CLIMATE FORWARD

Reduced Emissions from Megafires Forecast Methodology

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A program of the CLIMATE ACTION RESERVE

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Abbreviations and Acronyms

CO	Carbon monoxide
CO_2	Carbon dioxide
CH_4	Methane
FFE-FVS	Fire and Fuels Extension to the Forest Vegetation Simulator
FOFEM	First Order Fire Effects Model
FVS	Forest Vegetation Simulator
g	Gram
GHG	Greenhouse gas
kg	Kilogram
t	Metric ton (or tonne)
NMVOC	Non-methane volatile organic compounds
N_2O	Nitrous oxide
$PM_{2.5}$	Particulate matter, 2.5 micrometers or smaller
Reserve	Climate Action Reserve
SSR	Source, sink, and reservoir

1 Introduction

The Climate Action Reserve (Reserve) is an environmental nonprofit organization that promotes and fosters the reduction of greenhouse gas (GHG) emissions through credible market-based policies and solutions. Based in Los Angeles, the Reserve is the foremost carbon offset registry in North America with internationally recognized expertise in project-level GHG accounting. The Reserve establishes regulatory-quality standards for the development and quantification of GHG emission reduction projects; issues GHG emission reduction credits for use in compliance and voluntary carbon programs; and tracks the transaction of credits over time in a transparent, publicly-accessible registry system. Adherence to the Reserve's standards ensures that emission reductions associated with projects are real, permanent, and additional, thereby instilling confidence in the environmental benefit, credibility, and efficiency of carbon markets.

Climate Forward is a program of the Climate Action Reserve that issues greenhouse gas emission reduction credits on an *ex ante* basis to facilitate early investment in a wide array of innovative emission reduction projects. Climate Forward accelerates action on climate change by encouraging companies to make proactive investments now to mitigate their future emissions, with a goal of expanding the scope and scale of feasible emission reduction project types. Climate Forward facilitates investments in GHG reduction activities that are practical, scientifically-sound, transparent, and aligned with forward-looking mitigation needs, on a voluntary or compliance basis, such as the California Environmental Quality Act (CEQA). Under Climate Forward, estimated GHG reductions from the mitigation project are recognized as Forecasted Mitigation Units (FMUs), which are each equal to one metric ton of carbon dioxide equivalent (CO_2e) expected to be reduced or sequestered.

The Reduced Emissions from Megafires (REM) Forecast Methodology quantifies anticipated GHG emission reductions from the implementation of fuel treatments in forests in the Western United States[1] that are at risk for high severity wildfire due to fire-suppression and past harvesting history. Fuel treatments may consist of thinning, focused mainly on the removal of smaller diameter trees and understory vegetation, and reducing surface fuels through chipping, piling and burning, and/or prescribed fire. The implementation of fuel treatments aims to reduce high severity wildfire which, in turn, moderates GHG emissions. Projects involve implementing strategic fuel treatments to modify fire behavior such that fire severity, and its impact on forest vegetation, are reduced compared to the "business as usual," or baseline, scenario of no fuel treatment.

Project areas under this methodology include the locations of the treatment areas as well as treatment shadow areas expected to benefit from the treatment areas that are determined through modeling fire behavior (Figure 1.1). Since multiple treatment sites are likely to occur in a project area, the project area is also expected to contain some sections that do not experience a change in fire behavior between treatment sites. The quantification of reduced emissions from fuel treatments under this methodology includes accounting for forest carbon, emissions from fires, carbon in wood products, and mobile emissions, both within the treatment area and within the balance of the project area, for both the baseline (without treatment) and project (with treatment). Additionally, the emissions benefits from fuel treatments are considered within the context of the likelihood of a fire occurring each year.

[1] States currently eligible include Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, and Washington, and Wyoming.

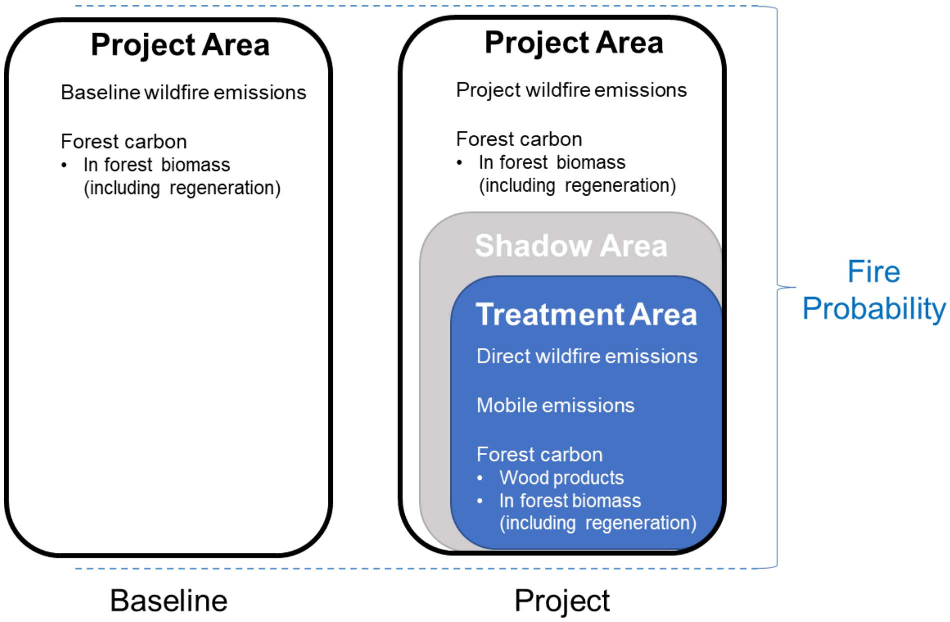


Figure 1.1. Reduced Emissions from Megafires Project Conceptual Outline

As a result of modified fire behavior and severity, fuel treatments can also provide significant carbon benefits with respect to post-fire recovery. High severity fire can result in a burned site remaining out of forest cover and in an early successional shrub phase for prolonged periods. Areas that have undergone fuel treatments, however, are likely to experience fires with reduced severity, allowing forest regeneration to occur more readily and rapidly.

In addition to such GHG benefits, fuel treatments can also provide an array of non-GHG benefits, including reduced chances of major negative impacts on human life and infrastructure, prevention of erosion and reduced water quality, protection of recreational resources, and the prevention of air pollution.

Fuel treatments are typically not considered a feasible project activity under traditional carbon offset crediting programs owing to the initial carbon loss resulting from the removal or manipulation of forest biomass to reduce wildfire risks, the long period of time before a project would achieve sufficient *ex post* climate benefits for crediting, and the relatively high initial and ongoing project costs until such net climate benefits could be shown and payments for resulting credits are received. This misalignment between project costs and potential revenues from credit generation provides a barrier to entry that would be difficult to overcome by most would-be project proponents. The *ex ante* approach under this methodology recognizes and credits for the future climate benefits resulting from fuel treatment activities, thus helping to finance a substantial portion of project activity costs. In doing so, the methodology expands the scope of GHG mitigation projects recognized by the market, especially for mitigation projects that would not happen otherwise.

In addition to addressing the financial challenge such projects face with respect to timing of initial costs and delayed revenue associated with more traditional carbon credit sales, this methodology also addresses the broader funding shortfall for ever-growing wildfire concerns. Even with increased funding commitments from state and federal agencies to address forest health and fuel concerns in recent years, such funding remains significantly inadequate to treat the acreage that has been identified as being at high risk as a result of fuel conditions.

Furthermore, lack of adequate funding today will only exacerbate the situation, leading to more acres in need of treatment in the future as fuel loading increases to dangerous levels on sites that may have previously been at lower risk levels. Crediting under this methodology provides a much-needed incentive for private funding to play a significant role in being a part of the solution to the problem.

Overall, this methodology is designed to ensure the complete, consistent, transparent, accurate, and conservative *ex ante* quantification and confirmation of GHG emission reductions associated with REM projects,[2] including in relation to tree biomass removed during project activities. Furthermore, programmatic monitoring of project sites over time by the Reserve provide the opportunity for adjustments to be made to the methodology to improve the accuracy and conservativeness of the FMUs quantified and issued to projects registering under this methodology.

[2] See the WRI/WBCSD GHG Protocol for Project Accounting (Part I, Chapter 4) for a description of GHG reduction project accounting principles.

2 The GHG Reduction Project

2.1 Project Definition

A Reduced Emissions from Megafires (REM) project is an activity, or set of activities, on forestlands that results in reduced wildfire emissions compared to wildfire emissions under "business as usual" activities, which are assumed to be the absence of fuel treatments to reduce fuel loading, recognizing that existing efforts that were previously fully government-funded may not be eligible under this methodology. The type, size, and distribution of fuel treatments all shape their effectiveness (Coen et al., 2018; Thompson et al., 2017). Eligible project activities include the following:

- Mastication: Grinding, shredding, or chopping "noncommercial sized trees or shrubs into small chunks or pieces. The method does not reduce biomass; rather, the operator creates these small pieces and places them in contact with the soil surface to decompose" (Jain et al., 2012).
- Broadcast, prescribed, or cultural burning (hereafter collectively referred to as 'prescribed burning'): "[C]ontrolled applications of fire to fuels, under specified environmental conditions that allow fire to be confined to a predetermined area and produces the fire behavior and fire characteristics required to meet forest health objectives identified in a burn plan" (USDA Forest Service, n.d.).
- Thinning: Removal of selected trees by hand or mechanical means, which may include the removal of some merchantable trees. Typical silvicultural prescriptions include the removal of biomass to a target stand density index (SDI), trees per acre, basal area, increase of canopy base height, minimum and/or maximum diameter at breast height (DBH) limit, and species selection (Agee and Skinner, 2005). Under this methodology, thinning operations must achieve the following minimum outcomes:
    1. The Quadradic Mean Diameter of thinned forest stands must increase on average following fuel reduction activities.
    2. Basal area shall be reduced following thinning to no less than 50 square feet of basal area per acre on average.
- Pruning: Removal of branches on the lower segments of a tree to reduce torching risk, i.e., crown ignition resulting from surface fires climbing into tree crowns.
- Mechanical removal of surface fuels: e.g., yarding and/or aggregating dead biomass such as branches and tops after a harvest to a designated location with the intent to pile-burn or dispose of off-site.

Projects may consist of an individual fuel treatment activity or a combination of multiple activity types within a single project, as long as the activities occur within a 3-year timeframe following the initiation of the first activity. Subsequent activities will require that a new project be initiated unless an extended timeframe for project activity completion has been approved by the Reserve, as described in Section 3.2.

2.2 The Project Proponent

The "project proponent" is an entity that has an active account on the Climate Forward registry, submits a project for listing and registration with Climate Forward, and is ultimately responsible for all project reporting and confirmation. The project proponent is the entity undertaking (organizing, planning, and/or implementing or overseeing the implementation of) the actions that will generate GHG reductions and therefore owns the GHG reductions and removals attributed to the project. In all cases, the project proponent must attest to the Reserve that they have exclusive claim to the GHG reductions and removals resulting from the project. At the time a project is confirmed, the project proponent must attest that no other entities are reporting or claiming (e.g., for voluntary reporting or regulatory compliance purposes) the GHG reductions or removals claimed by the project. Furthermore, the project proponent must notify all fee owners on whose lands fuel treatment activities are occurring that the project is being submitted to the Reserve. The Reserve will not issue FMUs for GHG reductions or removals that are reported or claimed by entities other than the project proponent.

See Section 3.6 for additional information about FMU ownership and Section 8.4.1 for guidance around confirmation of this requirement.

3 Eligibility Rules

REM projects that meet the definition of a GHG reduction project (Section 2.1) must fully satisfy the following basic eligibility rules to register with Climate Forward. See the remainder of this section for full details about all eligibility requirements.

Eligibility Rule I:	Location	→	*Under forest cover for at least 20 years*
		→	*On privately owned and/or public forestlands, including tribal lands, within an eligible state*
Eligibility Rule II:	Project Start Date	→	*Based on the date fuel treatment activities are initiated, with project submitted within 12 months of start date*
Eligibility Rule III:	Additionality	→	*Exceeding regulatory requirements*
Eligibility Rule IV:	Environmental and Social Safeguards	→	*In compliance with all applicable environmental laws*
		→	*Providing notification to relevant local resource management entities of project activities*
Eligibility Rule V:	Regulatory Compliance	→	*In compliance with all relevant rules and regulations pertaining to project activities, including acquisition of all relevant permits*
Eligibility Rule VI:	Ownership and Double Counting	→	*Having clear ownership of rights to GHG emission reductions from the project*
		→	*Not receiving credits from more than one program for the same project activities, where GHG boundaries overlap, except as specifically allowed*

3.1 Location

Location requirements are as follows:

- REM projects can be implemented on private or public lands, including tribal lands,[3] in the Western United States (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming), provided requisite data are available for project quantification, as described in Section 6, and provided they meet all other eligibility requirements described in this methodology.
- REM projects must be located on forestlands under tree cover (i.e., having greater than ten percent tree[4] canopy cover) for at least 20 years, with the project area defined by

[3] Tribal lands include land owned in fee by a tribe as a private entity as well as land held in trust by the US Department of Interior, Bureau of Indian Affairs, for the benefit of a tribe.

[4] For purposes of this methodology, a tree is defined as 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.

those areas where fire behavior may be influenced by the activities listed in Section 2.1, based on the requirements specified in Section 6.2.

Additionally, since forest conditions change and fuel treatment effectiveness diminishes over time, projects may be located on sites where a project has been previously registered under this methodology (based on project area or specific activity areas within a project area), so long as all other eligibility requirements under the version of this methodology in effect at the time of project submission are met, including the additionality requirements specified in Section 3.3, and vegetation and fuel model data serving as the basis for modeling is updated to reflect the conditions resulting from the previously registered project, as described in Section 6.3. Furthermore, REM projects may be located on sites where existing projects of the following types are also located:

- Forest carbon projects, so long as such forest carbon projects are in good standing, regardless of whether the project is currently active or has been completed at the time any co-located REM project undergoes confirmation;
- Biochar carbon project, for which feedstocks derived from eligible fuel treatment activities are sourced from treatment areas associated with a REM project.

Project proponents must obtain approval and guidance from the Reserve prior to such project stacking, as further described in Section 3.6, including for additional project types not listed above, as well as with projects registered with programs other than those administered by the Reserve.

3.2 Project Start Date and Crediting Period

The project start date is the date fuel treatment activities are initiated in accordance with the project definition described in Section 2.1.

- Projects with start dates on or after 12 months preceding the publication date of this methodology are eligible.
- The project must be submitted to Climate Forward for listing no more than one year after the project start date or the publication date of this methodology, whichever is later.
- The confirmation of the project must be completed no later than one year after the last activity has been completed, with project activities being completed within three years after the project start date, though projects may be allowed to complete project activities beyond three years with approval from the Reserve.

A crediting period is the length of time over which GHG emission reductions are forecasted and quantified. The crediting period under this methodology is 40 years. All projects that pass the eligibility requirements set forth in this REM methodology as of the project start date are eligible to register FMUs with Climate Forward for the duration of the project’s crediting period. Emission reductions for each project will be calculated as the sum of the forecasted emission reductions realized over the crediting period.

Although the quantification of FMUs is based on modeling performed over the entirety of the 40-year crediting period, in most cases, treatment benefits will attenuate over time, as further described in Section 6.7. As fuel conditions under the baseline and project scenarios become more similar (under the assumption that no further fuel reduction activities are performed on the project’s treatment areas), the impacts from any wildfires occurring also become similar. The length of time over which this convergence occurs depends on a variety of factors, including the forest type involved and the intensity of the treatments. In some cases, fuel conditions under the baseline versus under the project may remain significantly different through 40 years. In any event, the benefits associated with diminishing the extent of the area experiencing delayed post-fire reforestation would extend well beyond the point at which fire behavior under the baseline and project scenarios converge, even in situations where that convergence occurs well before 40 years.

3.3 Additionality

The Reserve registers only projects that yield surplus GHG reductions that are additional to what would have occurred in the absence of the project. To ensure additionality, the baseline management scenario must be based on an analysis of the risks of emissions resulting from fire under the current forest structural and fuel conditions and subsequent changes to those conditions over time in the absence of the fuel treatment activities. The baseline scenario needs to clearly identify and justify the trajectory for forest structural and fuel conditions over the crediting period, as further described in Section 6.

REM projects must satisfy the following tests to be considered additional:

1. The Performance Standard Test
2. The Legal Requirement Test

3.3.1 The Performance Standard Test

Projects pass the performance standard test by meeting a methodology-wide performance threshold that is applicable to all prospective projects, established on an *ex ante* basis. The performance standard threshold represents “better than business as usual.” Given current hazardous fuel loading conditions of forests in the United States, the backlog of areas that would benefit from treatments, the low prevalence of fuel treatment activities, and their typical inability to provide revenues that fully cover the costs of such activities, project activities meet the performance standard to the extent they are forecasted to reduce GHG emissions below what would have occurred under the “business as usual” scenario outlined by the baseline estimation requirements in Section 6.

3.3.2 The Legal Requirement Test

All projects are subject to a legal requirement test to ensure that the GHG reductions achieved by a project would not otherwise have occurred due to any law (including any rules, regulations, or other legally binding mandates) issued by any authority with jurisdiction over the project area. The project proponent must also demonstrate that the project was not established or implemented at any time prior to the start date, in anticipation of, or to avoid or satisfy the anticipated requirements of any law.

The legal requirement test is applied at the time of a project’s start date. To satisfy the legal requirement test, project proponents must submit a signed Attestation of Legal Additionality form prior to the commencement of confirmation activities. In addition to the attestation, the Project Implementation Report must demonstrate that the project passes the legal requirement test at the time of a project’s start date by describing the laws and regulations pertaining to the management of forestlands at the project location. Projects must pass this test at the project’s start date to register reductions with Climate Forward for the duration of the crediting period, and credit issuance is not impacted if legal requirements change or new legal requirements are enacted during that period (i.e., crediting is based on the market conditions at the time the project is initiated, not in response to unanticipated future legal or regulatory requirements that might have altered project financials if known at the time). The confirmation body must confirm the Attestation of Legal Additionality by reviewing evidence provided by the project proponent, and any other evidence they feel is necessary such as literature reviews, independent expert testimony, letters from relevant government agency representatives, or other means.

3.3.3 Enhancement Payments

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

- California Climate Investments (CCI);
- United States Department of Agriculture (USDA), Forest Service grants and agreements;
- USDA Natural Resources Conservation Service grants and agreements.

Project proponents and/or landowners whose forests comprise fuel treatment areas as part of a project under this methodology may pursue enhancement payments that support fuel treatment activities. Projects receiving enhancement payments that cover 50% or less of the expected costs to implement fuel treatments are considered additional under this methodology. Projects receiving or expecting to receive payments covering more than 50% of the expected fuel treatment implementation costs are not automatically considered additional under this methodology and must obtain approval from the Reserve, which maintains the right to determine whether such payment stacking impacts project eligibility since high levels of financing could call into question the additionality of a project. Project proponents are strongly encouraged to contact the Reserve as early as possible, including prior to initial submission, when considering stacking enhancement payments with a project in this way. Furthermore, they must disclose any such payments to the Reserve at the time of listing and to the confirmation body at the time of confirmation.

3.4 Environmental and Social Safeguards

REM projects can create long-term climate benefits as well as provide other environmental benefits, including the sustaining of natural ecosystem processes. However, projects that are not carefully designed may result in adverse environmental impacts. To be in conformance with this methodology, REM projects, at the time of initial project confirmation, must demonstrate that the fuel treatments adhere to environmental regulations such as wildlife habitat restrictions, stream buffer zone management regulations, or cultural provisions, as further specified in Section 3.5. Projects involving the draining or flooding of wetlands are prohibited under this methodology.

Additionally, the project proponent must describe in the Project Implementation Report how the project will have impacts (positive or negative) on environmental and social issues such as air and water quality, endangered species and natural resource protection, and environmental justice. This may include discussion of how the project aligns with the United Nations' Sustainable Development Goals,[5] as well as the optional quantification of any non-GHG benefits—though such quantification is not specified by this methodology.

All projects must be disclosed to local resource management groups involved in planning and implementing activities that reduce fuel loads, such as resource conservation districts, fire safety councils, and government agencies. Disclosure means:

[5] Additional information regarding the Sustainable Development Goals may be found online at https://sustainabledevelopment.un.org/.

1. Projects must be submitted with a fuels management plan that indicates proposed management activities over time and space for a planning period of at least five years into the future from the project start date.
2. Information pertaining to fuel treatments associated with the project must be provided to relevant local resource management groups to establish awareness of such activities prior to implementation. Such notifications must be documented by the project proponent and must include information about treatment locations, a description of the treatment(s) to be performed, and the timing of activities.

3.5 Regulatory Compliance

The project proponent must sign an Attestation of Regulatory Compliance prior to the commencement of project confirmation activities, attesting that no laws have been broken in the implementation of the project. Any permitting requirements applicable prior to the implementation of the project activities addressed in this methodology (e.g., timber harvest plan, water quality permit) must be described in the Project Implementation Report, including a description of the status in regard to fulfilling any such requirements at the commencement of confirmation activities. The project proponent must provide existing applicable authorizations, permits, and certifications from the appropriate authorities required for project operations to the confirmation body at the commencement of confirmation activities. The project proponent must also provide an assessment of any aspects of the project that may present a risk of future regulatory violations. Where such risks are identified, the project proponent shall describe measures undertaken to reduce and/or mitigate these risks. The confirmation body shall endeavor to confirm that the project implementation did not result in any regulatory noncompliance.

3.6 Ownership and Double Counting

Under this methodology, emissions reductions resulting from the project activities, as quantified according to Section 6, are considered to be owned by, and consequently issued to, the project proponent. Thus, emissions reductions forecasted to occur in shadow areas owned by entities that are not party to the project would still be owned by and issued to the project proponent implementing the fuel treatment activities. Shadow area landowners who are not undertaking fuel treatment activity(ies) under the project are not contributing to the reduction in GHG emissions quantified under this methodology and thus have no claim to the resulting credits. Furthermore, the implementation of a project under this methodology does not require any management actions on the part of such shadow area landowners nor does it restrict or otherwise impact their ability to conduct ongoing or future management activities on their lands.

The project proponent must provide a signed Attestation of Title document for each project, attesting to their ownership of all GHG emission reductions generated by the project and that the project is not being submitted for emission reductions credits under any other carbon crediting program world-wide. This signed attestation, and any necessary supporting evidence, must be provided to the confirmation body. In addition to the Attestation of Title, confirmation bodies may wish to review relevant contracts, agreements, and/or supporting documentation between project proponents and other parties that may have a claim to the FMUs generated by the project.

By signing the Attestation of Title, the project proponent attests that the FMUs have not and will not be registered with, reported in, held, transferred or retired via any emissions registry or inventory other than the Climate Forward registry, or registered with Climate Forward under a different project title or location. However, as described in Section 3.3.3, projects for which enhancement payments are pursued by the project proponent may still be eligible. Furthermore, as described in Section 3.1, if the project area encompasses any land included as part of a prior REM project or as part of a forest, biochar, or other relevant carbon project type (whether closed or actively reporting) in good-standing with the program in which it was or is enrolled, the project may still be eligible. Such REM projects remain subject to the quantification requirements of this methodology, including the use of vegetation and fuels data that accurately reflect conditions present prior to the start of the project as impacted by prior or existing projects, as well as the quantification adjustments specified in Section 6.11. Additionally, any such project stacking must be disclosed to the Reserve when the project is submitted for listing, at which time Reserve staff will determine if stacking is approved and will provide guidance on any further adjustments that may be required of the project.

3.7 Project Resilience Measures

By implementing the project activities as outlined in Section 2.1, forest conditions are changed in ways that inherently reduce the impacts of future wildfires in the project area relative to the baseline scenario—no further actions are required to maintain or manage the forest in a particular way once fuel treatments are completed. The quantification approach under this methodology forecasts the climate benefits associated with the fuel treatment activities modeled under the project scenario, with the assumption that no further fuel treatments occur on the treatment areas for the duration of the crediting period. Therefore, additional measures are not required to be taken by the project proponent during the project's crediting period to ensure the projected climate benefits are achieved. Nevertheless, project proponents are allowed to submit projects on locations where projects have been previously registered under this methodology, as described previously in Sections 3 and 3.6, and are thus incentivized to conduct fuel treatments again in the future to maintain the resilience of the forest.

Major risk categories for the emission of carbon stocks from trees within a project area are generally the same (e.g., timber harvest, land use conversion), but these risks—including from wildfires—are either reduced by fuel treatments within the crediting period or are accounted for under both the baseline and project scenarios during credit quantification, as described in Section 6.3. Additionally, the risk of land use conversion in ways that would impact credit integrity is expected to be minimal since project areas under this methodology are anticipated to be in rural settings, where forest conversion typically focuses on rural residential development that removes relatively few trees and reduces surface fuels.

3.8 Ensuring Permanence

Although forest carbon stocks are inherently at risk of being released into the atmosphere, the focus of credit quantification under this methodology is on the emissions that are reduced by undertaking fuel treatment activities that modify future wildfire behavior. While changes in forest carbon stocks are projected as part of the quantification approach, stocking levels are generally lower under the project scenario than under the baseline scenario and are thus not the basis for credit issuance. Rather, it is the lowering of emissions resulting from fires that is the basis for the credits that are issued to a project. As a result, none of the credits issued under this methodology are reversible. As stated by Buchholz et al. (2022), "through a probability-based carbon accounting framework […] stochastic events such as wildfire occurrence within a carbon offset project boundary would not be classified as reversal in the first place, but as an integral part of the ecological process." In fact, the loss of forest carbon within project areas is acknowledged as being likely during the crediting period of each project if and when wildfires or other disturbances occur. However, such losses are either reduced as a result of the project activities or are factored into both baseline and project scenarios as a part of credit quantification, as described in Section 6.3. Further risks to credit integrity are addressed in Sections 6.7 and 6.8.

3.9 Demonstration of *Ex Ante* Suitability

Fuel treatment activities under REM projects are suitable for *ex ante* estimates for several reasons:

- The climate benefits from fuel treatment activities are not immediate and have a range of time over which they may be realized, dependent on when a fire occurs on the project area.
- There are credible ways to quantify the climate benefits of fuel treatment activities on a forward-looking basis, as is further described in Section 6, which takes into account the understood effectiveness period following fuel treatment implementation and forecasts the emissions reductions based on a projection of probabilistic future emissions from wildfires.
- The climate benefits of fuel treatments quantified under this methodology are based solely on the successful implementation of such treatments and the resulting conditions in the forest upon their completion. Future and ongoing management activities within treatment areas are not a component of the climate benefits quantified under this methodology.

4 The Project Area

The effects of fuel treatments extend beyond those areas where they are installed, into even broader areas, referred to as 'shadow areas', where fire behavior is moderated as well. Shadow areas may extend across multiple landowners. Fuel treatments can also result in reduced individual fire size compared to the baseline of no fuel treatment activity, further limiting emissions (Fulé et al., 2003; Liang et al., 2018; Miller et al., 2009; Moghaddas et al., 2010; Moghaddas and Craggs, 2007; Peterson et al., 2005; Stephens et al., 2009a; Stephens et al., 2009b; Stephens et al., 2012).

Under this methodology, the project area is defined by the geographic area having potentially modified fire behavior and reduced fire severity as a result of fuel treatment activities and is delineated based on the guidance outlined in Section 6.2. It consists of individual treatment areas (i.e., the spatial extent of where a given fuel treatment activity occurs or set of coinciding fuel treatment activities occur) and untreated areas where the indirect effects from project activities are quantified (see Figure 1.1). The project area must be a contiguous spatial unit, whereas treatment areas may be disparate polygons but are otherwise within the spatial extent of the project area.

Treatment areas must be delineated according to the spatial extent of fuel treatment activities, i.e., where treatments were actually implemented, as opposed to where treatments had been planned. Where conditions allow, treatment area boundaries may be delineated using remotely sensed data. Otherwise, treatment area boundaries must be field-logged using a GPS device. Each treatment area must be delineated by fuel reduction activity type or combination of activity types (as defined in Section 2.1). Depictions of treatment areas and the project area must be made available as maps and GIS shapefiles for project reporting and confirmation. Treatment and project area GIS layers are used to conduct the quantification of GHG reductions and removals, as described in Section 6, and are reviewed by the confirmation body during the confirmation process, as described in Section 9.4.2.

As previously stated in Section 1, projects may be composed of treatment areas on multiple ownerships and individual treatment areas may cross ownership boundaries.

5 The GHG Assessment Boundary

The GHG Assessment Boundary defines all the GHG sources, sinks, and reservoirs (SSRs) that must be assessed by project proponents in order to determine the net change in emissions caused by a REM project,[6] including forest carbon stocks, sources of biological CO_2 emissions, and mobile combustion GHG emissions.

For accounting purposes, the SSRs included in the GHG Assessment Boundary are organized according to whether they are predominantly associated with a REM project's "primary effect" (i.e., the REM 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 REM project). Secondary effects may include increases in mobile combustion CO_2 emissions associated with project implementation, as well as increased CO_2 emissions caused by the shifting of emissions from harvesting activities from the project area to other forestlands or from the shifting of product use (often referred to as "leakage"). See Section 4 for a discussion on secondary effects.

Table 5.1 provides a comprehensive list of the GHG SSRs that may be affected by a REM project and indicates which SSRs must be included in the GHG Assessment Boundary.

Table 5.1. Description of all Sources, Sinks, and Reservoirs

SSR	SSR Description	Baseline/ Project	GHG	Included ?	Justification/Explanation
Primary Effect Sources, Sinks, and Reservoirs					
1	Standing live tree carbon (carbon in all portions of living trees)	**Baseline:** Modeled changes to stands over time based on growth, harvest, and fire **Project:** Modeled changes to stands over time based on fuel treatment activities, growth, harvest, and fire	CO_2	Yes	Changes in standing live trees and their associated carbon stocks are an important factor determining project outcomes relative to the baseline, both in relation to onsite carbon and potential emissions from wildfires. Fire can partially combust and/or modify live carbon in trees to dead carbon in trees. Emissions associated with combustion (see SSR 9) and the loss of future carbon sequestration in standing live trees is the largest primary effect of REM projects.
2	Shrubs and herbaceous understory carbon	**Baseline:** Modeled changes to stands over time based on growth, harvest, and fire **Project:** Modeled changes to stands	CO_2	Yes	Shrubs and herbaceous understory constitute a relatively small proportion of carbon stocks in a REM project but play a considerable role in fire behavior. Shrubs and herbaceous understory carbon can be heavily combusted during wildfire

[6] The definition and assessment of SSRs is consistent with ISO 14064-2 guidance.

SSR	SSR Description	Baseline/ Project	GHG	Included ?	Justification/Explanation
		over time based on fuel treatment activities, growth, harvest, and fire			events, which are modeled as part of determining project benefits. Fuel reduction treatments might considerably impact this pool through mastication, broadcast burning, etc. It is included in the standard growth and yield modeling approach. The data for this vegetation layer has to be also taken into account for fire behavior modeling.
3	Standing dead tree carbon (carbon in all portions of dead, standing trees)	**Baseline:** Modeled changes to stands (including dead trees) over time based on growth, harvest, and fire **Project:** Modeled changes to stands (including dead trees) over time based on fuel treatment activities, growth, harvest, and fire	CO_2	Yes	REM projects may significantly increase more natural standing dead carbon stocks over time due to reduced wildfire severity. A reduction in wildfire severity will increase retention of standing dead material at natural rates where it will slowly decompose.
4	Lying dead wood carbon	**Baseline:** Modeled changes to stands (including lying dead wood) over time based on growth, harvest, and fire **Project:** Modeled changes to stands (including lying dead wood) over time based on fuel treatment activities, growth, harvest, and fire	CO_2	Yes	Lying dead wood constitutes a relatively small proportion of carbon stocks in a REM project, but plays a considerable role in fire behavior. Lying dead wood can be heavily combusted during wildfire events, which are modeled as part of determining project benefits. Fuel reduction treatments might considerably impact this pool through mastication, broadcast burning, etc. It is included in the standard growth and yield modeling approach. The modeling of vegetation data will account for lying dead wood, both from a fire behavior perspective and an emission perspective.
5	Litter and duff carbon (carbon in	**Baseline:** Modeled changes to stands (including litter and	CO_2	Yes	Litter and duff carbon constitute a relatively small proportion of carbon stocks in a REM project,

SSR	SSR Description	Baseline/ Project	GHG	Included ?	Justification/Explanation
	dead plant material)	duff) over time based on growth, harvest, and fire **Project:** Modeled changes to stands (including litter and duff) over time based on fuel treatment activities, growth, harvest, and fire			but play a considerable role in fire behavior. Litter and duff are heavily combusted during wildfire events, which are modeled as part of determining project benefits. Fire reduction treatments might considerably impact this pool through mastication, broadcast burning, etc. It is included in the standard growth and yield modeling approach. The modeling of vegetation data will account for litter and duff, both from a fire behavior perspective and an emission perspective.
6	Soil carbon	**Baseline:** N/A **Project:** N/A	N/A	No	Soil carbon is not anticipated to change significantly as a result of REM project activities. Roots of live and dead standing trees are included in the accounting of live and dead standing trees, separate from soil carbon.
7	Carbon in harvested wood products in use	**Baseline:** N/A, because background harvesting is similarly assumed under both the baseline and project **Project:** Estimated from modeled harvesting volumes resulting only from project activities	CO_2	Yes, but not if project is stacked with a carbon project that accounts for carbon in wood products	Although the harvesting of trees for conversion into wood products may occur for both baseline and project activities, the only difference between the modeled baseline and project activities is the harvesting of trees, if any, as part of fuel treatments. Therefore, only biomass removed through fuel treatment activities are included for project accounting purposes. The quantification of harvested wood products that are in use is based on the contribution of the sequestered carbon over time based on estimates of product durability.

SSR	SSR Description	Baseline/ Project	GHG	Included ?	Justification/Explanation
8	Forest product carbon in landfills	**Baseline:** N/A, because background harvesting is similarly assumed under both the baseline and project **Project:** Estimated from modeled harvesting volumes resulting only from project activities	CO_2	Yes, but not if project is stacked with a project that accounts for carbon in wood products	Although the harvesting of trees for conversion into wood products may occur for both baseline and project activities, the only difference between the modeled baseline and project activities is the harvesting of trees, if any, as part of fuel treatments. Therefore, only biomass removed through fuel treatment activities are included for project accounting purposes. A portion of the wood products end up in landfills where their decomposition can be estimated. The quantification of harvested wood products in landfills is based on carbon sequestered over time using estimates of product durability once it is disposed of in a landfill.
9	Biomass combustion emissions from fires (prescribed burns and wildfires)	**Baseline:** Y **Project:** Y	CO_2	Yes	Changes to forest fuel conditions are the primary driver of GHG benefits produced by REM projects, resulting in modifications to CO2 emissions from the combustion of biomass resulting from wildfires. Emissions from prescribed burns are also quantified to ensure conservative accounting.
		Baseline: Y **Project:** Y	CH_4	Yes	Changes to forest fuel conditions are the primary driver of GHG benefits produced by REM projects, resulting in modifications to CH4 emissions from the combustion of biomass resulting from wildfires. Emissions from prescribed burns are also quantified to ensure conservative accounting.
		Baseline: Y **Project:** Y	N_2O	Yes	Changes to forest fuel conditions are the primary driver of GHG benefits produced by REM projects, resulting in modifications to N_2O emissions from the combustion of biomass resulting from wildfires.

SSR	SSR Description	Baseline/ Project	GHG	Included ?	Justification/Explanation
					Emissions from prescribed burns are also quantified to ensure conservative accounting.
		Baseline: Y **Project:** Y	CO	Yes	Changes to forest fuel conditions are the primary driver of GHG benefits produced by REM projects, resulting in modifications to CO emissions from the combustion of biomass resulting from wildfires. CO emissions from biomass combustion associated with REM projects are considered to ensure comprehensive accounting. Emissions from prescribed burns are also quantified to ensure conservative accounting.
		Baseline: Y **Project:** Y	$PM_{2.5}$	Yes	Changes to forest fuel conditions are the primary driver of GHG benefits produced by REM projects, resulting in modifications to $PM_{2.5}$ emissions from the combustion of biomass resulting from wildfires. $PM_{2.5}$ emissions from biomass combustion associated with REM projects are considered to ensure comprehensive accounting. Emissions from prescribed burns are also quantified to ensure conservative accounting.
		Baseline: Y **Project:** Y	NMVOC	Yes	Changes to forest fuel conditions are the primary driver of GHG benefits produced by REM projects, resulting in modifications to non-methane volatile organic compound (NMVOC) emissions from the combustion of biomass resulting from wildfires. NMVOC emissions from biomass combustion associated with REM projects are considered to ensure comprehensive accounting. Emissions from prescribed burns are also quantified to ensure conservative accounting.

SSR	SSR Description	Baseline/ Project	GHG	Included ?	Justification/Explanation
10	Mobile combustion emissions	**Baseline:** N/A **Project:** Y	CO_2	Yes	Mobile combustion CO_2 emissions from project implementation, including forestry and the transport of harvested trees, are likely to be small, but will be included.
		Baseline: N/A **Project:** N/A	CH_4	No	Changes in CH4 emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
		Baseline: N/A **Project:** N/A	N_2O	No	Changes in N2O emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
11	Biological emissions from converting forestlands to other uses outside the project area	**Baseline:** N/A **Project:** N/A	CO_2	No	REM projects are not expected to cause shifts in alternative land uses that might lead to clearing of forestland.
12	Biological emissions from changes in harvesting on forestland outside the project area	**Baseline:** N/A **Project:** N/A	CO_2	No	REM projects are designed to improve forest resiliency and are anticipated to enable forest stands, both within the treatment areas and within the broader project area, to be more productive than under the baseline scenario. Due to the higher overall productivity, no shifting of harvests from the project area is expected.
13	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	**Baseline:** N/A **Project:** N/A	CO_2	No	REM projects will not result in a shift of harvested wood products to other forest sites or to other building materials since REM projects will result in greater forest productivity than the baseline case. It is conservative not to include these emissions.

SSR	SSR Description	Baseline/ Project	GHG	Included ?	Justification/Explanation
		Baseline: N/A **Project:** N/A	CH_4	No	Combustion-related CH_4 emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.
		Baseline: N/A **Project:** N/A	N_2O	No	Combustion-related N_2O emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.
14	Biological emissions from decompositi on of forest products	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR 7) and landfills (SSR 8) **Project:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR 7) and landfills (SSR 8)	CO_2	Yes	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 7 and SSR 8)
		Baseline: N/A **Project:** N/A	CH_4	No	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. However, the proportion of fuel treatment-derived biomass ending up in a landfill is anticipated to be minimal relative to the overall GHG reductions from a project. Thus, forest product production from REM projects 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	SSR Description	Baseline/ Project	GHG	Included ?	Justification/Explanation
		Baseline: N/A **Project:** N/A	N_2O	No	Decomposition of forest is not expected to be a significant source of N_2O emissions.

5.1 Leakage Accounting

Leakage effects through activity shifting or market effects are not considered under this methodology since fuel treatment activities will include greater removal of forest products than in the baseline for projects involving thinning or other processes that remove biomass from the forest and will have equal removal of forest products (i.e., no additional removal relative to the baseline) for projects involving only prescribed burns.

6 Quantifying GHG Emission Reductions

GHG reductions are calculated by comparing the baseline to the forecasted mitigation project performance over the crediting period. GHG reductions are achieved when a REM project lowers GHG emissions compared to what would have happened absent the mitigation project. Net emissions reductions from fuel treatments under this methodology result from a combination of changes in forest carbon, emissions from fires, carbon in wood products, and mobile emissions, both within the treatment area and within the balance of the project area. Emissions benefits are also derived from limiting delays to post-fire forest regeneration. To quantify these impacts, forest vegetation data is modeled for growth, disturbance from wildfire, and regeneration, both with and without fuel management treatments, and with wildfire integrated based on a probabilistic fire return interval.

GHG reductions are aggregated for the entire project area on a per-unit-area basis in five-year increments based on the quantification requirements specified in this section and as outlined in Equation 6.1. The Reserve provides project proponents with a Microsoft Excel-based file called the Reduced Emissions from Megafires FMU Calculation Worksheet[7] to facilitate the calculations specified below, based on outcomes from the modeling requirements outlined in this section.

Equation 6.1. Calculating GHG Emission Reductions

$$ER = \left(\sum_{t}\left[(E_{bsl} - C_{bsl}) - (E_{pr} - C_{pr})\right]\right) \times (1 - 0.1)$$

Where, Units

ER	=	Total emission reductions across all years *t*	tCO_2e
t	=	Year within the crediting period	Year
0.1	=	Programmatic ex ante risk discount (See Section 6.7)	

And

$$E = \left(\sum_{i}(W_i) + C_{DR}\right) \times P_{fire} + C_{OPS}$$

Where,

E	=	Total emissions associated with either the baseline (E_{bsl}) or project (E_{pr}) scenario for year *t*	tCO_2e
i	=	Individual stand within the project area	
W_i	=	Wildfire and prescribed burn emissions from wildfire combustion for stand *i* for year *t* (See Equation 6.2 and Equation 6.3)	tCO_2e
C_{DR}	=	Carbon stock loss under the baseline or project scenario from delayed reforestation based on the % of burned acres that would have experienced delayed reforestation, time *t* (See Equation 6.4)	tCO_2e
P_{fire}	=	Annual fire probability (See Equation 6.5)	%
C_{OPS}	=	Direct fossil fuel GHG emissions associated with the management scenario (mechanical treatments or prescribed fire operations) for year *t* (project scenario only) (See Equation 6.6)	tCO_2e

And

[7] Available on the Reduced Emissions from Megafires Forecast Methodology webpage at https://climateforward.org/program/methodologies/reduced-emissions-from-megafires/.

$$C = \sum_{i} (C_{onsite,i}) + C_{WP}$$

Where,

C	=	Total carbon stocks associated with either the baseline (C_{bsl}) or project (C_{pr}) scenario for year *t*	tCO_2e
$C_{onsite,i}$	=	Carbon stocks in all included onsite pools (see Table 5.1) for stand *i* for year *t*	tCO_2e
C_{WP}	=	Carbon stocks in wood products derived from biomass removed during project activities for year *t* (project scenario only); excluded if project is stacked with another project type that has claim to the carbon in biomass removed from the project area	tCO_2e

The methods for quantification are the same in the baseline and project scenarios. Equation 6.1 and the equations in subsequent sections can be applied in either scenario, unless otherwise indicated. Thus, they are not presented twice. Rather, project proponents should add subscripts as needed to denote whether the parameters and results are relevant to the baseline scenario ("*bsl*") or the project scenario ("*pr*"), as is applied in Equation 6.1.

6.1 Overview of Quantification Approach

The following overarching quantification approach is the basis for the detailed guidance provided in subsequent sections regarding how project proponents are to calculate the forecasted GHG benefits associated with a project.

1. Delineate the project area (Figure 6.1 and Section 6.2) by establishing a buffer area around the treatment areas (TA) for the project, based on professional judgment.

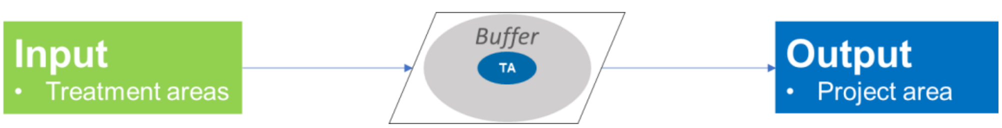


Figure 6.1. Determining the project area

2. Determine forest management scenarios applicable to the baseline and project scenarios, including background harvesting applied to both scenarios, and model changes to forest stand conditions over time in the absence of fire (Figure 6.2 and Section 6.3.1). Such modeling captures not only changes in live tree C stocks, but also changes to surface fuels and the removal of biomass during fuel treatments that are part of the project activity.

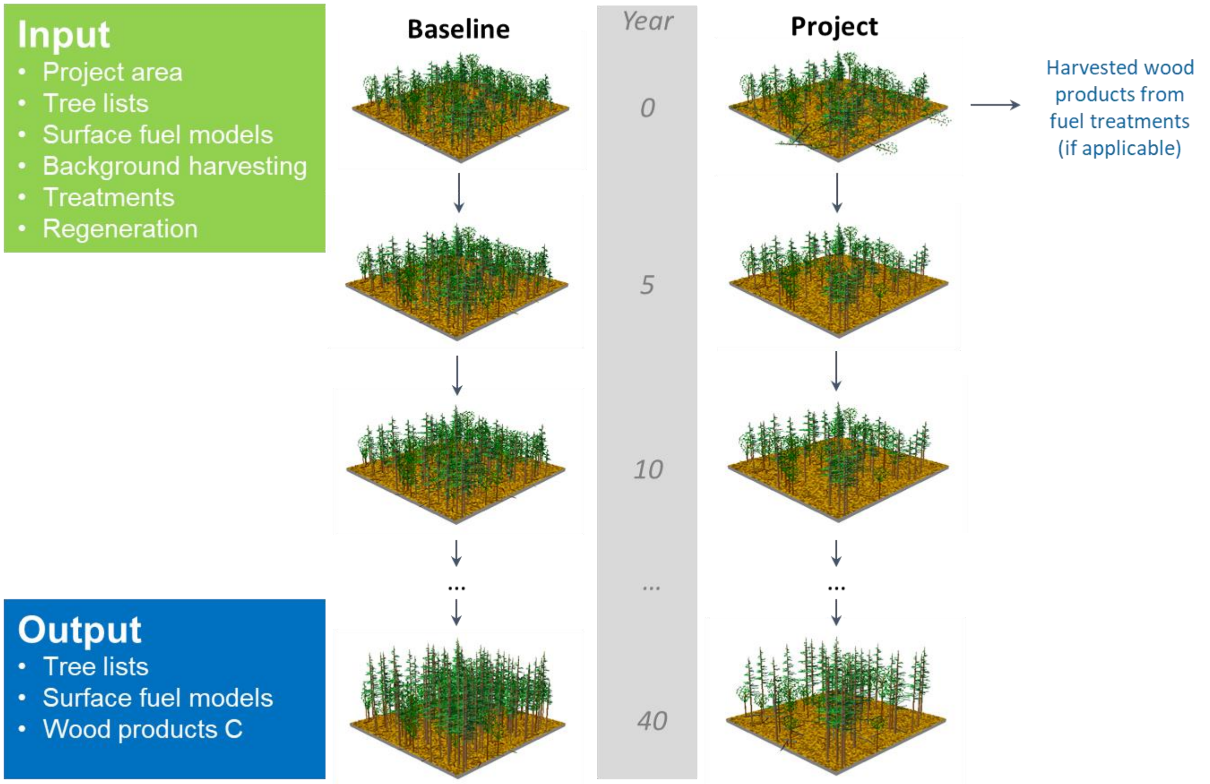


Figure 6.2. Modeling changes to forest conditions

3. Model wildfire behavior from ignition points within the project area to determine the likelihood of a given location to burn if a fire ignites under specified conditions within the project area (i.e., conditional burn probability, or CBP) and to calculate the resulting impacts of fuel treatments on fire behavior (Figure 6.3 and Section 6.3.6).

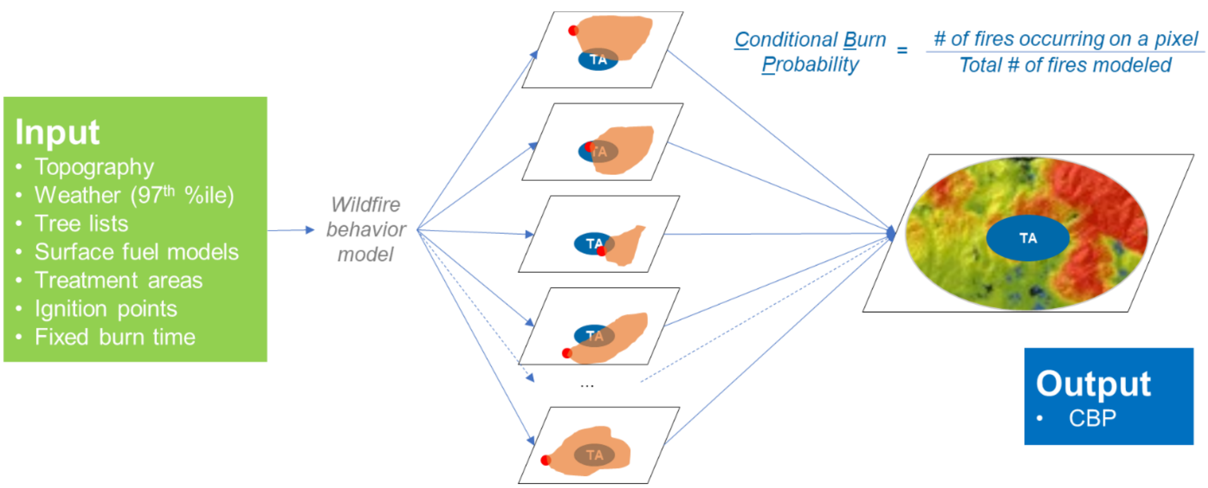


Figure 6.3. Determine likelihood of a given location to burn relative to other locations in the project area

4. Model a wildfire occurring across the project area for each modeling time step for both the baseline and project scenario to determine total gross emissions—including non-CO_2

emissions—that would occur during any given year throughout the project crediting period and calculate the GHG impacts from the ability of fuel treatments to modify fire severity in ways that prevent sites from being unable reestablish tree cover in a timely manner following the occurrence of a fire (Figure 6.4 and Sections 6.3.9 and 6.4).

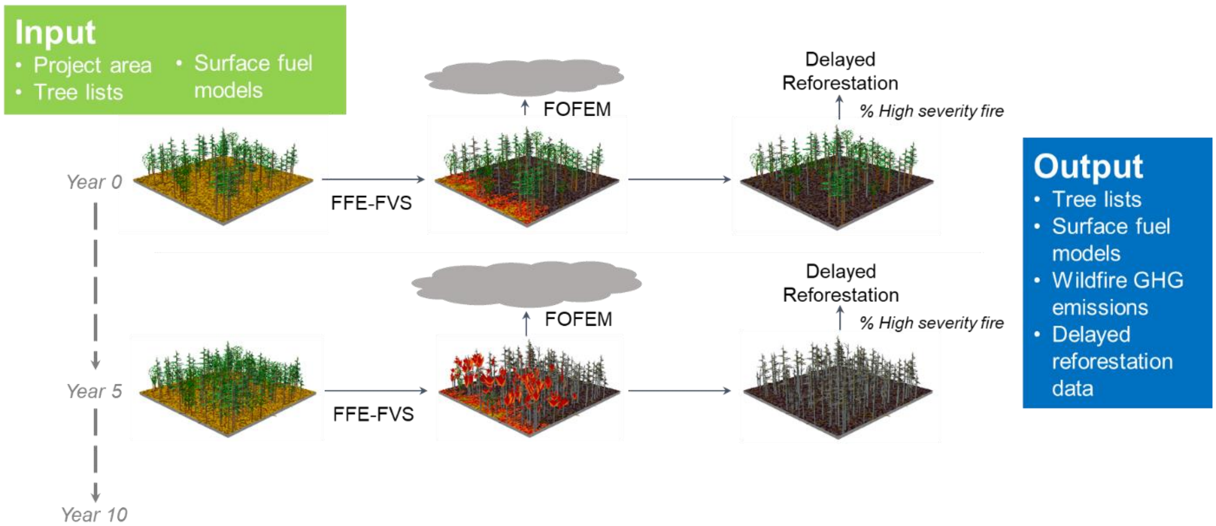


Figure 6.4. Modeling GHG emissions from wildfire and estimating delayed regeneration impacts

5. Quantify total GHG benefits by adjusting annual GHG emissions benefits from fuel treatments (relative to baseline conditions) based on the annual probability of a fire occurring in the project area (Figure 6.5 and Section 6.5).

Figure 6.5. Adjust calculated GHG benefits by annual risk of fire

This same approach is captured in Figure 6.6, which outlines the flow of the quantification steps in more detail with respect to how the involved models and tools—and their inputs and outputs—lead to FMU quantification.

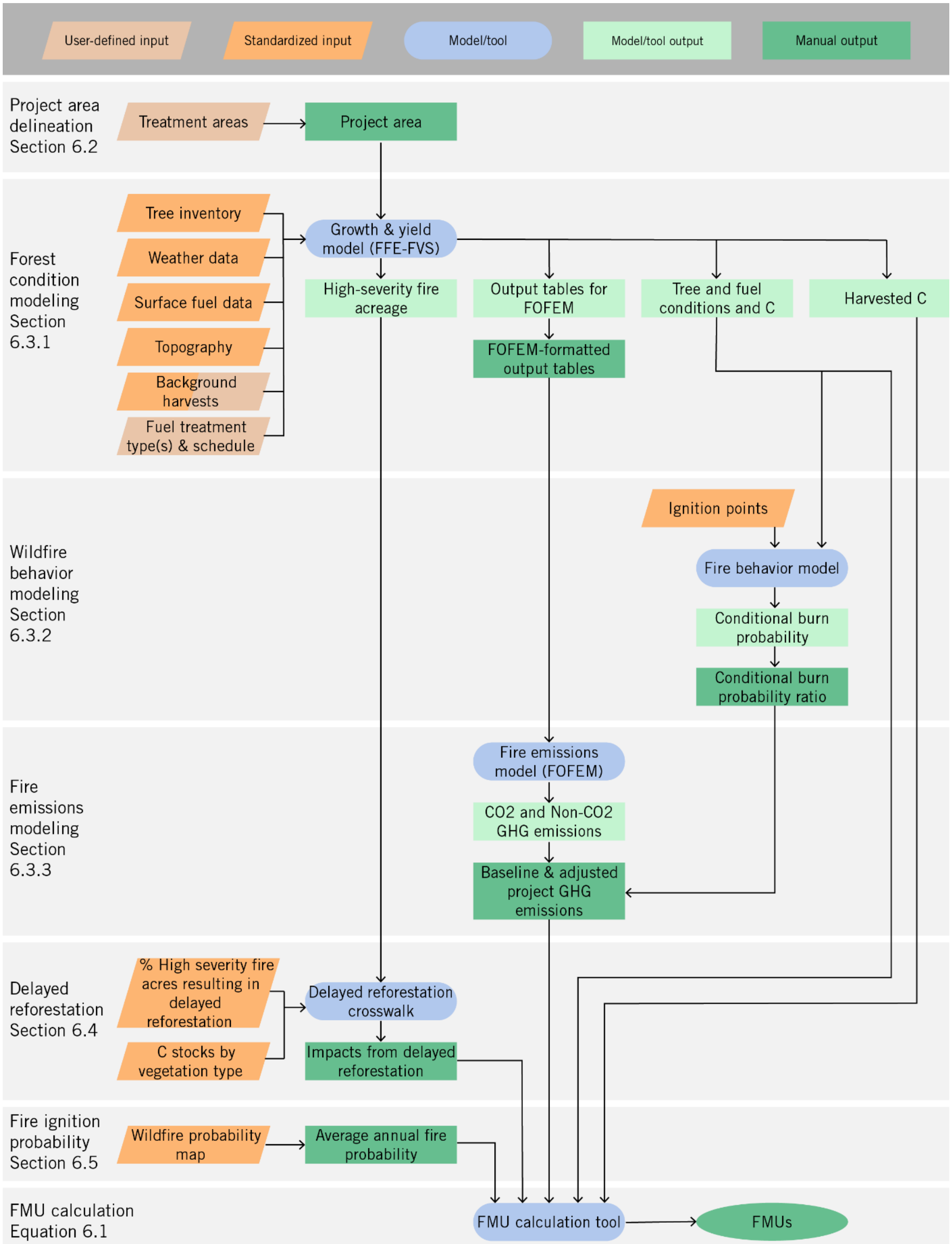


Figure 6.6. Flow chart of quantification steps

6.2 Establishing the Project Area

As described in Section 4, the project area is intended to encapsulate the geographic extent of the landscape within which wildfire behavior is potentially influenced by the fuel treatment activities being implemented by the project. Under this methodology, the project area serves as the area of analysis for the modeling performed according to the requirements described in Section 6.3. It is delineated by establishing a buffer area around the treatment area(s) associated with the project. It should include the area that is likely to experience a change in wildfire behavior as a result of the fuel treatments performed. The estimate should take into consideration the attributes defined in the modeling requirements described below, including the 8-hour burn time limit for wildfire behavior modeling. As a general rule of thumb, a buffer of 15 kilometers around a given treatment area is a reasonable starting point when delineating the project area.

6.3 Modeling Wildfire Emissions

To determine the impacts on future wildfire severity and behavior of the project relative to the baseline scenario, a series of modeling exercises must be performed. The modeling described below incorporates a variety of components that are combined to project the changes in forest and fire conditions throughout the crediting period, for both the baseline scenario and the project scenario.

Changes to forest and fuel conditions over time are projected in the absence of any wildfire to show how such conditions and associated carbon stocks may change throughout the crediting period. A wildfire that burns every location within the entire project area is also simulated at every modeling timestep to allow for an estimate of the total gross GHGs that would be emitted (i.e., irrespective of the likelihood of a fire burning each location or each year) should a fire occur at that point in time during the crediting period and to determine how severe the fire would be at any given location. Lastly, a series of simulations are run to determine how fire would spread across the landscape when starting from each of a set of ignition points within the project area, which allows for an estimate of the likelihood of any given location within the project area to burn relative to other parts of the project area. A comparison between wildfire behavior results under the project scenario and under the baseline scenario then provides an estimate of the shadow area(s) produced by the fuel treatment activities and a way to moderate the project area-wide wildfire emissions estimates as a result.

The total emissions impacts estimated from modeling requirements described here are then further adjusted by the annual fire risk, as described in Section 6.3, to provide a probabilistic estimate of the future emissions benefits from the fuel treatments associated with the project in a way that allows annual emissions results to be combined across the entire crediting period. In other words, the quantification approach under this methodology estimates the GHG benefits of a project based on the probability that fire behavior is modified in a given location within the project area if a fire were to occur and on the probability that a fire will even occur in any given year.

Three types of models must be applied to model wildfire emissions, with more detailed requirements for the use of each described further below:

1. A **forest growth and yield model with a fire component** that determines the changes in forest and fuel conditions over time and the impacts of wildfire on the conditions of a given stand at a given point in time during the crediting period. Under this methodology,

the Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS) is required to be used by all projects.

2. A **wildfire emissions model** that translates stand-level wildfire characteristics into emissions. The First Order Fire Effect Model (FOFEM), is required to be used by all projects under this methodology.
3. A **wildfire behavior model** that calculates wildfire spread and the probability of a stand to burn. Models to be used under this methodology must be pre-approved by the Reserve (see the Climate Forward website for a list of approved models) and must meet the following criteria:
    a. Peer-reviewed in a process involving experts in modeling and fire ecology/forestry/ecology;
    b. Used only in scenarios relevant to the scope for which the model was developed and evaluated;
    c. Parameterized for the specific conditions of the project.

The project area delineated according to Section 6.2 serves as the basis for the extent of the inputs used and outputs generated during modeling. Note that although suppression activities (i.e., actions to control or extinguish a fire after it has already started) can impact wildfire behavior, current wildfire behavior models are limited in their ability to integrate suppression activities. Therefore, the impact of these activities is not assessed under this methodology.

6.3.1 Forest Condition Modeling

Changes in forest vegetation and fuel conditions, resulting from a combination of growth and forest management activities within the project area, must be projected over the 40-year crediting period for both the baseline scenario and the project scenario using FFE-FVS. Modeling such changes serves as the basis for estimating changes in on-site carbon stocks, calculating how much carbon is removed during fuel treatment activities and potentially stored in wood products, determining the GHG emissions when a fire occurs at a given location at a given point in time, and simulating wildfire behavior from fires at a given point in time (see Section 6.3.6). Modeling of forest growth and harvesting must be completed with the appropriate regional variant of FVS using five-year output intervals across the entire crediting period. In addition to growth and yield modeling, the Fire and Fuels Extension is used to simulate a wildfire burning on each stand in the project area at each five-year modeling interval under the baseline scenario and the project scenario to determine expected fire severity and changes to forest conditions. FFE-FVS is also used to simulate the changes to stand conditions following any prescribed burning performed as part of the fuel treatment activities under the project scenario.

6.3.2 Modeling Parameters, Assumptions, and Input Data

FFE-FVS must be parameterized (e.g., regeneration inputs) for the specific conditions of the project using verifiable sources. For example, certain FVS variants such as the Western Sierra variant lack a forest regeneration sub-model, leaving the user to input this information. This shortcoming can distort forest stand conditions as they are projected into the future based on user inputs which may be inconsistent or subjective. Depending on the understory conditions, projected canopy base height can increase rapidly, thereby greatly reducing the potential for crown fire initiation (Moody et al. 2016). To counter this effect when such variants are used, adjustments and a pulse of mixed-conifer regeneration must be applied manually at every time step, along with a small-tree growth rate multiplier (Collins et al., 2011), based on the approach described on the Climate Forward website.

The inputs and assumptions outlined in Table 6.1 are required to perform forest condition modeling.

Table 6.1. Data inputs and assumptions for forest condition modeling

<table>
<tr><th>Model Input</th><th>Description</th></tr>
<tr><td>Tree inventory data</td><td rowspan="2">Required use of standardized tree inventory data and surface fuel models provided via the Climate Forward website. Once retrieved, such data must be updated to represent disturbances (e.g., wildfire, harvest, insect infestations) as well as growth between the year represented by the retrieved data and the start date of the project if greater than one year. This includes any modifications to vegetation and fuel conditions resulting from prior projects submitted under this methodology and on which a project is being stacked. The growth and yield modeling needs to be performed on a pixel basis using the tree inventory data as input. Standardized data are in raster format with 30m resolution. Stand polygons may not be used to aggregate tree inventory data. However, depending on the size of the project and computational resources available, aggregating pixels up to a 90m resolution (into ‘stands’) is allowed. For discussion purposes, the term ‘stands’ will be used hereafter to indicate either a pixel or an aggregation of pixels up to 90m resolution.</td></tr>
<tr><td>Surface fuel models</td></tr>
<tr><td>Topographic data</td><td>Required use of standardized data provided via the Climate Forward website.</td></tr>
<tr><td>Weather data</td><td>Required use of standardized data provided via the Climate Forward website. Weather data used for the project must represent a realistic weather scenario based on historical patterns. At least two weather data points must be used, including at least one data point per eighth-field (HUC8) watershed.

Extreme fire weather is likely to become more common in the near future such that the current 99th percentile weather conditions could drop to 95th percentile conditions by 2030 (e.g., Mann et al., 2016). Therefore, the project proponent is to employ a weather scenario based on 97th percentile conditions, based on annual data from each weather data point going back at least 10 fire seasons. The project proponent must analyze weather conditions observed during at least one significant, severe wildfire representing fire behavior that could be expected in or very near the project area to demonstrate the appropriateness of the weather conditions used for modeling purposes.

If wind gust speed data are not available, Table 6.2, as derived from Crosby and Chandler (2004), is to be used to convert average windspeeds to wind gust speeds.

Software such as FireFamilyPlus (FF+; Bradshaw and McCormick, 2000) can be used to summarize the weather data. For forest condition modeling, required weather inputs include wind speed at 20 feet off the ground, fuel moistures (specific values for 1-hr, 10-hr, 100-hr, >100-hr, duff, live or categories “very dry, “dry”, “moist”, or “wet”), season, and foliar moisture content. Potential deviations from weather stations due to local particularities need to be described and justified. Peer-reviewed future climate projections can be used to modify weather-related modeling parameters, if desired.</td></tr>
</table>

Background forest management assumptions	Required use of standardized assumptions regarding background forest management activities (activities expected to occur whether the project activities were to be implemented or not) provided via the Climate Forward website. Since these assumptions ultimately may be derived from multiple sources with varying accuracy, the project proponent must confirm and adjust background harvest assumptions based on verifiable documentation. Furthermore, all background harvest assumptions must reflect legal constraints to forest management relevant to the project area. Additionally, any known harvest plans that are already approved (e.g., for locations where state-permitting requirements necessitate approval by a state agency prior to harvest operations or on government-owned lands for which all harvest planning requirements have been completed) must be incorporated into harvest assumptions for the project area.
Fuel treatment types and schedule	The project proponent must define the details of the fuel treatment(s) applied under the project within each treatment area, including: ▪ Fuel treatment and silvicultural prescriptions ▪ Location(s), spatially defined in GIS layer ▪ Timing (if treatment activities are spread across >5 years) ▪ Fate(s) of treatment residues.

Table 6.2. Crosswalk for conversion of steady windspeed to wind gust speed

Standard 10 Minute Average (Miles per Hour)	Probable Average Wind Gust (Miles per Hour)	Standard 10 Minute Average (Miles per Hour)	Probable Average Wind Gust (Miles per Hour)	Standard 10 Minute Average (Miles per Hour)	Probable Average Wind Gust (Miles per Hour)
1	6	11	23	21	37
2	8	12	25	22	38
3	11	13	26	23	39
4	13	14	28	24	40
5	15	15	29	25	41
6	16	16	30	26	43
7	17	17	32	27	44
8	19	18	33	28	45
9	20	19	34	29	46
10	22	20	35	30	47

Fuel treatment activities modeled as part of the first time-step may result in surface fuel models being assigned by FFE-FVS that are not appropriate for each stand within the treatment areas (Collins et al., 2013). For stands within treatment areas, the project proponent must review surface fuel model outcomes in the time-step immediately after treatments are applied in the model. If the surface fuel model assigned by FFE-FVS does not accurately reflect post-treatment stand conditions and the ecology of the site, the project proponent may assign a fuel model that correctly describes post-treatment surface fuels. Besides matching actual post-treatment conditions on the ground, the project proponent must document all such assignments and describe how they are grounded in the surface fuel models relevant to the monitoring requirements under this methodology (i.e., Scott and Burgan (2005)), as outlined in Section 7.1.1. The project proponent can use a statistical model to assign fuel models based on stand structure (e.g., Fried et al. 2016, p. 40), as long as it matches post-treatment conditions observed on the ground.

Note that if a fire or other disturbance affecting more than 10% of the project area occurs after fuel treatments under the project are implemented, but prior to the completion of confirmation, tree data and surface fuel models used for forest condition modeling and wildfire behavior modeling (Section 6.3.6) must be updated to reflect the new stand conditions.

6.3.3 Forest Carbon Stock Estimates

Estimates of forest carbon stocks must be made based on the vegetation and fuel conditions resulting from growth and yield modeling using the default settings for FVS carbon outputs. The total stand carbon output from FVS modeling is entered into Equation 6.1 for the variable C_{onsite} for both the baseline and project scenario.

6.3.4 Carbon in Wood Products

As a part of forest carbon stock modeling, project proponents must also estimate the amount of carbon sequestered in wood products as a result of biomass removed from treatment areas under the project. Since background harvesting is applied to both the baseline and project scenarios, as described in Table 6.1, only the biomass removed during fuel treatment activities is included in project accounting. An estimate of carbon in wood products based on modeled harvest volumes and the fate and average stock levels over 100 years for both in-use wood products and those in landfills is provided as standardized output from FVS and is inserted into Equation 6.1 for the variable C_{WP}. However, if a REM project is stacked (i.e., spatially and temporally overlapping) with another project type that accounts for carbon in harvested wood products, carbon stocks in wood products are to be reported for the REM project but are not included in the quantification of emissions reductions in Equation 6.1. See Section 6.11 for additional information about reconciliation with stacked projects.

6.3.5 Fire Simulations

At each time step for both the baseline scenario and the project scenario, a wildfire must be simulated in FFE-FVS to determine the impacts on forest conditions. For projects involving prescribed burning as a fuel reduction activity, such fires must also be modeled to reflect the changes to stand conditions during the initial time step.

FFE-FVS outputs serve as the basis for the inputs required by the wildfire behavior model and the wildfire emissions model (FOFEM). The FVS keywords SimFire and Compute are used to produce the surface and canopy fuels variables (surface fuel model, canopy cover, canopy base height, etc.) needed for fire behavior modeling.

For wildfire emissions modeling, FFE-FVS fuel load outputs are required but must be formatted before being input into FOFEM. The necessary values, including P-Torch values, are stored in the FVS_Fuels and FVS_PotFire tables of the FVS output database. Some FVS output data required for FOFEM runs must be manually crosswalked to ensure alignment with FOFEM input requirements, including (but not restricted to):

- Fuel load data;
- Duff depth;
- Values for the percentage of rotten versus sound fuel in the >100-hr class;
- Distribution of >100-hr fuels;
- Fuel moisture;

- Estimate of percentage of crown burned (use P-torch value).

The project proponent must describe the crosswalks chosen.

6.3.6 Wildfire Behavior Modeling

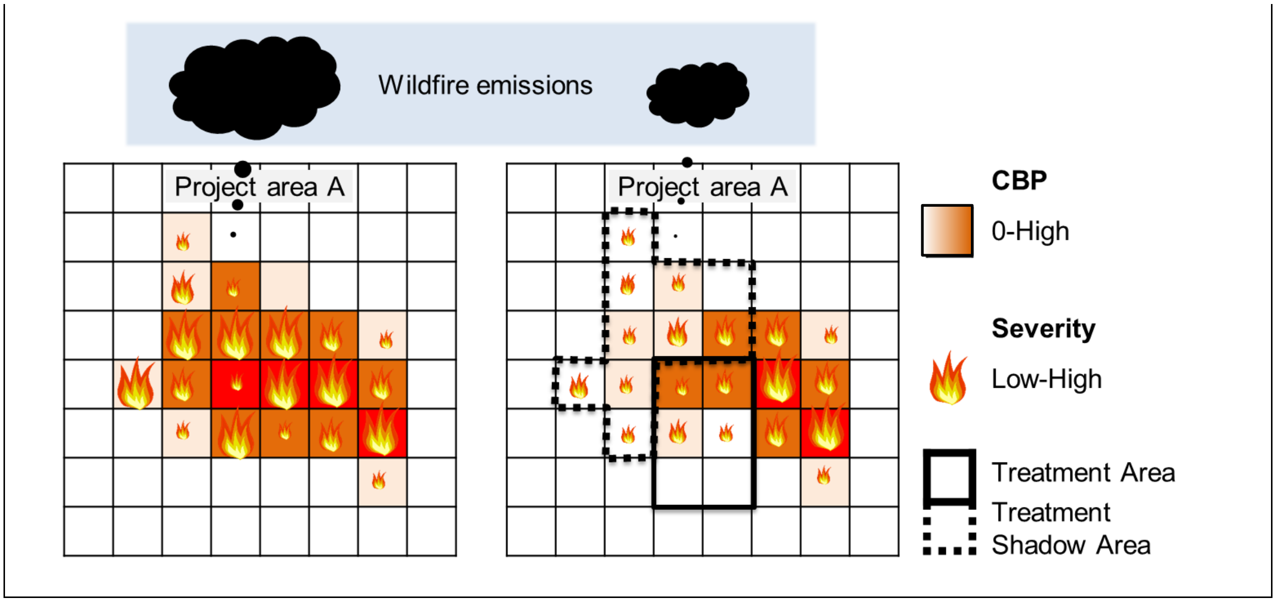
Fuel treatments can change wildfire severity and therefore reduce wildfire emissions. Changes in severity are captured in the wildfire emissions modeling performed using FFE-FVS, as described in Section 6.3.5). Fuel treatments can also change fire spread or the behavior of fire. Therefore, fuel treatments reduce wildfire emissions not only within the treatment areas themselves (through decreased fire severity), but also outside of the fuel treatments, in shadow areas. A shadow area is an untreated area that may or may not burn but is indirectly affected by nearby fuel treatments (Box 1). Changes in fire behavior are captured by simulating fire spread from ignition points within the project area and calculating the conditional burn probability (CBP) of each stand, i.e., the probability of a given stand burning assuming a fire occurs somewhere in the project area. A shadow area typically has a reduced CBP and reduced expected fire severity because of neighboring fuel treatments, despite being untreated itself. Note that changes in fire severity within shadow areas are not captured under this methodology.

Box 1: Calculating baseline and project wildfire emissions.

Wildfire emissions reductions occur within the treatment area as well as in the shadow area in adjacent untreated areas because of changes in fire severity and reductions in fire size induced by the fuel treatments. Because fire behavior models such as FlamMap-MTT (or alternatively, FconstMTT) are deterministic models and the baseline and project runs utilized must use identical ignition points, any difference in the conditional burn probability (CBP) between the two scenarios is an indication of fuel treatment effectiveness. Changes in expected fire severity due to fuel treatments (whether inside or outside of treatment areas) are captured by including an estimate of canopy consumption in the emissions modeling. Changes in burn probability are captured by multiplying each stand's expected emissions by the ratio of project CBP to baseline CBP. This term has a value of 1 for stands that are not affected in burn characteristics by the project, which translates to the project having no impact on emissions benefits from fire behavior modifications for those stands. However, in treatment areas and shadow areas, the ratio of project CBP to baseline CBP will be typically less than 1, though some exceptions may occur in limited locations within the project area where fuel treatments can result in increased CBP through opening up the canopy and higher surface wind speed downwind of the treatment area while still retaining a decreased fire severity.

The below figure graphically demonstrates the treatment area and the shadow area wildfire emissions when comparing the baseline and fuel treatment scenarios:

- **Baseline.** For the baseline untreated project area on the left, the fire footprint area is shown in red color.
- **Fuel treatment.** For the fuel treatment project area shown on the right, fire will be directly limited in severity on the treated stand acres, represented by the orange-colored treatment area. The shadow benefit results from the overall fire size and severity reduction, the difference in the red colored areas.



6.3.7 Modeling Parameters, Assumptions, and Input Data

Data required to conduct fire behavior modeling is indicated in Table 6.3. Additionally, each model run must have the burn time set to eight hours (California Air Resources Board, 2018). Although many wildfires burn longer than eight hours, a highly conservative assumption is applied here and is line with conventional fire modeling practices. Since burn time can greatly affect the modeled GHG impacts of fuel treatments, a standardized burn time is required to be used by all projects and is an intentional constraint to ensure a conservative estimate of GHG benefits from each project and consistency across all projects.

Table 6.3. Data inputs and assumptions for fire behavior modeling.

Model Input	Description
Tree inventory data Surface fuel models	Required use of standardized data provided via the Climate Forward website, as previously described in Table 6.1, including updates to represent disturbances (e.g., wildfire, harvest, insect infestations) and growth between the year represented by the retrieved data and the start date of the project if greater than one year. Additionally, tree inventory data and surface fuel models resulting from forest condition modeling (Section 6.3.1) are used to simulate fire behavior at each five-year time step for both the baseline and the project scenario.
Topographic data	Required use of standardized data provided via the Climate Forward website.
Weather data	Required use of standardized data provided via the Climate Forward website, as previously described in Table 6.1, including use of data at the 97th percentile. Data may be similarly summarized using software such as FireFamilyPlus. Specific data required for the fire behavior modeling include air temperature, relative humidity, wind speed at 20 feet off the ground, wind direction, fuel and foliar moisture values. Potential deviations from weather stations due to local particularities need to be described and justified. Peer-reviewed future climate projections can be used to modify weather-related modeling parameters, if desired.

Ignition points	Required use of standardized ignition point data provided via the Climate Forward website. Ignition data must be evaluated to determine the density of ignition points, as described below. Sufficient ignition points (which will represent individually simulated wildfires) are needed to ensure that all burnable areas encounter wildfires at least once. If the density of ignition points within the project area is less than 0.24 points per acre (Ager et al, 2007; Ager et al., 2010), ignition points must be added with a spatial distribution skewed based on historical ignition points.

6.3.8 Fire Behavior Simulations

The wildfire behavior model must be run repeatedly to simulate a wildfire starting from each ignition point within the project area at every five-year timestep for the baseline and project scenarios. The goal of the wildfire behavior modeling is to produce a CBP ratio map for each timestep for each project, e.g., CBP_P/CBP_{BSL} in year 0, CBP_P/CBP_{BSL} in year 5, etc., as described further below. These CBP ratio maps represent the extent and magnitude of changes in burn probability outside of fuel treatments due to the effects of the fuel treatments themselves. All paired wildfire behavior model runs must use the same randomly distributed wildfire ignition locations, weather conditions, and fire behavior parameters.

The following steps are performed to calculate CBP ratios for use in Equation 6.3:

1. Run the wildfire behavior model for each ignition point for each timestep for both the baseline and project scenarios.
2. Save the CBP outputs from each model run. CBP is the fraction of simulated wildfires that reach each pixel of the landscape, with values ranging between 0 and 1. The CBP outputs are then used to compute the average CBP for each stand within a given timestep for the baseline and project scenarios.
3. The average CBP values for each stand are used to determine the project wildfire and prescribed burn emissions (see Equation 6.3) based on the calculation of the ratio of the project to baseline CBP value for each stand. To calculate the CBP ratios, CBP raster maps must first be produced. For each timestep, one raster map of CBPs is produced for the baseline scenario and another for the project scenario. The resulting project scenario raster for a given timestep is divided by the baseline scenario raster for the same timestep ($CBP_{PR,stand}/CBP_{BSL,stand}$). Areas where the ratio is 1 have no change in CBP (and are neither a fuel treatment area nor a treatment shadow area) and areas where the ratio is less than 1 is either a fuel treatment area or a treatment shadow area. Although it is expected to be a rare occurrence, there may be areas where the ratio is greater than 1, which represents an increased likelihood of fire, as described in Box 1.
4. Correct for CBP ratio anomalies if necessary. The wildfire behavior model should produce identical maps of CBP for identical inputs. As long as the only differences in inputs (including ignition points) are related to fuels treatments, any differences in outputs will solely reflect the effects of those fuel treatments. Nonetheless, a basic check for reasonable outcomes is recommended to ensure that CBP values only differ where expected based on professional judgment with respect to the applied treatments and resulting stand and surface fuel conditions. If anomalies are found and corrected, such instances must be reported and described by the project proponent.

6.3.9 Fire Emissions Modeling

The emissions model FOFEM must be run for each stand and time step to determine periodic wildfire and prescribed burn emissions across all stands. Results from FOFEM are used in Equation 6.2 to calculate W_{BSL} and using Equation 6.3 to calculate W_{PR}, *as* described below.

6.3.10 Modeling Parameters, Assumptions, and Input Data

Output data generated using the FVS keywords SimFire and Compute during forest condition modeling are used as input for wildfire emissions modeling, as described in Section 6.3.5. Additionally, FOFEM requires an estimate of canopy consumption, which can be produced by the wildfire behavior model based on the P-Torch (probability of torching) value as estimated by FFE-FVS for each stand (e.g., Stephens et al. 2012). P-Torch is the probability that torching can occur in a small area of a forest stand and depends in large part on flame length (Rebain et al., 2015). Finally, CBP ratios determined in Section 6.3.8 are also used as input for the calculation of project emissions in Equation 6.3.

6.3.11 Emissions Modeling and Calculations

The emissions model FOFEM must be used to estimate smoke emissions created during the smoldering and flaming phases of combustion for the following GHG emissions: CO_2, CH_4, CO, non-methane volatile organic compounds (NMVOC), and particulate matter ($PM_{2.5}$). Default emissions output from FOFEM is reported in pounds per acre, which must be divided by 2,204.6 to convert to metric tonnes per acre; N_2O emissions are calculated based on FOFEM output for burned biomass ($m_{b,i}$). These emissions results are applied in Equation 6.2 and Equation 6.3 and are then multiplied by their respective global warming potential (GWP) factor (see Table 6.4)[8] to convert to CO_2e.

Equation 6.2. Baseline wildfire and prescribed burn emissions

$$W_{BSL,i} = \left[CO2_i + (CH4_i \times GWP_{CH4}) + \left(m_{b,i} \times (0.16/10^6) \times GWP_{N2O}\right) + (CO_i \times GWP_{CO}) + (PM2.5_i \times GWP_{PM2.5}) + (NMVOC_i \times GWP_{NMVOC})\right]$$

Where,

			Units
$W_{BSL,i}$	=	Baseline wildfire and prescribed burn emissions for stand *I* at time *t*	tCO_2e
$CO2_i$	=	Carbon dioxide emissions from fire for stand *i* at time *t*	tCO2e
$CH4_i$	=	Methane emissions from fire for stand *i* at time *t*	tCH_4
GWP_{CH4}	=	Global warming potential for CH_4 (Table 6.4)	tCO_2e/tCH_4
$m_{b,i}$	=	Oven-dry mass of biomass burned (from FOFEM) on stand *i* at time *t*	kg
0.16	=	Nitrous oxide emissions factor for wildfires[9]	gN_2O/kg fuel
10^6	=	Conversion factor for grams to metric tonnes	t/g
GWP_{N2O}	=	Global warming potential for N_2O (Table 6.4)	tCO_2e/tN_2O
CO_i	=	Carbon monoxide emissions from fire for stand *i* at time *t*	tCO
GWP_{CO}	=	Global warming potential for CO (Table 6.4)	tCO_2e/tCO
$PM2.5_i$	=	Particulate matter (2.5) emissions from fire for stand *i* at time *t*	$tPM_{2.5}$

[8] Project proponent must check Reserve guidance at the time of confirmation to ensure current programmatically recognized GWPs for CH_4, N_2O and other specified GHGs are used.

[9] Urbanski, S., 2014. Wildland fire emissions, carbon, and climate: Emission factors. For. Ecol. Manag., Wildland fire emissions, carbon, and climate: Science overview and knowledge needs 317, 51–60. https://doi.org/10.1016/j.foreco.2013.05.045

$GWP_{PM2.5}$	=	Global warming potential for $PM_{2.5}$ (Table 6.4)	$tCO_2e/tPM_{2.5}$
$NMVOC_i$	=	NMVOC emissions from fire for stand *i* at time *t*	tNMVOC
GWP_{NMVOC}	=	Global warming potential for NMVOC (Table 6.4)	tCO_2e/tNMVOC

Table 6.4. Non-CO_2 GHG emissions GWPs for conversion to CO_2e

GHG	GWP Factor[10]
CH_4	28
CO	1.8
NMVOC	5
N_2O	265
$PM_{2.5}$	9

The ratios of the project and baseline CBPs determined in Section 6.3.8 are then used to account for the fuel treatment impact on burn probability. Project wildfire and prescribed burn emissions, W_{PR}, are calculated according to Equation 6.3, taking into account these impacts to burn probability, as reflected by the CBP ratios.

Equation 6.3. Project scenario wildfire and prescribed burn emissions

$$W_{PR,i} = (UW_{PR,i} \times \frac{CBP_{PR,i}}{CBP_{BSL,i}})$$

Where,

			Units
$W_{PR,i}$	=	Project wildfire and prescribed burn emissions for stand *i* at time *t*	tCO_2e
$CBP_{PR,stand}$	=	Conditional burn probability for a given stand *i* under project conditions (from Section 6.3.8) at time *t*	%
$CBP_{BSL,stand}$	=	Conditional burn probability for a given stand *i* under baseline conditions (Section 6.3.8) at time *t*	%

And

$$UW_{PR,i} = CO2_i + (CH4_i \times GWP_{CH4}) + \left(m_{b,i} \times (0.16/10^6) \times GWP_{N2O}\right) + (CO_i \times GWP_{CO}) + (PM2.5_i \times GWP_{PM2.5}) + (NMVOC_i \times GWP_{NMVOC})$$

Where,

$UW_{PR,i}$	=	Unadjusted project wildfire and prescribed burn emissions for stand *i* at time *t*	tCO_2e
$CO2_i$	=	Carbon dioxide emissions from fire for stand *i* at time *t*	tCO2e
$CH4_i$	=	Methane emissions from fire for stand *i* at time *t*	tCH_4
GWP_{CH4}	=	Global warming potential for CH_4 (Table 6.4)	$tCO2e/tCH_4$
$m_{b,i}$	=	Oven-dry mass of biomass burned (from FOFEM) on stand *i* at time *t*	kg
0.16	=	Nitrous oxide emissions factor for wildfires (Urbanski, 2014)	gN_2O/kg fuel
10^6	=	Conversion factor for grams to metric tonnes	t/g
GWP_{N2O}	=	Global warming potential for N_2O (Table 6.4)	$tCO2e/tN_2O$
CO_i	=	Carbon monoxide emissions from fire for stand *i* at time *t*	tCO
GWP_{CO}	=	Global warming potential for CO (Table 6.4)	tCO2e/tCO
$PM2.5_i$	=	Particulate matter (2.5) emissions from fire for stand *i* at time *t*	$tPM_{2.5}$
$GWP_{PM2.5}$	=	Global warming potential for $PM_{2.5}$ (Table 6.4)	$tCO2e/tPM_{2.5}$
$NMVOC_i$	=	NMVOC emissions from fire for stand *i* at time *t*	tNMVOC
GWP_{NMVOC}	=	Global warming potential for NMVOC (Table 6.4)	tCO2e/ tNMVOC

[10] Values based on IPCC (2013).

Total wildfire and prescribed burn emissions, $W_{(BSL\ or\ PR)}$, are amortized using the fire probability for a given time period for application in Equation 6.1.

6.4 Determining Impacts from Delayed Reforestation

High severity fires not only kill most trees and vegetation, but they also can prevent the regeneration of forests on their own and under shrub cover for long periods (Collins and Roller 2013; Coppoletta et al., 2016; Roccaforte et al., 2012; Rother and Veblen, 2016; van Wagtendonk et al., 2012; Welch et al., 2016). Project proponents must quantify the area and emissions associated with project land that is projected to be temporarily or permanently converted from forestland to grass or shrubland following high severity fire over the crediting period.

GHG emissions from delayed reforestation are only accounted for based on the expected annual acreage projected to experience high-severity wildfires. Such emissions are calculated for the variable C_{DR} for application in Equation 6.1 (for both the baseline and project scenarios) and are determined from Equation 6.4 as the product of:

- The change in mean carbon stocks from pre-fire vegetation (e.g., forest) (C_{onsite}) to post-fire type-converted land (e.g., shrubland) ($\bar{C}_{TC}$);
- The fraction of the burned area under the baseline scenario and under the project scenario that is projected to have delayed reforestation (P_{DR}). This includes any delayed reforestation that will replace dominant forest vegetation over the crediting period of 40 years and is the product of the following for each forest type within the project area:
  - Fraction of high severity wildfire area that is likely to be converted to another landcover type ($P_{TC,f}$)
  - Area experiencing high severity wildfire ($A_{HS,f}$).

The acreage burned under high severity conditions ($A_{HS,f}$) is taken from the wildfire behavior modeling results where the output for fire intensity level (FIL) is a value of 5 or 6 (corresponding to flame lengths of greater than 4’). For these FILs , the aboveground dominant vegetation is consumed or dies as a result of stand-replacing wildfire (e.g., Ansley et al., 2000, p. 5).

The fraction of areas affected by high severity wildfire that is likely to experience delayed reforestation ($P_{TC,f}$) as well as the mean carbon stocking for forest-replacing vegetation ($\bar{C}_{TC}$) are provided on the Climate Forward website.

Equation 6.4. Emissions from delayed reforestation

$$C_{DR} = \left(C_{onsite} - (\bar{C}_{TC} \times A_{PA})\right) \times P_{DR}$$

Where,

			Units
C_{DR}	=	Carbon stock loss under the baseline or project scenario from delayed reforestation based on the % of burned acres that would have experienced delayed reforestation, time *t*	tCO_2e
C_{onsite}	=	Carbon stock for baseline or project scenario prior to wildfire	tCO_2e
$\bar{C}_{TC}$	=	Mean carbon stock for redirected vegetation type when high-severity fire causes delayed regeneration	tCO_2e/acre
A_{PA}		Area of the entire project area	Acres

And

$$P_{DR} = \left(\sum_f A_{HS,f} \times P_{TC,f} \right) \Big/ A_{PA}$$

Where,

P_{DR}	=	Proportion of the burned area where delayed reforestation is likely to occur for the baseline or project scenario	%
$A_{HS,f}$	=	Area burned by high intensity fire for the baseline or project scenario (FIL5 and FIL6) for forest type *f*	acres
$P_{TC,f}$	=	Ecological subregion-specific percentage of total acreage burned by high intensity fires that experienced delayed reforestation for forest type *f*	%

6.5 Estimating Fire Ignition Probability

The expected fire return interval (FRI) for the project area is used to determine the statistical fire probability on an annual basis over the crediting period. Determining the FRI allows the projected wildfire emissions from the project area under both the baseline and project scenarios to be amortized (discounted) by the annual fire ignition probability over each separate five-year interval period of the 40-year crediting period. Project proponents must calculate the average FRI of the project area, based on FRI spatial data provided on the Climate Forward website. The average FRI is then applied in Equation 6.5 to calculate the annual probability of fire occurrence (P_{fire}), which is subsequently applied in Equation 6.1. FRI data provided by the Reserve represent contemporary conditions,[11] as opposed to historical pre-suppression conditions. The FRI is assumed to be constant over the 40-year project term.

Equation 6.5. Annual fire probability for a specific fire return interval.

$$P_{fire} = 1/FRI$$

Where,

			Units
P_{fire}	=	*Annual fire probability*	*%*
FRI	=	*Mean fire return interval across the project area*	*years*

6.6 Calculating Fossil Fuel Emissions from Fuel Reduction Activities

For projects incorporating fuel treatments involving the use of equipment powered by the combustion of fossil fuel, the emissions from such fossil fuel combustion must be estimated using Equation 6.6 and applied in Equation 6.1 as C_{OPS}. Since the same background harvest operations are assumed to take place under both the baseline scenario and the project scenario, fossil fuel combustion from mobile equipment is only calculated based on the fuel reduction activities taking place under the project. Default emissions factors are applied, as described in Equation 6.6, based on the amount of biomass removed during fuel reduction activities, as indicated by the FVS cubic foot volume output from forest condition modeling for the project scenario under Section 6.3.1. This calculation is only applicable to the first timestep of the project, when fuel reduction activities occur.

[11] FRI data will be updated by the Reserve periodically to reflect changing wildfire trends over time.

Equation 6.6. Fossil fuel combustion emissions from mobile equipment

$$C_{OPS} = 0.00088 \times V$$

Where,			Units
0.00088	=	Emissions factor for fossil fuel combustion by mobile equipment used for fuel reduction activities, assuming: ▪ 8.5 l/m³ for sawlog harvesting plus 3.1 l/m³ for slash processing (Buchholz et al., 2021) ▪ Emissions rate from diesel fuel combustion of 10.19 kg CO_2/gallon (EIA, 2022)	tCO_2e/ft^3
V	=	Volume of biomass removed by mobile equipment during project activities across all treatment areas	ft^3

6.7 Estimating Performance Decline

Fuel treatments are known to have limited efficacy periods. Figure 6.7 (Collins et al., 2011) illustrates an example of how CBP for differing fuel treatment intensities (three different tree removal diameter limits) generally converge with the untreated scenario over time. In this example, (1) all fuel treatments provide a considerable (>50%) decrease in the initial fire hazard, (2) treatment intensity has little impact on effectiveness or longevity, and (3) effectiveness is significantly diminished after 20 years for all intensities.

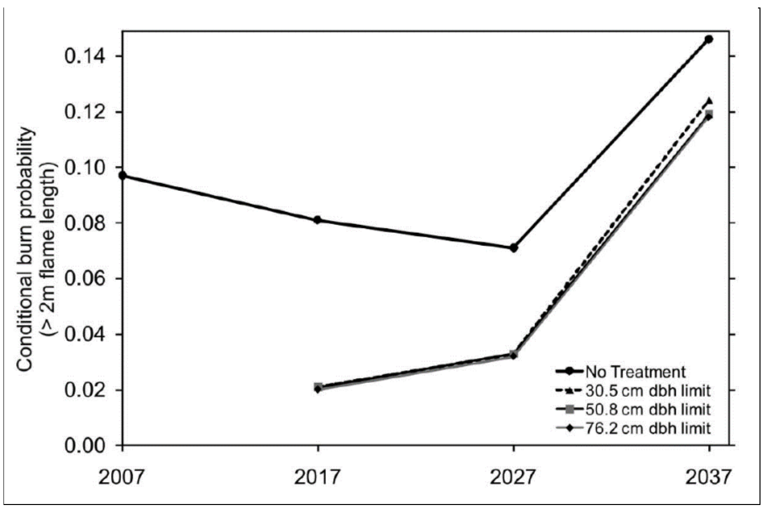


Figure 6.7. Decline in fuel treatment effectiveness over time, from Collins et al. (2011)

Decreases in fuel treatment effectiveness, as a reflection of changes in post-treatment stand conditions over time, are captured under this methodology via the modeling process, with stand conditions becoming more similar to baseline stand conditions as time progresses. Thus, although fuel treatments are known to have limited efficacy periods, such limits are accounted for and a REM project’s mitigation performance is not otherwise expected to decline over the crediting period. In other words, the ability of a project to produce the climate benefits projected under this methodology is not dependent on further management activities within the project area.

Although project performance is not expected to decline over the crediting period, a programmatic *ex ante* risk discount of 10% is applied to all projects to ensure conservative accounting and to address the uncertainty associated with estimating the climate benefits from fuel treatments and the probabilistic occurrence of future wildfires in the project vicinity throughout the crediting period. The Reserve will review the overall performance of registered projects periodically to determine if the discount rate needs to be adjusted to ensure programmatic integrity.

6.8 Estimating Abandonment Rates

REM projects are assumed not to be abandoned in the sense that crediting is largely based on the immediate and time-limited reduction in wildfire risk established when a site is treated. However, there is the possibility that a project area, or portions of it, could be subject to intentional disturbances (e.g., regeneration timber harvests or land use conversion) during the project's crediting period that alter the wildfire risk profile of the project area in ways that nullify the climate benefits of the project activity from that point in time going forward, relative to the baseline scenario identified at the time of project registration. To account for such risks, the management scenarios that serve as the basis for forest growth modeling must factor in such potentially significant non-wildfire disturbances, as described in Section 6.3.

6.9 Ensuring Conservativeness of Quantification

The Reserve recognizes the risk associated with crediting based on the probabilistic occurrence of future stochastic events and has incorporated various means of conservatively quantifying credits issued to any given project to provide, at a programmatic level, integrity to FMUs issued. The following are examples of how the methodology is designed to limit credit issuance relative to what otherwise may be claimed so the quantity of FMUs issued to each project is reasonable and conservative:

- Application of programmatic *ex ante* risk deduction;
- Standardized modeling parameters and assumptions that are fixed or restricted and are established on a conservative basis;
- Standardized data required to be used by all projects as the basis for baseline and project modeling;
- Standardized calculation guidance;
- Exclusion of elements that may otherwise increase credit issuance (e.g., bioenergy);
- Limited burn time of eight hours, though contemporary catastrophic wildfires burn for significantly longer periods;
- Mean fire return intervals applied across the entire project area and across the entire crediting period even though the probability of fire occurrence increases as spatial scale increases and fire return intervals are becoming shorter as a result of climate change;
- Current wildfire behavior models are limited in their ability to adequately capture extreme fire events, leading to a likely underestimation of calculated benefits from fuel treatments.
- Although changes in fire severity are expected in treatment shadow areas, the modeling approach employed under the methodology does not capture such changes in fire severity outside of treatment areas, only the changes in fire behavior and resulting impacts on conditional burn probability.

Additionally, modeling parameters appropriate for the project area must be applied in an identical manner for both the project and baseline scenarios. The project proponent must provide a description of how modeling parameters are reasonable and conservative.

6.10 Permanence Risk Pool

As described in Section 3.8, since the basis for credit quantification under this methodology is derived from the avoidance of high levels of emissions from wildfires and does not rely on future carbon sequestration-based benefits resulting from the project activity, there are no risks to the permanence of the credits. As such, projects registering under this methodology are not required to contribute to the Climate Forward permanence risk pool.

6.11 Reconciliation with Stacked Projects

As described in Sections 3 and 3.6, projects may take place on locations where previous REM projects or other forest carbon projects (e.g., improved forest management projects) have occurred or are currently occurring, with proper updating of vegetation and fuel model data to reflect the conditions present prior to the start of the project as impacted by prior or existing projects. Since the carbon associated materials that are the subject of treatment under REM projects are conservatively assumed to be immediately emitted into the atmosphere and are not the basis for crediting under this methodology, there is no need for credit quantification for REM projects to be reconciled with other project types. Nevertheless, project proponents must disclose if their REM project is occurring on prior REM project locations or on locations where relevant carbon projects were or are currently located. The Reserve maintains the right to determine if any reconciliation between a REM project and another project with which it is stacked is necessary and what the requirements for such reconciliation may be.

7 Project Implementation and Monitoring

The Reserve requires a Project Implementation Report (PIR) to be established for all monitoring and reporting activities associated with the project. A template PIR form is available from the Reserve to help to ensure all aspects of required reporting are included. The PIR will serve as the basis for the confirmation body to confirm that the monitoring and reporting requirements in this methodology have been met. The PIR must cover all aspects of monitoring and reporting contained in this methodology and must specify how data for all relevant parameters will be collected and recorded.

At a minimum, the PIR shall include the timing of data acquisition, parameter values, a record keeping plan, and the role of individuals performing each specific monitoring activity. The PIR must also demonstrate how the project passes the Legal Requirement Test and the Regulatory Compliance Test. Project proponents are responsible for ensuring that all monitoring and reporting requirements of this methodology have been met.

7.1 Quantification Parameters

Each project must include the prescribed monitoring parameters necessary to calculate baseline and project emissions. These must be described in a table as shown below in Table 7.1. The project proponent must provide the Reserve robust evidence demonstrating to the Reserve's satisfaction that proposed parameter values are reasonable and conservative. Confirmation bodies will also review all parameter values to ensure their use in the given project is appropriate.

Table 7.1. Project Monitoring Parameters

Eq. #, Section Reference	Parameter	Description	Data Unit	Applicable	Calculated(c) Measured (m) Reference (r) Operating Records (o)	Comment
Eq. 6.1	C_{ops}	Direct fossil fuel emissions from mobile combustion during fuel treatment activities (project scenario only)	tCO_2e	Project	c	Only applied at the start of the crediting period when fuel treatments take place
Eq. 6.1	$C_{onsite,i}$	Carbon in all onsite pools accounted for under the methodology in stand *i* at time *t*, including above- and below-ground components of live standing dead trees, lying dead wood, litter and duff, and shrubs and herbaceous vegetation	tCO_2e	Stand	m, c	Reported from FFE-FVS
Eq. 6.1	$C_{WP,i}$	Carbon stocks in wood products derived from biomass removed during project activities for stand *i* at time *t* (project scenario only);	tCO_2e	Stand	c	Applicable only if biomass removed is of merchantable dimensions. Merchantability specifications may be adjusted if evidence can be provided indicating specific wood product produced from project-sourced wood. Excluded if project is stacked with another project type that has claim to the carbon in biomass removed from the project area.

Eq. #, Section Reference	Parameter	Description	Data Unit	Applicable	Calculated(c) Measured (m) Reference (r) Operating Records (o)	Comment
Eq. 6.2, Eq. 6.3	$CO2_i$	Carbon dioxide emissions from fire for stand *i* at time *t*	tCO_2e	Stand	c	Reported from FOFEM
Eq. 6.2, Eq. 6.3	$CH4_i$	Methane emissions from fire for stand *i* at time *t*	tCH_4	Stand	c	Reported from FOFEM
Eq. 6.2, Eq. 6.3	GWP_{CH4}	Global warming potential for methane	tCO_2e/tCH_4	Project	r	
Eq. 6.2, Eq. 6.3	$m_{b,i}$	Amount of biomass burned during fire for stand *i* at time *t*	kg	Stand	c	Reported from FOFEM
Eq. 6.2, Eq. 6.3	GWP_{N2O}	Global warming potential for nitrous oxide	tCO_2e/tN_2O	Project	r	
Eq. 6.2, Eq. 6.3	CO_i	Carbon monoxide emissions from fire for stand *i* at time *t*	tCO	Stand	c	Reported from FOFEM
Eq. 6.2, Eq. 6.3	GWP_{CO}	Global warming potential for carbon monoxide	tCO_2e/tCO	Project	r	
Eq. 6.2, Eq. 6.3	$PM2.5_i$	Emissions of particulate matter that is 2.5 micrometers or smaller ($PM_{2.5}$) from fire for stand *i* at time *t*	$tPM_{2.5}$	Stand	c	Reported from FOFEM
Eq. 6.2, Eq. 6.3	$GWP_{PM2.5}$	Global warming potential for $PM_{2.5}$	$tCO_2e/tPM_{2.5}$	Project	r	
Eq. 6.2, Eq. 6.3	$NMVOC_i$	Non-methane volatile organic carbon emissions from fire for stand *i* at time *t*	tNMVOC	Stand	c	Reported from FOFEM
Eq. 6.2, Eq. 6.3	GWP_{NMVOC}	Global warming potential for NMVOC	tCO_2e/tCH_4	Project	r	
Eq. 6.3	$CBP_{PR,i}$; $CBP_{BSL,i}$	Conditional burn probability, or likelihood of a given location to burn relative to other locations in the project area, based on the percentage of total fires simulated for the project that burn each location	%	Stand	c	Manually calculated based on fire behavior model output

Eq. #, Section Reference	Parameter	Description	Data Unit	Applicable	Calculated(c) Measured (m) Reference (r) Operating Records (o)	Comment
Eq. 6.4	$\bar{C}_{TC}$	Mean carbon stocking for redirected vegetation type when fire causes delayed regeneration	tCO_2e/acre	Stand	r	
Eq. 6.4	A_{PA}	Area of the entire project area	acres	Project	c	
Eq. 6.4	$A_{HS,f}$	Area burned by high intensity fire for the baseline or project scenario for forest type *f*, based on fire intensity level (FIL) values of 5 or 6	acres	Forest type	c	
Eq. 6.4	$P_{TC,f}$	Ecological subregion-specific percentage of total acreage burned by high intensity fires that experienced delayed reforestation for forest type *f*	%	Forest type	r	
Eq. 6.5	*FRI*	Mean fire return interval across the project area	years	Project	c	
Eq. 6.6	*V*	Volume of biomass removed by mobile equipment during project activities across all treatment areas	ft^3	Project	c	Reported from FFE-FVS
Eq. 6.6	*G*	Specific gravity of the dominant species type (hardwood or softwood) removed by mobile equipment during project activities across all treatment areas	n/a	Project	r	

Data serving as the basis for modeling and project quantification, as indicated in Table 7.1, are derived from standardized data, as outlined in Section 6. However, those values must be validated by the project proponent to ensure such data accurately reflect actual conditions in the treatment areas both prior to and after fuel treatment activities are performed (i.e., representing baseline and project activity conditions, respectively). Such data, and any updates implemented to reflect actual conditions in the treatment areas, are also reviewed by the confirmation body, as further described in Section 9.4.2. The following guidance indicates monitoring and measurement activities that must be performed at the time a project is undertaken to validate project input data.

7.1.1 Treatment Area Monitoring

Forest conditions must be monitored on the ground by the project proponent, both before and after fuel treatments are performed within treatment areas. The primary means of monitoring will be capturing photographic imagery at pre-identified plot locations based on the requirements outlined in Table 7.2. The intent of the imagery is to capture visually the forest conditions within treatment areas to document if and how such conditions change as a result of project activities, including whether the resulting conditions align with modeled treatment outcomes. Confirmation that treatment results are accurately reflected in modeling outcomes is important since fuel treatments are modeled as part of the forest condition modeling described in Section 6.3.1 and post-treatment conditions are the basis for modeled fire behavior and severity in subsequent modeling steps. The guidance provided here is meant to ensure such imagery and plot locations allow for an adequate basis for evaluation by the confirmation body reviewing the project and associated imagery.

Table 7.2. Ground-based monitoring plot requirements

<table>
<tr><th>Plot attribute</th><th colspan="2">Requirement</th></tr>
<tr><td>Plot location</td><td colspan="2">Plot locations are georeferenced points located randomly or selected randomly from systematically (grid-based) located points within the boundaries of a treatment area. If the project incorporates different fuel reduction activity types or combination of activity types, plot locations must be distributed proportionally to reflect acreage by treatment area. Plot locations shall be established prior to treatment to capture pre-treatment conditions.[12] Project proponents planning to incorporate prescribed burning may wish to incorporate additional plots in areas adjacent to those planned treatment area(s) to ensure plot data is available in the event a prescribed burn extends beyond the planned treatment boundary.</td></tr>
<tr><td rowspan="7">Number of plots</td><td colspan="2">The number of plots established in each treatment area shall be based on the size of the treatment area as outlined below, not to exceed 50 total plots per treatment area:</td></tr>
<tr><td>Treatment Area Size (acres)</td><td>Number of plots (rounded up to nearest integer)</td></tr>
<tr><td>≤500</td><td>Treatment area acres / 25
(Minimum of five plots)</td></tr>
<tr><td>501 – 2,000</td><td>Treatment area acres / 50</td></tr>
<tr><td>2,001 – 5,000</td><td>Treatment area acres / 100</td></tr>
<tr><td>5,001 – 10,000</td><td>Treatment area acres / 200</td></tr>
<tr><td>≥10,001</td><td>Treatment area acres / 300</td></tr>
<tr><td>Sample timing</td><td colspan="2">Images are to be captured pre- and post-treatment as close to the time of treatment as possible, but no more than one year prior and one year after treatment implementation, respectively.</td></tr>
<tr><td>Imagery Setup</td><td colspan="2">Each plot visited must have both a pre- and a post-treatment image captured. The photo must be facing due north and must provide a clear view of the site conditions, with the intent to capture the fuel conditions within the broader</td></tr>
</table>

[12] Project proponents who initiated projects prior to the release of the methodology must contact the Reserve to determine if an acceptable replacement for pre-treatment monitoring can be provided.

Plot attribute	Requirement
	landscape in the vicinity of the plot. If a clear view cannot be obtained at the original plot location, the plot location may be offset by up to 10 meters, with the direction and distance of offsetting or the GPS coordinates of the new location recorded.
Image Attributes	Plot images are to be tagged with the project name, plot number, project proponent's name, and date. Images (including attribute information) shall be provided as an appendix to the Project Implementation Report at the time of submission for confirmation.

7.2 Voluntary Monitoring

Although project proponents have no obligation to monitor and report ongoing project outcomes after registration with Climate Forward, some may want to continue monitoring and reporting on the project on a voluntary basis with no bearing on credits issued, especially if wildfires have occurred within the project area. Project proponents may conduct such voluntary monitoring and reporting by submitting relevant documentation to be posted on the project's account page on the Climate Forward registry. Submitted documents will be reviewed by Reserve staff to ensure any claims being made are reasonable; however, they will not be subject to confirmation and will be indicated as such in the registry. Although project proponents reporting in this manner are doing so voluntarily and define how and what to report in their Climate Forward account, the following items are recommended for minimal reporting purposes:

- Reporting date
- Extent and severity of any wildfire that has occurred within the project area
- Extent and severity of any wildfire that has occurred in areas adjacent to the project area
- Current aerial/satellite imagery of the project area and surrounding vicinity

7.3 Voluntary Ongoing Monitoring Incentive

This methodology does not allow for registered projects to earn additional FMUs upon a determination from voluntary ongoing monitoring that the project achieved greater emissions reductions than originally quantified at the time of project confirmation.

7.4 Conversion of FMUs to CRTs

There is no identified pathway at this time for conversion of FMUs issued to REM projects to Climate Reserve Tonnes (CRTs) under the Climate Action Reserve's voluntary offset program. If an offset protocol corresponding to this methodology is developed by the Reserve in the future, projects may then be eligible for the conversion of FMUs to CRTs, as well as potentially the conversion of the project in its entirety to the offset program. If such a protocol is developed, guidance for the transition of credits and projects will be provided by the Reserve at that time.

8 Reporting and Record Keeping

This section provides requirements and guidance on reporting rules and procedures. A priority of Climate Forward is to facilitate consistent and transparent information disclosure among project proponents. Project proponents must submit an emission reduction report as part of the Project Implementation Report to the Reserve.

8.1 Project Submittal and Confirmation Documentation

Project proponents must provide the following documentation for project listing with Climate Forward:

- General Project Submission form
- GIS layers in shapefile and KML format delineating treatment area(s)[13]

After the project is listed, the project proponent must then submit the following documentation for confirmation:

- Project Implementation Report, including photo plot images
- Reduced Emissions from Megafires FMU Calculation Worksheet
- GIS layers in shapefile and KML format delineating project area
- Signed Attestation of Title form
- Signed Attestation of Legal Additionality form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form

As part of the confirmation process, the confirmation body must then submit the following documentation to Climate Forward:

- Confirmation Report
- Confirmation Statement
- Confirmation List of Findings
- Any additional documents as needed

All reports that reference carbon stocks must be submitted with the oversight of a Professional Forester so that professional standards and project quality are maintained. Any Professional Forester preparing a project in an unfamiliar jurisdiction must consult with a Professional Forester practicing forestry in that jurisdiction to understand all laws and regulations that govern forest practices within the jurisdiction. 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 KML files depicting the treatment areas and project area that match the maps submitted to depict the treatment areas and project area. The project's reported acres shall be calculated in accordance with the requirements in Sections 4 and 6.2.

[13] Treatment areas can be tentatively delineated at the time of listing if the treatments are yet to occur, with final treatment boundaries provided at the time of confirmation.

The above project documentation will be available to the public via the Climate Forward online registry, unless otherwise noted. Further disclosure and other documentation may be made available on a voluntary basis through the Climate Forward registry.[14]

8.2 Record Keeping

For purposes of independent confirmation and historical documentation, project proponents are required to keep all information outlined in this methodology for a period of seven years after the information is generated. Except for those documents identified in Section 8, this information will not be publicly available, but may be requested by the confirmation body or the Reserve. Records must be kept in hard copy and/or digital format. For documents that were originally created in hard copy form and for which the original hard copy bears original signatures or other evidence of authenticity (e.g., signed Attestation of Title), hard copies must be retained.

Examples of information the project proponent must retain include:

- All project submittal documentation, as listed in Section 8
- All data inputs for the calculation of the project emission reductions, including all required sampled data
- Copies of all permits, formal notices of regulatory violations, and any relevant administrative or legal consent orders dating back at least three years prior to the implementation of the first project device
- Executed Attestation of Title, Attestation of Regulatory Compliance, and Attestation of Legal Additionality forms
- Results of emission reduction calculations
- Confirmation records and results
- All evidence relating to Continued Implementation
- Any additional relevant documents

The Reserve also requires that the following project-related records be retained by the confirmation body for a minimum of seven years after completing confirmation activities. It must be noted that some records may be subject to fiscal or other legal requirements that are longer than the Reserve's mandated period.

Confirmation bodies shall retain electronic copies, as applicable, of:

- The Project Implementation Report
- The project proponent's SSR and/or project activity data as well as evidence cited
- The confirmation plan
- The sampling plan
- Measurement data from site visit and interpretation data from photo plot interpretation, as well as calculation of SSRs by confirmation body
- The Confirmation Report
- The List of Findings
- The Confirmation Statement

Each confirmation body must have an easily accessible record-keeping system, preferably electronic, that provides readily available access to project information. Copies of the original activity and source data records shall be maintained within said record-keeping system.

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[14] Climate Forward documents and forms are available at https://climateforward.org/program/program-and-projectforms/.

Records must be kept in both hard copy and/or digital format, where possible. For documents that were originally created in hard copy form and for which the original hard copy bears original signatures or other evidence of authenticity (e.g., signed Attestation of Title), hard copies must be retained. The Reserve may at any time request access to the record-keeping system or any supporting documentation for oversight or auditing purposes.

8.3 Reporting and Confirmation Period

For *ex ante* GHG mitigation projects, the reporting period is equivalent to the crediting period. Project proponents must report forecasted GHG reductions from the project for the entire crediting period.

A confirmation period is the period of time over which forecasted GHG reductions are confirmed. A confirmation period begins with the project start date and ends with the submission of the final Confirmation Report to Climate Forward. The end date of any confirmation period may not extend past the project crediting end date.

Since the implementation of project activities create immediate climate benefits, and there is no ongoing monitoring, confirmation activities may commence directly following the completion of all fuel treatment(s) planned under the project.

9 Confirmation Guidance

This section provides Confirmation Bodies with guidance on confirming GHG emission reductions associated with the project activity. This confirmation guidance supplements the Reserve's Climate Forward Program Manual and describes confirmation activities specifically related to this methodology.

Confirmation bodies trained to confirm a given methodology type must be familiar with the following documents:

- Climate Forward Program Manual
- Climate Forward Confirmation Manual
- Reduced Emissions from Megafires Forecast Methodology (this document)

The Reserve's Climate Forward Program Manual, Climate Forward Confirmation Manual, and forecast methodologies are designed to be compatible with each other and are posted on the Reserve's website at https://climateforward.org/.

In cases where the Climate Forward Program Manual or Climate Forward Confirmation Manual differs from the guidance in this methodology, this methodology takes precedence. Only Confirmation Bodies trained and accredited by the Reserve are eligible to confirm project reports. Information about confirmation body accreditation and Reserve project confirmation training can be found on the Climate Forward website at https://climateforward.org/.

The confirmation of the project must be conducted with the oversight of a Professional Forester so that professional standards and project quality are maintained. Any Professional Forester confirming a project in an unfamiliar jurisdiction must consult with a Professional Forester practicing in that jurisdiction to understand all laws and regulations that govern forest practices within the jurisdiction, as well as factors that may influence treatment effectiveness.

9.1 Standard of Confirmation

While there is no requirement for ex-post verification of REM projects under Climate Forward, there is a requirement for an accredited confirmation body to confirm the project has been implemented as described in the forecast methodology and that the estimated emission reductions have been calculated accurately. The confirmation incorporates both a desktop documentation review and a site visit assessment of the mitigation project.

9.2 Confirming Project Implementation Report

The Project Implementation Report serves as the basis for confirmation bodies to confirm that the monitoring and reporting requirements have been met. Confirmation bodies shall confirm that the PIR covers all aspects of monitoring and reporting contained in this methodology and specifies how data for all relevant parameters were collected and recorded.

When assessing the PIR, the confirmation body shall:

1. Assess the compliance of the PIR with the requirements of the methodology and Climate Forward Program Manual;
2. Identify the list of parameters required by the methodology and confirm that the PIR accounted for all necessary parameters;
3. Assess the means of implementation of the project data capture, including data management and quality assurance and quality control procedures, and determine

whether these are sufficient to ensure the accuracy of forecasted GHG emission reductions to be achieved by the project;

Where the project proponent has applied a sampling approach to determine data and other relevant parameters, the confirmation body shall assess the proposed sampling plan in accordance with sampling requirements described in Section 4.3.3 of ISO 14064-3.

9.3 Core Confirmation Activities

The Climate Forward Program Manual describes the core confirmation activities that shall be performed by confirmation bodies for all project confirmations.

Confirmation is a risk assessment and data sampling effort designed to ensure that the risk of reporting error is assessed and addressed through appropriate sampling, testing, and review. The core confirmation activities, which will be discussed in greater detail, are as follows:

- Reviewing GHG management systems and estimation methodologies
- Confirming emission reduction estimates
- Undertaking site visits
- Confirming evidence of project implementation

9.3.1 Reviewing GHG Management Systems and Estimation Methodologies

The confirmation body reviews and assesses the appropriateness of the methodologies and management systems that the project proponent uses to gather data and calculate baseline and project emissions. The REM Methodology relies largely on the use of standardized data, models, and modeling parameters. The confirmation body will review the application of such data, models, and parameters to ensure they have been correctly used to quantify the emissions reductions associated with the project. Furthermore, photo plots taken by the project proponent, as described in Section 7.1.1, will also be reviewed by the confirmation body to ensure that the vegetation data serving as the basis for the quantification of credits accurately represents the conditions within the treatment areas.

9.3.2 Confirming Emission Reduction Estimates

The confirmation body further investigates areas that have the greatest potential for material misstatements and then confirms whether or not material misstatements have occurred. This includes confirmation activities required to confirm emission reduction estimates, such as independent recalculation.

9.3.3 Undertaking Site Visits

In addition to undertaking a desk review, Confirmation Bodies shall conduct one or more site visits as part of confirmation activities. The specific itinerary for a site visit and the activities to be confirmed will be determined by the confirmation body, following an assessment of project risk.

During field site visits, at a minimum the confirmation body will:

- Confirm treatment area boundaries
- Confirm that treatments listed in the Project Implementation Report took place on-the-ground
- Evaluate fuel conditions within each treatment area to confirm whether modeled treatment outcomes are representative of conditions observed in the field.

9.3.4 Confirming Implementation of Project Resilience Measures

The project proponent will also provide evidence that the project modeling has incorporated background harvesting conditions based on the guidance provided in Section 6.3. The confirmation body shall review the Project Implementation Report and supporting project documentation to ensure background harvesting conditions were applied appropriately.

9.4 Confirmation Items

The confirmation body needs to address a set of items for each methodology type. This can be displayed in a table that lists the item, references the section in the methodology where requirements are specified, and identifies if professional judgment needs to be applied during the confirmation activity.

Confirmation bodies are expected to use their professional judgment to confirm that methodology requirements have been met in instances where the methodology does not provide sufficiently prescriptive guidance. For more information on the Reserve's confirmation process and professional judgment, please see the Climate Forward Program Manual.

Note: The following tables shall not be viewed as a comprehensive list or plan for confirmation activities, but rather guidance on areas specific to mitigation projects that must be addressed during confirmation.

9.4.1 Project Eligibility and Credit Issuance

To determine that a project is eligible under a given forecast methodology, it must meet a set of criteria that a confirmation body shall confirm during the confirmation process. These requirements determine if a project is eligible to register with Climate Forward and/or have credits issued. If any requirement is not met, the project may be determined ineligible. The following table lists the criteria for reasonable assurance with respect to eligibility and credit issuance for a given project.

Table 9.1 Eligibility Confirmation Items

Methodology Section	Eligibility Qualification Item	Apply Professional Judgment?
2.1 Project Definition	1. Project activities consist of mastication, prescribed burning, thinning, pruning, and/or mechanical removal of surface fuels. For projects incorporating thinning operations, residual stand conditions within thinning area(s) exhibit: a. An increase in quadratic mean diameter based on a comparison between pre- and post-treatment photo plots b. Greater than 50 square feet in basal area per acre across the thinned stand. Where the confirmation body is unable to make a decision based on professional judgment, satisfying the basal area threshold can be determined based on confirmation body measurements of a minimum of 10 random plots per 1,000 acres treated using a prism, angle gauge or similar tool. If the average basal area after initial sampling is below 50 square feet, the project proponent can request that the confirmation body continue sampling (in batches of 10 plots per 1,000 acres treated), in which case the additional sampling results must be added to the original sampling results to calculate the combined stocking.	Yes, for increase in quadratic mean diameter determination and basal area measurement

Methodology Section	Eligibility Qualification Item	Apply Professional Judgment?
	2. If multiple activities are planned, activities occur within a 3-year timeframe.	
3.1 Location	1. Project is located in the United States on public, private, or tribal lands in areas where required data is available. 2. Project area has been under forest cover for at least 20 years. 3. The project area is a contiguous spatial unit. 4. If projects occur on lands currently or formerly registered as carbon or emissions reductions projects, those projects must be or have ended in good standing.	No
3.2 Project Start Date	The date fuel treatment activities are initiated.	No
3.3.1 Performance Standard Test	Project activities are forecasted to produce GHG reductions in excess of those that would have occurred under "business as usual."	No
3.3.2 Legal Requirement Test	Proof that a signed Attestation of Legal Additionality form is on file with the Reserve.	No
3.4 Environmental and Social Safeguards	The project proponent describes in the Project Implementation Report how the project will not materially undermine progress on environmental and social issues. Evidence provided showing outreach to local fire safety-related resource management groups, including a fuels management plan covering a period of at least five years into the future and evidence of notifications provided.	No
3.5 Attestation of Regulatory Compliance	Proof that a signed Attestation of Regulatory Compliance form is on file with the Reserve. In addition to reviewing this form, the confirmation body must perform a risk-based assessment to confirm the statements made by the project proponent in the Attestation of Regulatory Compliance form and the Project Implementation Report with respect to compliance with applicable laws and regulations, as well as the potential risk of future regulatory non-compliance, has been mitigated.	Yes, with respect to the appropriateness of the reduction or mitigation of future risks
3.6 Double Counting	Via the Attestation of Title, the project proponent attests that the FMUs have not and will not be registered with, reported in, held, transferred or retired via any emissions registry or inventory other than the Climate Forward registry, or registered with Climate Forward under a different project title or location.	No
2.2 Ownership	Project proponent is the entity undertaking (organizing, planning, and/or implementing or overseeing the implementation of) the project activities and has notified the underlying fee owner(s) of treated lands that the project is being submitted to the Reserve.	No
3.6 Attestation of Title	Proof that a signed Attestation of Title form is on file with the Reserve.	No
3.7 - 3.8 Project Resilience and Permanence Measures	Modeling of both the baseline and project scenarios properly incorporates background harvesting activities that impact future fire behavior. See Table 9.2 for further guidance.	No
3.3.3	Project proponents may receive enhancement payments that support fuel treatment activities, unless such payments are specifically	No

Methodology Section	Eligibility Qualification Item	Apply Professional Judgment?
Enhancement Payments	quantified on a per tCO2e basis. Such payments must be reported in the Project Implementation Report. The confirmation body must seek guidance from the Reserve if payment stacking has occurred and has not previously been approved by the Reserve.	
6.3 Professional Forester oversight	Modeling in the project quantification must be submitted with the oversight of a Professional Forester.	No

9.4.2 Quantification

Confirmation Bodies shall include quantifications within the confirmation process that include recalculations and risk assessment. These quantification items inform any determination as to whether there are material and/or immaterial misstatements in the project's GHG emission reduction calculations. If there are material misstatements, the calculations must be revised before FMUs are issued. The following table lists the items that Confirmation Bodies shall include in their risk assessment and recalculation of the project's GHG emission reductions.

Table 9.2 Quantification Confirmation Items

Methodology Section	Quantification Item	Apply Professional Judgment?
4 Project Area	Treatment area(s) for the project have been accurately delineated in a GIS layer and depicted in maps in the PIR. Different fuel reduction activity types comprising an individual project are represented individually in the GIS layer as either single or multi-part polygons. Confirmation body shall review treatment area boundaries by field reconnaissance of at least 5% of the treatment area boundaries or by the use of earth observation data for cases where treatment boundaries are delineated using such data. Total acreage of treatment areas as calculated by the confirmation body must be within 5% of the acreage reported by the project proponent.	No
4 Project Area	A description and maps of the geographic boundaries defining the project area are provided in the PIR and a GIS layer has been submitted to the Reserve along with project documentation.	No
6.2 Project Area Delineation	Project area has been delineated according to the guidance in Section 6.2.	No
6.3.1 Modeling Changes to Forest Carbon Stocks	FFE-FVS modeling is performed as follows: ▪ Parameterization and regeneration assumptions are appropriate for the project location and conditions; ▪ Scenarios that are representative of background management conditions have been appropriately determined and incorporated into assumptions for growth and yield modeling under both the baseline and project activity to simulate changes to forest conditions and carbon stocks from regeneration harvest events over the crediting period, per Sections 6.3.1. The fuel treatments serving as the basis for the project are accurately characterized, with assumptions used for growth and yield modeling of the project activity appropriately reflecting the treatments performed and forest conditions achieved, as generally supported by photo plots taken, per Section 7.1.1.	Yes

Methodology Section	Quantification Item	Apply Professional Judgment?
	Project activity modeling must also incorporate baseline management conditions; ▪ Input data is correctly selected, including pre- and post-treatment surface fuel models. Tree and surface fuel models are updated to reflect changes to conditions within the project area since the applicable date of the retrieved data, including any disturbances occurring prior to the completion of confirmation; ▪ Any modifications, as allowed, have been appropriately made, including as related to regeneration assumptions, weather data, and post-fuel treatment surface fuel model outcomes. Carbon stock outputs are reported using the default settings in FFE-FVS. Modeling output is summarized to a per-acre average and converted to annualized carbon stock changes.	
6.3.4 Forest Biomass Removals	Standard outputs of harvest/biomass removal volumes and associated harvested wood products C from FFE-FVS are reported, with carbon in harvested wood products included in FMU quantification only for projects not being implemented in areas that overlap with other carbon projects with a claim to the climate benefits associated with the carbon in harvested wood products.	No
6.3.6 Wildfire Behavior Modeling	The wildfire behavior model used is one of the pre-approved models identified on the methodology page on Climate Forward website. The model has been applied correctly, including with respect to the parameters, assumptions, and inputs described in Table 6.3.	No
6.3.9 Fire Emissions Modeling	FOFEM has been applied correctly, per guidance in Section 6.3.9, including the input data derived from forest condition and wildfire behavior modeling. Wildfire emissions calculations are performed correctly and averaged on a per-acre basis for each modeling time step for both the baseline and project scenarios, with the CBP ratio applied to project wildfire emissions and all results annualized for reporting purposes.	No
6.4 Delayed Reforestation Impacts	Acreage affected by high-severity wildfire for each forest type within the project area is identified from wildfire behavior modeling and applied to delayed reforestation emissions calculation as variable $A_{HS,f}$ for both the baseline and project scenario. Pre- and post-high severity wildfire vegetation types and carbon stocking are correctly identified based on the project conditions and are reflected in the value(s) applied for the variables C_{onsite} and $\overline{C}_{TC}$, and $P_{TC,f}$ in Equation 6.4.	No
6.5 Fire Ignition Probability	Annual probability of fire (P_{fire}) is calculated correctly according to the guidance in Section 6.5.	No
0 Performance Decline	Programmatic *ex ante* risk deduction of 10% has been applied.	No
6 Quantifying GHG Emission Reductions	Reduced Emissions from Megafires FMU Calculation Worksheet has been completed and a clean copy of the worksheet (provided by the Reserve) completed by the confirmation body with the project input data provides an identical result.	No
6.11 Reconciliation	Project proponent has properly identified project stacking associated with the project and, in cases where projects stacked with a project being submitted under this methodology has a claim to credits based	No

Methodology Section	Quantification Item	Apply Professional Judgment?
with Stacked Projects	on carbon in harvested wood products, such carbon is not included in FMU quantification under this methodology.	
7.1.1 Treatment Area Monitoring	The following plot implementation requirements were met by the project proponent: ▪ Correct number of plots were established for each treatment area, per Table 7.2 ▪ Plots were located randomly or randomly selected from a systematically distributed set of potential plot locations. ▪ Pre- and post-treatment images were captured within one year prior to or after treatment implementation, respectively, for each treatment area. ▪ One clear image, following the requirements for 'Imagery Setup' and 'Imagery Attributes' in Table 7.2, was taken representing pre- and post-treatment conditions at each plot location.	No
7.1.1 Treatment Area Monitoring	The confirmation body will review pre- and post-treatment photo pairings to confirm the project activities performed within each treatment area are reflected in the general nature of the changes observed in the photos. The review shall also confirm the paired photos were taken at the same location. Additionally, the confirmation body will randomly select 20% of the photo plots within each treatment area to visit in the field and confirm the photos correspond to the location, and associated conditions, of each post-treatment photo and to assess the fuel-related metrics on site. The goal of this effort is to confirm that modeled treatment outcomes reasonably accurately reflect post-treatment conditions. The focus of the assessment is on the surface fuel model(s) selected for post-treatment conditions since that modeling input drives fire severity and behavior outcomes (and, hence, GHG emissions). The confirmation body must do the following: ▪ Identify the surface fuel model within the modeling data for each plot to be visited. ▪ At each plot being visited in the field, assess if plot conditions and surrounding buffer (~5 acre) are consistent with the surface fuel model chosen for the first five-year timestep. o Scott and Burgan models[15] can be used as guidance for verifying surface fuel models and corresponding flame length. To pass confirmation, the confirmation body's determination of the applicable surface fuel model at each plot (plus buffer area) visited must match the surface fuel model reported by the project proponent. If the surface fuel model determined in the field does not match, the confirmation body may use professional judgment to determine whether the surface fuel model reported by the project proponent is nevertheless a reasonable representation of the conditions on and around the plot.	Yes

[15] Scott and Burgan ref

In the event a treatment area fails confirmation based on the assessments performed at the selected photo plot locations or on the treatment area boundaries not being met, the project proponent can choose one of the following options for proceeding:

- Perform on-the-ground adjustments to the treatment area(s) (e.g., treat full area identified in the treatment area polygon, intensify the treatment)
- Adjust modeling inputs to reflect post-treatment conditions (e.g., decrease the size of treatment polygons, reduce treatment intensity)

9.4.3 Risk Assessment

Confirmation Bodies will review the following items in Table 9.3 to guide and prioritize their assessment of data used in determining eligibility and quantifying GHG emission reductions.

Table 9.3 Risk Assessment Confirmation Items

Methodology Section	Item that Informs Risk Assessment	Apply Professional Judgment?
2, 4, 6, 7	Confirm that the characterization of the fuel treatment(s) implemented and delineation of fuel treatment areas reflect conditions on the ground.	Yes
3	Confirm that potential claims to credit ownership, especially with respect to double-counting, have been addressed and/or accounted for properly.	No
6, 7	Confirm that modeling of fuel treatments under the project scenario results in immediate post-treatment stand conditions representative of actual post-treatment conditions on the ground, including confirming that any adjustments to surface fuel model outputs have been made appropriately.	Yes
6	Confirm that modeling data, assumptions and parameters, including any allowable modifications, are appropriate and reasonably reflect project or baseline conditions. Particular attention should be paid to surface fuel model choices, regeneration assumptions, and delayed regeneration assumptions.	Yes
6	Confirm that personnel with appropriate modeling experience are involved with the modeling aspects required under the methodology.	No
7	Confirm that the Project Implementation Report is sufficiently rigorous to support the requirements of the methodology	Yes

9.5 Completing Confirmation

The Climate Forward Program Manual provides detailed information and instructions for Confirmation Bodies to finalize the confirmation process. It describes completing a Confirmation Report, preparing a Confirmation Statement, submitting the necessary documents to the Reserve, and notifying the Reserve of the project's confirmed status.

10 Glossary of Terms

Accredited Confirmation Body	A confirmation firm approved by the Climate Action Reserve to provide confirmation services for project proponents.
Additionality	Project activities that are above and beyond "business as usual" operation, exceed the baseline characterization, and are not mandated by regulation.
Anthropogenic emissions	GHG emissions resultant from human activity that are considered to be an unnatural component of the Carbon Cycle (i.e., fossil fuel destruction, de-forestation, etc.).
Biogenic CO_2 emissions	CO_2 emissions resulting from the destruction and/or aerobic decomposition of organic matter. Biogenic emissions are considered to be a natural part of the Carbon Cycle, as opposed to anthropogenic emissions.
Broadcast burning	See definition for "prescribed burning"
Carbon dioxide (CO_2)	The most common of the six primary greenhouse gases, consisting of a single carbon atom and two oxygen atoms.
CO_2 equivalent (CO_2e)	The quantity of a given GHG multiplied by its total global warming potential. This is the standard unit for comparing the degree of warming which can be caused by different GHGs.
Confirmation	The process used to ensure that a given participant's GHG emissions or emission reductions have met the minimum quality standard and complied with the Reserve's procedures and protocols for calculating and reporting GHG emissions and emission reductions.
Cultural burning	See definition for "prescribed burning"
Direct emissions	GHG emissions from sources that are owned or controlled by the reporting entity.
Emission factor (EF)	A unique value for determining an amount of a GHG emitted for a given quantity of activity data (e.g. metric tons of carbon dioxide emitted per barrel of fossil fuel burned).
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.

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.
Fossil fuel	A fuel, such as coal, oil, and natural gas, produced by the decomposition of ancient (fossilized) plants and animals.
Fuel treatment activity	An action or set of actions intended to reduce forest fuel loading in ways that modify fire behavior and/or severity in the event of a fire.
Greenhouse gas (GHG)	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), or perfluorocarbons (PFCs).
GHG reservoir	A physical unit or component of the biosphere, geosphere, or hydrosphere with the capability to store or accumulate a GHG that has been removed from the atmosphere by a GHG sink or a GHG captured from a GHG source.
GHG sink	A physical unit or process that removes GHG from the atmosphere.
GHG source	A physical unit or process that releases GHG into the atmosphere.
Global Warming Potential (GWP)	The ratio of radiative forcing (degree of warming to the atmosphere) that would result from the emission of one unit of a given GHG compared to one unit of CO_2 a 100-year timeframe.
Indirect emissions	Reductions in GHG emissions that occur at a location other than where the reduction activity is implemented, and/or at sources not owned or controlled by project participants.
Metric tonne (t)	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.6 pounds or 1.1 short tons.
Prescribed burning	Controlled applications of fire to fuels, under specified environmental conditions that allow fire to be confined to a predetermined area and produces the fire behavior and fire characteristics required to meet forest health objectives identified in a burn plan (USDA Forest Service, 2022).
Professional forester	A forester who meets the requirements of professional registrations within jurisdictions where professional or certified foresters exist. For purposes of this methodology, an affiliation with state or national registries or certification by a professional society (e.g.,

	Society of American Foresters) is adequate for the professional to perform the role of a Professional Forester wherever the methodology is used, unless jurisdictional requirements otherwise prohibit this designation, in which case the jurisdiction's laws are assumed. Additionally, foresters with appropriate educational and professional experience (minimum: BA/BS or higher in forestry/natural resources with at least five years professional field experience, including experience with fuel treatment activities) may perform the role of Professional Forester under the methodology within jurisdictions where no professional or certified forester requirements exist.
Project baseline	A "business as usual" GHG emission assessment against which GHG emission reductions from a specific GHG reduction activity are measured.
Project proponent	An entity that undertakes a GHG project, as identified in Section 2.2 of this methodology.
Project resilience measures	Activities tailored to the specific project that are undertaken to ensure the continuing implementation of the project for the duration of the crediting period.
Shadow area	An untreated area that may or may not burn but where fire behavior is projected to be influenced by nearby fuel treatments.
Treatment area	The spatial extent of where a given fuel treatment activity or set of activities occur.

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