Barn Swallow (*Hirundo rustica*), Black Tern (*Childonias niger*), Rusty Blackbird (*Euphagus carolinus*), Yellow Rail (*Coturnicops noveboracensis*)
Fish and Fish Habitat	■ Fish and Fish Habitat Study Plan	■ Lake Sturgeon (*Acipenser fulvescens*) ■ Walleye (*Sander vitreus*) ■ Brook Trout (*Salvelinus fontinalis*) ■ Northern Pike (*Esox lucius*) ■ Lake Whitefish (*Coregonus clupeaformis*) ■ Chain Pickerel (*Esox niger*) ■ Yellow Perch (*Perca flavescens*) ■ Cisco (*Coregonus artedii*)

2. A proxy VC is used when looking at the effects of one species that represents many others.

Environmental Discipline	Study Plan Name	Valued Component(s)
		■ Burbot (*Lota lota*) ■ Longnose Sucker (*Catostomus catostomus*) ■ White Sucker (*Catostomus commersonii*) ■ Forage / Prey Species (including species such as Lake Chub [*Couesius plumbeus*]) ■ Lower Trophic Organisms (e.g., benthic invertebrates)
Social	■ Social Study Plan	■ Housing and Accommodation ■ Community Service and Infrastructure ■ Transportation ■ Community Well-being ■ Populations and Demographics
Economy	■ Economic Study Plan	■ Regional Economy ■ Labour Force and Employment ■ Government Finances
Land and Resource Use	■ Land and Resource Use Study Plan	■ Land Use Compatibility ■ Parks and Protected Areas ■ Extractive Industry ■ Forestry Industry ■ Energy and Linear Infrastructure ■ Recreation and Tourism
Human Health and Community Safety	■ Human Health and Community Safety Study Plan	■ Public Safety ■ Public Health ■ Diet ■ Environmental Factors Influencing Health
Visual Aesthetics	■ Visual Aesthetics Study Plan	■ Visual Contrast / Character ■ Visibility ■ Visual Sensitivity
Archaeological and Cultural Heritage	■ Cultural Heritage Study Plan	■ Archaeological Sites and Resources ■ Built Heritage Resources and Cultural Heritage Landscapes

It should be noted that while there is not a consultation study plan, the Project has developed the *Consultation and Engagement Plan to Support the Environmental Assessment / Impact Statement* (AECOM 2020) (referred to as the Impact Statement [IS] / EA Consultation Plan).

2. Purpose and Objectives

The key objectives of conducting an IA / EA are to describe the existing environment, gather sufficient information to predict Project-related effects (positive and negative, direct and indirect) of the Project and alternatives on the environment, determine measures needed to avoid or minimize adverse Project effects, and enhance beneficial Project effects where feasible, and to undertake consultation and engagement throughout. The purpose of this Study Plan is to explain:

- A baseline[3] study methodology that will result in a comprehensive description of the existing environment potentially impacted by the Project;
- How efficient and transparent data management and analysis will be undertaken;
- Effects assessment scoping inputs specific to the atmospheric environment that will allow for potential effects of the Project on the existing environment to be appropriately assessed in the IS / EA Report; and
- How the study plan aligns with federal and provincial requirements and guidance, including the Agency's Tailored Impact Statement Guidelines (TISG), dated February 24, 2020 (the Agency 2020c), for this Project and applicable provincial agency comments on the Draft Terms of Reference (ToR)4.

As required by the IAA and referenced in TISG Section 7.3, work plans will also be developed for disciplines as required. It is anticipated the work plans will include further details on how to action the study plans; for example they would contain such information as location of sampling sites, scheduling, and sequencing.

For the purposes of establishing appropriate context, the Study Plan begins with background and relevant information on:

- Study Plan related discussions with the Agency, the MECP and applicable agencies to date (**Section 3**);
- The approach to Project consultation and engagement (**Section 4)**;
- How Indigenous Knowledge will be collected and used in the IA / EA (**Section 5**); and
- The spatial and temporal boundaries that will be used for the IA / EA (**Section 6**).

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3. Baseline refers to the current conditions of the environment potentially impacted by the Project. Baseline conditions serve as a reference against which changes due the Project are measured.

4. If necessary, the Study Plan will be updated to reflect the approved ToR if approval is obtained.

2.1 Approach to Handling Confidential Information

2.1.1 Indigenous Knowledge

Permission from the Indigenous community will be sought before including Indigenous Knowledge in the IS / EA Report, regardless of the source of the Indigenous Knowledge. Sensitive and / or confidential information will be specifically collected through the Indigenous Knowledge Program to inform the IS / EA Report, and its use and publication will be governed by Indigenous community-specific Indigenous Knowledge Sharing Agreements. Sensitive and / or confidential information collected through Indigenous Knowledge Sharing Agreements will be protected from public or third-party disclosure and will be established between the Proponent and Indigenous communities participating in the Indigenous Knowledge Program prior to the sharing and use of any sensitive information. Instances where Indigenous Knowledge sharing has taken place during consultation activities (e.g., meetings) will be recorded in the Record of Consultation and Engagement, including where Indigenous Knowledge was incorporated into Project decisions and into the IS / EA Report (i.e., specifics will not be included in the Record of Consultation and Engagement given the potential sensitivity and / or confidentiality of the information shared).

3. Study Plan Technical Discussions

To facilitate the development of satisfactory study plans and eventually a satisfactory IS / EA Report, MFFN held technical discussions with the Agency, the MECP and applicable agencies on the content of the study plans. A summary of technical discussions and correspondence held to date on this Study Plan has been provided in **Table 3-1**.

Table 3-1: Summary of Study Plan Technical Discussions

Attendees / Responsible Party	Correspondence Date(s)	Discussion Points	Solution
■ **MECP** ■ **The Agency** ■ **Health Canada (HC)** ■ **Environment and Climate Change Canada (ECCC)** ■ **MFFN CAR Project Team**	Meeting - July, 2020	■ Types of monitoring equipment to be used for monitoring program ■ Compounds to be monitored ■ Approach to estimating baseline conditions for compounds that cannot be monitored ■ Siting of monitoring equipment in the community ■ Technical discussion with the MECP regarding general approach of monitoring plan and conformance to the MECP Operations Manual for Air Quality Monitoring (MECP, 2019)	■ There was agreement on the proposed monitoring, as detailed in the Study Plan
■ **MECP** ■ **The Agency** ■ **Health Canada (HC)** ■ **Environment and Climate Change Canada (ECCC)** ■ **Northern Development and Mines (ENDM)** ■ **NRCan** ■ **MFFN CAR Project Team**	Meeting - September 2020	■ Discuss comments submitted by the FRT on the draft atmospheric environment study plan. ■ Key receptors and establishing representative background concentrations ■ Model inputs / model design within the study plan ■ Discussion on applicable atmospheric phenomena ■ Relevant assessment standards and guidelines ■ Technical challenges with monitoring for PAHs	■ There was agreement on the proposed monitoring, as detailed in the Study Plan ■ Methodology for estimating baseline PAHs to be refined and discussed with agencies
■ **MECP** ■ **The Agency, Health Canada (HC)** ■ **Environment and Climate Change Canada (ECCC)** ■ **Ministry of Energy, Northern Development and Mines (ENDM)** ■ **MFFN CAR Project Team**	Meeting - December 2020	■ Changes to equipment to be used based on emerging technical (equipment) limitations and cellular network access within the community ■ Revised equipment and compounds to be monitored	■ There was agreement on the proposed monitoring, as detailed in the Study Plan

4. IS / EA Report Consultation and Engagement Process

4.1 Interested Persons and Government Agencies

The Proponent will provide Project notices and advise of opportunities for consultation and engagement with interested persons[5] which includes, at a minimum members of the public outlined in the *Public Participation Plan for the Marten Falls Community Access Road Project Impact Assessment* (the Agency 2020) (referred to as the Public Participation Plan). This will include the opportunity to provide input on the existing environment, VCs, effects assessment methods, effects assessment results, and mitigation and follow-up program measures as applicable. A variety of activities will be offered so that members of the public are informed of the IS / EA Report as it progresses and are aware of the opportunities and means to provide their input. The study plans have recognized public and agency input received on the Project to date. Government agencies and interested persons will have the opportunity to comment on components of the study plans throughout the IS / EA Report consultation and engagement process. The Project's approach to handling confidential and sensitive information is outlined in **Section 2.1**.

4.2 Indigenous Communities

The Proponent will provide Project notices and opportunities for consultation and engagement with Indigenous communities identified in **Table 4-1**, which is inclusive of all Indigenous communities identified in the *Indigenous Partnership and Engagement Plan for the Marten Falls Community Access Road Project Impact Assessment* (the Agency 2020a) (referred to as the Indigenous Engagement and Partnership Plan).

Indigenous communities will be provided the opportunity to be involved at critical decision-making points throughout the IS / EA Report so that the Proponent can consider and incorporate, where appropriate Indigenous Knowledge and Indigenous land and resource use information into the Project as it pertains to the existing environment, VCs, effects assessment methods, effects assessment results, and mitigation and follow-up program measures. A variety of activities will be offered so that Indigenous communities are informed of the IS / EA Report as it progresses and are aware of the opportunities, means and timelines to

5. *Interested persons, as defined in the IS / EA Consultation Plan, are individuals and groups (e.g., associations, non-governmental organizations, industry and academia) who could have an interest in the Project, including but not limited to communities in the region, those with commercial interests (e.g., forestry, trappers, outfitters, other mineral tenure holders in the area) and recreational users or those with recreational interest (e.g., campers, hunters and environmental groups).*

provide their input. The study plans have recognized Indigenous community input received on the Project to date. Indigenous communities will have the opportunity to comment on components of the study plans throughout the IS / EA Report consultation and engagement process.

Table 4-1: Identified Neighbouring Indigenous Communities, including their Provincial Territorial Organizations and / or Tribal Council Affiliations

Tribal Council Affiliation	Indigenous Community or Organization
Matawa First Nations Management *(Nishnawbe Aski Nation)*	■ **Marten Falls First Nation** (Proponent and potentially affected Indigenous community) ■ Aroland First Nation ■ Constance Lake First Nation ■ Eabametoong First Nation ■ Ginoogaming First Nation ■ Neskantaga First Nation ■ Nibinamik First Nation ■ Webequie First Nation
Matawa First Nation and the Union of Ontario Indians / Nishnawbe Aski Nation	■ Long Lake #58 First Nation**
Mushkegowuk Council *(Nishnawbe Aski Nation)*	■ Attawapiskat First Nation ■ Fort Albany First Nation ■ Kashechewan First Nation
Shibogama First Nations Council *(Nishnawbe Aski Nation)*	■ Kasabonika Lake First Nation ■ Kingfisher Lake First Nation ■ Wapekeka First Nation ■ Wawakapewin First Nation ■ Wunnumin Lake First Nation
Independent First Nations Alliance *(Nishnawbe Aski Nation)*	■ Kitchenuhmaykoosib Inninuwug First Nation
Independent First Nations *(Nishnawbe Aski Nation)*	■ Mishkeegogamang First Nation ■ Weenusk First Nation
Nokiiwin Tribal Council	■ Animbiigoo Zaagi'igan Anishinaabek First Nation*
Métis Nation of Ontario	■ Métis Nation of Ontario; Region 2*
Independent Métis Nation	■ Red Sky Independent Métis Nation*

*Notes: * Indigenous communities or organizations identified by the MECP who should be consulted on the basis that they may be interested in the Community Access Road.*
*** The MECP indicated in a letter to MFFN that Long Lake #58 First Nation was moved from interest-based to rights-based.*

4.3 Consideration of Identity and Gender-Based Analysis Plus in Engagement

To fulfill requirements of the IAA, the Consultation and Engagement Program will consider a diverse range of perspectives from interested persons and interested Indigenous communities and their members identified in the Agency's Indigenous Engagement and Partnership Plan and the Public Participation Plan. This will include at a minimum providing ongoing opportunities for engagement to:

- **Neighbouring Indigenous communities, including relevant subpopulations:**
  - Women;
  - Youth; and
  - Elders.
- **Non-Indigenous communities including:**
  - Women;
  - Youth; and
  - Activity-based subgroups (e.g., recreationalists, snowmobilers, tourism establishment operators).

The Proponent will also consult and engage with other subpopulations identified by communities during consultation and engagement. The information from these activities and any additional identity groups identified by communities through consultation and engagement will be considered by applicable environmental disciplines for the purposes of data collection and considering disproportionate effects.

During consultation and engagement, these aforementioned groups will be consulted and engaged with on targeted input.

When feedback is received from interested persons and Indigenous communities, issues, comments and questions will be tracked, which is consistent with the process described in the IS / EA Consultation Plan. Specific to Gender-Based Analysis Plus objectives, this will include efforts to engage with diverse populations. It is expected this will include activities specific to subgroups and tabulation of consultation and engagement participation with respect to identity factors. This will provide summary statistics to demonstrate the diversity achieved in consultation and engagement.

5. Consideration of Indigenous Knowledge in the IS / EA Report

The following provides a general description of how Indigenous Knowledge will be considered in the IA / EA process. The extent to which Indigenous Knowledge is considered by each specific VC will vary depending on the nature of the VC, the potential for Project effects on the VC and whether Indigenous knowledge that relates to a VC is provided / obtained. As such, not all aspects of the general approach described below may apply to all VCs / study plans.

There are two concurrent and complementary avenues for Indigenous communities and groups to be engaged with and provide input on the Project: the Indigenous Knowledge Program and the Consultation and Engagement Program. Both programs serve to support the collection of Indigenous perspectives, values, and input on the Project, including Aboriginal and Treaty Rights and how they may be impacted by the Project, to be integrated throughout the IA / EA process. However, the Indigenous Knowledge Program specifically aims to solicit and incorporate information that is considered sensitive and may have confidentiality requirements, including Indigenous Knowledge and information on Indigenous land and resource use. Indigenous Knowledge Sharing Agreements will be established between the Proponent and Indigenous communities participating in the Indigenous Knowledge Program prior to the sharing and use of any sensitive information.

All Indigenous communities and groups identified by the MECP and the Agency through the Indigenous Engagement and Partnership Plan have the opportunity to participate in the Indigenous Knowledge Program. The Indigenous Knowledge Program provides interested Indigenous communities an opportunity to: share existing Indigenous Knowledge and information on Indigenous land and resource use and cultural values that may be relevant to the Project, and / or complete Project-specific studies to collect and share Indigenous Knowledge and information on Indigenous land and resource use and cultural values. The Indigenous Knowledge Program includes opportunities for Indigenous communities and groups to meet with the Proponent to discuss the program, ask questions, and share concerns and interests. In support of this, the Proponent has created an Indigenous Knowledge Program Guidance Document (the Guidance Document) that provides:

- An overview of the Indigenous Knowledge Program and information on how Indigenous Knowledge, Indigenous land and resource use and cultural values and practices can be collected and / or shared;

- Information on how Indigenous Knowledge and information on Indigenous land and resource use and cultural values and practices may be used in the planning and design processes; and
- A suite of guidance materials that were developed based on the information requirements of both the federal and provincial assessment processes, including: question guides to support the collection of information on historical and current community context; Indigenous Knowledge that may be relevant to the various technical disciplines; information on Indigenous land and resource use, cultural values and practices and associated spatial data; and perspective on potential Project-related effects and associated mitigation and / or enhancement measures.

The Guidance Document will also support participating Indigenous communities in providing Project-specific information in a manner that facilitates meaningful incorporation into the IS / EA Report.

The IS / EA Consultation Plan outlines the process for obtaining information and feedback about the Project from Indigenous communities (i.e., the Consultation and Engagement Program). All Indigenous communities identified by the MECP and the Agency have the opportunity to participate in the Consultation and Engagement Program through community-specific meetings, Public Information Centres, web conferences, and other formats. All Indigenous communities identified by the MECP and the Agency will be provided information related to the Project and invited to participate at various points throughout the IA / EA process.

There are also opportunities for technical teams to engage with Indigenous communities to solicit perspectives and information relevant to the Project, including information related to collection of existing information and the development of the IS / EA Report. The Proponent also invites feedback and inputs throughout the Project via the Project website and ongoing communications with the Proponent.

The Indigenous Knowledge and Consultation and Engagement programs are designed to be complementary and provide multiple opportunities for communities to offer feedback and information, including perspectives on Aboriginal and Treaty Rights and interests and how these may be impacted by the proposed Project. Relevant information collected through both the Indigenous Knowledge and Consultation and Engagement programs, including potential effect pathways on Aboriginal and Treaty Rights and interests, will be shared with each of the relevant disciplines throughout the IA / EA to: guide and inform VCs; support characterization of the existing environment; identify the potential effects of the Project on VCs; help identify mitigation measures and potential monitoring programs; and ultimately guide Project planning. The nature of how the Indigenous Knowledge becomes integrated into the IS / EA Report will be dictated by the specific information provided by each Indigenous community and the parameters set out in the Indigenous Knowledge Sharing Agreements. A description of how Indigenous Knowledge was considered in the IA / EA and in each of the technical discipline areas will be included in the IS / EA Report.

It is also important to note that information collected through the various activities (e.g., field studies and programs, effects assessments) of each discipline area (e.g., wildlife, vegetation, cultural heritage) will be shared with the Indigenous Knowledge Program leads. This will support the establishment of the existing environment and the effects assessment for the Aboriginal and Treaty Rights and Interests discipline, as well as the identification of potential mitigation measures and monitoring programs, given the interrelated nature of Indigenous peoples and other environmental disciplines.

The Proponent will strive to respectfully collaborate with Indigenous communities on how Indigenous Knowledge and information on Indigenous land and resource use and cultural values will become part of the IS / EA Report, and how potential effects to Aboriginal and Treaty Rights and interests will be assessed. It is expected that measures to support this may include but are not limited to: engaging Indigenous communities to solicit information on Indigenous Knowledge and Indigenous land and resource use and cultural values to inform baseline conditions, providing Indigenous communities with draft sections of the IS / EA Report to illustrate how Indigenous Knowledge and information on Indigenous land and resource use and cultural values has been integrated and to confirm it has been presented appropriately, and completing collaborative working sessions with Indigenous communities for the effects assessment on Aboriginal and Treaty Rights and Interests. Further information on how potential effects on Indigenous rights will be assessed is provided in the Aboriginal and Treaty Rights and Interests Study Plan.

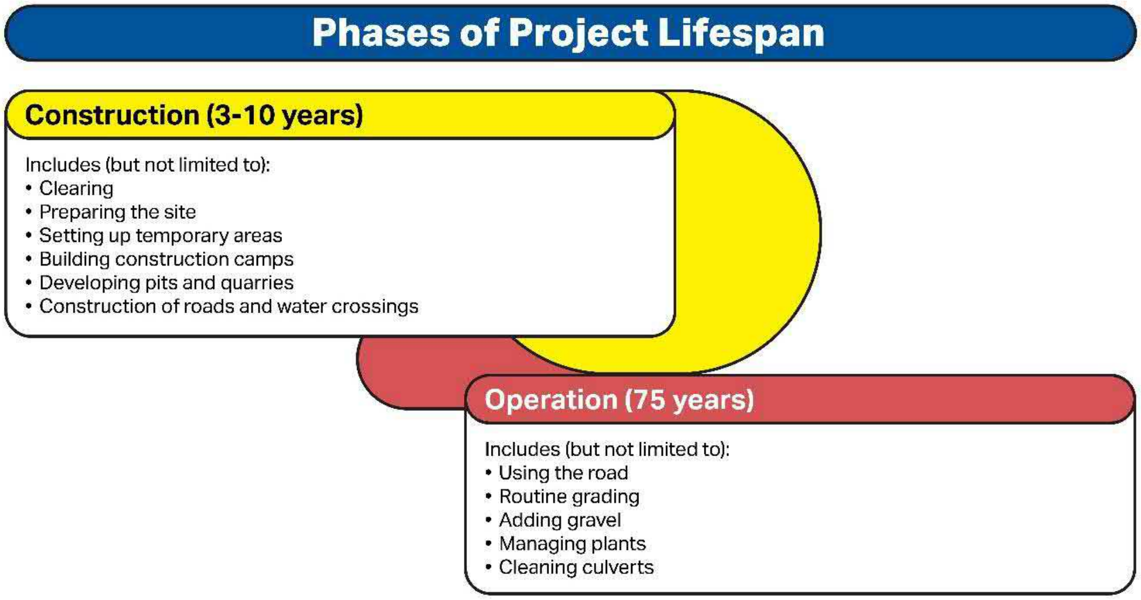
6. Assessment Boundaries

6.1 Temporal Boundaries: Project Phases

Project phases, which are temporal boundaries, are developed to establish the timeframes within which potential effects of the Project will be considered in the IS / EA Report. The Project is planned to occur in two phases, which are briefly described below and shown in **Figure 6-1**.

- **Construction Phase:**
  The time from start of construction, including site preparation activities, to the start of operations and maintenance of the CAR. Decommissioning of construction works is included in the construction phase. The construction phase is anticipated to take approximately 3 to 10 years to complete.
- **Operations and Maintenance Phase:**
  The operations and maintenance phase starts once construction activities are complete and lasts for the life of the Project. The operations and maintenance phase of the Project is considered to be 75 years based on the expected timeline for when major refurbishment of road components (e.g., bridges), is anticipated.

Figure 6-1: Project Schedule



There are currently no plans to decommission the CAR as there is no expected / known end date for its need. Therefore, future suspension, decommissioning and eventual abandonment of the CAR will not be considered in the IS / EA Report. It will be considered if and when a decommissioning or abandonment application is made for the road.

In determining the temporal boundaries, in particular the long operations and maintenance phase, consideration was given to the long-term effects on the well-being of present and future generations (Sustainability Principle #2). The final temporal boundaries to be used in the IS / EA Report will be based on regulatory agency guidance, professional judgement and input received through the Project consultation process.

6.2 Spatial Boundaries: Study Areas

Study areas identify the geographic extents within which potential effects of the Project are likely to occur and will be considered in the IS / EA Report. The existing conditions and potential effects are documented for three study areas selected for the Project:

- **Project Development Area (PDA):** area of direct disturbance;
- **Local Study Area (LSA):** the area where most of the direct effects of the Project are likely to occur; and
- **Regional Study Area (RSA):** the area where indirect effects of the Project are likely to occur.

The PDA encompasses the 100 metre-wide CAR right-of-way (ROW), temporary construction access roads, work areas, worker camps, and pits, quarries and associated access roads. The preliminary LSA currently being considered within the scope of the ongoing provincial regulatory review process generally includes the area within 2.5 km of the centreline of Alternative 1 and Alternative 4. The preliminary study area generally allows for the documentation of existing conditions and prediction of potential environmental effects for the Project. A 5 km wide study area also allows for route refinements during development of Project design (e.g., adjustment of the alignment to avoid sensitive features).

The specific location of Project components, including the roadway, quarries, pits and temporary infrastructure, are not yet known and will be included in the IS / EA Report. While most of the Project components are expected to be located within the preliminary 5 km wide study area, benefits (e.g., reduced environmental disturbance, avoidance of sensitive features, technical considerations, concerns received through consultation) for locating Project components on lands outside of the 5 km wide study area may become known during the IA / EA process. If the need to locate Project components outside the 5 km wide study area is determined to be required or of benefit to the Project, the study area would be adjusted.

The study area for each environmental discipline may vary from the above-described general study area based on the potential for the Project to directly or indirectly affect each environmental discipline; therefore, discipline-specific LSAs and RSAs have been defined for the Project. In defining the final LSAs and RSAs, each environmental discipline will consider:

- Location and other characteristics of the environmental discipline relative to the Project;
- The anticipated extent of the potential Project effects;
- Federal, provincial, regional, and local government administrative boundaries;
- Indigenous groups listed in **Table 4-1**;
- Community knowledge and Indigenous Knowledge;
- Current or traditional land and resource use by Indigenous communities;
- Exercise of Aboriginal and Treaty Rights of Indigenous peoples, including cultural and spiritual practices; and
- Physical, ecological, technical, social, health, economic and cultural considerations.

The study areas included in this document are preliminary, covering the extent to which readily available information suggests the Project may have noticeable effects on the environment. The size, nature and location of past, present and reasonably foreseeable projects will be taken into consideration in the development of the cumulative effects assessment study area(s). The appropriate study area(s) to assess cumulative effects are dependent on the VCs predicted to have direct residual adverse effects as a result of the Project, and therefore, cannot to defined until the IS / EA Report has sufficiently advanced.

For an activity to be considered foreseeable and included in the cumulative effects assessment, the activity will have to be known at the time of preparing the IS / EA Report. That is, sufficient information about the activity must be available to make a reasonable assessment of its potential effects. This will include development that is certain or reasonably foreseeable and activities with additive effects where appropriate (Canadian Environmental Assessment Agency 2018). Reasonably foreseeable activities that will not be considered are those for which formal plans have not been publicly disclosed and information is not available. If sufficient information is not available about a potential future activity to be able to include it within the Project cumulative effects assessment, it is anticipated that should that activity proceed, the proponent of that activity would consider the cumulative effects of their activity with the CAR as appropriate.

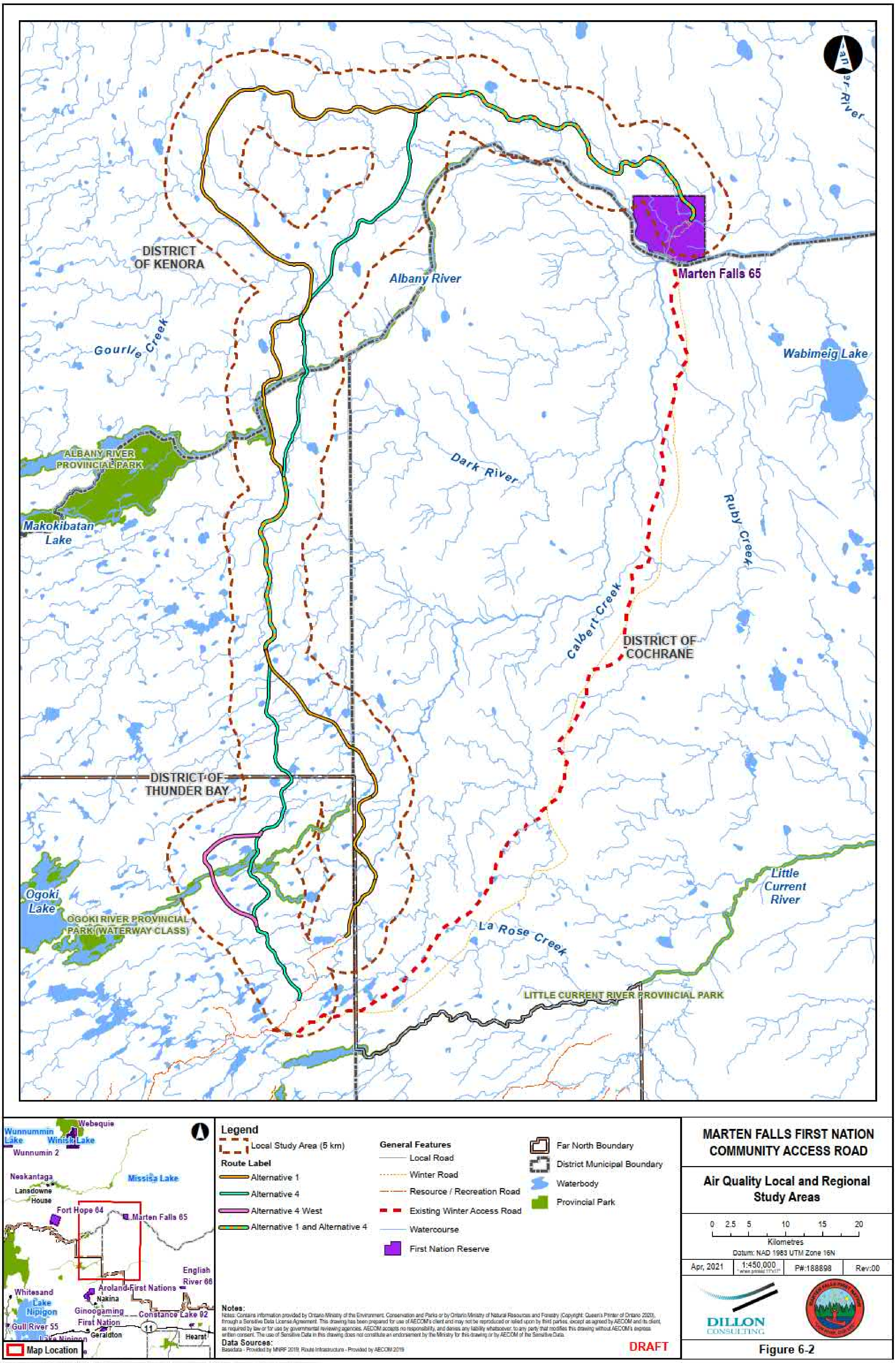
As further detailed in **Section 4**, the Proponent will continue to provide opportunities for neighbouring Indigenous communities and interested persons to provide input and inform the effects assessment, including the LSAs and RSAs.

The LSA and RSA boundaries for the Atmospheric Environment are detailed in **Table 6-1** and on **Figure 6-2.**

Table 6-1: Atmospheric Environment Study Areas

Study Area	Geographic Extent	Rationale
Local Study Area	▪ Air Quality: PDA plus a 5 km buffer that extends from the perimeter of the PDA ▪ GHGs: Physical footprint of the project during construction and operations, which is equal to the PDA	▪ Air Quality: Local study area has been selected to align with the Ontario MECP recommendations for local dispersion modelling, which is that effects be assessed up to 5 km from a source (MECP, 2019). ▪ GHGs: Direct GHG emissions impacts of the project will be limited to the PDA.
Regional Study Area	▪ Air Quality: Not applicable ▪ GHGs: Province (Ontario)	▪ Air Quality: Not Applicable as effects are not expected beyond the Local Study Area. ▪ GHGs: Will be assessed against provincial-scale emissions as well as federal and sectoral totals documented within the 2020 (or most current) National Inventory Report (NIR) by Environment and Climate Change Canada (ECCC, 2020a).

Figure 6-2: Atmospheric Environment Local and Regional Study Areas



7. Baseline Study Design

7.1 Desktop Assessment

A desktop review of existing information sources will be completed to identify information gaps that will need to be addressed through further study. A preliminary list of applicable information sources has been included in **Appendix A** and reflects federal and provincial guidance received to date. This Study Plan focuses on the additional studies that are anticipated to be required to gather information beyond what is currently available through existing information sources, including those as described in Section 7.2 'Sources of baseline information' in the Agency's TISG for this Project.

7.2 Study Methods

The following sections summarize the approaches to be deployed for development of baseline GHGs and Air Quality.

7.2.1 Air Quality Baseline

To characterize baseline Air Quality within the LSA a field monitoring program will be deployed. Up to one year of ambient air quality data will be collected within the community of Marten Falls to characterize baseline air quality.

Within the LSA, the community of Marten Falls is the primary area of human settlement and is the only location with sufficient power and serviceability access to support air quality monitoring equipment. The measured values in the community are a reasonably conservative characterization of baseline ambient air quality across the LSA. Concentrations of indicator compounds within Marten Falls are expected to be elevated in comparison with the remainder of the LSA due to the presence of sustained human activity (e.g., power generation, airport). Therefore, using background data collected from within Marten Falls is expected to result in a conservative characterization of baseline conditions.

The intention of the air quality assessment is to provide a realistic worst-case estimate of the cumulative[6] air quality as a result of the Project. The air quality assessment will add background concentrations to the

6. The cumulative impacts discussed here are distinct from the cumulative effects assessment, which will assess the effects of the Project with the effects of past, present and reasonably foreseeable projects.

predicted Project emissions to determine cumulative air quality within the LSA. Therefore, using the maximum background concentrations which would reasonably be expected within the LSA will result in a conservative air quality assessment.

Ambient air quality monitoring equipment will be deployed in the MFFN community to monitor the following indictor compounds:

- Particulate matter ($PM_{2.5}$);
- Ozone;
- Nitrogen oxides (NO_x);
- Sulphur dioxide (SO_2), and;
- BTEX (benzene, toluene, ethylbenzene, and xylene)

Meteorological parameters (wind speed, wind direction, temperature, relative humidity, barometric pressure, and precipitation) will also be measured. These contaminants are selected as they are commonly associated with transportation and construction activities, as prescribed by the Ontario Ministry of Transportation (MTO, 2020).Some of these indicator compounds may be monitored non-continuously, based on equipment limitations. Meteorological parameters that are not utilized in dispersion modelling (e.g., pan evaporation, extreme weather events) will not be monitored.

Other particulate matter size fractions (TSP and PM_{10}) will be determined by using measured $PM_{2.5}$ data to calculate TSP and PM_{10} background data. As $PM_{2.5}$ is a size fraction subset of PM_{10}, and PM_{10} is a size fraction subset of TSP, the PM_{10} and TSP background concentrations can be estimated based on the $PM_{2.5}$ background concentration. A literature review will be completed to gather representative particulate ratios that are considered to be reflective of the study area. This literature review may include an analysis of historical data collected at representative monitoring stations such as those included within the Environment and Climate Change Canada National Air Pollution Surveillance Program (NAPS), and a review of the United States Environmental Protection Agency (US EPA) studies and supporting documentation.

The ambient air quality monitoring equipment will be deployed for up to one year to address seasonal variations in baseline concentration. Collection of one full year of data may not be possible due to unforeseen circumstances such as power outages or equipment failure. BTEX and particulate matter will be used as surrogates for polycyclic aromatic hydrocarbons and diesel particulate matter which cannot be sampled for due to equipment limitations coupled with serviceability challenges given the remote location of the community. Concentrations of specific relevant contaminants such as acetaldehyde, formaldehyde, 1,3-

butadiene, and acrolein will be estimated based on monitored BTEX concentrations and published emission factors, such as the United Stated Environmental Protection Agency's (US EPA) AP-42 emissions database.

Diesel particulate matter (DPM) emissions as a result of the Project will be included in the air quality assessment. Due to the technical limitations of measuring DPM in the community, background DPM concentrations will be estimated based on the relative magnitude of emissions in the community. A cursory emission inventory will be developed for the community based on available data. This inventory will be used to speciate measured particulate concentrations.

The ambient air quality monitoring equipment is proposed to be located near the MFFN community's nursing station. Attempts will be made to adhere to station and probe siting criteria documented in the MECP Operations Manual for Air Quality Monitoring in Ontario (MECP, 2019) (hereafter referred to as the MECP Manual), however due to the location of project and limited power supply options, not all criteria may be met. If deviations from the MECP Manual (MECP, 2019) occur they will be documented and justified in the final baseline report. An Air Quality Monitoring Plan will be submitted to the MECP and IAAC prior to conducting the program to document alignment with the MECP Manual, as applicable.

The results will be statistically summarized based on the averaging period of the applicable standards and criteria. The Canadian Council of Ministers of the Environment Canadian Ambient Air Quality Standards (CAAQS) (CCME, 2021) and the MECP Ontario's Ambient Air Quality Criteria (AAQC) (MECP, 2020) will be considered in this assessment.

Monitored concentrations collected within the Community will be considered to be representative of all locations within the community and will be used as background concentrations within the LSA.

7.2.2 GHG Baseline

Releases of GHGs and their accumulation in the atmosphere influence provincial and national climate and may affect emission reduction targets for GHGs that have been set or are being developed federally and provincially. As such, GHGs will be presented in context relative to provincial, federal, and sectoral totals for comparison. The most current provincial, federal, and sectoral totals from the NIR (ECCC, 2020a) will be documented to contextualize project emissions within the effects assessment.

Baseline GHG emissions as a result of existing activities, such as air travel, will be quantified. GHG sinks such as forest sequestration along the proposed CAR will be considered in total GHG quantification. GHG emissions will be calculated using Environment and Climate Change (ECCC) guidance and emission factors from the appropriate United States Environmental Protection Agency AP-42: Complication of Air Emission Factors (US AP-42) resources, along with the most current NIR (ECCC, 2020a).

7.2.3 Reporting

The findings of the Baseline Study will be summarized in a Baseline Study Report which will support the development of the IS / EA Report. In addition to the monitoring data and baseline GHGs, the Baseline Study Report will include a description of the types of emissions that were identified within the Study Area.

8. Data Management and Analysis

Data management including quality assurance / quality control (QA / QC) will be deployed to minimize the potential for data entry and analysis errors, prepare data sets for analysis and limit sensitive data distribution in accordance with established agreements. Modelled and monitored data will be evaluated using method-specific quality assurance / quality control procedures.

8.1 Field Data Collection

Quality assurance measures will be implemented to manage data integrity. The operation, service and maintenance of the station and sampling equipment would be in accordance with both the manufacturers' operating manuals and the protocols outlined in the MECP's Operations Manual for Air Quality Monitoring in Ontario (MECP, 2019). Where the remote nature of the site requires deviations from these, those deviations will be documented.

The following quality control measures will be implemented to help ensure consistent data capture to meet the MECP protocols:

- The station installation will be best sited to meet criteria as outlined in the MECP Operation Manual for Air Quality Monitoring in Ontario (MECP, 2019);
- Selected monitoring equipment will be EPA designated and verified prior to use with NIST traceable calibration standards;
- Station temperature will be monitored and reported to help ensure adequate control of interior temperature;
- Gaseous analysers will include Internal Zero / Span options so that automatic instrument response checks can be conducted nightly to assess ongoing performance such as zero / span drift, repeatability and response time to adhere to the MECP reporting practices;
- VOC sampling will be conducted on a 6 day schedule (NAPS) using a Xontech 910 canister sampler. The sampler will be audited quarterly. Exposed samples will be shipped to the laboratory on a schedule not to jeopardize sample integrity;
- VOC analysis will be conducted by an accredited laboratory as per the MECP protocols;
- Instrument status and operation checks will be conducted and logged weekly by field monitors;

- Monitoring instrumentation will be audited at quarterly intervals using NIST certified standards;
- Meteorological instrumentation will be audited upon installation and annually as per the MECP protocols;
- Back-up or duplicate instrumentation will be made available to minimize data loss or if reported data are questionable;
- Data will be transmitted daily from the station via satellite communications. Manual download protocol available if needed;
- Data will be reviewed daily and quality assured by experienced and qualified analysts. Data will be subjected to various QA / QC tests prior to release;
- A Data Edit log will be implemented and retained for the data set. Data reports will be submitted monthly, and;
- Data will be compared to all applicable AAQCs, Standards and Guidelines.

8.2 Desktop Analysis

The desktop analysis (emissions quantification, modelling and reporting) will be subject to primary and secondary review processes in accordance with MFFN CAR Project Consultant protocols. Each task will have an assigned primary analyst, and work product will be reviewed at key steps in the overall analysis (e.g., calculation of emissions, setup of models, execution of models, draft report, final report). In addition to this ongoing review process, there will be an independent review of analysis conducted by an individual who did not generate content or conduct earlier reviews.

9. Effects Assessment

The following sections provide discipline-specific input and considerations as they pertain to the methodology for effects assessment. The Project is in the early stage of the IS / EA Report preparation and it is expected that the effects assessment methodology will be refined iteratively based on regulatory agency guidance, professional judgment and input received through the Project consultation and engagement process.

9.1 Project-Environment Interactions

The Project activities that may result in changes to the environment are described within the identified temporal and spatial boundaries. This includes identification of both direct and indirect changes by comparing the existing setting to the conditions anticipated to occur as a result of the Project. For each environmental discipline, the likely Project-environment interactions will be identified based on professional judgment, activities listed in TISG Section 3.2 as well as projects of similar magnitude and / or location.

A preliminary analysis of Project-environment interactions with the atmospheric environment is provided in **Table 9-1** and will be confirmed during the IA / EA process to identify the Project-environment interactions that are likely to have a potential effect, and to identify measures to avoid or minimize potential negative effects and enhance benefits.

Table 9-1: Project – Environment Interactions

Project Phases	Project Activities	Atmospheric Environment
Construction Phase	*Mobilization of Equipment and Supplies*	X
	Temporary Construction Staging Areas[1]	X
	Temporary Access Roads and Trails[1]	X
	Temporary Construction Camps[1]	X
	ROW Clearing and Grubbing	X
	Brush and Timber Disposal	
	Pits and Quarries[1]	X
	Drilling / Blasting / Aggregate Production	X
	Road Construction (stripping, subgrade excavation, embankment fill placement, grading, ditching)	X
	Bridge and Culvert Installation (approach embankments, foundations, substructures, superstructures, traffic protection, erosion controls)	X
	Construction Site Restoration	X

Project Phases	Project Activities	Atmospheric Environment
Construction Phase: Decommissioning	*Pits and Quarries*	X
	Temporary Camps, Roads / Trails and Staging Areas	X
Operations Phase	*Road Usage*	X
	Maintenance[2]	x

Notes: 1. Includes construction and use of
2. Includes General Maintenance (e.g., grading, erosion control, quarrying, pits), Seasonal Maintenance (e.g., snow clearing, bridge and culvert maintenance), and Special Maintenance (e.g., slope failures, road settlement / break-up.).

9.2 Valued Components and Indicators

VCs are the environmental, health, social, economic or additional elements or conditions of the natural and human environment that may be impacted by a proposed project and are of concern or value to the public, Indigenous peoples, federal authorities and interested parties (the Agency 2020b). Indicators represent the resource, feature, or issue related to the VC that, if changed, may demonstrate an effect on the environment. The indicators and rationale for selection and measurement of potential effects, to be used to assess and evaluate the alternative routes in the IS / EA Report are provided in **Table 9-2**. The table includes both quantitative and qualitative indicators. The final list of VCs and indicators to be used in the IS / EA Report will be based on regulatory agency guidance, professional judgement and input received through the Project consultation and engagement process.

The VCs for Atmospheric Environment and GHGs discipline have been determined through consideration of the following factors listed in the TISG[7]:

- VC presence in the study area;
- the extent to which the VC is linked to the interests or exercise of Aboriginal and Treaty Rights of Indigenous peoples, and whether an Indigenous group has requested the VC;
- the extent to which the effects (real or perceived) of the Project and related activities have the potential to interact with the VC;
- the extent to which the VC may be under cumulative stress from other past, existing or future undertakings in combination with other human activities and natural processes;

7. The TISG also states that information from ongoing and completed regional assessments in the proposed area of the Project should be used to inform VCs for the Project. In February 2020 a regional assessment of the Ring of Fire region commenced; however, it is not sufficiently advanced at this time to inform the Project VCs. The VCs will be consulted and engaged on early in the IA/ EA process and finalized taking into consideration the input received. Therefore, only information relevant to the Project that arises from the regional assessment of the Ring of Fire within an appropriate timeline will inform the VCs for the Project.

- the extent to which the VC is linked to federal, provincial, territorial or municipal government priorities (e.g., legislation, programs, policies);
- the possibility that adverse or positive effects on the VC would be of particular concern to Indigenous groups, the public, or federal, provincial, territorial, municipal or Indigenous governments; and
- whether the potential effects of the Project on the VC can be measured and / or monitored or would be better ascertained through the analysis of a proxy VC.

As well as consideration of:

- Industry standards and best practice;
- Provincial and federal guidance for assessments of Air Quality and GHG Emissions; and
- Other relevant and credible sources, such as scientific or academic publications or input from the public.

Inputs received to date from Indigenous communities, agencies and interested persons through the Consultation and Engagement Program, including inputs received on the Draft ToR, have also been used to inform the selection of the VCs and indicators for the Atmospheric Environment.

Table 9-2: Atmospheric Environment Indicators

Valued Component	Indicators	Rationale for Selection
Air Quality	■ Change in concentration of Air Contaminants : – NO_x – CO – SO – TSP – PM_{10} – $PM_{2.5}$ – Selected VOCs (acrolein, acetaldehyde, benzene, formaldehyde, 1,3-butadiene, toluene, ethylbenzene and xylene) – PAHs (benzo(a)pyrene)	■ The contaminants chosen for the indicators are based on those commonly associated with transportation and construction activities, as prescribed by the Ontario Ministry of Transportation (MTO, 2020).
Greenhouse Gases	■ Quantification of GHG emissions (CO_2, CH_4, N_2O) expressed as CO_2e	■ The contaminants chosen for the indicators are those prescribed by The Ontario Ministry of Transportation (MTO, 2020)

9.3 Indirect Effects

A direct effect occurs through the direct interaction of an activity with an environmental discipline. The Project-environment interactions currently anticipated, based upon preliminary analysis, to result in direct effects to the Atmospheric Environment Discipline have been identified in **Table 9-1**. The potential direct effects resulting from the Project-environment interactions will be confirmed during the IA / EA process and will be based on input received through the Indigenous Knowledge Program and Consultation and Engagement Program, regulatory agency guidance, and professional judgement.

An indirect effect occurs when a change to one environmental discipline resulting from a Project activity causes a change to another environmental discipline (e.g., changes in vegetation could indirectly affect wildlife). **Table 9-3** provides a preliminary identification of how changes to the atmospheric environment may result in indirect effects to other environmental disciplines.

Changes occurring in the following disciplines may result in a change to the Atmospheric Environment: Vegetation, Social and Land and Resource Use. Details are provided below that provide some examples of potential changes that may occur.

Vegetation

- Increases or decreases in quantity, or changes to vegetation type may affect the quantity of carbon sinks which can result in changes to GHG emissions and capture.

Social

- Changes in housing and accommodation types may result in changes in fuel consumption (heating fuel, wood burning), this can result in either an increase or decrease in community emissions of indicator compounds and GHGs.
- Changes in community services and infrastructure may result in changes in energy input method and consumption (switch from heating fuel to electricity), this can result in either an increase or decrease in community emissions of indicator compounds and GHGs.
- Changes in transportation mode (vehicle type) and volume (traffic loading) will result in either an increase or decrease in community emissions of indicator compounds and GHGs.
- Changes in population and demographics can result in either an increase or decrease in fuel usage for transportation, heating and community services. This change in fuel usage may result in either an increase or decrease in community emissions of indicator compounds and GHGs.

Land and Resource Use

- Changes in land use compatibility, parks and protected areas, local industries and linear infrastructure may have an effect on emission sources and quantities that may result in either an increase or decrease in community emissions of indicator compounds and GHGs.
- Changes to linear infrastructure may result in changes in fuel type and usage quantities that may result in either an increase or decrease in community emissions of indicator compounds and GHGs.
- Changes in recreation and tourism quantities can affect traffic loading and energy consumption within the community and may result in either an increase or decrease in community emissions of indicator compounds and GHGs.

Table 9-3: Potential Discipline Interactions

Discipline and Associated Valued Components	Aboriginal Treaty Rights and Interests	Atmospheric Environment and GHG	Acoustic and Vibration	Physiography, Geology, Terrain and Soils	Surface Water	Groundwater and Geochemistry	Vegetation	Wildlife	Fish and Fish Habitat	Social	Economy	Land and Resource Use	Human Health and Community Safety	Visual Aesthetics	Archaeological and Cultural Heritage
Atmospheric Environment ▪ **Air Quality** ▪ **GHG Emissions**	-		-	-	X	-	X	X	-	X	-	-	X	-	-

Notes: X = Potential pathway for indirect effect as a result of the Project.
- = No pathway for indirect effect is anticipated as a result of the Project.

9.4 Methods for Predicting Future Conditions

With respect to quantitative models and predictions, the IS / EA Report must detail the model assumptions, parameters, the quality of the data and the degree of certainty of the predictions obtained.

The following sub-sections describe the methods which will be used to predict future conditions associated with the indicators for the Project. In general, the assessment will involve quantifying emissions of selected contaminants from project activities, dispersion modelling to predict effects within the LSA, recommendation of mitigation measures to avoid or minimize identified effects, as well as identify opportunities to enhance benefits to the environment, and the prediction and assessment of potential environmental effects remaining after taking into consideration the recommended mitigation measures (i.e., residual effects).

9.4.1 Air Quality Emissions

As described earlier, a conservative air quality assessment is one which describes the reasonable worst-case impact of the Project. Background concentrations within Marten Falls are expected to be higher than the rest of the LSA. Therefore, using measured concentrations in the LSA will result in a conservative air quality assessment. The air quality assessment will include two bounding scenarios: roadway construction and roadway operation.

9.4.1.1 Construction Phase

Emissions will be estimated for the construction phase based on the projected types of activity and duration. Anticipated construction activity, such as land clearing, blasting, pit and quarry development, material hauling, road construction, and equipment and vehicle operation will be included in the estimate of emissions. Emissions will be estimated based on published emission factors, such as those found in the US EPA's AP-42 (US EPA, 2021), those generated in the most current version of US EPA Motor Vehicle Emissions Simulator (MOVES) (US EPA, 2020), or engineering principles, as applicable. Fugitive emissions such as wind erosion from uncovered soil or stockpiles will be estimated based on the size of the projected working area. A bounding scenario for construction activities will be developed (i.e., a scenario describing the maximum simultaneous construction activities) and will be used for the emission calculations.

9.4.1.2 Operation Phase

Emissions due to the operation phase will include vehicle emissions as well as roadway emissions of re-suspended particulate matter due to vehicle travel on the roadway. Routine road maintenance activities such as snow clearing are expected to be captured in the roadway vehicle data (traffic volumes and vehicle types) within the roadway operation scenario, and therefore will be included in the air quality assessment. Minor roadway maintenance activities, such as re-grading, are expected to have a lower impact than the initial construction bounding scenario, therefore the impact of these activities would have been assessed within that bounding scenario. Where applicable and available Canadian emission factors from NIR (ECCC, 2020a) will be used in lieu of US EPA emission factors. Within the MOVES (US EPA, 2020) emission model, meteorological and fuel composition data reflective of the study area will be used as inputs to generate emission factors.

Vehicle fleet information such as vehicle volumes will be based on the CAR design criteria. Vehicles will be assumed to travel at the posted speed limit. Fuel formulation will be based on the nearest available representative data source. Vehicle classification and traffic volume will be incorporated in emission calculations (i.e., light duty, heavy duty) if available as different vehicle classifications will have different traffic loadings and emission factors.

Re-suspended road dust will be estimated based on emission factors included in the US EPA’s AP-42 (US EPA, 2021) emission factor database.

9.4.1.3 Meteorology

Project-specific meteorological data will be developed for the LSA to be used in the dispersion modelling assessments detailed in **Section 9.4.3**. Prognostic data using the Weather Research and Forecasting model (WRF) will be purchased.

Data will be processed for use with the most currently approved version of the US EPA AERMOD (US EPA, 2019) dispersion modelling software, and CAL3QHCR (US EPA, 1995) models (as described in the following sections) using US EPA AERMET (US EPA, 2019) and RAMMET (US EPA, 1999) respectively. The meteorological dataset will include 5-years of data for the entire project, including the required AERMOD (US EPA, 2019) parameters: wind speed and direction, air temperature, net radiation, turbulence and precipitation data. Meteorological parameters such as pan evaporation and evapotranspiration, and climate data such as extreme weather events, are not considered in air dispersion modelling. Parameters not used as direct inputs into the air dispersion modelling software will have no influence on the model results and therefore the impact assessment. As such they will not be monitored nor documented in the AQIA Report.

9.4.1.4 Dispersion Modelling

Dispersion modelling will be conducted to assess Project effects. Modelling will be conducted following published guidance, as applicable, such as the MECPs' Guideline A-11 Air Dispersion Modelling Guideline for Ontario (MECP, 2017). The models selected for use in this assessment are ideally suited for near-field effects (i.e., on the scale of metres to <50 kilometres). Models that will be utilized within this assessment include the US EPA AERMOD (US EPA, 2019), US EPA's CAL3QHCR / CALINE (US EPA, 1995), and US EPA MOVES (US EPA, 2020). These models were selected as both construction and roadway activity will have the highest potential contaminant concentrations in the near-field immediately adjacent to activity, which disperse rapidly with downwind distance. Given the low projected traffic volumes on the roadway and the primarily near-field effects from roadways, secondary formation will not be included in the assessments.

9.4.1.5 Construction Phase

Air quality effects within the LSA from roadway construction will be assessed for the selected alternatives. Dispersion modelling will be performed using the MECPs' regulatory version of the US EPA's AERMOD (US EPA, 2019) dispersion model (version 19191 or newer at the time of modelling). AERMOD (US EPA, 2019) is the recognized model for regulatory purposes and is appropriate for assessing contaminant dispersion in the near-field to 5 km from the road with a higher degree of resolution. Modelling the full Project in one domain will not provide the resolution nor capture the localized effects of emissions at ground-level in the near-field based on the geography covered by the full length of the road and the predominance of near-field effects. Therefore, modelling utilizing AERMOD (US EPA, 2019) will be performed for an estimated representative construction area (physical size and level of activity). The representative area will be selected based on a review of the construction program for the entire CAR, identification of activities that represent a maximum operating condition, and proximity to receptors. Modelling results from the representative scenario will be extrapolated to predict the effects at sensitive receptors within the LSA. Additionally, a model representative of the community will be developed to assess the Project effects within the MFFN community. This model will include the CAR segments closest to the community of MFFN, and receptors specific to the MFFN community.

9.4.1.6 Operations Phase

Air quality effects within the LSA from roadway operations will be assessed for the selected alternatives. Project emissions will be modelled using the US EPA's CAL3QHCR / CALINE (US EPA, 1995) transportation source model, or equivalent, following modelling guidance from the MTO's *Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects (MTO, 2020)* as well as the MECP Guideline A-11: Air Dispersion Modelling

Guideline for Ontario (ADMGO) (MECP, 2017). As outlined in the Construction Phase, the modelling will be performed for a representative section of roadway in order to capture effects at a resolution appropriate for the Local Study Area (i.e., within 5 km of the roadway). The representative area will be selected based on a review of the operations phase for the entire CAR, identification of activities that represent a maximum operating condition, and proximity to receptors. The results of the modelling for the representative section of roadway will be extrapolated along the entire corridor to predict effects at sensitive receptors within the LSA. Additionally, a model representative of the community will be developed to assess the Project effects within the MFFN community.

One modelling scenario will be developed which considers the projected vehicle fleet (i.e., vehicle age, fuel type, and vehicle type), driving cycles, and roadway configuration. One future-build scenario will be assessed (i.e., build year plus 20 years as recommended by the Ontario Ministry of Transportation (MTO, 2020). The future-build scenario is aligned with MTO guidance to allow for predictability of key inputs to relevant models (e.g., vehicle fleet composition, vehicle age, fuel type). Selection of timelines beyond this may reduce the accuracy of model outputs. The results of the modelling will be extrapolated along the corridor to determine local air quality effects. Design case vehicle fleet information and published default vehicle fleet information (e.g., US EPA defaults) will be used as applicable.

9.4.1.7 Ground-Level Ozone

In the Ministry of Transportation's *Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects (MTO, 2020)*, the MTO states that with respect to the formation of ground-level ozone, "ground-level ozone O_3 is typically formed many kilometres downwind of the source of its precursors" and "concentrations are usually depressed around highways since NO emissions react relatively rapidly to convert O_3 into oxygen gas." The MTO also states that "For major roads, the collective experience of the scientific community suggests that the affected immediate vicinity is limited to the area within approximately 500 metres of the road". Based on this, the contribution of the Project to ground-level ozone is likely to be minor in comparison to the near-field concentration of precursors (i.e., NO_x.

The potential for the Project to contribute to ground-level ozone will be qualitatively assessed for both the construction and operation phases. This qualitative analysis will focus on the predicted increase in NO_x and Volatile Organic Compounds around the PDA which will provide an indication of the potential for ground-level ozone formation. Ozone formation will not be quantitatively assessed as the potential for ground level ozone formation is negligible.

9.4.1.8 Acid Deposition

The potential for the Project to contribute to acid deposition will be qualitatively assessed for both the construction and operation phases. Potential for acid formation will be evaluated based on the predicted increase in NO_x and SO_x to the airshed[8] and subsequent potential nitrate and sulphate formation. Acid deposition will not be quantitatively assessed as the magnitude of effects is expected to be negligible. Acid deposition is a regional effect, meaning that the potential of formation is minimal in close proximity to the roadway when compared to the larger airshed. It is estimated that the Project will partially displace air travel with road vehicle traffic. The impact of this modal shift on the contribution of NO_x and SO_x to the airshed will be assessed and a qualitative statement regarding the potential for acid deposition will be provided in IS / EA Report.

9.4.1.9 Secondary Transformation

Formation of secondary contaminants (fine particulate matter) through chemical and physical transformation is expected to be low-level based on the predicted roadway volumes. While some formation of secondary particulate is expected, the Project is in a pristine setting without large industrial or transportation sources. Secondary formation is dependent on the presence of precursor species[9] which will be limited because of the nature of the environment. Based on a low number of projected vehicles per day, the emissions of precursor species are expected to be relatively dilute in the atmosphere.

Additionally, the formation of secondary contaminants is not instantaneous, and happens downwind of the source at which point the initial precursor contaminants have begun to disperse. In consideration of these factors, it is expected that assessing the near-road impacts of primary contaminants will result in a reasonably conservative air quality assessment.

One exception to the above is the conversion of NO to NO_2. It will be conservatively assumed that 100% of all NO emitted from the Project will be converted to NO_2.

9.4.2 Air Quality Analysis

The predicted at-receptor concentrations of the indicator compounds will be statistically summarized based on the applicable standards and criteria (i.e., AAQC (MECP, 2020) and CAAQS (CCME, 2021)) for each sensitive receptor. 90th percentile monitored or calculated baseline concentrations of the contaminants will

8. Geographically defined area of the atmosphere.

9. Contaminants that are required to be present and to react to form a secondary contaminant be added to the modelled concentrations to conservatively predict the cumulative effects at each sensitive receptor. Sensitive receptors include areas where occupants may be more susceptible to adverse effects. Sensitive receptors include but are not limited to hospitals, schools, child care facilities and elderly housing. A detailed listed of sensitive receptors will be provided in the IS / EA Report. The selection of sensitive receptors will be done in collaboration with other disciplines and incorporate Indigenous Knowledge. Where exceedances of the standards or criteria are predicted (based on dispersion modelling), frequency analysis will be performed.

Differential effects will not be considered within the air quality assessment. The air quality assessment will consider the previously mentioned provincial and federal criteria and standards (AAQC (MECP, 2020) and CAAQS (CCME, 2021)) to evaluate the Project impacts on air quality. The results of the air quality dispersion modelling assessment will be used to inform air quality related human health effects in the Human Health and Community Safety Assessment. It is expected that the studies listed in **Table 9-3** will use evaluation criteria specific to each study's individual receptor types.

9.4.3 GHG Emissions

Net GHG emission related to the Project will be calculated based on the Strategic Assessment on Climate Change (SACC) (ECCC, 2020b) Equation 1 below:

Net GHG = Direct GHG emissions + Acquired energy GHG emissions
CO2 captured and stored - Avoided domestic GHG emissions - Offset credits.

It should be noted that not all components of this equation are relevant to the Project; only direct and avoided GHG emissions are relevant.

9.4.3.1 Construction Phase

GHG emissions will be estimated for the construction phase based on the projected types of activity and duration. Anticipated construction activity (direct GHG emissions), such as land clearing, blasting, pit and quarry development, material hauling, and road construction will be included in the estimate of emissions. Emissions will be estimated based on published emission factors, such as those found in the US EPA's AP-42 (US EPA, 2021) emission factor database, those generated with the US EPA Motor Vehicle Emission Simulator (MOVES) (ES EPA, 2020), or engineering principles, as applicable. A bounding scenario for construction activities will be developed (i.e., a scenario describing the maximum simultaneous construction activities) and will be used for the emission calculations.

GHG emissions will be estimated for vehicle and equipment activity as well as land use changes (direct GHG emissions), i.e., those associated with land use changes, including peatlands, and the removal of sources, sinks, and reservoirs).

9.4.3.2 Operation Phase

The GHG assessment will include two bounding scenarios, these being roadway construction (described above, and comprising direct emissions) and roadway operation (comprising direct emissions). Routine road maintenance activities such as snow clearing are expected to be captured in the roadway vehicle data (traffic volumes and vehicle types) within the roadway operation scenario, and therefore will be included in the GHG assessment. Minor roadway maintenance activities, such as re-grading, are expected to have a lower impact than the roadway construction scenario, therefore the impact of these activities would have been assessed within that bounding scenario. Where applicable and available, Canadian emission factors from ECCC NIR Reports (ECCC, 2020a) will be used in lieu of US EPA emission factors (US EPA, 2021). Vehicle emission factors, including GHGs, will be estimated using the most current approved version of the US EPA's MOVES (US EPA, 2020) emissions database which considers factors such as: vehicle type, vehicle age, road type, fuel formulation, ambient conditions, and vehicle speed to develop vehicle fleet emission factors per kilometre travelled.

As with the air quality assessment, vehicle fleet information such as vehicle volumes will be based on the CAR design criteria. Vehicles will be assumed to travel at the posted speed limit. Fuel formulation will be based on the nearest available representative data source. Vehicle classification and traffic volume will be incorporated in emission calculations (i.e., light duty, heavy duty) as different vehicle classifications will have different traffic loadings and emission factors.

The assessment of GHG emissions will also consider the potential change in emissions from existing sources (e.g., aircraft, winter road usage) as a result of the Project (avoided domestic GHG emissions).

9.4.4 GHG Analysis

Releases of GHGs and their accumulation in the atmosphere influence provincial and national climate and may affect emission reduction targets for GHGs that have been set or are being developed federally and provincially. As such, GHGs will be assessed relative to provincial totals for comparison. Net GHG emissions will be evaluated in terms of overall contribution over the life of the Project, which will be assumed to be 20 years starting from the initial phases of construction. This will provide consistency with the future-build scenario as prescribed by the Ontario Ministry of Transportation (MTO, 2020). The average per-annum GHG contribution as a result of the Project will be compared to provincial, federal, and sectoral totals where applicable.

Net GHG emissions as a result of the Project will be calculated using ECCC and SACC (ECCC, 2020b) guidance. The modal shift analysis identified in the Study Plan will be conducted based on the guidelines identified by IAAC (e.g., ECCC guidance, Infrastructure Canada's Climate Lens guidance), and will consider partial or full displacement of current forms of travel (e.g., winter road travel, air travel) with on-road vehicular traffic. The level of modal shift for each mode of transportation will be documented as part of the assessment. The Project is not anticipated to displace international emissions, and therefore this aspect will not be addressed within the analysis.

Emission factors for mobile and stationary equipment used during construction and operation phases will be gathered from the appropriate US EPA AP-42 (US EPA, 2021) resources, those generated from the most current approved version of MOVES (ES EPA, 2020), along with the most current NIR. Vehicle emissions will be estimated using the US EPA's Motor Vehicle Emission Simulator emissions database.

A qualitative description of the Project's net effects on Climate Change will include consideration of the requirements of the SACC guidance (ECCC, 2020). It is expected that in following the SAAC guidance (ECCC, 2020), Section 15.5 of the TISG will be met.

The impact assessment will not include a plan to achieve net zero by 2050 because the majority of the Project's emissions would arise from fuel consumption by third party users of the CAR. These emissions would not be owned by the Proponent and further policies to reduce or fully mitigate those emissions would fall under the jurisdiction of the federal and / or provincial governments. Additionally, emissions from fuel associated with vehicular travel on the CAR would have been subject to Government of Canada carbon price.

9.5 Mitigation and Enhancement Measures

Once potential effects have been identified, the effects assessment will explore technically and economically feasible mitigation measures to avoid or minimize the identified negative effects and enhancement measures to increase positive effects beyond those that are already inherent to the design. These measures will consist of industry-standard practices, federal and provincial standard specifications, regulator-mandated measures, best management practices, Indigenous and community recommendations and recommendations from industry and environmental professionals based on expertise, scientific publications, experience and judgement.

It is important that mitigation and enhancement measures are achievable, measurable and verifiable and monitored for compliance and effectiveness during all temporal phases as part of the Project follow-up monitoring plan. Required environmental monitoring will verify the potential environmental effects predicted in the IS / EA Report, evaluate the effectiveness of mitigation and enhancement measures, and identify the process the Proponent will follow if mitigation and enhancement measures are not effective.

9.5.1 TISG Section 20 Requirements

TISG section 20 includes the following requirements related to the atmospherics discipline. For each, the corresponding approach to fulfilling the requirement is documented.

- Identify and describe the use and application of best available technology and best environmental practice, including its effectiveness on the contaminants of concern, to prevent adverse effects on the receiving environment other than for GHG reduction purposes;
  - Following the ambient background air quality monitoring, a review of monitoring results in combination with an analysis of dispersion modelling outputs will be completed and used to provide input on what or if any mitigation and enhancement measures should be implemented. These mitigation and enhancement measures will be documented. During initial emission calculations select mitigation measures such as road watering will be taken into consideration when developing emissions rates for both mobile and stationary sources.
- Information on any offset credits that have been or will be obtained, including the offset regime that issued the credits, project type, project start date and vintage year. Proponents may also provide information on their intent to acquire or generate international offset credits;
  - It is not anticipated that the Project will generate any GHG offsets. However, as project activities are detailed through the EA process, these activities will be reviewed to gauge their alignment with typical GHG offset project types. The Project scope does not include the acquisition of offsets.
- To inform potential mitigation measures, a comparison of the Project's projected GHG emission intensity of similar projects in Canada and internationally that are a good example of energy efficiency or low emissions intensity projects. The comparison should explain why the emissions intensity may be different;
  - Where emissions intensity data exists in the public domain for comparable new road construction, this information will be used to compare the Project's projected emission intensity. A literature review will be conducted to identify potential data points for comparison, and intensity data captured in this review (if any) will be used as comparison

points. The focus of this assessment will be on the construction of the Project, as emissions from the Project's operations phase would be outside of the control of the Proponent. Specifically, the types of vehicles and resulting energy forms (fossil fuel or electricity) used within vehicles accessing the Project during operations would be outside of the scope of management of the Proponent. Further, the management of the types of vehicles and resulting energy forms used within vehicles would be within the purview of the Government of Canada and Government of Ontario.

9.6 Residual Effects

Residual effects are the effects remaining after the application of mitigation measures. The IS / EA Report will describe the potential adverse and positive residual effects in relation to each temporal phase of the Project (e.g., construction, operation). Residual effects will be described using criteria to quantify or qualify adverse and positive effects, taking into account important contextual factors. The residual effects will be described in terms of the direction, magnitude, geographic extent, duration, frequency, likelihood, and whether effects are reversible or irreversible[10]. For magnitude, environmental discipline-specific definitions are required and are proposed below in **Table 9-4**. Ecological and socio-economic context may also be relevant when describing a residual effect. Context relates to the existing setting, its level of disturbance and resilience to adverse effects. Context can also relate to timing as it applies to assessing the worst-case scenario (e.g., effect during migratory or calving season for wildlife). Where appropriate, information regarding residual effects will be disaggregated by sex, gender, age and other community relevant identify factors to identify disproportionate residual effects for diverse subgroups. For magnitude, VC-specific definitions are required and are proposed below in **Table 9-4** for Air Quality and **Table 9-5** for GHGs. The adverse effects magnitude criteria are intended to assess the ability of the Project to meet provincial and federal air quality criteria and standards. The air quality criteria and standards were developed to be protective of human health. Additionally, the results of the air quality assessment will be considered within the Human Health and Community Safety Study Plan.

10. TISG Section 13.1 identifies additional effects characteristics for certain disciplines (e.g., wetlands, birds, terrestrial wildlife, species at risk). These additional effects characteristics are described in the respective discipline-specific study plans.

Table 9-4: Atmospheric Environment – Air Quality Magnitude Definition

Magnitude Level	Definition	Rationale
Negligible	■ Cumulative concentrations are below Air Quality criteria and an increase of < 50% of baseline values at sensitive receptors	■ Magnitude definitions consider compliance with air quality criteria (AAQC (MECP, 2020) and CAAQS (CCME, 2021)) and changes from baseline conditions
Low	■ Cumulative concentrations are below Air Quality criteria and an increase of >50% of baseline values at sensitive receptors	
Medium	■ Cumulative concentrations exceed Air Quality criteria, and an increase of < 50% of baseline values at sensitive receptors	
High	■ Cumulative concentrations exceed Air Quality criteria, and an increase of > 50% of baseline values at sensitive receptors	

Table 9-5: Atmospheric Environment - Greenhouse Gas Magnitude Definition

Magnitude Level	Definition	Rationale
Negligible	■ Up to 0.1% of provincial totals[11]	■ Releases of GHGs and their accumulation in the atmosphere influence regional, national and global climate and may affect emission reduction targets for GHGs that have been set or are being developed federally and provincially. As there is no provincial or federal guidance to establish magnitude level of GHGs, the magnitude has been established as a percent contribution to provincial totals to assess the significance of Project emissions and hence potential effect on provincial reduction targets that may exist.
Low	■ 0.1%-0.5% of provincial totals	
Medium	■ 0.5%-1% of provincial totals	
High	■ >1% of provincial totals	

9.7 Consideration of Sustainability Principles

The sustainability assessment for the Project will be undertaken on the preferred alternative and will characterize the Project's contribution to sustainability incorporating the requirements set out in Section 25 of the TISG.

One aspect of the sustainability assessment is describing the process in selecting the preferred alternative to the Project and how the sustainability principles were considered. The effects assessment approach for the Project has included the consideration of the sustainability principles outlined in the Project TISG and the Agency's guidance on sustainability. The sustainability principles that have been considered include:

1. Consider the interconnectedness and interdependence of human-ecological systems;
2. Consider the well-being of present and future generations;
3. Consider positive effects and reduce adverse effects of the Project; and
4. Apply the precautionary principle by considering uncertainty and risk of irreversible harm.

11. Provincial totals refer to Provincial Transportation GHG Totals

The interconnectedness and interdependence of human-ecological systems will be considered through the assessment of potential indirect effects of each alternative. An indirect effect occurs when a change to one environmental discipline resulting from a Project activity causes a change to another environmental discipline (e.g., changes in vegetation could indirectly affect wildlife). A preliminary assessment of indirect effects has been included in **Section 9.3**.

The well-being of present and future generations will be considered in the effects assessment through the application of the long-term operations phase temporal boundary of 75 years (**Section 6.1**) and through the effects characteristics description of duration and reversibility for each residual effect predicted.

The consideration of positive effects and reducing adverse effects of the Project is fundamental to the effects assessment methodology through the identification of mitigation measures to reduce potential adverse effects and the identification of the preferred alternative through the evaluation of advantages (e.g., positive effects) and disadvantages (e.g., adverse effects).

The effects assessment will apply the precautionary principle by clearly describing and documenting all uncertainties and assumptions underpinning the analysis and identifying information sources. The effects assessment will consider risk of irreversible harm through the effects characteristics description of reversibility for each residual effect predicted and will describe any uncertainty associated with the assessment of residual effects.

The scope of the sustainability assessment will be defined by issues of importance identified by Indigenous communities and interested persons through consultation and engagement activities, while also ensuring to be inclusive of the diversity of views expressed. The selection of VCs that will be the focus of the sustainability assessment will be aligned with the issues of importance identified by Indigenous communities and interested persons, as well as residual effects identified through the effects assessment process. The sustainability assessment will describe how the planning and design of the Project, in all phases including follow-up monitoring, considered the sustainability principles.

9.8 Consideration of Identity and Gender-Based Analysis Plus in Effects Assessment

The Proponent recognizes that communities and sub-populations within those communities may be impacted differently by the Project with respect to VCs and indicators. As such, the Project aims to collect baseline information for the purpose of assessing differential effects and establishing relevant mitigation measures, as further elaborated on in **Section 4.3**. Gender-Based Analysis Plus will not be limited to community feedback, when offered or discussed in secondary texts, additional sub-population information as is applicable to the relevant assessment will be incorporated.

9.9 Follow-up Programs

A follow-up program verifies the accuracy of the effects assessment and evaluates the effectiveness of mitigation measures. Identification of follow-up programs for the Project are not described in this Study Plan as the information needed to determine environmental monitoring requirements is dependent on the outcome of the effects assessment and consultation with Indigenous communities, agencies and interested persons. Therefore, the Proponent will include information on follow-up programs, that address the requirements outlined in Section 26 of the TISG, in the IS / EA Report and will identify the compliance and effects monitoring activities to be undertaken during all phases of the Project, as required.

9.9.1 TISG Section 26 Requirements

Results of the air quality assessment will aid in determining if there is a need for follow-up monitoring programs described in TISG Section 26. The requirements of TISG section 26 will be considered when evaluating the air quality assessment results. The need for potential follow-up, such as additional monitoring, will be considered based on the air quality impact assessment results.

10. Assumptions

Any assumption used in the effects assessment will be clearly identified and a rationale provided in the IS / EA Report.

Examples of assumptions that will be used include but are not limited to:

- The average annual daily traffic on the CAR is considered to be a low traffic volume;
- Human settlement areas which will be assessed are assumed to be representative of all potential settlement areas over the lifespan of the Project;
- A worst-case year of vehicle emission rates will be used within modelling. Year over year improvements in vehicle fuel efficiency will not be considered;
- Specific inputs to the analysis will be selected based on currently available information (e.g., land use along the corridor, fuel type and composition). Changes to these types of parameters over the life of the Project cannot be accurately predicted, and;
- Vehicles will travel along the roadway at the posted speed limit.

11. Concordance with Federal and Provincial Guidance

This section provides the best information currently available on how federal and provincial requirements identified for the Project to date will be addressed. The final concordance with federal and provincial requirements will be included in the IS / EA Report, and will be based on regulatory agency guidance, professional judgement and input received through the Project consultation and engagement process.

Table 11-1: Study Plan Federal Concordance – Conformance with Requirements

ID #	Federal TISG Reference[12]	Requirement / Comment / Concern	Response	Study Plan Reference
1	TISG Section 1.1, page 4	■ The Guidelines correspond to factors to be considered in the impact assessment. These factors are listed in subsection 22(1) of IAAC and prescribe that the impact assessment of a designated project must take into account any change to the designated project that may be caused by the environment;	■ The potential effects of the Project on the atmospheric environment and the potential effects of the environment on the Project will be assessed in accordance with applicable standards and guidance.	■ Section 9
2	TISG Section 14.1, page 84	■ The Impact Statement must include an atmospheric dispersion model of the common air pollutants in order to estimate the contaminant concentrations present in the entire area that could potentially be affected by atmospheric emissions resulting from project activities (air pollutant emission sources);	■ AERMOD and CAL3QHCR modelling will be performed to assess atmospheric dispersion of pollutants within the LSA as a result of the Project.	■ Section 9.4.1
3	TISG Section 14.1, page 84	■ The Impact Statement must provide a comprehensive list of project activities (air pollutant emission sources) that may affect ambient air quality, such as, but not limited to: – the use of heavy machinery such as construction equipment; – vehicles and diesel generators during construction; – blasting activities; – exhaust emissions due to increased vehicular traffic during construction and operations; and – dust generation from material stockpiles, transportation and road maintenance during construction and operation.	■ All Project activities expected to contribute air pollutant emissions will be described in the Impact Statement.	■ Section 9.4
4	TISG Section 14.1, page 84	■ The Impact Statement must provide appropriately scaled contour map(s) plotting the predicted emission concentrations (isopleths). The choice of air quality model must be appropriate for the complexity of sources, terrain and meteorology;	■ Results will be presented for the LSA in scaled contour maps. The air quality models which have been selected (AERMOD, CAL3QHCR) are appropriate for the source types and nature of dispersion within the LSA.	■ Section 9.4.4
5	TISG Section 14.1, page 84	■ The Impact Statement must provide a quantitative assessment of common air pollutants (total particulate matter, fine particulate matter (PM2.5), respirable particulate matter with a diameter less than 10 microns (PM10), sulphur oxides, nitrogen oxides, volatile organic compounds polycyclic aromatic hydrocarbons, diesel particulate matter, and carbon monoxide), as well as any air contaminants potentially associated with the Project such as dust resulting from construction activities and ongoing vehicle use during operations or maintenance of the gravel road bed;	■ The Project will be assessed following the MECP dispersion modelling guidance and the MTO guidance for transportation air quality assessments for the requested contaminants. The contaminants assessed will be those required by the MTO guidance (i.e., NOx, CO, PM2.5, PM10, formaldehyde, acetaldehyde, benzene, 1,3-butadiene, and acrolein). Additionally, toluene, ethylbenzene, and xylene will be considered based on inclusion in the human health risk assessment.	■ Section 9.2
6	TISG Section 14.1, page 85	■ for air pollutants with numerical standards and/or established air quality criteria [e.g., Canadian Ambient Air Quality Standards (CAAQS), or Ontario Ambient Air Quality Criteria (AAQC)], observe the averaging time period and the statistical form associated with each numerical standard;	■ Predicted contaminant concentrations will be compared against applicable standards and / or criteria following the averaging time and statistical form associated with each standard and/or criteria.	■ Section 9.4.2
7	TISG Section 14.1, page 85	■ provide a description of all methods and practices (e.g., dust suppression strategies and guidelines, control equipment) to be implemented to reduce and control emissions. If the best available technologies are not included in the Project design, the proponent needs to provide a rationale for the technologies selected;	■ A description of the applicable control methods and practices will be included where applicable.	■ Section 9.4.1
8	TISG Section 14.1, page 85	■ provide justification for all control efficiencies used to reduce emission rates of sources within the model, including details of all assumptions associated with the related mitigation measures, and their achievability;	■ All modelling inputs and assumptions will be documented in the Impact Statement.	■ Section 9.4
9	TISG Section 14.1, page 85	■ The Impact Statement must describe the source characteristics (e.g., point emissions, area sources, incineration emissions, and fugitive sources, including dust generated by exposed soils that are cleared and stockpiled);	■ Each source included within the modelling will be described in the Impact Statement.	■ Section 9.4
10	TISG Section 14.1, page 85	■ The Impact Statement must use established methods for estimating emissions from on-road and off-road activities;	■ Emission rates will be estimated using the US EPA's Motor Vehicle Emission Simulator as well as established methods from ECCC and the US EPA.	■ Section 9.4
11	TISG Section 14.1, page 86	■ In regard to changes to the atmospheric, acoustic, and visual environment, the Impact Statement must describe any positive changes.	■ The Atmospheric and GHG effects assessment will identify positive and adverse effects that may be caused by the Project, on the environment.	■ Section 9.6

12. Federal TISG Reference should be the Section or subsection, page etc. that clearly identifies where comment/issue we are addressing can be found (ex. Section 8.1 of TISG)

ID #	Federal TISG Reference[12]	Requirement / Comment / Concern	Response	Study Plan Reference
12	TISG Section 14.1, page 86	■ describe consultation with regulators, stakeholders, community groups, landowners and Indigenous groups about potential effects to the atmospheric, acoustic, and visual environment	■ All consultation will be described in the Impact Statement.	■ Section 4
13	TISG Section 15.5, page 100	■ provide a description of each of the Project's main sources of GHG emissions	■ The Impact Statement will include a description and assessment of the total net GHG emissions associated with the Project, including each of the main sources. This assessment will include consideration of land use changes, such as the removal or alteration of existing peatlands.	■ Section 9.4.4
14	TISG Section 15.5, page 100	■ provide the estimated annual GHG emissions from each source, including calculation methods, assumptions and related parameters that would enable calculations to be reproduced	■ The Impact Statement will include a description and assessment of the total net GHG emissions associated with the Project.	■ Section 9.4.4
17	TISG Section 15.5, page 100	■ provide an estimate of yearly net GHG emissions for each year of the project lifetime, , including an uncertainty assessment, as per section 3 of the draft Strategic Assessment of Climate Change;"	■ The Impact Statement will provide an estimate of the annual net GHG emissions for each year of the Project. An uncertainty assessment will be conducted following guidance from section 3.3 of the SACC (2020). Assumptions that may result in variance to calculated GHG levels will be discussed relating both to data and methods used.	■ Section 9.4.4
18	TISG Section 15.5, page 100	■ provide a description of large sources of GHG emissions that may be the consequence of accidents or malfunctions	■ Where reasonable, the Impact Statement will provide an estimate of GHG emissions associated with accidents or malfunctions.	■ Section 9.4.4
19	TISG Section 15.5, page 100	■ provide a qualitative description of the Project's positive or negative effects on carbon sinks, including from the removal and alteration of wetlands	■ The Impact Statement will include an assessment of land use changes (e.g., wetlands or peatlands) and the resultant net GHG emissions.	■ Section 9.4.4
20	TISG Section 15.5, page 100	■ describe how the Project may contribute to Canada's efforts to reduce GHG emissions, if applicable (e.g., the Impact Statement could explain how the Project would result in emission reductions in Canada by avoiding emissions from another source)	■ The Impact Statement will present the predicted net change in GHG emissions.	■ Section 9.4.4
21	TISG Section 16.1, Page 103	■ With respect to biophysical determinants of health, the Impact Statement must provide an assessment of adverse and positive effects on human health in consideration of, but not limited to, potential changes in air quality.	■ The effects assessment will identify positive and adverse effects that may be caused by the Project, on the environment, related to the atmospheric environment. Refer to the Human Health and Community Safety Study Plan for more information on human health effects.	■ Human Health and Community Safety Study Plan
22	TISG Section 2.3, pages 6-7	■ The description should focus on aspects of the Project and its setting that are important in order to understand the potential environmental, health, social and economic effects and impacts of the Project. The following information must be included and, where appropriate, located on map(s): – geographic co-ordinates (i.e., longitude/latitude using international standard representation in degrees, minutes, seconds) for the beginning and end points of the proposed road; – current land and/or aquatic uses within the study areas; – distance of the project components to any federal lands and the location of any federal lands within the study areas; – all waterbodies and their location on a map; – navigable waterways; – the environmental significance and value of the geographical setting in which the Project will take place and the study areas; – environmentally sensitive areas, such as national, provincial, territorial and regional parks, UNESCO World Heritage Sites, geological heritage sites, ecological reserves, ecologically and biologically sensitive areas, wetlands, and habitats of federally or provincially listed species at risk and other sensitive areas; – Dedicated Protected Areas and any other areas of ecological and social significance identified by the community during the community-based land use planning processes with the Province of Ontario (e.g., Enhanced Management Areas; see Section 6.1 for requirements related to confidentiality); – lands subject to conservation agreements; – current mineral development proposals, and areas of early and advanced mineral exploration in the study areas;	■ The information related to landscape features, sensitive or protected areas and select others listed in the TISG will be illustrated on maps and / or described within the IS / EA Report, where appropriate.	■ Section 7

ID #	Federal TISG Reference[12]	Requirement / Comment / Concern	Response	Study Plan Reference
		– current areas of aggregate extraction; – description and locations of all potable drinking water sources (i.e., municipal or private), including spring water sources; – description of local communities and Indigenous groups that is culturally relevant and gender sensitive; – if the information is not confidential, provide a description and location of Indigenous traditional territories and/or consultation areas, Treaty and/or Title lands, Indian Reserve lands, Indigenous harvesting regions (with permission of Indigenous groups), Métis settlements; and – culturally important features of the landscape.		
22	TISG Section 20, page 119-128	■ Section 20 of the TISG describes the requirements around mitigation and enhancement measures that must be considered in the Impact Statement.	■ Identification of and assessment of effectiveness of impact management measures will be done as a discipline or VC-specific exercise where mitigation is required, and will be done as part of the IA / EA.	■ Section 9.5
23	TISG Section 21, pages 129-130	■ Section 21 of the TISG describes the requirements and guidance associated with determining residual effects.	■ Residual effects will be assessed in the IA / EA.	■ Section 9
24	TISG Section 26, Page 141	■ Section 26 of the TISG includes a description of the considerations for developing a follow-up program for environmental, health, social or economic effects, as applicable.	■ The IS / EA Report will include descriptions of follow-up programs, as required by VC.	■ Section 9
25	TISG Section 7.1, page 30	■ The Impact Statement must establish appropriate study area boundaries to describe the baseline conditions. The study area boundaries need to encompass the spatial boundaries of the Project, including any associated project components or activities, and the anticipated boundaries of the Project effects, including all potentially impacted local communities, municipalities and Indigenous groups. Considerations in assigning appropriate study areas or boundaries would include, but not be limited to: – areas potentially effected by changes to water quality and quantity or changes in flow in the watershed and hydrologically connected waters; – areas potentially effected by airborne emissions or odours; – areas determined by dispersion and deposition modelling; – areas within the range of vision, light and sound and the locations and characteristics of the most sensitive receptors; – species habitat areas, usage timing and migratory patterns; – emergency planning and emergency response zones; – the geographic extent of local and regional services; – any impacted local communities, including municipalities; – all potentially impacted Indigenous groups; – areas of known Indigenous land, cultural, spiritual and resource use; and – existing effected infrastructure.	■ The Study Areas are defined and described in this Study Plan, in Section 3.	■ Section 3
26	TISG Section 7.1, page 30	■ If the baseline data have been extrapolated or otherwise manipulated to depict environmental, health, social and/or economic conditions within the study area, modelling methods must be described and must include assumptions, calculations of margins of error and other relevant statistical information. Models that are developed should be validated using field data from the appropriate local and regional study areas. Ensure baseline data are representative of project site conditions. If surrogate data from reference sites are used rather than site-specific surveys, the proponent should demonstrate that the data are representative of project site conditions.	■ Baseline air quality monitoring will be collected at one location so will be considered representative of the entire study area, as described in the Study Plan.	■ Section 4
27	TISG Section 7.1, page 31	■ Where baseline data are available in geographic information system (GIS) format, this information is to be provided to the Agency as electronic geospatial data file(s) compliant with the ISO 19115 standard. This would support the Government of Canada's commitment to Open Science and Data and would facilitate the sharing of information with the public through the Canadian Impact Assessment Registry Internet Site	■ Complete data sets from all survey sites will be provided. They will be in the form of complete and quality assured relational databases, with precisely georeferenced site information, precise observation / visit information and with observations and measurements in un-summarized form. Databases and GIS files will be accompanied by detailed metadata that meets ISO 19115 standards (or equivalent). Documentation	■ Section 5.1

ID #	Federal TISG Reference[12]	Requirement / Comment / Concern	Response	Study Plan Reference
		and the Government's Open Science and Data Platform. The Agency intends to make the geospatial data files available to the public under the terms of the Open Government License – Canada.	and digital files will be provided for all results of analyses that allow for a clear understanding of the methods and a replication of the results.	
28	TISG Section 7.2, page 32	■ The Impact Statement must provide detailed descriptions of specific data sources, data collection, sampling, survey and research protocols and methods followed for each baseline environmental, health, social and economic condition that is described, in order to corroborate the validity and accuracy of the baseline information collected.	■ Descriptions of specific data sources, data collection, sampling, survey and research protocols and methods followed for each baseline environmental condition will be provided in the IS / EA Report and are summarized in this Study Plan.	■ Section 4
29	TISG Section 7.2, page 33	■ If using existing data sources, the Impact Statement must provide justification to show that the data sources are relevant in spatial and temporal coverage to the Project. Some data sources may have good coverage in Southern Ontario or existing road networks but be unsuitable as a baseline for these northern areas where there are not roads.	■ Justification for using existing data sources will be provided in the IS / EA Report	■ Section 7 ■ Appendix A
30	TISG Section 7.2, page 33	■ Existing data should be considered as a limited augmentation of this new data. See the "Establishing Baseline Conditions" (sections 8.5, 8.9, 8.10, 8.11) in this Tailored Impact Statement Guidelines for recommendations on survey design and methodology. Surveys and analyses should be conducted by qualified experts. Baseline data must be collected in a manner that enables reliable analysis, extrapolations and predictions. Resulting data should be suitable for analyses to estimate pre-project baseline conditions, derive predictions of impacts, and evaluate and compare post-project conditions and at scales of within and across the Project, Local and Regional Assessment areas. Modelling methods, error estimates and assumptions should be reported (as per section 7.1). Modelling and simulations should be used early in the planning phase to estimate the necessary sampling intensity and to quantitatively evaluate the effectiveness of design options. Ethical guidelines and relevant cultural protocols governing research, data collection and confidentiality must be adhered to.	■ Descriptions of specific data sources, data collection, sampling, survey and research protocols and methods followed for each baseline environmental condition will be provided in the IS / EA Report and are summarized in this Study Plan.	■ Section 4
31	TISG Section 7.2, page 33	■ Baseline data must be collected in a manner that enables reliable analysis, extrapolations and predictions. Resulting data should be suitable for analyses to estimate pre-project baseline conditions, derive predictions of impacts, and evaluate and compare post-project conditions and at scales of within and across the Project, Local and Regional Assessment areas. Modelling methods, error estimates and assumptions should be reported (as per section 7.1). Modelling and simulations should be used early in the planning phase to estimate the necessary sampling intensity and to quantitatively evaluate the effectiveness of design options. Ethical guidelines and relevant cultural protocols governing research, data collection and confidentiality must be adhered to.	■ Descriptions of specific data sources, data collection, sampling, survey and research protocols and methods followed for each baseline environmental condition will be provided in the IS / EA Report and are summarized in this Study Plan.	■ Section 4
32	TISG Section 7.2, pages 31-33	■ Information sources and data collection methods used for describing the baseline environmental, health, social and economic setting may consist of the following sources of information. For specific sources of baseline information, see Appendix 1. – Federal government (e.g., Environment and Climate Change Canada, Health Canada, Indigenous Services Canada, Statistics Canada, Women and Gender Equality Canada); – Ontario provincial government (e.g., Ministry of Environment, Conservation, and Parks, Ministry of Natural Resources and Forestry; – Bird Conservation Region plans; – academic institutions; – field studies, including site-specific survey methods; – database searches, including: – federal, provincial, territorial, municipal and local data banks; – Breeding Bird Atlas - Ontario (2001-2005) – monitoring program databases protected areas, watershed or coastal management plans; – natural resource management plans; – species recovery and restoration plans;	■ Data sources are being reviewed for their appropriateness and will be included in Study Plans where applicable. Information on specific data sources and their relevance to the Project will be included in the IS / EA Report.	■ Section 7 ■ Appendix A

ID #	Federal TISG Reference[12]	Requirement / Comment / Concern	Response	Study Plan Reference
		– field measurements to gather data on ambient or background levels for air, water, soil and sediment quality, light levels or acoustic environment (soundscape); – land cover data, including: • terrestrial ecosystem mapping products; • forest cover maps; • remote sensing resources; • important habitats and features to include: ○ water bodies, wetlands, watercourses; ○ riparian habitat; ○ river banks or other eroded habitats; ○ artificial water sources; ○ forest, tree patches, solitary trees (especially old decaying trees); ○ forest edges and tree rows; ○ ridges, including eskers; ○ caves and mines; ○ cliffs, rock outcrops, exposed bedrock, talus, and other karst topography; ○ buildings, bridges, and other anthropogenic features, including linear features; ○ sources of artificial lighting attracting insects; ○ critical habitat; and ○ and any other habitat features known to be important in the area. – Published literature, such as peer reviewed journals, reports by think tanks, non-government organizations and government reports; – environmental assessment documentation, including monitoring reports, from prior projects in the area and similar projects outside the area; – regional studies, project assessments and strategic assessments; – renewable harvest data; – Indigenous knowledge, including oral histories and knowledge gathered by spending time on the land with knowledge holders; – community based monitoring and studies conducted by Indigenous communities; – expert, community, public and Indigenous engagement and consultation activities, including workshops, meetings, open houses, surveys; – qualitative information gathered from interviews, focus groups or observation; – census data; – baseline human health risk assessments; – community and regional economic profiles; – community well-being studies; and – statistical surveys, as applicable.		
33	TISG Section 7.3, page 34	■ The list of valued components must be informed, validated and finalized through engagement with the public, Indigenous groups, lifecycle regulators, jurisdictions, federal authorities, and other interested parties. The Impact Statement must describe valued components, processes, and interactions that are identified to be of concern or that the Agency considers likely to be impacted by the Project and are included in the Guidelines.	■ A summary of the consultation plan for Indigenous communities, government agencies, and interested persons has been provided in Section 4 of the Study Plan; further details can be found in the IS / EA Consultation Plan included as Appendix B of the Proposed ToR. Specific consultation and engagement activities and schedules are currently in development and will be shared with the MECP and the Agency once available.	■ Section 4

ID #	Federal TISG Reference[12]	Requirement / Comment / Concern	Response	Study Plan Reference
34	TISG Section 7.4.1, page 36	■ For valued components establish three study area spatial boundaries to assess impacts to each valued component: 1) Project Study Area: defined as the project footprint for each alternative route; " 2) Local Study Area: defined for each valued component – see below; 3) Regional Study Area: defined for each valued component – see below ■ Provide a rationale for boundaries of the project study area, local study area, and regional study area for each valued component and indicate how the above objectives were met in establishing the boundaries.	■ Geographic extant, and the extant rationale, of the Project, Local, and Regional Study Areas for this VC are provided in this Study Plan.	■ Section 6
35	TISG Section 7.4.1, pages 35-36	■ The Impact Statement must describe the spatial boundaries, including project, local and regional study areas, for each valued component included in assessing the potential adverse and positive environmental, health, social and economic effects of the Project and provide a rationale for each boundary. Spatial boundaries are defined taking into account the appropriate scale and spatial extent of potential effects and impacts of the Project; community knowledge and Indigenous knowledge; current or traditional land and resource use by Indigenous groups; exercise of Aboriginal and Treaty rights of Indigenous peoples, including cultural and spiritual practices; and physical, ecological, technical, social, health, economic and cultural considerations. The size, nature and location of past, present and foreseeable future projects and activities are factors that should be included in the definition of spatial boundaries. It should be noted that in some cases, spatial boundaries might extend to areas outside of Canada. These transboundary spatial boundaries should be identified where transboundary effects are expected.	■ Geographic extant, and the extant rationale, of the Project, Local, and Regional Study Areas for this VC are provided in this Study Plan.	■ Section 6
36	TISG Section 8.1, page 39	■ The Impact Statement must provide the approximate number, distance and identity factors of likely human receptors, including any foreseeable future receptors, that may be impacted by changes in air, water, country food quality (e.g., dust deposition on vegetation), and noise levels. At minimum, provide a map showing approximate locations of permanent residences, temporary land uses (e.g., cabins and traditional sites) and known locations of sensitive human receptors (e.g., schools, hospitals, community centres, retirement complexes or assisted care homes).	■ Identified receptor locations will be described in the IS / EA Report. The sensitive receptors described in this TISG requirement are captured by other disciplines (e.g., Human Health and Community Safety and Aboriginal and Treaty Rights and Interests). Results from the Atmospheric Environment and GHG assessment will be used by other disciplines in assessing impacts to receptors. The relevant criteria (AAQC, CAAQS) have been developed in consideration of effects at any applicable receptor type.	■ Section 9.4
37	TISG Section 8.1, pages 38-39	■ The Impact Statement must: – provide the results of a baseline survey of ambient air quality by identifying and describing emission sources for the following contaminants: total suspended particulates, fine particulates smaller than 2.5 microns (PM2.5), respirable particulates of less than 10 microns (PM10), carbon monoxide (CO), ozone, sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOCs)25, polycyclic aromatic hydrocarbons (PAHs), diesel particulate matter (DPM), and any other toxic air pollutants (mobile and stationary sources); " – "for air pollutants with numerical standards and/or established air quality criteria, [e.g., Canadian Ambient Air Quality Standards (CAAQS), or Ontario Ambient Air Quality Criteria (AAQC)], observe the averaging time period and the statistical form associated with each numerical standard; " – "address seasonal variability in the baseline survey and include a determination of background or ambient contaminant concentrations at key receptor points (e.g., traditional land users, sensitive human receptors such as daycares, schools, hospitals, community centres, retirement complexes or assisted care homes) with monitoring data of appropriate duration, representativeness, data completeness, data validation and quality control, baseline air quality monitoring is to be provided for a minimum of one year to represent seasonal variability; – provide dispersion modelling of a base case to account for existing pollutant sources and to determine the spatial distribution of pollutants within the study area; – describe all direct and indirect sources of baseline air emissions, including mobile, stationary and fugitive;	■ These items are addressed in our study plan. Brief summary: – we will use monitoring to develop baseline concentrations of PM10, PM2.5, NOx, acetaldehyde, formaldehyde, benzene, acrolein, and 1,3-butadiene. – addressed above. Included within scope – we will use monitoring to represent baseline. No modelling of baseline concentrations will be performed to predict concentrations at specific receptor locations. – monitoring will be used to address base case. Dispersion modelling is not practical to quantify base case. – a description of general sources in the area will be included, but no quantification of emissions or modelling is included.	■ Section 7

ID #	Federal TISG Reference[12]	Requirement / Comment / Concern	Response	Study Plan Reference
38	TISG Section 8.2, page 40	■ The Impact Statement must: – describe the local and regional climate including historical records of relevant meteorological information (e.g., total precipitation (rain and snow)); – provide mean, maximum and minimum temperatures; – provide typical wind speed and direction; – identify the potential for extreme weather events such as, wind, precipitation and temperature extremes;	■ The IS / EA Report will describe local and regional climate, based on data availability. Up to one-year of meteorological data will be developed from prognostic data and will be provided, including: wind speed and direction, temperature, and precipitation.	■ Section 7.2
39	TISG Section 8.6, page 44	■ The Impact Statement must provide complete hydrometeorological (temperature, precipitation, evapotranspiration) information based on data from nearby weather stations or from a weather station on site;	■ Weather parameters will be summarized for the area and presented in the IS / EA Report.	■ Section 7.2
40	TISG Section 7.3, page 35	■ For each of the valued components that will be assessed in the Impact Statement, the proponent must create a study plan and a work plan to be validated by the Agency. Upon receipt of a study plan, the Agency may request that the proponent present and discuss the study plan at technical meetings, which will be scheduled during the impact statement phase.	■ The Study Plan meets this requirement. A summary of the technical discussions with agencies have been provided in Section 3 of the Study Plan.	■ Section 3
41	TISG Section 7.3, page 35	■ The valued components must be described in sufficient detail to allow the reviewer to understand their importance and to assess the potential adverse and positive environmental, health, social and economic effects and impacts arising from the Project activities.	■ The IS / EA Report will include detailed descriptions of the VCs and the rationale for their inclusion to describe their importance and the predicted residual effects (adverse and positive) as a result of the Project.	■ Section 9
42	TISG Section 7.4.2, page 37	■ The temporal boundaries of the impact assessment span all phases of the Project determined to be within the impact assessment. If potential effects are predicted after project decommissioning or abandonment, this should be taken into consideration in defining specific boundaries. In order to assess a project's contribution to sustainability, consideration should be given to the long-term effects on the well-being of present and future generations. When defining temporal boundaries, the proponent should consider how elements of environmental, health, social and economic well-being that local communities, including municipalities, and Indigenous groups identify as being valuable could change over time.	■ Modelling scenarios based on the MTO guidance (i.e., build year plus 20 years in future). The future-build scenario is aligned with MTO guidance to allow for predictability of key inputs to relevant models (e.g., vehicle fleet composition, vehicle age, fuel type). Selection of timelines beyond this may reduce the accuracy of model outputs.	■ Section 9.4.1
43	TISG Section 7.3, pages 34-35	■ In selecting a valued component to be included, the following factors should be considered: – valued component presence in the study area; " – "the extent to which the valued component is linked to the interests or exercise of Aboriginal and Treaty rights of Indigenous peoples, and whether an Indigenous group has requested the valued component; – "the extent to which the effects (real or perceived) of the Project and related activities have the potential to interact with the valued component; – "the extent to which the valued component may be under cumulative stress from other past, existing or future undertakings in combination with other human activities and natural processes; – "the extent to which the valued component is linked to federal, provincial, territorial or municipal government priorities (e.g., legislation, programs, policies); – "the extent to which the valued component is being addressed through any ongoing or completed regional assessment processes; – "the possibility that adverse or positive effects on the valued component would be of particular concern to Indigenous groups, the public, or federal, provincial, territorial, municipal or Indigenous governments; and – whether the potential effects of the Project on the valued component can be measured and/or monitored or would be better ascertained through the analysis of a proxy valued component.	■ The IS / EA Report will include detailed descriptions of the VCs and the rationale for their inclusion to describe their importance and the predicted residual effects (adverse and positive) as a result of the Project.	■ Section 9

Table 11-2: Study Plan Provincial Concordance – Conformance with Requirements

ID	Comment From Regulatory Agency	Comment Type	Requirement / Comment / Concern	Response	Study Plan Reference
1	MECP	■ Email from Agni Papageorgiou & Sasha McLeod, Special Project Officer Environmental Assessment Services Section, Ministry of the Environment, Conservation and Parks with comments of the Draft ToR	■ #17 Section 8 Page 54 – Consultation on Assessment Methodology - MFFN acknowledges that the proposed methodology will be open to input during the draft ToR review, but also says a more detailed method will be presented in the EA. Page 47 indicates the effects assessment criteria will be developed during the EA. While it is appropriate to defer some detailed work planning to the EA phase, the ToR should include commitments for how technical reviewers, and other interested persons, will be consulted during the development of specific evaluation methodologies or technical work plans. It is strongly recommended that those opportunities for review occur prior to the completion of studies (e.g., prior to the submission of a draft or final EA document).It is not clear whether MFFN plans to consult on the more detailed methodology and criteria during the EA phase or if the ToR phase is the main opportunity to provide input. – Please indicate how consultation on the ToR has informed the preliminary criteria and indicators. Please clarify when MFFN will consult and provide opportunity for input on the detailed assessment method, including criteria and indicators (and work plans as MECP has proposed), with agencies, communities and stakeholders during the EA phase in order to finalize the methodologies before EA studies get advanced.	■ The Study Plan meets this requirement. ■ As identified in Section 4.2 of the Study Plan, the Proponent will provide opportunities for consultation and engagement with Indigenous communities identified in Table 4-1, which is inclusive of all Indigenous communities identified in the Indigenous Partnership and Engagement Plan for the Marten Falls Community Access Road Project Impact Assessment (The Agency 2020a). ■ Further information on how Indigenous Knowledge will be considered in the IS / EA Report has been included in Section 5 of the Study Plan. Section 5 of the Study Plan provides further details on the two concurrent and complementary avenues for Indigenous communities and groups to be engaged with and provide input on the Project: the Indigenous Knowledge Program and the Consultation and Engagement Program.	■ Section 4 ■ Section 5
2	MECP	■ Email from Agni Papageorgiou & Sasha McLeod, Special Project Officer Environmental, MECP Assessment Services Section, Ministry of the Environment, Conservation and Parks with comments of the Draft ToR	■ Assessment Methods – For the most part, section 7.2 provides a description of potential environmental effects for each discipline. However this section also includes assessment methodologies for some subsections (7.2.1 and 7.2.2 AERMOD modelling, quantitative noise assessment) while the majority do not (7.2.3 – 12). The level of detail in the ToR about assessment methods should be consistent for all environmental components. – It is strongly recommended to include commitments to develop work plans at the outset of the EA phase, including opportunities for technical review by agencies and others. The work plans should include assessment methodology appropriate for each environmental component. The ToR could include a high level summary table for each environmental discipline listing data collection and assessment methods, with a commitment to develop the work plans at the outset of the EA phase to provide more details. Consider where the information about air and noise modelling is best placed.	■ The Study Plan meets this requirement.	■ Section 7 ■ Section 8
3	MECP	■ Email from Agni Papageorgiou & Sasha McLeod, Special Project Officer Environmental, MECP Assessment Services Section, Ministry of the Environment, Conservation and Parks with comments of the Draft ToR	■ #16 Section 8 Page 54 – Work Plans - Section 8 describes the approach that will be taken to evaluate alternative methods during the EA, including proposed criteria and indicators (presented in Appendix A). The information presented is high level and does not provide an opportunity for technical review of the methodologies that will be applied to evaluate those specific criteria and indicators. It is strongly recommended to include commitments to develop work plans at the outset of the EA phase, including opportunities for technical review by agencies and others.	■ This Study Plan will be reviewed by relevant federal and provincial agencies.	■ Section 9

ID	Comment From Regulatory Agency	Comment Type	Requirement / Comment / Concern	Response	Study Plan Reference
4	MECP	■ Email from Guowang Qiu, Air Quality Analyst Technical Support, Northern Region, Ministry of the Environment, Conservation and Parks with comments of the Draft ToR	■ #1 Section 7.1.4.1 – The Draft ToR indicates that a one-year air quality monitoring program is planned to measure concentrations of nitrogen oxides, particulate matter (e.g., PM2.5, PM10, total suspended particulate), carbon monoxide, sulphur dioxide, benzene, toluene, ethylbenzene, and xylene, which will be used to establish baseline air quality for the project. It is recommended that the proponent consult the ministry as early as possible to ensure that the proposed ambient air monitoring program will meet requirements as specified in the Operations Manual for Air Quality Monitoring in Ontario (2018 revised version).Section 7.1.4.1 should include a discussion on how the planned air quality monitoring program will meet the requirements of the Operations Manual for Air Quality Monitoring in Ontario to ensure the collection of accurate air monitoring data.	■ MECP will be consulted regarding the implementation of the monitoring program. Note: consultation is underway.	■ Section 7.2.1
5	MECP	■ Email from Guowang Qiu, Air Quality Analyst Technical Support, Northern Region, Ministry of the Environment, Conservation and Parks with comments of the Draft ToR	■ #3 Appendix A – Ambient Air Quality Criteria should be added into the Appendix A – Draft Criteria & Indicators for Alternatives Evaluation as one of the Potential Data Sources. – Please add Ontario's Ambient Air Quality Criteria into the Appendix A as one of the Potential Data Sources for Atmospheric Environment.	■ This source has been included in our provided Study Plan.	■ Appendix A
6	MECP	■ Completeness Review Memorandum compiled from MECP emails and August 2019 meetings with MECP and ENDM	■ Study areas are missing and lack clarity – maps show study area for 4 routes even though only 2 (or 1?) routes are proposed to be assessed; no indication of local and regional study areas for each environmental component (e.g., groundwater, surface water, caribou, etc.).	■ The Study Areas are defined and described in the Study Plan.	■ Section 6
7	MNRF	■ Letter received from Dave Barker, Resources Management Supervisor, Nipigon District, MNRF on the Draft Terms of Reference	■ Sec. 7 pg. 19 – Nearly one-half of the 190 to 230 km proposed road is through the James Bay Lowlands. Road construction through landscapes dominated by wetlands has a potential to significantly alter watershed hydrology, with changes in greenhouse gases (GHG) a likely outcome. This can have negative implications on GHG production, possibly altering carbon balances well beyond the 35-m width of the corridor. Retaining background carbon and GHG balances in response to land development remain national and international priorities. We strongly recommend that a carbon and GHG evaluation be completed as part of the EA so that these effects can be considered. At minimum, the review of literature on road construction effects on carbon should be undertaken for this EA. Data exists for the study region that the client should review and evaluate. These include government and conservation society reports, peer-reviewed manuscripts, and databases of carbon/GHG, weather, geology, vegetation, etc. The client is encouraged to apply the carbon/GHG calculations provided in 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. It is further recommended the project test the IPCC calculations against data collected along the length of road network.	■ The potential GHG emissions resulting from the Project will be assessed in accordance with applicable standards and guidance. As an example, IPCC resources may be used in the estimation of greenhouse gas emissions as a result of land use changes.	■ Section 9.4.8

Table 11-3: Study Plan Federal and Provincial Concordance – Requirement Deviations

ID #	Federal TISG Reference[13] or Provincial Draft ToR Comment Reference[14]	Requirement / Comment / Concern	Response (Rationale for not meeting requirement)	Justification (for not complying with requirement including for example scientific research, precedence)	Proposed TISG Amendment
1	TISG Section 7.2, page 33	▪ With regard to field studies, survey work must be planned to include multiple sampling locations and multiple visits to each location to support all required assessment analyses.	▪ The Atmospherics and Greenhouse Study Plan does not include multiple locations for survey work.	▪ Within the LSA the community of Marten Falls is the primary area of human settlement and is the only location with sufficient power and serviceability access to support air quality monitoring equipment. The measured values in the community are a reasonably conservative characterization of baseline ambient air quality across the LSA. Concentrations within Marten Falls are expected to be elevated in comparison with the remainder of the LSA due to the presence of sustained human activity (e.g., power generation, airport). Therefore, using background data collected from within Marten Falls is expected to result in a conservative characterization of baseline conditions.	▪ TISG should be updated to remove the requirement to include multiple sampling locations for the Atmospherics and Greenhouse Gasses Study Plan.
2	TISG Section 8.2, page 40	▪ The Impact Statement must: – provide hourly meteorological data (wind speed and direction, air temperature, net radiation, turbulence and precipitation data) from a minimum of one year to support dispersion modelling that captures the normal variability of meteorological conditions; and – provide pan evaporation measurements or estimates of monthly (or daily) evapotranspiration.	▪ Parameters not directly used within dispersion modelling will not be included within the Atmospheric and GHG Study Plan.	▪ The Potential for extreme weather events and pan evaporation measurements are not relevant to the air quality study and will not be provided. These values are not included within dispersion modelling.	▪ TISG should be updated to remove the requirement to include extreme weather events, and pan evaporation measurements , as well as parameters not directly used within dispersion modelling,
3	TISG Section 14.1, page 84	▪ "provide an assessment of the Project's emissions potentially contributing or adding to existing ground ozone levels;"	▪ The potential for the Project to contribute to ground-level ozone will be qualitatively assessed for both the construction and operation phases. Potential for the generation of ground-level ozone will be evaluated based on the predicted increase in NOx and Volatile Organic Compounds around the Project area. Ozone formation will not be quantitatively assessed as the magnitude of effects is expected to be negligible.	▪ In the Ministry of Transportation's Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects, the MTO states that, with respect to the formation of ground-level ozone, "ground-level ozone O3 is typically formed many kilometres downwind of the source of its precursors" and "concentrations are usually depressed around highways since NO emissions react relatively rapidly to convert O3 into oxygen gas." The MTO also states that "For major roads, the collective experience of the scientific community suggests that the affected immediate vicinity is limited to the area within approximately 500 metres of the road". Based on this, the contribution of the Project to ground-level ozone is likely to be minor in comparison to the near-field concentration of precursor species (i.e., NOx).	▪ TISG should be updated to remove the requirement to evaluate ground level ozone

13. Federal TISG Reference should be the Section or subsection, page etc. that clearly identifies where comment/issue we are addressing can be found (ex. Section 8.1 of TISG)
14. This should include ID # reference (from excel table you were provided with all Draft ToR comments) and commenter.

ID #	Federal TISG Reference[13] or Provincial Draft ToR Comment Reference[14]	Requirement / Comment / Concern	Response (Rationale for not meeting requirement)	Justification (for not complying with requirement including for example scientific research, precedence)	Proposed TISG Amendment
4	TISG Section 14.1, page 85	■ The Impact Statement must provide details of all air quality model configuration, including meteorology, land use, gridded and sensitive receptors and chemical and physical transformation settings	■ The air quality modelling will be described in detail within the Impact Statement. No chemical or physical transformation will be included in the modelling as the dispersion of emissions are expected to be generally low-level and near-field with respect to the Project.	■ The Study Plan intended to communicate that the formation of secondary contaminants through chemical and physical transformation is expected to be low-level based on the predicted roadway volumes. While some formation of secondary particulate is expected, the Project is in a pristine setting without large industrial or transportation sources. Secondary formation is dependent on the presence of precursor species which will be limited because of the pristine nature of the environment. Based on a projected AADT of 400 vehicles per day, the emissions of precursor species are expected to be relatively dilute in the atmosphere. ■ Additionally, the formation of secondary contaminants is not instantaneous, and occurs downwind of the source at which point the initial precursor contaminants have begun to disperse. In consideration of these factors, it is expected that assessing the near-road impacts of primary contaminants will result in a reasonably conservative Air Quality Assessment ■ One exception to the above is the conversion of NO to NO2. It will be conservatively assumed that 100% of all NO emitted from the Project will be converted to NO2.	■ TISG should be updated to remove the requirement to evaluate secondary transformation
5	TISG Section 14.1, page 85	■ The Impact Statement must assess the potential for emissions from the Project to contribute to acid deposition and exceedances of critical loads for terrestrial and aquatic ecosystems;	■ The potential for the Project to contribute to acid deposition will be qualitatively assessed for both the construction and operation phases. Potential for acid formation will be evaluated based on the predicted increase in NOx and SOx to the airshed and subsequent potential nitrate and sulphate formation. Acid deposition will not be quantitatively assessed as the magnitude of effects is expected to be negligible.	■ Acid deposition is a regional effect, meaning that near-roadway concentrations are not as important as airshed concentrations. It is estimated that the Project will partially displace air travel with road vehicle traffic. The impact of this modal shift on the contribution of NOx and SO2 to the airshed will be assessed and a qualitative statement regarding the implications for acid deposition will be provided.	■ TISG should be updated to remove requirement for quantitative analysis of acid deposition
6	TISG Section 14.1, page 85	■ The Impact Statement must provide emission rates for all project and regional sources within the study area, including emission factors (with methodology, uncertainty assessment and references) and all assumptions and related parameters that would enable calculations to be reproduced"	■ Baseline air quality monitoring will be used to represent the Project Area and is assumed to include in the effect of any relevant regional sources. Therefore, regional source emissions will not be quantified or included in the dispersion modelling.	■ The majority of sources are expected to be personal vehicles, residential heating, and other miscellaneous activities. There are no significant sources (e.g., large industries) which would contribute to emissions in the Study Area. ■ As described earlier, a conservative Air Quality Assessment is one which describes the reasonable worst-case impact of the Project. Background concentrations within Marten Falls are expected to be higher than the rest of the Study Area. Therefore, using measured concentrations in the Study Area will result in a conservative Air Quality Assessment.	■ TISG updated to remove requirement of providing emission rates for all Project and regional sources

ID #	Federal TISG Reference[13] or Provincial Draft ToR Comment Reference[14]	Requirement / Comment / Concern	Response (Rationale for not meeting requirement)	Justification (for not complying with requirement including for example scientific research, precedence)	Proposed TISG Amendment
7	TISG Section 14.1, page 85	■ The Impact Statement must provide a comparison of predicted air quality concentration against the Canadian Ambient Air Quality Standards (CAAQS) for fine particulate matter (PM2.5), sulphur dioxide (SO2) and nitrogen dioxide (NO2), and ozone (O3)."	■ Ozone is not a primary contaminant related to the Project.	■ Considering the projected roadway volumes (200-300 vehicles per day), an assessment of the formation of ozone is not warranted. Ozone formation will be qualitatively assessed.	■ TISG should be updated to remove requirement to provide comparison of ozone (O3) against CAAQS
8	TISG Section 14.1, page 85	■ "provide details of the achievement of emission standards for all mobile and stationary engines used in the Project;"	■ The Project is a public roadway. Ongoing operation of the roadway is not controlled by the project team. The project team cannot guarantee the types of vehicles that drive on the road.	■ The Project is a public roadway. Ongoing operation of the roadway is not controlled by the MFFN CAR Project Team. The MFFN CAR Project Team cannot guarantee the types of vehicles that drive on the road.	■ TISG should be updated to remove requirement to provide details of the achievement of emission standards for all mobile and stationary engines used in the Project
9	TISG Section 14.1, page 86	■ "describe the locations and characteristics of the most sensitive receptors including species at risk and differential effects for sensitive receptors;"	■ Identified receptor locations will be described in the Impact Statement. Differential effects will not be considered in the Atmospheric Environment assessment. Results from the Atmospheric Environment will be used by individual disciplines in assessing impacts to receptors.	■ The relevant criteria (AAQC, CAAQS) have been developed in consideration of effects at any applicable receptor type.	■ TISG should be updated to remove requirement of assessing differential effects for sensitive receptors
10	TISG Section 15.5, page 100	■ "describe how the Project could impact global GHG emissions, including if the Project is expected to displace emissions internationally. The Impact Statement should describe how the Project is likely to result in global emission reductions. For example, a Project that enables the displacement of high-emitting energy abroad with lower emitting energy produced in Canada could be considered as having a positive impact."	■ The Project will not displace international GHG emissions. GHG emissions will be assessed against provincial, federal and sector GHG totals.	■ Due to the size and nature of the Project the Project is not expected to displace international GHG emissions.	■ TISG should be updated to remove requirement to describe impact on global GHG emissions

12. References

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Appendix A

Preliminary List of Data Sources

Environment and Climate Change Canada:
Historical Weather Data, https://climate.weather.gc.ca/historical_data/search_historic_data_e.html

Environment and Climate Change Canada:
Greenhouse Gas Reporting Program, https://open.canada.ca/data/en/dataset/a8ba14b7-7f23-462a-bdbb-83b0ef629823

Environment and Climate Change Canada:
National Air Pollution Surveillance Program, https://open.canada.ca/data/en/dataset/1b36a356-defd-4813-acea-47bc3abd859b

Ontario GeoHub:
Ontario Provincial Digital Elevation Model data, https://geohub.lio.gov.on.ca/datasets/882a9059ec7c4881abbdb6afa0ae73e6

Appendix B

Agency Comments on the Draft Study Plan

Draft Study Plan Comments – Federal

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
GC	■ General Comment	■ Sections 5, 6, 7, 13, 19.2 and 25	The Agency	■ In addition to the required actions detailed below, other required actions to be addressed in the update to this study plan are detailed in a separate table titled “2020-07-02 – IAAC to MFCAR - General Comments on MFCAR Draft Study Plans”. The Agency has provided these other required actions to highlight common sections of the Guidelines where requirements were not met in the draft study plans submitted to the Agency. These additional actions must be addressed in the updated study plans.	■ Please see Comment / Context	■ We have reviewed the relevant comments and incorporated where appropriate. Please refer to the General Comments Table Response submitted separately to the Agency for specific responses.	■ Various Sections
GC	■ General Comment	■ Section 15.5	The Agency	■ It is unclear whether all requirements related to the Project’s impact on climate change were integrated into the atmospheric environment study plan. The climate change study plan only addresses requirements related to the effects of climate change on the Project. The Impact Statement must address all requirements related to the Project’s impact on climate change that are outlined in Section 15.5 of the Guidelines and the study plan should demonstrate clear approaches to meet those requirements.	■ Provide detail in the atmospheric environment study plan to explain the proposed approaches and methods used to integrate all of the requirements in the Guidelines related to the Project’s impact on climate change, particularly Section 15.5.	■ The Project’s impact on climate change is addressed in this Study Plan, and the impact of climate change on the Project is addressed in the Climate Adaptation and Resiliency Study Plan.	■ Section 9.4
AQ-01	■ Section 4.2 Study Methods – “The baseline Atmospheric Environment study will characterize the existing conditions for air quality. The study will involve a year-long field monitoring program. Quantifying existing emission sources for the Community as well as the remainder of the project footprint is not practical nor could it be completed to a degree that would produce reliable model results as a basis for establishing background.”	■ Section 8.1 – “address seasonal variability in the baseline survey and include a determination of background or ambient contaminant concentrations at key receptor points (e.g., traditional land users, sensitive human receptors such as daycares, schools, hospitals, community centres, retirement complexes or assisted care homes) with monitoring data of appropriate duration, representativeness, data completeness, data validation and quality control… provide the	The Agency	■ Section 8.1 of the Guidelines outlines the type of receptors and key receptor location points to be considered for baseline studies (e.g., traditional land users, sensitive human receptors such as daycares, schools, hospitals, community centres, retirement complexes or assisted care homes). The only reference to key receptors in the study plan is in Table 7-1. The study plan does not provide any details about the applicable receptor types and their potential locations. It is unclear whether the requirements of Section 8.1 of the Guidelines will	■ Provide details to demonstrate that key receptor points have been or will be identified and include details on how monitoring data of background or ambient contaminant concentrations will be collected for all key receptor points. ■ Explain how the selection of sensitive receptors will take into account the views of all Indigenous groups listed in the IEPP. This includes incorporating into the plan where Indigenous groups will be provided with opportunities to:	■ Sensitive receptor locations within the study area will be identified and evaluated in the IS / EA Report. Sensitive receptors will include the typical receptor types used in atmospheric assessments: residences, schools, healthcare facilities, daycares. In addition to the typical receptor types, indigenous receptor locations will be included in the assessment based on engagement completed as part of the project. ■ Background concentrations will be collected in the community of Marten Falls for a period of up to to	■ Section 9.4

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
	■ Section 7 Conformance with Federal and Provincial Guidance – "Identified receptor locations will be described in the Impact Statement. Differential effects will not be considered in the Atmospheric Environment assessment. The relevant criteria (AAQC, CAAQS) have been developed in consideration of effects at any applicable receptor type".	approximate number, distance and identity factors of likely human receptors, including any foreseeable future receptors, that may be impacted by changes in air, water, country food quality (e.g., dust deposition on vegetation), and noise levels. At minimum, provide a map showing approximate locations of permanent residences, temporary land uses (e.g., cabins and traditional sites) and known locations of sensitive human receptors (e.g., schools, hospitals, community centres, retirement complexes or assisted care homes)."		be met by the study plan. It is also unclear how the views of the Indigenous groups identified in the Indigenous Engagement and Partnership Plan (IEPP) would be included in the selection of key receptors and receptor locations.	– provide Indigenous knowledge during baseline data collection; – comment on the list of valued components and indicators; – inform the effects assessment and review its conclusions; and – inform the development of mitigation measures and follow-up programs.	one year. The data collected within the community will be conservatively assumed to represent the entire study area. It is expected that baseline concentrations within Marten Falls will be higher than the remainder of the Study Area. As a result, the use of data collected within Marten Falls will provide a more conservative assessment of impacts (based on cumulative impacts being defined as background concentrations plus predicted Project impacts), and will result in an assessment which is more protective of receptors. ■ Additionally, the logistics of collecting reference-level data in the remote wilderness of Northern Ontario is prohibitive to deploying any additional monitoring. Monitoring equipment requires a reliable power source and routine maintenance (e.g., snow cleared from around the inlet ports, filter changes) which are not feasible outside of a community. It is important to note that reference-level data are not practical using solely solar powered equipment.	
AQ-02	■ Section 4.2 Study Methods – "Quantifying existing emission sources for the Community as well as the remainder of the project footprint is not practical nor could it be completed to a degree that would produce reliable model results as a basis for establishing background. Therefore, modelling is not proposed for this aspect."	■ Section 8.2 – "provide hourly meteorological data (wind speed and direction, air temperature, net radiation, turbulence and precipitation data) from a minimum of one year to support dispersion modelling that captures the normal variability of meteorological conditions"	The Agency	■ It is unclear how the requirements from Section 8.2 of the Guidelines will be collected to support dispersion modelling that captures the normal variability of meteorological conditions.	■ Provide details on how the requirements of Section 8.2 of the Guidelines for hourly meteorological data to support dispersion modelling will be met in the Impact Statement.	■ A 5-year hourly meteorological data to support dispersion modelling will be developed. Environment and Climate Change Canada measured data from stations in proximity to the study area and prognostic data (e.g., WRF data) for the study area will be used.	■ Section 9.4

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
AQ-03	■ Section 4.2.1 Ambient Air Quality Monitoring – "An airpointer(2) will be deployed in the Community to monitor…as well as meteorological parameters including: wind speed, wind direction, temperature, relative humidity, barometric pressure, and precipitation."	■ Section 8.2 – "describe the local and regional climate including historical records of relevant meteorological information (e.g., total precipitation (rain and snow)); provide mean, maximum and minimum temperatures; provide typical wind speed and direction; identify the potential for extreme weather events such as, wind, precipitation and temperature extremes; provide hourly meteorological data (wind speed and direction, air temperature, net radiation, turbulence and precipitation data) from a minimum of one year to support dispersion modelling that captures the normal variability of meteorological conditions; and provide pan evaporation measurements or estimates of monthly (or daily) evapotranspiration."	The Agency	■ Section 4.2.1 of the study plan provides a list of meteorological parameters for the proposed ambient air quality monitoring that does not include all parameters outlined in Section 8.2 of the Guidelines. The Impact Statement must include all the requirements found in Section 8.2 of the Guidelines, and the study plan must describe a clear approach to meeting those requirements.	■ Provide details on how all requirements of Section 8.2 of the Guidelines will be included in the Impact Statement.	■ Meteorological parameters such as pan evaporation and evapotranspiration, and climate data such as extreme weather events, are not considered in air dispersion modelling. Any parameter not used as an input into the air dispersion modelling assessment will have no influence on the impact assessment and will therefore not be provided in the Air Quality Assessment Report.	■ Section 9.4
AQ-04	■ Section 4.2.1 Ambient Air Quality Monitoring – "Monitored concentrations collected within the Community will be considered to be representative of all locations within the community and will be used to help establish background concentrations within the PSA. – Baseline monitoring for the remainder of the PSA is not feasible given the remote nature of the Project corridor and lack of practical power and serviceability access. Therefore, monitoring at the Community will have to serve as the basis for establishing baseline and background values."	■ Section 7.1 – "Ensure baseline data are representative of project site conditions."	The Agency	■ It is unclear how it was determined that monitored concentrations from the monitoring station within the community will be representative of all receptor locations within the project study area (PSA).	■ Provide details and rationale for how data collected from the monitoring station located at the community nursing station will be representative of baseline emissions at all receptor locations within the PSA.	■ The intention of the Air Quality Assessment is to provide a realistic worst-case estimate of the impact on air quality as a result of the Project. The air quality assessment will add background concentrations to the predicted Project emissions to determine cumulative impacts within the PSA. Therefore, using the maximum background concentrations which would reasonably expected within the PSA will result in a conservative Air Quality Assessment. ■ Concentrations within Marten Falls are expected to be elevated in comparison with the remainder of the study area due to the presence of sustained human activity (e.g., power generation, airport, and heating fuel use). Therefore, using background data collected from within Marten Falls is expected to result in a conservative Air Quality Assessment.	■ Section 7.2.1

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
AQ-05	■ Section 4.2.1 Ambient Air Quality Monitoring – "….An airpointer2 will be deployed in the Community to monitor particulate matter (PM2.5), ozone, nitrogen oxides (NOx), sulphur dioxide (SO2), carbon monoxide (CO), and BTEX (benzene, toluene, ethylbenzene, and xylene) (…). BTEX and particulate matter will be used as surrogates for polycyclic aromatic hydrocarbons and diesel particulate matter which cannot be sampled for due to equipment limitations coupled with serviceability challenges given the relatively remote location. Concentrations of specific relevant contaminants such as acetaldehyde, formaldehyde, 1,3-butadiene, and acrolein will be estimated based on monitored BTEX concentrations and published emission factors, such as the United States Environmental Protection Agency's (US EPA) AP-42 emissions database." – (Note 2: Health Canada. 2016. Guidance for Evaluating Human Health Impacts in Environmental Assessment: AIR QUALITY.)	■ Section 8.1 – "• provide the results of a baseline survey of ambient air quality by identifying and describing emission sources for the following contaminants: total suspended particulates, fine particulates smaller than 2.5 microns (PM2.5), respirable particulates of less than 10 microns (PM10), carbon monoxide (CO), ozone, sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOCs)(25), polycyclic aromatic hydrocarbons (PAHs), diesel particulate matter (DPM), and any other toxic air pollutants (mobile and stationary sources); – (Note 25: It is recommended to assess specific aldehydes that are associated with diesel exhaust (DE), such as acetaldehyde, formaldehyde, 1,3-butadiene and acrolein, as well as benzene, for the evaluation of VOCs.)"	The Agency	■ The study plan suggests that levels of PAHs and VOCs will be estimated based on measured surrogate (i.e., BTEX) levels. Most PAHs are toxic (and carcinogenic) at very low concentrations. To ensure that PAH emissions during the different phases of the project are not underestimated, it is preferable to use benzo(a)pyrene [BaP] as a surrogate to assess the total PAHs. A less resource-intensive measurement method may be available for this approach. Alternately, a qualitative assessment based on reliable and verifiable information may be proposed. ■ BTEX analysis generally provides a good indication of the concentration of the total VOCs in the air. However, as the approach is limited to four substances (i.e., BTEX), the use of emission factors combined with air dispersion modelling to predict the concentrations of the target VOCs (i.e., acetaldehyde, formaldehyde, 1,3-butadiene and acrolein) is necessary to fully assess human health risks of exposure to these air pollutants during the different phases of the project. It is not clear whether the recommended approach is adequately considered in the Study Plan.	■ Describe any on-site sampling and quantitative analyses of common air pollutants (including SO2, PAHs, and DPM) listed in Section 8.1 and 14.1 of the Guidelines that is being considered to help assess the project impacts on contaminant levels with confidence. ■ Should other assessment approaches, including the use of surrogates and/or a qualitative assessment, be deemed more appropriate, or should an assessment be deemed unnecessary for any air pollutants, provide a detailed rationale for any deviation from recommended characterization/assessment approaches, as well as an estimate of the uncertainty associated with the use of the alternative approaches.	■ Background SO2 concentrations will be measured in the community. ■ Background concentrations of PAHs will be estimated based on monitoring data collected within the community. The monitoring program includes an assessment of up to 1-year of data for benzene, toluene, ethylbenzene, and xylenes (i.e., BTEX). ■ DPM emissions as a result of the Project will be included in the Air Quality Assessment. Due to the technical limitations of measuring DPM in the community, background DPM concentrations will be estimated based on the breakdown of fuel sources in the community. ■ The Air Quality Assessment will include quantitative assessments (numerical estimates or monitoring of background concentrations and numerical modelling of Project impacts) of the following contaminants: – NOx, PM2.5, PM10, Diesel Particulate Matter (DPM), SO2, CO, Formaldehyde, Acetaldehyde, Acrolein, Benzene, 1,3-Butadiene, Total PAHs, Total VOCs	■ Section 7.2.1
AQ-06	■ Section 6.1 Indicators and Expression of Change – "The indicators and rationale for selection and measurement of potential effects, to be used to assess and evaluate the alternative routes in the IA/EA are provided in Table 6-1. The table includes both quantitative and qualitative indicators. The final list of indicators to be used in the IA/EA will be based on regulatory	■ Section 14.1 – "provide a quantitative assessment of common air pollutants (total particulate matter, fine particulate matter (PM2.5), respirable particulate matter with a diameter less than 10 microns (PM10), sulphur oxides, nitrogen oxides, volatile organic compounds, polycyclic aromatic hydrocarbons, diesel particulate matter, and carbon monoxide), as	The Agency	■ It is unclear which air quality parameters will be assessed quantitatively (or qualitatively). It is also unclear why sulfur oxide (SO) is selected for the effect assessment, when SO2 is used in the baseline study. ■ Additionally, the assessment plan does not include some of the common air pollutants (e.g., PAHs, DPM, Carbon Monoxide), which is inconsistent with the baseline study	■ Provide details to demonstrate which air quality parameters will be assessed quantitatively and which will be assessed qualitatively. Clarify why sulfur oxide (SO) is selected for the effect assessment when SO2 is used in the baseline study. Resolve inconsistencies between lists of air contaminants to be assessed during the baseline and the effects assessment.	■ The following compounds will be quantitatively assessed within the Air Quality Assessment: – NOx, PM2.5, PM10, Diesel Particulate Matter (DPM), SO2, CO, Formaldehyde, Acetaldehyde, Acrolein, Benzene, 1,3-Butadiene, Total PAHs, Total VOCs ■ The following will be monitored during the baseline program:	■ Section 7.2.1

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
	agency guidance, professional judgement and input received through the Project consultation process….” ■ Table 6-1: Atmospheric Environment Indicators – “Expression of Change: NOx, CO, SO, TSP, PM10, PM2.5, Selected Volatile Organic Compounds (acrolein, acetaldehyde, benzene, formaldehyde, 1,3-butadiene, toluene, ethylbenzene and xylene) ■ Rationale for Selection: – The contaminants chosen for the expression of change are based on those commonly associated with transportation and construction activities, as prescribed by the Ontario Ministry of Transportation (MTO, 2012).” ■ Section 7 Conformance with Federal and Provincial Guidelines – “The Project will be assessed following MECP and MTO guidance for the requested contaminants. The contaminants assessed will be those required by MTO guidance (i.e., NOx, CO, PM2.5, PM10, formaldehyde, acetaldehyde, benzene, 1,3-butadiene, and acrolein). Additionally, toluene, ethylbenzene, and xylene will be consider based on inclusion in the human health risk assessment.”	well as any air contaminants potentially associated with the Project such as dust resulting from construction activities and ongoing vehicle use during operations or maintenance of the gravel road bed;”		plan and also deviates from the Guidelines requirement. Given the extensive use of heavy-duty diesel vehicles during project construction, DPM should be added to the list of contaminants selected for the expression of change.	■ Provide details to demonstrate that all common air pollutants listed in Section 14.1 of the Guidelines will be included in the effects assessment, including DPM.	– NOx, PM2.5, PM10, SO2, , BTEX (benzene, toluene, ethylbenzene, and xylene) ■ Baseline concentrations for the following compounds will be calculated from results of the monitoring program: – TSP, PAHs, DPM, Formaldehyde, Acetaldehyde, Acrolein, 1,3-Butadiene ■ Relevant literature, emission factors, referenced methods and other representative stations will be utilized to estimate baseline concentrations for compounds that are not monitored.	
AQ-07	■ Section 6.2.1 Emissions – “GHG emissions will be estimated using published emission factors, approved estimation guidance, or engineering calculations as applicable.”	■ Section 15.5 – “provide the estimated annual GHG emissions from each source, including calculation methods, assumptions and related parameters that would enable calculations to be reproduced” ■ Section 20 – “describe measures included in the design of the Project to	The Agency	■ The study plan does not describe the approach proposed to calculate GHG emissions, including calculation methods, assumptions and related parameters that would enable calculations to be reproduced, as required in Section 15.5 of the Guidelines. ■ The study plan also does not link and describe the measures and practices	■ Provide details on how GHG emissions will be calculated and the measures to mitigate the Project’s GHG emissions, as required in Sections 15.5 and 20 of the Guidelines. ■ Provide details to demonstrate how the measures and practices proposed to mitigate the Project’s GHG emissions, as required in	■ The GHG analysis will include mitigative measures as part of the quantification of emissions. As part of the impact assessment, an analysis will be conducted to identify if additional mitigative measures are required for GHG emissions. All mitigative measures identified will be documented and	

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
		mitigate its greenhouse gas emissions. These could include design decisions such as the use of low-emitting technologies, the use of low-carbon or renewable fuel or carbon capture and storage; describe practices that will be taken to mitigate the Project's greenhouse gas emissions, such as anti-idling practices for mobile equipment, or continuous monitoring systems".		proposed to mitigate the Project's GHG emissions, as required in Section 20 of the Guidelines or how those measures and practices will be factored into the GHG estimates in Section 15.5 of the Guidelines.	Section 20 of the Guidelines, will be factored into the GHG estimates in Section 15.5 of the Guidelines.	reported on as part of the IS / EA Report.	
AQ-08	■ 6.2.1.1 Construction Phase – "Emissions will be estimated for the construction phase based on the projected types of activity and duration. All anticipated construction activity, such as land clearing, blasting, aggregate extraction, material hauling, and road construction will be included in the estimate of emissions. Emissions will be estimated based on published emission factors, such as those found in the US EPA's AP-42 emission factor database, or engineering principles, as applicable. …)". ■ 6.2.1.2 Operation Phase – "The assessment of the operations phase will not include any ongoing road maintenance activities such as road repairs as they are considered short-term and insignificant".	■ Section 13.1 – "The Impact Statement must describe in detail the project's potential adverse and positive effects in relation to each phase of the Project (construction, operation, maintenance, suspension, decommissioning, and abandonment)." ■ Section 14.1 – "provide a quantitative assessment of common air pollutants …., as well as any air contaminants potentially associated with the Project such as dust resulting from construction activities and ongoing vehicle use during operations or maintenance of the gravel road bed;". – "provide a comprehensive list of project activities (air pollutant emission sources) that may affect ambient air quality, such as, but not limited to: dust generation from material stockpiles, transportation and road maintenance during construction and operation." ■ Section 15.5 – "provide the estimated annual GHG emissions from each source, including calculation methods, assumptions and related parameters that would enable calculations to be reproduced"	The Agency	■ Road maintenance activities are not included in the proposed assessment however these activities include the use of heavy machinery, result in vehicle emissions, and generate dust from vehicular travel and other activities. It is unclear how these activities are going to be included in the assessment, as per Section 14.1 of the Guidelines. ■ In addition to the proposed emission predictions during the construction and operation phases, an on-site monitoring at sensitive receptor locations (e.g., children or seniors) near the Project sites as per Section 6.8 of Health Canada's guidance (2016)2 is recommended. ■ Canadian-specific emission factors would be preferable to use over the proposed U.S. emission factors.	■ Provide details on the assessment of short-term effects, inclusive of road maintenance activities, during the operation phase relative to the applicable standards and/or criteria. Describe any on-site monitoring that is being considered during the construction and operation phases where sensitive receptors are identified near the project sites. ■ Use Canadian-specific emission factors where possible, and provide justification if Canadian data sources are not used in the estimation of GHG emissions.	■ The Air Quality Assessment will include two bounding scenarios: roadway construction and roadway operation. Routine road maintenance activities such as snow clearing are expected to be captured in the roadway vehicle data (traffic volumes and vehicle types) within the roadway operation scenario, and therefore will be included in the Air Quality Assessment. ■ Minor roadway maintenance activities, such as re-grading, are expected to have a lower impact than the initial construction bounding scenario, therefore the impact of these activities would have been assessed within that bounding scenario. ■ Where applicable and available Canadian emission factors will be used in lieu of US EPA emission factors. Within the MOVES emission model, meteorological conditions reflective of the study area and Canadian fuel composition data will be used as inputs, where possible.	■ Section 9.4

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
AQ-09	▪ Section 6.2.1.2 Operations Phase – "The assessment of GHG emissions will also consider the potential change in emissions from existing sources (e.g., aircraft, winter road usage) as a result of the project."	▪ Section 15.5 – "describe how the Project may contribute to Canada's efforts to reduce GHG emissions, if applicable (e.g., the Impact Statement could explain how the Project would result in emission reductions in Canada by avoiding emissions from another source)"	The Agency	▪ It appears that a modal shift analysis would be conducted to justify that GHG emissions would be avoided with this project. ▪ Environment and Climate Change Canada provides the following guidance for the development of scenarios to demonstrate avoided GHG emissions with the operation of this project: – Only avoided domestic GHG emissions may be subtracted from the project's net GHG emissions. Avoided domestic GHG emissions are GHG emissions that are reduced or eliminated in Canada as a result of the project. – Infrastructure Canada's Climate Lens General Guidance3 provides general guidance on how to quantify avoided emissions. The proponent must select the appropriate "total net baseline scenario emissions" and the "total net baseline scenario removals", and provide the rationale for those scenarios. The scenarios must consider new measures (e.g., policies, regulations, plans and programs) applicable to the project put in place by provincial, territorial and federal governments, be realistic, conservative and take into account market conditions and feasibility. – The quantification approach should ensure that the avoided emissions represent reductions or removals that are real, additional, quantified, verifiable, unique, and permanent. Avoided foreign emissions should not be quantified in the avoided domestic GHG emissions.	▪ Provide details on how the "potential change in emissions from existing sources" will be determined, and explain if and how the change in emissions would be calculated as part of the net GHG emissions of the project, in order to meet the requirements of Section 15.5 of the Guidelines.	▪ Net GHG emissions as a result of the Project will be calculated using ECCC guidance. The modal shift analysis identified in the Study Plan will rely on the guidelines identified by The Agency (e.g., ECCC guidance, Infrastructure Canada's Climate Lens guidance), and will consider partial or full displacement of current forms of travel (e.g., winter road travel, air travel) with on-road vehicular traffic. The level of modal shift for each mode of transportation will be determined and documented as part of the assessment. ▪ Foreign emissions will not be considered in the analysis.	▪ Section 9.4

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
AQ-10	▪ Table 6-2: Air Quality Magnitude Definition – Low: Up to 10% above applicable Criteria. – Medium: 11%-30% above applicable Criteria – High: 31%-70% above applicable Criteria – Very High: >70% above applicable Criteria ▪ Rationale: – To align with IAAC evaluation criteria presented in the Tailored Impact Statement Guidelines.	▪ Section 13.1 – "The effects to each valued component outlined in sub-sections 14.3, 15.2, 15.3, 15.4 must be described using the following criteria:" ▪ 21. Residual effects – "Proponents must describe the extent to which residual effects are adverse. Where relevant, or where best practice or evidence-based thresholds exist, effects should be described using criteria to quantify adverse effects. (…) Where the potential for human health effects exist due to exposure to a particular contaminant at any level (e.g., non-threshold air pollutants, including particulate matter and nitrogen dioxide, and water pollutants, such as but not limited to arsenic and lead) mitigation measures should aim to reduce the residual effects to as low as reasonably achievable…. – The Impact Statement must: • characterize the residual effects using criteria most appropriate for the effect; • characterize residual effects for human health using human health-related criteria most appropriate for the carcinogenic and non-carcinogenic health effects of non-threshold contaminants;" • provide the rationale for the choice of criteria used to determine the extent to which the predicted effects are adverse. The information provided must be clear and sufficient to enable the Agency, review panel, technical and regulatory agencies, Indigenous	The Agency	▪ The definition of the magnitude criteria for adverse effects proposed in Section 13.1 of the Guidelines are provided specifically for the ecological valued components described in Sections 14.3, 15.2, 15.3, and 15.4 of the Guidelines. A rationale is not provided for the use of the magnitude ranges provided in Table 6.2 for the evaluation of potential changes to air quality and associated potential for human health risks. It is noted that a change of "up to 10% above the applicable Criteria" would be considered "low" magnitude, yet there is a risk to human health any time pollutant levels are above the applicable criteria. ▪ Furthermore, the proposed ranges do not consider residual effects from pollutant levels below the applicable criteria. For example, the Canadian Air Quality Management System (AQMS) explicitly recognizes that health effects occur below the maximum thresholds (i.e., the Canadian Ambient Air Quality Standards, or CAAQS), and proposes additional management levels in recognition of the health and environmental benefits that can be realized by taking actions to decrease or maintain background levels of air pollution. ▪ Health Canada recommends the use of the AQMS approach, under which the CAAQS were developed, to inform the magnitude criteria definitions. The AQMS sets achievable air quality management targets (or thresholds) based on the fundamental principles of Keeping Clean Areas Clean, and Preventing Air Quality ▪ Deterioration. More information on air quality management threshold values is available (Canadian Council of	▪ Clarify how the proposed adverse effects magnitude criteria definitions are relevant to the protection of human health in relation to air quality.	▪ The Air Quality magnitude criteria have been updated. These criteria will characterize impacts on Air Quality using Air Quality criteria that are protective of human health. More specific analysis of Human Health impacts will be conducted within the Human Health assessment as is described within the Human Health and Community Safety Study Plan	▪ Section 9.6

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
		groups, and the public to review the proponent's analysis of effects;"		Ministers of the Environment. 2012)- (Note 4: Canadian Council of Ministers of the Environment. 2012. Guidance Document on Air Zone Management. Available at : http://www.ccme.ca/files/Resources/air/aqms/pn_1481_gdazm_e.pdf). Health Canada also encourages the proponent to use all available technologies to reduce their emissions as low as reasonably achievable (ALARA) and beyond those required to achieve maximum AQMS thresholds (i.e., CAAQS levels), in order to reduce the burden of air pollution on the population.			
AQ-11	■ Section 6.3 Magnitude of Effect. Table 6-3 – "Releases of GHGs and their accumulation in the atmosphere influence regional, national and global climate and may affect emission reduction targets for GHGs that have been set or are being developed federally and provincially. The magnitude is therefore established as a percent contribution to provincial totals to assess the significance of Project emissions and hence potential effect on provincial reduction targets that may exist."	■ Section 15.5 – "describe how the Project may contribute to Canada's efforts to reduce GHG emissions, if applicable (e.g., the Impact Statement could explain how the Project would result in emission reductions in Canada by avoiding emissions from another source)".	The Agency	■ The study plan should not be making a determination of the magnitude of the project's GHG emissions against national or provincial emissions or emissions targets. When compared to provincial and national GHG emissions, the project's GHG emissions will often be considered as low which does not help to contextualize the project's emissions against Canada's emissions targets.	■ Update the study plan to reflect that the requirement to describe the residual environmental, health, social or economic effects of the project does not extend to discussing the magnitude of the Project's GHG emissions against national and provincial emissions and emissions targets.	■ The Study Plan identifies the sources of GHGs and limits the assessment of GHGs to the specified magnitude criteria.	■ Section 9.4.3
AQ-12	■ Section 7 Conformance with Federal and Provincial Guidance – "….will be described in the Impact Statement. – The Impact statement will include…. – The Impact Statement will provide…. "	■ Section 14.1 and Section 15.5 [Relevant to many requirements]	The Agency	■ It is unclear if all requirements of Sections 14.1 and 15.5 of the Guidelines will be met. Table 7.1 provides general statements that the requirements will be included in the Impact Statement, but there is not enough information to determine how the requirements will be met. The Impact Statement must address all requirements outlined in the Guidelines and the study plan should demonstrate a clear approach to meet those requirements.	■ Provide details on the proposed approaches and methods used to ensure that all requirements of Sections 14.1 and 15.5 of the Guidelines are met in the Impact Statement. ■ Provide details to demonstrate that the effects assessment will consider the effects of each of the project components and physical activities, in all phases, and be based on a comparison to the proposed baseline work.	■ Traffic levels defined within the Project scope will be used for the Air Quality and GHG Assessment.	■ Section 9.4

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
				■ The effects assessment must consider the effects of each of the project components and physical activities, in all phases, and be based on a comparison to the proposed baseline work. The effects assessment for the operation phase must include the effect cause by all different users (traffic volume, type of vehicles, etc.), including Indigenous groups, the general public, and mining proponents of reasonably foreseeable future projects ((e.g., Eagle's Nest, Blackbird, Black Thor, Black Label, Big Daddy, anticipated future community access roads);".	■ Provide details to demonstrate that the effects assessment for the operation phase will include the effect cause by all different users (traffic volume, type of vehicles, etc.), including Indigenous groups, the general public, and mining proponents of reasonably foreseeable future projects ((e.g., Eagle's Nest, Blackbird, Black Thor, Black Label, Big Daddy, anticipated future community access roads);".		
AQ-13	■ Section 7.0 Conformance with Federal and Provincial Guidance – "The Impact Statement will include an assessment of land use changes (e.g., wetlands or peatlands) and the resultant net GHG emissions."	■ Section 15.5 – "provide a qualitative description of the Project's positive or negative effects on carbon sinks, including from the removal and alteration of wetlands"	The Agency	■ Environment and Climate Change Canada concurs with the study plan to quantify land use change emissions and that these are estimated with the net GHG emissions of the Project. However, they note that the qualitative description of the Project's effects on carbon sinks goes beyond estimating land use change emissions. This is because some projects may improve or reduce the ability of an ecosystem, land area or ocean to absorb carbon dioxide from the atmosphere. An impact on a carbon sink implies the interruption or alteration of a natural continual process that removes carbon from the atmosphere. The qualitative description of the project's positive or negative effects on carbon sinks should include: – Description of project activities in relation to significant landscape features such as topography, hydrology and regionally dominant ecosystems. – Land areas directly impacted by the project, by ecosystem type (forests, cropland, grassland,	■ Provide details to demonstrate that a qualitative description of the Project's positive or negative effects on carbon sinks will include consideration of the guidance provided by ECCC in the context column, in order to meet the requirements of Section 15.5 of the Guidelines.	■ The qualitative description of the Project's net effects on Climate Change will include consideration of the requirements of the Government of Canada's Strategic Assessment of Climate Change (SACC) guidance document (2020, and the guidance provided by ECCC). It is expected that in following the SAAC guidance, Section 15.5 of the Guidelines will be met.	■ Section 9.4

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
				wetlands, built-up land) over the course of the project lifetime; this includes the areas of restored or reclaimed ecosystem(s). – Initial carbon stocks in living biomass, dead biomass and soils (by ecosystem type) on land directly impacted by the project over the course of the project lifetime. – Fate of carbon stocks on directly impacted land, by ecosystem type: immediate emissions, delayed emissions (timeframe), storage (e.g., in wood products). – Anticipated land cover on the impacted land areas after the project is in place. ■ The above guidance was not included in the August 2019 draft SACC but provides more clarity on what information the study plan could provide to fulfill this requirement. This guidance, however, will be published in the forthcoming publication of the SACC (tentative publication in July 2020).			
AQ-14	■ Section 7 Conformance with Federal and Provincial Guidance – "Considering the projected roadway volumes (200-300 vehicles per day), an assessment of the formation of ozone is not warranted."		The Agency	■ The Marten Falls Community Access Road Detailed Project Description states that the road "will be designed using an Annual Average Daily Traffic amount of up to 400…". It is unclear why Table 7-1 provides a different average daily traffic amount.	■ Clarify why Table 7-1 has a different average daily traffic amount than what was described in the Detailed Project Description. Provide details to demonstrate that the effects assessment will consider the highest annual average daily traffic amount of vehicles the road is designed for, which was described as 400.	■ The effects assessment will consider the highest AADT over the life of the Project.	■ Section 9.4
AQ-15	■ Section 7 Conformance with Federal Guidance – "The air quality modelling will be described in detail within the Impact Statement. No chemical or physical transformation will be included in the modelling as the dispersion of emissions are	■ Section 13.1 – "Predictions must be made on clearly stated assumptions and the Impact Statement must clearly describe how it has tested each assumption." ■ Section 14.1	The Agency	■ It is unclear how the requirements of Section 14.1 of the Guidelines will be met if modelling of chemical and physical transformation is not proposed. It is also unclear how it was determined that the dispersion of emissions are "generally expected to be generally low-level."	■ Provide further detail on proposed methodologies, including the rationale, to meet the requirements of Section 14.1 of the Guidelines, including chemical and physical transformation. Provide details and rationale for describing the dispersion of emissions are	■ Any reference to the "dispersion of emissions" being low-level within the Study Plan is unintentional. The Study Plan intended to communicate that the formation of secondary contaminants through chemical and physical transformation is expected to be	■ Section 9.4

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
	generally expected to be generally low-level and near-field with respect to the Project."	– "provide details of all air quality model configuration ,including meteorology, land use, gridded and sensitive receptors and chemical and physical transformation settings;"			expected to be "generally low-level".	low-level based on the predicted roadway volumes. While some formation of secondary particulate is expected, the Project is in a pristine setting without large industrial or transportation sources. Secondary formation is dependent on the presence of precursor species which will be limited because of the pristine nature of the environment. Based on a projected low AADT, the emissions of precursor species are expected to be relatively dilute in the atmosphere. ■ Additionally, the formation of secondary contaminants is not instantaneous, and happens downwind of the source at which point the initial precursor contaminants have begun to disperse. In consideration of these factors, it is expected that assessing the near-road impacts of primary contaminants will result in a reasonably conservative Air Quality Assessment ■ One exception to the above is the conversion of NO to NO2. It will be conservatively assumed that 100% of all NO emitted from the Project will be converted to NO2.	
AQ-16	■ Section 7 Conformance with Federal Guidance – "The potential for the Project to contribute to acid deposition will be qualitatively assessed for both the construction and operation phases. Potential for acid formation will be evaluated based on the predicted increase in NOx and SOx to the airshed and subsequent potential nitrate and sulphate formation. Acid deposition will not be	■ Section 13.1 – "Predictions must be made on clearly stated assumptions and the Impact Statement must clearly describe how it has tested each assumption." ■ Section 14.1 – "assess the potential for emissions from the Project to contribute to acid deposition and exceedances of critical loads for terrestrial and aquatic ecosystems;"	The Agency	■ It is unclear if the potential for exceedances of critical loads for terrestrial and aquatic ecosystems will be assessed, as required in Section 14.1 of the Guidelines. It is also unclear how it was determined that the magnitude of effects related to acid deposition is expected to be negligible.	■ Provide details on how the potential for emissions from the Project to contribute to exceedances of critical loads for terrestrial and aquatic ecosystems will be assessed, to meet the requirements of Section 14.1 of the Guidelines. ■ Provide a rationale for determining that the magnitude of effects related to acid deposition is expected to be "negligible".	■ Acid deposition is a regional effect, meaning that near-roadway concentrations are not as important as airshed concentrations. It is estimated that the Project will partially displace air travel with road vehicle traffic. The impact of this modal shift on the contribution of NOx and SO2 to the airshed will be assessed and a qualitative statement regarding the implications for acid deposition will be provided in the IS / EA Report.	■ Section 9.4

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
	quantitatively assessed as the magnitude of effects is expected to be negligible."					■ There will be no assessment of emissions from the Project to contribute exceedances of critical loads for terrestrial and aquatic ecosystems. There is no threshold established to determine that a specific concentration of NOX and SO2 would be detrimental to the terrestrial and aquatic valued components.	
AQ-17	■ Section 7 Conformance with Federal Guidance – "The potential for the Project to contribute to ground-level ozone will be qualitatively assessed for both the construction and operation phases. Potential for the generation of ground-level ozone will be evaluated based on the predicted increase in NOx and Volatile Organic Compounds around the Project area. Ozone formation will not be quantitatively assessed as the magnitude of effects is expected to be negligible."	■ Section 13.1 – "Predictions must be made on clearly stated assumptions and the Impact Statement must clearly describe how it has tested each assumption." ■ Section 14.1 – "provide an assessment of the Project's emissions potentially contributing or adding to existing ground ozone levels;"	The Agency	■ It is unclear how it was determined that the magnitude of effects for ozone formation is expected to be negligible.	■ Provide a rationale for determining that the magnitude of effects for ozone formation is expected to be "negligible".	■ In the Ministry of Transportation's Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects, the MTO states that, with respect to the formation of ground-level ozone, "ground-level ozone O3 is typically formed many kilometres downwind of the source of its precursors" and "concentrations are usually depressed around highways since NO emissions react relatively rapidly to convert O3 into oxygen gas." The MTO also states that "For major roads, the collective experience of the scientific community suggests that the affected immediate vicinity is limited to the area within approximately 500 metres of the road". Based on this, the contribution of the Project to ground-level ozone is likely to be minor in comparison to the near-field concentration of precursor species (i.e., NOx).	■ Section 9.4

Comment # / Ref #	Study Plan Section	TISG Section	Agency/ Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
AQ-18	■ Section 7 Conformance with Federal Guidance – "Baseline air quality monitoring will be used to represent the Project Area and is assumed to include in the effect of any relevant regional sources. Therefore, regional source emissions will not be quantified or included in the dispersion modelling."	■ Section 13.1 – "Predictions must be made on clearly stated assumptions and the Impact Statement must clearly describe how it has tested each assumption." ■ Section 14.1 – "provide emission rates for all project and regional sources within the study area, including emission factors(with methodology, uncertainty assessment and references) and all assumptions and related parameters that would enable calculations to be reproduced;"	The Agency	■ It is unclear how the requirements of Section 14.1 of the Guidelines will be met if emission rates for regional sources will not be included in the dispersion modelling. It is also unclear how it was determined that baseline air quality monitoring will include the effect of regional sources.	■ Provide details on proposed methodologies, including rationales, to demonstrate how the studies described in the study plan will meet all requirements of Section 14.1 of the Guidelines, including emission rates for all regional sources within the study area. ■ Provide a rationale for how it was determined that baseline air quality monitoring will include the effect of regional sources.	■ Baseline air quality monitoring will be used to represent the Project Area and is assumed to include in the effect of any relevant regional sources. Therefore, regional source emissions will not be quantified or included in the dispersion modelling. ■ The majority of sources are expected to be personal vehicles, residential heating, and other miscellaneous activities. There are no significant sources (e.g., large industries) which would contribute to emissions in the Study Area. ■ A conservative Air Quality Assessment is one which describes the reasonable worst-case impact of the Project. Background concentrations within Marten Falls are expected to be higher than the rest of the Study Area. Therefore, using measured concentrations in the Study Area will result in a conservative Air Quality Assessment.	■ Section 7
AQ-19	■ Section 7 Conformance with Federal Guidance – "Identified receptor locations will be described in the Impact Statement. Differential effects will not be considered in the Atmospheric Environment assessment. The relevant criteria (AAQC, CAAQS) have been developed in consideration of effects at any applicable receptor type."	■ Section 14.1 – "describe the locations and characteristics of the most sensitive receptors including species at risk and differential effects for sensitive receptors;"	The Agency	■ It is unclear how the locations and characteristics of sensitive receptors, including species at risk, will be identified. It is also unclear how the requirement of Section 14.1 of the Guidelines will be met if differential effects will not be considered.	■ Provide details on how the locations and characteristics of sensitive receptors, including species at risk, will be identified. ■ Provide details on how the requirement in Section 14.1 of the Guidelines will be met, including differential effects for sensitive receptors.	■ Differential effects will not be considered within the air quality assessment. The air quality assessment will consider provincial and federal criteria and standards to evaluate the Project impacts on air quality. The results of the air quality dispersion modelling assessment will be used in subsequent assessments, such as the human health assessment and ecological assessments, which will form a part of the IA / EA. It is expected that the subsequent studies will use evaluation criteria specific to the receptor types. Locations of sensitive receptors, including species at risk, will be identified in various other study plans.	■ Fish and Fish Habitat Study Plan ■ Wildlife Study Plan ■ Vegetation Study Plan ■ Ungulates Study Plan ■ Bird Study Plan ■ Human Health and Community Safety Study Plan ■ Aboriginal and Treaty Rights and Interest Study Plan

Draft Study Plan Comments – Provincial

Comment ID	Study Plan Section	Agency / Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
1	N/A	■ MECP, Environmental Assessment Branch	■ Please review EAB comments on the Wildlife, Ungulates and Vegetation work plans that may apply to this work plan.	■ Please review EAB comments on the Wildlife, Ungulates and Vegetation work plans that may apply to this work plan	■ We have reviewed the relevant comments and incorporated where appropriate. Please refer to the Comment Tables appended to the Wildlife, Ungulates and Vegetation Study Plans for specific responses.	■ Wildlife Study Plan ■ Ungulates Study Plan ■ Vegetation Study Plan
2	General	■ MECP, Environmental Assessment Branch	■ Ontario's Guide for Considering Climate Change in the Environmental Assessment Process (MOECC, 2017) was not included in the draft work plan.	■ Please indicate that Ontario's Guide for Considering Climate Change in the Environmental Assessment Process (MOECC, 2017) will be considered and applied in this work plan as it pertains to climate change	■ Ontario's Guide for Considering Climate Change in the Environmental Process (MOECC, 2017) will be considered in the atmospheric and climate change components of the Project.	■ Section 9.4
1	Section 4.2.1	■ MECP, Air Quality Analyst	■ One year of ambient air quality data will be collected within the Community to characterize baseline air quality as stated in the Draft Work Plan, and an airpointer is proposed to be located at the community's nursing station. Please ensure that the proposed ambient air quality monitoring will meet the minimum requirements specified in the Operations Manual for Air Quality Monitoring in Ontario. The Draft Work Plan states that the collection of one full year of data may not be possible due to unforeseen circumstances such as power outages or equipment failure. For continuous air monitoring, a minimum target of 90% valid data collection per quarter per parameter can be routinely attained, and at least 75% of valid data are required to calculate the valid mean. Please ensure enough valid data to be obtained from the proposed air monitoring program to establish baseline air quality for the project site. ■ The work plan provides approaches that will be used to estimate baseline air quality for some contaminants if these contaminants cannot be sampled for due to equipment limitations, i.e., PAH, diesel PM, and some VOC compounds, etc. How about TSP and PM10?	■ To ensure that the data collected is accurate and acceptable to the MECP, please include a discussion on how the proposed air quality monitoring activities will meet the requirements of the Operations Manual for Air Quality Monitoring in Ontario. ■ Describe how the baseline concentrations of TSP and PM10 will be estimated for the proposed project site if these contaminants will not be monitored.	■ MECP will be consulted regarding the implementation of the monitoring program. An Air Quality Monitoring Plan that conforms with the requirements of the MECP Operations Manual for Air Quality Monitoring in Ontario will be developed. Deviations from the manual may be required due to the location of the Project. Deviations will be reviewed with the MECP and documented in the Air Quality Monitoring Plan.	■ Section 3 and Section 7.2.1
2	Section 6.1	■ MECP, Air Quality Analyst	■ There is a typo in Table 6-1: Atmospheric Environment Indicator. It should be SO2 instead of SO.	■ Please correct the typo in Table 6-1.	■ This has been corrected	■ N/A
3	Section 6.2.2	■ MECP, Air Quality Analyst	■ Project-specific meteorological data, generated from US Weather Research and Forecasting Model (WRF), will be used in the air dispersion modelling assessments as indicated in the Draft Work Plan. Air Dispersion Modelling Guideline for Ontario (ADMGO) states that if data other than the ministry's Regional Meteorological data sets are used in air dispersion modelling assessments, careful quality control must be used throughout the entire processing phase to ensure that the data set is complete and representative of the site being modelled. Section 6.4.1 of the ADMGO also lists the ministry's expectations for local meteorological data use, and there are different expectations for raw data obtained from Environment Canada, on-site meteorological stations, or data generated by advanced meteorological models.	■ It is strongly recommended that the modeller consult with Environmental Monitoring and Reporting Branch (EMRB) for guidance in advance of running the meteorological model. Please copy Sasha McLeod and Shannon Gauthier on this outreach, and please contact us if you need a contact name.	■ EMRB will be consulted in the selection and use of meteorological data for the air quality assessment	■ Section 9.4

Comment ID	Study Plan Section	Agency / Regulatory Body Comments Received From	Comment / Context	Action Item	Response	Study Plan Reference
4	Section 6.3	■ MECP, Air Quality Analyst	■ Air quality magnitude definition is proposed and listed in Table 6-2. The draft work plan indicates that the air quality magnitude definition is aligned with the IAAC evaluation criteria presented in the Tailored Impact Statement Guidelines. It should be noted that these criteria are used for evaluating species and ecosystem risk. ■ It may be more appropriate to describe the definition of air quality magnitude using the general approach as follows, i.e., the magnitude is low if the air quality level is well below the applicable criteria, and moderate if the air quality level is close to the criteria, but still below the criteria, and high if the air quality level is well above the criteria. In addition, the frequency of exceedances should also be included to assess the residue effects if the air quality level is well above the criteria	■ Please describe the air quality magnitude definition using an appropriate approach.	■ The magnitude definitions have been updated within the Study Plan.	■ Section 9.6
1	Section 4.2.1, page 6	■ MTO, Transportation Infrastructure Management Division	■ The list of contaminants to be monitored is appropriate. The study plan notes that diesel particulate matter is of interest. Please clarify how results related to diesel particulate matter will be interpreted given that there are no provincial or federal ambient air quality standards.	■ The Near-Road Air Pollution Pilot Study by the University of Toronto includes a discussion on potential standards for diesel exhaust. Consider consulting this or any other relevant documents.	■ Appropriate toxicological literature and studies will be consulted when interpreting results related to DPM.	■ Section 7.2
2	Section 6.2.1.2, Page 8	■ MTO, Transportation Infrastructure Management Division	■ It is recommended that non-tailpipe emissions such as brake and tire wear are also included.	■ Include non-tailpipe emissions into the air quality analysis. These are readily available through the MOVES model.	■ Non-tailpipe emissions will be included with emission calculations/quantification.	■ Section 9.4

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MARTEN FALLS FIRST NATION

Ambient Air Quality Monitoring Plan

August, 2021 – 18-8898

Table of Contents

Figures

1.0 Background

Marten Falls First Nation (the Community) is a remote First Nation community in northern Ontario located at the junction of the Albany and Ogoki rivers, approximately 430 kilometres (km) north of Thunder Bay, Ontario. Figure 1 below shows the community location.

Figure 1: Marten Falls First Nation Community Location

The Community is proposing an all-season Community Access Road (CAR; the Project) that will connect the Community to Ontario's provincial highway network (Highway 643) to the south via the existing Painter Lake Road. This ambient air quality monitoring plan has been completed to support a coordinated Impact Assessment (IA) required by the Impact Assessment Agency of Canada (IAAC) under the federal Impact Assessment Act and Environmental Assessment (EA) required by the Ministry of the Environment, Conservation and Parks (MECP) under the Ontario Environmental Assessment Act.

2.0 Purpose/Objectives of the Monitoring Plan

The monitoring program will characterize the existing conditions within Marten Falls to inform the air quality impact assessment. Baseline monitoring for the remainder of the Project Study Area (PSA) is not feasible given the remote nature of the Project corridor and lack of access to power and service access (to maintain equipment).

Ambient contaminant concentrations will be continuously monitored. The results will be statistically summarized based on the averaging period of the applicable standards and criteria. The May 2021 Marten Falls First Nation Atmospheric Environment and Greenhouse Gases (GHG) Study Plan[1] describes how the monitored concentrations collected within the Community will be considered to be representative of all locations within the community and will be used to help establish background concentrations within the PSA.

3.0 Expected Duration of the Monitoring Program

The monitoring program is to be conducted over the period of up to one (1) year. Deployment of the monitoring equipment occurred in May 2021. It should be noted that the collection of one full year of data is not likely due to circumstances such as power outages or equipment failure that may occur. A minimum target of 75% data capture is specified within the MECP Operations Manual for Air Quality Monitoring in Ontario (MECP Manual)[2]. This data capture percentage is recognized and will be targeted through the program. In the event that 75% data capture is unlikely to be achieved, Dillon will revisit the monitoring plan, in consultation with MFFN and the MECP and with consideration of the averaging periods of compounds being monitored and trends in the dataset, to assess the robustness of the data set and any additional actions required (e.g., extending the sampling period).

4.0 Identified and Suspected Air Emission Sources

The Community is a remote First Nation in northern Ontario located at the junction of the Albany and Ogoki rivers, approximately 430 kilometres (km) from Thunder Bay, Ontario. There are currently no industrial facilities, heavily used transportation routes such as major highways, and no large residential developments. The Community population is less than 1000 people. Suspected air emission sources within the Community include airport activity, community power generation by a large diesel generator, personal vehicles, heating oil used for residential heating, and open fire burning.

[1] Dillon Consulting Limited. May 2021. Marten Falls First Nation Study Plan – Atmospheric Environment and Greenhouse Gases (GHG) Study Plan

[2] Ministry of the Environment, Conservation and Parks. 2019. Operations Manual For Air Quality Monitoring in Ontario

5.0 Identified and Suspected Receptors

Receptors within the PSA include local residential dwellings and the natural environment. The air quality assessment will inform assessments for human health, wildlife, and vegetation. The concentrations collected within the Community will be considered to be representative of baseline values at all receptor locations. The Canadian Ambient Air Quality Standards (CAAQS) and Ontario's Ambient Air Quality Criteria will be considered in this assessment and used to evaluate impacts on air quality.

6.0 Location of Monitoring Site & Monitoring Equipment

An enclosed trailer equipped with air monitoring equipment was installed within Marten Falls located by the Community's nursing station (51.638645, -85.929023). The air monitoring equipment is connected to satellite communication so instrument diagnostics and data can be sent on a daily frequency. Monitoring within the Community is necessary based on the power requirements of the equipment, as well as to allow for daily inspections of the monitor and for maintenance activities such as clearing snow from around the monitor. Attempts were made to adhere to station and probe siting criteria documented in the MECP Manual, however due to the location of project, and limited power supply option, it was not possible to meet all the criteria. The MECP Manual indicates that metrological parameters are recommended to be taken from a height of 10 metres. For this project a 4.75 metre tower height was achievable and deployed.

Deviations from the MECP Manual will be documented in data reporting. Figure 2 below shows the proposed location of the monitor.

Figure 2: Monitor Location

Figure 3 below shows the location of the monitor in reference to a generator located at the airport. The location of the monitor has a separation distance of approximately 2.6 km. This distance is sufficient to minimize the potential for the generator to bias monitoring results.

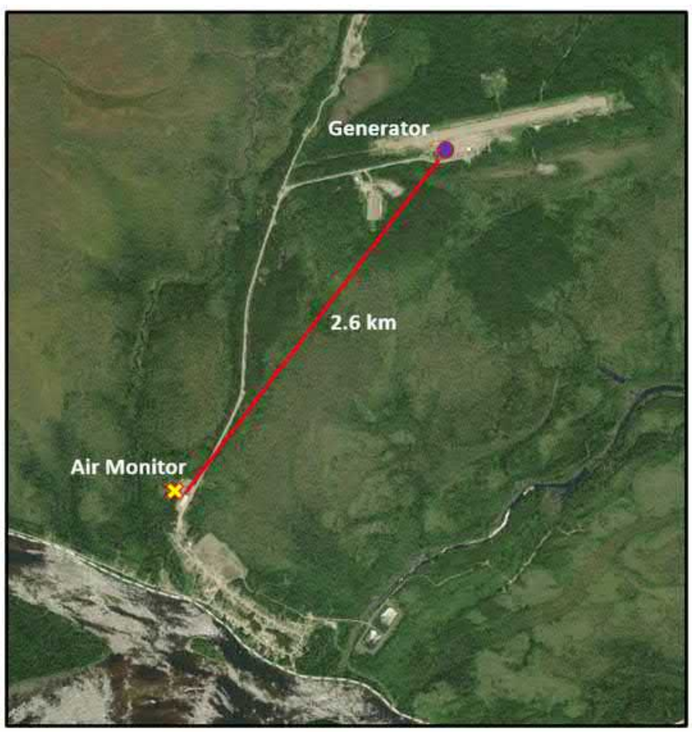

Figure 3: Generator Location in Reference to Monitor

7.0 Air Quality Parameters to be Monitored and the Monitoring Frequency

The air monitoring equipment deployed in the Community will monitor:

- Particulate matter ($PM_{2.5}$ and PM_{10});
- Ozone (O_3), nitrogen oxides (NO_x);
- Sulphur dioxide (SO_2);
- BTEX (benzene, toluene, ethylbenzene, and xylene); and,
- Meteorological parameters including: wind speed, wind direction, temperature, relative humidity, barometric pressure, and precipitation.

The air monitoring equipment will be deployed for up to one year to try to capture seasonal variations in baseline concentration. All parameters can be recorded in both 5 minute and hourly data resolution with the exception of VOC/BTEX which will be collected on a six (6) day schedule using a Xontech 910 canister sampler. .

8.0 Analytical Methods/Procedures

The air monitoring trailer contains multiple analyzer units which utilize a number of modules to monitor specific species. Below is a summary of the methods the equipment uses to analyze each contaminant:

Contaminant	Detection Method
Particulate Matter ($PM_{2.5}$)[1]	Nephelometry
Ozone (O_3)	UV absorption (EN 14625)
Nitrogen Oxides (NO_x)	Chemiluminescence (EN14211)
Sulphur Dioxide (SO_2)	UV fluorescence (EN14212)
BTEX (benzene, toluene, ethylbenzene, and xylene)	Canister Method TO-15, GC/MS

[1] The air monitoring trailer is equipped with a $PM_{2.5}$ sensor, other particulate matter size fractions (TSP and PM_{10}) will be calculated from $PM_{2.5}$ results.

BTEX and particulate matter will be used as surrogates for polycyclic aromatic hydrocarbons and diesel particulate matter which cannot be sampled for due to equipment limitations coupled with serviceability challenges given the remote location of the community. Concentrations of specific relevant contaminants such as acetaldehyde, formaldehyde, 1,3- butadiene, and acrolein will be estimated based on monitored BTEX concentrations and published emission factors, such as the United Stated Environmental Protection Agency's (US EPA) AP-42 emissions database.

9.0 QA/QC Plan

Quality assurance measures are implemented to ensure data integrity. The operation, service and maintenance of the station and sampling equipment are in accordance with both the manufacturers' operating manuals and the protocols outlined in the MECP's 'Operations Manual for Air Quality Monitoring in Ontario.

The following quality control measures will be implemented to help ensure consistent data capture to meet the MECP protocols:

- The station installation will be best sited to meet criteria as outlined in the MECP Operation Manual for Air Quality Monitoring in Ontario (MECP, 2019);
- Selected monitoring equipment will be EPA designated and verified prior to use with NIST traceable calibration standards;
- Station temperature will be monitored and reported to help ensure adequate control of interior temperature;
- Gaseous analysers will include Internal Zero / Span options so that automatic instrument response checks can be conducted nightly to assess ongoing performance such as zero / span drift, repeatability and response time to adhere to the MECP reporting practices;
- VOC sampling will be conducted on a 6 day schedule (NAPS) using a Xontech 910 canister sampler. The sampler will be audited quarterly. Exposed samples will be shipped to the laboratory on a schedule not to jeopardize sample integrity;
- VOC analysis will be conducted by an accredited laboratory as per the MECP protocols;
- Instrument status and operation checks will be conducted and logged weekly by field monitors;
- Monitoring instrumentation will be audited at quarterly intervals using NIST certified standards;
- Meteorological instrumentation will be audited upon installation and annually as per the MECP protocols;
- Back-up or duplicate instrumentation will be made available to minimize data loss or if reported data are questionable;
- Data will be transmitted daily from the station via satellite communications. Manual download protocol available if needed;
- Data will be reviewed daily and quality assured by experienced and qualified analysts. Data will be subjected to various QA / QC tests prior to release; and

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- A Data Edit log will be implemented and retained for the data set. Data reports will be submitted monthly.

10.0 Data Reporting Procedures

The data logger will format a report each day which will submitted via satellite transmission to a server located at Rotek Environmental in Hamilton, Ontario. The data are then verified, quality assured and archived in a central database. The central database server is backed up daily for contingency. A monthly report will be submitted to client in Excel format and include both hourly and five minute data, statistics and an exceedance summary as per applicable AAQC's, Standards and Guidelines. All data review and editing will be conducted by experienced staff and in accordance with Ministry protocols.

A back up protocol will be implemented to manually download data from the site in the event of issues with satellite communications. The data will be retrieved and emailed to the Rotek server by a local community member field technician trained by Rotek.

13 Attachment B – Greenhouse Gas Calculations

Marten Falls Community Access Road (MFCAR) Greenhouse Gas (GHG) Assessment

Appendix B0. Project GHG Emission Summary

Table 1. MFCAR Project GHG Emissions

Net GHG Emission Category[1,2,3,4]	Emission Source Types	Relevant Appendix
Direct GHG emissions	Construction mobile emissions	Appendix B1
	Quarry and road blasting	Appendix B2
	Operation mobile emissions	Appendix B3
	Land Use Change	Appendix B4
Acquired GHG emissions	Not Applicable The project is not anticipated or planned to acquire or purchase electricity or steam from a third party.	-
Avoided domestic emissions	Reduced travel by existing winter road	Appendix B5
Offset measures	Not Applicable No offset credits or CO_2 capture and storage are anticipated for the project.	-

Notes:

1. Per the SACC Technical Guide (Aug 2021) Equation 1, Net GHG emissions = Direct GHG emissions + Acquired GHG emissions - CO2 captured and stored - Avoided domestic emissions - Offset measures

2. Acquired GHG emissions and Offset measures are not applicable to the MFCAR project.

3. Land reclamation or afforestation are not planned for the project.

4. Following the SACC Technical Guide, the assessment of carbon sink impact due to land use change is separated from Project GHG emissions and presented in Appendix B6 .

Table 2. Project GHG Emissions by year

Net GHG Emission Category	Emission Source Types	Construction Phase GHG [1] (t/year)					Operation Phase GHG [1] (t/year)															Project Total (construction and operation)
		2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	
		Year -5	Year -4	Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	
Direct GHG emissions	Construction mobile emissions	18,459	18,459	18,459	18,459	7,384	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*81,220*
	Quarry and road blasting	407	407	407	407	163	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*1,791*
	Operation road traffic emissions	0	0	0	0	0	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	*400,506*
	Land Use Change	276,622	276,622	276,622	276,622	120,964	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	*1,485,331*
	Annual Total without Land Use Change	*18,866*	*18,866*	*18,866*	*18,866*	*7,547*	*26,700*	*26,700*	*26,700*	*26,700*	*26,700*	*26,700*	*26,700*	*26,700*	*26,700*	*26,700*	*26,700*	*26,700*	*26,700*	*26,700*	*26,700*	*483,517*
	Annual Total with Land Use Change	*295,489*	*295,489*	*295,489*	*295,489*	*128,511*	*43,892*	*43,892*	*43,892*	*43,892*	*43,892*	*43,892*	*43,892*	*43,892*	*43,892*	*43,892*	*43,892*	*43,892*	*43,892*	*43,892*	*43,892*	*1,968,848*
Avoided domestic emissions	Reduced winter road travel [2]	0	0	0	0	0	-21	-21	-21	-21	-21	-21	-21	-21	-21	-21	-21	-21	-21	-21	-21	- *317*
Net GHG Emissions		295,489	295,489	295,489	295,489	128,511	43,871	43,871	43,871	43,871	43,871	43,871	43,871	43,871	43,871	43,871	43,871	43,871	43,871	43,871	43,871	1,968,531

Notes:

1. Greenhouse Gas from the Project, including the construction and operation phase, are evaluated for 20 years starting from the anticipated first year of the construction, which aligns with the assessment requirement as prescribed by the Ontario Ministry of Transportation (MTO).

2. It is assumed the existing winter road traffic and resulting GHG emissions remain constant for the no-build scenario.

Table 3. Summary of Project Direct GHG Emissions by Source Types

Direct GHG source types	Maximum Annual GHG by Source Type (kt CO2 eq) [1,2,3]	Total GHG by Source Type (kt CO2 eq)	Percentages of Total GHG (%)
Construction mobile	18	81	4%
Quarry and road blasting	0.4	1.8	< 1%
Operation traffic emissions	27	401	20%
Land use change	277	1,485	75%
Total GHG without Land Use Change	27	484	24%
Total GHG with Land Use Change	295	1,969	100%

Notes:

1. Annual GHG emissions can vary by project phase and year. The Maximum annual GHG emissions for each source type throughout the assessment period, including the construction and operation phases, are presented.

2. kt CO2 eq means kilotonnes of carbon dioxide equivalent

3 The total GHGs with and without Land Use Change are based on a worst-case year during the assessment period. As such, the total GHGs are not equal to the sum of the max annual GHGs by source types which may occur in different years. For example, the max annual GHG emissions for construction mobile occur during a typical construction year while the max GHG emissions for the operation traffic occur after the construction phase.

Table 4. Summary of Direct GHG Emissions by Project Phase

Direct GHG Emissions	Project Construction Phase [1,2,3,4,5]			Project Operation Phase [1,2,3,4,5]			Project-Total
	Annual Emissions (kt CO2 eq)	Total Emissions (kt CO2 eq)	Percentage of total emissions by Project-Total with Land Use change (%)	Annual Emissions (kt CO2 eq)	Total Emissions (kt CO2 eq)	Percentage of total emissions by Project-Total with Land Use change (%)	Total Emissions (kt CO2 eq)
Direct GHG without Land Use Change	19	83	4%	27	401	20%	484
Land Use Change	277	1,227	62%	17	258	13%	1,485
Direct GHG with Land Use Change	295	1,310	67%	44	658	33%	1,969

Notes:

1. Annual GHG emissions for the construction phase are based on an estimate of 40 km of road built each year.

2. The numbers may not add up due to rounding.

3. kt CO2 eq means kilotonnes of carbon dioxide equivalent

4. Annual carbon sequestrations of land use are separated from direct GHG emission estimations as per the SACC Technical Guide.

5. The project's total GHG emissions are assessed for a total of 20 years starting from the first year of construction. This includes approximately 5 years of construction and 15 years of operation.

Construction Phase Equipment and Operation Info

Nonroad Machinery Equipment

Equipment Location	Construction Activity	Equipment Type/Model	Quantity	MOVES Source Type	MOVES Horsepower Range Bin	Percentage of Equipment Operating in a Given Hour[1]	Maximum Operating hours (hrs/day)	Maximum Operating days (days/yr)	Equipment Total Operating Time in a given hour (hrs/hr)	Equipment Total Operating Time (hrs/day)	Equipment Total Operating Time (hours/year)
Quarry	Drilling	Rock Drills	2	Bore/Drill Rigs	300 < hp <=600	65%	12	365	1.3	15.6	5,694
Roadway	Drilling	Rock Drills	1	Bore/Drill Rigs	300 < hp <=600	65%	12	365	0.65	7.8	2,847
Roadway	Placing Rock	CAT D8 Dozer	2	Crawler Tractor/Dozers	300 < hp <=600	80%	12	365	1.6	19.2	7,008
Roadway	Removing Snow/Clearing & Grubbing	CAT D6 Dozer	3	Crawler Tractor/Dozers	175 < hp <=300	100%	12	365	3	36	13,140
Roadway	Heavier ROW Work	CAT D7 Dozer	2	Crawler Tractor/Dozers	175 < hp <=300	100%	12	365	2	24	8,760
Roadway	Rock Crushing	Crusher	1	Crushing/Proc. Equipment	300 < hp <=600	80%	12	365	0.8	9.6	3,504
Quarry	Loading Trucks with Blast Rock	Deere 450D Exc.	2	Excavators	300 < hp <=600	80%	12	365	1.6	19.2	7,008
Roadway	Working Blast Mats and Removing	Deere 350D Exc.	2	Excavators	175 < hp <=300	80%	12	365	1.6	19.2	7,008
Roadway	Clearing Overburden/Culverts	CAT 325D Exc.	2	Excavators	175 < hp <=300	80%	12	365	1.6	19.2	7,008
Roadway	Deere 872GP	Grader	1	Graders	175 < hp <=300	80%	12	365	0.8	9.6	3,504
Roadway	Volvo A20 (Converted)	Water Truck	1	Off-highway Trucks	175 < hp <=300	40%	12	365	0.4	4.8	1,752
Roadway	Packing aggregates (Volvo SD116B)	Smooth Drum	2	Rollers	100 < hp <=175	80%	12	365	1.6	19.2	7,008
Quarry	Quarry Operation	CAT 972 Loader	1	Rubber Tire Loaders	300 < hp <=600	80%	12	365	0.8	9.6	3,504
Quarry	Quarry Operation	CAT 988H Loader	1	Rubber Tire Loaders	300 < hp <=600	80%	12	365	0.8	9.6	3,504
Bridge	Bridge Building	skid steers- JD323 & JD 333 Tracked	2	Skid Steer Loaders	75 < hp <=100	50%	12	365	1	12	4,380
Bridge	Bridge Building	pile driving rigs- PMx22	1	Bore/Drill Rigs	300 < hp <=600	65%	12	365	0.65	7.8	2,847
Bridge	Bridge Building	moveable cranes XCR40	2	Cranes	175 < hp <=300	80%	12	365	1.6	19.2	7,008
Bridge	Bridge Building	concrete pump truck 65-METER Z FOLD	1	Off-highway Trucks	175 < hp <=300	35%	12	365	0.35	4.2	1,533
Bridge	Bridge Building	concrete mixing trucks - Western Star 4700	3	Off-highway Trucks	300 < hp <=600	80%	12	365	2.4	28.8	10,512
Bridge	Bridge Building	concrete screed machine- Gamco PS-2600	1	Pavers	175 < hp <=300	80%	12	365	0.8	9.6	3,504
Bridge	Bridge Building	Haul Trucks Kenworth- t800 tandem	1	Off-highway Trucks	300 < hp <=600	80%	12	365	0.8	9.6	3,504
Bridge	Bridge Building	portable concrete batch plant- TRIA Products	1	Other Construction Equipment	75 < hp <=100	35%	12	365	0.35	4.2	1,533
Bridge	Bridge Building	Excavator- Komatsu PC 210 LC	1	Excavators	100 < hp <=175	80%	12	365	0.8	9.6	3,504
Bridge	Bridge Building	Compressor- 260 Sullair	1	Air Compressors	50 < hp <=75	80%	12	365	0.8	9.6	3,504
Bridge	Bridge Building	Heater- Flargo FVO-400RC	6	Other General Industrial Eqp	100 < hp <=175	80%	12	365	4.8	57.6	21,024
Bridge	Bridge Building	Generator -Magnum MMG55FH	1	Generator Sets	50 < hp <=75	80%	12	365	0.8	9.6	3,504
Bridge	Bridge Building	Light Plant -Magnum MLT5080/MLT 3060	3	Signal Boards/Light Plants	11 < hp <=16	35%	12	365	1.05	12.6	4,599
Bridge	Bridge Building	Forklift Zoom Boom- ZB8044-44	2	Rough Terrain Forklifts	100 < hp <=175	65%	12	365	1.3	15.6	5,694
Bridge	Bridge Building	SkyJack- SJB-46TK-RJ	1	Aerial Lifts	25 < hp <=40	65%	12	365	0.65	7.8	2,847
Bridge	Bridge Building	Pickup Trucks -F150 or RAM2500	3	Off-highway Trucks	300 < hp <=600	80%	12	365	2.4	28.8	10,512
Bridge	Bridge Building	Generators- BE Gen 3100W	2	Generator Sets	6 < hp <=11	80%	12	365	1.6	19.2	7,008
Bridge	Bridge Building	Water Pumps- Honday WB30XT	2	Pumps	3 < hp <=6	80%	12	365	1.6	19.2	7,008
Bridge	Bridge Building	Water Truck- CAT740	1	Off-highway Trucks	300 < hp <=600	40%	12	365	0.4	4.8	1,752
Roadway	Chipping wood	CBI Magnum Force 6800CT Horizontal Grinde	1	Other Construction Equipment	1000 < hp <=1200	100%	1	365	1	1	365

Onroad Vehicle Equipment

	Construction Activity	Equipment Type	Quantity [1]	MOVES Source Type	Regulatory Class	Fuel Type	Maximum Travel Speed (km/hr)	Percentage of Equipment Moving in a Given Hour [2](%)	Maximum Operating hours (hrs/day) [4]	Operating days (days/yr)	Equipment Total Operating Time [3] (hours/year)	Equipment Total Annual VKT (VKT/year)
Quarry Access Road and Roadway	Haul Rockfill to ROW	Rock Trucks 40T/45T	20	Single Unit Long-Haul Trucks	Heavy Heavy Duty Trucks	Diesel	30	80%	12	365	70,080	2,102,400
Quarry Access Road and Roadway	Processed Aggregate Haul	Semi Trailers	10	Single Unit Long-Haul Trucks	Heavy Heavy Duty Trucks	Diesel	40	80%	12	365	35,040	1,401,600
Roadway	Road Construction Supply	Fuel Truck	1	Single Unit Long-Haul Trucks	Heavy Heavy Duty Trucks	Diesel	50	20%	12	365	876	43,800
Roadway	Road Construction Supply	Flatbed Truck	2	Single Unit Long-Haul Trucks	Heavy Heavy Duty Trucks	Diesel	50	80%	12	365	7,008	350,400
Roadway	Road Construction Supply	Mechanic Truck	1	Light Commercial Trucks	Light Heavy Duty Trucks	Diesel	50	80%	12	365	3,504	175,200
Roadway	General use	half ton trucks	30	Light Commercial Trucks	Light Heavy Duty Trucks	Gasoline	50	80%	4.4	365	38,544	1,927,200

Notes

1 Unlike the air quality assessment which evaluates the worst-case emissions for each averaging period, the annual GHG estimates account for operations of all mobile construction equipment.

2 Construction equipment usage are provided by the CAR engineering team based on prior experience with similar projects.

3. Equipment total operating time is estimated based on the total number of equipment and the maximum operating hours for each equipment in a year.

As per the equipment usage provided by the CAR engineering team, construction vehicles, except half-ton trucks, are conservatively assumed to operate 80% of 12 hours in a day, 365 days in a year.

4. The average daily operating hour of 30 half-ton trucks is estimated based on the anticipated vehicle usage provided by the CAR engineering team.

For half-ton trucks, 10% utilized less than 2hr per day, 80% utilized 4hr per day, and 10% utilized 10hr per day.

Appendix B1. Construction Mobile GHG Emissions

Construction mobile equipment GHG emissions

Table 1. Nonroad Construction Equipment GHG Emissions

Major Equipment Use	Mobile Equipment	Maximum Operating Time [1]	MOVES Nonroad Mobile Emission Factor (g/hr)		Annual Emissions [2,3,4] (Tonnes/Year)			
		(hours/year)	CO2	CH4	CO2	CH4	N2O	CO2e
Quarry	Rock Drills	5,694	1.02E+05	7.21E-01	5.81E+02	4.11E-03	8.01E-04	5.81E+02
Roadway	Rock Drills	2,847	1.02E+05	7.21E-01	2.91E+02	2.05E-03	4.01E-04	2.91E+02
Roadway	CAT D8 Dozer	7,008	1.35E+05	2.07E-01	9.44E+02	1.45E-03	2.83E-04	9.44E+02
Roadway	CAT D6 Dozer	13,140	7.46E+04	5.87E-02	9.80E+02	7.72E-04	1.51E-04	9.80E+02
Roadway	CAT D7 Dozer	8,760	7.46E+04	5.87E-02	6.53E+02	5.14E-04	1.00E-04	6.53E+02
Roadway	Crusher	3,504	9.66E+04	3.49E-01	3.39E+02	1.22E-03	2.39E-04	3.39E+02
Quarry	Deere 450D Exc.	7,008	1.30E+05	1.21E-01	9.11E+02	8.48E-04	1.65E-04	9.11E+02
Roadway	Deere 350D Exc.	7,008	7.39E+04	5.11E-02	5.18E+02	3.58E-04	6.99E-05	5.18E+02
Roadway	CAT 325D Exc.	7,008	7.39E+04	5.11E-02	5.18E+02	3.58E-04	6.99E-05	5.18E+02
Roadway	Grader	3,504	7.32E+04	5.62E-02	2.57E+02	1.97E-04	3.84E-05	2.57E+02
Roadway	Water Truck	1,752	7.74E+04	5.21E-02	1.36E+02	9.13E-05	1.78E-05	1.36E+02
Roadway	Smooth Drum	7,008	4.19E+04	5.57E-02	2.93E+02	3.90E-04	7.61E-05	2.93E+02
Quarry	CAT 972 Loader	3,504	1.33E+05	4.04E-01	4.65E+02	1.41E-03	2.76E-04	4.66E+02
Quarry	CAT 988H Loader	3,504	1.33E+05	4.04E-01	4.65E+02	1.41E-03	2.76E-04	4.66E+02
Bridge	skid steers- JD323 & JD 333 Tracked	4,380	1.23E+04	2.85E-01	5.39E+01	1.25E-03	2.44E-04	5.40E+01
Bridge	pile driving rigs- PMx22	2,847	1.02E+05	7.21E-01	2.91E+02	2.05E-03	4.01E-04	2.91E+02
Bridge	moveable cranes XCR40	7,008	5.43E+04	5.17E-02	3.80E+02	3.62E-04	7.07E-05	3.80E+02
Bridge	concrete pump truck 65-METER Z FOLD	1,533	7.74E+04	5.21E-02	1.19E+02	7.99E-05	1.56E-05	1.19E+02
Bridge	concrete mixing trucks - Western Star 4700	10,512	1.33E+05	9.17E-02	1.40E+03	9.64E-04	1.88E-04	1.40E+03
Bridge	concrete screed machine- Gamco PS-2600	3,504	7.00E+04	6.17E-02	2.45E+02	2.16E-04	4.22E-05	2.45E+02
Bridge	Haul Trucks Kenworth- t800 tandem	3,504	1.33E+05	9.17E-02	4.66E+02	3.21E-04	6.27E-05	4.66E+02
Bridge	portable concrete batch plant- TRIA Products	1,533	2.96E+04	7.09E-02	4.54E+01	1.09E-04	2.12E-05	4.54E+01
Bridge	Excavator- Komatsu PC 210 LC	3,504	4.36E+04	4.70E-02	1.53E+02	1.65E-04	3.21E-05	1.53E+02
Bridge	Compressor- 260 Sullair	3,504	1.54E+04	2.54E-01	5.40E+01	8.91E-04	1.74E-04	5.41E+01
Bridge	Heater- Flargo FVO-400RC	21,024	2.98E+04	5.90E-02	6.26E+02	1.24E-03	2.42E-04	6.26E+02
Bridge	Generator -Magnum MMG55FH	3,504	1.52E+04	3.63E-01	5.33E+01	1.27E-03	2.48E-04	5.34E+01
Bridge	Light Plant -Magnum MLT5080/MLT 3060	4,599	3.48E+03	1.83E-01	1.60E+01	8.41E-04	1.64E-04	1.61E+01
Bridge	Forklift Zoom Boom- ZB8044-44	5,694	3.99E+04	5.98E-02	2.27E+02	3.41E-04	6.65E-05	2.27E+02
Bridge	SkyJack- SJB-46TK-RJ	2,847	4.82E+03	1.60E-01	1.37E+01	4.55E-04	8.89E-05	1.38E+01
Bridge	Pickup Trucks -F150 or RAM2500	10,512	1.33E+05	9.17E-02	1.40E+03	9.64E-04	1.88E-04	1.40E+03
Bridge	Generators- BE Gen 3100W	7,008	2.13E+03	2.57E-01	1.49E+01	1.80E-03	3.52E-04	1.51E+01
Bridge	Water Pumps- Honday WB30XT	7,008	1.32E+03	1.63E-01	9.26E+00	1.14E-03	2.23E-04	9.35E+00
Bridge	Water Truck- CAT740	1,752	1.33E+05	9.17E-02	2.33E+02	1.61E-04	3.14E-05	2.33E+02
Roadway	Wood Chipper- CBI Magnum Force 6800CT Horizontal Grinde	365	3.80E+05	3.37E+00	1.39E+02	1.23E-03	2.40E-04	1.39E+02
Nonroad Construction Equipment Annual Total Emissions (Tonnes/Year)					13,286	0.03	0.01	13,288

Notes:

1. For nonroad construction mobile, the Maximum Operating Time (hour/year) = Percentage of equipment operating in a given hour (%) x Maximum operating hours in a day (hour/day) x Maximum Operating days in a year (day/year)

2. Nonroad mobile emission factors (g/hr) from the US EPA MOVES model. The MOVES does not model N2O emission factors for nonroad equipment.

As such, the N2O emissions for nonroad equipment are estimated based on the ratio of CH4 and N2O emission factors in the 2016 USEPA Greenhouse Gas Inventory Guidance: Direct Emissions from Mobile Combustion Sources for Diesel Fuel Consumption

Diesel fuel combustion emission factors for mobile combustion sources	*CH4 Emission Factor (g N2O/gal)*	*N2O Emission Factor (g N2O/gal)*	*Ratio of N2O to CH4 Emission*
	0.41	*0.08*	*0.20*

3. CO2 equivalent emissions are estimated based on the Global Warming Potential (GWP) in the IPCC's Fifth Assessment Report.

	CO2	CH4	N2O
GWP	1	28	265

4. Annual Emission Rates (t/yr) = Maximum Operating Time (hrs/year) x Nonroad Mobile Emission Factor (g/hr)/1,000,000 (g/t)

Table 2. Onroad Construction Vehicle GHG Emissions

Appendix B1. Construction Mobile GHG Emissions

Construction mobile equipment GHG emissions

Major Equipment Use	Construction Activity	Onroad Vehicle	Fuel Type	Equipment Total Annual VKT (VKT/year)	Onroad Emission Factor (g/VKT) [1]				Annual Emissions [2,3] (t/yr)			
					CO_2	CH_4	N_2O	CO2e [4]	CO_2	CH_4	N_2O	CO2e
Quarry Access Road and Roadway	Haul Rockfill to ROW	Rock Trucks 40T/45T	Diesel	2,102,400	1.19E+03	1.94E-02	2.57E-03	1.19E+03	2.49E+03	2.30E-05	4.98E-11	2.50E+03
Quarry Access Road and Roadway	Processed Aggregate Haul	Semi Trailers	Diesel	1,401,600	1.19E+03	1.94E-02	2.57E-03	1.19E+03	1.66E+03	2.30E-05	4.98E-11	1.66E+03
Roadway	Road Construction Supply	Fuel Truck	Diesel	43,800	3.01E+02	5.93E-03	1.71E-03	3.01E+02	1.32E+01	1.78E-06	1.02E-11	1.32E+01
Roadway	Road Construction Supply	Flatbed Truck	Diesel	350,400	3.01E+02	5.93E-03	1.71E-03	3.01E+02	1.05E+02	1.78E-06	1.02E-11	1.06E+02
Roadway	Road Construction Supply	Mechanic Truck	Diesel	175,200	3.01E+02	5.93E-03	1.71E-03	3.01E+02	5.27E+01	1.78E-06	1.02E-11	5.28E+01
Roadway	General use	half ton trucks	Gasoline	1,927,200	4.38E+02	1.98E-02	4.96E-03	4.40E+02	8.44E+02	8.69E-06	9.84E-11	8.47E+02
Onroad Construction Vehicle Annual Total Emissions (t/yr)												5171

Notes:

1. Onroad emission factors obtained from the US EPA MOVES model run for the construction phase.

2. CO2 Equivalent are calculated based on the Global Warming Potential (GWP) in the IPCC Fifth Assessment Report.

3. Annual Emission rates (t/yr)= Annual VKT (km/yr) x Onroad Emission Factor (g/km)/1,000,000 (g/t)

Table 3. Construction (Onroad and Nonroad) Mobile GHG emissions

	Annual GHG Emissions (t CO2e/yr)
Nonroad Construction Equipment	13,288
Onroad Construction Vehicle	5,171
Total Construction Mobile (Nonroad and Onroad)	18,459

Appendix B2. Quarry/Road Blasting GHG Emissions

Blasting emissions are expected to be from the combustion of diesel fuel in the blasting explosive used for blasting quarry rocks and roadway.

Table 1. Usage of emulsion explosive for quarry and road blasting

	Number of blasts per year	Usage of explosive (Tonnes per blast)	Usage of explosive [1] (Tonnes/Year)	CO_2 Emission Factor [2] (Tonnes CO2/Tonnes explosive)	CO_2 Emissions [3] (Tonnes/year)
Quarry	24	51.1	1227.0	0.189	231.9
Roadway	1460	0.64	927.1		175.2
Total			2154.1		407.1

Notes:

1. Estimates of blasts and explosive usage are provided by the MFCAR engineering team.

2. CO2 emission factor for using ANFO explosive for blasting. Reference: The Mining Association of Canada, 2009. Energy and GHG Emissions Management Guidance.

3. CO2 emissions (tonnes CO2 per year) = usage of blasting explosive (tonnes per year) x emission factor (tonnes CO2 per tonnes blasting explosive)

Appendix B3. Operation Road Traffic GHG Emissions

North-South Segment (to ROF)	Vehicle Types	Total VKT in a year[1] (km/year)	CO2 Equivalent Emission Factor[2] (g/km)	CO2 Equivalent Emissions (tonne/year)
	Heavy Trucks	21,977,043	1120.0	24614
	Median Trucks	2,403,739	231.4	556
	Auto Traffic	9,958,348	122.2	1217
	Total	34,339,130	-	26387
East-West Segment (to MFFN)	Vehicle Types	Total VKT in a year (km/year)	CO2 Equivalent Emission Factor (g/km)	CO2 Equivalent Emissions (tonne/year)
	Heavy Trucks	54,088	1120.0	61
	Median Trucks	360,585	231.4	83
	Auto Traffic	1,388,251	122.2	170
	Total	1,802,923	-	314
MFCAR Segments Total	Total	36,142,053	-	26,700

Notes:

1. Total VKT in a year is conservatively estimated based on the anticipated traffic volume in the 2046 year and the road length. The AADT traffic volume is assumed to remain constant throughout the year.

2. Emission factors in CO_2 Equivalent are developed based on the output from the USEPA MOVES model run for the operation starting year (2035) and Global Warming Potential (GWP) in the IPCC Fifth Assessment Report.

Appendix B4. Land Use Change GHG Emissions

Technical Documents followed for the GHG Assessment due to Land Use Conversion:
- Technical Guide related to the Strategic Assessment of Climate Change (SACC) - Guidance on quantification of net GHG emissions, impact on carbon sinks, mitigation measures, net-zero plan and upstream GHG assessment. August 2021. (Referred to as the SACC Technical Guide).
- 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (LULUCF), Section 3.2 Forest Land
- 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (LULUCF), Annex 3A.1 Biomass Default Tables for Section 3.2 Forest Land
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other land Use, Chapter 2 Generic Methodologies Applicable to Multiple Land-Use Categories
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 4 - Forest Land
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 7 - Wetlands
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 8 - Settlements
- National Inventory Report (NIR), 2020. Greenhouse Gas Sources and Sinks in Canada- Part 1
- UNFCCC, 2011. Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity

Table 1. Annual Carbon Stock Changes in Carbon Pools During Construction Phase

Carbon Pool		Forest Land [1]	Wetlands [1]	Total Carbon Stocks [2,3,4,5] (Forest land + Wetlands)	Unit
Living Biomass	▲C_{B}	-17,839	- 21,062	- 38,900	tonnes C/year
Dead Organic Matter	▲C_{DOM}	-23,709	- 7,189	- 30,897	tonnes C/year
Soil Organic Matter	▲C_{Soils}	- 4,689	0	- 4,689	tonnes C/year
Total ▲C		-46,236	- 28,250	- 74,486	tonnes C/year

Notes:
1. Carbon stock changes in each carbon pool within forest lands and wetlands are calculated following the relevant methods or equations.
2. Carbon stock changes are calculated based on the anticipated disturbed land area in each construction year (i.e., 40km distance built each year).
3. The total carbon stocks represent the carbon loss resulting from land use changes (forest and wetlands) which equals a direct emission of carbon.
4. The value represents the annual carbon stock changes in a full construction year (i.e., all construction years except the last year of construction)
5. Carbon stock changes in each carbon pool within forest lands and wetlands are calculated following the relevant methods or equations.

Table 2. Annual Emissions from Land Use Change

Carbon Pool/GHG Category		Unit	Construction Phase					Operation Phase														
			2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
			Year -5	Year -4	Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Living Biomass	▲C_{B}	tonnes C/year	- 38,900	- 38,900	- 38,900	- 38,900	- 15,560	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dead Organic Matter	▲C_{DOM}	tonnes C/year	- 30,897	- 30,897	- 30,897	- 30,897	- 12,359	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soil Organic Matter [1]	▲C_{Soils}	tonnes C/year	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689	- 4,689
Total CO_2 [2] (except wood burning)	▲$C_{Total\text{-}except\ wood\ burning}$	tonnes CO_2/year	273,116	273,116	273,116	273,116	119,561	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192	17,192
Non-CO2 from Wood Burning [3]	▲$C_{Burning}$	tonnes CO_2/year	3,506	3,506	3,506	3,506	1,403	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Annual Emissions from Land Use Change	▲$C_{Total\text{-}Land\ Use}$	tonnes CO_2/year	276,622	276,622	276,622	276,622	120,964	17,191.80	17,191.80	17,191.80	17,191.80	17,191.80	17,191.80	17,191.80	17,191.80	17,191.80	17,191.80	17,191.80	17,191.80	17,191.80	17,191.80	17,191.80

Notes:
1. The soil carbon stock change is assumed evenly distributed over a 20-year period following the IPCC Tire 1 approach.
2. Annual total CO2 emissions emitted to the atmosphere from land-use change are calculated through the equation below.
Total CO2 (▲C_{Total}) = (Living Biomass (▲C_{B}) + Dead Organic Matter (▲C_{DOM}) + Soil Organic Matter (▲C_{Soils})) x 44/12
Loss of carbon from land use change is represented by negative values, while the resulting "direct" emissions of CO2 are represented by positive values.
3. See GHG emissions from Wood Burning. Annual Non-CO2 emissions from wood burning are estimated following relevant IPCC guidance.

Table 3. Net GHG emissions from Land-use Change for the MFCAR Project

Carbon Pool		Unit	Project Total [1] (Construction and Operation)
Living Biomass	▲C_{B}	tonnes C	- 171,161
Dead Organic Matter	▲C_{DOM}	tonnes C	- 135,948
Soil Organic Matter	▲C_{Soils}	tonnes C	- 93,773
Total CO_2 (except wood burning)	▲C_{Total}	tonnes CO_2	1,469,902
Non-CO2 from Wood Burning	▲$C_{Burning}$	tonnes CO_2	15,428
Total Emissions from Land Use Change	▲$C_{Total\text{-}Land\ Use}$	tonnes CO_2	1,485,331

Notes:
1. Negative carbon stock values indicate a removal from the stock and an emittance to the atmosphere. The values are converted to positive numbers in calculating CO2 emissions to the atmosphere.

Appendix B4. Land Use Change GHG Emissions

Existing Land Use within Construction Disturbance Area

Table 1. IPCC Land Use Category for Construction Disturbance Area

IPCC Land Use Category[1]	Construction Disturbance Area[2] (ha)	Percentage (%)
Forest Land	2311.7	49.18%
Wetlands[3] (including forested wetlands)	2352.9	50.06%
Settlements	1.8	0.04%
Other Land (e.g., Water and rocks)	33.8	0.72%
Total	4700.2	**100.00%**

Notes:

1. IPCC 2006 Chapter 2 - Generic Methodologies Applicable to Multiple Land-Use Categories.

2. The Construction Disturbance Area encompasses a 100 m wide right-of-way for the selected route and associated infrastructure (e.g., pits, quarries, and temporary access roads). The 100 m wide right-of-way consists of a width of 60m to be cleared for permanent use and a 40m width to be cleared to accommodate construction activities (e.g., construction of temporary laydown areas).

3. Wetlands include bog, fen, marsh, and swamp. The wetlands land use includes forested wetlands which consist of treed bog, treed fen, and conifer swamp.

Table 2. Land Use Category and Vegetation Community Grouping

IPCC Land Use Category	Vegetation Community Grouping[1]	Disturbed Area (ha)	Percentage (%)
Forest Land	Coniferous Forest *(Black Spruce Conifer, Fir Conifer, etc.)*	1640.1	34.89%
	Deciduous Forest *(Birch Hardwood and Oak Hardwood)*	526.7	11.21%
	Mixed Forest	139.4	2.97%
	Early Successional / Sparse Treed	5.5	0.12%
Wetlands[2,3] (including forested wetlands)	Bog *(Treed Bog and Sparse Treed Bog)*	29.2	0.62%
	Fen *(Sparse Treed Fen, Open Fen, and Shore fen)*	786.2	16.73%
	Marsh *(Organic Marsh, Mineral Marsh)*	37.4	0.79%
	Swamp *(Conifer Swamp and Thicket Swamp)*	1,500.2	31.92%
Settlements	Anthropogenic	1.8	0.04%
Other Land (e.g., Water and rocks)	Water	19.7	0.42%
	Rock / Barren	14.1	0.30%
Construction Disturbance Area -Total		4,700.2	**100.00%**

Notes:

1. The vegetation mapping (i.e., Land Use Map by WSP Vegetation Community Grouping) is used for assessing carbon stock changes in biomass and dead organic matter (DOM), and subsequent CO_2 emissions. For assessing carbon stock changes in soil, a peatland mapping is used which distinguishes mineral soils (e.g., mineral swamps and mineral marshes) from organic soils (i.e., peatlands). In the vegetation mapping, the organic and mineral soils are lumped together for each wetland class (e.g., organic soil marsh and mineral soil marsh are mapped as marsh) and therefore can not be used for soil carbon analysis.

2. IPCC land-use categories Wetlands and Forest Land are further split into meaningful classes to provide refined estimates of carbon stocks, following the SACC technical guide. For instance, wetland area is split into wetland classes such as bog and fen, as defined by the Wetland Classification System and forest land area is split into different forest types.

3. Forested wetlands (Treed Bog, Treed Fen, and Conifer Swamp) are classified as wetlands due to the available vegetation data. More specifically, ecosites are rolled up to broader vegetation community groups (e.g., treed fen and open fen are rolled up to Fen) during the vegetation mapping process for the MFCAR project. However, the forested wetlands are treated as forest land during the calculation of carbon stocks for biomass and DOM, following Step 4.2 of the SACC technical guide.

Table 3.Forest Land Distribution in Ecozones

IPCC Land Category	Ecozones	The CDA within each Ecozone (%)	Vegetation Community Grouping	Construction Disturbance Area (ha)
Forest Land	Boreal Shield	93.3%	Coniferous Forest	1492.3
			Deciduous Forest	523.1
			Mixed Forest	135.3
			Early Successional / Sparse Treed	5.5
			Total Boreal Shield Forest	2156.2
	Hudson Plains	6.7%	Coniferous Forest	147.8
			Deciduous Forest	3.6
			Mixed Forest	4.1
			Early Successional / Sparse Treed	0.0
			Total Hudson Plains Forest	155.5
	Total Forest Land	100.0%	Total Forest Land	2311.7

Notes:
The East-West section of the CAR route (to Marten Fall community) is mainly located in the Hudson Plains ecozone while the north-south section (to the Ring Of Fire) falls within the Boreal Shield ecozone. Based on the above land data, the Boreal Shield forest accounts for the majority of the forest land (93.3%) within the CDA and therefore review of representative carbon stocks was mainly based on the Boreal Shield forests.

Table 4. Converted land area in each construction year

Construction phase year	2030	2031	2032	2033	2034	Total Construction Period
	Year -5	Year -4	Year -3	Year -2	Year -1	
Annual road distance built (km)	40	40	40	40	24	184
IPCC Land Category	Cleared Land Area (ha)					
Forest Land (including forested wetlands)	502.5	502.5	502.5	502.5	301.5	2311.7
Wetlands	511.5	511.5	511.5	511.5	306.9	2352.9

Notes:
A detailed construction plan is not available at the time of the report preparation. However, road construction is planned to proceed in parallel from the MFCAR south heading northerly and from Marten Falls heading out of the community. An approximate road distance of 20 km is expected to be built annually from both directions which equals to a total of 40km built in each construction year. For the purpose of the GHG assessment, the project construction is assumed to begin in 2030 and be completed in 2034 year. The converted land area of each land use (Forest lands and wetlands) during each construction year is estimated based on the anticipated annual road distance built (i.e., 40km), except Year -1 (2034) for which the converted land area and subsequent carbon stock changes are prorated based on the remaining road distance to be built in that year.

Assumed total years of construction= *4.6* *Year*

Appendix B4. Land Use Change GHG Emissions

Forest land - Living Biomass Stock

Table 1: Living Biomass Stock Change ($\blacktriangle C_B$)

Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation2.15

$\blacktriangle C_B = \blacktriangle C_G + \blacktriangle C_{conversion} - \blacktriangle C_L$

Parameter	Value	Unit	Comment and/or value reference
$\blacktriangle C_G$	0	tonnes C/year	Annual biomass Growth. IPCC 2006, Equation 2.9 to 2.10. As per the SACC Technical Guide, Appendix B, Step 4.1, biomass growth can be assumed equal to zero in the case of any Land to Settlements conversions.
$\blacktriangle C_{conversion}$	- 17,838.5	tonnes C/year	Annual change in biomass from land conversion. Calculated below using the IPCC 2006, Equation 2.16.
$\blacktriangle C_L$	0	tonnes C/year	Biomass Losses from harvesting, fuel wood gathering and disturbance. Not applicable to lands converted to settlements and therefore the value is assumed equal to zero.
$\blacktriangle C_B$	- 17,838.5	tonnes C/year	Annual change in biomass stock. Calculated here using the IPCC 2006, Volume 4, Chapter 2, Equation 2.15.

Table 2: Change in Biomass from Land Conversion ($\blacktriangle C_{conversion}$)

Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation 2.16

$\blacktriangle C\ conversion = \sum_i \{(B_{AFTER\ i} - B_{BEFORE\ i})* \blacktriangle A_{TO\_OTHERS\ i}\} * CF$

Parameter	Value	Unit	Comment and/or value reference
B_{After}	0	t dry matter/ha	Biomass stock value after. As per the SACC Technical Guide , Appendix B, Step 4.1, it is assumed that living biomass will be zero after land conversion to Settlements.
B_{Before}	71.0	t dry matter/ha	Biomass stock value before.: As per the SACC Technical Guide, Appendix B, Step 4.1, a site-specific estimate for B_{Before} is required for Tier 2 assessments. A literature research was completed for applicable data from the Boreal Forest in Ontario and Canada. A representative biomass value was determined based on the land use within the CDA. See Table 3 below for the selection of data.
$\blacktriangle A_{TO\_OTHERS}$	502.5	ha/year	Area of forest land converted to settlements in each construction year.
CF	0.5	t C/t dry matter	Carbon fraction. As per the IPCC 2006 Table 8.4, carbon stock value can be multiplied by a carbon fraction (CF) of 0.5 to convert dry matter to carbon for forest land.
$\blacktriangle C_{conversion}$	- 17,838.5	t C/year	Annual change in biomass carbon stock in forest land.

Table 3: Forest Land Biomass Stock (B_{Before}) Review

Parameter	Value	Unit	Comment and/or value reference
B_{Before}	10-90	t dry matter/ha	Tier 1 Default value range. From: IPCC 2006, Volume 4, Chapter 4, Table 4.7. Boreal, Boreal coniferous forest, Asia, Europe, North America
	71.8	t dry matter/ha	NRCAN, 1997, Canada's Forest biomass Resources: Deriving Estimates from Canada's Forest Inventory. Table 6, Ecozone: Boreal Shield
	59.8	t dry matter/ha	NRCAN, 1997, Canada's Forest biomass Resources: Deriving Estimates from Canada's Forest Inventory. Table 6, Ecozone: Hudson Plains
	71.0	t dry matter/ha	Average biomass carbon stock value based on the percentages of disturbed trees that fall within the Boreal Shield (93.3%) and Hudson Plains (6.7%) ecozones.

Note: A literature review was performed to determine an appropriate biomass value (B_{Before}) for living biomass within the CDA. The living biomass (trees) that will be disturbed by construction falls within both the Boreal Shield and Hudson Plains ecozones. As such, an average biomass stock value (71 t dry matter/ha) is used based on the distribution of living biomass within both ecozones. The average biomass carbon stock is on the higher end of the global default Tier 1 range of 10 - 90.

Appendix B4. Land Use Change GHG Emissions

Forest land - Dead Organic Matter (DOM)

Table 1: Dead Organic Matter Change ($\blacktriangle C_{DOM}$)
Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation 2.23
- Annual change in carbon stocks in dead wood and litter due to land conversion

$\blacktriangle C_{DOM} = (C_n - C_o) * A_{on} / T_{on}$			
Parameter	Value	Unit	Comment and/or value reference
C_o	47.2	t C/ha	Deadwood and litter stock under the old land-use (forest land) category. As per the SACC Technical Guide, Appendix B, Step 4.2, a site-specific estimate of C_o is preferred for a Tier 2 assessment. Table 2 below provides a summary of background research and value selection for C_o.
C_n	0	t C/ha	Deadwood and litter stock under the new land-use category. As per the SACC Technical Guide, Appendix B, Step 4.2, it is assumed that there will be no dead wood/litter on the land after land conversion, therefore a value of zero is used.
A on	2311.7	ha	The total area of forest land converted to settlements.
T on	4.6	year	Time period of the transition from old to new land-use category. The construction phase for the project is about 4.6 years based on the total road length and an estimate of 40km distance built each year.
$\blacktriangle C_{DOM}$	- 23,708.7	t C/year	The estimated annual change of carbon stock dead wood and litter due to the conversion of forest land to settlement. The value applies to all construction years except the last construction year (Year -1) during which less land area is converted to settlement.

Table 2: Forest Land Deadwood/litter Carbon Density (C_o) Review

Parameter	Value	Unit	Comment and/or value reference
C_o	31 (6-86)	t C/ha	IPCC 2006, Volume 4, Chapter 2, Table 2.2. Tier 1 Default value for litter carbon stock of the needleleaf evergreen forest type in the Boreal, dry climate.
	55 (7-123)	t C/ha	IPCC 2006, Volume 4, Chapter 2, Table 2.2. Tier 1 Default value for litter carbon stock of the needleleaf evergreen forest type in the Boreal, moist climate.
	32.6	t C/ha	Average carbon stock value for litter. The carbon stock value is based on the IPCC default values for the major forest type within the CDA (needleleaf evergreen) and the percentages of forest land fall within the dry (Ontario Shield Ecozone) and moist climate (Hudson Bay Lowlands). See below for the determination of litter carbon stock value.
	14.6	t C/ha	Estimated deadwood carbon stock value. See below for the determination of deadwood carbon stock value.

Note: DOMs including litter (fine woody debris < 10 cm diameter) and deadwood (> 10 cm diameter) often continue to increase in size in mature forests as biomass has reached or exceeds maximum carbon storage capacity. Ongoing transfers to DOM through biomass mortality and turnover allow these pools to accumulate carbon. (NRCAN, 2013. Carbon in Canada's boreal forest — A synthesis).

To determine a representative carbon stock value for dead wood/litter for the forest land within the CDA, literature research was conducted for site-specific DOM value from a comparable ecosystem while no appropriate data were found at the time of the assessment. As Conifer, often called evergreens or needle-leaved trees, is the major forest type for both the Boreal Shield Ecozone (64.5% of forest) and Hudson Plains Ecozone (75.4% of forest) where the CAR is located, the IPCC Table 2.2- Tier 1 Default litter carbon value for needleleaf evergreen tree was reviewed for the representative climate condition (i.e., dry and/or moist).

Most of the forest land within the CDA (93.3%) is located within the Boreal Shield Ecozone (Ecoregion 2W), characterized by a cold, dry climate. A small percentage of the forest land (6.7%) in the northern part of the CDA is located within the Hudson Plains Ecozone (Ecoregion 2E) which has a cold, moist climate. As such, an average litter stock (32.6 t C/ha) is calculated based on the IPCC default values for the Boreal Shield Ecozone and Hudson Plains Ecozone and the percentages of forest land within each ecozone.

No regional estimates of carbon stock values were provided for deadwood in any forest types in the IPCC Table 2.2. A literature review shows estimates of deadwood carbon pool from a similar ecozone are unavailable at the time of preparing the assessment. A review of the study "NRCAN, 2013. Carbon in Canada's boreal forest — A synthesis" shows the averaged carbon stock of deadwood for all ecozones is around 21 t/ha, about 45% of the average litter stock carbon for all ecozones (about 47 t/ha). In the absence of site-specific carbon stock density for deadwood, the deadwood carbon stock for the CDA is estimated based on the average litter carbon stock and the ratio of deadwood/litter carbon stock (about 45%).

Appendix B4. Land Use Change GHG Emissions

Forest land - Soil Organic Carbon (SOC)

Table 1: Soil Carbon Stock Change (▲C $_{Soils}$)

Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation 2.24

▲C_{Soils} = ▲$C_{Mineral}$ − $L_{Organic}$ + ▲$C_{Inorganic}$			
Parameter	Value	Unit	Comment and/or value reference
▲C_{Soils}	- 4,688.7	t C/year	Annual carbon stock change in soils. Calculated below in Table 2 following IPCC 2006, Volume 4, Chapter 8, Section 8.3.3.2.
▲$C_{Mineral}$	- 2,605.1	t C/year	Annual carbon stock change in mineral soil. Calculated below in Table 2 following IPCC 2006, Equation 2.25.
-$L_{Organic}$	- 2,083.6	t C/year	The annual loss of organic carbon from soil drainage and other disturbances (e.g., soil excavation). Note the $L_{organic}$ in the IPCC Equation 2.24 has been revised to include organic carbon losses due to other disturbances (e.g., soil excavation) in addition to the soil drainage, following Step 4.3.2 of the Strategic Assessment of Climate Change Technical Guide.
▲$C_{Inorganic}$	0	t C/year	Annual change in inorganic carbon stock from soils. As per the SACC Technical Guide, Appendix B, Step 4.3, the change in inorganic carbon can be assumed equal to zero for Tier 1 and Tier 2 assessments.

Table 2: Carbon Stock Change in Mineral Soils (▲C $_{Mineral}$)

Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation 2.25

▲$C_{Mineral}$ = (SOC_0 - SOC_{0-T}) / D			
Parameter	Value	Unit	Comment and/or value reference
SOC_0	208,407.4	t C	Soil organic carbon (SOC) stock at the end of 20-year time period. Per the IPCC 2006, Section 8.3.3.2 or the SACC Technical Guide - Tire 1 method for estimating mineral soil stock change, 20% of mineral soil SOC can be assumed lost over 20 years as a result of disturbance, removal or relocation for most land-to-settlement conversions.
SOC_{0-T}	260,509.3	t C	The initial (pre-conversion) soil organic carbon stock. Calculated through the IPCC Equation 2.25 below.
D	20	Year	Time dependence of stock change factors which is the default time period for transition between equilibrium soil organic carbon values. The commonly used 20 years is assumed.
▲$C_{Mineral}$	- 2,605.1	t C/year	Annual change in carbon stocks in mineral soils.
SOC_{0-T} = SOC_{REF} * F_{lu} * F_{MG} * F_I *A			
Parameter	Value	Unit	Comment and/or value reference
SOC_{REF}	125.7	t C/ha	The reference carbon stock. Site-specific carbon stock value was provided by WSP Canada Inc. (2024) based on soil map units in Attachment D and soil laboratory data in Attachment E. The carbon stock value was measured for mineral soil samples collected within the MFCAR construction development area for a maximum depth of 30 cm, as required for the IPCC Tier 1 and Tier 2 methods. *Reference Literature:* *WSP Canada Inc. 2024. Draft Physiography, Terrain, and Soils Technical Support Document: Existing Conditions and Effects Assessment.*
F_{LU}	1	Dimensionless	A land-use factor that reflects C stock changes associated with type of land use. IPCC 2006, Volume 4, Chapter 4, Section 4.3.3.4. For forest land, all stock change factors are assumed equal to 1 for the Tier 1 method.
F_{MG}	1	Dimensionless	A management factor representing the principal management practice specific to the land-use sector. IPCC 2006, Volume 4, Chapter 4, Section 4.3.3.4. For forest land, all stock change factors are assumed equal to 1 for the Tier 1 method.
F_I	1	Dimensionless	An input factor representing different levels of C input to soil. See Section 8.3.3.2. IPCC 2006, Volume 4, Chapter 4, Section 4.3.3.4. For forest land, all stock change factors are assumed equal to 1 for the Tier 1 method.
A	2072.5	ha	The area of forest land that has mineral soil. The area is calculated as the total forest land area minus forest land area on organic soil.

Table 3: Loss of SOC in Organic Soils ($-L_{Organic}$)

Method Reference: SACC Technical Guide Step 4.3.2

$-L_{Organic} = \blacktriangle SOC_{excavation} + \blacktriangle SOC_{drainage}$			
Parameter	Value	Unit	Comment and/or value reference
$-L_{Organic}$ =	- 2,083.6	t C/year	Annual loss of SOC in organic soils due to soil excavation and drainage. Calculated here following the SACC Technical Guide Step 4.3.2.
$\blacktriangle SOC_{excavation}$	- 2,083.6	t C/year	Annual loss of SOC in organic soils due to soil excavation. Calculated below.
$\blacktriangle SOC_{drainage}$	0	t C	Annual loss of SOC in organic soils due to soil drainage. The project construction is not expected to alter the water level in forest land therefore the loss of carbon in organic soils due to soil drainage is assumed zero.
$\blacktriangle SOC_{excavation} = (SOC_{excavation-after} - SOC_{excavation-Initial})/T$			
$\blacktriangle SOC_{excavation}$	- 2,083.6	t C	Annual change of SOC in organic soils due to project excavation. Calculated based on the difference in SOCs before and after the construction and total construction years.
$SOC_{excavation-Initial}$	41,671.6	t C	The initial SOC in organic soils within forest land (e.g., coniferous and deciduous forests). The majority area of forest land within the CDA has mineral soil and a relatively small percentage of forest land has organic soil. Calculated in Table 4 below.
$SOC_{excavation-after}$	0	t C	The SOC in organic soils within forestland after project excavation. As per the SACC Technical Guide and IPCC guidelines, carbon stored in organic soil that is removed during construction is treated as CO2 releases to the atmosphere.
T	20	year	As per the SACC Technical Guide, changes in soil SOC are generally assumed not to be instantaneous, as in changes to biomass and DOM stocks, but they are instead calculated as emissions from soil stocks for a certain time-period. A default 20-year duration is applied for the carbon loss due to the soil's accelerated decomposition.

Table 4: Forest Land on Organic Soils and Carbon Storage

Vegetation Community Grouping	Area of Forest on Organic Soil (ha)	Average Organic Soil (peat) Thickness (m)	Soil Organic Carbon Estimations	Calculated Carbon Stock Density (t C/ha)	Calculated Carbon stock (t C)
Coniferous Forest	157.05	1.01	Carbon stock (kg/m2) = 0.4 x peat depth (m) +17	174.0	27,333.0
Deciduous Forest	9.43	1.04		174.2	1,642.3
Sparse Treed	0.04	0.93		173.7	6.9
Mixed Forest	72.71	1.13		174.5	12,689.3
Total Forest Land on organic soil	239.23	-	-		41,671.6

Notes

The carbon stock of organic soil in forests can vary depending on the organic soil depth, soil bulk density, and total organic carbon content which can be measured through field sampling. In the absence of organic soil samples within forests, the carbon stocks of organic soils within forest lands are estimated based on the linear regression for estimating peat carbon stocks in the peat carbon vulnerability study (McLaughlin and Packalen, 2021).

Table 5. Summary of forest land on Mineral and Organic Soils

	Area (ha)	Percentage (%)
Forest land on Mineral Soil	2,072.5	90%
Forest Land on Organic Soil	239.2	10%
Total Forest Land Area	2,311.7	100%

Appendix B4. Land Use Change GHG Emissions

Table 1. GHG Emissions from Wood Burning

Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation 2.27

$L_{fire} = A * M_B * C_f * G_{ef} * 10^{-3}$			
Parameter	Value	Unit	Comment and/or value reference [1,2,3]
$L_{Fire-CH4}$	82.2	Tonne/year	Amount of CH_4 emissions from fire.
$L_{Fire-N2O}$	4.5	Tonne/year	Amount of N_2O emissions from fire.
A	251.3	ha	Area burnt per year. Per the MFCAR engineering team, about half of the wood (conservatively assuming both biomass and deadwood/litter) in forest land will be chipped, stockpiled and burned. Wood from forest wetlands and wetlands will not be burned. As such, the area burnt per year can be estimated as 50% of the forest land area disturbed each year.
$M_B * C_f$	69.6	Tonne dry matter/ha	Mass of fuel (including biomass, ground litter and deadwood) available for combustion and Combustion factor C_f. In the absence of a representative mass of forestland DOM (tonnes dry matter/ha), the default value for the amount of fuel actually burnt (the product of Mb and Cf) for Boreal Forest- Post logging slash burn is used (see IPCC Table 2.4).
G_{ef-CH4}	4.7	g/kg dry matter burnt	CH_4 emission factor. G_{ef-CH4} for the Boreal forest is not provided in Table 2.5 of the IPCC Chapter 2 (only emission factors for tropical forest types are provided in the IPCC Table 2.5). A literature review of the study (UNFCCC, 2014) shows a default EF_{-CH4} of 4.7 can be used for forests other than tropical forests. *Reference literature:* *United Nations Framework Convention on Climate Change (UNFCCC) document -"Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity.*
G_{ef-N2O}	0.26	g/kg dry matter burnt	N_2O emission factor. G_{ef-N2O} for the Boreal forest is not provided in Table 2.5 of the IPCC Chapter 2 (only emission factors for tropical forest types are provided in the IPCC Table 2.5). A literature review of the study (UNFCCC, 2014) shows a default shows a default EF_{-N2O} of 0.26 can be used for forests other than tropical forests. *Reference literature:* *United Nations Framework Convention on Climate Change (UNFCCC) document -"Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity.*

Notes

1. Wood burning is expected to occur after the disturbance of biomass and DOM in the forestland, which is different from the biomass burning defined in the IPCC Chapter 2 for which the land remains in the same land use category after the fire

Table 2. GHG emissions from wood burning in CO2 equivalent

	Annual Emissions	Global Warming Potential [1]	Annual GHG Emissions in CO2e
	Tonne/year	(GWP)	(Tonne/year)
$L_{Fire-CH4}$	82.2	28	2,301
$L_{Fire-N2O}$	4.5	265	1,205
Total Non-CO2 Emissions			3,506

Notes:

1. Annual GHG emissions in CO2 Equivalent are calculated based on the Global Warming Potential (GWP) in the IPCC Fifth Assessment Report.

Appendix B4. Land Use Change GHG Emissions

Wetlands - Living Biomass Stock

Table 1: Living Biomass Stock Change ($\blacktriangle C_B$)

Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation 2.15

$\blacktriangle C_B = \blacktriangle C_G + \blacktriangle C_{conversion} - \blacktriangle C_L$			
Parameter	Value	Unit	Comment and/or value reference
$\blacktriangle C_G$	0	tonnes C/year	Annual biomass Growth. As per the SACC Technical Guide, Appendix B, Step 4.1, biomass growth can be assumed equal to zero in the case of any Land to Settlements conversions.
$\blacktriangle C_{conversion}$	- 21,061.6	tonnes C/year	Annual change in biomass from Land Conversion. Calculated below using IPCC 2006, Equation 2.16.
$\blacktriangle C_L$	0	tonnes C/year	Annual biomass Losses from harvesting, fuel wood gathering and disturbance. Not applicable to lands converted to settlements and therefore the value is assumed equal to zero.
$\blacktriangle C_B$	- 21,061.6	tonnes C/year	Annual change in biomass stock. Calculated here through IPCC 2006, Volume 4, Chapter 2, Equation 2.15.

Table 2: Change in Biomass from Land Conversion ($\blacktriangle C_{conversion}$)

Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation 2.16

$\blacktriangle C\ conversion = \sum_i \{(B_{AFTER\ i} - B_{BEFORE\ i})* \blacktriangle A_{TO\_OTHERS\ i}\} * CF$			
Parameter	Value	Unit	Comment and/or value reference
B_{After}	0	t dry matter/ha	Biomass after the conversion. As per the SACC Technical Guide, Appendix B, Step 4.1, living biomass is assumed to be zero after land conversion to settlements.
B_{Before}	see below	t dry matter/ha	Biomass before the conversion. As per the SACC Technical Guide, Appendix B, Step 4.1, a site-specific estimate for B_{Before} is required for Tier 2 assessments. See Table 3 below for determining the living biomass of wetlands before the land conversion.
$\blacktriangle A_{TO\_OTHERS}$	see below	ha/year	Area of wetlands converted to settlements. See Table 3 below.
CF	0.47	t C/t dry matter	Carbon fraction. See the SACC Technical Guide, Table 23- Calculating change in living biomass from land-use change for wetlands area
$\blacktriangle C_{conversion}$	- 21,061.6	tonnes C/year	Annual change of biomass carbon stocks in all wetland types. Calculated here through the IPCC 2006, Volume 4, Chapter 2, Equation 2.16

Table 3: Wetlands Land Area and Data Review for B_{Before}

Parameter	Value	Unit	Comment and/or value reference
▲ A_{bog}	29.2	ha	Total area of treed bog and sparsely treed bog.
▲ A_{Fen}	786.2	ha	Total area of sparse treed fen, open fen, and shore fen.
▲ A_{Marsh}	37.4	ha	Total area of Marsh.
▲ A_{Swamp}	1500.2	ha	Total area of conifer swamp and thicket swamp.
$B_{Before-bog}$	12.1	t dry matter/ha	Average biomass of open bog before conversion. A literature review (Kelly A. Bona, et. al, 2024) indicates the average biomass carbon stock for bog varies from 2.4 t C/ha for open bog, 5.7 t C/ha for treed bog, and 11.2 t C/ha for forested bog. As the bog within the CDA comprises treed bog and sparsely treed bog, the average biomass carbon of 5.7 t C/ha is used, which converts to 12.1 t dry matter/ha using the default carbon fraction of 0.47 t C/t dry matter. *Reference literature:* *Kelly A. Bona, et. al, 2024. Using the Canadian Model for Peatlands (CaMP) to examine greenhouse gas emissions and carbon sink strength in Canada's boreal and temperate peatlands.*
$B_{Before-fen}$	13.5	t dry matter/ha	Average biomass of open fen before conversion. The majority of fen within the CDA is sparsely treed fen. A study (Kelly A. Bona, et. al, 2024) indicates the average biomass carbon stock for treed fen is 6.35 t C/ ha (6.4 t C/ha for treed poor fen and 6.3 t C for treed rich fen), which converts to13.5 t dry matter/ha using the default carbon fraction of 0.47 t C/t dry matter. *Reference literature:* *Kelly A. Bona, et. al, 2024. Using the Canadian Model for Peatlands (CaMP) to examine greenhouse gas emissions and carbon sink strength in Canada's boreal and temperate peatlands.*
$B_{Before-Marsh}$	12.0	t dry matter/ha	Average biomass of marsh before conversion. The average above-ground biomass for marsh is about 1.2 kg/m^2 or 1.2 tonne/ha. *Reference literature:* *Bona et al 2018, A peatland productivity and decomposition parameter database.*
$B_{Before-Swamp}$	129.8	t dry matter/ha	Average biomass of swamp before conversion. Conifer swamps dominate the swamp land cover within the CDA and therefore a literature review was conducted for the average biomass carbon of conifer swamps. A study below (*Davidson, S. J., et al., 2024*) found that the average total biomass carbon stock at a boreal conifer swamp including both tall-treed and low-treed swamps is about 6.1 kg C/m2 or 61 t C/ha, which comprises 5 kg C/m2 of average above-ground biomass and 1.1 kg C/m2 of average below-ground biomass. The average biomass carbon stock for conifer swamps (61 t C/ha) is used to back-calculate biomass using the default carbon fraction (0.47 t C/t dry matter) for wetlands. The study also indicated that the greater variability in hydrological conditions compared to other wetland types allows swamp trees to grow taller compared to other forested wetland types and therefore can store more aboveground biomass. Another study (Davidson et al., 2022) also found the above-ground biomasses in swamps are significantly larger than other wetland types such as treed bogs, freed fens, or marshes. *Reference literature:* *Davidson, S. J., et al., 2024, Carbon stocks and fluxes from a boreal conifer swamp: Filling a knowledge gap for understanding the boreal C cycle.* *Davidson et al., 2022. The unrecognized importance of carbon stocks and fluxes from swamps in Canada and the USA.*

Wetland- Dead Organic Matter (DOM)

Table 1: Dead Organic Matter Change (▲C $_{DOM}$)

Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation 2.23

- Annual change in carbon stocks in dead wood and litter due to land conversion

▲C $_{DOM}$ = (C_n - C_o)* A_{on} /T_{on}			
Parameter	Value	Unit	Comment and/or value reference
C_o	See Table 2 below	t C/ha	Deadwood and litter stock under the old land-use (wetlands) category. As per the SACC Technical Guide, Appendix B, Step 4.2, a site-specific estimate of C_o is required for a Tier 2 assessment. Table 2 below provides a summary of background research and value selection for C_o.
C_n	0	t C/ha	Deadwood and litter stock under the new land-use category. As per the SACC Technical Guide, Appendix B, Step 4.2, it is assumed that there will be no dead wood and litter on the land after land conversion, so a value of zero is used.
A on	See Table 2 below	ha	Wetland area converted to settlement due to project construction.
T on	*4.6*	year	Time period of the transition from old to new land-use category. The construction phase for the project is about 4.6 years based on an estimate of 40km built each year.
▲C $_{DOM}$	- 7,188.6	t C/year	The estimated annual change of carbon stock dead wood and litter due to the conversion of wetlands to settlement. The value is calculated based on the area of each wetland type within the CDA and representative DOM values for each wetland type. The value applies to all construction years except the last construction year (Year -1) during which less wetland area is converted to settlement.

Table 2: Data Review for Dead wood/litter stock for wetlands

Parameter	Value	Unit	Comment and/or value reference
▲ A_{bog}	29.2	ha	Total area of treed bog and sparsely treed bog.
▲ A_{Fen}	786.2	ha	Total area of sparse treed fen, open fen, and shore fen.
▲ A_{Marsh}	37.4	ha	Total area of Marsh.
▲ A_{Swamp}	1500.2	ha	Total area of conifer swamp and thicket swamp.
$C_{o\ bog}$	8.3	t C/ha	Dead Organic Matter (DOM) for the bog land cover. As the bog within the CDA is dominated by treed bog, a literature review of representative DOM carbon stock value is performed for treed bog in the boreal region. This provides slightly conservative estimates of carbon stocks as a small percentage of the area is open bog which has little to zero DOM. The study below (Kelly A. Bona, et. al, 2024) shows an average DOM carbon stock of 8.3 t C/ha for the treed bog within Boreal ecozones. *Reference literature:* *Kelly A. Bona, et. al, 2024. Using the Canadian Model for Peatlands (CaMP) to examine greenhouse gas emissions and carbon sink strength in Canada's boreal and temperate peatlands.*
$C_{o\ Fen}$	17.9	t C/ha	DOM for the fen land cover. As mainly treed fen is present within the CDA, a literature review of representative DOM carbon stock value is performed for treed fen. This provides slightly conservative estimates of carbon stocks as a small percentage of the area is open fen with little to zero DOM. The study below (Kelly A. Bona, et. al, 2024) shows an average DOM carbon stock of 17.9 t C/ha for the treed fen within Boeal ecozones, including treed poor fen (12.8 t C/ha) and treed rich fen (23 t C/ha). *Reference literature:* *Kelly A. Bona, et. al, 2024. Using the Canadian Model for Peatlands (CaMP) to examine greenhouse gas emissions and carbon sink strength in Canada's boreal and temperate peatlands.*
$C_{o\ Marsh}$	0	t C/ha	DOM for the marsh land cover. DOM for non-forested wetlands (open bog, open fen, marsh) can be assumed zero as per the SACC Technical Guide, Table 26.
$C_{o\ Swamp}$	12.5	t C/ha	DOM for the swamp land cover. As the swamp within the CDA is mainly conifer swamps, a literature review of representative DOM carbon stock value is performed for the treed swamp. This provides slightly conservative estimates of carbon stocks as a small percentage of the area is thicket swamp which has relatively lower carbon storage than conifer swamps. Studies suggest that coniferous swamps in the Boreal Shield region can store significant amounts of carbon in DOM, contributing to overall carbon sequestration in these ecosystems. Carbon stocks in dead organic matter can vary widely depending on factors such as swamp age, hydrological conditions, and vegetation type. Estimates from various studies suggest a range of approximately 5 to 20 tonnes of carbon per hectare (t C/ha) stored in DOM in coniferous swamps. As such, an average carbon stock value of 12.5 t C/ha in DOM within Boreal coniferous swamps is used.

Wetlands - Soil Organic Carbon (SOC)

Table 1: Soil Carbon Stock Change ($\blacktriangle C_{Soils}$)

Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation 2.24

$\blacktriangle C_{Soils} = \blacktriangle C_{Mineral} - L_{Organic} + \blacktriangle C_{Inorganic}$			
Parameter	Value	Unit	Comment and/or value reference
$\blacktriangle C_{Soils}$	0	t C/year	Annual change in carbon stocks in soils. Calculated below in Table 2 following the IPCC 2006, Volume 4, Chapter 8, Section 8.3.3.2.
$\blacktriangle C_{Mineral}$	0	t C/year	Annual change in organic carbon stocks in mineral soils within wetlands. Calculated in Table 2 below.
$- L_{Organic}$	0	t C/year	Annual change in organic carbon stocks in organic soils within wetlands (i.e., peatlands). Calculated in Table 3 below. Loss of organic soil in forested wetlands is not expected as organic soil does not need to be excavated due to the "floating road" technique. In addition, no drainage of organic soil is planned due to the use of the "floating road" technique. As such, the loss of organic soil is expected to be negligible and thus zero carbon stock change in organic soils is assumed.
$\blacktriangle C_{Inorganic}$	0	t C/year	Change in inorganic carbon stock: As per the SACC Technical Guide, Appendix B, Step 4.3, the change in inorganic carbon can be assumed equal to zero for Tier 1 and Tier 2 assessments.

Table 2: Change of SOC in Mineral Soils (▲C $_{Mineral}$)

Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation 2.25

▲C $_{Mineral}$ = (SOC_0 - SOC_{0-T}) / D			
Parameter	Value	Unit	Comment and/or value reference
SOC_0	25,385	t C	Soil organic carbon (SOC) stock at the end of 20-year time period. A 20% loss of SOC for mineral soil SOC is generally assumed as a result of disturbance or removal. However, the project uses the "floating road" technique which requires no excavation of soils therefore no changes in SOC are expected.
SOC_{0-T}	25,385	t C	The initial (pre-conversion) soil organic carbon stock. Calculated through the IPCC Equation 2.25 below.
D	20	Year	Time dependence of stock change factors which is the default time period for transition between equilibrium soil organic carbon values. The commonly used 20 years is assumed.
▲C $_{Mineral}$	0	t C/year	Annual change in carbon stocks in mineral soils within wetlands.
SOC_{0-T} = SOC_{REF} * F_{lu} * F_{MG} * F_I *A			
Parameter	Value	Unit	Comment and/or value reference
SOC_{REF}	125.7	t C/ha	The reference carbon stock. Site-specific carbon stock value was provided by WSP Canada Inc. (2024) based on soil map units in Attachment D and soil laboratory data in Attachment E. The carbon stock value was measured for mineral soil samples collected within the MFCAR construction development area for a maximum depth of 30 cm, as required for the IPCC Tier 1 and Tier 2 methods. *Reference Literature:* *WSP Canada Inc. 2024. Draft Physiography, Terrain, and Soils Technical Support Document: Existing Conditions and Effects Assessment.*
F_{LU}	1	Dimensionless	A land-use factor that reflects C stock changes associated with type of land use.
F_{MG}	1	Dimensionless	A management factor representing the principal management practice specific to the land-use sector.
F_I	1	Dimensionless	An input factor representing different levels of C input to soil.
A	202	ha	Total area of mineral wetlands. See Table 4 below.

Table 3: Loss of SOC in Organic Soils ($-L_{Organic}$)

Method Reference: SACC Technical Guide Step 4.3.2

Equation Reference: IPCC 2006, Volume 4, Chapter 2, Equation 2.26

$-L_{Organic} = ▲SOC_{excavation} + ▲SOC_{drainage}$			
Parameter	Value	Unit	Comment and/or value reference
$-L_{Organic}$ =	0	t C/year	Annual loss of SOC in organic soils due to soil excavation and drainage. Calculated here following the SACC Technical Guide Step 4.3.2.
$▲SOC_{excavation}$	0	t C	Loss of SOC in organic soils due to soil excavation. Calculated below.
$▲SOC_{drainage}$	0	t C	Loss of SOC in organic soils due to soil drainage. The project construction is not expected to significantly alter the wetland's water levels and the carbon loss in organic soils due to soil drainage is assumed zero.
$▲SOC_{excavation} = SOC_{excavation\text{-}after} - SOC_{excavation\text{-}Initial}$			
$▲SOC_{excavation}$	0	t C	Change of SOC in organic soils due to project excavation. Calculated as the difference in SOCs before and after the construction.
$SOC_{excavation\text{-}Initial}$	1,385,541	t C	The initial SOC in organic soils within wetlands (i.e., peatlands). Following the SACC Technical Guide Step 4.3.2, the amount of peat carbon at the site before the project construction (i.e., initial SOC in organic soils) is determined through field sampling and peatland mapping data, as presented in Table 5 below.
$SOC_{excavation\text{-}after}$	1,385,541	t C	The SOC in organic soils within wetlands (i.e., peatlands) after project excavation. As the "floating road" technique will be used on disturbed wetlands which requires no excavation of soils, the SOC in organic soils is expected to remain unchanged from the initial condition.

Table 4. Peatland area within wetlands

	Area with the CDA	Percentages (%)
Peatlands	2,151	91.4%
Mineral wetlands	202	8.6%
Total Wetlands (Mineral Wetlands and Peatlands)	2,353	100.0%

Table 5. Estimates of Initial Soil Organic Carbon Storage ($SOC_{excavation\text{-}initial}$) within the CDA

Peatland Group	Peatland Area within the CDA [1] (ha)	Percentage of Area	SOC mass (kg/m^2) Estimates - Regression equation [2]	Mean Peat Thickness (cm)	Initial SOC Storage within the CDA [3] (t C)
Bog	29	1%	y = 0.455x + 1.543	209	24,157
Fen	786	37%	y = 0.398x + 11.952	149	558,208
Organic Marsh	26	1%	y = 0.2588x + 0.7974	177	11,775
Organic Swamp	1,309	61%	y = 0.485x + 13.532	98	791,400
Peatlands	2,151	100%	-	158	1,385,541

Notes:

1. Peatland data, including peatland area, average thickness, and carbon storage, are based on an analysis of soil sampling data and available mapping databases including vegetation ecosite and provincial soil data.

2. Y= soil organic carbon mass (kg/m2), x= peat or organic-rich soil thickness (cm). Ref: G. Magnan, 2023. A simple field method for estimating the mass of organic carbon stored in undisturbed wetland soils.

For the soil organic carbon mass calculation using Magnan et al. (2023) regressions, forested peatland was considered as organic swamp and freshwater marsh as organic marsh.

3. For each peatland group, the initial SOC storage is calculated as the sum of carbon stocks in each soil feature (i.e., represented as a polygon in the GIS soil database) which is estimated from the area of the feature, a representative peat thickness based on either soil sample or provincial soil data, and the Magnan et al. (2023) SOC regression equation. The analysis of the existing carbon stocks within the CDA and other discipline study areas is detailed in Peatland Baseline Study: Carbon Storage and Flux (AECOM, 2024)

Appendix B5. Avoided Domestic Emissions

- Reduced Winter Road Travel

Winter Road Length (km)	139
Average Daily Traffic (ADT) Volume	9.5
Number of Days of Travel	42
Total Annual Distance Driven (VKT/yr)	55,514

Estimated GHG emissions from winter road travel

	Passenger Car	Light Duty Commercial Truck	Heavy duty Trucks (Transport and Maintenance)	Total Vehicle
Vehicle Type Percentage [1]	0.7%	83.3%	16.0%	100%
Distance Driven (VKT/yr)	366	46,271	8,878	55,514
CO2 e EF [2] (g/VKT)	223.5	309.1	759.5	-
CO2 e (t/year)	0.1	14.3	6.7	21.1

Notes:

The vehicle type percentages are estimated based on the vehicle distributions for an All Season Road (ASR) project in Manitoba.

CO2 e EFs for vehicle types (Passenger cars, Commercial trucks, and Heavy-duty trucks) are based on the GHG emission factors from the MOVES "emission rate" run for the Winter Road Travel and IPCC fifth Global Warming Potential.

Avoided GHG Emissions due to Reduced Winter Road Travel

	Avoided Annual CO2 Emissions (t/year)
Reduced winter road travel	-21.1

Notes:

It is assumed the winter road travel will be zero once the MFCAR becomes operational (i.e., Avoided winter road travel and subsequent CO2 emission reductions, starting from Operation Year 1).

Avoided Annual CO2 emissions are expressed as negative values to represent GHG emission reductions.

Appendix B6. Carbon Sinks Impact Assessment

The assessment of the project's impact to carbon sinks resulting from land-use change followed the SACC Technique Guide Section 4 and *Annex D - Further guidance on the methodology used to quantify the impact to carbon sinks.* More specifically, the following four steps were undertaken to obtain the values needed for a quantitative assessment of carbon sink changes.

Step 1. Determine the project land area with carbon sink capacity for each land-use class and disturbance activity for each phase of the project

For the project, the land is only disturbed during the construction phase due to land clearing and road surface or pavement. Once the roadway is constructed the road surface or pavement will be permanent therefore there are no other phases of the project to consider.

The project's Construction Disturbance Area (CDA) is classified into land-use categories as defined by the IPCC guidelines (2006), as shown in Table 1. As per the SACC Technical Guide, only lands categorized by the IPCC guidelines as being Forest Land or Wetlands are considered as carbon sinks. The IPCC land use categories Forest Land and Wetlands are further split into meaningful classes to provide a refined estimate of carbon sinks, as shown in Table 2. The Wetland area is split into relevant wetland classes as defined by the Wetland Classification System (e.g., bogs and fens) and the Forest Land area is split into forest classes based on their characteristics (e.g., coniferous and deciduous). As the post-disturbance land cover will be a roadway, it is assumed the land will have zero to negligible carbon sink capabilities.

Table 1. IPCC Land Use Category for Construction Disturbance Area

IPCC Land Use Category	Construction Disturbance Area (ha)	Percentage (%)
Forest Land	2311.7	49.18%
Wetlands	2352.9	50.06%
Settlements	1.8	0.04%
Other Land	33.8	0.72%
Total	4700.2	**100.00%**

Table 2. Land classifiers and disturbance activities

IPCC Land Use Category	Land classes	Disturbed Land Area (ha)	Percentages within Each Land Use Category (%)
Forest Land	Coniferous Forest	1640.1	70.9%
	Deciduous Forest	526.7	22.8%
	Mixed Forest and Sparse Treed	144.9	6.3%
Wetlands	Bog	29.2	1.2%
	Fen	786.2	33.4%
	Marsh	37.4	1.6%
	Swamp	1500.2	63.8%

Step 2: Determine the natural carbon sink capacity and the appropriate time interval for each land class and phase of the project

Step 2.1 Carbon Sinks in Forest lands

Marten Falls is located in a pristine area which has minimum human disturbance (e.g., harvesting) due to inaccessibility to the area. The forests within the study area are generally old-growth forests which have reached or surpassed the age for the maximum carrying capacity (maturity). These forests have reached a stage where tree growth has significantly slowed and carbon uptake is balanced by respiration and decomposition processes. Therefore, those forests have the lowest carbon sequestration rates compared to younger forests. Some forests may have surpassed the age for the maximum carrying capacity and have a positive carbon flux rate (i.e., a carbon source instead of a sink). In this case, the forest land is excluded from the calculation of the impact to carbon sinks following the SACC Technical Guide, and the Total Natural Carbon Flux of forest land is assumed zero (Total $NatFlux_{forest, paved}$ = 0).

Step 2.2 Carbon Sinks in Wetlands

The majority of the wetlands (about 91.4%) within the Construction Disturbance Area (CDA) are peatlands, which store vast amounts of carbon and act as a natural carbon sink. A small percentage (about 8.6%) of the wetlands (e.g., mineral marshes) within the CDA contains mineral soil which has lower organic carbon content and therefore lower carbon sink capability compared to organic soils or peatlands. As such, the analysis of carbon sinks in Wetlands has been focused on the peatlands (i.e., peatlands are equivalent to the wetlands for the carbon sink analysis), including bogs, fens, organic marshes, and organic swamps.

To determine an appropriate annual carbon accumulation rate for peatlands, the assessment uses the sum of annual CO2 and CH4 flux approach. Daily CO2 or CH4 flux rates during the growing season are obtained from the MFCAR Peatland Baseline Study: Carbon Storage and Flux (AECOM, 2024; referred to as the Peatland Study), as shown in Table 3. The determinations of growing and non-growing seasons and associated flux rates are detailed in the Peatland Study. Below is a summary of the assessment methods and results.

Estimations of CO2 and CH4 flux rates (daily, seasonal, and annual)

The CO2 and CH4 daily flux rates of each peatland during the growing season are estimated based on a review of published flux data for a comparable wetland site (see Table 3). Non-growing season daily CO2 and CH4 flux rates were taken from Webster et al. (2018), where the authors report an average non-growing season CO2 flux of 1.3 g CO2/(m² *d) and of 3.3 mg CH4 /(m² *d), as presented in Table 4. These averages are taken from different studies on peatlands in northern Canada and are not differentiated between different types of peatlands.

The daily CO2 and CH4 fluxes were further converted to seasonal and annual carbon flux to account for the average growing and non-growing season length (see Table 4), using Webster et al. (2018) equations below. Meteorological data for the 1950-2012 period were used to determine the start and end of growing season length in a year. Non-growing season length, in number of days, corresponds to the number of days left in a year.

Seasonal CO2 Flux = (Daily CO2 x Growing season length)/5
Seasonal CH4 Flux= Daily CH4 x Growing season length
Annual CO2 Flux= (Non-growing season CO2 flux x Non-growing season length) + Seasonal CO2 flux
Annual CH4 Flux= (Non-growing season CH4 flux x Non-growing season length) + Seasonal CO2 flux

The non-growing season length and CO2 and CH4 flux rates are presented in Table 4. Daily, Seasonal, and Annual CO2 flux rates by Peatland Group are summarized in Table 5. As presented in Table 5, all peatland types within the CDA have positive annual fluxes of CO2 and CH4, which indicates the lands release more carbons than sequestrated.

Table 3. Typical CO2 and CH4 Flux by Peatland Group During the Growing Season

Peatland group [1]	Daily CO2 flux - Growing Season ($g\ CO_2 /(m^2*d)$)	Daily CH4 flux -Growing Season ($g\ CO_2 /(m^2*d)$)	Reference
Bog	-3.8 ± 1.4	28.8 ± 7.8	Webster et al. (2018). Spatially-integrated estimates of net ecosystem exchange and methane fluxes from Canadian peatlands.
Fen	-0.9 ± 2.2	17.1 ± 6.0	
Organic swamp	0.63 ± 0.1	13.5 ± 10.3	Davidson et al. (2022). The unrecognized importance of carbon stocks and fluxes from swamps in Canada and the USA.

Notes:
1. No reliable data on GHG fluxes for organic marshes was found. As organic marshes represent a small percentage of peatland, its carbon sequestration capabilities were not further studied.

Table 4. Growing and non-growing season length and average non-growing season GHG fluxes

Growing season length (days)	Non-growing season length (days)	Average non-growing season CO_2 **flux** ($g\ CO_2 /(m^2*d)$)	Average non-growing season CH_4 **flux** ($mg\ CH_4 /(m^2*d)$)
153	212	1.3 ± 1.1	3.3 ± 1.3

Table 5. Daily, Seasonal, and Annual CO2 and CH4 flux rate by Peatland Group

Peatland type	CO2 flux rate [1]			CH4 flux rate [1]		
	Daily flux -Growing Season ($g\ CO_2 /(m^2*d)$)	Growing Season flux ($g\ CO_2 /m^2$)	Annual flux ($g\ CO_2 /m^2$)	Daily flux ($g\ CH4 /m^2$)	Growing Season flux ($g\ CH4 /m^2$)	Annual flux ($g\ CH_4 /m^2$)
Bog	-3.8 ± 1.4	-116.3 ± 42.8	159.3 ± 118.6	0.3 ± 0.01	4.4 ± 1.2	5.1 ± 0.6
Fen	-0.9 ± 2.2	-27.5 ± 67.3	248.1 ± 121.4	0.02 ± 0.006	2.6 ± 0.9	3.3 ± 0.5
Organic swamp	0.6 ± 0.1	19.3 ± 3.1	294.9 ± 116.6	0.01 ± 0.01	2.1 ± 1.6	2.8 ± 0.8

Notes:
1. Estimations of CO2 and CH4 flux rates are detailed in the Peatland Baseline Study (AECOM, 2024)
2. Negative value indicates CO2 sinks from the atmosphere and positive value indicate emissions to the atmosphere.

Once the annual fluxes of CO2 and CH4 per peatland group are determined, the individual flux is converted to units of carbon (e.g., t CO2-C/yr) by multiplying the molar ratios for CO2 (12/44) and CH4 (12/16). Once CO2 and CH4 flux are converted to units of C, then they can be summed for a total carbon accumulation rate. Using the "sum of annual CO2 and CH4 flux approach", the total natural carbon accumulation rate for each peatland group within the CDA can be estimated in Table 6.

Total NatFlux bog, paved = 14 C/yr
Total NatFlux fen, paved = 549 C/yr
Total NatFlux organic swamp, paved = 1,083 t C/yr

As shown in Table 6 and above, peatlands within the CDA are determined as carbon sources instead of carbon sinks. Bog and Fens are carbon sink sources during the growing season while the sequestrated carbons are completely offset by the carbon releases from the non-growing season. Overall, the peatlands within the CDA emit about 1,646 tonnes of carbon annually.

Table 6. Annual CO2 and CH4 Flux and Total Carbon Flux for the Construction Disturbance Area

Peatland group	Area within the CDA (ha)	Annual CO2 flux [1,2]			Annual CH4 flux [1,2]			Total Carbon Flux (t C/yr)
		Annual CO2 flux rate ($g\ CO_2/m^2$)	Annual CO2 flux [3] (t CO2/yr)	Annual CO2 flux [4] (t C-CO2/yr)	Annual CH4 flux rate ($g\ CH_4/m^2$)	Annual CH4 flux [3] (t CH4/yr)	Annual CH4 flux [4] (t C-CH4 /yr)	
Bog	29.0	159	46	13	5.1	1	1	14
Fen	786	248	1,950	532	3.3	26	19	551
Organic swamp	1,309	295	3,860	1,053	2.8	37	27	1,080
Total [2]	2124	-	-	1,597	-	-	48	1,645

Notes:

1. Negative values represent carbon sink while position values represent carbon release to the atmosphere.

2. Annual CO2 and CH4 gas flux are calculated based on the mean annual flux rate and the area of each peatland group within the CDA.

3. Annual CO2 Flux= Area (ha) x Annual CO2 flux rate (g CO2/m2) x 10,000 (m2/ha) / 1,000,000 (g/t)

4. To convert CO2 gas flux (t CO2/yr) into units of carbon (t CO2-C/yr) multiply by the molar ratio 12/44. To convert CH4 gas flux (t CH4/yr) into units of carbon (t CH4-C/yr) multiply by the molar ratio 12/16.

Step 3: Determine the impact of the project on the carbon sink capacity of the site

As per the SACC Technical Guide, the default assumption is that the project will entirely interrupt the capacity of the land to act as a carbon sink for areas directly disturbed by project construction (e.g. infrastructure, excavation, highway construction). Although the floating road technique used in wetland areas is intended to minimize soil disturbance due to excavation and maintain its natural environmental conditions (e.g., hydrology), no comprehensive research or detailed analysis has been undertaken to determine the partial loss of carbon sinks in wetlands. As such, it is conservatively assumed the carbon sink capacities of wetlands (e.g., bog and fens) are completely lost after the road construction, a zero post-disturbance flux rate (PostDFlux) is used for wetlands.

$PostDFlux_{bog,\ paved} = 0$
$PostDFlux_{Fen,\ paved} = 0$
$PostDFlux_{Organic\ swamp,\ paved} = 0$

Step 4: Calculate the carbon sink impact (CSI) of the project for the appropriate time interval

The carbon sink impact can be estimated using Equation 5 from the SACC Technical Guide.

Equation 5: Estimated carbon sink impact

$$\textbf{CSI} = \sum_{i,j}((NatFlux - PostDFlux)_{i,j} \bullet T_{i,j} \bullet A_{i,j})$$

Where:

CSI is the estimated carbon sink impact (t C)
NatFlux is the natural annual carbon accumulation rate of the land being impacted (t C ha^{-1} y^{-1})
PostDFlux is the post-disturbance (i.e. post conversion) flux rate impacted by the project (t C ha^{-1} y^{-1})
T is the time interval (years)
A is the land area (ha)
i is the land-use class
j is the disturbance activity for each phase of the project (construction, operation, decommission including, for instance, site restoration or reclamation).

Note the flux rate per wetland class in this assessment has incorporated the land area (A) for each wetland class.
For wetlands, the default time interval of 100 years (T= 100) is applied following the SACC Technical Guide.

Calculate CSI for i = bog, j = paved:
$CSI_{bog,\ paved} = (NatFlux - PostDFlux)_{bog,\ paved} \cdot T_{bog,\ paved}$
$CSI_{bog,\ paved} =$ *1,371 t C*

Calculate CSI for i = fen, j = paved:
$CSI_{bog,\ paved} = (NatFlux - PostDFlux)_{fen,\ paved} \cdot T_{fen,\ paved}$
$CSI_{bog,\ paved} =$ *55,129 t C*

Calculate CSI for i = organic swamp, j = paved:
$CSI_{bog,\ paved} = (NatFlux - PostDFlux)_{Organic\ swamp,\ paved} \cdot T_{Organic\ swamp,\ paved}$
$CSI_{bog,\ paved} =$ *108,028 t C*

For forest lands, Both the natural carbon fluxes before and after the conversion are assumed as zero.
Calculate CSI total:

CSI = 164,528 t C
165 kt C

The estimated carbon sink impact for the Project is an estimated lost potential to release about 165 kilotonnes of carbon into the atmosphere.
From the carbon sink analysis perspective, the Project has positive impacts on carbon sinks as the disturbed land acted as a source of carbon emissions.
However, the land use changes due to the Project's construction cause a loss of carbon storage in carbon pools and result in subsequent CO2 emissions to the atmosphere.

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