Tree Planting Protocol

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Abbreviations, Acronyms, and Glossary

Carbon (C)	A chemical element
Carbon Dioxide (CO_2)	One carbon atom and two oxygen atoms
Carbon Dioxide Equivalent (CO_2e)	Unit for comparing the radiative forcing of a GHG to carbon dioxide
Credit	A unit representing one metric ton of CO_2e
Credit Commencement Date	The date from which credit issuance is calculated per specific Protocol requirements
Diameter at Breast Height (DBH)	The standard for measuring trees (4.5 feet above the ground)
Greenhouse gas (GHG)	Gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds
International Organization for Standardization (ISO)	Independent international nongovernmental organization made up of standards bodies
Project Implementation Agreement (PIA)	Contract with the Registry setting forth the Project Operator's obligation to comply with the Protocol
Project Operator (PO)	Individual or entity who undertakes a Project, registers it with the registry of City Forest Credits, and is ultimately responsible for all aspects of the Project and its reporting
Registry	City Forest Credits/Urban Forest Carbon Registry
Reversal	A reversal is tree loss that results in release of credited CO_2 such that the carbon stock in the project falls below credited CO_2
Vintage	The vintage of credits shall be the year in which credits are issued to a project. This includes credits issued under the status of "issued and held" in the Registry credit database

Introduction

This City Forest or Urban Forest Carbon Protocol sets forth the requirements for Tree Planting projects in urban areas in the United States to quantify greenhouse gas ("GHG") emission mitigation from woody biomass. That woody biomass is referred to herein by the broader terms "city forests" or "urban forests."

This protocol provides eligibility rules, methods for quantifying biomass and CO_2 storage, and reporting, monitoring, issuance of credits, reversal, and verification requirements. We have been guided in our drafting by one of the foundational documents for carbon protocols, the World Resources Institute/World Business Council for Sustainable Development Greenhouse Gas Protocol for Project Accounting, which describes greenhouse gas ("GHG") project accounting principles. We refer to this document as the WRI GHG Protocol.

Our goal in this protocol is to provide for accounting of GHG emission mitigation in a consistent, transparent, and accurate manner, consistent with the principles and policies set forth in the WRI GHG Protocol document. The CFC Standard document contains much more information and discussion of protocol elements such as additionality, permanence, and credit issuance.

The Registry, through its Protocol Drafting Group and iterative comment from stakeholders and projects, has developed an ex ante credit that contains numerous safeguards for its performance. These ex ante credits, called City Forest Carbon Forward Removal Credits,™ are based on forecasted CO_2 storage at Year 26 and are issued at five different time periods containing mortality checks and measurement of trees or canopy. Section 6 contains more details.

The Protocol Drafting Group and Registry developed these CFC Carbon Forward Removal Credits™ for the following reasons:

- Urban trees are never planted for harvest or for their timber value but for their environmental and social impacts delivered to human communities.
- Urban forests are public resources, and almost all tree planting and preservation is done by non-profit tree organizations, non-profit land trusts, and local governments.
- Urban tree canopies are in decline throughout the U.S., and public funding cannot keep up with tree loss.
- Ex ante crediting for city forests entails significantly less risk than rural forest carbon projects. City forests are planted for the sole purpose of providing social and environmental benefits through tree survival. They are not planted for harvest or

profit. No city forest project owner will face the economic temptation partway through a project to cut the trees down to reap a harvest profit. No city forest project will increase a harvest rotation to earn credits.

- Carbon crediting is the only way to monetize city trees. So city forests are aligned with carbon crediting, and risks of ex ante crediting are reduced – both the projects and the crediting seek long-term survival of the trees and forest.

- Urban forest planting projects cannot wait for 26 years to receive revenues. They need the revenues earlier to help maintain project trees.

The CFC Standard document posted publicly on the Registry website contains detailed information on urban forestry, urban forest carbon, and development of this protocol.

1. Eligibility Requirements

1.1 Project Operators and Projects

A Project requires at least one Project Operator (“PO”), an entity organized and licensed under the laws of its jurisdiction, or a governmental body, which undertakes a Project, registers it with the registry of City Forest Credits (the “Registry”), and is ultimately responsible for all aspects of the project and its reporting.

This Protocol contains requirements for afforestation and reforestation projects, both of which are referred to herein as Planting Projects.

1.2 Planting Designs and Quantification Methods

All Planting Projects must use one of three different quantification methods set out in Appendix A. The quantification method used depends on the planting design:

- Single Tree Quantification Method: this method applies to trees planted in a dispersed or scattered design and that are planted at least 10 feet apart (i.e. street trees). This method requires tracking of individual trees and tree survival
- Clustered Quantification Method: this method applies to trees planted at least 10 feet apart but are relatively contiguous and designed to create canopy over an area (i.e. park-like settings). This method requires tracking change in canopy, not individual tree survival
- Area Reforestation Quantification Method: this method applies to tree planting areas greater than 5 acres and where many trees are planted closer than 10 feet. Higher tree mortality is expected and the goals are to create canopy and a forest ecosystem. Project Operators have several quantification models to choose from, all of which produce a carbon index on a per-acre basis.

Appendix A contains more detail on these planting designs and quantification methods.

1.3 Project Implementation Agreement

The Project Operator must sign a Project Implementation Agreement (PIA) with the Registry setting forth the Project Operator’s obligation to comply with this Protocol for a 26-year project duration.

1.4 Project Location

Projects must be located in parcels within or along the boundary of at least one of the following:

A. The Urban Area or Urban Cluster boundary ("Urban Area"), defined by the most recent publication of the United States Census Bureau (https://www.census.gov/geographies/reference-maps/2010/geo/2010-census-urban-areas.html);

B. The boundary of any incorporated city or town created under the law of its state;

C. The boundary of any unincorporated city, town, or unincorporated urban area created or designated under the law of its state;

D. The boundary of any regional metropolitan planning agency or council established by legislative action or public charter. Examples include the Metropolitan Area Planning Council in Boston, the Chicago Municipal Planning Agency, the Capital Area Council of Governments (CAPCOG) in the Austin, Texas area, and the Southeastern Michigan Council of Governments (SEMCOG);

E. The boundary of land owned, designated, and used by a municipal or quasi-municipal entity for source water or watershed protection. Examples include Seattle City Light South Fork Tolt River Municipal Watershed (8,399 acres owned and managed by the City and closed to public access);

F. A transportation, power transmission, or utility right of way, provided the right of way begins, ends, or passes through some portion of A through D above.

In recognition of the urban-rural gradient and the strong public policy interest in preserving open space and forest land within and along that gradient, the Project may lie outside the boundary of one of A through F above. But any Project outside the boundary of A through F above must lie within or across parcels that constitute a sequence, chain, or progression of contiguously connected parcels. In addition, some part of the property line of one of those contiguously connected parcels must be coterminous with the boundary of one of A through F above.

1.5 Defining the Project Area

The Project Operator may include more than one planting site in a project. The initial planting of trees for all properties in a project must occur within a 36-month period or less.

The Project Operator may include multiple properties under one project including:

- Multiple properties in the same city or in multiple cities
- Properties under public and/or private ownership

The Project Operator must demonstrate compliance with all Protocol requirements for each property within a project.

The Project Design Document must include all properties. The final Project Design Document and request of credits shall be submitted after the last tree is planted in a project with multiple properties; i.e., all trees must be planted before a Project Operator submits its Project Design Document to request credits.

1.6 Programs of Aggregation

Stakeholders in a city, town, or other metropolitan area may design a separate, large-scale, long-term Program of Aggregation. A Program of Aggregation is a designed program that utilizes local or regional organizations to lead or facilitate a regional program that brings greater scale and efficiency.

The rules for those Programs of Aggregation are set forth in a separate document – the Programs of Aggregation Program Guidelines.

1.7 Ownership or Eligibility to Receive Potential Credits

The Project Operator must demonstrate ownership of potential credits or eligibility to receive potential credits by meeting at least one of the following:

A. Own the land, trees, and potential credits upon which the Project trees are located; or
B. Own an easement or equivalent property interest for a public right of way within which Project trees are located or own the Project trees and credits within that easement, and accept ownership of those Project trees by assuming responsibility for maintenance and liability for them; or
C. Have a written and signed agreement from the land or tree owner granting ownership to the Project Operator of any credits for carbon storage or other greenhouse gas benefits, and other co-benefits delivered by Project trees on that landowner's land. If Project trees are on private property, this agreement must be recorded in the public records of the county in which the land containing Project trees is located.

1.8 Legal Requirements Test

Trees planted due to an enacted ordinance or law are not eligible.

1.9 Conversion Out of Forest Before Planting Not Eligible

Proposed projects that convert a forested land use or that cut down healthy trees and plant project trees for crediting are not eligible.

2. Key Project Dates

2.1 Project Submittal Date

The Project Operator must submit an Application to the Registry and all other project documentation within six months of the planting of the last tree that is part of the planting project. This six-month limitation applies to trees planted under a Project and does not apply to the planting of replacement trees over a project's lifetime.

Plantings prior to May 1, 2017 are not eligible. The Registry retains sole discretion over approval of Applications and registration of projects.

2.2 Project Duration

The Project Operator must commit to a Project Duration of 26 years from the date the last Project Tree is planted ("Project Duration"). The phrase "Last Project Tree" is intended to mean the trees planted under a Project Application but not replacement trees planted over a Project's lifetime. Projects may earn credits after the 26-year Project Duration as provided in Section 9.

This Protocol is intended solely for trees planted for conservation, not harvest. Only trees planted for conservation are eligible, not trees planted for harvest.

City tree planting is generally undertaken on public land whose tenure is secure and is performed by cities, counties, and non-profit organizations rather than private landowners or those seeking a profit. The beneficiaries of these projects are the public. When a city invests in growing a tree for 26 years, all incentives drive toward maintaining and conserving the trees. These incentives include demands from the public, motivations of elected officials, support from utilities that benefit from stormwater and energy savings, and city budget managers who want their investments in the city forests to be fully realized. Further explanation can be found in the CFC Standard.

2.3 Tree Sampling, Quantification, and Issuance of Credits

Project Operators must sample Project trees and quantify as set forth below. The specific sampling and quantification requirements are set forth in Section 10 and in Appendix A

Quantification and Appendix B Verification. This Section 2.3 is intended to provide a short summary of dates for Project Operator ease of reference.

CFC Carbon Forward Removal Credits™ (ex-ante or forward credits):

- Sampling and mortality at Years 4 and 6
- Sampling, measurement of trees or canopy coverage at Year 14
- Sampling, measurement of trees or canopy coverage, and quantification of CO_2e at Year 26
- Credits issued as follows (subject to protocol compliance, validation, and verification):
    - 10% of projected credits after planting
    - 30% of projected credits at Year 4
    - 30% of projected credits at Year 6
    - 10% of projected credits at Year 14
    - Remaining credits issued based on quantification of CO_2e at Year 26

2.4 Credit Commencement Date

The starting date for the time period of sampling and credit issuance begins at the date the last project tree is planted (this does not include replacement trees). This starting date shall be called the "Credit Commencement Date."

For example, if the last project tree was planted on March 20, 2022, that is the Credit Commencement date and the following timeline applies, with credit issuance subject to Project Operator's compliance with all protocol requirements:

- Year 4 sampling and credit issuance can begin after March 20, 2025
- Year 6 sampling and credit issuance can begin after March 20, 2027
- Year 14 sampling and credit issuance can begin after March 20, 2035
- Year 26 quantification and credit issuance can begin after March 20, 2047

2.5 Monitoring Reports

Project Operators shall submit monitoring reports under Section 7 on each annual anniversary of the Verification Report.

2.6 Vintage of Credits

The vintage of credits shall be the year in which credits are issued to a project. This includes credits issued under the status of "issued and held" in the Registry credit database.

3. Project Documentation and Record-keeping

Project Operators shall submit all documents required by this Protocol and the Registry, using templates or forms supplied by the Registry, including:

- Application
- Project Implementation Agreement
- Ownership or Eligibility to Receive Potential Credits
- Project Design Document and supporting attachments
- Attestation of Planting
- Attestation of Planting Affirmation
- Attestation of Additionality
- Attestation of No Double Counting and No Net Harm
- Carbon and Co-Benefit Quantification
- Monitoring reports

At each credit issuance, Project Operators must update their Project Design Documents and quantification materials.

More information on credit issuance is in Section 10 below.

Project Operators shall keep all documents and forms related to the project for the Project Duration. If the Project seeks credits after the Project Duration, it must retain all documents for as long as it seeks issuance of credits. This information may be requested by the Registry at any time.

The Registry requires data transparency for all Projects. For this reason, all project data reported to the Registry will be publicly available on the Registry's website or by request.

4. Additionality

Project Operators must demonstrate compliance with the following additionality requirements:

- A Legal Requirements Test that declares city trees planted due to an enacted law or ordinance not eligible (Section 1.8);

- A prohibition against crediting for projects that convert land out of forested use or cut down healthy trees and plant project trees (Section 1.9);
- Either 1) a project-specific baseline or 2) the current version of the Registry's performance standard baseline developed in adherence with the WRI GHG Protocol (see CFC Standard document, Section 4.9 at 17);
- Project Operators must sign and comply with a Project Implementation Agreement with the Registry that requires a 26-year Project Duration.

Project Operators must also sign an Attestation of Additionality stating that its 26-year Project Duration commitment is additional to and longer than any commitment it makes to non-carbon project tree plantings.

Urban trees are planted for many reasons depending on the local communities' priorities, but almost no urban trees are planted for the purpose of storing carbon. And no urban trees have been credited other than under the City Forest Credits standards.

Because the urban forest is a public resource, and because public funding falls far short of maintaining tree cover and stocking, carbon revenues will result in additional trees planted or in additional maintenance that will result in additional trees surviving to maturity.

5. No Double Counting and No Net Harm

5.1 No Project shall seek credits on trees, properties, or projects that have already received credits from the City Forest Credits Registry or any other carbon registry. Project Operators must sign an attestation that there is no double counting of credits.

5.2 No Project shall cause net harm to the environment of urban communities. Project Operators must sign an attestation that there is no net harm.

6. Issuance of Ex Ante Carbon Forward Removal Credits

6.1. Credit Issuance Schedule

The Registry issues ex ante CFC Carbon Forward Removal Credits™ as follows and requires the following safeguards to ensure performance of these ex ante credits. "Last Project Tree" is intended to mean the trees planted under a Project Application but not replacement trees over a project's lifetime.

- After planting of the Last Project Tree, validation by the Registry, and third-party verification:
  - the Registry will issue 10% of total CO_2e stored by Year 26, according to quantification projections conducted under the Registry's quantification methodology used by that Project;
- In Year 4, after the third anniversary of the planting of the Last Project Tree in a project, validation by the Registry, and third-party verification:
  - the Registry will issue 30% of total projected CO_2e stored by Year 26, subject to data collection, sampling, and quantification projections conducted under the Registry's quantification methodology used by that Project;
- In Year 6, after the fifth anniversary of the planting of the Last Project Tree in a project, validation by the Registry, and third-party verification:
  - the Registry will issue 30% of total CO_2e stored by Year 26, subject to data collection, sampling, and quantification projections conducted under the Registry's quantification methodology used by that Project;
- In Year 14, after the thirteenth anniversary of the planting of the Last Project Tree in a project, validation by the Registry, and third-party verification:
  - the Registry will issue 10% of total projected CO_2e stored by Year 26, subject to data collection, sampling, measurement of sampled trees or canopy, and quantification projections conducted under the Registry's quantification methodology used by that Project;
- In Year 26, after the twenty-fifth anniversary of the planting of the Last Project Tree in a project:
  - the Registry will issue all remaining credits after Final Quantification and third-party verification of carbon stored. Twenty percent of projected credits are withheld until the end of the project at Year 26. At that point, the Project Operator will conduct a Final Quantification with data collection, sampling, measurement of trees or canopy, approval by the Registry of the quantification methods by the Registry, validation by the Registry, and third-party verification. At that time, the Registry will issue "true-up" credits equaling the difference between credits already issued (which were based on projected CO_2e stored) and credits earned based on Final Quantification and verification of CO_2e stored;
- Projects can continue after Year 26, and earn credits, as provided in Section 11.

6.2 Credits for Reversal Pool Account

The Registry will issue 95% of Project Credits earned and will hold 5% of total credits in the Registry's Reversal Pool Account.

6.3 Conversion and Marking of Carbon Forward Removal Credits as Ex Post at Year 26

After Final Quantification, all credits issued will embody CO_2e stored. All credits issued under the project to that point then will be marked in the Registry of credits as Ex Post Carbon+ Credits.

6.4 Issuance of Ex Post City Forest Carbon+ Credits

If a Project Operator wishes has a buyer or funder that wants to purchase ex post planting credits, the Project Operator may choose issuance of ex post credits rather than ex ante Carbon Forward Removal Credits.

If a Project Operator chooses this option, the ex post credits CFC Carbon+ Credits shall be issued only after sampling and measurement of trees or canopy coverage, and quantification of CO_2e at Year 14 and at Year 26. The credits shall be issued only for CO_2e stored in the trees at Year 14 and Year 26.

7. Monitoring and Reporting

Project Operators must submit an annual monitoring report to the Registry throughout the Project Duration.

Project Operators must submit the monitoring report on the annual anniversary of the date of the first Verification Report. Note that the annual monitoring and reporting required in this Section is different from the reporting done under Section 6 for issuance of credits. If a Project Operator submits documents and seeks credits under Section 6 for issuance of credits, it does not need to submit a monitoring report that year.

The reports must be in writing, and the Project Operator must attest to the accuracy of the reports. The report must address the following questions:

1. Has the contact information for the Project Operator changed? If so, provide new contact information.
2. Have there been changes in land ownership of the Project Area?
3. Have there been any changes in the Project Design?
4. Have there been any changes in the implementation or management of the Project?
5. Have there been any significant changes to the site (such as flooding or human changes)?
6. Have there been any significant tree or canopy losses estimated to be greater than 8% of Project Trees or 8% of canopy?
7. Any other significant elements to report?

The annual monitoring report is intended to be an update on any project information and a low-cost assessment of any tree or canopy loss, If the monitoring report indicates to the Registry that a credit reversal may have occurred, the Registry will require more precise quantification of the biomass carbon stock present within the project area.

If the Project Operator estimates cumulative net loss of 8% or more of tree canopy, further investigation will be required. The Registry will work with the Project Operator to determine an efficient way to assess tree or canopy loss or to quantify carbon stocks within the Project Area and determine whether there is a reversal under Section 8.

If a Project Operator fails to submit a report when due under this section, the Registry shall notify the Project Operator of such failure. The Project Operator shall then have 60 days to submit reports under this section.

If a Project Operator fails to monitor or to report after receiving notice and an opportunity to cure its failure under the preceding paragraph, the Registry can investigate and take actions including assessing carbon stock and invoking the reversal provisions of Section 8 as well as cancelling of the Project and all credits issued.

Project Operators are always subject to the reversal provisions of Section 8, regardless of any monitoring and reporting they do.

8. Reversals

Reversals can occur if tree loss results in release of credited CO_2 into the atmosphere. Or, put it another way, a reversal can occur if there is a loss of stored carbon serving as the basis for credits for GHG emission mitigation after credits have been received by projects but before the expiration of the Preservation Commitment. (References in this section to "carbon" shall mean CO_2e serving as the basis for credits for GHG emission mitigation). A "Reversal" is loss of stored carbon such that the remaining stored carbon within the Project Area is less than the amount of stored carbon for which Registry credits have been issued.

The Registry will retain in a Reversal Pool Account 10% of all credits issued to preservation projects and 5% issued to planting projects. This Reversal Pool Account shall be used to compensate for Unavoidable Reversals as set forth below. The Registry does not compensate Project Operators for the retained credits in the Reversal Pool Account. The

Registry may provide in the future for distribution of credits in the Reversal Pool Account to Project Operators if the actual reversals are less than current evaluation of risk.

This section sets forth rules for determining the type of Reversal, calculating the amount of the Reversal, and compensating for the Reversal.

8.1 Avoidable Reversals

A. Notice and Calculation of 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 trees in the Project Area due to the Project Operator's negligence, gross negligence or willful intent.

If the Project Operator becomes aware of a potential Avoidable Reversal, the Project Operator shall deliver written notice to the Registry within 60 days of becoming aware of the potential Reversal. If the Registry determines that an Avoidable Reversal has occurred, it shall deliver written notice to the Project Operator.

Within 90 days of receiving written notice from the Registry of an Avoidable Reversal, the Project Operator shall calculate the number of remaining creditable tonnes CO_2e in the Project Area using one of the quantification methods contained in this Protocol and its appendices. The Project Operator may use another quantification method only after receiving written approval by the Registry.

The Registry shall then determine the number of credits reversed and deliver written notice to the Project Operator of that amount and its obligation to compensate for those reversed credits.

B. Compensation for Avoidable Reversals

Within 60 days of being notified of the number of credits that it is obligated to replace, the Project Operator shall submit to the Registry a sufficient number of City Forest Carbon+ Credits to cover the shortfall. If the Project Operator is unable to obtain sufficient City Forest Carbon+ Credits, the Project Operator may pay the Registry $20 per tonne CO_2e of shortfall to satisfy the Project Operator's reversal obligation.

Quantifications of carbon stocks determined by the Registry shall be considered to be verified amounts under this section.

8.2 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 disease, fire, drought, cold, ice/snow, wind/hurricane, flooding, earthquake, landslide, and volcano.

A. Notice and Calculation of Unavoidable Reversals

If the Project Operator becomes aware of a potential Unavoidable Reversal, the Project Operator shall deliver written notice to the Registry within 60 days of becoming aware of the potential Reversal. If the Registry determines that an Unavoidable Reversal has occurred, it shall deliver written notice to the Project Operator.

The Registry shall calculate the number of remaining creditable tonnes CO_2e in the Project Area using one of the quantification methods contained in this Protocol and its appendices. If the Registry determines that more credits have been issued to the Project (counting both credits issued to the Project Operator and credits transferred to the Registry's Reversal Pool account), the Registry shall notify the Project Operator of its calculation of remaining CO_2e and of the shortfall.

B. Compensating for Unavoidable Reversals

Unavoidable Reversals are compensated by credits retired by the Registry from the Registry's Reversal Pool Account.

If a Project has had its carbon stock go below the carbon stock necessary to support credits issued by the Registry, no further credits will be issued to the Project until the carbon stocks are above the amounts needed to support issued credits, including credits allocated to the Registry's Reversal Pool Account.

If a Project Operator fails to compensate for a reversal, that Operator's projects may be terminated and the Project Operator may be barred, at the sole discretion of the Registry, from submitting applications to the Registry.

9. Continuation of Projects after 26-Year Project Duration

After the minimum 26-year Project Duration, Project Operators may continue their activities, submit Project Reports under Appendix A, and seek issuance of credits. Project Operators must comply with all applicable requirements of this Protocol.

If a Project Operator chooses to continue into a second 26-year Project Duration, the Project Operator can conduct at any time a quantification of CO_2 stored in project trees. If that quantification yields more credits than were issued during the project's 26-year project duration (due to additional growth after 26 years or the planting of replacement trees), the Project Operator can request issuance of those additional credits.

10. Quantification for Credits

The Registry will issue ex ante CFC Carbon Forward Removal Credits or ex post City Forest Carbon+ Credits™ to a Project upon request by a Project Operator, validation by the Registry, and third-party verification of compliance with this Protocol. Project Operators must follow the Quantification methods set forth in Appendix A.

Appendix A sets outs methods for quantification. Each method requires certain steps, data samples from the Project Operator, data from imaging, data from look-up tables that are or will be provided, and calculations.

Appendix A also provides methods for calculating co-benefits, such as rainfall interception (one element of stormwater run-off reduction), energy savings, and air quality. Appendix A contains a description of the quantification methods and the science used to develop those methods.

11. Social Impacts

In 2015, all United Nations Member States agreed to the 2030 Agenda for Sustainable Development, sharing a blueprint for peace and prosperity for people and the planet, now and into the future. The 17 United Nations Sustainable Development Goals (SDGs) are an urgent call for action and global partnership among all countries, representing key benchmarks for creating a better world and environment for everyone. There are 169 targets and associated indicators for the 17 SDGs. Urban tree preservation carbon projects drive action towards one or more SDGs. The City Forest Credits Carbon Projects Social Impact Background Document describes the alignment and connections in more detail.

Project Operators may evaluate use the Carbon Project Social Impact Form to evaluate the SDGs to determine how a Project provides social impacts that contribute towards achievement of the global goals. The form will be provided before request for credit issuance.

12. Validation and Verification

12.1 Verification

The Registry will retain a qualified and approved Validation and Verification Body (VVB) to verify compliance with this Protocol per the requirements set forth herein and per

International Standards Organization 14064-3 and in Appendix B, "Verification." Specifically, the Registry adopts and utilizes the following standards from ISO 14064-3:

- Upon receiving a completed Project Design Document with data on eligibility, quantification of carbon, and a request for credits, the Registry will retain a VVB to verify the project's compliance with this Protocol. The Registry will be independent of specific project activities.
- Verification by a VVB is described in more detail below. Urban forest projects, unlike many other types of carbon offset projects, will be conducted in and around urban areas, by definition. The trees in urban forest projects will be visible to virtually any resident of that urban area, and to anyone who cares to examine project trees.
- The Registry will maintain independence from the activities of projects and will treat all projects equally with regard to verification.
- The Registry requires a reasonable level of assurance in the accuracy the asserted GHG removals.
- The verification items identified in Appendix B and the following sections are all material elements, and any asserted GHG removals must be free of material errors, misstatements, or omissions regarding those elements.
- The Registry will record, store, and track all quantification and verification data and either display it for public review or make it available for public review upon request.
- The Registry will follow a process for follow-up and maintenance for consistency and continuity. This process will consist of a validation by the Registry to ensure that the Verification Report for each Project is consistent with the Project Documents submitted by the Project Operator.
- Appendix B contains requirements for geocoded photographs, imaging, data, or similar landmarking that provides verification of the Project Operator's data on quantification.
- Project Operators may use data from management or maintenance activities regularly conducted if the data was collected within 12 months of the project's request for credits.

Credits issued prior to completion of the 26-year project period will be subject to the Reversal Requirements set forth in Section 8.

12.2 Validation

The Registry shall conduct validation activities at three times.

A. Pre-Application

Before reviewing an application, the Registry conducts a validation screening:

- Validate eligibility under the protocol eligibility requirements
- Validate the Project Operator's understanding of the commitments it must make if it proceeds with the project:
    - Complying with the Protocol
    - Submitting project documents, including a Project Implementation Agreement with Registry
    - Quantifying carbon dioxide and ecosystem co-benefits according to the appropriate methodology
    - Conducting monitoring and reporting for the Project Duration

B. Before Third-Party Verification

Upon submittal of a final Project Design Document (PDD) and before third-party verification, the Registry will:

- Review the PDD and its supporting documents for:
    - Compliance with Protocol PDD requirements
    - Demonstration that the project meets the Protocol eligibility requirements

C. After Receiving the Verification Report

When the third-party verifier produces its Verification Report, the Registry then reviews that Report to ensure the following:

The Verification Report accurately reflects the documentation contained in the PDD and supporting documents.

The Registry shall document it validation activities in a written report that shall be posted publicly with other project documents.

CITY FOREST CREDITS

Tree Planting Protocol

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Appendix A
Quantification Methods

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Introduction

This City Forest Credits Tree Planting Protocol Appendix A on Quantification for Tree Planting Projects consists of three parts.

Part One sets out the three quantification methods based on the design of each planting project and describes the requirements for each quantification method.

Part Two contains a description of the scientific basis and methods underlying quantification of CO_2 and co-benefits in city trees.

Part Three contains a Summary of Quantification Steps, which is a more detailed walk-though of quantification methods using examples.

The principal authors of this Appendix A on Quantification are Dr. E.G. McPherson and Dr. Gordon Smith. Dr. McPherson also led the science teams that developed quantification methods for the State of California Air Resources Board Urban Forest Carbon Protocol in 2011 and the Climate Action Reserve Urban Forest Protocols in 2014. Dr. Smith has over two decades of experience in forest carbon, carbon protocol, and verification standards for forest carbon projects.

Note that quantification methods for Tree Preservation Projects, as distinct from Tree Planting Projects, are contained within the Tree Preservation Protocol.

Part One - Quantification Methods and Project Operator Requirements

1. Summary

Project Operators must use one of three different methods for quantifying carbon dioxide (CO_2) storage in urban forest carbon projects. Selection of the quantification method depends on the planting project design:

- Single Tree Method - trees planted in a dispersed or scattered design and that are planted at least 10 feet apart (i.e. street trees). This method requires tracking of individual trees and tree survival for sampling and quantification.
- Clustered Method - to trees planted at least 10 feet apart but are relatively contiguous and designed to create canopy over an area (i.e park-like settings). This method requires tracking change in canopy, not individual tree survival
- Area Reforestation Method – tree planting areas greater than 5 acres and where many trees are planted closer than 10 feet. Higher tree mortality is expected and the goals are to create canopy and a forest ecosystem. Project Operators have several quantification models to choose from, all of which produce a carbon index on a per-acre basis.

In all cases, the estimated amount of CO_2 stored 26-years after planting is calculated. The forecasted amount of CO_2 stored during this time is the value from which the Registry issues ex ante Carbon Forward Removal Credits.™

To ensure performance of the credits, the Registry issues Carbon Forward Removal Credits at five times during the 26-year Project Duration:

- 10% after planting
- 30% in Year 4, after sampling and mortality check or imaging and calculating canopy
- 30% in Year 6, after sampling and mortality check or imaging and calculating canopy
- 10% in Year 14, after measuring sampled trees or imaging and calculating canopy and
- "True-up" credits at the end of the initial Project Duration in Year 26, when CO2e is quantified from tree measurement and final credits are issued for CO2e stored minus credits already issued.

The mortality checks at Years 4 and 6 correspond to nationality mortality data that shows increased survival rates after three years and six years.

The Registry will issue 95% of Project Credits earned and will hold 5% of total credits in the Registry's Reversal Pool Account. This 5% Reversal Pool Account deduction is applied in all three quantification methods before calculation of any crediting, with these funds going into a program-wide pool to insure against unavoidable reversals due to catastrophic loss of trees.

All ex ante Carbon Forward Removal Credits convert to ex post City Forest Carbon+ Credits at Year 26 and are marked in the registry of credits.

2. Requirements for Each Quantification Method

2.1 Single Tree Quantification Method

In the Single Tree Method, the amount of CO_2 stored in project trees 26-years after planting is calculated as the product of tree numbers and the 26-year CO_2 index (kg/tree) for each tree-type (e.g., Broadleaf Deciduous Large = BDL).

Registry scientists have developed a spreadsheet tool that Project Operators must complete. The Single Tree Quantification Tool requires the Project Operator to input the following data into the Tool:

- Species
- Number of each species
- A default, initial, top-line mortality deduction of 20%, unless the Project Operator provides historical data justifying a different mortality deduction
- Data collection for trees, including species, location via GPS or address, and date planted

The Single Tree Quantification Tool contains equations for each climate zone that calculate CO2 stored and co-benefits in Resource Units and Avoided Costs for rainfall interception, air quality, and energy savings.

2.1.1 Single Tree Quantification Requirements After Planting and at Years 4, 6, 14, and 26

A. After Planting

The Single Tree Quantification Tool for each project contains a worksheet called "Data Collection" for use in tracking each tree. In that file, Project Operators must document the GPS coordinates for each tree planted. Project Operators may also use another tree inventory system, approved by the Registry.

In addition, The Single Tree Quantification Tool requires the Project Operator to input the following data into the Tool:

- Species planted
- Number of each species planted
- A default, initial, top-line mortality deduction of 20%, unless the Project Operator provides historical data justifying a different mortality deduction

Project Operators must also document the planting through the following templates provided by the Registry:

- Project Design Document, including maps or other items to meet eligibility requirements
- Ownership or Eligibility to Receive Potential Credits
- Attestation of Planting, with supporting documentary evidence of planting such as invoices and event photos
- Attestation of Planting Affirmation, signed by a participating organization attesting to the planting
- Single Tree Quantification Tool, including "Data Collection" for use in tracking each tree
- Attestation of Additionality
- Attestation of No Double Counting and No Net Harm

This credit issuance requires validation by the Registry and third-party verification.

B. Year 4

Project Operators must generate a random sample of project tree sites using the Single Tree Quantification Tool. Project Operators must visit those sampled tree sites and collect data on whether the sample contains a live tree, standing dead tree, or no tree.

Project Operators must submit geocoded photos or imaging of the sampled trees. The Single Tree Quantification Tool includes a column where each tree is assigned a unique serial number to help with tracking each coordinate and tree picture or image. Project Operators may also use their own inventory software, as approved by the Registry.

Based on this data, the number and species of project trees is adjusted and a new CO_2 projected amount by Year 26 is generated. Credits may be issued based on this adjusted amount. This credit issuance requires validation by the Registry and third-party verification.

C. Year 6

Project Operators must generate a random sample of project tree sites using the Single Tree Quantification Tool. Project Operators must visit those sampled tree sites and collect data on whether the sample contains a live tree, standing dead tree, or no tree.

Project Operators must submit geocoded photos or imaging of the sampled trees. The Single Tree Quantification Tool includes a column where each tree is assigned a unique serial number to help with tracking each coordinate and tree picture or image. Project Operators may also use their own inventory software, as approved by the Registry.

Based on this data, the number and species of project trees is adjusted and a new CO2 projected amount by Year 26 is generated. Credits may be issued based on this adjusted amount. This credit issuance requires validation by the Registry and third-party verification.

D. Year 14

Project Operators must follow the same process as stated above for Years 4 and 6, except they must also measure DBH on the sample of trees. The DBH will be used to ensure growth curve consistent with the projected CO2 storage at Year 26. If the actual growth curves of project trees are less than was projected, the number of credits issued at Year 14 will be adjusted downward.

E. Year 26

Project Operators must generate a random sample of project trees and measure DBH on the sample of trees. The DBH will be used to calculate CO2 storage at that time. Project operators must also submit geocoded photos of the sampled trees. Credits may be issued based on the actual CO2 storage at this Year 16 time, minus credits already issued. This credit issuance requires validation by the Registry and third-party verification.

2.2. Clustered Quantification Method

In the Clustered Planting Method, Registry scientists have developed a spreadsheet tool that Project Operators must complete. The Clustered Quantification Tool requires the Project Operator to input the following data into the Tool:

- Species planted
- Number of each species planted
- A default, initial, top-line mortality deduction of 20%, unless the Project Operator provides historical data justifying a different mortality deduction
- Mapping and boundaries for the area planted (the Project Area)

The Clustered Quantification Tool contains equations for each climate zone that calculate CO2 stored and co-benefits in Resource Units and Avoided Costs for rainfall interception, air quality, and energy savings.

2.2.1 Clustered Quantification Requirements After Planting and at Years 4, 6, 14, and 26

A. After Planting

In the Clustered Planting Method, Registry scientists have developed a spreadsheet tool that Project Operators must complete. The Clustered Quantification Tool requires the Project Operator to input the following data into the Tool:

- Species planted
- Number of each species planted
- A default, initial, top-line mortality deduction of 20%, unless the Project Operator provides historical data justifying a different mortality deduction

In addition, Project Operators must provide maps of the site, with boundaries, as well as a map showing the site within a larger context of land area, such as within a neighborhood, city, or region.

Project Operators must also document the planting through the following templates provided by the Registry:

- Project Design Document, including maps or other items to meet eligibility requirements
- Ownership or Eligibility to Receive Potential Credits
- Attestation of Planting, with supporting documentary evidence of planting such as invoices and event photos
- Attestation of Planting Affirmation, signed by a participating organization attesting to the planting
- Single Tree Quantification Tool, including "Data Collection" for use in tracking each tree
- Attestation of Additionality
- Attestation of No Double Counting and No Net Harm
- Imaging of the Project Area showing trees planted

Here is guidance for the imaging required after planting:

Projects must document the planting through photos or imaging. Select points and take geo-coded photos that when taken together capture the newly planted trees in the project area. If site is rectilinear, take a photo at each of the corners. If the site is large, take photos at points along the perimeter looking into the project area. If necessary to capture the trees, take photos facing each of the cardinal directions while standing in the middle of the project area. If site is nonrectilinear, identify critical points along property boundaries and take photographs at each point facing in towards the middle of the site. Next, take photographs from the middle of the project area facing out at each cardinal direction.

This credit issuance requires validation by the Registry and third-party verification.

B. Year 4

Project Operators provide images of the Project Area from any telemetry, imaging, remote sensing, i-Tree Canopy, or UAV service, such as Google Earth and estimate the area in tree canopy cover (acres).

- Imaging from Google Earth with leaf-on may be used. Project Operators will calculate the percent of canopy cover from the Google Earth imaging
- Projects can use i-Tree Canopy and point sampling to calculate canopy cover. Using i-Tree Canopy, continue adding points until the standard error of the estimate for both the tree and non-tree cover is less than 5%. i-Tree Canopy will supply you with the standard errors.
- If tree canopy cover is determined using another approach, such as image classification, a short description of the approach should be provided, as well as the QA/QC measures that were used. A tree cover classification accuracy assessment should be conducted, as with randomly placed points, and the percentage tree cover classification accuracy reported.

If the canopy coverage equals or exceeds 2.8% (400 trees per acre with an average canopy area of 3.14 square feet per tree (2-foot diameter of canopy) is 2.8% of an acre), then the credits projected in the Clustered Quantification Tool may be issued. If canopy coverage is below 2.8%, then the number of credits issued is reduced by the same percentage as the canopy coverage falls below 2.8%. This credit issuance requires validation by the Registry and third-party verification.

C. Year 6

Project Operators provide images of the Project Area from any telemetry, imaging, remote sensing, i-Tree Canopy, or UAV service, such as Google Earth and estimate the area in tree canopy cover (acres).

- Imaging from Google Earth with leaf-on may be used. Project Operators will calculate the percent of canopy cover from the Google Earth imaging
- Projects can use i-Tree Canopy and point sampling to calculate canopy cover. Using i-Tree Canopy, continue adding points until the standard error of the estimate for both the tree and non-tree cover is less than 5%. i-Tree Canopy will supply you with the standard errors.
- If tree canopy cover is determined using another approach, such as image classification, a short description of the approach should be provided, as well as the QA/QC measures that were used. A tree cover classification accuracy assessment should be conducted, as with randomly placed points, and the percentage tree cover classification accuracy reported.

If the canopy coverage equals or exceeds 11.5% (400 trees per acre with an average canopy area of 12.56 square feet per tree (4-foot diameter of canopy) is 11.5% of an acre), then the credits projected in the Clustered Parks Quantification Tool may be issued. If canopy coverage is below 11.5%, then the number of credits issued is reduced by the same percentage as the canopy coverage falls below 11.5%. This credit issuance requires validation by the Registry and third-party verification.

D. Year 14

Project Operators provide images of the Project Area from any telemetry, imaging, remote sensing, i-Tree Canopy, or UAV service, such as Google Earth and estimate the area in tree canopy cover (acres).

- Imaging from Google Earth with leaf-on may be used. Project Operators will calculate the percent of canopy cover from the Google Earth imaging
- Projects can use i-Tree Canopy and point sampling to calculate canopy cover. Using i-Tree Canopy, continue adding points until the standard error of the estimate for both the tree and non-tree cover is less than 5%. i-Tree Canopy will supply you with the standard errors.
- If tree canopy cover is determined using another approach, such as image classification, a short description of the approach should be provided, as well as the QA/QC measures that were used. A tree cover classification accuracy assessment should be conducted, as with randomly placed points, and the percentage tree cover classification accuracy reported.

If the canopy coverage equals or exceeds 46% (400 trees per acre with an average canopy area of 50 square feet per tree (8-foot diameter of canopy) is 46% of an acre), then the credits projected in the Clustered Quantification Tool may be issued. If canopy coverage is below 46%, then the number of credits issued is reduced by the same percentage as the canopy coverage falls below 46%. This credit issuance requires validation by the Registry and third-party verification.

E. Year 26

Project Operators provide images of the Project Area from any telemetry, imaging, remote sensing, i-Tree Canopy, or UAV service, such as Google Earth and estimate the area in tree canopy cover (acres).

- Imaging from Google Earth with leaf-on may be used. Project Operators will calculate the percent of canopy cover from the Google Earth imaging
- Projects can use i-Tree Canopy and point sampling to calculate canopy cover. Using i-Tree Canopy, continue adding points until the standard error of the estimate for both the tree and non-tree cover is less than 5%. i-Tree Canopy will supply you with the standard errors.

- If tree canopy cover is determined using another approach, such as image classification, a short description of the approach should be provided, as well as the QA/QC measures that were used. A tree cover classification accuracy assessment should be conducted, as with randomly placed points, and the percentage tree cover classification accuracy reported.

If the canopy coverage equals 100% of the Project Area at project outset, the credits projected in the Clustered Quantification Tool may be issued. If canopy coverage is below 100% of the Project Area, then the number of credits issued is reduced by the same percentage as the canopy coverage falls below 100%. This credit issuance requires validation by the Registry and third-party verification.

2.3. Area Reforestation Quantification Method

We provide first an overview of Project Operator requirements for using the Area Reforestation Quantification Method. This is followed by a detailed description of the Area Reforestation Quantification Method, including guidance.

2.3.1 Overview

To quantify the CO_2 for area reforestation projects, Project Operators may choose one of two methods – local data or a forest ecosystem approach using the USDA Forest Service General Technical Report (GTR), with its biometric data and allometrics for 51 forest ecosystems in regions of the U.S. (Smith et al., 2006). In this GTR method, the forecasted amount of CO_2 stored at 26-years is the product of the amount of TC and the CO_2 Index (CI, t CO_2 per acre).

More detail on both of these methods – use of local data or use of the U.S. Forest Service GTR tables – follows this summary.

A. After Planting

Project Operators must use local data or the GTR tables to demonstrate projected carbon storage by Year 26. In addition, Project Operators must provide maps of the site, with boundaries, as well as a map showing the site within a larger context of land area, such as within a neighborhood, city, or region.

Project Operators must also document the planting through the following templates provided by the Registry:

- Project Design Document, including maps or other items to meet eligibility requirements
- Ownership or Eligibility to Receive Potential Credits

- Attestation of Planting, with supporting documentary evidence of planting such as invoices and event photos
- Attestation of Planting Affirmation, signed by a participating organization attesting to the planting
- Attestation of Additionality
- Attestation of No Double Counting and No Net Harm
- Imaging of the Project Area showing trees planted

Here is guidance for the imaging required after planting:

Projects must document the planting through photos or imaging. Select points and take geo-coded photos that when taken together capture the newly planted trees in the project area. If site is rectilinear, take a photo at each of the corners. If the site is large, take photos at points along the perimeter looking into the project area. If necessary to capture the trees, take photos facing each of the cardinal directions while standing in the middle of the project area. If site is nonrectilinear, identify critical points along property boundaries and take photographs at each point facing in towards the middle of the site. Next, take photographs from the middle of the project area facing out at each cardinal direction. This credit issuance requires validation by the Registry and third-party verification.

B. At Year 4

Project Operators must either conduct a physical tree count using plots or use imaging to determine canopy coverage at Year 4. More detail is contained on both of these following this summary.

If the canopy coverage equals or exceeds 2.8% (400 trees per acre with an average canopy area of 3.14 square feet per tree (2-foot diameter of canopy) is 2.8% of an acre), then the credits projected in the Area Reforestation Quantification Tool may be issued. If canopy coverage is below 2.8%, then the number of credits issued is reduced by the same percentage as the canopy coverage falls below 2.8%. This credit issuance requires validation by the Registry and third-party verification.

C. At Year 6

Project Operators must either conduct a physical tree count using plots or use imaging to determine canopy coverage at Year 6. More detail is contained on both of these following this summary.

If the canopy coverage equals or exceeds 11.5% (400 trees per acre with an average canopy area of 12.56 square feet per tree (4-foot diameter of canopy) is 11.5% of an acre), then the credits projected in the Area Reforestation Quantification Tool may be issued. If canopy coverage is below 11.5%, then the number of credits issued is reduced by the same percentage as the canopy coverage falls below 11.5%. This credit issuance requires validation by the Registry and third-party verification.

D. Year 14

Project Operators must either conduct a physical tree count using plots or use imaging to determine canopy coverage at Year 6. More detail is contained on both of these following this summary.

If the canopy coverage equals or exceeds 46% (400 trees per acre with an average canopy area of 50 square feet per tree (8-foot diameter of canopy) is 46% of an acre), then the credits projected in the Area Reforestation Quantification Tool may be issued. If canopy coverage is below 46%, then the number of credits issued is reduced by the same percentage as the canopy coverage falls below 46%. This credit issuance requires validation by the Registry and third-party verification.

E. Year 26

Project Operators must either conduct a physical tree count using plots or use imaging to determine canopy coverage at Year 26. More detail is contained on both of these following this summary.

If the canopy coverage equals 100% of the Project Area at project outset, the credits projected in the Clustered Quantification Tool may be issued. If canopy coverage is below 100% of the Project Area, then the number of credits issued is reduced by the same percentage as the canopy coverage falls below 100%. This credit issuance requires validation by the Registry and third-party verification.

2.3.2 Full Description of Area Reforestation Quantification Method

The Area Reforestation method seeks to accomplish two main goals – create a dynamic forest ecosystem and generate canopy over parcels or properties greater than 5 acres and some cases over dozens or hundreds of acres. Examples are projects to convert agricultural land to forest or reforestation of natural areas.

To accomplish these goals, the area reforestation method requires that trees are planted closely together, using a diverse palette of species and size, with relatively high expected mortality. Mortality is not the central measure of success of area reforestation, because certain species and trees are expected to out-compete others. Recruitment often occurs that results in mature trees that were not planted by the Project Operator.

The amount of CO_2 stored after 26-years by planted project trees is based on the anticipated amount of tree canopy area (TC). The forecasted amount of CO_2 stored at 26-

years is the product of the amount of tree canopy (TC) and the CO_2 Index (CI, t CO_2 per acre). This approach recognizes that forest dynamics for area reforestation projects are different than for street trees or parks projects. In many cases, native species are planted close together and early competition results in high mortality and rapid canopy closure. The Single Tree Method and the Clustered Method, which are based on the biometrics of open-growing urban trees, do not adequately describe biomass distribution among closely spaced trees and the dynamic changes in CO_2 stored in dead wood and understory vegetation as a forest stand matures.

City Forest Credits (referred to as the Registry) issues credits at five times during a 26-year area reforestation project. Assuming compliance with all Protocol requirements and third-party verification, the Registry issues credits based on projected CO_2 storage over the 26-year project duration. The Registry issues 10% of projected credits after planting, 30% of projected credits at Year 4, and 30% of projected credits at Year 6 after planting, and 10% of projected credits at Year 14 after planting. At the end of the project, in year 26, the Project Operator will receive credits for all CO_2 stored, minus credits already issued. A 5% Reversal Pool Account deduction is applied at each issuance of credits, with these funds going into a program-wide pool to insure against catastrophic loss of trees (unavoidable reversals).

To quantify the CO_2 for these kinds of area reforestation projects, Project Operators may choose one of two methods – local data or a forest ecosystem approach using the USDA Forest Service General Technical Report (GTR), with its biometric data and allometrics for 51 forest ecosystems in regions of the U.S. (Smith et al., 2006). In this GTR method, the forecasted amount of CO_2 stored at 26-years is the product of the amount of TC and the CO_2 Index (CI, t CO_2 per acre).

A. Local Data

A Project Operator may apply to the Registry to quantify the projected CO_2 storage from local data for tree growth that more accurately reflects CO_2 storage than the GTR tables. If a Project Operator has local data for 26-year-old stands like those planted, it can submit that data to the Registry. The Registry retains sole discretion to determine the applicability of that data to the planting project of the Project Operator.

B. USDA Forest Service General Technical Report (GTR) Tables

A Project Operator may alternatively choose to use the USDA Forest Service General Technical Report (GTR), with its biometric data and allometrics for 51 forest ecosystems in regions of the U.S. (Smith et al., 2006). The GTR tables provide carbon stored per hectare for each of six pools as a function of stand age. We used values for 25-year old stands for afforestation projects, because the sites contain little carbon in down dead wood and forest floor material at the time of planting. Data used to derive the 51 forest ecosystem tables came from U.S. Forest Inventory and Assessment plots. More information on methods used to prepare the tables can be found in Smith et al. (2006). The value from the applicable table, for total non-soil carbon stock for age 25 (or other source approved by the registry) is the CO_2 Index (CI).

Project Operators determine their forest type and select the type from their region in the GTR tables. Project Operators then utilize the carbon totals for year 25 from the tables. If a project is planted on an area that has been tilled to grow crops for at least three of ten years before tree planting, then soil carbon may be claimed.

C. Soil Carbon Sequestration

- If a project converts land from tillage, the project may receive credit for increasing soil carbon sequestration. If a project does not convert land from tillage, the project shall not receive credit for soil carbon sequestration. To receive soil carbon credits, the project must document a history of cropping in at least three of the 10 years preceding initiation of the project. Options for documenting tillage include cropping records, crop subsidy payment receipts, and historical aerial photos showing cropping.

- Following the United Nations Framework Convention on Climate Change, Intergovernmental Panel on Climate Change (IPCC) afforestation/reforestation methodological tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities, Version 01," projects that are on sites that are productive enough to grow trees and that stop tillage are assumed to gain more than the IPCC's maximum creditable amount of soil carbon of 16 tC/ha, which is 23.7 tCO2e/acre over the 25 year life of the sequestration project.

- When a project converts agricultural land to forest and makes no change in the demand for agricultural products, the project creates pressure to bring other lands into agriculture. Economists call the rate that other resources are increased to serve a supply the "price elasticity of supply." The average price elasticity of supply of agricultural land in the U.S. is calculated by Barr et al. (2010) to be 0.018, which is 1.8%. To account for this expected conversion of some other land to agriculture, and assuming that land brought into agriculture loses the same amount of carbon that soil taken out of agriculture regains, the Registry deducts 1.8% of the IPCC creditable amount of carbon gain. As a result, projects that convert land from tillage to trees may count 23.3 tCO_2e per acre of soil carbon gain as a result of the project over the 25-year life of the project.

After conversions from Carbon to CO_2, **the CO_2 Index (CI) is tons CO_2 per acre of tree canopy (TC) and the forecasted amount of CO_2 stored after 26-years is the CI x TC.** This is the value from which the Registry will issue credits.

If a Project Operator feels that the GTR table applicable to its project does not reflect accurate CO_2 storage for that project, they may apply to the Registry for use of a different GTR table in a more accurate way. Here is a non-exhaustive list of factors the Registry will consider in any requests to deviate from the GTR values:

- Soils
- Precipitation
- Climate information for the area
- Site productivity
- Local measurements of growth
- Proximity to the border of another region

D. Guidance on Numbers of Trees per Acre to Plant

To determine how many trees to plant, the Project Operator must estimate what mortality of planted seedlings it will have. With professional tree planters, quality planting stock, growing conditions conducive to growth, and little animal damage, planting at 10' by 10' spacing (436 trees per acre) often results in more than 400 trees per acre surviving at Year 6.

In harsh site conditions, or planting at the wrong time of year, or not keeping seedlings cool and moist, or not planting with good contact between roots and soil, mortality of 30-50% is common. Planting by volunteer planters, or in sites with high animal browsing, can result in mortality greater than 80-90%. The Registry recommends having someone with tree planting expertise manage the acquisition of planting stock and manage the planting process.

E. Methods for Determining Canopy Cover Growth or Tree Survival, and Progress Standards for Issuance of Credits at Years 4 and 6

Project Operators may choose one of two methods for determining canopy or tree survival – the Canopy Cover Growth Method or the Trees Per Acre Method

i. Canopy Cover Growth Method

- Project Operator provides images of the Project Area from any telemetry, imaging, remote sensing, i-Tree Canopy, or UAV service, such as Google Earth and estimate the area in tree canopy cover (acres).

  - Imaging from Google Earth with leaf-on may be used. Project Operators will calculate the percent of canopy cover from the Google Earth imaging

  - Project Operator can use i-Tree Canopy and point sampling to calculate canopy cover. Using i-Tree Canopy, continue adding points until the standard error of the estimate for both the tree and non-tree cover is less than 5%. i-Tree Canopy will supply you with the standard errors.

  - If tree canopy cover is determined using another approach, such as image classification, a short description of the approach should be provided, as well as the QA/QC measures that were used. A tree cover classification accuracy assessment should be conducted, as with randomly placed points, and the percentage tree cover classification accuracy reported.

- Progress Requirements for Issuance of Credits in Years 4, 6, and 14:

  - At Year 4, projects must show canopy coverage of at least 2.8% of the Project Area (400 trees per acre with an average canopy area of 3.14 square feet per tree (2-foot diameter of canopy) is 2.8% of an acre)

  - At Year 6, projects must show canopy coverage of at least 11.5% of the Project Area (400 trees per acre with an average canopy area of 12.56 square feet per tree (4-foot diameter of canopy) is 11.5% of an acre)

  - At Year 14, projects must show canopy coverage of at least 46% of the Project Area (400 trees per acre with an average canopy area of 50 square feet per tree (8-foot diameter of canopy) is 46% of an acre)

Note, if projects exceed these Progress Requirements, they will not receive credits early or out of schedule. If projects fail to meet the Progress Requirements, they will either not be eligible to request credits until they meet the Progress Requirements or they will receive credits reduced by the same percentage as their canopy coverage is below the Progress Requirement percentages above.

ii. Trees Per Acre Method

- Select 60 plots within the Project Area. This can be done using i-Tree Canopy and downloading plot center coordinates, or by travelling to the Project Area, choosing a random starting point, and walk a grid that locates at least 60 plots within the project area, well distributed across the Project Area. If locating the plots in the field, record the coordinates of each plot center. The Registry can provide examples of methods for determining the grid spacing and doing a random start.

- Mark each plot center with flagging, with the plot number written on the flagging. For a circular plot with 11.78' radius measured horizontally from plot center (not slope distance). This 11.78' radius makes a 1/100 acre plot.
- Count the number of live trees on the plot, counting only tree species that typically will reach 6" DBH by age 26 under the conditions present within the project area.
- Calculate the average number of trees per plot. Multiply the average number of trees per plot by 100. This is the average number of trees per acre present on the project.
- Divide the number of trees per acre on the Project Area by 400. This is the fraction canopy cover expected to be achieved by age 26.
- Multiply the fraction canopy cover expected to be achieved by age 26 by the live tree carbon stock (in metric tons of carbon per acre) at age 26 from the appropriate afforestation table in US Forest Service GTR NE-343. This is the carbon stock expected to be present at age 26. Multiply this expected carbon stock by 3.67 to calculate the expected carbon stock in metric tons CO_2e per acre.
- Report to the Registry:
  - The method used to locate plot centers.
  - Plot center coordinates.
  - Plot data, specifically the number of trees on each plot, by plot.
  - The average number of trees per acre calculated from plot data.

To count as fully stocked, at Year 6 (after five years of growth since planting) the project must have 400 surviving trees per acre of species that typically will reach 6" DBH by age 26 under the conditions present within the project area.

If 200-400 trees per acre are surviving at Year 6, predicted carbon sequestration is adjusted by multiplying the predicted carbon stock for full stocking at age 26 times the fraction (live trees per acre divided by 400). If the project has fewer than 200 trees per acre at Year 6, the CFC "single tree" quantification tool should be used.

F. Quantification at Year 26

- Project Operator may calculate Trees Per Acre as described in Section 2.3.2E above, or
- Project Operator may provide images of the Project Area from any telemetry, imaging, remote sensing, i-Tree Canopy, or UAV service, such as Google Earth and estimate the area in tree canopy cover (acres).
  - Projects can use i-Tree Canopy and point sampling to calculate canopy cover. Using i-Tree Canopy, continue adding points until the standard error of the estimate for both the tree and non-tree cover is less than 5%. I-Tree Canopy will supply you with the standard errors.

- If tree canopy cover is determined using another approach, such as image classification, a short description of the approach should be provided, as well as the QA/QC measures that were used. A tree cover classification accuracy assessment should be conducted, as with randomly placed points, and the percentage tree cover classification accuracy reported.
- Project Operator calculates total CO2 storage at Year 26 as follows:
    - Multiply the CI (carbon index times the acres of TC (tree canopy) in the Project Area.

References

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Smith, James E.; Heath, Linda S.; Skog, Kenneth E.; Birdsey, Richard A. 2006. Methods for calculating forest ecosystem and harvested carbon with standard estimates for forest types of the United States. Gen. Tech. Rep. NE-343. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 216 p.

Part Two - Scientific Basis for Carbon and Co-Benefit Quantification and Source Materials

Ecoservices provided by trees to human beneficiaries are classified according to their spatial scale as global and local (Costanza 2008) (citations for Part Two are listed in References). Removal of carbon dioxide (CO_2) from the atmosphere by urban forests is global because the atmosphere is so well-mixed it does not matter where the trees are located. The effects of urban forests on building energy use is a local-scale service because it depends on the proximity of trees to buildings.

To quantify these and other ecoservices City Forest Credits (CFC) has relied on peer-reviewed research that has combined measurements and modeling of urban tree biomass, and effects of trees on building energy use, rainfall interception, and air quality. CFC has used the most current science available on urban tree growth in its estimates of CO_2 storage (McPherson et al., 2016a). CFC's quantification tools provide estimates of co-benefits after 25 years in Resource Units (i.e., kWh of electricity saved) and dollars per year. Values for co-benefits are first-order approximations extracted from the i-Tree Streets (i-Tree Eco) datasets for each of the 16 U.S. reference cities/climate zones (https://www.itreetools.org/tools/i-tree-eco) (Maco and McPherson, 2003). Modeling approaches and error estimates associated with quantification of CO_2 storage and co-benefits have been documented in numerous publications (see References below) and are summarized here.

1. Scientific Basis for Carbon Dioxide Quantification

Estimates of stored (amount accumulated over many years) and sequestered CO_2 (i.e., net amount stored by tree growth over one year) are based on the U.S. Forest Service's recently published technical manual and the extensive Urban Tree Database (UTD), which catalogs urban trees with their projected growth tailored to specific geographic regions (McPherson et al. 2016a, b). The products are a culmination of 14 years of work, analyzing more than 14,000 trees across the United States. Whereas prior growth models typically featured only a few species specific to a given city or region, the newly released database features 171 distinct species across 16 U.S. climate zones. The trees studied also spanned a range of ages with data collected from a consistent set of measurements. Advances in statistical modeling have given the projected growth dimensions a level of accuracy never before seen. Moving beyond just calculating a tree's diameter or age to determine expected growth, the research incorporates 365 sets of tree growth equations to project growth.

Users select their climate zone from the 16 U.S. climate zones (Fig. 1). Calculations of CO_2 stored are for a representative species for each tree-type that was one of the predominant street tree species per reference city (Peper et al., 2001). The "Reference city" refers to the city selected for intensive study within each climate zone (McPherson, 2010). About 20 of the most abundant species were selected for sampling in each reference city. The sample was stratified into nine diameter at breast height (DBH) classes (0 to 7.6, 7.6 to 15.2, 15.2 to 30.5, 30.5 to 45.7, 45.7 to 61.0, 61.0 to 76.2, 76.2 to 91.4, 91.4 to 106.7, and >106.7 cm). Typically 10 to 15 trees per DBH class were randomly chosen. Data were collected for 16 to 74 trees in total from each species. Measurements included: species name, age, DBH [to the nearest 0.1 cm (0.39 in)], tree height [to the nearest 0.5 m (1.64 ft.)], crown height [to the nearest 0.5 m (1.64 ft.)], and crown diameter in two directions [parallel and perpendicular to nearest street to the nearest 0.5 m (1.64 ft.)]. Tree age was determined from local residents, the city's urban forester, street and home construction dates, historical planting records, and aerial and historical photos.

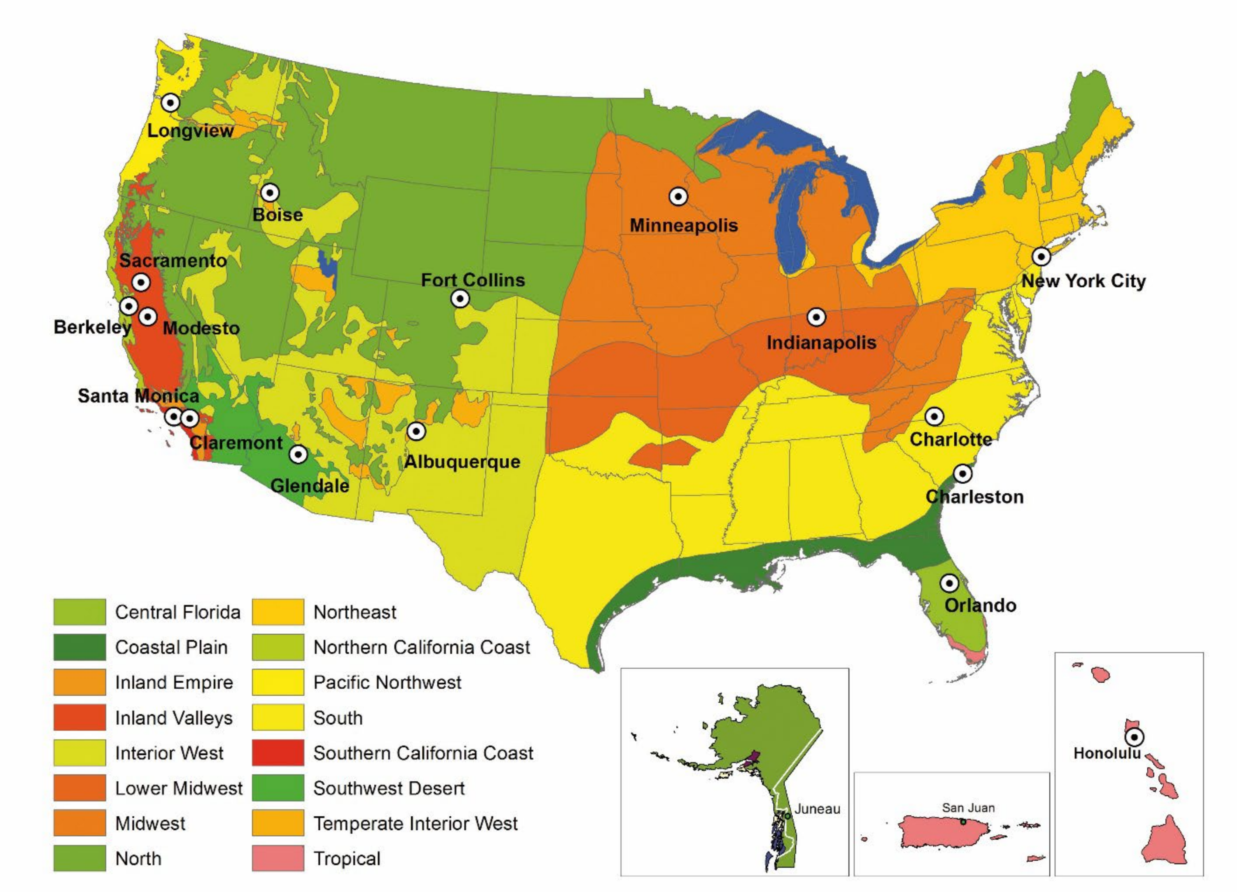

Figure 1. Climate zones of the United States and Puerto Rico were aggregated from 45 Sunset climate zones into 16 zones. Each zone has a reference city where tree data were collected. Sacramento, California was added as a second reference city (with Modesto) to the Inland Valleys zone. Zones for Alaska, Puerto Rico and Hawaii are shown in the insets (map courtesy of Pacific Southwest Research Station).

1.1 Species Assignment by Tree-Type

Representative species for each tree-type in the South climate zone (reference city is Charlotte, NC) are shown in Table 1. They were chosen because extensive measurements were taken on them to generate growth equations, and their mature size and form was deemed typical of other trees in that tree-type. Representative species were not available for some tree-types because none were measured. In that case, a species of similar mature size and form from the same climate zone was selected, or one from another climate zone was selected. For example, no Broadleaf Evergreen Large (BEL) species was measured in the South reference city. Because of its large mature size, *Quercus nigra* was selected to represent the BEL tree-type, although it is deciduous for a short time. *Pinus contorta*, which was measured in the PNW climate zone, was selected for the CES tree-type, because no CES species was measured in the South.

Table 1. Nine tree-types and abbreviations. Representative species assigned to each tree-type in the South climate zone are listed. The biomass equations (species, urban general broadleaf [UGB], urban general conifer [UGC]) and dry weight density (kg/m^3) used to calculate biomass are listed for each tree-type.

Tree-Type	Tree-Type Abbreviation	Species Assigned	DW Density	Biomass Equations
Brdlf Decid Large (>50 ft)	BDL	*Quercus phellos*	600	*Quercus macrocarpa* [1.]
Brdlf Decid Med (30-50 ft)	BDM	*Pyrus calleryana*	600	UGB [2.]
Brdlf Decid Small (<30 ft)	BDS	*Cornus florida*	545	UGB [2.]
Brdlf Evgrn Large (>50 ft)	BEL	*Quercus nigra*	797	UGB [2.]
Brdlf Evgrn Med (30-50 ft)	BEM	*Magnolia grandiflora*	523	UGB [2.]
Brdlf Evgrn Small (<30 ft)	BES	*Ilex opaca*	580	UGB [2.]
Conif Evgrn Large (>50 ft)	CEL	*Pinus taeda*	389	UGC [2.]
Conif Evgrn Med (30-50 ft)	CEM	*Juniperus virginiana*	393	UGC [2.]
Conif Evgrn Small (<30 ft)	CES	*Pinus contorta*	397	UGC [2.]
[1.] from Lefsky, M., & McHale, M.,2008. [2] from Aguaron, E., & McPherson, E. G., 2012				

1.2 Calculating Biomass and Carbon Dioxide Stored

To estimate CO_2 stored, the biomass for each tree-type was calculated using urban-based allometric equations because open-growing city trees partition carbon differently than forest trees (McPherson et al., 2017a). Input variables included climate zone, species, and DBH. To project tree size at 25-years after planting, we used DBH obtained from UTD growth curves for each representative species.

Biomass equations were compiled for 26 open-grown urban trees species from literature sources (Aguaron and McPherson, 2012). General equations (Urban Gen Broadleaf and Urban Gen Conifer) were developed from the 26 urban-based equations that were species specific (McPherson et al., 2016a). These equations were used if the species of interest could not be matched taxonomically or through wood form to one of the urban species with a biomass equation. Hence, urban general equations were an alternative to applying species-specific equations because many species did not have an equation.

These allometric equations yielded aboveground wood volume. Species-specific dry weight (DW) density factors (Table 1) were used to convert green volume into dry weight (7a). The urban general equations required looking up a dry weight density factor (in Jenkins et al. 2004 first, but if not available then the Global Wood Density Database). The amount of belowground biomass in roots of urban trees is not well researched. This work assumed that root biomass was 28% of total tree biomass (Cairns et al., 1997; Husch et al., 2003; Wenger, 1984). Wood volume (dry weight) was converted to C by multiplying by the constant 0.50 (Leith, 1975), and C was converted to CO_2 by multiplying by 3.667.

1.2.1 Error Estimates and Limitations

The lack of biometric data from the field remains a serious limitation to our ability to calibrate biomass equations and assign error estimates for urban trees. Differences between modeled and actual tree growth adds uncertainty to CO_2 sequestration estimates. Species assignment errors result from matching species planted with the tree-type used for biomass and growth calculations. The magnitude of this error depends on the goodness of fit in terms of matching size and growth rate. In previous urban studies the prediction bias for estimates of CO_2 storage ranged from -9% to +15%, with inaccuracies as much as 51% RMSE (Timilsina et al., 2014). Hence, a conservative estimate of error of ± 20% can be applied to estimates of total CO_2 stored as an indicator of precision.

2. Scientific Bases for Co-Benefit Calculations

2.1 Co-Benefit: Energy Savings

Trees and forests can offer energy savings in two important ways. In warmer climates or hotter months, trees can reduce air conditioning bills by keeping buildings cooler through reducing regional air temperatures and offering shade. In colder climates or cooler months, trees can confer savings on the fuel needed to heat buildings by reducing the amount of cold winds that can strip away heat.

Energy conservation by trees is important because building energy use is a major contributor to greenhouse gas emissions. Oil or gas furnaces and most forms of electricity generation produce CO_2 and other pollutants as by-products. Reducing the amount of energy consumed by buildings in urban areas is one of the most effective methods of combatting climate change. Energy consumption is also a costly burden on many lowincome families, especially during mid-summer or mid-winter. Furthermore, electricity consumption during mid-summer can sometimes over-extend local power grids leading to rolling brownouts and other problems.

Energy savings are calculated through numerical models and simulations built from observational data on proximity of trees to buildings, tree shapes, tree sizes, building age classes, and meteorological data from McPherson et al. (2017) and McPherson and Simpson (2003). The main parameters affecting the overall amount of energy savings are crown shape, building proximity, azimuth, local climate, and season. Shading effects are based on the distribution of street trees with respect to buildings recorded from aerial photographs for each reference city (McPherson and Simpson, 2003). If a sampled tree was located within 18 m of a conditioned building, information on its distance and compass bearing relative to a building, building age class (which influences energy use) and types of heating and cooling equipment were collected and used as inputs to calculate effects of shade on annual heating and cooling energy effects. Because these distributions were unique to each city, energy values are considered first-order approximations.

In addition to localized shade effects, which were assumed to accrue only to trees within 18 m of a building, lowered air temperatures and windspeeds from increased neighborhood tree cover (referred to as climate effects) can produce a net decrease in demand for winter heating and summer cooling (reduced wind speeds by themselves may increase or decrease cooling demand, depending on the circumstances). Climate effects on energy use, air temperature, and wind speed, as a function of neighborhood canopy cover, were estimated from published values for each reference city. The percentages of canopy cover increase were calculated for 20-year-old large, medium, and small trees, based on their crown projection areas and effective lot size (actual lot size plus a portion of adjacent street and other rights-of-way) of 10,000 ft^2 (929 m^2), and one tree on average was assumed per lot. Climate effects were estimated by simulating effects of wind and air-temperature reductions on building energy use.

In the case of urban Tree Preservation Projects, trees may not be close enough to buildings to provide shading effects, but they may influence neighborhood climate. Because these effects are highly site-specific, we conservatively apply an 80% reduction to the energy effects of trees for Preservation Projects.

Energy savings are calculated as a real-dollar amount. This is calculated by applying overall reductions in oil and gas usage or electricity usage to the regional cost of oil and gas or electricity for residential customers. Colder regions tend to see larger savings in heating and warmer regions tend to see larger savings in cooling.

2.1.1 Error Estimates and Limitations

Formulaic errors occur in modeling of energy effects. For example, relations between different levels of tree canopy cover and summertime air temperatures are not well-researched. Another source of error stems from differences between the airport climate data (i.e., Los Angeles International Airport) used to model energy effects and the actual climate of the study area (i.e., Los Angeles urban area). Because of the uncertainty associated with modeling effects of trees on building energy use, energy estimates may be accurate within ± 25 percent (Hildebrandt & Sarkovich, 1998).

2.2 Co-Benefit: Rainfall Interception

Forest canopies normally intercept 10-40% of rainfall before it hits the ground, thereby reducing stormwater runoff. The large amount of water that a tree crown can capture during a rainfall event makes tree planting a best management practice for urban stormwater control.

City Forest Credits uses a numerical interception model to calculate the amount of annual rainfall intercepted by trees, as well as throughfall and stem flow (Xiao et al., 2000). This model uses species-specific leaf surface areas and other parameters from the Urban Tree Database. For example, deciduous trees in climate zones with longer "in-leaf" seasons will tend to intercept more rainfall than similar species in colder areas shorter foliation periods. Model results were compared to observed patterns of rainfall interception and found to be accurate. This method quantifies only the amount of rainfall intercepted by the tree crown, and does not incorporate surface and subsurface effects on overland flow.

The rainfall interception benefit was priced by estimating costs of controlling stormwater runoff. Water quality and/or flood control costs were calculated per unit volume of runoff controlled and this price was multiplied by the amount of rainfall intercepted annually.

2.2.1 Error Estimates and Limitations

Estimates of rainfall interception are sensitive to uncertainties regarding rainfall patterns, tree leaf area and surface storage capacities. Rainfall amount, intensity and duration can vary considerably within a climate zone, a factor not considered by the model. Although tree leaf area estimates were derived from extensive measurements on over 14,000 street trees across the U.S. (McPherson et al., 2016a), actual leaf area may differ because of differences in tree health and management. Leaf surface storage capacity, the depth of water that foliage can capture, was recently found to vary threefold among 20 tree species (Xiao & McPherson, 2016). A shortcoming is that this model used the same value (1 mm) for all species. Given these limitations, interception estimates may have uncertainty as great as ± 20 percent.

2.3 Co-Benefit: Air Quality

The uptake of air pollutants by urban forests can lower concentrations and affect human health (Derkzen et al., 2015; Nowak et al., 2014). However, pollutant concentrations can be increased if the tree canopy restricts polluted air from mixing with the surrounding atmosphere (Vos et al., 2013). Urban forests are capable of improving air quality by lowering pollutant concentrations enough to significantly affect human health. Generally, trees are able to reduce ozone, nitric oxides, and particulate matter. Some trees can reduce net volatile organic compounds (VOCs), but others can increase them through natural processes. Regardless of the net VOC production, urban forests usually confer a net positive benefit to air quality. Urban forests reduce pollutants through dry deposition on surfaces and uptake of pollutants into leaf stomata.

A numerical model calculated hourly pollutant dry deposition per tree at the regional scale using deposition velocities, hourly meteorological data and pollutant concentrations from local monitoring stations (Scott et al., 1998). The monetary value of tree effects on air quality reflects the value that society places on clean air, as indicated by willingness to pay for pollutant reductions. The monetary value of air quality effects were derived from models that calculated the marginal damage control costs of different pollutants to meet air quality standards (Wang and Santini 1995). Higher costs were associated with higher pollutant concentrations and larger populations exposed to these contaminants.

2.3.1 Error Estimates and Limitations

Pollutant deposition estimates are sensitive to uncertainties associated with canopy resistance, resuspension rates and the spatial distribution of air pollutants and trees. For example, deposition to urban forests during warm periods may be underestimated if the stomata of well-watered trees remain open. In the model, hourly meteorological data from a single station for each climate zone may not be spatially representative of conditions in local atmospheric surface layers. Estimates of air pollutant uptake may be accurate within ± 25 percent.

2.4 Conclusion

Our estimates of carbon dioxide storage and co-benefits reflect an incomplete understanding of the processes by which ecoservices are generated and valued (Schulp et al., 2014). Our choice of co-benefits to quantify was limited to those for which numerical models were available. There are many important benefits produced by trees that are not quantified and monetized. These include effects of urban forests on local economies, wildlife, biodiversity and human health and well-being. For instance, effects of urban trees on increased property values have proven to be substantial (Anderson & Cordell, 1988). Previous analyses modeled these “other” benefits of trees by applying the contribution to residential sales prices of a large front yard tree (0.88%) (McPherson et al., 2005). We have not incorporated this benefit because property values are highly variable. It is likely that co-benefits reported here are conservative estimates of the actual ecoservices resulting from local tree planting projects.

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Part Three - Illustrative Summary of Quantification Steps using the Single Tree Quantification Tools

This section summarizes the steps in three Single Tree Tools used to quantify carbon storage in tree planting projects. These steps are set out in instructions on each sheet of the Single Tree Quantification Tools. The steps will be much clearer to many readers when viewed within the spreadsheets rather than read here without tables, fields, and inputs. The next section of this Appendix – entitled Quantification Methods and Examples – gives screen shots of the spreadsheets with explanatory text.

1. Steps for Single Tree Initial Credit Quantification after Planting

1) For each planting site, collect this information
    a. Unique site number
    b. Unique tree number (may be several tree numbers at same site if remove & replace)
        i. Tree species planted
        ii. Date planted
    c. Tree number removed
        i. Date removed
    d. GPS coordinates (lat/long)
    e. Notes
2) Photograph tree site or provide imaging of sufficient resolution to discern individual trees
    a. If using photographs, take photos at the four outer corners of each site, and also at 50 foot intervals on diagonal lines running between corners
    b. Include time stamp and GPS coordinates
3) The Tool will deduct 20% for mortality and 5% for the program-wide Reversal Pool Account and then show projected CO_2e storage and Credits
    a. The Project Operator can request to use an alternative value for the 20% mortality reduction. Justification for the value must be provided to the Registry based on historic mortality data for projects with similar species, planting stock, site quality and management regime.

2. Steps for the Single Tree Management Credit Quantification Used at Years 4 and 6

1) Collect the planting data described in initial credit quantification above, specifically,
    a. Unique site number
    b. Unique tree number (may be several tree numbers at same site if remove & replace)
        i. Tree species planted
        ii. Date planted

   c. GPS coordinates (lat/long)
   d. Notes
2) Use the Sample Size Calculator that we provide and the Stored CO_2 per Tree Look-Up Table to determine the number of tree sites to sample. We define a “tree site” as the location where a project tree was planted, and use the term “site” instead of “tree” because some planted trees may no longer be present in the sites where they were planted.
3) Randomly sample tree sites collecting data on species, status (alive, dead, removed, replaced).
4) With this sampled data, the Tool will then calculate projected CO_2 storage and credits, and will set those out for Years 4 and 6, along with quantified Co-Benefits.

3. Steps for the Single Tree Final Quantification Used at Year 14 and 26

1) Collect the planting data described in initial credit quantification above, or use the data already collected, specifically,
   a. Unique site number
   b. Unique tree number (may be several tree numbers at same site if remove & replace)
      i. Tree species planted
      ii. Date planted
   c. GPS coordinates (lat/long)
   d. Notes
2) Use the Sample Size Calculator that we provide and the Stored CO_2 per Tree Look-Up Table to determine the number of tree sites to sample. We define a “tree site” as the location where a project tree was planted, and use the term “site” instead of “tree” because some planted trees may no longer be present in the sites where they were planted.
3) Randomly sample tree sites collecting data on species, status (alive, dead, removed, replaced), diameter at breast height (dbh) (to nearest inch), and photo of tree site (may be with or without the tree planted) with geocoded location and date.
4) Fill in the table provided showing the number of live trees sampled in each 1” dbh class by tree-type.
5) Combine data from the step 5 table with the CO_2 Stored by DBH Look-Up Table for your climate zone to calculate CO_2 stored by sampled trees for each tree-type.
6) Fill in the table provided showing number of sites planted, sites sampled and status of sampled tree sites by tree-type. This table calculates Extrapolation Factors.
7) Combine data from tables in step 7 (Extrapolation Factors) and step 6 to scale-up CO_2 stored from the sample to the population of trees planted.
8) Fill in the table provided to incorporate error estimates of ±15% to CO_2 stored by the entire tree population.
9) Fill in the table provided to incorporate estimates of co-benefits.

4. Quantification Examples

4.1 Data Collection for all Single Tree Quantification and Tools

At planting, Project Operators must collect the data listed below. Project Operators can update that data as the Project proceeds.

Directions
Create a data sheet with the same fields seen in the example below.
At the time of data collection soon after planting, record the following information:
-Date of data collection.
-Names of the crew that collected that data.
At the time of data collection soon after planting record the following information on each tree:
-Date planted
-Tree Id#, the unique number that coincides with each tree that was planted at the site. When each tree has just been planted, and there are not any dead or missing trees, the tree id#s will all be the same as the site#s. As trees get replaced, the list of tree id#s will increase. In the example below, site# 1 has a replacement tree planted in it, therefore what was originally tree #1 is now tree #4. If tree #4 is the next one at the project that gets replaced, that new tree will then be tree #5.
-Site Id#, a unique number assigned to each spot a tree is planted at.
-Species name (botanical name)
-Latitude and Longitude (or x and y coordinates) of where each tree is located. These data are used to accurately locate the site for remeasurement.
-Image#1, the unique number for the first image of this site.
-Image#2, the unique number for the second image of this site taken at 90 degrees to the first.

Example Data Collection Table

Data Collection Dates: 1/1/24 Crew:

Date Planted	Tree ID #	Species	Site ID #	Latitude	Longitude	Image #1	Image #2	Live (Orig/Replace #1/Replace #2)	Standing Dead or Vacant Site	Date Removed	Date Replaced	Notes
1/1/2021	1	*Malus ioensis*	575	33.96872	-117.344							
1/1/2021	2	*Corylus americana*	575	32.96752	-117.263							
1/1/2021	3	*Prunus americana*	575	32.87346	-116.84							

4.2 Single Tree Initial Credit Quantification and Tool

The Registry will provide the Tools that contains look-up tables and calculations built into the spreadsheet so that Project Operators can enter their project data and then walk through the sheets to quantify CO_2 and co-benefits.

4.2.1 Planting List

Directions
1) In Table 1 record the number of sites planted for each tree species.
2) If species are not listed, add them to the bottom of Table 1.

Table 1. Planting List

Scientific Name	Common Name	Tree-Type Abbreviation	No. Sites Planted
Acer ginnala	Amur maple	BDS	
Acer negundo	boxelder	BDM	
Acer nigrum	black maple	BDL	
Acer palmatum	Japanese maple	BDS	
Acer platanoides	Norway maple	BDL	
Acer rubrum	red maple	BDL	
Acer saccharinum	silver maple	BDL	
Acer saccharum	sugar maple	BDL	
Acer species	maple	BDL	
Aesculus glabra	Ohio buckeye	BDL	
Albizia julibrissin	mimosa	BDS	
Alnus species	alder	BDM	
Amelanchier laevis	serviceberry, Allegheny	BDS	11
Amelanchier spp.	serviceberry, spp.	BDS	9
Betula nigra	river birch	BDM	
Betula papyrifera	paper birch	BDL	
Betula species	birch	BDM	
Broadleaf Deciduous Large	broadleaf deciduous large	BDL	
Broadleaf Deciduous Medium	broadleaf deciduous medium	BDM	

Table 2. Summary of Planting Sites

Tree-Type	Tree-Type Abbreviation	No. Sites Planted
Brdlf Decid Large (>50 ft)	BDL	1823
Brdlf Decid Med (30-50 ft)	BDM	41
Brdlf Decid Small (<30 ft)	BDS	1031
Brdlf Evgrn Large (>50 ft)	BEL	0
Brdlf Evgrn Med (30-50 ft)	BEM	0
Brdlf Evgrn Small (<30 ft)	BES	45
Conif Evgrn Large (>50 ft)	CEL	0
Conif Evgrn Med (30-50 ft)	CEM	0
Conif Evgrn Small (<30 ft)	CES	0
	Total Sites Planted	2940

4.2.2 Initial Credits – Total CO_2

This sheet calculates the Credits that can be issued in Year 1. It uses a default mortality of 20%. Project Operators may adjust that mortality deduction if they demonstrate to the Registry justification based on historic mortality data for projects with similar species, planting stock, site quality and management regime. Credits issued in Years 4 and 6 will depend on mortality based on sampling of trees in those years.

Directions

Using the information you provide and background data, the tool calculates the amount of Credits that could be issued after planting (10%), at Year 4 (30%), at Year 6 (30%), at Year 14 (10%), and at Year 26 (20%) after planting. A mortality deductions (% loss) is applied to account for anticipated tree losses (Cell D6). A 5% Reversal Pool Account deduction is applied that will go into a program-wide pool to insure against catastrophic loss of trees. This tool is used to determine credits issued after planting (Intial Crediting). A different tool is used for credit issuance in Years 4 and 6. The tool in those years requires calculation of a sample and collection of data on tree status in the sample sites.

Mortality Deduction (%): 20%

Table 3. Credits are based on 10% after planting, 30% at Year 4, 30% at Year 6, 10% at Year 14, and 20% at Year 26 after planting of the projected CO_2 stored by live trees 26-years after planting. These values account for anticipated tree losses and the 5% buffer pool deduction.

						10%	30%	30%	10%	20%
	No. Sites Planted	No. Live Trees	Mortality Deduction (%)	26-yr CO_2 stored (kg/tree)	Tot. 26-yr CO_2 stored w/ losses and 5% deduction (t)	10% CO_2 (t)	30% CO_2 (t)	30% CO_2 (t)	10% CO_2 (t)	20% CO_2 (t)
BDL	1823	1458	0.20	3,978.85	5512.6	551.26	1653.78	1653.78	551.26	1102.52
BDM	41	33	0.20	2,451.33	76.1	7.61	22.92	22.92	7.61	15.28
BDS	1031	825	0.20	700.27	548.7	54.87	164.61	164.61	54.87	109.74
BEL	0	0	0.20	0.00	0.0	0.00	0.00	0.00	0.00	0.00
BEM	0	0	0.20	0.00	0.0	0.00	0.00	0.00	0.00	0.00
BES	45	36	0.20	475.12	16.2	1.62	4.87	4.87	1.62	3.25
CEL	0	0	0.20	0.00	0.0	0.00	0.00	0.00	0.00	0.00
CEM	0	0	0.20	0.00	0.0	0.00	0.00	0.00	0.00	0.00
CES	0	0	0.20	0.00	0.0	0.00	0.00	0.00	0.00	0.00
	2940	2352	0.20	7,605.57	6154.0	615.40	1846.19	1846.19	615.40	1230.79

In Table 4 the tool infers the amount of CO_2 stored after 26 years from the sample to the population of live trees. Values in column H account for anticipated tree losses and the 5% Reversal Pool Account deduction.

Table 4. Grand Total CO_2 Stored after 26 years (all live trees, includes tree losses and buffer pool deduction)

Tree-Type	No. Sites Planted	Mortality Deduction (%)	Total Live Trees After Mortality	26-yr CO_2 stored (kg/tree)	CO_2 Tot. - No Deductions (t)	Grand Total CO_2 w/ Deductions (t)
Brdlf Decid Large (>50 ft)	1823	0.20	1458	3,978.85	7,253.4	5,512.6
Brdlf Decid Med (30-50 ft)	41	0.20	33	2,451.33	100.5	76.4
Brdlf Decid Small (<30 ft)	1031	0.20	825	700.27	722.0	548.7
Brdlf Evgrn Large (>50 ft)	0	0.20	0	0.00	0.0	0.0
Brdlf Evgrn Med (30-50 ft)	0	0.20	0	0.00	0.0	0.0
Brdlf Evgrn Small (<30 ft)	45	0.20	36	475.12	21.4	16.2
Conif Evgrn Large (>50 ft)	0	0.20	0	0.00	0.0	0.0
Conif Evgrn Med (30-50 ft)	0	0.20	0	0.00	0.0	0.0
Conif Evgrn Small (<30 ft)	0	0.20	0	0.00	0.0	0.0
	2940		2352	7606	8,097.3	6,154.0

Directions

In Table 5, enter the low and high price of CO_2 in $ per tonne (t).

This table incorporates error estimates of ±15% to the high and low estimates of the total CO_2 (t) stored by the live tree population after 26 years. For planning purposes only, it calculates dollar values.

Table 5. CO_2 value

	CO_2 $ per tonne
Low	$20.00
High	$40.00

Table 6. Summary of CO2 stored after 26 years (all live trees, includes tree losses)

Tree-Type	Total CO_2 (t) at 25 years	Low $ value	High $ value
Brdlf Decid	6137.7	$122,754.07	$245,508.14
Brdlf Evgrn	16.2	$324.98	$649.97
Conif Evgrn	0.0	$0.00	$0.00
Total	6154.0	$123,079.05	$246,158.11
	CO_2 (t)	Total $	Total $
Grand Total CO_2 (t) at 25 years:	6154.0	$123,079.05	$246,158.11
High Est. with Error:	7077.0	$141,540.91	$283,081.82
Low Est. with Error:	5230.9	$104,617.20	$104,617.20

± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement

4.2.3 Co-Benefits

Using the information you provide and background data, the tool provides estimates of co-benefits after 26 years.

Table 7. Co-Benefits per year after 26 years (all live trees, includes tree losses)

Ecosystem Services	Resource Units Totals	Total $
Rainfall Interception (m3/yr)	15,342.38	$109,837.06
Air Quality (t/yr)		
O3	0.1967	$657.05
NOx	0.0316	$105.38
PM10	0.1033	$293.31
Net VOCs	0.1368	$1,131.15
Air Quality Total	0.4684	$2,186.89
Energy (kWh/yr & kBtu/yr)		
Cooling - Electricity	454,631.80	$34,506.55
Heating - Natural Gas	6,746,192.64	$65,672.38
Energy Total ($/yr)		$100,178.93
Grand Total ($/yr)		$219,120.95

4.3 Resources

The look-up tables in both examples were created from allometric equations in the Urban Tree Database, now available on-line at: http://www.fs.usda.gov/rds/archive/Product/RDS-2016-0005/. A US Forest Service General Technical Report provides details on the methods and examples of application of the equations and is available online at: http://www.fs.fed.us/psw/publications/documents/psw_gtr253/psw_gtr253.pdf.

The citations for the archived UTD and the publication are as follows.

McPherson, E. Gregory; van Doorn, Natalie S.; Peper, Paula J. 2016. Urban tree database. Fort Collins, CO: Forest Service Research Data Archive. http://dx.doi.org/10.2737/RDS-2016-0005

McPherson, E. Gregory; van Doorn, Natalie S.; Peper, Paula J. 2016. Urban tree database and allometric equations. General Technical Report PSW-253. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA. http://www.fs.fed.us/psw/publications/documents/psw_gtr253/psw_gtr253.pdf

The i-Tree Canopy Tools is available online at: http://www.itreetools.org/canopy/.

Features of ten software packages for tree inventory and monitoring are evaluated in this comprehensive report from Azavea: https://www.azavea.com/reports/urban-tree-monitoring/.

4.4 Error Estimates in Carbon Accounting

Our estimates of error include 3 components that are additive and applied to estimates of total CO_2 stored:

Formulaic Error (± 10%) + Sampling Error (± 3%) + Measurement Error (± 2%)

We take this general approach based on data from the literature, recognizing that the actual error will vary for each project and is extremely difficult to accurately quantify. We limit the amount of sampling error by providing guidance on the minimum number of trees to sample in the single-tree approach and the minimum number of points to sample using i-Tree Canopy. If sample sizes are smaller than recommended these error percentages may not be valid. Project Operators are encouraged to provide adequate training to those taking measurements, and to double-check the accuracy of a subsample of tree dbh measurements and tree canopy cover classification. A synopsis of the literature and relevant sources are listed below.

4.4.1 Formulaic Error

A study of 17 destructively sampled urban oak trees in Florida reported that the aboveground biomass averaged 1201 kg. Locally-derived biomass equations predicted 1208 kg with RMSE of 427 kg. Tree biomass estimates using the UFORE-ACE (Version 6.5) model splined equations were 14% higher (1368 kg) with an RMSE that was more than 35% higher than that of the local equation (614 kg or 51%). Mean total carbon (C) storage in the sampled urban oaks was 423 kg, while i-Tree ECO over-predicted storage by 14% (483 kg C) with a RMSE of 51% (217 kg C). The CTCC under-predicted total C storage by 9% and had a RMSE of 611 kg (39%)

Result: Prediction bias for carbon storage ranged from -9% to 14%

Source: Timilsina, N., Staudhammer, C.L., Escobedo, F.J., Lawrence, A. 2014. Tree biomass, wood waste yield and carbon storage changes in an urban forest. Landscape and Urban Planning. 127: 18-27.

The study found a maximum 29% difference in plot-level CO_2 storage among 4 sets of biomass equations applied to the same trees in Sacramento, CA. i-Tree Eco produced the lowest estimate (458 t), Urban General Equations were intermediate (470 t, and i-Tree Streets was highest (590 t).

Source: Aguaron, E., McPherson, E.G. Comparison of methods for estimating carbon dioxide storage by Sacramento's urban forest. pp. 43-71. In Lal, R. and Augustin, B. (Eds.) Carbon Sequestration in Urban Ecosystems. New York. Springer.

4.4.2 Sampling Error

This error term depends primarily on sample size and variance of CO_2 stored per tree. If sample size is on the order of 80-100 sites for plantings of up to 1,000 trees, and most of the trees were planted at the same time, so the standard deviation in CO_2 stored is on the order of 30% or less of the mean, then the error is small, about 2-4%.

Source: US Forest Service, PSW Station Statistician Jim Baldwin's personal communication and sample size calculator (Sept. 6, 2016)

4.4.3 Measurement Error

In this study the mean sampling errors in dbh measurements with a tape were 2.3 mm (volunteers) and 1.4 mm (experts). This error had small effect on biomass estimates: 1.7% change (from 2.3 mm dbh) in biomass calculated from allometric equations.

Source: Butt, N., Slade, E., Thompson, J., Malhl, Y., Routta, T. 2013. Quantifying the sampling error in tree census measurements by volunteers and its effect on carbon stock estimates. Ecological Applications. 23(4): 936-943.

CITY FOREST CREDITS

Tree Planting Protocol

Version 10 | February 7, 2022

Appendix B
Validation and Verification

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1. Verification

The Registry will retain a qualified and approved Validation and Verification Body (VVB) to verify compliance with this Protocol per the requirements set forth in Protocol Section 12 and per International Standards Organization 14064-3.

The Registry will retain a qualified and approved Validation and Verification Body (VVB) to verify compliance with this Protocol per the requirements set forth herein and per International Standards Organization 14064-3 and in Appendix B, "Verification." Specifically, the Registry adopts and utilizes the following standards from ISO 14064-3:

- Upon receiving a completed Project Design Document with data on eligibility, quantification of carbon, and a request for credits, the Registry will retain a VVB to verify the project's compliance with this Protocol. The Registry will be independent of specific project activities.
- Verification by a VVB is described in more detail below. Urban forest projects, unlike many other types of carbon offset projects, will be conducted in and around urban areas, by definition. The trees in urban forest projects will be visible to virtually any resident of that urban area, and to anyone who cares to examine project trees.
- The Registry will maintain independence from the activities of projects and will treat all projects equally with regard to verification.
- The Registry requires a reasonable level of assurance in the accuracy the asserted GHG removals.
- The verification items identified in Appendix B and the following sections are all material elements, and any asserted GHG removals must be free of material errors, misstatements, or omissions regarding those elements.
- The Registry will record, store, and track all quantification and verification data and either display it for public review or make it available for public review upon request.
- The Registry will follow a process for follow-up and maintenance for consistency and continuity. This process will consist of a validation by the Registry to ensure that the Verification Report for each Project is consistent with the Project Documents submitted by the Project Operator.
- Appendix B contains requirements for geocoded photographs, imaging, data, or similar landmarking that provides verification of the Project Operator's data on quantification.
- Project Operators may use data from management or maintenance activities regularly conducted if the data was collected within 12 months of the project's request for credits.

Credits issued prior to completion of the 26-year project period will be subject to the Reversal Requirements set forth in Protocol Section 8.

2. Validation

The Registry shall conduct validation activities at three times.

A. Pre-Application

Before reviewing an application, the Registry conducts a validation screening:

- Validate eligibility under the protocol eligibility requirements
- Validate the Project Operator's understanding of the commitments it must make if it proceeds with the project:
  - Complying with the Protocol
  - Submitting project documents, including a Project Implementation Agreement with Registry
  - Quantifying carbon dioxide and ecosystem co-benefits according to the appropriate methodology
  - Conducting monitoring and reporting for the Project Duration

B. Before Third-Party Verification
Upon submittal of a final Project Design Document (PDD) and before third-party verification, the Registry will:

- Review the PDD and its supporting documents for:
  - Compliance with Protocol PDD requirements
  - Demonstration that the project meets the Protocol eligibility requirements

C. After Receiving the Verification Report
When the third-party verifier produces its Verification Report, the Registry then reviews that Report to ensure the following:

The Verification Report accurately reflects the documentation contained in the PDD and supporting documents.

The Registry shall document it validation activities in a written report that shall be posted publicly with other project documents.

3. Verification for Issuance of Credits - Single Tree Quantification Method

Table C.1 displays the various verification requirements to be performed upon request by a Project Operator for credits under Section 10 of the Tree Planting Protocol.

Table C.1

Item	**Elements to Verify**	**Protocol Section**	**How**
1	Project Operator Identity	1.1	State/local records
2	Project Implementation Agreement (PIA)	1.3	Signed/received
3	Location	1.3	Mapping/location data
4	Ownership or Eligibility to Receive Potential Credits	1.7	Signed Attestation of Land Ownership or Agreement to Transfer Credits
5	Legal Requirements Test	1.8	Signed PIA and ordinances
6	Commencement	2.4	Project documentation
7	Project Documentation	6	Confirm all documents
8	Project Duration	5	Signed PIA
9	Additionality	4	Attestation of Additionality
10	Performance Standard Baseline	Standard	Attachment to PDD
11	No Net Harm and No Double Counting	5	Attestation of No Double Counting Credits and No Net Harm
12	Credit Quantification	10, Appendix A	
	After Planting:		

	A. Initial quantification tool including data collection for trees with species, location via GPS or address, and date planted		Check appropriate quantification tool
	B. Attestation of Planting		Signed Attestation of Planting, including invoices and images
	C. Attestation of Planting Affirmation		Signed Attestation of Planting Affirmation
	At Year 4 and 6:		
	A. Accuracy of Process and Quantification Documents:		Check appropriate quantification tool
	1. Sample size calculations		Check appropriate quantification tool
	2. Randomization of sample		Check appropriate quantification tool
	3. Calculations		Check appropriate quantification tool
	4. Integrity of spreadsheet		Check appropriate quantification tool
	B. Field Data and Inputs into Spreadsheets:		
	1. Data from sampled trees		Geocoded photos or imaging of sampled trees
	2. Data input accuracy		Check inputs
	At Year 14:		
	A. Accuracy of Process and Quantification Documents:		Check appropriate quantification tool

	1. Sample size calculations		Check appropriate quantification tool
	2. Randomization of sample		Check appropriate quantification tool
	3. Calculations		Check appropriate quantification tool
	4. Integrity of spreadsheet		Check appropriate quantification tool
	B. Field Data and Inputs into Spreadsheets:		
	1. Data from sampled trees, measure DBH		Geocoded photos or imaging of sampled trees
	2. Data input accuracy		Check inputs
	At Year 26:		
	Accuracy of Process and Quantification Documents:		Check appropriate quantification tool
	Sample size calculations		Check appropriate quantification tool
	Randomization of sample		Check appropriate quantification tool
	Calculations		Check appropriate quantification tool
	Integrity of spreadsheet		Check appropriate quantification tool
	Field Data and Inputs into Spreadsheets:		
	Data from sampled trees, measure DBH		Geocoded photos or imaging of sampled trees

	Data input accuracy		Check inputs
13	Co-Benefit Quantification		Check appropriate quantification tool
14	Reversal Pool Account Deduction	8	Ensure Reversal Pool Account Deduction before Project Operator's GHG mitigation assertion

4. Verification for Issuance of Credits - Clustered Quantification Method

Table C.2 displays the verification requirements to be performed upon request by a Project Operator for credits using the Clustered Quantification.

Table C.2

Item	Elements to Verify	Protocol Section	How
1	Project Operator Identity	1.1	State/local records
2	Project Implementation Agreement (PIA)	1.3	Signed/received
3	Location	1.3	Mapping/location data
4	Ownership or Eligibility to Receive Potential Credits	1.7	Signed Attestation of Land Ownership or Agreement to Transfer Credits
5	Legal Requirements Test	1.8	Signed PIA and ordinances
6	Commencement	2.4	Project documentation
7	Project Documentation	6	Confirm all documents
8	Project Duration	5	Signed PIA
9	Additionality	4	Attestation of Additionality
10	Performance Standard Baseline	Standard	Attachment to PDD
11	No Net Harm and No Double Counting	5	Attestation of No Double Counting Credits and No Net Harm
12	Credit Quantification	10, Appendix A	
	After Planting:		
	D. Initial quantification tool including data collection for trees with species, location via GPS or address, and date planted		

	E. Mapping and boundaries for the area planted		Check map and boundaries of Project Area showing trees planted
	F. Attestation of Planting		Signed Attestation of Planting, including invoices and images
	G. Attestation of Planting Affirmation		Signed Attestation of Planting Affirmation
	At Year 4:		
	C. Accuracy of Process and Quantification Documents:		Check appropriate quantification tool
	5. Sample size calculations		Check appropriate quantification tool
	6. Randomization of sample		Check appropriate quantification tool
	7. Calculations		Check appropriate quantification tool
	8. Integrity of spreadsheet		Check appropriate quantification tool
	D. Field Data and Inputs into Spreadsheets:		
	1. Imaging of Project Area with leaf-on to calculate percent of tree canopy cover		Confirm canopy coverage equals or exceeds 2.8% (400 trees per acre with an average canopy area of 3.14 square feet per tree (2-foot diameter of canopy)
	At Year 6:		
	Accuracy of Process and Quantification Documents:		Check appropriate quantification tool
	Sample size calculations		Check appropriate quantification tool

	Randomization of sample		Check appropriate quantification tool
	Calculations		Check appropriate quantification tool
	Integrity of spreadsheet		Check appropriate quantification tool
	Field Data and Inputs into Spreadsheets:		
	Imaging of Project Area with leaf-on to calculate percent of tree canopy cover		Confirm canopy coverage equals or exceeds 11.5% (400 trees per acre with an average canopy area of 12.56 square feet per tree (4-foot diameter of canopy
	At Year 14:		
	Accuracy of Process and Quantification Documents:		Check appropriate quantification tool
	Sample size calculations		Check appropriate quantification tool
	Randomization of sample		Check appropriate quantification tool
	Calculations		Check appropriate quantification tool
	Integrity of spreadsheet		Check appropriate quantification tool
	Field Data and Inputs into Spreadsheets:		
	Imaging of Project Area with leaf-on to calculate percent of tree canopy cover		Confirm canopy coverage equals or exceeds 46% (400 trees per acre with an average canopy area of 50 square feet per tree (8-foot diameter of canopy)

	At Year 26:		
	Accuracy of Process and Quantification Documents:		Check appropriate quantification tool
	Sample size calculations		Check appropriate quantification tool
	Randomization of sample		Check appropriate quantification tool
	Calculations		Check appropriate quantification tool
	Integrity of spreadsheet		Check appropriate quantification tool
	Field Data and Inputs into Spreadsheets:		
	Imaging of Project Area with leaf-on to calculate percent of tree canopy cover		Confirm canopy coverage equals 100% of the Project Area at project outset
13	Co-Benefit Quantification		Check appropriate quantification tool
14	Reversal Pool Account Deduction	8	Ensure Reversal Pool Account Deduction before Project Operator's GHG mitigation assertion

5. Verification for Issuance of Credits - Area Reforestation Quantification Method

Table C.3 displays the verification requirements to be performed upon request by a Project Operator for credits using the Area Reforestation Quantification Method.

Table C.3

Item	Elements to Verify	Protocol Section	How
1	Project Operator Identity	1.1	State/local records
2	Project Implementation Agreement (PIA)	1.3	Signed/received
3	Location	1.3	Mapping/location data
4	Ownership or Eligibility to Receive Potential Credits	1.7	Signed Attestation of Land Ownership or Agreement to Transfer Credits
5	Legal Requirements Test	1.8	Signed PIA and ordinances
6	Commencement	2.4	Project documentation
7	Project Documentation	6	Confirm all documents
8	Project Duration	5	Signed PIA
9	Additionality	4	Attestation of Additionality
10	Performance Standard Baseline	Standard	Attachment to PDD
11	No Net Harm and No Double Counting	5	Attestation of No Double Counting Credits and No Net Harm
12	Credit Quantification	10, Appendix A	See Appendix A for details
13	Co-Benefit Quantification		Check appropriate quantification tool
14	Reversal Pool Account Deduction	8	Ensure Reversal Pool Account Deduction before Project Operator's GHG mitigation assertion

6. Guidance on Specific Elements of Verification

Although the Registry reviews eligibility criteria upon initial application, this early review is not a verification review and does not suffice for issuance of credits. The following gives guidance for select eligibility criteria.

6.1 Location

Projects must occur within the locations specified in Section 1.4 of the Protocol. Verification can include review the Project Operator's designation of parcel numbers, addresses, or other indications of property location with reference to maps, KLM files, images from Google Earth or other reliable imaging sources.

6.2 Ownership or Eligibility to Receive Potential Credits

Verification includes review of the signed Attestation of Ownership and Right to Receive Credits, or, if the Project Operator does not own the land upon which project trees are planted, the Agreement to Transfer Potential Credits from the owner to the Project Operator. Verification entails a risk-based review that requires further review in any cases of lack of clarity or detail.

6.3 Project Commencement

Verification includes confirmation of the commencement date, and in the Registry's database, plus confirmation that the commencement date meets the requirements of Section 7 of the Protocol.

6.4 Additionality

Verification requires review of the Project Design Document Statement on Additionality, including the Attestation of Additionality, Legal Requirements Test (Protocol Section 1.8), review of a Project-Specific Baseline or Performance Standard Baseline attached to the Project Design Document, and review of the Project Implementation Agreement that requires a 26-year Project Duration. Further review of local ordinances of laws may be required to give a reasonable assurance that this requirement has been met.

6.5 CO_2 and Co-Benefit Quantification Tool Review

A critical component of verification includes review of the Project Operator's planting data and completion of other data required to complete the mortality assessment or quantification of CO_2. Appendix A details the requirements for each quantification method.

6.6 Attestation of Planting and Planting Affirmation

The following verification data is required.

a. Attestation of Planting: a statement by the Project Operator that includes the following, with any supporting documentation:

- Dates of planting
- Number of trees planted by species
- Invoices for trees planted, or invoices or a statement from the party who funded the tree purchase or supplied the trees attesting to the number of trees purchased, or any other reliable estimate of trees planted
- Geo-coded photos of the tree stock and planting event(s)

b. Attestation of Planting Affirmation confirms that:

- They have attended at least one planting event for the project and has verified from the planting schedule that any other scheduled planting events occurred
- They have reviewed the data from the Attestation of Planting and confirm that it accurately reflects their own observations of planting activities

6.7 Attestation of No Double Counting and No Net Harm

Verification requires review of the signed Attestation of No Double Counting and No Net Harm.

7. Completing Verification

A verification report must be completed in order for credits to be issued. That report and statement must include:

a. Findings of the verifier as to each element in Table C.1 , C.2, and C.3.
b. A verification statement that supports the GHG assertion contained in the Project Operator's appropriate spreadsheet and that states the number of credits that can be issued.