

**QUANTIFICATION PROTOCOL FOR
AFFORESTATION PROJECTS:**

ABRIDGED

Submitted to:

Alberta Environment

and

Alberta Agriculture, Food and Rural Development

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Disclaimer

The following document presents an abridged version of the Afforestation protocol prepared for Alberta Environment and Alberta Agriculture, Food and Rural Development which has completed an initial round of technical review. This document has been prepared as a means of supporting a broader stakeholder consultation process. As such, this document should not be used as a quantification protocol.

The full-length protocol is largely based on the *Offset System Quantification Protocol for Afforestation Projects* dated July 31, 2006. Peter Graham, M.F., R.P.F., Senior Economist with the Policy, Economics and Industry Branch of the Canadian Forest Service / Natural Resources Canada was the chief developer and contact person. Peter's work represents the culmination of a multi-stakeholder consultation project and reliance on a number of guidance documents.

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1.0 Project and Methodology Scope and Description

This quantification protocol is applicable to the quantification of direct and indirect reductions of greenhouse gas (GHG) emissions resulting from the implementation of afforestation projects. Given the potential range of conditions across Canada and the variety of specific activities that may be involved in afforestation projects, this protocol serves as a generic 'recipe' for proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements. **FIGURE 1.1** offers a project element life cycle chart for a typical project.

In practice, much of the land that will be afforested in Canada will be agricultural land (under varying degrees of management), and this protocol will cover most afforestation projects on such lands. In addition to conversion of agricultural land to treed area, the scope of this protocol may cover conversion of urban land to plantations, agroforestry, or the rehabilitation of degraded industrial lands, such as mine sites.

The baseline condition is considered to be the conversion of agricultural land to a treed area, of urban land to plantations, agroforestry, or the rehabilitation of degraded industrial lands, such as mine sites. The emissions under the baseline condition will be calculated using existing models covering the activities under the baseline condition. Given the number of years since the land may have been treed, and has since been under other land use(s) such as agriculture, it is reasonable to assume that the land would not become a treed area without the project. Therefore, the reasonable baseline scenarios range from no management activity to some degree of agricultural activity, from grazing to intensive cultivation.

Given the scope of this protocol, the soil carbon pool is the only baseline SSR that is expected to change over time. However, the degree of change will be insignificant and the direction of change may alternate between sink and source over time. In addition, there is a very low likelihood of an event occurring that is beyond the control of the proponent, and that would require an adjustment of the baseline scenario. As such, the approach to quantifying the baseline will be projection-based as there are suitable models for the applicable baseline condition that can provide reasonable certainty.

The projection-based baseline scenario for this protocol is static as the emissions profile for the baseline activities would not be expected to change materially during the registration period. **FIGURE 1.2** offers an element life cycle chart for a typical baseline configuration.

It is not appropriate to apply this protocol to projects that involve planting trees on land that has recently been cleared of trees, since this does not constitute a land use change and could not be classified as afforestation. While some procedures in this protocol would be transferable to such projects, their baselines would have to incorporate any expected natural regeneration, regulatory requirements or tree cover among other possible differences in baseline and project activities.

FIGURE 1.1: Project Element Life Cycle Chart

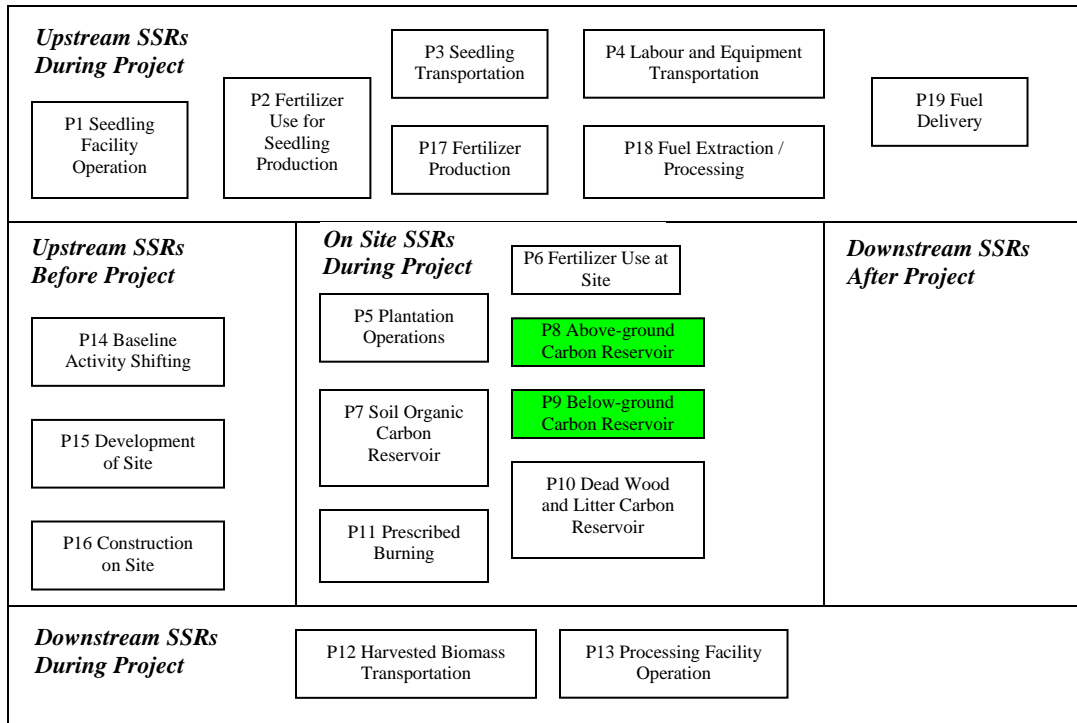
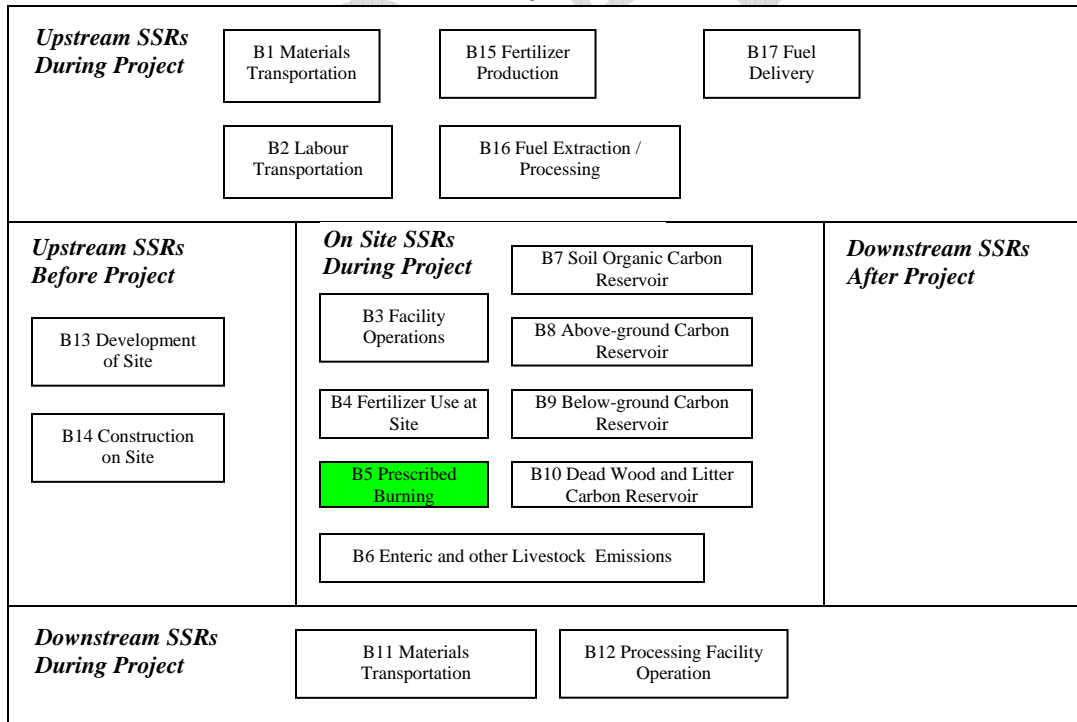


FIGURE 1.2: Baseline Element Life Cycle Chart



* Sources, sinks and reservoirs selected for measurement and monitoring under this protocol are highlighted.

An afforestation project will achieve GHG reductions/removals through the increase in carbon stocks on the project site as a result of the growth of trees. Initial carbon stocks vary, but in all cases are lower than future expected carbon stocks, both above and below ground. Emissions from the project are expected during establishment due to site preparation and planting. Other emissions following establishment will occur as a result of the maintenance required by the plantation design. These emissions are expected to be small compared to the carbon sequestered by the project.

This afforestation protocol has been developed for a sub-set of afforestation projects that are considered to reflect the most common afforestation situations. To demonstrate that a project meets the requirements under this protocol, the project proponent must supply sufficient evidence to demonstrate that:

1. The afforestation project area was non-treed prior to project implementation as confirmed by land-use records, aerial photos, or other means;
2. The afforestation project area is greater than or equal to 1 hectare in size as indicated on project maps and/or aerial photos;
3. The trees established under the afforestation project are capable of achieving a minimum height of 5 metres at maturity as confirmed by an attestation of the project proponent;
4. The trees established under the afforestation project are capable of achieving a minimum crown cover of 25% at maturity as confirmed by an attestation of the project proponent; and
5. The quantification of reductions achieved by the project is based on actual measurement and monitoring (except where indicated in this protocol) as indicated by the proper application of this protocol.

Flexibility in applying the quantification protocol is provided to project developers in three ways:

1. Agroforestry projects: While these may be eligible under this quantification protocol, there must be a sufficient number of trees planted that have the capability of reaching 5 metres in height. Carbon sequestered in the agricultural crop shall not be included in the quantification, however emissions related to the management of agricultural crops or livestock must be included in the estimate of project emissions. The Proponent must provide a quantification methodology with their Project Document for review at the time of registration. Any exclusion of agriculture-related emissions must be justified as in Section 2.4;
2. Proponents may choose to measure, monitor and account for soil organic carbon. However, this must be completed from the outset of the project to account for any initial decreases in soil organic carbon as the treed area is established;

3. Site specific emission factors may be substituted for the generic emission factors indicated in this protocol document. The methodology for generation of these emission factors must be sufficiently robust as to ensure reasonable accuracy; and
4. Flexibility in field sampling design and survey techniques and equipment is permitted, provided that the estimates based on statistical samples are within the prescribed bounds of accuracy and uncertainty.

If applicable, the proponent must indicate and justify why flexibility provisions have been used.

2.0 Quantification of Identified Sources, Sinks and Reservoirs

Quantification of the reductions, removals and reversals for the sources, sinks and reservoirs selected for measurement and monitoring under this protocol will be completed using the methodologies outlined in **TABLE 2.1**, below. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

$$\text{Emission Reduction} = \text{Emissions}_{\text{Baseline}} - \text{Emissions}_{\text{Project}}$$

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Prescribed Burning}}$$

$$\text{Emissions}_{\text{Project}} = - ((\text{Sequestration}_{\text{Above-ground Carbon Reservoir}} \\ * \text{Assurance Factor}) \\ + \text{Sequestration}_{\text{Below-ground Carbon Reservoir}})$$

TABLE 2.1: Quantification Procedures

1. Project/Baseline SSR	2. Parameter / Variable	3. Unit
Project SSRs		
P8 Above-ground Carbon Reservoir	Sequestration Above-ground Carbon Reservoir = [(Incremental Vol. Above Ground Tree * Area Afforested) + (Vol. Biomass Harvested)] * Expansion Factor Biomass * Conversion Factor C-CO2	
	Sequestration Above-ground Carbon Reservoir	kg of CO _{2E}
	Volume of Above Ground Biomass Accumulating as Trees / Incremental Vol. Above Ground Tree	m ³ / ha
	Volume of Above Ground Biomass Harvested / Vol. Biomass Harvested	m ³
	Biomass Expansion Factor / Expansion Factor Biomass	kg of Carbon per m ³
	Area of Afforestation Project / Area Afforested	Ha
	Conversion factor for Carbon to Carbon Dioxide / Conversion Factor C-CO2	-
P9 Below-ground Carbon Reservoir	Sequestration Below-ground Carbon Reservoir = Incremental Vol. Above Ground Tree * Ratio Root-Shoot * Expansion Factor Biomass * Area Afforested * Conversion Factor C-CO2	
	Sequestration Above-ground Carbon Reservoir	kg of CO _{2E}
	Ratio of Below-ground Biomass to Above-ground Tree Volume	-
Baseline SSRs		
B5 Prescribed Burning	Emissions Prescribed Burning = Area Burn * EF Biomass CO2E	
	Emissions Prescribed Burning	kgs of CH ₄ and N ₂ O
	Area of Affected by Burn / Area Burn	ha
	CO _{2E} Emissions Factor for Biomass / EF Biomass CO2E	kg CO _{2E} per ha

APPENDIX A: Glossary of New Terms

Afforestation/Reforestation:	The creation of a new treed area where none existed through planting, seeding and/or the human-induced promotion of natural seed sources.
Allometric Equation:	Allometry is defined as the study and measurement of the relative growth of a part of an organism in comparison with the whole. Allometric equations can relate tree diameter at breast height (1.3 m) to other attributes such as biomass and standing carbon stock.
Assurance Factor:	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.
Carbon Stock:	The absolute quantity of carbon held within a reservoir at a specified time, expressed in units of mass.
Reversal:	A reduction in the amount of carbon previously stored (sequestered) in a reservoir, resulting in CO ₂ emissions.
Sequestration	The process of increasing the carbon stock in a reservoir other than the atmosphere.
Tree	<p>A woody, perennial plant generally with a single, well-defined stem and a more or less definitely formed crown.</p> <p>A tree is a woody plant that is usually single-stemmed and has the potential to reach a height of 5 m at maturity. This definition excludes woody shrubs but it would include agroforestry projects that include the planting of a sufficient number of trees, including fruit trees that meet the height requirements.</p>

Treed Area

An area where the vegetation cover consists primarily of trees. Areas normally forming part of the treed area which are temporarily unstocked as a result of human intervention, such as harvesting, or as a result of natural causes, such as fire or disease, but which are expected to revert to treed areas are also included in the definition.

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APPENDIX B: Development of Relevant Assurance Factors

The assurance factor accounts for the average risk of reversal across all afforestation projects within a given region. Technical experts and the materials listed in the bibliography were consulted to assess both the range of values and to explore the relationships across regions, tree species and risk types. There were significant gaps in the availability of conclusive and specifically relevant scientific and insurance data to establish definitive assurance factor.

Based on an analysis of the available data, the range of data available provided a reasonable basis for concluding that over a creditable life of an afforestation project, considering cross-subsidy effects across regions and species, that a reasonable assurance factor would be greater than 90%. As the effects of many of these events would be captured in the assessment of above ground biomass accumulation over a given period, this appears to be a reasonable factor. However, there was not sufficient data to support refining this estimate above this level at this time, and as such, a 90% assurance factor was deemed reasonable.

Further research would be useful in supporting this assessment of an assurance factor and in refining the values by ecozone and tree species.

Primary Source Materials

W.J.A. Volney, R.I. Alfaro, P. Bothwell, E.H. Hogg, A. Hopkin, G. Laflamme, J.E. Hurley, G. Warren, J. Metsaranta and K.I. Mallett. 2005. A framework for poplar plantation risk assessments. *Unasylva*. No. 221, Vol. 56.

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