Draft for Review

British Columbia
Forest Offset Protocol

June 24, 2009

Forest Practices Branch
BC Ministry of Forests and Range

Version 1.0

Disclaimer

This Protocol contains instructions and guidance to those preparing or validating forest offset projects under the BC *Emission Offsets Regulation*. The document will be periodically revised as learning and new information becomes available. This document refers to various legal requirements which are subject to change. In the event of any discrepancy between the instructions and guidance contained in this document and applicable Acts and regulations, such as the *Forest and Range Practices Act* and regulations under that Act, and the *Emission Offsets Regulation*, the Acts and regulations prevail.

Any comments, questions or suggestions regarding the content of this document may be directed to:

Climate Change and Forest Carbon
Forest Practices Branch
BC Ministry of Forests
PO Box 9513 Stn Prov Govt
Victoria, BC V8W 9C2
E-mail: Brian.Raymer@gov.bc.ca

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The document was prepared with the assistance of an inter-agency BC Forest Offset Protocol Working Group (see Appendix D).

Draft for Review

We appreciate any comments you may have on this review draft. Please send your comments via e-mail or mail using addresses shown above by or before **July 10th, 2009.**

Executive Summary

Protocol overview

The *Greenhouse Gas Reduction Targets Act* (GGRTA) legislates BC's target of reducing greenhouse gas emissions (GHGs) by at least 33% below 2007 levels by 2020. The GGRTA also requires the public sector to become carbon neutral by 2010. As part of GGRTA's carbon-neutral requirements, the first course of action will be to reduce emissions and the second to offset the remainder. The *Emission Offsets Regulation* establishes eligibility criteria for valid offsets. A protocol provides instructions on specificied offset activities consistent with the regulation.

The Pacific Carbon Trust's role is to deliver quality offsets. In April 2009, the corporation released a request for information to develop forest-based carbon offsets for three types of projects approved by government: (i) afforestation; (ii) use of select seed, and (iii) fertilization.

This BC Forest Offset Protocol was developed in support of the current call for forest offset proposals. The Protocol is primarily intended to assist project proponents but it can also support project validation and verification efforts.

Several documents provided a source of good practice guidance in the development of this Protocol including Environment Canada's 2008 draft *Turning the Corner: Canada's Offset System for Greenhouse Gases - Guide for Protocol Developers*.

Key legal requirements applicable to forest offset projects are identified and described in the Protocol such as the *Forest and Range Practices Act* on Crown land and the *Private Managed Forest Land Act* on private land.

The applicability of the Protocol is addressed as it relates to:

- the three project types (afforestation, select seed use, fertilization);
- duration of project activities within one project plan;
- eligible project areas;
- need to identify the project's geographic boundary;
- identification and measurement of GHGs;
- information sharing; and
- protocol flexibility.

Eligible projects and GHG sources, sinks and reservoirs

The three eligible types of projects are described in further detail in the Protocol i.e.,:

- Afforestation: increasing the size and number of BC forests by planting land that has not been forested since December 31, 1989;
- Select Seed Use: planting seedlings selected for specific traits to promote faster growth, increased timber volume and carbon content, and resistance to insects and disease; and/or
- Fertilization: adding nutrients to increase tree growth on sites deficient in one or more soil nutrients.

Following a description of eligibility requirements for each project type (e.g., to address the 'additionality' test associated with offset projects), both baseline and project considerations are discussed in the Protocol.

Sources, sinks and reservoirs (SSRs) relevant to forest offset projects within the scope of this Protocol are described in the Protocol where baseline and project reporting are required. These are:

- SSR1 – Materials Facility Operations (if using fertilizers)
- SSR2 – Off-Site Materials Transportation (if aircraft used)
- SSR3 – Labour and Equipment Transportation
- SSR4 – On Site Development and Operations
- SSR5 – Fertilizer Use on Site (where applicable)
- SSR6 – Prescribed Burning (where applicable)
- SSR8 – Living Biomass Reservoirs
- SSR9 – Dead Wood Reservoirs

Other SSRs are either excluded (e.g., not within scope of this Protocol or likely having only a negligible effect) or optional (i.e., SSR10 regarding Litter and Soil Reservoirs).

Quantification of Project Reductions

The quantification framework is built on the terms defined in the *Emission Offsets Regulation* where:

Project Reduction = Emission Reduction + Removals Enhancement – Discount

Acceptable quantification approaches involve the use of pre-approved growth and yield models (e.g., TIPSY) and forest carbon accounting models (e.g., CBM-CFS3) that are described in the Protocol. Other models may be considered for use in carbon offset projects where justification is provided. Quantification methods for projects where harvesting is or is not planned within 100 years are described and further illustrated in Appendix A.

The time period for estimating emission reductions and removals enhancement should be for the validated baseline period in the project plan. Baseline and project emissions and removals will vary over time and must be portrayed in a table and supporting graph.

Permanence

The Protocol addresses the issue of permanence by describing risk of reversals due to disturbance where stored carbon is released as GHGs to the atmosphere. Three alternative approaches for addressing risk of reversals are described that have been used in other areas:

- applying a discount factor
- establishing a buffer pool
- reversal replacement.

No recommendation is being made at this time on how to proceed in this draft Protocol.

A risk-mitigation and contingency plan must be developed as required in the *Emission Offsets Regulation*. The plan can provide a basis for assessing due diligence should a

reversal occur. The plan can also be used to help determine a suitable risk approach and how it should be applied at the project level.

Leakage

Leakage is the unanticipated decrease or increase in GHG benefits outside of the project's accounting boundary as a result of the project activity. The Protocol recognizes the potential for leakage and describes how government can address this concern; there is no requirement that the project plan address leakage. Three types of potential leakage described in the Protocol are: (i) deforestation, (ii) the allowable annual cut effect, and (iii) select seed supply shortages inadvertently stemming from forest offset projects.

Inventory and monitoring

The frequency and approach for undertaking inventory and monitoring in support of an offset project is described for different types of projects. Inventory and monitoring methods in BC are well established with a variety of standards and procedures available for offset project proponents to use including silviculture stocking surveys and change monitoring inventory (CMI) following vegetation resource inventory (VRI) standards. Further details about inventory and monitoring are provided in Appendix C.

Proponents proposing alternative inventory and monitoring approaches to those described in this Protocol must demonstrate that the information is gathered in a manner that is transparent, reliable, and verifiable.

A monitoring document needs to be prepared and submitted as part of the project report and must include an estimate of removals and identify any natural or human disturbances that have affected the project.

The Reporting Silviculture Updates and Land status Tracking System (RESULTS) should be used to track inventory and monitoring results (including silviculture stocking surveys and select seed use) from forest offset projects over time including projects on both Crown and private land.

All inventory and monitoring data and mapping prepared for forest offset projects, including the monitoring document, needs to be made publicly available (including use by verifiers, agency staff and stakeholders) and be consistent with the requirements under section 9 of the *Emission Offsets Regulation* concerning the retention of project records.

Third party assurance

Third party assurance includes:

- *Validation*: the process used to determine that a proposed project meets the offset system eligibility criteria; and
- *Verification*: the process for evaluating a GHG assertion of emission reductions or removals against agreed verification criteria.

Requirements for validation of the project plan and verification of project reports are provided in the *Emission Offsets Regulation*. This Protocol can serve as a tool that assists validators and verifiers -- as well as proponents preparing a project plan.

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1.0 Protocol Overview

1.1 Purpose of this Protocol

The *Greenhouse Gas Reduction Targets Act* (GGRTA) legislates BC's target of reducing greenhouse gas emissions (GHGs) by at least 33% below 2007 levels by 2020. The GGRTA also requires the public sector to become carbon neutral by 2010. As part of GGRTA's carbon-neutral requirements, the first course of action will be to reduce emissions and the second to offset the remainder. There is also private sector interest in becoming carbon neutral.

The Pacific Carbon Trust's mandate is *to deliver quality BC-based greenhouse gas offsets to help clients meet their carbon reduction goals and to support growth of this industry in B.C.* The corporation plays an important role in assisting the provincial public sector to meet its carbon neutral commitments by sourcing offsets that represent incremental GHG removals or emission reductions. In April 2009, the corporation released a request for information to develop forest-based carbon offsets for three types of projects approved by government: (i) afforestation; (ii) use of select seed, and (iii) fertilization.

To ensure high quality offsets, the Ministry of Environment has developed the provincial *Emission Offsets Regulation* that establishes eligibility criteria for valid offsets.

A protocol provides instructions on specified offset activities. In BC, protocols must meet the criteria for offset projects under the *Emission Offsets Regulation.* Protocols can also assist project validation and verification.

This BC Forest Offset Protocol was developed for the three types of government-approved projects. The Protocol can also be used if more than one type of project activity is proposed (e.g., afforestaton with use of select seed). This Protocol was designed to support the current call for forest offset proposals. This Protocol addresses the need to ensure that offset projects:

- Chapter 2.0: are *eligible* and provide *real* and *additional* offset benefits by assessing relevant baseline and project sources, sinks and reservoirs (SSRs);
- Chapter 3.0: *quantify* project reductions considering emissions and removals;
- Chapter 4.0: address the *permanence* of project reductions;
- Chapter 5.0: do not cause *leakage* based on evaluations by government;
- Chapter 6.0: undertake appropriate *inventory and monitoring*; and
- Chapter 7.0: provide *third party assurance* through validation and verification.

This document represents the initial version (1.0) of the Forest Offset Protocol. Having an initial Protocol in place allows 'learning by doing'. The Ministry of Forests and Range will periodically review and improve this Protocol considering with experience gained applying this version, feedback received, and as new information becomes available. Please send any comments, questions or suggestions for improvement to: brian.raymer@gov.bc.ca

1.2 Good practice guidance review

The following documents served as primary source of good practices guidance in the development of this Protocol (see 'References'):

- Environment Canada's 2008 draft *Turning the Corner: Canada's Offset System for Greenhouse Gases - Guide for Protocol Developers;*
- Canadian Forestry Service's 2006 draft *Offset System Quantification Protocol for Afforestation Projects*;
- International Organization for Standardization (ISO). 2006. *Greenhouse gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas reductions or removal enhancements.* ISO14064-2. (Environment Canada's draft *Guide for Protocol Developers* follows the ISO approach);
- Climate Action Reserve's 2009 *Updated Forest Project Protocol* (public draft) for California; and
- Canadian Council of Forest Minister's 2009 draft *Forest Management Carbon Quantification Framework* (FMCQF) developed under contract by Eco Ressources Consultants Inc. (not currently publicly available).

Other documents that provided sources of information and ideas included:

- Alberta's Offset System including its 2007 *Quantification Protocol for Afforestation Projects* (under review);
- Clean Development Mechanism (CDM) methodologies for afforestation and reforestation project activities http://cdm.unfccc.int/methodologies/ARmethodologies/index.html; CDM is under guidance of United Nations Framework Convention on Climate Change;
- World Resources Institute and the World Business Council for Sustainable Development's 2005 *The Greenhouse Gas Protocol: The GHG Protocol for Public Accounting;*
- The Climate Registry's (TCR) 2008 *General Reporting Protocol: Accurate, transparent, and consistent measurement of greenhouse gases across North America;* and
- Regional Greenhouse Gas Initiative's 2009 *Draft Model Offset Project Consistency Application – Afforestation*.

1.3 Requirements in British Columbia

Projects must be consistent with the requirements of the *Emission Offsets Regulation* under the *GGRTA,* for example, that 'real' reductions in GHGs will be achieved (as discussed further in 1.4 below).

Forest offset projects must also comply with all applicable municipal, provincial and federal laws, including the *Forest and Range Practices Act* (for Crown land) and the federal *Fisheries Act* (on Crown and private land).

The *Forest and Range Practices Act* (FRPA) and its regulations, which took effect in 2004, govern the activities of forest and range licensees in BC. The statute sets the requirements for planning, road building, logging, reforestation and grazing. FRPA protects a wide range of forest values including watersheds and wildlife habitat while providing efficiencies for both government and industry through streamlined planning processes. FRPA encourages innovation by qualified resource professionals and holds industry responsible for achieving desired outcomes. Forest offset projects on Crown land and some private land under *Forest Act* tenure must be undertaken consistent with FRPA requirements.

The *Private Managed Forest Land Act* regulates forest practices on private managed forest lands in BC that are not subject to a tenure under the *Forest Act*. The Private Forest Landowners Association members also address key public environmental values by following their Best Management Practices (BMP) program.

Other provincial Acts apply to forest management on Crown and private land, including the *Water Act, Wildlife Act, Drinking Water Protection Act* and *Fisheries Act*.

Legal requirements for forest offset activities will vary according to the type of activity as well as with the jurisdiction (i.e., Crown or private land) within which the activity is located. They include, but are not limited to, the items listed below:

- activities on Crown land (and private land under a *Forest Act* tenure) are subject to *FRPA*, the *Forest Planning and Practices Regulation,* the *Woodlot Licence Planning and Practices Regulation*; and
- tree seeds and vegetative material for the purposes of establishing a stand under s. 29 of FRPA (reforestation obligations on Crown land and private land under a *Forest Act* agreement) as governed by the *Chief Forester's Standards for Seed Use*[1] http://www.for.gov.bc.ca/code/cfstandards/CFstds20Nov2008.pdf.

In addition to existing legal requirements, this Protocol also requires:

- activities on Crown land be governed by fertilization standards set for the Forest Investment Account and Forests For Tomorrow programs; and
- consistency with FRPA regulations and the *Chief Forester's Standards for Seed Use* for select seed use projects on private land not under a *Forest Act* tenure. The purpose of these standards is to maintain the identity, adaptability, diversity and productivity of the Province's tree gene (genetic) resources; including establishing criteria for the registration of seedlots and vegetative lots, and regulating storage, selection and use, and transfer of registered lots.

[1] For example, the Standards prohibit the use of genetically modified trees and limits the use of species collected outside of BC.

1.4 Applicability of this Protocol

Given the potential range of conditions across BC and the variety of specific activities that may be involved in forest offset projects, this Protocol serves as a generic 'recipe' for proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements.

Description of the project type

The focus of this Protocol is on three types of government-approved forest offset projects:

- Afforestation: increasing the size and number of BC forests by planting land that has not been forested since December 31, 1989;
- Select Seed Use: planting seedlings selected for specific traits[2] to promote faster growth, increased timber volume and carbon content, and resistance to insects and disease; and
- Fertilization: adding nutrients to increase tree growth on sites deficient in one or more soil nutrients.

An example of an associated forest management activity could include use of older growing stock for afforestation projects.

Over time, other protocols may be developed that address other types of projects (e.g., restoration of linear disturbances such as non-status roads).

Duration of Activities

The project plan can include afforestation, select seed use, and fertilization activities for up to 10 years in the project area. Offset activities beyond 10 years will need to be validated in a separate subsequent offset project plan. However the offset activities undertaken within the 10-year period of a validated plan can undergo verification beyond the 10 years (e.g., the proponent may choose to monitor/verify reductions stemming from offset projects in one approved project plan for several decades).

The up to 10-year timeframe for offset activities in one project plan is intended to provide a balance between efficiencies in transaction costs (e.g., preparing project plan by the proponent, having the plan validated, and approved by government) and the need to validate the baseline scenario as conditions can change over time (e.g., new legislative requirements, changes in what is considered common practice over the area).

Eligible project area

The Protocol is applicable for forest offset projects on the following areas approved by government:

- Private land including privately managed forest land, land held by local governments, Indian Reserves and treaty settlement lands; and
- Crown land that is under long-term area-based tenures (e.g., tree farm licences, woodlot licences, community forest agreements, and long-term *Land Act* leases).

[2] 'specific traits' with known (measurable) genetic worth; see chapter 2.2

A proponent may also bring forward a forest offset project proposal in a protected area or park provided that all the necessary licences/permissions from the relevant ministries (e.g., Ministry of Environment) for operating on the land are obtained.

Identification of project's geographic boundary

A forest offset proposal must include geographical information about the location where the project will be carried out and any other information allowing for the unique identification of the project as per section 3(2)(f) of the *Emission Offsets Regulation*. The project can be contiguous or separated into tracts.

The proposal must be accompanied by a geo-referenced map that shows the treatment area. Proponents are encouraged to use provincial base mapping, corporate spatial data stored in the Land and Resource Data Warehouse (LRDW), and GIS-based analytical and reporting tools and map viewers such as iMapBC, MapView, or SeedMap to improve communication with agency staff and other interested parties.

The map provided should be at a sufficiently large scale (e.g., 1:20 000 or greater) and include sufficient topographic features, place names and administrative boundaries to enable field interpretation. The following information should be provided on the map:

- Forest ownership and project boundaries
- Size of forest ownership area
- Latitude/longitude, or land title or land survey
- Existing land cover and land use
- Topography
- Forest vegetation types
- Site classes
- Watercourses in area

Identification and measurement of GHGs that will be tracked

- Mandatory: CO_2, CH_4 and for fertilization projects also N_2O

The project proposal must track GHG emissions and removals; accepted methods to do so are outlined in the Protocol. As per section 2 of the *Emission Offsets Regulation*, reductions and removals must be expressed in tonnes of each specific GHG measured in CO_2 equivalent.

Description of how real reductions will be achieved

The *Emission Offsets Regulation* (section 3(2)(e)) requires an offset proposal to describe how the project will achieve a GHG reduction. This involves describing the project's baseline scenario (including baseline emissions and removals) and project conditions (including project emissions and removals). Project reductions in GHGs means project removal enhancements plus emission reductions (or minus emission increases) associated with the project relative to the baseline scenario, less any discounts applied in accordance with a risk-mitigation and contingency plan.

Demonstrating that a real reduction in GHGs can be achieved is often referred to as the 'additionality' (or 'incrementality') test where the offset proposal demonstrates that project reductions exceed the baseline scenario.

For forest projects, carbon offsets will be achieved primarily through sequestration and storage of carbon in above- and below-ground parts of trees beyond what would occur under the baseline scenario.

The 'baseline scenario' for forest projects will typically involve an assessment of current land use and forest practices. For example on Crown land this would include:

- land use requirements (e.g., land use objectives under the *Land Act's Land Use Objectives Regulation*);
- forest practices requirements (e.g., under FRPA and its regulations); and
- current practices even if not legally required (e.g., those modeled in timber supply review when making allowable annual cut determinations).

Information sharing

The project plan must contain a description of any consultations undertaken respecting the project and a summary of the results of the consultations. This may include First Nations, organizations or individuals that may be affected by the offset activity.

Protocol flexibility

The Protocol provides flexibility in several ways including:

- sections of the Protocol note the opportunity for the proponent to vary from the direction provided where they can demonstrate that an alternative approach is better; and
- the Protocol recommends that some aspects be reported on whereas other aspects are at the discretion of the proponent (e.g., quantification of soil organic carbon).

2.0 Eligible Projects and GHG Sources, Sinks and Reservoirs

2.1 Afforestation projects

Eligible projects: Tree planting on land that has not been forested since December 31, 1989. To be consistent with the national and provincial inventory report on greenhouse gases sinks and sources (and corresponding changes due of offset projects), more specifically to be eligible evidence needs to be provided that:

- the project area was non-forest as of December 31, 1989, and
- The project area is greater than or equal to 1 hectare in size, with a minimum width of 20 metres, measured tree-base to tree-base (stump to stump);
- the trees established under the project are capable of achieving a minimum height of 5 metres at maturity;
- the trees established under this project are capable of achieving a minimum crown cover of 25% at maturity; and
- the project area is currently non-forest.

Areas that may be suitable for afforestation projects include:

- historically deforested areas
- marginal agriculture land
- urban land
- rehabilitation of degraded industrial lands such as mine sites and non-status roads.

Baseline considerations: The emissions and removals under the baseline condition will be calculated using one of the pre-approved (or alternative) models described in Chapter 3.2. The baseline scenario should assume a realistic succession of vegetation without the project. Baseline management activities may range no management activity (e.g., non-commercial brush; unused marginal agricultural land) to some degree of agricultural activity from grazing to cultivation. In cases where there is no activity, the baseline management activity is effectively nil. In situations where some baseline activity occurs, the emissions stemming from those activities will need to be reported (e.g., SSRs 1 to 4 where applicable and significant) as part of the baseline.

For baseline conditions, the above- and below-ground and soil carbon pools are expected to change over time, however the degree of change is expected to be insignificant. Therefore the recommended baseline scenario for this project type is static for carbon stocks (i.e., current estimated baseline reservoirs are projected to be the same over the length of the project). A similar approach is recommended with respect to addressing baseline emissions (i.e., current estimated emissions from activities on the land will continue) with no (or negligible) activity levels.

Project considerations: An afforestation project will achieve GHG reductions/removals through the increase in carbon stocks (above and below ground, and possibly also soil carbon) on the project site as a result of the growth of trees on a currently (and previously) non-forested site. While the initial baseline carbon stocks will vary by site, in all cases they are expected to be lower than future carbons stocks with the project.

Emissions are expected during project establishment due to site preparation (which may include prescribed burning) and planting. Emissions are also expected following project establishment as a result of the maintenance of the plantation.

Project managers must ensure that afforestation activities are captured in the National Afforestation Inventory (NAI) e.g., area afforested, location, etc. as required by the NAI for use in determining provincial GHG inventory areas. Managers of afforestation projects can provide information about their projects to the Canadian Forest Service using forms accessible through a web browser. For more information on this, see http://carbone.scf.rncan.gc.ca/Afforestation_e.html

2.2 Select seed use projects

Eligible projects: Projects that plant seedlings selected for specific traits to promote faster growth, increased timber volume and carbon content, and resistance to insects and disease. More specifically to be eligible evidence needs to be provided that the use of select seed in the project:

- Is on areas that would otherwise not be reforested with select seed, or
- provides:
  i) greater genetic worth, and/or
  ii) planting in greater proportions.

Select seed includes both: (i) natural stand superior provenance seed sources and (ii) orchard seed sources. Genetic worth is a measure of the genetic quality of a seed or vegetative lot expressed as a percentage increase over wild seed, measured for a specific trait (e.g., growth, wood density, pest resistance).

Select seed use refers to the selection or planting of seed and vegetative material from select seed sources. Select seed is often expressed as a percentage of the select seed seedlings requested/trees planted over the total number of seedlings requested/trees planted.

Select seed use projects on both Crown and private land must be consistent with:

- the *Forest Planning and Practices Regulation* or *Woodlot Licence Planning and Practices Regulation* concerning select seed (i.e., similar requirements apply in either regulation) e.g., www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm#section43; and
- the *Chief Forester's Standards for Seed Use* (including amendments) http://www.for.gov.bc.ca/code/cfstandards/CFstds20Nov2008.pdf.

Select seed use projects should also be consistent with guidance identified under the Future Forest Ecosystem Initiative (www.for.gov.bc.ca/hts/Future_Forests/). Climate change adaptation strategies such as increasing the diversity of genetically-adapted, healthy and resilient stands across the landscape are encouraged. For example, it is recommended that the proponent select a range of tree species and seedlots, where ecologically and genetically suitable, for deployment at multiple scales (stand and landscape) within the project area.

A geo-referenced map must be provided that indicates where seedlots have been planted including trees from select seed sources.

Baseline considerations: The baseline condition is considered to be:

- the reforestation of areas without the use of select seed; or
- the reforestation of areas with the use of select seed that meet the following criteria (based on 'common practice' – see below):
  - i) an 'average select seed use' (see below) that is expected to be used without the project, and/or
  - ii) a 'weighted average genetic worth' (see below) that is expected to be used without the project.

'Common practice' over the past 5 years can be determined by referring to:

1. select seed use and genetic gain summary reports based on planned seed use (i.e., seedling requests) available through the Seed Planning and Registry System (SPAR) www.for.gov.bc.ca/HTI/spar/; or
2. area-based seed use and genetic gain summaries derived from the Reporting Silviculture Updates and Land status Tracking System (RESULTS) www.for.gov.bc.ca/his/results/index.htm.

A rationale regarding the chose of one of the two approaches above should be provided in the project plan.

'Common practice' (or 'baseline conditions') is addressed in timber supply analyses that support allowable annual cut determinations. The select seed use baseline condition should be modeled (e.g., using TIPSY – see chapter 3.2) to determine forest growth over time.

'Average select seed use' is the sum of the total seedlings requested/trees planted with select seed *as determined* by the seedlots selected/planted, *divided* by the total number of seedlings requested/trees planted.

'Weighted average genetic worth' is the sum of the total seedlings requested/trees planted with select seed, *weighted by* the genetic worth for each seedlot requested/planted, *divided by* the total number of seedlings requested/trees planted.

Calculation of select seed use genetic gain inputs into a growth and yield model (e.g., TIPSY) for the 'select seed use baseline condition' is based on the average select seed use multiplied by the weighted average genetic worth for the specified tree species in the project area based on either:

- *Number of seedlings requested/trees planted with select seed*: Calculated based on the weighted average genetic worth, for the trait of interest, of the seedlots selected *multiplied by* the proportion of select seed use for the specified tree species; or
- *Area treated with select seed:* Calculated based on the weighted average genetic worth, for the trait of interest, of the seedlots selected *multiplied by* the proportion of total area treated (planted) with select seed, for the specified tree species.

Note: Select seed use and genetic worth estimates may require further adjustment or area-weighting, prior to entering genetic gain inputs into growth and yield models, based on

the proportion of select seed used on the land base (e.g., Seed Planning Unit within a tree farm licence).

Project considerations: A select seed project will achieve GHG reductions/removals through the incremental increase in carbon stocks (above and below ground, and possibly soil carbon) on the project as a result of the increased growth of trees. This is achieved through the planting of reforestation stock from select seed with known (measurable) genetic gain. While the initial carbon stocks will vary by project site, in all cases they would be lower than expected future carbon stocks on project sites planted with improved (greater genetic worth) or more select seed. Forecasting project conditions (including project emissions and removals) due to select seed use is undertaken using the models described in Chapter 3.2.

2.3 Fertilization projects

Eligible projects: Projects that add nutrients to increase tree growth on sites deficient in one or more soil nutrients. More specifically to be eligible evidence needs to be provided that, without the project, the land would not otherwise be fertilized. More specifically to be eligible evidence needs to be provided that the project is:

- an area that has not been fertilized in the last 10 years; and
- exceeds 'common practice' by being additional to:
  i) existing government funded fertilization programs on Crown land, or
  ii) fertilization activity levels on private land over the last five years.

Fertilizers not used as part of 'common practice' (e.g., using phosphorus to augment the existing nitrogen fertilization programs) are eligible provided that the incremental benefits of using that additional fertilizer can be demonstrated.

Projects must be consistent with the Ministry of Forest and Range's Fertilization Standards for Ministry funded Programs available at:
http://forestsfortomorrow.com/fft/guide/fertilization-standards/202

Baseline considerations: The baseline condition is considered to be the growth of areas without the project. The emissions and removals under the baseline condition will be calculated using one of the pre-approved (or alternative) models described in Chapter 3.2.

Project considerations: A fertilization project will achieve GHG reductions/removals through the incremental increase in carbon stocks (above and below ground, and possibly soil carbon) on the project as a result of the increased growth of trees. While the initial carbon stocks will vary by project site, in all cases they would be lower than expected future carbon stocks on fertlilized sites.

2.4 Projects in combination

Projects are eligible if more than one of the activities described in 2.1 to 2.3 are undertaken. For example, an afforestation project may involve the use of select seed and/or fertilization, and a project may combine the use of select seed and fertilization. In these cases the project proposal would assess the cumulative impact in GHG reductions/removals above the baseline.

2.5 Sources, sinks and reservoirs relevant to forest offset projects

A forest offset project will achieve GHG reductions/removals through the increase in carbon stocks (above and/or below ground and possibly soil carbon) on the project site as a result of the growth of trees. Initial carbon stocks vary, but in all cases would be lower than expected future carbon stocks from the project, both above and below ground. For some projects such as afforestation, emissions from the project are expected during establishment due to site preparation and planting. Other emissions following establishment will occur as a result of maintaining the plantation as well as project monitoring and verification activities. These project emissions will normally be small compared to the carbon sequestered by the project.

Table 1 below identifies the Sources, Sinks, and Reservoirs (SSR) for afforestation, fertilization and select seed offset projects. The table describes each SSR, notes if they are required to be reported on or not, with supporting comments. SSR10 related to litter and soil reservoirs is noted as optional – which means it is at the discretion of the proponent whether or not to report on both baseline and project conditions (i.e., if reported both conditions must be addressed).

Figure 1 illustrates the on-site/off-site and emissions/reservoirs aspects of Table 1.

Table 1 and Figure 1 note harvested wood products reservoirs (SSR12) as they can be an important sink. BC is supporting the expansion of this sink through various policies including BC Wood First and opportunities for six story wood buildings. This sink however is outside the scope of this Protocol as methods to track it are still being addressed in international and national discussions – and therefore are shown as 'excluded' in this Protocol. This important 'downstream' sink may be addressed in another protocol once procedures for tracking have been worked out.

Table 1: Sources, Sinks, and Reservoirs (SSR) for Afforestation, Fertilization and Select Seed Offset Projects (see process diagram Fig. 1)

SSR	Description	Baseline reporting	Project reporting	Comments
SSR1 Materials Facility Operations	GHG emissions arise from the operation and maintenance of the facilities producing the materials to be used on site (i.e., production of fertilizers, growing of seedlings). This may include running any mechanical or electrical systems. Emissions from the project are the incremental to those under the baseline scenario.	Required if using fertilizer	Required if using fertilizer	Otherwise exclude since the emissions are expected to be negligible relative to both: (i) reductions due to carbon storage as a result of the project; and (ii) small increase in facility operations.
SSR2 Off-Site Materials Transportation	Materials may be transported to and from the site by truck, barge, aircraft, and/or train. The related energy inputs for fuelling this equipment are captured under this SSR, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to estimate emissions. This includes log transport to the mill or sort yard.	Required; if no activity, baseline=0	Required if aircraft used	Required if aircraft used; otherwise exclude since the emissions are expected to be negligible relative to reductions due to carbon storage as a result of the project.
SSR3 Labour and Equipment Transportation	Labour and equipment may be transported to the site by truck, barge, aircraft and/or train. The related energy inputs for fuelling this equipment are captured under this SSR, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to estimate emissions.	Required; if no activity, baseline=0	Required	e.g., Site preparation equipment transported to the site; emissions from follow-up maintenance, monitoring, and verification activities
SSR4 On Site Development and Operations	GHG emissions may occur that are associated with baseline and project operations and maintenance. This includes fossil fuels used to power equipment and run vehicles as well as operate any facilities at the project site. Quantities and types for each of the energy inputs would be tracked. GHG emissions arising from the application of aerial fertilizer application and any harvesting activity are to be tracked under this SSR.	Required; if no activity, baseline=0	Required	e.g., Access structure construction and maintenance, Site preparation equipment use, fertilizer application equipment, etc.
SSR5 Fertilizer Use on Site	Volatilization of fertilizer used at the project site may result in emissions of greenhouse gases, primarily N_2O. Quantities and composition of fertilizer and any associated greenhouse gas emissions through the breakdown of the fertilizers on site would need to be tracked.	Required; if no activity, baseline=0	Required if fertilizers used	e.g., release of N_2O resulting from fertilizer breakdown.
SSR6 Prescribed Burning	Biomass may be combusted at the project site as part of site preparation or fuel management. The quantity of biomass combusted would need to be tracked.	Required; if no activity, baseline=0	Required if burning undertaken	e.g., broadcast burning or woody waste pile burning

SSR7 Enteric and other Livestock emissions	Greenhouse gas emissions from enteric fermentation and/or other livestock related activities may result under the baseline condition. Afforestation activities may reduce livestock use.	Excluded	Excluded	Excluded in order to be conservative in overall project reduction estimates.
SSR8 Living Biomass Reservoirs	Carbon occurs within living reservoirs including trees and shrubs. The baseline conditions and the extent of loss or accumulation need to be tracked.	Required	Required	Existing trees are not considered a part of a project therefore must be tracked over time and not included with the carbon capture of the planted trees.
SSR9 Dead Wood Reservoirs	Carbon may occur within dead wood reservoirs including standing snags and coarse woody debris. The baseline conditions and the extent of loss or accumulation need to be tracked.	Required	Required	Default is zero if no snags or coarse woody debris present (e.g., for afforestation projects)
SSR10 Litter and Soil Reservoirs	Carbon may be sequestered within the soil matrix. The soil carbon content would need to be tracked.	Optional	Optional	If reported for the project, baseline conditions must also be determined.
SSR11 Milling and product transportation	This SSR is targeted at the mill processing and transportation of wood products to end-market users. Quantities and types for each of the energy inputs and associated emissions would be tracked. Note: harvesting tracked in SSR4 and log transport in SSR2.	Excluded	Excluded	Outside scope of this Protocol; may be handled in another protocol.
SSR12 Harvested Wood Products Reservoirs	Describes the fate of the future woody biomass produced as a result of the project and considers the amount of carbon that is sequestered.	Excluded	Excluded	Outside scope of this Protocol; may be handled in another protocol.
SSR13 Harvested Biomass Decay and Burning	Describes the fate of the future woody biomass produced as a result of the project and considers the amount of carbon that is emitted back to the atmosphere.	Excluded	Excluded	Outside scope of this Protocol; may be handled in another protocol.
SSR14 Baseline Activity Shifting	There may be emissions associated with shifting portions of the baseline activity to another site. These are anticipated to be primarily emissions due to the transportation of livestock and equipment.	Excluded	Excluded	Excluded since the emissions are expected to be negligible relative to reductions due to carbon storage as a result of the project.

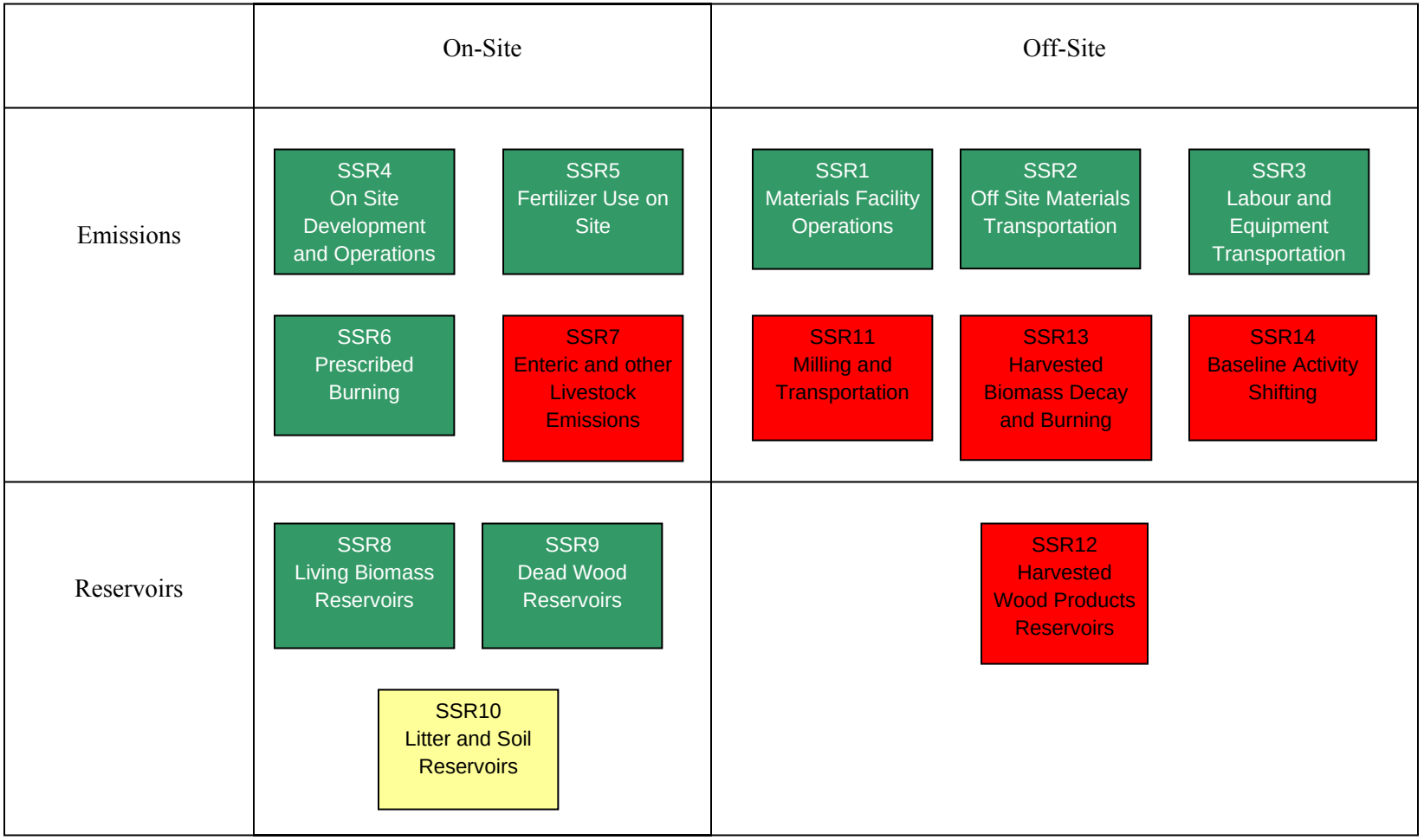
Figure 1 Afforestation, Fertilization, and Select Seed Offset Projects in BC

(see Table 1 for baseline and project applications)

Green = required

Red = excluded

Yellow = optional



3.0 Quantification of Project Reductions

3.1 Quantification framework

The following equations use terms defined in the *Emission Offsets Regulation* to summarize how project reductions will be calculated:

Project Reduction = Emissions Reduction + Removals Enhancement – Discount

Emissions Reduction = Baseline Emissions – Project Emissions

Removals Enhancement = Baseline Removals – Project Removals

Where:

- Emissions are expressed as a positive number (i.e., adding emissions to atmosphere) and removals are expressed as a negative number (i.e., removing GHGs from the atmosphere).
- 'Discount' refers to any applied in accordance with a risk-mitigation and contingency plan – this issue is addressed in Chapter 4 of the Protocol related to 'Permanence'.
- 'Emissions' are assessed based on adding applicable SSRs (e.g., SSRs 1-6) in Table 1 for the both baseline scenario and project.
- 'Removals' or 'emissions' are assessed based on assessing applicable SSR reservoirs (e.g., SSRs 8-10 in Table 1) for both the baseline scenario and project.

3.2 Quantification – use of models

The use of simulation models is required for estimating baseline and project removals related to the forest offset proposal. They are used in conjunction with a field survey that characterizes existing site conditions (e.g., species, height and density), assumptions about the site (e.g., site index), and proposed practices (baseline scenario and project related). They are also used to forecast future volumes and carbon storage over time. Monitoring (see Chapter 5.0) provides the field measurements needed to set parameters in the models.

Models that are used for producing estimates of carbon values provide two basic functions. First, they determine values for existing tree volume and related carbon stocks (e.g., dead wood, litter and soil). These include models that predict tree biomass from other tree characteristics (e.g., dbh). The models noted below are pre-approved for use in the project. If it is desirable to use other models, such models must be equivalent to or more accurate than those that have been pre-approved. If another model is proposed for use, the equivalency or greater accuracy must be demonstrated in the proposal. All assumptions used in the model chosen must be transparent in the proposal.

The second function of the model is to project the effects of forest management activities through simulation, using the field measurements to initially calibrate the model. These models typically project tree or stand volume growth and mortality over time. The net volume increment must be converted into whole ecosystem carbon using models such as CBM-CFS3 (Kurz et al.

2009) which is used for national-level and forest management unit-level forest carbon accounting in Canada. Alternatively, FORECAST (Kimmins et al. 1999) is also pre-approved for use in BC. Both of these models have been parameterized using field data from BC forest ecosystems.

The following growth and yield models have been approved for use:

	Range of applicability	
Model name	Geographic/biogeoclimatic area	Stand types
TASS	Province-wide	Second growth, simple stands
TIPSY	Province-wide	Second growth, simple stands
VDYP	Province-wide	Natural stands
Prognosis^{BC}	IDF, ICH, ESSF, MS	Existing mixed species, complex stands
Sortie-ND	SBS, ICH (north-west)	Mixed species, complex stands, MPB areas

The above table should be used as a guideline only when deciding which model to use. Each model has its own advantages, for example, TASS and TIPSY can address growth and yield due to fertilization. The proponent should indicate why a particular model is used.

Other models may be considered for use in carbon offset projects where justification is provided. However, the following minimum requirements for the model must be met:

- Has been peer reviewed in a process that: (i) primarily involved reviewers with the necessary technical expertise (e.g., modelling specialists and relevant fields of biology, forestry, ecology, etc.), and (ii) was open and rigorous.
- Is parameterized and validated for the specific conditions of the project and/or entity land area.
- Use is limited to the scope for which the model was developed and evaluated.
- Be clearly documented to include the scope of the model, assumptions, known equations, data sets, factors or parameters, etc.
- Underwent a sensitivity analysis to assess model behaviour for the range of parameters for which the model is applied.
- Is periodically reviewed.

Project validation should involve comparison testing with a pre-approved model.

3.3 Quantification methods

The Emission Offsets Regulation (Section 3(2)(r)) requires that biological projects must store carbon away from the atmosphere for 100 years or more, or the equivalent. This requires taking the average of a timber growth curve rather than the peak at rotation age. Furthermore, if rotations are less than 100 years long, the carbon stored is 'normalized' to 100 years. The two methods below describe quantification methods based on if or when harvesting is planned. The two methods described account for the 100-year effect when quantifying project reductions.

Method One: where no harvesting is planned within 100 years of verification:

Verified Project Reduction = Enhanced Sequestration CO_{2e}

Method Two: where harvesting is planned within 100 years of verification:

Verified Project Reduction = Reduction Value Achieved (RVA) +
Future Reduction Value (FRA) + Delayed Harvest Value (DHV)

where:

- RVA = (Enhanced Sequestration CO_{2e})*(Years since last verified reduction/100)
- FRV = (Enhanced Sequestration CO_{2e})*(Years until next planned harvest/100)
- DHV = (Enhanced Sequestration CO_{2e} as of last verification)*(Years since planned harvest or years since last verification/100 which ever date is most recent)
- Note: DHV only calculated if the date for a planned harvest has been passed, no harvest has occurred and there has been no reversal

The two methods are illustrated by examples and graphs in Appendix A.

3.4 Quantification time period

Baseline and project emissions and removals will vary over time and must be forecast in a table and supporting graph depicting time on the x-axis and tonnes of CO_2e on the y-axis. Baseline and project emissions and removals must be projected forward from the date of project initiation. The table and graph should be supported with written explanations about changes in emissions and removals over time. An example of quantification of emissions and removals is shown in Appendix A.

The validation of the plan, including the forecasts in the plan, is valid for a chosen period that may be shorter than the total project length (e.g., the first 20 or more years of a full rotation of 80 years). The *Emission Offsets Regulation* uses 10-year validation periods for most projects, but permits longer validation periods for biological projects such as forest offset projects. It is expected that the validation period will be:

- 10 to 20 years for fertilization projects; and
- Up to the year of planned harvest but no more than 100 years for afforestation and select seed use projects. The time period to planned harvest will normally be shorter for short-lived species and longer for long-lived species.

Note that the validation time period being referred to here is how long project reductions can be verified in project reports. In Chapter 1.4 related to 'duration of activities', the Protocol sets up to a 10 year time period for which afforestation, select seed use, and fertilization offset activities can occur. For example, a project plan may validate up to 10 years of fertilization activity and also validate that project reductions stemming from those activities may be verified over a 50 year period.

At the end of the validation period (which is either 10 years or as established by order under the *Emission Offsets Regulation*), a new project and validation are required. This new project could be simply an extension of the initial project (e.g., years 21-40 of the 80 year rotation). Baseline and project emissions and removals must be updated if better information, for example through inventory and monitoring (see Chapter 5.0), is available at the start of this new project. This may happen, for example, if a change in climate results in a change in the growth of trees or other carbon pools.

4.0 Permanence

4.1 Framework

For forest offset projects, the *Emission Offsets Regulation* (Section 3(2)(r)) requires that the atmospheric effect of a GHG reduction achieved by the project will endure for at least 100 years. The quantification methods discussed in Chapter 3.3 above take this requirement into account.

A reversal is a loss to the atmosphere of an amount of carbon or GHGs stored or sequestered in reservoirs. In forests, a reversal could occur due to natural disturbances (fire, insects, disease) or harvesting. Project proponents must demonstrate, through monitoring, that any increase in carbon stocks relative to baseline levels is maintained over time. If there is a loss in verified project reductions between one reporting period and the next, this will be considered to be a reversal, regardless of cause, unless the reduction is part of planned forest management activities that are documented in the project plan and accounted for in the project reduction quantification.

4.2 Alternative approaches to risk

The *Emission Offsets Regulation* (Section 3(2)(r)) requires that a risk-mitigation and contingency plan be prepared for sequestration projects.

However, regardless of the measures taken in a risk-mitigation and contingency plan, there is still a risk, which varies according to ecosystem, weather and other factors, that carbon stored in forests will be emitted to the atmosphere due to natural disturbance. It is unlikely that any risk-mitigation and contingency plan could fully ensure that there would be no reversals.

Approaches to addressing the risk of reversals in three other protocols were reviewed (see Appendix C) and summarized in Table 2.

This draft Protocol does not recommend an approach to the risk of reversals but one is expected to be developed after consultation on the Protocol. While adoption of an approach to the risk of reversals will provide greater certainty upon which to base project proposals, subsequent

procurements may provide an opportunity for proponents to propose an alternative approach in their project plan if justification is provided e.g., based on their risk-mitigation and contingency plan. Risk aspects of a project (such as continued corporate existence) may also be addressed explicitly through a procurement or contract.

Table 2: Approaches for Addressing Risk of Reversals

Discount (assurance) factor	Buffer pool	Reversal replacement
A discount is applied when calculating project reductions to account for the risk of reversals.	A 'buffer pool' is formed (i.e., that exceeds the area of credited reductions) to account for risk reversals. For example, if ten 100 hectare sized areas are treated – a similar eleventh one is added in case of reversal.	Proponent commits in their contigency plan to replace the reversed offset credits with a treatment project. This may also be addressed by obtaining insurance*

* For example a type of insurance where the reversal of offsets are covered; although at the present time there are no functioning insurance mechanisms for forest offset projects, this may emerge.

4.3 Risk-mitigation and contingency plan

Regardless of the risk management approach that is used, a risk-mitigation and contingency plan must be developed, as required in the *Emission Offsets Regulation*. The plan can provide a 'benchmark' for assessing due diligence should a reversal occur. Such a plan could include:

- identification of the reversible elements of the project's GHG reductions, including a discussion of the history and level of risks to the specific ecosystems and tree species involved in the project.
- actions to be taken to suppress or mitigate the reversibility of GHG reductions, which could include:
    - taking a landscape or portfolio view. For example, a project could consist of several stands dispersed over a landscape, or of stands with differing age or species characteristics (e.g., susceptibility to fire or a disease or insect pest) to reduce the risk that the entire project will be affected by a disturbance;
    - selecting sites with relatively low risk of natural disturbance;
    - using preventative measures such as fuel management (e.g., prescribed burning), fire breaks, and ensuring suppression infrastructure is readily available.
- if a default risk approach is not used, mechanisms for compensating for reversals of carbon storage.
- plans for monitoring carbon reversibility and risk (also see Chapter 5.0).

4.4 Reversals due to planned harvesting

One method for ensuring that GHG reductions are additional to the baseline and are permanent for the duration of the project is to establish stands so that they will reach harvestable conditions

at different times. Such an approach would increase the likelihood that the project carbon stocks would exceed the baseline at all times.

The project plan should identify when (or if) harvesting is expected in the offset treatment area. The potential for earlier harvesting should be addressed in the risk-mitigation and contingency plan (e.g., to address a forest pest) and reflected in the quantification of project reductions (i.e., via the 'discount' in the *Emission Offsets Regulation* noted in chapter 3.1). If harvesting is conducted before expected timelines in the validated project plan or for reasons other than noted in the risk-mitigation and contingency plan, then the project proponent may be held responsible for the reversal.

As noted on Table 1, it is recognized in SSRs 11, 12 and 13 that milling and transportation, and the fate of harvested wood products as reservoirs or through decay and burning, can have an effect on emissions and reductions. However, activities that are related to harvested wood products are not included as SSRs for the forest projects in this Protocol. How to address and quantify these impacts may be the subject of another protocol. Policy and technical issues need to be addressed before these SSRs can be tracked.

4.5 Reversals below the project baselines

A reversal may occur due to a catastrophic disturbance (like wildfire) that lowers the live standing forest carbon stocks on the project area below the standing live stocks established for the baseline. In such a case, a decision will be required on whether to terminate the project or proceed with a new project. If a new project proceeds, an appropriate baseline will need to be re-defined.

5.0 Leakage

The International Panel on Climate Change (IPCC) defines 'leakage' as the "unanticipated decrease or increase in GHG benefits outside of the project's accounting boundary…as a result of the project activities." This Protocol (below) recognizes the potential for leakage due to the specified forest offset projects but does not require that the project plan address leakage. Government can address this concern as noted below.

Three potential kinds of leakage are: (i) deforestation, (ii) the allowable annual cut (AAC) effect, and (iii) select seed supply shortages inadvertently stemming from forest offset projects. Related to the 'deforestation' concern, an afforestation offset project in one location (e.g., that converts agriculture land to forest land) could contribute to deforestation in another area (e.g., where forest land is converted to agricultural use). This potential leakage concern should be prevented or mitigated by the BC government's commitment to develop legislation in 2010 to achieve zero net deforestation by 2015. Government is expected to monitor deforestation activities and can assess if offset projects are creating an unintended pressure.

In the 'AAC effect' example, the increased forest cover and timber volume generated by an offset project could result in the AAC overall being increased within the management unit (e.g., tree farm license). For example, an offset project in ungulate winter range could address existing forest cover constraints and allow greater harvesting in non-project areas. This potential leakage concern may be prevented/mitigated when the chief forester (or deputy chief forester) makes

AAC determinations by accounting for the intent of an approved forest carbon offset project, or alternatively assessed so that this leakage issue (if a concern) is better addressed in the future.

Related to select seed supply, in general there is sufficient select seed available for both conventional (non-offset) and offset project uses so that leakage should not be a concern. Offset project use may increase demand for select seed which could result in increased select seed supply. Tree Improvement Branch routinely monitors select seed use and genetic worth, including changes in natural stand and orchard seed inventories. Impacts related to leakage issues stemming from offset projects due to potential seed supply shortages (should they occur) can be assessed and, if needed, be reflected in future revisions to the Protocol.

6.0 Inventory and Monitoring

A baseline inventory based on a field assessment is needed to quantify initial baseline removals (existing carbon stocks) and, using an appropriate model, to forecast baseline and project removals over time (as addressed in Chapter 3.0). Periodic monitoring is needed in order to assess whether the forecasted project removals in the project plan materialize. Monitoring can be used: (i) to update reported project removals; (ii) identify potential pests where treatments may be needed to prevent reversals (e.g., consistent with the risk-mitigation and contingency plan); and (iii) identify if a reversal has occurred (as discussed in Chapter 4.0). This section of the Protocol describes how inventory and monitoring should be carried out. The recommended frequency and approach to monitoring is summarized in Table 3 below.

Table 3: Inventory and Monitoring Frequency and Approach

	Small or less complex projects	Large or more complex projects
Description	Small area treated and/or project is less complex (e.g., high confidence in growth and yield model; no material loss of shrub biomass expected)	Large area treated and/or project is more complex (e.g., concerns about growth and yield model as it relates to project activities; material change in shrub biomass expected)
Inventory and monitoring frequency	In support of project report but no longer than 10 years	In support of project report but no longer than 10 years
Inventory and monitoring method	Silviculture stocking surveys (to assess stocking and growth) and following free growing with change monitoring inventory (CMI)	Silviculture stocking surveys (to assess stocking and growth) and following free growing with change monitoring inventory (CMI)
Reversal assessment	As identified in the risk-mitigation and contingency plan but no longer than 5 years	As identified in the risk-mitigation and contingency plan but no longer than 5 years

6.1 Inventory and monitoring methods

Inventory and monitoring to a well defined set of standards and procedures is essential in order to verify that estimated project removals in the project plan are being attained. Two methods for project monitoring are recommended: (1) one suitable for small or less complex projects (e.g., an afforestation project covering a few hectares); and (2) the other method suitable for larger or more complex forest offset projects where information is required over a significantly larger area (e.g., project covers one or more tree farm licenses, or where the ability to forecast project reductions is difficult). For both small and large projects, a field reversal assessment should be undertaken consistent with commitments made in the risk-mitigation and contingency plan.

The BC Ministry of Forest and Range's (2009) *Silviculture Survey Procedures Manual – Stocking and Free Growing Survey* provides methods for data collection and compilation (see http://www.for.gov.bc.ca/hfp/publications/00099/Surveys/Silviculture%20Survey%20Procedures%20Manual-April%201%202009.pdf)

After free growing is achieved, the silviculture stocking surveys are replaced by Change Monitoring Inventory (CMI) where attributes collected are to Vegetation Resource Inventory (VRI) standards. BC Ministry of Forests and Range's standards and procedures for VRI and CMI – and their application for inventory and monitoring - are provided in Appendix C.

Proponents proposing alternative inventory and monitoring approaches to those described in this Protocol must demonstrate that the information needed to assess project removals (carbon stocks) relative to baseline removals is gathered in a manner that is transparent, reliable, and verifiable.

Written procedures should be established for each measurement task outlining responsibility, timing and record location requirements. The greater the rigour of the management system for the data, the more easily an audit will be to conduct for the project as part of third party assurance e.g., the verification process (see Chapter 7.0 below).

6.2 Monitoring document

A monitoring document needs to be prepared and submitted as part of the project report. The purpose of the monitoring document is to account for project removals and confirm that no reversals are occurring (or alternatively if they are occurring to describe their nature and extent).

Specifically, the monitoring document must include the following:

Carbon removal estimate: Provide an estimate of the project removals, based on the inventory and monitoring method employed that may include a combination of sample plots and use of growth models. Appropriate forest growth models are outlined in Chapter 3.2. The project's carbon stocks will be reported individually by carbon pools (e.g., applicable SSRs on Table 1).

Reversal assessment: The monitoring document should identify if any natural or human disturbances have occurred, the date of the disturbance, the extent of the disturbance, whether it is a significant disturbance, and whether it led to a reversal of obligated reductions. Disturbances should be captured in inventory updates (as discussed below in 6.3).

The Reporting Silviculture Updates and Land status Tracking System (RESULTS) www.for.gov.bc.ca/his/results/index.htm should be used to track inventory and monitoring results (including silviculture stocking surveys and select seed use) from forest offset projects over time including projects on both Crown and private land.

6.3 Forest inventory updates

The management of the project must include a methodology to update the forest inventory, accounting for harvest, growth, and natural disturbances. The inventory needs to be updated following a significant reversal (as discussed in 6.2 above). Otherwise inventory updates can be conducted with the use of forest growth models that rely on field data collected from field monitoring surveys. This is intended to minimize errors associated with dependence on growth models.

6.4 Inventory and monitoring data transparency

All inventory and monitoring data and mapping prepared for forest offset projects, including the monitoring document, needs to be made publicly available (including use by verifiers, agency staff and stakeholders) and be consistent with the requirements under section 9 of the *Emission Offsets Regulation* concerning the retention of project records.

7.0 Third Party Assurance

Third party assurance includes:

- *Validation*: the process used to determine that a proposed project meets the offset system eligibility criteria; and
- *Verification*: the process for evaluating a GHG assertion of emission reductions or removals against agreed verification criteria.

Requirements for validation of the project plan and verification of project reports are provided in the *Emission Offsets Regulation*. This Protocol can serve as a tool that assists validators and verifiers -- as well as proponents preparing a project plan. Over time a separate forest verification protocol may be developed to complement and augment this Protocol.

Third-party verifiers can provide quality assurance about key information such as that obtained from inventory and monitoring. Verification can include, for example, visiting portions of the project area, as well as an office review of inventory and monitoring procedures as they relate to the offset activities (e.g., afforestation, select seed use, fertilization).

References

Alberta Environment. February 2008. *Offset Credit Project Guidance Document*. www.carbonoffsetsolutions.ca/policyandregulation/abOffsetSystem.html

Alberta Environment. September 2007. *Quantification Protocol for Afforestation Projects.* http://www.carbonoffsetsolutions.ca/offsetprotocols/abprotocolReviewProcess.html

BC Ministry of Forests and Range. 2009. *Carbon Trust looks to invest in forest offsets*. April 3, 2009 News Release and Backgrounder. http://www2.news.gov.bc.ca/news_releases_2005-2009/2009FOR0064-000652.htm

Canadian Council of Forest Ministers. 2009. *Forest Carbon Quantification Framework* – Final Draft Report. Prepared by Eco Ressources Consultants Inc. Not currently publicly available; to be posted at: www.ccfm.org

Canadian Forestry Service. July 2006. Offset System Quantification Protocol for Afforestation Projects. Draft

Climate Action Reserve. April 2009. *Updated Forest Project Protocol* - Public Draft. www.climateregistry.org/

Environment Canada. August 2008. *Turning the Corner: Canada's Offset System for Greenhouse Gases: Guide for Protocol Developers.* Draft for consultation. http://ec.gc.ca/creditscompensatoires-offsets/default.asp?lang=En&n=7CAD67C6-1

Government of Canada. January 2004. *Climate Change Technology Early Action Measures (TEAM): Requirements and Guidance for the System of Measurement and Reporting for Technologies (SMART)*. www.team.gc.ca/english/publications/team_smart/

Greig, Mike and Gary Bull. 2009. *Carbon Management in British Columbia's Forests: Opportunities and Challenges.* FORREX Series 24. www.forrex.org/publications/forrexSeries/series.asp

International Organization for Standardization (ISO). 2006. *Greenhouse gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas reductions or removal enhancements.* ISO14064-2. www.iso.org/iso/catalogue_detail?csnumber=38382

International Panel on Climate Change. 2003. *Good Practice Guidance for Land Use, Land-Use Change and Forestry.* www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

Kimmins, J.P. , D. Mailly and B. Seely, 1999. Modelling forest ecosystem net primary production: the hybrid simulation approach used in FORECAST, *Ecol. Model.* 122 (1999), pp. 195–224.

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. *CBM-CFS3: A model of carbon-dynamics in forestry and land-use change implementing IPCC standards*. Ecological Modelling 220: 480–504.

Regional Greenhouse Gas Initiative. May 2009. *Draft Model Offset Project Consistency Application – Afforestation.* http://rggi.org/offsets/update/sponsors

The Climate Regisry. May 2008. *General Reporting Protocol: Accurate, transparent, and consistent measurement of greenhouse gases across North America.* www.theclimateregistry.org/resources/protocols/general-reporting-protocol/

The Carbon Trust. 2007. Introduction to carbon footprinting: Glossary to carbon footprinting. www.carbontrust.co.uk/solutions/CarbonFootprinting/carbon_footprinting_glossary.htm

World Resources Institute and the World Business Council for Sustainable Development. 2005. *The Greenhouse Gas Protocol: The GHG Protocol for Public Accounting.* www.ghgprotocol.org/files/ghg_project_protocol.pdf

Glossary

Additionality (or incrementality) – to create forest carbon credits, proponent needs to demonstrate that the carbon reduced (i.e., due to emission reductions or removal enhancements) from the project is 'in addition' to what would have occurred had no change in management strategy taken place (i.e., the 'baseline scenario') (Greig and Bull 2009)

Afforestation– activities that increase the size and number of forests by planting land that has not been forested since December 31, 1989 (BC Ministry of Forests and Range 2009)

Assurance factor – accounts for the risk and magnitude of carbon sequestration reversal. The assurance factor accounts for the expected reversal events across all the years the forest is eligible to receive credits for carbon sequestration. This addresses liability accruing with credits for projects due to risk of reversal (Alberta Environment 2007)

Baseline emissions – in relation to a project, means an estimate of GHG emissions from all selected sources and reservoirs, assuming the project is not carried out (*Emission Offsets Regulation*)

Baseline removals - in relation to a project, means an estimate of removals by all selected sinks and reservoirs, assuming the project is not carried out (*Emission Offsets Regulation*)

Baseline scenario – in relation to a project, means one or more hypotheses that: (a) are made, in part, on the assumption that the project is not carried out, (b) are about activities that will have an effect on GHG emissions or removals, and (c) enable the estimation of baseline emissions and baseline removals (*Emission Offsets Regulation*)

Biomass Expansion Factors – converts merchantable volume (cubic metres/ha) to biomass (t/ha). (Canadian Forestry Service 2006)

Carbon dioxide equivalent (CO2-e) – There are six main greenhouse gases which cause climate change and are limited by the Kyoto protocol. Each gas has a different global warming potential. For simplicity of reporting, the mass of each gas emitted is commonly translated into a carbon dioxide equivalent (CO2e) amount so that the total impact from all sources can be summed to one figure. (The Carbon Trust 2007) It is derived for carbon in a forest by way of conversion once the amount of carbon is known (1 tonne carbon = 3.667 tonnes CO2e)

Carbon stock – quantity of carbon held within a reservoir at a specified time (Environment Canada 2008)

Clean Development Mechanism – an arrangement under the Kyoto Protocol allowing industrialized countries with greenhouse gas reduction commitments to invest in projects that reduce emissions in developing countries as an alternative to more expensive reductions in their own country. A crucial feature of an approved CDM carbon project is that it has established that the planned reductions would not occur without the additional incentive provided by emission reductions credits, a concept known as "additionality". The CDM is under guidance of the Conference of Parties (COP/MOP) of the United Nations Framework Convention on Climate Change (UNFCCC). http://cdm.unfccc.int/index.html

Climate Change Technology Early Action Measures (TEAM) – TEAM's mission is to invest in technology demonstration and late stage development in support of early action to reduce

GHG emissions (or enhance GHG removals), nationally and internationally, while sustaining economic and social development. www.team.gc.ca/english/ (Government of Canada)

Emission offset – as established, approved or recognized under the *Emission Offsets Regulation* for the purpose of (a) reducing GHG emissions, or (b) reducing atmospheric GHG concentrations through storage, sequestration or other means (*Greenhouse Gas Reductions Target Act)*

Emissions reduction – means baseline emissions minus project emissions (*Emission Offsets Regulation*)

Fertilization – adding nutrients to increase tree growth on sites deficient in one or more soil nutrients ((BC Ministry of Forests and Range 2009)

Forest - refers to one or both of land (forest land) and its associated plant community (forest cover), where the land area exceeds 0.5 ha and 10% of the land area is covered by the crowns of trees able to reach a height of 5 metres at maturity (State of BC's Forests report)

Genetic worth (GW) – means a measure of the genetic quality of a seed or vegetative lot over wild stand material, measured for a specific trait (e.g., growth, wood density, pest resistance).

Greenhouse gas – means any or all of carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride and any other substance prescribed by regulation (*Greenhouse Gas Reductions Target Act)*

Greenhouse Gas (GHG) protocol – a widely used standard for emissions reporting developed by the World Resources Institute and the World Business Council for Sustainable Development (2005)

Greenhouse gas reduction – means (a) a reduction of GHG emissions, or (b) an enhancement of GHG removals (*Emission Offsets Regulation*)

ISO 14064 - an international standard for corporate emissions reporting. It builds on the approach outlined in the Greenhouse Gas Protocol (The Carbon Trust 2007)

Leakage (or land use leakage) – the indirect impact that a targeted land use, land-use change and forestry activity in a certain place at a certain time has on carbon storage at another place or time (IPCC 2003) i.e., that emissions or removals being shifted to another site or source is taken into account

Monitoring – periodic measurement of GHG emissions/removals (Canadian Forestry Service 2006)

Permanence - refers to the longevity of a carbon pool and the stability of its stocks within its management and disturbance environment (Greig and Bull 2009)

Project – means a course of action undertake to achieve GHG reduction (*Emission Offsets Regulation*)

Project emissions – means an estimate of GHG emissions from all selected sources and reservoirs (*Emission Offsets Regulation*)

Project reduction – means the total emissions reductions and the removals enhancement, less any discount applied in accordance with a risk-mitigation and contingency plan (*Emission Offsets Regulation*)

Project removals – means an estimate of removals by all selected sinks and reservoirs (*Emission Offsets Regulation*)

Quantification methodology – provides detailed information on the baseline, monitoring, reporting and quantification of GHG emission reductions/removals for a specific project in an offset system. (Alberta Environment 2008)

Real – an eligibility criterion requiring that the offset project be a specific and identifiable action that results in net GHG reductions or removals after leakage is taken into account (Environment Canada 2008)

Removals enhancement – means baseline removals minus project removals (*Emission Offsets Regulation*)

Reservoir – a physical unit or component of the biosphere, geosphere or hydrosphere with the capability to store or accumulate a GHG removed from the atmosphere by a GHG sink or a GHG captured from a GHG source, for example, trees, soil, oil and gas reservoirs and oceans (Canadian Forestry Service 2006)

Reversal – means loss to the atmosphere of an amount of carbon or GHGs stored or sequestered in reservoirs (*Emission Offsets Regulation*)

Select seed use– planting seedlings, from natural stand superior provenances and orchard seed sources, selected for specific traits to promote faster growth, increased timber volume and carbon content, and resistance to insects and diseases (BC Ministry of Forests and Range 2009)

Sink – any process, activity or mechanism that removes a GHG from the atmosphere (Canadian Forestry Service 2006)

Source – any process or activity that releases a GHG into the atmosphere (Canadian Forestry Service 2006)

Tree – a woody plant that is usually single-stemmed and has the potential to reach a height of 5 metres at maturity (Canadian Forestry Service 2006)

Validation – the process used to determine that a proposed project meets the offset system eligibility criteria (Canadian Forestry Service 2006)

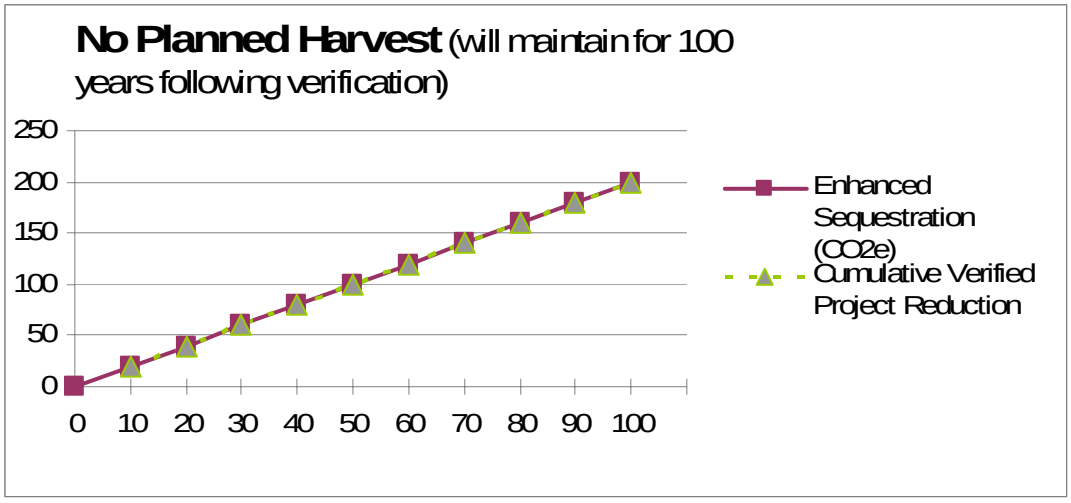
Verification – a systematic, independent and documented process for the evaluation of a GHG assertion of emission reductions or removals against agreed verification criteria (Canadian Forestry Service 2006)

Appendix A: Project Quantification Methods

See Chapter 3.3 for related discussion. More detailed example(s) are intended when Protocol is finalized.

Method One: where no harvesting is planned within 100 years of verification:

Verified Project Reduction = Enhanced Sequestration CO_{2e}



Method Two: where harvesting is planned within 100 years of verification:

Verified Project Reduction (VPR) = Reduction Value Achieved (RVA) + Future Reduction Value (FRA) + Delayed Harvest Value (DHV)

Where:

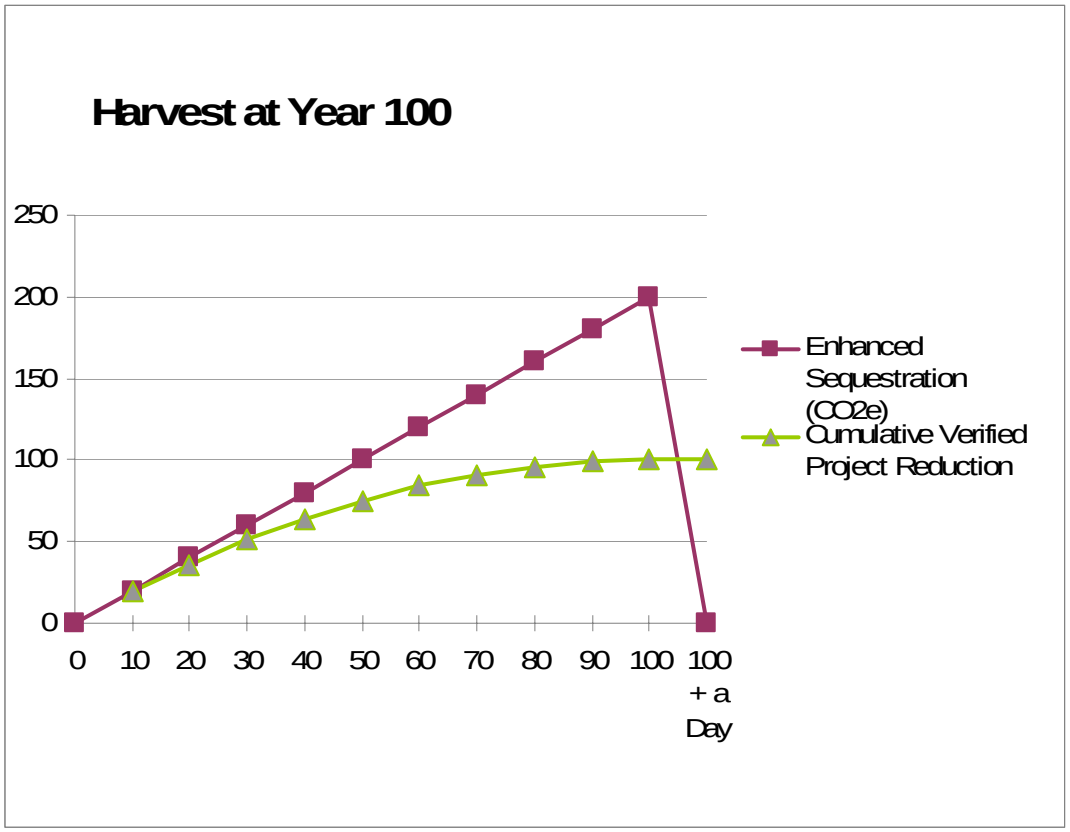
- RVA = (Enhanced Sequestration CO_{2e})*(Years since last verified reduction/100)
- FRV = (Enhanced Sequestration CO_{2e})*(Years until next planned harvest/100)
- DHV = (Enhanced Sequestration CO_{2e} as of last verification)*(Years since planned harvest or years since last verification/100 which ever date is most recent)
- Note: DHV only calculated if the date for a planned harvest has been passed, no harvest has occurred and there has been no reversal

And:

- YV = Year of Verification
- ES = Enhanced Sequestration CO_{2e}
- NPH = No Planned Harvest
- CVPR = Cumulative Verified Project Reduction

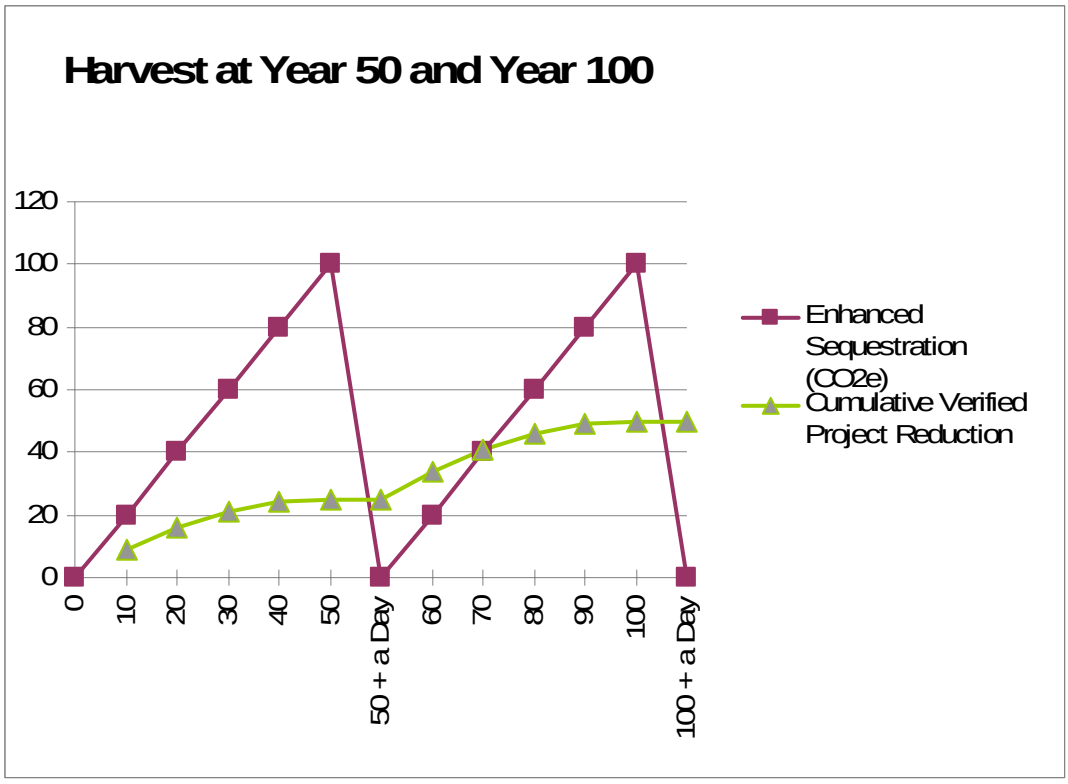
Example A: Harvest at Year 100

YV	ES	NPH	RVA	FRV	VPR	CVPR
0	0	100				
10	20	100	1	18	19	19
20	40	100	1	16	17	36
30	60	100	1	14	15	51
40	80	100	1	12	13	64
50	100	100	1	10	11	75
60	120	100	1	8	9	84
70	140	100	1	6	7	91
80	160	100	1	4	5	96
90	180	100	1	2	3	99
100	200	100	1	0	1	100
100 + a Day	0					100



Example B: Harvest at Year 50 and Year 100:

YV	ES	NPH	RVA	FRV	VPR	CVPR
0	0	50				
10	20	50	1	8	9	9
20	40	50	1	6	7	16
30	60	50	1	4	5	21
40	80	50	1	2	3	24
50	100	50	1	0	1	25
50 + a Day	0					25
60	20	100	1	8	9	34
70	40	100	1	6	7	41
80	60	100	1	4	5	46
90	80	100	1	2	3	49
100	100	100	1	0	1	50
100 + a Day	0					50



Appendix B: Comparison of Risk Management Approaches

Climate Action Reserve Updated Forest Project Protocol April 2009	**Alberta. Quantification Protocol for Afforestation Projects September 2007**	**CFS Offset System Quantification Protocol for Afforestation Projects DRAFT July 2006**
Proponents contribute to **"buffer pool"** based on project specific risk assessment. The protocol provides a framework and default values for assessing financial, management, social natural disturbance and data accuracy risks. Appendix C pp 65-71. In the event of a reversal, the proponent is obligated to compensate the reversal using mechanisms in a specified order: (1) surrender unsold credits; (2) withdraw from the buffer pool; or (3) purchase credits from outside the buffer pool – if the reversal is a result of negligence. At page 6, the protocol says: "A forest project will terminate when a non-intentional reversal occurs that reduces the standing live carbon stocks below the baseline of standing live carbon that was established at the project's inception. A new forest project may be initiated in the same area as a previously terminated forest project as long as any reversal of GHG reductions from the former project has been completely compensated for through the Reserve's buffer pool or alternatively through a third-party insurance mechanism"	**Assurance factor** – a 10% reduction is applied to GHG removals for all projects to account for the average risk of reversal, based on a review of average rates of disturbance (pg 29). "The assurance factor accounts for the risk and magnitude of carbon sequestration reversal due to fire, drought, pest and other disturbances. This factor accounts for the average number of reversal events anticipated over a 20 year period. The assurance factor accounts for the reversal event across all of the years that the forest is eligible to receive credits for carbon sequestration. This prevents any liability accruing with credits for afforestation projects due to the risk of reversal." Page 5	**Proponent replaces reversal**: If a reversal of issued offset credits occurs, as determined in a verified Reductions/Removals report, the Proponent is required to replace the reversed offset credits with eligible and valid units. Page 16. Proponents would be expected to manage risks through risk management actions such as: risk reduction, monitoring, diversification of project portfolios, and conservative sale and estimation of carbon credits.

The three protocols deal with the risk of reversals in different ways in terms of:

- Balancing of risk between project proponents and the GHG offset purchaser.
- The factors considered (i.e., natural disturbance *versus* more comprehensive assessment of biological, economic, business management and social risks).

Appendix C: Developing a Forest Project Carbon Inventory

This appendix provides guidance to quantify a forest project's initial forest carbon inventory. It explains how to identify the required and optional forest carbon pools to measure for a forest project, as well as the steps necessary for calculating the existing carbon stocks in the selected pools within the project area. This information will serve as the basis for estimating carbon stocks in a project's baseline over time, as well as the anticipated changes in carbon stocks due to the project activity. The assessment of GHG reductions and emissions from forest projects are based on changes in forest carbon stocks over time. The forest project inventory provides the accounting foundation for assessing these changes.

This appendix explains the essential components to complete the forest project carbon inventory. It then provides guidance regarding the quantification of all required and optional direct carbon pools. Please refer to the Worksheet for Summarizing Carbon Pools and Calculating Total Carbon Weight, Table C2, which should be used to quantify each of these pools.

C.1 Provide Background Information on Forest Area

To begin the inventory process, you must supply a general description of the activities and land use patterns that influence your project forest carbon stocks and biological emissions. This information should help inform the initial design of your forest inventory if needed, as well as your estimations of forest carbon stock and emissions. This information will be reviewed in the verification process.

When you are ready to quantify your forest carbon stocks, you should provide the following information which is also included on a map:

- Forest ownership and project boundaries
- Size of forest ownership area
- Latitude/longitude, or land title or land survey
- Existing land cover and land use
- Topography
- Forest vegetation types
- Site classes
- Watercourses in area

C.2 Measure Carbon Pools in the Project Area

The required measurements to determine carbon stocks are broadly grouped into the following categories:

1. Above-ground living biomass (part of SSR8 from Table 1)
2. Below-ground living biomass (part of SSR8 from Table 1)
3. Dead wood biomass on-site (SSR9 from Table 1)
4. Litter and soil carbon (SSR10 from Table 1)

C.3 Onsite Forest Inventories

All calculations are to be done in metric units in accordance with the standards for forest information provided on the website. All calculations must be correctly converted to metric tonnes carbon dioxide equivalent. To develop estimates of carbon stocks in the carbon pools identified in Table C.2, a forest inventory must first be conducted.

Standard forest inventories require the establishment of sample plots and provide inventory estimates in terms of cubic meter volume. These measurements are based on the species, trunk or bole diameter, form and height of the tree.

The equations provided in this appendix facilitate biomass and carbon mass estimations using the bole diameter and total height for live trees and sound standing dead trees. Estimates of lying dead and standing dead tree (for non-sound trees) biomass can be computed in terms of cubic volume and subsequently converted to biomass/carbon mass estimates.

A complete inventory must include a sampling methodology, a set of inventory plots, and analytical methods to translate field measurements into volume and/or biomass estimates. The plot data used for deriving the estimates for verification must have been sampled within the last 10 years. The scheduling of plot sampling may occur in one time period or be distributed over several time periods. Either approach is acceptable so long as an inventory of the entire project area (its required carbon pools and corresponding sample plots) is completed within 10-year intervals.

For guidelines on how to develop an inventory plan that meets statistical needs please refer to the BC Ministry of Forest and Range's (2007) *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Factor Sampling* www.for.gov.bc.ca/hts/vri/standards/index.html

Ground sampling standards and procedures for conducting change monitoring inventory (CMI) sampling are found in the BC Ministry of Forest and Range's (2000) *Vegetation Resources Inventory Change Measurement: Preliminary Field Procedures*. www.for.gov.bc.ca/hts/inventory/reports/gymonitor/index.html

Ground sampling quality assurance standards and procedures which define the level of accuracy required can be found in the BC Ministry of Forest and Range's (2007) *Change Monitoring Inventory Ground Sampling Quality Assurance Standards* and (2002) *Change Monitoring Inventory Ground Sampling Quality Assurance Procedures*, respectively www.for.gov.bc.ca/hts/vri/standards/index.html

An exception to the 10-year plot life is accepted where the Project Developer can demonstrate to the verifier that the process utilized for updating the inventory, addressing both forest growth and harvest, adequately estimates the current inventory. To accomplish this, a statistically valid subsample must be conducted and determined to be the same as the updated (computer grown and updated for harvest) inventory with a 90% confidence (α=0.10).

Step 1 – Develop Inventory Methodology and Sample Plots *Required*

As your initial inventory step, you must develop and describe a methodology to sample for biomass or volume in the required carbon pools. Sampling methodologies for all included carbon pools, where a determination of the biomass or volume is derived from sampling, is also required. If you are using an existing inventory either partially or for all your data then follow the same sequence of steps to ensure the existing inventory meets the requirements.

Your sampling methodology and measurement standards should be consistent throughout the time you report to the verifier. Improvements in forest inventory accuracy or efficiency from new methodologies may occur over time that may prompt you to make changes to your inventory. The overall quality of the inventory should be maintained or improved by such

changes and estimates of carbon stock changes shall not be reduced in accuracy relative to the original sampling design. All sampling methodologies and measurement standards must be statistically sound and reviewed by verifiers.

While stratification is not a requirement, it should be noted that it does have the potential to simplify verification and possibly lower the costs of verification for reporters. Temporary flagging of plot center, as is customary to allow for check cruising, is required to ensure ongoing inventory quality and potential opportunities for verifiers to visit plots when verifying inventory procedures. If permanent plots are used, which are statistically efficient for stock change estimates, then permanent plot marking must be sufficient for relocation. Plot centers should be referenced on maps, preferably from GPS coordinates. The methodologies utilized shall be documented and made available for verification and public review.

METHODOLOGY

Plot Establishment Options

Two options are proposed for establishing plots to estimate change in a project site:

1. Measure a subset of existing or planned VRI plots.

2. Establish a set of plots independent of the VRI.

The choice of option should depend on specific project site considerations. For example, the first option may be preferred if a VRI already exists and the focus is to check the predicted change (i.e.,, growth) in timber volume over time. However, this option may not address issues requiring an independent sample of the land base or the need to monitor non-timber attributes.

Sample Size

A minimum sample size of 30 plots is suggested per project site. However, sample size should be determined for each project site after considering the attributes of interest, natural variability, desired level of precision in estimates of change, and the level of confidence in existing predictions. Larger samples will be required in most cases to permit post-stratification of the data.

Sample Selection

Plots can be selected with equal probability based on simple random or systematic sampling. It is preferable not to pre-stratify the target population, but post-stratification may be done to examine specific portions of the population. Systematic sampling can be done from an ordered list (with random start) or by using a systematic grid over the project site.

Plot Measurement

Plots should be established and measured in the initial target population over as short a time frame as possible (preferably within 1 year). All plots should be re-measured on a consistent cycle (e.g., every five years) to provide a common time increment for change observations.

Field Procedures

Change measurement data definitions, standards, measurements, and field cards for the initial measurement and re-measurements will be based on the VRI ground sampling procedures manual (with some additions). The major additions include a fixed-area plot for large trees (≥ 4.0 cm diameter at breast height) and polygon boundary mapping on the plot cards. The additions are

described in *Vegetation Resources Inventory Change Measurement: Preliminary Field Procedures.* Modifications may be made to the field procedures, depending on the specific project type (afforestation versus forest management) and site objectives. For example, project developers may elect to employ 3.99m radius plots on a 100m grid to collect stocking and height information only.

The next version of TIPSY – which is expected to be released within a year – enables estimates of both above- and below-ground Carbon directly from field sampling. Where applicable relative to the requirements of the growth and yield model chosen in Chapter 3.2, the design of your sampling methodology and measurement standards must also include the requirements stated in Table C.1:.

Table C.1: Minimum required sampling criteria for estimated pools.

Carbon Pool	**Name of Requirement**	**Description of Requirement**	
Above-ground Living Biomass (part of SSR8)	Diameter (breast height) Measurements	Stated minimum diameter in methodology not to be greater than 5 inches (12.7 cm).	
	Measurement Tools	Description of tools used for height measurement, diameter measurement, and plot measurement.	
	Measurement Standards	The methodology shall include a set of standards for tree and plot size measurements.	
	Plot Layout	A description of plot layout.	
	Merchantability of Trees	The methodology shall include all trees regardless of current merchantability to be included in the sampling design.	
	Allometric Equation used for Estimating Biomass	The methodology will include a description of the allometric equation used to estimate the whole tree biomass (bole, branches, and leaves) from bole diameter measurements.	
	Below-ground Living Biomass	Plot-level Allometric Equation used for Estimating Biomass	The TIPSY model will be providing estimates for below-ground biomass.
Understory (part of SSR8)	Sampling Methodology	Vegetation Resource Inventory	

Standing Dead Wood (part of SSR9)	Diameter (breast height) and top Diameter Measurements	Stated minimum breast height diameter in methodology not to be greater than 5 inches. Description of how top diameter is derived.
	Measurement Tools	Description of tools used for height, diameter and plot measurement.
	Measurement Standards	The methodology shall include a set of standards for height and diameter measurements.
	Plot Layout	A description of plot layout (may be the same layout as for live tree biomass).
	Merchantability of Trees	The methodology shall include all trees regardless of current merchantability to be including in the sampling design.
Litter and Soil (SSR10)	Sampling Methodology	Reporting of litter and soil (SSR10) is optional (see Table 1); if undertaken an appropriate method must be specified. T
Lying Dead Wood (part of SSR9)	Diameter	Stated minimum average diameter in methodology not to be greater than 6 inches (15.2 cm) for pieces of dead wood at least 10 feet (3.05 m) in length. If the average diameter is greater than 16 inches (40.6 cm), the minimum length for reporting not to be greater than 6 feet (1.83 m). Anything not meeting the measurement criteria for lying dead wood will be considered litter.
	Measurement Tools	Description of tools used for length, diameter and plot measurement.
	Measurement Standards	The methodology shall include a set of standards for height and length measurements

Plot Layout	A description of plot layout (may be the same as the layout for live tree biomass).
Merchantability of Trees	The methodology shall include all trees regardless of current merchantability to be including in the sampling design.
Density by Decay Class	Description of methodology used to derive density estimates for each species (group) by wood density class.

Step 2 – Estimate Carbon in Living Biomass Reservoir from Sample Plots *Required*

Above and below ground live tree and shrub biomass estimates are required for all projects. You are responsible for determining appropriate methodologies for sampling to determine living biomass. These estimates should be computed on a per hectare basis. The estimate of above-ground live tree biomass will be combined with the estimates of biomass from other carbon pools for a mean estimate of the included pools derived from sampling, along with a statistical summary that describes the statistical confidence of the estimate.

Step 3 – Estimate Carbon Standing Dead Wood Reservoir from Sample Plots *Required*

The carbon stocks in standing dead wood must be included in the project inventory report unless adequately justified to leave out. If included, it must be considered in the monitoring process and any projections of project stocks.

The sampling methodology and standards for deriving estimates will be developed as part of an overall sampling strategy (discussed in Step 1). The estimate of standing dead wood for highly decayed trees (broken tops, missing branches, etc.), must be calculated first volumetrically and subsequently converted to biomass and carbon tonnes. Sound dead trees can be computed using the equations provided for live trees in Step 2. The equations used in Step 2 provide an estimate of biomass in kilograms. The estimate must be converted to metric carbon tonnes by multiplying the result by 0.5.

For those trees where volume is computed, the volume will need to be converted to biomass density by applying conversion factors based on a sub-sample of material that represents the species groups and decomposition classes. The methodology developed for both lying dead wood and standing dead biomass must include a description of the calculation techniques used to determine biomass density by decomposition classes and species (groups). The estimate of biomass density must be computed in terms of metric carbon tonnes on a per hectare basis. A description of a methodology to generate the density factors can be found in the Brown et al. (2004) document mentioned above.

Step 4– Estimate Carbon in Lying Dead Wood Reservoir *Required*

For the collection of data needed for this Step please refer to *Vegetation Resources Inventory Ground Sampling Procedures.*

The carbon content of lying dead wood refers to coarse woody debris. As with standing dead wood, this category may not be present initially. It should be considered in the monitoring process and any projections of entity carbon stocks.

Step 5 – Estimate Carbon in the Understory from Sample Plots *Required for Reforestation Projects, Optional Otherwise*

Any methodology developed for measuring carbon in shrubs will need to be reviewed by verifiers. For the collection of data needed for this Step please refer to *Vegetation Resources Inventory Ground Sampling Procedures.*

The estimate will be computed in terms of metric carbon tonnes.

The use of the most applicable biomass estimation methods may be used including photo series, the use of estimation functions from published papers, direct sampling, or combinations of approaches.

Step 6 – Estimate of Carbon in Litter and Soil *Optional*

Litter is the dead plant material that can still be identified as leaves, grasses and small branches. The largest material that can be considered litter is the minimum diameter stated in the methodology for lying dead wood. The duff layer is the organic material layer at the soil surface under the litter layer. The duff layer consists of dead plant materials that cannot be identified as

leaves, grasses, and small branches. For the collection of data needed for this Step please refer to *Vegetation Resources Inventory Ground Sampling Procedures.*

The estimate will be computed in terms of metric carbon tonnes. The mean estimate is input into the Litter and Duff Section in the worksheet in Step 8 on a per hectare basis.

The use of the most applicable biomass estimation methods may be used including photo series, the use of estimation functions from published papers, direct sampling, or combinations of approaches.

Step 7 – Sum Carbon Pools

Table C.2: Worksheet for Summarizing Carbon Pools and Calculating Total Carbon

Carbon Pool	Required Pool?	Gross Carbon Tonnes per Hectare
Step 2 Living Biomass	Yes	From sampling results of trees.
Steps 3 – 4 Standing and Lying Dead Wood	Yes	From sampling results of standing and lying dead wood.
Step 5 Understory	Yes	From sampling results of the understory.
Step 6 Litter and Soil	No	From sampling results of litter and soil.

Appendix D: BC Forest Offset Protocol Working Group

Ministry of Forest and Range:

Tom Niemann (co-chair), Manager, Climate Change and Forest Carbon, Forest Practices Branch
Brian Raymer (co-chair), Climate Change and Forest Carbon, Forest Practices Branch
Kevin Astridge, Forest Practices Branch
Tamara Brierley, Forest Analysis and Inventory Branch
Lee Charleson, Tree Improvement Branch
Caren Dymond, Research Branch
Christine Fletcher, Forest Analysis and Inventory Branch
Don Gosnell, Resource Tenures and Engineering Branch
Graham Hawkins, Forest Analysis and Inventory Branch
Bud Koch, Forest Analysis and Inventory Branch
Leslie McAuley, Tree Improvement Branch
Tavis McDonald, BC Timber Sales
Gordon Nigh, Research Branch
Allan Powelson, Forest Practices Branch

Ministry of Environment:

Warren Bell, Climate Action Secretariat
Chris Koski, Climate Change Branch
Tim Lesiuk, Cimate Action Secretariat
Dennis Paradine, Climate Change Branch
Jessica Verhagen, Climate Action Secretariat

Ministry of Agriculture and Lands:

Mathew Dickson, Strategic Policy and Planning
Andrew Leitch, Strategic Policy and Planning

Pacific Carbon Trust:

George Macauley, Consultant
Theresa Taaffe, Governance & Performance
Ronald Zeilstra, Offset Delivery