Improved Forest Management on Private Land

Federal Offset Protocol

Public Consultation Draft

June 2023

Canada's Greenhouse Gas Offset Credit System

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Canada

EC23040

Environment and Climate Change Canada
Public Information Centre
Place Vincent Massey building
351 St-Joseph boulevard
Gatineau Quebec K1A 0H3
Toll free: 1-800-668-6767
Email: enviroinfo@ec.gc.ca

Aussi disponible en français

Foreword

Canada's Greenhouse Gas (GHG) Offset Credit System is established under Part 2 of the *Greenhouse Gas Pollution Pricing Act* (GGPPA) to provide an incentive to undertake projects that result in domestic GHG reductions that would not have been generated in the absence of the project, that go beyond legal requirements and that are not subject to carbon pollution pricing mechanisms.

Canada's GHG Offset Credit System consists of:

- The *Canadian Greenhouse Gas Offset Credit System Regulations* (the Regulations), which establish the system, implement operational aspects and set general requirements applicable to all project types;
- Federal offset protocols, included in the *Compendium of Federal Offset Protocols* (the Compendium), each containing requirements for project implementation and methods for quantifying GHG reductions for a given project type; and
- The Credit and Tracking System (CATS) to register offset projects, issue and track offset credits, and share key information through a public registry.

Only projects following a federal offset protocol included in the Compendium and meeting all requirements outlined in the Regulations can generate offset credits under the Regulations.

Text in blue boxes is provided throughout this draft version for context but will not be included in the final protocol.

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1.0 Introduction

Forest ecosystems have a large capacity to sequester and store carbon. Forests sequester carbon by converting atmospheric carbon dioxide (CO_2) into biomass through photosynthesis. This carbon is stored in the forest as live biomass as well as dead organic matter and forest soil. The implementation of improved forest management relative to the baseline can increase and/or maintain the amount of carbon stored by managed forests by reducing the amount of carbon lost from the forest and/or by increasing the rate of carbon sequestration in the forest biomass and soils.

The *Improved Forest Management on Private Land* protocol is intended for use by a proponent undertaking a project to implement forest management activities on managed forestlands that go beyond a business-as-usual management scenario to generate offset credits under the *Canadian Greenhouse Gas Offset Credit System Regulations*. The requirements contained in this protocol are part of the Regulations and must be read in conjunction with provisions in the Regulations.

The proponent must follow the methodology and requirements set out in this protocol, including to quantify and report greenhouse gas (GHG) emission reductions (by removing GHGs from the atmosphere) generated by the eligible project activities. This protocol is designed to ensure the project generates GHG reductions that are real, additional, quantified, verified, unique and permanent. The protocol is also developed in accordance with the principles of ISO 14064-2:2019 *Greenhouse gases – Part 2 – Specification with guidance at the project level for quantification, monitoring and reporting greenhouse gas emission reductions or removal enhancements* to ensure reported GHG reductions are relevant, complete, consistent, accurate, transparent, and conservative.

GHG reductions generated by a project under this protocol can only result from the implementation of improved forest management. GHG reductions under this protocol cannot be generated from afforestation/reforestation or avoided conversion of forestlands, and the protocol is not applicable to projects on provincial or federal Crown lands (excluding First Nation reserves) and public lands in the territories, or lands captured by provincial and/or territorial forest management regulations.

2.0 Terms and definitions

Act

means the *Greenhouse Gas Pollution Pricing Act (GGPPA)*.

Activity-shifting leakage

means an increase in GHG emissions as a result of shifting forest management activities from the project site to controlled lands.

Afforestation

means the process of introducing trees to an area of land from which trees have always, or for at least 50 years before the project start date, been absent.

Avoided conversion of forestland

means preventing the loss of forestland to a non-forest land use.

Conservation easement

means a legal agreement, registered on title, between a landowner and a qualified organization (land trust, government agency, or municipality) that protects the property for a specified period of time, and includes restrictions on land use and forest management activities that ensure the conservation of the property covered by the agreement. Other easement types that are not for the purpose of conservation are not included in this definition (e.g., right-of-way easements).

Controlled lands

means non-project lands for which the forest operator has the legal right to, and is responsible for, implementing forest management activities.

Critical habitat

means the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species, as defined under section 2 of the *Species at Risk Act.*

Forestland

means treed areas of 1 ha or more with at least 25% crown cover and trees capable of reaching at least 5 m in height.

Forest management activities

means activities that enhance or recover forest growth or harvest yield (e.g., site preparation, planting, thinning, fertilizing, harvesting, etc.) and other silvicultural activities.

Forest operator

means the entity or individual(s) who has the legal right to, and is responsible for, implementing forest management activities on a given forestland.

Forest tree breeding

means the genetic manipulation of trees through species selection, testing, and controlled mating, to solve some specific problem or to produce a specially desired product.

Genetic engineering

means a method used to directly transfer DNA from one tree into another that results in a genetically engineered tree.

Genetically modified tree

means a tree that has had its DNA sequence altered through genetic engineering.

Global Warming Potential (GWP)

means a metric representing the ability of a GHG to trap heat in the atmosphere compared to CO_2, as provided in Column 2 of Schedule 3 to the Act.

Harm

means a measurable decline in the quality or quantity of key environmental attributes of the project site over the crediting period, as it relates to environmental safeguards described in Section 6.4.

Indigenous-led project

means a project for which the proponent or the forest operator is registered in the Indigenous Business Directory, and they can provide a registration number.

> ECCC is seeking feedback on the definition of Indigenous-led project and other verifiable ways that a proponent could demonstrate a project is Indigenous-led.

Managed forestland

means forestland that is legally capable of supporting forest management activities.

Market leakage

means an increase in GHG emissions on lands outside of the project site and controlled lands as a result of changing market conditions from the reduction in the production of forest products within the project site.

Native species

means a species that naturally occurs within the project site.

Natural forest

means forestland that does not meet the definition of plantation forest.

Non-native species

means a species that was introduced to the project site.

Permanence monitoring period

means the period of time for which the proponent must monitor the permanence of GHG reductions achieved by the project in accordance with subsection 22(1) of *Canada's Greenhouse Gas Offset Credit System Regulations*.

Plantation forest

means forest stands established by planting and/or seeding which are either of non-native species (all planted stands) or intensively managed stands of native species, which meet all the following criteria: one or two species at plantation, even age class, regular spacing.

Primary forest

means naturally regenerated forest of native tree species where there has been no human activity.

Private land

means land that meets the following eligibility criteria: (1) ownership is held either in fee simple or fee simple equivalent; (2) the forest operator has exclusive use and occupation; or (3) is not provincial or federal Crown land (excluding First Nation reserves) or public land in the territories or land covered by provincial and territorial forest management regulations.

Project period

means the period of time for which the proponent is subject to the *Canadian Greenhouse Gas Offset Credit System Regulations* for a registered project, inclusive of the crediting period and the permanence monitoring period.

Project site

means the area, comprised of contiguous or separated discrete parcels of land, where forest management activities are being implemented as a part of a project and for which there is a single forest operator.

Reconciliation unit

means the spatial units used in the National Forest Carbon Monitoring, Accounting and Reporting System (NFCMARS) that combine ecological reporting zones with provincial and territorial boundaries.

Regulations

means the *Canadian Greenhouse Gas Offset Credit System Regulations*.

Reforestation

means renewal of tree cover on an area from which trees used to be present, but tree cover has not been restored through planting or natural regeneration for at least 20 years before the project start date.

Silvicultural activities

means practices aimed at ensuring wise harvesting of forest resources, such as conservation, regeneration, reforestation, natural disturbance management and cutting.

Sustainable forestry

means the management of forestland in order to provide wood products in perpetuity, soil and watershed integrity, persistence of most native species and maintenance of highly sensitive species or suitable conditions.

Sustained yield

means the yield of defined forest products of specific quality and in projected quantity that a forest can provide continuously at a given intensity of management.

3.0 Baseline scenario

3.1 Baseline condition

The following baseline conditions must apply to the project before the project start date in order for the project to be eligible under this protocol:

- The project site meets the definition of managed forestland as defined in Section 2.0.
- The project contains one project site.
- The project is on private land;
- The project site is capable of sustainable forestry through demonstration of one or more of the following:
    - The project site or the forest operator of the project site is certified under the Forest Stewardship Council (FSC) or the Sustainable Forestry Initiative (SFI);
    - The project site adheres to a forest management plan, traditional use plan[1] or another form of long-term management plan, demonstrating sustained yield and natural forest management; or
    - For projects where no forest management has previously taken place but for which harvesting is planned, the proponent must demonstrate that the project site would be capable of supporting sustainable forestry through certification or adhering to a management plan before any planned harvests occur.
- The project site must not include non-forest land uses or areas that do not meet the definition of managed forestland under Section 2.0.
- The project site, or any portion of it, is not subject to a restriction prior to the project start date that mandates conservation, such as conservation easements, Indigenous Protected and Conserved Areas (IPCAs)[2], Indigenous-led Area-based Conservation Measures or Other Effective area-based Conservation Measures (OECMs). This excludes any restrictions that were put in place and/or recorded less than or equal to one year prior to the project start date.

3.2 Determining the baseline scenario

The proponent must determine the baseline scenario for the project that represents the forest management activities that would have been implemented within the project site in the absence of the project and represents the GHG reductions associated with the included baseline sources, sinks and reservoirs (SSRs) referred to in Section 7.0.

The proponent must follow the procedure in Section 3.2.1 to determine the baseline scenario.

3.2.1 Procedure to determine baseline scenario

The proponent must determine the baseline scenario by projecting a 100-year growth and harvesting regime that represents the forest management activities that are most likely to be implemented within the project site. All legal requirements that directly or indirectly impact the GHG reductions that would be generated by the baseline scenario as described under Section 5.1 must be reflected in the baseline

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[1] It is recognized that traditional use plans are often not documented and may be communicated orally.
[2] Conservation Through Reconciliation. “Indigenous Protected and Conserved Areas”. Accessible here.

scenario. Further, the proponent cannot include either of the following in the projection of the baseline scenario:

- Any type of land use change, such as the project site or any portion of it converting to a non-forest land use, excluding land use conversion for the purpose of carrying out forest management activities (e.g., construction of forest roads) within the project site. Re-establishment of forest cover after harvest is not considered a land use change.
- Natural disturbance.

The 3-step process outlined below results in the following:

1. An assessment of the typical forest management activities of similar forest operators in the geographic region in which the project is located, and a 100-year growth and harvesting regime based on the typical regional forest management activities and the financial feasibility within the project site.
2. An assessment of project-specific conditions, including historical management activities, and a 100-year growth and harvesting regime based on a continuation of historical practices and the project-specific conditions.
3. An assessment of conservativeness, which determines the baseline scenario applicable to the project site.

Step 1: *Assessment of the typical regional forest management regime*

Selecting reference sites

The proponent must match the project site to other forest sites to be used as reference sites to assess the typical forest management activities for the geographical region in which the project is located. The reference sites must be within the same reconciliation unit[3] and must be functionally equivalent to the project site. If ownership of the project site has changed in the last 10 years prior to the project start date, the functional equivalence of the reference sites can be matched to the conditions of the project site prior to the change in ownership.[4] The reference sites must be functionally equivalent to the project site in at least one of the following ways:

1. Produce similar forest products;
2. Share the same or similar land tenure (e.g., a project on private land should be preferentially compared to a reference site on private land, as defined under this protocol); and/or
3. Share similar ownership and/or management structure (e.g., the forest operator of the project site is a non-governmental organization (NGO), the reference site should be managed by an NGO or similar entity).

The proponent must provide verifiable information supporting the assertion of functional equivalence of the reference sites. Of the identified functionally equivalent sites, the proponent must use the k-nearest neighbor optimal (pair or full) matching approach to match reference sites to the project site based on shared forest attributes. The resulting matched sites will be used for the assessment of regional forest

[3] A copy of a shapefile of the reconciliation units is provided on ECCC's website to ensure accurate interpretation of the project location.
[4] ECCC recognizes that the project site may be acquired for the purpose of carrying out the project and in the absence of the project, the pre-purchase management scenario of the project site would have continued.

management activities. Matching conditions are defined referencing two or more of the following attributes:

- Forest age;
- Stand density;
- Species composition;
- Even-aged or uneven-aged management;
- Other forest biophysical forest attributes that could reasonably be used to match the project site and influence forest management and/or forest carbon stocks.

Ideally, information is collected at the plot- or stand-level for the reference sites, but where this is not possible the proponent may provide information averaged across the reference site. Where plot- and/or stand-level information is available, the proponent must derive weights for all attributes (used for matching) for the project site and the resulting matched reference sites. Weights must be calculated based on the inverse of (Euclidean or Minkowski) distances to generate weighted averages that account for influence over the average (i.e., inverse distance weighting). Attribute information for reference sites must be verifiable and supporting documentation could include aerial photographs, remote sensing (e.g., Landsat), or national or sub-national forest database information. The proponent may use national or provincial/territorial forest inventory plots as the reference site(s) where such information is available and where the forest inventory plots conform to the functional equivalence conditions. If only one reference site matched the project site based on the above requirements, the proponent may use one reference site.

Assessment of the regional forest management activities of selected reference sites

After the proponent has selected the appropriate reference sites, the proponent must assess the regional forest management activities using information from the reference sites. Information supporting the assertion of the regional forest management activities must be recent (i.e., collected within 2 years of the project start date) to reflect current market and management conditions. The proponent must provide verifiable evidence (including, but is not limited to, expert opinion from a 3rd party Registered Professional Forester that practices in the same province or territory of the project site, or an equivalent professional in provinces and territories that do not have an association) supporting the assertion of the forest management activities for the reference sites by evaluating and describing the following for the reference sites, where relevant:

- Silvicultural treatments and systems in use, and their prevalence across the reference sites;
- Annual harvest volumes in m^3/ha/year;
- Typical rotations ages for similar forest types where the clearcut system is used, or the typical ages of intervention when partial cutting systems (e.g., commercial thinning, single tree or group selection, shelterwood, etc.) are used, including the typical age of final harvest;
- Average minimum harvest restriction criteria, including minimum tree age, size and/or stand volume;
- Average tree retention policies for single or grouped merchantable and un-merchantable trees, such as riparian buffers and wildlife trees;
- Operational constraints which would limit regional logging equipment, including maximum harvest slope;
- Reforestation and stand management practices for regeneration, including site preparation activities, typical machinery used, and planting density; and

- Harvest/silvicultural activities that are required by provincial/territorial, county, and municipal laws and bylaws regarding private forest lands.

The result of the above assessment is used to inform the 100-year growth and harvesting regime that represents the regional forest management baseline scenario. If the regional forest management activities for similar forest operators does not adhere to the principle of sustainable forestry, the proponent must reflect a management scenario that represents sustainable forest management that could achieve long-term sustained yield.

Assessment of financial feasibility of resulting regional forest management baseline scenario

The regional forest management baseline scenario must be consistent with local market capacity for the projected baseline activities and products (i.e., availability of contractors and their capacity, timber markets, mill capacity, etc.) and operationally feasible within the project site. The proponent must be able to demonstrate that the management regime in the baseline scenario is not expected to lose money in the practice of performing long-term forest management activities, including activities such as road construction and management, watercourse restoration, and fuels management. Any constraints that would impact the feasibility of the baseline scenario must be incorporated into the modelled baseline. The baseline scenario cannot include activities that would not be feasible regionally, such as projecting a level of harvest that local mills could not handle annually without considerable additional investment into local logging infrastructure or including harvesting equipment that is not available in the defined geographic region. Any consideration for market capacity and products outside the project site's reconciliation unit must be demonstrated to still be feasible and must be standard practice for the forest operator of the project site.

Based on the financial feasibility assessment, the proponent must adjust the regional forest management baseline scenario to reflect what is feasible within the project site. This resulting baseline represents the final regional forest management baseline scenario to be used in the assessment of conservativeness in Step 3.

Step 2: *Assessment of project-specific conditions*

The proponent must at a minimum assess the following for the project site for how these conditions could alter the baseline scenario, and must provide verifiable supporting documentation:

- Whether a forest management plan for the project site was prepared before the project start date (i.e., within the two years) and approved by a 3rd party Registered Professional Forester (or an equivalent professional in provinces and territories that do not have an association), and whether the plan indicates forward-looking silvicultural treatments and harvest volumes.

Including the assessment of the conditions above, the proponent must also assess the historical management of the project site by projecting a 100-year growth and harvest regime that represents a continuation of historical practices that were occurring prior to the project start date according to the following:

- The proponent must use a lookback period to the most recent harvest or of at least 10 years, whichever results in a longer lookback period, and must provide verifiable evidence of the forest management activities and harvest volumes indicated in the historical management scenario.

- Where ownership has changed in less than 10 years prior to the project start date, the proponent may use the historical practices associated with the original landowner before the change in ownership, where records are available.
- In the case where there are no historical records for the project site, but there are controlled lands within the same province or territory of the project site of the same forest type that provides the same forest products, the proponent may use the historical practices of the controlled lands if the proponent can demonstrate that similar activities would have been carried out within the project site.
- If there are no records available on historical management practices for the project site nor any other controlled lands, but where the proponent can demonstrate in the absence of the project harvests would have been carried out within the project site, the proponent can exclude a review of historical practices.
- The proponent must provide market information that explains past management practices implemented within the project site (e.g., timber prices, capital costs, employee expenditures). The proponent must also note any environmental and socio-economic influences that may have caused anomalies in business-as-usual management practices in the historical lookback period (e.g., the COVID-19 pandemic, historic drought, wildfire, etc.).

The result of the above assessment is used to inform the 100-year growth and harvesting regime that represents the continuation of historical practices baseline scenario to be used in the assessment of conservativeness in Step 3.

Step 3: *Assessment of conservativeness and selection of the baseline scenario*

The proponent must select the baseline scenario that is the most conservative (i.e., results in less carbon storage over the 100-year period) between the regional forest management baseline scenario (outcome of Step 1 above) and the continuation of historical practices baseline scenario (outcome of Step 2 above).

3.2.2 Projects previously registered in other GHG offset credit systems

For a project that was previously registered in a GHG offset credit system other than the one set out in the Regulations, the baseline scenario is the initial carbon stocks within the project site for each included SSR as per Table 1 as determined in the initial forest carbon inventory, following the requirements of Section 9.1, and these carbon stock levels must remain static for the entire crediting period. However, if the proponent can demonstrate that there were no credits issued to the project when it was registered in the other GHG offset credit system, the proponent may use the approach to determining the baseline set out in Section 3.2.1.

> ECCC is considering the use of dynamic baselines under this protocol. ECCC is seeking feedback on the challenges, benefits, and any other relevant considerations in the use of dynamic baselines for improved forest management projects.

4.0 Project scenario

The project scenario represents the GHG reductions associated with the included project SSRs referred to in Section 7.0.

4.1 Project condition

The following project condition must apply to the project site in order for the project to be eligible under this protocol:

- Implementation of one or more eligible project activities on private land, as described in Section 4.2.

4.2 Eligible project activities

Eligible project activities under this protocol are any forest management activities that enhance carbon stocks within the project site relative to the baseline scenario carbon stocks. Eligible project activities could include, but are not limited to:

- Reducing competition
- Thinning
- Minimizing site degradation
- Rehabilitating and reforesting access roads, trails, and landings
- Increasing the rotation age
- Maintaining carbon stocks at a high level (i.e., conservation)

4.3 Ineligible project activities

The following activities are not eligible under this protocol:

- Any activities that involve a land use change, prevent a land use change or change land cover, specifically afforestation/reforestation and avoided conversion of forestlands, excluding land use conversion for the purpose of carrying out forest management activities (e.g., construction of forest roads); and
- Salvage harvesting and avoided burning of slash piles. The proponent is permitted to carry out salvage harvesting and avoided burning of slash within the project site, but any GHG reductions as a result of implementing these activities are not eligible to generate offset credits.

The proponent must also not implement any of the activities listed in Section 6.4.2 for the purpose of avoiding negative environmental impacts within the project site.

5.0 Additionality

5.1 Legal additionality

GHG reductions generated by the project must not occur as a result of federal, provincial or territorial laws, regulations, municipal by-laws, or any other legally binding mandates that could impact the GHG reductions associated with any of the included SSRs, including those that indirectly result in the requirement to maintain or store forest carbon or implement the project activities, such as harvest restrictions.

Legal requirements could include:

1. Federal, provincial, territorial or municipal laws, regulations or bylaws related to harvest restrictions or minimum stocking standards and soil disturbance, as well as forest practice rules and best management practices (e.g., practices to protect water courses, soil, forest productivity and wildlife) established by any of these governments;
2. Restrictions on land use and management such as easements, conservation plans or other relevant environmental plans, and deed restrictions, excluding restrictions on land use and management that were put in place and/or recorded less than or equal to one year prior to the project start date; and
3. Silvicultural treatments that impact harvesting and management within the project area as a result of a submitted, active or approved forest management plan legally required at the time of the project start date.

If at any time after project registration the GHG reductions generated by the project become required by law or the result of a legal requirement, the GHG reductions will no longer be additional and, therefore, can only be quantified and offset credits can only be generated up to the date immediately preceding the date on which the law or the legal requirement comes into force.

> As per the Regulations, the reductions can only be additional if those reductions were not required by law or the result of activities that are required by law.

5.2 Performance standard test

The determination of the baseline scenario supports the assertion of additionality as it establishes the business-as-usual forest management scenario for the project site. Only GHG reductions beyond the baseline scenario are additional. To support the assertion of additionality, the proponent must provide verifiable evidence that harvest is the most likely management scenario for the project site in the absence of the project (e.g., offer from a mill to contract harvest within the project site, forward-looking forest management plans for the project site, etc.).

6.0 General requirements

6.1 Project start date

The start date of a project corresponds to one of the following and must be on or after January 1st, 2017:

- The registration date; or
- For a project previously registered in a GHG offset credit system other than the one set out in the Regulations, the date on which the proponent registered in the other GHG offset credit system.

The project start date must be confirmed by supporting documentation.

In the case of an aggregation, the start date of each project within the aggregation must be established using one of the abovementioned options.

6.2 Crediting period

A project implemented under this protocol has a crediting period of 25 years.

6.3 Project location and geographic boundaries

The proponent must document and report the location and geographic boundaries of the project site and submit a site plan. The site plan must be displayed on a geo-referenced map that shows the following boundary types:

- Project site, which comprises the area in which the project activities will be implemented; and
- Controlled lands located in the same province or territory as the project site.

If the project site includes more than one discrete parcel of land, each area must be uniquely identified on the site plan. The site plan must be at a sufficiently large scale and include geographical features, places names and administrative boundaries to enable field interpretation and identification of the project site.

The following features must be displayed on the site plan for both the project site and any controlled lands within the same province or territory as the project site:

- Geographic boundaries;
- Total area;
- Longitude/latitude, or land title or land survey;
- Existing land cover and land use;
- Topography;
- Forest vegetation types;
- All roads and trails, labelling which type of road and/or trail (e.g., access roads);
- Site index; and
- Watercourses.

The following must also be displayed on the site plan for the project site:

- Strata as determined in developing the forest carbon inventory in Section 9.1;

- Plot centers for sample plots used to establish the forest carbon inventory in Section 9.1; and
- Location of reversal events, if applicable.

Acceptable file formats for project location and site plan information include SHP, GDB and JSON.

In the case of an aggregation, a site plan must be provided for each project within the aggregation.

The geographic boundary of the project site cannot change after the first reporting period, but project activities can expand within the boundary. Any changes to the site plan must be communicated as specified in the Regulations.

6.4 Environmental and social safeguards

6.4.1 Compliance with applicable environmental legal requirements

The proponent must ensure that the project activities comply with any federal, provincial, territorial and municipal by-laws or regulations, operating permits or licenses applicable to the project site, such as those related to species at risk and the protection of ecological goods and services.

6.4.2 Avoiding potential negative environmental impacts

The proponent must not implement any of the following activities as a part of the project:

- Broadcast fertilization;
- Changes to the hydrology of the project site (e.g., draining or flooding of wetlands);
- Use of non-native species on the project site, unless verifiable documentation can be provided demonstrating that the range of the selected non-native species now includes that of the project site or the presence of the non-native species within the project area would not cause adverse environmental impacts;
- Removal of snags and standing deadwood beyond the volumes in the baseline scenario, unless it can be demonstrated that the proponent is managing deadwood as the result of a natural disturbance, such as carrying out risk mitigation measures in accordance with the risk management plan;
- Conversion of natural forests to plantation forests or to different forest types, unless where there is a conservation restoration plan in place and the project site already is considered a plantation forest;
- Harvests in areas that are primary forest, unless the project site is under the use and occupation of Indigenous peoples, or the project is Indigenous-led;
- Clear-cutting in uneven-aged forests, unless the proponent can justify that it would be necessary for adhering to best management practices, the prevention of natural disturbance (e.g., preventing pest/disease outbreaks, implementing fire breaks, etc.) or would not cause adverse environmental impacts; and
- Use of genetically modified trees. This does not include forest tree breeding for the purpose of tree improvement within the project site (e.g., selective breeding to build climate resistance).

6.4.3 Project-specific assessment of environmental impacts

The proponent must conduct a project-specific assessment of the project site to determine the environmental safeguards that must be in place. The proponent must take a “no net harm” approach to the assessment of environmental safeguards, meaning that the project activities implemented as a part of the project must not have a net negative impact on any environmental attribute of the project site compared to the baseline scenario activities.

The proponent must assess whether the project activities would be likely to have a positive, neutral or negative impacts on the following environmental attributes:

- Biodiversity, including consideration for genetic diversity, species at risk and species endemic to the project site;
- Habitat protection and creation, including consideration for threatened or rare ecosystems and forest stands;
- Water resources, including consideration for impacts on watershed management, hydrology of the project site, and water quality;
- Soil quality and fertility, including consideration for impacts on erosion and compaction; and
- Ecosystem resilience and integrity, including consideration for key ecosystem services.

The proponent must assess the potential positive, negative or neutral impacts on the abovementioned environmental attributes of the following activities, where relevant:

- Forest stand or soil alteration from harvesting, tree planting, site preparation, and/or tending activities for pre-commercial trees;
- Alteration of fire regimes and/or burning conditions;
- Development of forest roads;
- Use of forest machinery; and
- Fertilizer, insecticide, and herbicide application.

The proponent must use the result of the above assessment to develop a list of environmental safeguards that must be implemented to address any identified negative impacts, including a description of each safeguard and an explanation of how the safeguarding activities will ensure any potential negative impacts are mitigated.

The proponent of a project where the only project activity is conservation does not need to carry out the project-specific assessment, as it can be reasonably assumed that the project scenario will result in neutral to positive impacts compared to a baseline scenario that includes harvesting.

7.0 Project GHG boundary

The project GHG boundary (Figure 2) contains the GHG SSRs that must be included or excluded in the baseline and/or the project scenario to determine the GHG reductions generated by the project.

Table 1 provides additional details on the SSRs identified for the baseline and project scenarios, as well as justification for their inclusion or exclusion in the quantification of GHG reductions. For SSR5, SSR6, SSR7, and SSR12, the proponent may exclude any of these if they can meet the conditions described in the corresponding column in Table 1.

Three GHGs are relevant to the SSRs in this protocol: Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

Figure 2: Illustration of the project GHG boundary

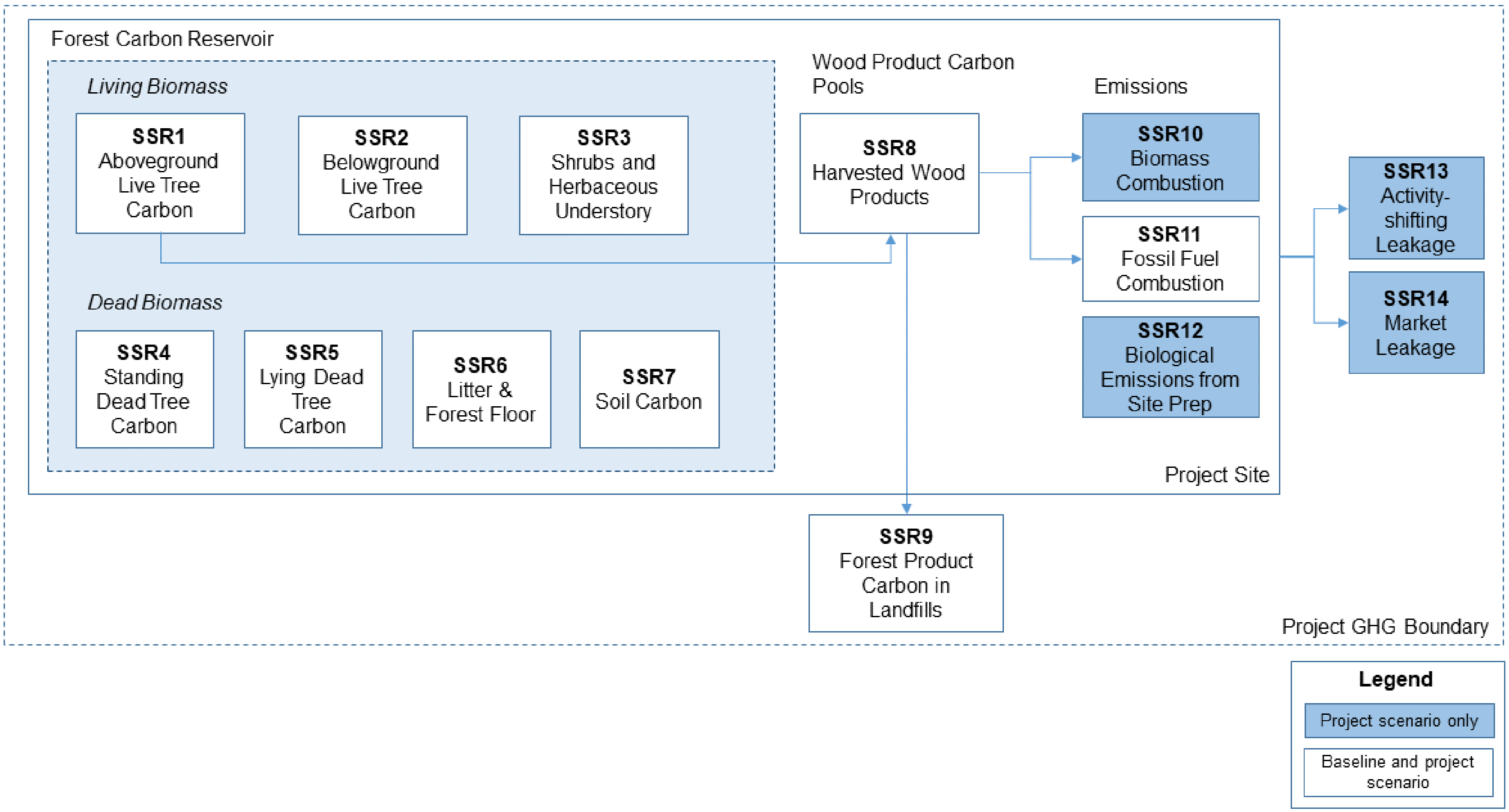

Table 1: Details on baseline and project scenario SSRs

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
1	Aboveground live tree carbon	Standing live trees include the stem, branches, leaves or needles of all aboveground biomass, regardless of species. Standing trees are trees that are self supporting and would remain standing if all supporting materials were removed. Trees must be ≥1.3 m in height and have a DBH ≥9 cm, and must be able to reach a mature height of 5 m within its natural range.[5] However, the proponent may define and justify an alternative minimum tree DBH and height used to develop the inventory, if appropriate.	Controlled	Baseline (B1)	CO_2	**Included:** modelled in tonnes of carbon (t C), following the requirements of Section 9.2, to be used in Equation 4. In the case of a project previously registered in a GHG offset credit system other than the one set out in the Regulations, this SSR remains static at the initial carbon stocks as determined in the initial forest carbon inventory following the requirements in Section 9.1.
				Project (P1)	CO_2	**Included:** quantified in tonnes of carbon (t C) through direct measurements and updating the forest carbon inventory, following the requirements of Sections 9.1 and 9.2, to be used in Equation 16.
2	Belowground live tree carbon	Carbon in belowground portions of the aboveground live tree carbon (i.e., SSR1), principally roots.	Controlled	Baseline (B2)	CO_2	**Included:** modelled in tonnes of carbon (t C) as a function of the proportion of aboveground biomass using growth and yield models, following the requirements of Section 9.2, to be used in Equation 4.

[5] National Forest Inventory. 2008. "Canada's National Forest Inventory Ground Sampling Guidelines Version 5.0". https://nfi.nfis.org/resources/groundplot/Gp_guidelines_v5.0.pdf

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
						In the case of a project previously registered in a GHG offset credit system other than the one set out in the Regulations, this SSR remains static at the initial carbon stocks as determined in the initial forest carbon inventory following the requirements in Section 9.1.
				Project (P2)	CO_2	**Included:** estimated in tonnes of carbon (t C) based on aboveground live tree biomass, which is measured via direct measurement and updating forest carbon inventory, following the requirements of Sections 9.1 and 9.2, to be used in Equation 16.
3	Shrubs and herbaceous understory	Aboveground living woody and herbaceous plant biomass that does not meet the description of aboveground live tree carbon (i.e., SSR1).	Controlled	Baseline (B3) Project (P3)	CO_2	**Excluded:** CO_2 emissions from this carbon pool are not significant relative to the size of the total forest carbon pool.
4	Standing dead tree carbon	Carbon in standing dead trees, which includes the stem, branches, or section thereof, regardless of species. Stumps are not considered standing dead tree carbon. Standing trees are trees that are self supporting and would remain standing if all	Controlled	Baseline (B4)	CO_2	**Included:** quantified in tonnes of carbon (t C) through direct measurement from the initial forest carbon inventory, following the requirements of Sections 9.1 and 9.2, to be used in Equation 4. This SSR

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
		supporting materials were removed.[6]				remains static at the initial carbon stocks as determined in the initial forest carbon inventory.
				Project (P4)	CO_2	**Included:** quantified in tonnes of carbon (t C) through direct measurement and updating the forest carbon inventory, following the requirements of Sections 9.1 and 9.2, to be used in Equation 16.
5	Lying dead tree carbon	Any piece(s) of dead woody material from a tree (e.g., dead boles, limbs, and large root masses), on the ground in forest stands with a diameter >7.5 cm. Stumps are not considered lying dead tree carbon.	Controlled	Baseline (B5)	CO_2	**Included:** Included if this SSR is included in the project scenario. Modelled in tonnes of carbon (t C), following the requirements of Section 9.2, to be used in Equation 4. In the case of a project previously registered in a GHG offset credit system other than the one set out in the Regulations, this SSR remains static at the initial carbon stocks as determined in the initial forest carbon inventory following the requirements in Section 9.1.

[6] National Forest Inventory. 2008. “Canada’s National Forest Inventory Ground Sampling Guidelines Version 5.0”. https://nfi.nfis.org/resources/groundplot/Gp_guidelines_v5.0.pdf

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
				Project (P5)	CO_2	**Included:** This SSR is included if it cannot be demonstrated that the project activities would result in equal or greater carbon storage compared to the baseline. If it can be demonstrated that the project will result in equal or greater carbon stocks compared to the baseline, this SSR is optional. If this SSR is included in the project scenario it must be included in the baseline scenario. Quantified in tonnes of carbon (t C) through direct measurement and updating the forest carbon inventory, following the requirements of Sections 9.1 and 9.2, to be used in Equation 16.
6	Litter and forest floor	Any pieces of dead woody material from a tree on the ground in forest stands that is ≤7.5 cm in diameter.	Controlled	Baseline (B6)	CO_2	**Included:** Included if this SSR is included in the project scenario. Modelled in tonnes of carbon (t C), following the requirements of Section 9.2, to be used in Equation 4. In the case of a project previously registered in a GHG offset credit system other than the one set out in the Regulations, this SSR remains static at the

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
						initial carbon stocks as determined in the initial forest carbon inventory following the requirements in Section 9.1.
				Project (P6)	CO_2	**Included:** This SSR is included if it cannot be demonstrated that the project activities would result in equal or greater carbon storage compared to the baseline. If it can be demonstrated that the project will result in equal or greater carbon stocks compared to the baseline, this SSR is optional. If this SSR is included in the project scenario it must be included in the baseline scenario. Quantified in tonnes of carbon (t C) through direct measurement and updating the forest carbon inventory, following the requirements of Sections 9.1 and 9.2, to be used in Equation 16.
7	Soil carbon	Belowground carbon not included in other SSRs. This SSR can be a net source or sink depending on circumstances (see SSR12).	Controlled	Baseline (B7)	CO_2	**Included:** Included if this SRR is included in the project scenario. Quantified in tonnes of carbon (t C) through direct measurement from the initial forest carbon inventory, following

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
						requirements of Sections 9.1 and 9.2, to be used in Equation 4. This value remains static at the initial carbon stocks as determined in the initial forest carbon inventory.
				Project (P7)	CO_2	**Included:** This SSR is included if it cannot be demonstrated that the project activities would result in equal or greater carbon storage compared to the baseline. If it can be demonstrated that the project will result in equal or greater carbon stocks compared to the baseline, this SSR is optional. If this SSR is included in the project scenario it must be included in the baseline scenario. If the project scenario includes site preparation activities, this SSR must be included. Quantified in tonnes of carbon (t C) through direct measurement and updating the forest carbon inventory, following the requirements of Sections 9.1 and 9.2, to be used in Equation 16.
8	Harvested wood	Wood that is harvested or otherwise collected from the forest, transported	Controlled	Baseline (B8)	CO_2	**Included:** estimated from modelled harvest volumes from

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
	products (HWPs)	outside of the project area, and is being processed or is in-use.				the 100-year growth and harvesting regime in the baseline using Equations 8 through 13.
				Project (P8)	CO_2	**Included:** estimated based on measured harvest volumes using Equations 20 through 25.
9	Forest product carbon in landfills	Harvested wood products decomposing in landfills and dumps.	Related	Baseline (B9) Project (P9)	CO_2	**Excluded:** There is considerable uncertainty and variability in waste disposal practices, and the volume of harvest wood products that would result in landfill.
10	Biomass combustion	Emissions from the combustion of harvested forest biomass within the project area, or downstream of the project area for various purposes, including heating, slash pile burning, or HWP processing.	Controlled	Project (P10)	CH_4 N_2O	**Included:** estimated from measured quantities of burned biomass using Equations 17 through 19.
11	Fossil fuel combustion	Mobile and/or stationary combustion emissions from site preparation activities, and ongoing project operation and maintenance.	Controlled	Baseline (B11) Project (P11)	CO_2 CH_4 N_2O	**Excluded:** emissions from this SSR in the project scenario are not significantly different from baseline levels.
12	Biological emissions from site preparation	Emissions from soil as a result of disturbing stored organic carbon, leading to increased decomposition and	Controlled	Project (P12)	CO_2	**Included:** Included if the soil carbon pool (SSR7) is included. Emissions from this SSR are captured through the

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
		release of CO_2 emissions.				quantification of SSR7.
13	Activity-shifting leakage	An increase in emissions as a result of shifting forest management activities from the project site to controlled lands.	Controlled	Project (P13)	CO_2	**Included:** included when it cannot be demonstrated that there is no risk of activity-shifting leakage to lands controlled by the project proponent, following the requirements of Section 8.4.1. When included, this SSR is estimated from measured increases in harvest volumes occurring on controlled lands as described in Section 8.4.1 using Equation 27.
14	Market leakage	An increase in emissions on lands outside of the project site and controlled lands as a result of changing market conditions from the reduction in the production of forest products within the project site.	Affected	Project (P14)	CO_2	**Included:** estimated based on a regional leakage risk discount factor following the requirements of Section 8.4.2 using Equation 28 or Equations 29 through 31.

8.0 Quantification methodology

This section contains the quantification methodology that must be followed to quantify baseline and project scenario GHG reductions, which are subsequently used to quantify the total GHG reductions generated by the project.

Baseline scenario GHG reductions are the GHG reductions that would have occurred in the absence of the project, quantified based on included SSRs within the project GHG boundary. Project scenario GHG reductions are the actual GHG reductions that occur from included SSRs within the project GHG boundary.

The GHG reductions generated by the project are quantified by deducting the baseline scenario GHG reductions from the project scenario GHG reductions as outlined in Section 8.5.

The quantification of both the baseline and project scenario GHG reductions must include all the GHG reductions that occurred during the reporting period and must include sub-totals in tonnes of CO_2 equivalent (t CO_2e) for each full or partial calendar year to support issuance of the resulting offset credits by calendar year.

A project within an aggregation must use the same quantification approach for the baseline and project scenarios, including models, equations, and measurements. Default factors, such as those for leakage, must be specific to each project within the aggregation.

8.1 Baseline scenario GHG reductions

The proponent must follow the quantification methodology below to quantify the baseline scenario GHG reductions for each full or partial calendar year covered by the reporting period, based on the included SSRs outlined in Table 1.

This protocol quantifies the baseline scenario GHG reductions by calculating the baseline carbon stocks based on the modelled 100-year growth and harvesting scenario, determined following the requirements Section 3.2 and 9.2. The proponent will need the following information to calculate baseline carbon stocks:

1. Total baseline carbon stocks for each included SSR as per Table 1 (i.e., $SC_{\mathrm{B1,C}}$, $SC_{\mathrm{B2,C}}$ and $SC_{\mathrm{B4,C}}$, as well as $SC_{\mathrm{B5,C}}$, $SC_{\mathrm{B6,C}}$ and $SC_{\mathrm{B7,C}}$ if included as per Table 1), determined following the requirements of Section 9.1 and 9.2;
2. Average baseline carbon stocks (i.e., $SC_{\mathrm{Baseline,AVG}}$), determined following the requirements of Section 9.1 and 9.2; and
3. Average annual harvest volume (i.e., $SC_{\mathrm{Baseline,dm,i,C}}$, $HV_{\mathrm{Baseline,i,C}}$ or $HW_{\mathrm{Baseline,i,C}}$), as determined by the baseline scenario in Section 3.2 and following the requirements of Section 9.2.

In the case of a project previously registered in a GHG offset credit system other than the one set out in the Regulations, there will be no value associated with baseline carbon that would have been stored in harvested wood products for 100 years after harvest (i.e., $SC_{\mathrm{Baseline,HWP,C}}$ in Equation 1 is 0) and the proponent does not need to follow the quantification methodology set out in Section 8.1.1. There will also not be a change in baseline carbon stocks ($\Delta SC_{\mathrm{Baseline,C}}$) between calendar years covered by a reporting period or between reporting periods, so the proponent only uses Equation 7 to determine $\Delta SC_{Baseline,C}$.

The baseline scenario GHG reductions are determined using Equation 1.

Equation 1: Baseline scenario GHG reductions

$$BR_C = \Delta SC_{Baseline,C} + SC_{Baseline,HWP,C}$$

Where,			Units
BR_C	=	Baseline scenario GHG reductions for a calendar year covered by the reporting period	*t CO_2e*
$\Delta SC_{Baseline,C}$	=	Change in baseline carbon stocks for a calendar year covered by the reporting period as per Equation 5, 6 or 7	*t CO_2e*
$SC_{Baseline,HWP,C}$	=	Total baseline carbon that would have been stored in harvested wood products for 100 years after harvest for a calendar year within the reporting period as per Equation 13 (SSR B8)	*t CO_2e*
C	=	Calendar year	-

The proponent must use the total baseline carbon stocks to calculate $\Delta SC_{Baseline,C}$ until the total baseline carbon stocks are equal to the average baseline carbon stocks. Subsequently, the average baseline carbon stocks are used to calculate $\Delta SC_{Baseline,C}$. To determine whether the proponent must begin using average baseline carbon stocks to calculate $\Delta SC_{Baseline,C}$ for the remainder of the crediting period, the proponent uses Equation 2 if initial carbon stocks (as determined from the forest carbon inventory, see Section 9.1) are above the average baseline carbon stocks and Equation 3 if initial carbon stocks are lower than the average baseline carbon stocks. The proponent must repeat this process for each calendar year covered by a reporting period until the if statements in Equations 2 or 3 are satisfied.

Equation 2: Determining whether average baseline carbon stocks are used to determine $\Delta SC_{Baseline,C}$ for the remainder of the crediting period when initial carbon stocks are greater than average carbon stocks

$$\text{IF } SC_{Baseline,C} + SC_{Baseline,HWP,C} \leq SC_{Baseline,AVG},$$
$$\text{then } SC_{Baseline,AVG} \text{ is used for remainder of crediting period}$$

Where,			Units
$SC_{Baseline,C}$	=	Total baseline carbon stocks for a calendar year covered by the reporting period as per Equation 4	*t CO_2e*
$SC_{Baseline,HWP,C}$	=	Total carbon that would have been stored in harvest wood products for 100 years after harvest achieved in the baseline	*t CO_2e*

		for a calendar year covered by the reporting period as per Equation 13	
$SC_{Baseline,AVG}$	=	Average baseline carbon stocks for the 100-year growth and harvesting regime that represents the baseline scenario	*t CO_2e*
C	=	Calendar year	-

Equation 3: Determining whether average baseline carbon stocks are used to determine $\Delta SC_{Baseline,C}$ for the remainder of the crediting period when initial carbon stocks are less than average carbon stocks

$$\text{IF } SC_{Baseline,C} + SC_{Baseline,HWP,C} \geq SC_{Baseline,AVG},$$

$$\text{then } SC_{Baseline,AVG} \text{ is used for remainder of crediting period}$$

Where,			Units
$SC_{Baseline,C}$	=	Total baseline carbon stocks for a calendar year covered by the reporting period as per Equation 4	*t CO_2e*
$SC_{Baseline,HWP,C}$	=	Total carbon that would have been stored in harvest wood products for 100 years after harvest achieved in the for a calendar year covered by the reporting period as per Equation 13	*t CO_2e*
$SC_{Baseline,AVG}$	=	Average baseline carbon stocks for the 100-year growth and harvesting regime that represents the baseline scenario	*t CO_2e*
C	=	Calendar year	-

Equation 4: Total baseline carbon stocks

$$SC_{Baseline,C} = \left(SC_{B1,C} + SC_{B2,C} + SC_{B4,C} + SC_{B5,C} + SC_{B6,C} + SC_{B7,C}\right) \text{ x } 3.667$$

Where,			Units
$SC_{Baseline,C}$	=	Total baseline carbon stocks for a calendar year covered by the reporting period	*t CO_2e*
$SC_{B1,C}$	=	Total baseline carbon stored in SSR B1 for a calendar year covered by the reporting period	*t C*
$SC_{B2,C}$	=	Total baseline carbon stored in SSR B2 for a calendar year covered by the reporting period	*t C*
$SC_{B4,C}$	=	Total baseline carbon stored in SSR B4 for a calendar year covered by the reporting period	*t C*

$SC_{B5,C}$	=	Total baseline carbon stored in SSR B5 for a calendar year covered by the reporting period, if required to be included as per Table 1	*t C*
$SC_{B6,C}$	=	Total baseline carbon stored in SSR B6 for a calendar year covered by the reporting period, if required to be included as per Table 1	*t C*
$SC_{B7,C}$	=	Total baseline carbon stored in SSR B7 for a calendar year covered by the reporting period, if required to be included as per Table 1	*t C*
3.667	=	Conversion factor to convert to t CO_2e	-
C	=	Calendar year	-

In the years prior to the year when the total baseline carbon stocks are equal to the average baseline carbon stocks, the proponent uses Equation 5 to determine $\Delta SC_{Baseline,C}$. In the years prior to the year when total baseline carbon stocks are equal to the average baseline carbon stocks, $\Delta SC_{Baseline,C}$ will most likely be negative for projects where initial carbon stocks are higher than average baseline carbon stocks and positive when lower than average baseline carbon stocks.

Equation 5: Change in baseline carbon stocks

$$\Delta SC_{Baseline,C} = SC_{Baseline,C} - SC_{Baseline,C-1}$$

Where,			Units
$\Delta SC_{Baseline,C}$	=	Change in baseline carbon stocks for a calendar year covered by the reporting period	*t CO_2e*
$SC_{Baseline,C}$	=	Total baseline carbon stocks for a calendar year covered by the reporting period	*t CO_2e*
$SC_{Baseline,C-1}$	=	Total baseline carbon stocks for the previous calendar year covered by the reporting period or reported in the final year of the previous project report if calendar year C represents the beginning of a new reporting period	*t CO_2e*
C	=	Calendar year	-
$C\text{-}1$	=	Previous calendar year covered by the reporting period or the final year covered by the previous project report if calendar year C represents the beginning of a new reporting period	-

In the year in which total baseline carbon stocks are now equal to average baseline carbon stocks (i.e., the year in which the if statements in Equation 2 or 3 is satisfied), the proponent must use Equation 6 to calculate $\Delta SC_{Baseline,C}$.

Equation 6: Change in baseline carbon stocks when total baseline carbon stocks equal average baseline carbon stocks

$$\Delta SC_{\mathrm{Baseline,C}} = SC_{\mathrm{Baseline,AVG}} - SC_{\mathrm{Baseline,C-1}}$$

Where,			Units
$\Delta SC_{\mathrm{Baseline,C}}$	=	Change in baseline carbon stocks for a calendar year covered by the reporting period	$t\ CO_2e$
$SC_{\mathrm{Baseline,AVG}}$	=	Average baseline carbon stocks for the 100-year growth and harvesting scenario that represents the baseline scenario	$t\ CO_2e$
$SC_{\mathrm{Baseline,C-1}}$	=	Total baseline carbon stocks for the previous calendar year or reported in the final year of the previous project report if calendar year C represents the beginning of a new reporting period	$t\ CO_2e$
C	=	Calendar year	-
$\mathrm{C\text{-}1}$	=	Previous calendar year covered by the reporting period or the final year covered by the previous project report if calendar year C represents the beginning of a new reporting period	-

In all subsequent years after the year in which the total baseline carbon stocks equal the average baseline carbon stocks, the proponent must use Equation 7 to calculate $\Delta SC_{\mathrm{Baseline,C}}$.

Equation 7: Change in baseline carbon stocks using average baseline carbon stocks

$$\Delta SC_{\mathrm{Baseline,C}} = 0$$

Where,			Units
$\Delta SC_{\mathrm{Baseline,C}}$	=	Change in baseline carbon stocks for a calendar year covered by the reporting period	$t\ CO_2e$
0	=	Default value for change in baseline carbon stocks when using average baseline carbon stocks. Average baseline carbon stocks will be the same for each calendar year, resulting in no change in baseline carbon stocks between calendar years or reporting periods for the remainder of the crediting period	-
C	=	Calendar year	-

8.1.1 Calculating baseline carbon stored in harvested wood products (SSR B8)

As a part of the 100-year growth and harvesting scenario (see Section 3.2) modelled to determine baseline carbon stocks, the proponent must forecast the level of harvesting within the project site that would have occurred in the baseline scenario following the requirements of Section 9.2 and convert this to an average annual harvesting volume by species to determine the baseline carbon stocks for SSR B8. From this modelled harvest volume, the proponent then determines the amount of carbon that would have been stored each full or partial calendar year in harvested wood products 100 years after harvest using Steps 1-5 below. For a project where the harvest in the project scenario is greater than or equal to harvest volumes in the baseline scenario, the proponent has the option to assume all harvested wood carbon is immediately emitted as CO_2.

Step 1: *Determining the baseline amount of carbon that would have been harvested and delivered to mill*

Determine the amount of baseline carbon in aboveground live trees (bole only, no bark) (SSR B1) that would have been delivered to mill for each calendar year within the reporting period and stored in harvested wood products for 100 years.

If the model used to develop the baseline carbon stocks as per Section 9.2 provides metric tonnes of carbon (t C) in the bole, without bark, for each species that would have been harvested, the proponent can skip to Step 2. The output data from the model for the amount of baseline carbon in aboveground live tree biomass that would have been harvested and delivered to mill for a calendar year within the reporting period is used in Equation 10.

If the model used to develop the baseline carbon stocks as per Section 9.2 does not provide metric tonnes of carbon (t C) in the bole, without bark, for each species that would have been harvested, the proponent must use Equation 8 if based on volume (m^3) and Equation 9 is based on green weight (kg) to determine the amount of baseline carbon in aboveground live tree biomass that would have been harvested and delivered to mill.

Equation 8: Baseline carbon delivered to mill using wood volume

$$\mathrm{SC_{Baseline,dm,i,C}} = \frac{(\mathrm{HV_{Baseline,i,C}} \text{ x } \mathrm{WDF_i}) \text{ x } 0.5}{1000}$$

Where,			Units
$\mathrm{SC_{Baseline,dm,i,C}}$	=	Baseline carbon stored in aboveground live tree biomass harvested and delivered to mill calculated separately for each species for a calendar year covered by the reporting period	*t C*
$\mathrm{HV_{Baseline,i,C}}$	=	Volume of harvested wood determined separately for each species for a calendar year covered by the reporting period as per the baseline scenario	*m^3*
$\mathrm{WDF_i}$	=	Wood density factor determined by species. Obtain wood density factor from Table 5-3a from the USFS Wood Handbook.[7] If located in B.C., use Table 2. If a species is not listed in the USFS Wood Handbook, the proponent must select an appropriate substitute species, and any substitute must be consistently applied across the baseline and project scenarios	*$t\ m^{-3}$*

[7] Forest Products Laboratory. Wood handbook — Wood as an engineering material. General Technical Report FPL-GTR-190. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 508 p. 2010.

0.5	=	Conversion factor to total carbon weight	-
1000	=	Conversion factor to convert from kg of carbon to metric tonnes (t C) of carbon	-
C	=	Calendar year	-
i	=	Tree species	-

Equation 9: Baseline carbon delivered to mill using green weight of wood

$$SC_{Baseline,dm,i,C} = \frac{(HW_{Baseline,i,C} - WW_i) \text{ x } 0.5}{1000}$$

Where,			Units
$SC_{Baseline,dm,i,C}$	=	Baseline carbon stored in aboveground live tree biomass harvested and delivered to mill calculated separately for each species for a calendar year within the reporting period	*t C*
$HW_{Baseline,i,C}$	=	Weight of harvested wood determined separately for each species for a calendar year within the reporting period as per the baseline scenario	*kg*
WW_i	=	Water weight of wood based on moisture content of the wood harvested, determined by species	*kg*
0.5	=	Conversion factor to total carbon weight	-
1000	=	Conversion factor to convert from kg of carbon to metric tonnes (t C) of carbon	-
C	=	Calendar year	-
i	=	Tree species	-

Table 2: B.C.-specific wood density factors (WDF_i) for oven-dry stemwood[8]

Species	**Wood density (t m^{-3})**
Red alder (Alnus rubra)	0.42
Trembling aspen (Populus tremuloides)	0.42
Western red cedar (Thuja plicata)	0.35
Yellow cypress (Chamaecyparis nootkatensis)	0.45
Douglas-fir (Pseudotsuga menziesii)	0.50

[8] Draft British Columbia Greenhouse Gas Offset Protocol: Forest Carbon Version 2.0, March 30, 2021. https://www2.gov.bc.ca/assets/gov/environment/climate-change/ind/protocol/draft_fcop.pdf. Table 3.

Species	Wood density (t m^{-3})
True firs (Abies spp.)	0.40
Western hemlock (Tsuga heterophylla)	0.47
Western larch (Larix occidentalis)	0.64
Lodgepole pine (Pinus contorta)	0.46
Ponderosa pine (Pinus Ponderosa)	0.46
Spruce (Picea spp.)	0.43
Sitka spruce (Picea sitchensis)	0.41

Step 2: *Determining the amount of baseline carbon in aboveground live tree biomass transferred to wood products*

Determine the total amount of baseline carbon in harvested aboveground live tree biomass (SSR B1) delivered to mill that would have been transferred into wood products for each calendar year covered by the reporting period ($\mathrm{CHWP}_{\mathrm{i,C}}$) using Equation 10.

The proponent must use the actual mill efficiencies from the mill or derived from monitored data, where available. The proponent must use mill efficiencies at the species level where available, otherwise an aggregate mill efficiency may be used. If data are not available on the actual mill efficiency, the proponent must use a default average mill efficiency factor of 40%[9], meaning 40% of the total carbon in harvested wood is transferred to wood products. For projects located in B.C., the proponent must use an average mill efficiency factor of 50%.[10] Any mill residues and by-products are considered to have been immediately emitted to the atmosphere under this methodology.

Equation 10: Baseline carbon transferred to wood products

$$\mathrm{CHWP}_{\mathrm{Baseline,i,C}} = \mathrm{SC}_{\mathrm{Baseline,dm,i,C}} \text{ x } \mathrm{ME}_{\mathrm{i}}$$

Where,			Units
$\mathrm{CHWP}_{\mathrm{Baseline,i,C}}$	=	Baseline carbon stored in harvested live tree biomass that would have been transferred to wood products calculated separately for each species for a calendar year covered by the reporting period	*t C*
$\mathrm{SC}_{\mathrm{Baseline,dm,i,C}}$	=	Baseline stored carbon is aboveground live tree biomass harvested that would have been delivered to a mill calculated	*t C*

[9] A Cradle-to-Gate Life Cycle Assessment of Canadian Surface Dry Softwood Lumber. March 2018. Table 8. http://www.athenasmi.org/wp-content/uploads/2018/07/CtoG-LCA-of-Canadian-Surfaced-Dry-Softwood-Lumber.pdf

[10] A Cradle-to-Gate Life Cycle Assessment of Surfaced Dry Softwood Lumber Produced in British Columbia. March 2021. Table 8. http://www.athenasmi.org/wp-content/uploads/2022/01/CtoG-LCA-of-BC-Surfaced-Dry-Softwood-Lumber-20210331-1.pdf

		separately for each species for a calendar year covered by the reporting period	
ME_i	=	Mill efficiency determined separately for each species where available*.* The proponent must use specific mill efficiencies where available. Otherwise, the proponent must use a default factor of 0.4 for projects outside BC or 0.5 for projects within BC	*%*
C	=	Calendar year	-
i	=	Tree species	-

Step 3: *Determining the amount of baseline carbon that would have been transferred to each wood product class*

Determine the amount of baseline carbon that would have been transferred to each product class, calculated separately for each species if wood product classes are broken down by species, using Equation 11.

The proponent must first determine the percentage of harvested wood that would have ended up in each wood product class for a calendar year covered by the reporting period ($PC_{i,C}$), determined separately for each species if data are available at the species level. The proponent must obtain $PC_{i,C}$ by:

- Obtaining a report from the mill where the project area's logs are sold indicating the product class categories the mill sold that year; or
- If breakdowns for wood product classes are not available, wood product classes must be derived using Table 3, or for projects located in BC, using Table 4.

Equation 11: Baseline carbon transferred to each wood product class

$$CWPC_{Baseline,i,C} = CHWP_{Baseline,i,C} \text{ x } PC_{i,C}$$

Where,			Units
$CWPC_{Baseline,i,C}$	=	Baseline carbon that would have been transferred to each product class calculated for each species (if wood product classes are broken down by species) for a calendar year covered by reporting period	*t C*
$CHWP_{Baseline,i,C}$	=	Baseline carbon stored in harvested live tree biomass that would have been transferred to wood products calculated for each species (if wood product classes are broken down by species) for a calendar year covered by the reporting period	*t C*

$PC_{i,C}$	=	Percentage of harvest that ends up in each product class for each species (if data is broken down by species) for a calendar year within the reporting period	%
C	=	Calendar year	-
i	=	Tree species	-

Table 3: Wood product class by percentage of harvest volume[11]

Wood Product Class	Percentage of Harvest Volume (%)
Softwood lumber	38.15
Hardwood lumber	0.38
Pulp and paper	34.60
Panels (plywood and OSB)	12.42
Other industrial roundwood	3.55
Fuelwood	11.29

Table 4: Wood product class by percentage of harvest volume for projects located in BC[12,13]

Wood Product Class	Coast	Northern Interior	Southern Interior
Softwood Lumber	39.1	36.3	39.3
Hardwood Lumber	0.4	3.2	0.2
Softwood Plywood	4.1	3.8	4.1
Oriented Strandboard	3.8	3.8	3.8
Paper	18.3	18.3	18.3
Fuel	33.7	33.7	33.7
Landfill	0.2	0.2	0.2
Effluent	0.4	0.4	0.4

[11] Values are based off the national average harvested wood product production ratios developed by the FAO based on a reference period of 1990-2020. Ratio of softwood lumber to hardwood lumber for harvested industrial roundwood was based on a reference period of 2014-2021 from Statistics Canada (Table 16-10-0017-01 Lumber production, shipments, and stocks by species, monthly (x 1,000), DOI: https://doi.org/10.25318/1610001701-eng).
[12] Dymond CD. 2012. Forest carbon in North America: Annual storage and emissions from British Columbia's harvest, 1965-2065. Carbon Balance and Management 7(1):8.
[13] https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/ministry-of-forests-lands-and-natural-resource-operations-region-district-contacts

Step 4: *Determining the amount of baseline carbon that would have been stored in harvested wood products for 100 years after harvest for each wood product class*

Determine the amount baseline carbon stored in harvested wood products for each wood product class for each species (if Equation 11 was broken down by species) using Equation 12.

Using Table 5, the proponent must estimate the carbon storage in various harvested wood products 100 years after harvest by applying the appropriate 100-year storage factor based on the wood product class.

Equation 12: Baseline carbon stored in harvested wood projects 100 years after harvest

$$SCHWP_{Baseline,i,t,C} = CWPC_{Baseline,i,C} \times SF_j$$

Where,			Unit
$SCHWP_{Baseline,i,t,C}$	=	Baseline carbon that would have been stored in harvested wood products 100 years after harvest for each species (if broken down by species) for a calendar year covered by the reporting period for wood product class	*t C*
$CWPC_{Baseline,i,C}$	=	Baseline carbon that would have been transferred to each product class calculated for each species (if wood product classes are broken down by species) for a calendar year covered by the reporting period	*t C*
SF_j	=	Storage factor for wood product class as per Table 5	-
C	=	Calendar year	-
i	=	Tree species	-
j	=	Wood product class	-

Table 5: 100-year storage factor for each wood product class[14]

Wood Product Class	Storage Factor
Softwood Lumber	0.213
Hardwood Lumber	0.156
Softwood Plywood	0.215
Oriented Strandboard	0.285
Non-structural Panels	0.174
Miscellaneous Products	0.149

[14] Hoover et al, “Chapter 6: quantifying greenhouse gas sources and sinks in managed forest systems”, a chapter in "Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory”, US Department of Agriculture, 2014. https://www.usda.gov/sites/default/files/documents/USDATB1939_07072014.pdf

Wood Product Class	Storage Factor
Fuelwood	0
Paper	0

Step 5: *Determining the total amount of baseline carbon that would have been stored in harvested wood products for 100 years after harvest*

Finally, to determine the total amount of baseline carbon that would have been stored in harvested wood products 100 years after harvest (SSR B8), the proponent must sum all the resulting values from Step 4 across all species (if calculated separately for each species) using Equation 13.

Equation 13: Total amount of baseline carbon stored in harvested wood products 100 years after harvest

$$SC_{Baseline,HWP,C} = \sum_{i,j}^{n} [\, SCHWP_{Baseline,i,j,C} \text{ x } 3.667]$$

Where,			Units
$SC_{Baseline,HWP,C}$	=	Total baseline carbon that would have been stored in harvested wood products for 100 years after harvest for a calendar year covered by the reporting period (SSR B8)	*t CO_2e*
$SCHWP_{Baseline,i,j,C}$	=	Stored carbon in harvested wood products 100 years after harvest for each species (if broken down by species) for a calendar year covered by the reporting period for wood product class	*t C*
3.667	=	Conversion factor to convert to tCO_2e	-
C	=	Calendar year	-
i	=	Tree species	-
j	=	Wood product class	-

8.2 Project scenario GHG reductions

The proponent must follow the below quantification methodology to quantify the project scenario GHG reductions for each full or partial calendar year covered by the reporting period, based on the included SSRs outlined in Table 1.

This protocol quantifies the project scenario GHG reductions by calculating the total project carbon stocks and quantifying the incremental change in project carbon stocks throughout the crediting period. Project carbon stocks are determined from the initial forest carbon inventory and by periodically updating the forest carbon inventory (see Section 9.1) throughout the crediting period. This is supported by model projections (see Section 9.2) in the years the forest carbon inventory is not updated. The proponent will need the following information to determine project carbons stocks:

1. Total annual project carbon stocks for each included SSR as per Table 1 (i.e., $SC_{\mathrm{P1,C}}$, $SC_{\mathrm{P2,C}}$ and $SC_{\mathrm{P4,C}}$, as well as $SC_{\mathrm{P5,C}}$, $SC_{\mathrm{P6,C}}$ and $SC_{\mathrm{P7,C}}$ if included as per Table 1), determined following the requirements of Section 9.1 and 9.2;
2. Total project carbon stocks for the previous calendar year covered by the reporting period and reported on in the previous project report (i.e., $SC_{\mathrm{Project,C-1}}$);
3. Amount of biomass burned during each calendar year covered by the project report (i.e., $SC_{\mathrm{burn,C}}$), determined by updating the forest carbon inventory following the requirements of 9.1; and
4. Annual harvest volume (i.e., $\mathrm{HV_{Baseline,i,C}}$ or $\mathrm{HW_{Baseline,i,C}}$), as determined by updating the forest carbon inventory by following the requirements of Section 9.1.

The project scenario GHG reductions are determined using Equation 14.

Equation 14: Project scenario GHG reductions

$$\mathrm{PR_C} = \Delta\mathrm{SC_{Project,C}} + \mathrm{SC_{Project,HWP,C}} - \mathrm{GHG_{Project,C}} - \mathrm{L_{Activity,C}} - \mathrm{L_{Market,C}}$$

Where,			Units
$\mathrm{PR_C}$	=	Project scenario GHG reductions for a calendar year covered by the reporting period	*t CO_2e*
$\Delta\mathrm{SC_{Project,C}}$	=	Change in project carbon stocks for a calendar year covered by the reporting period as per Equation 15	*t CO_2e*
$\mathrm{SC_{Project,HWP,C}}$	=	Total carbon remaining stored in harvested wood products for 100 years after harvest for a calendar year covered by the reporting period as per Equation 25	*t CO_2e*
$\mathrm{GHG_{Project,C}}$	=	Total GHG emissions as a result of implementing project activities for a calendar year covered by the reporting period as per Equation 19	*t CO_2e*
$\mathrm{L_{Activity,C}}$	=	Total change in carbon stored on controlled lands for a calendar year covered by the reporting period to capture activity-shifting leakage as per Equation 27	*t CO_2e*
$\mathrm{L_{Market,C}}$	=	Total carbon lost due to market leakage risk for a calendar year covered by the reporting period as per Equation 28 or Equation 31	*t CO_2e*
C	=	Calendar year	-

The proponent must use Equation 15 to determine the total change in project carbon stocks for a calendar year covered by the reporting period.

Equation 15: Calculating change in project carbon stocks

$$\Delta SC_{Project,C} = \left[SC_{Project,C} \text{ x } (1 - CD_C)\right] - \left[SC_{Project,C-1} \text{ x } (1 - CD_{C-1})\right]$$

Where,			Units
$\Delta SC_{Project,C}$	=	Change in project carbon stocks for a calendar year covered by the reporting period	*t CO_2e*
$SC_{Project,C}$	=	Total project carbon stocks for a calendar year covered by the reporting period as per Equation 16	*t CO_2e*
CD_C	=	Confidence deduction factor to reflect uncertainty for a calendar year covered by the reporting period as per Section 8.3	*%*
$SC_{Project,C-1}$	=	Total project carbon stocks in the previous calendar year covered by the reporting period or reported in the final calendar year of the previous project report if calendar year C represents the beginning of a new reporting period	*t CO_2e*
CD_{C-1}	=	Confidence deduction factor to reflect uncertainty for the previous calendar year covered by the reporting period or reported in the final calendar year of the previous project report if calendar year C represents the beginning of a new reporting period, unless a reversal has occurred since the previous project report, in which case the confidence deduction that was re-calculated as a part of updating the forest carbon inventory after the reversal event is used	*%*
C	=	Calendar year	-
C-1	=	Previous calendar year covered by the reporting period or the final calendar year of the previous project report if calendar year C represents the beginning of a new reporting period	-

Equation 16: Total carbon stocks for included SSRs

$$SC_{Project,C} = \left(SC_{P1,C} + SC_{P2,C} + SC_{P4,C} + SC_{P5,C} + SC_{P6,C} + SC_{P7,C}\right) \text{ x } 3.667$$

Where,			Units
$SC_{Project,C}$	=	Total project carbon stocks for a calendar year covered by the reporting period	*t CO_2e*
$SC_{P1,C}$	=	Total project carbon stored in SSR P1 for a calendar year covered by the reporting period	*t C*
$SC_{P2,C}$	=	Total project carbon stored in SSR P2 for a calendar year covered by the reporting period	*t C*

$SC_{P4,C}$	=	Total project carbon stored in SSR P4 for a calendar year covered by the reporting period	*t C*
$SC_{P5,C}$	=	Total project carbon stored in SSR P5 for a calendar year covered by the reporting period, if required to be included as per Table 1	*t C*
$SC_{P6,C}$	=	Total project carbon stored in SSR P6 for a calendar year covered by the reporting period, if required to be included as per Table 1	*t C*
$SC_{P7,C}$	=	Total project carbon stored in SSR P7 for a calendar year covered by the reporting period, if required to be included as per Table 1	*t C*
3.667	=	Conversion factor to convert from t C to t CO_2e	-
C	=	Calendar year	-

The proponent must determine the amount of GHG emissions associated with the burning of biomass in the project scenario. Only methane (CH_4) and nitrous oxide (N_2O) emissions are included in quantification, as the amount of CO_2 that is burned is captured through updating plot data in the forest carbon inventory after harvest following the requirements of Section 9.1. A proponent that carries out salvage harvest must treat this biomass as an immediate release of CO_2 into the atmosphere by updating the forest carbon inventory. The proponent must use Equation 17 and Equation 18 to determine the amount of CH_4 and N_2O emissions associated with the burning of biomass in the project scenario, respectively. The proponent must include all SSRs impacted by burning and must follow the requirements of Section 9.1 to inform the value of $SC_{burn,C}$ to be used in Equations 17 and 18 below.

Equation 17: CH_4 emissions from the burning of biomass in the project

$$GHG_{Project,CH4,C} = SC_{burn,C} \text{ x } ER_{CH4} \text{ x } \frac{16}{12} \text{ x } GWP_{CH4}$$

Where,			Units
$GHG_{Project,CH4,C}$	=	Amount of CH_4 emissions released from SSR P10 for a calendar year covered by the reporting period	*t CO_2e*
$SC_{burn,C}$	=	Amount of stored carbon burned from the combustion of biomass for a calendar year covered by the reporting period	*t C*
ER_{CH4}	=	Emission ratio for the mass of CH_4 released relative to the mass of total carbon lost from burning. The proponent must use local data on combustion efficiency if available, otherwise proponents use the IPCC default value of 0.012[15]	-

[15] Table 3A.1.15, Annex 3A.1. Chapter 3: LCUF Good Practice Guidance. IPCC 2003 Good Practice Guidance for LULUCF.

$\frac{16}{12}$	=	The ratio of the molar mass of CH_4 to C	
GWP_{CH4}	=	The global warming potential of CH_4, as set out in Schedule III of the *Act*	-
C	=	Calendar year	-

Equation 18: N_2O emissions from the burning of biomass in the project

$$GHG_{Project,N2O,C} = SC_{burn,C} \text{ x } N/C_{ratio} \text{ x } ER_{N2O} \text{ x } \frac{44}{28} \text{ x } GWP_{N2O}$$

Where,			Units
$GHG_{Project,N2O,C}$	=	Amount of N_2O emissions released from SSR P10 for a calendar year covered by the reporting period	*t CO_2e*
$SC_{burn,C}$	=	Amount of stored carbon burned from the combustion of biomass for a calendar year covered by the reporting period	*t C*
N/C_{ratio}	=	The ratio of N to C in the fuel. The proponent uses the IPCC default value of 0.01[16]	-
ER_{N2O}	=	Emission ratio for the mass of N_2O released relative to the mass of total nitrogen lost from burning. The proponent must use local data on combustion efficiency if available, otherwise proponents use the IPCC default value of 0.007[17]	-
$\frac{44}{28}$	=	The ratio of the molar mass of N_2O to N	-
GWP_{N2O}	=	The global warming potential of N_2O, as set out in Schedule III of the *Act*	-
C	=	Calendar year	-

The proponent uses Equation 19 to determine the total amount of GHG emissions occurring in the project scenario for a calendar year covered by the reporting period, to be used in Equation 14.

[16] Chapter 3: LCUF Sector Good Practice Guidance. IPCC 2003 Good Practice Guidance for LULUCF.
[17] Table 3A.1.15, Annex 3A.1. Chapter 3: LCUF Good Practice Guidance. IPCC 2003 Good Practice Guidance for LULUCF.

Equation 19: Total GHG emissions released in the project scenario

$$GHG_{Project,C} = GHG_{Project,CH4,C} + GHG_{Project,N2O,C}$$

Where,			Units
$GHG_{Project,C}$	=	Total GHG emissions as a result of implementing activities for a calendar year covered by the reporting period (SSR P10)	*t CO_2e*
$GHG_{Project,CH4,C}$	=	Amount of CH_4 emissions released from SSR P10 for a calendar year covered by the reporting period as per Equation 17	*t CO_2e*
$GHG_{Project,N2O,C}$	=	Amount of N_2O emissions released from SSR P10 for a calendar year covered by the reporting period as per Equation 18	*t CO_2e*
C	=	Calendar year	-

8.2.1 Calculating project carbon stored in harvested wood products (SSR P8)

The proponent must determine the amount of carbon harvested from within the project site for each calendar year covered by the reporting period for the purpose of producing harvested wood products. The proponent uses the measured harvest volumes from updating the forest carbon inventory following the requirements of Section 9.1 and must use the same measured or default parameters used in the calculation of SSR B8 in Section 8.1.1. Trees of non-commercial sizes and species must be excluded from the quantification of total harvest. The proponent determines the amount of carbon stored in harvested wood products for 100 years using steps 1-5 below. For a project where the harvest in the project scenario is greater than or equal to harvest volumes in the baseline scenario, the proponent may assume all harvested wood carbon is immediately emitted as CO_2.

Step 1: *Determining the amount of project carbon harvested and delivered to mill*

Determine the amount of carbon in aboveground live trees (bole only, no bark) (SSR P1) that is delivered to mill for each full or partial calendar year covered by the reporting period.

The proponent must use actual harvested wood volumes and species must be based on 3rd party scaling reports or weigh tickets. If such documentation is not available, the proponent must provide other supporting documentation to justify the quantity of wood volume harvested stated in the project report.

The proponent must determine the amount of carbon in aboveground live tree biomass (SSR P1) that was harvested and sent to mill for a calendar year covered by the reporting period using Equation 20 if based on harvest volume (m^3) or Equation 21 if based on green weight (kg).

Equation 20: Project carbon delivered to mill using wood volume

$$SC_{Project,dm,i,C} = \frac{(HV_{Project,i,C} \text{ x } WDF_i) \text{ x } 0.5}{1000}$$

Where,			Units
$SC_{Project,dm,i,C}$	=	Project carbon stored in aboveground live tree biomass harvested and delivered to a mill for a calendar year covered by the reporting period, calculated separately for each species	*t C*
$HV_{Project,i,C}$	=	Volume of harvested wood determined separately for each species for a calendar year covered by the reporting period	*m^3*
WDF_i	=	Wood density factor determined by species. Obtain wood density factor from Table 5-3a from the USFS Wood Handbook[18]. If located in B.C., use Table 2. If a species is not listed in the USFS Wood Handbook, the proponent must select an appropriate substitute species, and any substitute must be consistently applied across the baseline and project scenarios	*$t\ m^{-3}$*
0.5	=	Conversion factor to total carbon weight	-
1000	=	Conversion factor to convert from kg of carbon to metric tonnes (t C) of carbon	-
C	=	Calendar year	-
i	=	Tree species	-

Equation 21: Project carbon delivered to mill using green weight of wood

$$SC_{Project,dm,i,C} = \frac{(HW_{i,C} - WW_i) \text{ x } 0.5}{1000}$$

Where,			Units
$SC_{Project,dm,i,C}$	=	Project carbon stored in aboveground live tree biomass harvested and delivered to a mill for a calendar year covered by the reporting period, calculated separately for each species	*t C*
$HW_{Project,i,C}$	=	Weight of harvested wood for a calendar year covered by the reporting period	*kg*
WW_i	=	Water weight of wood based on moisture content of the wood harvested, determined by species	*kg*
0.5	=	Conversion factor to total carbon weight	-

[18] Forest Products Laboratory. Wood handbook — Wood as an engineering material. General Technical Report FPL-GTR-190. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 508 p. 2010.

1000	=	Conversion factor to convert from kg of carbon to metric tonnes (t C) of carbon	-
C	=	Calendar year	-
i	=	Tree species	-

Table 6: B.C.-specific wood density factors (WDF_i) for oven-dry stemwood[19]

Species	**Wood density (t m^{-3})**
Red alder (Alnus rubra)	0.42
Trembling aspen (Populus tremuloides)	0.42
Western red cedar (Thuja plicata)	0.35
Yellow cypress (Chamaecyparis nootkatensis)	0.45
Douglas-fir (Pseudotsuga menziesii)	0.50
True firs (Abies spp.)	0.40
Western hemlock (Tsuga heterophylla)	0.47
Western larch (Larix occidentalis)	0.64
Lodgepole pine (Pinus contorta)	0.46
Ponderosa pine (Pinus Ponderosa)	0.46
Spruce (Picea spp.)	0.43
Sitka spruce (Picea sitchensis)	0.41

Step 2: *Determining the amount of project carbon in aboveground live tree biomass transferred to wood products*

Determine the total amount of project carbon in harvested aboveground live tree biomass (SSR P1) delivered to mill transferred into wood products for each calendar year covered by the reporting period ($CHWP_{i,C}$) using Equation 22.

The proponent must use the actual mill efficiencies from the mill or derived from monitored data, where available. The proponent must use mill efficiencies at the species level where available, otherwise an aggregate mill efficiency may be used. If data are not available on the actual mill efficiency, the proponent must use a default average mill efficiency factor of 40%[20], meaning 40% of the total carbon in harvested wood is transferred to wood products. For projects located in B.C., the proponent must use

[19] Draft British Columbia Greenhouse Gas Offset Protocol: Forest Carbon Version 2.0, March 30, 2021. https://www2.gov.bc.ca/assets/gov/environment/climate-change/ind/protocol/draft_fcop.pdf. Table 3.
[20] A Cradle-to-Gate Life Cycle Assessment of Canadian Surface Dry Softwood Lumber. March 2018. Table 8. http://www.athenasmi.org/wp-content/uploads/2018/07/CtoG-LCA-of-Canadian-Surfaced-Dry-Softwood-Lumber.pdf

an average mill efficiency factor of 50%.[21] Any mill residues and by-products are considered to have been immediately emitted to the atmosphere under this methodology.

Equation 22: Project carbon transferred to wood products

$$CHWP_{Project,i,C} = SC_{Project,dm,i,C} \text{ x } ME_i$$

Where,			Units
$CHWP_{Project,i,C}$	=	Project carbon stored in harvested live tree biomass transferred to wood products calculated separately for each species for a calendar year covered by the reporting period	*t C*
$SC_{Project,dm,i,C}$	=	Project carbon stored in aboveground live tree biomass harvested and delivered to a mill calculated separately for each species for a calendar year covered by the reporting period	*t C*
ME_i	=	Mill efficiency determined separately for each species where available. The proponent must use specific mill efficiencies where available. Otherwise, the proponent must use a default factor of 0.4 for projects outside of BC and 0.5 for projects within BC	*%*
C	=	Calendar year	-
i	=	Tree species	-

Step 3: *Determining the amount of project carbon transferred to each wood product class*

Determine the amount of project carbon that is transferred to each product class, determined separately for each species if wood product classes are broken down by species, using Equation 23.

The proponent must first determine the percentage of harvested wood that ends up in each wood product class for a calendar year covered by the reporting period ($PC_{i,C}$), determined separately for each species if data are available at the species level. The proponent can obtain $PC_{i,C}$ by:

- Obtaining a report from the mill where the project area's logs are sold indicating the product class categories the mill sold that year; or
- If breakdowns for wood product classes are not available, wood product classes must be derived using Table 7, or for projects located in BC, using Table 8.

[21] A Cradle-to-Gate Life Cycle Assessment of Surfaced Dry Softwood Lumber Produced in British Columbia. March 2021. Table 8. http://www.athenasmi.org/wp-content/uploads/2022/01/CtoG-LCA-of-BC-Surfaced-Dry-Softwood-Lumber-20210331-1.pdf

Equation 23: Project carbon transferred to each wood product class

$$CWPC_{Project,i,C} = CHWP_{Project,i,C} \text{ x } PC_{i,C}$$

Where,

			Units
$CWPC_{Project,i,C}$	=	Project carbon transferred to each product class calculated for each species (if wood product classes are broken down by species) for a calendar year covered by the reporting period	*t C*
$CHWP_{Project,i,C}$	=	Project carbon stored in harvested live tree biomass transferred to wood products calculated for each species (if wood product classes are broken down by species) for a calendar year covered by the reporting period	*t C*
$PC_{i,C}$	=	Percentage of harvest that ends up in each product class for each species (if data is broken down by species) for a calendar year covered by the reporting period	*%*
C	=	Calendar year	-
i	=	Tree species	-

Table 7: Wood product class by percentage of harvest volume[22]

Wood Product Class	Percentage of Harvest Volume (%)
Softwood lumber	38.15
Hardwood lumber	0.38
Pulp and paper	34.60
Panels (plywood and OSB)	12.42
Other industrial roundwood	3.55
Fuelwood	11.29

[22] Values are based off the national average harvested wood product production ratios developed by the FAO based on a reference period of 1990-2020. Ratio of softwood lumber to hardwood lumber for harvested industrial roundwood was based on a reference period of 2014-2021 from Statistics Canada (Table 16-10-0017-01 Lumber production, shipments, and stocks by species, monthly (x 1,000), DOI: https://doi.org/10.25318/1610001701-eng).

Table 8: Wood product class by percentage of harvest volume for projects located in BC[23,24]

Wood Product Class	Coast	Northern Interior	Southern Interior
Softwood Lumber	39.1	36.3	39.3
Hardwood Lumber	0.4	3.2	0.2
Softwood Plywood	4.1	3.8	4.1
Oriented Strandboard	3.8	3.8	3.8
Paper	18.3	18.3	18.3
Fuel	33.7	33.7	33.7
Landfill	0.2	0.2	0.2
Effluent	0.4	0.4	0.4

Step 4: *Determining the amount of project carbon stored in harvested wood products for 100 years after harvest for each wood product class*

Determine the amount project carbon stored in harvested wood products for each wood product class for each species, if Equation 23 was broken down by species, using Equation 24.

Using Table 9, the proponent estimates the carbon storage in various harvested wood products 100 years after harvest by applying the appropriate 100-year storage factor based on the wood product class.

Equation 24: Project carbon stored in harvested wood projects 100 years after harvest

$$SCHWP_{Project,i,j,C} = CWPC_{Project,i,C} \text{ x } SF_j$$

Where,			Units
$SCHWP_{Project,i,j,C}$	=	Project carbon stored in harvested wood products 100 years after harvest for each species (if broken down by species) for a calendar year covered by the reporting period for wood product class	*t C*
$CWPC_{Project,i,C}$	=	Project carbon transferred to each product class calculated for each species (if wood product classes are broken down by species) for a calendar year covered by the reporting period	*t C*

[23] Dymond CD. 2012. Forest carbon in North America: Annual storage and emissions from British Columbia's harvest, 1965-2065. Carbon Balance and Management 7(1):8.

[24] https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/ministry-of-forests-lands-and-natural-resource-operations-region-district-contacts

SF_j	=	Storage factor for wood product class as per Table 9	-
C	=	Calendar year	-
i	=	Tree species	-
j	=	Wood product class	-

Table 9: 100-year storage factor for each wood product class[25]

Wood Product Class	Storage Factor
Softwood Lumber	0.213
Hardwood Lumber	0.156
Softwood Plywood	0.215
Oriented Strandboard	0.285
Non-structural Panels	0.174
Miscellaneous Products	0.149
Fuelwood	0
Paper	0

Step 5: *Determining the total amount of project carbon stored in harvested wood products for 100 years after harvest*

Finally, to determine the total amount of project carbon stored in harvested wood products 100 years after harvest (SSR P8), the proponent must sum all the resulting values from step 4 across all species (if calculated separately for each species) using Equation 25.

Equation 25: Total amount of project carbon stored in harvested wood products 100 years after harvest

$$SC_{Project,HWP,C} = \sum_{i,j} \left[SCHWP_{Project,i,j,C} \text{ x } 3.667 \right]$$

Where,

			Units
$SC_{Project,HWP,C}$	=	Total project carbon stored in harvested wood products for 100 years after harvest for a calendar year covered by the reporting period (SSR P8)	*t CO_2e*
$SCHWP_{Project,i,j,C}$	=	Stored carbon in harvested wood products 100 years after harvest for each species (if broken down by species) for a	*t C*

[25] Hoover et al, “Chapter 6: quantifying greenhouse gas sources and sinks in managed forest systems”, a chapter in "Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory”, US Department of Agriculture, 2014. https://www.usda.gov/sites/default/files/documents/USDATB1939_07072014.pdf

		calendar year covered by the reporting period for wood product class	
3.667	=	Conversion factor to convert from t C to t CO_2e	-
C	=	Calendar year	-
i	=	Tree species	-
j	=	Wood product class	-

8.3 Quantification of Sampling Uncertainty

This section describes the process the proponent must follow to determine the uncertainty associated with carbon stock estimates due to sampling uncertainty when developing the forest carbon inventory (Section 9.1). The proponent must apply an uncertainty deduction foreach full or partial calendar year covered by the reporting period to the total project carbon stocks within the project site. Ton order to determine this deduction, the proponent must calculate the sampling error for each of the sampled forest carbon pools (i.e., SSR1, SSR2, and SSR4, as well as SSR5, SSR6 and SSR7 if included as per Table 1) at a 90% confidence level and subsequently calculated as a percentage of the mean. To determine the sampling error, the proponent must use Equation 26.

Equation 26: Quantification of the sampling error associated with forest carbon inventory estimates

$$E_{Sampling} = \left(\frac{z^* \text{ x } SE}{SC_{Project,t}}\right) \text{ x } 100$$

Where,			Units
$E_{Sampling}$	=	Sampling error expressed as a percentage of the mean forest carbon inventory estimate from field sampling for a 90% confidence interval, rounded to the nearest 1/10th percentage	*%*
z^*	=	Critical value for a 90% confidence level. The proponent uses a default value of 1.645	-
SE	=	Standard error of the forest carbon inventory estimate based on all the included SSRs that represent forest carbon pools	-
$SC_{Project,C}$	=	Total project carbon stocks for a calendar year covered the reporting period as per Equation 16	*t CO_2e*
100	=	Conversion factor to convert to percentage	-

The proponent must use the result of Equation 26 and Table 10 below to determine the uncertainty deduction percentage (CD_C in Equation 15) to be applied to the forest carbon inventory estimate of carbon stocks to calculate project scenario GHG reductions. Under this methodology, the sampling error (expressed as a percentage of the total inventory estimate) must be lower than 20%. The uncertainty deduction is not applied to the baseline scenario.

Table 10: Forest carbon inventory uncertainty deduction

$E_{Sampling}$	Uncertainty Deduction
0% – 5.0%	0%
5.1% – 19.9%	Sampling error % minus 5.0%
≥20%	100%[26]

The uncertainty deduction must be updated each time the forest carbon inventory is updated and must be verified. In between updates to the inventory, the same uncertainty deduction must be applied to each calendar year covered by the reporting period(s). If upon an update to the inventory a new uncertainty deduction is calculated, the new uncertainty deduction is applied to each calendar year covered by the current reporting period.

8.4 Leakage

A project that reduces harvest in the project scenario compared to baseline scenario levels poses a leakage risk, which includes both activity-shifting leakage risks and market leakage risks. If harvest levels are reduced in the project scenario compared to the baseline scenario, the proponent must follow Section 8.4.1 to determine the activity-shifting leakage risk ($L_{Activity,C}$) and Section 8.4.2 to determine the market leakage risk ($L_{Market,C}$) associated with a project to be used in Equation 14. If harvest levels are not reduced between the project scenario and baseline scenario (as is the case for all projects previously registered in a GHG offset credit system other than the one set out in the Regulations), it is conservatively assumed the project does not pose a leakage risk. In this case, the proponent must use a value of 0 for $L_{Activity,C}$ and $L_{Market,C}$ in Equation 14. Under this protocol, there is no leakage discount factor that corresponds with parameter C_i in the formula in subsection 20(1) of the Regulations.

8.4.1 Activity-shifting leakage (SSR P13)

For a project where harvest is reduced within the project site, the proponent does not have to account for activity-shifting leakage if it can be demonstrated that there is no risk of activity-shifting leakage within their controlled lands. Acceptable evidence includes:

- Controlled lands are not forestlands or are not legally able to be harvested (e.g., conservation areas).
- All controlled lands are included within the project site.
- All controlled lands are certified as being managed as sustainable forestland under FSC or SFI.
- Covenants, conservation easements, existing right of ways, or other restriction(s) are in place on all controlled lands, and the restriction(s) are in place for an equivalent or greater length of time compared to project life. The restriction(s) must demonstrate that the activity-shifting leakage risk is 0, such as putting limits on the level of harvest.

[26] Projects cannot have an $E_{Sampling}$ that is greater than 20%, therefore the corresponding uncertainty deduction is 100%. Project proponents that calculate an $E_{Sampling}$ at 20% must increase the sampling intensity until an $E_{Sampling}$ of less than 20% is achieved.

- Historical records that establish baseline harvesting trends for controlled lands to be compared to the project scenario and that demonstrate there are no increases in the trend of harvesting levels, using a historical lookback period of 10 years.
- Forest management plans prepared equal to or greater than two (2) years prior to the project start date that demonstrate harvest plans on all controlled lands to be compared to the project scenario to ensure no deviation from management plans has occurred on controlled lands.

If the proponent cannot provide any of the above pieces of evidence to demonstrate that there is no risk of activity-shifting leakage, the proponent must report on the change in carbon storage for all controlled lands within the same province or territory as the project site and quantify the change in carbon storage as a result of activity-shifting leakage using Equation 27. The proponent must use the same methods described in Section 8.1 for the baseline scenario and Section 8.2 for the project scenario to establish equivalent scenarios for the controlled lands, excluding the calculation of carbon stored in harvested wood products (Section 8.1.1 and Section 8.2.1) and emissions from the combustion of biomass.

Equation 27: Total change in the carbon storage associated with activity-shifting leakage

$$\mathrm{L}_{\mathrm{Activity,C}} = \Delta\mathrm{SC}_{\mathrm{Project,CL,C}} - \Delta\mathrm{SC}_{\mathrm{Baseline,CL,C}}$$

Where,			Units
$\mathrm{L}_{\mathrm{Activity,C}}$	=	Total change in carbon stored in controlled lands for a calendar year covered by the reporting period to capture activity-shifting leakage	*t CO_2e*
$\Delta SC_{\mathrm{Project,CL,C}}$	=	Change in project stored carbon stocks for controlled lands for a calendar year covered during the reporting period, determined using Equations 15 and 16 in Section 8.2	*t CO_2e*
$\Delta SC_{\mathrm{Baseline,CL,C}}$	=	Change in project stored carbon stocks for controlled lands for a calendar year covered by the reporting period, determined using Equations 4 and 5 in Section 8.1	*t CO_2e*
C	=	Calendar year	-

8.4.2 Market leakage (SSR P14)

The proponent of a project that poses a market leakage risk by reducing harvest levels compared to the baseline scenario must apply a market leakage default factor to the GHG reductions achieved by the project. The proponent must select the regional market leakage factor that applies to their project using Table 11 based on the geographic location of the project site.[27] In the event a project site falls within two or more reconciliation units, the proponent must select the highest of the applicable leakage

[27] A copy of a shapefile of the reconciliation units used to delineate regional market leakage factors is provided on ECCC's website to ensure accurate interpretation of the project location and selection of the applicable market leakage factor.

factors. The proponent has two options for how to apply the regional market leakage factor to the GHG reductions achieved by the project and determine the carbon lost as a result of market leakage risk:

1. The regional market leakage factor is applied to the total GHG reductions achieved by the project (this option is best suited for projects where the only project activity implemented in the project scenario is conservation), in which case Equation 28 is used; or
2. The regional market leakage factor is applied only to GHG reductions that are related to harvesting activities, in which case Equations 29-31 are used.

Table 11: Regional market leakage factors by reconciliation unit

Province or Territory	Reconciliation Unit	Regional Market Leakage Factor (%)
NL	1	46
NL	3	47
NL	4	47
NS	5	47
PE	6	47
NB	7	46
QC	11	53
QC	12	52
QC	13	47
QC	14	47
QC	15	54
ON	16	59
ON	17	60
ON	18	47
ON	19	62
MB	21	47
MB	22	50
MB	23	52
MB	24	51
MB	25	46
SK	26	49

Province or Territory	Reconciliation Unit	Regional Market Leakage Factor (%)
SK	27	48
SK	28	52
SK	29	52
SK	30	52
AB	31	64
AB	32	71
AB	33	63
AB	34	64
AB	35	64
AB	36	68
AB	37	61
BC	38	74
BC	39	75
BC	40	75
BC	41	51
BC	42	71
YK	44	47
YK	45	47
YK	46	47
NT	50	48
NT	51	47
NT	52	47
NT	53	48
NU	58	50
NU	60	45

Equation 28: Total carbon lost as a result of market leakage risk – option 1

$$L_{Market,C} = (\Delta SC_{Project,C} + SC_{Project,HWP,C} - L_{Activity,C}) \text{ x } LF$$

Where,

			Units
$L_{Market,C}$	=	Total carbon lost due to market leakage risk during a calendar year covered by the reporting period	*t CO_2e*
$\Delta SC_{Project,C}$	=	Change in project carbon stocks for a calendar year covered by the reporting period as per Equation 15	*t CO_2e*
$SC_{Project,HWP,C}$	=	Total project carbon stored in harvested wood products for 100 years after harvest for a calendar year covered by the reporting period as per Equation 25	*t CO_2e*
$L_{Activity,C}$	=	Total change in carbon stored in controlled lands for a calendar year covered by the reporting period to capture activity-shifting leakage as per Equation 27	*t CO_2e*
LF	=	Regional market leakage factor applicable to the project as per Table 11	*%*
C	=	Calendar year	-

A proponent following option 2 for determining market leakage will need to first determine the amount of carbon that is lost from the project site as a result of harvesting activities in the project compared to the baseline scenario ($\Delta SC_{Market,C}$). This includes carbon lost from the project site as a result of the following:

- Wood that is harvested from the project site;
- Losses associated with harvesting that are assumed to be released into the atmosphere as CO_2 in the calculation of $SC_{Project,HWP,C}$, which includes branches, tops, etc. (i.e., all the biomass that is not in the bole, excluding bark); and
- Biomass that is combusted as a result of harvesting activities.

To capture carbon lost to the abovementioned sources and to subsequently determine $\Delta SC_{Market,C}$, the proponent must determine the harvest efficiency ($HE_{i,C}$), which is the ratio of dry weight harvested biomass to total dry weight of woody biomass prior to harvest. Harvest efficiency will be specific to the project based on the species harvested, harvesting equipment, forest management and silvicultural activities within the project site, as well as other relevant factors. As a result, the proponent must justify the harvest efficiency used in Equation 29. At a minimum, the proponent must consider tree species, age of trees at harvest, harvesting equipment and silvicultural treatment. The proponent provides a harvest efficiency for each species harvested but may provide a single harvest efficiency if it can be demonstrated to not under-estimate leakage. The proponent must use the same harvest efficiency for the project and baseline scenarios.

Equation 29: Difference in carbon stocks as a result of harvest

$$\Delta SC_{Market,C} = \left[\left(\sum_{i} SC_{Baseline,dm,i,C} \div HE_{i,C}\right) - \left(\sum_{i} SC_{Project,dm,i,C} \div HE_{i,C}\right)\right] \text{ x } 3.667$$

Where,			Units
$\Delta SC_{Market,C}$	=	Difference in carbon stocks as a result of biomass removed from the project site from harvest-related activities in the project scenario compared to the baseline scenario for a calendar year covered by the reporting period	*t CO_2e*
$SC_{Baseline,dm,i,C}$	=	Baseline carbon stored in aboveground live tree biomass harvested and delivered to a mill for a calendar year covered by the reporting period, calculated separately for each species, as per Equation 8 or 9	*t C*
$HE_{i,C}$	=	Harvest efficiency factor as justified by the proponent and determined separately for each species (if the proponent chose a species-specific harvest efficiency)	-
$SC_{Project,dm,i,C}$	=	Project carbon stored in aboveground live tree biomass harvested and delivered to a mill for a calendar year covered by the reporting period, calculated separately for each species, as per Equation 20 or 21	*t C*
3.667	=	Conversion factor to convert to t CO_2e	-
C	=	Calendar year	-
i	=	Tree species	-

Equation 30: Difference in carbon stored in harvested wood products

$$\Delta SC_{HWP,C} = SC_{Project,HWP,C} - SC_{Baseline,HWP,C}$$

Where,			Units
$\Delta SC_{HWP,C}$	=	Difference in carbon stored in harvested wood products 100 years after harvest in the project scenario compared to the baseline scenario for a calendar year covered by the reporting period	*t CO_2e*
$SC_{Project,HWP,C}$	=	Total project carbon stored in harvested wood products for 100 years after harvest achieved by the project for a calendar year covered by the reporting period (SSR P8), as per Equation 25	*t CO_2e*
$SC_{Baseline,HWP,C}$	=	Total baseline carbon that would have been stored in harvested wood products for 100 years after harvested	*t CO_2e*

		achieved by the project for a calendar year covered by the reporting period (SSR B8), as per Equation 13	
C	=	Calendar year	-

The result of Equation 31 cannot be a negative value as this would result in a higher credit issuance when following Equation 14 but would not represent real GHG reductions. If the results of adding and subtracting the values within the brackets of Equation 31 is a negative number, the proponent uses a default value of 0 for $L_{Market,C}$.

Equation 31: Total carbon lost as a result of market leakage risk – option 2

$$L_{Market,C} = (\Delta SC_{Market,C} + \Delta SC_{HWP,C} - L_{Activity,C}) \text{ x } LF$$

Where,			Units
$L_{Market,C}$	=	Total carbon lost due to market leakage risk for a calendar year covered by the reporting period	*t CO_2e*
$\Delta SC_{Market,C}$	=	Difference in carbon stocks as a result of biomass removed from the project site from harvest-related activities in the project scenario compared to the baseline scenario for a calendar year covered by the reporting period, as per Equation 29	*t CO_2e*
$\Delta SC_{HWP,C}$	=	Difference in carbon stored in harvested wood products 100 years after harvest in the project scenario compared to the baseline scenario for a calendar year covered by the reporting period, as per Equation 30	*t CO_2e*
$L_{Activity,C}$	=	Total change in carbon stored in controlled lands for a calendar year covered by the reporting period to capture activity-shifting leakage as per Equation 27, if there is an activity-shifting leakage risk associated with the project	*t CO_2e*
LF	=	Regional market leakage factor applicable to the project, as per Table 11	*%*
C	=	Calendar year	-

8.5 GHG reductions

The GHG reductions (ER), determined in accordance with Equation 32, correspond to the total GHG reductions generated by the project, determined in accordance with section 20 of the Regulations

Equation 32: GHG reductions

$$ER_C = PR_C - BR_C$$

Where,

			Units
ER_C	=	GHG reductions during a calendar year covered by the reporting period	*t CO_2e*
PR_C	=	Project scenario GHG reductions for a calendar year covered by the reporting period, as per Equation 14	*t CO_2e*
BR_C	=	Baseline scenario GHG reductions for a calendar year covered by the reporting period, as per Equation 1	*t CO_2e*

In the first project report, it is possible that the uncertainty deduction applied to the project scenario will result in negative GHG reductions despite there being no net increase in GHG emissions compared to the baseline scenario. Any negative GHG reductions as a result of the uncertainty deduction are carried over to the subsequent reporting period covered by the project report in accordance with subsection 20(5) of the Regulations. The absolute value of the negative GHG reductions (i.e., the net increase in GHGs) corresponds with variable D_i in subsection 29(2) of the Regulations. This balance will apply to the first calendar year of the following reporting period and is subsequently carried over each calendar year until enough project scenario GHG reductions have been achieved to account for the entirety of the initial negative GHG reductions.

9.0 Measurement and data

9.1 Field measurement and forest carbon inventory development

9.1.1 General requirements for the forest carbon inventory

The proponent must provide an estimate of the total carbon stocks within the project site by estimating the carbon stored in each of the included SSRs as per Table 1 that represent forest carbon pools (i.e., SSR1, SSR2 and SSR4, as well as SSR5, SSR6 and SSR7 if included as per Table 1). The sum of the individual SSR carbon stocks represents the total carbon stocks for the project site (see Equation 16). Estimates of project carbon stocks based on field measurements are used as the basis for establishing uncertainty in Section 8.3.

The proponent estimates carbon stocks by developing a forest carbon inventory. The proponent must provide the initial carbon stocks for each included SSR at the beginning of the crediting period, which must represent the entire project site and be a complete initial forest carbon inventory with the required number of plots to achieve the required confidence level. The proponent may use a provincial or territorial standard for developing a forest carbon inventory, the procedures of the National Forest Inventory, or the proponent may develop their own forest carbon inventory methodology. The forest carbon inventory methodology selected must be supported by peer-reviewed literature, produce verifiable documentation, provide enough information to be repeatable by another forest professional and be demonstrated to produce accurate estimates of forest carbon stocks that do not overestimate carbon storage. Sampling and measurement methods used to develop the forest carbon inventory must be statistically sound and must be able to achieve the required level of uncertainty as per Section 8.3.

A proponent of an aggregation of projects may develop a single forest carbon inventory inclusive of all the project sites within the aggregation. However, the proponent must provide carbon stock estimates (see 4 below) for each included SSR for each project within the aggregation.

The proponent must ensure that the forest carbon inventory provides the information necessary to estimate the carbon stocks for each included SSR that represents forest carbon pools. All tree species within the project site, living and dead, must be measured regardless of the merchantability of the species. All forest carbon inventories must at a minimum include:

1. A description of the forest management activities, physical site characteristics, and land use patterns that influence carbon stocks within the project site, using this information to inform the initial design of the forest carbon inventory and estimates of carbon stocks. At a minimum, the proponent must include descriptions of how the following factors influenced inventory design:
    a. Age class distribution;
    b. Climate;
    c. Disturbance history;
    d. Harvesting practices employed;
    e. Vegetation type, species composition and species distribution of merchantable species;
    f. Topography;
    g. Legal and financial constraints;
    h. Ownership structure;
    i. Management history and planned management activities;
    j. Whether there is a legal restriction that mandates conservation (e.g., conservation easement) within the project site, and any associated land management and/or land use requirements; and
    k. Whether there are any known or potential threats of disease(s) or pest(s) that would impact the health of either the aboveground live tree carbon or standing dead tree carbon included in the forest carbon inventory.
2. For SSR1, SSR2 and SSR4 in Table 1, the methodology and sampling procedure to determine measured tree attributes that support the calculation of tree volume and/or biomass as per the requirements of Section 9.1.4, with references to peer-reviewed literature or official government publications to support the chosen methodologies and procedures. Live tree-based measurements must include wood, bark, branches, and foliage. The approaches must be described in enough detail that measurements could be easily replicated by any Registered Professional Forester or an equivalent professional in provinces and territories that do not have an association. The description must include:
    a. Tools used for height measurement, diameter measurement, age and plot measurement;
    b. Where and how to measure parameters used in volume and biomass equations, models, and associated calculations such as diameter at breast height (DBH), height and age (including irregular trees);
    c. How structural loss is assessed when either live trees or standing dead trees are missing biomass (i.e., any deformities that reduce tree biomass, including cavities and broken tops);
    d. How deadwood is classified; and
    e. Any other aspect of sampling where a consistent method needs to be documented.
3. If SSR5, SSR6 and SSR7 in Table 1 are included, the proponent must follow the sampling requirements in Section 9.1.5 for SSR5 and SSR6, and Section 9.1.6 for SSR7.
4. A distinct inventory estimate for each included SSR representing forest carbon pools, including:

    a. Mean carbon stocks per hectare (t C ha^{-1}) by stratum;
    b. Total carbon stocks (t C) by stratum; and
    c. Total carbon stocks (t C) for the entire project site.
5. Stratification, including a description of the pre- and post-sampling stratification rules. In addition to the strata being indicated in the site plan as per Section 6.3, the description must include the area of each stratum, the tools used to develop the stratification (e.g., GIS, aerial photos), and a description of how the strata boundaries were determined (i.e., by age class, management regime, vegetation type, etc.).
6. Monumented plots, and a description of the procedure used to establish these plots. The proponent must include a description of plot layout and plot locations, including a description of the procedure used to determine plot layout and location.
    a. The proponent must mark the plot center to ensure ongoing inventory quality and allow for verifiers to visit plots when verifying inventory procedures. The GPS coordinates of the plot centers must also be provided in addition to being indicated in the site plan as per Section 6.3.
    b. The proponent must establish enough plots to reach the confidence level set for limiting uncertainty and ensuring accuracy as per Section 8.3. Plots can be added to the sampling pool if the initial plots are unable to reach the required confidence level.
    c. If randomly generated plots fall in a location that is inaccessible or hazardous, then a new randomly generated plot can be selected.
7. Standards for tree and plot size, and a justification for the chosen standards.
8. A procedure for the frequency for updating or replacing sample plots and the forest carbon inventory as a whole.
9. A log that documents any changes in the inventory methods or volume and biomass equations used to calculate carbon stocks. Once an inventory methodology is established and has received a positive verification statement, it must remain consistent for the entirety of the project period unless the proponent can demonstrate that a new methodology would achieve an equal or greater accuracy as compared to the initial inventory methodology. If changes of this nature do occur, they must be reflected in the change log.
10. Standard operating procedures for updating the forest carbon inventory, including procedures to account for:
    a. Harvest;
    b. Growth;
    c. Age;
    d. Mortality;
    e. Disturbance;
    f. Incorporating new inventory and plot data;
    g. Retiring older sample plots;
    h. Changes in modelling; and
    i. Application of appropriate confidence deduction.

9.1.2 Updating the forest carbon inventory to capture growth

After the initial forest carbon inventory, the proponent must continue to quantify changes in carbon stocks for included SSRs representing forest carbon pools using periodic field measurements to update the forest carbon inventory. Inventory plot data must be re-measured at least every 10 years, including a final complete inventory update in the last calendar year of the crediting period. The proponent may decide to perform all their inventory sampling in a given year or distribute it throughout the 10-year timeframe, but no single plot can go more than 10 years without being re-measured.

The proponent must provide annual total carbon stock estimates throughout the crediting period to support the quantification of project scenario GHG reductions. The proponent may choose to exclusively use a field measurement-based approach, where annual carbon stock estimates are solely based on forest carbon inventory measurements. Alternatively, the proponent may update plot data using growth models that mimic the DBH and height increment of trees in the inventory or use Natural Resources Canada's Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3), following the requirements of Section 9.2. The proponent must incorporate field measurements from the forest carbon inventory into modelled projections of project carbon stocks on an ongoing basis throughout the crediting period when updates occur, and the proponent must use the initial carbon stocks as the starting point for the initial modelled projection of both the baseline and project scenarios.

Updated plot data must coincide with the end of the reporting period covered by the project report and the proponent must use the most recent plot data to support growth models. If plot data are collected before the end of a reporting period covered by a project report, growth must be forecasted to coincide with the end date of the reporting period covered by the project report or backcasted to coincide with the beginning of the reporting period covered by the project report. The proponent must establish and document a method for apportioning growth to the end and beginning of the reporting period as a part of the forest carbon inventory methodology, and this method must be used for all subsequent inventory re-measurements.

9.1.3 Updating the forest carbon inventory after disturbance

The forest carbon inventory must be updated for each calendar year covered by a reporting period during which a disturbance event (including harvest and implementation of risk mitigation measures) occurs if it reduces stored carbon in any of the included SSRs by 1% or more. The update to the inventory will support the determination of the values for $\mathrm{HV}_{\mathrm{Project,i,C}}$, $\mathrm{HW}_{\mathrm{Project,i,C}}$ and $\mathrm{SC}_{\mathrm{Burn,C}}$ used to calculate project scenario GHG reductions in Section 8.2. Impacted plots must be remeasured to determine the magnitude of stored carbon that has been lost as a result of the disturbance. The proponent can exclude up to 5% of the total disturbed inventory plots used to update the forest carbon inventory at any one time for a single reporting period, and any excluded plots must be re-measured during the next reporting period. Any modelled projections of project carbon stocks must be updated after a disturbance and must be based on the updated plot data.

Offset credits cannot be generated as the result of GHG reductions from natural regeneration after a disturbance, so plots impacted by disturbance must be removed from the forest carbon inventory and replacement plots must be selected following the procedure outlined in the forest carbon inventory methodology, achieving the required confidence level as per Section 8.3. If the inventory is stratified, the area that was disturbed must be re-stratified to reflect the post-disturbance conditions, following the stratification rules outlined in the forest carbon inventory methodology. The proponent must adjust both the baseline and project scenarios to reflect the area removed from quantification as a result of a disturbance.

9.1.4 Measurement of tree-based forest carbon pools (SSR1, SSR2, and SSR4)

The proponent must generate estimates of mean biomass in metric tonnes per hectare (t ha^{-1}) by stratum for SSR1, SSR2 and SSR4 to support the quantification of total carbon stocks (t C). The proponent must use measurements of tree height and DBH from the forest carbon inventory to calculate aboveground live tree (SSR1), belowground live tree (SSR2) and standing dead tree (SSR4) biomass and must justify equations selected to convert these measured attributes into biomass.

For tree-level estimates to determine aboveground live tree biomass (SSR1), the proponent must use the equations found in Lambert et al. (2005)[28] and Ung et al. (2008).[29] Individual tree-level biomass estimates are then summed to provide plot-level estimates. The proponent must use the equations in Li et al. (2003)[30] for belowground live tree biomass (SSR2), which predict belowground biomass from total aboveground biomass at the plot level. Tree-level belowground live tree biomass equations, such as Brassard et al. (2011)[31], may be acceptable if the proponent can demonstrate that the equations are appropriate based on tree species present within the project site, calibrated to the geographic region of the project site, and have undergone peer-review.

The proponent may also use the stand-level equations of Boudewyn et al. (2007)[32] to estimate aboveground live tree biomass. These equations use merchantable wood volume per hectare (m^3 ha^{-1}) as input, and have parameters that vary by species, province, and terrestrial ecozone. Wood volume must be compiled to specific standards of merchantability, defined by stump height, minimum DBH, and minimum top diameter. These standards vary by province and in some cases by region and species within provinces. The proponent must ensure that volumes are compiled in accordance with these provincial/territorial/regional standards when using the stand level equations of Boudewyn et al. (2007)[33] to convert volume to biomass. To determine the plot-level estimates of merchantable wood volume to support the estimation of aboveground biomass using these equations, the proponent must use peer-reviewed wood volume or taper equations appropriate for the tree species present within the project site and the geographic region, or the National Standards for Ground Plots Compilation Procedures of Canada's National Forest Inventory.[34] The proponent must provide justification for the procedures selected. Tree-level volume estimates are summed to obtain plot-level estimates. Merchantable wood volume estimates may also be obtained as an output from growth and yield models as per Section 9.2.

[28] Lambert, M.-C., C.-H. Ung, and F. Raulier. 2005. Canadian national tree aboveground biomass equations. Can. J. For. Res. 35:1996-2018. doi:10.1139/X05-112

[29] Ung C.-H., P. Bernier, and X.-J. Guo, 2008. Canadian national biomass equations: new parameter estimates that include British Columbia data. Can. J. For. Res. 38:1123-1132. doi:10.1139/X07-224.

[30] Li, Z., Kurz, W.A., Apps, M.J. and Beukema, S.J., 2003. Belowground biomass dynamics in the Carbon Budget Model of the Canadian Forest Sector: recent improvements and implications for the estimation of NPP and NEP. Can. J. For. Res. 33:126-136. doi:10.1139/x02-16

[31] Brassard, B. W., H. Y. H. Chen, Y. Bergeron, and D. Paré. 2011. Coarse root biomass allometric equations for Abies balsamea, Picea mariana, Pinus banksiana, and Populus tremuloides in the boreal forest of Ontario, Canada. Biomass. Bioenrg. 35:4189-4196. doi:10.1016/j.biombioe.2011.06.045

[32] Boudewyn, P., X. Song, S. Magnussen, and M.D. Gillis. 2007. Model-based, volume-to-biomass conversion for forested and vegetated land in Canada. Natural Resources Canada. https://cfs.nrcan.gc.ca/pubwarehouse/pdfs/27434.pdf.

[33] Boudewyn, P., X. Song, S. Magnussen, and M.D. Gillis. 2007. Model-based, volume-to-biomass conversion for forested and vegetated land in Canada. Natural Resources Canada. https://cfs.nrcan.gc.ca/pubwarehouse/pdfs/27434.pdf. Relevant parameters are updated regularly, so proponents should use this link to find appropriate values to be used in models: https://nfi.nfis.org/en/biomass_models.

[34] National Forest Inventory. 2021. Canada's National Forest Inventory - national standards for ground plots compilation procedures, version 2.4. Available from http://nfi.nfis.org.

The CBM-CFS3 uses the equations in Boudewyn et al. (2007)[35] to estimate aboveground biomass and the equations of Li et al. (2003) to estimate belowground biomass. The proponent may use the CBM-CFS3 to perform these calculations. Similar to using the equations directly, the proponent must ensure that the inputs are consistent with the required assumptions.

For standing dead tree biomass (SSR4), using tree-level equations to convert measured tree attributes to biomass as described for aboveground live tree biomass is acceptable. Dead trees have less carbon than live trees, so the following adjustment factors[36] must be applied to the live tree biomass estimate to account for the status of structural loss of dead trees:

1. For trees that contain structural components (branches and twigs) and resemble live trees excluding foliage: 0.97
2. For trees with no twigs but with lasting small and large branches: 0.95
3. For trees with large branches only: 0.90
4. For trees with bole only: 0.80

Individual tree-level estimates of standing dead tree biomass are then summed to provide plot-level estimates. The stand-level equations of Boudewyn et al. (2007) and the CBM-CFS3 are also capable of generating estimates of standing dead tree biomass. The proponent may, if necessary for the sake of methodological consistency, also use these approaches for estimating standing dead tree biomass.

Once the proponent has estimates of mean biomass per hectare (t ha^{-1}) by stratum for SSR1, SSR2 and SSR4, the proponent must carry out the following steps to produce an estimate of total carbon stocks for SSR1, SSR2 and SSR4 ($SC_{\mathrm{P1,C}}$, $SC_{\mathrm{P2,C}}$ and $SC_{\mathrm{P4,C}}$) to be used in Equation 16 in Section 8.2:

1. Multiply the estimate of mean biomass (t ha^{-1}), keeping each SSR separate, by 0.5 to convert mass to mean metric tonnes of carbon per hectare (t C ha^{-1}) by stratum;
2. Multiply the result of 1, keeping each SSR separate, by the area in each stratum to get total carbon stocks (t C) by stratum; and
3. Sum the estimate of total carbon stocks per stratum, keeping each SSR separate, to get the estimate of total carbon stocks across the project site for SSR1, SSR2 and SSR4.

9.1.5 Measurement of lying deadwood (SSR5 and SSR6)

The proponent must generate estimates of mean biomass in metric tonnes per hectare (t ha^{-1}) by stratum for SSR5 and SSR6, if included as per Table 1. The proponent must use line transects to determine the biomass of lying deadwood (SSR5 and SSR6) within the project site following the sampling procedures found in Section 7.0 of Canada's National Forest Inventory Ground Sampling Guidelines. The proponent must follow the methods for large and medium coarse woody debris for SSR5 and the methods for small and fine woody debris for SSR6 and must apply the same procedure for classifying deadwood as used for SSR4.

[35] Boudewyn, P., X. Song, S. Magnussen, and M.D. Gillis. 2007. Model-based, volume-to-biomass conversion for forested and vegetated land in Canada. Natural Resources Canada. https://cfs.nrcan.gc.ca/pubwarehouse/pdfs/27434.pdf. Relevant parameters are updated regularly, so proponents should use this link to find appropriate values to be used in models: https://nfi.nfis.org/en/biomass_models.
[36] IPCC Good Practice Guidelines 2006. http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglu-lucf_files/Chp4/Chp4_3_Projects.pdf.

The proponent must use the volume and biomass equations found in National Standards for Ground Plots Compilation Procedures[37] based on Marshall et al. (2000)[38] and Van Wagner (1982)[39] separately for each density class (i.e., sound, intermediate and rotten) to determine the biomass of lying deadwood from the measured transect information from the forest carbon inventory. Similar to standing deadwood, lying deadwood contains less carbon than live trees, so the following deductions must be applied to volume estimates based on the density class, as recommended by IPCC Good Practice Guidance for LULUCF[40]:

1. Hardwoods, sound: no deduction
2. Hardwoods, intermediate: 0.45
3. Hardwoods, rotten: 0.42
4. Softwoods, sound: no deduction
5. Softwoods, intermediate: 0.71
6. Softwoods, rotten: 0.45

Once the proponent has estimates of mean biomass per hectare (t ha^{-1}) by stratum for SSR5 and SSR6, the proponent must carry out the following steps to produce an estimate of total carbon stocks for SSR5 and SSR6 ($SC_{P5,C}$ and $SC_{P6,C}$) to be used in Equation 16 in Section 8.2:

1. Multiply the estimate of mean biomass per hectare (t ha^{-1}), keeping each SSR separate, by 0.5 to convert mass to mean metric tonnes of carbon per hectare (t C ha^{-1}) by stratum;
2. Multiply the result of 1, keeping each SSR separate, by the area in each stratum to get total carbon stocks (t C) by stratum; and
3. Sum the estimate of total carbon stocks by stratum, keeping each SSR separate, to get the estimate of total carbon stocks across the project site for SSR5 and SSR6.

9.1.6 Measurement of soil carbon pool (SSR7)

The proponent must determine total soil carbon stocks (SSR7) using the sampling procedures found in Section 10.0 of Canada's National Forest Inventory Ground Sampling Guidelines. Soil pits must be ≥ 60 cm deep unless bedrock or a water table prevents this sampling depth from being reached. Depth starts at the surface of the mineral soil. In deep organic soils, the soil pit should be excavated to a minimum depth of 100 cm when possible. Where site preparation activities are carried out, the proponent must include a full site-specific soil profile for the impacted area.

The proponent must generate estimates of mean soil carbon stocks in metric tonnes per hectare (t C ha^{-1}) by stratum for SSR7 using established, peer-reviewed methods and procedures to convert measured attributes from the forest carbon inventory into carbon stocks in order to support the quantification of total project carbon stocks. The proponent must provide a description of the methods

[37] National Forest Inventory. 2021. Canada's National Forest Inventory - national standards for ground plots compilation procedures, version 2.4. Available from http://nfi.nfis.org. See page 51.
[38] Marshall, P.L., Davis, G. and LeMay, V.M., 2000. Using line intersect sampling for coarse woody debris. Research Section, Vancouver Forest Region, BC Ministry of Forests, Nanaimo, BC, Canada. Technical Report TR-003. 34 pp. See equations 8 and 16. Available from www.for.gov.bc.ca/rco/research/cwd/tr003.pdf
[39] Van Wagner, C.E., 1982. Practical aspects of the line intersect sampling method. Canadian Forest Service. Information Report PI-X-12. See equations 1 and 2. Available from https://d1ied5g1xfgpx8.cloudfront.net/pdfs/6862.pdf
[40] Penman, J., Gytarsky, M., Hiraishi, T., Krug, T., Kruger, D., Pipatti, R., Buendia, L., Miwa, K., Ngara, T., Tanabe, K. and Wagner, F. 2003. Good practice guidelines for land use, land-use change and forestry. ISBN 4-88788-003-0.

and procedures used to determine the carbon stocks associated with the soil carbon pool and justify how these methods and procedures will not lead to overestimation of GHG reductions achieved by the project. Once the proponent has determined mean soil carbon stocks per hectare (t C ha^{-1}) by stratum, the proponent must carry out the following steps to produce an estimate of total carbon stocks for SSR7 ($SC_{P7,C}$) to be used in Equation 16 in Section 8.2:

1. Multiply mean soil carbon stocks (t C ha^{-1}) by stratum by the area in each stratum to get total carbon stocks (t C) by stratum; and
2. Sum the estimate of total carbon stocks by stratum to get the estimate of total carbon stocks across the project site for SSR7.

9.2 Growth models and carbon modelling

To estimate baseline carbon stocks for included SSRs representing forest carbon pools, the proponent must use a modelled projection of the baseline scenario determined in Section 3.2. This excludes projects previously registered in a GHG offset credit system other than the one set out in the Regulations, in which case baseline carbon stocks for included SSRs remain static at the levels indicated in the initial forest carbon inventory determined following the requirements of Section 9.1.

To estimate project carbon stocks for included SSRs representing forest carbon pools, the proponent can choose an exclusively field measurement-based approach or may use models between forest carbon inventory updates as described in Section 9.1.2.

Where modelling is selected and/or necessary, the proponent has two choices for modelling project and baseline carbon stocks:

1. If only SSR1, SSR2 and SSR4 are included as per Table 1, then growth and yield models can provide sufficient information to support the estimate of project and baseline carbon stocks following the requirements of Section 9.2.1. If SSR7 must also be included as per Table 1, a proponent following this approach must use field sampling approaches to update SSR7 for the project scenario for each reporting period, as described in Section 9.1.
2. If SSR5 and SSR6 are included as per Table 1, then the proponent must forecast the project and baseline scenarios using the CBM-CFS3.[41]

However, in both approaches the proponent will need to use growth and yield models to support estimations of tree growth, following the requirements in Section 9.2.1.

All modelled outputs for either the project or the baseline scenario must include periodic harvest, forest carbon inventory, and growth estimates as total tonnes of carbon (or t CO_2e) and mean tonnes of carbon per hectare (t C ha^{-1}), provided for the whole project area. For harvest yield on modelled stands (i.e., the baseline scenario), the output must:

- Be averaged by silvicultural treatment and constraints associated with those methods;
- Include the period over which the harvest occurred; and
- Include the estimate of average tonnes of carbon, volume or green weight of harvested wood removed (i.e., the amount of harvested wood that was delivered to mill ($SC_{Baseline,dm,i,C}$,

[41] Kurz, W. A., C. C. Dymond, T. M White, G. Stinson, C. H. Shaw, G. J. Rampley, C. Smyth, B. N. Simpson, E. T. Neilson, J. A. Trofymow, J. Metsaranta and M. J. Apps. 2009. BM-CFS3: a model of carbon-dynamics in forestry and land-use change implementing IPCC standards. Ecol. Model. 220(4):480–504. doi:10.1016/j.ecolmodel.2008.10.018

$HV_{Baseline,i,C}$ or $HW_{Baseline,i,C}$) to be used in the calculation of carbon stored in harvested wood products as per Section 8.1.1).

The proponent must also provide the following to support modelled outputs:

- A description of the silvicultural methods modelled, which must include the following for each method:
  - A description of retained trees (by species groups, if appropriate) at harvest; and
  - The frequency of harvest (i.e., year between harvests).
- A list of all legal requirements that impact forest management activities in the project area, which must include:
  - A description of each legal requirement;
  - The government agency responsible for the legal requirement (i.e., local, provincial, territorial, or federal);
  - A description of how the legal requirement impacts forest management within the project area, including any assumptions for canopy retention and/or habitat conditions and any required conditions that have a temporal element (i.e., conditions that must be met by a certain year); and
  - A description of the silvicultural treatments that will be modelled to ensure the conditions of the legal requirement are met.
- A description of the model used, and a description of any model calibration procedures used to ensure the model was appropriate for local use. This includes description of any assumptions and user-input data or parameters, and any choices made within the model must be justified using scientific peer-reviewed literature or government publications.
- A description of the site indexes used for each species, which must include an explanation of the source of the site index values used.

9.2.1 Growth and yield models

Growth and yield models are mathematical models that predict tree growth, mortality and recruitment using various input data and a series of component equations (sub-models) that produce outputs for indicators of interest. A proponent who has selected to use a modelling-based approach must use a growth and yield model to project forest growth and must use the same model for both the project and baseline scenarios.

The proponent must ensure that the forest carbon inventory procedures described in Section 9.1 gather all the measurements required by the selected growth and yield model. The selected growth and yield model must generate all of the outputs required by the selected tree carbon estimation procedures outlined in Section 9.1.4. If tree-level biomass equations were used, then the growth and yield model must output a tree list identifying tree species, tree height (m) and/or DBH (cm). If stand-level volume to biomass equations are used, then the output may also be a tree list or merchantable wood volume per hectare (m^3 ha^{-1}). The proponent must compile the merchantable wood volume output according to the merchantability standards (stump height, minimum DBH, and top diameter) assumed by the stand level volume to biomass estimation models in Boudewyn et al. (2007).

The following is a list of acceptable growth and yield models the proponent can select based on their geographic region and characteristics of the project site (e.g., even-aged vs uneven-aged):

- AB: GYPSY, MGM
- BC: TASS (SYLVER, TIPSY), PrognosisBC
- NB/NS/PEI/NL: FVSOntario, FVS-ACD, Open Stand Model, OSM-ACD

- ON: FVSOntario, FVS-ACD
- QC: NATURE2014 (stand-level), ARTEMIS2014 (tree-level)
- SK/MB: MGM

The proponent may use a model not listed above if it can be demonstrated that the selected growth and yield model is applicable to conditions of the project site, including jurisdiction, forest type, and the forest management activities implemented within the project site. The proponent must describe any relevant assumptions, known limitations, embedded hypotheses, assessment of uncertainties, and/or other factors potentially relevant to the use of the model. The proponent must support the model selected using reference to scientific and/or technical literature, reference to specific software packages (name and version number), and/or reference to open-source data and code repositories containing the equations, coefficients, data, and/or other information that supports the model. Sources for equations, data sets, factors or parameters must also be listed and described.

The proponent must report on carbon stock changes on an annual basis to calculate GHG reductions for each full or partial calendar year covered by a project report (i.e., to calculate Equations 5 and 15). If model projections are based on time increments other than annual increments (e.g., 5 or 10 years), the proponent must annualize the output to report on carbon stock change for each full or partial calendar year covered by a project report.

9.2.2 Carbon modelling with the CBM-CFS3

A proponent using the CBM-CFS3 to model the baseline and/or project carbon stocks must match the included SSR definitions with the component estimates generated by the CBM-CFS3 and ensure consistency in these definitions in the project and baseline scenarios.

9.2.3 Modelling the baseline scenario

Except in the case of a project previously registered in a GHG offset credit system other than the one set out in the Regulations, the proponent must model the baseline SSRs separately through a 100-year growth and harvesting regime beginning at the project start date based on the baseline scenario determined in Section 3.2. This represents the total baseline carbon stocks (i.e., $\mathrm{SC}_{\mathrm{B1,C}}$, $\mathrm{SC}_{\mathrm{B2,C}}$ and $\mathrm{SC}_{\mathrm{B4,C}}$, as well as $\mathrm{SC}_{\mathrm{B5,C}}$, $\mathrm{SC}_{\mathrm{B6,C}}$ and $\mathrm{SC}_{\mathrm{B7,C}}$ if included as per Table 1) that are used to support the calculation of $\mathrm{SC}_{\mathrm{Baseline,C}}$ in Equation 4 in Section 8.1. The proponent then averages the periodic model outputs on an annual basis, which will result in a 100-year average value for each of the included baseline SSRs. The sum of the average carbon stocks for each included SSR represents the average baseline carbon stocks and is the value for $\mathrm{SC}_{\mathrm{Baseline,AVG}}$ used in the calculation of baseline scenario GHG reductions in Section 8.1. The proponent must assume that the standing dead tree carbon (SSR4) and soil carbon (SSR7) pools would remain static at the initial forest carbon inventory levels over the 100-year growth and harvesting regime modelled in the baseline scenario. In the case of a project previously registered in a GHG offset credit system other than the one set out in the Regulations, all included baseline SSRs as per Table 1 remain static at the initial forest carbon inventory levels for the entirety of the crediting period.

Baseline carbon stock projections must be displayed on a graph that includes time in years on the x-axis and t C or t CO_2e on the y-axis. The graph must be supported by a qualitative description of the growth and harvesting regime informing annual changes in baseline carbon stocks over time based on baseline scenario determined in Section 3.2.

9.3 Measurement and modelling frequency

Table 12 identifies the measurement or modelling frequency of the parameters that must be measured or modelled to quantify GHG reductions generated by a project.

Table 12: Quantification parameters for an improved forest management on private lands project

Parameter	Description	Units	Measurement or modelling frequency[42]	Equation(s)
$SC_{B1,C}$	Total baseline carbon stored in SSR B1 for a calendar year covered by the reporting period	t C	Modelled once at the beginning of the crediting period. In the case of a project previously registered in a GHG offset credit system other than the one set out in the Regulations, measured once at the beginning of the crediting period, and remains static for entire crediting period.	4
$SC_{B2,C}$	Total baseline carbon stored in SSR B2 for a calendar year covered by the reporting period	t C	Modelled once at the beginning of the crediting period. In the case of a project previously registered in a GHG offset credit system other than the one set out in the Regulations, measured once at the beginning of the crediting period, and remains static for entire crediting period.	4
$SC_{B4,C}$	Total baseline carbon stored in SSR B4 for a calendar year covered by the reporting period	t C	Measured once at the initial forest carbon inventory and remains static for entire crediting period.	4
$SC_{B5,C}$	Total baseline carbon stored in SSR B5 for a calendar year covered by the reporting period, if required to be included as per Table 1	t C	Modelled once at the beginning of the crediting period. In the case of a project previously registered in a GHG offset credit system other than the one set out in the Regulations, measured once at the beginning of the crediting period, and remains static for entire crediting period.	4
$SC_{B6,C}$	Total baseline carbon stored in SSR B6 for a calendar year covered by the	t C	Modelled once at the beginning of the crediting period. In the case of a project previously	4

[42] Unless otherwise stated, all calculated parameters are calculated for each calendar year covered by the reporting period.

Parameter	Description	Units	Measurement or modelling frequency[42]	Equation(s)
	reporting period, if required to be included as per Table 1		registered in a GHG offset credit system other than the one set out in the Regulations, measured once at the beginning of the crediting period, and remains static for entire crediting period.	
$SC_{B7,C}$	Total baseline carbon stored in SSR B7 for a calendar year covered by the reporting period, if required to be included as per Table 1	t C	Measured once at the initial forest carbon inventory and then remains static for entire crediting period.	4
$HV_{Baseline,i,C}$	Volume of harvested wood by species for a calendar year covered by the reporting period according to baseline model	m^3	Modelled once at the beginning of the crediting period.	8
$HW_{Baseline,i,C}$	Weight of harvested wood by species for a calendar year covered by the reporting period according to baseline model	kg	Modelled once at the beginning of the crediting period	9
$SC_{Baseline,dm,i,C}$	Baseline stored carbon is aboveground live tree biomass harvested that would have been delivered to a mill calculated separately for each species for a calendar year covered by the reporting period	t C	Modelled once at the beginning of the crediting period if the model used to project the baseline scenario uses t C as the output. Otherwise calculated based on Equation 8 or 9.	10
$SC_{P1,C}$	Total project carbon stored in SSR PR1 for a calendar year covered by the reporting period	t C	Measured via forest carbon inventory updates at least every 10 years and after disturbance and modelled for each calendar year covered by the reporting period between inventory updates.	16
$SC_{P2,C}$	Total project carbon stored in SSR PR2 for a calendar year covered by the reporting period	t C	Measured via forest carbon inventory updates at least every 10 years and after disturbance and modelled for each calendar year covered by the reporting period between inventory updates.	16

Parameter	Description	Units	Measurement or modelling frequency[42]	Equation(s)
$SC_{P4,C}$	Total project carbon stored in SSR PR4 for a calendar year covered by the reporting period	t C	Measured via forest carbon inventory updates at least every 10 years and after disturbance and modelled for each calendar year covered by the reporting period between inventory updates.	16
$SC_{P5,C}$	Total project carbon stored in SSR PR5 for a calendar year covered by the reporting period, if required to be included as per Table 1	t C	Measured via forest carbon inventory updates at least every 10 years and after disturbance and modelled for each calendar year covered by the reporting period between inventory updates.	16
$SC_{P6,C}$	Total project carbon stored in SSR PR6 for a calendar year covered by the reporting period, if required to be included as per Table 1	t C	Measured via forest carbon inventory updates at least every 10 years and after disturbance and modelled for each calendar year covered by the reporting period between inventory updates.	16
$SC_{P7,C}$	Total project carbon stored in SSR PR7 for a calendar year covered by the reporting period, if required to be included as per Table 1	t C	Measured via forest carbon inventory updates at least every 10 years and after disturbance and modelled for each calendar year covered by the reporting period between inventory updates.	16
$SC_{burn,C}$	Amount of stored carbon burned from the combustion of biomass for a calendar year covered by the reporting period	t C	Measured in each calendar year covered by the project report where burning of biomass occurs.	17, 18
$HV_{Project,i,C}$	Volume of harvested wood for species for a calendar year covered by the reporting period	m^3	Measured in each calendar year covered by the reporting period where there is a harvest via updates to the forest carbon inventory.	20
$HW_{Project,i,C}$	Weight of harvested wood for species for a calendar year covered by the reporting period	kg	Measured in each calendar year covered by the reporting period where there is a harvest via	21

Parameter	Description	Units	Measurement or modelling frequency[42]	Equation(s)
			updates to the forest carbon inventory.	

9.4 Quality assurance and quality control

The proponent must implement quality assurance and quality control (QA/QC) procedures to ensure that all measurements and calculations have been made correctly and can be verified.

The proponent must outline a QA/QC procedure that includes an internal review process to ensure standard operating procedures are being adhered to in the development of the forest carbon inventory and update it continuously throughout the project period. The QA/QC procedure must include:

- An assessment and description of the quality of data collection;
- How field data is transferred and archived;
- Processes for data entry and analysis, as well as data maintenance and archiving procedures; and
- Any other relevant processes to ensure quality and consistency for the collection and maintenance of data used to quantify the GHG reductions indicated in the project report.

10.0 Permanence and reversals

A reversal has occurred if the change in total GHG reductions generated by a project compared to the previous reporting period results in a negative number, meaning GHG reductions for which credits have already been issued have been released back into the atmosphere. A voluntary reversal is the result of an intentional activity or action on the behalf of the proponent, such as overharvesting, forest conversion, failure to implement the risk management plan, and growth and yield models overestimating carbon stocks. Any voluntary reversal is considered to be an immediate emission of CO_2 into the atmosphere. An involuntary reversal is the result of an activity that is out of the control of the proponent including natural disturbance, such as wildfire, pests, or disease, and 3rd party illegal harvesting.

10.1 Reversal risk management plan

As per section 21 of the Regulations, the proponent must develop and implement a reversal risk management plan based on the relevant risk types to improved forest management projects. The proponent must identify the reversal risks present within the project site and must include descriptions of how these risks will be managed throughout the project period, such as through the implementation of risk mitigation and monitoring measures. The risk management plan must include consideration for:

- Fire risk;
- Pest and disease risks;
- Drought risk;
- Wind risk;
- Hydrological and/or flooding risks;

- Geomorphic and/or geological risks; and
- Climate change risks, such as reduced tree growth and vigour.

The proponent must list and describe the appropriate risk mitigation measures that will be implemented to reduce the likelihood, magnitude and/or frequency of each identified reversal risk. The proponent must also describe how each identified reversal risk will be monitored throughout the project period and how monitoring activities will ensure reversals are caught in a timely manner. The proponent must consider project geographic location (e.g., ecozone), forest age structure and species composition in determining what risks are relevant to the project site and what mitigation measures are appropriate.

The use of Indigenous community-based monitoring programs is a potential mitigation measure under this protocol. A proponent that implements this mitigation measure must provide a description of the governance structure of the monitoring program and demonstrate that the program has community support. The monitoring program should include monitoring and reporting of natural disturbance or environmental impacts on forest ecosystems. Examples include Indigenous Guardians Programs or Indigenous Community-Based Climate Monitoring Programs.

Assumptions used to inform the identification of reversal risks and the appropriate mitigation measures must be supported by recent[43] peer-reviewed literature, government publications, Indigenous knowledge, or other justifiable sources of information (e.g., Canadian Council of Forest Ministers, IPCC, etc.).

10.2 Permanence monitoring

Subsection 22(1) of the Regulations specifies that the proponent of a sequestration project must monitor the quantity of GHGs emitted or GHGs removed from the atmosphere and submit a monitoring report with each project report submitted during the crediting period and every 6 years for 100 years after the end of the last crediting period. The proponent must monitor all included SSRs as per Table 1.

Following the quantification methodology outlined in Section 8.0, the proponent must quantify total GHG reductions achieved by the project for each calendar year covered by a monitoring report throughout the permanence monitoring period. The proponent must also continue to update the forest carbon inventory in accordance with Section 9.1 after the end of the crediting period. During the permanence monitoring period, inventory plot data must be re-measured at least every 20 years (following the requirements of Section 9.1) compared to the 10-year interval specified for during the crediting period. In the years when sampling is not conducted, proponents can use modelling to determine changes in project carbon stocks following the requirements of Section 9.2. As per the requirements of Section 9.1, if a reversal occurs during the permanence monitoring period, the forest carbon inventory must be updated.

The proponent may use remote sensing and satellite imagery to monitor for reversals during the permanence monitoring period and does not have to exclusively rely on ground-level monitoring.

10.3 Identification of a reversal

The proponent must use Equation 33 to determine, for each calendar year covered by the reporting period, whether a reversal has occurred. If the result of Equation 33 is negative, a reversal has

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[43] Recent publications include those published within the last 10 years.

occurred within the project site. The result of Equation 33 represents the magnitude of the reversal during the crediting period.

The proponent must continue to use Equation 33 for each calendar year covered by a monitoring report for the duration of the permanence monitoring period. If the result of Equation 33 is negative during the permanence monitoring period, the proponent uses Equation 34 to determine whether a reversal has occurred. If the result of Equation 34 is also negative, a reversal has occurred during the permanence monitoring period. The result of Equation 34 represents the magnitude of the reversal.

Equation 33: Determining whether a reversal has occurred within the project site

$$\mathrm{R} = (\mathrm{PR_C} - \mathrm{BR_C}) - (\mathrm{PR_{C-1}} - \mathrm{BR_{C-1}})$$

Where,			Units
R	=	GHG reductions achieved by the project that have been reversed. A reversal has only occurred if this value is negative.	*t CO_2e*
$\mathrm{PR_C}$	=	Project scenario GHG reductions for a calendar year covered by the reporting period or the monitoring report, as per Equation 14	*t CO_2e*
$\mathrm{BR_C}$	=	Baseline scenario GHG reductions for a calendar year covered by the reporting period or the monitoring report, as per Equation 1	*%*
$\mathrm{PR_{C-1}}$	=	Project scenario GHG reductions reported in the final calendar year covered by the previous reporting period or the previous monitoring report, as per Equation 14	*t CO_2e*
$\mathrm{BR_{C-1}}$	=	Baseline scenario GHG reductions reported in the final calendar year covered by the previous reporting period or the previous monitoring report, as per Equation 1	*%*
C	=	Calendar year in which the reversal occurred	-
$\mathrm{C\text{-}1}$	=	Final calendar year in the previous reporting period or the previous monitoring report	-

Equation 34: Determining the magnitude of a reversal within the project site

$$\mathrm{R_{Mointor}} = \mathrm{ER_{Monitor}} + \mathrm{R}$$

Where, Units

$\mathrm{R_{Mointor}}$	=	Magnitude of GHG reductions achieved by the project that have been reversed during the permanence monitoring period. A reversal has only occurred if this value is negative.	*t CO_2e*
$\mathrm{ER_{Monitor}}$	=	The sum of GHG reductions achieved by the project for each calendar year during the permanence monitoring period. Calculated by summing the results of Equation 32 for each calendar year during the permanence monitoring period.	*t CO_2e*
R	=	GHG reductions achieved by the project that have been reversed, expressed as a negative value, as per Equation 33.	*t CO_2e*

11.0 Environmental integrity account

For the purposes of determining variable C_i in subsection 29(2) of the Regulations, the percentage set out under this protocol that corresponds to the reversal risk mitigation measures and monitoring activities implemented for the project for a calendar year is 25%, which may be reduced if certain mitigation activities defined in Table 13 are implemented as part of the project. The percentage listed in the “Discount” column of Table 13 represents the value that is subtracted from 25% when the corresponding mitigation measure is implemented.

To the percentage obtained from the paragraph above, a value of 3% must be added to obtain the final percentage to be used in the calculation of the number of offset credits that must be deposited into the environmental integrity account for each calendar year.

Table 13: Discounts to the contribution to the Environmental Integrity Account

Activity	Description	Discount
1 – Indigenous community-based monitoring	Involvement of an Indigenous-led community-based environmental monitoring program(s) that includes monitoring and reporting of natural disturbance or environmental impacts on forest ecosystems, as described in Section 10.1. The proponent must demonstrate there is community support for the monitoring program by providing documentation of involvement or support from the relevant community or communities based on their engagement protocols (such as a memorandum of understanding, a Band Council resolution or a benefit sharing agreement).	4%
2 – Use of conservation	Implementation of conservation easements that explicitly encumber land use change and timber harvesting within the	4%

Activity	Description	Discount
easements or other restrictions on land use change/forest management	project site, or other restrictions that explicitly encumber land use change and timber harvesting within the project site, such as IPCAs, Indigenous-led Area-based Conservation Mechanisms, OECMs, title transfers to conservation organizations, the Ecological Gifts Program, and gifts of land to conservation organizations. The proponent must provide verifiable documentation that the conservation mechanism implemented includes restrictions on land use and management activities that ensure the protection of the entire project site and the restriction specifies a time period equal to or longer than the project period.	
3a – Indigenous-led or Indigenous-partnered projects	The project is Indigenous-led, as defined in Section 2.0.	2%
3b – Indigenous involvement in risk management planning	Risk management plans are developed in collaboration with and on the advice of Indigenous communities where it can be demonstrated there is community support for the content of the risk management plan. The proponent must demonstrate there is community support for the risk management plan by providing documentation of involvement or support from the relevant community or communities based on their engagement protocols (such as a memorandum of understanding, a Band Council resolution or a benefit sharing agreement). The proponent can only apply this discount where 3a is not already applied.	2%
4 – Natural disturbance mitigation measures	Implementation of one or more of the following activities: • The project site is within a FireSmart area; • Species selection for fire, pest and/or disease resistance; • Maintaining stand diversity, including genetic diversity, on greater than 50% of the project site; • Prescribed and/or cultural burning; • Reducing fuel load on greater than 50% of the project site; • Fire suppression equipment on or adjacent to the project site protecting greater than 50% of the project site; and • Implementation of fuel breaks protecting greater than 50% of the project site.	2%

12.0 Records

In addition to the record keeping requirements in the Regulations, the proponent must retain records that support the implementation of a project, including invoices, contracts, measured results, calculations, databases, and photographs at the location and for the period of time specified in the Regulations. Additional records include:

- Documentation demonstrating the project start date.
- Documentation supporting the location and geographic boundaries of the project site, including the site plan.
- Documentation supporting the determination of required environmental safeguards.
- Documentation demonstrating the legal requirements applicable to the project that impact baseline carbon stocks.
- Documentation supporting that the baseline conditions are applicable to the project.
- Documentation supporting the assertion of the baseline scenario, including:
    - Documentation that indicates in the absence of the project, harvesting is the most likely management scenario;
    - Documentation that demonstrates the baseline scenario is financially feasible;
    - Documentation supporting the assessment of the regional forest management baseline scenario, including the results of the statistical analysis to identify reference sites and any information collected from the reference sites used in developing the regional forest management baseline scenario;
    - Documentation supporting the assessment of the continuation of historical practices baseline scenario, including documentation that indicates the harvest volumes and silvicultural treatments of the historical management scenario, and documentation that supports the market, environmental and socio-economic factors that explain historical practices, if relevant; and
    - Forest management plans applicable to the project site.
- Documentation that supports the exclusion of SSR5, SSR6, SSR7 and SSR12, if relevant.
- All information and data used to support the quantification of total GHG reductions including:
    - Documentation supporting the calculation of harvested wood products, including the volume of harvested wood delivered to mill, mill efficiency data, and documentation from the mill on wood product class categories sold in a given calendar year covered by the project report;
    - Documentation that demonstrates that activity-shifting leakage is not occurring on controlled lands, if relevant;
    - Documentation that indicates the volume of harvest on controlled lands to support the calculation of activity-shifting leakage, if relevant;
    - Documentation supporting the determination of the harvest efficiency to support the calculation of market leakage, if relevant;
    - If the methodology used to develop the forest carbon inventory is an established published approach (e.g., provincial or territorial standard), a copy of the methodology;

  - Information supporting the forest carbon inventory methodology[44], including:
    - Any documentation that supports the methodology chosen, such as peer-reviewed literature and/or government publications;
    - Documents indicating the sampling procedures, measurement methods, tools and methods used to measure forest characteristics (e.g., DBH, height), procedures to assess structural loss, procedures to classify deadwood, and any other relevant information on the sampling method;
    - Pre- and post-sampling stratification rules, including a map of the strata, the area of each stratum, documentation on the tools used to develop the stratification, and documentation indicating how strata boundaries were determined;
    - Documentation indicating the procedure used to develop sampling plots and the location of the plots, including GPS coordinates;
    - Documentation indicating the standards for tree and plot size;
    - Documentation indicating the frequency for updating and replacing sample plots;
    - Change logs indicating changes to the inventory methods or volume and biomass equations used to calculate carbon stocks; and
    - Documentation indicating the standard operating procedures of the forest carbon inventory.
  - The results of conducting the forest carbon inventory and inventory updates throughout the crediting period, including all the measured data collected;
  - Documentation indicating the equations used to estimate aboveground and belowground live tree carbon, and standing dead tree carbon, and documentation demonstrating the equations are calibrated to the geographic region and tree species of the project site;
  - Documentation indicating the growth and yield model selected, and if required documentation demonstrating that the model selected is appropriate for the geographic region of the project site, the scope of the project, and the forest type of the project site. This includes any assumptions, limitations, embedded hypotheses, assessment of uncertainties, and/or other factors that are relevant to the use of the model for the project; and
  - All documentation indicating the model inputs and outputs, including modelled projections of the project and baseline scenarios, and any databases created either to input into the model or created as a model output.
- Documentation outlining the QA/QC procedure to be applied to the forest carbon inventory, including the assessment of the quality of the data collection, procedures for data entry and analysis, data maintenance and archiving procedures, and any other relevant QA/QC procedures implemented by the proponent.
- Documentation that supports assumptions used to inform the identification of reversal risks and appropriate mitigation measures, including the list and description of risk mitigation and monitoring measures implemented.
- Documentation demonstrating which risk mitigation measures were implemented that reduce the number of credits deposited into the environmental integrity account.

[44] If the proponent is following an established forest carbon inventory approach such as the National Forest Carbon Inventory procedures, this information may be outlined in the procedural documents and therefore does not need to be provided again to satisfy the record retention requirement.

- In the case of a reversal, an updated site plan showing the areas of the project site impacted by the reversal.

As per the Regulations, records must be retained until 10 years after the last day of the period for which monitoring reports are required.

13.0 Reporting

In addition to the reporting requirements specified in the Regulations, the proponent must report the quantified GHG reductions for each SSR included in the baseline and project scenarios in t CO_2e for each full or partial calendar year covered by the reporting period.

In the case of a reversal, the proponent must indicate in the project report any changes from the previous project report as a result of the reversal, such as changes to the project activities, site plan, forest carbon inventory, and/or quantification of sampling uncertainty.

14.0 Verification

14.1 Competency requirements for verification teams

In addition to the verification requirements in the Regulations, the verification team of the verification body conducting the verification of a project under this protocol must include a Registered Professional Forester who practices within the same jurisdiction as the project site, or an equivalent professional in provinces and territories that do not have an association.