Alberta Offset System Guidance for Protocol Development
Background Information

PART A

Alberta Afforestation Protocol

Given the potential range of conditions across Alberta (and Canada) and the variety of specific activities that may be involved in afforestation projects, this protocol serves as a generic 'recipe' for project developers to follow in order to meet the measurement, monitoring and greenhouse gas quantification requirements.

An afforestation project will achieve greenhouse gas removals through the increase in carbon stocks (above and/or below ground carbon) within the project site as a result of the establishment and growth of trees and shrubs. Emissions from the project are expected during establishment due to site preparation and establishment. Other emissions following establishment might occur as a result of the maintenance required by the plantation design on the project site.

Rationale for initiating the development of the Proposed Protocol:

The former Afforestation protocol was approved in 2007 in the first round of protocols adapted from initial efforts made by the National Offset Quantification Team. Upon attempts to operationally implement the protocol it was recognized that it contained quantification errors. In early 2009, the protocol was pulled for review. During that review, quantification errors were corrected however it was determined that the protocol was out of step with what has developed in Carbon Markets around the world. A review was initiated to ensure the protocol was consistent with offset policy – specifically the treatment of harvested biomass.

The TWG could not come to a consensus on the treatment of harvested biomass prior to the February 2011 stakeholder review. At this time, the group elected to make this protocol a default afforestation conservation protocol whereby harvest would not be allowed. Work continues on the development of an afforestation protocol which will allow for harvest.

Part B
Description of Technical Protocol Plan Content

B.1. Description of the Project Type: (The **project type** is a set of project practices or technologies that represent the change from a normal business operation/practices or common industry practice.)

This quantification protocol is written for the *afforestation* project developer. Some familiarity with, or general understanding of silviculture including *tree* plantations is expected. Familiarity with agricultural practices and/or land conditions would also help in understanding the context of this protocol.

The opportunity for generating carbon offsets with this protocol arises mainly from the direct removal of greenhouse gas emission through the *sequestration* of carbon from the establishment of *tree*s or *shrub*s on land that has been non-forested for at least twenty years. Eligible lands may include *agricultural land*, urban land areas, non continuous, non-linear, *silvopasture*, *alleycropping* or buffer areas (as defined in this protocol) and potentially the rehabilitation of industrial lands.

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 project developers to follow in order to meet the measurement, monitoring and GHG quantification requirements.

An *afforestation* project will achieve GHG reductions/removals through the increase in *carbon stock*s (above and/or below ground) on the project site as a result of the establishment and growth of *tree*s. Initial *carbon stock*s may vary.

This protocol provides procedures for quantification methodology to determine both the above and below ground carbon that is based on statistical samples of field measurements. Extensive work has been carried out on calculating growth rates and carbon sequestration rates of trees for many years. Using best practice guidance this protocol builds upon the vast knowledge developed through many field trials and research. The protocol quantifies the amount of carbon stored in the above ground and below ground component of the tree by the use of expansion factors. These expansion factors are a ratio that can be applied to a known stem volume to determine the amount of carbon in the leaves, branches, roots and shoots of a tree. Stem volume is based on actual measurements during the afforestation project. A separate methodology for shelterbelts will also be included in the protocol based on the work of Kort and Turnock (1993).

The protocol is based on a project life of 60 years.

This protocol allows a flexibility mechanism (that requires independent verification of applicability) that covers the conversion of urban land to plantations, *agroforestry*, or the rehabilitation of degraded industrial lands, such as mine sites (review the Flexibility Mechanism for additional protocol requirements).

The protocol will apply to the activities that involve the establishment of *tree*s through planting, or the removal of impediments to natural reforestation, where a project developer is able to demonstrate that a project meets the requirements under this protocol.[1]

It is not appropriate to apply this protocol to projects that involve establishing *tree*s on land that has recently been cleared of *tree*s, since this does not constitute a land use change and thus cannot be classified as *afforestation*.[2] This protocol specifies that lands eligible for use must be un-treed for at least 20 years prior to project commencement. It is therefore reasonable to assume that the un-treed lands would have remained that way. Therefore a static historic baseline is assumed in this protocol. Presently in Alberta, limited lands are afforested on an annual basis compared to potential landbase.

This *afforestation* protocol has been developed for a sub-set of *afforestation* projects that are considered to reflect the most common *afforestation* situations. The project developer must supply sufficient evidence to demonstrate that:

1. A legal impediment, such as a conservation easement, deed restriction or caveat must be in place which addresses the following:
    1. The legal impediment must state that lands cannot be harvested and biomass cannot be disturbed. This legal impediment must be in place for a minimum of 60 years;
    2. The legal impediment must state that the land is managed according to a sound silviculture plan; and
    3. The legal impediment must address reversals.
        - **i. Unintentional Reversals**
            1. If an unintentional reversal occurs as a result of oil and gas exploration and development, utilities expansion, road expansion or
            2. An unintentional reversal occurs as a result of an event beyond the control of the project developer such as a fire or insect or disease outbreak, then any loss in carbon will be accounted for by the pool of offsets arising from the assurance factor; and
        - **ii. Intentional Reversals**
            1. If an intentional reversal occurs not related to oil and gas exploration, the project developer for the reversal must replace any lost tonnes.
2. *Agroforestry* projects are quantified according an Appendix.
3. Eligible species will be listed in an Appendix. Flexibility will be given to project developers to utilize other species provided they can provide sufficient evidence to support the permanence of the claim.
4. Project lands have not been forested land for at least 20 years prior to the establishment of the treed area. As *afforestation* projects have extended eligible crediting periods, this criterion must be confirmed relative to the year prior to the *project start*. This baseline will only be applicable through to the end of the eligible crediting period at which time this baseline condition will no

1 Reforestation projects may involve the removal of obstacles to the natural re-growth of trees (e.g., removing livestock from the land to stop grazing).

[2] While some quantification procedures in this protocol are transferable to other project types involving the establishment of trees, the approach to baselines would have to incorporate any expected natural regeneration, regulatory requirements or tree cover among other possible differences in baseline and project activities.

longer be true. Documentary evidence (i.e. Arial Photos) must also be provided to support previous land use 1 year prior to site establishment.

5. Lands which were peat bog (or fen) areas prior to or during the twenty years prior to establishment as confirmed by land-use records, aerial photos, or other means do not qualify for use in this protocol.
6. The Project Developer is responsible for developing an Offset Project Plan to determine the project and the baseline, as well as to document how the project meets all Alberta Offset System and protocol criteria. This Plan must contain a silviculture plan and must have acceptance of concept (sealed by) a Registered Forestry Professional, Professional Agrologist or Professional Biologist.
7. Multiple project sites must be aggregated according to the procedures outline in an Appendix.
8. The quantification of reductions achieved by the project is based on actual measurement and monitoring as indicated by the proper application of this protocol.
9. The project must meet the requirements for offset eligibility as specified in the applicable regulation and guidance documents for the Alberta Offset System. Of particular note:
    1. All sites of a project must be located in Alberta.
    2. The date of the establishment of the project must be on or after January 1, 2002 as indicated by project records. The project start date is defined as the date that trees were planted on a given legal land description or the date when the impediment to natural regeneration is removed (whichever is earlier).
    3. As per offset system guidance, afforestation projects have a longer crediting period to reflect the slower rate of growth of trees. The crediting period for this protocol have been established as one 60 year cycle after which point, the activity is considered reforestation and is no longer eligible for the generation of offset credits. Afforestation projects will maintain a project baseline and project condition for a 20-year crediting period. Project developers that wish to apply for an extension (for an additional 20 years) must submit a written request to Alberta Environment requesting an extension for the project. The letter must include rationale for how the project continues to meet the requirements of the protocol, and continues to be additional (beyond business as usual) for the sector.
    4. Ownership of the emission reduction offsets must be clearly established as indicated by land owner/land lessee agreements or other legally binding arrangement.
    5. Projects must achieve GHG reductions or removals above and beyond any GHG reductions or removals that would result from compliance with any federal, state, or local law, statute, rule, regulation, or ordinance.

Description of how real reductions or removals will be achieved: (The Protocol Developer must ensure the GHG(s) that will be reduced by the activities for this project type are within the scope and criteria of the Alberta Offset System and the Specified Gas Emitters Regulation.)

An afforestation project will achieve GHG removals through the increase in carbon stocks (above and below ground) on the project site as a result of the planting/natural regeneration and subsequent 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, planting, and tending. 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.

All reductions will be based on real measurement (not forecasted) and will be surplus to any regulations.

B.2. Demonstration of Additionality: (The Protocol Developer must demonstrate how real reductions or removals are beyond business as usual. Please provide a summary of how your protocol ensures additionality of offset projects based on sections B.4., B.5., B.6., B.8, B.11., B.12., and B.13. Also include a discussion of whether your project type additionality is impacted by input and/or activity mobility, and/or management decisions influenced by market or social forces.

The baseline condition is considered to be the non-treed land area. The project condition therefore is the conversion of this land to a treed area; of urban land to plantations; conversion to agroforestry; or the rehabilitation of degraded industrial lands, such as mine sites, to forested lands. 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. Also, given the capital-intensive nature of all afforestation projects relative to limited or no expectations of financial return in the early years of a project, afforestation project proponents must only demonstrate that the afforestation project is not required by law in order to demonstrate that the project is additional. Therefore, the reasonable baseline scenarios may range from no management activity to some degree of agricultural activity, from grazing to intensive cultivation.

As with all offset projects, this protocol will apply only to lands which do not have any legislated requirement for re-plant. Lands harvested by commercial forest operations in Alberta, which have mandated regeneration requirements, or lands which have reclamation requirements that stipulate or otherwise require planting trees, do not qualify under this protocol.

This protocol will apply to lands that have been planted (or the impediments to natural regeneration have been removed) on or after January 1, 2002, per Offset System criteria.

B.3. Description of Background Information/Best Practice Guidance Used:

Table 1: Best Practice Guidance

1. Document Title	2. Publishing Body/Date	3. Description
Canada's National Inventory	Government of Canada, 2006	Description of IPCC tier 2 and 3 applications for quantifying GHGs from sectors at a national level.
Draft CFS Afforestation Protocol	Canadian Forest Service with the National Offset Quantification Team	Draft protocol to quantify carbon sequestration in Afforestation projects
Carbon Reserve and Biomass in Canadian Prairie Shelterbelts.	Kort, J. and R. Turnock. 1999. . Agroforestry Systems. 44: 175-186.	Provides quantification of shelterbelts
Canadian national tree aboveground biomass equations.	Lambert, M. C., Ung, C.H., and Raulier, F. 2005. Can. J. For. Res. 35:1996-2018.	Provides quantification of biomass

Sourcebook for Land Use, Land-Use Change and Forestry Projects.	Pearson, T., S. Walker and S. Brown. 2005. (available at: http://www.winrock.org/ecosystems/files/Winrock-BioCarbon_Fund_Sourcebook-compressed.pdf. (accessed on December 10, 2010))	Provides guidance on measurement
Ecologically Based Individual Tree Volume Estimation for Major Alberta Tree Species. Report #1. Individual tree volume estimation procedures for Alberta: Methods of formulation and statistical foundations.	Huang, Shongming 1994. Alberta Sustainable Resource Development. Pub No.: T/288; ISBN: 0-7732-1267-1. Pp 91.	Provides quantification of tree volume
Belowground biomass dynamics in the Carbon Budget Model of the Canadian Forest Sector: recent improvements and implications for the estimation of NPP and NEP.	Zhong, Li, Kurz, Werner A., Apps, Michael J., and Beukema, Sarah J. 2003. Can. J. For. Res. 33: 126-136.	Provides belowground carbon quantification
Biomass equations and carbon content of aboveground leafless biomass of hybrid poplar in Coastal British Columbia.	Zabek, L.M., and Prescott, C.E. 2005.. For. Ecol and Manag. 223: 291-302.	Provides quantification of biomass in Hybrid Poplar
Carbon, Water and Energy Exchanges of a Hybrid Poplar Plantation During the First Five Years Following Planting. Ecosystems	Cai, Price, Orchansky and Thomas. 2011. Published online April 12, 2011.	Hybrid poplar information

B.4. Regulatory, Legal Requirements and/or Government Incentive/Grant Programs:

List of potentially relevant regulations/legal requirements:

It will be necessary to consult Forest, Energy and Environmental regulations in addition to Municipal permits to ensure that an activity is not required.

Timber Quotas/ Licenses/ FMAs – may have requirements to reforest harvested lands, which will therefore not be eligible for this protocol. It should be noted, however, that lands may exist on a landbase which has requirements for reforestation that may still be eligible for afforestation projects. For example, many FMAs have lands such as abandoned industrial sites, etc that should be considered eligible for this protocol if the tenure holder wishes to pursue afforestation projects.

Development permits may require the establishment of trees as part of a reclamation certificate and therefore are not eligible. The Government of Alberta has a set of criteria it has established to assist in the reclamation of wellsites. Project Developers should consult Alberta Environment Guidance on the current reclamation criteria this to ensure that no reforestation requirements exist. http://www.environment.alberta.ca/documents/2010-Reclamation-Criteria-for-Wellsites-and-Associated-

Facilities-for-Forested-Lands.pdf.

Possible future regulations may change the additionality of some projects and therefore it will be necessary to watch for future regulations.

List of potentially relevant climate change incentives:

Feasibility of Afforestation for Carbon Sequestration (FAACS) – Federal Initiative (completed in 2005). The main focus of the FAACS initiative was to evaluate the feasibility of afforestation and undertake information collection and land assessment research on privately owned lands as well as help establish Canada's carbon measurement and accounting infrastructure.

As a component of the AAFC-PFRA Agroforestry Division, the Prairie Shelterbelt Program (PSP) provides technical services and tree and shrub seedlings for establishment of shelterbelts and other agroforestry, conservation and reclamation projects on agricultural and eligible lands in Manitoba, Saskatchewan, Alberta and in the Peace River region of British Columbia. The seedlings provided are an incentive to producers adopting beneficial management practices and environmental stewardship. The aim of the Prairie Shelterbelt Program is to improve the performance and sustainability of the agricultural sector by helping to achieve the social, economic and environmental benefits of agroforestry.

The primary objective of the Forest 2020 initiative was to determine the role plantations can play in helping meet Canada's Kyoto Protocol targets. The capacity for plantations to store carbon in roots, stems, branches and soil will be analyzed. Across Canada some 10 million fast-growing trees were planted on over 6,000 ha of under-used agricultural land. Research studies on plantations, evaluated growth rates, best species-to-site matches and cost-effective establishment techniques.

B.5. Barriers to Implementation: (Review and discuss the barriers impeding the projects outlined in the protocol from being implemented)

The largest barrier to the establishment of plantations is financial. The establishment cost of plantations is cost prohibitive in most cases. In the absence of a no harvest caveat, revenue from plantations be generated from the harvest of trees, however, due to the long growth period, revenue from harvest is often not received until decades in the future. In this protocol, as harvest is not allowed, there is no future revenue associated with the project, and the financial barrier is greater.

The establishment of an afforestation initiative also involves tying up land in a specific use for a number of years. Therefore there is foregone revenue that could have been earned in the absence of the project (i.e. the opportunity cost associated with not producing an annual crop on that land). Verification costs are also expected to be substantial.

The maintenance of an early establishing stand can also be costly as it may be necessary to manage the stand to ensure that the seedlings survive.

B.6. Risks to Implementation: (Review and discuss the risks associated with the protocols project-type and how these risks are being addressed / mitigated)

Permanence [Are emission reductions and/or removals reversible. If so, how does the protocol developer propose to address permanence of Offset Credits associated with this activity?]

The protocol addresses permanence in growing *tree*s by applying a risk based *assurance factor* to account for unintentional *reversal*s of carbon (eg. fire, insect, disease).

Unintentional Reversals

This protocol uses an Alberta specific assurance factor to account for the average risk of reversal across all afforestation projects within a given region. This factor is applied to the above ground carbon sequestered in all projects. Technical experts and the materials listed below 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, which considered cross-subsidy effects across regions and species, the range of data available provided a reasonable basis for concluding that over a creditable life of an afforestation project 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, and thus no further crediting would be eligible, 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, the technical working group agreed that a 90% assurance factor was deemed reasonable and conservative.

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.

International Risk Management Group Ltd. 2005. RFP 05-0906: Report – Tasks 1-4. Natural Resources Canada

Intentional Reversals through Harvest

The protocol requires a legal impediment to exist which addresses the reversal of carbon due to harvest.

The legal impediment must address reversals.

i. **Unintentional Reversals**
   1. If an unintentional reversal occurs as a result of oil and gas exploration and development, utilities expansion, road expansion or
   2. An unintentional reversal occurs as a result of an event beyond the control of the project developer such as a fire or insect or disease outbreak, then any loss in carbon will be accounted for by the pool of offsets arising from the assurance factor; and

ii. Intentional Reversals

1. If an intentional reversal occurs not related to oil and gas exploration, the project developer for the reversal must replace any lost tonnes.

Leakage [Will this protocol result in or threaten leakage of greenhouse gas emissions, and if so, how will these risks be mitigated? Include a discussion on possible scenarios that may occur.]

Negative leakage associated with afforestation activities is minimal. There is minimal potential for the activity of establishing trees where they have not existed previously to result in the loss of cropland. This potential loss could pressure conversion of grassland or forest land into cropland in other areas of Alberta. Typically lands in marginal areas that was better suited for growing trees provided very little value to the landowner in regards to crop production.

Conservativeness [How does the proposed protocol idea address conservativeness in emission reduction quantifications?]

This protocol ensures conservativeness in a number of ways:

1. Use of conservative, peer reviewed biomass equations.
2. Requirement for a legal impediment to ensure permanence of stored carbon.
3. Exclusion of soil carbon although soil carbon is expected to increase as a result of the project.
4. Use of a risk based assurance factor to account for unforeseen reversals of above ground carbon stocks (fire, insect, disease).

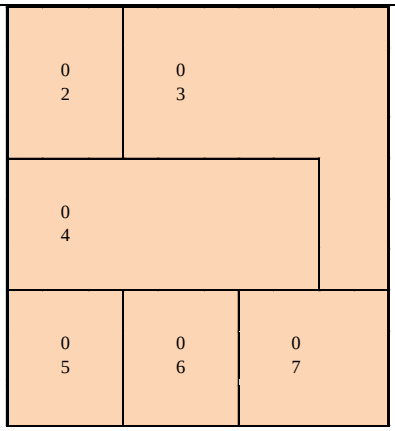
Aggregation [Is this protocol likely to result in aggregated projects? If so, are there risks associated with aggregated projects, and how does the protocol propose to handle these risks?]

Aggregation is possible and in fact very likely. With proper record keeping many of the risks associated with aggregation (i.e. risk of double counting) can be mitigated. As this is a land based protocol, certain records will need to be collected to ensure no double counting (see verification section)

Afforestation projects will likely involve many small plantings rather than one large one. A Project Developer can elect to 'aggregate' – combine together - several newly planted sites into one project (each site meeting all protocol and offset system criteria).

An aggregated project is defined by the **area weighted average** year of propagule planted in any one land area. The area weighted average is the mean in which each planting year being averaged is multiplied by a number (hectares) based on the item's relative importance. The result is summed and the total is divided by the sum of the weights and rounded to the nearest digit. The area weighted average year of afforestation is either the area weighted average of the year that the area was planted, or the year that the impediment to natural regeneration was removed

Table 2: Sample Aggregated Project



Afforestation date	ha	
2002	9	9/100*2002
2003	27	27/100*2003
2004	24	24/100*2004
2005	12	12/100*2005
2006	12	12/100*2006
2007	16	16/100*2007
total	100	Sum = area weighted average year planted

=180+540.81+480.96+240.6+240.72+321.12
=2004

An aggregated project can elect to combine together several newly afforested sites into one project (each site meeting all protocol and offset system criteria), however, by doing so the project start date (and thus crediting period) is defined as the area weighted average year of afforestation.

Verifying an Aggregated Project

Aggregation enables economies of scale by allowing smaller projects to register as part of a group. Aggregation also ensures that the greater statistical uncertainty of an individual project is compensated through aggregation with other projects. In other words, the target sampling error for the individual projects can be increased while still achieving an estimate for the entire aggregate that is +/- 5% of the mean with 90% confidence. Hence, a project within an aggregate requires fewer sample plots to generate a carbon inventory than if it were a standalone project – which results in significant cost savings for the project developer.

The Afforestation Protocol draws on work by the Climate Action Reserve who consulted a number of statisticians in order to maximize the cost savings while ensuring that the entire aggregate achieves an estimate that is +/- 5% of the mean with 90% confidence. The statistical analysis involved rigorous modeling exercises, and the results suggested that the sliding scale shown in Table 3 was appropriate.

For aggregated projects to qualify for the Alberta Offset System the carbon inventory estimate across the entire aggregate must meet the target sampling error of +/- 5% of the mean at the 90% confidence level. However, the target sampling error for individual projects participating within the aggregate must only meet the values shown in Table 3, which are based on the number of projects participating in the aggregate at the time of verification.

Table 3: Target Sampling Error at the 90% Confidence Level for Projects Participating in an Aggregate.

Number of Participating Projects in the Aggregate	Target Sampling Error
2	7%
3	8%
4	9%

5	10%
6	11%
7	12%
8	13%
9	14%
10	15%
11	16%
12	17%
13	18%
14	19%
15+	20%

Source: *Climate Action Reserve, Forest Project Protocol, Proposed Guidelines for Aggregation, 22 April 2010*

Verification *[What types of records are available to support implementation and verification of the proposed activity or project?]*

As this is a land based protocol, which will likely have aggregation (not unlike other land based projects), it is necessary to ensure the project results in real removals and that there is no double counting. It will therefore be necessary to acquire, compile and compare site specific data. Minimal record management will be specified in the protocol and it will be necessary for an impartial body (like the offset project registry) to conduct duplication checks of land areas in a similar manner as the tillage protocol.

Required Records Documentation

The following project related documentation must be collected in order to ensure quantification and verification. Minimum required records are outlined in table 4 below.

Demonstration of Project Eligibility

1. Proof that the *afforestation* project area was non-treed during the 20 years prior to project initiation. Proof is also required that the project does not include any area that was a peat bog or fen during the 20 year period. Evidence may involve the use of archives and/or maps of land use or land cover, aerial photography or satellite imagery if available, or other types of information that could be verified. Supplementary surveys of land-use might also be required in cases where land cover alone is not sufficient to distinguish between forests and non-forests (e.g., bare lands that may be forests due to forest regeneration under way) (UNFCCC, 2005).
2. Demonstrated ownership of the emission reduction offsets must be established as indicated by land owner/land lessee agreements or other legally binding arrangement.

Project Site Documentation

Detailed geographic boundaries defining the project area must be described in the Offset Project Plan at

the time of project registration. Boundaries must be defined using a map, or maps that display public and private roads, major watercourses, topography, towns, ranges, townships, sections or latitude/longitude.

Land Based Requirements

As this is a land based project protocol, which will likely be aggregated in some cases, it is necessary to ensure reductions are verifiable for each project and to ensure that no double counting occurs. It will therefore be necessary to acquire, compile and compare site specific data. Project proponents must provide information about the location of the site, and if the project consists of more than one parcel of land, the location of each parcel must be documented. The location must be described to the extent that a third-party could locate the site without any difficulty. The Project Developer will collect the appropriate information and compile it in the Offset Project Plan which is signed by an expert. At a minimum, the following should be collected:

- Identity of the closest community to the site.
- Global Positioning System (GPS) coordinates of the site perimeter or a legal survey of boundaries. If neither of these two methods are available, it is acceptable to provide the dimensions of the site (length and width in meters; area in hectares) and legal land location where located. When using GPS, record the grid datum and note the format under which all data points were recorded.
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Additional information that may be included:

- Photographs of the site that may assist in locating the site.
- The elevation of the site, either using a portable GPS or from large-scale topographic maps. The elevation should be recorded at the center of the GPS shape file using a 3-D GPS receiver.

The minimum required data for each reporting period is summarized in Table 4. These records must be retained for the life of the project plus 7 years.

Table 4: Minimum Records Required for Verification

Data	Unit	Frequency	Source
Land location	Section, Township, Range, Meridian – or Lat/long based shape	Upon Credit Claim and declared in Offset Project Plan	ATS legal survey Satellite/GPS
Size of Plantation	Hectares	Upon Credit Claim	Aerial Photo, GPS
Species	*Tree* Species	Upon Credit Claim	Timber Cruising/ Permanent Sample Plots
Tree measurements	Diameter Breast Height (cm) Height (m) - optional	Upon Credit Claim	Timber Cruising/ Permanent Sample Plots

B.7. Review of Technology/Scientific Knowledge: (Describe the applicable practice(s) or technology producing the GHG emission reductions and the scope of activities considered for the protocol)

Related Protocols and/or Methodologies [Do other jurisdictions, programs or offset systems have similar or related protocols available, and if so, discuss similarities and differences between the

proposed protocol idea for Alberta relative to other jurisdictions.]
This protocol builds on the 2008 Afforestation protocol developed for the Alberta Offset System drawing heavily from CAR Forest Protocol 3.1.

Protocols in other systems include:

- CAR Forest Project Protocol Development - Version 3.2
- BC Forest Carbon Protocol
- VCS
- CarbonFix Standard
- CDM
- RGGI

References [Provide a list of relevant references.]

See above good practice guidance section

Table 5: Members of the Technical Working Group[3]

Dave Beck	Ainsworth Lumber
Brad Rabie	The Carbon Farmer
Darcie Booth	NRCan
Don Sullivan	Manitoba Conservation
Doug Macaulay	Alberta Agriculture
Jenny Glesson	Ontario Ministry of Natural Resources
Jim McCammond	Alberta Newsprint Company
Kelly Bolitho	Bluesource
Kerrianne Koehler-Munro	Alberta Agriculture
Keith Murray	Alberta Forest Products
Milo Mihajlovich	Incremental Forest Technologies
Peter Graham	NRCan
Robert Hamaliuk	Alberta Environment
Robyn Kuhn	Alberta Environment
Stan Kavalinas	Sustainable Resource Development
Steve Colombo	Ontario Ministry of Natural Resources
Barb Thomas	ALPAC
Tom Tarpey	Peace River Pulp Division (DMI)
Jessica Verhagen	BC Environment
Willi Fast	Forestry Corp
Samuel Elkins	Peace River Pulp Division (DMI)
Jay Anderson	EarthEcon / Alberta Conservation Association

B.8. Review of Existing Projects: (Review of trends and statistics on existing practices/projects in the Alberta and/or Canadian context.)

[3] These members have been consulted at various points in the protocol development process.

Afforestation is not common practice in Alberta. Each year in Alberta, only a few thousand hectares are planted (Toso Bozic, pers. comm., Sept 2010). In fact, many more hectares of lands are cleared of trees on an annual basis than are established voluntarily as treed areas.

National Afforestation database (run by the Canadian Forest Service) -https://nai.nfis.org. According the database, 403.9 ha of plantation were established in AB between 2004 and 2010.

B.9. Summary of Quantification Approaches: (Include a summary of GHG quantification approaches and methodologies. At a broad level, not exact formulae and emission factors, but where formulae will come from, activity data and emission factors, ie. Best Practice Guidance, any special considerations for quantification and gaps in knowledge.)

Quantification of the removals and reversals of relevant sinks and sources (SS's) for each of the greenhouse gases will be completed using the methodologies outlined in the protocol.
Where:

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

$$\text{Emissions}_{\text{Baseline}} = 0$$

$$\text{Emissions}_{\text{Project}} = -\{[\text{Sequestration}_{\text{Above-ground Carbon Reservoir during the period that credits are claimed}} + \text{Sequestration}_{\text{Shrubs during the period that credits are claimed}} \text{(OPTIONAL)}] * (1 - \text{Assurance Factor}) + \text{Sequestration}_{\text{Below-ground Carbon Reservoir during the period that credits are claimed}}\}$$

Emissions $_{\text{Baseline}}$ = sum of the emissions under the baseline condition. All SSs are excluded in the baseline a therefore emissions are assumed to be zero.

Emissions $_{\text{Project}}$ = sum of the emissions under the project condition.

Sequestration $_{\text{Above-ground Carbon Reservoir}}$ = Sequestration under **SS P14** Above-ground Carbon Reservoir the period that credits are claimed[4]

Assurance Factor = Factor which accounts for the possibility of future *reversal* of sequestered carbo [The assurance factor will be provided in an Appendix]

Sequestration $_{\text{Below-ground Carbon Reservoir}}$ = Sequestration under **SS P15** Below-ground Carbon Reservoir during the period that credits are claimed

OPTIONAL: Sequestration $_{\text{shrubs}}$ = carbon contained in shrubs. Quantification procedures are provided in an Appendix.

[4] It is important to distinguish that the credits can only be generated on the carbon that is sequestered during the crediting period claimed. This allows for project developers to periodically claim and sell credits that are sequestered by the project. For example, a project developer can claim credits associated with an *afforestation* project that began in 2002 well before the 60 year project life. In 2020, the project developer could claim credits associated with the carbon sequestered during the period of 2002 through 2020 on that same *afforestation* project (assuming less than 25% disturbance on establishment). Then, in 2036 the project developer could claim credits associated with the carbon sequestered between 2021 and 2036.

Proposed equations for calculating the above and below ground carbon will be included in an appendix to the protocol.

B.10. Other Impacts and Co-Benefits: (Include other air emissions, odours, risks, environmental impacts on vegetation, wildlife, water resources etc.)

Other Benefits

- Contributes to ecological balance of some eco-systems (e.g., parkland, dry mixedwood forest);
- Contributes to biological diversity;
- Acts as catchments for the soil and water conservation;
- Stabilizes soils by increasing interception;
- Prevents floods ;
- Brings soil together and prevents soil erosion;
- Acts as windbreaks;
- Stabilizes the climate; and
- Retains carbon within forest products.

Adverse Effects

- Takes productive land out of the agricultural land base;
- Creates mono-cultures;
- Increases risks of fire and disease.
- There may be an environmental footprint associated with some short rotation intensive culture plantation practice. Some intensive operations may involve frequent tillage, multiple herbicide treatments and mulching that may or may not equal what would have been done under the management regime prior to afforestation.

B.11. Assessment of Baseline Scenarios

Evaluate all possible Baseline Approaches in the list below, and identify which ones are appropriate for the proposed protocol. Justify why each selected Baseline Scenario is appropriate. Justification should relate to why each appropriate Baseline Scenario conservatively and accurately represents "business as usual". Also, justify why the other Baseline Scenarios are not appropriate and are excluded from the Protocol.

TABLE 6: Assessment of Possible Baseline Scenarios

1. Baseline Options	2. Description	3. Static / Dynamic Baseline	4. Accept or Reject and Justify
Historic Benchmark:	*(Typically site-specific and can be constructed to reflect reductions in a base period (such as the average emissions of the previous three year)).* Typical site specific conditions can vary greatly across project types and need to be assessed.	Dynamic	The historic benchmark would be based on the carbon stock levels and activities at the project site prior to project commencement. In the case of an afforestation project, where the project lands have been in a non-forest state for at least 20 years, it is reasonable to expect that the historic non-

			forest state of the land would continue in the absence of the project. Thus, this approach would give a reasonable and conservative estimate of what would be most likely to occur in the absence of the project. Given that in a non-forest state, it is unlikely that there would be any changes to forest carbon at the site over time during the baseline, a static rather than dynamic baseline would be appropriate.
Performance Standard:	*(Assumes the typical emissions profile for the industry or sector is a reasonable representation of the baseline.)*	Dynamic	Rejected as projects vary greatly across the province and can be substantially different. The pre-project land use scenario and conditions would be project-specific, and a performance standard approach would not be suitable.
Comparison-based:	*(Actual measurements of parameters from a control group to compare with the project)*	Dynamic	Could be utilized but not the preferred method. It would be possible to use other non-forest areas with similar land use as the project lands prior to project commencement and subject to similar conditions to the project during the project as a basis for comparison.
Projection-Based:	*(Projections of reductions in the future can use a variety of techniques, from simple straight-line growth assumptions to complex models.)*	Dynamic	**Preferred method** as it takes into account site specific conditions as well as growth over time. Factors are already scientifically established to allow this method. The projection-based approach would involve considering the range of activities that might be undertaken on the project lands in the absence of the project and selecting the most likely scenario. Since it is reasonable to expect

			that the historic non-forest state of the project lands would continue in the baseline, use of a projection-based approach is not appropriate.
Adjusted Baseline:	*(Takes into account current practice levels of a particular project and specified that the same baseline is used for all projects of a certain type, regardless of historical practices.)*	Dynamic	N/A to project type.

B.12. Selection of Baseline Scenario: (For the selected baselines scenario(s) from the above analysis, the Protocol Developer must explain why the Baseline approach is static or dynamic, justify the selection of the most appropriate baseline scenario(s) including references and any assumptions.)

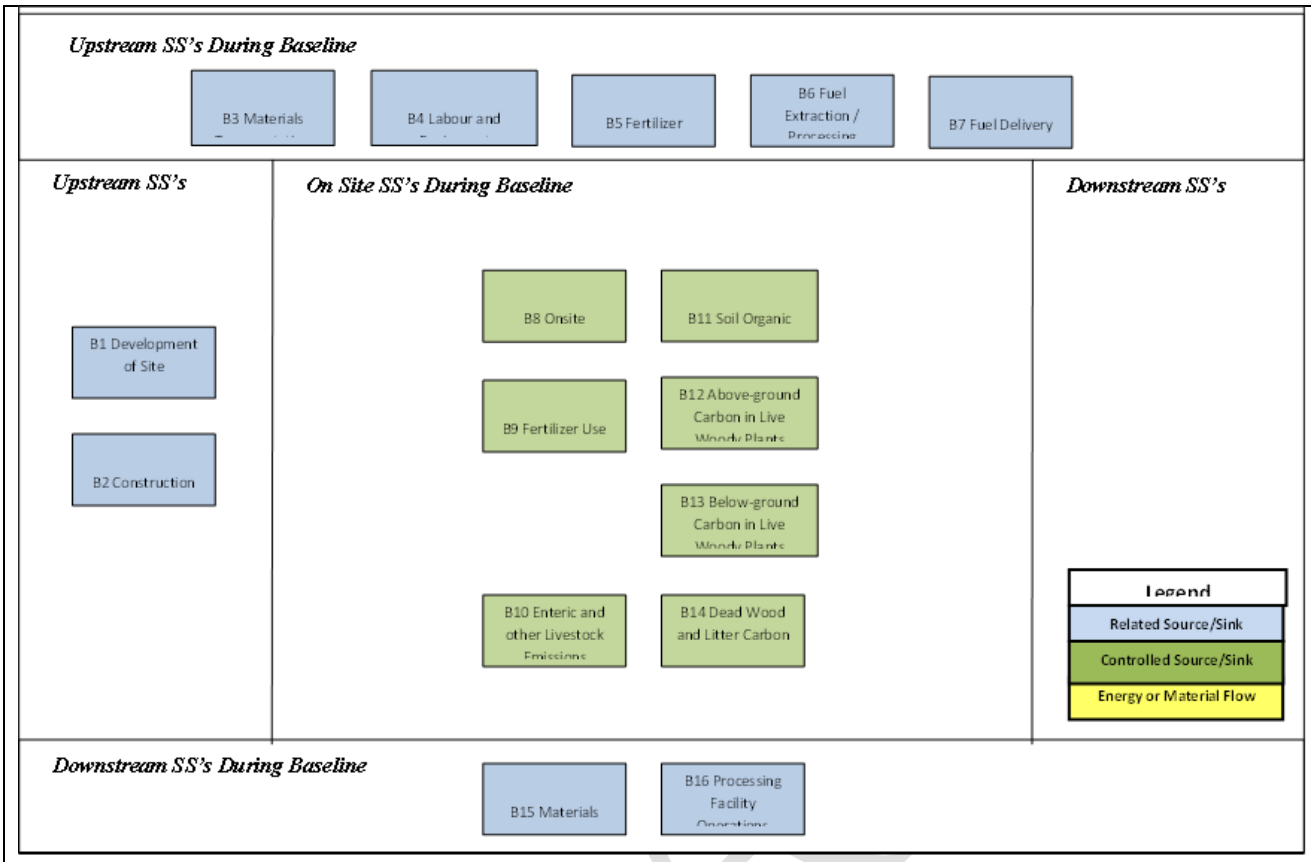
The baseline condition is considered to be the non-treed area under a variety of usages.

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 SS 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: Process Flow Diagram for the Baseline Condition



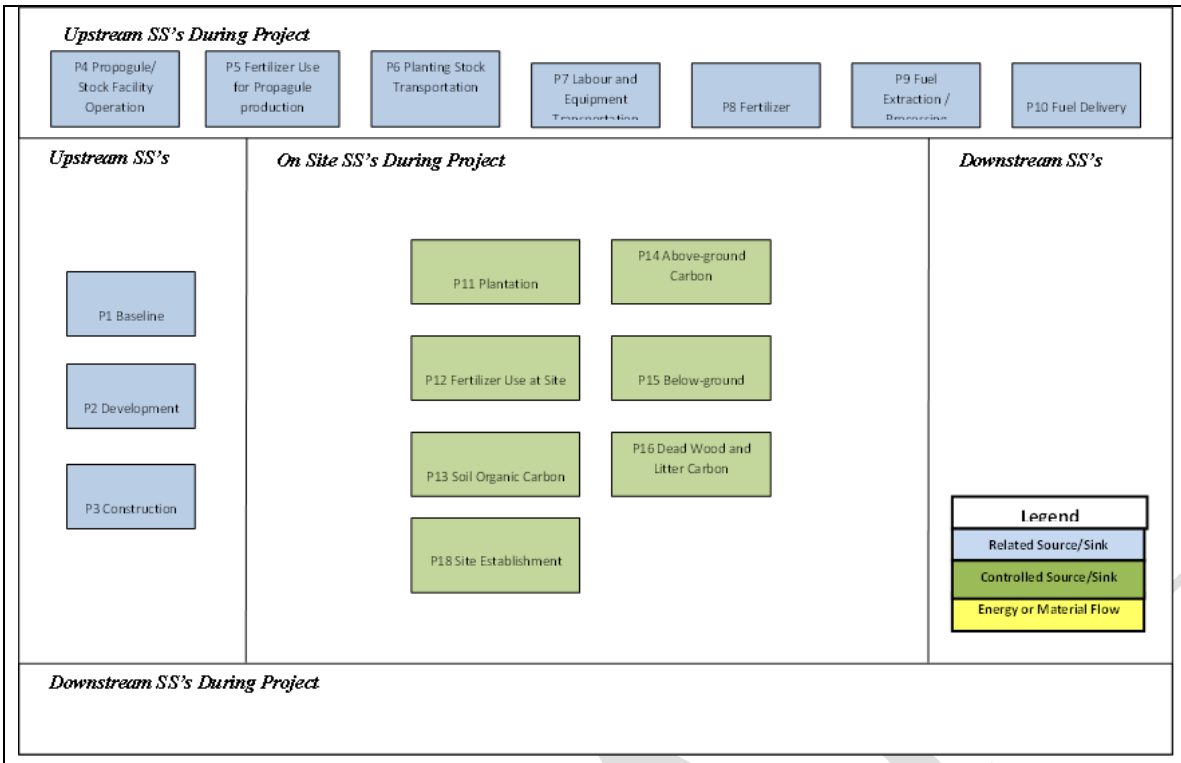
B.13. Definition of the Project Condition: (Define the project condition and justification for the scope of the activity considered.)

The project condition is the planting (or removal of the impediment to natural regeneration), maintenance, growth and harvest of trees on previously non-forested lands. Carbon is quantified in the above ground portion of the tree, the below ground portion of the tree, the option to quantify the carbon in shrubs and herbaceous understory. Quantification uses the total stem volume estimated from the timber cruse together with expansion factors provided to estimate the total carbon.[5] In order to be conservative and ensure the permanency of the project, the protocol discounts for the potential loss of carbon that would occur due to the harvest of trees by taking harvested wood products (the C sequestered in these products) into account.

Proposed changes to the quantification methodology are included at the end of this document.

Figure 2: Process Flow Diagram for the Project Condition

[5] The use of total stem volume differs from the original afforestation protocol in that it allows for the project developer to capture the carbon in early establishing stands as it removes the overlay of merchantability.



B. 14. Functional Equivalence: (Explain and justify how the project and the baseline are comparable in terms of products and/or activity level. This type of comparison requires a common metric or unit of measurement (such as the mass of beef produced, tonne-kilometers traveled, or energy content of fuel volumes in the case of displacing fossil fuels with biofuels)).

The project and baseline condition greenhouse gas emissions will be determined equivalent through units of CO_2e/acre.

B.15. Flexibility Mechanisms: (Explain optional approaches for quantifying the reductions to be achieved from the project type.)

Flexibility in applying the quantification protocol is provided as follows:

1. Project developers can elect to use an Appendix to quantify carbon contained in the biomass of agroforesty projects (such as *shelterbelts* and *riparian buffers*). This quantification approach, based on Kort and Turnock (1999) is equally rigorous to the default approach proposed in this protocol.
2. Project developers may elect to claim offsets from the carbon stored in *shrub*s. A quantification approach for calculating the carbon in *shrub*s will be contained in an Appendix.
3. Projects that do not meet the definition of 'treed area' may still be eligible for use under this protocol. Project developers may choose to claim offsets for project types that are non

continuous, non-linear, silvopasture, alleycropping or areas that provide riparian buffers (as defined in this protocol).

4. Afforestation projects involving species not listed in an Appendix may have eligibility providing the project developer demonstrate sufficient evidence to support the permanence of the claim.
5. Site specific 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 verifiability (such as species specific wood density, etc).
6. This protocol is written for private lands. Project developers can elect establish an afforestation project on public lands if the appropriate Government of Alberta signoff can be obtained.
7. The afforestation protocol can be co-implemented (or stacked) with other approved Alberta Quantification Protocols such as those related to land-use management quantifying soil organic carbon – such as the Quantification Protocol For Tillage System Management (or a perennial forage protocol, if developed).
8. Flexibility in field sampling design, survey techniques and equipment is permitted, provided that the estimates based on statistical samples are within the bounds of accuracy and uncertainty typical of the methods outlined in this protocol. It is necessary for inventory samples (i.e., the estimate of carbon stock accumulated within trees and shrubs) of a project to have a target sampling error of +/-5% of the mean at the 90% confidence level. Details on determining sample plots to ensure this level of confidence can be found in a number of reference materials including Pearson et al., (2005) available at: http://www.winrock.org/ecosystems/files/Winrock-BioCarbon_Fund_Sourcebook-compressed.pdf. If variability between inventory samples is large, then a large number of samples will be necessary to achieve the desired level of accuracy. As a flexibility mechanism the project developer may elect to use less rigorous sampling and use the lower bound of the confidence limits about the mean inventory value. Confidence limits can be calculated using the following formula: CI = $\bar{x} \pm Z * \frac{s}{\sqrt{n}}$ where x = mean sample value, Z is taken from a standard Z table, s is the sample standard deviation and n is the number of samples.

Appendix A: Afforestation Revisions – Technical Background Document and Record of Decisions

1. Change in scope of the protocol to include "the planting of trees, or removal of impediments to natural reforestation" (similar to Climate Action Reserve (CAR)).

During discussions the idea of having a project type where by trees are established by removing impediments to natural reforestation was raised. Reference was made to the Climate Action Reserve Forest Protocol as it allows that project type.

2.1.1.1 The project involves tree planting, or removal of impediments to natural reforestation, on land that:
a. Has had less than 10 percent tree canopy cover for a minimum of 10 years; or
b. Has been subject to a Significant Disturbance that has removed at least 20 percent of the Project Area's live biomass in trees.

Source: Version 3.2 August 2010
The TWG unanimously agreed to include this as a project type.

2. Removal of discount for afforestation projects that create perpetual forests.

Afforestation projects may or may not involve the harvest of trees over the project life. In the event that trees will not be harvested, and a legal instrument (i.e. caveat, etc.) is put in place which ensures that the trees will not be harvested, the **TWG agreed that when a legal impediment exists, it ensures that trees will not be harvested and full above ground carbon can be quantified (minus assurance factor).** In effect, this means that the project will be awarded credits based on the risk adjusted carbon stored in the trees.

(Source: Alberta Land Stewardship Act, 2009, http://www.canlii.org/en/ab/laws /stat/sa-2009-c-a-26.8/latest/sa-2009-c-a-26.8.html)

Registering a Conservation Easement

A conservation easement may be registered
(a) under the Land Titles Act with the Registrar of Titles, or
(b) under the regulations under the Metis Settlements Act with the Registrar of the Metis Settlements Land Registry, subject to any General Council Policy.

A person intending to register a conservation easement must give prior notice of the registration to the following persons, as required:

- the Minister responsible for the Municipal Government Act , if the land that is the subject of the conservation easement is located in an improvement district;
- the Special Areas Board, if the land that is the subject of the conservation easement is located in a special area;
- the council of the municipality or the council of the Metis settlement in which the land that is the subject of the conservation easement is located,
- the Minister of Infrastructure, and
- the Minister of Transportation.

When a conservation easement is presented for registration, the appropriate Registrar must endorse a memorandum of the conservation easement on the certificate of title. Since an afforestation conservation project is meant to retain carbon within the trees and shrubs, this memorandum should contain the restriction that *there be no disturbance (physical or chemical) to any of the vegetation on the land, except for what is required for weed control.*

Participating Parties

A registered landowner may, by agreement, grant a conservation easement to a qualified organization. Here, a "qualified organization" means:

(i) the Government,
(ii) a Government agency,
(iii) a local government body, or
(iv) a corporation that
  (a) has as one of its objects the acquisition and holding of interests in land for purposes that are substantially the same as any of the purposes for which a conservation easement may be granted,
  (b) has in its constating instrument a requirement that, on or in contemplation of the winding-up of the corporation, all conservation easements that the corporation holds are to be transferred to another qualified organization, and
  (c) is a registered charity within the meaning of the Income Tax Act (Canada).

Enforcement of Conservation Easements

A landowner may not designate more than one qualified organization at a time to enforce a conservation easement. The designated qualified organization may assign a conservation easement to another qualified organization, so long as proper documentation is provided (see Alberta Land Stewardship Act 2009). The qualified organization that holds the conservation easement is ultimately responsible for monitoring and enforcement.

Modifying or Terminating a Conservation Easement

A conservation easement may be modified or terminated:
(a) by agreement between the landowner and the designated qualified organization, or
(b) by order of a Designated Minister if the Designated Minister considers that it is in the public interest to modify or terminate the conservation easement.

Risks of Reversibility

A conservation easement is registered on the land title, and stays on title even if the land is sold. If a landowner illegally harvests trees from land with a conservation easement, it

would be a breach of the easement. If such a breach occurred, the landowner would be legally required to replace any previously sold offsets with offsets purchased from the open market (explicitly stated in the conservation easement).

The TWG unanimously agreed to include this as a project type.

3. Treatment of Harvested Wood Products

The TWG could not come to a consensus on the treatment of harvested biomass prior to the February 2011 stakeholder review. At this time, the group elected to make this protocol a default afforestation conservation protocol whereby harvest would not be allowed. Work continues on the development of an afforestation protocol which will allow for harvest.

4. Total Biomass versus Merchantable Volume in Determining Greenhouse Gas Emission Offsets

"Merchantable" volume is the volume that can be turned into products. If one is considering carbon, then branches, leaves, etc. are valuable and merchantable volume will not provide a good estimate of the carbon present in the stand. The previous protocol approach was to use merchantable volume and apply expansion factors to determine the biomass. The revised protocol will be based on Total biomass (including un-merchantable volume such as stump, branches, foliage, etc).

The difference between merchantable volume and total biomass has substantial implications for estimation of total and incremental CO2 capture and storage. Total biomass better reflects the accumulation of carbon over time as merchantable volume acts as an effective “go” – “no go” filter whereby young stands may be growing rapidly and capturing substantial quantities of CO2 but are effectively invisible because the trees have not yet crossed the merchantability threshold. The red circle in the figure below clearly illustrates the filtering action of merchantable volume standards on early capture of CO2 in forest stands. This is particularly problematic with the slow growth rates associated with boreal forests as the slow growth rates effectively increase the interval to merchantability and hence delay forest “owners” realizing any offset values accruing to improved or enhanced forest management.

Biomass equations are taken from Lambert et al. (2005). This peer-reviewed paper provides two sets of equations based on CFS research across Canada – definitely applicable beyond Alberta. The first set of equations is for use when diameter at breast height (DBH) data is available. The second set of equations can be used when DBH and height data are available. According to Lambert et al. (2005) both are accurate as the role of height is significant but secondary after DBH for predicting stem biomass components.

Table 7: Biomass Equations from Lambert et al., (2005)

DBH Based Equations (Equation Set 2 in Lambert et. al., (2005)	DBH and Height Based Equations (Equation Set 3 in Lambert et. al., (2005)
$y_{wood} = \beta_{wood1} D^{\beta wood2} + e_{wood}$	$y_{wood} = \beta_{wood1} D^{\beta wood2} H^{\beta wood3} + e_{wood}$
$y_{bark} = \beta_{bark1} D^{\beta bark2} + e_{bark}$	$y_{bark} = \beta_{bark1} D^{\beta bark2} H^{\beta wood3} + e_{bark}$
$y_{stem} = \hat{y}_{wood} + \hat{y}_{bark} + e_{stem}$	$y_{stem} = \hat{y}_{wood} + \hat{y}_{bark} + e_{stem}$
$y_{foliage} = \beta_{foliage1} D^{\beta foliage2} + e_{foliage}$	$y_{foilage} = \beta_{foliage1} D^{\beta foliage2} H^{\beta foliage3} + e_{foliage}$

$y_{branches} = \beta_{branches1} D^{\beta branches2} + e_{branches}$	$y_{branches} = \beta_{branches1} D^{\beta branches2} H^{\beta branches3} + e_{branches}$
$y_{crown} = \hat{y}_{foilage} + \hat{y}_{branches} + e_{crown}$	$y_{crown} = \hat{y}_{foilage} + \hat{y}_{branches} + e_{crown}$
$y_{total} = \hat{y}_{wood} + \hat{y}_{bark} + \hat{y}_{foliage} + \hat{y}_{branches} + e_{total}$	$y_{total} = \hat{y}_{wood} + \hat{y}_{bark} + \hat{y}_{foliage} + \hat{y}_{branches} + e_{total}$

The DBH equations must be populated using a Table provided in the protocol; and the DBH and height based equations must be populated using a Table provided in the protocol. Both tables are taken directly from Lambert et al. (2005). Using field measurements of the appropriate statistical significance, these equations and tables can be used to quantify the biomass of 33 tree species.

Note: The equations generate values for dry biomass in kg. D is DBH (in cm) and His height (in m).

5. Belowground Carbon Expansion Factors

Expansion equations take the volume in the tree and put it in an equation to determine the portion of biomass in the branches, tops, leaves and bottoms. These will serve as default equations for use in the protocol.

By explicitly calculating the biomass in the various components of the trees (i.e. the branches) this approach should facilitate the co-implementation of this protocol with the biomass protocol. This approach will increase the strength of the protocol by increasing transparency of the calculations.

Belowground biomass equations are taken from Zhong et al. (2003). This peer reviewed paper provides two equations (pg: 130) for estimating belowground root biomass. One of the equations is for softwoods and one is for hardwoods.

RBs = 0.222ABs

RBh = 1.576ABh0.615

Where: RB is root biomass in t / ha; AB is total aboveground biomass in t / ha; the subscript s is softwood; and the subscript h is hardwood.

Note: These formulas use the value for total aboveground biomass as calculated in the Lambert et al. (2005) equations shown above. It is important to ensure that the values for total aboveground biomass is converted from kilograms to tonnes.

6. Treatment of Soil Carbon over the lifespan of the crop

Proposed Afforestation Protocol Technical Position Statement.

Position: The afforestation protocol will conservatively exclude soil carbon changes over the lifespan of the tree crop duration. Much scientific literature exists that shows us there is a reasonable expectation that soil carbon accumulation will occur during the lifespan of a plantation.

Context: During the initial establishment years of the trees (from 0 to 5) minimal cultivation is allowed to control invasive species that may compete with young trees. The land is typically not disturbed during the rest of the growth period.

Rationale:

1. Canadian GHG inventory: National Carbon and Greenhouse Gas Accounting and Verification System (NCGAVS) uses a positive sequestration coefficient for soils under afforestation. The coefficient used is that used for forage land. This is conservative since the trees are not included in the calculation and the area between tree rows is the forage area.

2. Clean Development Mechanism, CDM: The CDM takes a global, conservative approach that allows some tillage during establishment years and does not allow credits for C sequestration (CDM, 2007). Their guidance is for both afforestation as well as reforestation. The area cannot include organic soils, minimal vegetation disturbance and requires little tillage disturbance. The CDM stipulates "Changes in the carbon stocks of the mineral soil component of the soil organic carbon pool may be conservatively neglected in CDM A/R projects..." when carbon changes are recalculated for projects on mineral soils where steady state soil C is assumed.

Literature:

Bambrick (2009) working on afforestation projects in Ontario found that over the length of the project the amount of carbon stored will reach or exceed the amount of carbon initially released from planting and establishment.

Post and Kwon (2000) reviewed research studies around the world to determine soil carbon changes after trees were established on agricultural land. In the cool temperate moist region, twelve of fourteen sites showed positive soil C gain with tree plantings.

These studies include disturbance of the soil during the stand establishment years.

Paul et al (2002) synthesized global literature (43 sites) on afforestation of agricultural land and found a general decrease in soil C during establishment followed by a steady increase in soil C for at least 30 years. Previous land use had more of an impact than climate with cropland having a larger increase in soil C that pastureland which sometimes had a small decrease. The most soil C accumulated under short duration hardwoods in warm climates. The least accumulation was under pine plantations. Overall the average change in soil C was 0.14 T/ha/yr, small compared to the aboveground C changes.

The Climate Action Reserve (California) commissioned a white paper on soil carbon changes from forestry activities and found that no soil carbon changes were affected under normal harvest conditions (Climate Action Reserve, 2010). Whole tree harvesting reduced soil C while saw log harvesting did not. The longer the tree growth period, the greater the assuranc e of recovering the soil C status. Subsequent public review emphasized the need to measure soil C changes in order to get credit for positive soil C changes (Climate Action Reserve, 2011). Since Alberta considers all sources of greenhouse gas emissions it might be worthy to note some work from Australia found that nitrous oxide and methane emissions reduced when pastures were afforested (Allen etal., 2009).

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