Urban Tree Planting Quantification Guidance

May 2016

1 Introduction

This document provides guidance for quantifying an Urban Tree Planting (UTP) Project's carbon stocks, both for purposes of estimating a project's baseline as well as providing ongoing estimates of project carbon stocks throughout the project life. This guidance document is based on addressing important monitoring requirements. The specific monitoring objectives are to provide estimates of carbon inventories within the Project Area[1] for purposes of calculating credits generated.

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

2 Reporting Requirements for Urban Forest Carbon Pools

Only Standing Live and Dead Trees can be included in quantifying UTP Project baselines and project estimates.

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

Table 2.1. Unit Conversions

Base Unit	Conversion		Final Unit
Biomass	0.5 * biomass	=	Carbon
Carbon	3.67 * carbon		CO_2e
Kilograms	Kilograms/1000		Metric Tons (MT) or Tonnes
Tons	0.90718474 * tons		Metric Tons (MT) or Tonnes
Hectares	0.404686 * hectares		Acres

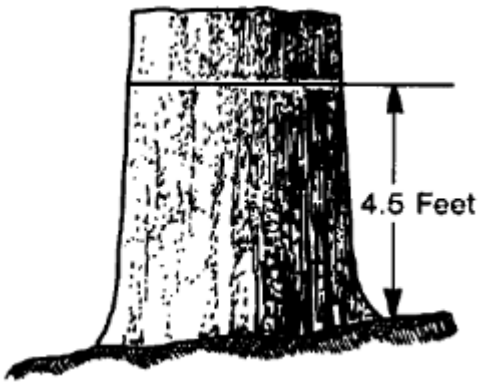
3 Methodology for Estimating CO_2e in Urban Tree Planting Projects

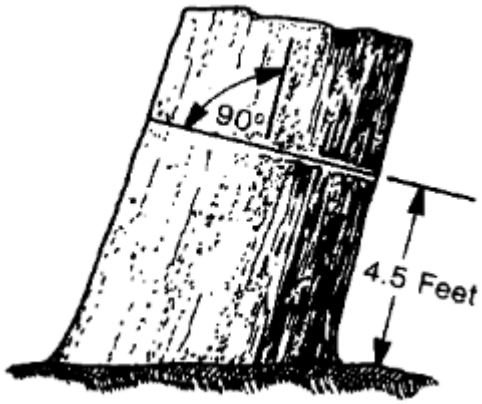
Since individual trees planted under UTP Projects are disaggregated and must be identified separately from non-project trees, trees in UTP Projects must be 100% inventoried. Sampling is not currently allowed for individual UTP Projects. The Reserve will consider alternative methodologies; including sampling methodologies, as they are developed and reviewed. The data required at the time of planting for each tree is identified in Table 3.1. These data must be maintained within a database and updated per requirements described within this section.

Table 3.1. Measurement Standards for Urban Trees

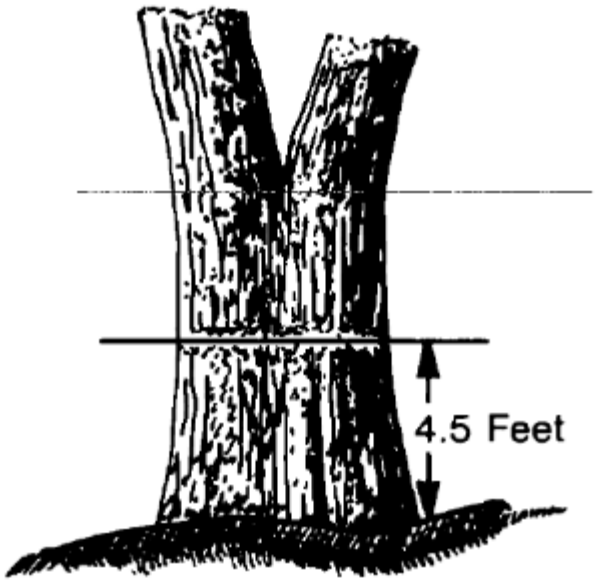
For Each Tree	
Attribute	**Description**
Date of Tree Visit	Day/Month/Year
Latitude of Tree Center	From GPS
Longitude of Tree Center	From GPS

[1] Capitalized terms are defined in the Urban Tree Planting Project Protocol Version 2.0.

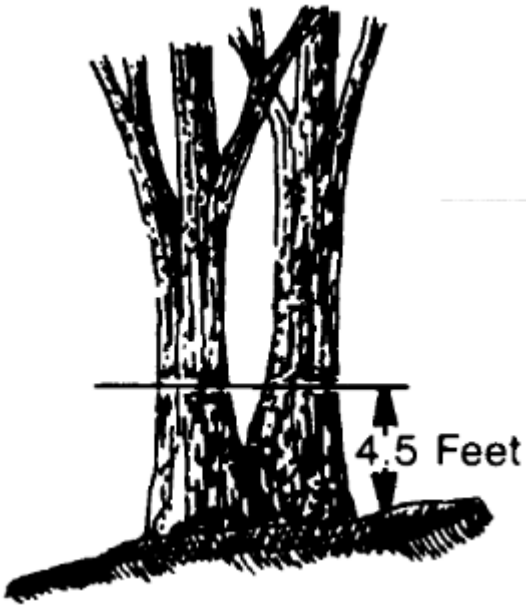
Navigational Feature 1	Description of a resilient feature that can be used to help relocate the tree in the future. Features might include manhole covers, building corners, street signs, etc.	(fire hydrant, street sign, building corner, etc.)
	Distance from feature to the tree	Feet
	Azimuth from feature to the tree	Degrees
Navigation Feature 2	Description of a resilient feature that can be used to help relocate the tree in the future. Features might include manhole covers, building corners, street signs, etc.	(fire hydrant, street sign, building corner, etc.)
	Distance from feature to the tree	Feet
	Azimuth from feature to the tree	Degrees
Tree Number	Enter the unique tree number for the tree.	
Inventory Personnel	Enter the initials of the inventory technicians responsible for measuring and recording data for the tree.	
Species	Enter the species code for the tree. The species code can be found for each species in the corresponding biomass equation reference document on the Reserve's website. The species code is based on the first two letters of the genus and the first two letters of the species for any given species.	
DBH	Measure and record Diameter at Breast Height (DBH) of all trees 3" DBH and greater to the nearest inch using a diameter tape and wrapping the tree at a height of 4.5 feet from the base of the tree on the uphill side. 	



Forked trees above DBH are counted as one tree. Forked trees below DBH are counted as two trees (or however many forked stems exist).



One tree

<table>
<tr><td></td><td> 

Two trees

Images via FSH 2409.12 USDA Forest Service Timber Cruising Handbook</td></tr>
<tr><td>Total Height</td><td>Measure of total height (height from base of tree to top) to the nearest foot.</td></tr>
<tr><td>Growth Condition</td><td>An attribute of ‘Open’ or ‘Closed’ must be assigned to the tree according to the description below:
<table>
<tr><th>Class</th><th>Description</th></tr>
<tr><td>O</td><td>An open attribute is assigned to trees growing in non-natural settings. Tree species may be a variety of native and non-native species. Most often, trees exist in areas where disturbance of natural areas and conversion to another land use has occurred.</td></tr>
<tr><td>C</td><td>A closed attribute is assigned to trees growing in natural settings. Trees present are characteristic of the species diversity and structure in forested areas outside the urban area.</td></tr>
</table></td></tr>
<tr><td>Vigor</td><td>Provide a rating of the tree’s apparent vigor. Determination of vigor based on consideration of color of foliage, crown proportion and appearance, retention of leaves/needles, appearance of apical growth, length between growth whorls, and presence of cavities and fungal growth. The code is assigned based on the following classes:
<table>
<tr><th>Code</th><th>Description*

*Based on conditions present during growing periods. Professional judgment need be applied if sampling conducted outside of growing periods.</th></tr>
<tr><td>1</td><td>Excellent – Tree exhibits high level of vigor and no barriers (soil, light, etc.) to continued vigor. No decay or broken branches are observed.</td></tr>
<tr><td>2</td><td>Good - Tree exhibits high level of vigor and some minor barriers (soil, light, etc.) to continued vigor. No decay or broken branches are observed.</td></tr>
<tr><td>3</td><td>Fair – Tree appears generally healthy. Barriers (soil, light, etc.) affect the tree’s vigor. Tree’s crown may be smaller proportionally</td></tr>
</table></td></tr>
</table>

		than in healthier trees. Decay and/ or broken branches, if observed, are not likely to have negative impacts in the short term.
	4	**Poor** – Tree appears notably unhealthy, as determined by reduced crown, presence of decay and/or broken branches and/or significant barriers to future growth. Observed problems have high likelihood of being rectified through management of said tree and trees surrounding it.
	5	**Critical –** Tree appears notably unhealthy, as determined by reduced crown, presence of decay and/or broken branches and/or significant barriers to future growth. Observed problems have low likelihood of being rectified through management of said tree and trees surrounding it.
	6	**Dying -** Tree is unhealthy. Minimal live crown is present; portions of bark may be missing and/or substantial levels of broken stems and branches. Tree may exhibit advanced decay. No further investment in restoring the tree to a higher vigor is deemed worthwhile.
	7	**Dead-** No live material is observed in the tree. Trees with this attribute will be used to quantify SSR3 – Standing Dead Wood.
Defect – Bottom 1/3 Defect – Middle 1/3 Defect – Top 1/3	For each portion of the tree (based on total height), provide an ocular estimate of the portion of tree that is missing (as a percentage of the section) as the result of breakage or cavities.	

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

3.1 Quantification of Carbon in Live and Dead Trees from Project Data

All projects must use the appropriate biomass found on the Reserve's Urban Forest Project Protocol webpage. The biomass equations will enable the calculation of CO_2e in the above-ground portion of trees, using any necessary conversion from volume to carbon and CO_2e described in this section. The below-ground portion of trees shall be estimated as 26% of the above-ground portion of the tree and added to the above-ground portion to calculate an overall estimate for the tree. This calculation shall be included in both the project and baseline accounting.

3.2 Baseline Development for Urban Tree Planting Projects

The baseline of UTP Projects is determined using a performance standard statistic. The performance standard statistic is the CO_2e associated with the average of tree planting data between the 50th and 100th percentiles over the past 5 years from entities similar to the project entity. The performance standard statistics are organized by region, by entity class (utility, educational institution, and municipality), and by size of entity. The performance standard statistic can be found on the Urban Forest Project Data link on the Reserve's Urban Forest Project Protocol webpage.[2]

The performance standard statistic number of trees is assumed to continue to be planted on an annual basis and grow. The baseline CO_2e trend is based on the ongoing planting of performance standard trees annually plus growth from trees previously planted. The baseline planting of trees is halted at a time when the Project Operator stops planting project trees, other than replacing dead and dying trees, for a period of 5 years or more. The Project Operator must complete a form indicating the project will not account for any newly planted trees for the minimum 5-year period.

Individual trees are not attributed with a designation of being a performance standard tree. Rather, the performance standard trees are calculated as a percentage of all trees planted and the percentage is applied to the total CO_2e stocks. This removes the threat of bias in estimating the amount of CO_2e associated with the performance standard trees. Figure 3.1 below displays an example of baseline and project accounting and displays how removals are calculated.

Project Year	0	1	2	3	4	5	6	7	8	9	10	Notes
Trees Planted in Project Year		350	654	539	-	101	-	-	-	-	-	# trees planted in year-X. Note that no trees were planted in year-4 and that a hiatus occurred in year-6
CO_2e associated with trees planted in project year		14	26	22	-	4	-	-	-	-	-	CO_2e determined by analyzing tree data (for trees planted in year-X) with biomass equations.
Annual Growth		-	1	2	4	4	5	5	5	5	5	CO_2e based on annual growth of project trees
Total Project Inventory (CO_2e)	-	14	41	65	69	77	82	87	92	97	102	Sum of CO_2e associated with all trees planted during project (including annual growth). This is updated annually through inventory updates.
Performance Standard Trees Planted		50	50	50	50	50	-	-	-	-	-	Performance standard, based on entity, size, and region
Baseline Trees as a % of All Trees Planted		14%	10%	10%	13%	15%	15%	15%	15%	15%	15%	The running total of baseline trees compared, as a percentage, to the running total of project trees. Note that baseline trees are arrested when the project entered into hiatus.
Baseline CO_2e (based on CP trees, initial CO_2e, and	-	2	4	6	9	12	12	13	14	15	15	The percentage above applied to the total inventory of project

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

growth rate)												CO_2e.
Annual Removals		12	25	22	1	5	5	4	4	4	5	Total Project Inventory – Previous Removals – Baseline CO2e; or Project(year x) – Baseline(yearx)
Total Removals		12	37	59	60	65	70	74	78	82	87	Sum of Project (all years)-Sum of Baseline (all years)

Figure 3.1. Example of the Use of a Performance Standard for Baseline Calculations

The example displays how the performance standard is calculated in terms of a percentage of all trees planted, how that value is interpreted in terms of CO_2e, and the mechanism for calculating annual and total project removals.

4 Updating Forest Inventories

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

Plot data can be 'grown', or projected for a maximum of 10 years, after which additional field work is required to either update the plot data or establish new plots. In the case of UTP Projects, each tree is considered a plot and, therefore, the tree data can be projected for a period of no more than 10 years before the tree must be re-measured in the field.

It is important to note that the basis of a successful verification depends on alignment (within tolerance bands defined in the verification guidance) between verifier data and Project Operator data for each randomly selected plot (selected by verifier), therefore these guidelines do not ensure successful project verification. The actual timeframe between plot re-measurement may need to be reduced to less than 10 years if the updates of inventory data prove to be inaccurate on a plot by plot basis.

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

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

In any case, plot data that is updated to reflect current conditions with the use of predicted increments of height and diameter data, as well as updates for removals, will be used during

onsite verifications to compare against verifiers' field measurements using the sequential sampling techniques described in the verification section. This provision ensures that plot measurements and update processes are within accuracy thresholds.