Advanced Carbon Restored Ecosystem (ACRE)

December 13, 2011

GreenTrees, LLC

GreenTrees

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A.
PROJECT OVERVIEW

A1. PROJECT TITLE

GreenTrees ACRE (Advanced Carbon Restored Ecosystem).

A2. PROJECT TYPE

Programmatic Afforestation/Reforestation.

A3. PROOF OF PROJECT ELIGIBILITY

Under the *American Carbon Registry Forest Carbon Project Standard Version 2.1* dated November 2010, Afforestation/Reforestation (AR) is an eligible project type under Chapter 1 (D). Under Chapter 7 (F), ACRE project will be considered a programmatic project development approach. The project proponent is GreenTrees, LLC.

The project is to be validated and verified under ACR *Methodology for Afforestation and Reforestation of Degraded Land*, Version 1.0, March 2011.

The project meets the applicability requirements of the *ACR Forest Carbon Project Standard v2.1*:

- The project started in 2008, which is after the earliest allowable start date of November 1, 1997.
- GreenTrees commits to a minimum project term of 40 years, meeting the ACR project term requirement.
- Only direct emission mitigation is counted.
- Ownership of offsets is clear.
- Ownership titling of land is clear.
- Project lands are eligible because they were not converted from forest within 10 years before the project start date.
- Project lands were not forest at the project start date.
- The project uses site preparation and planting to establish forest.

A3. LOCATION

Project lands are located in the US Forest Service South Central and Southeast regions, primarily within the Mississippi Alluvial Valley (MAV). A map of project lands is in section B3 of this document.

Project land parcel boundaries are unambiguously specified and recorded in government land ownership registries. Project planting area boundaries are mapped using a GPS receiver. Often planting areas are less than entire legal parcel. Areas are excluded from the project if they have pre-existing trees or if they are expected to remain non-forest, such as water bodies and built sites. Shape files geolocating project lands boundaries are on file in the project database and can be made available to ACR and the verifier.

A critical resource, the bottomland hardwood ecosystem of the MAV is one of the most important on the North American continent. Considered North America's rainforest, the MAV is a vital habitat for migratory birds and numerous plant and animal species. Forty percent of North America’s waterfowl and sixty percent of all bird species migrate along the Mississippi River, although their population has been dwindling from habitat loss. Federal biologists estimate that in just seven years, a GreenTrees forest would hold twice the migratory birds than would a comparable field planted with just hardwoods.

The Mississippi River is a critical body of water in North America for commerce, climate and energy. It is the largest river in the United States and the third longest in the world. It drains the water of 33 states and two Canadian provinces, approximately forty one percent of the United States. Keeping its ecosystem sound is important for commerce: each year over 505 million tons of product valued at $80-$114 billion travels down the river.

Deforestation of the MAV accelerated with the arrival of mechanized agriculture following World War II. It escalated between the mid 1960s and mid 1970s, when prices for soybeans were driven upward and much of the land was converted to farmland. Intensive deforestation and change in land use over the last 50 years have dramatically affected the ecosystem.

Deforestation of the MAV has resulted in a decline in the quality of the water and wildlife in the watershed because it has lost so much of its natural flood control buffer. According to the U.S. Geological Survey, for every 100,000 acres of farmland restored to its natural bottomland forest, the release of 1,550,000 pounds per year (23,250,000 pounds over fifteen years) of nitrogen and phosphorous into the Mississippi River would be avoided. EPA estimates that at least 12 tons of soil wash into the Gulf from every acre of cropland in the MAV. A one million acre restored bottomland forest would prevent at least 12 million tons of soil annually from adding to the dead zone in the Gulf. GreenTrees' aim is, over the coming decades, to reforest 1,000,000 acres of marginal and/or frequently flooded lands in this area.

The GreenTrees program is divided up into planting years with multiple start dates. For each particular tract, the start date is defined by when the project proponent began planting or site prep.

A4. BRIEF SUMMARY OF PROJECT

The project uses site preparation and tree planting to establish trees on lands that have been in continuous agricultural use for decades. Landowners commit to protecting the trees. Limited harvest is allowed after trees grow to the point where crowding of trees is expected to cause some trees to die, but in no case may harvesting occur if it would result in a basal area of live trees of less than 100 square feet per acre after the harvesting. Tree planting is interplanting of fast growing cottonwoods and native hardwoods. The cottonwoods protect the hardwoods from direct sun, which speeds the growth of the hardwoods. Cottonwoods are planned to be removed from the stand in the first 25 years of the project, resulting in a native hardwood forest.

Given the MAV's importance as an ecological and commercial artery and the change in its use in recent decades, it has become increasingly apparent that this land is in dire need of restoration conservation. The GreenTrees Program meets this need by creating a set of standards for reforestation management to improve conservation incentives through carbon credits. By bringing together private capital and conservation, GreenTrees Program creates an appreciating asset that produces increasing valuation and multiple revenue streams for struggling farmers and landowners.

The GreenTrees Program is intended to be a mechanism to bring carbon finance and conservation together so that conservation projects can move forward. Large-scale restoration is critical to conservation; the GreenTrees Program is intended to be a mechanism to achieve scale and have a multiplier impact on the restoration of this critical watershed. The GreenTrees Program is a “River System Approach” and the program aims to reforest 1,000,000 acres in the region.

Not only do projects certified under the GreenTrees Program promote conservation and good land management practice, the trees grown under the specifications set out by the Protocol also will supply the biomass industry with offtake for renewable energy generation. Projects using the GreenTrees Program will be able to sustainably produce biomass materials while restoring the ecosystem. Given the trend towards renewable energy, GreenTrees Program projects will enable an enhanced and blended carbon, conservation and biomass return for the landowner and the environment.

A5. PROJECT ACTION

GreenTrees is designed to provide landowners the highest combination of financial and conservation value possible from bottomland hardwood afforestation. Voluntary landowner enrollment in GreenTrees creates regional scale to produce multiple conservation, wildlife, and ecosystem benefits. By using a specific inter-planting of 302 eastern cottonwoods with 302 mixed, indigenous hardwoods per acre, GreenTrees directly supplies the growing demands for verifiable forestry carbon offsets and renewable biomass feedstock supplies.

Utilizing our special, heavily researched silviculture, GreenTrees interplants native hardwoods with cottonwoods on each acre. Cottonwoods are the fastest growing native tree, and can grow 8 to 12 feet in height each year. They act as a “nurse tree” helping to accelerate the growth and quality of the forest and speed up the sequestration of carbon while creating habitat for wildlife within three years.

GreenTrees uses carbon origination and biomass to tip the economic scales for landowners in favor of conservation, wildlife and ecosystem restoration, thus directly providing the MAV region and our nation a new economic and environmental resource to enjoy for generations to come.

A6. *EX ANTE* OFFSET PROJECTION

Because GreenTrees is a programmatic offset project, it is continuing to enroll and plant lands. The amount to sequestration that will be achieved over time depends both on how many acres are enrolled in the project, and how quickly trees grow on enrolled acres. As of July 2011, GreenTrees has enrolled 6298.68 acres and planted 4841.79 acres.

Table 1. Estimated GHG removal enhancements by year, in metric tons of CO_2e, for 50,000 acres of plantings, before deduction for any risk buffer.

Year	ERTs Generated
2008	0
2009	0
2010	1,119
2011	38,096
2012	20,821
2013	53,127
2014	126,321
2015	245,052
2016	430,870
2017	638,185
2018	803,683
2019	920,879
2020	941,569
2021	913,699
2022	811,403
2023	743,547
2024	663,284
2025	643,662
2026	924,941
2027	858,643
2028	739,635
2029	523,214
2030	19,002
2031	0
2032	0
2033	0
2034	0
2035	0
2036	0
2037	0
2038	0
2039	0
2040	0
2041	0
2042	0
2043	0
2-44	0
2045	0
2046	0
2047	0
TOTAL	**11,060,752**

For each acre where forest is successfully established, over the life of the project, the acre will generate approximately 200 metric tons CO_2e of offsets. These offsets are generated in the first 15 years of tree growth. The trees continue to grow rapidly after age 15, but growth after age 15 could be largely removed by later selective harvests, if the landowner chooses to harvest. The project does not count as an offset any sequestration that might be later negated by harvest, so the project does not claim any offsets after the 15th year after planting. These ex-ante projections assume all planting occurs within the first five years of the project.

The GreenTrees project focuses on bottomlands. These lands can support vigorous tree growth and provide important wildlife habitat and hydrologic benefits. However, along with hydrologic benefits of having lands available for flooding comes the effect of reduced tree growth in high flood years. Decreases in tree growth resulting from flooding are particularly pronounced in the first years after planting. If sites flood the year of planting, and the year after, tree growth can be slowed significantly. If growth is slowed, sequestration and offset generation will be slower than the rate projected for lands with unimpaired growth.

GreenTrees does not have a fixed maximum size. Enrollment will depend on both landowner interest and commitments by offset buyers and investors. The proximate project goal is to have 50,000 acres enrolled by the end of 2013. Offsets expected to be generated from 50,000 acres are estimated in

Table 1. These numbers assume that all 50,000 acres are enrolled and planted in the first five years. The numbers also assume that all landowners exercise their options to do forest thinnings. If a landowner thins the maximum allowable amount the carbon stock in future years could drop to the amount present in the 15th year after planting, so no offsets are claimed after the 15th year after planting. If landowners do not thin to the maximum allowed amount, more offsets could be generated.

A7. PARTIES

GreenTrees, LLC is the Project Proponent. GreenTrees is the manager of both the GreenTrees Carbon Fund 1, LLC (GCF1) and Whistle Green, LLC. GCF1 is a Series LLC. Either GreenTrees or GCF1 or Whistle Green is the holder of the title to the carbon rights as recorded in the courthouse for each landowner enrolled in the program. As manager, GreenTrees performs title and credit checks on each land enrolled.

Name	***Affiliation***	***Title***	***Responsibility***	***Contact Information***
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Bob Misso	*GreenTrees, LLC*	*Chief Forester*	*Overall and Monitoring/Measurement*	*540-687-8945*
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B.
METHODOLOGY

B1. APPROVED METHODOLOGY

The project is validated and verified under ACR *Methodology for Afforestation and Reforestation of Degraded Land*, Version 1.0, March 2011.

Tools used by the project are:

- Afforestation and Reforestation (A/R) methodological tool "Tool for testing significance of GHG emissions in A/R CDM project activities, Version 01".
- A/R methodological tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities, Version 01".

B2. METHODOLOGY JUSTIFICATION

This methodology was chosen for this project because:

1. It is an ACR methodology;
2. The methodology is for A/R projects and the project is an AR project;
3. The project meets the eligibility provisions of the methodology; and
4. The methods and equations in the methodology are appropriate to the physical and biological conditions of the project.

The project meets the applicability requirements of the methodology under which the project is validated and verified:

a. The project is implemented on degraded lands that are expected to remain degraded. Project lands meet the eligibility requirements of the CDM "Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities" by satisfying the requirements of both section III(c)(ii) that soil organic matter has declined and topsoil litter and debris is scarce, and III(c) (iv) there is a reduction in plant cover due to land management practices. These declines have been caused by repeated plowing. Agricultural use was continuing prior to the project start, and would have continued in the absence of the project.
b. The project is not implemented on organic soils.
c. The project is implemented on lands that prior to the start of the project would be classified as croplands under IPCC guidelines.
d. Project lands are not defined as wetlands under IPCC guidelines.
e. Litter remains on the site and is not removed.
f. Plowing, ripping or scarification is done in accordance with conservation practices, is only done within the first five years of the initial site preparation of each parcel and is not repeated within 20 years.

B3. PROJECT BOUNDARIES

The project start date is January 1, 2008. Conforming to the *ACR Forest Carbon Project Standard version 2.1*, page 17, the project has a crediting period of 40 years. Thus, the end date of the project crediting period is December 31, 2047. If conditions and ACR rules allow, the project proponent will seek to renew the crediting period at the expiration of the current crediting period.

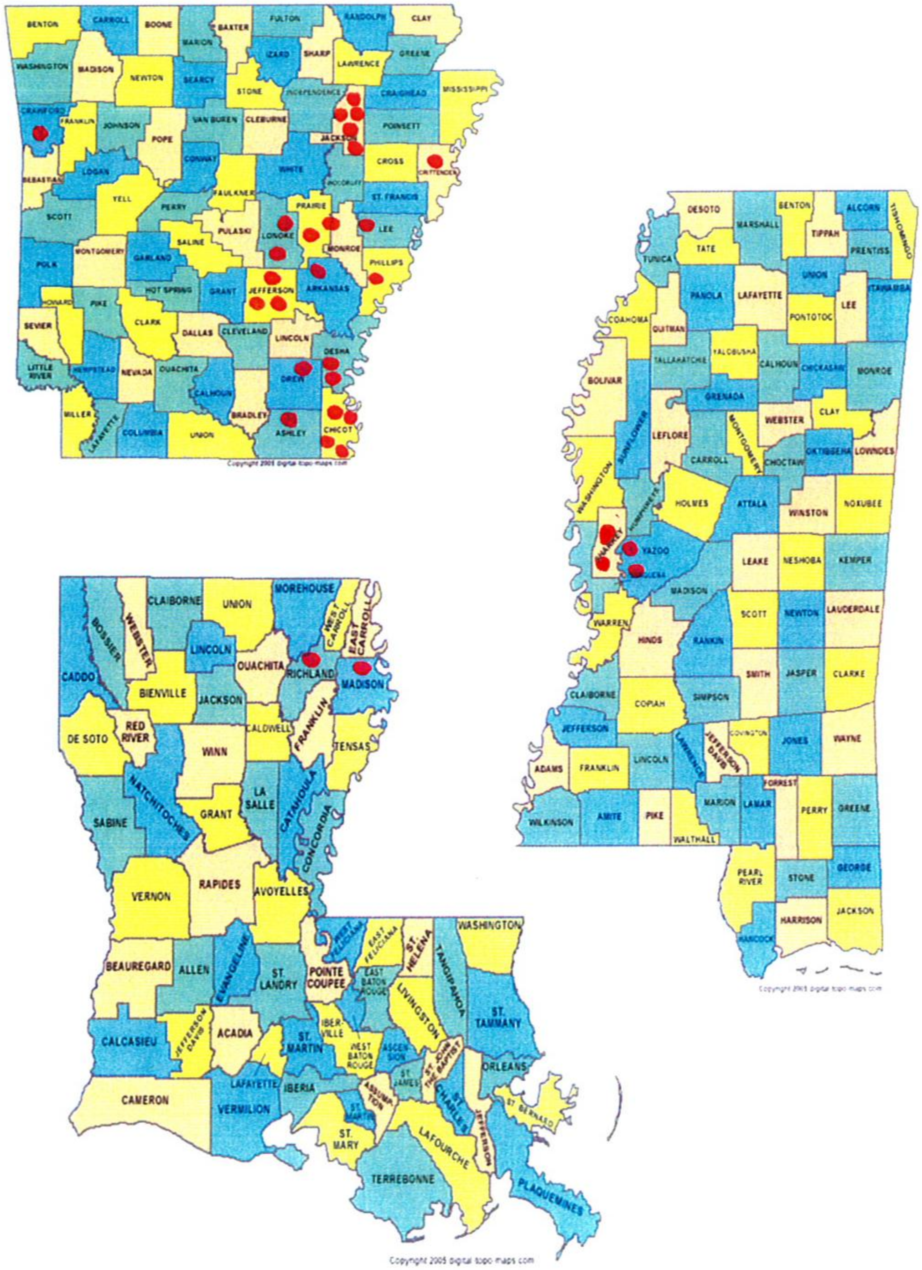
The project is physically located in the US Forest Service South Central and Southeast regions, primarily in the lower Mississippi Alluvial Valley. The project is programmatic and is continuing to enroll lands. As of July, 2011, the project has enrolled 6298.68 acres. The project seeks to enroll 50,000 acres by the end of 2013. Figure 1 is a map showing the locations of lands enrolled in the project as of July, 2011. Electronic files specifying the project property boundaries have been made available to the validator, verifier, and ACR.

The sources and sinks counted within the project boundary are described in the next section. Included sinks are aboveground woody biomass, belowground woody biomass, soil organic carbon, and harvested wood products. Initially, dead wood will not be counted but will be counted when the stock rises to a level that justifies the cost of measurements. Counting of dead wood will probably start at the time of the first harvests.

To meet ACR eligibility requirements, lands in AR projects must not have been cleared of forest since 1989. Each of the green trees sites is agricultural land that has been in cleared condition since 1989. In the process of enrolling the land the landowner is asked the question “How long has the land been cropped or when was this land cleared?” Only those lands that have been cleared since before 1990 are considered for GreenTrees enrollment. In working with USDA field personnel the green trees field forester enters into discussion about the cropping history of the lands being considered and this informal discussion will further confirm what the landowner has previously stated.

Further, to be eligible, lands must not be in forest at the time of enrollment. Currently, all of the lands in the GreenTrees program enroll in the Conservation Reserve Program jointly with GreenTrees enrollment. To enroll in CRP must have cropping history showing that the land was cropped at least four of the preceding six crop years. Also, GreenTrees staff traverse the lands to inspect their suitability for the project. These multiple checks ensure that the land is not in forest at the time of enrollment.

Figure 1. Map showing locations of project parcels by county.



B4. IDENTIFICATION OF GHG SOURCES AND SINKS

Following the ACR *Forest Carbon Project Standard version 2.1*, Chapter 2, "Accounting and Data Quality Principles," Section D, "Relevance and Completeness," and the ACR A/R methodology, the project elects to monitor aboveground biomass, and below-ground biomass.

Table 2. Pools monitored by the project.

Carbon pools	Accounted for	Justification / Explanation
Above-ground biomass	Yes	Major carbon pool subjected to project activity.
Below-ground biomass	Yes	A significant carbon pool expected to increase due to the implementation of the A/R project activity.
Dead wood	Initially No, later Yes	The baseline dead wood carbon stock is zero. Initially, the project will not monitor dead wood stocks because they will be trivially small and it is conservative to exclude them because dead wood carbon stocks will increase more in the project than in the baseline. After initial harvest, the project may begin monitoring standing dead wood. It is anticipated that the project will not monitor down dead wood.
Litter	No	This pool is declared to be insignificant by the ACR Forest Carbon Project Standard version 2.1. Also, it is conservative to exclude this pool because this pool can be conservatively expected to increase more under the project management than under the baseline. Under the baseline management of annual cropping, this pool declines to zero each spring. Under the baseline, but litter pool is expected to continuously have a positive carbon stock.
Soil organic carbon (SOC)	Yes	A significant carbon pool expected to increase due to the implementation of the A/R project activity and cessation of cropping.
Wood products	Yes	A significant carbon pool expected to increase relative to the baseline due to the implementation of the A/R project activity on lands formerly used for crops.

The project does not include burning of woody biomass as a project activity. Thus, it is conservative to exclude emissions from burning woody biomass. As stated by the methodology, if there is burning then CO_2 emissions from burning of biomass are accounted for in measurements of on-site carbon stocks and would appear decreases in carbon stocks relative to what those stocks would have been in the absence of burning.

B5. BASELINE

Following the ACR Forest Carbon Project Standard version 2.1, Chapter 6, Section 1, and following application of the CDM combines baseline/additionality tool, the baseline for the AR project is the carbon stock present shortly before site preparation. Below, application of the baseline guidance in the ACR Forest Carbon Project Standard is discussed, and then application of the CDM tool is described.

Prior to the start of the project, project lands were used to grow annual crops or used for pasture. There were no trees or other woody vegetation present on project lands in the decade immediately before the project start. The baseline is that project lands would have remained devoid of woody vegetation because of agricultural use.

Continuation of agricultural use does not violate any law or regulation. Indeed, agriculture continues from year to year on millions of acres in the region where the project is located, with agricultural activities on many of those acres supported by federal subsidy payments.

This baseline activity is continuation of the land use immediately prior to the project. The baseline was chosen as most appropriate for the project because, in the absence of the project, continuation of tillage for cropping or maintenance of pasture would prevent natural regeneration of trees. Planting of trees to convert the land use from agriculture to forestry would require significant capital investment. Also, conversion of land use to forestry would result in decrease in income for decades, as discussed in the Section C, addressing additionality.

Acceptable methods for determining the presence of cropping prior to the start of the project include:

- GreenTrees site visit
- Aerial photos that clearly show tillage;
- Crop insurance records for annual crops; and / or
- Crop incentive payment contracts tied to the individual fields.

Primarily the project is using crop records and aerial photos showing past tillage. These records are on file and made available to the verifier.

There are some pre-existing trees within the legal boundaries of land parcels enrolled in the project. These trees are mapped and excluded from the project area. Only actual cropping areas are included in project area counts.

The baseline assumes that soil carbon would have remained constant in the absence of the project. This assumption is conservative. Modeling of soil carbon stocks for earlier series of this project indicate that, under continuation of pre-project land uses, soil carbon stocks would continue to decline and generate emissions. This project does not claim offsets based on avoiding these baseline soil carbon emissions and makes the conservative assumption that soil carbon stocks would have remained constant under the baseline.

The CDM combined baseline/additionality tool specifies steps that result in selection of the baseline scenario. The first step in the tool is Step 0, preliminary screening. The project starts after 1999 and contracts with landowners show that revenues from expected sale of GHG offsets were a motivation to implement project activities.

Step 1 is identification of alternative scenarios. The credible alternative land use scenarios that are consistent with law and regulation, as identified in sub-step 1b, are continuing the pre-project agricultural uses, primarily cropping soybeans, cotton, corn, or pasture. As required by the tool, the project activity without offset revenues is included as an analyzed scenario. Sub-step 2a is to identify barriers blocking at least one of the alternatives specified in 1b. All scenarios comply with applicable laws and regulations. Thus the two analyzed scenarios are continuing the pre-project land use and implementing the project activity in the absence of offset revenues.

Step 2 is barrier analysis. In the absence of offset revenues, the project activity faces the barrier of providing below-market economic returns and is blocked (sub-step 2a) and eliminated from further consideration (sub-step 2b). The outcome of sub-step 2b is that the only remaining viable scenario is continuing the pre-project land use. This list contains only one scenario, so this scenario is determined to be the baseline scenario (sub-step 2c). Forestation without an offset project is not the selected scenario, so step 3 is skipped. Step 4 is the common practice test. Results of the common practice test are presented in section C2 of this document. The project activity is not common practice, thus the project is determined to be additional.

B6. PROJECT SCENARIO

The project converts lands from agricultural use to forest by contracting with landowners to establish and protect trees, and planting and managing trees. For Kyoto Protocol signatory countries, ACR uses the Kyoto Protocol definition of "forest." The U.S. signed the Kyoto Protocol but did not ratify or implement the agreement. Under the Protocol, countries choose a definition of forest, from an acceptable range of conditions, and this definition is promulgated by the country's Designated National Authority. The U.S. has not created a Designated National Authority so we use the U.S Forest Service definition of forest: a land area at least 120 feet wide, at least 1 acre in size, with at least 10% cover (or equivalent stocking) of live trees of any size, including land that formerly had such tree cover and that will be naturally or artificially regenerated. The project forests also will meet the most restrictive definition of forest under the Kyoto Protocol: areas of land at least 1 hectare (2.47 acres) in size, with at least 30% tree cover, of trees capable of growing to 5 meters (16.4 feet) in height.

The GreenTrees program only enrolls lands that are much larger than the minimum parcel size threshold and have productive capacity to support trees stocking and tree sizes well above the minimum thresholds of the forest definitions. Enrollment is limited to areas of at least 40 acres (16.2 hectares). Trees are planted to fully occupy the site. At maturity, the heights of the dominant trees will be typically more than 100 feet (30 meters) and some of the trees planted by the project that have had three growing seasons already exceed 23 feet (7 meters) in height.

Project staff independently map project lands by traversing the boundary of the area after planting and recording the boundary line with a GPS receiver. This mapping is done even if there is a Farm Service Agency (FSA) map of the field with a FSA contract area. Planting boundaries may not match FSA boundaries because of exclusions of areas too wet to grow trees, pre-existing woody vegetation, exclusion of roads, or other reasons.

The central project activity is planting trees and establishing a forest on land that was previously in agricultural use. The typical project tree planting spacing is 302 cottonwoods per acre interspersed with 302 native hardwood seedlings. 302 trees per acre is about twelve-foot spacing. Decades of agriculture have left many of the soils in the region with a hardpan layer just below plow depth. This hard layer inhibits draining and inhibits root penetration of the soil. Typical site preparation activity is to clear existing weeds and vines that compete with tree seedlings, and rip vertical slices into the soil to a depth of at least 20". Slices are ripped 12' apart, and then a second set of lines is cut perpendicular to the first, resulting in lines making a 12' by 12' square grid. The typical planting pattern is to plant native hardwoods at the intersection of ripped lines, resulting in 12’ by 12’ spacing. Then, along one set of ripped lines (often the north-south set) a cottonwood is planted at approximately the mid-point between consecutive hardwoods. Hardwood planting stock is rooted seedlings. Cottonwood planting stock is sticks cut from the project tree nursery.

Landowners have the right but not the obligation to harvest 1/3rd of the cottonwoods at years 10, ½ of the cottonwoods at year 17 and the remaining balance at year 25. Landowners retain the right but not the obligation to harvest down to 100 square feet of basal area of the planted hardwoods in year 35, 45 and 55. All projections of carbon assume that the landowner exercises 100% of his or her harvesting rights.

B7. REDUCTIONS AND ENHANCED REMOVALS

The project enhances removals of CO_2 from the atmosphere by establishing and growing trees where trees would not have grown in the absence of the project. Although emissions from baseline activities are reduced on project lands, the project does not claim offsets based on reducing baseline emissions and makes the conservative assumption that the baseline change in stocks and emissions is zero.

B8. PERMANENCE

Potential causes of unintentional reversals of project carbon sequestration are tree death from wildfire, disease, drought, or wind. Each issue is addressed here and the risk buffer withholding proportion is calculated using the required tool. The required tool is the most recent version of the VCS AFOLU Non-Permanence Risk Tool, v3.0, issued March 2011.

Note that for each sub-total in the risk rating, the cumulative score may not be less than zero.

The project has very strong professional management which gives it low project management risk. Project staff have years of experience in forestry and GHG offsets and are located within one day of travel time of project sites. The project has essentially no staff turnover. The planting regime is tested in both research and commercial settings, and matches the physiological attributes of the species being planted. The species being planted are native hardwoods, plus native cottonwoods that provide nurse trees that facilitate establishment and growth of the hardwoods that will provide the long term forest and carbon stock.

Table 1. Project Management	
0	a. More than 20% of carbon stocks are in non-native species of from other agro-ecological zones
0	b. Ongoing enforcement is required to protect more than 50% of carbon stocks on which previously issued credits are based
0	c. Management team lacks necessary skills or has less than 5 years experience
0	d. Management team does not have presence within one day of travel time from project
-2	e. Management team includes individuals with significant AFOLU project design, implementation, validation, and verification experience
-2	f. Adaptive management plan in place
0	**Project management sub-total**

The project is financially viable if no more acres are planted and is anticipating breakeven within four years. Most of project costs occur within a two year time window before and after project planting. The project has capital from investors that is used to operate a nursery that grows planting stock and provides signing payments to landowners. A significant fraction of planting cost is covered by federal cost share payments. If, for some reason, the project were not to have sufficient capital to implement plantings at the scheduled rate, the rate of planting could be slowed without threatening the financial viability of the project.

Table 2. Financial Viability	
0	a. Project cash flow breakeven point is more than ten years from current risk assessment
0	b. Project cash flow breakeven is 7-10 years
0	c. Project cash flown breakeven is 4-7 years
0	d. Project cash flow breakeven is less than 4 years
0	e. Project has secured less than 15% of cash needed before breakeven
0	f. Project has secured 15-40% of cash needed to breakeven
0	g. Project has secured 40-80% of cash needed to breakeven
0	h. Project has secured more than 80% of cash needed to breakeven
0	i. Project has callable financial resources at least 50% of total cash out before breakeven
0	**Financial viability sub-total**

Unlike most lands in the U.S. that are physically suitable for growing trees, lands enrolled in the GreenTrees project have a modest range of alternative non-forest uses, thus have modest opportunity costs that have to be overcome by offset revenues. Project lands are located in very rural areas and there is little demand for development. Further, the project seeks lands that are at risk of seasonal flooding, which makes the lands even less desirable for development. The lands are suitable for growing crops, and most commonly are in soybean production prior to the project, which has an NPV of 20-50% more than forestry without offset revenues. As discussed in Section C3, soybeans provide modest revenues. Lands enrolled in GreenTrees tend to be at risk of winter and spring flooding, which can prevent the planting of more profitable crops of corn or early soybeans, reducing the opportunity costs (the trees planted by the project are species that naturally occur on floodplains and are adapted to flooding). Also, converting the land to non-forest use would require removing tree stumps, and revenues from crops are not sufficient provide a positive economic return on the thousands of dollars per acre it costs to remove stumps and roots and smooth the soil for cropping.

The project includes timber harvesting, which significantly contributes to the financial return of the project activity, lessening the NPV contribution required of offset revenues. Also, in the lower Mississippi, forests are valued for hunting, either for hunting lease revenues, or as an environmental service used by the landowner.

The GreenTrees contract stipulates that should a landowner opt out during the production period or intentionally does something to negatively impact the carbon during the period, GreenTrees will assess a 1.25 ton replacement for every 1 offset ton impacted by the withdrawal. Replacement offsets must be of the similar utility and kind, or replacement paid for at whatever the current market rate is for afforestation offsets. This penalty further reduces the landowner's potential value of alternative non-forestry land uses.

Table 3. Opportunity Cost	
0	a. NPV of most profitable alternative land use expected to be at least 100% more than project
0	b. NPV of most profitable alternative land use expected to be 50-100% more than project
4	c. NPV of most profitable alternative land use expected to be 20-50% more than project
0	d. NPV of most profitable alternative land use expected to be within 20% of project NPV
0	e. NPV of most profitable alternative land use expected to be 20-50% less than project
0	f. NPV of most profitable alternative land use expected to be more than 50% less than project
0	g. Project proponent is a non-profit organization
0	h. Project protected by legally binding commitment to continue management practices protecting crediting carbon stocks through project crediting period
0	i. Project protected by legally binding commitment to continue management practices protecting crediting carbon stocks for at least 100 years
4	**Opportunity cost sub-total**

The project is designed to have incentives to keep project lands permanently in forest. The project is only planning to claim carbon credits on the first 15 years of growth after planting, so that if landowners do commercial forest harvesting in the future, the net carbon stocks under forestry should remain at least the amount counted as offsets. As a result, future commercial harvesting will not reverse issued offsets. However, some offsets are only guaranteed by GreenTrees for only 40 years, without further contractual obligations requiring landowners to keep lands in forests. GreenTrees expects that by 2050 there will be broad regulatory requirements that will keep the GreenTrees carbon stored indefinitely (or require accounting of emissions), assuring protection of the atmosphere. However, the risk rating tool makes no assumptions that further protections will be enacted in the coming several decades and the risk rating tool requires a 16% withholding because of the 40 year project life. Some project lands have legal commitments recorded with the property that require the retention of forest for 70 years. If all project lands had this 70 year commitment, the project longevity risk rating would be 10%.

Table 4. Project Longevity	
16	a. Without legal agreement to continue practice: = 24 - (Project Life/5) = 24 –(40/5) = 16
0	b. With legal agreement to continue practice: = 30 - (Project Life/2)
16	**Project longevity sub-total**

As shown in risk Table 5, the sum of internal risks is 20%.

Table 5. Total Internal Risk	
20	Sum of internal risks

Project lands are located in the US where land ownership is rarely disputed. Ownership and use rights are held by the same entity. As a consequence of these factors, the project gets a 0% withholding for land tenure risk.

Table 6. Land Tenure	
0	a. Ownership and resource access/use rights held by same entity
0	b. Ownership and resource access/use rights held by different entities
0	c. Land tenure disputes exist in more than 5% of the project area
0	d. Access/use disputes exist
0	e. Lands protected by legally binding commitment to continue management practices for project crediting period
0	f. Where tenure or use disputes exist, project has implemented activities to resolve disputes
0	**Land tenure sub-total**

Unlike projects implemented in developing countries, where large numbers of people may be using project lands for subsistence purposes, or may have use claims to lands, this project is located in the US. Although the owners of project lands do not physically live within the project boundary (project boundaries exclude developed areas, such as residences, barns, etc.), landowners were considered to be "living" within the project area for the purposes of this element of the risk analysis. All landowners were consulted. In fact, all landowners signed contracts to join the project. The project is designed to perpetually provide stable income from and work on project lands, giving it a negative risk score. However the tool does not allow scores less than zero for any section sub-total so the project gets a 0 risk rating for community engagement.

Table 7. Community Engagement	
0	a. Less than 50% of the households living within the project area who are reliant on the project area have been consulted
0	b. Less than 20% of the households living with 20 km of the project boundary outside project area and who are reliant on the project area have been consulted
-5	c. Project generates net positive impacts on the social and economic wellbeing of local communities who derive livelihoods from the project area
0	**Community engagement sub-total**

Averaged for 2005 through 2009, the US gets a governance score of 0.85, calculated using the equations in the risk rating tool and scores from the World Bank "Worldwide Governance Indicators" website. The US has an established national FSC standards body so a -2 rating is given in risk element 8f.

Table 8. Political Risk	
0	a. Governance score less than -0.79
0	b. Governance score of -0.79 to less than -0.32
0	c. Governance socre of -0.32 to less than 0.19
0	d. Governance score of 0.19 to less than 0.82
0	e. Governance score of 0.82 or higher
-2	f. Country implementing activities listed in VCS risk analysis tool section 2.3.3.(2)
0	**Political risk sub-total**

As shown in risk Table 9, the sum of external risks is zero.

Table 9. Total External Risk	
0	**Sum of external risks**

The project faces very low natural risk. Project lands are moist and rarely dry enough to burn. Cumulatively, from 1991 through 2005, less than 0.1% of the Mississippi delta physiographic region (the region where project lands are located) forests burned.[1] Ignitions are frequent, but only a small area burns. Also, fires in Mississippi are correlated with pine forests and the project establishes hardwood forest. Even if a fire were to become ignited on project lands, it is highly unlikely that the fire would burn more than a few acres. Even an intense fire that kills all trees consumes only a fraction of the biomass. Tree boles, typically branches, and much of the roots, remain after fires. This dead wood then decomposes over time, as remaining live trees grow. This project is claiming no sequestration in the forest floor, so any loss of forest floor carbon would not negate offsets issued to the project. Also, project lands are geographically dispersed. Even if a wildfire were to occur within project lands, it would not spread across non-contiguous ownerships and growth on unburned acres would most likely more than offset any possible losses from wildfire. Therefore, no net wildfire loss is anticipated. Fire is such a low risk that the project is not implementing significant firefighting measures, so the project gets a fire risk of loss of zero but mitigation score of 1.

Disease is not a major factor in Mississippi forests. Research for this project revealed concerns about Southern Pine Beetle, Laurel Wilt Disease, and Redbay Ambrosia Beetle, but disease and pests appear to be minor enough that mortality is not regularly surveyed. For example, review of the Mississippi Forestry Commission forest health web pages did not review any quantification of the extent of tree mortality from disease. Also, the tree species most at risk are not planted on project lands. No loss is anticipated, beyond what is built into net growth projections based on growth of existing forests. Disease losses on other similar forests support assigning a zero risk for disease loss. The project plants biodiverse and pest/disease resistant species so it earns a pest/disease mitigation score of 0.5.

Wind disturbance also appears to be only a modest hazard to project forests. The 2009 Forest Service forest inventory report states that despite significant damage to trees in Mississippi caused by Hurricane Katrina in 2005, Mississippi's total tree volume increased by 25 percent from the inventory conducted in 1994 to the 2006 inventory.[2] Despite being miles from the Gulf Coast, major wind disturbance events conceivably could occur as frequently as every 10-25 years. However, because project lands are geographically dispersed and because wind disturbance often damages trees (which can cause major reductions in timber value of the damaged trees) but growth of damaged and undamaged trees in the forest typically continues. As a result, even with a loss of live tree standing stock there is likely to be little or no decrease in on-site carbon stocks and wind disturbance is judged to have a transient loss. Full recovery is expected within 10 years and this risk is rated "insignificant." Geographic dispersal of project lands mitigates wind loss risk. Note that particular ownership would have to experience very large wind losses for the net sequestration of the entire project to decline.

[1] Grala, Katarzyna, and William H. Cooke. 2010. "Spatial and temporal characteristics of wildfires in Mississippi, USA." *International Journal of Wildland Fire*. 19:14-28.
[2] Ibid.

Drought is becoming more of an issue as the global climate changes, and weather becomes more variable. A recent U.S. Forest Service analysis finds that Mississippi forests are growing.[3] The project forests should be more protected from drought than most other forests because the project focuses on bottomlands, which tend to have the water table within reach of tree roots. Flooding is common on project lands and, once established, planted species are very tolerant of flooding. If extensive flooding occurs during the year of planting, growth is delayed but there is no reversal of sequestration and the risk of drought and flood loss is insignificant. Species selection mitigates flood risk and site selection mitigates drought risk.

There is no known geological risk in the region so the project gets a “no loss” rating for geological risk. With no risk, there is no mitigation, and the project gets a mitigation score of 1 for geological risk. Similarly, no other natural risks are anticipated so the project gets an “other natural risk” rating of zero for loss and 1 for not mitigating unforeseen risks.

The sum of these natural risk scores is 0.5%.

Table 10. Natural Risks			
Score (Loss times Mitigation)	**Loss (LS)**	**Mitigation (M)**	
0	0	1	Fire
0	0	0.5	Pest and disease
0.5	1	0.5	Extreme weather
0	0	1	Geological
0	0	1	Other natural risk
0.5	**Natural Risk Total**		

The sum of all risk score subtotals is 20.5% and the project is assigned a 20.5% buffer withholding rate.

TOTAL RISK	
20.5	**Sum of Internal, External, and Natural Risk Totals**

[3] USDA Forest Service, Southern Research Station. 2009. *Mississippi’s Forests, 2006.* http://www.srs.fs.usda.gov/pubs/rb/rb_srs147.pdf.

C.
ADDITIONALITY

The project additionality analysis conforms both to the ACR three-part additionality test and to the CDM A/R Methodological tool “Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities” version 01, as used in *ACR Methodology for Afforestation and Reforestation of Degraded Land*, Version 1.0, March 2011. The project passes the Step 0 preliminary screening that the project start date is allowed.

C1. REGULATORY SURPLUS TEST

Discussion with federal land management agencies, consulting foresters, landowners, and investigation by GreenTrees legal counsel has revealed no law or regulation requiring afforestation of agricultural lands in the region. Per CDM tool step 1b, the project activity and possible alternative land uses are not required by law or regulation. The landowner shall attest that there is no law, regulation, or contract in effect at the time the landowner signs a letter of intent or contract with GreenTrees that requires or commits the landowner to afforesting the project lands. That the project activity is not legally required is an applicability requirement of the CDM additionality tool.

C2. COMMON PRACTICE TEST

Following the CDM tool step 1a, the only credible alternative scenarios identified are (1) the project activity and (2) continuing the prior agricultural land uses. Following CDM tool step 4, conversion of agricultural lands to forest is not common practice in the project area. Examination of land cover change measurements made by the Natural Resources Conservation Service as reported in the National Resources Inventory, show that rates of conversion of crop land to forest in the GreenTrees project are, the five-year rates of conversion, averaged over 15 years, range from 0.08% to 0.84% of the cropland being converted to forest.[4] The lower of these rates is for the Mississippi Valley Aluvium major land resource area, the core of the project region. With compounding these rates reflect annual conversion rates of 0.016% to 0.17% per year.

C3. IMPLEMENTATION BARRIERS TEST

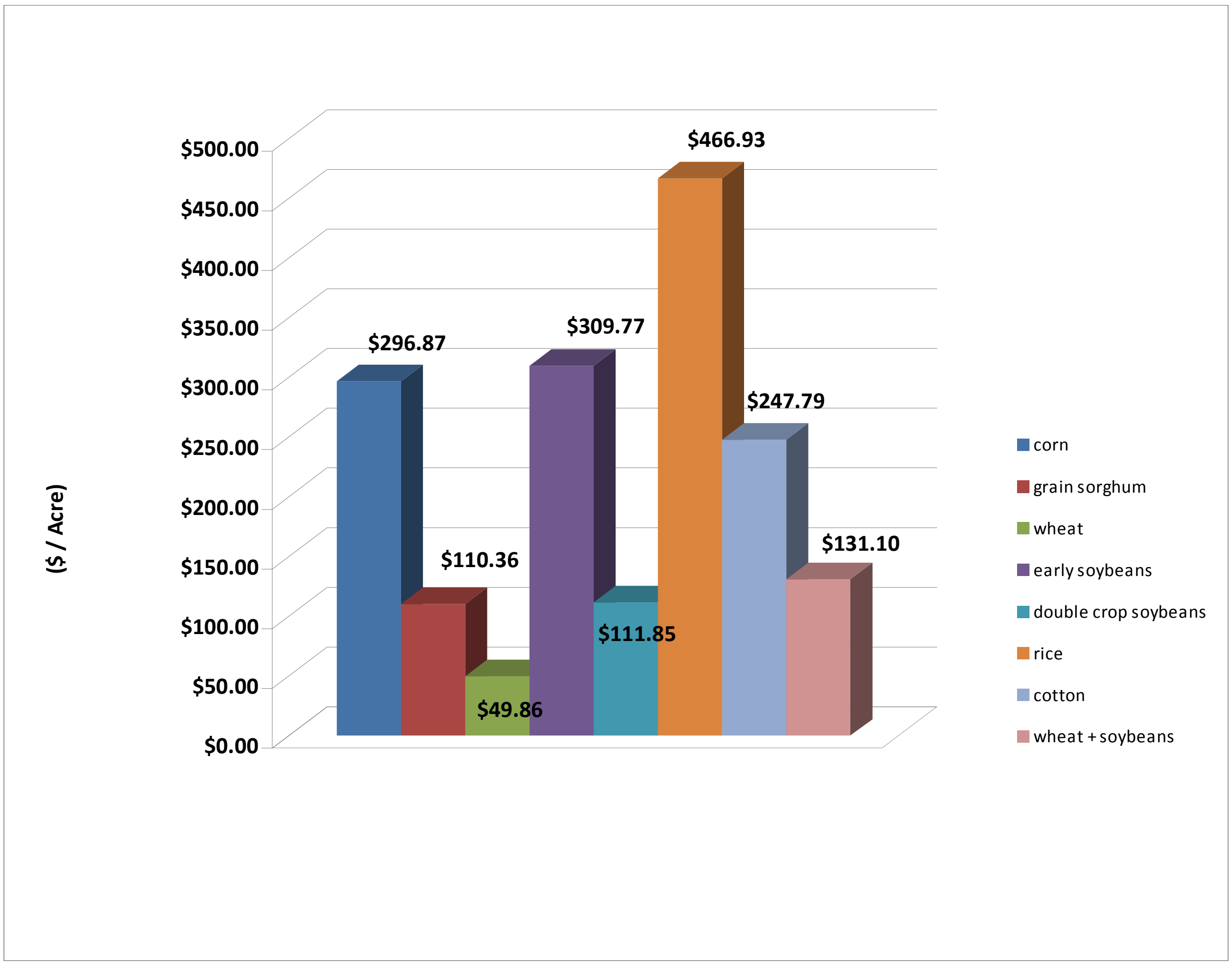
The project uses ACR option II, investment comparison analysis, to show the implementation barrier to the project activity. Under this test, the Project Developer must demonstrate that without carbon finance, the project would not have gone forward or would have had a below market rate of return on investment. Per step 2a of CDM tool, the barrier to the project activity is that it provides a lower financial return than growing corn, cotton, or soybeans, or using the land as pasture which are the possible alternative land uses. Financial additionality can be demonstrated with reference and documenting showing land-use as rotated crops and related commodity pricing. Specifically, in Arkansas the University of Arkansas Division of Agriculture Cooperative Extension Service crop budgets[5] for 2009 calculate typical net returns to soybeans and cotton (the two crops most frequently grown on lands prior to GreenTrees enrollment) of $309.77 and $247.79 per acre, respectively, excluding crop subsidy payments. In contrast, over the life of a GreenTrees forest restoration project, the average annual

[4] Rates calculated from National Resources Inventory data for each Major Land Resources Area by the US EPA Climate Leaders RAPCOE tool, available on line at: http://ecoserver.env.duke.edu/RAPCOEv1/.

[5] Downloaded from http://www.uaex.edu/depts/ag_economics/default.htm.

landowner revenue, excluding carbon payments but including federal cost share payments (federal payments should be added to the University of Arkansas crop budgets to calculate total return to the landowner), is $102.33 per acre. This amount includes wood product revenues, including pulp wood in early years and saw logs in later years. The returns form forestry are substantially less than the typical financial returns from cropping. This document updates the previously approved GreenTrees Monitoring Reporting and Verification Protocol, and retains the validated numbers from that original document. If the analysis were to be done with current crop prices, the use with the highest financial return would be corn, and cotton and soybeans would continue to give higher returns than the project activity. Thus, per project steps 2b and 2c, the credible land uses are not blocked by any barrier and Step 3b investment analysis shows that in the absence of carbon finance the project activity provides a lower financial return than the pre-project land uses and is additional and the baseline is valid.

Figure 2. Financial returns of alternative land uses, present value of cumulative return per acre.



Source: H. Scott Stiles. 2008. *Planning Budgets for Arkansas Row Crops.* http://www.uaex.edu/depts/ag_economics/default.htm. Little Rock, AK: University of Arkansas, Division of Agriculture, Cooperative Extension Service.

C4. PERFORMANCE STANDARD TEST

This project does not use a performance standard test.

D.
MONITORING PLAN

GreenTrees uses a rigorous monitoring system to accurately measure changes in project carbon stocks.

The monitoring system begins with the specification of the boundaries of project lands and uses periodic sampling of trees to quantify carbon stocks at multiple times through the project life. If part of a parcel or planting area is removed from the project, the remaining parcel or forest area boundary will be re-mapped. If an entire parcel is removed from the project, it is not necessary to re-measure that parcel.

Project land parcel boundaries are unambiguously specified and recorded in government land ownership registries. Project planting area boundaries are mapped using a GPS receiver. Often planting areas are less than entire legal parcel. Areas are excluded from the project if they have pre-existing trees or if they are expected to remain non-forest, such as water bodies and built sites. Shape files and paper maps are included in the project files and archive. Shape files geolocating project lands boundaries are on file in the project database and can be made available to ACR and the verifier.

Plots center locations are randomly assigned in advance using a GIS program. GPS is used to navigate to the assigned plot center. Alternatively, a grid pattern can be used, with the spacing assigned in advance, and a random start used to locate the grid within a planting block. Project staff will use the variability of prior plot measurements to estimate the number of plots needed to achieve a level of sampling precision where there will be no uncertainty deduction at the threshold specified by the *ACR Forest Carbon Project Standard version 2.1*. This number of plots will be assigned and measured. If more plots are needed to avoid an uncertainty deduction, the project may measure more plots or may accept the uncertainty deduction.

The project monitors site conditions and measures the numbers, sizes and species of trees. For efficiency, trees of different sizes are measured differently. The main bifurcation in monitoring is measuring sites where most trees are less than 4.5” DBH and sites where most dominant and co-dominant trees are 4.5” DBH or larger.

In stands expected to have most of the trees less than 1” DBH, 1/100 acre circular plots (11.78 foot radius, horizontal distance) will be used. In stands where most of the dominant and co-dominant trees are expected to have a DBH between 1.0” and 4.5”, 1/50 acre circular plots (16.65 foot radius, horizontal distance) will be used. It is anticipated that in stands where the DBH of most dominant and co-dominant trees is greater than 4.5” that variable radius prism plots will be used. Prism plots may be combined with fixed area plots for measuring trees below a specified diameter, or fixed area plots may be used for larger trees.

Trees with DBH less than 1.0 inches will have the basal diameter measured and recorded. Trees with DBH of 1.0 inches or more will have DBH measured and recorded. All trees in the plot will have height measured and recorded, and species identified and recorded.

In stands where most dominant and co-dominant trees are expected to have DBH of at least 4.5”, trees can be measured using standard timber inventory techniques utilizing prism plots and 1” diameter size classes. A single prism factor will be used for all plots in an individual stratum. The prism factor shall result in an average of at least five trees per plot being measured, except the minimum prism factor shall be 5 square feet of basal area per acre and the maximum prism factor shall be 20 square feet of basal area per acre. The prism factor or implied plot diameter is to be recorded with each tree record. Alternatively, the project may choose to use fixed area plots (including nested fixed area plots of different sizes, with larger plots used to measure larger trees). Height and species of each tree will be measured and recorded. Height is measured as the length of the main stem of the tree; if the tree trunk is significantly off vertical the measured height may be greater than the height of the highest vegetation above the ground.

Diameter will be measured to the nearest 0.1 inch. Height will be measured to the nearest half foot for trees up to 16' tall. For trees taller than 16', height will be measured to the nearest foot.

All stands will be measured using ground based monitoring after the first growing season (after planting, or after enrollment in the project if the stands are enrolled after the year when they are planted). For the first three years of the project, all stands will be measured using ground-based measurements as described here. After the first three years, the project growth model will be calibrated using observed growth, and ground-based measurements may be reduced in frequency to once every five years (with the exception that all stands will be measured at least once within one year of planting or enrollment, whichever comes later). Modeling is acceptable for projecting carbon stocks, sequestration, and offsets for years between field measurements, as long as observations by the landowner and project staff discern no significant tree mortality or failure to grow as projected.

Initially, no dead trees will be measured. As discussed in Section B4, it is conservative to omit measurement of dead trees because the baseline dead wood stock is zero. If the project monitors dead trees, all standing dead trees that would be measured if they were alive will be measured. Dead trees with roots in the ground, and with the main axis of its main trunk angled within 45 degrees of vertical shall be classified as standing dead. Dead trees that do not meet the criteria of standing dead shall be considered woody debris and are not measured. Live plot trees are measured regardless of the orientation of the main stem of the tree.

All data is stored and archived until at least two years after the end of the project life. Data is archived in the C2I data archive and backup system, including offset backup. Copies of data are archived by partners that analyze the data.

D1. MONITORED DATA AND PARAMETERS

Data or Parameter Monitored	*Acres*
Unit of Measurement	*Acres*
Description	*Area of an individual tract*
Data Source	*GIS*
Measurement Methodology	*GPS survey of tract boundaries by project staff*
Data Uncertainty	*<1%*
Monitoring Frequency	*Once*
Reporting Procedure	*Tallied in database reports or downloaded to spreadsheet and tallied*
QA/QC Procedure	*Compare to legal survey acres and FSA acres*

Notes	

Data or Parameter Monitored	*County*
Unit of Measurement	*n/a*
Description	*Name of county in which tract is located*
Data Source	*Land title, map, or landowner*
Measurement Methodology	*n/a*
Data Uncertainty	*None*
Monitoring Frequency	*Once*
Reporting Procedure	*n/a*
QA/QC Procedure	*Compare to land title*
Notes	

Data or Parameter Monitored	*Day of measurement*
Unit of Measurement	*Day*
Description	*Number, permissible values 1-31*
Data Source	*Field technician*
Measurement Methodology	*n/a*
Data Uncertainty	*n/a*
Monitoring Frequency	*n/a*
Reporting Procedure	*Recorded with plot data*
QA/QC Procedure	*n/a*
Notes	*Day that a particular plot measurement is made*

Data or Parameter Monitored	*DBA*
Unit of Measurement	*Inches, tenths of inches*
Description	*Diameter, basal: Diameter of tree as close to ground level as can be measured yet above any root crown swelling*
Data Source	*Field technician*
Measurement Methodology	*Measured with caliper*
Data Uncertainty	*+/- 0.2”*
Monitoring Frequency	*Once per monitoring period*
Reporting Procedure	*Recorded with plot data*
QA/QC Procedure	*Value range validity checking; check cruise*
Notes	*Also called DRC, for diameter at root collar. Only measured on trees with DBH < 1” and dead trees less than 4.5’ tall*

Data or Parameter Monitored	*DBH*
Unit of Measurement	*Inches, tenths of inches*
Description	*Diameter at breast height: Diameter of tree at 4.5’ above the ground surface*

Data Source	*Field technician*
Measurement Methodology	*Measured with caliper, diameter tape, or laser*
Data Uncertainty	*+/- 0.5”*
Monitoring Frequency	*Once per monitoring period*
Reporting Procedure	*Recorded with plot data*
QA/QC Procedure	*Value range validity checking; check cruise*
Notes	*Only measured on trees with DBH >= 1”*

Data or Parameter Monitored	*Decomposition class*
Unit of Measurement	*Numeric*
Description	*Decomposition condition of dead trees, number scale defined in quantification section E5.*
Data Source	*Field technician*
Measurement Methodology	*Observed*
Data Uncertainty	*1 class*
Monitoring Frequency	*Once per monitoring period*
Reporting Procedure	*Recorded with plot data*
QA/QC Procedure	*Value range validity checking; check cruise*
Notes	*Live trees may have no decomposition class or be recorded as class 0 or L.*

Data or Parameter Monitored	*Height*
Unit of Measurement	*Feet, half feet*
Description	*Height of tree from ground to end of growth leader, measured as length of stem*
Data Source	*Field technician*
Measurement Methodology	*Measurement pole (small trees only), clinometer, or laser tool*
Data Uncertainty	*+/-3%*
Monitoring Frequency	*Once per monitoring period*
Reporting Procedure	*Recorded with plot data*
QA/QC Procedure	*Value range validity checking; check cruise*
Notes	

Data or Parameter Monitored	*Month of measurement*
Unit of Measurement	*Month*
Description	*Number, permissible values 1-12*
Data Source	*Field technician*
Measurement Methodology	*n/a*
Data Uncertainty	*n/a*
Monitoring Frequency	*n/a*
Reporting Procedure	*Recorded with plot data*
QA/QC Procedure	*n/a*
Notes	*Month that a particular plot measurement is made*

Data or Parameter Monitored	*Planting year*
Unit of Measurement	*Year*
Description	*Number, permissible values 2008-2037*
Data Source	*Project manager*
Measurement Methodology	*n/a*
Data Uncertainty	*n/a*
Monitoring Frequency	*Once per planting, typically once per tract*
Reporting Procedure	*n/a*
QA/QC Procedure	*Inspection of reports*
Notes	

Data or Parameter Monitored	*Plot number*
Unit of Measurement	*Number*
Description	*Positive integer, unique within tract*
Data Source	*Assigned by field technician or data recording software*
Measurement Methodology	*n/a*
Data Uncertainty	*n/a*
Monitoring Frequency	*Once per plot*
Reporting Procedure	*n/a*
QA/QC Procedure	*Data set searched for duplicates*
Notes	

Data or Parameter Monitored	*Plot size*
Unit of Measurement	*Acres*
Description	*Area of plot*
Data Source	*Assigned by project manager*
Measurement Methodology	*Horizontal distance measured from plot center, measured using a tape*
Data Uncertainty	*+/- 1"*
Monitoring Frequency	*Once per plot*
Reporting Procedure	*Recorded in plot data*
QA/QC Procedure	*Check cruise*
Notes	*Used only for surveys where most dominant trees are less than 4.5" DBH*

Data or Parameter Monitored	*Prism factor*
Unit of Measurement	*Square feet per acre*
Description	*Factor describing the prism angle, such that tallied trees each represent the prism factor of basal area; only one prism factor is allowed for any single tract*
Data Source	*Prism manufacturer*

Measurement Methodology	*Seen prism calibration procedures in a forest measurement handbook*
Data Uncertainty	*< 1%*
Monitoring Frequency	*n/a*
Reporting Procedure	*Recorded with data for each plot*
QA/QC Procedure	*Calibrate once per prism, annually calibrate devices, and calibrated devices after significant shock*
Notes	*Used in point sampling of stands with dominant trees of 4.5" DBH or greater; each tree tallied will represent the prism factor; for example with a prism factor of 10 square feet per acre each tree tallied will represent 10 square feet per acre of basal area*

Data or Parameter Monitored	*Series*
Unit of Measurement	*Number or letter, or combination*
Description	*Legal grouping that a tract is part of*
Data Source	*Assigned by contract between landowner and proejct*
Measurement Methodology	*n/a*
Data Uncertainty	*n/a*
Monitoring Frequency	*n/a*
Reporting Procedure	*Recorded for each tract in project database*
QA/QC Procedure	*Inspection*
Notes	*Typically a series encompasses only a single planting vintage; there may be more than one series per planting year*

Data or Parameter Monitored	*Species*
Unit of Measurement	*Name or species code*
Description	*Species or species group of tree*
Data Source	*Identified by field technician*
Measurement Methodology	*Tree identification*
Data Uncertainty	*No error allowed*
Monitoring Frequency	*Once per plot*
Reporting Procedure	*Recorded in plot data*
QA/QC Procedure	*Check cruise*
Notes	

Data or Parameter Monitored	*State*
Unit of Measurement	*Name*
Description	*Name of state in which tract is located*
Data Source	*Land owner, project manager or land title*

Measurement Methodology	*n/a*
Data Uncertainty	*None*
Monitoring Frequency	*Once*
Reporting Procedure	*Recorded in project database*
QA/QC Procedure	*Inspection*
Notes	

Data or Parameter Monitored	*Top diameter*
Unit of Measurement	*Inches, tenths of inches*
Description	*Diameter of main stem at top of tree*
Data Source	*Field technician*
Measurement Methodology	*Measured with laser, Relascop, or estimated*
Data Uncertainty	*+/- 1"*
Monitoring Frequency	*Once per monitoring period*
Reporting Procedure	*Recorded with plot data*
QA/QC Procedure	*Value range validity checking; check cruise*
Notes	*Only measured on dead trees. Assumed to be zero if not recorded.*

Data or Parameter Monitored	*Tract ID*
Unit of Measurement	*Alphanumeric*
Description	*Unique identifier for each tract*
Data Source	*Assigned by project staff*
Measurement Methodology	*n/a*
Data Uncertainty	*n/a*
Monitoring Frequency	*n/a*
Reporting Procedure	*Recorded in project database*
QA/QC Procedure	*n/a*
Notes	

Data or Parameter Monitored	*Tract name*
Unit of Measurement	*Name*
Description	*Name of owner of tract; may be abbreviated*
Data Source	*Assigned by project manager*
Measurement Methodology	*n/a*
Data Uncertainty	*n/a*
Monitoring Frequency	*Once*
Reporting Procedure	*n/a*
QA/QC Procedure	*n/a*
Notes	

Data or Parameter Monitored	*Tree number*
Unit of Measurement	*Number*

Description	*Integer*
Data Source	*Assigned by field technician*
Measurement Methodology	*Starting at 1 on each plot, numbers are assigned sequentially as trees are located.*
Data Uncertainty	*n/a*
Monitoring Frequency	*Once*
Reporting Procedure	*Recorded with plot data*
QA/QC Procedure	*Check cruise*
Notes	

Data or Parameter Monitored	*Year of measurement*
Unit of Measurement	*Number*
Description	*Year in which a particular plot measurement is made*
Data Source	*Recorded by field technician or date stamp by data recorder*
Measurement Methodology	*n/a*
Data Uncertainty	*none*
Monitoring Frequency	*Once*
Reporting Procedure	*Recorded with plot data*
QA/QC Procedure	*Inspection*
Notes	

E.
QUANTIFICATION

E1. BASELINE

Following *ACR Forest Carbon Project Standard version 2.1*, section 6.A, the baseline carbon stocks are taken as unchanging over time. The baseline is continuation of the pre-project agricultural uses, and no woody biomass would grow. Modeling indicates that, under pre-project land uses, net soil carbon was declining. Instead of claiming a decline, the project makes the conservative assumption that baseline soil carbon stocks do not change over time.

E2. PROJECT SCENARIO

Carbon stock and emission mitigation calculations conform to "Guidlines on conservative choice and application of default data in estimation of the net anthropogenic GHG removals by sinks".

See the monitoring chapter above for descriptions of how data will be collected from project lands. Equations for calculating sequestration and offsets from data are given below. Biomass carbon stocks and sequestration are calculated from data collected using the described ground-based measurement methods. Between times when ground-based measurements are made, sequestration is calculated by extrapolating from the most recent measurements using the project growth model, and adjusting for any harvests or other mortality that have occurred since the most recent measurement. Soil carbon sequestration is calculated using the CDM A/R Methodological Tool: *Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities*, version 01, EB 55, Report Annex 21.

E3. LEAKAGE

The *ACR Forest Carbon Project Standard version 2.1*, Chapter 6, section D states that AR projects do not generally need to account for market leakage. There is considerable year-to-year fluctuation in the areas planted to different crops and no market leakage is attributed to this project, and the project follows the guidance for typical AR projects. Unless some leakage is suspected and can be quantified, leakage is calculated to be zero.

ACR also requires that activity shifting leakage be addressed. Activity shifting leakage is when a landowner shifts the pre-project activity to a new location outside the project boundary, displacing emissions from inside the project boundary to outside the project boundary. Types of possible leakage that could occur as a result of this project include intensification of agriculture elsewhere, and conversion of other forested lands to crops (replacing a portion of the croplands converted to forest by the project).

This project makes no claims that agricultural emissions are reduced. As a result, if intensification of agriculture on other cropped acres increases the per-acre emissions by condensing agricultural production onto fewer acres, and aggregate agricultural emissions remain constant, there is no leakage to be counted because the project makes no claim that agricultural emissions are reduced.

GreenTrees uses four approaches to address the risk that activity shifting could shift agriculture to other lands owned by landowners participating in the project. First, landowners grow crops to provide revenue and the GreenTrees provides alternative revenue. Second, it is expensive to clear trees to make crop land and the returns from cropping do not pay for the cost of stump removal. Third, GreenTrees seeks landowners who are interested in providing forest habitat, thus disinclined to remove forest elsewhere. Fourth, GreenTrees visits all sites at least annually. Forest clearing is very obvious, and if it were to occur, GreenTrees would see it and account for it.

Harvested wood produced by the project could displace wood harvest elsewhere thus increasing sequestration elsewhere. Displacement of wood harvesting elsewhere is called positive leakage and positive leakage is not creditable as an offset, and is not counted in GreenTrees accounting. However these benefits would show up in the U.S. national GHG inventory. Another example of possible positive leakage is if wood produced by the Project were to displace concrete or steel in construction, resulting in reduced emissions from the production of concrete or steel.

If for some reason the project would start to cause leakage, the leakage would be calculated using the formula given in the methodology.

$$LK = \sum_{t=1}^{t^*} LK_{AGRIC,t} \qquad \textbf{(1)}$$

where:

LK	Total GHG emissions due to leakage; t CO_2-e
$LK_{AGRIC,t}$	Leakage due to the displacement of agricultural activities in year *t*, as calculated in the tool "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity"; t CO_2-e

E4. UNCERTAINTY

For sampling of forest carbon stocks, Chapter 2, section C of the *ACR Forest Carbon Project Standard version 2.1* requires that if the statistical confidence interval, at the 90% statistical confidence level be no more than ±10% of the mean estimated carbon stock. If the sampling uncertainty exceeds this level, an uncertainty deduction is applied to the mean estimated carbon sequestration when calculating the number of offsets generated by the project.

To calculate uncertainty, the carbon stock measured by sampling is calculated on a per-acre basis for each carbon pool included in quantification. Then the carbon masses of all pools measured on the particular plot are summed to obtain a per-acre carbon stock represented by each plot. Then the standard deviation across plots is calculated. If different plots are used to measure different carbon pools (e.g. separate plots for trees and soil), then the standard deviation is calculated for each set of plots. Pooled variance, across the strata, is calculated, and used to calculate the pooled standard deviation. Following the *ACR Forest Carbon Project Standard version 2.1*, if the project cannot meet the targeted ±10% of the mean at 90% confidence, then the reportable amount of offsets shall be the mean minus the lower bound of the 90% confidence interval, applied to the final calculation of emission reductions/removals. The precision target is applied across the entire project, not within particular carbon pools, strata, or land ownerships.

The standard error of the estimate for the carbon stock for the project as a whole is calculated as:

$$s_{\bar{y}_s}^2 = \sum_{h=1}^{k} \left(\frac{n_h}{n} \right)^2 \times s_{\bar{y}_h}^2 \qquad \textbf{(2)}$$

where $s_{\bar{y}_s}$ is the standard error of the estimated mean sequestration across the entire project area, across strata h = 1 to k, n_h is the number of plots in stratum h, n is the number of plots in all strata, and $s_{\bar{y}_h}$ is the standard error estimated for stratum h.

The confidence interval is calculated by multiplying the standard error by the appropriate "*t*" critical point, from a student's "*t*" test table. The appropriate *t* critical point is selected using the appropriate number of degrees of freedom and the critical point such that 5% of the probability is in each tail of the probability distribution (and 90% of the probability distribution is within one confidence interval of the estimated mean). For the numbers of plots expected for GreenTrees Program projects, the "t" critical point will be 1.64 to 1.66. The number of degrees of freedom is the number of plots, minus one more than the number of strata.

E5. REDUCTIONS AND REMOVAL ENHANCEMENTS

Net anthropogenic GHG removals by sinks

The net anthropogenic GHG removals by sinks is the actual net GHG removals by sinks minus the baseline net GHG removals by sinks minus leakage, therefore, the following general formula can be used to calculate the net anthropogenic GHG removals by sinks of an AR ACR project activity (CAR-ACR), in t CO2-e.

$$C_{AR-ACR} = \Delta C_{ACTUAL} - \Delta C_{BSL} - LK \qquad \textbf{(3)}$$

where:

C_{AR-ACR}	Net anthropogenic GHG removals by sinks; t CO_2-e
ΔC_{ACTUAL}	Actual net GHG removals by sinks; t CO_2-e

ΔC_{BSL} Baseline net GHG removals by sinks; t CO_2-e

LK Total GHG emissions due to leakage; t CO_2-e

In addition an uncertainty deduction, if required per the Forest Carbon Project Standard (i.e. if the precision target of ±10% of the mean at 90% confidence, applied to the final calculation of emission reductions/removal enhancements, is not achieved), must be applied to the result from Equation 28 to give an adjusted value of $C_{AR\text{-}ACR}$ accounting for uncertainty.

As discussed in Section E1, the baseline of this project is constant through time. As a result, ΔC_{BSL} is zero. As discussed in the section, *LK* is zero.

Actual Net GHG Removals by Sinks

Under the applicability conditions of this methodology:

- Changes in carbon stock of above-ground and below-ground biomass of non-tree vegetation may be conservatively assumed to be zero for all strata in the project scenario.

The actual net GHG removals by sinks shall be calculated as:

$$\Delta C_{ACTUAL} = \Delta C_P - GHG_E \quad \textbf{(4)}$$

where:

ΔC_{ACTUAL} Actual net GHG removals by sinks; t CO_2

ΔC_P Sum of the changes the carbon stock in the selected carbon pools within the project boundary; t CO_2

GHG_E Increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the project activity; t CO_2

If the project has no activities that result in non-CO_2 GHG emissions, then actual net GHG removals by sinks equals the sum of changes in the carbon stocks of the selected pools within the project.

As noted in Section E1, the project baseline is continuation of cropping and thus the baseline net GHG removals by sinks is:

$$\Delta C_{BSL} = 0 \quad \textbf{(5)}$$

Calculation of ERTs

To estimate the ERTs to be issued to the project at time $t = t_2$ (the date of verification) for the monitoring period $T = t_2 - t_1$, the methodology uses the equation provided by ACR, which uses a buffer pool or other approved mechanisms to mitigate the risk of reversals. ERTs shall be calculated by applying the buffer deduction, if applicable:

$$ERT_t = \left(C_{AR-ACR,t_2} - C_{AR-ACR,t_1}\right) * \left(1 - BUF\right) \quad \textbf{(6)}$$

where:

ERT_t	Number of Emission Reduction Tonnes to be issued to the project at time *t=t2-t1*
C_{AR-ACR,t_2}	Cumulative total net GHG emission reductions up to time t_2; tCO_2-e
C_{AR-ACR,t_1}	Cumulative total net GHG emission reductions up to time t_1; tCO_2-e
BUF	Percentage of project ERTs contributed to the ACR buffer pool, if applicable

Per the Forest Carbon Project Standard, *BUF* is determined using an ACR-approved risk assessment tool. As of November 2011 the approved risk assessment tool used by the project is the VCS "AFOLU Non-Permanence Risk Tool, v3.0." If the Project Proponent elects to mitigate the assessed reversal risk using an alternate risk mitigation mechanism approved by ACR (including but not limited to insurance), *BUF* shall be set equal to zero.

Estimation of Changes in Project Carbon Stocks

The verifiable changes in the carbon stock in the selected carbon pools within the project boundary are estimated using the following equation:

$$\Delta C_P = \sum_{t=1}^{t^*} \Delta C_t \quad \textbf{(7)}$$

where:

ΔC_P	Sum of the changes in carbon stock in all selected carbon pools in stratum *i,* since start of the project; t CO_2
ΔC_t	Change in carbon stock in all selected carbon pools, in year *t*; t CO_2
t	*1, 2, 3, … t** years elapsed since the start of the A/R project activity; years

Change in carbon stock in all selected carbon pools, in year *t*, is calculated as:

$$\Delta C_t = \sum_{i=1}^{M_{PS}} (\Delta C_{TREE,i,t} + \Delta C_{DW,i,t} + \Delta C_{WP,i,t} + \Delta C_{SOC,i,t}) \quad \textbf{(8)}$$

where:

ΔC_t	Change in carbon stock in all selected carbon pools, in year *t*; t CO_2
$\Delta C_{TREE,i,t}$	Change in carbon stock in above-ground and below-ground biomass of trees in stratum *i*, in year *t*; t CO_2
$\Delta C_{DW,i,t}$	Change in carbon stock in the dead wood carbon pool in stratum *i*, in year *t*; t CO_2
$\Delta C_{WP,i,t}$	Change in carbon stock in the wood product carbon pool in stratum *i*, in year *t*; t CO_2
$\Delta C_{SOC,i,t}$	Change in carbon stock in the soil organic carbon pool in stratum *i*, in year *t*; t CO_2
i	*1, 2, 3, … M_{PS}* strata in the project scenario
t	*1, 2, 3, … t* years elapsed since the start of the A/R CDM project activity

Estimating Change in Carbon Stock in Tree Biomass

The change in carbon stock in tree biomass is estimated on the basis of field measurements in sample plots at a point of time in year t_1 and again at a point of time in year t_2. The rate of change of carbon stock in trees is calculated as:

$$dC_{TREE,i,(t_1,t_2)} = \frac{C_{TREE,i,t_2} - C_{TREE,i,t_1}}{T} \quad \textbf{(9)}$$

where:

$dC_{TREE,i,(t_1,t_2)}$	Rate of change in carbon stock in above-ground and below-ground biomass of trees in stratum *i*, for the period between year t_1 and year t_2; t CO_2 yr^{-1}
C_{TREE,i,t_2}	Carbon stock in trees in stratum *i*, at a point of time in year t_2; t CO_2
C_{TREE,i,t_1}	Carbon stock in trees in stratum *i*, at a point of time in year t_1; t CO_2
T	Time elapsed between two successive estimations ($T=t_2 - t_1$); years
i	*1, 2, 3, … i* strata in the project scenario

Between years when sample trees are measured in the field, carbon stock change in trees can be estimated by either (a) modeling growth of trees measured during the most recent sampling and using the modeled tree sizes as inputs for the equations given here, or (b) straight-line extrapolation of the sequestration observed between the last two field measurements of trees. Projected growth must be adjusted for harvest and any other significant removals of trees from the project area.

Change in carbon stock in tree biomass in year t ($t_1 \leq t \leq t_2$) is then calculated as:

$$\Delta C_{TREE,i,t} = dC_{TREE,i,(t_1,t_2)} * 1 year \quad \textbf{(10)}$$

where:

$\Delta C_{TREE,i,t}$	Change in carbon stock in above-ground and below-ground biomass of trees in stratum *i*, in year *t*; t CO_2
$dC_{TREE,i,(t_1,t_2)}$	Rate of change in carbon stock in tree biomass within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; t CO_2 yr^{-1}

Carbon stock in above-ground and below-ground tree biomass ($C_{TREE,i,t}$) is estimated by the allometric method as applied in year *t*.

The total carbon stock in tree biomass for each stratum is calculated as follows:

$$C_{TREE\ i} = \frac{A_i}{N_i} \sum_{p=1}^{P} C_{TREE\ p,i} \quad \textbf{(11)}$$

where:

$C_{TREE,i}$	Carbon stock in trees in stratum *i*; t CO_2
$C_{TREE\ p,i}$	Carbon stock in trees in plot *p* of stratum *i*; t CO_2 $acre^{-1}$
N_i	Number of sample plots in stratum *i*; dimensionless
A_i	Total area of stratum *i*; acres
j	*1, 2, 3, …* J_i species or group of species of trees in stratum *i*
p	*1, 2, 3, …* P_i sample plots in stratum *i* in the project scenario
i	*1, 2, 3, … i* strata in the project scenario

Because sampled masses are scaled up to a per-acre basis for use in Equation 11, Equation 11 divides by the number of plots measured within the stratum rather than the sum of the areas of the plots measured within the stratum.

Equation 11, when applied at two consecutive years t_1 and t_2 (e.g. two consecutive verification years), provides two values C_{TREE,i,t_1} and C_{TREE,i,t_2} which are then inserted in equation 9.

Carbon stock per plot is used to calculate the statistical confidence interval of measurement of project carbon stocks.

$$C_{TREE\ p,i} = \sum_{j=1}^{J_i} C_{TREE,j,p,i} \quad \textbf{(12)}$$

where:

$C_{TREE\ p,i}$	Carbon stock in trees in plot p; t CO_2 acre^{-1}
$C_{TREE,j,p,i}$	Carbon stock in tree j in plot p of stratum i; t CO_2 acre^{-1}
j	*1, 2, 3, …* J_i trees in p sample plots in stratum i of the project
p	*1, 2, 3, …* P_i sample plots in stratum i in the project
i	*1, 2, 3, …* i strata in the project

Allometric Method of Estimating Tree Biomass

The allometric method directly calculates above-ground tree biomass without relating it to tree stem volume. The method depends upon availability of allometric equations which express above-ground tree biomass as a function of diameter at breast height (*DBH*) and/or tree height (*H*). Total tree biomass is then obtained by multiplying the above-ground tree biomass by (1+*R*) where *R* is the root-shoot ratio.

Ex post estimation of tree biomass is based on actual measurements carried out on trees that occur within the sample plots. The sample plot centers are located randomly by a GIS software program, or are located in a grid pattern with a random start. The spacing of the grid or the number of plots located by the GIS is estimated to be sufficient to avoid uncertainty deductions, with the number calculated using the coefficient of variation observed on previous plot measurements within the project. If the number of plots is not sufficient to avoid an uncertainty deduction, more plots may be measured and added to the sample.

Convert tree measurements to the per-acre biomass represented by each sample tree using the following equation:

$$C_{TREE\ j,p,i} = f(DBH, H, DBA) \times (1 + R_j) \times CF_j \times \left(\frac{44}{12}\right) \times \left(\frac{1}{pa}\right) \quad \textbf{(13)}$$

where:

$C_{TREE,j,p,i}$	Total carbon stock in tree j in sample plot p in stratum i; t CO_2/acre

$f(DBH, H, DBA)$ Above-ground biomass of trees of species or group of species *j* in sample plot *p* calculated using allometric function returning total above-ground tree biomass on the basis of breast height (*DBH*) and/or height of the tree (*H*) and/or diameter at base (*DBA*); t d.m.

R_j Root-shoot ratio for tree species or group of species *j*; dimensionless

CF_j Carbon fraction of biomass for tree species or group of species *j*; t C (t d.m.)$^{-1}$

44/12 Ratio of molecular weights of CO_2 and carbon; dimensionless

pa Area of plot *p*; acres

p *1, 2, 3*, … sample plots in stratum *i*

i *1, 2, 3,* … strata in the project scenario

Allometric Equations

Equations for smaller trees of species planted by the project are given here. Equations for additional species and larger trees will be added as needed using published biomass equations or by adapting equations using procedures described Willey and Chameides (2007).[6]

Table 3. Scientific and common names of species planted by the project.

Scientific Name	Common Name	Biomass Equation Source
Carya illinoensis	Sweet Pecan	Clark et al., 1986
Fraxinus pennsylvanica var. lanceolata	Green Ash	Clark et al., 1986
Liquidambar styracifula	Sweet Gum	Clark et al., 1986
Populus deltoides	Eastern Cottonwood	Clark et al., 1986
Quercus nigra L.	Water Oak	Clark et al., 1985
Qurecus nuttallii	Nuttall Oak	Clark et al., 1985
Quercus pagoda Raf.	Cherrybark Oak	Clark et al., 1985
Qurecus phellos	Willow Oak	Clark et al., 1985

[6] Willey, Z. and B. Chameides, eds. 2007. *Harnessing Farms and Forest in the Low-Carbon Economy: How to Create, Measure, and Verify Greenhouse Gas Offsets.* Durham: Duke University Press. 229 p.

Quercus shumardii	Shumard Oak	Clark et al., 1985
Taxodium Distichum	Bald Cypress	Jenkins et al., 2003 Means et al., 1994

Cottonwood, Less than 1” DBH

Minimum diameter applied	Maximum diameter applied	Minimum diameter valid	Maximum diameter valid	Equation	R^2	RMSE[7]
0.18” DBA	1” DBH	0.18” DBA	3.55” DBA	$BAT=(27.98*D^{2.715})*(0.37/0.35)$	.99	--

BAT=biomass aboveground total, in grams. D=basal diameter in centimeters. Equation was developed for Populus tremuloides and factor (0.37/0.35) adjusts for difference in specific gravity of Populus deltoides and Populus tremuloides, per method described in Nicholas Institute, 2007. Equation from Smith and Brand, 1983.

Hardwoods Other than Cottonwood, Less than 1” DBH

Minimum diameter applied	Maximum diameter applied	Minimum diameter valid	Maximum diameter valid	Equation	R^2	RMSE
0.23” DBA	1” DBH	0.23” DBA	4.06” DBA	$BAT=44.726*D^{2.649}$	.99	--

BAT=biomass aboveground total, in grams. D=basal diameter in centimeters. Equation was developed for Quercus rubra, which as a specific gravity of 0.56, which is a mid-range value for the species being planted by this project. Equation from Smith and Brand, 1983.

Sweet Pecan:

Minimum diameter	Maximum diameter	Minimum diameter	Maximum diameter	Equation	R^2	RMSE

[7] RMSE is root mean square error.

applied	applied	valid	valid			
1” DBH	10.9” DBH	1” DBH	10.9” DBH	$B=(0.20243*((D^2*H)^{0.92544}))/0.975$	.99	0.0895
11” DBH	18.1” DBH	11” DBH	18.1” DBH	$B=(0.01344*((D^2)^{1.49088})*(H^{0.92544}))/0.975$	.99	0.0895

Notes: Where B=dry biomass aboveground total in pounds, D=tree DBH in inches, and H=total height in feet. Dividing by 0.975 adds stump mass, per Jenkins et al., 2003. Equation includes log bias correction. Equation was developed for Hickory species, which is the genus Carya, which includes Pecan. No density correction is applied because the reported density of Pecan within the range of density of various Hickory species, 0.59-0.61. Source: Clark et al., 1986, Table 11, Total tree wood, bark and foliage.

Green Ash:

Minimum diameter applied	Maximum diameter applied	Minimum diameter valid	Maximum diameter valid	Equation	R^2	RMSE
1” DBH	10.9” DBH	1” DBH	10.9” DBH	$B=(0.20927*((D^2*H)^{0.88203}))/0.975$	.98	0.0965
11” DBH	19.3” DBH	11” DBH	19.3” DBH	$B=(0.06179*((D^2)^{1.13639})*(H^{0.88203}))/0.975$	.98	0.0965

Notes: Where B=dry biomass aboveground total in pounds, D=tree DBH in inches, and H=total height in feet. Dividing by 0.975 adds stump mass, per Jenkins et al., 2003. Equation includes log bias correction. Source: Clark et al., 1986, Table 11, Total tree wood, bark and foliage.

Sweet Gum:

Minimum diameter applied	Maximum diameter applied	Minimum diameter valid	Maximum diameter valid	Equation	R^2	RMSE
1” DBH	10.9” DBH	1” DBH	10.9” DBH	$B=(0.10413*((D^2*H)^{0.95735}))/0.975$	.99	0.0515
11” DBH	17.2” DBH	11” DBH	17.2” DBH	$B=(0.02658*((D^2)^{1.24205})*(H^{0.95735}))/0.975$	.99	0.0515

Notes: Where B=dry biomass aboveground total in pounds, D=tree DBH in inches, and H=total height in feet. Dividing by 0.975 adds stump mass, per Jenkins et al., 2003. Equation includes log bias correction. Source: Clark et al., 1986, Table 11, Total tree wood, bark and foliage.

Eastern Cottonwood:

Minimum diameter applied	Maximum diameter applied	Minimum diameter valid	Maximum diameter valid	Equation	R^2	RMSE
1" DBH	10.9" DBH	1" DBH	10.9" DBH	$B=((0.05927*((D^2*H)^{1.02331}))/0.975)*(0.37/0.40)$	.98	0.0715
11" DBH	18.7" DBH	11" DBH	18.7" DBH	$B=((0.06152*((D^2)^{1.01555})*(H^{1.02331}))/0.975)*(0.37/0.40)$	.98	0.0715

Notes: Where B=dry biomass aboveground total in pounds, D=tree DBH in inches, and H=total height in feet. Dividing by 0.975 adds stump mass, per Jenkins et al., 2003. This equation was developed for Liriodendron tulipifera L. (Yellow-poplar) and is adapted to Eastern Cottonwood using the specific gravities of the wood of the two species given by Jenkins et al., 2004 using the method given in Nicholas Institute, 2007. Equation includes log bias correction. Source: Clark et al., 1986, Table 11, Total tree wood, bark and foliage.

Cherrybark Oak:

Minimum diameter applied	Maximum diameter applied	Minimum diameter valid	Maximum diameter valid	Equation	R^2	RMSE
1" DBH	10.9" DBH	1" DBH	10.9" DBH	$B=(0.20007*((D^2*H)^{0.93915}))/0.975$	.99	0.0496
11" DBH	20.7" DBH	11" DBH	20.7" DBH	$B=(0.07578*((D^2)^{1.14158})*(H^{0.93915}))/0.975$	.99	0.0496

Notes: Where B=dry biomass aboveground total in pounds, D=tree DBH in inches, and H=total height in feet. Dividing by 0.975 adds stump mass, per Jenkins et al., 2003. Equation includes log bias correction. Equation was developed for White oak (*Quercus alba* L.) which has a growth form and specific gravity that are similar to Cherrybark oak. Source: Clark et al., 1985, Table 11, Total tree wood, bark and foliage.

Water, Nuttall, Willow, and Shumard Oaks:

Minimum diameter applied	Maximum diameter applied	Minimum diameter valid	Maximum diameter valid	Equation	R^2	RMSE
1" DBH	10.9" DBH	1" DBH	10.9" DBH	$B=(0.23742*((D^2*H)^{0.92299}))/0.975$	.99	0.0592

11" DBH	20" DBH	11" DBH	20" DBH	$B=(0.15568*((D^2)^{1.01099})*(H^{0.92299}))/0.975$	.99	0.0592

Notes: Where B=dry biomass aboveground total in pounds, D=tree DBH in inches, and H=total height in feet. Dividing by 0.975 adds stump mass, per Jenkins et al., 2003. Equation includes log bias correction. Equation was developed for Water oak (*Quercus nigra* L.) which has a growth form and specific gravity that are similar to Nuttall, Willow, and Shumard oaks. Source: Clark et al., 1985, Table 11, Total tree wood, bark and foliage.

Bald Cypress:

Minimum diameter applied	Maximum diameter applied	Minimum diameter valid	Maximum diameter valid	Equation	R^2	RMSE
1" DBH	1.4" DBH	1" DBH	98" DBH	B=(EXP(-2.0336+(2.2592* Ln(D*2.54))))*2.205	.98	0.2946
1.5" DBH	27.1" DBH	1.5" DBH	27.1" DBH	B=(40400+(0.0969*((D*2.54)^2)* (H*30.48)))*(0.42/0.31)	.97	SEE 37.62

Notes: Where B=biomass aboveground total in grams, D=tree DBH in inches, H=total height in feet. Equation for trees 1-1.4" DBH is from Jenkins et al., 2003, for cedar-larch species. Equation for 1.5-27.1" trees is from Means et al., 1994, equation number 855. The equation was developed for *Thuja plicata*, which has a similar growth form to *Taxodium distichum*, and the factor (0.42/0.31) adjusts for the density difference between the two species, following the method described in Nicholas Institute, 2007.

Root Biomass

Root biomass will be calculated as a function of aboveground biomass using the root:shoot ratio for the appropriate forest type from the Intergovernmental Panel on Climate Change.[8] Factors for R_j are:

Forest Type	$\boldsymbol{R_j}$
Oak, greater than 70 metric tons aboveground dry mass/hectare	0.35
Other broadleaf, less than 75 metric tons aboveground dry mass/hectare	0.43
Other broadleaf, 75-150 metric tons aboveground dry mass/hectare	0.26
Other broadleaf, greater than 150 metric tons aboveground dry mass/hectare	0.24

[8] Intergovernmental Panel on Climate Change. 2003. *Good Practice Guidance for Land Use, Land-Use Change and Forestry.* IPCC Natinoal Greenhouse Gas Inventories Programme, Technical Support Unit. Kanagawa, Japan: Institute for Global Environmental Strategies. Table 3.A.1.8.

Standing Dead Wood

Standing dead trees are measured on the same plots and using the same criteria and monitoring frequency used for measuring live trees. In addition to the data collected on live trees, two additional data points are collected for each dead tree. One, the decomposition class of the individual dead tree is determined and recorded. Two, the top diameter of the main stem of the tree is determined and recorded. If the top diameter is not recorded, it is assumed to be zero. Stumps are considered to be very short dead trees. As with live trees that are less than 4.5' tall, the basal diameter of stumps is measured and recorded.

Following the approved ACR methodology *Improved Forest Management Methodology for Quantifying GHG Removals and Emission Reductions through Increased Forest Carbon Sequestration on U.S. Timberlands*, the decomposition class of each sampled dead tree categorized under the following four decomposition classes:

1. Tree with branches and twigs that resembles a live tree (except for leaves)
2. Tree with no twigs but with persistent small and large branches
3. Tree with large branches only
4. Bole only, no branches

The biomass of decomposition class 1 dead trees is estimated using the same methods as if the tree were alive. The biomass of trees of decomposition classes 2, 3 or 4 is estimated by assuming that the aboveground part of the tree is a conic section. This method is conservative because it ignores biomass that may remain in branches and it generally underestimates bole mass. Tree boles are typically paraboloid in form, with the trunk in the crown of the tree thicker than it would be if the tree were conic in form.

Following the approved ACR *Methodology for Afforestation and Reforestation of Degraded Land, Version 1.0*, the biomass of dead wood is determined by using the following dead wood density classes deductions: Class 1 – same as live tree biomass; Class 2 – 95% of live tree biomass; Class 3 – 90% of live tree biomass; Class 4 – 80% of live tree biomass.

Wood Products

Wood product carbon sequestration is calculated using what is commonly called the "1605(b) method" after the U.S. Voluntary Reporting of Greenhouse Gases Program authorizing legislation. Wood product calculation is:

$$\Delta C_{WP,t} = \frac{C_{WP,t_2} - C_{WP,t_1}}{T} \quad \textbf{(14)}$$

where:

$\Delta C_{WP,t}$	Annual carbon stock change in wood products, (averaged over a monitoring period); t CO_2 yr^{-1}
$C_{WP,t2}$	Carbon stock of wood products at time *t=2*; t CO_2
$C_{WP,t2}$	Carbon stock of wood products at time *t=1*; t CO_2
T	Number of years between monitoring t_2 and t_1 ($T = t_2 - t_1$); yr
t	*1, 2, 3 … t* years elapsed since the start of the project activity

Step 1: Calculate the biomass of the total volume extracted from the start of the project to date from within the project boundary with extracted timber differentiated into sawnwood and pulpwood classes (if necessary convert volumes in ft^3 to m^3 by multiplying by 0.0283):

$$EXC_{WP,s/p} = \sum_{h=1}^{H_{PS}} \sum_{j=1}^{S_{PS}} (V_{ex,h,s/p,j} * D_j * CF_j * \frac{44}{12}) \qquad \textbf{(15)}$$

where:

$EXC_{WP,s/p,t}$	The summed stock of extracted biomass carbon from within the project boundary by wood product disposition (sawnwood/pulpwood) *s/p*; t CO_2
$V_{ex,s/p,j,t}$	The volume of timber extracted from within the project boundary during harvest *h* by species *j* and wood product disposition (sawnwood/pulpwood) *s/p*; m^3
D_j	Basic wood density of species *j*; t d.m. m^{-3}
CFj	Carbon fraction of biomass for tree species *j*; t C t^{-1} d.m. (IPCC default value = 0.5 t C t^{-1} d.m.)
h	*1, 2, 3 …*number of harvests since the start of the project activity
$\frac{44}{12}$	Ratio of molecular weights of CO_2 and carbon; dimensionless
j	*1, 2, 3 …* S_{PS} tree species in the baseline scenario
s/p	Wood product disposition – defined here as sawnwood or pulpwood

Step 2: Calculate the proportion of extracted timber that remains sequestered after 100 years. Instead of tracking annual emissions through retirement, burning and decomposition, the methodology calculates the proportion of wood products that have not been emitted to the atmosphere 100 years after harvest and assumes that this proportion is permanently sequestered.

The method uses Table 1.6 from the Forestry Appendix of the Technical Guidelines of the US Department of Energy's Voluntary Reporting of Greenhouse Gases Program (known as Section 1605b)[9]. Users will determine the region the project is located in (using Figure 1.1 of the same document) and whether the timber is softwood or hardwood. The proportions defined as "In Use" and "Landfill" 100 years after production will be used here.

$$C_{WP,t} = \sum_{s,p}^{s/p} EXC_{WP,s/p} * 1605b \quad \textbf{(16)}$$

where:

$EXC_{WP,ty,t}$	The summed stock of extracted biomass carbon from within the project boundary by class of wood product *ty*; t CO_2
1605b	The proportions of extracted timber still "in use" or sequestered in a "landfill" as wood products 100 years after production from Table 1.6 of the Forestry Appendix to the Technical Guidelines[10]; t C in products permanently sequestered t C^{-1} extracted biomass carbon
s/p	Wood product disposition – defined here as sawnwood (s) or pulpwood (p)
t	*1, 2, 3 … t* years elapsed since the start of the project activity

Soil Carbon

Changes in stocks of soil organic carbon are estimated using the approved methodological tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities". That is:

$$\Delta C_{SOC,i,t} = \Delta SOC_{AL,t} \times \frac{44}{12} \quad \textbf{(17)}$$

[9] http://www.eia.doe.gov/oiaf/1605/Forestryappendix[1].pdf
Also available as a US Forest Service General Technical Report at:
http://www.fs.fed.us/ne/durham/4104/papers/ne_gtr343.pdf

[10] http://www.eia.doe.gov/oiaf/1605/Forestryappendix[1].pdf
Also available as a US Forest Service General Technical Report at:
http://www.fs.fed.us/ne/durham/4104/papers/ne_gtr343.pdf

where:

$\Delta C_{SOC,i,t}$	Change in carbon stock in the SOC pool in stratum *i*, in year *t*; t CO_2
$\Delta SOC_{AL,t}$	Change in carbon stock in the SOC pool as estimated in the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" applied to stratum *i*; t C
$\frac{44}{12}$	Ratio of molecular weights of CO_2 and carbon; dimensionless

E6. EX-ANTE ESTIMATION METHODS

C2I, the parent company of GreenTrees LLC, created a carbon stock model for this project, based on published cottonwood growth equations by Quang Cao, and inventories of native hardwood forests by forester Pat Weber. Growth and harvest of cottonwood, planted native hardwood and naturally regenerated native hardwoods were modeled. Growth models were fitted to the data by Peters Forestry. Ecofor LLC built components of the model that convert growth and yield information into carbon.

The carbon module of the model takes the cubic feet per acre of merchantable wood predicted by the growth model and converts this to metric tons carbon dioxide equivalent per acre contained in live trees. Calculations are made separately for each of the three growth cohorts that successively dominate the stand, cottonwood, planted hardwood, and natural hardwood, and then summed.

The growth module predicts merchantable wood volume as a function of stand age. This must be converted to mass, and expanded from stem wood mass to total tree mass. Then tree mass is converted to carbon dioxide equivalent mass.

The conversion of wood volume to mass is accomplished by multiplying by the specific gravity of the wood of each growth cohort. Green weight and moisture content are not used in the carbon module. The specific gravity specific gravity values are taken from the *Wood Handbook* (Forest Products Laboratory, 1999)[11] for woods grown in the U.S. The green wood specific gravity of Cottonwood (*Populus deltoides*) is 0.37. The hardwoods that will be planted by the project are Nuttall oak (*Quercus texana*), Water oak (*Q. nigra*), and Willow oak (*Q. phellos*). Green wood specific gravities were obtained for Water oak and Willow oak, and were both 0.56. Project contributor Pat Weber reports that Nuttall oak also has a specific gravity of 0.56, so this value was used as the specific gravity of hardwoods other than cottonwood.

[11] Forest Products Laboratory. 1999. *Wood Handbook—Wood as an Engineering Material.* FPL-GTR-113. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 463 p.

Total aboveground biomass is calculated as a function of stem wood biomass using regression coefficients for hardwood published by Jenkins et al. (2003).[12] The term "biomass" refers to dry biomass, excluding the water present in live plants. The proportions of total tree biomass in the stem, branches, foliage, and roots vary by tree species and tree diameter. In general, as diameter increases, the proportion of stem mass to total tree mass increases. However, for hardwoods above 15" DBH there is little variation in the relationship. Tree diameters were taken from the growth model, except the model does not generate a diameter for cottonwood. For the purpose of determining the relative proportions of non-stem component mass to stem wood mass, cottonwood diameter at breast height, in inches, was assumed to be 0.8 inches per year of age. This growth rate is from the experience of Pat Weber. Changing this diameter relationship would have very little effect on the total estimated amount of carbon sequestration, particularly for larger trees. Stem wood biomass calculated from growth model outputs was converted to total aboveground biomass by multiplying by the ratio of one divided by the proportion of aboveground biomass in stem wood. The growth model predicts merchantable wood volume, excluding bark, stump, top, branches, roots and foliage. Following Jenkins et al. (2003) the stump was assumed to be 2.5% of aboveground biomass. Experience on other sites suggests that the Jenkins equations may underestimate biomass because the equations assume that trees will be shorter than the trees will actually grow to on these moderately productive sites.

Root biomass is estimated as a proportion of aboveground biomass, using the regression coefficients for hardwood published by Jenkins et al. (2003). Like non-stem aboveground components, the proportion of total biomass in roots declines as DBH increases. However, at diameters above 4" this relationship largely stabilizes. These coefficients are less than the IPCC coefficients used to calculate sequestration, this modeling is conservative.

Dry wood biomass is assumed to be 50% carbon, by weight. This proportion follows calculation methods of the Intergovernmental Panel on Climate Change (1996).[13]

Carbon sequestered in wood products is calculated by multiplying the wood removed by harvest by the 1605(b) value appropriate to the location, species and product class.

Carbon in parts of logged trees not removed from the site (stump, roots, branches) is assumed to remain on site and becomes dead wood. Dead wood is assumed to decompose at a rate of 11.2% per year. This factor is from the 1605(b) Forestry Technical Guidelines, page 264, for southern bottomland hardwood.

Soil carbon sequestration is estimated using the "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities". Soil carbon sequestration is assumed

[12] Jenkins, Jennifer C., David C. Chojnacky, Linda S. Heath, and Richard A. Birdsey. 2003. National-scale biomass estimators for United States tree species. *Forest Science.* 49(1): 12-35.

[13] Intergovernmental Panel on Climate Change. 1996. *Greenhouse Gas Inventory Reporting Instructions: IPCC Guidelines for National Greenhouse Gas Inventories, Revised. Volume 3: Reference Manual.* IPCC National Greenhouse Gas Inventories Programme Technical Support Unit, Kanagawa, Japan. Available at http://www.ipcc-nggip.iges.or.jp/index.html.

to occur at a rate of 1.1876 metric tons CO_2e per acre per year. Soil carbon sequestration is assumed to occur for 20 years following tree planting, and then be zero in all subsequent years.

F.
COMMUNITY & ENVIRONMENTAL IMPACTS

F1. NET POSITIVE IMPACTS

ACR defines community as:

> A community includes all groups of people including indigenous peoples, mobile peoples and other local communities, who live within or adjacent to the project area as well as any groups that regularly visit the area and derive income, livelihood or cultural values from the area. This may include one or more groups that possess characteristics of a community, such as shared history, shared culture, shared livelihood systems, shared relationships with one or more natural resources (forests, water, rangeland, wildlife, etc.), and shared customary institutions and rules governing the use of resources

GreenTrees has received the endorsement of local groups like Wildlife Mississippi, Audubon Arkansas, Arkansas Forestry Commission, Arkansas Game & Fish. GreenTrees has received national endorsement from the National Wildlife Federation. Additionally, GreenTrees has received the Innovator Award from Southern Growth Policy Board via Gov. Haley Barbour of Mississippi.

There are many project co-benefits to GreenTrees reforestation, described below. Without the project, these community and environmental benefits would not occur.

Social and Economic Co-Benefits

GreenTrees Program Projects will provide sustainable income to low-income landowners. Because of the combination of CRP, periodic timber thinnings, and private capital, landowners who allow their land to participate in a GreenTrees Program Project will be able to maintain ownership of their land while contributing to conservation. Harvesting of wood products will produce jobs for harvesters, wood processors, and those who support those wood product production activities. As former U.S. Senator Blanche Lincoln from Arkansas said, "The GreenTrees reforestation program is a win-win for the landowner, the land and the Delta region. As we move toward a new energy economy rural areas cannot be underestimated."

Additionally, Heidi Garrett-Peltier and Robert Pollin from the University of Massachusetts Political Economy and Research Institute found that reforestation and sustainable forestation management produces 39.7 jobs per $1 million invested, making it the biggest job stimulator of all the categories analyzed.[14]

Water Quality Co-Benefits

Water quality will greatly benefit from afforested riparian buffers. Reforestation minimizes soil erosion and absorbs farm chemicals from surface runoff and groundwater. Furthermore, reforestation reduces sediment and pesticide contamination of streams.

Biodiversity Co-Benefits

Reforestatin restores wildlife habitat. Studies on the effects of reforestation in the MAV have shown that reforested land contains significantly more varieties of species as compared with land that has not been reforested. A study by the U.S. Forest Service states that the type of planting that GreenTrees performs holds twice the amount of birds than other forms of reforestation.[15]

Biomass Offtake Co-Benefits

Landowners under the GreenTrees Program will be entitled to revenue from thinning the stand for the purpose of producing biomass supply or other purposes. If the biomass is used for energy generation, the energy could displace generation from fossil fuel, providing the GHG benefit of reducing fossil fuel emissions. If fossil fuel emission reductions are counted, they will be counted by the entity that reduces fossil fuel emissions, not by the GreenTrees program.

F2. STAKEHOLDER COMMENTS

During the design phase of the program from 2004 to 2007, GreenTrees met with landowners, planters, private foresters, government agencies (federal and state), NGOs, land use lawyers, commodity experts, banks (national and local) and government labs such as the USDA Bottomland Hardwood Research Center. The outcome of the program today is a result of that consultation process. GreenTrees retains a deep database of over 700 individuals that it remains in contact with and is always working to improve the impact that is being delivered to all stakeholders involved in the restoration of this native ecosystem.

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[14] Multipliers derived using IMPLAN 2.0 with 2007 data. Infrastructure multipliers and assumptions are presented in "How Infrastructure Investments Support the U.S. Economy: Employment, Productivity and Growth," Political Economy Research Institute, January 2009, http://www.peri.umass.edu/236/hash/efc9f7456a/publication/333/

[15] Hamel, Paul B. 2003. Winter bird community differences among methods of bottomland hardwood forest restoration: results after seven growing seasons. *Forestry.* 76(2): 189-197.

GreenTrees holds meeting several times a year for state, federal and local officials as well as landowners. Our recent meeting was on April 26th, where people from the LA Department of Wildlife and Fisheries, LA Department of Ag and Forestry, Black Bear Conservation Coalition, Trust for Public Lands, Senator Landrieu's office and many more local officials and landowners were present to take a tour of one of our properties, learn about our brand of restoration, and ask questions. Everyone walked away with very positive experience. GreenTrees conducts multiple meetings of this nature throughout the project area several times per year.

G.
OWNERSHIP AND TITLE

G1. PROOF OF TITLE

GreenTrees takes a *profit-a-prendre* right in the land as it relates to carbon and places restrictive covenants on the land as it pertains to the carbon rights. GreenTrees performs credit and title checks on each and every landowner before counter signing the landowner contract.

The GreenTrees contract with each landowner conveys rights to GHG credits to GreenTrees using the following language:

Landowner hereby (B)(i) leases the Property to Lessee, (ii) grants and conveys to GreenTrees a *profit a' prendre* in the Property consisting of all of the title and rights to any and of all Carbon Sequestration Credits currently on or related to the Property and to be produced on or related to the Property, (iii) grants GreenTrees, and its agents, including but not limited to, the American Carbon Registry or other Permitted Exchange, and Verifier, continuing access for 40 years, with all rights of ingress and egress, to the Property and the rights to (1) verify and register the carbon sequestered by the Property, (2) convert such amount into Carbon Sequestration Credits and (3) sell the Carbon Sequestration Credits on the American Carbon Registry or other Permitted Exchange.

GreenTrees records its contracts with landowners in the official records of land ownership with the appropriate state or local government agency. The document recording GreenTrees claims is a covenant that runs with the land for at least 40 years (some GreenTrees covenants run longer), unless any issued offsets are replaced by other valid offsets or allowances (tradable offsets owned by GreenTrees may be cancelled without replacement). The covenant limits the amount of tree cutting that may occur such that sufficient carbon sequestration is maintained.

As the project proponent, GreenTrees commits to 40-year project life with the American Carbon Registry. Meanwhile our landowners commit to a contract term that follows the production of the carbon from the afforestation activities (net of any emissions from sustainable forest management). At the end of the production term, should the landowner wish to renew and generate more credits, the landowner will need to forfeit in part or in whole the option of future timber thinnings to create additional carbon from the improved forest management of the stand.

G2. CHAIN OF CUSTODY

Not Applicable.

G3. PRIOR APPLICATION

GreenTrees was approved under Version 1.0 of the *American Carbon Registry Forestry Standard*. This revision of the GreenTrees project document shows conformance with the *ACR Standard Version 2.1*, and the *ACR Forest Carbon Project Standard, version 2.1*. This document converts project accounting from the "GreenTrees Monitoring, Reporting and Verification Protocol" approved by ACR in 2009, updating to conformity with the ACR "Methodology for Afforestation and Reforestation of Degraded Land" version 1.0, issued by ACR in March 2011. This revision also converts the project document into the current ACR project document format.

H.
PROJECT TIMELINE

H1. START DATE

The base year for the project is 2008, and the baseline carbon stock is the carbon stock present on project lands on January 1, 2008. The start date of GreenTrees initial plantings is February 18, 2008. GreenTrees is a programmatic project, the project is treated as a single project with a single overall baseline and start date.

H2. PROJECT TIMELINE

The GreenTrees project activities began in 2008 with the programs initial reforestation in the project area. The project life is 40 years from the start date. Conforming to the *ACR Forest Carbon Project Standard Version 2.1*, the crediting period is also 40 years. GreenTrees is a programmatic approach treated as a single project composed of multiple plantings on multiple land ownerships and with multiple planting dates. GreenTrees will apply a 40-year commitment to each tract that is planted. This means that every land parcel will be bound by the project for 40 years, even if that parcel is enrolled and planted after the start year of 2008. A result of having all parcels committed for 40 years is that the commitments on parcels of land enrolled after the first year of the project will run beyond 2047, the current end of the project life and project crediting period.

Because GreenTrees is a programmatic approach with the goal of restoring 1 million acres of marginal and/or frequently flood lands in the project area, the project anticipates enrolling lands for several years. All lands, including lands enrolled after the project start year, will be monitored with site visits no less frequently than once every five years. Having plantings in multiple years can result in field monitoring activities occurring in more than 1/5th of years of the project. Initially, field monitoring is being done every year. If lands with different starting dates are brought into a common field monitoring cycle, the alignment of monitoring will be done by shortening the time interval between field monitoring visits on some lands, and no enrolled land ownership will be visited less than every fifth year.