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Forest

Project Protocol

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Abbreviations and Acronyms

C	Carbon
CH_4	Methane
CO_2	Carbon dioxide
CRT	Climate Reserve Tonne
FIA	USFS Forest Inventory and Analysis[1]
FPP	Forest Project Protocol
GHG	Greenhouse gas
lb	Pound
IFM	Improved Forest Management
N_2O	Nitrous oxide
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
USFS	United States Forest Service

[1] http://fia.fs.fed.us/program-features/rpa/

1 Introduction

The Forest Project Protocol (FPP) provides requirements and guidance for quantifying the net climate benefits of activities that sequester carbon on forestland in the United States. The protocol provides project eligibility rules; methods to calculate a project's net effects on greenhouse gas (GHG) emissions and removals of CO_2 from the atmosphere ("removals"); procedures for assessing the risk that carbon sequestered by a project may be reversed (i.e., released back to the atmosphere); and approaches for long term project monitoring and reporting. The goal of this protocol is to ensure that the net GHG reductions and removals caused by a project are accounted for in a complete, consistent, transparent, accurate, and conservative manner and may therefore be reported to the Climate Action Reserve (Reserve) as the basis for issuing carbon offset credits (called Climate Reserve Tonnes, or CRTs).

The Reserve is a national offsets program working to ensure integrity, transparency and financial value in the North American carbon market. It does this by establishing regulatory-quality standards for the development, quantification and verification of GHG emissions reduction projects in North America; issuing carbon offset credits known as CRTs generated from such projects; and tracking the transaction of credits over time in a transparent, publicly-accessible system. Adherence to the Reserve's high standards ensures that emissions reductions associated with projects are real, permanent and additional, thereby instilling confidence in the environmental benefit, credibility and efficiency of the U.S. carbon market.

Only those Forest Projects that are eligible under and comply with the FPP may be registered with the Reserve. Section 9 of this protocol provides requirements and guidance for verifying the performance of project activities and their associated GHG reductions and removals 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 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, 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 circumstances of the disturbance. Forests function as reservoirs in storing CO_2.Depending on how forests are managed or impacted by natural events, they can be a net source of emissions, resulting in a decrease to the reservoir, or a net sink, resulting in an increase of CO_2 to the reservoir. In other words, forests may have a net negative or net positive impact on the climate.

Through sustainable management and protection, forests can also play a positive and significant role to help address global climate change. The Reserve's 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.

2 Forest Project Definitions and Requirements

For the purposes of the FPP, a Forest Project is a planned set of activities designed to increase removals of CO_2 from the atmosphere or reduce or prevent emissions of CO_2 to the atmosphere, through increasing and/or conserving forest carbon stocks.

A glossary of terms related to Forest Projects is provided in Section 10 of this protocol. Throughout the protocol, important defined terms are capitalized (e.g., "Avoided Conversion Project").

2.1 Project Types

The Reserve will register the following types of Forest Project activities.[2]

2.1.1 Improved Forest Management

An Improved Forest Management Project involves management activities that maintain or increase carbon stocks on forested land relative to baseline levels of carbon stocks, as defined in Section 6.1 of this protocol. An Improved Forest Management Project is only eligible if:

1. The project takes place on land that has greater than ten percent tree canopy cover.
2. The project employs natural forest management practices, as defined in Section 3.9.2 of this protocol.
3. The project does *not* employ broadcast fertilization.
4. The project does not take place on land that was part of a previously registered Forest Project, unless the previous Forest Project was terminated due to an Unavoidable Reversal (see Section 7).

Eligible management activities may include, but are not limited to:

- Increasing the overall age of the forest by increasing rotation ages
- Increasing the forest productivity by thinning diseased and suppressed trees
- Managing competing brush and short-lived forest species
- Increasing the stocking of trees on understocked areas
- Maintaining stocks at a high level

Improved Forest Management Projects may be eligible on both private and public lands.

2.1.2 Avoided Conversion

An Avoided Conversion Project involves preventing the conversion of forestland to a non-forest land use by dedicating the land to continuous forest cover at existing or increased stocking levels through conservation easement recordation or transfer to public ownership. An Avoided Conversion Project is only eligible if:

[2] Reforestation Projects were previously included within the FPP. Please refer to the Reserve's website for information about that project type.

1. The Project Operator can demonstrate that there is a significant threat of conversion of project land to a non-forest land use by following the requirements for establishing the project's baseline in Section 6.2 of this protocol.
2. The project does *not* employ broadcast fertilization.
3. The project does not take place on land that was part of a previously registered Forest Project, unless the previous Forest Project was terminated due to an Unavoidable Reversal (see Section 7).

An Avoided Conversion Project may involve tree planting, harvesting, and other silvicultural activities as part of the project activity.

Avoided Conversion Projects are eligible only on lands that are privately owned prior to the project start date.

2.2 Forest Owners and Project Operators

A Forest Owner is an individual or a corporation or other legally constituted entity, city, county, state agency, or a combination thereof that has legal control of any amount of forest carbon[3] within the Project Area. Control of forest carbon means the Forest Owner has the legal authority to effect changes to forest carbon quantities, e.g., through timber rights or other forest management or land-use rights. Control of forest carbon occurs, for purposes of satisfying this protocol, through fee ownership and/or deeded encumbrances, such as conservation easements.

Multiple Forest Owners may exist with respect to a single Forest Project, since control of forest carbon may be associated with fee ownership or through one or more deeded encumbrances that exist within a Project Area, any one of which may convey partial control of the project's forest carbon. However, only one fee owner may exist with respect to a single Forest Project. Any unencumbered forest carbon is assumed to be controlled by the fee owner. Individuals or entities holding mineral, gas, oil, or similar *de minimis*[4] interests in the forest carbon, are precluded from the definition of Forest Owner. Where any Forest Owner chooses to exclude the forest carbon it controls from becoming part of the Forest Project, the project's baseline must demonstrate the exclusion as a legal constraint.

The Project Operator is responsible for undertaking a Forest Project and registering it with the Reserve, and is ultimately responsible for all Forest Project reporting and attestations. The Project Operator has an account with the Reserve and executes the Project Implementation Agreement (see Section 3.6). A Project Operator must be one of the Forest Owners or must have an explicit legal agreement granting the right to operate the project from all other Forest Owners. In the latter case, the Project Operator must at least have fee ownership of the Project Area. The legal agreement granting the right to operate the project on behalf of the Forest Owner(s) will be subject to review and approval by the Reserve.

In all cases, the Project Operator must secure an agreement from all other Forest Owners that (1) assigns authority to the Project Operator to undertake a Forest Project, subject to any conditions imposed by any of the other Forest Owners to include or disallow any carbon they control; and (2) waives any right on the part of the Forest Owners to seek damages, penalties,

[3] See definition of Forest Carbon in glossary.
[4] *de minimis* control includes access right or ways and residential power line right of ways.

costs, losses, expenses, or judgments from the Reserve arising from or in any way connected with the Forest Project, except as explicitly provided for in the PIA.

The Reserve maintains the right to determine which individuals or entities meet the definition of "Forest Owner."

The Project Operator may engage an independent third-party project developer to assist or consult with the Project Operator and to implement the Forest Project. All information submitted to the Reserve on behalf of the Project Operator shall reference the Project Operator, who is responsible for the accuracy and completeness of the information submitted, and for ensuring compliance with this Forest Project Protocol.

2.3 Forest Project Aggregation

Eligible Forest Projects[5] may be aggregated to improve cost-effectiveness while maintaining rigor in overall carbon inventory accounting. Individual Forest Projects can benefit through participation in an aggregate by meeting carbon inventory confidence standards across an aggregate, rather than within each project. This reduces the sampling intensity required within each project to meet statistical confidence requirements. Similarly, verification of aggregated projects is considered across the broader population, which reduces the verification costs to individual Project Operators participating in an aggregate. An aggregate consists of two or more individual Forest Projects enrolled with an Aggregator. For more information, please refer to the Guidelines for Aggregating Forest Projects.

[5] As described in the Guidelines for Aggregating Forest Projects available on the Reserve website.

3 Eligibility Rules and Other Requirements

In addition to the definitions and requirements described in Section 2, Forest Projects must meet several other criteria and conditions to be eligible for registration with the Reserve, and must adhere to certain requirements related to their duration, crediting period, and management activities.

Section 3.1	Project Location	→	*U.S., U.S. Territories (avoided conversion only), and tribal areas*
Section 3.2	Project Start Date	→	*No more than twelve months prior to project submission*
Section 3.3	Additionality	→	*Exceed legal requirements*
		→	*Meet performance standard*
Section 3.4	Project Crediting Period	→	*One hundred year crediting period*
Section 3.5	Permanence	→	*One hundred years following the issuance of CRTs*
Section 3.6	Project Implementation Agreement	→	*Project Operator executes PIA with the Reserve*
Section 3.7	Qualified Conservation Easement	→	*Optional*
Section 3.8	Regulatory Compliance	→	*Compliance with all applicable laws*
Section 3.9	Sustainable Harvesting and Natural Forest Management	→	*Ongoing compliance with the requirements for the project's assessment area(s)*

3.1 Project Location

All Forest Projects located in the United States of America are eligible to register with the Reserve provided they meet all other eligibility requirements described in this protocol. Improved Forest Management Projects may be located on private land or on state or municipal public land. Avoided Conversion Projects must be implemented on private land, unless the land is transferred to public ownership as part of the project. All projects can be transferred from private to public lands, whereby the public entity acquires all terms and conditions described in this protocol.

All Improved Forest Management Projects that are on public lands as of the project's start date must be approved by the government agency or agencies responsible for management activities on the land. This approval must include an explicit approval of the project's baseline, as determined in Section 6, and must involve any public vetting processes necessary to evaluate management and policy decisions concerning the project activity.

Forest Projects on federal lands may be eligible if and when their eligibility is approved through a federal legislative or regulatory/rulemaking process. Forest Projects in tribal areas must demonstrate that the land within the Project Area is owned by a tribe or private entities.

Companion documents to the Forest Project Protocol contain data tables, equations, and benchmark data applicable to projects located in the United States. The Reserve may add approved equations and models as they are developed in future versions of the Forest Project Protocol.

The methods required by this protocol for estimating baseline carbon stocks for Forest Projects cannot currently be applied outside the United States, as they rely on U.S.-specific data sets and models, particularly for Improved Forest Management Projects. Avoided Conversion Projects are eligible in U.S. Territories, as they do not depend on the U.S.-specific data sets mentioned above.

3.2 Project Start Date

The start date of a Forest Project is the date on which an activity is initiated that will lead to increased GHG reductions or removals relative to the Forest Project's baseline. All forest projects must be submitted to the Reserve within 12 months of their project start date.[6]

The following sections detail actions that identify the project start date for each project type.

3.2.1 Improved Forest Management Project Start Date

For an Improved Forest Management Project, the action is initiating forest management activities that increase sequestration and/or decrease emissions relative to the baseline. The start date must be linked to a discrete, verifiable action that delineates a change in practice relative to the project's baseline. Project Operators may choose to identify one of the following actions:

- Recordation of a conservation easement on the Project Area. The project start date is the date the easement was recorded.
- Transferring of property ownership (to a public or private entity). The project start date is the date of property transfer.
- Submitting the project to the Reserve.[7] The project start date is the date of submittal, provided that the project completes verification within 30 months of being submitted. If the project does not meet this deadline, it must be resubmitted under the latest version of the protocol; it will not retain the initial submittal date and will be subject to any new project start date requirements.

Project Operators must affirm the action denoting the project start date by providing documentation. Adequate documentation could include deeds of trust, title reports, conservation easement documentation, dated forest management plans, and/or contracts or agreements.

3.2.2 Avoided Conversion Project Start Date

For an Avoided Conversion Project, the action is committing the Project Area to continued forest management and protection through conservation easement recordation with a provision to maintain the Project Area in forest cover or transferring the Project Area to public ownership where the Project Area will be maintained in forest cover.

[6] See the Reserve's Program Manual for requirements for listing a project with the Reserve, available at http://www.climateactionreserve.org/how-it-works/program/program-manual/.

[7] Submitting a project to the Reserve is considered an initiation of a commitment to employ practices that will maintain or grow net carbon stocks for the duration of the FPP's commitment period, per the requirements of the FPP and signing the Project Implementation Agreement (PIA).

Where recordation of a conservation easement is used to signal the project start date, multiple conservation easements may be used to cover a single Project Area. Where transfer of the Project Area to public ownership is used to signal the project start date, multiple transfers may be used to cover a single Project Area. In either case, the following provisions must be met, as applicable:

- The Project Area being placed under easements has one fee owner, as required by Section 2.2, or the Project Area is being transferred to a single public entity;
- The easements must all have been recorded within the span of 12 months, or the transfers all take place within the span of 12 months;
- The alternative non-forest land use being avoided must be identical for all portions of the project and the default rate of conversion must be used (see Table 6.3); and,
- The Conversion Risk Adjustment Factor must be the same for all portions of the project (see Equation 6.11).

In these cases, the project start date will be the date of the last recorded easement, or the date of the final transfer of land.

3.3 Additionality

The Reserve strives to register only projects that yield surplus GHG emission reductions and removals that are additional to what would have occurred in the absence of a carbon offset market (i.e., under "Business As Usual"). For a general discussion of the Reserve's approach to determining additionality, see the Reserve's Program Manual (available at http://www.climateactionreserve.org/how/program/program-manual/).

The approach to additionality for Forest Projects recognizes increases in the amount of CO_2 removed from the atmosphere relative to Business As Usual management. It also considers the long-term risks to carbon sequestered in the Project Area presented by Business As Usual management and the potential emissions of such carbon into the atmosphere. Under such an approach, it takes into account the following:

- On-site carbon stocks are at risk on a 100-year time scale.
- Land ownership and management direction are not permanent, except in cases where binding commitments limit management options, such as conservation easements.
- Management goals and objectives are likely to change over time, especially as ownership of a forest changes hands, as often happens between generations of family forest owners[8] or between entities owning forests as a financial investment.[9]
- Over the length of a project lifetime and in the absence of a long-term commitment to a Forest Project, emissions may have resulted from the clearing of trees to convert a forest to another land cover type (for avoided conversion projects) or from harvest activities that reduce average on-site carbon stocking (for improved forest management projects).
- Committing a site to a Forest Project for at least 100 years and the long-term requirements specified in this protocol (e.g., monitoring, reporting, and verification; compensation for reversals; buffer pool contributions) removes such risks to emissions.

[8] Butler, B. J., *et al*. 2016. "Family Forest Ownerships of the United States, 2013: Findings from the USDA Forest Service's National Woodland Owner Survey." *Journal of Forestry* 114 (6): 638–47. doi:10.5849/jof.15-099.
[9] Bliss, J. C., *et al*. 2010. "Disintegration of the U. S. Industrial Forest Estate: Dynamics, Trajectories, and Questions." *Small-Scale Forestry* 9 (1): 53–66. doi:10.1007/s11842-009-9101-7.

Furthermore, this protocol acknowledges that the project's baseline, as the way Business As Usual management is represented for quantification purposes, is a counterfactual scenario, i.e., a representation of what may have actually occurred if the project had never happened. Additionality is assured over 100-year crediting period, during which project activities ensure forest carbon stocks are maintained or increase compared to the baseline, since the precise timing of potential outcomes within the counterfactual scenario are impossible to pinpoint. This and other assumptions incorporated into the quantification of a project's baseline and GHG reductions, as described below in Section 6, are used to create more consistency and simplicity in crediting while maintaining conservativeness.

Forest Projects must satisfy the following tests to be considered additional:

1. *Legal Requirement Test*. Forest Projects must achieve GHG reductions or removals above and beyond any GHG reductions or removals that would result from compliance with any federal, state, or local law, statute, rule, regulation, or ordinance. Forest Projects must also achieve GHG reductions and removals above and beyond any GHG reductions or removals that would result from compliance with any court order or other legally binding mandates including management plans (such as Timber Harvest Plans) that are required for government agency approval of harvest activities.

   Deeded encumbrances, such as timber deeds or conservation easements, may effectively control forest carbon, such that there may be multiple Forest Owners within the Project Area. Deeded encumbrances are considered legally binding mandates for the purposes of the legal requirement test, unless they are recorded within a year of the Forest Project's start date with clear agreement from all Forest Owners.

   Deeded encumbrances may contain terms that do not directly refer to forest carbon, but that nevertheless restrict the effect the ability of any one Forest Owner to change forest carbon stocks. These terms must be interpreted with respect to their effect on forest carbon for the purposes of the legal requirement test and baseline determinations. Where the terms of deeded encumbrances are not explicit with regards to forest carbon, the following assumptions shall be made:

   a. Restrictions or references related to canopy cover, basal area, density, volume, carbon or biomass apply to standing live and dead trees of all species.
   b. Carbon in other pools (soil, litter, duff, shrubs, etc.) is assumed to be associated with the other defined terms, such as trees.
   c. Terms related to forest (tree) growth apply to growth in all tree species.

2. *Performance Test*. Forest Projects must achieve GHG reductions or removals above and beyond any GHG reductions or removals that would result from engaging in Business As Usual activities, as defined by the requirements described below (Section 3.3.2).

   Project quantification (Section 6) further ensures that forest projects are additional via checks on financial feasibility.

3.3.1 Legal Requirement Test

The legal requirement test is satisfied if the following requirements are met, depending on the type of Forest Project.

3.3.1.1 Improved Forest Management Projects

At the Forest Project's initial verification, the Project Operator must sign the Reserve's Attestation of Voluntary Implementation form indicating that the Forest Project is not legally required (as defined above) and was not legally required at the time of the project's start date. For the purposes of the attestation, the "Project" is defined as maintaining onsite carbon stocks at or above their current levels (at the time the attestation is signed) for at least 100 years.

A project's final baseline must reflect all legal constraints in effect at the time of the project's start date, as required in Section 6.1 of this protocol.

3.3.1.2 Avoided Conversion Projects

At the Forest Project's initial verification, the Project Operator must sign the Reserve's Attestation of Voluntary Implementation form indicating that the Forest Project's planned forest conservation activities are not legally required (as defined above) and were not legally required at the time of the project's start date.

A project's final baseline must reflect all legal constraints, as required in Section 6.2 of this protocol.

3.3.2 Performance Test

The performance test is satisfied if the following requirements are met, depending on the type of Forest Project.

3.3.2.1 Improved Forest Management Projects

An Improved Forest Management Project automatically satisfies the performance test. Project activities are considered additional to the extent they produce GHG reductions and/or removals in excess of those that would have occurred under a Business As Usual scenario, as defined by the baseline estimation requirements in Section 6.1.

3.3.2.2 Avoided Conversion Projects

An Avoided Conversion Project satisfies the performance test if the Project Operator provides a real estate appraisal (or real estate appraisals) for the Project Area (as defined in Section 4) indicating the following:

1. *The Project Area is suitable for conversion*. The appraisal(s) must clearly identify the highest value alternative land use for the Project Area and indicate how the physical characteristics of the Project Area are suitable for the alternative land use.
2. The appraisal(s) must conform with the following minimum standards[10]:
    a. Appraisal reports shall be prepared and signed by a Licensed or Certified Real Estate Appraiser in good standing.
    b. Appraisal reports shall include descriptive photographs and maps of sufficient quality and detail to depict the subject property and any market data relied upon, including the relationship between the location of the subject property and the market data.

[10] Adapted from Sections 5096.501 and 5096.517, Public Resources Code, State of California.

c. Appraisal reports shall include a complete description of the subject property land, site characteristics and improvements. Valuations based on a property's development potential shall include:

   i. Verifiable data on the development potential of the land (e.g., Certificates of Compliance, Tentative Map, Final Map).
   ii. A description of what would be required for a development project to proceed (e.g., legal entitlements, infrastructure).
   iii. Presentation of evidence that sufficient demand exists, or is likely to exist in the future, to provide market support for the development.
   iv. Where conversion to commercial, residential, or agricultural land uses is identified as the highest value alternative land use, the appraisal(s) must demonstrate that the slope of Project Area land is compatible with the alternative land use by identifying two areas with similar average slope conditions to the Project Area that have been converted within the past ten years in the project's Assessment Area. Alternatively, the Project Area must have an average slope less than 40 percent.
   v. Where conversion to agricultural land use is anticipated, the appraisal(s) must provide:

      1) Evidence of soil suitability for the type of expected agricultural land use.
      2) Evidence of water availability for the type of expected agricultural land use.
      3) Where conversion to mining land use is anticipated, the appraisal(s) must provide evidence of the extent and amount of mineral resources existing in the Project Area.

   vi. Where conversion to residential, commercial, or recreational land uses is anticipated, the appraisal(s) must also describe the following information:

      1) The proximity of the Project Area to metropolitan areas
      2) The proximity of the Project Area to grocery and fuel services and accessibility of those services
      3) Population growth within 180 miles of the Project Area

d. Appraisal reports shall include a statement by the appraiser indicating to what extent land title conditions were investigated and considered in the analysis and value conclusion.
e. Appraisal reports shall include a discussion of implied dedication, prescriptive rights or other unrecorded rights that may affect value, indicating the extent of investigation, knowledge, or observation of conditions that might indicate evidence of public use.
f. Appraisal reports shall include a separate valuation for ongoing forest management prepared and signed by a certified or registered professional qualified in the field of specialty interest. This valuation shall be reviewed and approved by a second qualified, certified or registered professional, considered by the appraiser, and appended to the appraisal report(s). The valuation must identify and incorporate all legal constraints that could affect the valuation of both the ongoing forest management.
g. The appraisal(s) must provide a map that displays specific portions of the Project Area that are suitable for the identified alternative land use. (For example, an appraisal that identified a golf course as an alternative land use must specify the

approximate acres suitable for fairways, greens, clubhouses, and outbuildings.). The smaller of the two areas identified in the appraisals must be used.

3. *The alternative land use for the Project Area has a higher market value than maintaining the Project Area for sustainable forest management.* The appraisal(s) for the property must provide a value for the current forest land use condition of the Project Area and a fair market value of the anticipated alternative land use for the Project Area. The anticipated alternative land use for the Project Area must be at least 40 percent greater than the value of the current forested land use.

The appraisal(s) must be conducted in accordance with the Uniform Standards of Professional Appraisal Practice[11] and the appraiser must meet the qualification standards outlined in the Internal Revenue Code, Section 170 (f)(11)(E)(ii).[12]

3.3.3 Enhancement Payments

Enhancement payments provide financial assistance to landowners in order to implement discrete practices that address natural resource concerns and deliver environmental benefits. Examples of relevant enhancement payments include:

- California Climate Investments (CCI), formerly called Greenhouse Gas Reduction Funds (GGRF)
- USFS grants and agreements

Forest Owner(s) may pursue enhancement payments that support forest carbon project activities. Because every available enhancement payment is not comprehensively addressed by the protocol at this time, the Forest Owner(s) must still disclose any such payments to the verifier and the Reserve on an ongoing basis. The Reserve maintains the right to determine if payment stacking has occurred and whether or not it would impact project eligibility.

3.4 Project Crediting Period

The baseline for any Forest Project registered with the Reserve under this version of the Forest Project Protocol is assumed to be valid for 100 years. This means that a registered Forest Project will be eligible to receive CRTs for GHG reductions and/or removals quantified using this protocol, and verified by Reserve-approved verification bodies, for a period of 100 years following the project's start date. Projects may not end their crediting period early without penalty, as all quantification performed in this protocol assumes reporting and verification will continue for 100 years.

3.5 Permanence

Project Operators must monitor and verify a Forest Project for a period of 100 years following the issuance of any CRT for GHG reductions or removals achieved by the project. For example, if CRTs are issued to a Forest Project in year 99 following its start date, monitoring and

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

[12] 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."

verification activities must be maintained until year 199. All Forest Projects must undergo an initial site visit verification to register with the Reserve. After the initial verification, all Forest Projects must undergo a site visit verification at the interval required in Section 8.3.2.1.

There are three possible exceptions to this minimum time commitment:

1. A Forest Project automatically terminates if a Significant Disturbance occurs,[13] leading to an Unavoidable Reversal that reduces the project's standing live tree carbon stocks below the project's baseline standing live tree carbon stocks. Once a Forest Project terminates in this manner, the Project Operator has no further obligations to the Reserve.
2. A Forest Project may be voluntarily terminated prior to the end of its minimum time commitment if the Project Operator surrenders a quantity of CRTs, as specified under 'Retiring CRTs Following Project Termination' below.
3. A Forest Project may be automatically terminated if there is a breach of certain terms described within the Project Implementation Agreement. Such a termination will require the Project Operator to retire a quantity of CRTs, as specified under 'Retiring CRTs Following Project Termination' below.

Retiring CRTs Following Project Termination

1. For an Avoided Conversion Project, the Project Operator must surrender a quantity of CRTs from its Reserve account equal to the total number of CRTs issued to the project over the preceding 100 years.
2. For an Improved Forest Management Project, the Project Operator must surrender a quantity of CRTs from its Reserve account equal to the total number of CRTs issued to the project over the preceding 100 years, multiplied by the appropriate compensation rate indicated in Table 3.1.
3. For any project seeking to terminate project activities on only a portion of the project area, the change must be treated as a potential Avoidable Reversal. If it is determined that the revision to the project area would lead to an Avoidable Reversal, then credits must be cancelled as described in Section 7.3.2. Improved Forest Management projects must also apply the early termination compensation rate in Table 3.1 below. If the revision to the project area would lower standing live carbon stocks below baseline levels, then this will be considered a complete project termination.
4. In addition:
    a. The cancelled CRTs must be those that were issued to the Forest Project, or that were issued to other Forest Projects registered with the Reserve. If neither of those options is available, CRTs from other land use projects will be given preference. If those are not available, then any other CRT is acceptable.
    b. The cancelled CRTs must be designated in the Reserve's software system as compensating for an Avoidable Reversal.

Table 3.1. Compensation Rate for Terminated Improved Forest Management Projects

[13] The natural disturbance shall not be the result of intentional or grossly negligent acts of any of the Forest Owners.

Number of Years that have Elapsed Between the Start Date and the Date of Termination	Compensation Rate
0-5	1.40
6-10	1.20
11-20	1.15
21-30	1.10
31-50	1.05
>50	1.00

3.6 Project Implementation Agreement

For a Forest Project to be eligible for registration with the Reserve, the Project Operator is required to enter into a Project Implementation Agreement (PIA) with the Reserve. The PIA is an agreement between the Reserve and a Project Operator setting forth: (i) the Project Operator's obligation (and the obligation of its successors and assigns) to comply with the Forest Project Protocol, and (ii) the rights and remedies of the Reserve in the event of any failure of the Project Operator to comply with its obligations. The PIA must be signed by the Project Operator before a project can be registered with the Reserve. It must be signed by all entities that are fee simple owners of the Project Area property. The PIA is recorded and submitted after the Reserve has reviewed the verification documents and is about to register the project.

3.7 Use of Qualified Conservation Easements or Qualified Deed Restrictions

A Qualified Conservation Easement is a conservation easement that explicitly (1) refers to, and incorporates by reference, the terms and conditions of the PIA agreed to by the Project Operator, thereby binding both the grantor and grantee – as well as their subsequent assignees – to the terms of the PIA for the full duration of the Forest Project's minimum time commitment, as defined in Section 3.5 of this protocol; (2) makes all future encumbrances and deeds subject to the PIA; and (3) makes the Reserve a third party beneficiary of the conservation easement.

A Qualified Deed Restriction is a deed restriction that ensures that the Project Implementation Agreement runs with the land and explicitly (1) refers to, and incorporates by reference, the terms and conditions of the PIA agreed to by the Project Operator, thereby Project Operator—as well as their subsequent assignees to the terms of the PIA for the full duration of the Forest Project's minimum time commitment, as defined in Section 3.5 of this protocol; (2) makes all future encumbrances and deeds subject to the PIA; and (3) makes the Reserve a third party beneficiary of the deed restriction. A deed restriction is not "qualified" if it merely consists of a recording of the Project Implementation Agreement or a notice of the Project Implementation Agreement, as such a recording is already required by the Project Implementation Agreement. The Reserve maintains the discretion to determine whether a deed restriction meets the terms to be considered a Qualified Deed Restriction.

Qualified Conservation Easements or Qualified Deed Restrictions may be voluntarily employed with any project type. Projects that choose to employ Qualified Conservation Easements or Qualified Deed Restrictions have reduced obligations to the Reserve's CRT Buffer Pool, as described in Section 7 and Appendix A.

Qualified Conservation Easements and Qualified Deed Restrictions must be recorded no earlier than one year before a project's start date. If a Qualified Conservation Easement or Qualified Deed Restriction was recorded more than one year prior to the start date, the limits imposed by the easement or deed restriction on forest management activities must be considered as a legal mandate for the purpose of satisfying the legal requirement test for additionality (Section 3.3.1) and in determining the project's baseline (Section 6).

3.8 Regulatory Compliance

Each time the Forest Project is verified, the Project Operator must attest that the project is in material compliance with all applicable laws relevant to the project activity. For this protocol, instances of non-compliance are likely to be considered "material" if they directly pertain to the management of project carbon stocks. Project Operators are required to disclose in writing to the verifier all instances of violations of laws that directly protect forests (trees), wildlife, water quality, or other environmental benefits, and which result in criminal or civil penalties. If a verifier finds that a project is in a state of material non-compliance, then CRTs will not be issued for GHG reductions that occurred during the period of non-compliance. Non-compliance solely due to administrative or reporting issues, or due to "acts of nature," will not affect CRT crediting.

3.9 Sustainable Harvesting and Natural Forest Management Practices

Forest Projects can create long-term climate benefits as well as provide other environmental benefits, including the sustaining of natural ecosystem processes. To be in conformance with this protocol, Forest Projects must:

1. Employ sustainable long-term harvesting practices, both within their Project Area and on other forest landholdings controlled by the Project Operator and its Affiliate(s) within the project's Assessment Area(s), as described in Section 3.9.1. Forest landholdings are considered "controlled" by the Project Operator if the Project Operator owns the land in fee or has been deeded timber rights on it.
2. Employ Natural Forest Management practices within the Project Area, including meeting species composition, forest structure, and age and habitat distribution requirements, as described in Section 3.9.2.
3. Maintain or increase standing live carbon stocks over the project life, as described in Section 3.9.3.

3.9.1 Sustainable Harvesting Practices

At the time Commercial Rotational Harvesting is initiated on any of the forest landholdings controlled by the Project Operator and its Affiliate(s) within the project's Assessment Area(s), the Project Operator and its Affiliate(s) must employ and demonstrate sustainable long-term harvesting practices on all of its forest landholdings within the project's Supersection(s), including the Project Area, using one of the following options:

1. Certification under the Forest Stewardship Council, Sustainable Forestry Initiative, or Tree Farm System certification programs. Regardless of the program, the terms of certification must require adherence to and verification of harvest levels which can be permanently sustained over time.

2. Adherence to a renewable long-term (50 years minimum) 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 federal lands only).
3. The use of silvicultural practices (if harvesting occurs) that maintain canopy cover averaging at least 40 percent, as measured on any 20 acres of the Project Operator's and its Affiliate(s') landholdings within the project's Supersections(s), including the Project Area.[14] Exceptions may be granted by the Reserve where it can be demonstrated that the harvest openings are intended to restore plantations to forest conditions with greater species diversity. The Project Operator is not responsible for harvest openings that preceded their ownership if the previous ownership had no direct business affiliation with the current ownership.
4. Adherence to a deeded conservation easement(s) with terms that ensure growth equals or exceeds harvest over time.

This requirement shall be met always during the project life and is assessed at each site visit verification. Failure to meet this requirement will result in all Reserve account activity being suspended until it is met.

Project Operators and their Affiliate(s) who acquire new forest landholdings within the project's Assessment Area(s) have up to five years to incorporate such acquisitions under their certification or management plan, or otherwise must abide immediately by the terms of the Sustainable Harvesting Practices, whether or not such land is contiguous with the Project Area.

3.9.2 Natural Forest Management

All Forest Projects must promote and maintain a diversity of native species and utilize management practices that promote and maintain native forests comprised of multiple ages and mixed native species within the Project Area and at multiple landscape scales ("Natural Forest Management").

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

1. Forest Projects must show verified progress (verified at scheduled site visit verifications) towards native tree species composition and distribution requirements described below, consistent with the forest type and forest soils native to the Assessment Area.
2. Forest Projects must manage the distribution of habitat/age classes and structural elements, as described below, to support functional habitat for locally native plant and wildlife species naturally occurring in the Project Area.

Forest Projects must incorporate the criteria for Natural Forest Management throughout the project life. The information provided in Table 3.3 shall be used to determine if the Forest Project meets the criteria for engaging in Natural Forest Management. This evaluation must be completed and verified at a Forest Project's initial verification and at all subsequent verifications. Forest Project carbon stock inventories (requirements for which are found in Appendix B) should be used as the basis of these assessments where applicable. Forest Projects that do not initially meet Natural Forest Management criteria but can demonstrate progress towards meeting these criteria at the times identified in Table 3.3 are compliant with the protocol.

[14] Areas impacted by Significant Disturbance may be excluded from this test.

1. Species Composition

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 are defined as those forests occurring naturally in an area, as neither a direct nor indirect consequence of human activity post-dating European settlement, and are based on reference metrics for each Assessment Area provided in an Assessment Area Data File, a companion document to the FPP available on the Reserve's website. The planting of native species outside of their current distribution is allowed up to 5% of the overall native species requirement as an adaptation strategy due to climate change. Plantings that will result in more than 5% of native species from beyond their current distribution must be done in accordance with a state or federally approved adaptation plan, or a local plan that has gone through a transparent public review process. In all cases, the Project Operator must obtain a written statement from the government agency in charge of forestry regulation in the state where the project is located stipulating that the planting of native trees outside their current range is appropriate as an adaptation to climate change. The specifications for meeting the requirements for species composition are included in Table 3.3.

2. Forest Structure

A variety of silvicultural practices may be employed in the Project Area during the course of a Forest Project, though the protocol does not endorse any particular practice. Any practices employed, however, must meet a minimum set of standards to ensure environmental integrity associated with a balanced distribution of age and habitat classes across the landscape, as well as certain structural elements within the forest.

Harvesting may be conducted within forest projects using a variety of silviculture methods. However, to ensure harvest practices maintain habitat refugia, even-aged rotations are limited to the following guidelines in Table 3.2.

Table 3.2. Even-Aged Management Retention Guidelines

Harvest Retention (Square Feet Basal Area/Acre of All Species)	**Maximum Size of Harvest Block** (Acres)
0	40
>= 15 < 20	60
>=20 < 25	80
>=25 < 30	120
>= 30 < 40	400
>= 40 < 50	600
>=50	Unlimited

Harvest retention is evaluated based on conditions immediately following harvest. Up to 10% of the harvest retention standard may be met with standing dead trees. Where any harvest occurs in harvest blocks where the harvest retention is less than 50 square feet of basal area per acre, additional harvesting may only occur within 300 feet of the harvest area (with less than 50 square feet basal area per acre) if the harvest retention of the additional harvest exceeds 50 square feet of basal area per acre. This requirement shall remain in place until the regeneration within the original harvested area (i.e., with retention less than 50 square feet basal area per acre) achieves a height of five feet or is five years old.

On a watershed scale up to 10,000 acres, all projects must maintain, or make progress toward maintaining, no more than 40 percent of their forested acres in ages less than 20 years. Areas

impacted by a Significant Disturbance are exempt from this test until 20 years after reforestation of such areas.

The protocol does not override a landowner's obligation to abide by applicable laws and regulations, including any governing forest practice rules that may be more stringent. Regardless of the silvicultural practice employed, landowners must fulfill their commitment under the protocol to permanently maintain or increase onsite standing live carbon stocks (i.e., the carbon in live trees within the Project Area) as specified in Section 3.9.3.

Structural elements such as standing dead trees and lying dead wood are features typically found in natural forests. They provide a variety of benefits, including wildlife habitat. Management of Forest Projects must ensure that standing dead trees and lying dead wood are present on the Project Area at certain minimum levels in accordance with the requirements outlined in Table 3.3.

Table 3.3. Evaluation Criteria to Test if a Forest Project Meets the Requirement for the Establishment and Maintenance of Native Species and Natural Forest Management

Criteria	Assessment	Application Rules
Native Species		
Project consists of at least 95% native species, or demonstrates continuous progress over 50 years toward 95% native species. The assessment shall be conducted using basal area per acre from the inventory of standing live trees.	Assessed at initial verification from inventory data. Assessment during site visit verifications must demonstrate continuous compliance with goal (if already met) or continuous progress toward the goal (if not yet met).	Applies to all project types throughout the project life. If criterion is not met within 50 years, all the Forest Project's Reserve account activity will be suspended[15] until the criterion is met.
Composition of Native Species		
No single species' prevalence in a given Assessment Area, measured as the percent of the basal area of all live trees in that Assessment Area, exceeds the percentage value shown under the heading 'Composition of Native Species' in the Assessment Area Data File maintained on the Reserve's website. Where portions of the Project Area falling within a given Assessment Area naturally consists of a single species' dominance, and is inconsistent with the percentage value in the Assessment Area Data File, the Project Operator may obtain a letter from the State Forester or their representative stating that the Project Area's species diversity is reflective of background natural species diversity (despite any inconsistencies with the Assessment Area Data File). Projects must show continuous progress toward criteria. These criteria must be met within 50 years, except in cases where a variance has been granted at the initial verification, a Significant Disturbance has impacted species diversity, or natural mortality takes a project out of compliance	Species composition is assessed at initial verification from inventory data. Species composition is also assessed during the project at each site visit verification.	Applies to all project types throughout the project life. If criterion is not met within 50 years, all the project's Reserve account activity will be suspended until the criterion is met (excluding the aforementioned exceptions).
Distribution of Age Classes		
On a watershed scale up to 10,000 acres (or the Project Area, whichever is smaller), all projects must maintain, or make progress toward maintaining, no more than 40 percent of their forested acres in ages less than 20 years. (Areas impacted by Significant Disturbance may be excluded from this test.) Applies to all project types at first Commercial Rotational Harvest. Project must show continuous progress toward criterion. This criterion must be met within 25 years	Age classes are assessed during project life at each site visit verification.	If criterion is not met within 25 years, all Reserve account activity will be suspended until the criterion is met.

[15] For the purpose of Table 3.3, suspension of Reserve account activity refers to issuance of CRTs and transaction of CRTs. Projects can continue to provide documentation to the Reserve for purposes of completing verification and demonstrating compliance with the Natural Forest Management criteria.

Structural Elements (Standing and Lying Dead Wood)		
Project Operators must ensure that dead wood is recruited and maintained in sufficient quantities, as described below. **Option I**. Monitoring dead wood throughout Project Area. Project Operators may maintain inventories of lying dead wood as part of their normal inventory processes. Where inventory measurements are used to demonstrate compliance with this requirement, monumented plots or line transects must be used so the plot data can be verified. Dead wood measurements must achieve a minimum statistical confidence of +/- 30% at 1 Standard Error. The combination of standing dead and lying dead wood shall be retained at average per acre values at quantity levels identified in the Assessment Area data file. If dead material does not exist at the quantities identified in the Assessment Area data file, dead trees shall be recruited as described below for Option II. **Option II**: Monitoring dead wood on harvested areas. The assessment of sufficient lying and standing dead material shall be made in areas harvested since the last site verification. **For portions of the Project Area that have been harvested under normal circumstances (not salvage harvested):** The combination of standing dead and lying dead wood shall be retained at average per acre values at quantity levels identified in the Assessment Area data file within each harvested unit. If dead material does not exist at the required levels within the harvest units, live trees shall be retained and tagged with aluminum tags at three times the amount identified in the Assessment Area data file minus whatever quantity does exist within each harvest unit. **For portions of the Project Area that have been salvage harvested:** The combination of standing dead and lying dead wood shall be retained at a combined four tonnes per acre on average within each harvest unit. Verification that the requirement has been met shall be conducted using the methodology for verification of dead material transects found in Appendix B **Option III:** No harvesting Projects without any harvesting activities within the project area do not need to monitor specifically for structural elements.	Assessed during project at each site visit verification.	Applies to all project types throughout the project life. If not met within 25 years, all Reserve account activity will be suspended until the areas verified since the previous site-verification meet the requirement.

3.9.3 Promotion of the Onsite Standing Live Carbon Stocks

To promote and maintain the environmental benefits of Forest Projects, the Reserve requires that the standing live carbon stocks within the Project Area be maintained and/or increased during the project life. Therefore, except as specified below, the Reserve will not issue CRTs for quantified GHG reductions and removals achieved by a Forest Project if the Forest Project's monitoring reports – over any ten-year consecutive period – indicate a decrease in the standing live carbon stocks.

Exceptions to this policy are allowed where reductions in standing live carbon stocks are important for maintaining and enhancing forest health, environmental co-benefits, or the long-term security of all carbon stocks; where reductions are due to non-harvest disturbances; or where reductions are required by law. Note that these exceptions in no way change or affect the Reserve's policies and requirements related to compensating for reversals, as detailed in Section 7.3.

Forest Project standing live carbon stocks that have decreased over a ten-year period may continue to receive CRTs issued by the Reserve for verified GHG reductions and removals if, and only if, the decrease in standing live carbon stocks is due to one of the following causes:

1. The decrease is demonstrably necessary to substantially improve the Project Area's resistance to wildfire, insect, or disease risks. The Project Operator must 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 or professionally-accepted standards.
2. The decrease is associated with a planned balancing of age classes (regeneration, sub-merchantable, and merchantable) and is detailed in a long term environmentally responsible management plan. The Project Operator must demonstrate, using documentation submitted to the Reserve at the time of the Forest Project's registration, that the balancing of age classes, resulting in a decrease in the standing live carbon stocks, was planned at the initiation of the Forest Project.

3. The decrease is part of normal silviculture cycles for forest ownerships less than 1,000 acres. Inventory fluctuations are a normal part of silvicultural activities. Periodic harvest may remove more biomass than the biomass growth over the past several years. At no time shall the Forest Project's inventory of carbon in the standing live carbon stocks fall below the Forest Project's baseline carbon stock estimates for the standing live carbon stocks, or 20 percent less than the Forest Project's standing live carbon stocks at the project's initiation, whichever is higher. Documentation submitted to the Reserve at the time the Forest Project is registered must indicate that fluctuations in the Forest Project's standing live carbon stocks are an anticipated silvicultural activity and that the overall trend will be for standing live carbon stocks to increase or stay the same over the life of the project (Figure 3.1).

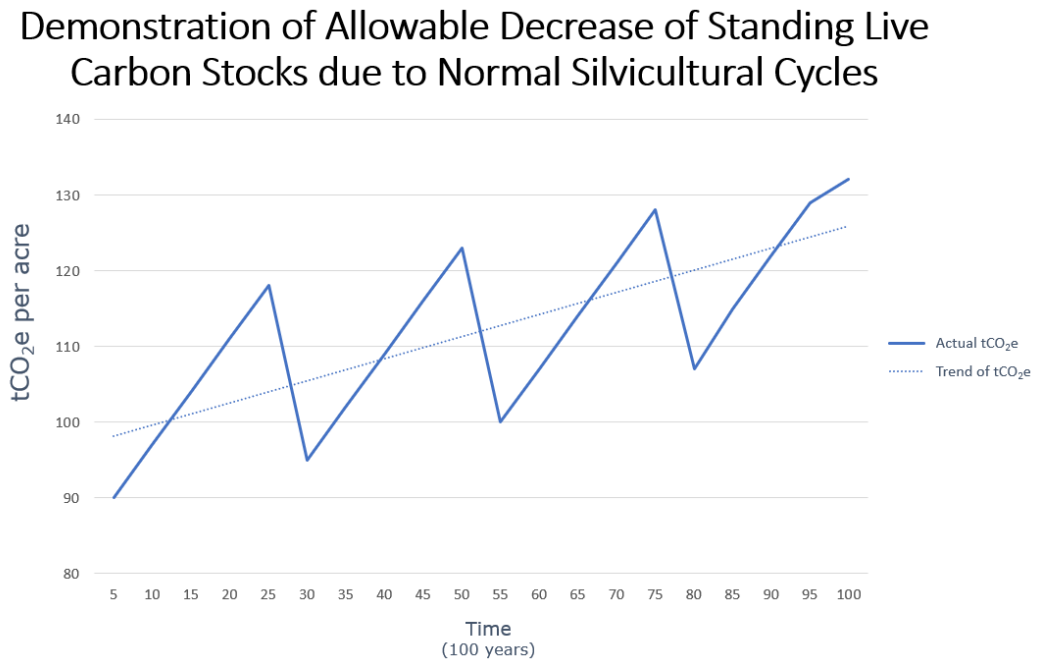


Figure 3.1. Example of Allowable Decrease of Standing Live Carbon Stocks due to Normal Silviculture Cycles

4. The decrease is part of a non-harvest disturbance, including wildfire, disease, flooding, wind-throw, insect infestation, landslides, or as otherwise approved by the Reserve.

4 Identifying the Project Area

The geographic boundaries defining the project area must be described in detail at the time a Forest Project is listed on the Reserve. The boundaries must be defined using a map, or maps that displays public and major private roads, major watercourses (fourth order or greater), topography, towns, and Public Land Survey Townships, Ranges, and Sections or latitude and longitude. The maps must be of adequate resolution to clearly identify the required features.

Once a project's Supersection(s) has been identified, Assessment Area(s) must be determined. A project may do this by comparing dominant species present in the project inventory to the list of native species provided in the Assessment Area Data File. Projects may also utilize Landfire Existing Vegetation Types (EVT) to determine the most appropriate Assessment Areas for the project. EVT descriptions must be used to identify the species descriptions that most closely match the native species provided in the Assessment Area Data File. The Reserve also reserves the right to provide a spatially explicit map of Assessment Areas to be used for identification purposes. The Project Area may also extend across multiple Assessment Areas within a Supersection), and across no more than two adjacent Supersections.

A Geographical Information System (GIS) file depicting the Project Area must be submitted to the Reserve with the project. The file must be submitted in the KML file format. Additionally, the current assessor's parcel identification numbers associated with the project area must be submitted to the Reserve.

For Avoided Conversion Projects, the Project Area is defined through the required appraisal process. The Project Area must be determined following the guidance in Table 4.1 based on the type of anticipated conversion.

Table 4.1. Project Area Definition for Avoided Conversion Projects

Conversion Type	Project Area Definition
Residential	The boundary of the parcel or parcels that have been appraised as having a 'higher and better use' in residential development.
Agricultural Conversion	The boundary of the parcel or parcels that have been appraised as having a 'higher and better use' in agricultural production.
Golf Course	The boundary of the parcel or parcels that have been appraised as having a 'higher and better use' as a golf course. This is to include forested areas within 200 feet of fairways, greens, and buildings.
Commercial Buildings	The boundary of the parcel or parcels that have been appraised as having a 'higher and better use' in commercial buildings. This is to include forested areas with 200 feet of suitable building sites.

4.1 Project Configuration and Limitations

To ensure Project Areas are representative of the Forest Owners' general forest management, Improved Forest Management projects must include all forested areas owned by the Forest Owner(s) within an area no smaller than an area defined by HUC 14-digit hydrological units (HUC 14) where available (or HUC 12-digit hydrological units if HUC 14 is unavailable), or the entire area owned by the Forest Owner, whichever is smaller. HUC 14 or HUC 12 hydrological units must be identified using the USGS National Hydrography Dataset.[16] Exceptions may be

[16] The National Hydrography Dataset can be accessed via the USGS website: http://nhd.usgs.gov/.

provided if approved by the Reserve. Non-forested areas (brush, rocks, range, etc.) may be excluded from all project types. For Improved Forest Management Projects, areas not under forest management may also be excluded from the Project Area. For all project types, the Project Area can be contiguous or separated into tracts or distinct polygons (areas).

4.2 Project Area Acreage

Project acreage shall be based on area calculations derived from GIS analysis, such as ArcGIS or Google Earth. GIS data are generally considered to be improvements over strict adherence to county parcel acreages as they are based on correcting property boundaries to geographic characteristics and/or property corners as described in property deeds or official survey notes. A KML (Google Earth) file depicting the Project Area shall be included with the PDD.

The project must list the county assessor's parcels (APs), the portion of each AP included in the project as a percentage (if GIS parcel data is available from the relevant state, county, or municipality), the sum of acres derived from the county tax records for all included APs, and the sum of acres derived from the GIS analysis. The sum of acres should be compared between the AP and GIS sources, with the lesser of the two used for the project area.

If there is a discrepancy between AP and GIS acres, the Project Operator has the following options:

- Resolve the acres on a per AP basis by using the lesser of the two area references
- Work with the county assessor to resolve acreage disputes on AP acres
- Demonstrate to verifier that GIS acres are based on recorded surveyed corners and correctly referenced with GPS

4.3 Modifying the Project Area

It is possible for project activities to be terminated on a portion of the Project Area. These adjustments must be treated as Avoidable Reversals, as described in Section 3.5. If a project proceeds with terminating the project on a portion of the Project Area, a new KML file must be provided to reflect the new Project Area. An addendum to the Project Design Document (PDD) must also be submitted to reflect this change, and the new legal description of the project will be recorded with the next PIA or PIA Amendment after the change has been verified. The inventory for the modified Project Area will be assessed during the next regularly scheduled site visit verification, unless it is determined that an Avoidable Reversal has taken place, in which case, the guidance in Section 7.3.2 must be followed.

5 GHG Assessment Boundary

The GHG Assessment Boundary defines all the GHG sources, sinks, and reservoirs that must be accounted for in quantifying a Forest Project's GHG reductions and removals (Section 6). The GHG Assessment Boundary encompasses all the GHG sources, sinks, and reservoirs that may be significantly affected by Forest Project activities, including forest carbon stocks, sources of biological CO_2 emissions, and mobile combustion GHG emissions. For accounting purposes, the sources, sinks, and reservoirs included in the GHG Assessment Boundary are organized according to whether they are predominantly associated with a Forest Project's "Primary Effect" (i.e., the Forest Project's intended changes in carbon stocks, GHG emissions, or GHG removals) or its "Secondary Effects" (i.e., unintended changes in carbon stocks, GHG emissions, or GHG removals caused by the Forest Project).[17] Secondary Effects may include increases in mobile combustion CO_2 emissions associated with site preparation, as well as increased CO_2 emissions caused by the shifting of harvesting activities from the Project Area to other forestlands (often referred to as "leakage"). Projects are required to account for Secondary Effects following the methods described in Section 6.

The following tables provide a comprehensive list of the GHG sources, sinks, and reservoirs (SSRs) that may be affected by a Forest Project and indicate which SSRs must be included in the GHG Assessment Boundary for each type of Forest Project. If an SSR is designated as a "reservoir/pool," this means that GHG reductions and removals are accounted for by quantifying changes in carbon stock levels. For SSRs designated as sources or sinks, GHG reductions and removals are accounted for by quantifying changes in GHG emission or removal rates, as described in the tables.

5.1 Improved Forest Management Projects

Table 5.1. GHG Assessment Boundary – Improved Forest Management Projects

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
Primary Effect Sources, Sinks, and Reservoirs						
IFM-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	*Included*	**Baseline:** Modeled based on initial field inventory measurements, regulatory environment, and financial feasibility **Project:** Measured by field measurements and updating forest carbon inventory	Increases in standing live carbon stocks are likely to be the largest Primary Effect of Improved Forest Management Projects.
IFM-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Shrubs and herbaceous understory constitute a relatively small proportion of carbon stocks in an Improved Forest Management project.

[17] The terms "Primary Effect" and "Secondary Effect" come from WRI/WBCSD, 2005. *The Greenhouse Gas Protocol for Project Accounting*, World Resources Institute, Washington, DC. Available at http://www.ghgprotocol.org.

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
IFM-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	*Included*	**Baseline:** Assumed to be static based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory	Improved Forest Management Projects may significantly increase standing dead carbon stocks over time. The protocol requires recruitment and retention of dead material, including standing dead wood as a structural element. Minimum volume thresholds are stated to meet Natural Forest Management criteria. (See Section 3.9.2).
IFM-4	Lying dead wood carbon	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Lying dead wood is highly variable and it is therefore difficult to achieve accurate estimates. It also constitutes a minor portion of forest carbon. With required retention for Natural Forest Management (see below), it is a conservative programmatic measure not to include it. For Natural Forest Management criteria, the protocol requires recruitment and retention of dead material, including lying dead wood as a structural element. Minimum volume thresholds are stated to meet Natural Forest Management criteria. (See Section 3.9.2).
IFM-5	Litter and duff carbon (carbon in dead plant material)	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in this reservoir are unlikely to have a significant effect on total quantified GHG reductions/removals. It is a conservative programmatic measure not to include it.
IFM-6	Soil carbon	Reservoir / Pool	CO_2	*Included for emissions estimates*	**Baseline:** Assumed to be static with start date inventory estimates **Project:** Emissions from project activities estimated with standardized guidelines in found in Appendix B	Soil carbon is not anticipated to change significantly as a result of most Improved Forest Management activities. However, all projects must use standardized guidance to account for potential soil carbon emissions associated with management activities.
IFM-7	Carbon in in-use forest products	Reservoir / Pool	CO_2	*Included*	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes	Included because many Improved Forest Management Projects may significantly change carbon storage in in-use forest products relative to baseline levels. Treated as a "source/sink" because forest product carbon is quantified according to the change in harvesting volumes, relative to baseline levels, in each year. Of this change (increase or decrease), only the average amount of carbon expected to remain stored for 100 years is included in the final

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						quantification of annual net GHG removals/emissions. This approach accounts for CO_2 emissions from decomposition or disposal of wood products (see SSR IFM-17).
IFM-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	*Excluded when project harvesting exceeds baseline* *Included when project harvesting is below baseline*	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes	Because of significant uncertainties associated with forecasting the quantity of forest product carbon that will remain stored in landfills, landfill carbon is excluded from quantification in years when project harvesting volumes exceed baseline volumes. Landfill carbon is included, however, in years when project harvesting volumes are below baseline levels. This case-dependent exclusion or inclusion is necessary to ensure that total GHG reductions and removals caused by the Forest Project are not overestimated.
Secondary Effect Sources, Sinks, and Reservoirs						
IFM-9	Biological emissions from site preparation activities	Source	CO_2	*Included*	**Baseline:** N/A **Project:** Quantified based on measured carbon stock changes in included reservoirs (SSR IFM-6, where applicable)	Biological emissions from site preparation are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs (soil carbon, where applicable). For other carbon reservoirs, changes are unlikely to have a significant effect on total quantified GHG reductions/removals.
IFM-10	Mobile combustion emissions from site preparation activities	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Mobile combustion CO_2 emissions from site preparation are not expected to be significantly different from baseline levels for Improved Forest Management Projects. In addition, this protocol assumes that combustion emissions in the U.S. will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in CH_4 emissions from mobile combustion associated with site preparation activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in N_2O emissions from mobile combustion associated with site preparation activities are not considered significant.

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
IFM-11	Mobile combustion emissions from ongoing project operation and maintenance	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Mobile combustion CO_2 emissions from ongoing project operation and maintenance are unlikely to be significantly different from baseline levels, and are therefore not included in the GHG Assessment Boundary. In addition, this protocol assumes that such emissions will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in CH_4 emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in N_2O emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
IFM-12	Stationary combustion emissions from ongoing project operation and maintenance	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Stationary combustion CO_2 emissions from ongoing project operation and maintenance could include GHG emissions associated with electricity consumption or heating/cooling at Project Operator facilities, or at facilities owned or controlled by contractors. These emissions are unlikely to be significantly different from baseline levels, and are therefore not included in the GHG Assessment Boundary. In addition, this protocol assumes that such emissions will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in CH_4 emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in N_2O emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
IFM-13	Biological emissions from clearing of forestland outside the Project Area	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Improved Forest Management Projects are not expected to cause significant shifts in alternative land uses that might lead to clearing of forestland.
IFM-14	Biological emissions/ removals from changes in harvesting on forestland outside the Project Area	Source / Sink	CO_2	*Included / Excluded*	**Baseline:** N/A **Project:** Estimated "leakage" factor applied to the difference in harvested carbon relative to baseline based on the magnitude of that difference relative to baseline harvest amounts	Improved Forest Management Projects may either increase or decrease harvesting relative to baseline levels. If harvesting is reduced in the Project Area, harvesting on other lands may increase to compensate for the lost production. This "leakage" effect is included in the GHG Assessment Boundary. If harvesting is increased in the Project Area, harvesting on other lands may decrease in response to the increased production. The reduction in harvesting may lead to increased carbon stocks on other lands. Carbon stock increases on other lands are excluded from the GHG Assessment Boundary, however, because it is not possible to ensure their permanence.
IFM-15	Combustion emissions from production, transportation, and disposal of forest products	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	This protocol assumes that combustion emissions will be controlled under a regulatory cap-and-trade program in the near future. Thus, for most of a Forest Project's duration, changes in activity due to the project will have no effect on total net emissions due to production, transportation, and disposal of forest products. These emissions are therefore excluded from the GHG Assessment Boundary.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related CH_4 emissions related to changes in the production, transportation, and disposal of forest products are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related N_2O emissions related to changes in the production, transportation, and disposal of forest products are not considered significant.
IFM-16	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in forest-product production may cause consumers of these products to increase or decrease their consumption of substitute materials (such as alternative building materials, including cement or steel). In many cases, alternative materials will have

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						higher combustion GHG emissions associated with their production, transportation, and/or disposal than wood products. This protocol assumes, however, that combustion emissions will be controlled under a regulatory cap-and-trade program in the near future. Thus, for most of a Forest Project's duration, changes in activity due to the project will have no effect on total net emissions due to production, transportation, and disposal of alternative materials. These emissions are therefore excluded from the GHG Assessment Boundary.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related CH_4 emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related N_2O emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.
IFM-17	Biological emissions from decomposition of forest products	Source	CO_2	*Included*	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR IFM-7) and landfills (SSR IFM-8) **Project:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR IFM-7) and landfills (SSR IFM-8)	CO_2 emissions from the decomposition of forest products are built into calculations of how much forest product carbon will remain in in-use wood products and in landfills, averaged over 100 years (see SSR IFM-7 and Appendix B).
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	In-use wood products will produce little to no CH_4 emissions. CH_4 emissions can result from anaerobic decomposition of forest products in landfills. This protocol assumes that landfill CH_4 emissions will be largely controlled in the near future due to federal and/or state regulations. Thus, changes in forest-product production are assumed to have no significant effect on future CH_4 emissions from anaerobic decomposition of forest products in landfills. These emissions are therefore excluded from the GHG Assessment Boundary.

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Decomposition of forest is not expected to be a significant source of N_2O emissions.

5.2 Avoided Conversion Projects

Table 5.2. GHG Assessment Boundary – Avoided Conversion Projects

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
Primary Effect Sources, Sinks, and Reservoirs						
AC-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	*Included*	**Baseline:** Modeled based on initial field inventory measurements and expected land-use conversion rates **Project:** Measured by field measurements and updating forest carbon inventory	Preservation and/or increases of standing live carbon stocks and/or soil carbon stocks relative to baseline levels are likely to be a large Primary Effect of Avoided Conversion Projects.
AC-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in this reservoir/reservoir are unlikely to have a significant effect on total quantified GHG reductions/removals. Additionally, it is a conservative programmatic measure to exclude shrubs and herbaceous understory carbon.
AC-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	*Included*	**Baseline:** Assumed to be static based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory	Avoided Conversion Projects may significantly increase standing dead carbon stocks over time. The protocol requires recruitment and retention of dead material, including standing dead wood as a structural element. Minimum volume thresholds are stated to meet Natural Forest Management criteria. (See Section 3.9.2).
AC-4	Lying dead wood carbon	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Exclusion of lying dead wood is programmatically conservative for accounting of total quantified GHG reductions/removals, since project activities most likely will lead to increases in lying dead wood carbon. Lying dead wood is highly variable and is difficult to measure accurately, and therefore challenging to achieve confidence with estimates For Natural Forest Management criteria, the protocol requires recruitment and retention of dead material, including lying dead wood as a structural element. Minimum volume thresholds are stated

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						to meet Natural Forest Management criteria. (See Section 3.9.2).
AC-5	Litter and duff carbon (carbon in dead plant material)	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Exclusion of litter and duff carbon is programmatically conservative for accounting of total quantified GHG reductions/removals, since project activities most likely will lead to increases in litter and duff carbon. Litter and duff is highly variable, difficult to measure accurately, and therefore challenging to achieve confidence with estimates.
AC-6	Soil carbon	Reservoir / Pool	CO_2	*Optional for reporting project benefits* *Included for reporting project emissions*	**Baseline:** When included, assumed to have emissions and emission rates according to soil order and baseline conversion activity **Project:** Emissions calculated using standardized guidance in Appendix B. Project Operators may opt to quantify net removals or avoided emissions by updating forest soil carbon inventory	Soil carbon is likely a large primary effect of an Avoided Conversion Project. It is conservative to exclude the conversion effect on soil from the project accounting, which is why it is optional. All projects must use standardized guidance to account for potential soil carbon emissions associated with project management activities. If Project Operators choose to quantify net removals or avoided emissions from soil carbon, they may do so by undertaking and updating a soil carbon inventory.
AC-7	Carbon in in-use forest products	Reservoir / Pool	CO_2	*Included*	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes	Included because many Avoided Conversion Projects may significantly change carbon storage in in-use forest products relative to baseline levels. Treated as a "source/sink" because forest product carbon is quantified according to the change in harvesting volumes, relative to baseline levels, in each year. Of this change (increase or decrease), only the average amount of carbon expected to remain stored for 100 years is included in the final quantification of annual net GHG removals/emissions. This approach accounts for CO_2 emissions from decomposition or disposal of wood products (see SSR AC-17).
AC-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	*Excluded when project harvesting exceeds baseline* *Included when project harvesting is below baseline*	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes	Because of significant uncertainties associated with forecasting the quantity of forest product carbon that will remain stored in landfills, landfill carbon is excluded from quantification in years when project harvesting volumes exceed baseline volumes. Landfill carbon is included, however, in years when project harvesting volumes are below baseline levels. This case-dependent exclusion or inclusion is necessary to ensure that total GHG

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						reductions and removals caused by the Forest Project are not overestimated.
Secondary Effect Sources, Sinks, and Reservoirs						
AC-9	Biological emissions from site preparation activities	Source	CO_2	*Included*	**Baseline:** N/A **Project:** Quantified based on measured carbon stock changes in included reservoirs (SSR AC-6, where applicable)	Biological emissions from site preparation are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs (soil carbon, where applicable). For other carbon reservoirs, changes are unlikely to have a significant effect on total quantified GHG reductions/removals.
AC-10	Mobile combustion emissions from site preparation activities	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Mobile combustion CO_2 emissions from site preparation (including land-use conversion activities) are likely to be higher in the baseline than under project. These emissions are therefore excluded from the GHG Assessment Boundary in order to be conservative. In addition, this protocol assumes that combustion emissions in the United States will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Differences in CH_4 emissions from mobile combustion associated with site preparation activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Differences in N_2O emissions from mobile combustion associated with site preparation activities are not considered significant.
AC-11	Mobile combustion emissions from ongoing project operation and maintenance	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Mobile combustion CO_2 emissions from ongoing project operation and maintenance are unlikely to be significantly different from baseline levels and are therefore not included in the GHG Assessment Boundary. In addition, this protocol assumes that such emissions will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in CH_4 emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in N_2O emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
AC-12	Stationary combustion emissions from	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Stationary combustion CO_2 emissions from ongoing project operation and maintenance could include GHG

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
	ongoing project operation and maintenance					emissions associated with electricity consumption or heating/cooling at Project Operator facilities, or at facilities owned or controlled by contractors. These emissions are unlikely to be significantly different from (or will be lower than) baseline levels and are therefore not included in the GHG Assessment Boundary. In addition, this protocol assumes that such emissions will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in CH_4 emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in N_2O emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.
AC-13	Biological emissions from clearing of forestland outside the Project Area	Source	CO_2	*Included*	**Baseline:** N/A **Project:** Estimated using default forestland conversion factors	Avoided Conversion Projects may cause land-use pressures to shift to other forestlands, causing biological emissions that partially negate the benefits of the project.
AC-14	Biological emissions/ removals from changes in harvesting on forestland outside the Project Area	Source / Sink	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Over time, Avoided Conversion Projects will tend to increase harvesting levels relative to the baseline, potentially causing other landowners to reduce harvesting in response to increased wood product supply. The reduction in harvesting may lead to increased carbon stocks on other lands. Carbon stock increases on other lands are excluded from the GHG Assessment Boundary, however, because it is not possible to ensure their permanence. Avoided Conversion Projects are not expected to cause an increase in harvesting on other lands over the long run (except where clearing is involved for other land uses, per SSR AC-13), so this potential effect is also excluded from the GHG Assessment Boundary.
AC-15	Combustion emissions from production, transportation, and disposal of forest products	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	This protocol assumes that combustion emissions will be controlled under a regulatory cap-and-trade program in the near future. Thus, for most of a Forest Project's duration, changes in activity due to the project will have no effect on total net emissions due to production, transportation, and disposal of forest products. These emissions are therefore

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						excluded from the GHG Assessment Boundary.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related CH_4 emissions related to changes in the production, transportation, and disposal of forest products are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related N_2O emissions related to changes in the production, transportation, and disposal of forest products are not considered significant.
AC-16	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in forest-product production may cause consumers of these products to increase or decrease their consumption of substitute materials (such as alternative building materials, including cement or steel). In many cases, alternative materials will have higher combustion GHG emissions associated with their production, transportation, and/or disposal than wood products. This protocol assumes, however, that combustion emissions will be controlled under a regulatory cap-and-trade program in the near future. Thus, for most of a Forest Project's duration, changes in activity due to the project will have no effect on total net emissions due to production, transportation, and disposal of alternative materials. These emissions are therefore excluded from the GHG Assessment Boundary.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related CH_4 emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related N_2O emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.
AC-17	Biological emissions from decomposition of forest products	Source	CO_2	*Included*	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR AC-7) and landfills (SSR AC-8) **Project:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR AC-7) and landfills (SSR AC-8)	CO_2 emissions from the decomposition of forest products are built into calculations of how much forest product carbon will remain in in-use wood products and in landfills, averaged over 100 years (see SSR AC-7 and Appendix B).

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	In-use wood products will produce little to no CH_4 emissions. CH_4 emissions can result from anaerobic decomposition of forest products in landfills. This protocol assumes that landfill CH_4 emissions will be largely controlled in the near future due to federal and/or state regulations. Thus, changes in forest-product production are assumed to have no significant effect on future CH_4 emissions from anaerobic decomposition of forest products in landfills. These emissions are therefore excluded from the GHG Assessment Boundary.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Decomposition of forest is not expected to be a significant source of N_2O emissions.

6 Quantifying Net GHG Reductions and Removals

This section provides requirements and guidance for quantifying a Forest Project's net GHG reductions and removals. The Reserve will issue Climate Reserve Tonnes (CRTs) to a Forest Project upon confirmation by an ISO-accredited and Reserve-approved verification body that the Forest Project's GHG reductions and removals have been quantified following the applicable requirements of this section (see Section 9 for verification requirements).

For each type of Forest Project, quantification proceeds in seven steps:

1. **Estimating baseline onsite carbon stocks.** The baseline is an estimate of what would have occurred in the absence of a Forest Project. To establish baseline onsite carbon stocks, the Project Operator must estimate 100 years of carbon stock changes in each of the Forest Project's required and selected optional onsite carbon pools (identified in Section 5). The baseline must be based on inventoried carbon stocks at the time of the Forest Project's initiation, following the applicable requirements in this section for modeling or implementing a conservative default baseline. Onsite carbon stocks are inventoried following the requirements described in Appendix B. Modeling of onsite carbon stocks over time must be conducted following the requirements in this section and the guidance in Appendix B. Baseline onsite carbon stocks are estimated over a Forest Project's entire crediting period (100 years) at the time of the project's initiation and are not modified thereafter, except for reconciliation of project baselines to changes in inventory estimates associated with inventory methodology updates.
2. **Estimating baseline carbon in harvested wood products.** In conjunction with estimating baseline onsite carbon stocks, the Project Operator must forecast any harvesting that would have occurred in the baseline and convert this to an average annual harvesting volume. From this, the Project Operator must determine the amount of carbon that would have been transferred each year (on average) to long-term storage in wood products. Baseline harvesting is forecasted following the guidance in this section, depending on the project type - either through a default or modeling approach, and carbon stored in wood products must be calculated following the requirements in Appendix B.
3. **Determining actual onsite carbon stocks.** Each year, the Project Operator must determine the Forest Projects' actual onsite carbon stocks. This must be done by updating the Forest Project's forest carbon inventory for the current year, following the guidance in this section and in Appendix B. The estimate of actual onsite carbon stocks must be adjusted by an appropriate confidence deduction, as described in Appendix B.
4. **Determining actual carbon in harvested wood products.** Each year, the Project Operator must report any harvesting in the Project Area and from this determine the amount of carbon transferred to long-term storage in wood products. Carbon stored in wood products must be calculated following the requirements available in Appendix B
5. **Calculating the project's Primary Effect.** Each year, the Project Operator must quantify the actual change in GHG emissions or removals associated with the Forest Project's intended ("Primary") effect, as defined in Section 5. For any given year, the Primary Effect is calculated by:

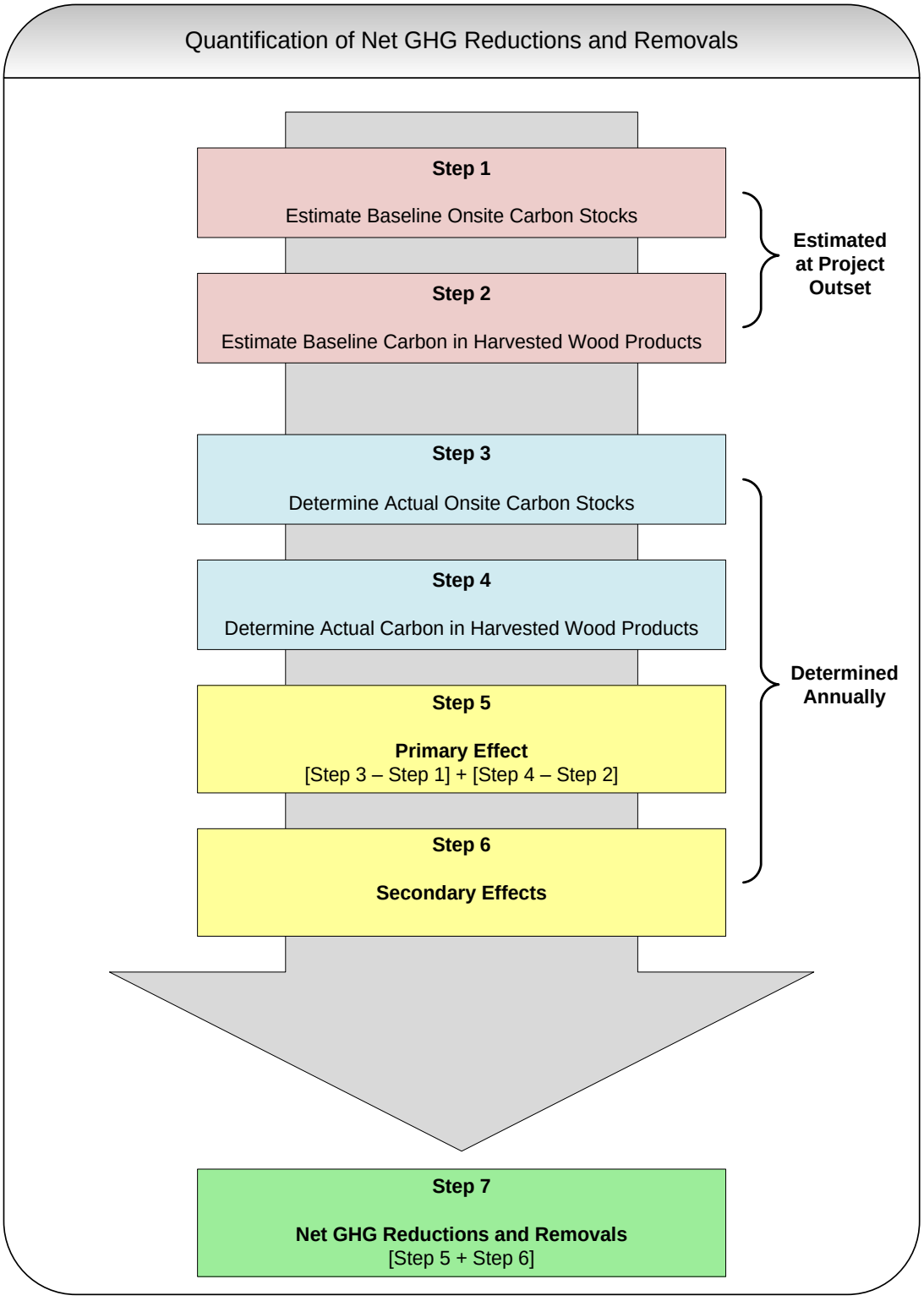
a. Taking the difference between actual onsite carbon stocks for the current year and actual onsite carbon stocks for the prior year[18]
b. Subtracting from (a) the difference between baseline onsite carbon stocks for the current year and baseline onsite carbon stocks for the prior year[19]
c. Adding to (b) the calculated difference between actual and baseline carbon in harvested wood products for the current year (see Equation 6.1)

6. **Quantifying the project's Secondary Effects.** Each year, the Project Operator must quantify the actual change in GHG emissions or removals associated with the Forest Project's unintended ("Secondary") effects, as defined in Section 5. Requirements and guidance for quantifying Secondary Effects are provided below for each type of Forest Project.
7. **Calculating total net GHG reductions and removals.** For each year, total net GHG reductions and removals are calculated by summing a Forest Project's Primary and Secondary Effects. If the result is positive, then the Forest Project has generated GHG reductions and/or removals in the current year. If the result is negative, this may indicate a reversal has occurred (see Section 7).[20]

Requirements and guidance for how to perform quantification steps 1 to 4 for each Forest Project type are presented in the remainder of this section.

The required formula for quantifying annual net GHG reductions and removals is presented in Equation 6.1. Net GHG reductions and removals must be quantified and reported in units of carbon dioxide-equivalent (CO_2e) metric tons.

[18]For the purposes of calculating the project's Primary Effect, actual and baseline carbon stocks prior to the start date of the project are assumed to be zero.
[19] See footnote 18.
[20] A reversal occurs only if: (1) total net GHG reductions and removals for the year are negative; and (2) CRTs have previously been issued to the Forest Project. If calculated GHG reductions and removals are negative and no CRTs have been issued to the project since its start date, then the result should be treated as a "negative carryover" to GHG reduction calculations in subsequent years (variable N_{y-1} in Equation 6.1). This may happen, for example, because the confidence deduction applied to actual onsite carbon stocks can result in actual values being less than baseline values in a Forest Project's initial years.


Quantification of Net GHG Reductions and Removals
Step 1
Estimate Baseline Onsite Carbon Stocks
Step 2
Estimate Baseline Carbon in Harvested Wood Products
Estimated at Project Outset
Step 3
Determine Actual Onsite Carbon Stocks
Step 4
Determine Actual Carbon in Harvested Wood Products
Step 5
Primary Effect
[Step 3 – Step 1] + [Step 4 – Step 2]
Step 6
Secondary Effects
Determined Annually
Step 7
Net GHG Reductions and Removals
[Step 5 + Step 6]

Equation 6.1. Annual Net GHG Reductions and Removals

$$\boldsymbol{QR_y = \left[(\Delta AC_{onsite} - \Delta BC_{onsite}) + SC_y + \left(AC_{wp,y} - BC_{wp,y}\right) \times 0.80 + SE_{as,y}\right] + N_{y-1}}$$

Where,			Units
QR_y	=	Quantified GHG reductions and removals for year *y*	CO_2e
SC_y	=	Soil carbon project emissions (if included, and if using the standardized guidance in Appendix B). If an avoided conversion project is reporting avoided emissions from sampled soil carbon, it will be included in AC_{onsite}, in order to apply the confidence deduction as required by Appendix B.	CO_2e
$AC_{wp, y}$	=	Actual carbon in wood products produced in year *y* that is projected to remain stored for at least 100 years (i.e., derived for actual harvest volumes following the guidance in Appendix B)	CO_2e
$BC_{wp,y}$	=	Annual baseline carbon in wood products that would have remained stored for at least 100 years (i.e., derived for baseline harvest volumes following the guidance in Appendix B)	CO_2e
0.80	=	The net change in carbon in harvested wood products, ($AC_{wp,y}$ – $BC_{wp,y}$), is multiplied by 80 percent in Equation 6.1 to reflect market responses to changes in wood-product production. The general assumption in this protocol is that for every tonne of reduced harvesting caused by a Forest Project, the market will compensate with an increase in harvesting of 0.2 tonnes on other lands (see Section 6.1.6). Since wood product production is directly related to harvesting levels, the net change in wood products caused by a project is subject to this same market dynamic. Thus, any one-tonne increase in wood product production by a project will result in only a 0.8 tonne increase overall, because it has been assumed other landowners will decrease production by 0.2 tonnes in response. Similarly, any one-tonne decrease in wood product production by a project will result in only a 0.8 tonne decrease overall, because it has been assumed other landowners will increase production by 0.2 tonnes in response	
$SE_{as,y}$	=	Secondary Effect GHG emissions that may result from activity shifting outside the project area, as a result of the project activity in year *y*	CO_2e
N_{y-1}	=	Any negative carryover from the prior year (occurs when total quantified GHG reductions are negative prior to the issuance of any CRTs for the project– see footnote 20, p. 38)	CO_2e

And,

$$\boldsymbol{\Delta AC_{onsite} = \left(AC_{onsite,y}\right)\left(1 - CD_y\right) - \left(AC_{onsite,y-1}\right)\left(1 - CD_{y-1}\right)}$$

Where,

$AC_{onsite, y}$	=	Actual onsite carbon as inventoried for year *y* (*y* may be less than a year for the first reporting period following the start date). Includes soil carbon for avoided conversion projects reporting avoided emissions from sampled soil carbon	CO_2e
$AC_{onsite, y-1}$	=	Actual onsite carbon as inventoried for year *y-1*. Includes soil carbon for avoided conversion projects reporting avoided emissions from sampled soil carbon	CO_2e
CD_y	=	Appropriate confidence deduction for year *y*, as determined following the Appendix B	%
CD_{y-1}	=	Appropriate confidence deduction for year *y-1*, as determined following the Appendix B	%

And,

$$\Delta BC_{onsite} = \left(BC_{onsite,y}\right) - \left(BC_{onsite,y-1}\right)$$

Where,

$BC_{onsite,\ y}$	=	Baseline onsite carbon as estimated for year *y* (*y* may be less than a year for the first reporting period following the start date)	CO_2e
$BC_{onsite,\ y-1}$	=	Baseline onsite carbon as estimated for year *y-1*	CO_2e

6.1 Improved Forest Management Projects

Improved Forest Management Projects that take place on private land – or on land that is transferred to public ownership at the time the project is initiated – must estimate baseline onsite carbon stocks following the requirements and procedures in Section 6.1.1 (default approach) or Section 6.1.2 (modeling approach). Improved Forest Management Projects that take place on land that was publicly owned prior to the project start date must estimate baseline onsite carbon stocks following the requirements and procedures in Section 6.1.3. Requirements for determining actual onsite carbon stocks, determining actual carbon in harvested wood products, and quantifying Secondary Effects are the same for all Improved Forest Management Projects.

The approach to additionality for all Improved Forest Management Projects relies on an averaged baseline value. The time commitment for a project under this protocol is 100 years, and the baseline is a counterfactual representation of one of a multitude of potential legally compliant and financially feasible management scenarios that could play out in reality in the absence of the project.

6.1.1 Estimating Baseline Onsite Carbon Stocks – Private Lands – Default Approach

The baseline approach for Improved Forest Management Projects on private lands applies a standardized set of assumptions to project-specific conditions. A project must determine a start date inventory and consider how legal and financial constraints affect the baseline carbon stocks. Furthermore, performance standard criteria are applied to Improved Forest Management Projects based on Common Practice statistics, described below in this section.

The first baseline approach option for an Improved Forest Management Project on private lands is to use a conservative default approach, which eliminates the modeling effort required for baseline estimation. The steps are:

1. Determine the start date inventories of aboveground standing live carbon stocks, belowground standing live carbon stocks, aboveground standing dead carbon stocks, and belowground standing dead carbon stocks for the Project Area.
2. Determine Common Practice for the Project Area. Determine the project's initial baseline, based on whether initial carbon stocks are above or below the Common Practice value.
3. Determine the applicable level of legal and financial constraints applicable to the Project Area based on the guidance below and adjust the initial baseline accordingly.
4. Determine the baseline harvest volume based on the guidance below.
5. Combine the results to produce the final baseline for all required carbon stocks.

6.1.1.1 Inventory Carbon Stocks within the Project Area

The start date inventory of standing live carbon stocks, separated into aboveground and belowground portions, and the start date inventory of standing dead carbon stocks, also with aboveground and belowground portions separated, must be determined following the guidance in Appendix B. Projects may choose to use the Standardized Inventory Methodology and/or the Climate Action Reserve Inventory Tool (CARIT),[21] both available on the Reserve's website, but use of the methodology and CARIT is optional.

In the formulas throughout this section, initial carbon stocks are denoted by the variable PUB_0 (i.e., the *preliminary unadjusted baseline* at time zero).

6.1.1.2 Determining Common Practice and the Initial Baseline

Common Practice refers to the average stocks of aboveground standing live and standing dead carbon associated with the Assessment Area(s) covered by the Project Area. This value represents the result of the suite of management activities taking place within the Assessment Area(s) and is used to approximate a Performance Standard for Improved Forest Management Projects. The overall intent of this protocol is for projects to contribute to long-term increases in average carbon stocking in the Assessment Area(s) where they are located. Projects with initial stocking below Common Practice will increase their stocking over time. Projects with initial stocking above Common Practice will also likely increase their stocking over time, but, as or more importantly, will prevent activities that otherwise would have decreased the stocking on the project site to or below Common Practice stocking. In the absence of a forest project, there is no guarantee that a site with stocking above Common Practice will maintain their stocking levels, especially over the 100-year period committed to by projects.

The Common Practice statistic applicable to a project can be found by consulting the Assessment Area Data File on the Reserve's FPP webpage. If the Project Area covers multiple Assessment Areas, Common Practice must be calculated as the average of the values for each Assessment Area, weighted by the percentage of the Project Area that falls within each Assessment Area.

Common Practice statistics are calculated from United States Forest Service Forest Inventory and Analysis (USFS FIA) program. The Reserve will update the Common Practice statistics in the Assessment Area Data File periodically. The frequency of updating Common Practice statistics will be subject to the availability of new USFS FIA data but will be no more frequent than once every five years. The Reserve will announce any forthcoming updates to the Common Practice statistics before they are released, and any updates will not be retroactive.

The performance standard criteria establish minimum aboveground standing live and standing dead carbon stock values for the baseline, regardless of what is legally and financially viable. For projects whose initial aboveground standing live and standing dead carbon stocks are above Common Practice, the *initial baseline* for the project is equal to Common Practice. For projects whose initial aboveground standing live and standing dead carbon stocks are below Common Practice, the *initial baseline* for aboveground standing live and standing dead carbon stocks is either (1) the initial aboveground standing live and standing dead carbon stocks (PUB_0) or (2) the High Stocking Reference, whichever is greater. The High Stocking Reference is a measure of carbon stocks in aboveground standing live and standing dead biomass over

[21] The Standardized Inventory Methodology and Climate Action Reserve Inventory Tool (CARIT) were developed based upon work supported by the Natural Resources Conservation Service, U.S. Department of Agriculture, under number 69-3A75-16-024.

the 10 years preceding the project start date. It governs baseline carbon stocks in certain instances where aboveground standing live and standing dead carbon stocks have declined prior to the start date. Refer to Section 6.1.2.4.1 for guidance around determining High Stocking Reference.

6.1.1.3 Adjust the Initial Baseline for Legal and Financial Constraints

To ensure that projects receive credits for only those GHG removals that are undertaken in addition to existing legal requirements, such legal and financial constraints must be factored into the project's baseline. For the conservative default approach, the Reserve has calculated a multiplier to be applied to the *initial baseline*, which is designed to be a conservative representation of project constraints. Equation 6.2 describes how the *initial baseline* is adjusted. However, if:

1. deeded encumbrances exist that limit forest management beyond existing federal, state, and local laws and regulations that govern forest management, or
2. the project does not pass the Reserve's conservative default baseline screening tool[22], which considers the extent of legal and financial constraints on the Project Area,

then the project may not proceed with the default approach and must instead use the baseline modeling approach described in Section 6.1.2.

Equation 6.2. Determining the *Adjusted Initial Baseline*

$$\boldsymbol{AB = IB \times 1.06}$$

Where,			Units
AB	=	*Adjusted initial baseline* for aboveground standing live and aboveground standing dead carbon stocks value	tCO_2e/acre
IB	=	*Initial baseline* for aboveground standing live and aboveground standing dead carbon stocks (determined according to the guidance in Section 6.1.1.2)	tCO_2e/acre
1.06	=	A conservative multiplier to raise the *initial baseline* by 6%, to account for legal and financial constraints that may prevent harvesting to minimum baseline levels	

6.1.1.4 Estimate the Project's Baseline Harvest Volume

The estimate of baseline harvest volume shall be based on the equation below. The resulting volume shall be used in conjunction with the guidance in Appendix B to determine harvested wood products. The harvest volume shall remain constant for the project life.

[22] The Reserve's default baseline screening tool is available on the FPP website.

Equation 6.3. Calculate the Baseline Harvest Volume

$$HV_{BL} = ((\frac{PUB_0 - IB}{IB}) \times 0.0272) + 0.02$$

Where,			Units
HV_{BL}	=	Baseline harvest volume	tCO_2e/acre
PUB_0	=	Initial aboveground standing live and standing dead carbon stocks	tCO_2e/acre
IB	=	*Initial baseline* for aboveground standing live and aboveground standing dead carbon stocks (determined according to the guidance in Section 6.1.1.2)	tCO_2e/acre
0.0272	=	Regression coefficient derived from analysis to predict baseline harvest volumes based on data reported by existing Improved Forest Management offset projects[23]	
0.02	=	Y-intercept derived from analysis to predict baseline harvest volumes based on data reported by existing Improved Forest Management offset projects[24]	

6.1.1.5 Calculate the Final Baseline for Onsite Carbon Stocks

The final baseline is determined by accounting for belowground biomass and adding the estimated harvested wood products to the *adjusted initial baseline*.

Equation 6.4. Calculate the *Final Baseline*

$$FBL = AB + (\frac{AB \times IBG}{PUB_0}) + HWP_{BL}$$

Where,			Units
FBL	=	*Final baseline* for all required onsite carbon stocks	tCO_2e/acre
AB	=	*Adjusted initial baseline* for aboveground standing live and aboveground standing dead carbon stocks value, from Equation 6.2	tCO_2e/acre
IBG	=	Belowground standing live and standing dead carbon stocks measured in the project's initial inventory	tCO_2e/acre
PUB_0	=	Initial aboveground standing live and dead carbon stocks per acre within the Project Area	tCO_2e/acre
HWP_{BL}	=	Baseline harvested wood products calculated following Appendix B, using HV_{BL}	tCO_2e/acre

6.1.2 Estimating Baseline Onsite Carbon Stocks – Private Lands – Modeling Approach

The following steps must be followed to estimate baseline carbon stocks:

1. Determine the start date inventories of aboveground standing live carbon stocks, belowground standing live carbon stocks, aboveground standing dead carbon stocks, and belowground standing dead carbon stocks for the Project Area.

[23] Includes only those Improved Forest Management offset projects that are participating in the California Air Resources Board's Compliance Offset Program and have completed their initial verification as of 10/02/2018.
[24] See footnote 23.

2. Model a 100-year growth and harvest regime reflecting legal and financial constraints. The result is a *preliminary unadjusted baseline* for aboveground standing live carbon stocks that reasonably reflects the harvesting opportunities present within the Project Area.
3. Standardize the *preliminary unadjusted baseline* for aboveground standing live carbon stocks by averaging the annual values or, if legal constraints require stocks to increase over time, constructing an upward sloping straight line to the apex of the legal constraints and averaging annual values thereafter. Baseline carbon stocks for other carbon pools must be similarly averaged. This results in the *unadjusted averaged baseline* for reported carbon stocks.
4. Apply performance standard criteria to adjust the aboveground standing live and standing dead portions of the *unadjusted averaged baseline*. The result is an *adjusted averaged baseline* for aboveground standing live and standing dead carbon stocks.
5. Proportionally adjust other reported carbon stocks to match the *adjusted averaged baseline*.
6. Combine the results to produce the *final baseline* for all onsite carbon stocks.

For all calculations in this section, all values for "carbon stocks" should be expressed in metric tons of CO_2-equivalent.

6.1.2.1 Inventory Carbon Stocks within the Project Area

The start date inventory of standing live carbon stocks, separated into aboveground and belowground portions, and the start date inventory of standing dead carbon stocks, also with aboveground and belowground portions separated, must be determined following Appendix B. Projects may choose to use the Standardized Inventory Methodology and/or the Climate Action Reserve Inventory Tool (CARIT), both available on the Reserve's website, but use of the methodology and CARIT is optional.

In the formulas throughout this section, initial carbon stocks are denoted by the variable PUB_0 (i.e., the *preliminary unadjusted baseline* at time zero).

6.1.2.2 Model Growth and Harvesting Over 100 Years

The *preliminary unadjusted baseline* for onsite carbon stocks must be estimated through a modeling exercise. The modeling exercise must use the inventories of the carbon from Section 6.1.2 as a starting point for modeling. The *preliminary unadjusted baseline* will consist of each of the following carbon pools that are maintained separately during this stage of baseline development:

- Aboveground standing live
- Belowground standing live
- Aboveground standing dead
- Belowground standing dead
- Harvested aboveground and belowground standing live
- Bole portion of harvested standing live

To determine the *preliminary unadjusted baseline,* model the initial inventory of aboveground standing live carbon stocks through a series of growth and harvesting scenarios over a 100-year timeframe. Modeling must be conducted using an approved growth model, as identified in the

Modeling Carbon Stocks section of Appendix B. Modeling of the growth and harvesting scenarios must reflect all legal requirements that constrain the ability to harvest carbon stocks. In addition, harvesting assumptions must reflect realistic financial constraints, as described in Section 6.1.2.2.2.

Standing dead carbon stocks shall be assumed to remain static throughout the modeling process. Exceptions may be provided, at the Reserve's discretion, if compelling justification can be provided that standing dead carbon stocks are likely to fluctuate substantially as part of the project's baseline.

6.1.2.2.1 Modeling Legal Constraints

All legal constraints that affect the ability to manage carbon stocks must be included in the model design. The *preliminary unadjusted baseline* must represent a growth and harvesting regime that fulfills all legal requirements. Voluntary agreements that can be rescinded, such as rental contracts and forest certifications, are not legal constraints. Habitat Conservation Plans (HCPs) and Safe Harbor Agreements (SHAs) that are in place more than one year prior to the project's start date shall be modeled as legal constraints. HCPs and SHAs that are approved after the date one year prior to the project's start date are not considered legal constraints for baseline modeling and may be disregarded.

Legal constraints include all laws, regulations, and legally-binding commitments applicable to the Project Area at the time of the project's initiation that could affect carbon stocks. Legal constraints include:

1. Federal, state/provincial, or local government regulations that are required and might reasonably be anticipated 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
    c. Minimum stocking standards
2. Forest practice rules, or applicable Best Management Practices established by federal, state, provincial or local government that relate to forest management.
3. Other legally binding 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, HCPs, SHAs, and deed restrictions, excepting an encumbrance that was put in place and/or recorded less than one year prior to the project start date, as defined in Section 3.7.

For Forest Projects located in California, the *preliminary unadjusted baseline* must be modeled to reflect all silvicultural treatments associated with timber harvest plans (THPs) active within the Project Area at the time of the project's initiation. All legally enforceable silvicultural and operational provisions of a THP – including those operational provisions designed to meet California Forest Practice Rules requirements for achieving Maximum Sustained Production of High Quality Wood Products [14 CCR 913.11 (933.11, 953.11)] – are considered legal constraints and must be reflected in baseline modeling for if the THP will remain active. For portions of the Project Area not subject to THPs (or over time periods for which THPs will not be active), baseline carbon stocks must be modeled by considering any applicable requirements of the California Forest Practice Rules and all other applicable laws, regulations, and legally

binding commitments that could affect onsite carbon stocks. On a case-by-case basis, the California Department of Forestry and Fire Protection (CAL FIRE) may assist Project Operators in identifying minimum carbon stocking levels that would be effectively required under California Forest Practice Rules.

6.1.2.2.2 Modeling Financial Constraints

Harvest assumptions included in the model must be financially viable. The Project Operator must demonstrate that the growth and harvesting regime assumed for the *preliminary unadjusted baseline* is financially feasible through a financial analysis of the anticipated growth and harvesting regime that captures all relevant costs and returns, taking into consideration all legal, physical, and biological constraints. Cost and revenue variables in the financial analysis may be based on regional norms or on documented costs and returns for the Project Area or other properties in the project's Assessment Area.

A financially viable project is defined in this protocol as a project that has a positive net present value using a discount rate of 4%. This would indicate a management regime that does not lose money in the practice of performing long-term forest management activities, including road management, watercourse restoration, fuels management, etc. Inputs to the analysis include the volume of species harvested, logging and hauling costs, delivered log prices, and forest management costs.

6.1.2.3 Generate an Unadjusted Averaged Baseline

The periodic modeled outputs from the *preliminary unadjusted baseline* must be standardized according to the following guidance for each carbon pool. The result will be an *unadjusted averaged baseline* for each carbon pool.

Aboveground standing live carbon stocks: The periodic modeled outputs for aboveground standing live carbon stocks must be either averaged or converted to a straight-line approximation reflective of legal constraints.

If legal constraints do *not* result in an upward trend in aboveground standing live carbon stocks, then the periodic model outputs must be averaged using Equation 6.5. See Figure 6.1 for a simplified example of the resulting *unadjusted averaged baseline*.

If legal constraints do result in an increasing trend of aboveground standing live carbon stocks, beginning at the project start date, then the periodic model outputs may be standardized using a straight-line approximation, as defined in Equation 6.6. The approximation must consist of two line segments. The first of the line segments must initiate at the initial inventory at the project start date and terminate at the point where carbon stocks reach their highest legally required level. The second segment is a straight line with a constant value, defined by the terminus of the first line segment, for the balance of the 100-year modeling timeframe. See Figure 6.2 for a simplified example of the resulting *unadjusted averaged baseline* with an upward slope.

Equation 6.5. Formula for Averaging *Preliminary Unadjusted Baseline* Carbon Stocks

For all years *y*, $UAB_y = \frac{\sum_{y=0}^{100} PUB_y}{100}$

Where,			Units
UAB_y	=	*Unadjusted averaged baseline* value for year *y (*including the start date at *y*=0*)*	tCO_2e/acre
PUB_y	=	*Preliminary unadjusted baseline* value for year *y.*	tCO_2e/acre

Equation 6.6. Formula for Approximating *Preliminary Unadjusted Baseline* Carbon Stocks as a Straight-Line Trend

For years *y* < Y, $UAB_y = PUB_0 + y \times \frac{ES - PUB_0}{Y}$

For years *y* ≥ Y, $UAB_y = ES$

Where,			Units
UAB_y	=	*Unadjusted averaged baseline* value for year *y*	tCO_2e/acre
Y	=	Time in years between the project start date and the year at which the highest legally required stocking level is reached. This is determined by modeling a forest growth and yield simulation that includes legal and financial constraints (in Section 6.1.2.2, above)	years
PUB_0	=	Initial aboveground standing live and dead carbon stocks per acre within the Project Area (as determined in Section 6.1.2)	tCO_2e/acre
ES	=	Ending stocks = The highest legally required stocking level, as determined in Step 2	tCO_2e/acre

Belowground standing live carbon stocks: The belowground portion of the standing live carbon stocks must be standardized in the same way as the aboveground standing live carbon stocks, i.e., either averaged (Equation 6.5), or calculated with an upward-sloping line to a potential terminus (Equation 6.6).

The aboveground and belowground portions of standing dead carbon stocks: Standing dead carbon stocks shall be set at the quantity of carbon stocks present in the standing dead carbon stock pool at the project start date. Exceptions may be provided, at the Reserve's discretion, if compelling justification can be provided that standing dead carbon stocks are likely to fluctuate substantially as part of the project's baseline. Standing dead stocks are not adjusted based on adjustments to the standing live carbon stocks. However, aboveground and belowground portions of standing dead carbon stocks should be maintained as separate values since aboveground standing dead stocks should be combined with the *unadjusted averaged baseline* for aboveground standing live carbon for the purpose of applying the performance standard criteria as described in Section 6.1.2.4 below.

Carbon stocks in the aboveground and belowground portions of standing live trees harvested for wood products: The carbon stocks shall be calculated as the average of the periodic outputs for the entire 100-year modeling if the aboveground live tree carbon stocks do not result in an upward trend.

If the carbon stocks in aboveground standing live carbon stocks results in an upward trend, the carbon stocks shall be calculated as an average from the start date to the highest point of the

aboveground standing live carbon stocks. A separate average of carbon stocks in both the aboveground and belowground portions of standing live trees harvested for wood products between the highest point of the aboveground standing live carbon stocks and the end point of the 100-year modeling shall be calculated, as applicable.

Carbon stocks in the bole portion of trees harvested for wood products: The carbon stocks shall be calculated as the average of periodic outputs for the entire 100-year modeling if the aboveground live tree carbon stocks do not result in an upward trend.

For upward-sloping lines, the values shall be based on the carbon stocks harvested to the legal constraint terminus and be based on the average carbon stocks from the terminus to the balance of the 100-year modeling (if applicable).

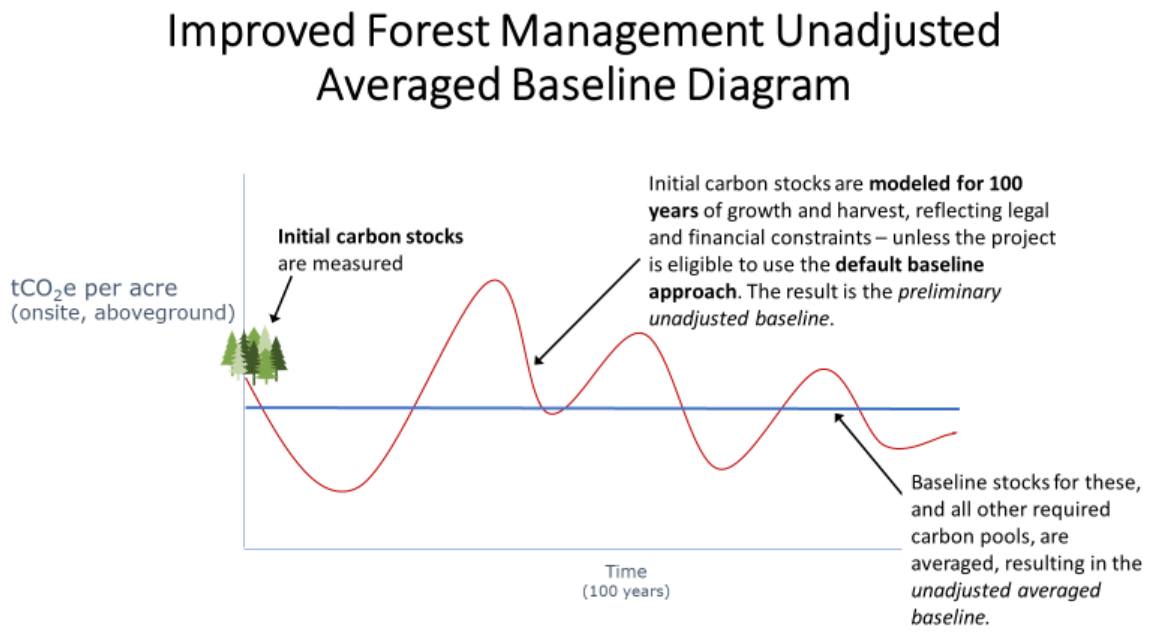


Figure 6.1. Example of an *unadjusted averaged baseline*
(Resulting from Equation 6.5.)

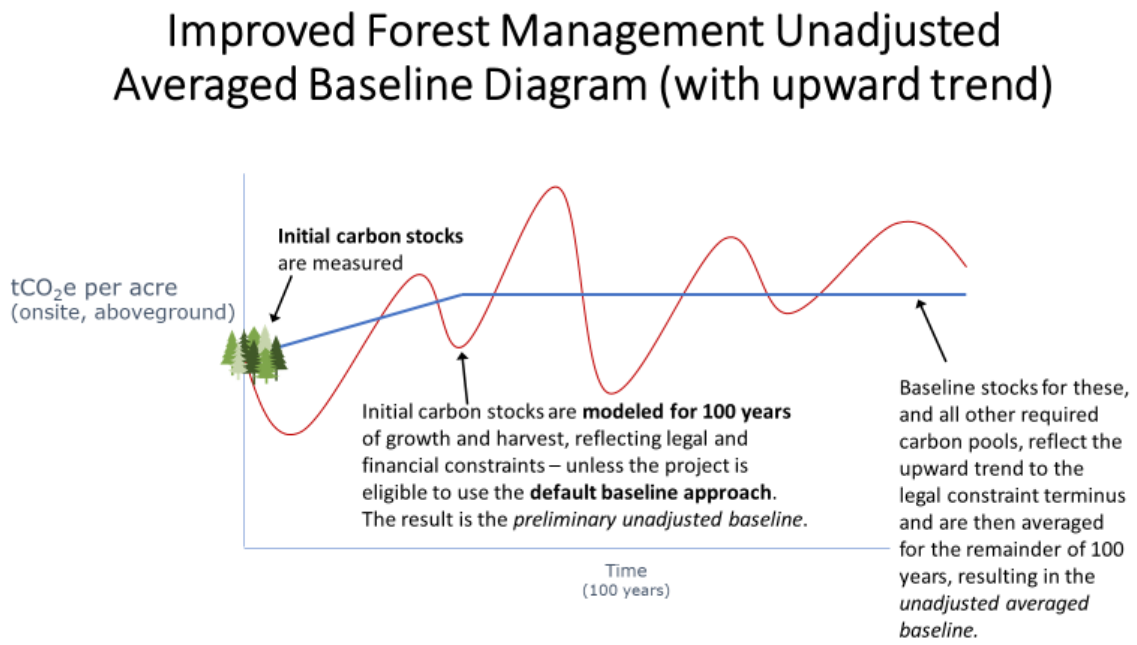


Figure 6.2. Example of an *unadjusted averaged baseline* with an upward trend (Resulting from Equation 6.6.)

6.1.2.4 Apply Performance-Standard Criteria

Once the components of the *unadjusted averaged baseline* are determined in Section 6.1.2.3, the aboveground standing live and standing dead components must be adjusted to conform to a set of performance standard criteria, as described below. The result is an *adjusted averaged baseline* for aboveground standing live and standing dead carbon stocks. Other reported carbon pools are adjusted in Section 6.1.2.5.

The performance standard criteria establish minimum aboveground standing live and standing dead carbon stock values for the baseline, regardless of what is legally and financially viable. The elements of the performance standard are:

- *The High Stocking Reference:* The High Stocking Reference is a measure of carbon stocks in aboveground standing live and standing dead biomass over the 10 years preceding the project start date. It governs baseline carbon stocks in certain instances where aboveground standing live and standing dead carbon stocks have declined prior to the start date. See further guidance below on how to determine the High Stocking Reference.
- *Comparison of initial carbon stocks to Common Practice*: If the *unadjusted averaged baseline* for aboveground standing live carbon stocks was determined according to Equation 6.5, then the *adjusted averaged baseline* may depend on how the initial carbon stocks compare to Common Practice levels (see guidance in Section 6.1.1 for how to determine Common Practice). For projects whose initial aboveground standing live and standing dead carbon stocks are above Common Practice, the *adjusted averaged baseline* for aboveground standing live and standing dead carbon stocks may not be below Common Practice. For projects whose initial aboveground standing live and standing dead carbon stocks are below Common Practice, the *adjusted averaged*

baseline for aboveground standing live and standing dead carbon stocks may not be below either (1) the initial inventory level or (2) the High Stocking Reference, whichever is greater. See Equation 6.7 and Equation 6.8 below.

The procedure for determining the *adjusted averaged baseline* depends on whether the *unadjusted averaged baseline* for aboveground standing live carbon stocks was determined according to Equation 6.5, or as an upward sloping straight-line trend (according to Equation 6.6.

Where the *unadjusted averaged baseline* for aboveground standing live carbon stocks was determined using Equation 6.5:

- If the project's initial aboveground standing live and standing dead carbon stocks (PUB_0) are above Common Practice, use Equation 6.7 to determine the *adjusted averaged baseline*
- If the project's initial aboveground standing live and standing dead carbon stocks (PUB_0) are below Common Practice, use Equation 6.8 to determine the *adjusted averaged baseline*

In both cases, values must be determined for all years, *y*, starting with zero (the start date of the project) and ending with 100.

Equation 6.7. Determining the *Adjusted Averaged Baseline* for Aboveground Live and Aboveground Standing Dead Carbon Stocks Where Initial Stocks Are at or Above Common Practice

$$\boldsymbol{AAB_y = MAX\left(CP, MIN\left(PUB_0, UAB_y\right)\right)}$$

Where,			Units
AAB_y	=	*Adjusted averaged baseline* for aboveground standing live and aboveground standing dead carbon stocks value in year *y*	tCO_2e/acre
CP	=	Common Practice (determined according to the guidance in Section 6.1.1)	tCO_2e/acre
PUB_0	=	Initial aboveground standing live and dead carbon stocks per acre within the Project Area (as determined in Section 6.1.2)	tCO_2e /acre
UAB_y	=	Value of the aboveground standing live and aboveground standing dead portion of the *unadjusted averaged baseline* for year *y,* as determined in Section 6.1.2.3	tCO_2e/acre

Equation 6.8. Determining the *Adjusted Averaged Baseline* for Aboveground Live and Aboveground Standing Dead Carbon Stocks Where Initial Stocks Are Below Common Practice

$$AAB_y = MAX\left(MAX(HSR, PUB_0), MIN(CP, UAB_y)\right)$$

Where,			Units
AAB_y	=	*Adjusted averaged baseline* for aboveground standing live and aboveground standing dead carbon stocks value in year *y*	tCO_2e/acre
HSR	=	"High Stocking Reference" for the Project Area. See guidance below for how the *HSR* is determined	tCO_2e/acre
CP	=	Common Practice (determined according to the guidance in Section 6.1.1)	tCO_2e/acre
PUB_0	=	Initial aboveground standing live and standing dead carbon stocks per acre within the Project Area (as determined in Section 6.1.2)	tCO_2e /acre
UAB_y	=	Value of the *unadjusted averaged baseline* for year *y,* as determined in Section 6.1.3.3, plus the aboveground standing dead carbon stocks for year *y*	tCO_2e/acre

Where the *unadjusted averaged baseline* for aboveground standing live and standing dead carbon stocks was determined using Equation 6.6, the *adjusted averaged baseline* (*AABy*) may be determined according to Equation 6.9.

Equation 6.9. Formula for Determining the *Adjusted Averaged Baseline* Where the *Unadjusted Averaged Baseline* was Approximated using Equation 6.6

For years $y <$ Y, $AAB_y = MAX(PUB_0, HSR) + y \times \frac{ES - PUB_0}{Y}$

For years $y \geq$ Y, $AAB_y = ES$

Where,			Units
AAB_y	=	*Adjusted averaged baseline* value for year *y*	tCO_2e/acre
Y	=	Time in years between the project start date and the year at which the highest legally required stocking level is reached. This is determined by modeling a forest growth and yield simulation that includes legal and financial constraints (in Section 6.1.2.2, above)	years
PUB_0	=	Initial aboveground standing live and dead carbon stocks per acre within the Project Area (as determined in Section 6.1.2)	tCO_2e/acre
HSR	=	"High Stocking Reference" for the Project Area. See guidance below for how the *HSR* is determined.	tCO_2e/acre
ES	=	Ending stocks = The highest legally required stocking level, as determined in Section 6.1.2.2	tCO_2e/acre

6.1.2.4.1 Determining the High Stocking Reference

The High Stocking Reference is defined as 80 percent of the highest value for aboveground standing live and standing dead carbon stocks per acre within the Project Area during the 10-year period preceding the project start date. To determine the High Stocking Reference, the Project Operator must document changes in the Project Area's aboveground standing live and standing dead carbon stocks over the 10 years prior to the initiation of the project, or for as long as the Project Operator has had control of the stocks, whichever is shorter. Figure 6.3. presents a graphical portrayal of a High Stocking Reference determination.

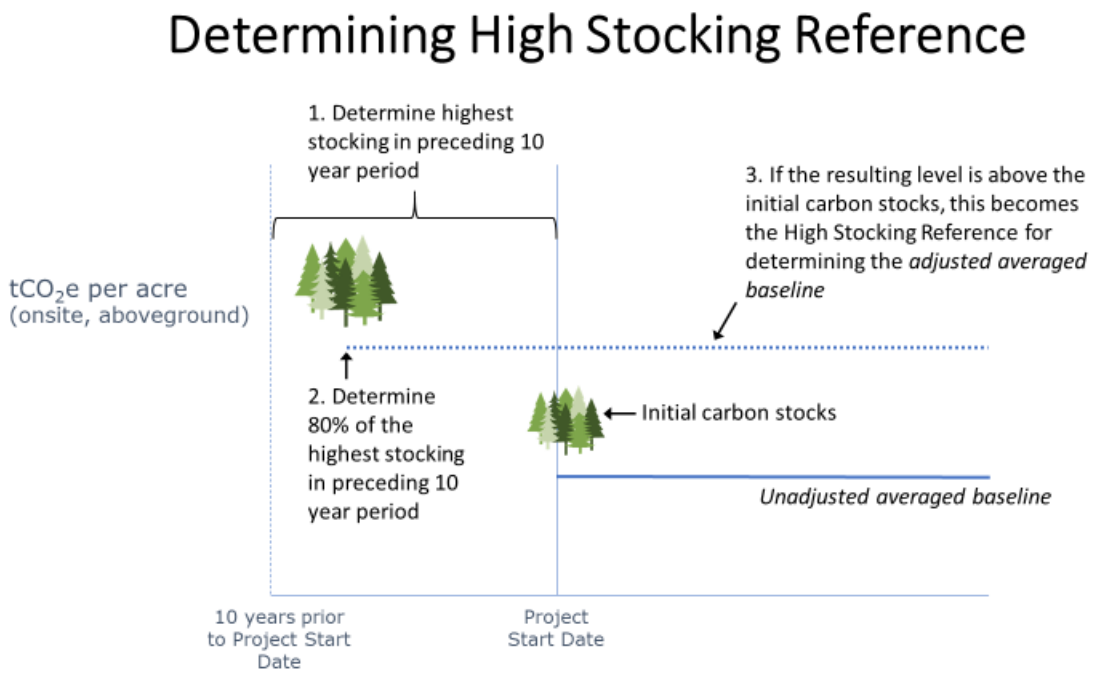


Figure 6.3. Determining a Project Area's High Stocking Reference

Note that it is possible for the High Stocking Reference to be higher than Common Practice, even where initial live and standing dead tree carbon stocks for the project are below Common Practice.

6.1.2.5 Proportionally Adjust Other Reported Carbon Stocks

The *adjusted averaged baseline* for other reported carbon stocks must be determined by adjusting carbon stock values to reflect the *adjusted averaged baseline* for aboveground standing live and standing dead carbon stocks. The guidance for adjusting the other reported carbon stocks is shown in Table 6.1.

Table 6.1. Guidance for Adjusting Other Carbon Pools

Carbon Pool	Relationship to Adjustments of Aboveground Live Carbon Stocks	Adjustment
Belowground Standing Live Carbon Stocks	Directly Proportional	$\boldsymbol{AAB_{bg,y} = \left(AAB_{ag,y} / UAB_{ag,y}\right) \times UAB_{bg,y}}$ *Where,* $AAB_{bg,y}$ = *Adjusted averaged baseline* for belowground standing live carbon stocks in year *y* $AAB_{ag,y}$ = *Adjusted averaged baseline* for aboveground standing live and standing dead carbon stocks in year *y* $UAB_{ag,y}$ = *Unadjusted averaged baseline* for aboveground standing live carbon stocks in year *y*,

Carbon Pool	Relationship to Adjustments of Aboveground Live Carbon Stocks	Adjustment
		plus the aboveground standing dead carbon stocks for year *y* $UAB_{bg,y}$ = *Unadjusted averaged baseline* for belowground standing live carbon stocks in year *y*
Aboveground and Belowground Standing Dead Carbon Stocks	N/A	No adjustment is conducted. Aboveground and belowground standing dead carbon stocks remain constant with inventories of aboveground and belowground standing dead carbon stocks at the project start date. Exceptions may be allowed as described previously. Standing dead carbon stocks are not adjusted based on changes to standing live carbon stocks, but must be used in the comparison to Common Practice.
Harvested Aboveground and Belowground Standing Live Carbon Stocks	Inversely Proportional	$\boldsymbol{AAB_{ht,y}} = \frac{\boldsymbol{UAB_{ht,y}}}{(\boldsymbol{AAB_{ag,y}}/\boldsymbol{UAB_{ag,y}})}$ *Where,* $AAB_{ht,y}$ = *Adjusted averaged baseline* for harvested aboveground and belowground standing live carbon stocks in year *y* $UAB_{ht,y}$ = *Unadjusted averaged baseline* for harvested aboveground and belowground standing live carbon stocks in year *y* $UAB_{ag,y}$ = *Unadjusted averaged baseline* for aboveground standing live carbon stocks in year *y*, plus the aboveground standing dead carbon stocks for year *y* $AAB_{ag,y}$ = *Adjusted averaged baseline* for aboveground standing live and standing dead carbon stocks in year *y*
Harvested Bole Portion of Aboveground and Belowground Standing Live Carbon Stocks	Inversely Proportional	$\boldsymbol{AAB_{htb,y}} = \frac{\boldsymbol{UAB_{htb,y}}}{(\boldsymbol{AAB_{ag,y}}/\boldsymbol{UAB_{ag,y}})}$ *Where,* $AAB_{htb,y}$ = *Adjusted average baseline* for the bole portion of harvested aboveground and belowground standing live carbon stocks in year *y* $UAB_{htb,y}$ = *Unadjusted averaged baseline* for the bole portion of harvested aboveground and belowground standing live carbon stocks in year *y* $UAB_{ag,y}$ = *Unadjusted averaged baseline* for aboveground standing live carbon stocks in year *y*, plus the aboveground standing dead carbon stocks for year *y* $AAB_{ag,y}$ = *Adjusted averaged baseline* for aboveground standing live and standing dead carbon stocks in year *y*

6.1.2.6 Combine All Adjusted Averaged Baseline Components

The *final baseline* is the sum of *adjusted averaged baselines* for all reported *onsite* carbon stocks and must include:

- Aboveground and belowground standing live carbon stocks
- Aboveground and belowground standing dead carbon stocks
- Harvested wood products

The *adjusted averaged baselines* for harvested standing live carbon stocks (aboveground and belowground) and the bole portion of harvested standing live carbon stocks must also be maintained separately from the carbon stocks listed above. The reporting of harvested carbon stocks is conducted separately from other reported carbon stocks.

6.1.3 Estimating Baseline Onsite Carbon Stocks – Public Lands

The baseline is developed for a public forest by determining carbon levels in the Project Area with the assumed condition that the entire forest is at a rotation age common for the forest community (by Assessment Area). The rotation ages are provided as default values and are found with the Assessment Area data. Where forest practice laws, or any other legal encumbrances, require specific management of forest stands at levels that exceed the age criteria mentioned above, the stands must be managed at sufficient stocking levels to ensure compliance with the legal constraints. Project credits are determined by calculating the project's carbon stocks and subtracting the baseline stocks from them.

6.1.3.1 Generate COLE Report

Using the Carbon Online Estimator (COLE),[25] select Forest Inventory and Analysis (FIA) plots using the "plots within this radius" tool. The circle developed must be centered within the Project Area. The radius of the sample area must be at least 100 kilometers. Following the guidance on the website, fetch the data within the circle. Next, filter the data using the 'Filter' tab on the website by selecting species in the 'Forest Type' menu bar that are found in the species list in the Assessment Area Data File for Assessment Area(s) the project is in. Click on the 'Reports' tab and submit the request to produce the 1605(b) report, which will be provided through a web interface. The report must be included as an appendix in the PDD.

Using Table 1 of the COLE 1605(b) report, the baseline for the project, barring any adjustments as part of the legal analysis (below), shall be determined by summing the live tree and dead tree values from the COLE 1605(b) report that correspond with the rotation length value found in Table 6.2. The 1605(b) values are given as metric tons of carbon per hectare and shall be converted into metric tons CO_2e per acre. The determination of rotation length is made using the Assessment Area Data File and identified for rotation length.

Table 6.2. Table Rotation Lengths

Rotation Length	Years
Short	30
Medium	40
Long	60
Extremely Long	70

[25] http://www.ncasi2.org/COLE/. After opening, zoom into project area on map and follow instructions to "get plots within this radius…". Once the data has been retrieved, the report can be obtained following the instructions on the site.

6.1.3.2 Adjust for Legal Constraints

The baseline must exceed all legal constraints. A determination must be made whether the legal constraints that affect forest management within the Project Area require further adjustments to the initial baseline developed above, using the following steps:

1. Identify legal constraints affecting the Project Area.
    a. Identify and describe the legal requirements affecting the Project Area.
    b. Spatially identify (map) the areas to which the legal requirements apply within the Project Area to determine the affected acres.
2. Determine forest structure needed to comply with the legal requirements.
    a. Describe the forest structure needed to ensure compliance with the legal requirements affecting each area.
    b. Explain and justify the forest conditions and associated age class that meets the forest conditions identified for meeting the minimum criteria of the legal requirement. In no case shall the age class be less than the age class associated with the rotation length from Table 6.2.
3. Adjust baseline values
    a. Use the live and dead tree values associated with the age class from the COLE 1605(b) report that is associated with the previous step. The 100-year values for live and dead trees in the COLE 1605(b) report shall be used in cases where determinations of forest structure are not easily justified.
    b. Develop a weighted average by multiplying the acres for each constraint class by the COLE 1605(b) values and dividing by the total acres to determine the adjusted baseline.

6.1.3.3 Estimate the Project's Baseline Harvest Volume

The estimate of baseline harvest volume shall be determined by multiplying the adjusted baseline (above) by 3%. The resulting volume shall be used in conjunction with the guidance in Appendix B to determine harvested wood products. The harvest volume shall remain constant for the project life.

6.1.3.4 Determining the Final Project Baseline

The final baseline is determined by adding the estimated harvested wood products to the adjusted baseline.

6.1.4 Determining Actual Onsite Carbon Stocks

Actual carbon stocks for Improved Forest Management Projects must be determined by updating the Project Area's forest carbon inventory. This is done by:

1. Incorporating any new forest inventory data obtained during the previous year into the inventory estimate. Any plots sampled during the previous year must be incorporated into the inventory estimate.
2. Using an approved model or a stand table projection to "grow" (project forward) prior-year data from existing forest inventory plots to the current reporting year. Guidance for projecting forest inventory data is identified in Appendix B.

3. Updating the forest inventory estimate for harvests and/or disturbances that have occurred during the previous year. To allow some flexibility in updating the forest inventory during onsite verification years, a project may defer updating a small percentage of plots until the following reporting period, as detailed in Appendix B. This will help streamline the sequential sampling process when recent disturbances have taken place.
4. Applying an appropriate confidence deduction for the inventory based on its statistical uncertainty, following the guidance in Appendix B.

6.1.5 Determining Actual Carbon in Harvested Wood Products

Perform the following steps to determine actual carbon in harvested wood products:

1. Determine the actual amount of carbon in standing live carbon stocks (prior to delivery to a mill) harvested in the current year (based on harvest volumes determined in Section 6.1.4).
2. Determine the amount of actual harvested carbon that will remain stored in wood products, averaged over 100 years, following the requirements in Appendix B.

6.1.6 Quantifying Secondary Effects

For Improved Forest Management Projects, significant Secondary Effects can occur if a project reduces harvesting in the Project Area, resulting in an increase in harvesting on other properties. Emission reductions due to substituting wood for materials with higher GHG footprints, such as concrete or steel, are not accounted for as an emission reduction in this protocol because the emission reductions are accounted for by the energy sector.

The risk that Secondary Effects may be occurring is calculated in this protocol. However, the magnitude of risk of Secondary Effects is dependent on how much harvesting occurs on the Project Area relative to the baseline scenario. This protocol considers the impacts of shifting harvest activities over the project life. As discussed above, since the baseline is a representative scenario of legally permissible and financially feasible growth and harvesting regimes in the absence of a project, baseline pools, including those used to quantify the risk of Secondary Effects, are averaged across the baseline period (i.e., 100 years). The risk of Secondary Effects for the project are thus considered in relation to such averaged baseline harvesting. Improved Forest Management Projects, where harvesting is anticipated to be an ongoing activity over the project life, are expected to increase harvest levels over time compared to baseline management due to improved stocking and growth levels and harvesting closer to an optimal age for forest productivity. However, this SSR must be reported annually due to the risk that Secondary Effects may be occurring in any given year.

Equation 6.10 must be used to estimate the Secondary Effects risk for Improved Forest Management Projects. Recognizing that Secondary Effects from projects may be influenced by long term harvesting trends, the evaluation in Equation 6.10 considers how actual cumulative harvest amounts vary from baseline cumulative harvest amounts since project inception.

When baseline cumulative harvested carbon exceeds actual cumulative harvested carbon - *but actual onsite harvested carbon exceeds the baseline amount in a given reporting period* - net GHG reductions are increased (Equation 6.10.B). This allows for prior deductions for Secondary Effects to be recouped, because the risk has been lowered. However, once actual cumulative harvest amounts exceed baseline cumulative harvest amounts, Secondary Effects risk is zero,

and will remain zero for as long as actual cumulative harvest amounts exceed baseline cumulative harvest amounts (Equation 6.10.A). Under no circumstances shall the net balance of Secondary Effects CRTs over the course of a project be positive. However, maintaining actual cumulative harvest above baseline cumulative harvest will allow a project to accrue any uncredited positive carryover that can counteract the amount of future Secondary Effects deductions that would be applied if baseline cumulative harvested carbon were to exceed actual harvested carbon again (Equation 6.10.C). Refer to Appendix B for an example of how Secondary Effects are evaluated over time, and how prior Secondary Effects may be recouped. The Reserve also provides a calculation workbook for quantifying Secondary Effects risk (in addition to the other calculations required by the protocol).

Values used for onsite carbon harvested in the project and baseline scenarios ($AC_{hv,n}$ and $BC_{hv,n}$) shall represent all harvested trees, not just merchantable species.

Equation 6.10. Secondary Effects Emissions

Equation 6.10.A:

$$If \sum_{n=1}^{y} (\boldsymbol{AC_{hv,n}} - \boldsymbol{BC_{hv,n}}) \geq 0, and \sum_{n=1}^{y-1} \boldsymbol{SE_{as,n}} \geq 0,$$

$$then\ \boldsymbol{SE_{as,y}} = \boldsymbol{0}^{\dagger}$$

Equation 6.10.B:

$$If \left(\sum_{n=1}^{y} (\boldsymbol{AC_{hv,n}} - \boldsymbol{BC_{hv,n}}) < 0\ and \sum_{n=1}^{y-1} \boldsymbol{SE_{as,n}} < 0 \right) or \left(\sum_{n=1}^{y} (\boldsymbol{AC_{hv,n}} - \boldsymbol{BC_{hv,n}}) \geq 0\ and \sum_{n=1}^{y-1} \boldsymbol{SE_{as,n}} < 0 \right),$$

$$then\ \boldsymbol{SE_{as,y}} = \boldsymbol{MIN} \left(\left(\boldsymbol{AC_{hv,y}} - \boldsymbol{BC_{hv,y}}\right) \times \boldsymbol{20\%}, \left| \sum_{n=1}^{y-1} \boldsymbol{SE_{as,n}} \right| \right)$$

Equation 6.10.C:

$$If \sum_{n=1}^{y} (\boldsymbol{AC_{hv,n}} - \boldsymbol{BC_{hv,n}}) < 0, and \sum_{n=1}^{y-1} \boldsymbol{SE_{as,n}} \geq 0,$$

$$then\ \boldsymbol{SE_{as,y}} = \boldsymbol{MIN} \left(\sum_{n=1}^{y-1} \boldsymbol{SE_{as,n}} + \left(\left(\boldsymbol{AC_{hv,y}} - \boldsymbol{BC_{hv,y}}\right) \times \boldsymbol{20\%} \right), \boldsymbol{0} \right)^{\dagger}$$

Where,

			Units
$SE_{as,y}$	=	Estimated annual Secondary Effects in current reporting period *y* (used in Equation 6.1)	tCO_2e
$SE_{as,n}$	=	Estimated annual Secondary Effects in reporting period *n*	tCO_2e
$AC_{hv,n}$	=	Actual amount of onsite carbon harvested in reporting period *n* (prior to delivery to a mill)	tCO_2e
$BC_{hv,n}$	=	Estimated average baseline amount of onsite carbon harvested in reporting period *n* (prior to delivery to a mill), as determined above	tCO_2e
$AC_{hv,y}$	=	Actual amount of onsite carbon harvested in current reporting period *y* (prior to delivery to a mill)	tCO_2e

$BC_{hv,y}$	=	Estimated average baseline amount of onsite carbon harvested in current reporting period *y* (prior to delivery to a mill), as determined in Section 6.1.1.4, 6.1.2.5, or 6.1.3.3 as applicable	tCO_2e

† Secondary Effects are not awarded CRTs but may accrue as positive carryover. Annual accruals are calculated in the same way that Secondary Effects are calculated when baseline cumulative harvested carbon exceeds actual harvested carbon. Cumulative Secondary Effects as of the current reporting period are calculated by the following: $\sum_{n=1}^{y} \boldsymbol{SE_{as,n}} = \sum_{n=1}^{y-1} \boldsymbol{SE_{as,n}} + ((\boldsymbol{AC_{hv,y}} - \boldsymbol{BC_{hv,y}}) \times \mathbf{20}\%)$. Positive carryover reduces or negates future Secondary Effects deductions.

6.2 Avoided Conversion Projects

6.2.1 Estimating Baseline Onsite Carbon Stocks

The baseline for Avoided Conversion Projects is a projection of onsite forest carbon stock losses that would have occurred over time due to the conversion of the Project Area to a non-forest land use. Estimating the baseline for Avoided Conversion Projects involves two steps:

1. Characterizing and projecting a baseline
2. Adjusting the baseline based on conversion risk

Step 1 – Characterizing and Projecting the Baseline

Project Operators must characterize and project the baseline by:

1. Clearly specifying an alternative highest-value land use for the Project Area, as identified by an appraisal(s) (required by this protocol). The appraisal(s) must include accompanying documentation that demonstrates the type of anticipated land use conversion is legally permissible. Such documentation must fall into at least one of the following categories:
    a. Documentation indicating that the current land use policies, including zoning and general plan ordinances, and other local and state statutes and regulations, permit the anticipated type of conversion.
    b. Documentation indicating that the Project Operator has obtained all necessary approvals from the governing county to convert the Project Area to the proposed type of non-forest land use (including, for instance, certificates of compliance, subdivision approvals, timber conversion permits, other rezoning, major or minor use permits, etc.).
    c. Documentation indicating that similarly situated forestlands within the project's Assessment Area were recently able to obtain all necessary approvals from the governing county, state, or other governing agency to convert to a non-forest land use (including, for instance, certificates of compliance, subdivision approvals, timber conversion permits, other rezoning, major or minor use permits, etc.).
2. Estimating the rate of conversion and removal of onsite standing live and dead carbon stocks. The rate of conversion and removal of onsite standing live and dead carbon stocks must be estimated by either:
    a. Referencing planning documentation that has been approved and permitted by the appropriate planning department for the Project Area (e.g., construction

documents or plans) that specifies the timeframe of the conversion and intended removal of forest cover on the Project Area; or

b. In the absence of specific documentation, identifying a default annual conversion rate for carbon in standing live and dead carbon stocks from Table 6.3. The default value is subject to any legal constraints, which must be incorporated in modeling the project's baseline.

Table 6.3. Default Avoided Conversion Rates for Standing Live and Dead Carbon Stocks

Type of Conversion Identified in Appraisal	Total Conversion Impact	Annual Rate of Conversion
	This is the assumed total effect over time of the conversion activity on standing live and dead carbon stocks. (The total conversion impact is amortized over a 10-year period to determine the annual rate of conversion in the next column.)	This is the assumed annual rate of the conversion activity on standing live and dead carbon stocks. The percentages below are multiplied by the initial standing and dead carbon stocks for the project on an annual basis for the first 10 years of the project.
Residential	Estimate using the following formula: *TC*% = (min(1,(*P**3) / *PA*)) *Where,* *TC* = % total conversion (*TC* cannot exceed 100%) *PA* = the Project Area (acres) identified in the appraisal *P* = the number of unique parcels that would be formed on the Project Area as identified in the appraisal * Each parcel is assumed to deforest 3 acres of forest vegetation	Estimate using the following formula: *ARC* = *TC* / 10 *Where,* *ARC* = % annual rate of conversion *TC* = % total conversion
Mining and Agricultural Conversion, including Pasture or Crops	90%	9.0%
Golf Course	80%	8.0%
Commercial Buildings	95%	9.5%

A computer simulation, based on 2a or 2b above, must be conducted to project changes in onsite standing live and dead carbon stocks over 100 years. The computer simulation of the onsite standing live and dead carbon stocks must approximate the identified rate of conversion over time to estimate changes in standing live and dead carbon stocks, beginning with the Project Area's initial onsite standing live and dead carbon stocks. If the projected conversion rate does not result in a complete removal of onsite standing live and dead carbon stocks, the baseline projection must account for any residual forest carbon value as a steady condition for the balance of a 100-year projection.

3. Estimating the rate of soil carbon emissions (optional):
   Soil carbon emissions associated with conversion to agriculture (for all soil types) or residential and commercial (for histosols only) may be reported for the baseline. The amount of soil carbon and the rate of soil carbon emissions are dependent upon the soil type ("soil order") and the conversion activity. Emissions from soil carbon are estimated by applying the default emissions estimators from Table B.19 of Appendix B to the estimates of soil carbon in the Project Area. Appendix B provides an estimated

percentage emitted as the result of conversion and presents the rate of emissions associated with each soil order. A weighted estimate of emissions must be conducted where more than one soil order is found in the Project Area.

4. As with standing live and dead carbon, the baseline trend of soil carbon stocks must be graphed to display the soil carbon stocks on an annual basis.

The carbon stock trends for standing live carbon, standing dead carbon, and soil carbon are added together to determine a project baseline for the onsite carbon stocks. Figure 6.4. displays a simplified view of the the baseline trend of onsite carbon stocks, as well as the basis for project crediting over time.

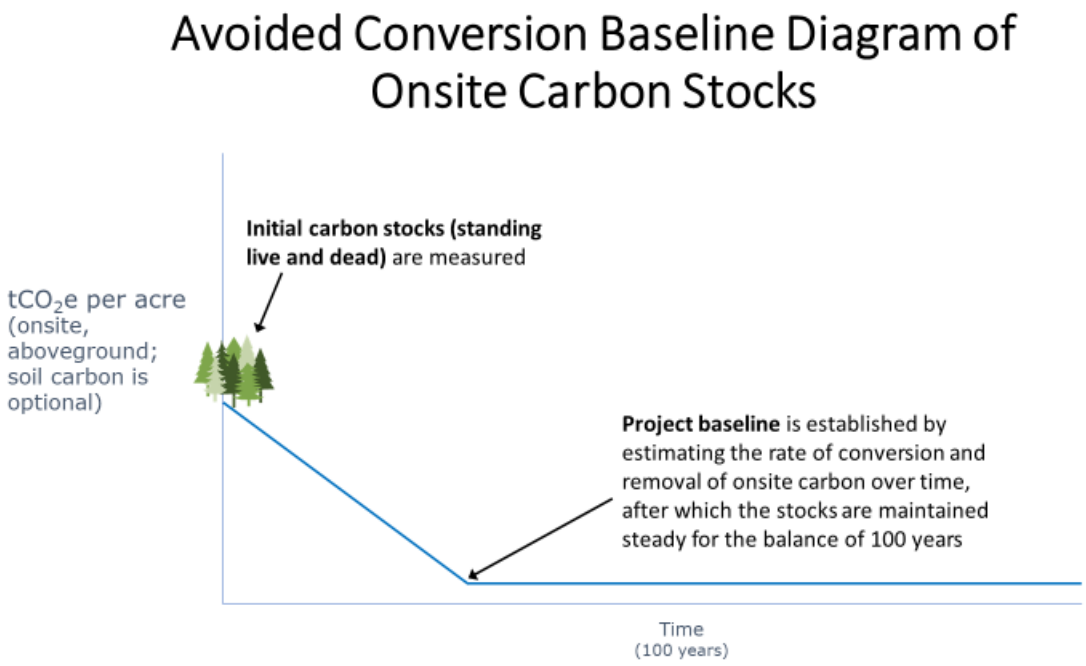


Figure 6.4. Example of an Avoided Conversion Project Baseline

Step 2 – Adjusting the Baseline Based on Conversion Risk

If the fair market value of the anticipated alternative land use for the Project Area (as determined by the required appraisal) is *not more than 80 percent greater* than the value of the current forested land use, then the baseline must be adjusted to reflect uncertainty about the risk of conversion. If the project utilizes multiple appraisals to cover the entire Project Area, the appraisals must all result in the same Conversion Risk Adjustment Factor to be considered for use in the same project.

Equation 6.11. Conversion Risk Adjustment Factor

If 0.4 < ((*VA* / *VP*) – 1) < 0.8, **then** *CRA* = [80% – ((*VA* / *VP*) – 1)] x 2.5
If ((*VA* / *VP*) – 1) ≥ 0.8, **then** *CRA* = 0%
If ((*VA* / *VP*) – 1) ≤ 0.4, **then** *CRA* = 100%

Where,

CRA	=	Conversion Risk Adjustment factor
VA	=	Appraised fair market value of the anticipated alternative land use for the Project Area
VP	=	Appraised fair market value of the current forested land use for the Project Area

The baseline is adjusted by applying the Conversion Risk Adjustment factor to the unadjusted baseline determined in Step 1, using Equation 6.12 below.

Equation 6.12. Adjusted Baseline Onsite Carbon Stocks

$$\boldsymbol{BC_{onsite,y} = BLU_y + \left(IS - BLU_y\right) \times CRA}$$

Where,

			Units
$BC_{onsite,\ y}$	=	Adjusted baseline onsite carbon stocks in year *y*, for each of the 100 years calculated in the project's baseline	tCO_2e
BLU_y	=	Unadjusted baseline onsite carbon stocks in year *y*, for each of the 100 years calculated in the project's baseline (determine in Step 1, above)	tCO_2e
IS	=	Initial onsite carbon stocks at the project start date	tCO_2e
CRA	=	Conversion Risk Adjustment factor, as described above	%

6.2.2 Estimating Baseline Carbon in Harvested Wood Products

Harvesting is assumed to occur in the baseline over time as the Project Area is converted to another land use. To estimate the baseline carbon transferred to long-term storage in harvested wood products each year:

1. Determine the amount of carbon in standing live carbon stocks (prior to delivery to a mill) that would have been harvested in each year, consistent with the rate of reduction in baseline standing live carbon stocks determined in Section 6.2.1. This projection is determined at the project outset, using the same biomass equations used to calculate biomass in live trees, and will not change over the course of the project.
2. On an annual basis, determine the amount of harvested carbon that would have remained stored in wood products, averaged over 100 years, following the requirements in Appendix B.

6.2.3 Determining Actual Onsite Carbon Stocks

Actual carbon stocks for Avoided Conversion Projects must be determined by updating the Project Area's forest carbon inventory. This is done by:

1. Incorporating any new forest inventory data obtained during the previous year into the inventory estimate. Any plots sampled during the previous year must be incorporated into the inventory estimate.
2. Using an approved model to "grow" (project forward) prior-year data from existing forest inventory plots to the current reporting year. Approved growth models are identified in

Appendix B. Guidance for projecting forest inventory plot data using models is also provided in Appendix B.

3. Updating the forest inventory estimate for harvests and/or disturbances that have occurred during the previous year. To allow some flexibility in updating the forest inventory, a project may defer updating a small percentage of plots until the following reporting period, as detailed in Appendix B.
4. Applying an appropriate confidence deduction for the inventory based on its statistical uncertainty, following the guidance in Appendix B.

6.2.4 Determining Actual Carbon in Harvested Wood Products

Perform the following steps to determine actual carbon in harvested wood products:

1. Determine the actual amount of carbon in standing live carbon stocks (prior to delivery to a mill) harvested in the current year (based on harvest volumes determined in Section 6.2.2).
2. Determine the amount of actual harvested carbon that will remain stored in wood products, averaged over 100 years, following the requirements in Appendix B.

6.2.5 Quantifying Secondary Effects

Significant Secondary Effects for Avoided Conversion Projects can arise if the type of land use conversion that would have happened on the Project Area is shifted to other forest land.

To quantify Secondary Effects risk for Avoided Conversion Projects, Project Operators must quantify Secondary Effect emissions risk using Equation 6.13. The value for Secondary Effect emissions will always be negative or zero.

Equation 6.13. Secondary Effects Emissions Risk

$$\boldsymbol{SE_{as,y} = (-1) \times 3.6\% \times (\Delta AC_{onsite} - \Delta BC_{onsite})}$$ **or 0, whichever is lower**

Where,			Units
$SE_{as,y}$	=	Secondary Effect GHG emissions that may result from activity shifting outside the project area, as a result of the project activity in year *y* (Equation 6.1)	tCO_2e
$\Delta\ AC_{onsite}$	=	Annual difference in actual onsite carbon as defined in Equation 6.1	tCO_2e
$\Delta\ BC_{onsite}$	=	Annual difference in baseline onsite carbon as defined in Equation 6.1	tCO_2e

7 Ensuring the Permanence of Credited GHG Reductions and Removals

The Reserve requires that credited GHG reductions and removals be effectively "permanent." For Forest Projects, this requirement is met by ensuring that the carbon associated with credited GHG reductions and removals remains stored for at least 100 years.

The Reserve ensures the permanence of GHG reductions and removals through three mechanisms:

1. The requirement for all Project Operators to monitor onsite carbon stocks, submit regular monitoring reports, and submit to regular third-party verification of those reports along with periodic verification site visits (as detailed in Sections 7 through 9 of this protocol) for the duration of the Project Life.
2. The requirement for all Project Operators to sign a Project Implementation Agreement with the Reserve, as described in Section 3.6, which obligates Project Operators to retire CRTs to compensate for reversals of GHG reductions and removals.
3. The maintenance of a Buffer Pool to provide insurance against reversals of GHG reductions and removals due to unavoidable causes (including natural disturbances such as fires, pest infestations, or disease outbreaks).

GHG reductions and removals can be "reversed" if the stored carbon associated with them is released (back) to the atmosphere. Many biological and non-biological agents, both natural and human-induced, can cause reversals. Some of these agents cannot completely be controlled (and are therefore "unavoidable"), such as natural agents like fire, insects, and wind. Other agents can be controlled, such as the human activities like land conversion and over-harvesting. Under this protocol, reversals due to controllable agents are considered "avoidable". As described in this section, Project Operators are required to identify and quantify the risk of reversals from different agents based on project-specific circumstances. The resulting risk rating determines the quantity of Climate Reserve Tonnes (CRTs) that the project must contribute to the Reserve Buffer Pool to insure against reversals.

7.1 Definition of a Reversal

Project owners must demonstrate, through annual reporting and periodic site visit verification, that stocks associated with credited GHG reductions and removals are maintained for a period of time considered to be permanent (i.e., 100 years). If the quantified GHG reductions and removals (i.e., QR_y in Equation 6.1) in a given year are negative, and CRTs were issued to the Forest Project in any previous year, the Reserve will consider this to be a reversal regardless of the cause of the decrease. Planned thinning or harvesting activities, for example, may cause a reversal if they result in a negative value for QR_y.

7.2 Insuring Against Reversals

The Reserve requires Project Operators to insure against reversals, based on a project-specific risk evaluation. Currently, insurance must take the form of contributing CRTs to the Buffer Pool administered by the Reserve. In the future, the Reserve anticipates that other insurance instruments may be available to insure against reversals.

7.2.1 About the Buffer Pool

The Buffer Pool is a holding account for Forest Project CRTs, which is administered by the Reserve. All Forest Projects must contribute a percentage of CRTs to the Buffer Pool any time they are issued CRTs for verified GHG reductions and removals. Each Forest Project's contribution is determined by a project-specific risk rating, as described in Section 7.2.2. If a Forest Project experiences an unavoidable reversal of GHG reductions and removals (as defined in Section 7.3), the Reserve will retire a number of CRTs from the Buffer Pool equal to the total amount of carbon that was reversed (measured in metric tons of CO_2-equivalent). The Buffer Pool therefore acts as a general insurance mechanism against unavoidable reversals for all Forest Projects registered with the Reserve.

7.2.2 Contributions to the Buffer Pool

Each time the Reserve issues CRTs for verified GHG reductions and removals achieved by a Forest Project, a certain percentage of those CRTs must be contributed to the Buffer Pool. The size of the contribution to the Buffer Pool will depend on the Forest Project's risk rating for reversals. For example, if a Forest Project is issued ten CRTs after annual verification, and the project's reversal risk rating is ten percent, then nine CRTs will be issued to the Project Operator's Reserve account and 1 CRT must be deposited in the Buffer Pool.

Project Operators must determine the reversal risk rating for a project by following the requirements and guidance in Appendix A. The risk rating must be determined prior to registration and recalculated in every year the project undergoes a verification site visit (see Section 9.3.2).

Project Operators who record a Qualified Conservation Easement or Qualified Deed Restriction in conjunction with implementing a Forest Project will receive a lower risk rating (see Appendix A).

Project Operators may be able to reduce the risk rating through actions that lower the risk profile of their project. If a Forest Project's risk rating declines, the Reserve may distribute previously withheld Buffer Pool CRTs to the Project Operator in proportion to the reduced risk. Similarly, however, the Reserve may require additional contributions to the Buffer Pool if the risk rating increases, to ensure that all CRTs (including those issued in prior years) are properly insured.

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 may include direct insurance. Alternative insurance mechanisms could be used to directly reduce the required Buffer Pool contributions for a project. The Reserve must review and approve alternative insurance mechanisms before they may be used.

7.3 Compensating for Reversals

The Reserve requires that all reversals be compensated through the retirement of CRTs. If a reversal associated with a Forest Project was unavoidable (as defined below), then the Reserve will compensate for the reversal on the Project Operator's behalf by retiring CRTs from the Buffer Pool. If a reversal was avoidable (as defined below) then the Project Operator must compensate for the reversal by surrendering CRTs from its Reserve account.

7.3.1 Unavoidable Reversals

An Unavoidable Reversal is any reversal not due to the Project Operator's negligence, gross negligence or willful intent, including wildfires or disease that are not the result of the Project Operator's negligence, gross negligence or willful intent. Requirements for Unavoidable Reversals are as follows:

1. If the Project Operator determines there has been an Unavoidable Reversal, it must notify the Reserve in writing of the Unavoidable Reversal within six months of its occurrence.
2. The Project Operator must explain the nature of the Unavoidable Reversal and provide a verified estimate of onsite carbon stocks so that the reversal can be quantified (in units of CO_2-equivalent metric tons).
    a. Annual monitoring reports submitted for the project must provide observations of ongoing mortality. Based on such observations, an estimate of mortality related to the natural disturbance must be provided. Once mortality has stabilized to background levels, a full verified estimate of the onsite carbon stocks must be submitted to the Reserve, no later than 2 years following the occurrence. Exceptions to this timing may be made if the Reserve agrees that an extension is warranted, for example, if mortality has not stabilized. Observations submitted by the Project Operator are subject to oversight by the Reserve.

If the Reserve determines that there has been an Unavoidable Reversal, it will retire a quantity of CRTs from the Buffer Pool equal to the size of the reversal in CO_2-equivalent metric tons (i.e., QR_y, as specified in Equation 6.1).

7.3.2 Avoidable Reversals

An Avoidable Reversal is any reversal that is due to the Project Operator's negligence, gross negligence, or willful intent, including harvesting, development, and harm to the Project Area due to the Project Operator's negligence, gross-negligence, or willful intent. Avoidable Reversals may also be caused by planned harvest activities or overestimation of the project's growth and yield model.

Requirements for Avoidable Reversals are as follows:

1. If an Avoidable Reversal has been identified during annual monitoring, the Project Operator must give written notice to the Reserve within thirty days of identifying the reversal.
2. Alternatively, if the Reserve determines that an Avoidable Reversal has occurred, it shall deliver written notice to the Project Operator. Within thirty days of receiving the avoidable reversal notice from the Reserve, the Project Operator must provide a written description and explanation of the reversal to the Reserve.
3. Within a year of notifying the Reserve of an Avoidable Reversal or receiving the Avoidable Reversal notice, the Project Operator must provide the Reserve with a verified estimate of current onsite carbon stocks. The verified estimate may be a desk review verification, unless:
    a. a regularly scheduled site visit verification coincides with the year of the reversal, or

b. the loss represents 35% or more of the previous year's onsite carbon stocks or peak carbon stocks in all previous years of the carbon project.

4. Within four months of the Reserve's approval of the verified estimate of onsite carbon stocks, the Project Operator must surrender a quantity of CRTs from its Reserve account equal to the size of the reversal in CO_2-equivalent metric tons (i.e., QR_y, as specified in Equation 6.1). In addition:
    a. The surrendered CRTs must be those that were issued to the Forest Project, unless those CRTs were previously retired for other purposes. Otherwise, the surrendered CRTs must be from other Forest Projects (US or Mexico) registered with the Reserve.
    b. The surrendered CRTs will be cancelled by the Reserve and designated in the Reserve's software system as compensating for the Avoidable Reversal.

7.3.3 Computational Reversals

Computational Reversals include reversals that occur as a result of required protocol calculations. Confidence deductions and accounting for Secondary Effects may cause a computational reversal under certain circumstances. These types of reversals – which are not directly related to on-the-ground activities, but which nonetheless result in a situation in which the project has been overcredited – must be compensated for as described below.

Requirements for Computational Reversals are as follows:

1. If a Computational Reversal has been identified during annual monitoring, the Project Operator must give written notice to the Reserve within thirty days of identifying the reversal.
2. Alternatively, if the Reserve determines that a Computational Reversal has occurred, it shall deliver written notice to the Project Operator.
3. No additional verification requirements will be imposed for a Computational Reversal – the Project Operator may conduct verification at the next regularly scheduled verification period.
4. The Project Operator may true up the Computational Reversal during the next regularly scheduled verification period by deducting the reversed quantity from the to-be-issued CRTs. If growth has not compensated for the amount of the Computational Reversal, then existing CRTs will be cancelled as follows:
    a. The Reserve will cancel CRTs that were issued to the Forest Project, preferably from the relevant vintage, unless those CRTs were previously retired for other purposes or are no longer held by the Project Operator. Otherwise, CRTs must be purchased from other Forest Projects registered with the Reserve and provided for cancellation.
    b. The cancelled CRTs must be designated in the Reserve's software system as compensating for the Computational Reversal.

7.4 Disposition of Forest Projects after a Reversal

If a reversal lowers the Forest Project's actual standing live carbon stocks below its approved baseline standing live carbon stocks, the Forest Project will automatically be terminated, as the original approved baseline for the project would no longer be valid. If the Forest Project is automatically terminated due to an Unavoidable Reversal, another project may be initiated and

submitted to the Reserve for registration on the same Project Area. New projects may not be initiated on the same Project Area if the Forest Project is terminated due to an Avoidable Reversal.

If the Forest Project has experienced a reversal and its actual standing live carbon stocks are still above the approved baseline levels, it may continue without termination as long as the reversal has been compensated. The project must continue contributing to the Buffer Pool in future years based on its verified risk rating.

8 Project Monitoring

This section provides requirements and guidance on project monitoring, reporting rules and procedures.

8.1 Project Documentation

Project Operators must provide the following documentation to the Reserve in order to register a forest project.

- Project Submittal form
- KML file
- Project Design Document
- Signed Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form
- Verification Report
- Verification Statement
- Project Implementation Agreement
- Project Operator agreement (if Project Operator is not a Forest Owner)

Project Operators must provide the following documentation each time a Forest Project is verified in order for the Reserve to issue CRTs for quantified GHG reductions.

- Monitoring report
- Calculation worksheet
- Verification Report
- Verification Statement
- Signed Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form (Improved Forest Management projects only)
- Project Implementation Agreement Amendment
- Conservation Easement (if one is employed)

Project submittal forms can be found at http://www.climateactionreserve.org/how/program/documents/.

All reports that reference carbon stocks must be submitted with the oversight of a Professional Forester, for jurisdictions with a Professional Forester law or regulation, or a Certified Forester, managed by the Society of American Foresters (see www.certifiedforester.org) so that professional standards and project quality are maintained. Any Professional Forester or Certified Forester preparing a project in an unfamiliar jurisdiction must consult with a Professional Forester or Certified Forester practicing forestry in that jurisdiction to understand all laws and regulations that govern forest practice within the jurisdiction. The Reserve may evaluate and approve alternative certification credentials if requested, but only for jurisdictions where professional forester laws or regulations do not exist. This requirement does not preclude the project's use of technicians or other unlicensed/uncertified persons working under the supervision of the Professional Forester.

All projects shall submit a KML file depicting the Project Area that matches the maps submitted to depict the Project Area. The project's reported acres shall be calculated in accordance with the requirements in Section 4.1. The Reserve will create a file of all verified forest carbon projects on Google Maps for public dissemination.

8.1.1 Forest Project Design Document

The forest Project Design Document (PDD) is a required document for reporting information about a project. The document is submitted at the initial verification. A PDD template has been prepared by the Reserve and is available on the Reserve's website. The template is arranged to assist in ensuring that all requirements of the FPP are addressed. The template is required to be used by all projects. The template is designed to manage the varying requirements based on project type.

Each project must submit a PDD at the project's first verification. The Project Operator must include a general description of the methodology that will be incorporated by the Project Operator to update their inventory estimates on an annual basis per guidance in Appendix B for the reported carbon pools.

PDDs are intended to serve as the main project document that thoroughly describes how the project meets eligibility requirements, discusses the quantification methodologies utilized to generate project estimates, outlines how the project complies with terms for additionality and describes methods for updating inventory estimates and how permanence will be addressed, including how project reversal risks are calculated. All methodologies used by Project Operators and descriptions in the PDD must be clear in a way that facilitates review by verifiers, Reserve staff, and the public. PDDs must be of professional quality and free of incorrect citations, missing pages, incorrect project references, etc.

8.2 Monitoring Report

Monitoring is the process of regularly collecting and reporting data related to a project's performance. Annual monitoring of Forest Projects is required to ensure up-to-date estimates of project carbon stocks and provide assurance that GHG reductions or removals achieved by a project have not been reversed. Project Operators must conduct monitoring activities and submit monitoring reports according to the schedule and requirements presented in Section 8.3. Monitoring is required for a period of 100 years following the final issuance of CRTs to a project for quantified GHG reductions or removals.

For Forest Projects, monitoring activities consist primarily of updating a project's forest carbon inventory, entering the updated inventory into the Forest Project's Calculation Worksheet, and submitting it to the Reserve at frequencies defined in Section 8.3. CRTs are only issued in years that the project data are verified, as described in Section 9.

A monitoring report must be prepared for each Reporting Period. Monitoring reports must be provided to verification bodies whenever a Forest Project undergoes verification. In addition, monitoring reports must be provided to the Reserve upon the completion of any Reporting Period for which verification will be deferred (e.g., if the Project Operator foregoes a desk-review verification). All monitoring reports are due within 12 months of the end of the Reporting Period. Monitoring reports must include an update of the project's calculation worksheet. The project's calculation worksheet includes:

1. An updated estimate of the current year's carbon stocks in the reported carbon pools. Specific methods used to update the forest inventory must follow the inventory methodology approved at the time the project is registered. Modifications to inventory methodologies must be approved in advance by the Reserve. Any changes in inventory estimates associated with the use of the modified inventory methodology will need to be reconciled with previously verified project inventory estimates and baseline projections. The updated estimate of carbon stocks is determined by:
    a. Including any new forest inventory data obtained during the Reporting Period.
    b. *Applying growth estimates to existing inventory.
    c. Updating inventory estimates for harvest and/or disturbances that have occurred during the Reporting Period.
2. The appropriate confidence deduction for the forest carbon inventory, as determined at the last full site visit verification for the project (following Appendix B). The same confidence deduction must be used in interim years between verification site visits.
3. An estimate of current-year harvest volumes and associated carbon in harvested wood products.
4. Estimated mill efficiency, as determined following the guidance in Appendix B.
5. The baseline carbon stock estimates for all required and optional carbon pools for the current year, as determined following the requirements in Section 6 and approved at the time of the project's registration.
6. An estimate of Secondary Effects, following calculation steps and/or factors provided in Section 6 and approved at the time of the project's registration.
7. The uncertainty discount for Avoided Conversion Projects, as determined following the requirements of Section 6.2 and approved at project registration. (Once a project is registered with the Reserve, the uncertainty discount does not change.)
8. A calculation of total net GHG reductions and removals (or reversals) for the year, following the requirements in Section 6.
9. The project's reversal risk rating, as determined following the requirements in Section 7 and Appendix A. The risk rating is updated during each full site visit verification. Between verification site visits, the project's reversal risk rating does not change.
10. A calculation of the project's Buffer Pool contribution.

In addition to data reported using the project calculation worksheet, the following must be submitted to the Reserve as part of a monitoring report.

For each Reporting Period:

1. A description of how the project meets (or will meet) the definition of Natural Forest Management (refer to Section 3.9.2), including progress on criteria that have not been fully met in previous years.
2. An updated estimate of canopy cover across the Project Area. Estimates may be conducted using recent satellite images from within the last year.

Conditional reporting, as pertinent:

1. An explanation for any decrease over any ten-year consecutive period in the standing live carbon pool.
2. Any changes in the status of the Project Operator including, if applicable per Section 3.9.1, the acquisition of new forest landholdings.
3. If a reversal has occurred during the previous year, the report must provide a written description and explanation of the reversal, whether the Reserve classified the reversal as Avoidable or Unavoidable, and the status of compensation for the reversal.

8.3 Reporting and Verification Cycle

A Forest Project is considered automatically terminated (see Section 3.5) if the Project Operator chooses not to report data and undergo verification at required intervals.

8.3.1 Reporting Period Duration and Cycle

A Reporting Period is a discrete period of time for which a Project Operator quantifies and reports GHG reductions and removals, as well as required project data to the Reserve. The initial Reporting Period may cover any length of time, up to one year. Reporting Periods subsequent to the initial Reporting Period must cover 12 months of project activity.

Reporting Periods must be contiguous, i.e., there must be no gaps in reporting during the crediting period of a Forest Project once the project has begun receiving CRTs.

8.3.2 Verification Cycle

All Forest Projects must be initially verified within 30 months of being submitted to the Reserve. The initial verification of all project types must include the initial Reporting Period, confirm the project's eligibility, and confirm that the project's initial inventory and the baseline have been established in conformance with the FPP. Subsequent verification may include multiple Reporting Periods and is referred to as the "Verification Period." The end date of any Verification Period must correspond to the end date of a Reporting Period.

Verification is required at specific intervals to ensure that ongoing monitoring of forest carbon stocks, inventory confidence, and risk ratings are accurate and up to date. Optional verification is at the Project Operator's discretion and may be conducted between required verifications for crediting (non-aggregated projects), to adjust the project's confidence estimate and/or risk ratings, among other rationale, based on changed management circumstances. Submission of annual monitoring reports to the Reserve is required even if the Project Operator chooses to forego an optional verification. The schedule of required verification is dependent upon the project type and whether the project is aggregated or non-aggregated. Details of verification scheduling requirements are provided in Table 8.1.

Verification must be completed within 12 months of the end of the Reporting Period(s) being verified. For required verifications, failure to complete verification within the 12 month time period will result in account activities being suspended until the verification is complete. The project will terminate if the required verification is not completed within 36 months of the end of the Reporting Period(s) being verified. There is no consequence for failure to complete verification activities within 12 months for optional verifications.

8.3.2.1 Site Visit and Desk Review Verification Schedule

Refer to the table below for minimum required site visit schedules, optional desk reviews, and any exceptions to the minimum requirements by project type.

Table 8.1. Forest Project Verification Schedule

Aggregation	Project Type	Verification Type	Required Timing
All	All Forest Projects	Initial verification of the first Reporting Period (with or without site visit, as detailed below)	Must be completed within 30 months of being submitted to the Reserve
All	All Forest Projects	All verifications (full site visit verifications, and desk reviews)	Must be completed within 12 months of the end of the Reporting Period(s) being verified
All	All Forest Projects	Site Visit	Required any time the Project Operator would like to establish new confidence deductions and/or reversal risk ratings, except when confidence deduction changes as a result of a project joining an aggregate
			Required to be completed within one year of notifying the Reserve of an avoidable reversal, when the threshold in section 7.3.2 is met
			Required to be completed within 2 years of notifying the Reserve of an unavoidable reversal
		Desk Review	Required to be completed within one year of notifying the Reserve of an avoidable reversal, unless the threshold in section 7.3.2 is met
Non-aggregated	All Forest Projects	Site Visit	Required for initial verification
			Required for the verification following the end of every 6th Reporting Period thereafter, unless one of the exceptions below are applicable (for under 4,000 CRTs/year, or no CRTs in a given year)
		Desk Review	Optional, between required site visit years
	Any Forest Project receiving under 4,000 CRTs/year[26]	Site Visit	Required for the verification following the end of every 12th Reporting Period after a site visit verification has taken place, or once 48,000 CRTs have been accumulated across the unverified Reporting Periods.[27] If the Reserve has reason to believe that a project proponent has been reporting artificially low numbers to take advantage of this option, the Reserve will require the project to revert to the 6 year site visit cycle.[28]

[26] The 4,000 CRT/year threshold will be assessed as an average of the reported annual gross CRTs (including buffer pool credits) since the last site visit.

[27] When the 48,000 CRT threshold is met, a site visit will be required after the following reporting period. For example, if the threshold is met during reporting period 7, a site visit will be required following reporting period 8.

[28] "Artificially low numbers" will be assessed based on the verifier's review of quantitative materiality. If the project experiences an avoidable reversal, then it will not be eligible for the 12-year verification cycle and will revert to following the 6-year verification cycle until the completion of the next site visit.

Aggregation	Project Type	Verification Type	Required Timing
		Desk Review	Optional, between required site visit years
	Any Forest Project not seeking CRTs by the time a site visit is required	Desk Review	If a forest project opts not to receive additional CRTs during a normal site visit year and has not experienced a reversal, they must undergo a desk review of the monitoring reports submitted since the last verification. If canopy cover has declined on the project area by more than 5%, then the project must be evaluated for a potential reversal and a site visit may be required as described in Section 7.3.. Reporting periods evaluated as part of this type of desk review are considered to be part of the project crediting period, even though credits are not sought. This type of verification cannot be used in the last year of a project's crediting period.[29]
Aggregated	All Forest Projects	Site Visit	Refer to the Reserve's *Guidelines for Aggregating Forest Projects*
		Desk Review	Refer to the Reserve's *Guidelines for Aggregating Forest Projects*

8.3.3 Issuance and Vintage of CRTs

The Reserve will issue Climate Reserve Tonnes (CRTs) for quantified GHG reductions and removals that have been verified through either site visits, desk reviews, or in an aggregate through the aggregated method of site visits and desk reviews described above. A site visit verification may determine that earlier desk reviews overestimated onsite carbon stocks. A net downward adjustment to carbon stock estimates will be treated as a reversal (see Section 7.1). In this case, the Project Operator must retire CRTs in accordance with the requirements for compensating for a reversal (Section 7.3).

Vintages are assigned to CRTs based on the proportion of days in each calendar year within a reporting period.

8.4 Record Keeping

For purposes of independent verification and historical documentation, Project Operators are required to keep all documents and forms related to the project for a minimum of 100 years after the final issuance of CRTs from the Reserve. This information may be requested by the verification body or the Reserve at any time.

8.5 Transparency

The Reserve requires data transparency for all Forest Projects, including data that displays current carbon stocks, reversals, and verified GHG reductions and removals. For this reason, all non-confidential project data reported to the Reserve will be publicly available on the Reserve's website.

[29] This option is not possible in the project's final year because certain aspects of project quantification (like leakage) are assessed over the 100-year time frame of the project. A verification is required in the final year in order to true-up this quantification and ensure the project has not been over-credited.

9 Verification Guidance

This section provides guidance to Reserve-approved verification bodies for verifying GHG emission reductions associated with a planned set of activities to remove, reduce or prevent CO_2 emissions in the atmosphere by conserving and/or increasing forest carbon stocks.

This section supplements the Reserve's Verification Program Manual,[30] which provides verification bodies with the general requirements for a standardized approach for independent and rigorous verification of GHG emission reductions and removals. The Verification Program Manual outlines the verification process, requirements for conducting verification, conflict of interest and confidentiality provisions, core verification activities, content of the verification report, and dispute resolution processes. In addition, the Verification Program Manual explains the basic verification principles of ISO 14064-3:2006 which must be adhered to by the verification body.

Forest Project verification bodies must read and be familiar with the following International Organization for Standardization (ISO) and Reserve documents and reporting tools:

1. Forest Project Protocol (this document)
2. Reserve Program Manual
3. Reserve Verification Program Manual
4. Reserve software
5. ISO 14064-3:2006 Principles and Requirements for Verifying GHG Inventories and Projects

Only Reserve-approved Forest Project verification bodies are eligible to verify Forest Project reports. To become a recognized Forest Project verifier, verification bodies must become accredited under ISO 14065. Information on the accreditation process can be found on the Reserve website at http://www.climateactionreserve.org/how/verification/how-to-become-a-verifier/.

The verification of reports that reference carbon stocks must be conducted with the oversight of a Professional Forester, for jurisdictions with a Professional Forester law or regulation, or a Certified Forester,[31] managed by the Society of American Foresters, so that professional standards and project quality are maintained. Any Professional Forester or Certified Forester verifying a project in an unfamiliar jurisdiction must consult with a Professional Forester or Certified Forester practicing forestry in that jurisdiction to understand all laws and regulations that govern forest practice within the jurisdiction. The Reserve may evaluate and approve alternative certification credentials if requested, but only for jurisdictions where professional forester laws or regulations do not exist.

9.1 Standard of Verification

The Reserve's standard of verification for Forest Projects is the Forest Project Protocol (FPP), the Reserve Program Manual, and the Reserve Verification Program Manual. To verify a land owner's initial Forest Project Design Document and annual monitoring reports, verification

[30] Found on the Reserve website at http://www.climateactionreserve.org/how/program/program-manual/.
[31] See www.certifiedforester.org.

bodies apply the verification guidance in the Reserve's Verification Program Manual and this section of the FPP to the requirements and guidance described in Sections 2 through 8 of the FPP.

This section of the protocol provides requirements and guidance for the verification of projects associated with the two Forest Project types defined in Section 2. Both project types involve planned activities that result in conserving and/or increasing forest carbon stocks. This section describes the core verification activities and criteria for both Forest Project types that are necessary for a verification body to provide a reasonable level of assurance that the GHG removals or reductions quantified and reported by Project Operators are materially correct.

Verification bodies will use the criteria in this section to determine if there exists reasonable assurance that the data submitted on behalf of the Project Operator to the Reserve addresses each requirement in the FPP, Sections 2 through 8. Project reporting is deemed accurate and correct if the Project Operator is in compliance with the Section 2 through 8.

Further information about the Reserve's principles of verification, levels of assurance, and materiality thresholds can be found in the Reserve's Verification Program Manual at http://www.climateactionreserve.org/how/program/program-manual/.

9.2 Emission Sources, Sinks, and Reservoirs

For all verification activities, verification bodies review a project's reported sources, sinks, and reservoirs to ensure that all are identified properly and to confirm their completeness. Table 5.1 and Table 5.2 in Section 5 provide comprehensive lists of all GHG sources, sinks, and reservoirs that must be included in the quantification and reporting of GHG reductions and removals for the two Forest Project types.

It is the Project Operator's responsibility to ensure that verifications are conducted according to the minimum required schedule specified in Section 8.3.2. A Verification Report, List of Findings, and Verification Statement must be submitted within twelve months of the end of any verification period. Site visit verification requirements are described in Section 9.3.2. Desk review verification requirements are described in Section 9.3.3.

9.3 Project Verification Activities

Required verification activities for Forest Projects will depend on whether the verification body is conducting an initial verification for registration on the Reserve, a minimum required verification involving a site visit, or an optional annual verification involving a desk review. Both the initial verification and ongoing verifications must include review of the criteria for Natural Forest Management, inventory of onsite carbon stocks, assessment of carbon in harvested wood products, and review of reversal risk ratings. The following sections contain guidance for all of these verification activities.

9.3.1 Initial Verification

Initial verification includes verification that the Forest Project has met the FPP criteria and requirements for eligibility, Project Area definition, modeling baseline onsite carbon stocks, and calculating baseline carbon in harvested wood products. The initial verification must include a site visit. The verification body must assess and ensure the completeness and accuracy of all required reporting elements for the Forest Project Design Document (Section 8.1.1). Initial verification items are presented in Table 9.1A through 9.1H.

At a Forest Project's initial verification, these items must be verified in addition to all the items required for a standard site visit verification, as detailed in Section 9.3.2.

9.3.1.1 Initial Eligibility

Verification bodies are required to affirm the project's eligibility according to the rules in this protocol. Tables 9.1A and 9.1B provide the initial verification items concerning eligibility for the different Forest Project types and include references to sections of this protocol where requirements are further specified.

Table 9.1A. Initial Eligibility Verification Items – Improved Forest Management Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Project Definition	a. Evidence is provided indicating the canopy cover exceeds 10%. b. No evidence exists for use of broadcast fertilization.	2.1.1	Yes (for 1.b)
2. Legal Requirement Test	Proof that a signed Attestation of Voluntary Implementation form is on file with the Reserve.	3.3.1.1	No
3. Start Date	Identification of a discrete, verifiable action that delineates a change in practice relative to the project's baseline.	3.2	No
4. Project Implementation Agreement	Proof that a Project Implementation Agreement (PIA) between the Project Operator and the Reserve has been signed and recorded in the county of interest.	3.6	No
5. Project Location	a. Project is located in the United States of America. b. Project is on private land, or c. If non-federal public lands, provide documentation showing approval by the government agency or agencies responsible, or d. If tribal land, provide documentation that demonstrates that the land within the Project Area is owned by a tribe or private entities.	3.1	No

Table 9.1B. Initial Eligibility Verification Items – Avoided Conversion Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Project Definition	a. Proof that the project is/was on private land prior to project initiation. b. Proof that a conservation easement was recorded, or the land was transferred to public ownership. c. Demonstration that conversion out of forest is a significant risk (following the requirements of Section 6.2.1 – see also Table 9.1H). d. No evidence exists for use of broadcast fertilization.	2.1.2, 6.2.1	Yes (for 1.c and 1.d)
2. Legal Requirement Test	a. Proof that a signed Attestation of Voluntary Implementation form is on file with the Reserve. b. Documentation has been provided that demonstrates that the type of land use conversion anticipated by the project is legally permissible; documentation must fall into at least one of the three categories specified in Section 3.3.1.2.	3.3.1.2	No
3. Performance Test	Copy of real estate appraisal(s) for the Project Area indicating conformance to criteria in Section 3.3.2.2.	3.3.2.2	No
4. Start Date	Identification of date on which a conservation easement that dedicates the Project Area to continuous forest cover was recorded or the Project Area was transferred to public ownership.	3.2, 3.7	No
5. Project Implementation Agreement	Proof that a Project Implementation Agreement (PIA) between the Project Operator and the Reserve has been signed and recorded in the county of interest.	3.6	No
6. Project Location	a. Project is located in the United States of America. b. Project is on private land, or c. If non-federal public lands, provide documentation showing approval by the government agency or agencies responsible, or d. If tribal land, provide documentation that demonstrates that the land within the Project Area is owned by a tribe or private entities.	3.1	No

9.3.1.2 Project Area Definition

Verification bodies are required to review the geographic boundaries defining the Project Area and their compliance with the requirements outlined in Section 4 of this protocol. These items are verified only at the project's initiation.

Table 9.1C. Project Area Definition Verification Items

Project Type	Verification Items	Section of FPP	Apply Professional Judgment?
1. All	Proof that a description, shapefile, and maps of the geographic boundaries defining the Project Area are on file at the Reserve.	4, 8.1	No
2. Avoided Conversion	Project Area has been defined following the guidance in Section 4, Table 4.1 for the appropriate conversion type.	4	No

9.3.1.3 Baseline Onsite Carbon Stocks

Verification bodies are required to confirm that the Project Operator has developed a baseline characterization for onsite carbon stocks according to the requirements in this protocol. These items are verified only at the project's initiation.

Table 9.1D. Baseline Estimation Verification Items – Improved Forest Management Projects – Private Lands

Verification Items		Section of FPP	Apply Professional Judgment?
1. Inventory of Onsite Carbon Stocks	An inventory of the Project Area's carbon stocks in required and optional pools has been conducted in accordance with the requirements of the FPP (see Section 9.3.5 for further verification guidance).	6.1.2, Appendix B	Yes
2. Compare Initial Aboveground Standing Live Carbon Stocks with Common Practice	a. Initial aboveground standing live and standing dead carbon stocks have been estimated correctly following the requirements of the FPP. b. The baseline analysis utilizes the correct value for Common Practice c. The project has undertaken the correct baseline analysis, according to whether initial carbon stocks are above or below Common Practice.	6.1.1, 6.1.2, Appendix B	No
3. Estimating Baseline Carbon Stocks	a. The project is qualified to use the conservative default approach, and has correctly implemented the baseline in accordance with the guidance in Section 6.1.1. b. Where using the modeled approach, a 100-year forest management simulation of standing live and dead carbon stocks has been conducted in accordance with the requirements and guidance in Section 6.1.2 and Appendix B (see Section 9.3.6 for further verification guidance).	6.1.1, 6.1.2, Appendix B	Yes
4. Description of Forest Project Activities	A description has been provided of the management activities that will lead to increased carbon stocks in the Project Area compared to the baseline.	2	No

Table 9.1E. Baseline Estimation Verification Items – Improved Forest Management Projects – Public Lands

Verification Items		Section of FPP	Apply Professional Judgment?
1. Initial Forest Carbon Stock Inventory	An inventory of the Project Area's carbon stocks in required and optional pools has been conducted in accordance with the requirements of the FPP (see Section 9.3.5 for further verification guidance).	6.1.3, Appendix B	Yes
2. Estimating Baseline Carbon Stocks	A COLE report and analysis has been conducted per the requirements in Section 6.1.3 and the Appendix B.	6.1.3, Appendix B	Yes
3. Description of Forest Project Activities	A description has been provided of the management activities that will lead to increased carbon stocks in the Project Area compared to the baseline.	2	No

Table 9.1F. Baseline Modeling Verification Items – Avoided Conversion Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Initial Forest Carbon Stock Inventory	An inventory of the Project Area's carbon stocks in required and optional pools has been conducted in accordance with the requirements of the FPP (see Section 9.3.5 for further verification guidance).	6.2.1, Appendix B	Yes
2. Baseline Carbon Stock Modeling	a. An alternative highest-value land use for the Project Area has been clearly identified by the required appraisal(s). b. The rate of conversion and removal of onsite forest carbon stocks has been appropriately estimated in accordance with the requirements of Section 6.2.1. c. A 100-year forest management simulation of standing live carbon stocks has been conducted per the requirements in Section 6.2.1, and Appendix B (see Section 9.3.6 for further verification guidance).	3.3.2.2, 6.2.1	Yes
3. Discount for the Uncertainty of Conversion Probability	The Avoided Conversion Discount factor has been correctly calculated per Equation 6.6 in Section 6.2.1.	3.3.2.2, 6.2.1	No
4. Description of Forest Project Activities	A description has been provided of the management activities that will lead to increased carbon stocks in the Project Area compared to the baseline.	2	No

9.3.1.4 Calculating Baseline Carbon in Harvested Wood Products

Verification bodies are required to confirm that the Project Operator has developed a baseline characterization for carbon in harvested wood products according to the requirements of this protocol and requirements and guidance in Section 6.1.1, Section 6.1.2, Section 6.1.3, or Section 6.2.2, and Appendix B.

Table 9.1G. Baseline Carbon in Wood Products Verification Items – Improved Forest Management Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Baseline Harvest Volume	The average volume of harvesting in the baseline has been derived from the growth and harvesting regime used to develop the baseline for onsite carbon stocks, following the requirements and guidance in Section 6.1.2, or through the appropriate default approach in Section 6.1.1 or Section 6.1.3, and Appendix B (see Section 9.3.7 for further verification guidance).	6.1.1, 6.1.2, 6.1.3, Appendix B	No
2. Long-Term Storage in Wood Products	The average amount of carbon expected to be transferred to wood products each year and stored over the long-term (100 years) has been calculated following the requirements and guidance in Appendix B (see Section 9.3.7 for further verification guidance).	Appendix B	No

Table 9.1H. Baseline Carbon in Wood Products Verification Items – Avoided Conversion Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Baseline Harvest Volume	The volume of harvesting in each year of the baseline over 100 years has been derived from the harvesting regime assumed for the baseline for onsite carbon stocks, following the requirements and guidance in Section 6.2.2, and Appendix B (see Section 9.3.7 for further verification guidance).	6.2.2, Appendix B	No
2. Long-Term Storage in Wood Products	The amount of harvested wood that would be delivered to mills in each year has been determined, and the amount of carbon expected to be transferred to wood products each year and stored over the long-term (100 years) has been calculated following the requirements and guidance of Section 6.2.2 and Appendix B (see Section 9.3.7 for further verification guidance).	6.2.2, Appendix B	No

9.3.2 Site Visit Verification

Site visit verification involves review of the Forest Project's carbon stock inventory estimates, relevant attestations, soil carbon emissions associated with management activities, risk of reversal ratings, and compliance with Natural Forest Management criteria. After a Forest Project's initial verification, subsequent site visits must assess and ensure accuracy in measurement and monitoring techniques and onsite record keeping practices.

Table 9.2. Site Visit Verification Items

Verification Items		Section of FPP	Apply Professional Judgment?
1. Attestation of Title	Proof that a signed Attestation of Title is on file at the Reserve for the dates of the verification period. In addition to reviewing this form, the verification body must conduct a review to confirm ownership and claims to GHG reductions/removals that have occurred over the verification period.	3.7	Yes
2. Attestation of Regulatory Compliance	Proof that a signed Attestation of Regulatory Compliance form is on file with the Reserve for the reporting period. In addition to reviewing this form, the verification body must perform a risk-based assessment to confirm the statements made by the Project Operator in the Attestation of Regulatory Compliance form.	3.8	Yes
3. Attestation of Voluntary Implementation	Proof that a signed Attestation of Voluntary Implementation form is on file with the Reserve for the reporting period. Required for every reporting period for Improved Forest Management projects, and for initial reporting periods only for Avoided Conversion projects.	3.3	No
4. Sustainable Harvesting Practices	a. Commercial Rotational Harvesting has not commenced within the Project Area, or b. At the time Commercial Rotational Harvesting is initiated within the Project Area, the Project Operator meets sustainable harvest practices on all of its landholdings, as described in Section 3.9.1.	3.9.1	No
5. Change in Project Operator Landholdings	If the Project Operator has acquired additional forestlands outside of the Project Area, the Project Operator must incorporate the newly acquired land in their demonstration of sustainable long-term harvesting practices within 5 years of the acquisition.	3.9.1	No
6. Maintenance of Standing Live Carbon Pool	No decrease has occurred in the Project Area's standing live carbon stocks over any ten-year consecutive period not accounted for by allowable exceptions.	3.9.3	No
7. Natural Forest Management	Natural Forest Management eligibility criteria in Section 3.9.2 have been and continue to be met (see Section 9.3.4 for further verification guidance).	3.9.2	Yes
8. Estimates of Actual Onsite Carbon Stocks	An inventory of the Project Area's carbon stocks in required and optional pools has been conducted in accordance with the requirements in Section 6 and the requirements and guidance in Appendix B (see Section 9.3.5 for further verification guidance)	6, Appendix B	Yes
9. Estimates of Actual Carbon	The amount of harvested wood that has been delivered to mills over the reporting period has been determined correctly, and the amount of	6, Appendix B	No

Verification Items		Section of FPP	Apply Professional Judgment?
in Harvested Wood Products	carbon expected to be transferred to wood products and stored over the long-term (100 years) has been calculated correctly, per the requirements in Section 6 and Appendix B (see Section 9.3.7 for further verification guidance).		
10. Quantification of Primary Effect	Calculations for the Primary Effect are complete and accurate for both onsite carbon stocks and harvested wood products.	6	No
11. Quantification of Secondary Effects	Calculations for quantifying Secondary Effects are complete and accurate.	6.1.6, 6.2.5	No
12. Reversal Determination	If a reversal has occurred, the type of reversal (avoidable or unavoidable) has been properly identified.	7.3	Yes
13. Reversal Risk Rating	Project's risk rating has been calculated following the requirements of Appendix A	Appendix A	No

9.3.3 Desk Review Verification

For reporting periods in between required site visits, project verification activities may consist of a desk review. During a desk review, the verification body will review the data in annual monitoring reports to check calculations and information for reasonability, accuracy, and completeness.

Table 9.3. Desk Review Verification Items

Verification Items		Section of FPP	Apply Professional Judgment?
1. Attestation of Title	Proof that a signed Attestation of Title is on file at the Reserve for the dates of the verification period. In addition to reviewing this form, the verification body must conduct a review to confirm ownership and claims to GHG reductions/removals that have occurred over the verification period.	3.7	Yes
2. Attestation of Regulatory Compliance	Proof that a signed Attestation of Regulatory Compliance form is on file with the Reserve for the reporting period. In addition to reviewing this form, the verification body must perform a risk-based assessment to confirm the statements made by the Project Operator in the Attestation of Regulatory Compliance form.	3.8	Yes

Verification Items		Section of FPP	Apply Professional Judgment?
3. Attestation of Voluntary Implementation	Proof that a signed Attestation of Voluntary Implementation form is on file with the Reserve for the reporting period. Required for every reporting period for Improved Forest Management projects, and for initial reporting periods only for Avoided Conversion projects.	3.3	No
4. Maintenance of Standing Live Carbon Pool	No decrease has occurred in the Project Area's standing live carbon stocks over any ten-year consecutive period not accounted for by allowable exceptions.	3.9.3	No
5. Estimates of Actual Onsite Carbon Stocks	Reported onsite carbon stocks are within expected bounds given reported harvest, growth, and disturbance effects since the prior reporting period.	6, Appendix B	Yes
6. Estimates of Actual Carbon in Harvested Wood Products	The reported amount of wood that has been delivered to mills over the reporting period is consistent with reported harvest levels, and the amount of carbon expected to be transferred to wood products and stored over the long-term (100 years) has been calculated correctly, per the requirements in Section 6 and Appendix B (see Section 9.3.7 for further verification guidance).	6, Appendix B	Yes
7. Quantification of Primary Effect	Calculations for the Primary Effect are complete and accurate for both onsite carbon stocks and harvested wood products.	6	No
8. Quantification of Secondary Effects	Calculations for quantifying Secondary Effects are complete and accurate.	6.1.6, 6.2.5	No
9. Reversal Determination	If a reversal has occurred, the type of reversal (avoidable or unavoidable) has been properly identified.	7.3	Yes
10. Reversal Risk Rating	Reversal risk rating is the same used since the previous site visit verification.	Appendix A	No

9.3.4 Natural Forest Management

All Forest Projects must promote and maintain a diversity of native species and utilize management practices that promote and maintain native forests comprised of multiple ages and mixed native species at multiple landscape scales (Natural Forest Management). At a Forest Project's first site visit verification and at all subsequent site visit verifications, the verification body must evaluate the project against the Natural Forest Management criteria described in Section 3.9.2, referencing the most current Assessment Area Data File available on the Forest Project Protocol webpage. Forest project carbon stock inventories (requirements for which are contained in Appendix B) should be used as the basis of these assessments where applicable. Forest projects that do not initially meet Natural Forest Management criteria but can

demonstrate progress towards meeting these criteria within the required timelines are eligible to register and maintain that registration with the Reserve.

Table 9.4. Natural Forest Management Verification Items

Verification Items		Apply Professional Judgment?
1. Native Species	Completed inventory demonstrates that project consists of at least 95% native species. Must demonstrate continuous progress toward goal and criterion must be met within 50 years.	No
2. Composition of Native Species	Completed inventory demonstrates distribution of average basal area of standing live tree species meets composition of native species goal. Project is not eligible unless it is demonstrated that management activities will enable this goal to be achieved over the project life or an exception has been made through a letter from the State Forester as described in Section 3.9.	No
3. Sustainable Harvesting Practices	a. Documentation showing that the forest, including entity lands outside Project Area, is currently under one of the following: i. Third party certification under the Forest Stewardship Council or Sustainable Forestry Initiative/ Tree Farm System, or ii. A renewable long-term management plan sanctioned and monitored by a state or federal agency within a Reserve-approved Assessment Areas, or iii. Silvicultural practices that maintain canopy retention averaging at least 40% across the entire forestland owned by the Project Operator in the same Assessment Areas covered by the Project Area, as measured on any 20 acres within the Project Operator's landholdings found in any of these Assessment Areas, including land within and outside of the Project Area (areas impacted by Significant Disturbance may be excluded from this test), or iv. Possessing a deeded conservation easement(s) that contain terms that ensure growth equals or exceeds harvest over time. Verifiers should make a reasonable attempt to contact the steward of the conservation easement to confirm compliance.	No
4. Forest Structure	a. If the project employs even-aged management, ensure the retention guidelines have been followed. b. Completed inventory demonstrates the project maintains, or makes progress toward maintaining, no more than 40% of forested acres in ages less than 20 years (on a watershed scale up to 10,000 acres, or the Project Area, whichever is smaller). Project must show continuous progress and this criterion must be met within 25 years.	No
5. Structural Elements (Lying and Standing Dead Wood)	Completed inventory work demonstrates that lying and standing dead wood is retained in sufficient quantities and for sufficient duration depending on whether portions of the Project Area have undergone salvage harvesting.	Yes

9.3.5 Verifying Carbon Inventories

Verification bodies are required to verify carbon stock inventory estimates of all sampled carbon pools within the Project Area. Inventories of carbon stocks are used to determine the project baseline and to quantify GHG reductions and removals against the project baseline over time.

Verification of carbon inventories consists of ensuring the Project Operator's sampling methodology conforms to requirements listed in the protocol and that the project's inventory sample plots are within specified tolerances when compared to the verifier's sample plots. Verification is effectively an audit to infer that the inventory estimate is sound. Verification of the project's onsite stocks must occur at each site verification and focus on ensuring that the project's inventory methodology is technically sound and that the methodology has been correctly implemented.

The project must meet the inventory standards in Table 9.5 prior to the verification body initiating field sampling activities. The verifier will re-measure existing monumented sample plots or install sample plots, consistent with the objectives of a random, risk-based, and efficient approach. In doing so, the verifier may weigh the probability of selecting strata and plots based on various criteria – including carbon stocking, access difficulty, and vegetation heterogeneity. Verifiers may choose to sample project plots within a given stratum with a cluster design. The selection of a stratum may use probability proportional to carbon stocks or probability proportional to the risk of errors (as hypothesized by the verifier).

9.3.5.1 Sequential Sampling for Verification

As a policy to ensure a trend of agreement with sampled data is sustained between the verifier and Project Operator, this protocol requires a sequential sampling method for verification of project estimates. Sequential sampling is intended to provide an efficient sampling method for verifiers to determine if randomly selected project measurements are within specified tolerance bounds established by the protocol.

Verification using the sequential sampling methodology requires the verification body to sequentially sample successive plots. Sequential approaches have stopping rules rather than fixed sample sizes. Verification is successful after a minimum number of successive plots in a sequence indicate agreement. Where the stopping rules indicate the potential presence of a bias, additional verification plots may be collected after that time if it is felt that random chance may have caused the test to fail and a convergence towards agreement is expected with additional verification samples. The results of any additional verification plot may also be inconclusive and require additional verification plots for a determination to be made. For effective application of the sequential statistics in the field, the determination of when the stopping rule is met is made as soon as is convenient for the verification team and will include the full set of plots measured in that timeframe.

Worksheets are available on the Reserve's website for use by verifiers to assist in verifying sampled data. The verifier will review the descriptive statistics of the carbon stocks independently for each pool or combination of pools that is being reported for crediting (applicable pool) as shown below:

- Standing live and dead trees
- Soil

To increase efficiency in the verification process, three nested levels of sequential sampling are processed in the sequential sampling worksheets, based on a single sampling exercise performed by the verifier. All tests are performed with the same randomly selected plots and can only be completed by analysis of the plots in the sequential order they were randomly selected. However, inventory data is only considered successfully verified when the stopping rules for the CO_2e/acre test have been met. Passing the diameter and height tests only improves the overall

efficiency of the verification effort. The data identified below used for each test are input into the appropriate sequential sampling tool.

- CO_2e/acre: The testing of inventory data can only be satisfied when the CO_2e/acre comparison between the verifier and Forest Owner is completed. This test is conducted on a plot by plot basis using estimates of CO_2e/acre. The verifier's estimates of CO_2e/acre are derived by measurements of diameter and height (measured by verifier or using Forest Owner's data, as described below), species determinations, defect and decay determinations, and a determination of the appropriate trees to be included in the sample ("in" or "out" trees).
- Diameter Test (paired sequential sampling only): A comparison of diameter data between the verifier and the Forest Owner is conducted on a tree by tree basis until sequential sampling stopping rules have been achieved, indicating that the verifier and Forest Owner measurements of diameter are aligned within acceptable tolerance levels. If the stopping rule for diameter is met before the sequential sampling exercise has ended for CO_2e/acre, verifiers may stop taking their own diameter measurements and may instead use the diameter data provided for each tree from the Forest Owner's database for any additional data inputs needed for the CO_2e/acre comparison. If this happens, the focus of the sampling exercise from that point on will be measuring height (if applicable, see below), making species determinations, defect and decay determinations, and "in" or "out" tree assessments.
- Height Test (paired sequential sampling only): Like the diameter test, a comparison of height data is performed between the verifier and the Forest Owner until sequential sampling stopping rules have been achieved, indicating that the verifier and Forest Owner measurements of height are aligned within acceptable tolerance levels. If the stopping rule for height is met before the sequential sampling exercise has ended for CO_2e/acre, verifiers may stop taking their own height measurements and may instead use the height data provided for each tree from the Forest Owner's database for any additional data inputs needed for the CO_2e/acre comparison. If this happens, the focus of the sampling exercise from that point on will be measuring diameter (if applicable, see above), making species determinations, defect and decay determinations, and "in" or "out" tree assessments.

Separate worksheets have been developed to assess both monumented (paired) and non-monumented (unpaired) plots as well as for DBH, height, and CO_2e/acre. Worksheets are found on the Forest Project Protocol webpage.

The Reserve has established a ten percent allowance as an acceptable level of agreement between the verifier and the Project Operator, without adjusting the project estimates for uncertainty.

9.3.5.2 Inventory Estimates

The items in Table 9.5 are evaluations that should be made before the verifier goes to the field and analyzes the plots. If a project opts to utilize the Reserve's Standardized Inventory Methodology, the methodology need not be assessed beyond correct implementation.

Table 9.5. Inventory Methodology Verification Items

Verification/Evaluation Standards	
1.a	Inventory methodology describes the methodology for plot location in the field. The plot locations are either random or systematic with a random initial point.
1.b	If inventory methodology describes a stratification design: The stratification methodology, including rules for stratification, is clearly defined. The stratification design is relevant for the sampling of biomass. In particular, the stratification design applies to all tree species without a bias for commercial tree species. Verifier shall randomly select 10% of the vegetation units, or strata polygons, by area, or 500 acres (whichever is least) to evaluate that the vegetation (or stratum) label assigned to the polygon is consistent with the stratification rules documented in the inventory methodology. The selection shall be made from a database or spreadsheet list of all vegetation (stratum) polygons within the project that have not experienced a harvest or disturbance that affects carbon stocks by more than 10%, using verifier judgment, within the past 10 years. Evaluation of post-harvest polygons and plots is described in 1.c. Evaluation for consistency shall be conducted through comparison with aerial photos or other remotely sensed data, and/or field observation. During evaluation, a verifier must use professional judgment to determine if a polygon is consistent or inconsistent with the stratification rules. Inconsistent means the existing vegetation (stratum) label is grossly incorrect to an extent that would substantially alter the associated carbon stocks. If more than 10% of the polygons evaluated are determined to be inconsistent with the stratification rules documented in the inventory methodology, the verification shall expand the assessment to an additional 10% of the vegetation units (stratum polygons), or an additional 500 acres (whichever is least) and expand the analysis, or determine that the project has failed to meet the standard.
1.c	Inventory methodology states how the inventory is updated on an annual basis to reflect growth, harvest, and other disturbances. An event is deemed to be a disturbance, whether natural or the result of human activities, if the event results in an estimated loss of more than 10% of the pre-disturbance carbon stocks in the applicable carbon pools. The methodology includes a process to: ▪ Update the inventory for harvest and other disturbances. The immediate updating of an inventory for disturbances will require that a tree list is assigned to the area disturbed, rather than developing a tree list from field measurements, to represent the area disturbed. This may occur by assigning a vegetation label (stratifying) and compiling the inventory so that the area disturbed obtains a tree list representative of the disturbed condition. For stratified inventories, this may be a solution that lasts many years until the forest vegetation is re-stratified due to changes from forest growth. Immediately updating an inventory may also occur by assigning a 'best-fit' tree list that represents the stand conditions to the plots that were affected by disturbance. This solution is a shorter term solution since the plots used to estimate the inventory have been affected. During all site visit verifications (following the initial site visit verification in cases where the project start date is the same year as the initial site visit verification), the Project Operator must provide a map(s) that displays areas where disturbance has occurred. For stratified inventories, a pre-disturbance map must display the vegetation stratum prior to the disturbance and a post-disturbance map must display the vegetation stratum following the disturbance. For non-stratified inventories, the disturbance map must display the underlying plots, if any, affected by the disturbance. For stratified inventories, a summary tree list associated with the updated vegetation strata shall be provided. For non-stratified inventories, tree lists shall be provided for each plot affected by disturbance. During site verification, verifiers shall randomly select a minimum of 10% of the vegetation polygons (strata polygons) or plots updated for disturbance and determine if the assigned tree lists do not obviously overestimate the carbon associated with the forest structure remaining after the disturbance. Where plots are updated through assignment of a tree list (instead of assigning a vegetation stratum) following the disturbance, the verifier shall ensure all plots have been updated and the updated tree list is consistent with

	the forest structure remaining after disturbance. For non-stratified inventories, it is not acceptable for a Project Operator to simply remove disturbed plots from the inventory. The plots must be assigned a tree list to estimate the post-disturbance condition. It is acceptable to remove plots from an inventory that is strata-based upon disturbance that affects the plots. Tree lists resulting from stratification or assignment are determined to be inconsistent if the tree list would result in carbon stocks substantially above what in the verifier's professional judgment would associate with the post-disturbance condition. The determination for consistency can be made through an office review by comparing the assigned tree lists with the disturbance events. A verifier can choose to enhance their review for consistency by visiting disturbed sites in the field. To minimize the risk of inaccuracies to the inventory, no more than 10% of the plots used to characterize the project's inventory can be developed from estimated tree lists without increased scrutiny from verification. The plots assigned an estimated tree list must be appropriately coded in the inventory database so that they can be queried and isolated. Plots assigned with an estimated tree list are not to be used in sequential sampling efforts unless the number of plots with estimated tree lists exceeds 10%, in which case all plots, measured or estimated, must be available for random selection for sequential sampling during verification. ▪ Update the inventory for growth using and approved growth model or a stand table projection, as described in Appendix B. The inventory being verified is determined to be current using the update methodology.
1.d	The inventory methodology has been implemented in a consistent manner since the project's inception. If changes have been made to the inventory methodology, such changes have been discussed and approved in writing by the Reserve.
1.e	The inventory methodology describes the volume and biomass equations used to compute the project's carbon stocks and these equations are consistent with those required by the protocol. Appropriate use of biomass equations is demonstrated.

Each applicable pool/combination of pools must meet the minimum precision threshold of +/- 20 percent at the 90 percent confidence interval. Project Operators can improve the precision of their estimates through additional inventory effort but can only include it in their reporting after the confidence estimate has been verified. Projects must include the uncertainty adjustment associated with their most recent verification effort.

Use of the Standardized Inventory Methodology (available on the Reserve's Forest Project Protocol webpage) will be considered to automatically meet the evaluation standards in Table 9.5 and does not need to be verified beyond ensuring proper implementation. The Reserve has also developed the Climate Action Reserve Inventory Tool (CARIT), an inventory management computer application that Project Operators may also optionally use to manage and update their forest inventories. The use of the Standardized Inventory Methodology does not obligate a Project Operator to use CARIT, nor does the use of CARIT obligate a Project Operator to use the Standardized Inventory Methodology. However, CARIT will only function properly if certain inventory standards are followed. Refer to Appendix B for more information.

9.3.5.3 Measurement Specifics for Verifiers

Verifiers must use the highest standard to conduct measurements during field measurements. Measurements utilized by verifiers during field inspections shall be consistent with the tolerance standards for measurements identified in Appendix B, with the following exceptions:

1. Verifiers shall measure the heights of all trees according to the height measurement used for the species-specific biomass equation on the Reserve's Forest Project Protocol webpage.

2. The use of regressions to estimate heights is allowable for Forest Operators; verifiers should measure each height for comparisons with Forest Operator's estimates.
3. Tools and methods used for distance measurements for plot boundaries should be accurate within 1"/30'.
4. Tools and methods used for distance measurements for height measurements must be able to obtain an accuracy of 6"/100'.
5. Rules for determining 'in'/'out' trees:
    a. All borderline trees should be measured to determine status as an 'in' or 'out' tree.
    b. Verifiers may encounter trees that are 'in' that were not measured by the Project Operator. The cause of the omission(s) may be that the trees were determined to be too small to be included, per sampling methodology criteria, at the time of the Project Operator measurement. Per Appendix B, inventory estimates developed by the Project Operator must include all trees 5 inches DBH and larger.
    c. Additionally, Appendix B permits Project Operators to develop an inventory methodology with varying plot areas that are expanded on a per acre basis depending on the size of the plots and with varying DBH requirements for which trees are included in each plot. In such cases, trees that were determined to be too small to be included in a larger plot by the Project Owner, may have grown and now exceed the minimum threshold for inclusion in the larger plot.
    d. To account for this limited growth, the verifier shall not include trees in the verifier measurements (for sequential sampling purposes) if the tree was omitted by the Forest Owner and the tree diameters, at time of verification audit, are less than 7 inches DBH. Similarly, trees that were included by the Forest Owner in a plot with a certain expansion factor and, at the time of verifier audit, have not exceeded the threshold for being switched to a plot with a different expansion factor by more than 10%, shall continue to be entered in the plot determined by the Project Operator, such that the expansion values are consistent for the Project Operator and the verifier.
        i. This applies a reasonable cushion to Project Operators who apply the sampling methodology correctly, but through no fault of their own would otherwise be penalized due to forest growth changing measurement parameters. It should be noted that the cushion is minimal and will not relieve Project Operators from growth over long periods of time that would exceed these allowances. Hence, Project Operators need to base the re-measurement of the plots on an adequate timeframe to avoid verification problems with their inventory data.
        ii. Any trees that do not meet the criteria of the standards listed above shall be included as part of the verifier's plot estimate for purposes of sequential sampling.
6. Verifiers shall insert their own determination of species for each tree included in the verifier's inventory.
7. For defect and decay, verifiers may first consider the inputs of the Forest Owner and determine whether or not they were reasonable. If considered reasonable, the verifier may insert the same classification as the Forest Owner for each tree included in the verifier's inventory. If, however, not considered reasonable, or not recorded by the Forest Owner, the verifier shall insert their own determination.

9.3.5.4 Verifying a Stratified Inventory

If the Project Operator's inventory is based on a stratified design, verification shall be based on the measurement error that can be assessed at the stratum level, using the sequential sampling tools developed by the Reserve. Individual plots within the strata selected for assessment shall be selected randomly. The verifier shall perform independent assessments on a minimum of three strata, unless the stratification design has less than three strata, in which case the assessment is conducted on two strata. Verifiers shall select the strata used to perform the assessment based on their own professional judgement of where the risks of measurement error are likely to have the biggest effect on the overall inventory estimate. This may be based on criteria related to:

- Carbon stocking levels
- Area of a particular stratum relative to other strata
- Strata that may be found in difficult to access areas due to remoteness or terrain which could lead to a reduced effort by forest inventory personnel

9.3.5.5 Verifying a Non-Stratified Inventory

If the project is not stratified for each applicable pool, the verifier shall select the plots randomly (if plot center can be located) or allocate the plots systematically or in clusters for efficiency. Plots may be measured and assessed one at a time or in reasonable batches that correspond to logistical realities of fieldwork.

9.3.5.6 Verification Within a Strata

Plots must be independently selected using a random or systematic design.

Table 9.6. Number of Passing Plots in Sequence, as a Function of Project Size

Test	Number of Strata Verified		Project Acres			
			<100 – 500	501 - 5,000	5,001 – 10,000	>10,000
Paired/Unpaired	3		3	4	5	6
	2		4	6	8	10
	1		8	10	12	12

The project passes sequential sampling when the minimum number of passing plots in sequence is achieved (as identified in Table 9.6), or the first passing plot after a minimum of 12 plots (paired) or 30 plots (unpaired) have been measured – whichever is achieved first. There are two possible statistical procedures that can be applied to the stratum-level verifications. A paired test can be applied when plot locations can be found and it is statistically appropriate to use a paired test (i.e., plot measurements can be replicated). An unpaired test can be applied when plots cannot be relocated. The range of acceptable error (***δ*, delta**) is fixed at ten percent for both tests.

Paired Plots

The statistical test is based on a comparison of the verifier's measurements of plots within a selected stratum, calculated as CO_2e compared to the Project Operator's measurements of plots, which may include any adjustments for growth.

Use ***α*=0.05** and ***β*=0.20** to control for error.

The null hypothesis (H_0) is that the verification and project plots are equal.

1) Perform verification sampling on at least the minimum number of passing plots required in a sequence from Section 9.3.5.4.

2) If $\boldsymbol{n \geq ((Z_\alpha + Z_\beta)^2 \times S_n^2) / D^2}$ then stop and evaluate. Otherwise take another sample.

   Where,
   n = Number of verification plots measured
   $Z_\alpha = \alpha\%\ N(0,1) = 1.645$
   $Z_\beta = \beta\%\ N(0,1) = 0.8416$
   S_n^2 = sample variance of the differences
   $D = \delta \times$ project average estimate

3) If stopped, then evaluate.

   If $\bar{X}_N \leq K$ then accept H_0,
   If $\bar{X}_N > K$ then reject H_0.

   Where,
   $\bar{X}_N$ = sample mean of the differences
   N = total number of plots measured
   $K = (Z_\alpha \times D) / (Z_\alpha + Z_\beta)$.

4) If H_0 was rejected, then additional samples may be taken as long as the verifier is of the opinion that there is a chance that H_0 may be accepted based on the variability and trend observed.

Unpaired Plots

The statistical test is based on comparing the average CO_2e estimates for each stratum from the verifier plots to the Project Operator plots.

Use $\boldsymbol{\alpha=0.05}$ to control for error; the β is not specified because we are constructing a confidence interval not a test. The null hypothesis (H_0) is that the verification and stratum averages are equal. The following procedure is appropriate for the unpaired test.

1) Perform verification sampling on at least the minimum number of plots required in a sequence from Section 9.3.5.5. Calculate n as the sum of the number of plots from both the stratum (n_p) and the verification (n_v).

2) Calculate the following:

   $T_n = \bar{X}_P - \bar{X}_n$

   Where,
   T_n = the difference between the means
   $\bar{X}_P$ = stratum mean
   $\bar{X}_n$ = verification mean after sample n

3) If $\boldsymbol{n \geq (a^2/D^2) \times (S_n^2 + S_P^2)}$ then stop and evaluate. Otherwise take another sample.

   Where,
   a = the percentile from a standard normal distribution for one half of alpha; 1.96 for α=0.05
   $n = n_p + n_v$
   S_n^2 = sample variance of the verification plots
   S_P^2 = sample variance of the stratum plots
   $D = \delta \times$ stratum average estimate

4) If stopped, then evaluate. Construct a confidence interval $T_n \pm D$.
   If the confidence interval includes zero then accept H_0,
   Otherwise reject H_0.

5) If H_0 was rejected, then additional samples may be taken until as long as the verifier is of the opinion that there is a chance that H_0 may be accepted based on the variability and trend observed.

If the stopping rule in step (3) above cannot be attained within 100 plots, then apply a standard unpaired t-test comparison using $\boldsymbol{\alpha}$**=0.05** and $\boldsymbol{\beta}$**=0.80**.

9.3.5.7 Determining if the Stopping Rules Have Been Met

The verifier must determine if the stopping rules have been met for each stratum as soon as is convenient. The Reserve provides tools to assist verifiers with determining if the stopping rules have been met or not. The tools are Microsoft Excel based and are distinct for paired designs and for unpaired designs.

The verifier must enter their data into the appropriate spreadsheet based upon use of a paired or unpaired test. It is required that the verifier apply the random order selection in the sampling process. The verifier is free to measure the set of plots that were randomly selected in any order that provides the greatest efficiency while sampling in the field, but when the verifier inputs data into the spreadsheet, the verifier must follow the random selection order in order to properly conduct the analysis and maintain the integrity of sequential analysis. This may provide significant efficiencies when selected stands and/or plots are in close geographic proximity and it is hypothesized that the stopping rules will require the full number of plots.

The statistical test is based on a comparison of the verifier's measurements of plots, calculated as CO_2e per acre compared to the Forest Owner's measurements of plots, which may include any adjustments for growth. The inventory verification is complete based on the stopping rules detailed in Section 9.3.5.1. Passing of the plot height and/or diameter stopping rules is not required to pass the inventory verification; however, as discussed above, verifiers may separately compare their measurements for height and diameter with the Forest Owner's measurements in the sequential sampling tool. When those inputs have met the sequential sampling stopping requirements, verifiers may use the height and diameter data provided for each tree from the Forest Owner's database for any additional data inputs needed for the CO_2e/acre comparison.

Finally, in addition to evaluating and verifying adherence to the Project Operator's inventory methodology, the verification body must verify the items in Table 9.7. If the project is using the

Standardized Inventory Methodology and/or CARIT, the verification team need not verify these tools beyond proper implementation.

Table 9.7. Additional Verification Items for Inventory Methodology and Implementation

Verification Items		Apply Professional Judgment?
1. Inventory Update Processes	a. Project Operator's inventory document describes methodology for updating inventory data resulting from growth, harvest, and disturbances. Methodology adheres to acceptable forestry practices* b. Harvest/Disturbance updates in inventory management system are implemented per the specified methodology and are representative of the harvest or disturbance. c. Growth is accounted for using an approved growth model or using a stand table projection, as described in Appendix B.	Yes
2. Biomass Equations and Calculations	a. The carbon tonnes per acre for a representative sample plot, computed using the Project Operator's calculation tools, replicate output computed by the verification body.** b. All conversions and expansions are accurate.	Yes

*A forest biometrician employed by the state in which the project is located, or a consulting forest biometrician may be consulted in the event of a dispute between the verification body and Project Operator. The written opinion of the forest biometrician, submitted to the Reserve as part of the verification report, shall be considered the authoritative word.
**The verification body must provide an (idealized) 'verification plot' consisting of all tree species in Project Area with varying heights and diameters existing within the Project Area. The plot need not correspond to an actual plot within the Project Area.

9.3.6 Baseline Estimation

Forest Project baselines include assumptions about forest growth and harvest, as influenced by legal and financial constraints, and assumptions regarding the extent of harvest operations under Business As Usual conditions. These are based on either modeled assumption, or default assumptions, as described in Section 6.

Verification bodies are required to verify the baseline estimate for the project at the initial site visit verification for Improved Forest Management Projects and Avoided Conversion Projects.

All reports that reference carbon stocks must be submitted by the Project Operator with the oversight of a Professional Forester. If the project is located in a jurisdiction without a Professional Forester law or regulation, then Certified Forester credentials managed by the Society of American Foresters (see http://www.certifiedforester.org) are required so that professional standards and project quality are maintained.

Table 9.8. Modeled Baseline Verification Items
(Improved Forest Management projects using the modeling approach, and Avoided Conversion Projects)

Verification Items		Section of FPP	Apply Professional Judgment?
1. Document	A modeling document exists that contains all the verification items in this table.	9	No

Verification Items		Section of FPP	Apply Professional Judgment?
2. Qualitative Characterization (Avoided Conversion Projects Only)	A sufficiently detailed qualitative characterization has been included in the modeling document that documents the general assumptions of the project's baseline. The qualitative assessment addresses the vegetative conditions and activities that would have occurred.	6.2	Yes
3. Model Choice and Calibration	a. The model used is an approved model. b. The Project Operator has provided a rationale for any model calibrations or a sufficient explanation of why calibrations were not incorporated. c. The Project Operator has provided a description of the site indexes used for each species and a sufficient explanation of the source of the site index values used.	Appendix B	Yes
4. Legal Constraints	A list of legal constraints is provided that includes an accurate description of the type and effect of each constraint on the ability to harvest trees and the area constrained.	3.3.1, 6.1.2, 6.2.1	Yes
5. Financial Constraints	a. A sufficient qualitative description is provided indicating that the harvesting activity modeled in the baseline is a financially viable activity. b. For Improved Forest Management projects, Project Operator has provided either a financial analysis of the anticipated growth and harvesting regime that captures all relevant costs and returns, taking into consideration all legal, physical, and biological constraints.	3.3.2, 6.1.3, 6.2.1	Yes
6. Silviculture Guidelines	The silviculture guidelines incorporated in the model demonstrate all legal constraints are applied in the model. The silviculture guidelines must include: i. A description of the trees retained by species group ii. The level of retention iii. Harvest frequency iv. Regeneration assumptions	Appendix B	No
7. Modeling Guidelines	a. Improved Forest Management: Modeling is conducted per Section 6.1. b. Avoided Conversion: Modeling is conducted per Section 6.2.	6.1, 6.2	No
8. Modeling Outputs	a. The Project Operator has provided reports that display periodic harvest, inventory, and growth estimates for the entire Project Area presented as total carbon tonnes and carbon tonnes per acre. b. Estimates are within the range of expected growth patterns for the Project Area.	9, Appendix B	Yes

Table 9.9. Default Baseline Verification Items
(Improved Forest Management projects using the conservative default approach, and Improved Forest Management projects on public lands)

Verification Items		Section of FPP	Apply Professional Judgment?
1. Document	The PDD explains the baseline quantification steps undertaken.	9	No
2. Default Approach	a. The project is eligible to use the conservative default approach and has followed the steps to establish a default baseline in Section 6.1.1 b. The project has correctly run the COLE report as described in Section 6.1.3	6.1.1, 6.1.3, Appendix B	No
4. Legal Constraints	The project has correctly accounted for baseline legal constraints	6.1.1, 6.1.3	Yes
5. Incorporating Other Carbon Stocks	The final baseline has been adjusted to account for all required SSRs	6.1.1, 6.1.3, Appendix B	No

9.3.7 Verifying Estimates of Carbon in Harvested Wood Products

Verification bodies are required to verify the estimates of carbon that are likely to remain stored in wood products over a 100-year period, as submitted in the Forest Project Design Document (for baseline estimates) and annual monitoring reports (for actual wood product production). Accounting for wood product carbon must be applied only to actual or baseline volumes of wood harvested from within the Project Area. Trees harvested outside of the Project Area are not part of the Forest Project and must be excluded from any calculations.

Table 9.10. Carbon in Harvested Wood Products Verification Items

Verification Items		Section of FPP	Apply Professional Judgment?
1. Carbon in Harvested Wood Delivered to Mills	a. Amount of wood harvested that will be delivered to mills has been estimated and reported. b. The appropriate wood density factor has been applied and/or water weight subtracted to result in pounds of biomass with zero moisture content. c. Total dry weights for all harvested wood have been calculated. d. Total carbon weight has been computed. e. The total has been converted to metric tons of carbon.	Appendix B	No
2. Account for Mill Efficiencies	The correct mill efficiency factors have been used to calculate total carbon transferred into wood products.	Appendix B	No

3. Wood Product Classification	The percentages of harvest by wood product class has been determined correctly with verified reports from the mill(s) where the Project Area's logs are sold; or by looking up default wood product classes for the project's Assessment Area(s); or if not available from either of these sources, by classifying all wood products as "miscellaneous."	Appendix B	No
4. Calculation of In-Use and Landfill Carbon Storage	a. The average amount of carbon stored in in-use wood products over 100 years has been calculated correctly using the worksheets referenced in Appendix B. b. The average amount of carbon stored in landfilled wood products over 100 years has been calculated correctly using the worksheets referenced in Appendix B.	Appendix B	No
5. Total Average Carbon Storage in Wood Products Over 100 Years	Total average carbon storage in wood products over 100 years for a given harvest volume has been calculated and reported.	Appendix B	No

9.3.8 Verifying Calculations of Reversal Risk Ratings and Contributions to the Buffer Pool

At each site visit verification, Project Operators must derive a reversal risk rating for their Forest Project using the worksheets in Appendix A. The worksheets are designed to identify and quantify the specific types of risks that may lead to a reversal, based on project-specific factors.

Table 9.11. Reversal Risk Rating Verification Items

Verification Items		Section of FPP	Apply Professional Judgment?
1. Financial Risk	Use of a Qualified Conservation Easement or Qualified Deed Restriction, occurrence on public lands, or use of a PIA alone.	Appendix A.1	No
2. Management Risk	a. Management Risk I – Illegal removals of forest biomass. b. Management Risk II – Conversion of Project Area to alternative land uses. c. Management Risk III – Over-harvesting.	Appendix A.2	No
3. Social Risk	Social Risk.	Appendix A.3	No
4. Natural Disturbance Risk	a. Natural Disturbance Risk I – Wildfire, Disease or insect outbreak. c. Natural Disturbance Risk II – Other episodic catastrophic events.	Appendix A.4	Yes

Verification Items		Section of FPP	Apply Professional Judgment?
5. Completing the Risk Rating Analysis	Reversal risk rating calculated correctly using the formula in Appendix A.5.	Appendix A.5	No

9.4 Completing the Verification Process

After completing the core project verification activities for a Forest Project, the verification body must do the following to complete the verification process:

1. Complete a detailed List of Findings containing both immaterial and material findings (if any) and deliver it to the Project Operator (private document).
2. Exchange correspondence as necessary to resolve issues detailed in the List of Findings, until all material misstatements and nonconformances have been addressed.
3. If a reasonable level of assurance opinion is successfully obtained, complete a Verification Report to be delivered to the Project Operator (public document).
4. Complete the Verification Statement form, detailing the vintage and the number of GHG reductions and removals verified and deliver it to the Project Operator (public document).
5. Verify that the number of GHG reductions and removals, as well as the reversal risk rating, specified in the Verification Report and Statement match the number entered into the Reserve software.
6. Conduct an exit meeting with the Project Operator to discuss the Verification Report, List of Findings, and Verification Statement.
7. Upload electronic copies of the Verification Report, List of Findings, Verification Statement, and Verification Activity Log into the Reserve.

The recommended content for the Verification Report, List of Findings, and Verification Statement can be found in the Reserve's Verification Program Manual.[32] The Verification Program Manual also provides further guidance on quality assurance, negative verification statements, use of an optional Project Verification Activity Log, goals for exit meetings, dispute resolution, and record keeping.

[32] Available at http://www.climateactionreserve.org/how/program/program-manual/.

10 Glossary of Terms

Aboveground Live Biomass	Live trees including the stem, branches, and leaves or needles, brush, and other woody live plants aboveground.
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 fuel reductions, and other management activities designed to achieve forest sustainability health objectives.
Additionality	A criterion for Forest Project eligibility. A Forest Project is "additional" if it would not have been implemented without incentives provided by the carbon offset market, including the incentives created through the Climate Action Reserve program. Under this protocol, Forest Projects meet the additionality criterion by demonstrating that they pass a legal requirement test and a performance test, as described in Section 3.1, and by achieving GHG reductions and removals quantified against an approved baseline, determined according to the requirements in Section 6.
Affiliate	An "affiliate" is defined as any person or entity that, directly or indirectly, through one or more intermediaries, controls or is controlled by or is under common control with the Forest Owner(s) participating in a project, including any general or limited partnership in which the Forest Owner is a partner and any limited liability company in which the Forest Owner is a member. For the purposes of this definition, "control" means the possession, direct or indirect, of the power to direct or cause the direction of the management and policies of a person, whether through the ownership of voting securities, by contract or otherwise, and "person" means an individual or a general partnership, limited partnership, corporation, professional corporation, limited liability company, limited liability partnership, joint venture, trust, business trust, cooperative or association or any other legally-recognized entity.
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 belowground root volume to be estimated using the aboveground bole volume.
Assessment Area	A distinct forest community within geographically identified ecoregions defined by the Reserve that consists of common regulatory and political boundaries that affect forest management. The size of the Assessment Areas is determined by efforts to achieve optimal statistical confidence across multiple scales using U.S. Forest Service Forest Inventory and Analysis Program (FIA) plots

	for biomass. Maps of the Assessment Areas and the associated data may be found on the Reserve's website.
Avoidable Reversal	An avoidable reversal is any reversal that is due to the Project Operator's negligence, gross negligence, or willful intent, including harvesting, development, and harm to the Project Area
Avoided Conversion Project	A type of Forest Project consisting of specific actions that prevent the conversion of forestland to a non-forestland use by dedicating the land to continuous forest cover through conservation easement recordation or transfer to public ownership.
Baseline	The level of GHG emissions, removals, and/or carbon stocks at sources, sinks or reservoirs affected by a Forest Project that would have occurred under a Business As Usual scenario. For the purposes of this protocol, a project's baseline must be estimated following standard procedures in Section 6.
Best Management Practices	Management practices 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.[33]
Biological Emissions	For the purposes of the Forest Project Protocol, biological emissions are GHG emissions that are released directly from forest biomass, both live and dead, including forest soils. For Forest Projects, biological emissions are deemed to occur when the reported tonnage of onsite carbon stocks, relative to baseline levels, declines from one year to the next.
Biomass	The total mass of living organisms in a given area or volume; recently dead plant material is often included as dead biomass.[34]
Bole	A trunk or main stem of a tree.
Broadcast Fertilization	A fertilizer application technique where fertilizer is spread across the soil surface by tractor or aerial application.
Buffer Pool	The buffer pool is a holding account for Forest Project CRTs administered by the Reserve. It is used as a general insurance mechanism against unavoidable reversals for all Forest Projects registered with the Reserve. If a Forest Project experiences an unavoidable reversal of GHG reductions and removals (as defined in Section 7.3), the Reserve will retire a number of CRTs from the buffer pool

[33] Helms. (1998).
[34] Metz, Davidson, Swart, & Pan. (2001).

	equal to the total amount of carbon that was reversed (measured in metric tons of CO_2-equivalent).
Business As Usual	The activities, and associated GHG reductions and removals that would have occurred in the Project Area in the absence of incentives provided by a carbon offset market. Methodologies for determining these activities – and/or for approximating carbon stock levels that would have resulted from these activities – are provided in Section 6 of this protocol for each type of Forest Project.
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 aboveground or belowground biomass or harvested wood products, among others.
Climate Reserve Tonne (CRT)	The unit of offset credits used by the Climate Action Reserve. Each Climate Reserve Tonne represents one metric ton (2204.6 lbs) of CO_2 reduced or removed from the atmosphere.
Commercial Rotational Harvesting	For the purpose of this protocol, commercial rotational harvesting refers to harvesting activities undertaken by a Forest Owner with the intent to create a new cohort of regenerated trees, where the harvested trees are delivered to a mill.
Common Practice	The average stocks of the aboveground standing live and dead carbon pools from within the Forest Project's Assessment Area, derived from FIA plots on all private lands within the defined Assessment Area.
Computational Reversal	A computational reversal is any reversal that is due to required protocol calculations (including the confidence deduction and secondary effects).
Even-Aged Management	Management where the trees in individual forest stands have only small differences in their ages (a single age class). By convention, the spread of ages does not differ by more than 20 percent of the intended rotation.
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.
Forest Carbon	The carbon found in forestland resulting from photosynthesis in trees and associated vegetation, historically and in the present. Forest Carbon is found in soils, litter and duff, plants and trees, both dead and alive.

Forest Management	The commercial or noncommercial growing and harvesting of forests.
Forest Owner	A corporation or other legally constituted entity, city, county, state agency, individual(s), or a combination thereof that has legal control (described in Section 2.2) of any amount of forest carbon within the Project Area
Forest Project	A planned set of activities designed to increase removals of CO_2 from the atmosphere, or reduce or prevent emissions of CO_2 to the atmosphere, through increasing and/or conserving forest carbon stocks.
Forest Project Design Document	A standard document for reporting required information about a Forest Project. The Forest Project Design Document must be submitted for review by a verification body and approved by the Reserve before the Forest Project can be registered with the Reserve.
Forestland	Land that supports, or can support, at least ten percent tree canopy cover and that allows for management of one or more forest resources, including timber, fish and wildlife, biodiversity, water quality, recreation, aesthetics, and other public benefits.
GHG Assessment Boundary	The GHG Assessment Boundary defines all the GHG sources, sinks, and reservoirs that must be accounted for in quantifying a Forest Project's GHG reductions and removals (Section 6). The GHG Assessment Boundary encompasses all the GHG sources, sinks, and reservoirs that may be significantly affected by Forest Project activities, including forest carbon stocks, sources of biological CO_2 emissions, and mobile combustion GHG emissions.
GHG Reductions and Removals	See definitions for Reduction and Removal.
Greenhouse Gas (GHG)	Gas that contributes to global warming and climate change. For the purposes of this Forest Project Protocol, GHGs are the six gases identified in the Kyoto Protocol: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
Improved Forest Management Project	A type of Forest Project involving management activities that increase carbon stocks on forested land relative to baseline levels of carbon stocks.
Listed	A Forest Project is considered "listed" when the Project Operator has created an account with the Reserve, submitted the required Project Submittal form and other required documents, paid the project submission fee, and the Reserve has approved and accepted the project for listing.

Litter	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 that is smaller than material identified as lying dead wood.
Lying Dead Wood	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. Lying dead wood is all dead tree material with a minimum average diameter of five inches and a minimum length of eight feet. Anything not meeting the measurement criteria for lying dead wood will be considered litter. Stumps are not considered lying dead wood.
Metric Ton or "tonne" (t)	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.6 pounds or 1.1 short tons.
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 landscape scales. The application of this definition, its principles, detailed definition, and implementation are discussed further in Section 3.9.2.
Non-Forest Cover	Land with a tree canopy cover of less than ten percent.
Non-Forest Land Use	An area managed for residential, commercial, or agricultural uses other than for the production of timber and other forest products, or for the maintenance of 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.
Onsite Carbon Stocks	Carbon stocks in living biomass, dead biomass, and soils within the Project Area.
Permanence	The requirement that GHGs must be permanently reduced or removed from the atmosphere to be credited as carbon offsets. For Forest Projects, this requirement is met by ensuring that the carbon associated with credited GHG reductions and removals remains stored for at least 100 years.
Primary Effects	The Forest Project's intended changes in carbon stocks, GHG emissions or removals.
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 Area	The area inscribed by the geographic boundaries of a Forest Project, as defined following the requirements in Section 4 of this protocol. Also, the property associated with this area.
Project Life	Refers to the duration of a Forest Project and its associated monitoring and verification activities, as defined in Section 3.5.
Public Lands	Lands that are owned by a public governmental body such as a municipality, county, state or country.
Project Operator	A Forest Owner responsible for undertaking a Forest Project and registering it with the Reserve. The Forest Owner who executes the Project Implementation Agreement, as described in Section 2.2.
Qualified Conservation Easement	A qualified conservation easement must explicitly refer to the terms and conditions of the Project Implementation Agreement, apply to current and all subsequent Project Operators for the full duration of the Forest Project's minimum time commitment, as defined in Section 3.5 of this protocol.
Qualified Deed Restriction	A qualified deed restriction shall ensure that the Project Implementation Agreement runs with the land and applies to all current and subsequent Project Operators for the full duration of the Forest Project's minimum time commitment, as defined in Section 3.4 of this protocol, to be determined in the Reserve's reasonable discretion. A deed restriction is not "qualified" if it merely consists of a recording of the Project Implementation Agreement or a notice of the Project Implementation Agreement, as such a recording is already required by the Project Implementation Agreement.
Reduction	The avoidance or prevention of an emission of CO_2 (or other GHG). Reductions are calculated as gains in carbon stocks over time relative to a Forest Project's baseline (also see Removal).
Registered	A Forest Project becomes registered with the Reserve when it has been verified by a Reserve-approved and ISO-accredited verification body, all required documentation (see Section 8) has been submitted by the Project Operator to the Reserve for final approval, and the Reserve approves the project.
Removal	Sequestration ("removal") of CO_2 from the atmosphere caused by a Forest Project. Removals are calculated as gains in carbon stocks over time relative to a Forest Project's baseline (also see Reduction).

Reporting Period	The period of time over which a Project Operator quantifies and reports GHG reductions and removals.
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 captured from a source.
Retire	To retire a CRT means to transfer it to a retirement account in the Climate Action Reserve's software system. Retirement accounts are permanent and locked, so that a retired CRT cannot be transferred or retired again.
Reversal	A reversal is a decrease in the stored carbon stocks associated with quantified GHG reductions and removals that occurs before the end of the Project Life. Under this protocol, a reversal is deemed to have occurred if there is a decrease in the difference between project and baseline onsite carbon stocks from one year to the next, regardless of the cause of this decrease (i.e., if the result of (Δ AC_{onsite} - Δ BC_{onsite}) in Equation 6.1 is negative).
Secondary Effects	Unintended changes in carbon stocks, GHG emissions, or GHG removals caused by the Forest Project.
Sequestration	The process of increasing the carbon (or other GHGs) stored in a reservoir. Biological approaches to sequestration include direct removal of CO_2 from the atmosphere through land-use changes[35] and changes in forest management.
Significant Disturbance	Any natural impact that results in a loss of least 20 percent of the aboveground live biomass that is not the result of intentional or grossly negligent acts of the Project Operator.
Sink	Physical unit or process that removes a GHG from the atmosphere.
Source	Physical unit or process that releases a GHG into the atmosphere.
Stand	An individual unit or polygon that is relatively homogeneous in terms of the carbon stocking within its borders. For live and dead trees, the determination of stand boundaries is usually based on forest vegetation attributes, such as species, size (age), and density characteristics. For soils, the determination of soil stand boundaries is made on similar soil orders.
Standing Dead Carbon Stocks	The carbon in standing dead trees. Standing dead trees include the stem, branches, roots, or section thereof, regardless of species, with minimum diameter (breast

[35] Metz, Davidson, Swart, & Pan. (2001).

	height) of five inches and a minimum height of 15 feet. Stumps are not considered standing dead stocks.
Standing Live Carbon Stocks	The carbon in the live tree pool. Live trees include the stem, branches, roots, and leaves or needles of all aboveground live biomass, regardless of species, with a minimum diameter (breast height) of five inches and a minimum height of 15 feet (inventory methodology must include all trees five inches and greater)
Stocks (or Carbon Stocks)	The quantity of carbon contained in identified carbon pools.
Strata	Plural of stratum. The set of different groupings for a specific attribute, such as vegetation or soil.
Stratum	A group of stands that contain a similar attribute, such as vegetation or soils attributes.
Submitted	The Reserve considers a Forest Project to be "submitted" when all of the appropriate forms have been uploaded and submitted to the Reserve's software system, and the Project Operator has paid a project submission 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 five inches and a minimum height of 15 feet with no branches within three feet from the ground at maturity.[36]
Unavoidable Reversal	An unavoidable reversal is any reversal not due to the Project Operator's negligence, gross negligence or willful intent, including wildfires or disease that are not the result of the Project Operator's negligence, gross negligence or willful intent.
Uneven-Aged Management	Management that leads to forest stand conditions where the trees differ markedly in their ages, with trees of three or more distinct age classes either mixed or in small groups.
Verification	The process of reviewing and assessing all of a Forest Project's reported data and information by an ISO-accredited and Reserve-approved verification body, to confirm that the Project Operator has adhered to the requirements of this protocol.
Verification Period	The period of time over which GHG reductions/removals are verified. A verification period may cover multiple reporting periods. The end date of any verification period must correspond to the end date of a reporting period.

[36] Helms. (1998).

Appendix A Determination of a Forest Project's Reversal Risk Rating

Project Operators must derive a reversal risk rating for their Forest Project using the worksheets in this section. The worksheets are designed to identify and quantify the specific types of risks that may lead to a reversal, based on project-specific factors.

This risk assessment must be updated every time the project undergoes a verification site visit. Therefore, a project's risk profile and its assessment are dynamic. Furthermore, estimated risk values and associated mitigation measures will be updated periodically by the Reserve as improvements in quantifying risks or changes in risks are determined. Any adjustments to the risk ratings will affect only current and future year contributions to the Buffer Pool. The Reserve may, from time to time, transfer Climate Reserve Tonnes (CRTs) from the Buffer Pool to the Project Operator's account if the Reserve determines that previously assessed risk ratings were unnecessarily high. Alternatively, the Reserve may waive a Project Operator's future contributions to the Buffer Pool until excess contributions from previous years are recouped. If a Forest Project's risk rating increases, the Project Operator must contribute additional CRTs to the Buffer Pool to ensure that all CRTs (including those issued in prior years) are properly insured.

Risks that may lead to reversals are classified into the categories identified in Table A.1.

Table A.1. Forest Project Risk Types

Risk Category	Risk Type	Description	How Risk is Managed in this Protocol
Financial	Financial Failure Leading to Bankruptcy	Financial failure can lead to bankruptcy and/or alternative management decisions to generate income that result in reversals through over-harvesting or conversion	Default Risk
	Project Implementation Agreement (PIA) Subordination	Subordinating the PIA to mortgages or deeds on or affecting the Project	Default Risk
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
	Over-Harvesting	Exercising timber value at expense of project carbon	Default Risk
Social	Social Risks	Changing government policies, regulations, and general economic conditions	Default Risk

Risk Category	Risk Type	Description	How Risk is Managed in this Protocol
Natural Disturbance	Wildfire	Loss of project carbon through wildfire	Project-specific Risk
	Disease/Insects	Loss of project carbon through disease and/or insects	
	Other Episodic Catastrophic Events	Loss of project carbon from wind, snow and ice, or flooding events	

A.1 Financial Risk

Financial failure of an organization resulting in bankruptcy can lead to dissolution of agreements and forest management activities to recover losses that result in reversals. Projects that employ a Qualified Conservation Easement or Qualified Deed Restriction, or that occur on public lands, are at a lower risk than projects with a PIA alone.

Table A.2. Financial Failure Leading to Bankruptcy

Applies to all projects		
Identification of Risk	**Contribution to Reversal Risk Rating**	
	PIA only	PIA combined with Qualified Conservation Easement or Qualified Deed Restriction or on public or tribal[37] lands
Default Financial Risk	5%	1%

Table A.3. PIA Subordination

Applies to all projects		
Identification of Risk	**Contribution to Reversal Risk Rating**	
	PIA with "Subordination Clause Type II"	PIA with "Subordination Clause Type I"
Default Financial Risk	10%	2%

A.2 Management Risk

Management failure is the risk of management activities that directly or indirectly could lead to a reversal. Projects that employ a conservation easement or deed restriction, or that occur on public lands, are exempt from this risk category.

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.

[37] For the purposes of this protocol, "tribal lands" includes tribal land, land owned by Alaska Native Corporations, and Hawaiian home land.

Table A.4. Risk of Illegal Removals of Forest Biomass

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
United States Default Harvesting Risk	0%

Management Risk II – Conversion of Project Area to Alternative Land Uses

High values for development of housing and/or agriculture may compete with timber and carbon 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.

Table A.5. Risk of Conversion to Alternative Land Use

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
With Qualified Conservation Easement or Qualified Deed Restriction that explicitly encumbers all development rights or on public or tribal lands	0%
Without Qualified Conservation Easement or Qualified Deed Restriction	2%

Management Risk III – Over-Harvesting

Favorable timber values, among other reasons, may motivate some project managers to realize timber values at the expense of managing carbon stocks for which CRTs have been credited. Additionally, reversals can occur as the result of harvest associated with fuels treatments.

Table A.6. Risk of Over-Harvesting

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
With Qualified Conservation Easement or Qualified Deed Restriction that explicitly encumbers timber harvesting associated with project stocks or on public or tribal lands	0%
Without Qualified Conservation Easement or Qualified Deed Restriction	2%

A.3 Social Risk

Social risks exist due to changing government policies, regulations, and general economic conditions. The risks of social or political actions leading to reversals are low but could be significant.

Table A.7. Social Risk Identification

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
United States Default Social Risk	2%

A.4 Natural Disturbance Risk

Natural disturbances can pose a significant risk to the permanency GHG reductions and removals. 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, Disease, or Insect Outbreak

Wildfire, disease, or insect outbreak have the potential to cause significant reversals, especially in certain carbon pools. These risks can be reduced by certain techniques including reducing surface fuel loads, removing ladder fuels, adding fuel breaks, and reducing stand density. However, these techniques cannot reduce emission risk to zero because all landowners will not undertake fuel treatments, nor can they prevent wildfire from occurring. Strategies implemented to reduce fuel loads can also improve resiliency to disease or insect outbreak.

Table A.8. Natural Disturbance Risk I – Wildfire, Disease, or Insect Outbreak

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
Refer to the Assessment Area Data File for the project's Natural Disturbance risk rating	*X*%
If vegetation management treatments have been implemented for the Project Area, reduce the value above by the appropriate percent as indicated below.	*X*% **x** *Y*%

Vegetation treatments must be available in a report and aligned with aa comprehensive vegetation management plan that identifies specific temporal and spatial actions to enhance forest resilience across the Project Area. The vegetation management plan must be approved by a state agency or, if approval by a state agency is not possible, developed under the oversight of a Professional Forester and reviewed by the Reserve. Verifiers must confirm the status of implementation of the management plan.

Table A.9. Vegetation Management Treatments (Y)

Description of Status of Vegetation Management	Y
Approved vegetation management plan exists, and the plan is being implemented across at least 80% of the intended implementation area detailed in the plan	20%
Approved vegetation management plan exists, and the plan is being implemented across at least 50% of the intended implementation area detailed in the plan	70%
Approved vegetation management plan does not exist, or the plan has not yet been implemented across at least 50% of the intended implementation area detailed in the plan	100%

Natural Disturbance Risk II – Other Episodic Catastrophic Events

A major wind-throw event (hurricane, tornado, high wind event) has the potential to cause a reversal, especially in certain carbon pools.

Table A.10. Natural Disturbance Risk III – Other Episodic Catastrophic Events

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
Default Risk Contribution from Other Catastrophic Events	3%

A.5 Summarizing the Risk Analysis and Contribution to Buffer Pool

Use the table below to summarize the Forest Project's reversal risk rating. As indicated above, projects that employ a conservation easement or deed restriction, or that occur on public or tribal lands, are exempt from certain risk categories. Such Qualified Conservation Easements and Qualified Deed Restrictions must clearly identify the goals and objectives of the Forest Project according to the terms of this protocol.

Table A.11. Project Contribution to the Buffer Pool Based on Risk

Risk Category	**Contribution from Risk Descriptions Above**		
	Source	**PIA Only**	**PIA and Qualified Conservation Easement and/or a Qualified Deed Restriction and/or Public or Tribal Ownership**
Financial Failure[38]	Default Risk -Remedies for reversals addressed in PIA	15% or 7%	11% or 3%
Illegal Forest Biomass Removal	Default Risk	0%	0%
Conversion	Default Risk - Remedies for reversals addressed in PIA	2%	0%
Over-Harvesting	Default Risk - Remedies for reversals addressed in PIA	2%	0%
Social	Default Risk	2%	2%
Wildfire, Disease, or Insect Outbreak	Calculated Risk from Table A.8	*X*% or (*X*% x *Y*%)	*X*% or (*X*% x *Y*%)
Other Catastrophic Events	Default Risk	3%	3%

[38] When determining the appropriate risk rating for the Financial Failure Risk Category, use the higher value if intending to use PIA Subordination Clause Type I and the lower value if intending to use PIA Subordination Clause Type II. Please refer to the Project Implementation Agreement on the Reserve website for further information.

Completing the Risk Rating Analysis

The project's reversal risk rating is calculated as follows:

$$100\% - [(1 - FinancialFailure\%) \times (1 - IllegalForestBiomassRemoval\%) \times (1 - Conversion\%) \times (1 - OverHarvesting\%) \times (1 - SocialRisk\%) \times (1 - Wildfire\ /\ Disease/\ InsectOutbreak\%) \times (1 - OtherCatastrophicEvents\%)]$$

Appendix B Quantification Guidance for Use with Forest Carbon Projects

This appendix provides guidance for quantifying a forest project's onsite carbon stocks and carbon in harvested wood products, both for purposes of estimating a project's baseline as well as providing ongoing estimates of onsite project carbon stocks throughout the project life.

B.1 Reporting Requirements for Forest Carbon Pools

Onsite forest carbon pools are broadly grouped into living biomass, dead biomass, and soils. Living biomass includes biomass in live trees and shrubs and herbaceous understory (live non-tree biomass). Onsite dead biomass includes biomass in dead trees, lying dead wood, and litter. Offsite dead biomass includes harvested wood products.

For standardized reporting, all estimates of forest carbon stocks must be provided in terms of metric tons (tonnes) of CO_2-equivalent (CO_2e) on a project and a per acre basis. Unless otherwise required in the referenced biomass equations, the following conversion formulae shall be used:

Base Unit	Conversion		Final Unit
Biomass	0.5 **x** biomass		Carbon
Carbon	3.667 **x** carbon	=	CO_2e
Pounds	lbs **/** 2204.6		Metric tons or tonnes (t)
Acres	0.404686 **x** acres		Hectares

Reporting requirements vary for each of the carbon pools. The estimates for the pools that are derived from sampling must meet the quality standards described later in this document. Table B.1 displays the reporting requirements for each of the carbon pools.

Table B.1. Reserve Requirements for Carbon Pool Categories and Determination of Value for Pool

Category	Carbon Pool	Improved Forest Management	Avoided Conversion
Living Biomass	Live Trees	Required for project reporting	
	Shrubs and Herbaceous Understory	Not allowed for project reporting	
Onsite Dead Biomass	Standing Dead Trees	Required for adherence to Natural Forest Management criteria	
		Required for project reporting	
	Lying Dead Wood	Required for adherence to Natural Forest Management criteria	
		Not allowed for project reporting	
	Litter	Not allowed for project reporting	
Soil	Soil	Required for emissions reporting associated with management activities, if applicable	

		Not allowed for reporting of project benefits	Optional for reporting of project benefits in Avoided Conversion projects only
Offsite Dead Biomass	Harvested Wood Products	Required for project reporting	

B.2 Guidance for Estimating Carbon in Forest Carbon Pools

This section describes requirements for the development of values for the forest carbon pools described in Table B.1. Project Operators must include an inventory methodology in the Project Design Document. The inventory methodology must include the required provisions identified in this section.

B.2.1 Inventory Methodologies

All inventory methodologies must be based on randomized or systematic sampling and include the minimum quality parameters described in this section for each carbon pool. Inventory methodologies must describe the process for locating sample plots. Sample plot locations may be monumented in such a way to assist in relocating them for quantification and verification purposes. Plot monument strategies that incorporate Global Positioning Systems (GPS) along with additional navigational strategies at close range to plot centers (that direct verifiers to the precise plot location) that are resistant to weather, wildlife, and other environmental factors, can substantially reduce verification costs. Project Operators are advised to consider the verification guidance (Section 9) associated with verification of sampled carbon pools (in particular, the sequential sampling guidance) prior to settling on a strategy to monument plot locations.

To increase the efficiency of both project development by Project Operators and verification by verifiers, the Reserve has developed a Standardized Inventory Methodology that Project Operators may optionally use to determine how to collect sample data. The Standardized Inventory Methodology is available on the Forest Project Protocol webpage and draws on observations about the standards and methodologies that have performed well for registered forest carbon projects. Designed in consultation with experienced project developers, verifiers and forest mensuration experts, it was created in consideration of a variety of factors, such as being suitable for use in a variety of forest conditions, achieving consistent results in consecutive plot measurements, and minimizing ambiguity in interpretation of conditions in the field.

Additionally, the Standardized Inventory Methodology was developed to be consistent with the Climate Action Reserve Inventory Tool (CARIT), an inventory management computer application that Project Operators may also optionally use to manage and update their forest inventories. CARIT is available on the Forest Project Protocol webpage at no cost. With CARIT, Project Operators will be able to manage forest inventories, calculate timber and carbon stocking, and update inventories for growth, disturbances (including harvests), and updated sampling data. The volume and biomass equations required by the Forest Project Protocol are already programmed into CARIT, eliminating the need for Project Operators to apply such equations on their own and ensure they are correctly applied. Additionally, CARIT generates reports that are tailored specifically to the reporting requirements of the Forest Project Protocol.

The use of the Standardized Inventory Methodology does not obligate a Project Operator to use CARIT, nor does the use of CARIT obligate a Project Operator to use the Standardized

Inventory Methodology. However, CARIT will only function properly if certain inventory standards are followed. For example, only fixed area plots may be used—variable radius plots are not allowed.

B.2.2 Updating Forest Inventories

Forest inventories are always in flux due to forest growth, harvest, and natural disturbances. Therefore, inventories of carbon pools must either be updated or re-measured at a frequency commensurate with the anticipated or actual changes in the specific carbon pools so that sample plots and forest stratification reflect current conditions. Project Operators must report their estimated carbon stocks on an annual basis. Since it is infeasible to immediately re-measure all plots following forest growth and disturbances that affect plot measurements, acceptable strategies for updating project inventory estimates are described in this section.

B.2.2.1 Updating for Forest Growth

Updating plot data for forest growth can be accomplished through the use of growth models or stand table projections that mimic the diameter and height increment of trees in the inventory database. Any plot data that are updated to reflect current conditions with the use of predicted increments of height and diameter data will be used during site visit verifications to compare against verifier's field measurements using the sequential sampling techniques described in Section 9 of the protocol. This provision ensures that plot measurements and update processes are within accuracy thresholds.

Plot data reported should always coincide with the end of the reporting period. If plot data was taken before the end of the reporting period, it should be grown forward to coincide with the end date. Similarly, if plot data was taken after the end of the reporting period, it should be degrown to the end date. The Project Operator may determine a reasonable method for apportioning growth to the reporting period end date, and should employ the same method whenever new inventory measurements are taken. Projects utilizing CARIT should report plot data for the relevant reporting period year as output by CARIT.

B.2.2.2 Updating for Disturbances (Including Harvest)

Inventory estimates must be updated annually for any disturbance (including harvest disturbance) that results in an estimated reduction to the reported carbon pools of 0.5 percent or more. However, given that it may be infeasible to re-measure all plots following a disturbance, up to 5 percent of the total inventory plots used to derive the inventory estimate can be excluded at any one time. Only plots in disturbed areas may be excluded, and no plot can be excluded for a period of time greater than one reporting period. Plots that are geographically situated in areas that experienced forest cover class-changing harvests and/or natural disturbances in the previous year must be excluded from the inventory analysis until the plots are updated with re-measured data from field visits, subject to the 5 percent limit on excluded plots outlined above.

If the inventory is stratified, the area that has been disturbed can simply be re-stratified with a stratum that reflects the post-disturbance forest condition, following the stratification rules developed for the project. Any plots that existed in the disturbed area must be removed from the set of plots used to estimate the stratum average unless, and until, the affected plots are re-measured. Verification of stratified inventories must ensure that the area disturbed is accurately characterized in the inventory GIS system and that the assigned stratum reflects the forest condition.

For non-stratified inventories, an estimated tree list that represents the post-disturbance condition of the forest must be assigned to any plots affected by the disturbance. The tree list must be carefully selected to not overstate the carbon pools present. Site verification of post-disturbance plots will evaluate whether the tree list assigned is appropriate for the post-disturbance condition. No more than 10 percent of the project's area may be represented through estimated plots without increased verification scrutiny during a site visit. Specifically, where more than 10 percent of the project's area is based on estimated tree lists assigned to plots, verification using sequential sampling techniques shall include all plots (including estimated plots) in the sequential sampling comparison between Project Operator estimates and verifier estimates.

Plots that are estimated shall not be used in the calculations for sampling error. Estimates from sampled pools must meet a minimum confidence standard of +/- 20 percent at the 90 percent confidence interval. It is acceptable to calculate the descriptive statistics, including confidence intervals, using plot data that have been updated to a current date. Discounts for uncertainty are applied to project estimates when confidence standards are below +/- 5 percent at the 90 percent confidence interval. This is described in greater detail below.

B.2.3 Requirements for Estimating Carbon in Standing Live and Dead Trees

It is required that both standing live and standing dead trees be sampled. It is acceptable, but not required, to combine standing live and dead trees during sampling such that descriptive statistics, including confidence statistics, address the combined pools. Whether combined or not, tree data must be coded so that mean estimates can be interpreted independently for standing live and standing dead pools to allow monitoring of standing dead trees with respect to requirements in Section 3.9.2 (Natural Forest Management).

Inventory methodologies must include a description of how the sampled data will be archived and the analytical tools that will be included in the analysis of carbon stocks. The tree lists that are developed from inventory sampling and used to expand inventory estimates to the project level must be available for verification review. It is acceptable for the tree list to be presented and reviewed in an electronic format, such as in a database or spreadsheet application. Table B.2 displays the requirements that all project inventory methodologies must include for standing live and dead trees.

Table B.2. Requirements for Sampling Standing Live and Standing Dead Trees

Species	1. All trees sampled must include a species identifier. The inventory methodology must provide a crosswalk between any codes used to identify a species and the species name the codes represent. 2. Since all trees contain carbon, the inventory methodology must indicate that the sample methodology will include all species present within the project area.
Diameter at Breast Height (DBH) Measurements	1. Inventory estimates must include all trees 5 inches DBH and larger. It is acceptable that inventory methodologies include trees with DBH less than 5 inches. 2. The location of the measurement of DBH must follow U.S. FIA sampling guidelines (can be found on the Forest Project Protocol webpage). 3. Measurement precision must be no greater than the nearest inch.

Height	1. Inventory methodologies must describe whether all trees on sample plots are measured for height or whether a subset of the sample plot heights is measured and regression estimators are developed for unmeasured heights. 2. Inventory methodology must describe whether height measurements describe the tree's total height or some other top height measurement (regression estimators, or published form equations, may also be used to estimate top heights from a partial height or vice versa). Where regression estimators are used for tree heights, the inventory methodology must describe the populations from which the regression estimators were acquired. 3. The sampling precision for tree heights (when measured) must be stated in the inventory methodology. Stated acceptable precision for measured heights not to be greater than +/- 10 feet. 4. The inventory methodology must include a description of the maximum angle accepted for measuring tree heights. The stated maximum acceptable slope to the measured height shall not exceed 120 percent.
Weight (Plot Area and Forest Strata)	1. All methodologies must describe the sample plot areas used to determine which trees are included for measurement. 2. All tree lists must include a field(s) that displays the weighting of each sampled tree in order to expand the sampled tree to a per acre value. 3. Where inventories are stratified, the governing rules for stratification and stratification methodology must be described. The process for updating forest strata must be described. 4. Where inventories are stratified, stratum areas must be provided at verification with maps and tabular outputs.
Status	1. Each sampled tree must be identified as live or dead. 2. Dead trees must be coded with the decay status so density adjustments can be made. Decay class descriptions and density adjustments are provided below.
Biomass Equations	1. All projects must calculate the biomass in each tree using the biomass equations provided by the Reserve (can be found on the Forest Project Protocol webpage). 2. The project's inventory methodology must include a list of the equations and cite the version of the Reserve's equation file from which they were copied. a. The CARIT tool (optional) includes approved biomass equations to reduce the burden of verification.
Deductions for Missing Biomass	1. Both live and dead trees may have cavities, broken tops or other deformities that reduce the biomass in the trees. Therefore, the inventory methodology must include a description of how deductions are estimated to account for missing biomass. The Reserve has provided guidance below that is acceptable. Alternative methods that address deductions for missing biomass are subject to approval by the Reserve.

Sampling methodologies and measurement standards should be consistent throughout the duration of the forest project. If new sampling methodologies are incorporated during the project life, they must be approved by the Reserve. Sampling methodologies and measurement standards will be evaluated for their statistical validity. Additionally, uncertainties in estimates associated with modifications to sampling methodologies may require reconciliation to project data and/or baseline estimates and shall be conducted at the Reserve's sole discretion. The application of a revised sampling methodology can only occur as part of a site visit verification.

B.2.4 Use of Regression Equations

It is acceptable to develop carbon inventories using regression estimators to estimate tree heights. Project Operators must keep in mind that plots or (sub) populations will be randomly selected for verification and that regression estimators should be used where a high level of certainty can be developed from the estimators. Failure to do so will result in increased effort and cost to meet the standards of verification.

B.2.5 Forest Vegetation Stratification

Stratification is not required, but it may simplify verification and possibly lower the costs of verification. Where forest vegetation is stratified, inventory methodologies must describe the guidelines used for stratification. Traditional stratification decisions are usually based on species composition, forest stem size (DBH or height), and density. It is important that the stratification be relevant to sampling forest carbon. The minimum polygon size to which the stratification guidelines apply must be included in the methodology. A map of current forest strata must be included in the Project Design Document. The methodology must also include the process guidelines for updating forest strata for disturbance and growth events.

B.2.6 Quantification of Carbon in Live Trees from Project Data

All projects must use the appropriate biomass equations for the assessment areas the project is located in. The required biomass equations are found on the Reserve's Forest Project Protocol webpage. The calculation of CO_2e for each tree must be conducted in a manner that provides project estimates for:

- Whole tree biomass (roots, stump, bark, bole, top, and branches). Whole tree estimates are used to provide project totals and estimates of emissions associated with harvest activities.
- Bole biomass. The bole must be calculated when the bole portion of harvested trees are delivered to manufacturing facilities for processing. It is used as the basis for determining carbon persisting in long-term wood products.
- Aboveground portion (stump, bark, bole, top, and branches) used to compare project data to Common Practice statistics for Improved Forest Management projects.

Projects outside of California, Oregon, Washington, Alaska, and Hawaii use estimators for non-bole portions of the tree referred to as the Component Ratio Method (CRM). The CRM must be used to compute the various portions of the tree mentioned above. Guidance for the use of the CRM is provided in the biomass equations section of the Reserve's Forest Project Protocol webpage.

Projects in California, Oregon, Washington, Alaska, and Hawaii must use the biomass equations provided on the Reserve's Forest Project Protocol webpage to calculate the aboveground portion of the trees. The Cairn's equations (Cairns, Brown, Helmer, & Baumgardner, 1997) must be used to calculate CO_2e in the below-ground portion of the trees. The Cairn's equations must be used for the appropriate latitude for the project. The Cairn's equations are as follows:

Equation B.1. California, Oregon, Washington (Temperate Equation)

BBD = exp[-0.7747 + 0.8836 x ln(ABD)]

Where,			Units
BBD	=	Belowground biomass density of standing live trees	tonnes/hectare
ABD	=	Aboveground biomass density of standing live trees	tonnes/hectare

Equation B.2. Alaska (Boreal Equation)

BBD = exp[-0.8713 + 0.8836 x ln(ABD)]

Where,			Units
BBD	=	Belowground biomass density of standing live trees	tonnes/hectare
ABD	=	Aboveground biomass density of standing live trees	tonnes/hectare

Equation B.3. Hawaii (Tropical Equation)

BBD = exp[-1.0587 + 0.8836 x ln(ABD)]

Where,			Units
BBD	=	Belowground biomass density of standing live trees	tonnes/hectare
ABD	=	Aboveground biomass density of standing live trees	tonnes/hectare

This estimate must be converted from biomass in tonnes per hectare to CO_2e in tonnes per acre using the conversions identified earlier in this guidance.

B.2.7 Adjustments to Standing Live and Standing Dead Trees for Missing Volume and Decay

Both standing dead trees and standing live trees may be missing portions of the tree as the result of physical and biological disturbances. Tree biomass needs to be adjusted for missing parts to produce an improved estimate of the tree's biomass. Calculating CO_2e in standing dead trees raises additional challenges since they may be in stages of decay such that density equations in standard biomass equations for live trees do not provide an accurate estimate. The guidance in this section provides a standardized method to account for biomass adjustments.

The first step is to estimate the gross biomass in the tree as if it were whole, using the biomass equations (the first step in the biomass and carbon calculations) provided on the Reserve's Forest Project Protocol webpage. The tree's biomass is then adjusted based on the tree's 'net' biomass and adjusted density estimates for standing dead trees. To standardize, the tree is divided into four parts: top, middle, bottom (visually estimating the original disposition of the aboveground portion of the tree when it was alive and vigorous), and the below-ground portion. The below-ground portion must be calculated as it would for a normal, healthy tree, using the Cairn's equation where the regional biomass equations are used instead of the CRM. It is assumed that the below-ground portion is intact and complete. The standardized percentages assumed to be in each portion of the tree are shown in Table B.3.

Table B.3. Assumed Percentages of Biomass in Each Portion of the Tree

Tree Portion	Percent of Tree Biomass
Top 1/3	10%
Middle 1/3	30%
Bottom 1/3	60%

An ocular estimate is made of the portion remaining in each section of the tree during field sampling. Deductions from gross volume are made for anything that reduces the tree's gross biomass, including breakage and cavities. The percentage remaining in each third is then summed to calculate the net biomass remaining in the tree.

The tree's density must be adjusted to account for the varying states of decay in the remaining portion of the tree. Because standing dead wood does not have the same density as a live tree, a density reduction must be applied. Standing dead wood may fall into five decay classes, which must be recorded during the field sampling. The five decay classes, described in Table B.4, are qualitative, based on the physical characteristics of the dead tree (USDA 2007, Woundenberg et al., 2010).

Table B.4. Decay Classes

Decay Class	Description of Condition of Standing Dead Wood
1	All limbs and branches are present; the top of the crown is still present; all bark remains; sapwood is intact with minimal decay; heartwood is sound and hard.
2	There are few limbs and no fine branches; the top may be broken; a variable amount of bark remains; sapwood is sloughing with advanced decay; heartwood is sound at base but beginning to decay in the outer part of the upper bole.
3	Only limb stubs exist; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay in upper bole and is beginning at the base.
4	Few or no limb stubs remain; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay at the base and is sloughing in the upper bole.
5	No evidence of branches remains; the top is broken; less than 20 percent of the bark remains; sapwood is gone; heartwood is sloughing throughout.

The density identified for each species in the biomass equations posted on the Reserve's Forest Project Protocol webpage must be modified for decay classes 2 to 5 using the reduction factors displayed in Table B.5,[39] which are multiplied by the densities provided in the biomass equations.

Table B.5. Average Density Reduction Factors for Standing Dead Wood for Hardwoods and Softwoods by Decay Class

Softwoods		Hardwoods	
Decay Class	**Reduction Factor**	**Decay Class**	**Reduction Factor**
2	1.0	2	0.8
3	0.92	3	0.54
4	0.55	4	0.43
5	0.29	5	0.22

[39] Harmon et al. (2011). Differences between standing and downed dead tree wood density reduction factors: A comparison across decay classes and tree species. Res. Pap. NRS-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 40 p.

An example of field data that has all of the required elements for calculating the standing dead tree's CO_2e is shown in Table B.6.

Table B.6. Example: Data Attributes Needed to Calculate CO_2e in Standing Dead Trees

Tree Number	Species (type)	Status	DBH (inches)	Height* (feet)	Percent Remaining			Decay Class
					Top 1/3 of Tree	Middle 1/3 of Tree	Bottom 1/3 of Tree	
1	Hardwood	Dead	16	95	0%	50%	100%	3

*Estimated height prior to death

The density of the tree must be adjusted based on its decay class. The first step is to calculate the tree's biomass as if the tree were a normal tree to determine the tree's gross biomass. Net biomass is determined by multiplying the gross biomass of the tree by the reduction factor displayed in Table B.5. An example is provided in Table B.7.

Table B.7. Example: Adjusting Biomass Calculation for Decay Using Density Adjustment Factors

Tree Gross Biomass	Density Reduction Based on Decay	Net Biomass
(tonnes CO_2e) (Assumed)	(from Table B.5 for a hardwood with a decay class '3')	(tonnes CO_2e) (Assuming tree is whole)
0.100	0.54	0.054

As an example of the application of the biomass deductions for missing sections of the tree, using the data from Table B.6 above, a tree (assuming normal form) with a net biomass of 0.054 CO_2e tonnes would be further adjusted to a net biomass for the missing portions of the tree as shown in Table B.8.

Table B.8. Example: Calculating Net Biomass in a Tree

Tree Portion	Percent of Tree Biomass	Gross Biomass	Percent Remaining in Tree	Net Biomass
	(from Table B.3)	(tonnes CO_2e) Percent of tree biomass **x** tree biomass adjusted for density (Table B.7)	(from example in Table B.6)	(tonnes CO_2e) Percent remaining in tree **x** gross biomass
Top 1/3	10%	10% **x** 0.054 **=** 0.0054	0%	0.00000
Middle 1/3	30%	30% **x** 0.054 **=** 0.0162	50%	0.0081
Bottom 1/3	60%	60% **x** 0.054 **=** 0.0324	100%	0.0324
Total Biomass			200	0.0405

B.2.8 Requirements for Estimating Lying Dead Wood Carbon

All projects must either maintain an inventory of lying dead wood for the project area or monitor harvested areas according to the guidance in this section to ensure the project meets the conditions identified in Section 3.9.2 (Natural Forest Management). Lying dead wood is not eligible for crediting due to the high variability associated with estimating lying dead wood, resulting in estimates with unacceptable levels of uncertainty for crediting. Project Operators are required to include the status of lying dead wood with each monitoring report.

Project Operators that choose to meet the monitoring requirement by maintaining an inventory of lying dead wood must meet the following requirements:

1. Inventory plots or transects used to provide the lying dead wood estimate must be no older than 12 years.
2. Data collected for lying dead wood must include the estimated species, adequate data to estimate volume, and decay class, as defined by Table B.9 below, to estimate the density of the piece of lying dead wood to determine biomass.
3. The sampling methodology must be included in the Project Design Document. The Reserve is not prescriptive with regards to the sampling design, other than adhering to general statistical principles of randomness. Fixed area plots and line transects, among other sampling methodologies, are acceptable.
4. The inventory sampling confidence in the estimate of lying dead wood must be at +/- 30 percent at 1 standard error.

Project Operators that choose to meet the monitoring requirement through monitoring of harvested areas must meet the following requirements:

1. A harvested area is any area where commercial removal of forest vegetation has occurred.
2. A map of all areas harvested during the last reporting period must be submitted with the annual monitoring report and must include the harvest date.
3. All harvested areas must be monitored within one year of the harvest date.
4. Fixed area strips shall be randomly located on compass bearings chosen by the Project Operator (but maintained consistent within each harvest area). A recommended width of the fixed area strip is 66 feet (1 chain), which will require monitoring in each of the 33 foot areas on either side of the center line. Ten square chains equals one acre. Project Operators can determine the width of the strip that best suits the vegetation conditions present in the harvested area.
5. A map shall be produced that displays the location of the fixed area strips on the harvested areas. The width of the strip shall be documented for each strip.
6. The minimum area monitored shall be 5 percent of each harvested area.
7. Data collected within the fixed area strip must include the estimated length of the piece of lying dead wood, the average diameter of the lying dead wood, the estimated species, and the decay class as defined by Table B.9 below.

Lying dead wood density must be adjusted to account for the state of decay. Because lying dead wood does not have the same density as a live tree, a density reduction must be applied. Lying dead wood may fall into five decay classes, which must be recorded during the field sampling. The five decay classes are qualitative based on the physical characteristics of the dead tree (USDA 2007, Woundenberg et al., 2010).

Table B.9. Decay Class Descriptions of Lying Dead Wood

Decay Class	Description of Condition of Lying Dead Wood
1	Sound, freshly fallen, intact logs with no rot; no conks present indicating a lack of decay; original color of wood; no invading roots; fine twigs attached with tight bark.
2	Sound log sapwood partly soft but cannot be pulled apart by hand; original color of wood; no invading roots; many fine twigs are gone and remaining fine twigs have peeling bark.
3	Heartwood is still sound with piece supporting its own weight; sapwood can be pulled apart by hand or is missing; wood color is reddish-brown or original color; roots may be invading sapwood; only branch stubs are remaining which cannot be pulled out of log.
4	Heartwood is rotten with piece unable to support own weight; rotten portions of piece are soft and/or blocky in appearance; a metal pin can be pushed into heartwood; wood color is reddish or light brown; invading roots may be found throughout the log; branch stubs can be pulled out.
5	There is no remaining structural integrity to the piece with a lack of circular shape as rot spreads out across ground; rotten texture is soft and can become powder when dry; wood color is red-brown to dark brown; invading roots are present throughout; branch stubs and pitch pockets have usually rotten down.

The density identified for each species in the biomass equations posted on the Reserve's website must be modified for decay classes 2 to 5 using the reduction factors displayed in Table B.10,[40] which are multiplied by the densities provided in the biomass equations.

Table B.10. Average Density Reduction Factors for Lying Dead Wood for Hardwoods and Softwoods by Decay Class

Softwoods		Hardwoods	
Decay Class	**Reduction Factor**	**Decay Class**	**Reduction Factor**
2	0.87	2	0.74
3	0.70	3	0.51
4	0.40	4	0.29
5	0.29	5	0.22

An adjusted density coefficient for the downed logs is calculated by multiplying the density coefficient provided with the biomass equations on the Reserve's Forest Project Protocol webpage by the reduction value in the table above. The adjusted density value is multiplied by the volume estimate in the lying dead wood to determine the biomass.

[40] Harmon et al. (2011). Differences between standing and downed dead tree wood density reduction factors: A comparison across decay classes and tree species. Res. Pap. NRS-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 40 p.

B.2.9 Requirements for Estimating Soil Carbon Emissions and Soil Carbon Quantification for Avoided Conversion Projects

All projects must estimate the soil carbon emissions associated with project management practices. Avoided Conversion projects are eligible (optional) to report the baseline soil carbon emissions the project activity is avoiding. This section provides guidance for estimating soil CO_2e within the project boundaries, and quantifying emissions associated with project activities.

No direct sampling of soil carbon is required for projects that are reporting soil carbon emissions only as part of project management practices. Rather, the estimate of emissions is based on soil carbon estimates from United States Geological Survey (USGS) data for project sites and comparing the data to standardized guidance to assess emissions based on management activities.

For Avoided Conversion projects, the project benefit is determined by comparing the project soil carbon estimate (from sampling) to the standardized estimate of emissions associated with the activity. Currently, only Avoided Conversion projects that demonstrate a risk of conversion to agriculture (all soil orders, grazing not included) and projects that demonstrate a risk of conversion to residential and commercial use (only histosols) are eligible to report soil carbon benefits associated with the avoided conversion activity. Other conversion risks are not currently eligible for this type of reporting.

To summarize, Table B.11 provides the two different approaches to quantifying soil carbon benefits and/or emissions.

Table B.11. Soil Carbon Quantification Methods by Project Type

Project Description	Project Type Identification	Method to Estimate Project Soil Carbon (CO_2e) Stocks	Method to Estimate Project Effects on Soil Carbon (CO_2e)
Project will provide benefits by avoiding soil carbon emissions associated with conversion to agriculture and, in certain cases, residential or commercial (Avoided Conversion)	1	Soil carbon sampling required at project initiation	Initial avoided conversion effects estimated through standardized guidance
			Follow guidance in Step 7
		Follow guidance in Steps 1, 4, 5, and 6	Ongoing project effects estimated through default estimates of soil carbon emissions
			Follow guidance in Steps 1, 4, 5, and 6
Project is reporting management-related emissions	2	Use of USGS data	Project effects estimated through default estimates of soil carbon emissions
		Follow guidance in Steps 1, 2, 3, and 6	Follow guidance in Step 7

B.2.9.1 Developing an Estimate of Soil CO_2e within the Project Boundaries

Step 1: Identify Soil Orders Present Within Project (**Project Types 1 and 2**)

Project Operators must determine the soil orders present in their project area and the area each soil order represents. Where Natural Resource Conservation Service (NRCS) soil data is

available on the NRCS website (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx), projects must use this data. Where NRCS data is either unavailable or believed to be in error at the project site, Project Operators may present the soil orders and area represented by each order with an official letter from a local NRCS representative stating that the portrayal of the soil orders by the Project Operator is accurate. The letter must state why existing data is either absent on the NRCS website or why the data is not accurate.

On the NRCS website mentioned above, users must create an Area of Interest (AOI), using the website tools, that approximates the project boundaries. To determine the soil order, users select the soil reports tab, select land classifications, and select "Taxonomic Classification of Soils". This report provides a taxonomic classification of each of the soils in the AOI. The last four letters of the soil descriptions correspond to the soil order. For example, a soil classified as Xerochrepts is in the Inceptisol order. Table B.12 below displays the soil orders associated with the last four letters in the soil descriptions.

Table B.12. Soil Orders

Soil Order	Last Four Letters in Soil Description
Alfisol	-alfs
Andisol	-ands
Inceptisol	-epts
Mollisol	-olls
Spodosol	-ods
Ultisol	-ults
Histosol	-ists

Step 2: Obtain Soil Organic Matter Values (**Project Type 2**)

Select the tab entitled 'Soil Properties and Qualities', then select 'Soil Organic Matter' and within the advanced options, select 'Weighted Average'. For the aggregation method, select 'Higher' as the tie break rule, and designate '0-30 cm' for the soil depth. Next, click 'View Ratings' to review the organic matter percentage for each soil type in the AOI. Convert the number from the rating to decimal percent by dividing by 100.

Step 3: Obtain the Soil Bulk Density Values (**Project Type 2**)

Soil bulk density estimates are determined by first selecting the 'Soil Properties and Qualities' tab, the 'Bulk Density' tab next, followed by the 'On-third Bar'. Specify the 'Weighted Average' method and soil depth (0-30 cm, unless otherwise noted). Select 'View Ratings. The ratings will provide bulk density values for each soil type in the AOI. If the bulk density values are not available in the database, determine whether the soil orders are qualified as sandy, loamy, or clay using the 'Surface Texture' value in the Soil Properties and Qualities tab and then apply default values of 1.2 g/cm^3 for clay soils, 1.6 g/cm^3 for sand soils, and 1.4 g/cm^3 for loam soils.

Step 4: Sample for Soil Organic Matter (**Project Type 1**)

Soil carbon estimates are based on sampling soil organic matter for the project. Materials needed include:

- Rubber mallet
- Square spade (for removing organic material from core site)
- Soil probe

- Compass
- Trowel and/or sturdy knife (for cleaning soil off outside service of probe)
- Plastic bags (1 bag for each soil core)
- Marking pen
- Measuring tools (meters and centimeters)

Step 4a: Identifying the Plot Locations

Plots must be located randomly or systematically with a random start in each of the soil orders that occur on the project site. An adequate number of plots is needed to ensure the overall estimate of soil carbon meets or exceeds the minimum confidence levels stated in the protocol (+/- 20 percent at 90 percent confidence level). It is acceptable to use the same, or a subset of, plot locations as used for biomass sampling, so long as each soil order is sampled and the overall soil carbon estimate achieves the confidence standards stated above.

Step 4b: Identify Four Random Locations at Each Plot and Extract Soil Organic Matter Samples

4b-i: Select a random number by glancing at a watch's second hand (or digital version). Multiply this number by six to derive a compass bearing to use for the soil sample locations. Following the determined compass bearing, measure 10 meters from the plot center and establish each of the four soil sample locations. Minimal spatial adjustments (less than 2 meters) can be made to avoid rocks and roots from impacting the ability to sample. If obstacles cannot be avoided within 2 meters, an additional sample location must be selected using the method described above.

4b-ii: For each sample location, insert a soil core probe (minimum diameter, ½ inch) into the soil at the sample location to a depth of 30 cm. A rubber mallet may be used to facilitate penetration. If the probe will not penetrate to the required depth, the probe must be removed, wiped free of soil, and inserted in an alternate location with a 2 meter radius from the sample location. If repeated efforts result in difficulties achieving full penetration, an additional sample location must be chosen as described in Step 4b-i. If full penetration is not achieved within two efforts to locate a satisfactory sampling location, the sample must be taken from the initial sample location and the depth recorded.

4b-iii: Soil must be extracted carefully from the probe to avoid losing any of the soil collected. Should any soil be lost, the sample must be rejected and a new sample location selected as described above. The extracted soil is placed in a sealable plastic bag. Label the bag with the plot number followed by the letter "SOM", indicating the sample is a "soil organic matter" sample (not a bulk density sample).

4b-iv: The soil organic matter samples must be sent to a laboratory with expertise in analyzing soil carbon and physical properties within 106 hours of the acquisition of the samples from the plot sites. The laboratory must receive instructions that the samples are to be heated to over 1000 degrees Celsius. This heat will burn off the carbon and a detector is to be used to measure the amount of carbon dioxide produced and reported as a percent of the volume sampled.

Step 5: Sample for Bulk Density (**Project Type 1**)

Sampling for soil bulk density must be conducted on the project site. Materials needed include:

- Rubber mallet
- Piece of wooden 2x4 approximately 1 to 2 feet in length
- Square spade
- Soil core/ring with known volume
- Trowel and/or sturdy knife
- Plastic bags (1 bag for each soil pit)
- Marking pen
- Measuring tools (meters and centimeters)

Step 5a: One random location 4 meters from each plot center must be selected for soil data collection to dig a soil pit to a depth of at least 30 cm^3. The measure of depth must be below the organic layer (branches, leaves, moss, etc.). The sides of the pit can be made straight using the trowel or the study knife. Random selection is achieved through the use of the second-hand method described in Step 4b-i. Adjustments to the location of the pit can be made using the adjustments allowed for difficulties associated with inserting soil probes described in 4b-ii.

Step 5b: Two samples will be taken from the soil pit. The sample is taken by centering the soil ring at a depth of 7.5 cm and the second is taken by centering the ring at a depth of 22.5 cm. The ring is inserted perpendicular to the pit face. The location of each insertion must be into undisturbed soil, as occurs during the process of extracting the soil rings. The soil pit can be expanded to ensure that undisturbed soil is sampled.

5b-i: For each of the samples the sharp end of the ring is pushed in, without twisting, as far as possible with the hands.

5b-ii: The piece of wood is placed over the ring and gently hammered evenly into the soil. If strong resistance is encountered, an alternate location may be found within the pit, or a new pit located using the guidance described above.

5b-iii: Using the trowel or sturdy knife, soil is removed around the outside of the ring to allow for extraction of the ring without losing soil. The surfaces of the ring should be cleaned and cut flush to the surface of the ring. Small losses during extraction and cleaning (up to 2 cm^3) can be restored by filling the void with soil from the pit site and smoothing. Samples must be rejected if soil losses from the ring occurring during extraction and cleaning are greater than 2 cm^3.

5b-iv: The soil from both ring samples is placed in one sealable plastic bag and labeled with BD and the plot number.

5b-v: The bulk density samples must be sent to laboratory with expertise in analyzing soil carbon and physical properties within 106 hours of the acquisition of the samples from the plot sites. Bulk density instructions sent with the samples shall describe that the samples are to be dried at 105 degrees centigrade for at least 48 hours and that all portions of the sample are to be retained (including rocks). The laboratory shall present the results of the analysis of bulk density estimates as g/cm^3, displaying dry weight over total sample volume.

Step 6: Calculate the Total Soil CO_2 per Acre (**Project Types 1 and 2**)

Use Equation B.4 (below) to calculate the soil CO_2 per acre.

Equation B.4. Soil CO_2e per Acre

Soil CO_2e	=	Organic Matter Value (Steps 2 or 4) **x** 0.58 (Conversion of Organic Matter to Carbon) **x** Bulk Density Value (Steps 3 or 5) **x** Soil Depth Sampled (30 cm) **x** 40,468,600 (Conversion of 1 cm^2 to 1 acre) **x** 10^{-6} (Conversion of 1 gram to 1 metric ton) **x** 3.667 (Conversion of Carbon to CO_2)

An example is provided in Table B.13 below.

Table B.13. Example: Calculation for Total CO_2 per Acre

Organic Matter from Steps 2 or 4		0.05
Conversion of Organic Matter to Carbon	x	0.58
Bulk Density (g/cm^3) from Steps 3 or 5	x	1.2
Soil Depth Sampled (30 cm)	x	30
Conversion of 1 cm^2 to 1 acre (1 acre = 40,468,600 cm^2)	x	40,468,600
Conversion of 1 gram to 1 metric ton Carbon	x	0.000001
Conversion of 1 metric ton Carbon to 1 metric ton CO_2	x	3.667
Estimated Metric Tons CO_2 per Acre	=	155.05

Step 7: Quantify the Project Effects on Soil CO_2e (**Project Types 1 and 2**)

Project effects are calculated using the standardized guidance below. Avoided Conversion projects must use the standardized guidance for purposes of estimating project benefits. Soil carbon emissions resulting from management activities are determined where the activity, or set of activities, leads to a net loss of soil carbon across the entire project. Net emissions can occur across the project area in a sustainably managed forest where emissions from management activities are not restored during the rest, or growth, cycle of the stand. The default values provided are derived from scientific literature and address the high-end estimates of net emissions associated with management activities, except in the case of conversion where it is more conservative to underestimate the emissions associated with the avoided activity. The background documentation[41] for the default values is found on the Reserve's Forest Protocol Version 3.3 webpage under References.

Default emission values are provided as percentages for each soil order, based on harvesting intensity, site preparation intensity, and the frequency of disturbance. Project Operators must report their soil carbon emissions by grouping the total acres in each permutation, or class of soil order, harvesting intensity, site preparation intensity, and frequency of disturbance, rather than reporting on an individual stand basis. An example of reporting classes of management activities is provided below, following the descriptions of the management activities.

[41] Gershenson, Alex. Establishing a Standardized Method to Account for Soil Carbon Emissions Associated with Management Activities.

Net carbon emissions are estimated as the difference between carbon stocks (CO_2e) in the soil prior to the management activity and the carbon stocks (CO_2e) in the soil immediately prior to the subsequent harvest event for each harvested stand. Index values are provided for both harvesting intensity and site preparation intensity that, when combined, classify the harvesting intensity for the stand. The index value for harvesting intensity is derived from both the amount of biomass removed during harvest and the soil disturbance associated with the biomass removal. The index value for site preparation is based on the amount of soil disturbance associated with site preparation activities.

For each stand harvested in a given reporting year, Project Operators must determine the harvesting intensity using the guidance below. For Avoided Conversion projects, the guidance is used below to assist in determining baseline conditions and applied to the project rather than individual stands.

Step 7a: Harvesting Intensity

First, the biomass removal index value is determined for the stand based on the amount of biomass removed during harvest. The harvesting intensity value is calculated using a factor for the amount of biomass removed and the amount of soil disturbance that occurs removing the biomass. Both values are added together to calculate the harvesting intensity. The value for disturbance related to biomass removal is determined using Table B.14 below:

Table B.14. Determination of Biomass Removal Index

Biomass Affected by Harvest		
Percentage Pre-Harvest Aboveground Biomass Removed	**Silviculture Activities Generally Associated with Level of Biomass Removed**	**Biomass Removal Index**
< 10%	Sanitation Salvage	0
10 – 50%	Selection, Thinning	0
51 – 80%	Rotation harvest with biomass remaining in tree tops, seed/shelterwood and/or retained trees	1
> 80%	Rotation harvest with whole tree harvesting and little retention	2
Not a Silvicultural Activity – There is no intent to follow up with efforts to regenerate forested conditions		
Based on Table 6.3	Conversion – only relevant to assessment of Avoided Conversion baseline	10

Step 7b: Soil Disturbance from Harvesting Activities

The second value considered for determining the harvest intensity is based on the level of soil disturbance associated with biomass removal. Soil disturbance within the harvested stands boundary may be the result of skidding logs, tree falling, and harvesting equipment. The disturbance may be extensive or minimized, depending on site-specific conditions and care taken during harvesting operations. The soil disturbance index is based on the amount of mineral soil (below the organic layer, including litter and duff) exposed due to harvest activities. The determination of the amount of mineral soil disturbance is from ocular inspection of harvested stands. Table B.15 below is used to determine the soil disturbance index from harvesting.

Table B.15. Determination of Soil Disturbance Index

Percent of Mineral Soil Exposed during Harvest	Soil Disturbance Index
< 5%	0
5 - 20%	2
20 - 40%	3
40 - 60%	4
> 60%	5

Step 7c: Determining the Harvesting Intensity Class

The values for the biomass removal index and the soil disturbance index are summed together to determine the harvesting intensity class, displayed below in Table B.16.

Table B.16. Harvesting Intensity Classes based on Summing the Biomass Removal and Soil Disturbance Indexes

Harvesting Intensity Classes	
Harvesting Intensity Class	**Sum of Biomass Removal and Soil Disturbance Indexes**
Light to Medium	< 3
High	3 - 4
Very High	5 - 7
Conversion	> 7

Step 7d: Determining Site Preparation Classes

For each stand harvested, the Project Operator must determine the site preparation index using the guidance in Table B.17.

Table B.17. Site Preparation Classes and Descriptions of Management Activities

Site Preparation	
Site Preparation Class	**Description**
Very Light	Less than 5% surface area disturbance of soil below litter and duff due to ripping, grading, raking, etc.
Light	5% to 24% surface area disturbance below litter and duff due to ripping, grading, raking, etc.
Medium	25% to 59% surface area disturbance below litter and duff due to ripping, grading, raking, etc.
Heavy	60% to 100% surface area disturbance below litter and duff due to ripping, grading, raking, etc.
Conversion	Soils cleared of trees, stumps and other forest vegetation and prepared for agriculture, grazing, and/or development. No return to forest vegetation.

Step 7e: Determining the Frequency of Disturbance

The frequency of disturbance is determined as the time between harvest activities associated with the specific silviculture event that is being evaluated for soil carbon emissions. The value for frequency of disturbance is assigned to each harvested stand based on the amount of pre-harvest basal area remaining in the post-harvest stand. The standardization of these values is

based on protocol requirements that onsite forest carbon stocks be maintained or increased and the minimum rotation age in even-aged management silviculture effectively set at 50 years.

Table B.18. Frequency of Disturbance Classification

Frequency of Disturbance	Harvest Retention	Assumed Years to Next Harvest
Short	> 75% of pre-harvest basal area	Up to 15 years
Medium	51 – 75% of pre-harvest basal area	16 to 35 years
Long	26 – 50% of pre-harvest basal area	36 to 50 years
Very Long	< 26% or pre-harvest basal area	> 51 years

Step 7f: Determining Emissions Associated with Management Activities

For each class of harvested stands, or stands that have received site treatment, a value is determined for each combination of harvest intensity, frequency of disturbance, site preparation, and soil order. A percent value is derived from Table B.19 below based on the combination of the various classes.

Table B.19. Estimated Net Carbon Loss

Harvesting Intensity	Frequency of Disturbance	Site Treatment	Estimated Net Carbon Loss by Soil Order						
			Alfisol	***Andisol***	***Inceptisol***	***Mollisol***	***Spodosol***	***Ultisol***	***Histosol***
Light to Medium	Short	Very Light	0%	0%	0%	0%	0%	0%	80%
	Medium		0%	0%	0%	0%	0%	0%	80%
	Long		0%	0%	0%	0%	0%	0%	80%
	Very Long		0%	0%	0%	0%	0%	0%	80%
High	Short	Very Light	Conifers 0% Hardwoods 20%	0%	8%	0%	10%	9%	80%
		Light	Conifers 5% Hardwoods 20%	5%	8%	5%	10%	9%	80%
		Medium	Conifers 10% Hardwoods 20%	10%	10%	10%	20%	11%	80%
		Heavy	Conifers and Hardwoods 20%	20%	20%	20%	41%	22%	80%
	Medium	Very Light	Conifers 6% Hardwoods 20%	0%	0%	0%	33%	24%	80%
		Light	Conifers 6% Hardwoods 20%	5%	5%	5%	33%	24%	80%
		Medium	Conifers 10% Hardwoods 20%	10%	10%	10%	33%	24%	80%
		Heavy	Conifers and Hardwoods 20%	20%	20%	20%	41%	24%	80%
	Long	Very Light	Conifers 0% Hardwoods 20%	0%	0%	0%	31%	0%	80%
		Light	Conifers 5% Hardwoods 20%	5%	5%	5%	31%	5%	80%
		Medium	Conifers 10% Hardwoods 20%	10%	10%	10%	31%	11%	80%
		Heavy	Conifers and Hardwoods 20%	20%	20%	20%	41%	22%	80%
	Very Long	Very Light	0%	0%	0%	0%	5%	0%	80%
		Light	0%	0%	0%	0%	10%	5%	80%
		Medium	0%	0%	0%	0%	20%	11%	80%
		Heavy	0%	0%	0%	0%	41%	22%	80%

Harvesting Intensity	Frequency of Disturbance	Site Treatment	Estimated Net Carbon Loss by Soil Order						
			Alfisol	***Andisol***	***Inceptisol***	***Mollisol***	***Spodosol***	***Ultisol***	***Histosol***
Very High	Short	Very Light	Conifers 6% Hardwoods 20%	6%	28%	6%	1%	6%	80%
		Light	Conifers 6% Hardwoods 20%	6%	28%	6%	10%	6%	80%
		Medium	Conifers 10% Hardwoods 20%	10%	28%	10%	20%	11%	80%
		Heavy	Conifers and Hardwoods 20%	20%	53%	20%	41%	22%	80%
	Medium	Very Light	Conifers 6% Hardwoods 20%	6%	6%	6%	0%	5%	80%
		Light	Conifers 6% Hardwoods 20%	6%	6%	6%	10%	6%	80%
		Medium	Conifers 6% Hardwoods 20%	10%	10%	10%	20%	11%	80%
		Heavy	Conifers and Hardwoods 20%	20%	20%	20%	41%	22%	80%
	Long	Very Light	Conifers 6% Hardwoods 20%	5%	6%	6%	0%	6%	80%
		Light	Conifers 6% Hardwoods 20%	6%	6%	6%	10%	6%	80%
		Medium	Conifers 6% Hardwoods 20%	10%	10%	10%	20%	11%	80%
		Heavy	Conifers and Hardwoods 20%	20%	20%	20%	41%	22%	80%
	Very Long	Very Light	Conifers 6% Hardwoods 6%	6%	6%	6%	0%	6%	80%
		Light	Conifers 6% Hardwoods 6%	6%	6%	6%	10%	6%	80%
		Medium	Conifers 6% Hardwoods 6%	6%	6%	6%	20%	6%	80%
		Heavy	Conifers 6% Hardwoods 6%	6%	6%	6%	41%	6%	80%

Harvesting Intensity	Frequency of Disturbance	Site Treatment	Estimated Net Carbon Loss by Soil Order						
			Alfisol	***Andisol***	***Inceptisol***	***Mollisol***	***Spodosol***	***Ultisol***	***Histosol***
Conversion	Conversion	Agriculture	30%	30%	30%	30%	30%	30%	80%
		Residential - Commercial	0%	0%	0%	0%	0%	0%	80%
		Timing of Estimated Emissions	30% in first 10 years	30% in first 10 years	30% in first 10 years	30% in first 10 years	30% in first 10 years	30% in first 10 years	8% every 10 years over 100 years

This percentage is multiplied by the soil carbon (CO_2e) estimate on a per acre basis and multiplied by the stand's acres to determine the emissions to report for each stand. The stand emissions are summed to determine the soil carbon emissions (CO_2e) reported annually. An example of the calculation is provided in Table B.20 below. For avoided conversion projects calculating baseline soil carbon, a weighted average must be used, taking into account the decadal soil carbon emissions, as shown in Table B.21.

Table B.20. Example: Calculations for Annual Soil Carbon Reporting

Reporting Year			**2012**						
A	B	C	D	E	F	G	H	I	J
Stand ID	Soil Order	Soil Carbon (tCO_2e) per Acre	Acres	Stand Soil Carbon (tCO_2e)	Harvesting Intensity	Disturbance Frequency	Site Preparation	Estimated Soil Carbon Loss %	Stand Soil Carbon Loss (tCO_2e)
	From Step 1	From Step 6		C **x** D	From Step 7a	From Step 7e	From Step 7d	Table B.19	I **x** E
1	Alfisol	85	595	50,575	Very High	Very Long	Heavy	6%	3,035
2	Alfisol	85	683	58,055	Light - Medium	Short	Very Light	0%	-
3	Alfisol	85	2,232	189,720	High	Long	Light	5%	9,486
Sum of Soil Carbon Emissions (tonnes CO_2e) for 2012									**12,521**

Table B.21. Example: Calculations for Avoided Conversion Baseline Soil Carbon Estimates

Conversion Type			**Agriculture**						
A	B	C	D	E	F	G	H	…	I
Stand ID	Soil Order	Soil Carbon (tCO_2e) per Acre	Acres	Timing of Estimated Emissions	Project Start Date Soil Carbon (tCO_2e)	Soil Carbon after 10 Years (tCO_2e)	Soil Carbon after 20 Years (tCO_2e)	…	Soil Carbon after 100 Years (tCO_2e)
	From Step 1	From Step 6			C **x** D	E **x** F		Table B.19	
1	Inceptisol	70	150	30% of stand soil carbon in first 10 years	10,500	7,350	7,350	…	7,350
2	Histosol	110	3500	8% of stand soil carbon every 10 years	385,000	354,200	323,400	…	77,000

B.2.10 Total Onsite Carbon Stocks and Calculating the Confidence Deduction

Annual reporting is conducted by summing the carbon stocks present at the end of the reporting period in all of the relevant carbon sources, sinks, and reservoirs for the project. The Reserve has developed a Monitoring Calculation Worksheet to assist in the reporting relevant pools and calculation of CRTs. The worksheet is available on the Reserve's Forest Project Protocol webpage in a bundle with the Harvested Wood Products Calculation Worksheet, and contains instructions for its use. Certain reported pools are sampled and the mean estimate is used for

annual reporting. The number reported for the sampled pools is adjusted based on the confidence in the estimate of the carbon. The sampling error is calculated for each of the sampled pools at the 90 percent confidence level and subsequently calculated as a percentage of the mean, using the following steps:

Step 1: Calculate the mean and the standard error[42] of the inventory estimate (for each pool or combined pools where applicable, such as with standing live and dead wood).

Step 2: Multiply the standard error by 1.645.

Step 3: Divide the result in Step 2 by the total inventory estimate and multiply by 100. This establishes the sampling error (expressed as a percentage of the mean inventory estimate from field sampling) for a 90 percent confidence level.

[42] Under certain circumstances, the finite population correction factor is normally required for the calculation of the standard error. As a conservative measure, Project Operators may opt not to apply the finite population correction factor.

Table B.22. Example: Summing All Onsite Carbon Stocks and Calculating the Confidence Deduction

Carbon Pool	Source of Data	Project Type(s)	Required/ Optional	Mean CO_2e (Tonnes per Acre)	Sampling Error at 90% Confidence Level	Sampling Error as a Percentage of the Mean Carbon Pool Estimate
Data Derived from Sampling						
				Example Data		
Standing Live Trees	Sampled within project boundaries	All project types	Required	95	6	6.32%
Standing Dead Trees	Sampled within project boundaries	All project types	Required	6	2	33.33%
Soil Carbon	Sampled within project boundaries	Avoided Conversion	Optional	65	8	12.31%
				Sum of Reported Pools	Calculation of Combined Sampling Error	Calculation of Combined Sampling Error as a Percentage
Summarizing Sampled Data				All Reported Pools from Sampling	Combined Sampling Error as a Percentage*Sum of All Reported Pools from Sampling Used to Determine the Confidence Deduction	$U_S = \frac{((U_1 \mathbf{x} R_1)^2+(U_2 \mathbf{x} R_2)^2+ \ldots+(U_n \mathbf{x} R_n)^2)^{0.5}}{\lvert R_1 + R_2 + \ldots + R_n \rvert}$ *Where*, U_S = percentage uncertainty of the sum U_i = percentage uncertainty associated with pool *i* R_i = removal (emission) estimate for pool *i*
Summary of Example Data from Sampled Pools				**166**	**10.20**	**6.14%**
Data Not Derived from Sampling						
Soil Carbon Emissions	Standardized Guidance	All Projects	Required	-5 (Example)	NA Not Subject to Sampling Error	NA Not Subject to Sampling Error
Sum of Onsite CO_2e Tonnes				**156**	**NA**	**NA**

The per-acre unit must be expanded to the project area based on the number of acres in the project. The sum of onsite CO_2e tonnes for the project is input into the calculation worksheet for annual reporting.

B.2.10.1 Applying a Confidence Deduction to Sampled Estimates

Any forest carbon inventory derived from sampling will be subject to statistical uncertainty. Where statistical confidence is low, there is an increased risk of overestimating a project's actual carbon stocks and therefore a higher risk of over-quantifying GHG reductions and removals. To help ensure that estimates of GHG reductions and removals are conservative,

Project Operators are required each year to apply a confidence deduction to the inventory of actual onsite carbon stocks. A confidence deduction is *not* applied to the forest carbon inventory when it is used to model baseline carbon stocks. Confidence deductions are applied, where appropriate, to estimated onsite forest carbon stocks each reporting period.

The confidence deduction must be updated each time the project is subject to a site visit verification but must remain unchanged between verification site visits. If increased sampling over time results in a lower confidence deduction at the time of a site visit verification, the lower deduction may be applied to inventory estimates in all previous years. The Reserve will issue CRTs in the current year for any increase in quantified GHG reductions and removals in prior years associated with the new (lower) confidence deduction. Conversely, if a loss of qualified sampling plots results in a higher confidence deduction, this higher deduction must also be applied to inventory estimates in all previous years. Any resulting decrease in creditable GHG reductions and removals for prior years will be treated as an avoidable reversal and must be compensated for by retiring CRTs in accordance with Section 7.3.2.

B.2.10.2 Applying a Confidence Deduction to Non-Aggregated Projects

The target sampling error for the combined inventory estimates for non-aggregated projects is +/- 5 percent of the mean at the 90 percent confidence level. Projects that cannot meet this target statistic are still eligible but may have to take a "confidence deduction" that reduces their net reported carbon stocks.

The process for calculating the combined sampling error at the 90 percent confidence level is shown above. The combined sampling error must be compared to the table below to determine the confidence deduction for the reporting period in which a site visit verification has occurred. The confidence deduction shall not be modified in the interim years between site visit verifications. The percent deduction from the table below is input into the calculation worksheet which calculates the net reported onsite stocks.

Table B.23. Forest Carbon Inventory Confidence Deductions Based on Level of Confidence in the Estimate Derived from Field Sampling

Sampling Error (Percent of Inventory Estimate)	Confidence Deduction
0 to 5%	0%
5.1 to 19.9%	(Sampling Error – 5%) to the nearest 1/10 percentage
20% or greater	100%

B.2.10.3 Applying a Confidence Deduction for Aggregated Projects

The target sampling error for the combined inventory estimates for aggregated projects is on a sliding scale based on the number of projects participating within the aggregate. Project Operators enrolled in an aggregate may submit project inventories with reduced sampling requirements based on the statistical principle that the targeted standard error (+/- 5 percent of the mean at the 90 percent confidence level) is achieved across the entire aggregate. Refer to the Reserve Guidelines for Aggregating Forest Projects for the targeted sampling error for individual aggregate participants.

B.2.11 Requirements for Calculating Carbon in Harvested Wood Products

A portion of the carbon in harvested trees continues to be sequestered for long periods of time as wood products. Standardized guidance is provided to account for forest carbon that remains sequestered in harvested wood products. The protocol bases the accounting of harvested wood products on the average amount of carbon sequestered over a 100-year period. The 100-year period is consistent with the Forest Project Protocol's definition of permanence. The average amount of carbon remaining sequestered over the 100-year period is determined by calculating the amount of carbon delivered to the mills, the portion of the carbon that is converted to wood products using a coefficient that estimates the mill's efficiency, and determining the wood product classes manufactured by the mill, as different wood products have different decay rates.

An estimate of the average carbon remaining in use over the 100-year term is provided for each wood product class, which is the basis of baseline and annual reporting of harvested wood products. Furthermore, some wood products eventually end up in landfills where anaerobic conditions serve to reduce the rate of further decomposition. Since the amount of harvested wood products that end up in landfills and the actual decay rate of the wood products in landfills are highly uncertain, the accounting of harvested wood products in landfills is included only when it is conservative to do so. Conservative in this case means that if, in a given reporting year, the amount of harvested wood products in the baseline exceeds the amount of harvested wood products in the project activity, the carbon in landfills is reported. If there is more harvesting of wood products in the project case than in the baseline case, harvested wood products are not considered in either the baseline or the project case.

The Reserve has developed a spreadsheet tool to assist in the calculation of harvested wood products, which is available on the Reserve's Forest Project Protocol webpage. The Harvested Wood Products Calculation Worksheet contains step by step instructions for its use. Project reporting of harvested wood products occurs on an annual basis. The volume of logs delivered to the mill in the baseline case remains static throughout the project life. However, the mill efficiencies and the wood product classes identified in a reporting period are applied to the baseline harvested wood products the same way they apply to the project harvested wood products. The intent of this policy is to provide the best comparison of project activity to baseline activity possible.

The spreadsheet is designed with default values for converting volumetric units from logs delivered to mills to cubic feet and the values of mill efficiencies to be used on a geographic basis. The annual reporting of carbon in trees harvested for wood products is based on the relative proportion of volume in trees harvested for wood products and volume delivered to the mill(s) in the baseline case. Therefore, the reporting of volume delivered to mills is essential to calculating the volume in trees harvested for wood products.

Mill efficiency estimates from the actual mills the project logs are delivered to can be used if data exists to support the claim in a form that can be verified. Users must identify the mill(s) the project logs are delivered to and input the volume that is manufactured into lumber, plywood, oriented strand board, non-structural panels, miscellaneous products, and paper/pulp. Where the wood product class is unknown, the Project Operator must classify the product as miscellaneous products. In order to quantify unknown products categorized as miscellaneous conservatively, miscellaneous products are assigned a default storage factor of zero.

Project Operators must provide an affidavit from the mill that the reported wood product classes are reasonable according to production records at the mill, unless they use the default product classes provided in the Assessment Area Data file. Again, the wood product classes reported for a given reporting year apply both to the project and the baseline case which eliminates the calculation of project benefits or detriments based on comparisons of the decay rates of wood products alone.

B.2.12 Improved Forest Management Leakage

Secondary Effects, or leakage, reflect market responses to changes in harvesting levels. The general assumption in this protocol is that modifying harvest in a Forest Project relative to baseline harvesting levels will lead the market to compensate via modifications to harvesting levels by other landowners. The greater the change in harvest by a Forest Project relative to baseline levels, the greater the response by the market to compensate.

Market leakage effects are accounted for under Improved Forest Management Projects by considering the impacts of shifting activities over the life of the project. Recognizing that risk of Secondary Effects from a project may be influenced by long term harvesting trends, the evaluation in Equation 6.10 considers cumulative harvest amounts since project inception. In some years, Secondary Effects may be negative, if project harvesting is below baseline harvesting (on both a cumulative and individual reporting period basis). If project harvesting later increases, deductions for prior negative Secondary Effects can be recouped. However, once all prior negative Secondary Effects are recouped, Secondary Effects when actual harvested carbon exceeds baseline harvested carbon are zero – under no circumstances shall the net balance of the Secondary Effects over the course of a project be positive. However, positive Secondary Effects may accrue as uncredited positive carryover that can counteract the amount of future negative Secondary Effects applied if baseline cumulative harvested carbon were to exceed actual harvested carbon again. Accruals of positive Secondary Effects carryover and their application against future negative Secondary Effects, if they occur, are calculated within the calculation worksheet.

Table B.24. Examples: How Secondary Effects Can Be Recouped and Positive Carryover Can Be Applied Over Time

a. Qualitative example

Reporting Period	Greater of Actual or Baseline		Protocol Equation Reference	Secondary Effect
	Annual	Cumulative		
1	Baseline	Baseline	Equation 6.10.B	Negative Secondary Effect resulting in deduction applied to GHG reductions
2	Actual	Baseline	Equation 6.10.B	Positive Secondary Effect resulting in recouping of previously deducted GHG reductions up until the cumulative Secondary Effect is zero
3	Actual	Actual	Equation 6.10.A	No Secondary Effect, excepting any previous negative Secondary Effect deductions that have not been recouped and including any positive Secondary Effects that are carried over to the following year
4	Baseline	Actual	Equation 6.10.C	No Secondary Effect, though adjusting any positive Secondary Effect carryover and carrying forward any remaining balance to the following year
5	Baseline	Baseline	Equation 6.10.B	Negative Secondary Effect resulting in deduction applied to GHG reductions, with deduction lowered by any positive secondary effects carryover from when actual cumulative harvest carbon exceeded baseline cumulative harvested carbon

b. Quantitative example

Reporting Period	1	2	3	4	5
Annual actual carbon in harvested trees	500	**1,400**	**1,400**	800	800
Annual baseline carbon in harvested trees	**1,000**	1,000	1,000	**1,000**	**1,000**
Cumulative actual carbon in harvested trees	500	1,900	**3,300**	**4,100**	4,900
Cumulative baseline carbon in harvested trees	**1,000**	**2,000**	3,000	4,000	**5,000**
Cumulative difference between actual and baseline C in harvested trees	(500)	(100)	300	100	(100)
Annual difference between actual and baseline C in harvested trees	(500)	400	400	(200)	(200)
Gross annual Secondary Effects	(100)	80	80	(40)	(40)
Adjusted gross annual Secondary Effects, not allowing positive cumulative Secondary Effects but not including positive Secondary Effects carryover	(100)	80	20	0	(40)
Carryover of positive Secondary Effects from prior year	NA	0	0	60	20
Net annual Secondary Effects	**(100)**	**80**	**20**	**-**	**(20)**

B.3 Modeling Carbon Stocks

This protocol requires the use of certain empirical models to estimate the baseline carbon stocks and project stocks of selected carbon pools within the project area for private land IFM projects (with the exception of the IFM default baseline approach). These models may also be used to supplement assessments of actual changes in carbon stocks resulting from the forest project.

B.3.1 Models and their Eligibility for Use with Forest Projects

Empirical 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 (standing live and dead trees) provide the base input data for these models. Project Operators should be careful to ensure that all required data inputs for the models are included in the inventory methodology.

The models that simulate growth projections have two basic functions in the development and management of a forest project. Models project the results of direct sampling through simulated forest management activity. These models, often referred to as growth and yield simulation models, may project information regarding tree growth, harvesting, 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.

Models are also used to assist in updating inventory plots so that the plots can represent a reporting year subsequent to their actual sample date. The model simulates the diameter and height increment of sampled trees for the length of time between their sampled date and the reporting year. Plot data can be projected for the length of time the projection method is expected to accurately reflect actual forest growth. Inaccurate updating of plot data can lead to the inability of a project to be verified. Verifiers are directed to randomly select plots or stands for verification. If the Project Operator's estimates deviate from the verifier's measurements, the verification will fail. Hence, it is required that plot data be no older than 12 years.

The following growth models have been approved:

- 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
- FORESEE

A Project Operator may update inventory plot data for estimating diameter and height growth by incorporating data obtained from sample plots, as in a stand table projection. An example of an appropriate method of applying a stand table projection is as follows:

1. The project area is stratified into even-age management and uneven-age management.

2. Diameter increment shall be based on the average annual increment of a minimum of 20 samples of radial growth for diameter increment for each 8 inch diameter-at-breast-height (DBH) class, beginning at 0 to 8 inch DBH for each management type (even-age or uneven-age). The average annual increment shall be added for each year according to the plot's sample date.
3. Height increment is based on regression curves for each management type (even-age or uneven-age) developed from height measurements from the same trees the diameter increment data was obtained. The estimated height shall be determined using the regression estimators for the 'grown' diameters as described above.

The Reserve may include additional models following approval of a state forestry authority (i.e., a state agency responsible for oversight of forests) who will acknowledge in writing 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 area
- Limits use to the scope for which the model was developed and evaluated
- Is clearly documented with respect to 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

B.3.2 Using Models to Forecast Carbon Stocks

The use of simulation models is required for estimating a forest project's baseline carbon stocks (with the exception of projects using the Improved Forest Management default baseline approach). Models may also be required to forecast actual carbon stocks expected under the forest project (e.g., in conjunction with determining expected harvesting volumes or in updating forest carbon inventories).

Standing live tree information must be incorporated into the simulation models to project 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. Standing dead trees must be assumed to be static over the baseline modeling. Exceptions to this rule are allowed if approved in writing by the Reserve prior to verification.

Projected 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 forest project's start date. 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.

B.3.3 Modeling Requirements

A modeling plan must be prepared that addresses all required forecasting of baseline carbon stocks for the forest project (with the exception of projects using the Improved Forest

Management default baseline approach). The modeling plan shall contain the following elements:

1. A description of all silviculture methods modeled. The description of each silviculture method will include:
    a. A description of the trees retained (by species groups if appropriate) at harvest.
    b. The harvest frequency (years between harvests) for each silviculture method modeled.
    c. Regeneration assumptions.
2. A list of all legal constraints that affect management activities on the project area. This list must identify and describe the legal constraint, how the legal constraint affects the project area, and discusses the silviculture methods that will be modeled to ensure the constraint is respected.
3. A description of the site indexes used for each species and an explanation of the source of the site index values used.
4. A description of the model used and an explanation of how the model was calibrated for local use, if applicable.

Modeling outputs must include:

1. Periodic harvest, inventory, and growth estimates for the entire project area presented as total carbon tonnes and carbon tonnes per acre.
2. Harvest yield streams on modeled stands, averaged by silviculture method and constraints, which must include the period over which the harvest occurred and the estimated CO_2e of wood (CO_2e in logs delivered to mills) removed.