CLIMATE ACTION RESERVE

Urban Forest Management Project Protocol

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Abbreviations and Acronyms

C	Carbon
CAL FIRE	California Department of Forestry and Fire Protection
CH_4	Methane
CO_2	Carbon dioxide
CRT	Climate Reserve Tonne
DBH	Diameter at Breast Height
FIA	Forest Inventory and Analysis Program of the U.S. Forest Service
GHG	Greenhouse gas
GIS	Geographical Information System
ISO	International Organization for Standardization
N_2O	Nitrous oxide
PDD	Project Design Document
PIA	Project Implementation Agreement
Reserve	Climate Action Reserve
RPF	Registered Professional Forester (California only)
SSR	Source, sink, or reservoir
UFM	Urban forest management
UFMPP	Urban Forest Management Project Protocol
USFS	United States Forest Service
VOC	Volatile Organic Compound

1 Introduction

This Urban Forest Management Project Protocol (UFMPP) provides requirements and guidance for quantifying the net climate benefits of activities that sequester carbon in woody biomass within an urban environment. The protocol provides: project eligibility rules; methods to calculate a project's net effects on greenhouse gas (GHG) emissions and removals of CO_2 from the atmosphere ("removals"); procedures for assessing the risk that carbon sequestered by a project may be reversed (i.e. released back to the atmosphere); and approaches for long term project monitoring and reporting.

The goal of this protocol is to ensure that the net GHG reductions and removals caused by a project are accounted for in a complete, consistent, transparent, accurate, and conservative manner[1] and may therefore be reported to the Climate Action Reserve (Reserve) as the basis for issuing carbon offset credits (called Climate Reserve Tonnes, or CRTs). Additionally, it is the goal of the Reserve to ensure the protocol is as efficient and practical as possible for Project Operators.

As the premier carbon offset registry for the North American carbon market, the Reserve encourages action to reduce greenhouse gas (GHG) emissions by ensuring the environmental integrity and financial benefit of emissions reduction projects. The Reserve establishes high quality standards for carbon offset projects, oversees independent third-party verification bodies, issues carbon credits generated from such projects and tracks the transaction of credits over time in a transparent, publicly-accessible system. The Climate Action Reserve is a private 501(c)(3) nonprofit organization based in Los Angeles, California.[2]

Only those Projects that are eligible under and comply with this UFMPP may be registered with the Reserve. Section 8 of this protocol provides requirements and guidance for verifying the performance of Project activities and their associated GHG reductions and removals reported to the Reserve.

1.1 About Urban Forests, Carbon Dioxide and Climate Change

Urban forests have the capacity to both emit and absorb carbon dioxide (CO_2), a leading greenhouse gas that contributes to climate change. Trees, through the process of photosynthesis, naturally absorb CO_2 from the atmosphere and store the gas as carbon in their biomass, i.e. trunk (bole), leaves, branches, and roots. Carbon may also be stored in the soils that support the urban forest, as well as the understory plants and litter on the urban forest floor. After trees are removed, their wood residue may be converted into mulch, with CO_2 gradually released to the atmosphere through decomposition. Carbon may continue to be sequestered for a substantial amount of time in wood products and in landfills. Carbon from urban forests may also be used to provide fuel for biomass energy. Also, urban trees can reduce summertime air temperatures and building energy use for air conditioning, thus reducing GHG emissions from electricity generation (Akbari 2002). In winter, trees can increase or decrease GHG emissions associated with energy consumed for space heating, depending on local climate, site features, and building characteristics (Heisler 1986).

[1] See the WRI/WBCSD GHG Protocol for Project Accounting (Part I, Chapter 4) for a description of GHG reduction project accounting principles.
[2] For more information, please visit www.climateactionreserve.org.

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

2 Urban Forest Management Definition and Requirements

For the purposes of this protocol, an urban forest management (UFM) project ("Project") is a planned set of activities designed to increase removals of CO_2 from the atmosphere, or reduce or prevent emissions of CO_2 to the atmosphere, through increasing and/or conserving urban forest carbon stocks.

A glossary of terms used in this protocol is provided in Section 9. Throughout the protocol, important defined terms are capitalized (e.g. "Urban Forest Owner").

2.1 Project Definition

A UFM Project focuses on activities that maintain or increase carbon inventories relative to baseline levels, as defined in this protocol, of carbon within the project boundary. Eligible management activities may include, but are not limited to:

- Increasing the overall age of the urban forest by changing rotation ages. This applies specifically to urban forests that include management for commercial products within the Urban Area
- Increasing the urban forest productivity by removing diseased and suppressed trees
- Reducing emissions by avoiding tree removals
- Planting additional trees on available and appropriate sites
- Monitoring, protecting, and treating trees to avoid premature mortality from stressors such as drought, pests, storm damage, and abiotic agents
- Reducing the vulnerability of trees to impacts of climate change by increasing resilience

2.2 Urban Forest Owners

Credits for a Project must be quantified from carbon that is owned by participating entities. An Urban Forest Owner is a corporation, a legally constituted entity (such as a utility or special district), city, county, state agency, educational campus, individual(s), or a combination thereof that has legal control of any amount of urban forest carbon[3] within the Project Area.

Only counties, municipalities, educational institutions, and utilities/ special districts may develop a Project independently. Other Urban Forest Owners must develop a Project as an aggregated project. Aggregated projects may only include the carbon controlled by municipalities, counties, educational institutions, and utilities/special districts by permission as described in Section 2.3. However, counties, municipalities, educational institutions, and utilities may not enroll the same area in both an independent project and an aggregation project. An aggregated project must allow participation by all Urban Forest Owners within the Project Area. No more than one aggregated project can exist within the limits of a Project Area.

Control of urban forest carbon means the Urban Forest Owner has the legal authority to effect changes to urban forest carbon quantities (right to plant or remove, for example). Control of urban forest carbon occurs, for purposes of satisfying this protocol, through fee ownership, perpetual contractual agreements, and/or deeded encumbrances. This protocol recognizes the fee owner as the default owner of urban forest carbon where no explicit legal encumbrance exists. Individuals or entities holding mineral, gas, oil, or similar *de minimis*[4] interests without fee ownership, are precluded from the definition of Urban Forest Owner.

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

Urban Forest Owners are able to combine, or aggregate, forest carbon with other Urban Forest Owners to develop a Project at increased scale. Urban Forest Owners must agree to a single Project Operator (see below) who is designated to manage the requirements of the Project.

2.3 Project Operators

A Project Operator must be one of the Urban Forest Owners or a legally created entity to represent the Urban Forest Owners. The Project Operator is responsible for undertaking a Project and registering it with the Reserve, and is ultimately responsible for all project listing, monitoring, reporting and verification. The Project Operator is responsible for any reversals associated with the Project and is the entity that executes the Project Implementation Agreement (see below) with the Reserve.

In all cases where multiple Urban Forest Owners participate in a Project, the Project Operator must secure an agreement from all other Urban Forest Owners that assigns authority to the Project Operator to include the carbon they own in the Project, subject to any conditions imposed by any of the Urban Forest Owners to include or disallow any carbon they control and any provisions to opt out of the Project.

2.4 Project Implementation Agreement

A Project Implementation Agreement (PIA) is a required agreement between the Reserve and a Project Operator setting forth the Project Operator's obligation (and the obligation of its successors and assigns) to comply with the Urban Forest Management Project Protocol.

3 Eligibility Rules

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

3.1 Project Location

Only those activities that occur within the Urban Area boundaries, defined by the most recent publication of the United States Census Bureau (http://www.census.gov/geo/maps-data/maps.html), are eligible to develop a project under this protocol. Projects must be entirely within the Urban Area boundary as of Project Commencement.

3.2 Project Area

The Project Area is the geographic extent of the Project. The Project Area may be made up of consolidated or disaggregated polygons. A KML file must be submitted with the Project to clearly identify the project boundaries. UFM Projects must be a minimum of 50 acres, or 50% of the Urban Area (whichever is smaller) and can be made up of one or many participating Forest Owners.

3.3 Limits to Site Preparation

UFM Projects that plow, till, or rip soils, resulting in the removal of the roots of herbaceous understory in preparation for planting trees where more than 2% of the Project Area is disturbed on an annual basis are not eligible, since soil-related emissions above baseline levels are not quantified in this protocol. Where such plowing, tilling, or ripping of soils occurs as described within an existing project in any one year, the transacting of credits will be suspended until the subsequent years and soil disturbance rates brings the average below the 2% threshold, after which time the 2% threshold in any given year is renewed.

3.4 Project Commencement

The commencement date for a Project is the date at which the Project Operator initiates an activity that will lead to increased GHG reductions or removals with long-term security relative to the Project baseline. The commencement date can be as early as August 1, 2008 (the date of the adoption of the Urban Forest Project Protocol Version 1.0 by the Reserve's Board); however no credits can be issued for carbon stored more than two years prior to the Project Submission Date.

The commencement date is initiated by activities that increase carbon inventories and/or decreases emissions relative to the baseline. Evidence of discrete and verifiable activities that justify a commencement date include:

- Submitting the project to the Reserve. The Project Commencement is the date of submittal.
- Dated planning documents that indicate the date in which the activities were initiated.

3.5 Additionality

The Reserve will only register projects that yield surplus GHG emission reductions and removals that are additional to what would have occurred in the absence of a carbon offset market (i.e. under "Business As Usual"). For a general discussion of the Reserve's approach to

determining additionality, see the Reserve's Program Manual (available at http://www.climateactionreserve.org/how/program/program-manual/).

Projects must satisfy the following tests to be considered additional.

3.5.1 Legal Requirement Test

Projects must achieve GHG reductions or removals above and beyond any GHG reductions or removals that would result from compliance with any federal, state, or local law, statute, rule, regulation, or ordinance. Projects must also achieve GHG reductions and removals above and beyond any GHG reductions or removals that would result from compliance with any court order or other legally binding mandates. Deeded encumbrances, tree planting and management ordinances, and contractual agreements, collectively referred to as Legal Agreements, may effectively control urban forest carbon and possess ownership rights to the carbon inventories controlled. Similarly, deeded encumbrances, tree planting and management ordinances, and contractual agreements may have an effect on urban forest carbon inventories beyond the control of any of the Urban Forest Owners.

The baseline trend for UFM Projects is based on comparison of historic data with current data and includes the effects of legal requirements. Therefore, no further consideration is needed. A subsequent evaluation of additionality will occur at the initiation of the subsequent crediting period.

3.5.2 Performance Test

Projects must achieve GHG reductions or removals above and beyond any GHG reductions or removals that would result from engaging in Business As Usual activities, as defined by the requirements described below.

3.5.2.1 Performance Standard for Urban Forest Management Projects

The performance standard is to exceed the project baseline for UFM Projects as described in Section 5.1.1.

3.6 Project Crediting Period

The crediting period a Project is 25 years. Projects may be renewed for additional crediting periods with the prospect of incorporating updated technology into the project analysis. The initial baseline can be maintained for the crediting period. While the project can be renewed indefinitely, the baseline must be renewed at the end of the crediting period. Any previously issued credits are respected for the life of the project.

3.7 Minimum Time Commitment

Projects must monitor, report, and undergo verification activities for 100 years following the last credit issued to the Project.

3.8 Social and Environmental and Co-Benefits

All Projects will provide climate benefits to the extent in which they generate credits. The ability to achieve additional environmental and social co-benefits depends on consideration of additional factors, some of which are described in this section. Only those projects where public and/or tribal entities participate in direct urban tree management activities (e.g., planting, tree distribution, etc.) are required to include the provisions for social and environmental co-benefits. However, these provisions may serve as suggestions to NGOs and other privately funded

projects that may wish to enhance social and environmental co-benefits. Where required, the provisions must be described in the Project Design Document (PDD) and implemented throughout the project life. The Reserve has developed a tree-planting template that outlines elements that need to be addressed and provides important considerations that may be helpful in decision-making (template pending; will be available on the urban forest webpage[5]). The template provides considerations that will enable verifiers to ensure progress is being achieved over time.

3.8.1 Social Co-Benefits

Projects can create long-term climate benefits as well as providing other social and environmental benefits. Investment in Projects has the potential to improve the quality of life for urban communities in a number of ways. Among other benefits, tree planting projects can improve air quality and reduce storm water runoff, provide shade, and increase property values by creating a more aesthetically pleasing environment. Projects also have the potential to create negative social externalities such as an uneven distribution of project benefits due to an uneven distribution of projects sites throughout a community (e.g. skewed toward more affluent communities).

Table 3.1. Social Co-Benefits of Urban Forest Management Projects

Social Provisions	Elements to Include in the Project Design Document (PDD)
Equitable distribution of forest resources	Describe how the project will make progress toward achieving relatively equal distribution of tree canopy cover by neighborhood whenever possible.
Public participation	Establish guidelines to ensure adequate notification, opportunities for public participation, and documentation with regards to public activities with urban forest management.

3.8.2 Environmental Co-Benefits

The protocol has a goal of permanently removing greenhouse gases from the atmosphere by sustaining carbon benefits generated from urban forests for at least 100 years. Healthy urban forests can also provide a number of environmental benefits as well as create negative externalities. Projects have the potential to improve air quality and reduce storm water runoff and energy usage. They can also contribute to reduced biodiversity, introduce invasive species, and damage infrastructure. Inefficient water usage during maintenance can also put pressure on local and regional water supplies.

Table 3.2. Environmental Co-Benefits of Urban Forest Management Projects

Environmental Provisions	Elements to Include in the Project Design Document (PDD)
Biodiversity	Describe how UFM Project activities will maintain and enhance biodiversity, including: 1. Benefits of tree species selection and composition to biodiversity within the project area. 2. Use of specific tree species, sizes and/or distributions

[5] http://www.climateactionreserve.org/how/protocols/urban-forest/

	to support unique habitat elements.
Native species	Describe how UFM Project activities will promote the use of native species, including: 1. Strengths and limitations of using native trees in the Project. 2. Preferential treatment of native species.
Non-native species	Describe how UFM Project activities will limit and target the use of any non-native species, including: 1. Strengths and limitations of using non-native trees in the Project. 2. Resistance to insects and disease.
Climate change resilience	Describe how UFM Project activities will enhance the resilience of the urban forest to climate change, including: 1. Ability of urban forest to adapt to climate change. 2. Resistance to natural disturbances.
Air quality	Describe how UFM Project activities will enhance air quality benefits, including: 1. Tree selection and distribution to reduce air pollutants. 2. Tree selection and distribution to reduce emissions of Biogenic Volatile Organic Compounds (BVOCs). 3. Design tree maintenance activities to reduce fossil fuel emissions.
Physical characteristics	Describe how UFM Project activities will enhance physical characteristics of the urban environment, including: 1. Tree shading. 2. Wind protection. 3. Minimize disturbance to city infrastructure (e.g. sidewalks, power lines, etc.)
Water Management	Describe how UFM Project activities will improve water management, including: 1. Increase infiltration and recharge of groundwater. 2. Reduce stormwater runoff. 3. Conserve water from urban forest management.

4 GHG Assessment Boundaries

The quantification of all included sources, sinks, and reservoirs (SSR) (Table 4.1 below) are described in the quantification guidance in Appendix A.

Table 4.1. Description of all Sources, Sinks, and Reservoirs

SSR	Source Description	Type	Gas	Included (I) or Excluded (E)	Justification/Explanation
UF-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	Included	Increases in standing live carbon stocks are likely to be a large Primary Effect of UFM Projects.
UF-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	Excluded	For crediting purposes shrubs and herbaceous understory are excluded since changes in this reservoir are unlikely to have a significant effect on total quantified GHG reductions or removals. Furthermore, it is generally not practical to undertake measurements of shrubs and herbaceous understory accurate enough for crediting purposes.
UF-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	Excluded	Standing dead wood is expected to be a small portion of UFM Projects.
UF-4	Lying dead wood carbon	Reservoir / Pool	CO_2	Excluded	For crediting purposes lying dead wood carbon is excluded since changes in this reservoir are unlikely to have a significant effect on total quantified GHG reductions or removals. Changes associated with carbon projects are likely to increase lying dead wood. Furthermore, it is generally not practical to undertake measurements of lying dead wood accurate enough for crediting purposes.
UF-5	Litter and duff carbon (carbon in dead plant material)	Reservoir / Pool	CO_2	Excluded	Litter and duff carbon is excluded since changes in this reservoir are unlikely to have a significant effect on total quantified GHG reductions or removals. Furthermore, it is generally not practical to undertake measurements of litter and duff accurate enough for crediting purposes.
UF-6	Soil carbon	Reservoir / Pool	CO_2	Excluded	Soil carbon is not anticipated to change significantly as a result of UFM Projects.

SSR	Source Description	Type	Gas	Included (I) or Excluded (E)	Justification/Explanation
UF-7	Carbon in in-use forest products	Reservoir / Pool	CO_2	Excluded	Urban forests do not produce significant levels of wood products that persist for long enough periods of time to meet permanence requirements and Projects will not substantially change wood product production.
UF-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	Excluded	Urban forests do not produce significant levels of wood products and Projects will not substantially change wood product production.
UF-9	Nutrient application	Source	N_2O	Excluded	The use of nitrogen-based fertilizers is not expected to be a significant source of emissions.
UF-10	Biological emissions from site preparation activities	Source	CO_2	Excluded	Biological emissions from site preparation are not quantified since projects that involve intensive site preparation activities are not eligible.
UF-11	Mobile combustion emissions from site preparation activities	Source	CO_2	Excluded	Mobile combustion CO_2 emissions from site preparation are not quantified since projects that involve intensive site preparation activities are not eligible.
			CH_4	Excluded	Changes in CH_4 emissions from mobile combustion associated with site preparation activities are not considered significant.
			N_2O	Excluded	Changes in N_2O emissions from mobile combustion associated with site preparation activities are not considered significant.
UF-12	Mobile combustion emissions from ongoing project operation and maintenance	Source	CO_2	Excluded	Mobile combustion CO_2 emissions from ongoing project operation and maintenance are unlikely to be significantly different from baseline levels, and are therefore not included in the GHG Assessment Boundary.
			CH_4	Excluded	CH_4 emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	Excluded	N_2O emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.

SSR	Source Description	Type	Gas	Included (I) or Excluded (E)	Justification/Explanation
UF-13	Stationary combustion emissions from ongoing project operation and maintenance	Source	CO_2	Excluded	Stationary combustion CO_2 emissions from ongoing project operation and maintenance could include GHG emissions associated with electricity consumption or heating/cooling at Urban Forest Owner facilities or at facilities owned or controlled by contractors. These emissions are unlikely to be significantly different from baseline levels, and are therefore not included in the GHG Assessment Boundary.
			CH_4	Excluded	CH_4 emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	Excluded	N_2O emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.

5 Quantifying Net GHG Reductions and Removals

This section provides general requirements and guidance for quantifying a Project's net GHG reductions and removals. Detailed methodological approaches to quantifying GHG reductions and removals are provided in Appendix A (Quantification Guidance). The Reserve will issue Climate Reserve Tonnes (CRTs) to a Project upon confirmation by an ISO-accredited and Reserve-approved verification body that the Project's GHG reductions and removals have been quantified following the applicable requirements of this section (see Section 8 for verification requirements). The Reserve provides an Urban Forest Calculation Tool on its website to assist with the annual calculation of reductions and removals.

Quantification proceeds according to the steps below.

1. **Estimating baseline onsite carbon stocks**. The baseline is an estimate of what would have occurred in the absence of a Project. To establish baseline onsite carbon stocks, the Project Operator must apply the appropriate performance test from Section 3.5.2 of this protocol to the Project Onsite Inventory at Project Commencement. The Project Onsite Inventory must have been developed according to the guidelines established in Appendix A (Quantification Guidance). Baseline estimates are developed for a 100-year period. Generally, baselines do not change during this period absent findings of errors in initial calculation or reconciliation associated with methodological updates.

2. **Determining actual onsite carbon stocks**. Each year, the Project Operator must determine the Project's actual onsite carbon stocks. This must be done by updating the Project's forest carbon inventory for the current year, following the guidance in this section and in Appendix A. The estimate of actual onsite carbon stocks must be adjusted by an appropriate confidence deduction, as described in Appendix A.

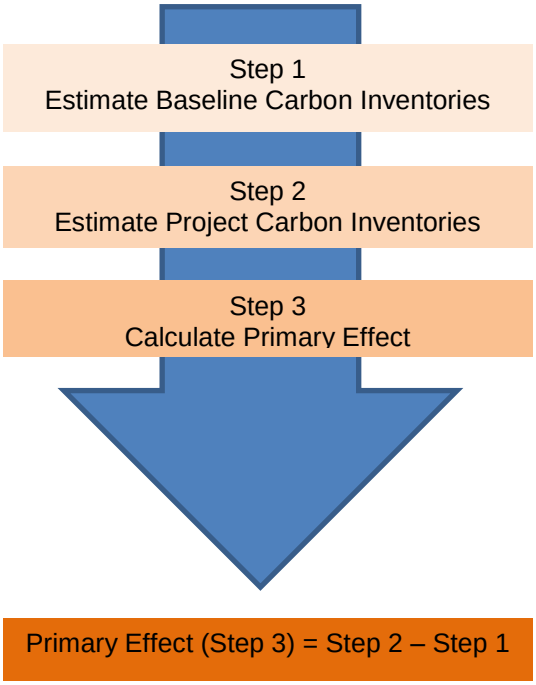
3. **Calculating the project's Primary Effect**. Each year, the Project Operator must quantify the actual change in GHG emissions or removals associated with the Project's intended ("primary") effect. For any given year, the Primary Effect is calculated by:
    a. Taking the difference between actual onsite carbon stocks for the current year and actual onsite carbon stocks for the prior year.[6]
    b. Subtracting from (a) the difference between baseline onsite carbon stocks for the current year and baseline onsite carbon stocks for the prior year.

4. Calculating total net GHG reductions and removals. For each year, total net GHG reductions and removals are calculated by summing a Project's Primary and Secondary Effects. If the result is positive, then the Project has generated GHG reductions and/or removals in the current year. If the result is negative, this may indicate a reversal has occurred (see Section 6).[7]

The required formula for quantifying annual net GHG reductions and removals is presented in Equation 5.1. Net GHG reductions and removals must be quantified and reported in units of carbon dioxide-equivalent (CO_2e) metric tons.

[6] For the purposes of calculating the Project's Primary Effect, actual and baseline carbon stocks prior to the Project Commencement Date are assumed to be zero.

[7] A reversal occurs only if: (1) total net GHG reductions and removals for the year are negative; and (2) CRTs have previously been issued to the Project.



Equation 5.1. Annual Net GHG Reductions and Removals

$$\boldsymbol{QR_y} = (\Delta\, \boldsymbol{AC_{onsite}} - \Delta\, \boldsymbol{BC_{onsite}})$$

Where,

			Units
QR_y	=	Quantified GHG reductions and removals for year y	tCO_2e
$\Delta\, AC_{onsite}$	=	$(AC_{onsite,\, y}) - (AC_{onsite,\, y\text{-}1})$	tCO_2e
		Where,	
		$AC_{onsite,\, y}$ = Actual carbon (CO_2e) as inventoried for year y (y may be less than a year for the first reporting period following Project Commencement).	tCO_2e
		$AC_{onsite,\, y\text{-}1}$ = Actual carbon (CO_2e) as inventoried for year y-1	tCO_2e
$\Delta\, BC_{onsite}$	=	$(BC_{onsite,\, y}) - (BC_{onsite,\, y\text{-}1})$	tCO_2e
		Where,	
		$BC_{onsite,\, y}$ = Baseline onsite carbon (CO_2e) as estimated for year y (y may be less than a year for the first reporting period following Project Commencement).	tCO_2e
		$BC_{onsite,\, y\text{-}1}$ = Baseline onsite carbon (CO_2e) as estimated for year y-1	tCO_2e

5.1 Urban Forest Protocol Baselines

A key component of determining additionality for a project is identifying a baseline that appropriately represents what emissions would have occurred in absence of a project. The approach to determining baseline is based on standardized rules defined in this section.

5.1.1 Urban Forest Management Projects

To develop a project baseline for a UFM Project, a trend line is developed by calculating a historic estimate of carbon stocks and a recent estimate of carbon stocks. The historic estimate must be between 10 and 20 years prior to the Project Commencement. More recent images may be requested and permitted (in writing) by the Reserve if data are not available in the Project Area jurisdiction. Both estimates are developed by first estimating tree canopy area for each time period from remotely sensed data and developing a ratio of CO_2e to tree canopy area from ground sampling. The resulting trend is extended 20 years into the future, provided legal constraints have not changed substantially during the 20 year period, at which point the baseline is held steady for the balance of the 100-year projection. A description of how legal constraints affect baseline considerations and technical issues associated with the baseline are described in Appendix A (Quantification Guidance).

6 Ensuring the Permanence of Credited GHG Reductions and Removals

Changes in urban forest management have the potential to enhance the rate of CO_2 absorption, providing removals, and reducing or eliminating emissions associated with the loss of trees (reductions). Reductions may be possible with some UFM Projects. The Reserve requires that credited GHG reductions and removals be effectively "permanent." For UFM Projects, this requirement is met by ensuring that the carbon associated with credited GHG reductions and removals remains stored for at least 100 years.

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

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

GHG reductions and removals can be "reversed" if the stored carbon associated with them is released (back) to the atmosphere. Many biological and non-biological agents, both natural and human-induced, can cause reversals. Some of these agents cannot completely be controlled (and are therefore "unavoidable"), such as natural agents like fire, insects, pathogens, drought, and wind.

Other agents can be controlled, such as the human activities like land conversion. Under this protocol, reversals due to controllable agents are considered "avoidable". As described in this section, Project Operators must contribute to the Reserve Buffer Pool to insure against reversals. If the quantified GHG reductions and removals in a given year are negative, and CRTs were issued to the Project in any previous year, the Reserve will consider this to be a reversal regardless of the cause of the decrease.

The Buffer Pool is a holding account for Project CRTs, which is administered by the Reserve. All Projects must contribute a percentage of CRTs to a Buffer Pool any time they are issued CRTs for verified GHG reductions and removals. A project that has an unavoidable reversal will use Buffer Pool CRTs proportionally from all projects that have contributed to the pool to compensate for the reversal. Project Operators do not receive compensation for their contributions to the Buffer Pool.

If a Project experiences an unavoidable reversal of GHG reductions and removals (as defined in Section 6.2.2), the Reserve will retire a number of CRTs from the Buffer Pool equal to the total amount of carbon that was reversed (measured in metric tons of CO_2). The Buffer Pool therefore acts as a general insurance mechanism against unavoidable reversals for all Projects registered with the Reserve. The Reserve may determine to re-distribute CRTs to Project Operators in the future, or modify the amount of contributions to the Buffer Pool, if actual unavoidable reversals fluctuate significantly from the current evaluation of risks.

6.1 Contributions to the Buffer Pool

Projects may be affected by financial risks, management risks, social risks, risks from pollution, and risks from natural disturbances (disease/insects, wildfire, flooding, drought etc.). To compensate for these risks, each project must contribute 6% of their issued CRTs to the Buffer Pool.

6.2 Compensating for Reversals

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

6.2.1 Avoidable Reversals

An Avoidable Reversal is any reversal that is due to the Project Operator's negligence, gross negligence, or willful intent, including harvesting, development, and harm to the Project Area due to the Project Operator's negligence, gross-negligence or willful intent. Requirements for Avoidable Reversals are as follows:

1. If an Avoidable Reversal has been identified during annual monitoring, the Project Operator must give written notice to the Reserve within thirty days of identifying the reversal. Additionally, if the Reserve determines that an Avoidable Reversal has occurred, it shall deliver written notice to the Project Operator.
2. Within thirty days of receiving the avoidable reversal notice from the Reserve, the Project Operator must provide a written description and explanation of the reversal to the Reserve.
3. Within four months of receiving the avoidable reversal notice, the Project Operator must retire a quantity of CRTs from its Reserve account equal to the size of the reversal in CO_2-equivalent metric tons (i.e. QR_y, as specified in Equation 5.1). In addition:
    a. The retired CRTs must be those that were issued to the Project, or that were issued to other UFM Projects registered with the Reserve.
    b. The retired CRTs must be designated in the Reserve's software system as compensating for the Avoidable Reversal.
4. Within a year of receiving the avoidable reversal notice, the Project Operator must provide the Reserve with a verified estimate of current onsite carbon stocks and the estimated quantity of the Avoidable Reversal.

6.2.2 Unavoidable Reversals

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

1. If the Project Operator determines there has been an Unavoidable Reversal, it must notify the Reserve in writing of the Unavoidable Reversal within six months of its occurrence.
2. The Project Operator must explain the nature of the Unavoidable Reversal and provide a verified estimate of onsite carbon stocks within one year so that the reversal can be quantified (in units of CO_2-equivalent metric tons).

If the Reserve determines that there has been an Unavoidable Reversal, it will retire a quantity of CRTs from the Buffer Pool equal to size of the reversal in CO_2-equivalent metric tons.

6.3 Disposition of Projects after a Reversal

If a reversal lowers the UFM Project's carbon stocks below its approved baseline carbon stocks, the Project will be terminated as the original baseline approved for the project would no longer be valid. If a Project is terminated due to an Unavoidable Reversal, a new project may be initiated and submitted to the Reserve for registration on the same Project Area. New projects may not be initiated on the same Project Area if the Project is terminated due to an Avoidable Reversal.

7 Project Monitoring, Reporting, and Verification

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

7.1 Project Documentation

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

Table 7.1. Project Documentation Submittal Requirements

Document	When Submitted/Required
Project Submittal Form	Once, at project initiation when the Project Operator wishes to submit project concept to Reserve. Must be submitted within 6 months of the Commencement Date.
Project Design Document	Once, prior to initial verification.
Signed Attestation of Title Form	Prior to issuance of credits. Required at initial verification, onsite verification, and every optional desktop verification.
Signed Attestation of Regulatory Compliance Form	Prior to issuance of credits. Required at initial verification, onsite verification, and every optional desktop verification.
Signed Attestation of Voluntary Implementation Form	Once, prior to the issuance of credits as part of the initial verification.
Verification Report	Upon completion of verification and prior to issuance of credits. Required at initial verification, onsite verification, and every optional desktop verification.
Verification Statement	Upon completion of verification and prior to issuance of credits. Required at initial verification, onsite verification, and every optional desktop verification.
Project Implementation Agreement	Upon completion of verification and prior to issuance of credits. Required at initial verification, onsite verification, and every optional desktop verification.

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

All reports that reference carbon stocks must be submitted with the oversight of a Certified Arborist, a Certified Forester, or Professional Forester so that professional standards and project quality are maintained. Any Certified Arborist, Professional Forester or Certified Forester preparing a project in an unfamiliar jurisdiction must consult with a Certified Arborist, Professional Forester or Certified Forester practicing forestry in that jurisdiction to understand all laws and regulations that govern urban 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, Certified Arborist, or Certified Forester.

All projects shall submit a shapefile as a KML that matches the maps submitted to depict the Project Area. The project's reported acres shall be based on the shapefile submitted to the

Reserve. The Reserve will create a file of all verified forest carbon projects on Google Maps for public dissemination.

7.1.1 Urban Forest Project Design Document

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

Each project must submit a PDD at the project's first verification. PDDs are intended to serve as the main project document that thoroughly describes how the project meets eligibility requirements, discusses summaries associated with developing data according to quantification requirements, outlines how the project complies with terms for additionality and describes how project reversal risks are calculated. All methodologies used by Project Operators and descriptions in the PDD must be clear in a way that facilitates review by verifiers, Reserve staff, and the public. PDDs must be of professional quality and free of incorrect citations, missing pages, incorrect project references, etc.

7.2 Monitoring Report

Monitoring is the process of regularly collecting and reporting data related to a project's performance. Annual monitoring of UFM Projects is required to ensure up-to-date estimates of project carbon stocks and provide assurance that GHG reductions or removals achieved by a project have not been reversed. Project Operators must conduct monitoring activities and submit monitoring reports according to the schedule and requirements presented in Section 7.2. Monitoring is required for a period of 100 years following the final issuance of CRTs to a project for quantified GHG reductions or removals.

Monitoring activities consist primarily of updating a project's forest carbon inventory, entering the updated inventory into the Project's calculation worksheet, and submitting it to the Reserve at frequencies defined in Section 7.3. CRTs are only issued in years that the project data are verified, as described in Section 7.4.

A monitoring report must be prepared for each Reporting Period. Monitoring reports must be provided to verification bodies whenever a Project undergoes verification. Monitoring reports must include an update of the project's calculation worksheet. The Project's calculation worksheet includes:

1. An updated estimate of the current year's carbon stocks in the reported carbon pools. Acceptable methodologies for updating the project's inventory are provided in Appendix A (Quantification Guidance). The update is determined by:
    a. Including any new forest inventory data obtained during the Reporting Period.
    b. Applying growth estimates to existing inventory.
    c. Updating inventory estimates for removals and/or disturbances that have occurred during the Reporting Period.
2. The baseline carbon stock estimates for the current year, as determined following the requirements in Section 5 and approved at the time of the project's registration.
3. A preliminary calculation of total net GHG reductions and removals (or reversals) for the year, following the requirements in Section 5.

4. *A preliminary calculation of the project's Buffer Pool contribution.

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

Conditional reporting, as pertinent:

1. If a reversal has occurred during the previous year, the report must provide a written description and explanation of the reversal, whether the Reserve classified the reversal as Avoidable or Unavoidable, and the status of compensation for the reversal.

7.3 Reporting and Verification Cycles

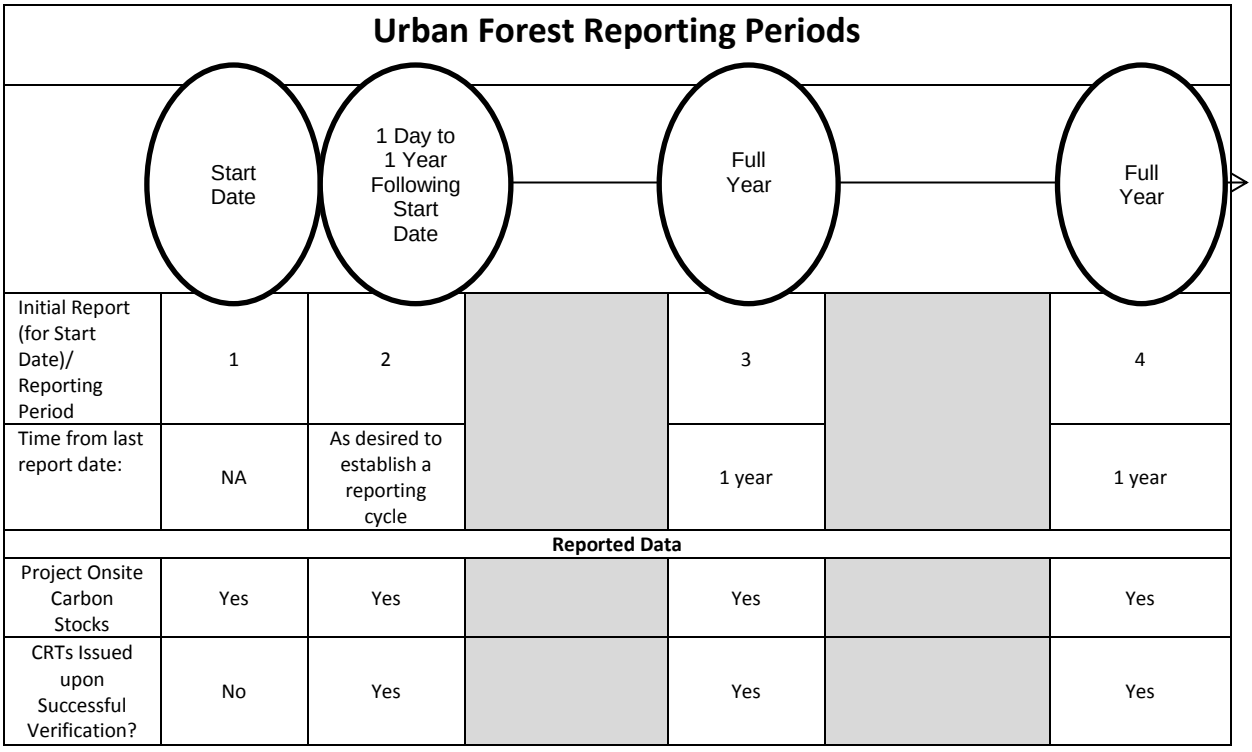
This section describes the required reporting and verification cycles. A Project is considered automatically terminated (see Section 6.3) if the Project Operator chooses not to report data and undergo verification at required intervals.

7.3.1 Reporting Period Duration and Cycles

Projects must report their initial inventory data associated with the Project Commencement Date. Project Operators must report their project inventories annually with the exception of the reporting period immediately following Project Commencement, which can be any length of time up to one year. This enables Project Operators to establish an annual reporting cycle that is convenient for the entity.

Figure 7.1 displays the Reporting Periods in graphical form.

Reporting Periods must be contiguous, i.e. there must be no gaps in reporting during the crediting period of a Project once the first reporting period has commenced.



Initial Report (for Start Date)/ Reporting Period	1	2		3		4
Time from last report date:	NA	As desired to establish a reporting cycle		1 year		1 year
Reported Data						
Project Onsite Carbon Stocks	Yes	Yes		Yes		Yes
CRTs Issued upon Successful Verification?	No	Yes		Yes		Yes

Figure 7.1. Urban Forest Management Project Reporting Periods

7.3.2 Verification Cycles

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

Verification has both required frequencies and optional frequencies. Required verification is established on a temporal framework to ensure that ongoing monitoring of urban forest carbon stocks are accurate and up-to-date. Optional verification is at the Project Operator's discretion and may be conducted in the years in which verification is not required and the Project Operator wishes to receive credits. Required verifications are referred to as onsite verifications. Optional verifications are referred to as desk review verifications. Details of verification scheduling requirements are provided within this section.

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

7.3.3 Requirements of Onsite Verifications

Onsite verification is a verification in which project inventory data are verified through a process that audits data in the office as well as data in the field. The Reserve requires that an approved third-party verification body verify all reported data and information for a Project and conduct a site visit for the Verification Period that coincides with Project Commencement and the end of every fifth reporting period following the Project Commencement Date. Buffer Pool contributions are also verified during onsite verifications.

7.3.4 Desk Review Verification

In between onsite verifications, the Project Operator may choose to have an approved third-party verification body conduct a desk review of annual monitoring reports as an optional verification. CRTs may be issued for GHG reductions/removals verified through such desk reviews.

Submission of annual monitoring reports to the Reserve is required even if the Project Operator chooses to forego desk review verification.

7.4 Issuance and Vintage of CRTs

The Reserve will issue Climate Reserve Tonnes (CRTs) for quantified GHG reductions and removals that have been verified through either onsite verifications or desk reviews. Onsite verification may determine that earlier desk reviews overestimated onsite carbon stocks. Any resulting downward adjustment to carbon stock estimates will be treated as a reversal (see Section 6). In this case, the Project Operator must retire CRTs in accordance with the requirements for compensating for a reversal (Section 6.2). Vintages are assigned to CRTs based on the proportion of days in a calendar year within a reporting period.

7.5 Record Keeping

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

7.6 Transparency

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

8 Verification Guidance

This section provides guidance to Reserve-approved verification bodies for verifying GHG emission reductions associated with urban forest projects.

This section supplements the Reserve's Verification Program Manual,[8] which provides verification bodies with the general requirements for a standardized approach for independent and rigorous verification of GHG emission reductions and removals. The Verification Program Manual outlines the verification process, requirements for conducting verification, conflict of interest and confidentiality provisions, core verification activities, content of the verification report, and dispute resolution processes. In addition, the Verification Program Manual explains the basic verification principles of ISO 14064-3:2006 which must be adhered to by the verification body.

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

- Urban Forest Management Project Protocol (this document)
- Reserve Program Manual
- Reserve Verification Program Manual
- Reserve software
- ISO 14064-3:2006 Principles and Requirements for Verifying GHG Inventories and Projects

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

The verification of reports that reference carbon stocks must be conducted with the oversight of a Certified Arborist, a Professional Forester, or a Certified Forester,[9] managed by the Society of American Foresters, so that professional standards and project quality are maintained. Any Certified Arborist, Professional Forester or Certified Forester who is not currently working with urban forest activities within the Project Area must consult with a Certified Arborist, a Professional Forester, Certified Forester, or planning agency familiar with the practice of urban forestry in that jurisdiction to understand all laws and regulations that govern urban forest practice within the jurisdiction. The Reserve may evaluate and approve alternative professional credentialing requirements if requested, but only for jurisdictions where laws or regulations that govern professional urban forest management do not exist.

8.1 Standard of Verification

The Reserve's standard of verification for UFM Projects is the Urban Forest Management Project Protocol (UFMPP), the Reserve Program Manual, and the Reserve Verification Program Manual. To verify a Project Operator's initial Project Design Document and annual monitoring reports, verification bodies apply the verification guidance in the Reserve's Verification Program

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

Manual and this section of the UFMPP to the requirements and guidance described in Sections 2 through 7 of the UFMPP.

This section of the protocol provides requirements and guidance for the verification of UFM Projects. This section describes the core verification activities and criteria that must be undertaken and addressed by a verification body in order to provide a reasonable level of assurance that the GHG removals or reductions quantified and reported by Project Operators are materially correct.

Verification bodies will use the criteria in this section to determine if there exists a reasonable assurance that the data submitted on behalf of the Project Operator to the Reserve addresses each requirement in the UFMPP, Sections 2 through 7. Project reporting is deemed accurate and correct if the Project Operator is in compliance with Sections 2 through 7.

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

8.2 Project Verification Activities

Required verification activities for UFM Projects vary depending on whether the verification body is conducting an initial verification for registration on the Reserve, onsite verification, or an optional annual verification involving a desk review. The following sections contain guidance for all of these verification activities.

8.2.1 Initial Verification

Verifiers must ensure that the project has met the UFMPP criteria and requirements for eligibility, Project Area definition, additionality, quantification and calculation of baseline. The initial verification must include onsite verification. The verification body must assess and ensure the completeness and accuracy of all required reporting elements submitted in the Urban Forest Project Design Document.

8.2.2 Onsite Verification

Onsite verification involves review of the Project's quantification, relevant attestations, soil carbon emissions associated with management activities, adherence to environmental and social safeguards (if applicable), and risk of reversal ratings. After a Project's initial verification, subsequent site visits must assess and assure accuracy in measurement and monitoring techniques and onsite record keeping practices. Onsite verifications must be completed during the initial verification and for every fifth subsequent reporting cycle. That is, onsite verification is required every 5-years.

8.2.3 Optional Annual Verification

Optional annual verifications can occur according to preferences of the Project Operator. Credits can be verified and registered as the result of an optional annual verification. Optional annual verification occurs in the interim years between onsite verifications. The main focus of optional annual verifications is to assure that Annual Monitoring Reports are complete and that reported project carbon inventories are within acceptable bounds, as described in the Appendix A.

Table 8.1 displays the protocol sections that are verified at the initial verification, the onsite verification, and/or the optional annual verification.

Table 8.1. Verification Items and Related Schedules

Verification Items	Section of UFMPP	Initial	Site	Optional	Apply Professional Judgment?
1. Project Definition	2.1 Urban Forest Management	X			Yes
2. Urban Forest Owner	2.2 Urban Forest Owners	X	X		Yes
3. Project Operator	2.3 Project Operators	X	X		No
4. Project Implementation Agreement	2.4 Project Implementation Agreement	X	X	X	No
5. Project Location	3.1 Project Location	X			No
6. Project Area	3.2 Project Area	X			No
7. Limits to Site Preparation	3.3 Limits to Site Preparation	X	X		Yes
8. Project Commencement	3.4 Project Commencement	X			Yes
9. Additionality	3.5.1 Legal Requirement Test 3.5.2 Performance Test	X	X		Yes
	3.5.2.1 Performance Standard for Urban Forest Management Projects	X			
10.Project Crediting Period	3.6 Project Crediting Period	X	X		No
11.Minimum Time Commitment	3.7 Minimum Time Commitment	X	X		No
12. Social and Environmental Co-Benefits	3.8 Social and Environmental Co-Benefits	X	X		Yes for public entities only
13. Social Co-Benefits	3.8.1 Social Co-Benefits	X	X		Yes for public entities only
14. Environmental Co-Benefits	3.8.2 Environmental Co-Benefits	X	X		Yes for public entities only
15. GHG Assessment Boundaries	4 GHG Assessment Boundaries	X	X		No
The verification topics below are linked to quantification requirements. The verification of project inventories is described in detail below this table. Verifiers shall assure that requirements associated with the references in this table have been satisfied and implement the specific guidance requirements for verifying inventories below.					
16. Quantifying Net GHG Reductions and Removals	5 Quantifying Net GHG Reductions and Removals 8.3 Verifying Carbon Inventories Appendix A Urban Forest Quantification Guidance	X	X	X	No
17. Urban Forest Protocol Baselines	5.1.1 Urban Forest Management Projects A.2.6 Baseline Development for Urban Forest Management Projects	X			No
18. Permanence and Buffer Pool Contributions	6.1 Contributions to the Buffer Pool	X	X		No
19. Permanence and Compensating for Reversals	6.2 Compensating for Reversals 6.2.1 Avoidable Reversals 6.2.2 Unavoidable Reversals	X	X	X	No

8.3 Verifying Carbon Inventories

Verification bodies are required to verify carbon stock inventory calculations of all sampled and/or measured carbon pools within the Project Area. Inventories of carbon stocks are used to determine the project baseline and to quantify GHG reductions and removals against the project baseline over time. The method of verification of carbon inventories varies depending on whether the verification is part of the initial verification, onsite verification, or an optional verification. The verification elements and their periodicity are explained in this section.

Verification Item	Item Description	Frequency of Verification
1 – Historical Tree Canopy Area	Confirming that the methodology for quantifying the historical tree canopy area specified in Appendix A was implemented correctly and that the estimates (if not completely measured) meet minimum confidence requirements stated in the quantification guidance, as part of the initial onsite verification.	Initial onsite verification.
2 – Current Tree Canopy Area	Confirming that the methodology for quantifying current tree canopy area specified in Appendix A was implemented correctly and that the estimates (if not completely measured) meet minimum confidence requirements stated in the quantification guidance, as part of onsite verification.	Initial onsite verification and every subsequent 5-year onsite verification following initial onsite verification.
3 – Carbon Estimates for Transfer Functions	Confirming that the methodology and requirements for quantifying carbon estimates specified in Appendix A were implemented correctly and that the field measurements, use of biomass equations, and summary of project data meet minimum tolerance standards for accuracy, as part of onsite verification.	Initial onsite verification and every subsequent 10-year onsite verification following initial onsite verification.
4 – Transfer Functions and Summary Calculations	Confirming that transfer functions are correctly calculated and expansions to the Project Area are performed correctly, as part of onsite verification.	Initial verification and every subsequent 5 years.
5 – Updated Data	Confirming that updated data are within acceptable bounds.	Optional, in years in between onsite verifications.

8.3.1 Verifying Urban Forest Management Projects

The verifier shall progress through each successive step according to the guidance below. Verification activities may proceed to field verification activities only once the following items have been successfully verified:

Verification Element	Description	Verification Frequency
1	Prior to verification of project inventories, items 1- 16 in Table 8.1 have been reviewed and deemed satisfactory by the verifier, both in terms of clear presentation and aligned with the protocol requirements.	Initial site verification only.

2	Confirm the entire Project Area is stratified for urban forest classes. Verifier shall inspect the project map and determine if the entire Project Area is stratified. The appropriateness of stratification will occur during plot audits.	Initial site verification and every 10-year site verification.
3	Confirm ground-based plots have been properly allocated and attributed per guidance in Appendix A (A.2.2-1).	Initial site verification and every 10-year site verification, only if ground-based plots have been moved or new plots added.
4	Confirm that ground-based plots have been randomly ordered and organized per Appendix A (A.2.2-3).	Initial site verification and every 10-year site verification, only if ground-based plots have been moved or new plots added.
5	Confirm that the Project Operator included the required minimum sample plots for each urban forest class per Appendix A (A.2.2-5).	Initial site verification and every 10-year site verification.
6	Confirm the correct biomass equations and conversion factors (A.1) were used in calculating carbon values.	Initial, 5-year, and 10-year site verifications.
7	Confirm that the calculation of transfer functions and expansion to urban forest classes and Project Area, for historical estimates and current estimates, were implemented correctly.	Historical estimates verified at initial site verification only, other data verified at initial site verification, 5-year, and 10-year verifications.
8	Confirm that confidence statistics for canopy cover were correctly calculated and meet minimum requirements per Appendix A (A.2.3-3).	Initial, 5-year, and 10-year site verifications.

The verification activities must include re-measurement of a randomly selected subset of project data used to calculate the inventory estimate for the project. The data sampled by verifiers are the tree canopy measurements and the ground-based plot measurements. The verification approach for all metrics derived from measured and/or sampled data is based on a randomly selected comparison of verifier data to Project Operator data in a process referred to as sequential sampling.

Verification using the sequential sampling methodology requires the verification body to sequentially sample successive plots. Sequential approaches have stopping rules rather than fixed sample sizes. Verification is successful after a minimum number of successive plots in a sequence indicate agreement according to the tolerance thresholds established in the sequential sampling workbook. The evaluation of the three themes that utilize sequential sampling (CO_2e estimates from plots, current tree canopy area, and historical tree canopy area) shall utilize separate worksheets and include a copy of the results within the verification report.

Where sequential data calculated from the verifier result in a trend of agreement with the Project Operator, verification can proceed toward a finding of accuracy. The minimum number of plots measured by the verifier and the tolerance bounds are established by the Reserve and described in Appendix A. Where a high level of agreement is found between the Project Operator and the verifier, a finding of acceptable accuracy may be established with the minimal number of plots required by the Reserve. As divergence between verifier estimates and Project

Operators increases, the number of plots measured by the verifier must increase in order to work toward establishing a finding of acceptable accuracy. In cases where continued verifier effort does not result in convergence, the Project Operator must decide whether continued investment in verification effort is justified. Alternatively, verification can be suspended while the Project Operator improves the quality of the inventory and revises related project documentation. Verification of measured and/or sampled data must be reinitiated following any modifications to measured and/or sampled data during verification activities.

The worksheet provided by the Reserve includes the established stopping rules. Where agreement between the verifier and the Project Operator is within specified tolerance bounds, verification of plot data is successful. Sequential sampling is described in greater detail in the next section.

For the verification of canopy area, both historical and current, CO_2e estimates from ground-based plots and stratification of urban forest classes, the verifier must randomly select an initial set of 40 ground-based sample plots from the full set of plots measured by the Project Operator, maintaining the order of their selection in sequential order (1-40). The verifier must develop an initial strategy to efficiently visit (both in the office and in the field) the first 20 plots (1-20) in the list. The plots to not need to be visited and measured sequentially, but they all need to be visited prior to entering the data in the sequential sampling works. The entries of plot summaries into the sequential sampling worksheet provided by the Reserve must be in the same order the plots were randomly selected. Prior to initiated field verification activities, the verifier must:

Verification Element	Description	Verification Frequency
9	Confirm that the estimates of **current tree canopy area** are accurate. Note: Verification of current tree canopy area estimates are conducted in the field if ground-based methods for estimating tree canopy are used. The verifier must independently calculate per-acre estimates of tree canopy area for each of the 20 plots randomly selected by the verifier. The verifier shall independently estimate the canopy area using the methodology described in Section A.2.2, for projects where ground-based methods were used to estimate current canopy area, or they must review the Project Operator's GIS layer of canopy area and compare with the remotely-sensed data that was used to develop it. This review must confirm that the plot radii are accurate per requirements of Section A.2.2-4 and that the tree canopy area is accurate for the selected plots. Regardless of the methodology used by the OPO to develop the tree canopy estimate, the verifier's estimates are compared to the Project Operator's estimates for the same plots. The results from the verifier's estimates must be compared with the Project Operator's estimates for the same 20 plots using the sequential sampling worksheet provided by the Reserve.	Initial and every subsequent 5-year onsite verification.

	The verifier estimates must be shared with the Project Operator upon completion of the verifier effort. Should a dispute arise on any plot estimate, the Project Operator may request that the verifier independently visit the plot in the field to determine if a modification should be made to the verifier's estimate. Any modifications shall be conducted at the verifier's sole discretion.	
10	Confirming that estimates of historical tree canopy area are accurate (first verification only). The verifier must confirm that the image used to estimate the historical canopy area meets the requirements of Section A.2.5. The verifier must independently calculate the per-acre canopy area estimates for each of the 20 plots it randomly and compare their estimates to the Project Operator's estimates for the same plots. The results from the verifier's estimates must be compared with the Project Operator's estimates for the same 20 plots using the sequential sampling worksheet provided by the Reserve. The verifier estimates must be shared with the Project Operator upon completion of the verifier effort. Should a dispute arise on any plot estimate due to what may be the presence of non-tree canopy that may have influenced the verifier's opinion, the Project Operator may request that the verifier consider the claim, after which the verifier shall review their estimate. Any modifications will be conducted at the verifier's sole discretion.	Initial verification only.

8.3.1.1 Field-based Inventory Verification Activities

The verifier shall visit the same plots (from above) in the field to continue verification for the following themes:

Verification Element	Description	Verification Frequency
11	Ensuring that the urban forest classes are accurately assigned. The verification of accurate stratification must occur simultaneously with the verification of ground-based plots (described below) for carbon estimates. The verifier must determine if the urban forest class identified for each plot is appropriate or not based on characteristics present during the field visit using professional judgment with the consideration for minimum mapping units described in Section A.2.1. The project must achieve a 90% approval rating from the set of the 20 selected plots. **Consequences of failing to meet the accuracy requirements for stratification**: In the event that adequate accuracy cannot be confirmed from the first 20 plots, the verifier must visit and evaluate the	Initial verification and every subsequent 10-year onsite verification.

	second set of 20 randomly selected plots as above. The 90% approval rating must be achieved by the full set of 40 visited plots. If the project does not succeed following evaluation of 40 plots, the Project Operator must refine their stratification and update the plot association with urban forest classes before continuing with verification activities.	
12	Ensuring that the CO_2e estimates from individual plots are accurate. The verifier must independently calculate per-acre estimates of CO_2e for each of the 20 plots randomly selected by the verifier, utilizing the sampling methodology described in Section A.2.2. The verifier shall measure the trees on each plot, calculating the CO_2e values represented by the trees using the appropriate biomass equations (provided on the Reserve's website), conversion and expansion factors (provided in Appendix A). The results from the verifier's calculations shall be compared with the Project Operator's estimates for the same 20 plots using the sequential sampling worksheet provided by the Reserve. Measurement standards for verifiers include: a. Measuring every diameter (DBH) to the nearest inch. b. Measuring every height (total height) to the nearest foot. Measuring every tree that is 'borderline' to determine if the tree is either in the plot or out of the plot.	Initial verification and every subsequent 10-year onsite verification.

Where Project Operator and verifier are not in agreement after the verifier data from the 20 initial verification plots has been inputted into the sequential sampling worksheets for each of the themes, additional sets of 20 plots (in 20 plot lots as described for the initial set) may be randomly selected to add to the total set of verification plots. The decision to add additional plots to the total set of verification plots is primarily the Project Operators, based on an assumption that random chance caused the initial test to fail and convergence towards agreement would occur with additional verification effort.

The results of any additional verification plot may also be inconclusive and require additional verification plots for a determination to be made. For effective application of the sequential sampling statistics in the field, the determination of when the stopping rule is met is done at the end of the measurement of a batch of plots (20 plots) in the field.

Worksheets are provided by the Reserve on the Reserve's website (pending) for use by verifiers to assist in verifying sampled data. The Reserve has established a ten percent allowance as an acceptable level of agreement between the verifier and the Project Operator.

Verification Element	Description	Verification Frequency
13	Ensuring that the updated reported inventory estimate for all reported carbon pools are within tolerance bounds in years when no onsite verification occurs. A UFM Project's reported inventory meets verification requirements if the change in reported CO_2e for the current reporting year is within 4% of the previous	Initial verification and every subsequent 10-year onsite verification.

	reporting year.	
14	A desk verification is optional for Project Operators in reporting years when onsite verifications are not required. Verifiers shall compare current reported data with previously verified data and calculate if the reported data are within acceptable tolerance bounds. Data that are not within tolerance bounds must undergo the requirements for a 5-year or 10-year onsite verification (depending on the time since the previous verification) and verify the current estimate of urban tree canopy area. Additionally, the verifier shall inspect the calculations of transfer functions and expansions to the Project Area.	In interim years between onsite verifications.

8.4 Completing the Verification Process

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

1. Complete a Verification Report to be delivered to the Project Operator (public document).
2. Complete a detailed List of Findings containing both immaterial and material findings (if any), and deliver it to the Project Operator (private document).
3. Prepare a concise Verification Statement detailing the vintage and the number of CRTs verified, and deliver it to the Project Operator (public document).
4. Verify that the number of CRTs specified in the Verification Report and Statement match the number entered into the Reserve software.
5. Conduct an exit meeting with the Project Operator to discuss the Verification Report, List of Findings, and Verification Statement and determine if material misstatements (if any) can be corrected. If so, the verification body and Project Operator should schedule a second set of verification activities after the Project Operator has revised the project submission.
6. If a reasonable level of assurance opinion is successfully obtained, upload electronic copies of the Verification Report, List of Findings, Verification Statement, and Verification Activity Log into the Reserve.
7. Return important records and documents to the Project Operator for retention.

The recommended content for the Verification Report, List of Findings, and Verification Statement can be found in the Reserve's Verification Program Manual.[10] The Verification Program Manual also provides further guidance on quality assurance, negative verification statements, use of an optional Project Verification Activity Log, goals for exit meetings, dispute resolution, and record keeping.

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

9 Glossary of Terms

Additionality	GHG emission reductions should occur as a result of specific GHG mitigation incentives; additionality is achieved when GHG reductions are beyond what would occur under business as usual operation and result from activities that are not mandated by regulation.
Allometric Equation	An equation that utilizes the genotypical relationship among tree components to estimate characteristics of one tree component from another. Allometric equations allow the below ground root volume to be estimated using the above-ground bole volume.
Avoidable Reversal	An avoidable reversal is any reversal that is due to the project operator's negligence, gross negligence, or willful intent, including harvesting, development, and harm to the project area.
Baseline	An estimate of GHG emissions and removals that would have occurred in absence of the project under business as usual operations.
Best Management Practices	Management practices determined by a state or designated planning agency to be the most effective and practicable means (including technological, economic, and institutional considerations) of controlling point and nonpoint source pollutants at levels compatible with environmental quality goals.[11]
Biological Emissions	For the purposes of the Urban Forest Management Project Protocol, biological emissions are GHG emissions that are released directly from forest biomass, both live and dead, including forest soils. Biological emissions are deemed to occur when the reported tonnage of onsite carbon stocks, relative to baseline levels, declines from one year to the next.
Biomass	The amount of living matter comprising, in this case, a tree.
Bole	The trunk or main stem of a tree.
Buffer Pool	The buffer pool is a holding account for urban forest project CRTs administered by the Reserve. It is used as a general insurance mechanism against unavoidable reversals for all UFM projects registered with the Reserve.
Business As Usual	The activities, and associated GHG reductions and removals that would have occurred in the project area in the absence of incentives provided by a carbon offset

[11] (Helms, 1998)

	market.
Carbon Pool	A reservoir that has the ability to accumulate and store carbon or release carbon. In the case of forests, a carbon pool is the forest biomass, which can be subdivided into smaller pools. These pools may include above-ground or belowground biomass or roots, litter, soil, bole, branches and leaves, among others.
Climate Reserve Tonnes (CRT)	One metric ton (tonne) of verified CO_2 equivalent emission reduction or sequestration.
Carbon Sink	A carbon sink is any process, activity or mechanism that removes carbon dioxide from the atmosphere.
Carbon Source	A carbon source is any process or activity that releases carbon dioxide into the atmosphere.
Carbon Stock	A pool of stored carbon. Urban forest carbon stocks include biomass of the project trees. Include living and standing dead vegetation, woody debris and litter, organic matter in the soil, and harvested stocks such as wood for wood products and fuel.
Carbon stock change or Carbon sequestration	The annual incremental change in carbon stocks.
C_{emis}	CO_2 and other GHG emissions from project maintenance activities, for example, due to vehicular or equipment use.
C_{proj}	Project carbon, i.e. carbon stored annually in project trees, reported as CO_2.
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.
Certified Arborist	Certified Arborist is the rank of a Registered Consulting Arborist (or above), as certified by the International Society of Arboriculture.
Certified Forester	A professional with certified forester credentials managed by the Society of American Foresters (see www.certifiedforester.org). See also, Professional Forester.
Dry weight (DW) biomass	The weight of aboveground tree biomass when dried to 0% moisture content. Also known as oven-dry and bone-dry biomass. Convert from green biomass to dry weight biomass by multiplying by 0.56 for hardwoods or 0.48 for softwoods.
Entity	The individual, organization, agency or corporation that owns, controls, or manages urban trees.

Freshweight or green biomass	The weight of aboveground tree biomass when fresh (or green), which includes the moisture present at the time the tree was cut. The moisture content of green timber varies greatly among different species. The Reserve assumes that the moisture content of fresh weight biomass is 30%.
Global Warming Potential (GWP)	Factors used to convert emissions from GHGs other than carbon dioxide to their equivalent carbon dioxide emissions.
Greenhouse gas (GHG)	Greenhouse gases mean carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
GHG Assessment Boundary	The GHG Assessment Boundary defines all the GHG sources, sinks, and reservoirs that must be accounted for in quantifying a project's GHG reductions and removals.
Inherent uncertainty	The scientific uncertainty associated with calculating carbon stocks and greenhouse gas emissions.
Leakage	According to the Intergovernmental Panel on Climate Change: "the unanticipated decrease or increase in greenhouse gas benefits outside of the project's accounting boundary as a result of project activities."
Permanence	The requirement that GHGs must be permanently reduced or removed from the atmosphere to be credited as carbon offsets. For UFM projects, this requirement is met by ensuring that the carbon associated with credited GHG reductions and removals remains stored for at least 100 years.
Primary Effects	The project's intended changes in carbon stocks, GHG emissions or removals.
Professional Forester	A professional engaged in the science and profession of forestry. A professional forester is credentialed in jurisdictions that have professional forester licensing laws and regulations. Where a jurisdiction does not have a professional forester law or regulation then a professional forester is defined as having the certified forester credentials managed by the Society of American Foresters (see www.certifiedforester.org).
Project (UFM Project)	A planned set of activities designed to increase removals of CO_2 from the atmosphere, or reduce or prevent emissions of CO_2 to the atmosphere, through increasing and/or conserving forest carbon stocks. An urban forest management (UFM) project focuses on activities that maintain or increase carbon inventories relative to baseline levels of carbon within the project boundary. Eligible activities may include, but are not limited to, increasing the overall age of the urban forest

	by changing rotation ages (specifically for urban forests that include management for commercial products within the urban area), increasing the urban forest productivity by removing diseased and suppressed trees, reducing emissions by avoiding tree clearing, and planting additional trees on available and appropriate sites.
Project Activity	The carbon storage, emission reductions, and emissions due to an urban forest management project.
Project Area	The area inscribed by the geographic boundaries of an project.
Project Commencement (Project Commencement Date)	The commencement date is initiated by activities that increase carbon inventories and/or decrease emissions relative to the baseline.
Project Life	Refers to the duration of a project and its associated monitoring and verification activities.
Project Onsite Inventory	The inventory of trees eligible to generate emission reductions or removals in a project. Developed according to the guidelines in Appendix A, Quantification Guidance.
Project Operator	One of the urban forest owners or a legally created entity to represent the urban forest owners that is responsible for undertaking a project.
Project Submission Date	The date that a project is submitted for listing in the Reserve program. The Reserve considers a project to be "submitted" when all of the appropriate forms have been uploaded to the Reserve's software system, and the project operator has paid a project submission fee.
Reporting Uncertainty	The level of uncertainty associated with an entity's chosen method of sampling and/or inventorying carbon stock and calculation methodologies. Contrast with inherent uncertainty.
Reporting Period	The time period for which an entity is reporting its project activity and quantifying GHG reductions. This period will typically be 12 months, except for 1) the initial reporting period which begins at the project commencement date and may be more than 12 months, and 2) the second reporting period, which may be less than 12 months.
Reversal	A reversal is a decrease in the stored carbon stocks associated with quantified GHG reductions and removals that occurs before the end of the project life. Under this protocol, a reversal is deemed to have occurred if there is a decrease in the difference between project and baseline onsite carbon stocks from one year to the next, regardless of the cause of this decrease (i.e. if the result of (Δ AC_{onsite} - Δ BC_{onsite}) in Equation 5.1 is negative).
Secondary Effects	Unintended changes in carbon stocks, GHG emissions,

	or GHG removals caused by the project.
Sequestration	The process by which trees remove carbon dioxide from the atmosphere and transform it into biomass.
Start Date	See Project Commencement.
Tree	A woody perennial plant, typically large and with a well-defined stem or stems carrying a more or less definite crown with the capacity to attain a minimum diameter at breast height of five inches and a minimum height of 15 feet with no branches within three feet from the ground at maturity.[12]
Tree Residue	Aboveground biomass from urban trees (as distinguished from construction debris) that can be salvaged for reuse, such as mulch, wood products, or fuel for biomass power plant.
Unavoidable Reversal	An unavoidable reversal is any reversal not due to the project operator's negligence, gross negligence or willful intent, including windstorms or disease that are not the result of the project operator's negligence, gross negligence or willful intent.
Urban Area	The most recent Urbanized Area definition provided by the United States Census Bureau at http://www.census.gov/geo/maps-data/maps/2010ua.html.
Urban Forest Owner	A corporation, legally constituted entity (such as a utility), city, county, state agency, individual(s), or combination thereof that has legal control (e.g. right to plant or remove, etc.) of any amount of urban forest carbon within the project area.
Verification	The process of reviewing and assessing all of a project's reported data and information by an ISO-accredited and Reserve-approved verification body, to confirm that the project operator has adhered to the requirements of this protocol.
Verification Cycle	The Reserve requires onsite verification of projects every five years, but project operators can choose to have more frequent 'desktop' verifications. In between site visits, desk reviews of project reports can be completed by an approved verification body. The Reserve will only issue CRTs for verified emission reductions.
Verification Period	The period of time over which GHG reductions/removals are verified. A verification period may cover multiple reporting periods. The end date of any verification period must correspond to the end date of a reporting period.

[12] (Helms 1998)

Appendix A Urban Forest Quantification Guidance

This section provides guidance for quantifying a Project's carbon stocks, both for purposes of estimating a project's baseline as well as providing ongoing estimates of project carbon stocks throughout the project life. The quantification portion of this protocol is based on addressing important monitoring requirements. The specific monitoring objectives are to provide estimates of carbon inventories within the Project Area for purposes of calculating credits generated.

The Project Area must be defined prior to initiating inventory activities. Once defined, the Project Area may only be modified through agreement with the Reserve. Modification of the Project Area may impact the baseline, analysis of legal requirements affecting the Project Area and other aspects of UFM Projects.

The quantification guidance is organized into the following sections:

A.1 Reporting Requirements for Urban Forest Carbon Pools

For UFM Projects, only Standing Live and Dead Trees can be included in quantifying project baselines and project estimates.

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

Base Unit	Conversion		Final Unit
Biomass	.5 * biomass	=	Carbon
Carbon	3.67 * carbon		CO_2e
Tons	0.90718474 * tons		Metric Tons (MT) or Tonnes
Hectares	0.404686 * hectares		Acres

A.2 Methodology for Estimating Current and Historical CO_2e in Urban Forest Management Projects

Where trees are not 100% inventoried in UFM Projects they must be sampled. Sampling can be an efficient way to generate estimates of CO_2e in urban forests. The approach to estimating CO_2e estimates for Projects includes deriving a measurement or estimate of the canopy area within the Project Area and, through the use of ratio estimators developed through on the ground sampling of trees, deriving an estimate of CO_2e for the project.

The general approach to developing estimates of CO_2e in UFM Projects has the following generalized steps, all of which are described in more detail in this section:

1. Stratify the Project Area into urban forest classes.
2. Develop a ratio estimate (transfer function) of CO_2e estimates in standing trees.
3. Develop a measure or estimate of the canopy cover in Standing Trees for each of the urban forest classes within the Project Area.
4. Multiply the transfer function by the total canopy cover measure/estimate for each of the urban forest classes to estimate the CO_2e within each urban forest class.
5. Sum the estimates of CO_2e in standing trees for each urban forest class to develop an estimate for the project.

A.2.1 Stratifying the Project Area into Urban Forest Classes

Stratify the Project Area into the urban forest classes described in Table A.1. The result of the stratification shall be a GIS layer for which the sum of the area of the polygons developed through stratification is equal to the Project Area sum and no areas within the Project Area are without an urban forest class identifier.

Table A.1. Urban Forest Class Labels and Descriptions

Urban Forest Class	Description
Commercial/Industrial Code = CI	In addition to standard commercial and industrial land uses, this category includes outdoor storage/staging areas as well as parking lots in downtown areas that are not connected with an institutional or residential use. [NOTE: For mixed-use buildings, land use is based on the dominant use, i.e., the use that receives the majority of the foot traffic. It might not always occupy the majority of space in the building. For example, a building with commercial use of the first floor and apartments on upper floors would be classified as Commercial/Industrial.]
Institutional Code = IN	Schools, hospitals/medical complexes, colleges, religious buildings, government buildings, etc. Note: If a parcel contains large unmaintained areas, possibly for expansion or other reasons, treat the area as Vacant. However, small forested islands in a maintained landscape would be considered Institutional.
Open Space Code = OS	This category includes land with no clear immediate use, including natural forest stands that are not identified as parks. Abandoned buildings and vacant structures should be classified based on their original intended use.
Residential High Density (>= 8 dwellings per acre) Code = RH	Freestanding structures serving one to four families each with 8 or more structures per acre.
Residential Low Density (<8 dwellings per acre) Code = RL	Freestanding structures serving one to four families each with less than 8 structures per acre. [Note: A block of attached one- to four-family structures is considered multi-family residential. A residential complex consisting of many

	separate one- to four-family structures.]
Transportation Code = TR	Road right of ways where vehicle traffic commonly exceeds 45 miles per hour and vegetation management of the right of ways is distinct from the areas around it.
Parks Code = PS	Parks include undeveloped (unmaintained) as well as developed areas (but must be identified as a park).
Cemetery Code = CE	Includes any small unmaintained areas within cemetery grounds.
Agriculture Code = AG	Cropland, pasture, orchards, vineyards, nurseries, farmsteads and related buildings, feed lots, rangeland, timberland/plantations that show evidence of management activity for a specific crop or tree production are included.
Utility Code = UT	Power-generating facilities, sewage treatment facilities, covered and uncovered reservoirs, and empty stormwater runoff retention areas, flood control channels, and conduits.
Water/Wetland Code = WA	Streams, rivers, lakes, and other water bodies (natural or man-made). Small pools and fountains should be classified based on the adjacent land use.
Other Code = OT	Land uses that do not fall into one of the categories listed above. This designation should be used very sparingly as it provides very little useful information for the model. Clarify with comments in Notes.

A.2.2 Develop Ratio Estimates (Transfer Functions) of CO_2e Estimates in Standing Trees

Transfer functions provide the ability to estimate the CO_2e in Standing Trees as a function of canopy cover. Transfer functions are developed from ground-based plots in which all trees in the plots are measured for variables that enable calculation of CO_2e estimates and canopy cover within the plot. This enables a ratio of CO_2e per unit area of canopy cover to be derived that can be applied to a measurement or estimate of canopy cover for each of the urban forest classes within the Project Area.

The following sub-steps are required to develop the transfer functions:

1. A grid of points spaced equally at 100 foot spacing across the Project Area must be created within the GIS map. Each point shall be attributed with latitude, longitude, and a unique identifier that is established in a sequential order within a database. Individual points will be selected from this set of points to serve as the basis for random sample locations of Standing Trees. A map of the point location and urban forest classes must be included within the Project Design Document.

2. The points shall be grouped into sets within a database based on the urban forest class they are associated with.

3. Points shall be randomly ordered from the sets of urban forest class/point combinations for sampling. A list must be included in the Project Design Document that displays the sets of points with their associated urban forest classes. Randomization shall be conducted by organizing the plots in separate lists in Microsoft Excel based on their associated urban forest classes using the following steps.

A field shall be added and identified as plot/urban class number. A sequential value (1-n) shall be assigned to each plot. The Microsoft Excel function 'randbetween' shall be used with a minimum value of 1 and a maximum value the total number of plots in the plot/urban class association. In a separate added field, the order of random selection shall be identified until all of the plots are assigned a random value or a minimum of 100 plots are assigned a random value (whichever comes first). In the event a plot is selected more than once, the value assigned to the plot shall be the first time it was selected.

4. The sample points are to be installed as fixed radius plots. The size of the radius from the plot center (from the point coordinates) is 37.2 feet (1/10th acre). Only the random plots selected need to be installed (measured). Certain randomly selected points may be impossible to sample due to safety or accessibility and therefore must be rejected, as in cases where permission to trespass is not granted. Additionally, many points may not have any Standing Trees associated with them. Since the purpose of the sample plots is to develop a relationship between CO_2e and Urban Forest Canopy, points with no trees within the radius described above can be rejected. Project Operators must document the rationale for rejecting plots prior to selecting the next random plot in their list. In the event of plot rejection, the Project Operator shall select the next numerical point (1,2,3,…) in the plot list as a potential plot for measuring. In the event a successive plot is a plot that was selected randomly, the Project Operator shall continue to the next plot (1,2,3,…) in the plot list. Plot rejections and selections of subsequent plots shall be documented in the Project Design Document.

   Plot centers must be monumented so they can be relocated for future measurement or for verification. Monumenting plot locations so that they are available for re-measurement and/or verification can be challenging. GPS coordinates must be recorded for each plot at, or offset from, the plot center. Since GPS coordinates will only partially assist in relocating the plot center due to accuracy of GPS, additional navigational devices are necessary. It is recommended that, where possible, an object or marking be placed at plot center that is highly resistant to environmental features, including weather, animals, and fire.

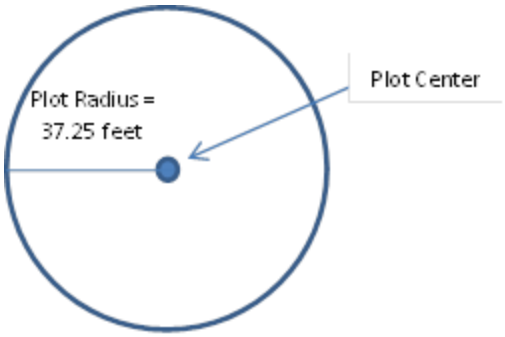
   However, the placement of a monument at plot center is not feasible in urban areas under most circumstances. Therefore, monumenting plot location may require identifying features that can be used to triangulate to the plot center using distance and compass bearing measurements. Care should be used to ensure features are selected that are likely to endure up to 10 years. This might include building corners, fire hydrants, street signs, etc. Notes should clearly describe the feature being used as well as distance and bearing data. A minimum of two navigational features are required. It is recommended that the features be separated by at least 20 degrees to plot center.

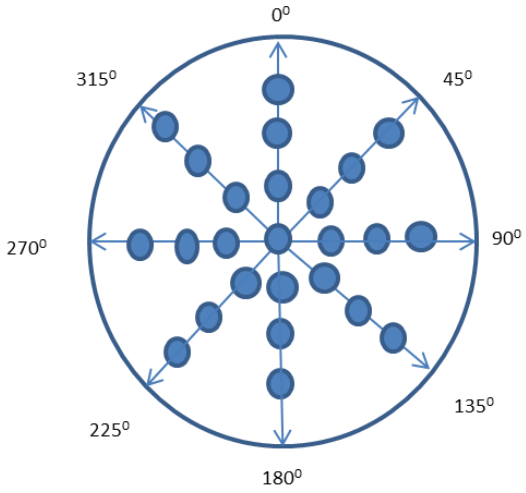
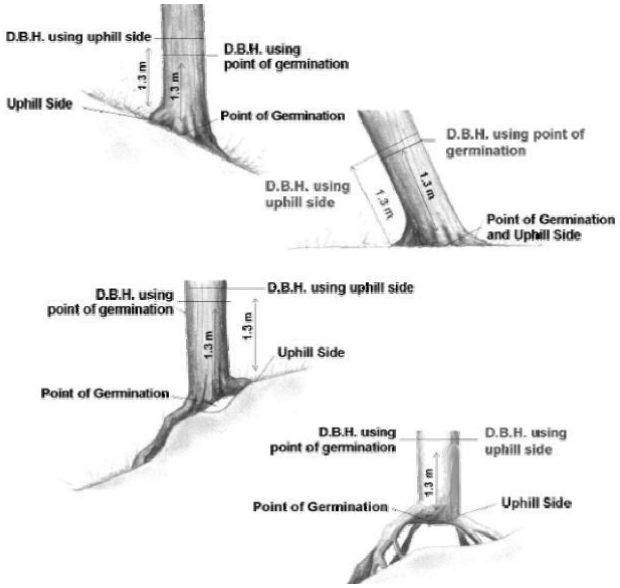
Measurement standards and data requirements on each plot are outlined in Table A.2.

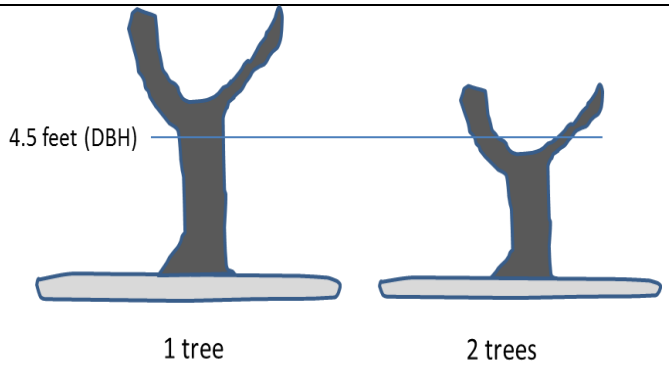
Table A.2. Measurement Standards for Urban Forest Sample Plots

For Each Plot	
Attribute	**Description**
Date of Plot Visit	Day/Month/Year
Latitude of Plot Center	From GPS
Longitude of Plot Center	From GPS

<table>
<tr><td rowspan="3">Navigational Feature 1</td><td>Description of a resilient feature that can be used to help relocate plot center in the future. Features might include manhole covers, building corners, street signs, etc.</td><td>(Fire hydrant, street sign, building corner, etc.)</td></tr>
<tr><td>Distance from feature to plot center</td><td>Feet</td></tr>
<tr><td>Azimuth from feature to plot center</td><td>Degrees</td></tr>
<tr><td rowspan="3">Navigation Feature 2</td><td>Description of a resilient feature that can be used to help relocate plot center in the future. Features might include manhole covers, building corners, street signs, etc.</td><td>(Fire hydrant, street sign, building corner, etc.)</td></tr>
<tr><td>Distance from feature to plot center</td><td>Feet</td></tr>
<tr><td>Azimuth from feature to plot center</td><td>Degrees</td></tr>
<tr><td>Urban Forest Class</td><td colspan="2">Enter the Urban Class Code associated with the plot.</td></tr>
<tr><td>Plot Number</td><td colspan="2">Enter the plot number for the plot, as described in the section (Plots) above.</td></tr>
<tr><td>Inventory Personnel</td><td colspan="2">Enter the initials of the inventory technicians responsible for measuring and recording data on the plot.</td></tr>
<tr><td>Measure all canopy area and all trees within a Fixed 1/10th Acre Radius (Radius = 37.25 feet) according to guidance below

Radial measurements need to be corrected for horizontal distances
<table>
<tr><td>Slope %</td><td>5</td><td>10</td><td>15</td><td>20</td><td>25</td></tr>
<tr><td>Adj. Radius</td><td>37.30</td><td>37.44</td><td>37.67</td><td>37.99</td><td>38.40</td></tr>
<tr><td>Slope %</td><td>30</td><td>35</td><td>40</td><td>45</td><td>50</td></tr>
<tr><td>Adj. Radius</td><td>38.89</td><td>39.47</td><td>40.12</td><td>40.85</td><td>41.65</td></tr>
<tr><td>Slope %</td><td>55</td><td>60</td><td>65</td><td>70</td><td>75</td></tr>
<tr><td>Adj. Radius</td><td>42.51</td><td>43.44</td><td>44.43</td><td>45.47</td><td>46.56</td></tr>
<tr><td>Slope %</td><td>80</td><td>85</td><td>90</td><td>95</td><td>100</td></tr>
<tr><td>Adj. Radius</td><td>47.70</td><td>48.89</td><td>50.11</td><td>51.38</td><td>52.68</td></tr>
</table></td><td colspan="2"> 
</td></tr>
</table>

To determine canopy area, use a sighting tube at plot center and at 10 feet, 20 feet, and 30 feet from plot center on the compass bearings shown to determine a canopy 'hit' or canopy 'miss'. **Multiply the sum of the hits by 4 to estimate the canopy cover percentage within the 1/10th acre fixed plot.**	
For Each Tree	
Attribute	**Description**
Tree Number	Trees are assigned a number 1 to X starting from 0 degrees (North) and generally proceeding clockwise. The numbering convention facilitates the relocation and the verification of the trees.
Species	Enter the species code for each species on the plot. The species code can be found for each species in the corresponding reference document. The species code is based on the first two letters of the genus and the first two letters of the species for any given species.
DBH	Measure and record Diameter at Breast Height (DBH) to the nearest inch on every tree using a diameter tape and wrapping the tree at a height of 4.5 feet from the base of the tree on the uphill side.  Forked trees above DBH are counted as one tree. Forked trees below DBH are counted as two trees (or however many forked stems exist).

<table>
<tr><td></td><td> 
</td></tr>
<tr><td>Total Height</td><td>Measure of total height (height from base of tree to top) of each tree to the nearest foot.</td></tr>
<tr><td>Growth Condition</td><td>An attribute of ‘Open’ or ‘Closed’ must be assigned to each tree according to the description below:
<table>
<tr><th>Class</th><th>Description</th></tr>
<tr><td>O</td><td>An open attribute is assigned to trees growing in non-natural settings. Tree species may be a variety of native and non-native species. Most often, trees exist in areas where disturbance of natural areas and conversion to another land use has occurred.</td></tr>
<tr><td>C</td><td>A closed attribute is assigned to trees growing in natural settings. Trees present are characteristic of the species diversity and structure in forested areas outside the urban area.</td></tr>
</table></td></tr>
<tr><td>Vigor</td><td>For each tree, provide a rating of the tree’s apparent vigor. Determination of vigor based on consideration of color of foliage, crown proportion and appearance, retention of leaves/needles, appearance of apical growth, length between growth whorls, and presence of cavities and fungal growth. The code is assigned based on the following classes:
<table>
<tr><th>Code</th><th>Description*

*based on conditions present during growing periods. Professional judgment need be applied if sampling conducted outside of growing periods.</th></tr>
<tr><td>1</td><td>Excellent – Tree exhibits high level of vigor and no barriers (soil, light, etc.) to continued vigor. No decay or broken branches are observed.</td></tr>
<tr><td>2</td><td>Good – Tree exhibits high level of vigor and some minor barriers (soil, light, etc.) to continued vigor. No decay or broken branches are observed.</td></tr>
<tr><td>3</td><td>Fair – Tree appears generally healthy. Barriers (soil, light, etc.) affect the trees vigor. Tree’s crown may be smaller proportionally than in healthier trees. Decay and/ or broken branches, if observed, are not likely to have negative impacts in the short term.</td></tr>
<tr><td>4</td><td>Poor – Tree appears notably unhealthy, as determined by reduced crown, presence of decay and/or broken branches and/or significant barriers to future growth. Observed problems have high likelihood of being rectified through management of said tree and trees surrounding it.</td></tr>
<tr><td>5</td><td>Critical – Tree appears notably unhealthy, as determined by reduced crown, presence of decay and/or broken branches and/or significant barriers to future growth. Observed problems have low likelihood of being rectified through management of said tree and trees surrounding it.</td></tr>
<tr><td>6</td><td>Dying – Tree is unhealthy. Minimal live crown is present; portions of bark may be missing and/or substantial levels of broken stems and branches. Tree may exhibit advanced decay. No further investment</td></tr>
</table></td></tr>
</table>

		in restoring the tree to a higher vigor is deemed worthwhile.
	7	**Dead –** No live material is observed in the tree.
Defect – Bottom 33%	For each portion of the tree, provide an ocular estimate of the portion of tree that is missing (as a percentage of the section) as the result of breakage or cavities.	
Defect – Mid 33%		
Defect – Top 33%		

5. A minimum of 40 1/10th acre plots shall be measured in each urban forest class. The tree canopy shall be measured as shown in Table A.2 above. The percent estimate derived from the plot shall be multiplied by 43,560 to provide an estimate of the square feet per acre represented by the plot. CO_2e shall be calculated for each tree using the appropriate biomass equations provided by the Reserve on the Reserve's Urban Forest Protocol website. The biomass equations enable calculation of CO_2e for the above-ground portion of trees, using the units of conversion provided at the top of this section. The below-ground portion of trees shall be calculated by multiplying the above-ground portion of trees by 26%. This value shall be added to the above-ground portion to produce a value that represents the above and below-ground tree. These values shall be summed for each plot and multiplied by 10 to establish a per-acre estimate from each plot. All values shall be presented as metric tonnes CO_2e per acre.

   The average canopy cover (per acre basis) and the average CO_2e value (per acre basis) from all measured plots shall be calculated and documented in the Project Design Document. A ratio of CO_2e per square foot of canopy cover shall be calculated, as shown in Table A.3.

Table A.3.

Urban Forest Class	Average Canopy Cover Area from Ground-based Plots (ft^2/acre)	Average CO_2e from Ground-based plots (per acre)	Transfer Functions (CO_2e/ft^2 of canopy cover)
Commercial/Industrial	3,485	15	0.0043044
Utility	5,227	20	0.0038261
Residential – High Density	15,246	60	0.0039355
Transportation	3,485	12	0.0034435

A.2.3 Measure or Estimate the Current Canopy Cover in Standing Trees for Each of the Urban Forest Classes within the Project Area

The canopy of Trees must be measured or estimated for each of the urban forest classes using remotely-sensed data. If measured, the entire canopy cover for the Project Area will be mapped as a layer in a GIS. If the canopy layer is sampled rather than measured, the sampled portion must be mapped as a layer in a GIS. An exception is allowed for canopy samples derived from ground plots, for which canopy estimates were derived through ground-based methods. Mapping the canopy layer, or the portion of the canopy sampled, enables the overall canopy area to be calculated within the Project Area and facilitates verification. Verification of ground-based canopy estimates can be conducted at the plot level.

The GIS layer can be derived directly from remotely-sensed data (through processing of LIDAR data, for example), or it can be manually digitized from aerial photos. Any data used to derive a GIS layer must be ortho-rectified, less than 5-years old, and be of adequate resolution to define

a square foot of tree canopy. An example of remotely-sensed data that is widespread in availability is from Google Earth. The following guidance must be applied when sampling Urban Forest Canopy:

1. The Project Operator must sample canopy from the list of randomly generated plots from sub-step 3 in Step 2 (Develop Ratio Estimates (Transfer Functions) of CO_2e estimates in Standing Trees). The sampling process shall occur through GIS analysis. The 1/10th acre plot radius shall be drawn in the GIS around each point. The plot boundary shall be overlaid (using GIS techniques) on a remotely sensed image with adequate resolution to determine tree canopy from non-tree (brush) canopy.

2. A grid of points must be placed over the project area for the purposes of estimating canopy area within each 1/10th acre circular area. The spacing between the points in the grid may not exceed six feet, which will ensure a sufficient number of points within the 1/10th acre area. The Project Operator shall count the number of points within each 1/10th acre plot boundary and subsequently count the number of points that overlay tree canopies. In both cases, points are only counted if 50% of the point is in the element considered (plot or tree canopy). An example of a grid overlaid on a plot boundary and tree canopies is shown in Figure A.1. In the example, 76 points were determined to be within the plot boundary and 32 points were determined to be within tree canopy, resulting in a plot estimate of 42% canopy cover. Only those points within the plot radius are considered in the analysis.

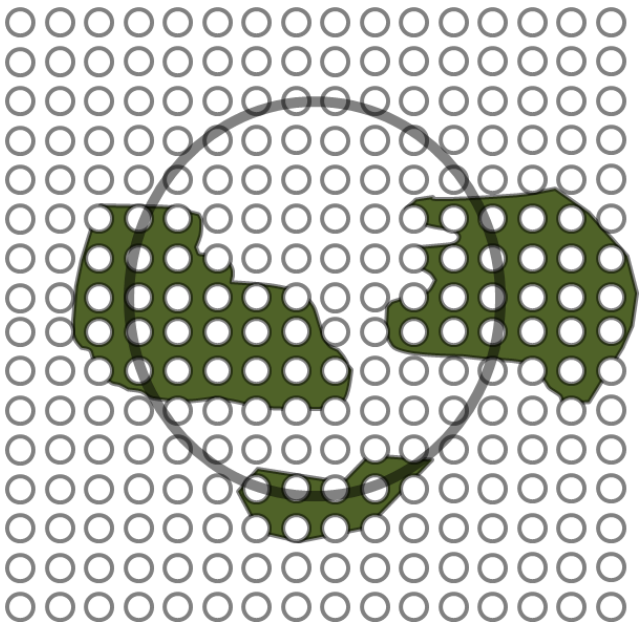


Figure A.1. Example of Overlaying Points on a Sample Plot to Determine Canopy Cover Percentage for the Plot

3. Sampling 1/10th acre plots for canopy cover must continue until a confidence estimate for average canopy cover for each urban forest class is achieved at +/-10% @ 90% confidence interval. A list of plots sampled and each plot's estimated percentage and canopy area estimate must be included in the Project Design Document.

4. A table must be presented in the Project Design Document that provides the data shown in Table A.4. Data shall be carried out to two decimal points. If canopy was 100% measured, the canopy area can be entered directly into the table below. If sampled, the mean percent canopy estimate from sampling is multiplied by the area within each urban forest class to estimate the canopy area.

Table A.4. Example of Canopy Cover Data Required in Project Area

Urban Forest Class	Total Area within Project Area (acres)	Total Area of Tree Canopy within Project Area (acres)	Total Area of Tree Canopy within Project Area (ft^2)	Mean Estimate at 90% CI (if sampled. If not sampled, enter measured)
Commercial/Industrial	50.45	5.35	233,046.00	4.50%
Utility	10.56	1.87	81,457.20	7.90%
Residential – High Density	155.67	54.32	2,366,179.20	3.70%
Transportation	67.23	4.57	199,069.20	9.30%
Total	283.91	60	2,613,600.00	5.20%

A.2.4 Determine the Current Project Area Estimate of CO_2e

With the total tree canopy area estimated or measured and transfer functions developed for each of the urban forest classes, an estimate of CO_2e for the Project Area can be estimated. The transfer functions are multiplied by the total square feet of canopy cover in each urban forest class and summed to determine the estimated CO_2e in the Project Area, as shown in Table A.5.

Table A.5. Example of Expanding Transfer Functions Based on Canopy Cover Area to Estimate Total Current CO_2e within the Project Area

Urban Forest Class	Transfer Functions (from above) (CO_2e/ft^2 of canopy cover)	Current Estimated/Measured Canopy Cover Area (ft^2)	Total CO_2e (metric tons)
Commercial/Industrial	0.0043044	233,046.00	1,003.12
Utility	0.0038261	81,457.20	311.66
Residential – High Density	0.0039355	2,366,179.20	9,312.10
Transportation	0.0034435	199,069.20	685.49
		Total	11,312.38

A.2.5 Calculating the Historic Project Area Estimate of CO_2e

A historic inventory is required to develop a trend used in the development of the project baseline. The historic project area estimate of CO_2e is calculated by expanding the transfer functions developed for the current inventory data using canopy cover estimates from remotely-sensed data that was produced at least 10 years prior to the image used to produce the current canopy cover estimate.

It is acceptable to either measure the entire canopy area from an earlier image or to sample the canopy area as described above for current images. If sampled, the plot locations sampled shall

be the same as those used to develop the current inventory. The analysis of plot area shall terminate upon completion of the same plots sampled for the current inventory estimate. The image used must be available to a verifier and identified in the PDD. An example of using a historic estimate of canopy cover to expand transfer functions in order to calculate a historic CO_2e estimate is shown in Table A.6.

Table A.6. Example of Expanding Transfer Functions Based on Historic Canopy Cover Area to Estimate Historic CO_2e within the Project Area

Urban Forest Class	Transfer Functions (from above)	Historic Estimated/Measured Canopy Cover Area	Total CO_2e
	(CO_2e/ft^2 of canopy cover)	(ft^2)	(metric tons)
Commercial/Industrial	0.0043044	201,222.00	866.14
Utility	0.0038261	79,566.00	304.43
Residential – High Density	0.0039355	2,375,898.20	9,350.35
Transportation	0.0034435	168,951.20	581.78
		Total	11,102.70

A.2.6 Baseline Development for Urban Forest Management Projects

The baseline for UFM Projects is calculated by developing a trend based on the historic and current inventory estimates of Standing Live and Dead Trees. The slope developed by plotting the two points of inventory on their respective year of reporting is continued into the future for the next 20 years and then held steady for the subsequent 80 years where legal requirements have not been modified substantially, as described below.

An analysis of legal requirements must accompany the baseline development. The PDD must include a full disclosure of legal requirements affecting tree management within the Project Area. Any substantial change in legal requirements, including ordinances, regulations, or other legal obligations that would modify the trend described above over the next 20 years must be modeled for the next 20 years or as long as stated in the requirements (whichever is longer). Modeling is conducted by projecting any carbon stored by trees obligated by the regulation forward into time. Modeling must be conducted by a Certified Arborist, a Certified Forester, or a Professional Forester. Where modeling must be conducted, the baseline shall be defined by a straight line from the Project's Initial Stocks to the highest point determined from baseline modeling. Examples of sources of legal obligations may include, but are not limited to, tree ordinances, urban forest ordinances or management plans, landscaping ordinances, or other environmental regulations associated with urban development and land use change.

Examples of the baseline approach are displayed in Figures A.2 and A.3.

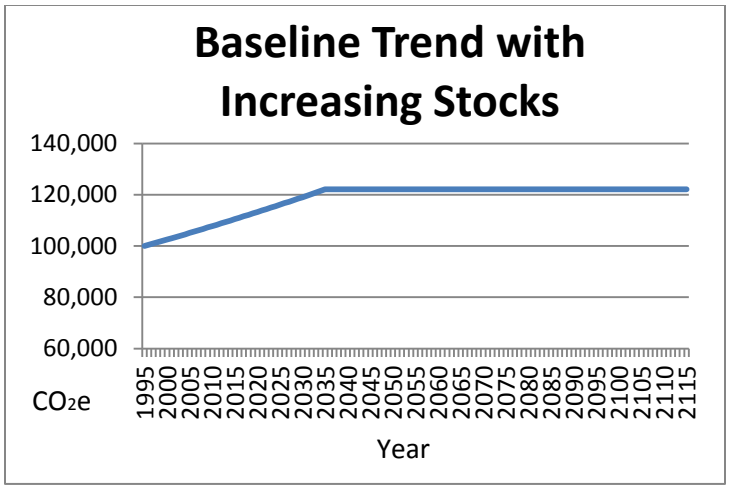


Figure A.2. Example of Increasing Baseline Trend Extending 20 Years Beyond Current Inventory and then Static for Balance of 100 Years

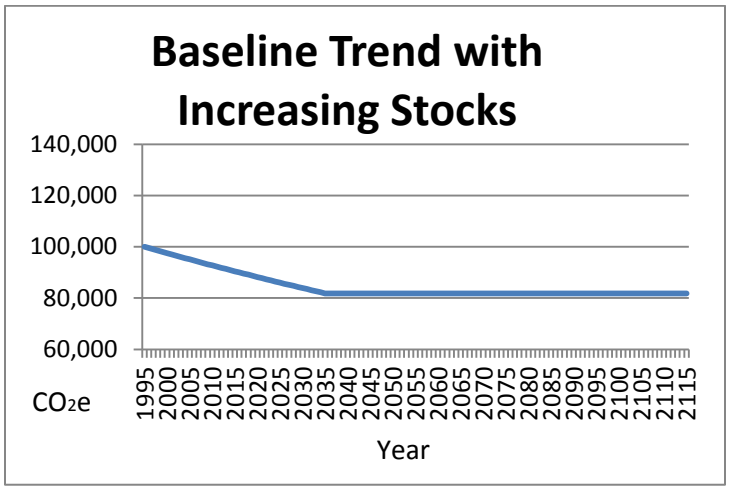


Figure A.3. Example of Increasing Baseline Trend Extending 20 years Beyond Current Inventory and then Static for Balance of 100 Years

A.3 Updating Forest Inventories

Urban forest inventories must be reported to the Reserve on an annual basis. Urban forest inventories are in constant flux due to forest growth and mortality or removal and therefore must be updated on an annual basis for reporting. The inventory must be updated annually through a combination of projecting existing inventory data and/or re-measuring inventory data with an objective of reporting inventory data that reflects actual conditions in the field.

Plot data can be 'grown', or projected for a maximum of 10 years, after which additional field work is required to either update the plot data or establish new plots.

It is important to note that the basis of a successful verification depends on alignment (within tolerance bands defined in the verification guidance) between verifier data and Project Operator data for each randomly selected plot (selected by verifier), therefore these guidelines do not

ensure successful project verification. The actual timeframe between plot re-measurement may need to be reduced to less than 10 years if the updates of inventory data proof to be inaccurate on a plot by plot basis.

Since the biomass of sampled trees is determined through the use of equations that are based on diameter (breast height) and total height variables, updating plot data for forest growth can be accomplished through the use of projections of inventory data in the database that mimic the diameter and height increment of trees in the field. An additional resource document posted on the urban forest webpage (pending) provides a list of publications that reference urban forest growth rates. The references in the resource document may be useful for Project Operators in designing an appropriate mechanism to 'grow' their plot data.

Most references address the annual increment of diameter (DBH). Height growth also needs to be addressed to ensure the most accurate comparison of tree records in the database to actual conditions in the field. Heights can be estimated through regression analysis by comparison of measured diameters to measured heights for a given species. It is recommended that, rather than simply relying on the height estimate from the regression analysis, that Project Operators apply the height increment derived from the regression analysis to the height that was measured in the field.

In any case, plot data that is updated to reflect current conditions with the use of predicted increments of height and diameter data, as well as updates for removals, will be used during onsite verifications to compare against verifiers field measurements using the sequential sampling techniques described in the verification section. This provision ensures that plot measurements and update processes are within accuracy thresholds.