CLIMATE ACTION RESERVE

Updated Forest Project Protocol

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Abbreviations and Acronyms

BAU	business as usual
C	carbon
CDM	Clean Development Mechanism: an arrangement under the Kyoto Protocol allowing industrialized countries with a greenhouse gas reduction commitment (called Annex B countries) to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries.
CER	Certified Emission Reduction: climate credits (or carbon credits) issued by the Clean Development Mechanism (CDM) Executive Board for emission reductions achieved by CDM projects and verified by a DOE under the rules of the Kyoto Protocol.
CH_4	methane
CO_2	carbon dioxide
CRT	Climate Reserve Tonne
EJ	environmental justice: refers to inequitable environmental burdens born by groups such as racial minorities, women, residents of economically disadvantaged areas, or residents of developing nations
FIA	Forest Inventory Assessment [http://fia.fs.fed.us/program-features/rpa/]
FPP	Forest Project Protocol
FVP	Forest Verification Protocol
GHG	greenhouse gas
GRP	General Reporting Protocol
HFC	hydrofluorocarbon
lb	pound
IFM	Improved Forest Management
N_2O	nitrous oxide
PFC	perfluorocarbon
PF	Professional Forester, in the case of California a 'Registered Professional Forester'

PIA	Project Implementation Agreement
Reserve	Climate Action Reserve
RPF	Registered Professional Forester, a person registered to practice professional forestry in California
SF_6	sulfur hexafluoride
SSR	sinks, sources, and reservoirs
USFS	United States Forest Service

1 Introduction

The Forest Project Protocol (FPP) of the Climate Action Reserve (the Reserve) provides guidance to account for and report greenhouse gas (GHG) emission reductions associated with forest projects. The protocol provides eligibility rules, methods to calculate reductions, procedures for assessing risks, and approaches for long term monitoring and reporting. The goal of this protocol is to facilitate the creation of GHG emission reductions and ensure that they are calculated in a complete, consistent, transparent, accurate, and conservative manner.

The Reserve is a private non-profit organization that develops and promotes GHG reporting standards and tools for organizations to measure, monitor, third-party verify, and reduce their GHG emissions consistently across industry sectors and geographical borders. In addition, the Reserve tracks and registers voluntary projects that reduce emissions of GHGs.

Only those forest projects that are eligible under and comply with the FPP may be registered with the Reserve. A separate, but related protocol, the Reserve's Forest Verification Protocol (FVP), provides guidance to approved forest verifiers for conducting verification of project activities and the quantification of GHG emission reductions reported to the Reserve.

1.1 About Forests, Carbon Dioxide and Climate Change

Forests have the capacity to both emit and sequester carbon dioxide (CO_2), a leading greenhouse gas (GHG) that contributes to climate change. Trees, through the process of photosynthesis, naturally absorb CO_2 from the atmosphere and store the gas as carbon in their biomass, i.e. trunk (bole), leaves, branches, and roots. Carbon is also stored in the soils that support the forest (i.e. forest soil), as well as the understory plants and litter on the forest floor. Wood products that are harvested from forests can also provide long term storage of carbon.

When trees are disturbed, through events like fire, disease, pests or harvest, some of their stored carbon may oxidize or decay over time releasing CO_2 into the atmosphere. The quantity and rate of CO_2 that is emitted may vary, depending on the particular circumstances of the disturbance. Thus, depending on how forests are managed or impacted by natural events, they can be a net source or a net reservoir of CO_2. In other words, they may have a net negative or net positive impact on the climate.

However, through sustainable management and protection, forests can also play a positive and significant role to help address global climate change. The Reserve's Forest Project Protocol (FPP) is designed to address the forest sector's unique capacity to sequester, store, and emit CO_2 and to facilitate the positive role that forests can play to address climate change.

1.2 Forest Project Protocol Update Process

This Forest Project Protocol (Version 3.0, June 2009) is the result of over a year and a half of discussion by a dedicated work group. The multi-stakeholder work group began meeting with the explicit task of updating the forest protocols to:

- Allow greater landowner participation, particularly publicly-owned lands and industrial working forests.
- Make improvements to the protocols' clarity, accuracy, conservatism, environmental integrity, and cost-effectiveness (where doing so does not infringe on other principles).

Additionally, the framework of the protocol update is designed to allow the protocols to be used beyond California's boundaries with minimal additional analysis. The intent of this effort is to provide a forest protocol that can be applied to an extensive geographic area for generating high-quality GHG offsets for use in the voluntary market.

The Reserve uses a very rigorous, open, and comprehensive process for developing all of its protocols and is primarily focused on accuracy and conservative GHG accounting to ensure that the resulting emission reductions meet the tests of being clearly real, permanent, additional, verifiable, and enforceable. The Reserve may update the FPP occasionally to reflect new scientific findings or policy direction. For additional information about the update process and further news on future updates, please visit the Reserve website at www.climateactionreserve.org. Clarification about CRTs verified under previously adopted versions of the FPP is currently provided on the Reserve's website. Language related to this issue is also found in the Reserve's Program Manual.

2 Forest-Based GHG Projects

For the purposes of the FPP, a forest project is a planned set of activities to remove, reduce or prevent CO_2 emissions in the atmosphere by conserving and/or increasing forest carbon stocks.

2.1 Eligible Forest Project Types and Definitions

In the future, the Reserve may consider additional project activities that may be reported and verified by the Reserve. At this time, the Reserve will register only the following types of forest project activities.

2.1.1 Reforestation

A Reforestation Project must have been previously forested but have had less than 10% tree canopy cover for a minimum time of ten years, or have been subject to a recent significant disturbance that has removed at least 20% of the above-ground live biomass. The significant disturbance on the proposed project area shall not be the result of intentional or grossly negligent acts of the landowner. Reforestation Projects are only eligible if there is no consideration of sawtimber harvest within the first 30 years of the project or the baseline analysis. This project type may apply to both private and public lands.

2.1.2 Improved Forest Management

An Improved Forest Management Project is based on forest management activities that increase forest based sequestration and/or decrease forest based emissions in the project area compared to established 'common practice' over the project life. A standardized methodology for assessing 'common practice' is described in Section 6 of this protocol. An Improved Forest Management Project must employ natural forest management practices which are described in Section 3 of this protocol. This project type may apply to both private and public lands.

2.1.3 Avoided Conversion

An Avoided Conversion Project is the act of removing a significant conversion threat to a non-forest use and dedicating the forest to continued forest use and forest cover. The project area may include harvesting in the future as part of the project activity.

2.2 Project Developers

A Project Developer may be a “forest entity”, or an independent third-party who carries out the design and/or implementation of a forest project on behalf of a forest entity. While a third-party Project Developer may design and implement the forest project, the forest entity must be identified in project information reported to the Reserve. A forest entity must own the trees within the project area in order for the project to be eligible for registration with the Reserve.

A Project Developer may also carry out the design and/or implementation of an ‘aggregated” forest project on the combined acreage of several entities. Multiple entities can aggregate projects to reach an economy of scale and one representative may do the aggregation and report, so long as all the entities’ names and information are also listed. The Reserve will develop guidance for aggregation after completing this version of the FPP.

3 Forest Project Eligibility Criteria

A forest project must meet a specific set of criteria to be eligible for reporting and verification in the Reserve.

3.1 Additionality

The Reserve will register only projects that yield GHG reductions that are above and beyond any carbon stocks that would have occurred under “business as usual”, where the climate change mitigation benefits of an activity are presumably not considered.

Under the FPP, any registered project credits must meet a test of “additionality” determined by using a rigorously defined quantitative baseline estimate of business-as-usual carbon stocks on lands affected by the project activity. A Project Developer will estimate the project baseline utilizing standardized assessments reflecting legal, physical, and economic factors that influence changes in carbon stocks on project lands over time, as well as management practices that are present on lands with similar environmental conditions within a project’s assessment area. Net increases in carbon stocks caused by the project activity relative to the baseline will result in creditable GHG reductions. The specific requirements for developing baseline carbon stocks for each type of eligible project activity are contained in Section 6.

3.2 Project Start Date

The start date of a forest project, and its corresponding baseline, is determined by the date on which an eligible project, (as defined in Section 2.1), begins an action that over the project life increases the sequestration or decreases the emissions relative to the baseline activity. This is not the same as submission or listing dates which are associated with formalizing a project with the Reserve. The following actions identify the project start date for each project type:

- For a Reforestation Project, the action is the planting of trees, or site preparation for the planting of trees, whichever comes first.
- For an Improved Forest Management Project, the action is the point at which forest management activities are initiated that increase sequestration and/or decrease emissions relative to the baseline.
- For an Avoided Conversion Project, the action is the act of committing the project area to continued forest management and protection.

Until 12 months after the adoption of the updated protocol, a Project Developer may list a project that has a project start date as early as 2001 if all the necessary information can be provided to meet the requirements of this protocol. Project baseline data for each consecutive year following the project start date must be reported to the Reserve and verified. After the 12-month period, projects must be listed on the Reserve within 6 months of their project start date.

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 (see Section 7.2). The start date for the new project will be determined by implementation of the new project activity.

3.3 Project Implementation Agreement

To be eligible, each project is required to enter into a Project Implementation Agreement (PIA) with the Reserve. The Project Implementation Agreement (PIA) is an agreement between the Reserve and a landowner setting forth: (i) the landowner's obligation (and the obligation of its successors and assigns) to comply with the Forest Project Protocol established by the Reserve for a term commensurate to meet the permanency definition in the FPP, and (ii) the rights and remedies of the Reserve in the event of any failure of landowner to comply with those obligations.

If a conservation easement, or any other deed restriction, is used in addition to the Project Implementation Agreement (PIA), the conservation easement/deed restriction must be recorded no sooner than a year before the project start date as a demonstration that any limits to forest management defined in the conservation easement/deed restriction are intended to support the project activity. If the conservation easement was recorded more than one year prior to the start date, the limits described in the conservation easement must be considered as a legal restriction in the baseline analysis. In the specific case of an Avoided Conversion Project the protocol requires the use of a conservation easement or transfer to public ownership.

While forest projects on public lands are required to enter into Project Implementation Agreement (PIA) with the Reserve, they are exempt from the need to utilize either a deed restriction or conservation easement, since the risks of conversion, and land transfers to private parties is low and done in a process incorporating public review.

3.4 Project Location

All forestry-based GHG projects located on public or private lands in the United States of America are eligible to register with the Reserve, provided they meet all other eligibility requirements described in this document. Prior to implementing a project through the Reserve, all public land entities shall have the project, including the project baseline, approved by an authority of the state or federal agency responsible for management activities on the land. This approval includes any accompanying public vetting processes associated with the applicable management and policy decisions connected to project activity.

The framework of the FPP update is designed to allow the protocols to be used beyond California's boundaries with minimal additional analysis. The intent of this effort is to provide a forest project protocol that can be applied to an extensive geographic area for generating high-quality GHG offsets for use in the voluntary market. Inclusion of projects from other states will require expanded tools for measurement and analysis. Approved equations and models will be added as they are developed and/or reviewed for each region. The methods required by this protocol for estimating baseline carbon stocks for forestry projects cannot currently be applied outside the United States, as they rely on U.S.-specific data sets and models.

3.5 Use of Native Species and Natural Forest Management Practices

Forest projects should create both long-term climate benefits and provide other environmental benefits. Under the FPP, project activities will achieve climate benefits and will also improve and/or sustain natural ecosystem processes. Forest projects, and their associated forest entity, must demonstrate environmentally responsible long-term forest management under one of the following options:

- If and when commercial harvesting occurs in the project area, certification under a nationally-recognized third-party forest management certification program in which the certification standards require adherence to and verification of harvest levels which can be permanently sustained over time. If and when commercial harvesting occurs, operating under a renewable long-term management plan that demonstrates harvest levels which can be permanently sustained over time and that is sanctioned and monitored by a state or federal agency.
- For entities of 1000 acres or less, operating with uneven aged silvicultural practices and canopy retention averaging ≥ 40% across the forest.

Additionally, all forest projects must promote and maintain a diversity of native species and utilize natural forest management, as described below.

3.5.1 Promotion and Maintenance of Native Species

All forest projects are required to establish and/or maintain forest types that are native to the project area. For the purposes of this protocol, native forests shall be defined as those forests occurring naturally in an area, as neither a direct nor indirect consequence of human activity post-dating European settlement. Appendix D provides required references by State for the determination of defining native forests. If a state/regional reference is unavailable or inadequate, the Project Developer shall provide documentation from a state botanist or other qualified independent resource, recognized as expert by academic, private and government organizations, that the project meets the definition above. Where supported by scientific peer-reviewed research, the planting of native species outside of their current distribution is allowed as an adaptation strategy due to climate change.

Forest projects, regardless of project type, shall incorporate natural forest management. The evaluation worksheet provided in Table 3.1 shall be used to determine if the project meets the criteria of natural forest management. Natural forest management is defined as silvicultural treatments that promote and maintain native forests comprised of multiple ages and mixed native species at multiple landscape scales. Conformance with this requirement can be evaluated on as small a project as a harvest unit, of less than 40 acres, or a project encompassing a watershed spatial scale up to a maximum of 10,000 acres. If a project encompasses several or many watersheds, then the natural forest management requirement must be met for every 10,000 acres.

The following key requirements shall apply to projects regardless of the silvicultural or regeneration methods that are used to manage or maintain the forest:

1. Maintain or increase the stocking of live native trees over the project life, except for cases, as described in Section 3.5.2, which include exceptions for increasing resiliency, balancing age classes, silvicultural cycles on small ownerships, and non-harvest disturbances.
2. Maintain or make progress towards native tree species composition and distribution consistent with the forest type and forest soils native to the assessment area.
3. Manage the distribution of habitat/age classes and structural elements to support functional habitat for endemic plant and wildlife species.

Projects that initially meet the natural forest management criteria will maintain this requirement over the course of the project life. Projects that do not meet the natural forest management criteria but demonstrate that management will make progress towards and meet these criteria during the project's life are eligible to register credits on the Reserve.

For all projects, the following evaluation must be completed and verified at the project's initiation and at each subsequent verification cycle for all projects. Project carbon stock inventories are to be used as the basis of the assessments where applicable.

Table 3.1 Evaluation criteria to test if a forest project meets the requirement for the establishment and maintenance of native species and natural forest management

Criteria	When Assessed	Results of not passing criteria	Application Rules
Native Species			
Project consists of at least 95% native species based on the sum of carbon in the standing live pool.	Assessed at project initiation	Project is not eligible unless demonstrated that management will achieve this goal over the project life.	Applies to all project types throughout the project life
	Assessed during project	100% of reductions generated during period are withheld until the criterion is met unless project is demonstrating continued progress toward goal.	
Composition of Native Species			
Improved Forest Management and Avoided Conversion Projects Where the forest project site naturally consists of a mixed species distribution, no one species standing live carbon can be more than the value of standing live carbon shown under the heading 'Composition of Native Species' in the Assessment Area table in Appendix F. **Reforestation** To the extent seed is available, and/or physical site characteristic limit, reforestation projects must plant a mixture of species such that no one species can be more than the value shown under the heading 'Composition of Native Species' in the Assessment Area table in Appendix F	Assessed at project initiation	Project is not eligible, unless it is demonstrated that management activities will enable this goal to be achieved over the project life.	Applies to all project types throughout the project life
	Assessed during project	100% of reductions generated during period are withheld until the criterion is met, unless it is demonstrated that the project is making progress toward this goal.	
Distribution of Age Classes/Sustainable Management			
The forest, including entity lands outside project area, is currently under one of the following: 1. Under a nationally-recognized third-party program in which the certification standards require adherence to and verification of harvest levels which can be permanently sustained over time, or 2. Operating under a renewable long-term management plan that demonstrates harvest levels which can be permanently sustained over time and that is sanctioned and monitored by a state or federal agency, or 3. For entities of 1000 acres or less, restricted to uneven aged silvicultural practices and canopy retention averaging > 40% across the forest.	Assessed at project initiation	Project is not eligible	Applies to all project types if and when commercial harvesting occurs
	Assessed during project	100% of reductions generated during period are withheld until the criteria is met, unless demonstrated that management will achieve this goal over the project life.	
Structural Elements			
Project carbon in standing dead wood will not actively be reduced.	Assessed during project	100% of reductions generated during period are withheld until the criteria is met, unless demonstrated that management will provide for this structural element or processes that produce these structural elements over the project life.**	Applies to all project types throughout the project life

*The withheld reductions will be distributed back to the landowner once it can be demonstrated that the project is in compliance with the criteria. This is intended to be an incentive to ensure the minimal standards are maintained.	
** The withheld reductions will be distributed back to the landowner once it can be demonstrated that the project is in compliance with the criterion. This is intended to be an incentive to ensure the minimal standards are maintained. Decreases in inventories of lying dead and standing dead associated with a natural significant disturbance are allowed.	

3.5.2 Promotion of On-Site Standing Live Forest Carbon Stocks

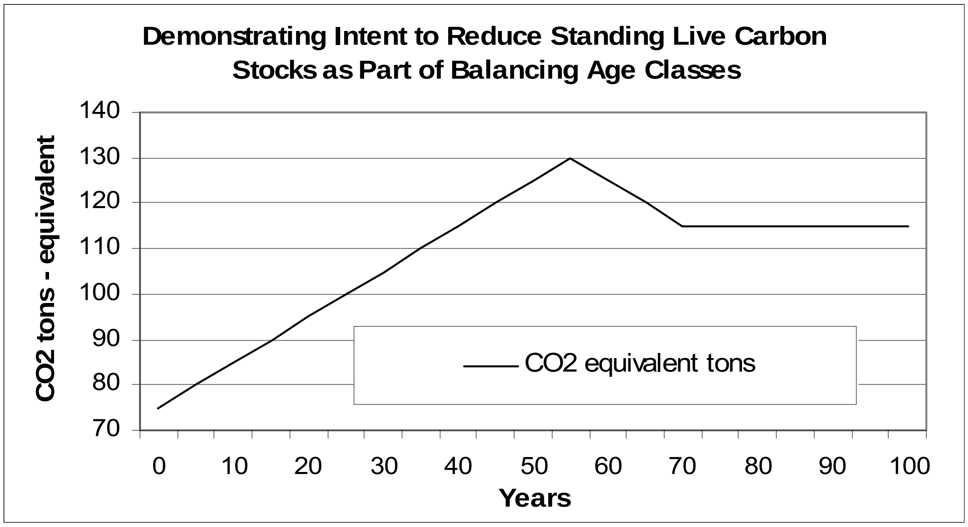
In an effort to promote and maintain the environmental integrity of forest projects, the Reserve requires, regardless of the overall trend in the sum of the total carbon pools, that the standing live (live tree) portion of a project's carbon stocks is maintained and/or increased during the project life. Therefore, emissions reductions will not be credited to a project or registered on the Reserve where annual monitoring results show a decrease in the standing live pool.

Exceptions to this policy are detailed below and include where decreases are important for maintaining and enhancing forest health, environmental co-benefits, long-term security of carbon stocks, or due to non-harvest disturbances. Note these are exceptions related to the policy concerning registration of credits on the Reserve, and in all cases, reversals, regardless of cause, need to be accounted for and compensated per the guidelines in Section 7.

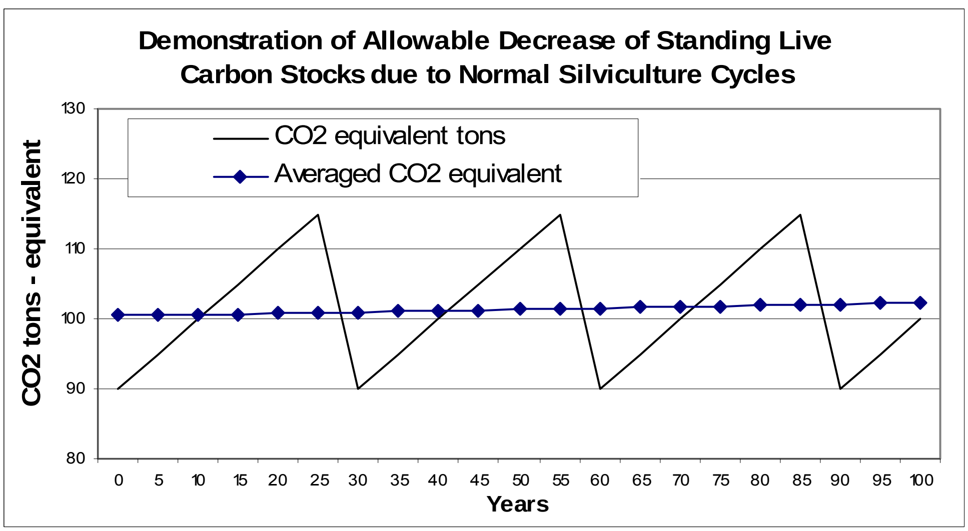
Emissions reductions will not be registered on the Reserve where annual monitoring results show a decrease in the standing live pool unless one of the following four circumstances apply:

1. The decrease is demonstrably necessary to substantially improve the resistance to wildfire, insect, or disease risks. The Project Developer must present and document the risks and the actions that will be taken to reduce the risks. The techniques used to improve resistance must be supported by relevant published peer reviewed research.

2. The decrease is associated with a planned balancing of age classes (regeneration, sub-merchantable, and merchantable) and as is detailed in a long term environmentally responsible management plan. The projected project activity stocks declared at the project's submission must demonstrate that the balancing of age classes, resulting in a decrease in the standing live pool, was planned at project initiation.



3. The decrease is part of normal silviculture cycles for forest ownerships less than 1000 acres. The projected project activity stocks declared at the project's submission must demonstrate that the silviculture activity was planned and that the average standing live forest stocks do not decline over successive harvest entries during the life of the project. Additionally, the actual project stocks shall not be less than what was declared from modeling the project at the project's initiation. In the example below, the project activity has demonstrated that the average stocks do not decline over the project life. Averaged project stocks (CO2 equivalent) must remain stable or increase throughout the project life.



4. The decrease is part of a non-harvest disturbance (e.g., wildfire, disease, flooding, windthrow, etc.).

4 Identifying a Forest Project's Geographic Boundary

The geographic boundary of a forest project must be defined at the time the project is listed. This shall be conducted using a map that displays public and private roads, major watercourses, topography, towns, and public land survey Townships, Ranges, and Sections. The project can be contiguous or separated into tracts. For improved forest management projects, the geographic area cannot extend beyond the boundaries of an assessment area by more than 5% of the project's total area (see Glossary). An improved forest management project that involves activities in multiple assessment areas must be submitted as a series of separate projects (one project for each assessment area).

5 Defining a Forest Project's GHG Assessment Boundary

The GHG Assessment boundary include the carbon sources, sinks, and reservoirs that quantify the total GHGs produced or sequestered directly and indirectly from the activities involved in a forest project. Project-level reporting in this protocol addresses forest carbon stocks, biological CO_2 emissions, and mobile combustion emissions. The reporting of other types of GHGs, as identified by the Kyoto Protocol,[1] is optional for forest projects at this time.

5.1 Accounting for Primary Effects[2]

The "primary", or intended, effect of forestry-based GHG projects will be either a net increase in forest carbon stocks due to increased removals of CO_2 from the atmosphere (reforestation and forest management projects), or a net reduction in CO_2 emissions from harvesting, clearing, or other disturbance of forest carbon stocks (forest management and avoided conversion projects).

Table 5.1 provides a comprehensive list of all GHG pools that must be included in the primary GHG reporting for forestry projects

Table 5.1. GHG Primary Effects - Required and Optional Reporting

GHG ASSESSMENT BOUNDARY - PRIMARY EFFECTS						
Category	Carbon Pool	Type	Forest Management	Reforestation	Avoided Conversion	Determination of Value
Living biomass	Above-ground living Biomass	Reservoir	Required	Required[1]	Required	Sampled in Project
	Below-ground living biomass	Reservoir	Required	Required[1]	Required	Calculation based on above ground sampling
	Shrubs and Herbaceous Understory	Reservoir	Optional	Required	Optional	Sampled in Project

[1] The six GHGs identified by the Kyoto Protocol are: carbon dioxide, nitrous oxide, methane, hydroflourocarbons, perflourocarbons, and sulphur hexafluoride.
[2] The terms "primary effect" and "secondary effect" come from WRI/WBCSD 2005. The Greenhouse Gas Protocol for Project Accounting, World Resources Institute, Washington, DC, Chapter 5. Available at http://www.ghgprotocol.org.

On-site Dead biomass	Standing Dead Biomass	Reservoir	Required	Required	Required	Sampled in Project
	Lying Dead Wood	Reservoir	Optional	Optional	Optional	Sampled in Project
	Litter	Reservoir	Optional	Optional	Optional	Sampled in Project
Soil	Soil[2]	Reservoir	Optional	Optional	Optional	Sampled in project
Off-site dead biomass	Wood Products	Reservoir	Required	NA	Required	Decay calculation from volume of harvested wood

1. Existing trees are not considered a part of a reforestation project initially, but must be tracked over time to keep separate from regeneration. Since residual and new trees are easy to identify for several decades, this may be done at the first inventory in which the project is seeking verified reductions.
2. Soil carbon is not anticipated to change significantly due to forestry activities, however, exceptions may exist including deep ripping or significant soil erosion.

5.2 Accounting for Secondary Effects

Forest projects may also have secondary, or unintended effects on GHG emissions, including CO_2 mobile emissions associated with site preparation as well as CO_2 emissions from tree harvesting displaced by the project to other forest sites often referred to as "leakage". Projects are required to account for any activity- shifting leakage or increase in greenhouse gas emissions caused by a project outside of its geographic boundaries. Section 6 provides methods that address the risk of leakage for each project type. A project's estimate of leakage results in a net reduction of the increases in carbon stocks associated with a project. Table 5.2 provides a list of the categories of secondary GHG reporting for forestry projects.

Table 5.2. GHG Secondary Effects - Required and Optional Reporting

GHG ASSESSMENT BOUNDARY - SECONDARY EFFECTS					
Category	Type	Forest Management	Reforestation	Avoided Conversion	Determination of Value
Leakage	Reservoir/ Source	Required: Shift of harvest activities or shift to substitute products	Required: Shift of cropland or grazing activities	Required: Shift of conversion activities	Leakage risk assessment tables, regional conversion rates
Mobile Combustion Emissions	Source	Optional	Required: Site Preparation	Optional	Calculation based on industry averages

6 Quantifying GHG Emission Reductions

This section provides guidance to Project Developers to calculate GHG reductions that can be registered on the Reserve through developing and forecasting project baselines, project activities, and project leakage. To establish a baseline, the Project Developer must model 100 years of forest stock changes, beginning with the inventoried stocks at the time of project initiation. The baseline is computed once in the life of a project. Additional technical information about the requirements for calculating forest carbon inventories is contained in Appendix A. Additional information about modeling and forecasting baselines for each project type are contained in Appendix B.

6.1 Reforestation Projects

6.1.1 Primary Effect – Estimating On-Site Baseline Carbon Stocks

In order to establish a baseline for Reforestation Projects, Project Developers must provide the following information for reforestation projects at the time of project submittal:

- An explanation of how the project, at the time of project initiation, meets the eligibility requirements of 1) being out of forest cover for at least ten years; or, 2) due to a significant natural disturbance, the project area has lost at least twenty percent (20%) of its forest carbon stocks that existed before the disturbance.
- An indication that the project area was previously under native forest cover (i.e. soils capable of supporting native forest cover). The historical review is limited to the Holocene geologic period (covering approximately the last 12,000 years of earth's history).
- An explanation of why the forest was out of forest cover or a description of the disturbance if a natural significant disturbance occurred.
- A description of how the project meets (or will meet) the definition of "natural forest management" (refer to Section 3.5.1).

Due to the GHG emissions resulting from fertilizer use, Reforestation Projects that incorporate practices of broadcast fertilization are not eligible under the FPP at this time.

The qualitative characterization of the baseline must also provide an assessment of the likely vegetative conditions, amidst a likely set of conditions and activities that would develop in the absence of the project, taking into consideration any mandatory statutes or regulations that would encourage or require reforestation at the project site.

Project Developers must demonstrate that the reforestation activity would not have otherwise happened based on economic evaluation (See Appendix E). A demonstration that reforestation would not provide adequate financial returns in the absence of the project provides assurance that where there was prior harvesting, it did not occur simply to take advantage of a carbon market during subsequent regrowth. Further, Reforestation Projects are only eligible if there is no consideration of sawtimber harvest within the first 30 years of the project. The required financial tests do not apply to project proponents who do not as a course of normal business harvest timber during the life of the project. Examples of this include local, state, and federal parks.

A look up table to assist in this determination has been provided as Appendix E. The determination and this table are based on a present net worth determination of the value of the planted trees at rotation age. The factors used in the calculation are:

- Site Class
- Stumpage Value
- Rotation Age
- A standardized interest discount rate
- Site Preparation Costs
- Cost of Seedlings and planting
- Cost of Follow-up treatments (control of competing vegetation)

The basic formula used in development of the lookup table is:

[Cost of Establishment + (Volume of Harvest x Value of Harvest)] x (1- Discount Rate ^ Rotation Age) = Net Present Value

If this calculation shows a zero or positive value then the project does not qualify as a reforestation project.

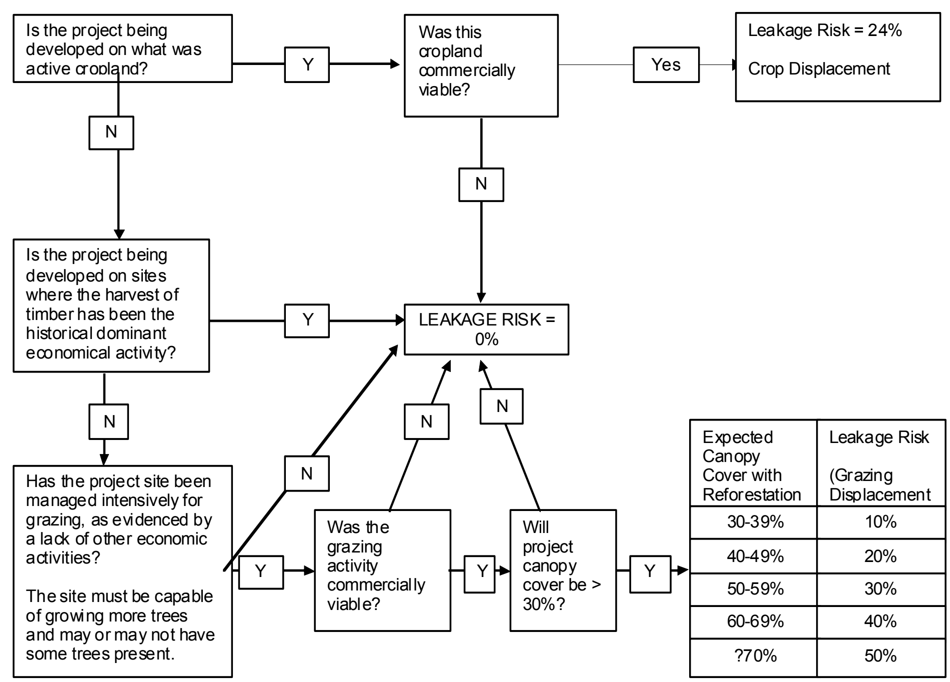
To quantify the reforestation baseline, the current inventory of carbon stocks is determined at the project's initiation, using the inventory methodology set out in Appendix A of this protocol.[3] The Project Developer shall perform a computer simulation that simulates the characterization of carbon stocks (from required and any optional pools) associated with the conditions and activities that would develop in absence of the project, following the guidance in Appendix B. Where the site does not have at least a 10% canopy cover of trees prior to the project a narrative describing future conditions without the project shall be provided in lieu of a computer modeling simulation.

6.1.2 Secondary Effects – Quantifying Net Changes at Other Affected GHG Sources

For Reforestation Projects, onsite activity-shifting leakage can occur when activities to plant trees shift agriculture pressure or grazing pressure and result in the removal of trees elsewhere either within the entity, or within the region where the project is located. Project Developers must account for leakage in a Reforestation Project pursuant to the chart below which includes an assessment for the displacement of commercially viable cropland or sites where grazing has been the historically dominant activity.

[3] Please note that reforestation initial stocks could be zero if the area has no forest cover or required carbon pools that can be quantified.

Leakage Risk Assessment for Reforestation Projects



Expected Canopy Cover with Reforestation	Leakage Risk (Grazing Displacement
30-39%	10%
40-49%	20%
50-59%	30%
60-69%	40%
?70%	50%

Assumptions:

- Leakage risk for cropland displacement is based on a default rate developed by Murray et al (*Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture,* USEPA, 2005). Rates are regionally dependent so this would need to be adjusted if projects are occurring outside of CA.
- If canopy cover associated with the reforestation project in < 30%, grazing activity will not be affected.
- With increasing canopy cover, competition among grazers increases and, therefore, total grazing on the project land decreases and is displaced.
- Demand for crops is inelastic.
- "Commercially viable" is defined here as profitable either without subsidies or with a reliable, long-termed sustained form of subsidies. The assessment of commercially viable shall be determined by analysis of comparable practices within the assessment area on comparable conditions (slope, soils, access to markets, etc.). For grazing, if the level of grazing activity has been equal to, or less than, .5 Animal Unit Months (AUMs) per acre, the grazing activity is not commercially viable.

Increases in emissions associated with machinery use in site preparation for reforestation and restoration project activities as well as some rehabilitation activities associated with forest management projects must also be accounted for as shown in Table 6.1. These estimates have been derived from surveys of contractors and foresters in California during 2008 and 2009.

SITE PREP - REFORESTATION PROJECTS Emissions Associated with Mobile Combustion		
Average Metric Tons CO_2e Per Acre		
Light	Medium	Heavy
25% Brush Cover	50% Dense Brush Cover	> 50% Brush Cover, stump removal
0.090	**0.202**	**0.429**

6.2 Improved Forest Management Projects

6.2.1 Primary Effect – Estimating Baseline Carbon Stocks

6.2.1.1 Improved Forest Management Baseline for Private Forest Lands

The baseline approach for private lands is based on a standardized set of assumptions applied to project-specific attributes. The standardized baseline must take into consideration management activities present on similar landscapes, project inventory in relation to common practice, legal requirements, and economic feasibility.

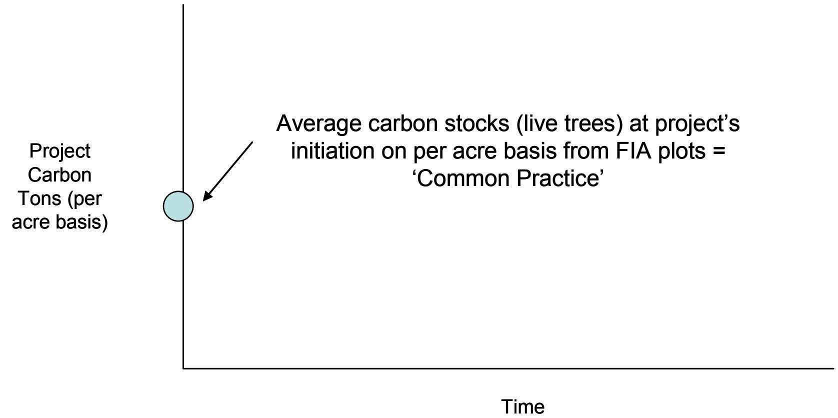
Baseline calculations for Improved Forest Management projects involve multiple steps. The steps are:

1. Determination of “Common Practice” of live tree carbon stocks within a project’s assessment area.
2. Determination of 80% of the highest amount of live tree carbon stocks (metric tonnes per acre) in live trees within the last 10 years, or since project ownership changed, referred to as a “High Stocking Reference.”
3. Calculation of the project’s “Financial and Legal Reference.”
4. Determining the baseline of project live tree carbon (metric tonnes per acre) through a modeling approach that references Common Practice, the Stocking Reference, and the project’s Legal Reference.
5. Completing the baseline determination by adding other carbon pools included in the project.

Determining Common Practice on Similar Landscapes:
All Improved Forest Management Projects are analyzed in reference to the average stocks of the live standing carbon pool from within the project’s assessment area. The average stocks are derived from the USDA Forest Service (USFS) Forest Inventory and Analysis program (FIA). This average is used for each assessment area as an objective and unbiased measure of ‘Common Practice.’ The project’s ‘assessment area’ is defined as a geographic area defined by the Reserve that consists of a distinct natural forest community within common regulatory and political boundaries that affect forest management. The mean is derived from plots on all private lands within the defined assessment area. The mean is based on live trees, which includes all portions of the tree (roots, bole, branches, and leaves). The size of the assessment area is established at the point where further limiting the geographic scope would result in the confidence estimate of the mean carbon in live trees to exceed 15% @ 1SE using plot data from

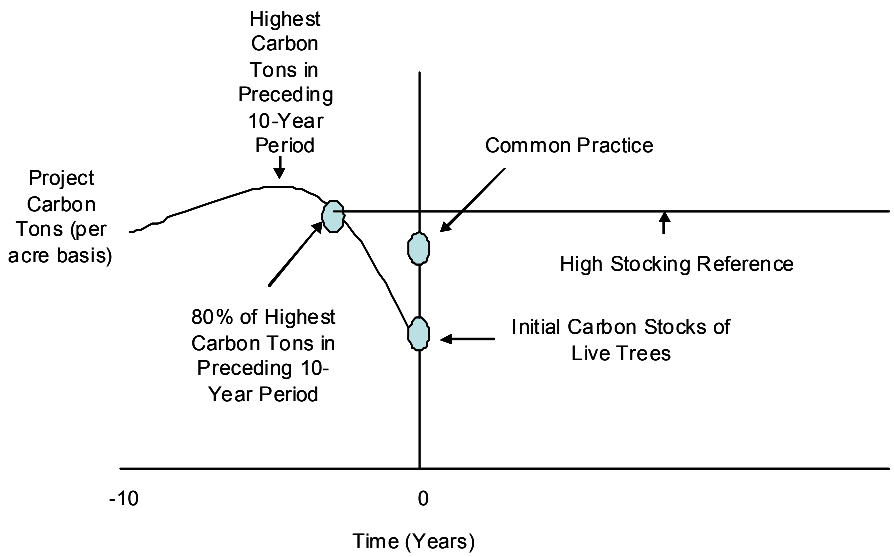
USFS FIA. Maps of the assessment areas and the FIA means are provided on the Reserve's website.

Graphic of FIA average in assessment area. FIA Average is used as a measure of Common Practice as a reference point for baseline development.



Determination of the High Stocking Reference:
For projects with initial live tree carbon stocks below Common Practice, the Project Developer must document changes in the project's live tree carbon over the preceding 10 years, or as long as the current owner has had control of the stocks. The Stocking Reference is defined as 80% of the highest carbon stocks in live trees during the preceding 10-year period.

Graphic displaying how the High Stocking Reference is determined.



Determination of the Financial and Legal Reference:

The project's baseline must demonstrate that it exceeds all legal requirements and that the baseline is economically feasible.

To demonstrate legal constraints, the modeling of the live tree carbon for a 100-year period must be pursuant to applicable laws, regulations, and permanent legally-binding commitments in effect that impact carbon stocks at the project site at the time of project initiation. Legal constraints include:

1. Federal, state/provincial, local government regulations that are required and might reasonably be assumed to influence carbon stocking over time including but not limited to a) zones with harvest restrictions (e.g. buffers, streamside protection zones, wildlife protection zones), b) harvest adjacency restrictions, and c) minimum stocking standards.

2. In the absence of applicable forest practice rules, applicable Best Management Practices established by federal, state, provincial or local government that relate to forest management must be included in the characterization.

3. Other legally binding and irreversible requirements affecting carbon stocks including but not limited to covenants, conditions and restrictions, and other title restrictions in place prior to or at the time of project initiation, including pre-existing conservation easements with the following exceptions:.
    a. Previously existing legally binding and irreversible requirements are excepted if they were put in place and/or recorded less than one year prior to the project start date, as defined in Section 3.2.
    b. The modeled baseline projection need <u>not</u> take into consideration voluntary reversible agreements including, but not limited to, voluntary constraints included in Habitat Conservation Plans, Safe Harbor Agreements, and rental contracts.

To demonstrate financial constraints, the modeling of the live tree carbon must be demonstrated through one of the following mechanisms:

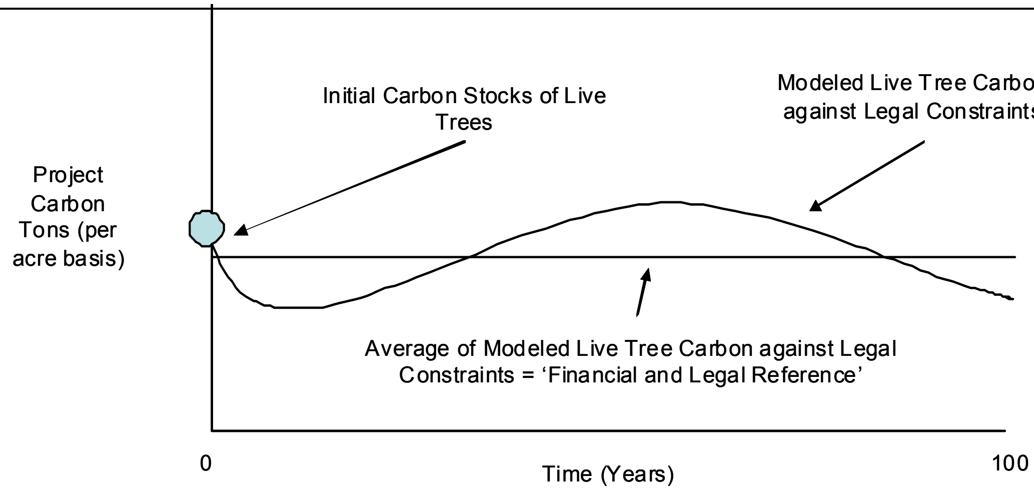
1. A financial analysis of the baseline activity that captures the relevant costs and returns for the baseline scenario, taking into consideration all legal, physical, and biological constraints, with reference to regional norms or demonstration of actual costs and returns on the subject property or other properties in the assessment area.

2. Providing evidence of activities similar to the proposed activities in the baseline within the past 15 years in the assessment area. The comparison must demonstrate that harvesting activities have taken place on at least one other comparable site where a reduction in live standing stocks has occurred on:
    a. Slopes (does not exceed project slopes by more than 10%)
    b. Same zoning class
    c. Comparable species composition (within 20% of project species composition based on trees per acre)
    d. Similar access by road, cable, or helicopter to project access

The modeled carbon stocks shall be averaged for the 100-year period, creating a Financial and Legal Reference that must be compared to the current standing live carbon estimate for the project. If the current project's live tree carbon stocks meet or exceed the Financial and Legal

Reference, the project's baseline of live tree carbon is considered to be the current live tree carbon plus all of the additional required pools. If the project's live tree carbon stocks do not meet or exceed the Financial and Legal Reference, the baseline must demonstrate the growth of the project's stocks of live tree carbon until it meets the Financial and Legal Reference.

Step 1 - Determination of the Financial and Legal Reference is conducted by modeling a financially feasible and legal growth and harvest scenario and subsequently averaging the data.



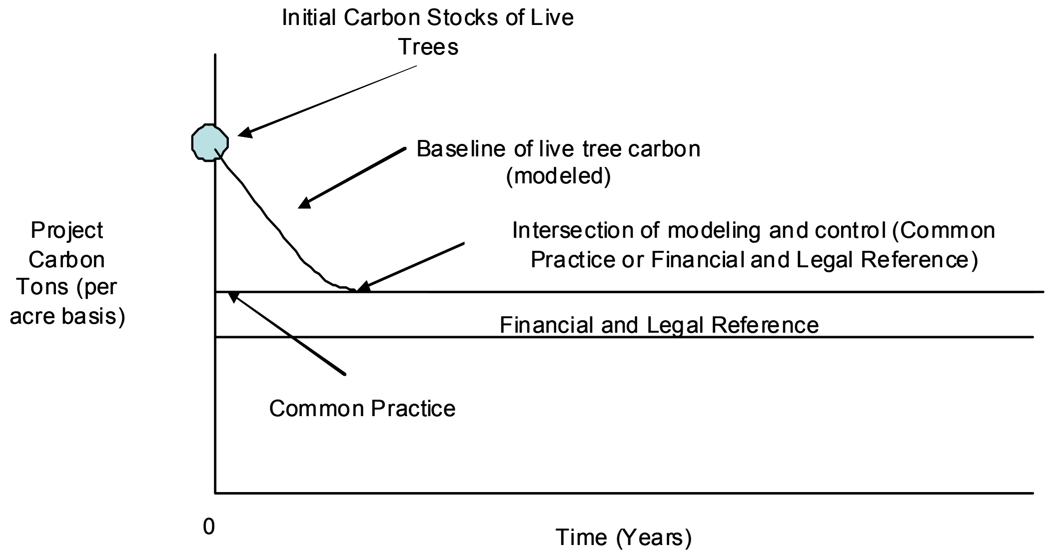
Determining the baseline of Project Live Tree Carbon relative to Common Practice, the Stocking Reference, and the Financial and Legal Reference:

The approach to the determination of the baseline calculation varies depending on the relationship of the project's live tree carbon stocks (metric tonnes per acre) to Common Practice.

1. *For projects with initial live tree carbon stocks (metric tonnes per acre) that exceed Common Practice,* baseline modeling of standing live carbon stocks cannot go below the higher of:
    a. Common Practice, or
    b. The Financial and Legal Reference

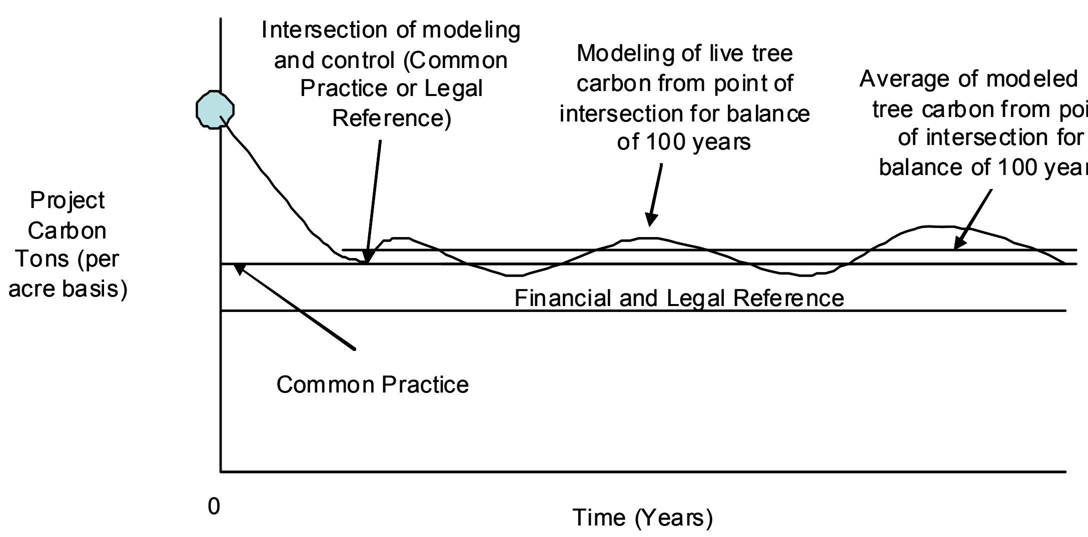
    The modeling must take into consideration the same legal and financial considerations that were incorporated in the development of the Financial and Legal Reference.

Step 2 - Modeling live tree carbon to the higher of Financial and Legal Reference or Common Practice.



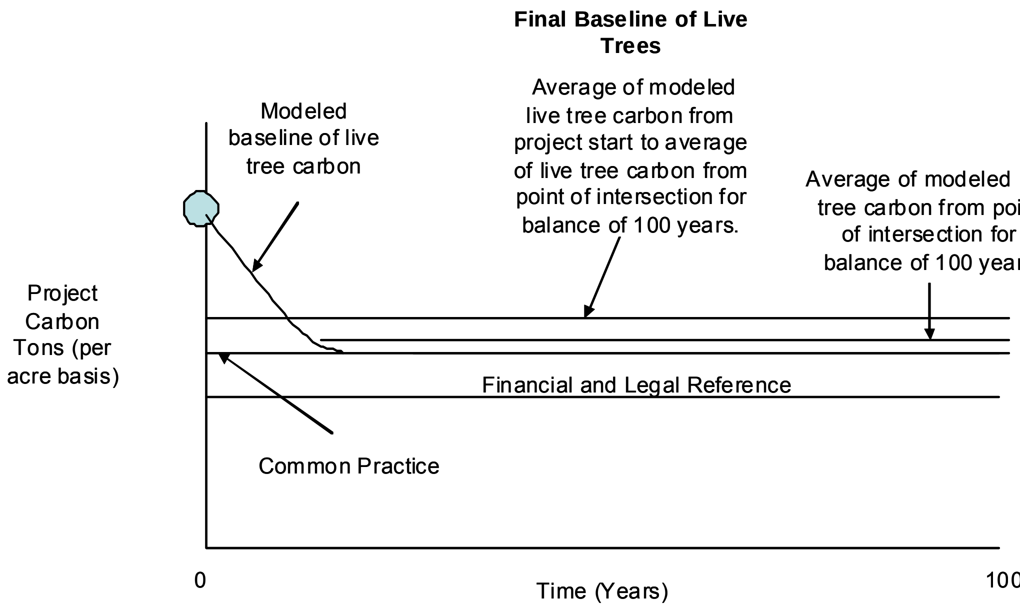
At the point the baseline modeling intersects the controls described above (Common Practice or Financial and Legal Reference), a modeling approach shall be conducted that demonstrates that the live tree carbon, when averaged from the point of intersection to the 100-year point, is at or above the control points mentioned above (Common Practice or Financial and Legal Reference).

Step 3 - Modeling of live onsite stocks (metric tonnes per acre) is conducted in proximity to the control (Financial and Legal Reference or Common Practice) from the intersection of modeling from Step 2 and is subsequently averaged. The averaged baseline must be equal to or above the control.



The final baseline of live tree carbon is determined by averaging the combination of the data from Step 2 (modeling live tree carbon from initial stocks to the control point (Common Practice or Legal Reference)) and Step 3 (average of live tree carbon from the point of intersection in Step 2 with the control point for the balance of the 100-year period).

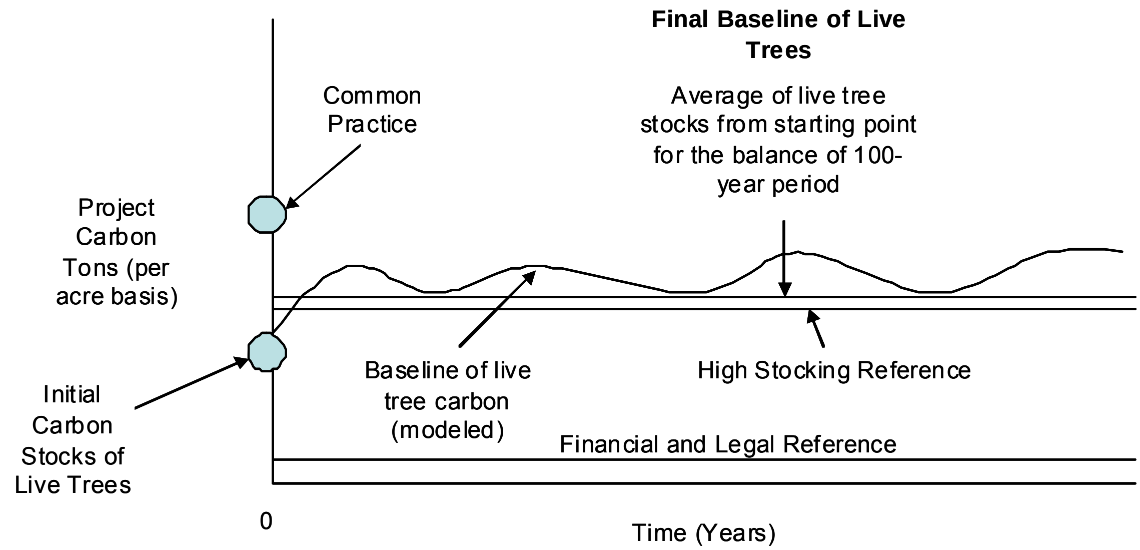
Step 4 - The modeled baseline from Step 1 and the modeled and averaged baseline from Step 2 are averaged together to create a Final Baseline of Live Tree Carbon.



2. *For projects with initial live tree carbon stocks (metric tonnes per acre) that are below Common Practice,* baseline modeling of standing live carbon stocks cannot go below the current live tree carbon stocks (metric tonnes per acre) and exceed or increase until the current stocks exceed the higher of:
    a. The Legal Reference
    b. The High Stocking Reference

   The baseline of live tree carbon stocks shall be considered static at the point the modeling of the baseline reaches the higher of the controls described above.

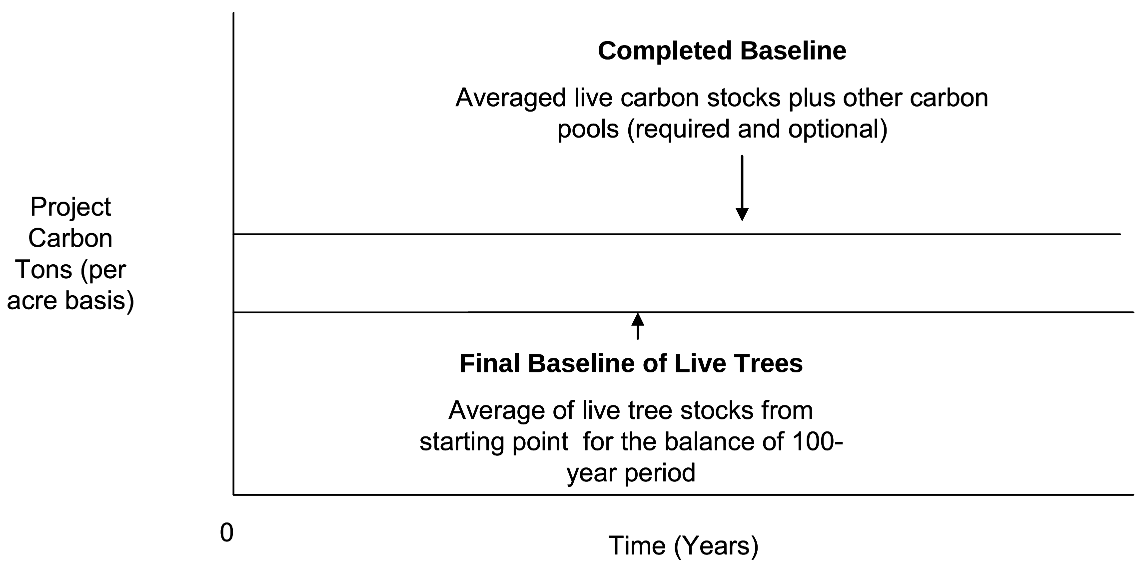
Step 5 - Baseline modeling of live tree carbon is conducted for the 100-year period such that the average of the live tree carbon stocks is at or above the High Stocking Reference, the Financial and Legal Reference, or the Initial Carbon Stocks. The example shows the High Stocking Reference as the control.



Completing the Baseline by Adding other Pools

Once the baseline of live tree carbon has been determined, the other carbon pools included in the project, such as standing and lying dead and harvested carbon must be added to the baseline of live tree carbon to determine the project's baseline. Wood products added to the baseline shall be the actual estimated wood products averaged over the 100-year period. All carbon pools other than live trees and wood products shall use the estimated values at the point the modeled live tree carbon intersects with a control as the value for the balance of the 100-year period.

Final Baseline Step: Other required and optional pools are added to the baseline at the project's initiation and over time. The baseline has an increasing trajectory due to the inclusion of the averaged annual estimate of harvested carbon production.



6.2.1.2 Improved Forest Management Baseline for Public Lands

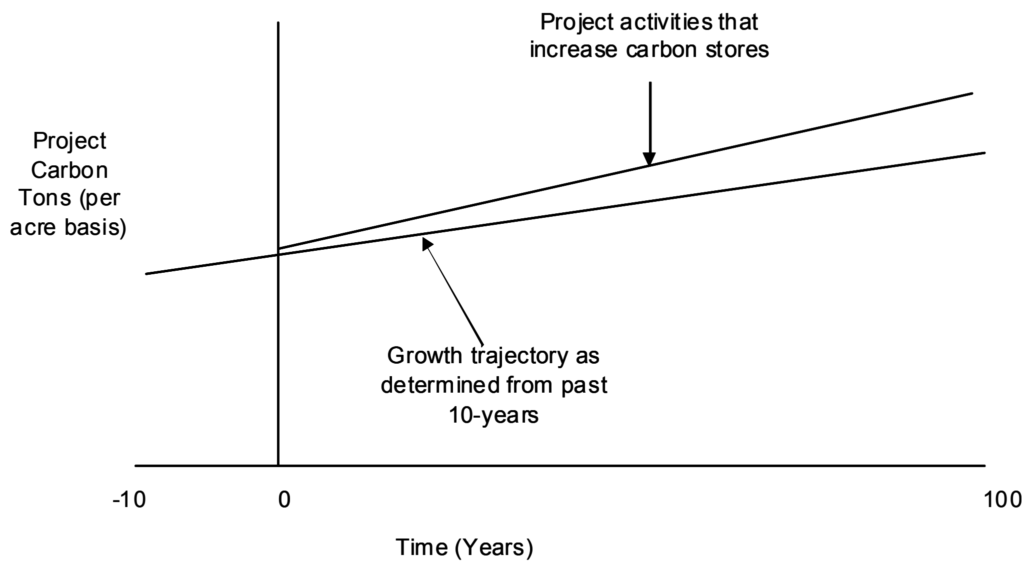
The baseline for improved forest management projects on lands owned or controlled by public agencies must be based on a future projected with historical trends and evaluation of public policy. The Project Developer will need to list and justify assumptions about past activities and how likely they are to be continued into the future.

The characterization should be determined by applicable statutes, regulations, policies, plans and activity-based funding over the past ten years. The subsequent quantification of the baseline projection shall use a current inventory estimate and project it into the future for the life of the project based on this qualitative characterization. In the event that such statutes, regulations, policies, budgets, and plans have changed to materially affect the project carbon over the past ten years, the policies outcomes that lead to the baseline estimates with higher levels of baseline carbon stocking should be used. In situations where considerable controversy and substantive challenge to future management activities exist, a full disclosure of these challenges and their potential to produce a different carbon inventory must be disclosed.

For project areas that have a ten-year history of declining carbon stocks, the baseline shall be defined by the average of the carbon stocks over the past ten years and considered static for the project life. For project areas that demonstrate an increasing inventory of carbon stocks over the past ten years, the growth trajectory of the baseline shall continue until the forest (under the baseline stocks) achieves its productive capacity.

Example of Incorporating Public Lands Baseline Guidance for Improved Forest Management Projects

1) **Review of statutes, regulations, policies, plans, activity-based funding over the past ten years:** A hypothetical public land entity is mandated under a legally adopted Forest Management Plan to harvest timber in a non-depletionary (sustained yield) manner. The same Forest Management Plan requires the maintenance of other ecosystem values including water quality and yield, biodiversity, wildlife habitat, and other amenity values.
2) **Baseline assumption:** This baseline projection takes the history of all required and optional project area carbon stocks over the last ten years (as influenced by policies, environmental influences, and funding) and projects the pools into the future using the trend of all required and optional carbon pools that occurred during the past ten years.



6.2.2 Secondary Effects – Quantifying Net Changes at Other Affected GHG Sources

For Improved Forest Management Projects, activity-shifting leakage can occur when activities shift harvest activities and result in the removal of trees elsewhere or as a shift to substituted products. Project Developers must account for external leakage in Improved Forest Management Projects pursuant to an evaluation based on recognizing a higher risk of leakage associated with activities that reduce harvest over the long term. Project Developers must account for internal leakage by reviewing increases in harvest data for the entity.

Leakage

The evaluation of leakage for Improved Forest Management Projects should be completed utilizing the chart below. The analysis contains the following assumptions:

1. Improved Forest Management Projects are on land bases that have historical and projected future patterns of harvesting biomass for direct or indirect economic activities. That is, changes in forest management activity will represent a decrease in supply.

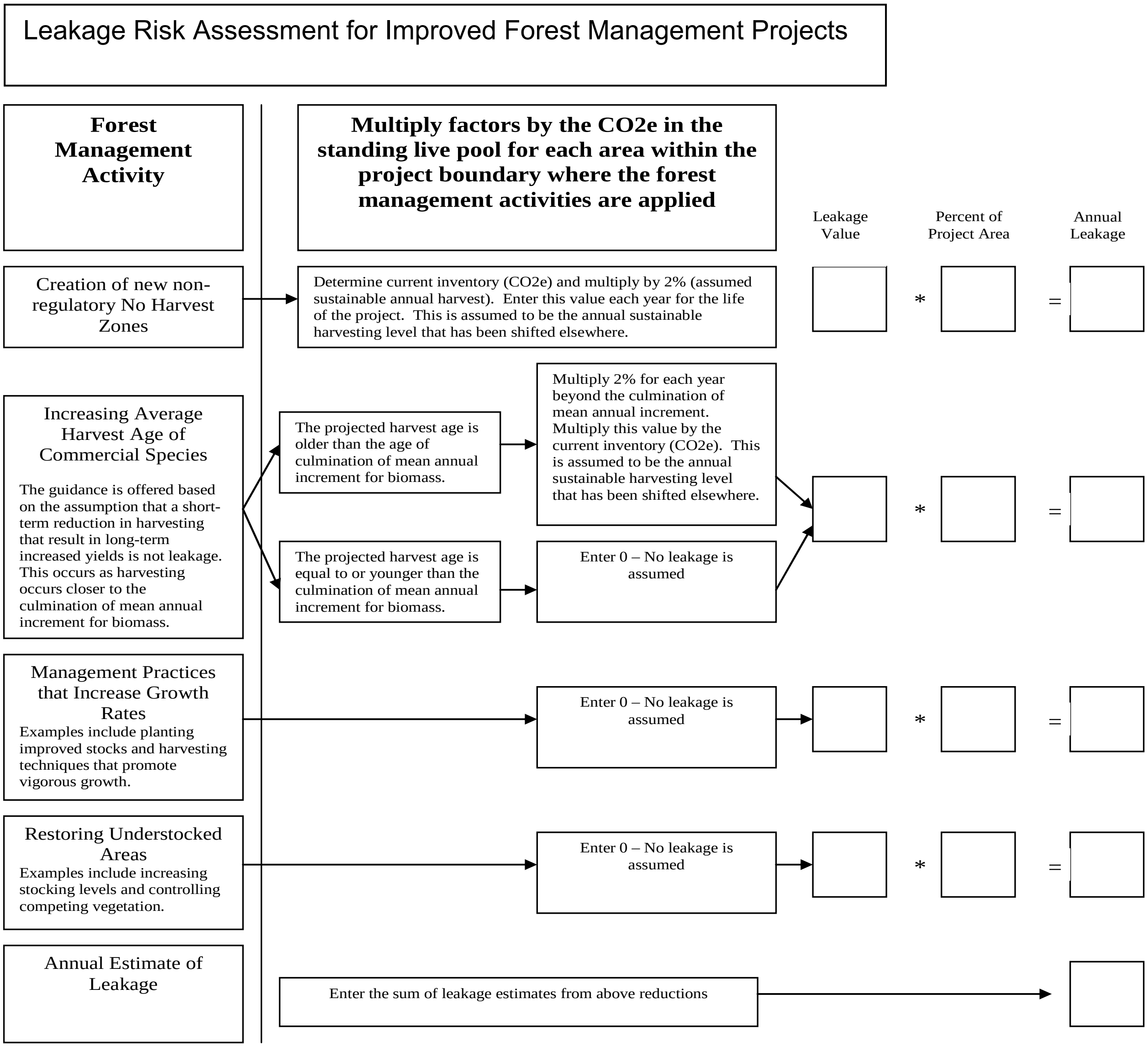
2. Demand of wood products is inelastic in relationship to supply (Murray et al, date).

3. The optimal management for carbon on 'working forests' bases rotation ages at the point where the average annual growth in that forest reaches its maximum, also known as the culmination of mean annual increment. It is assumed that the annual growth rate of forests (board feet) at this point is 2% - 3%. This is applied as an annual leakage estimate (2% * forest inventory (expressed as carbon)). The 2% is a conservative assumption of growth at the asymptote and is used as a proxy to reflect the inelasticity of supply in wood products.

4. The theoretical optimal carbon stocking on managed forestlands occurs when harvest takes place at the point that biomass accumulation in a stand begins to decline.

5. Leakage is measured as a shift of harvest activities or as a shift to substituted products over a temporal scale. A short term reduction in harvest that leads to increased production (i.e. harvesting closer to the mean annual increment for biomass) over a longer term does not constitute leakage as overall productivity is increased over a temporal scale.

6. Biomass in this instance refers to standing live tree carbon.


Leakage Risk Assessment for Improved Forest Management Projects
Forest Management Activity
Multiply factors by the CO2e in the standing live pool for each area within the project boundary where the forest management activities are applied
Leakage Value
Percent of Project Area
Annual Leakage
Creation of new non-regulatory No Harvest Zones
Determine current inventory (CO2e) and multiply by 2% (assumed sustainable annual harvest). Enter this value each year for the life of the project. This is assumed to be the annual sustainable harvesting level that has been shifted elsewhere.
Increasing Average Harvest Age of Commercial Species
The guidance is offered based on the assumption that a short-term reduction in harvesting that result in long-term increased yields is not leakage. This occurs as harvesting occurs closer to the culmination of mean annual increment for biomass.
The projected harvest age is older than the age of culmination of mean annual increment for biomass.
Multiply 2% for each year beyond the culmination of mean annual increment. Multiply this value by the current inventory (CO2e). This is assumed to be the annual sustainable harvesting level that has been shifted elsewhere.
The projected harvest age is equal to or younger than the culmination of mean annual increment for biomass.
Enter 0 – No leakage is assumed
Management Practices that Increase Growth Rates
Examples include planting improved stocks and harvesting techniques that promote vigorous growth.
Enter 0 – No leakage is assumed
Restoring Understocked Areas
Examples include increasing stocking levels and controlling competing vegetation.
Enter 0 – No leakage is assumed
Annual Estimate of Leakage
Enter the sum of leakage estimates from above reductions
*
=

6.3 Avoided Conversion Projects

The baseline approach for avoided forestland conversion projects rely on a real estate appraisal that substantiates the probability of forestland conversion based on the criteria provided below. The physical boundaries for this project type should correspond with the anticipated conversion footprint. This approach is intended to pertain to privately owned lands that may either remain in private ownership or be transferred to public ownership.

Substantiating the Conversion Baseline through an Appraisal:

A real estate appraisal for the project area, developed by a qualified appraiser, shall be provided as evidence of the likelihood of conversion. The appraisal shall be conducted in accordance with the Uniform Standards of Professional Appraisal Practice[4] and the appraiser shall meet the qualification standards outlined in the Internal Revenue Code, Section 170 (f)(11)(E)(ii).[5]

At a minimum, the appraisal shall include and meet the following criteria:

Suitability of Project Area for Conversion

Provide a clear description of the specific type of conversion that would take place on the project property and how the physical characteristic of the land are suitable for the land use to which it would be converted in the absence of the project. At a minimum, the physical characteristics shall also provide and meet the following criteria:

Slope:

1. Slope of land: conversion for commercial or residential development $\leq$ 40%
2. Slope of land: conversion for agriculture $\leq$ 40%

For agricultural conversion:

1. Evidence of soil suitability for type of agricultural conversion
2. Evidence of water availability for the likely conversion scenario

[4] The Uniform Standards of Professional Appraisal Practice may be accessed at: http://commerce.appraisalfoundation.org/html/2006%20USPAP/toc.htm

[5] Section 170 (f)(11)(E) of the Internal Revenue Code defines a qualified appraiser as "an individual who -
(I) has earned an appraisal designation from a recognized professional appraiser organization or has otherwise met minimum education and experience requirements set forth in regulations prescribed by the Secretary,
(II) regularly performs appraisals for which the individual receives compensation, and
(III) meets such other requirements as may be prescribed by the Secretary in regulations or other guidance."

Legal Permissibility of Conversion

It shall be demonstrated that the proposed conversion is (or could be) legally permissible. Criteria to establish this permissibility shall include, but not be limited to, the following:

1. Documentation to establish that the current land use policies, including zoning and general plan ordinances, and other local and state statutes and regulations permit the proposed type of conversion; or

2. Documentation that the project proponent has obtained all necessary approvals from the governing County to convert the project property to the proposed type of conversion (including, for instance, certificates of compliance, subdivision approvals, timber conversion permits, other rezoning, major or minor use permits, etc.); or

3. In the case where the documentation above has not been attained, analogous proof shall be provided based on similarly situated lands in the surrounding area to demonstrate that all necessary approvals from the governing County to convert the project property to the proposed type of conversion (including, for instance, certificates of compliance, subdivision approvals, timber conversion permits, other rezoning, major or minor use permits, etc.) could be attained.

Disparity in Value:

The appraisal for the property shall demonstrate that the fair market value of the proposed conversion for the project area is at least 40% greater than the value of the current land use.

Additional Criteria:

The appraisal shall also include: 1) proximity to metropolitan area, 2) proximity and access to services, 3) population growth within 180 miles, and 4) cost of services as elements to substantiate the likelihood of the proposed conversion.

Characterizing and Projecting the Baseline

After substantiating the likelihood of conversion for the project area based on the appraisal as described above, the baseline conversion scenario should include the forest carbon pools identified for avoided conversion projects in Appendix A and be projected through a model simulation over 100 years using the following information:

Estimated removal of carbon and rate of conversion for the project area

Provide a description of the impact of the proposed conversion in terms of the rate and quantity of forest carbon removal. The rate and quantity of forest carbon removal from the hypothetical conversion shall be substantiated with one of the following:

1. Documentation for the project site (e.g., construction documents/plans) that specifies the timeframe of the conversion and intended removal of forest area for the project;

2. Documentation that the proposed rate and quantity of forest area removed from the project area is consistent with similar conversions on lands of similar physical and political characteristics in the local region that have occurred within the last five years;

3. Documentation that there is a demonstrated trend of conversion on other properties where the type of conversion and removal of forest area are similar (i.e. extent and volume of tree removal over time) to that anticipated in the project area.

Baseline forecasting/modeling
The baselines for avoided conversion projects should be forecasted over a 100-year timeframe. Substantiated by the documentation above, they should be forecasted using the initial forest inventory in the following manner:

1. If there is specific documentation that identifies the rate of conversion and forest area removals, the baseline should be forecasted (i.e., modeled) pursuant to this documentation for the project area.

2. In the absence of documentation for the project area that details the rate of conversion, but the fair market value of the proposed conversion exceeds the current land use value by at least 40%, the baseline and rate of conversion should be forecasted by evenly apportioning the conversion and removal of forest area over the first ten years of the project.

3. In instances where the proposed conversion does not result in complete removal of forest carbon, the baseline projection should account for the residual forest carbon value and hold that carbon estimate constant in the baseline projection after any initial depletion in forest carbon stocks due to the likely conversion scenario.

Discount for uncertainty of conversion probability
To account for uncertainty in the likelihood of conversion of the project area, a discount shall be applied to the project's emission reductions (ER). This discount shall be based on the percent difference in fair market value between the project area's current land use and the proposed conversion, where the proposed conversion has greater value by at least 40%. The discount shall be applied as follows:

Difference in value between proposed conversion and current use	ER Discount %
≥ 80%	0
70 – 79%	10
60 – 69%	20
50 – 59%	30
40 – 49%	40
≤ 39%	100

6.3.1 Secondary Effects – Quantifying Net Changes at Other Affected GHG Sources

Each project must refer to the table below to determine the leakage value that will be used for the region in which the project exists. Avoided conversion project developers must demonstrate accounting for leakage pursuant to the guidance in this section.

Region/State	Basis	Source	Use of Data	Accounting Guidance
California	Maximum forestland conversion rate by county. The maximum value was chosen as a conservative estimate of leakage.	CalFire Fire and Resource Assessment Program (FRAP)	The maximum conversion rate in the state is 1.8%. This rate reflects the conversion rate across all forestlands, regardless of consideration of attributes that place certain lands at a higher risk of conversion than others. Assuming that 50% of forested landscapes are available for conversion, the 1.8% is doubled for a defined leakage risk of 3.6%	The estimated leakage value is applied to reductions as they accrue.

6.4 Quantifying Total Net GHG Reductions

Project modeling is required to forecast the estimated climate benefits from project activities over time. All project types must include a description of the management activities in the project submission form that lead to increased sequestration and/or decreased emissions compared to the baseline. A chart shall be provided with the project submission form that displays both the baseline and the anticipated project stocks which enable estimates of project reductions to be calculated. The project modeling is a good faith estimate of projections at the project's initiation and is not verified. Only actual carbon stocks associated with project activities are verified for determination of project reductions.

A forest project's total GHG reductions or net CO_2 emissions (i.e. biological emissions) must be calculated and reported on an annual basis. The Reserve defines GHG reductions as an increase in project carbon stocks relative to baseline levels, as well as other net GHG removals, reductions, and avoided emissions. The total net GHG reductions at sources, sinks, and reservoirs identified within the project's scope of reporting (Section 5) must be quantified and reported each year, even if net GHG reductions are negative (i.e. there was a net decrease in carbon stocks relative to baseline levels, and/or an overall net increase in GHG emissions due to emissions from any GHG sources).

The steps required for quantification are as follows:

1. Determine actual onsite carbon stocks for the current year, net of any confidence deduction, following the guidance in Appendix A.
2. Subtract actual onsite carbon stocks for the prior year (net of the appropriate confidence deduction), to determine the net change in actual onsite carbon stocks.
3. Subtract from this the difference between current and prior year baseline carbon stocks, as estimated following the requirements in this chapter and the guidance in Appendixes A and B. This will yield the net increment (decrement) in carbon stocks relative to the baseline for the current year.
4. Multiply the result by any leakage adjustment for offsite harvesting, following the requirements in this chapter.

5. Add the difference between actual and the averaged baseline carbon in wood products produced in the current year that will remain sequestered for at least 100 years.
6. Subtract any emissions from secondary effects (other than harvest leakage), following the requirements in this chapter.

In accordance with these steps, quantified reductions for each year must be calculated using the following formula:

$$QR_y = [AC_{onsite,\,y} * (1 - CD_y) - AC_{onsite,\,y\text{-}1} * (1 - CD_{y\text{-}1}) - (BC_{onsite,\,y} - BC_{onsite,\,y\text{-}1})] * [1 - L_y] + [AC_{wp,\,y} - BC_{wp,\,y}] - SE_y$$

Where,

QR_y	quantified GHG reductions for year y
$AC_{onsite,\,y}$	actual onsite carbon (CO_2e) as inventoried for year y
$AC_{onsite,\,y\text{-}1}$	actual onsite carbon (CO_2e) as inventoried for year y-1
CD_y	appropriate confidence deduction for year y, as determined in Appendix A
$CD_{y\text{-}1}$	appropriate confidence deduction for year y-1, as determined in Appendix A
$BC_{onsite,\,y}$	baseline onsite carbon (CO_2e) as estimated for year y
$BC_{onsite,\,y\text{-}1}$	baseline onsite carbon (CO_2e) as estimated for year y-1
L_y	leakage risk percentage for year y *
$AC_{wp,\,y}$	actual carbon in wood products produced in year y that is projected to remain sequestered for at least 100 years
$BC_{wp,}$	averaged annual baseline carbon in wood products that would have been projected to remain sequestered for at least 100 years
SE_y	other net secondary emissions caused by the project activity in year y **

* See guidance in this section ** See guidance following this section

Example of Annual Calculation Activities. A similar worksheet is found on the Reserve Software. This example demonstrates the annual reporting requirements that result in the calculation of emissions/reductions associated with the project activity.

Steps shaded below are automatically calculated by the Reserve's online software.								Steps not shaded demand input from the project developer
Annual On-Site (Estimated) Carbon Stocks Accounting Example								
Project Activity Stocks								
Steps		**Year**						Notes
		0	1	2	3	4	5	
1	Live Standing Carbon (Live Trees)	90.0	95.0	100.0	105.0	110.0	115.0	This is the estimated sum of the carbon for the identified pool in the current year, determined through a sampling process and in conformance with the quantification section of this protocol. Enter 'na' if the pool will not be quantified in the project, following guidance on required pools in the quantification section in this protocol.
2	Dead Standing Carbon (Dead Trees and Stumps)	5.0	5.0	5.0	5.0	5.0	5.0	
3	Lying Dead Carbon (Dead Down Wood)	5.0	5.0	5.0	5.0	5.0	5.0	
4	Shrubs/Herbaceous Understory	na	na	na	na	na	na	
5	Litter and Duff	na	na	na	na	na	na	
6	Soil	na	na	na	na	na	na	
7	Project Activity Tons	100	105	110	115	120	125	This is the net carbon for all reporting pools on site in the project area. The project should always report the project activity tons as the best annual estimate of the project, despite any concerns about confidence.
8	Confidence Deduction	10%	10%	10%	5%	5%	0%	The confidence deduction is based on the sampling error of the combined carbon pools quantified in the project, as described in the quantification section. The confidence deduction is applied annually to the annual monitoring reports. This value is calculated as shown in the quantification section.
9	Project Activity Tons(adjusted for confidence for determination of reductions)	90.0	94.5	99.0	109.3	114.0	125.0	The project activity tons are reduced based on confidence only for the determination of reportable reductions. Reportable reductions can change in the year that the confidence is improved (or worsens). In the year that the confidence adjustment changes, the reportable reductions will change as well, provided there are reductions to report.
Baseline Stocks								
10	Live Standing Carbon (Live Trees)	90.0	80.0	70.0	70.0	70.0	70.0	This is the estimated sum of the carbon in the identified pool in the current year, determined through a sampling process for the first year and subsequently through a modeling effort and in conformance with the quantification section and baseline description of this protocol. Enter 'na' if the pool will not be quantified in the project, following guidance on required pools in the quantification section in this protocol.
11	Dead Standing Carbon (Dead Trees and Stumps)	5.0	5.0	5.0	5.0	5.0	5.0	
12	Lying Dead Carbon (Dead Down Wood)	5.0	5.0	5.0	5.0	5.0	5.0	
13	Shrubs/Herbaceous Understory	na	na	na	na	na	na	
14	Litter and Duff	na	na	na	na	na	na	
15	Soil	na	na	na	na	na	na	
16	Baseline Tons	100.0	90.0	80.0	80.0	80.0	80.0	The baseline tons are not affected by the confidence deduction. The baseline incorporates the initial mean and is modeled thereafter. It is considered correct and remains so unless altered from a significant disturbance or justified through an inventory error (generally early in process).
Calculation of Initial Carbon Reductions								
17	Total Initial Cumulative Reductions Discounted for Confidence	0.0	4.5	19.0	29.3	34.0	45.0	The discount is intended to provide a conservative estimate of the allowable reductions to report and sell. A confidence deduction that results in negative reductions (emissions) is reported as zero. Emissions (negative numbers) should be reported if the gross project carbon tons (unadjusted for confidence) minus the baseline tons results in the negative values.
18	Total Annual Initial Reductions Discounted for Confidence (New Tons by Vintage Year)	0.0	4.5	14.5	10.3	4.8	11.0	New annual reductions (emmissions) are the net value of total reductions in current year minus net reductions from the previous year.

Applying Deductions to Initial Carbon Reductions for Leakage and Other Effects								
Steps		Year						Notes
		0	1	2	3	4	5	
19	Leakage Adjustment %	0.0%	3.0%	3.0%	3.0%	3.0%	3.0%	This value comes from the project type specific worksheet of the leakage assessment in the Leakage Section.
20	Leakage Adjustment Value (Tons of Carbon)	0.0	0.1	0.4	0.3	0.1	0.3	Leakage Adjustment value, multiply Total Reductions by the leakage adjustment percentage.
21	Other Effects	0.0	0.0	0.0	0.0	0.0	0.0	Other effects is the calculation of non-biological emissions (above baseline emissions) associated with certain project activities. See the guidance provided under 'Other Effects'.
22	Total Annualized Initial Carbon Reductions (Adjusted for Leakage and Other Effects)	0.0	4.4	14.1	9.9	4.6	10.7	Annualized reductions are the new reductions (emissions) reduced for leakage
Conversion of Carbon Tons to Metric Tons CO2								
23	Conversion to Tons of CO_2	0.0	16.0	51.6	36.5	16.9	39.1	Conversion of Tons of Carbon to Tons of CO_2 (Multiply metric tons of carbon by 3.6667 to estimate CO_2)

Annual Off-Site Reductions (Non-Estimated) Accounting Example

Steps		Year						Notes
		0	1	2	3	4	5	
	Wood products is not subject to the confidence deduction since the initial value is measured, not the result of a sampling process that results in an estimation of values.							
Offsite Project Activity Stocks								
24	Harvested Wood Products Carbon Tons	0.0	2.0	2.0	0.0	5.0	5.0	This is the net carbon off-site in the form of the harvested wood products pool from the project area. This value comes from entity records and can be verified from tax records.
25	Mill Efficiency %	0.0%	67.5%	67.5%	67.5%	67.5%	67.5%	This value comes from the mill where wood products were delivered or from the regional worksheet of mill efficiency provided in the Appendix.
26	Harvested Wood Products Reduced for Mill Efficiency, in Carbon Tons	0.0	1.4	1.4	0.0	3.4	3.4	Mill efficiency reduction is the loss in converting logs into wood products. The Harvested Wood Products is muliltiplied by the mill effiiciency adjustment percentage.
27	End Use %	0.0%	47.0%	47.0%	47.0%	47.0%	47.0%	This value comes from the wood product type specific values for 100 year end use worksheet found in the Quantification Section of this protocol.
28	Landfill %	0.0%	29.4%	29.4%	29.4%	29.4%	29.4%	This value comes from the wood product type specific values for 100 year landfill worksheet found in the Quantification Section of this protocol.
29	Total Annualized Carbon in Harvested Wood Products (Adjusted for Emmisions over 100 Years in use Life)	0.0	0.9	0.9	0.0	2.3	2.3	Harvested wood products tons of carbon remaining after 100 years from the date of production, including the percentage remaining in use.
30	Total Annualized Carbon in Harvested Wood Products (Adjusted for Emmisions over 100 Years for landfills)	0.0	0.4	0.4	0.0	1.0	1.0	Harvested wood products tons of carbon remaining after 100 years from the date of production, including the percentage remaining in landfills.
31	Conversion to Metric Tons of CO2 for In-Use wood products	0.0	3.3	3.3	0.0	8.4	8.4	Conversion of Tons of Carbon to Tons of CO_2 (Multiply metric tons of carbon by 3.6667 to estimate CO_2)
32	Conversion to Metric Tons of CO2 for Landfills	0.0	1.5	1.5	0.0	3.6	3.6	Conversion of Tons of Carbon to Tons of CO_2 (Multiply metric tons of carbon by 3.6667 to estimate CO_2). This value is reported separately.
Wood Products Baseline Stocks								
33	Harvested Wood Products Carbon Tons	0.0	4.0	4.0	4.0	4.0	4.0	This is the average annual net carbon off-site in the form of the harvested wood products pool from the baseline activity. It is determined from a modeling process.
34	Mill Efficiency %	0.0%	67.5%	67.5%	67.5%	67.5%	67.5%	This value comes from the mill where wood products would likely be delivered or from the regional worksheet of mill efficiency provided in the Appendix.
35	Harvested Wood Products Reduced for Mill Efficiency, in Carbon Tons	0.0	2.7	2.7	2.7	2.7	2.7	Mill efficiency reduction is the loss in converting logs into wood products. The Harvested Wood Products is muliltiplied by the mill effiiciency adjustment percentage.
36	End Use %	0.0%	47.0%	47.0%	47.0%	47.0%	47.0%	This value comes from the wood product type specific values for 100 year end use worksheet found in the Quantification Section of this protocol.
37	Total Annualized Carbon Tons in Harvested Wood Products (Adjusted for Emmisions over 100 Years in use)	0.0	1.3	1.3	1.3	1.3	1.3	Harvested wood products tons of carbon remaining after 100 years from the date of production, including the percentage remaining in use.
38	Conversion to Metric Tons of CO_2	0.0	4.7	4.7	4.7	4.7	4.7	Conversion of Tons of Carbon to Tons of CO_2 (Multiply metric tons of carbon by 3.6667 to estimate CO_2)

Calculation of Emmissions/Reductions Associated with Offsite Stocks								
39	Total Annual Initial CO2 Reductions/Emissions (New Tons by Vintage Year)	0.0	-1.3	-1.3	-4.7	3.7	3.7	This is the comparision of the project activity offsite stocks with the baseline offsite stocks to calculate the emissions/reductions related to offsite stocks
Sum of Onsite and Wood Products Stocks								
40	**Total annual CO2 (metric tons) Reductions/Emissions**	**0.0**	**14.7**	**50.3**	**31.8**	**20.6**	**42.8**	This is the sum of the wood products emissions/reductions and the onsite emissions/reductions. Since reversal is already calculated into wood products as a decay, the calculation of CO2 tons for the reserve pool does not change.
41	**Avoided Conversion Discount %**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	If the project type is Avoided Conversion, then record the discount based on value between proposed conversion and current use.
42	**Total annual CO2 (metric tons) Reductions/Emissions after Conversion Discount**	**0.0**	**14.7**	**50.3**	**31.8**	**20.6**	**42.8**	This is the sum of the wood products emissions/reductions and the onsite emissions/reductions. An adjustment is made for Avoided Conversion projects, see section 6.3.1. Multiply line 40 by (1.0 - line 41).

7 Ensuring Permanence of Credited Emissions Reductions

The Reserve requires that credited GHG reductions be effectively permanent. For projects that sequester CO_2, this requirement is met by ensuring that credited GHG reductions remain sequestered for at least 100 years. The Reserve strongly encourages Project Developers to take steps to mitigate the risk that credited GHG reductions will be "reversed," i.e. emitted back to the atmosphere.

The Reserve has three requirements related to ensuring the permanence of crediting GHG reductions: (1) a required monitoring, reporting, and verification regime, detailed in Sections 8 and 9 and in the Forest Project Verification Protocol (FVP); (2) the establishment of a Project Implementation Agreement (PIA) with the Reserve, as detailed in Section 3.3 and available on the Reserve website; and (3) the maintenance of an appropriate buffer pool or insurance contract, as detailed in this Section 7.

The maintenance of the carbon stocks used in offsets can be reversed by many biological and non-biological agents, both natural and human-induced. Some of these agents cannot completely be controlled, such as the natural agents like fire, insects, and wind. Other agents can be controlled, such as the human-induced agents like conversion and over-harvesting which may be exacerbated by financial problems, political instability and so forth. The FPP utilizes an approach to identify and quantify the risks of reversals from these different agents using project-specific data where possible. This approach results in a risk-rating that determines the quantity of CRTs that the project must contribute to a Reserve buffer pool to insure against reversals

The other key component of managing permanence is detecting a reversal through monitoring. The FPP has explicit requirements for monitoring and verification. Verification must be conducted by third-party auditors who are trained in assessing forest inventories, growth and yield models, and the use of equations in the carbon assessments. The Project Implementation Agreement (PIA) ensures that monitoring will occur until every reduction has met its permanency requirement.

7.1 Definition of a Reversal

Project owners must demonstrate, through annual reporting, that any increase in carbon stocks relative to baseline levels that results in verified reductions must be maintained over time. If the difference between project and baseline carbon stocks decreases from one year to the next that results in a loss of verified reductions, the Reserve will consider this to be a reversal in credited reductions. Reversals are the loss of verified reductions regardless of cause

7.2 Insuring Against Reversals

The Reserve requires Project Developers to demonstrate that they have insured against reversals, based on a project-specific risk evaluation. Currently, insurance must take the form of contributing CRTs to a buffer pool administered by the Reserve. In the future, the Reserve expects an array of alternative mechanisms to insure against reversals will be available.

7.2.1 Establishing a Buffer Pool Account

All projects are required to establish a buffer pool at the first verification of CRTs**.** Each project's buffer pool requirements will be determined by the project risk rating as described in this section and Appendix C. The buffered reductions will enter a pool to be used in managing reversals for any Reserve forest project. The Reserve will maintain records of buffer pool contributions and withdrawals as well as CRTs in each project account. The percentage of project CRTs required in buffer pools may vary over time, as risks and risk mitigation measures change.

Computing the Buffer Pool Contribution								
43	Onsite CO2 Tons (from row 23 above)	0.0	16.0	51.6	36.5	16.9	39.1	These are the reductions that are at risk of reversal
44	Risk of Reversal %	0.0%	7.5%	7.5%	7.5%	7.5%	7.5%	This value comes from the final worksheet of the risk assessment in Permanence Section
45	**Contribution ot Buffer Pool**	**0.0**	**1.2**	**3.9**	**2.7**	**1.3**	**2.9**	Project contribution to the Reserve Pool for risk of reversal. These will be registered tons, but are not available for sale.

7.2.2 Compensating for Reversals

In the event of a reversal, the Project Developer is obligated under the PIA to compensate the reversal in the order specified below:

- Surrender of any unsold CRTs (from the project subject to the reversal) to the Reserve where they will be removed from the project's account.
- Withdraw CRTs from the buffer pool. Only reversals that are not the result of gross negligence are eligible to use the buffer pool.
- Purchase CRTs from outside the buffer pool. This will be instituted for reversals that are the result of gross negligence and may include penalties.

If a reversal lowers the project activity's live standing forest carbon stocks below the standing live stocks established for the baseline, the project will be terminated. A reversal that reduces stocks below baseline is indicative of a situation where the original baseline is no longer valid. The baseline will need to be re-evaluated prior to continuing or implementing further project accounting. For example, a Reforestation Project following a reversal from a wildfire or other substantial natural disturbance would incorporate a new baseline.

If the project is not terminated, the project can begin creating reductions immediately through project activities that increase sequestration or decrease emissions. The project must continue contributing to the buffer pool based on the risk assessment that occurs at the subsequent verification.

7.2.3 Other Insurance Options for Reversals

It is the Reserve's expectation that other options to insure against reversals will develop for projects in the future. These options or mechanisms could include direct insurance. These other options could be used to directly reduce the calculated reserves required for a project. Should third-party insurance instruments arise to manage the risks of reversals and settle claims, the Reserve will maintain control over the credits that compensate reversals to ensure that all offsets, whether project offsets or buffer pool offsets, meet the Reserve's standards for reductions. The capitalization and financial liability requirements of any insurance component related to reversals will be thoroughly reviewed prior to approving any third-party insurance contracts for a project. The Reserve is currently engaged in discussions with third-party insurance carriers and will add options to the FPP when they become available.

7.3 Risk Assessment for Reversals

A risk assessment must be used to determine the quantity of CRTs issued to a project that must be set aside in a buffer pool, as described in Appendix C. Each year a project is issued CRTs, a risk rating is calculated and a corresponding percentage of CRTs is placed in the buffer pool. For example, a project has a verified increase in its onsite carbon stocks relative to baseline levels equivalent to 10 tonnes of CO_2. The project's risk assessment yields a 10% risk for reversals. Thus, 9 CRTs are issued to the project owner's account and 1 CRT must be deposited in the Reserve's buffer pool.

A project's risk calculation must be renewed with each verification. Therefore a landowner can reduce their risk profile through actions that lower the risk profile of their project. The Reserve will consider how to redistribute any surplus reductions based on further refinement of the assessment of risks.

8 Project Monitoring

The systematic monitoring of project activities and carbon stocks is essential to ensure that the project is adhering to all terms of the FPP and that project reductions are sustained for the FPP's defined permanence period.

8.1 Crediting Period and Required Duration of Monitoring Activities

The Reserve requires all forest projects to ensure the project's CRTs are sustained for 100 years from the year in which the reduction is first measured and reported. During this period, all monitoring and verification activities must be maintained. Exceptions to the monitoring requirements occur when a significant unintentional disturbance occurs,[6] leading to an unintentional reversal that reduces the standing live carbon stocks below the baseline of standing live carbon stocks that were initially established for the project. This occurrence allows the Project Developer to terminate a project.

[6] The natural disturbance shall not be the result of intentional or grossly negligent acts of the forest entity or project developer.

8.2 Annual Monitoring Requirements

As part of an ongoing assessment and reporting of a project's carbon stocks and project activities, annual monitoring is required. The purpose of the monitoring process is to update the reported project's carbon stocks and identify if a reversal has occurred. A complete field review is required periodically in addition to the annual monitoring report. These periods are described in the Forest Verification Protocol, which will be published on the Reserve's website within 90 days following the adoption of the FPP. Further details of third-party verification's role in monitoring will also be explained in the Forest Verification Protocol (FVP) (again – not there yet).

8.2.1 Annual Monitoring Report

On an annual basis, Project Developers are required to complete an online Annual Monitoring Form which is found on the Reserve's website. The purpose of this report is to account for annual carbon stock inventory and confirm that no reversals are occurring. The management of the project inventory must include a methodology to update the forest inventory, accounting for harvest, growth, and natural disturbances on an annual basis. Inventory updates can be conducted with the use of forest growth models that rely on field data that are no older than allowed in Appendix A (normally 12 years). This is intended to minimize errors associated with dependence on growth models.

Specifically, the Annual Monitoring Report must include the following:

Carbon stock estimate

Provide an estimate of the project's carbon stocks, based on your inventory methodology that may include a combination of sample plots, harvest deductions and modeled growth. Requirements for allowable forest growth models are outlined in Appendix B. The project's carbon stocks will be reported individually by carbon pools.

Harvested Wood Products

Harvested wood products need to be reported on an annual basis and calculated by the methodology outlined in Appendix A.

Risk Assessment

The Risk Rating for Forest Projects needs to be evaluated at each verification using the appropriate guidance from Appendix C. During interim years between verification audits, the last risk rating will be used. The buffer pool requirements and contributions need to be calculated and reported.

Disturbances

The written report should list any disturbances that 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. A change in inventory associated with the disturbance should be managed with updated procedures, which may include field sampling activities. A good faith estimate of the inventory reduction should be submitted if insufficient time exists to update the inventory following a disturbance. The inventory should be rectified with acceptable inventory procedures in the subsequent year if a good faith estimate is provided.

Leakage

The leakage estimate is verified as part of the verification audit. The monitoring report shall use the most recent verified estimate of leakage between verification cycles.

8.2.2 Field Review

In addition to the annual reports, field audits by approved third-party verifiers must occur at periods described in the Forest Verification Protocol. The period between field reviews varies depending on the project type. This field review includes visiting portions of the project area, as well as an office review of inventory management procedures. The field review includes a variety of verification activities, as described in the Forest Verification Protocol (FVP), depending on ownership and project types such as:

- Compare mapped areas and data records with actual field conditions
- Inspect seedlings
- Verify inventory confidence levels
- Check development activities in proximity to project area
- Inspect results of silvicultural activities

8.3 Rationale for Verification

The Climate Action Reserve's verification process requires that an approved third-party verifier (listed on the Reserve's website: www.climateactionreserve.org) review and assess reported required data to confirm that the forest entity has adhered to the Reserve's reporting protocols and has compiled GHG inventories accurately each year. This process is an integral component of the Reserve's program. It helps to ensure the consistency and credibility of GHG data reported across organizations, which in turn facilitates consideration as part of meeting compliance regimes, such as a cap-and-trade market system to managing GHG emissions. In addition, the verification process provides confidence to the public that the GHG information report is accurate. A detailed description of verification activities and scheduling is found in the companion Forest Verification Protocol (FVP).

9 Reporting Requirements

Placeholder (list of everything reported to the Reserve)

9.1 Forest Carbon Inventory

The Reserve requires a complete inventory for the estimates of carbon stocks to be verified. A complete inventory must be executed by the time you report your annual carbon stock estimate to the Reserve. This complete inventory must be maintained throughout the time the project is reported to the Reserve. A complete inventory includes an estimate of carbon stocks from the required pools within the project that meets or exceeds the minimum confidence standards described in Appendix A.

The inventory and the required verification will be used as the basis for determining whether a reversal has occurred. All credited reductions for a project are assumed to be reversed if a Project Developer, or subsequent landowner, chooses not to undergo verification and the remedy for intentional reversals in the PIA must be followed.

Expertise of a Professional Forester:

All reports that reference biological emissions must be submitted with the oversight of a professional forester. See the definition section for professional forester. If the project is located in a jurisdiction without a professional forester law or regulation then the Certified Forester credentials is required so that professional standards and project quality are maintained. The Climate Action Reserve may evaluate and approve alternative certification credentials if requested, but this would only apply to jurisdictions where professional forester laws or regulations do not exist. This requirement does not preclude the use of technicians or other unlicensed/uncertified persons working under the supervision of the professional forester.

9.2 Attestation of Title

To promote transparency, an ownership summary must be included in the project documentation and annual reporting. The purpose of this summary is to confirm reporting eligibility and to track details regarding transfers in the sales, trading, crediting and other aspects of project account management. Please note that in collecting this ownership information, the Reserve is not providing credit or acting as a broker to trade any project GHG reductions. The ownership summary should include the name of the owner(s), or representative of a collection of owners, of the project's land and trees.

9.3 Transparency

The Reserve requires complete data transparency for all forest projects, including data that displays current carbon stocks, reversals, and verified reductions. This data will likely be of interest to and potentially used by a variety of stakeholders after it is reported to the Reserve. To uphold this principle, project data will be publically available on The Reserve's website.

10 Glossary of Terms

Above-Ground Live Biomass	Live trees including the stem, branches, and leaves or needles, brush and other woody live plants above ground.
Activity-based Funding	The budget line items that are dedicated to agency accomplishments in vegetation management, including pre-commercial thinning, commercial thinning, harvest, hazard tree removal, hazardous fuels reductions, and other management activities designed to achieve forest sustainability health objectives.
Activity Shifting Leakage	An increase in greenhouse gas emissions caused by a project outside of its geographic boundaries, such as tree harvesting displaced by a project to other forest sites.
Additionality	Forest project practices that exceed the baseline characterization, including any applicable mandatory land use laws and regulations.
Allometric equation	An equation that utilizes the genotypical relationship among tree components to estimate characteristics of one tree component from another. Allometric equations allow the below ground root volume to be estimated using the above-ground bole volume.
Applicable Mean	The averaged carbon in the standing live carbon pool (live tree pool) from private lands within a project's assessment area, as calculated using the USFS FIA sample plots.
Assessment Area	A geographic area defined by the Reserve that consists of a distinct forest community within common regulatory and political boundaries that affect forest management. The size of the assessment area is based on the point where further limiting the geographic scope would result in the confidence estimate of the mean carbon in live trees to exceed 15% @ 1SE using plot data from USFS FIA. Maps of the assessment areas and the FIA means are provided on the Reserve's website.
Avoided Conversion	Specific actions that prevent the conversion of native forest to a non-forest use, i.e. residential or commercial development or agriculture. This activity is also a type of project that may be registered in the Reserve.
Baseline Activity	The volume/biomass of harvest, inventory, and growth of forests and forest products associated

	with the baseline modeling scenario.
Best Management Practices	A practice or usually a combination of practices that are determined by a state or designated planning agency to be the most effective and practicable means (including technological, economic, and institutional considerations) of controlling point and nonpoint source pollutants at levels compatible with environmental quality goals.[7]
Biological emissions	For the purposes of the forest protocol, biological emissions are GHG emissions that are released directly from forest biomass, both live and dead, including forest soils. In the first three years of reporting the only biological emission type that is required to be reported for forest entities and projects is CO_2, as identified in the Quantification Section of the protocol. Biological emissions are deemed to occur when the reported tonnage of carbon stocks decline at the project level.
Biomass	The total mass of living organisms in a given area or volume; recently dead plant material is often included as dead biomass.[8]
Bole	A trunk or main stem of a tree.
Carbon Pool	A reservoir that has the ability to accumulate and store carbon or release carbon. In the case of forests, a carbon pool is the forest biomass, which can be subdivided into smaller pools. These pools may include above-ground or below-ground biomass or harvested wood products, among others.
Carbon Reservoir	Physical unit or component of the biosphere, geosphere or hydrosphere with the capacity to store or accumulate carbon removed from the atmosphere by a sink or a carbon captured from a source. This refers to either naturally occurring areas that have the ability to hold carbon or manmade areas.
Carbon Sink	Physical unit or process that removes a GHG from the atmosphere.
Carbon Source	Physical unit or process that releases carbon into the atmosphere.
Carbon Stocks	The carbon contained in identified forest biomass categories (i.e. carbon pools), such as above and

[7] Obtain reference from the Dictionary of Forestry
[8] Climate Change 2001, mitigation; Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change

	below-ground biomass, at a specific point in time.
Climate Reserve Tonne	The unit of offset credits used by the Climate Action Reserve. One Climate Reserve Tonne is equal to one metric tonne (2204.6 lbs) of GHG reduced/sequestered.
Commercial Viability	Capable of success or continuing operations with an adequate return; practicable for the investor or landowner.
Common Practice	The average stocks of the live standing carbon pool from within the project's assessment area derived from FIA plots on all private lands within the defined assessment area.
Culmination of Mean Annual Increment	The culmination of the mean annual increment (biomass increase) is the point where the maximum mean annual increment is reached.
De minimis	The emissions associated with a carbon pool at any point during the project life is so minor as to merit disregard; defined as less than or equal to 5% on a cumulative basis for total carbon stocks.
Direct emissions	Greenhouse gas emissions from sources that are owned or controlled by the reporting entity.
Entity non-biological baseline	Datum against which a forest entity can measure its non-biological GHG emissions.
Equity Share	Fractional percentage or share of an ownership interest.
EJ Community	Based on the principle that all people should be protected from environmental pollution and have the right to a clean and healthy environment. Environmental justice (EJ) is the protection of the health of the people and the environment, equity in the administration of environmental programs, and the provision of adequate opportunities for meaningful involvement of all people with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. EJ communities are those communities that have the potential to be underrepresented in EJ issues.
FIA	USDA Forest Service Forest Inventory and Analysis program. FIA is managed by the Research and Development organization within the USDA Forest Service in cooperation with State and Private Forestry and National Forest Systems. FIA has been in operation under various names (Forest Survey, Forest Inventory and Analysis) for 70 years.

FIA Mean	See Common Practice definition
FIA Sample Plots	Plots from the most recent published remeasurement used to calculate the FIA Mean.
Forest	Lands that support, or can support, at least 10 percent tree canopy cover and that allow for management of one or more forest resources, including timber, fish and wildlife, biodiversity, water quality, recreation, aesthetics and other public benefits.
Forest Entity	A corporation or other legally constituted body, city or county, each state or federal government agency or individual that owns forest land.
Forest Management	The commercial or noncommercial growing and harvesting of forests.
Forest Project	A planned set of activities to remove, reduce or prevent carbon dioxide emissions in the atmosphere by conserving and/or increasing forest carbon stocks.
Forest project baseline	A long-term forecast of the forest practices (or absence thereof) that would have occurred within a project's boundaries in the absence of the project activity.
Forest project greenhouse gas reduction	Removals or reductions of CO_2 and prevented CO_2 emissions resulting from Reserve-approved forest projects. GHG reductions are calculated as gains in carbon stocks over time relative to the project baseline.
GHG Assessment Boundary	Encompasses all primary and significant secondary effects associated with the project activities.
GHG Reductions	See forest project greenhouse gas reduction.
Greenhouse Gases (GHG)	For the purposes of the Reserve, GHGs are the six gases identified in the Kyoto Protocol: Carbon Dioxide (CO_2), Nitrous Oxide(N_20), Methane(CH_4), Hydroflourocarbons (HFCs), Perflourocarbons (PFCs), and Sulphur Hexafluoride(SF_6).
Grossly Negligent	Conscious and voluntary disregard of the need to use reasonable care, which is likely to cause foreseeable grave injury or harm to persons, property, or both. [West's Encyclopedia of American Law]
Historically Dominant Economic Activity	The historically dominant activity in a specified

	geographic area that has resulted in jobs, industry, production, distribution, consumption, and creation of wealth in that area.
Improved Forest Management	Changes in forest management to increase or maintain overall forest carbon stocks. This activity is also a type of forest project that may be registered in the Reserve.
Leakage	A situation where emissions shift from one location to another resulting in a direct increase in emissions.
Listed	A project is considered “listed” when the Project Developer has created an account with the Reserve, submitted the required Project Submission Form and related required documents, paid the project submission fee, and the Reserve has approved and accepted the project for listing.
Lying dead biomass	Any piece(s) of dead woody material from a tree, e.g. dead boles, limbs, and large root masses, on the ground in forest stands. The Reserve requires the carbon in lying dead biomass with a minimum diameter of 6 inches to be measured.
Mean Annual Increment	The average volume production per year for a forest of known age.
Native Forest	For the purposes of this protocol native forests shall be defined as those occurring naturally in an area, as neither a direct nor indirect consequence of human activity post-dating European settlement.
Natural forest management	Forest management practices that promote and maintain native forests comprised of multiple ages and mixed native species at multiple scales from the harvest unit (less than 40 acres) up to the watershed spatial scale (third or fourth order watershed level) approximately 10,000 acres in size. The application of this definition, its principles, detailed definition, and implementation, are discussed further in the Section 3 (eligibility criteria)
Non-biological emissions	Greenhouse gas emissions that are not directly released from biomass. For example, GHGs from fossil fuel combustion qualify as non-biological emissions.
Non-Forest Cover	Land with a tree canopy cover of less than 10 percent.
Non-Forest Use	An area managed for residential, commercial, or

	agricultural uses other than for the production of timber and other forest products or maintained as woody vegetation for such indirect benefits as protection of catchment areas, wildlife habitat or recreation.
Non-Harvest Disturbance	Reduction in forest cover that is not a direct result of harvest such as wildfire and insect disturbances.
Optional reporting	Greenhouse gas reporting results that are reported to, but not verified by, the Reserve.
Permanence	Refers to the duration of the greenhouse gas reductions that are achieved and maintained as a consequence of the forest project. Pursuant to this protocol, forest-based reductions shall be permanent and are considered permanent when maintained for 100 years.
Primary Effects	The intended change caused by a project activity in GHG emissions, removal, or storage associated with a GHG source, sink, or reservoir.
Professional Forester	A professional engaged in the science and profession of forestry. A professional forester is credentialed in jurisdictions that have professional forester licensing laws and regulations. Where a jurisdiction does not have a professional forester law or regulation then a professional forester is defined as having the Certified Forester credentials managed by the Society of American Foresters (see www.certifiedforester.org).
Project Developer	An entity that undertakes a project activity, as identified in the Forest Project Protocol. A Project Developer may be an independent third-party or the forest entity.
Project Guidance	Outline of process and requirements for undertaking projects.
Project Life	Refers to the duration that a project activity and its associated monitoring and verification are maintained.
Reforestation	The establishment and subsequent maintenance of native tree cover on lands that were previously forested but have had less than 10% tree canopy cover for a minimum time of ten years or have been subject to a significant disturbance within the last ten years that is not the result of intentional or grossly negligent acts of the landowner or reporting entity. This activity is also a type of project for public or private forest lands

	that can be registered in the Reserve.
Registered	A project is considered "registered" when the project has been verified by an accredited third-party verifier, submitted by the Project Developer to the Reserve for final approval and approved by the Reserve.
Reversal	The loss of verified reductions.
Secondary Effects	An unintended change caused by a project activity. A secondary effect may result in a GHG reduction or a GHG emission.
Sequestration	The process of increasing the carbon content of a carbon reservoir other than the atmosphere. Biological approaches to sequestration include direct removal of CO_2 from the atmosphere through land-use changes[9] and changes in forest management.
Significant disturbance	Any natural impact that results in a loss of least 20% of the above-ground live biomass that is not the result of intentional or grossly negligent acts of the forest entity or Project Developer.
Standing dead biomass	Standing dead tree or section thereof, regardless of species, with minimum diameter of three inches.
Standing Live Pool	Live trees including the stem, branches, and leaves or needles, brush and other woody live plants above ground. Also known as the "Above-Ground Live Biomass.
Submitted	A project is considered "submitted" when all of the appropriate forms have been uploaded and submitted to Reserve software, and the Project Developer has paid the project listing fee.
Tree	A woody perennial plant, typically large and with a well-defined stem or stems carrying a more or less definite crown with the capacity to attain a minimum diameter at breast height of 3 inches and a minimum height of 15 feet with no branches within 3 feet from the ground at maturity.[10]
Verification	The process used to ensure that a given participant's greenhouse gas emissions or emissions reductions has met the minimum quality standard and complied with the Reserve's

[9] Climate Change 2001, mitigation; Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change

[10] Insert Society of American Foresters citation

	procedures and protocols for calculating and reporting GHG emissions and emission reductions.
Work Group	The Forest Protocol Work Group was convened to expand the guidance in the existing forest protocols: The revision process began in November 2007 and is scheduled to be completed in June 2009.

Appendix A Appendix A 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 A.,which should be used to quantify each of these pools. In Appendix B, additional guidance is provided on the use of models to project baseline carbon stocks over time.

A.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 refer to the Project Summary Worksheet on the Reserve website to provide the following information:

- Forest entity and project boundaries
- Acreage of entity forest area
- Latitude/longitude or Public Land Survey
- Existing land cover and land use
- Topography
- Forest vegetation Types
- Site classes
- Watercourses in area (4^{th} order or greater)
- Land pressures and climate regime

This information must also be presented in a map during verification or a justification for exclusion provided.

A.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
2. Below-ground living biomass
3. Dead biomass on-site
4. Soil

5. Dead biomass off-site (wood products)

Values for some of these categories of carbon will be determined through direct sampling. Table A.2 summarizes the categories with their associated pools and identifies which pools must be quantified for all projects versus those that may be excluded depending on the project. It also shows how the value for the pool is determined.

Table A.2. Reserve requirements of carbon pool categories and determination of value for pool.

Category	Carbon Pool	Forest Management	Reforestation	Avoided Conversion	Determination of Value
Living biomass	Above-ground living biomass	Required	Required[1]	Required	Sampled in Project
	Below-ground living biomass	Required	Required[1]	Required	Calculation based on above ground sampling
	Shrubs and Herbaceous Understory	Optional	Required	Optional	Sampled in Project
On-site Dead biomass	Standing Dead Biomass	Required	Required	Required	Sampled in Project
	Lying Dead Wood	Optional	Optional[2]	Optional	Sampled in Project
	Litter	Optional	Optional	Optional	Sampled in Project
Soil	Soil[2]	Optional	Optional	Optional	Sampled in project
Off-site dead biomass	Wood Products	Required	NA	Required	Decay calculation from volume of harvested wood

1. Existing trees are not considered a part of a reforestation project initially, but must be tracked over time to keep separate from regeneration. Since residual and new trees are easy to identify for several decades, this may be done at the first inventory.
2. Soil carbon is not anticipated to change significantly due to forestry activities, however, exceptions may exist including deep ripping or significant soil erosion.

A.3 Onsite Forest Inventories

All calculations can be done in either English or metric units. All calculations of Registered Tonnes must be correctly converted to metric tonnes carbon dioxide equivalent. To develop estimates of carbon stocks in the carbon pools identified in Table A.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 or board foot 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. The Reserve may grant approval to use different allometric equations than those provided by the Reserve, provided they are more accurate.

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 12 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 12-year intervals.

An exception to the 12-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 ($\alpha=0.10$).Below is an example of the test assuming the plots are not paired and assuming they are paired. In no case shall any plot measurements be more than 18 years old.

The hypotheses are:

H_0: the subsample and updated inventory are the same
H_A: the subsample and updated inventory are not the same

The formula for the test statistic (t) is:

$$t = \frac{(\bar{x}_u - \bar{x}_s)}{s_{\bar{d}}}$$

where $\bar{x}_u$ = the updated carbon estimate from the original inventory,
$\bar{x}_s$ = the subsample carbon estimate, and
$s_{\bar{d}}$ = the standard error of the difference between the two estimates, which is explained below for the situation where plots are unpaired and paired.

The standard error calculation for unpaired plots, which may occur with temporarily located plots, assumes that the variance is the same for both estimates since they are from the same population. The standard error estimate is given as:

$$s_{\bar{d}} = \sqrt{\frac{\left(\frac{(n_u \times s_u^2) + (n_s \times s_s^2)}{(n_u - 1) + (n_s - 1)}\right)}{n_u + n_s}}$$

where s_u^2 = the variance or standard deviation squared of the updated sample,
s_s^2 = the variance or standard deviation squared of the subsample, and
n_u and n_s = the sample size of the updated and subsample respectively.

A one-tailed Students t-value is taken from a table using the α=0.10 and a degrees of freedom of $n_u + n_s - 2$. If t < t(table) then accept *H_0, otherwise reject H_0.*
Where the plots are paired, as with remeasured permanent plots, then the standard error estimate is given as:

$$s_{\bar{d}}^2 = \sqrt{\frac{s_d^2}{n}}$$

where s_d^2 is the variance, or standard deviation squared, of the plot differences and *n* is the number of plots.

The t-value from the table uses n - 1 degrees of freedom.

The steps that follow provide more detailed guidance to establish and maintain a complete inventory and estimate carbon stocks. Please use the worksheet in Step 10 to organize your results.

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. Appendix G contains recommended references for developing sampling methodologies. 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 Reserve. 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 monumenting 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. The design of your sampling methodology and measurement standards must include the requirements stated in the following table.

Table A.3.1. Minimum required sampling criteria for estimated pools.

Carbon Pool	Name of Requirement	Description of Requirement
Above-ground Living Biomass	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. The use of functions other than those provided in the protocol will need to be approved by the verifier.
Below-ground Living Biomass	Plot-level Allometric Equation used for Estimating Biomass	Apply model (Cairns et al. 1997) to estimate below-ground biomass density. This model equation is based on above-ground biomass density in tonnes per hectare. The use of a function other than that provided in the protocol will need to be approved by the Reserve.
Herbaceous Understory	Sampling Methodology	The Reserve recommends the sampling methodology prepared by Brown et al. (2004). This methodology is referenced in Appendix C. Alternative methodologies will need to be reviewed and approved by the Reserve.
Standing Dead Biomass	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 Duff	Sampling Methodology	The Reserve recommends the litter and duff methodology prepared by Brown et al. (2004). This methodology is referenced in Appendix C. Alternative methodologies will need to be reviewed and approved by the Reserve.
Lying Dead Biomass	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 Live Trees from Sample Plots

Required

Above and below ground live tree biomass estimates are required for all projects. You are responsible for determining appropriate methodologies for sampling to determine tree 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.

The following equations are provided for a few common California species for estimating tree biomass from diameter (DBH) and total height (HT) measurements. This list does not contain all species that you may encounter in your projects, the references contain a comprehensive list of biomass functions. The Reserve will accept the application of equations that are more accurate than those referenced here. Diameter measurements are in inches and height measurements are in feet (note: the use of these functions is required for improved forest management projects on private lands, for which you need to compare your current inventory to the FIA mean, which is based on these functions). The bole total volume (VOL) is calculated first and then multiplied by the wood density value for each species. This result is divided by 2.204622 to convert from pounds to kilograms. Conifer species have separate functions for bole, live crown and bark biomass. Some hardwood species have volume functions that include these elements and therefore only one equation is used. The appropriate volume function for each species is cited in the references, which are Means et al. (1994) and Waddel and Hiserote (2005).

Table A.3.2. Sample of the Equations for Tree Species Biomass Estimates

Species	Bole Biomass (kg)	Bark Biomass (kg)	Live Crown Biomass (kg)
Douglas-fir	(VOL * 28.70) / 2.204622	Exp(-4.3103+2.43*ln(DBH*2.54))	Exp(-3.6941+2.1382*ln(DBH*2.54))
Ponderosa pine	(VOL * 23.71) / 2.204622	Exp(-3.6263+1.34077*ln(DBH*2.54)+ 0.8567*ln(HT*0.3048))	Exp(-4.1068+1.5177*ln(DBH*2.54)+ 1.0424*ln(HT*0.3048))
Coast redwood	(VOL * 21.22) / 2.204622	Exp(7.189689+1.58375*ln(DBH*2.54))/1000	0.199+0.00381*(DBH*2.54)^2*(HT*0.3048)
Tanoak*	(VOL * 36.19) / 2.204622		
*Tanoak biomass is in one equation because the bole, bark and crown volume is in one equation.			

The derived estimate of biomass shall be multiplied by 0.5 to calculate the mass (kg) in carbon. This product shall be multiplied by 0.001 to convert the mass to metric carbon tonnes.

Because of the difficulties associated with measuring the below-ground carbon component of trees, the Reserve allows for the estimation of this component of tree carbon through the use of a regression equation (Cairns et al., 1997). This equation provides a practical and cost-effective approach that estimates below-ground biomass based on the sampling-based calculation of above-ground biomass only:

$$BBD = \exp(-0.7747 + 0.8836 * \ln(ABD))$$

Where,

BBD = below-ground biomass density in tonnes per hectare
ABD = above-ground biomass density in tonnes per hectare

It is important to note that this equation must be applied at the plot level, after estimates of above-ground biomass have been calculated as described above.

Example A.3. Quantification Example (Part III – Tree Biomass)

The chart below displays summary data for tree biomass for the first plot in Strata 1.

Tree Biomass								
1	2	3	4	5	6	7	8	9
Plot	Tree Number	Species	DBH (cm)	Total Height (m)	Status	Biomass (kg)	Weight (Expansion per Hectare)	Biomass (kg per Hectare)
1	1	Redwood	65	32	L	2,560	21	53,768
1	2	Douglas-fir	65	29	L	2,007	21	42,152
1	3	Tanoak	28	14	L	280	112	31,402
1	4	Redwood	68	30	L	2,677	19	50,858
1	5	Redwood	76	27	L	3,086	15	46,287
1	6	Douglas-fir	65	34	L	2,310	21	48,501
1	7	Tanoak	42	17	L	729	50	36,442
1	8	Tanoak	46	18	L	914	41	37,464
							Total	346,874

The plot in this example was measured using a 30 square foot basal area factor prism. The plot number is entered in column 1. All ‘in’ trees (trees on the plot) are measured and input consecutively starting at North and proceeding clockwise (this facilitates check cruising, quality control). Each tree is numbered (column 2), the species documented (column 3), the DBH measurements entered as centimeters in column 4, and the total height entered as meters in column 5.

The status of the tree goes in column 6. The status codes are shown below.

Status Codes	Description
L	Live
D1	Dead, with large and small branches and twigs
D2	Dead, with large and small branches and no twigs
D3	Dead, with large branches only
D4	Dead, with no branches

Only live trees are input into the Tree Biomass worksheet. The biomass for each tree is determined (column 7) using the volume, mass and allometric equations provided in Step 2 in the Forest Project Protocol. The basal area factor and each tree’s diameter (breast height) are used to determine the expansion factor, or weight, of each tree (column 8). The expansion factor is multiplied by each tree's biomass to portray the biomass estimate of each tree on a per hectare basis (column 9). Each tree's expanded biomass is summed to calculate the estimated total biomass in trees on plot 1. Plot 1's estimate of above-ground tree biomass in Strata 1 is calculated to be 346,874 kilograms per hectare. Based on this estimate, an estimate of below-ground biomass on a per hectare basis can be calculated using the equation above. The estimate of below-ground biomass is 80,918 kilograms per hectare. The combined estimate of biomass in Plot 1 is 427,792 kilograms per hectare.

Step 3 – Estimate Carbon Standing Dead Biomass from Sample Plots

Required

The carbon stocks in standing dead biomass 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. References for developing sampling methodologies are included in Appendix C..

The sampling methodology and protocols for deriving biomass estimates will be developed as part of an overall sampling strategy (discussed in Step 1). The estimate of standing dead biomass 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 0.001.

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

Optional

The carbon content of lying dead wood, that is wood biomass that is not standing, may also be estimated in all entity inventories where it can be shown to increase and provide atmospheric benefits. 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. References for developing sampling methodologies, which are referenced in Appendix C, include Brown (1974), Harmon and Sexton (1996), and Brown et al. (2004).

Field measurements of lying dead wood enable the calculation of volume to be easily computed. The computed volume will need to be converted to biomass density by applying conversion factors that may be based on default density values by decay class found in Harmon et al. (2008) or a sub-sample of material that represents the species groups and decomposition classes. If direct sampling is used then the methodology developed for lying dead wood 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 carbon tonnes on a per hectare basis. The carbon tonnes estimate is inserted into the worksheet in this Appendix. A description of a methodology to generate the density factors, if direct sampling is used, can be found in the Brown et al. (2004) document mentioned above.

The estimate of carbon tonnes for the lying dead pool and the standing dead pool may be summed with the live tree pool for each sampled plot. This will provide the basis for determining the overall carbon tonne estimate and descriptive statistics for the pools, including wood products if applicable. The overall carbon tonne (per hectare) estimate of the required pools and the descriptive statistics are input into the worksheet in Step 10.

Example A.5. Quantification Example (Part V – Lying Dead Wood)

Lying dead wood is sampled on every plot. The chart below displays summary data for lying dead biomass for the first plot in Stratum 1.

Strata 1										
Lying Dead Wood										
1	2	3	4	5	6	7	8	9	10	11
Plot	Log Number	Species	Large end Diameter	Small end Diameter	Total Length on plot (mt)	Density	Volume (cubic meters)	Biomass (kg)	Weight (per Hectare)	Total Biomass per Hectare
1	1	Tanoak	30	15	3.6	Rotten	0.6	24.0	25	600
1	2	Redwood	109	96	2.3	Sound	1.9	684.0	25	17,100
							Sum			17,700

The sampling method used in this example is a fixed area plot. The area sampled is a 1/25th hectare plot. The entries in the columns are similar to those already discussed for trees and standing dead trees. The volume in lying dead wood is calculated first and subsequently converted to biomass using the coefficients developed from the density sub-samples.

The sum of the per hectare biomass estimates from the tree, standing dead, and lying dead biomass are summed to determine the combined biomass estimate on Plot 1. The result of summing this example is shown below.

Plot 1		
Carbon Pool	**Biomass Sum per Hectare (kg)**	**Carbon Metric Tonnes per Hectare**
Trees	427,792	213.9
Standing Dead	57,054	28.5
Lying Dead	17,700	8.9
Total Biomass	502,546	251.3

The biomass sums are multiplied by .5 to convert to carbon biomass and subsequently by 0.001 to convert to metric carbon tonnes, as described in Step 2 in the forest project protocols. This process is completed for all plots in Stratum 1 and Stratum 2. The sample results from Plot 1 indicate that there is 211 carbon tonnes per hectare.

Step 5 – Estimate Carbon in Shrubs and Herbaceous 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. Appendix C provides a reference that can be used to predict above-ground biomass of plant species in early successional forests of the western Cascade Ranges. The estimate will be computed in terms of metric carbon tonnes and input into Table A..

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 Duff

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. 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 10 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 – Estimate of Carbon Tonnes in Soil

Optional

Changes in total soil carbon are a challenge to measure over short timeframes as this pool changes slowly and is usually dependent on the rate of biomass input relative to soil decomposition. The sampling methodology and protocols for deriving carbon estimates in soil must be developed as part of an overall sampling strategy (discussed in Step 2). The Reserve recommends the soil sampling methodology prepared by Brown et al. (2004) that can be found in Appendix C..

The estimate will be computed in terms of metric carbon tonnes. The mean metric carbon tonne estimate for this pool will be input into the Soil Section in Table A. on a per hectare basis.

A.4 Estimate Carbon in Wood Products

Required

The carbon in wood products is estimated herein as the average carbon that persists over a 100-year period of wood products estimated to be in use. The processes described here were adapted from the U.S. Department of Energy (DOE) 1605(b) methodology (Technical

Guidelines for Voluntary Reporting of Greenhouse Gas Program, Ch. 1, Emission Inventories, Section 1) for accounting for the long-term storage of wood products. The process is provided here for convenience. Please see Smith et al. (2006) for a more detailed description, since the 1605(b) procedure was adapted from this publication. The general procedures for product-based estimates are found in Section 1.3.2 of the 1605(b) document.

The accounting of wood products should include only those trees harvested within the project boundaries. Trees harvested outside of your forest project's physical boundaries shall not be counted as part of your wood product pool. A harvest that leads to the production of wood products within your entity must occur for the wood products pool to have value. The carbon from harvested trees is transferred to the wood products pool in the year that it was harvested and must be accounted for in this manner. The timing of this is important to keep in mind for reporting clarity and proper accounting. The amount added to the wood carbon pool for the purpose of accounting for emissions reductions in a project is the average adjusted value for wood that is estimated to still be in-use after 100 years. Additionally, in recognition of the potential duration in landfills of some portion of wood products after the end of their useful life, Project Developers will also report separately an estimate of this potential landfill storage over 100 years[11].

Each year the volume of harvested material that creates wood products is added at the wood product specific 100-year average in-use percentage as shown in the wood products worksheet below. (See table A.5 for national 100-year average in use percentages.)

Process 1: Determine amount of carbon harvested and transferred to Wood Products Pool

This process applies to projects that have removed forest stocks for conversion to wood products in the reporting year. If you have no removals reported in the reporting year, you will go to Process 3 to record the pool from previous years. Your annual estimate for your wood products pool must be based on the current or most recent harvest volume reported to third-party scaling reports. The BOE reports will include a summary of harvested volume (board feet or cubic feet) by species delivered to the point of sale. The starting point is the dry weight of wood. This may be calculated from either volume or green weight, as described below.

If you have volume measures then the conversion from volume to carbon weight is done by multiplying the cubic foot volume by the appropriate wood density factor in table A.4. This results in the biomass (lbs.) with zero moisture content. Additional specific gravities are available from the Wood Handbook (1999). Multiply the specific gravity by the density of water (62.4 lbs/ft^3) to get the wood density.

If you have the weight of wood products then subtract the water weight based on the moisture content of the wood. This results in the biomass (lbs.) with zero moisture content.

Sum the weights for each species to get a total dry weight for all harvested wood. Multiply this total value by 0.5 pounds of carbon/ pound of wood to compute the total carbon weight, and then convert to tonnes of carbon (1 metric tonne = 2,240 pounds). This value is multiplied taken to process 2 below.

[11] While recognized herein as a potential storage pool, landfill stores of wood products are not accounted for in calculations of emissions reductions at this time due to the potential of change in wood flows to landfills over the lifetime of projects. Further, accounting for wood products in landfills presents significant challenges to accuracy and verification of emissions reductions at the project level.

Table A.5.1. Specific gravity of green softwoods and hardwoods by forest type for the Pacific Southwest (from EPA 1605(b) Table 1.4).

Forest Type	Specific Gravity of Softwoods	Specific Gravity of Hardwoods	Wood Density of Softwoods (lbs/ft^3)	Wood Density of Hardwoods (lbs/ft^3)
Mixed Conifer	0.394	0.521	24.59	32.51
Douglas-fir	0.429	0.483	26.77	30.14
Fir-spruce-m.hemlock	0.372	0.510	23.21	31.82
Ponderosa pine	0.380	0.510	23.71	31.82
Redwood	0.376	0.449	23.46	28.02

Process 2: Accounting for mill inefficiencies

The conversion of logs to wood products has been estimated to be approximately 67.5% efficient for the Pacific Southwest (see DOE 1605(b) Table 1.6, year 0, in use). That is, approximately 67.5% of the delivered log volume is converted into wood product volume. Where possible, the Reserve will provide mill efficiencies for each assessment area. The remainder is considered to be immediately emitted for accounting purposes in this protocol. The calculation for mill efficiency is accomplished by multiplying the carbon tonnes from Process 1 by 0.675. This value is taken to Process 3.

Process 3: Wood product in use accounting

In order to account for the decomposition of harvested wood over time, a decay rate is applied to wood products based on the life of carbon stored in solid wood product as determined by the wood product class. The Reserve will provide wood product classes for each assessment area from mill surveys within each survey area. The applicant must check with the mill(s) where the logs are sold to determine the product categories they sell and place in the first row and appropriate column of the worksheet below. The annual reporting for a removal shall be a constant value over time since the average value over 100 years is used based on DOE 1605(b) Tables 1.8 (in use). Specific values were used where available; otherwise the miscellaneous products value was used.

Table A.5.2. Wood Products Worksheet

<table>
<tr><td colspan="6">Metric Carbon Tonnes in Current Year’s Wood Products from Process 2 above.</td><td>(1)</td></tr>
<tr><td colspan="7">Allocate the end use of the total wood products by assigning a percentage for each class (A – G). Multiply value from (1) by percentages assigned below in order to separate wood products carbon into product classes. Insert values into boxes (3A-G) below each corresponding product class. Values in (3A-G) are carbon (metric tonnes) in each product class for the current year. Multiply the values in 3A-G by the 100-year in use factor and put in 4A-G.</td></tr>
<tr><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr>
</table>

Softwood Lumber	Hardwood lumber	Softwood Plywood	Oriented Strandboard	Non Structural Panels	Miscellaneous Products	Paper
(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)
(3A)	(3B)	(3C)	(3D)	(3E)	(3F)	(3G)
0.470	0.262	0.490	0.585	0.387	0.189	0.078
(4A)	(4B)	(4C)	(4D)	(4E)	(4F)	(4G)

Sum the row values of 4A-G to get the total current wood products value. Add this to the previous years' sum to carry forward. For example, if you have 10,000 tonnes from previous years and 3,000 tonnes this year, carry forward 13,000 tonnes in the wood products pool. Since the values incorporate a 100-year in-use value there is no need to make further adjustments with time.

Process 4: Landfill Storage

Landfill storage estimates are not included in the wood products pool for purposes of calculating and registering reductions. This calculation is included to recognize that some sequestered carbon may remain in landfill storage after use. Due to uncertainty as to the volume and duration of landfill storage over 100 years, the figures derived from the DOE 1605(b) Table 1.9 (landfill) will not be included in the verifiable calculations of project emissions reductions but will be reported separately.

Use table A.5.3 to calculate the landfill storage amount. This table is completed in the same manner as the in-use wood products table (A.6). Different multipliers will be applied.

Table A.5.3. Landfill Worksheet

Metric Carbon Tonnes in Current Year's Landfill contribution from Process 2 above.						(1)
Allocate the landfill use of the total wood products by assigning a percentage for each class (A – G). Multiply value from (1) by percentages assigned below in order to separate wood products carbon into product classes. Insert values into boxes (3A-G) below each corresponding product class. Values in (3A-G) are carbon (metric tonnes) in each product class for the current year. Multiply the values in 3A-G by the 100-year decay factor and put in 4A-G.						
A	B	C	D	E	F	G
Softwood Lumber	Hardwood lumber	Softwood Plywood	Oriented Strandboard	Non Structural Panels	Miscellaneous Products	Paper

(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)
(3A)	(3B)	(3C)	(3D)	(3E)	(3F)	(3G)
0.294	0.407	0.283	0.231	0.339	0.446	0.173
(4A)	(4B)	(4C)	(4D)	(4E)	(4F)	(4G)

Guidance will be provided by the Reserve about how to interpret the resulting numbers.

Step 10 – Sum Carbon Pools

Table A.5.4. Worksheet for Summarizing Carbon Pools and Calculating Total Carbon

Carbon Pool	Required Pool?	Gross Carbon Tonnes per Hectare
Step 2 Live Trees	Yes	From sampling results of trees.
Steps 3 – 4 Standing Dead Trees, and Lying Dead Wood	Yes, unless justified	From sampling results of standing dead biomass and lying dead biomass.
Step 6 Shrubs and Herbaceous Understory	Yes, unless justified	From sampling results of shrubs and herbaceous understory.
Step 7 Litter and Duff	Yes, unless justified	From sampling results of litter and duff.
Step 8 Soil	Yes, unless justified	From sampling results of soil.
Sum of Carbon Tonnes from Included Pools		
Computation and Application of Confidence Deduction		
Section A5 Wood Products	Yes, unless justified	From Board of Equalization Reports and calculations explained in Step 5.
Sum of Carbon Tonnes from Included Pools Adjusted for Confidence and Wood Products		

Appendix B Modeling Carbon Stocks

This protocol requires the use of certain empirical-based models to estimate the baseline carbon stocks and project stocks of selected carbon pools within a project's geographic boundary. These models may also be used to supplement assessments of actual changes in carbon stocks resulting from the project activity.

B.1 About models and their eligibility for use in the Reserve

Empirical-based models are used for estimating existing values where direct sampling is not possible or cost-effective. They are also used to forecast the estimations derived from direct sampling into the future. Field measurements provide the basis for inferring value through the use of these models.

Models used for producing estimates of carbon values provide two basic functions. First, they determine values for existing tree volume and correlated carbon stocks. These include equations that infer tree biomass from diameter measurements.

The equations provided in the preceding sections are pre-approved for use in the Reserve. If Project Developers or forest entities would like to use equations that are different from those provided in this Protocol, such equations must be equivalent to or more accurate than those provided. This equivalency or greater accuracy must be demonstrated to the verifier during the verification process. Also, the assumptions applied in the model must be transparent and made available to the verifier.

The second function of models is the projected results of direct sampling through simulated forest management activity. These models, often referred to as growth simulation models, may project information regarding tree growth and mortality over time – values that must ultimately be converted into carbon in an additional step. Other models may combine steps and estimate tree growth and mortality, as well as changes in other carbon pools and conversions to carbon, to create estimated projections of carbon stocks over time.

The following growth models have been approved for the states listed.

State	Models Approved
California	▪ CACTOS: California Conifer Timber Output Simulator ▪ CRYPTOS: Cooperative Redwood Yield and Timber Output Simulator ▪ FVS: Forest Vegetation Simulator ▪ SPS: Stand Projection System ▪ FPS: Forest Projection System ▪ FREIGHTS: Forest Resource Inventory, Growth, and Harvest Tracking System ▪ CRYPTOS Emulator

The Reserve will include additional models when upon demonstration to a state forester that the model:

- Has been peer reviewed in a process that: 1) primarily involved reviewers with necessary technical expertise (e.g. modeling specialists and relevant fields of biology, forestry, ecology, etc.) and 2) was open and rigorous
- Is parameterized for the specific conditions of the project and/or entity land area
- Limits use to the scope for which the model was developed and evaluated
- Be clearly documented to include the scope of the model, assumptions, known limitations, embedded hypotheses, assessment of uncertainties and sources for equations, data sets, factors or parameters, etc.
- Underwent a sensitivity analysis to assess model behavior for the range of parameters for which the model is applied
- Is periodically reviewed[12]

B.2 Requirements for using models to forecast baseline carbon stocks

The use of simulation models is required for quantifying a project's baseline carbon stocks. .

Inventory information from Appendix A must be incorporated into the simulation models to develop the project baseline, which is a projection of carbon stocks over time. If a model has the ability to convert biomass to carbon, it must include all the carbon pools required by this protocol.

The baseline carbon stocks must be portrayed in a graph depicting time in the x axis and carbon tonnes in the y-axis. Baseline carbon stocks must be projected forward from the date of project initiation. The graph should be supported with written characterizations that explain any annual changes in baseline carbon stocks over time. These characterizations must be consistent with the baseline analysis required in Section 6.

[12] Prisley, S.P. and M.J. Mortimer. 2004. A synthesis of literature on evaluation of models for policy applications, with implications for carbon accounting. For. Ecol. & Mgt. 198(1-3):89-103.

Appendix C Determination of the Buffer Pool Contribution for Forest Projects

The worksheets in this section are designed to identify and quantify the risks associated with reversals for a specific project. The worksheets will identify a risk-rating that is established for each project's risk profile. The risk profile is used to determine the quantity of CRTs that the project must hold in reserve to insure against reversals. This analysis is conducted on a project by project basis.

This risk assessment shall be updated on the same schedule as project verification. Therefore, a project's risk profile and its assessment are dynamic. The risks and risk mitigations are linked to monitoring that is required for the project life. Project Developers and verifiers will provide feedback to the Reserve that will assist in improving the risk and mitigation assessment. The estimated risk values and associated mitigation will be updated periodically as improvements in quantifying risks or changes in risks are determined.

Reversals of project reductions may be the result of natural and human-related causes. The risks that may impact the ability of a Project Developer to meet the permanency requirements are classified into the following categories identified in Table C;

Table C

Risk Category	Risk Type	Description	How managed in this protocol
Financial	Financial failure leading to bankruptcy	Financial failure can lead to bankruptcy and alternative management decisions to generate income that result in reversals through over-harvesting or conversion	Default Risk Remedies for reversal addressed in PIA
Management	Illegal Harvesting	Loss of project stocks due to timber theft	Default by Area
	Conversion to Non-forest uses	Alternative land uses are exercised at project carbon expense	Default Risk Remedies for reversal addressed in PIA
	Over-harvesting	Exercising timber value at expense of project carbon	Default Risk Remedies for reversal addressed in PIA
Social	Various Social Risks	Changing climate policy	Default Risk
		Changing regulatory environment and/or accounting guidelines	
		Lack of liquidity across accounting standards	
		Environmental justice	
		Employment effects	

		Environmental perceptions	
Natural Disturbance	Wildfire	Loss of project carbon through wildfire	Risk and risk-mitigation worksheet
	Disease/Insects	Loss of project carbon through disease and/or insects	Risk mitigation worksheet
	Storm-related damage	Loss of project carbon from wind, snow and ice, or flooding events	Risk mitigation worksheet
Accuracy of Carbon Stocks Estimates	Statistical Confidence	Quality of inventory estimate determined by variability in forest conditions and sampling intensity	Risk worksheet

C.1 Financial Risk

Financial failure of an organization resulting in bankruptcy can lead to dissolution of agreements and management activities to recover losses that result in reversals.

Table C.1. Financial Risk Identification.

Financial Risk	
Applies to all projects	
Project Criteria Description	**Risk Contribution**
Default Financial Risk	1%

C.2 Management Risk

Management failure is the risk of management activities directly or indirectly impacting forest stocks that are obligated as permanent reductions.

Management Risk I – Illegal removals of forest biomass

Illegal logging occurs when biomass is removed either by trespass or outside of a planned set of management activities that are controlled by regulation. Illegal logging is exacerbated by lack of controls and enforcement activities.

Table C.2. Risk of Illegal Harvesting.

Project Criteria	**Impact of Unmitigated Risk on**

	Carbon Reductions
This risk is assessed for all project types	
United States	0%
Enter value that reflects project's illegal forest biomass removals risk:	

Management Risk II – Conversion of forestland to other uses that impact current carbon stocking and future sequestration.

High values for development to housing and/or agriculture may compete with current values and lead to a change in land use that affects carbon stocks. The risk of conversion of any project area to other non-forest uses is related to the probability of alternative uses, which are affected by many variables, including population growth, topography, proximity to provisions and metropolitan areas, availability of water and power, and quality of access to the project area. Remedies for reversals associated with conversion are defined in the Project Implementation Agreement, which is required for all projects.

Management Risk III – Reducing obligated reductions through over-harvesting

Favorable timber values, among other reasons, may motivate some project managers to realize timber values at the expense of managing obligated reductions. Additionally, reducing obligated reductions can occur as the result of harvest associated with fuels treatments. Timber value as used below is the sum of the individual species stumpage value at any time multiplied by the estimated volume per acre of that species. Remedies for reversals associated with over-harvesting are defined in the Project Implementation Agreement, which is required for all projects.

C.3 Social Risk

This section addresses social elements which may represent risks to permanence. This section addresses the risk of those with authority taking actions that will negatively affect the stability of carbon emission reduction projects through ownership, financing, or measurement and validation.

The risks of social or political actions or reactions impacting a forest protocol project are low but if a negative event occurs under one of the risk factors the impact on the project can be very significant to the individual project. Social risks are difficult to assess from a quantitative perspective. Certain identified risks are shown below and an overall assessment of 5% is assigned to all social risks, regardless of project type and location.

Table C.3. Social Risk Identification.

Identification of Risk	Risk Contribution

Social Risk I - Risk of government changing climate policy The risk of a government changing climate policy is dependent on the degree of governmental stability and centralized policy development authority.	
Social Risk II - Frequently changing regulations or guidelines on GHG accounting Changing regulations or guidelines on GHG accounting can impact the quantity of reductions determined for a project. Changes to regulations and guidelines also impact investments into management activities that maintain reductions.	
Social Risk III - Monetary decisions that impact, hinder, or enable CER projects The risk of non-permanence is greater among projects with declining values for reductions. Such a decline may result in inadequate funding for project maintenance and monitoring.	
Social Risk IV - Environmental Justice Impacts Unintended consequences of project development, such as increased exposure to wildfire or reduced water supply, may result in political actions to curb project activities.	
Social Risk V - Effects on employment A negative impact on local or regional employment can result in CER project failure.	
Social Risk VI - Environmental perceptions Social perceptions of significant environmental harm can lead to opposition resulting in CER project delay, costs, or failure.	
Default Social Risks	2%

C.4 Natural Disturbance Risk

Natural disturbances can pose a significant risk to reductions. Natural disturbance risks are only partially controllable by management activities. Management activities that improve resiliency to wildfire, insects, and disease can reduce these risks. Management activities that shift harvesting practices from live sequestering trees to trees that have succumbed to natural disturbances reduce or negate the reversal depending on the size and location of the disturbance.

Natural Disturbance Risk I – Wildfire

A wildfire can lead to significant unplanned emissions on a forest project. A wildfire has the potential to reverse obligated reductions especially in certain carbon pools. These risks can be reduced by certain techniques including treating fuel loading, fuel breaks, ladder fuel reduction, stand structure techniques, but likely cannot be reduced to zero because all landowners will not undertake fuel treatments. These reduction estimates maybe updated with subsequent verification efforts.

Table C.4.1 Natural Disturbance Risk Identification.

Identification of Risk		Risk Contribution
C.4.1	For the assessment area the project is located in, determine long term fire risk potential from fire history perimeter maps (at least 30 years) – enter rate as a annualized percentage.[1]	X%
C.4.1a	Reduce value from C.4.1 by 50% to estimate catastrophic loss from perimeter values.	X%/2
C.4.1b	If fuel treatments have been implemented for the project area, reduce the value calculated in C.4.1a by the appropriate % from discussion below.[2]	(C.4.1a)*Y%

[1] If the project proponent has more property specific fire data of at least 30 years in duration that may be used in lieu of the regional assessment area values.

[2] Depending on the level of fuel treatments the Y% in C4.1b is set as follows: high level of fuel treatments = 50%, medium level of fuel treatments = 66.3%, low level of fuel treatments = 82.6%, no fuel treatments = 100%.

Natural Disturbance Risk II - Disease or insect outbreak

A disease or insect outbreak has the potential to reverse obligated reductions especially in certain carbon pools

Table C.4.2. Natural Disturbance Risk Identification.

Identification of Risk	Risk Contribution
Default Contribution from Disease or Insect Outbreak for project areas where harvest does not occur at least every 30 years:	2%
Default Contribution from Disease or Insect Outbreak for project areas where harvest does occur at least every 30 years	1%

Natural Disturbance Risk III - Other episodic catastrophic events

A major wind-throw event (hurricane, tornado, simply high wind event) has the potential to reverse obligated reductions especially in certain carbon pools. Prompt reforestation if the episodic catastrophic event is large enough has been shown to transform sites back to net sequestration in as little as ten years.

Table C.4.3 Natural Disturbance Risk Identification.

Identification of Risk	Risk Contribution
Default Contribution from Other Catastrophic Events for project areas where harvest does not occur at least every 30 years	2%
Default Contribution from Other Catastrophic Events for project areas where harvest does occur at least every 30 years	1%

C.5 Accuracy of Carbon Stock Estimates

Inventory estimates with low statistical confidence have a higher risk of over-estimating reductions than inventory estimates with higher levels of confidence which can translate into a reversal if more accurate estimates identify lower stocks than previously estimated.

The risk of reversal associated with statistical confidence is based on evaluating the Standard Error of the inventory estimate relative to the Estimate of the Mean. This establishes the Confidence Limits and can be expressed as a percentage of the Mean. Project level estimates will be evaluated at 90% Confidence Limits (1 Standard Error* 1.645 (t value for infinite degrees of freedom)). Larger Confidence Intervals indicate that there is less confidence in the Mean Estimate than smaller Confidence Intervals.

Confidence levels will be determined for the combined estimate of the included pools derived from sampling (does not include wood products pool).

Table C.5 Biomass deductions based on level of confidence in the estimate derived from field sampling.

Sampling Error no Greater than X% (Percentages Below) on Either Side of the Mean Estimate at the 90% Confidence Level (1 standard error x 1.645)	Risk Contribution
0 to 5%	0%
5.1 to 20%	Amount over 5.1% to the nearest 1/10th percentage
20% or greater	100%
Enter value for accuracy of carbon stocks estimates	

C.6 Summarizing the Risk Analysis and Contribution to Buffer Pool

The table below summarizes the project's contribution to the buffer pool. The table includes a buffer pool contribution for projects with a Project Implementation Agreement (PIA) only and for projects with Project Implementation Agreements and a conservation easement or a deed Restriction. Conservation easements and/or deed restrictions add further protections to the remedies in the PIA and therefore are at a lower risk profile. Such conservation easements, deed restriction must clearly identify the project goals and objectives or the PIA itself. A project on public ownership also has the same lower risk profile.

Risk Rating	Contribution from Descriptions Above		
	Source	Project Implementation Agreement Only	Project Implementation Agreement and Conservation Easement and/or a Deed Restriction and/or Public Ownership
Financial Failure	Remedies for reversals addressed in PIA	1%	0%
Illegal Forest Biomass Removal	From worksheet		
Conversion	Remedies for reversals addressed in PIA	2%	0%
Over-Harvesting	Remedies for reversals addressed in PIA	2%	0%
Social	Default	2%	2%
Wildfire	From worksheet		
Disease or Insect Outbreak	From worksheet		
Other Catastrophic Events	From worksheet		
Accuracy of Carbon Stocks Estimates	From worksheet		

Completing the Risk Analysis:

The project's risk contribution to the buffer pool is applied to all reductions that are accrued in a given year. The formula for determining the contribution is:

100% -((1- Financial Failure %) * (1- Illegal Forest Biomass Removal %) * (1- Conversion %) * (1- Over-Harvesting %) * (1- Social %) * (1- Wildfire %) * (1- Disease or Insect Outbreak %) * (1- Other Catastrophic Events %) * (1-Accuracy of Carbon Stocks Estimates))* (Reductions accrued in Year X)

Appendix D Native Forests Resources

State	References
California	Jepson Flora Project, which may be accessed on-line at: http://ucjeps.berkeley.edu/jepsonflora/.

http://www.botany.org/Resources/ Shows state resources of plant related ecological and conservation interests on a state-by-state basis

Appendix E Reforestation Criteria

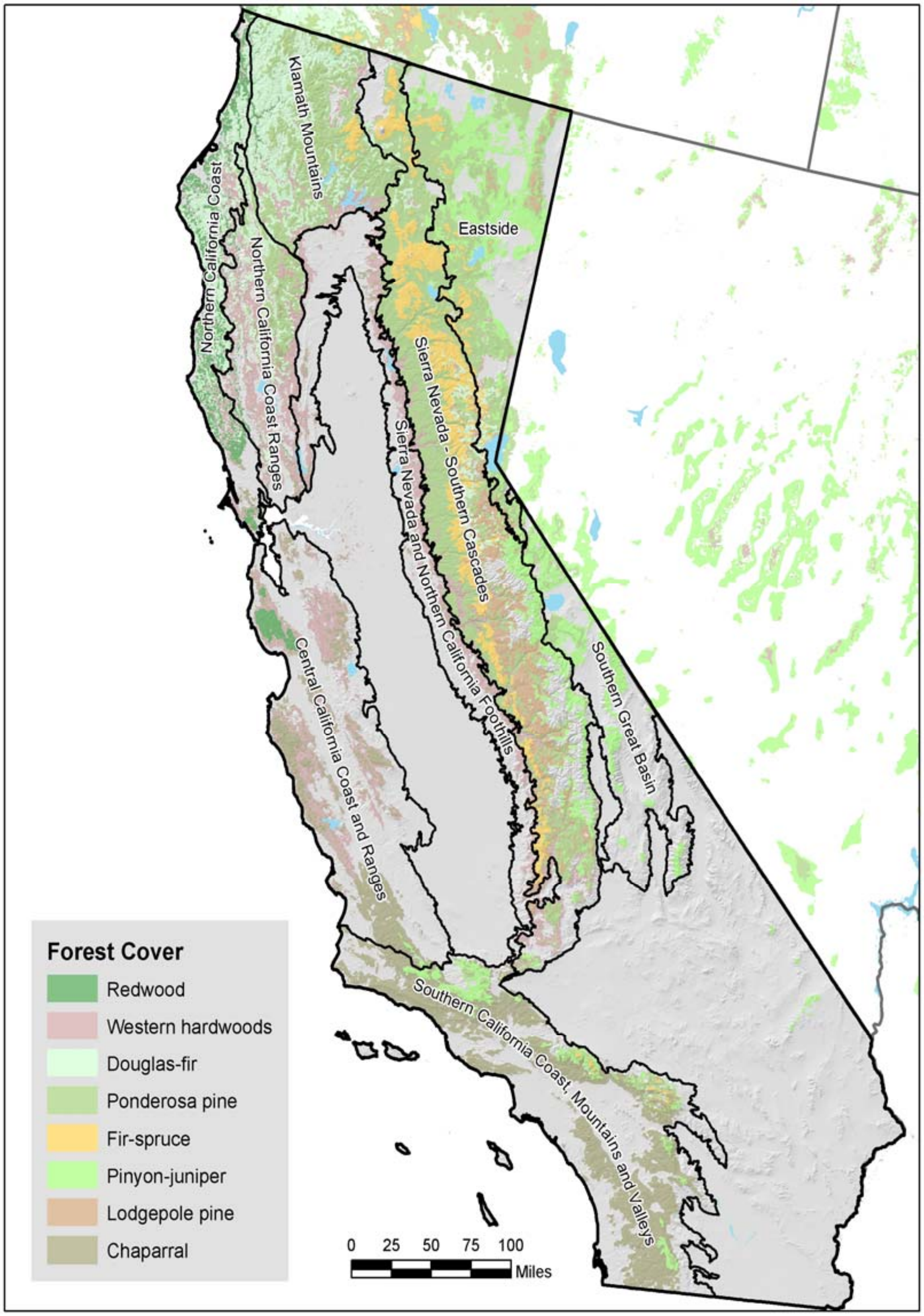
Determination of Eligible Reforestation Projects

Site Preparation (per acre basis)	Cost of Capital - Farm Credit Rates	Stumpage per mbf	Rotation Age (Years)	Volume Produced (mbf/acre)	Scenario	Net Present Value
Site preparation is considered high if it involves any of the following components: * Brush removal across more than 50% of the area * Soil ripping across more than 50% of the area Site preparation is otherwise considered low	These are updated annually from published rates by region	Stumpage is the the value returned to the landowner after logging and transportation costs.	The anticipated average rotation age proposed for the project. For projects that do not anticipate harvesting, a value of 120 is used.	The assumed volume available at rotation age. The landowner must select the site class that best suits their ownership.	Number of scenario	Demonstration of financial incentive to reforest is based on break-even analysis. If the scenario is 0 or greater then the project is not eligible.
High Site Preparation	6.75%	>$750/mbf	30	Medium to High Site	1	$2,407
				Medium to Low Site	2	$1,280
			40	Medium to High Site	3	$1,372
				Medium to Low Site	4	$589
			50	Medium to High Site	5	$551
				Medium to Low Site	6	$32
			60	Medium to High Site	7	$22
				Medium to Low Site	8	$346
			70	Medium to High Site	9	$396
				Medium to Low Site	10	$593
			120	Medium to High Site	11	$943
				Medium to Low Site	12	$954
		$500 - $750/mbf	30	Medium to High Site	13	$1,667
				Medium to Low Site	14	$786
			40	Medium to High Site	15	$858
				Medium to Low Site	16	$247
			50	Medium to High Site	17	$217
				Medium to Low Site	18	$188
			60	Medium to High Site	19	$230
				Medium to Low Site	20	$484
			70	Medium to High Site	21	$523
				Medium to Low Site	22	$677
			120	Medium to High Site	23	$950
				Medium to Low Site	24	$959
		$250 - $500/mbf	30	Medium to High Site	25	$399
				Medium to Low Site	26	$59
			40	Medium to High Site	27	$22
				Medium to Low Site	28	$339
			50	Medium to High Site	29	$355
				Medium to Low Site	30	$566
			60	Medium to High Site	31	$588
				Medium to Low Site	32	$719
			70	Medium to High Site	33	$740
				Medium to Low Site	34	$820
			120	Medium to High Site	35	$962
				Medium to Low Site	36	$967
		0-$250/mbf	30	Medium to High Site	37	$447
				Medium to Low Site	38	$623
			40	Medium to High Site	39	$608
				Medium to Low Site	40	$731
			50	Medium to High Site	41	$737
				Medium to Low Site	42	$818
			60	Medium to High Site	43	$826
				Medium to Low Site	44	$877
			70	Medium to High Site	45	$885
				Medium to Low Site	46	$915
			120	Medium to High Site	47	$970
				Medium to Low Site	48	$972

Determination of Eligible Reforestation Projects

Site Preparation (per acre basis)	Cost of Capital - Farm Credit Rates	Stumpage per mbf	Rotation Age (Years)	Volume Produced (mbf/acre)	Scenario	Net Present Value
Site preparation is considered high if it involves any of the following components: * Brush removal across more than 50% of the area * Soil ripping across more than 50% of the area Site preparation is otherwise considered low	These are updated annually from published rates by region	Stumpage is the the value returned to the landowner after logging and transportation costs.	The anticipated average rotation age proposed for the project. For projects that do not anticipate harvesting, a value of 120 is used.	The assumed volume available at rotation age. The landowner must select the site class that best suits their ownership.	Number of scenario	Demonstration of financial incentive to reforest is based on break-even analysis. If the scenario is 0 or greater then the project is not eligible.
Low Site Preparation	6.75%	>$750/mbf	30	Medium to High Site	49	$2,557
				Medium to Low Site	50	$1,430
			40	Medium to High Site	51	$1,522
				Medium to Low Site	52	$739
			50	Medium to High Site	53	$701
				Medium to Low Site	54	$182
			60	Medium to High Site	55	$128
				Medium to Low Site	56	$196
			70	Medium to High Site	57	$246
				Medium to Low Site	58	$443
			120	Medium to High Site	59	$793
				Medium to Low Site	60	$804
		$500 - $750/mbf	30	Medium to High Site	61	$1,817
				Medium to Low Site	62	$936
			40	High Site	63	$1,008
				Medium to Low Site	64	$397
			50	High Site	65	$367
				Medium to Low Site	66	$38
			60	High Site	67	$80
				Medium to Low Site	68	$334
			70	High Site	69	$373
				Medium to Low Site	70	$527
			120	High Site	71	$800
				Medium to Low Site	72	$809
		$250 - $500/mbf	30	High Site	73	$549
				Medium to Low Site	74	$91
			40	High Site	75	$128
				Medium to Low Site	76	$189
			50	High Site	77	$205
				Medium to Low Site	78	$416
			60	High Site	79	$438
				Medium to Low Site	80	$569
			70	High Site	81	$590
				Medium to Low Site	82	$670
			120	High Site	83	$812
				Medium to Low Site	84	$817
		0-$250/mbf	30	High Site	85	$297
				Medium to Low Site	86	$473
			40	High Site	87	$458
				Medium to Low Site	88	$581
			50	High Site	89	$587
				Medium to Low Site	90	$668
			60	High Site	91	$676
				Medium to Low Site	92	$727
			70	High Site	93	$735
				Medium to Low Site	94	$765
			120	High Site	95	$820
				Medium to Low Site	96	$822

Appendix F California Assessment Areas



Assessment Area			
California Assessment Areas		Common Practice Indicator - Carbon Tons per Acre in Live Trees*	Composition of Native Species Threshold (maximum percentage of any one species) for Natural Forest Management Table 3.1
Ecosection	Forest Type		
Eastside	California mixed conifer	27	80%
	Mixed hardwoods	5	80%
Sierra Nevada-Southern Cascades	California mixed conifer	39	80%
	Mixed hardwoods	22	80%
Sierra Nevada and North CA Foothills	California mixed conifer	22	80%
	Mixed hardwoods	14	80%
Klamath Mountains	California mixed conifer	41	80%
	Mixed hardwoods	14	80%
Northern California Coast Ranges	California mixed conifer	45	80%
	Mixed hardwoods	30	80%
Northern California Coast	Mixed hardwoods	45	80%
	Redwood	72	80%
Central California Coast and Ranges	Mixed hardwoods	19	80%
	Redwood	61	80%
Central California Coast Mountains and Valleys	California mixed conifer	25	80%
	Mixed hardwoods	20	80%

*Estimated Carbon on forest land, private ownerships only, California 2001-2007

Appendix G References

Use APA style for references.

(Murray et al, date). …on inelasticity of wood products demand

Cairns et al., 1997…measuring below-ground inventory of live tree biomass