Bluesource – Shafer-Tuuk Improved Forest Management Project

ACR 374

[November 27, 2018]

The Nature Conservancy

Prepared by: Bluesource LLC

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A.
PROJECT OVERVIEW

A1. PROJECT TITLE

The project title is “Bluesource – Shafer-Tuuk Improved Forest Management Project”.

A2. PROJECT TYPE

This project is to be registered under the American Carbon Registry Standard[1] (ACR, 2018) as an Improved Forest Management (IFM) project and an approved ACR Improved Forest Management Methodology.[2]

A3. PROOF OF PROJECT ELIGIBILITY

Eligibility for this Improved Forest Management project has been determined with reference to ACR Standard Version 5.0.

The Shafer-Tuuk forest carbon project meets all relevant eligibility requirements as described in Table A3.1 below.

Table A3.1. Project Eligibility Requirements

Eligibility Requirements	Proof of Eligibility	Reference
Ownership Type	The project ownership is private non-federal U.S. forestland.	See section G1. PROOF OF TITLE
Project proponent has third-party certification or no commercial timber harvesting	The Shafer-Tuuk Tree Farm, LLC is certified under the Forest Stewardship Council (FSC).	See also section A5.1. Background Information
Project area meets the definition of Forestland condition as per USFS FIA program definition	Per the ACR Forest Carbon Project Standard, the project meets the definition of forestland through a minimum of 10% forest cover (or equivalent stocking) by live trees of any size.	See also section A4. LOCATION
Project start date	The project start date of July 29, 2016 complies with the ACR Standard Version 5.0 start date of January, 2015 or later.	See also section H1. START DATE.

[1] ACR. 2018. American Carbon Registry Standard, Version 5.0. American Carbon Registry, Arlington, VA, USA.

[2] ACR. 2016. *Improved Forest Management Methodology for Quantifying GHG Removals and Emission Reductions through Increased Forest Carbon Sequestration on Non-Federal Forestlands*, Version 1.2, December 2016, American Carbon Registry, Arlington, VA, USA.

	The start date predates the implementation of a conservation easement signed on December 21, 2016. The evidence referenced above further complies with the methodology (Improved Forest Management Methodology for Quantifying GHG Removals and Emission Reductions through Increased Forest Carbon Sequestration on Non‐Federal U.S. Forestlands) requirement that "If the project Start Date is more than one year before submission of the GHG plan, the Project Proponent shall provide evidence that GHG mitigation was seriously considered in the decision to proceed with the project activity. Evidence shall be based on official and/or legal documentation. Early actors undertaking voluntary activities to increase forest carbon sequestration prior to the release of this ***requirement may submit as evidence recorded conservation easements*** or other deed restrictions that affect onsite carbon stocks."	
Project term	The project proponent commits to maintain the carbon project scenario stocking levels on the project area at least for the required Project Term of 40 years.	See also section H2. PROJECT TIMELINE.
Crediting Period	In compliance with the ACR Standard Version 5.0, the crediting period for the project is 20 years.	See also section H2. PROJECT TIMELINE.
Real	GHG removals are quantified based on inventory of the standing stock in the project area at the time of verification.	See also sections D. MONITORING PLAN and E. QUANITIFCATION
Land Title	For all areas included in the project, long term land titles have been issued and ownership is thus clear, unique, and uncontested.	See also appendix A. Land Owner and Contracts.

Direct Emissions/ Offset Title	GHG emission reductions generated by the project activity are generated from forest carbon sources and sinks over which Shafer-Tuuk Tree Farm LLC has all management (see Appendix A, conservation easement and ownership) rights. Shafer-Tuuk Tree Farm LLC holds title to all lands in the project area (see Section G below) and all rights to carbon credits/offsets produced through management of forests in the project area (see Appendix A, conservation easement).	See also section G2. CHAIN OF CUSTODY
Additionality	Additionality for the project has been shown through a regulatory surplus test, a common practice test, and an implementation barrier test.	See also section C. ADDITIONALITY
Permanent	The long-term setup, risk analysis, and buffer establishment assure permanence of the project benefits.	See also section B8. PERMANENCE.
Net of Leakage	Possible leakage effects due to activity shifts are quantified and deducted from the GHG benefits.	See also section E3. LEAKAGE.
Independently Validated and Verified	In accordance with ACR methodology, the project benefits will be verified by SCS Global Services.	
Community and Environmental Impacts	Impacts on community and environment were analyzed in accordance with the ACR Standard 5.0, net positive impacts were confirmed.	See also section F. COMMUNITY & ENVIRONMENTAL IMPACTS

A4. LOCATION

A GIS shapefile of the project area, 'Tuuk_ Boundary_10_31_17' was provided separately for verification. This shapefile gives unique identification and delineation of the specific extent of the project. Vicinity map (Figure A-1.) gives project location and latitude/longitude coordinates. Figure A-2. shows Shafer-Tuuk IFM in the context of local hydrology. The canopy cover map (Figure A-3.) clearly shows that the project meets the US Forest Service definition of forestland (at least 10% tree cover) as forest covers the majority of the project area. Non-forested acres were removed from the project to a minimum mapping unit of 2.5 acres. The project area topography (Figure A-4.) and public and private road infrastructure (Figure A-5.) are shown below.

As described in the Shafer-Tuuk Forest Management Plan (FMP): "The Shafer-Tuuk Timberland is located in central Tennessee 7.5 air miles northeast of Sparta mostly in northeastern White County (Figure 1). A small portion of the tract on the far northeast of the boundary, approximately two acres, appears to overlap into Putnam County. However, for the purposes this plan, White County is considered the primary area of analysis given the proportion of the tract there. It is positioned between Highways 84 to the north and 70 to the south and primary access is via Cantown, Pass Cove, and Cove Roads. The property

comprises 4.9 square miles or ~3,111 acres of protected lands, encompassed by 21 miles of external boundary and can be found primarily on the DeRossett United States Geological Services (USGS) 7.5-minute quadrangle with a small portion of the western boundary on the Sparta USGS 7.5-minute quadrangle. The property comprises the entire width of the Cumberland Escarpment where it occurs, and it abuts and includes portions, vegetation, and geologic affinities of the Interior Low Plateau ecoregion on the western boundary, and of the Cumberland Plateau ecoregion on the east."

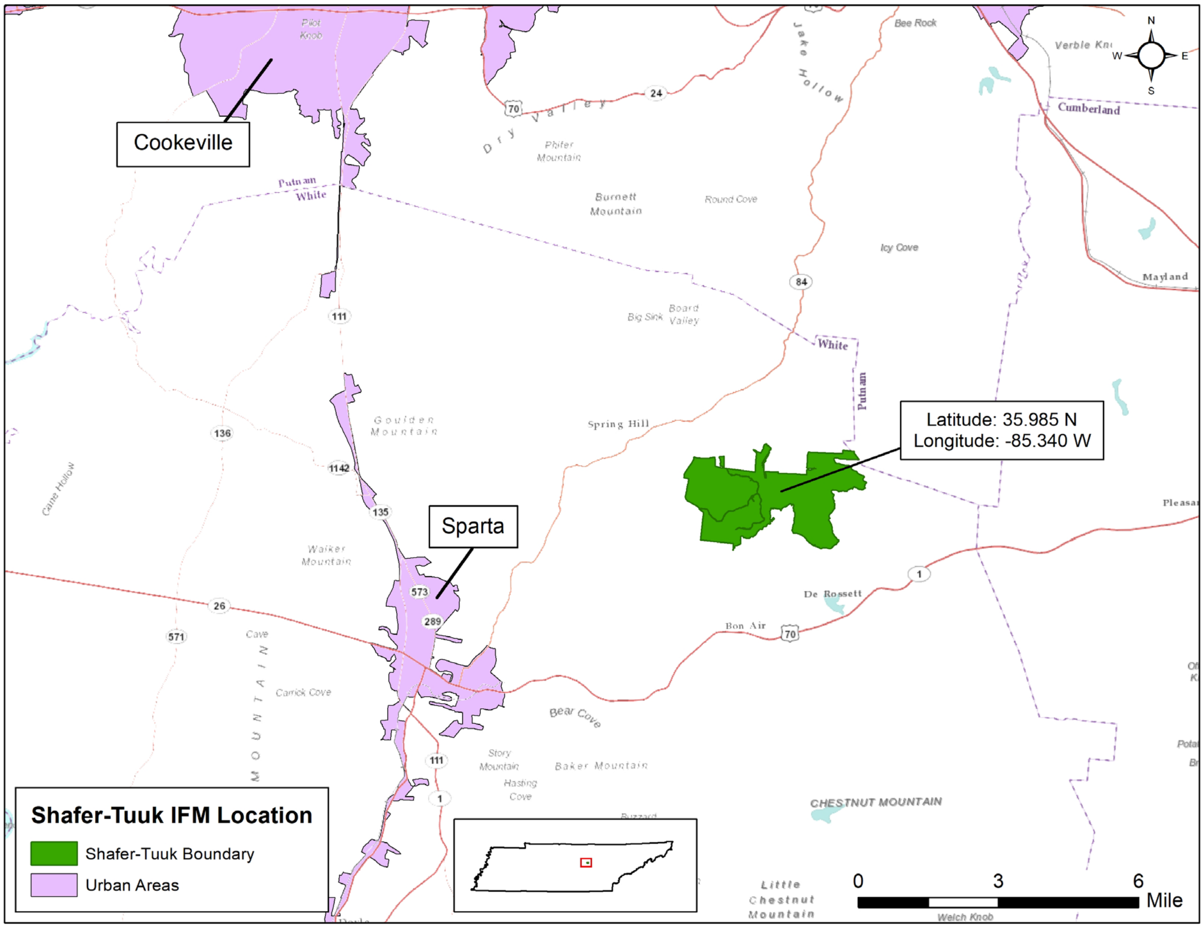


Figure A-1. Vicinity Map with Latitude and Longitude

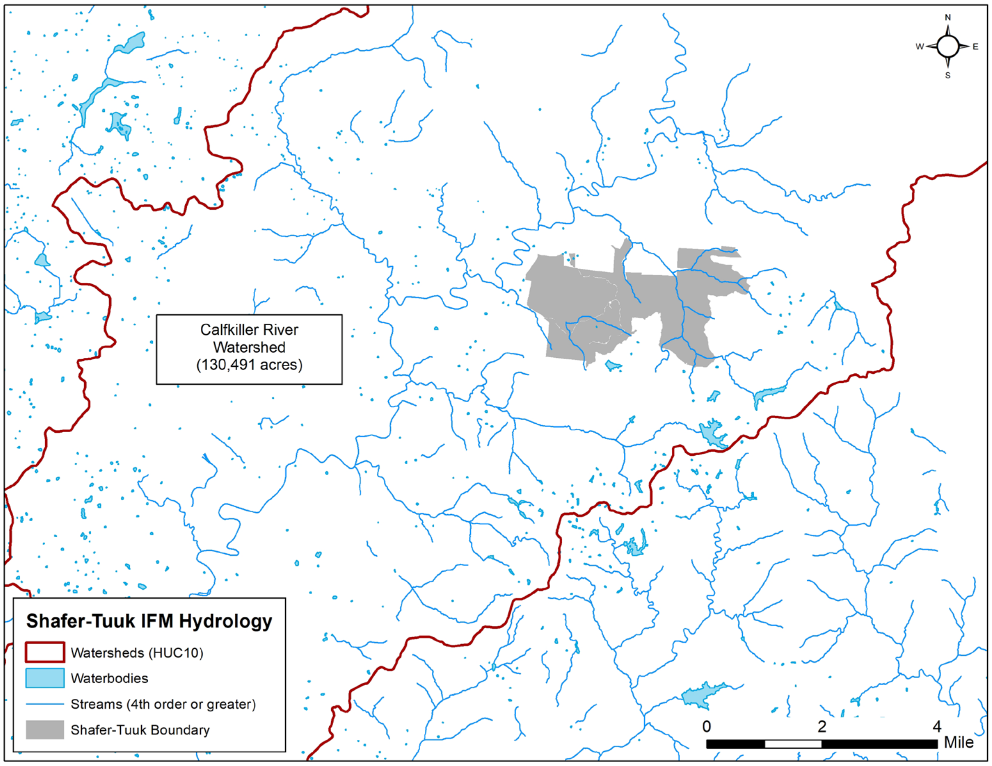


Figure A-2. Regional Hydrology Map

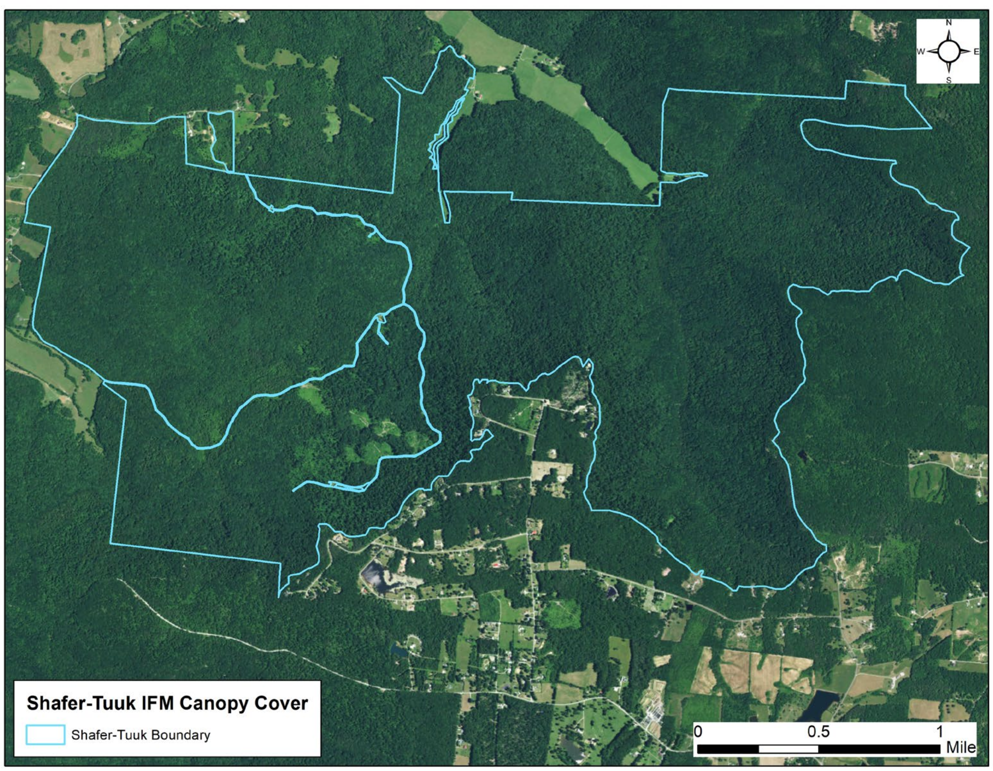


Figure A-3. Canopy Cover Map depicting greater than 10% canopy cover

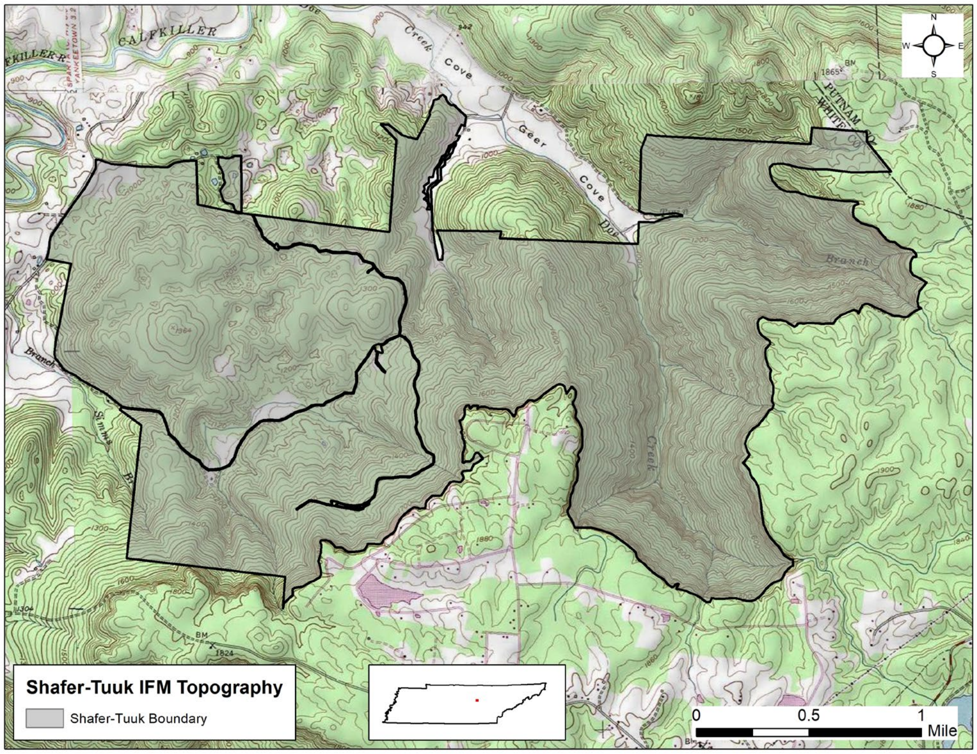


Figure A-4. Topography Map

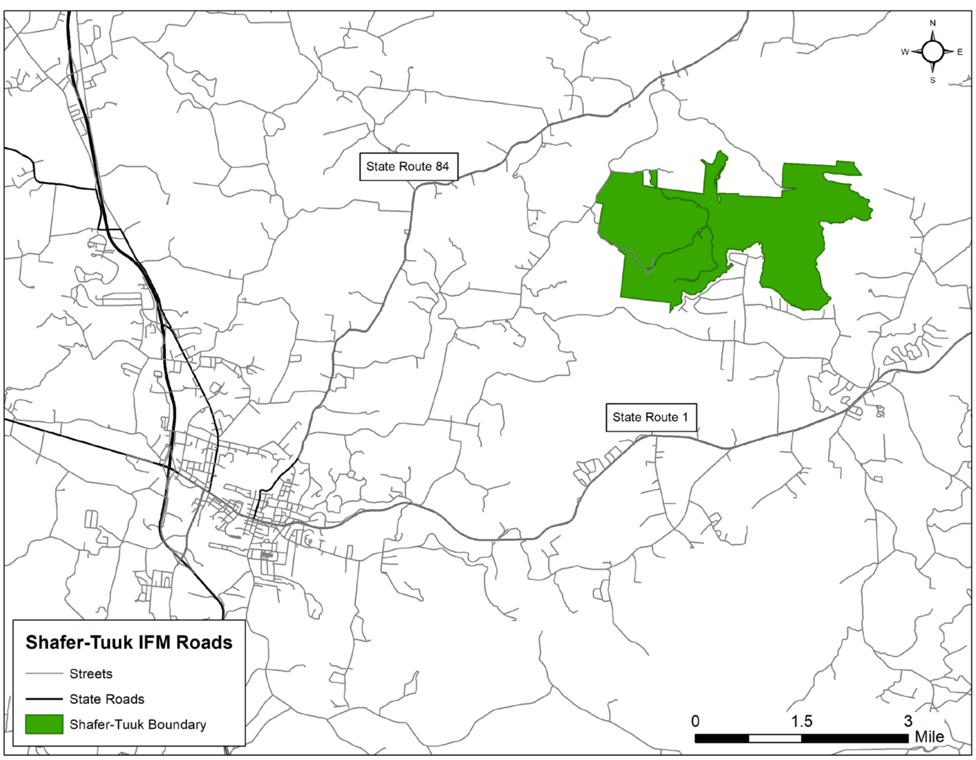


Figure A-5. Roads Map

A5. BRIEF SUMMARY OF PROJECT

A5.1 Background Information

The Bluesource – Shafer-Tuuk Improved Forest Management Project is located on 3,111 acres of northern hardwoods, mixed hardwoods, cove forest and oak-hickory forest in the Eastern Cumberland Plateau of Tennessee. The Shafer-Tuuk Tree Farm LLC implemented the carbon project in tandem with a permanent conservation easement signed several months after the initial project start date. The project start date coincided with the contractual signing of the carbon project development agreement (provided separately for verification purposes) with the project developer, Bluesource LLC (Bluesource).

The Shafer-Tuuk FMP outlines the recent history and current management goals set out in tandem with the carbon project: "The Shafer-Tuuk Timberland property (the Property) lies on the Cumberland Plateau, a conservation priority for TNC. The forests, rivers, and caves of the Cumberland Plateau are among of the most biologically diverse in the United States. Within Tennessee, the Cumberlands contain a highly-connected network of some of the largest remaining, intact core blocks of forest in the East. These areas form forest anchors that contribute to landscape-scale conservation efforts including surrounding forest blocks that link from Alabama to Pennsylvania. The biodiversity of the Cumberlands is unparalleled elsewhere within temperate deciduous forest regions of North America. The Shafer-Tuuk property is rich in natural resources representative of the Plateau and provides opportunity to manage and protect a significant forested landscape to the highest standards.

The landowner's long-term management goals for the property have been identified as:

- Maintain healthy and vigorous forest stands through active management.
- Market commercial timber resources for income.
- Conserve and protect soil and water.
- Protect rare, unique natural areas and species.
- Maintain and improve habitat for wildlife (deer, bear, turkey, and rare, threatened and
- endangered species).
- Provide opportunity for outdoor recreation activities including wildlife for hunting.

These goals and objectives as identified by the landowner will be accomplished through a variety of methods including active forest management, wildlife management, and resource protection."

A5.2 Description of Project Activity

The project activity is improved forest management, with Shafer-Tuuk Tree Farm LLC's forest management practices representing a significant improvement in the carbon storage and conservation value than higher return, more aggressive management regimes of industrial private lands in the region, which are characterized by shorter, even-aged rotations. Management decisions of the forest focus on sustainable, natural forest growth and maintenance harvests for essential activities and forest health. The project ensures long-term sustainable management of the forests, which could otherwise undergo significant commercial timber harvesting.

A5.3 Project Purpose and Objectives

By committing to maintain forest CO2 stocks above the regional baseline level, the project will provide significant climate benefits through carbon sequestration. The aim of this project is also to ensure long-term continuance of all environmental benefits provided by the conservation of this forestland.

A6. PROJECT ACTION

A6.1 Prior Physical Conditions

Climactic zone: The project falls within zone 6b and 7a on the USDA plant hardiness zone map. Average annual extreme minimum temperatures for 6b are -5 to 0 degrees Fahrenheit, and for 7a are 0 to 5 degrees Fahrenheit.

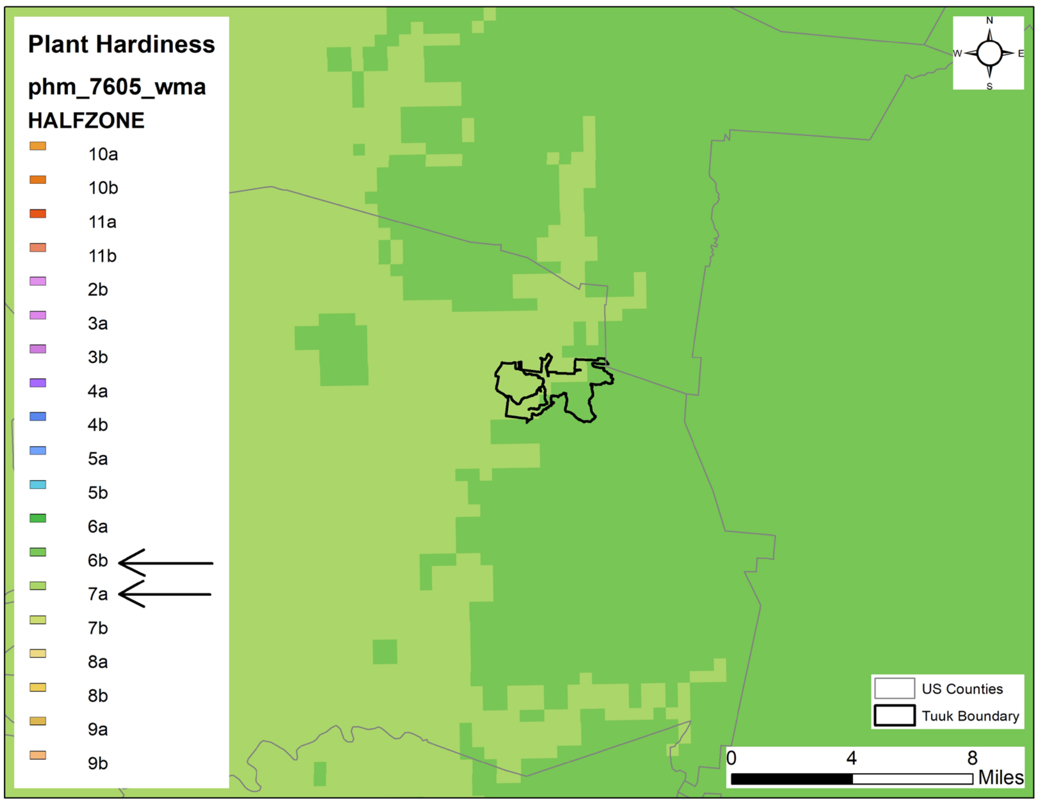


Figure A6. Plant Hardiness Map with Project Boundary Overlay

Ecosystem:

> "This tract is typical of the region with mixed mesophytic and xeric/sub-xeric forest types. The mixed mesophytic and xeric/sub-xeric forest types vary based on moisture availability and are known for their species richness and productivity. Often these forests have over 75 species of trees and numerous under and mid-story species and are frequently classified into forest types based on site characteristics and soils – which can be difficult to determine various boundaries due to overlap of species and conditions." -Shafer-Tuuk FMP

Vegetation:

"Many of these forests are dominated by Yellow poplar (Liriodendron tulipifera), various oak species including White oak (Quercus alba) and Red oak (Quercus rubra), maple (Acer rubrum and A. saccharum), and hickory (Carya spp.). Other valuable species such as Black cherry (Prunus serotina) and Black walnut (Juglans nigra) are also present.

Under- and mid-story species frequently include Spicebush (Lindera benzoin) Eastern redbud (Cercis Canadensis), Flowering dogwood (Cornus florida), Sassafras (Sassafras albidum), Sourwood (Oxydendrum arboreum), Flame azalea (Rhododendron calendulaceum), rhododendron (Rhododendron species), and Mountain laurel (Kalmia latifolia). A rich and diverse herbaceous layer usually includes grapevine (Vitas spp.), greenbrier (Smilax spp.), poison ivy (Toxicodendron radicans), Virginia creeper (Parthenocissus quinquefolia), Mayapple (Podophyllum peltatum), trillium (Trillium spp.), cohosh (Cimicifuga racemosa and Caulophyllum thalictroides), ginseng (Panax quinquefolius), violets, geraniums and numerous other species. Over 1,500 herbaceous plant species are known in the Southern Appalachians." -Shafer-Tuuk FMP

Land Use:

The Shafer-Tuuk Forest Management Plan outlines much of the major past and ongoing forest and land history of the region: "The majority of the land surrounding the Shafer-Tuuk property in White County has residential, agricultural, mineral, and forestry uses (Figure 3). Additionally, there is continued and increasing support for tourism and outdoor recreation as the area includes several quality rivers offering boating opportunities, multiple public lands for recreation, and high concentrations of caves and waterfalls. Much of the region maintains productive forestlands and agricultural fields. Both agriculture and forest product industries have played a prominent role in the region historically, and continue to be major land uses today. Agricultural uses currently include both row crops such as corn and soybeans and animal husbandry, particularly livestock and poultry. Forest products include both native hardwood and more intensively managed pine products. Additional natural resources such as coal and limestone have historically played and continue to play a role in the region.

Since the ownership by the Tuuks, the property has been managed for forest resources and timber products. Harvesting and professional land management techniques have been employed across the tract for a variety of purposes. Prior to Tuuk ownership, the tract was also maintained for timber resources, though evidence is present to suggest prior habitations and minor agriculture.

The forest of the Shafer-Tuuk property is resultant and demonstrates impacts from past management. Historic harvest practices have left a forest, that in most cases, has had multiple entries for timber extraction. Additionally, past home sites and forest stands resultant from cleared agricultural fields are present on the property."

A6.2 Description of Project Technologies, Products, Services, and Expected Level of Activity

"The landowners of the Shafer-Tuuk Timberland are committed to long-term management of the property to continue to provide ecosystem services such as clean air, water, and sustainable forest products. This is demonstrated through their historic management working to employ the best practices and further emphasized through the donation of a working woodlands conservation easement to The Nature Conservancy.

> To accomplish the stated goals and objectives for management for future conditions of the Property, integrative and adaptive management strategies will be applied for forests, water, wildlife, recreation, and other resources. This includes formal forest planning and active management such as commercial timber harvest, timber stand improvement (TSI), Integrated Pest Management (IPM), protection of aquatic resources, and wildlife management such as habitat improvement and restoration.
>
> In order to maintain long-term sustainable timber management, it is critical harvest rates do not exceed growth rates. Annual allowable cut (AAC) was determined based on the results of the 2014 forest inventory and average growth rates across the region conservatively applied at 2.65 percent (FIA 2017). For the Shafer-Tuuk property, AACs are maintained on a moving 10-year average. This means that while in any year the harvest drain may exceed the mean annual increment, harvest drains should not exceed periodic annual increments for any 10-year period."

The types of harvests recommended by the FMP include shelterwood, seed tree, regeneration, group selection, and individual tree selection – all in accordance with the FSC certification. The intention of the management is to avoid low-grade cuts by removing poor or low-quality tree in order to promote high quality timber and wildlife trees (including snags and den trees).

A6.3 Project Action

By committing to maintain forest CO2 stocks above the baseline level, the project will provide significant climate benefits through carbon sequestration. The project action will allow the forest to progress naturally with no commercial harvesting. In tandem with the project, a conservation easement has been put into place to ensure permanence. Bluesource – Shafer-Tuuk Improved Forest Management Project will achieve GHG removals by sequestering more atmospheric CO_2 than a baseline scenario in live aboveground biomass, belowground biomass, dead wood, and soil.

A7. *EX ANTE* OFFSET PROJECTION

Total projected GHG removal is 320,669 mtCO_2e (without risk buffer deduction) over the first crediting period of 20 years (including GHG removal from long-term wood products). Table A7.1 lists the estimates of GHG emissions reductions per year:

Table A7.1. Estimate of Net ERTs by Year.

Project Year	*Year*	*Estimates of GHG emission reductions (mtCO_2e)*
0	*2016*	Start year
1	*2017*	59,732
2	*2018*	61,148

3	*2019*	59,006
4	*2020*	59,006
5	*2021*	951
6	*2022*	5,646
7	*2023*	5,646
8	*2024*	5,646
9	*2025*	5,646
10	*2026*	5,646
11	*2027*	6,032
12	*2028*	6,032
13	*2029*	6,032
14	*2030*	6,032
15	*2031*	6,032
16	*2032*	4,487
17	*2033*	4,487
18	*2034*	4,487
19	*2035*	4,487
20	*2036*	4,487

A8. PARTIES

The project was implemented by Shafer-Tuuk Tree Farm LLC, the land owner, and Bluesource, LLC, a carbon offsets developer. The project was also coordinated by the conservation easement holder, The Nature Conservancy. Project verification was completed by SCS Global Services and the forest carbon inventory was conducted American Forest Management. Technical modeling was conducted by Bluesource LLC.

Table A-3. Project Partners & Responsibilities

Project Parties	**Personnel/Point of Contact**	**Roles and Responsibilities**	**Contact Information**
Shafer-Tuuk Tree Farm LLC	Rebecca Tuuk, Landowner	Project Proponent – financing and implementation of long-term project management	Shafer-Tuuk Tree Farm LLC 205 Southwoods Avenue, Fremont, MI 49412
The Nature Conservancy	Trish Johnson, Director of Forest Conservation	Easement Holder	Trish Johnson 210 25th Ave N #810, Nashville, TN 37203
Bluesource, LLC	Josh Strauss, Vice President	Offset Developer – coordination of project implementation, modeling	Bluesource LLC 1935 E. Vine Street Murray, UT 84121 Phone: 949-233-1501

SCS Global Services	Scott Eaton, Associate, Greenhouse Gas Verification	Verifier	SCS Global Services 2000 Powell Street Emeryville, CA 94608 Phone: 510-452-8000
American Forest Management	Jake Almond, Regional Manager	Contractor- Forest Inventory	AFM 208 Clifton Turnpike, Waynesboro, TN 38485 Phone: 865-248-8315

B.
METHODOLOGY

B1. APPROVED METHODOLOGY

The methodology used for the Bluesource – Shafer-Tuuk Improved Forest Management Project is the American Carbon Registry Improved Forest Management Methodology for Quantifying GHG Removals and Emission Reductions through Increased Forest Carbon Sequestration on Non-Federal U.S. Forestlands, Version 1.2. (December 2016)

(hereinafter called the "methodology")

B2. METHODOLOGY JUSTIFICATION

All applicability criteria of the selected methodology are fulfilled by the Bluesource – Shafer-Tuuk Improved Forest Management Project:

- Shafer-Tuuk Tree Farm LLC is non-federally owned forestland.
- Shafer-Tuuk Tree Farm LLC controls the timber rights on the forestland and can legally harvest (appendix I2. Land Owner and Contracts). The conservation easement put into place in conjunction with the carbon project will restrict future harvesting.
- There is no commercial timber harvesting occurring on or after the project Start Date. Shafer-Tuuk Tree Farm LLC maintains an FSC certification valid as of March 10, 2018, which is in compliance with the protocol that states the Landowner much be certified within one year of the project Start Date.
- Bluesource – Shafer-Tuuk Improved Forest Management Project is not on tribal lands.
- Bluesource – Shafer-Tuuk Improved Forest Management Project is not on public non-federal lands.
- There is no use of non-native species where adequately stocked native stands were converted for forestry or other land uses after 1997.
- There is no draining or flooding of wetlands on or after the project Start Date.
- See attached Deeds (appendix I2. Land Owner and Contracts).
- Stocking levels increase well above the baseline conditions for the duration of the project and by the end of the Crediting Period (see section E1. Baseline).

B3. PROJECT BOUNDARIES

The physical project boundaries include 3,111 acres of forestland, shown in the maps in section A4. Location and in the shapefile "Tuuk_Boundary_10_31_2017".

See H2. Project Timeline for the temporal boundaries of the project.

B4. IDENTIFICATION OF GHG SOURCES AND SINKS

Identify the GHG sources and sinks within the project boundaries. If any sources or sinks will be considered de minimis*, include a justification.*

Carbon pools	Included / Optional / Excluded	Justification / Explanation of Choice
Above-ground biomass carbon	Included	Major carbon pool subjected to the project activity.
Below-ground biomass carbon	Included	Major carbon pool subjected to the project activity.
Standing dead wood	Included/Optional	Major carbon pool in unmanaged stands subjected to the project activity. Project Proponents may also elect to include the pool in managed stands. Where included, the pool must be estimated in both the baseline and with project cases. *For Bluesource - Shafer-Tuuk Improved Forest Management Project, standing dead wood will be included in all stands.*
Lying dead wood	Optional	Project proponents may elect to include the pool. Where included, the pool must be estimate in both the baseline and with project cases. *For Bluesource – Shafer-Tuuk Improved Forest Management Project, lying dead wood will not be included.*
Harvested wood products	Included	Major carbon pool subjected to the project activity.
Litter/Forest Floor	Excluded	Changes in the litter pool are considered *de minimis* as a result of project implementation.
Soil organic carbon	Excluded	Changes in the litter pool are considered *de minimis* as a result of project implementation.

Gas	Source	Included / Excluded	Justification / Explanation of choice
CO_2	Burning of biomass	Excluded	However, carbon stock decreases due to burning are accounted as a carbon stock change.
CH_4	Burning of biomass	Included	Non-CO_2 gas emitted from biomass burning.
N_2O	Burning of biomass	Excluded	Potential emissions are negligible.

Leakage Source		**Included / Optional / Excluded**	**Justification/ Explanation of Choice**
Activity-Shifting	Timber Harvesting	Excluded	Project Proponent must demonstrate no activity-shifting leakage beyond the *de minimis* threshold will occur as a result of project implementation.
	Crops	Excluded	Forestland eligible for this methodology to not produce agricultural crops that could cause activity shifting.
	Livestock	Excluded	Grazing activities, if occurring in the baseline scenario, are assumed to continue at the same levels under the project scenario and thus there are no leakage impacts.
Market Effects	Timber	Included	Reductions in project outputs due to project activity may be compensated by other entities in the marketplace. Those emissions must be included in the quantification of project benefits.

B5. BASELINE

The baseline scenario represents an aggressive industrial harvest regime, targeted to maximize net present value at a 5% discount rate, typical of ca. 2016 practices in the project region on private lands. Baseline practices involve large scale clear-cuts and high-grading. Derivation and justification for the baseline is detailed in Section E. Quantification.

B6. PROJECT SCENARIO

The project scenario consists of growing the forestland with commercial harvesting maintaining carbon removals above the annual allowable cut as described in Section A5. Project Action.

B7. REDUCTIONS AND ENHANCED REMOVALS

The project will achieve greenhouse gas reductions through natural growth of forestland and improved silvicultural practices such as shelterwood, group selection, seed tree cuts, regeneration, and individual tree selection cuts on lands that otherwise could be heavily cut in the baseline scenario. The existing carbon stocks will be preserved through maintaining growth above the annual allowable cut over a moving 10-year average as described in Section A5. Project Action and in the FMP.

B8. PERMANENCE

Project Proponents must conduct their risk assessment using the *ACR Tool for Risk Analysis and Buffer Determination*. All Project types must claim a value from risk categories A, B and C. Additional values that must be selected by project type include:

Forestry projects claim one value from each:

D Conservation Easement (if applicable)

E Fire
F Disease/pest
G Levee failure/water table changes (required only if forested wetlands comprise more than 60% of project area)
H Other natural disaster risk scores.

1. Management and Governance Risks: All project types must select one value form each risk category that applies:

A	Financial	• 4% Default Value • 3% US Public and Tribal Lands
B	Project Management	• 4% Default Value • 3% US Public and Tribal Lands
C	Social/Policy	• 2% Default Value • 5% if project is located outside of the US • 3% if project is located outside of the US and demonstrates community engagements through ACR-approved mechanism
D	Conservation Easement Deduction	• -2% Default value • -3% if there is regular onsite monitoring of activities related to carbon-specific conservation activities

2. Natural Disaster Risks: Select one value from each risk category that applies:

E	Fire	• 8% if project is located in an area where fire greater than 1000 acres has occurred within 30 mile radius of project area in prior 12 months • 4% if project is located in high fire risk region • 2% if project is located in low fire risk region (verifiable evidence must be provided) • 1% for agriculture and grassland projects only
F	Diseases and Pests	• 8% if epidemic disease or infestation is present within project area, or within 30 mile radius of project area • 4% Default Value
G	Levee Failure and Water Table Changes	• 2% Default for all wetland projects (and for forest projects where more than 60% of the project area is a forested wetland)
H	Other Natural Disaster Events	• 2% Default Value for all sequestration projects

Calculated Risk Score

Section 1 (A + B + C + D*) + Section 2 (E + F + G + H) = Total Risk score %

Section 1 (4 + 4 + 2 + -2) + Section 2 (2 + 4 + 0 + 2) = 16%

NOTE: D. *Conservation Easement attached in "Project Supporting Documents.zip"*

NOTE: E. *According to the Wildfire Hazard Potential (WHP) map provided by the USFS (Figure B-1)*

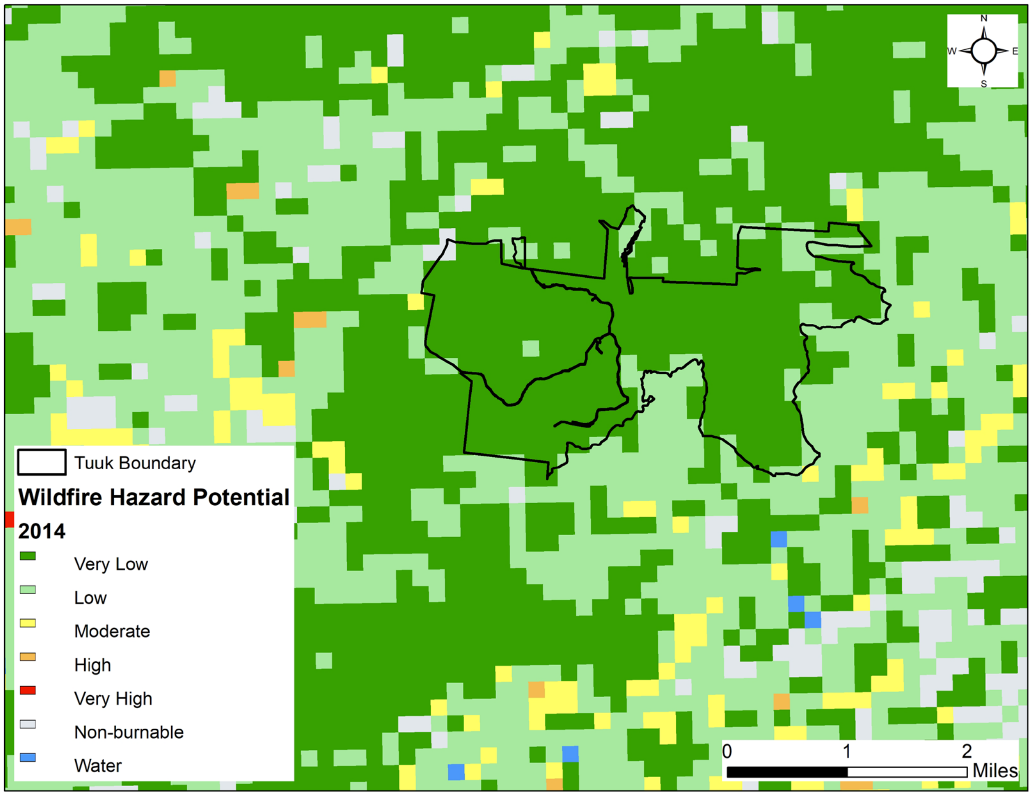


Figure B-1. Shafer-Tuuk Wildfire Hazard Potential Map

Buffer Pool Contribution

Total Risk score % * Total ERTs generated for crediting period = Buffer pool contribution in ERTs

*16% * 320,669 = 51,307 credits of buffer pool contribution*

C. ADDITIONALITY

C1. REGULTORY SURPLUS TEST

Relevant laws, regulations, statues, legal rulings, and other regulatory frameworks that affect the project activity:

National laws, regulations and policies.

Clean Water Act
Endangered Species Act
Fair Labor Standards Act (1938) (amended)
Multiple-Use Sustained-Yield Act of 1960
National Environmental Policy Act (NEPA)
National Forest Management Act (NFMA)
Resources Planning Act (RPA)
Wilderness Act
The Logger's Guide to the New OSHA Logging Safety Standards, 1995

State & Local laws.

TCA 43-28-312– Cutting timber from property of another - Civil liability

Binding International Agreements.

Paris Agreement, 2016
Kyoto Protocol, 1997 (signed, not ratified)
United Nations Framework Convention on Climate Change, 1992
United Nations Convention on Biological Diversity, 1992 (signed, not ratified)
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973
UNESCO World Heritage Convention, 1972

None of the above or any other existing law, regulation, statute, legal ruling, or other regulatory framework in effect as of the Start Date in 2016 effectively requires the forest carbon project activity and its associated GHG emissions reductions/removal enhancements. Consequently, the project passes the Regulatory Surplus test.

C2. COMMON PRACTICE TEST

The geographic region for timber is referred to as "Appalachia" in the annual Timber Mart-South Report, which includes eastern Tennessee, western North Carolina, southwestern Virginia. Wood products including sawtimber (pine, oak, and mixed hardwood), chip-n-saw (pine), and pulpwood (pine and hardwood) are distributed to mills throughout this region. The forest type for this project is industrial

forestland ownership due to the size of the property and its status as private landholding. Throughout the geographic region, the industrial forestland type is heavily cut and managed for maximizing NPV of the forestland investment. If the Bluesource – Shafer-Tuuk Improved Forest Management Project was not implemented, the forest management could feasibly resemble that of industrial forestland ownership in the region. Instead, the project will exceed the common practice as described in Section A6. Project Action.

C3. IMPLEMENTATION BARRIERS TEST

Implementation Barriers	*Choose one of the following three:*
Financial	Does the project face capital constraints that carbon revenues can potentially address; *or* is carbon funding reasonably expected to incentivize the project's implementation; *or* are carbon revenues a key element to maintaining the project action's ongoing economic viability after its implementation? **Yes = Pass; No = Fail**
Technological	Does the project face significant technological barriers such as R&D deployment risk, uncorrected market failures, lack of trained personnel and supporting infrastructure for technology implementation, or lack of knowledge on practice/activity, and are carbon market incentives a key element in overcoming these barriers? **Yes = Pass; No = Fail**
Institutional	Does this project face significant organizational, cultural, or social barriers to implementation, and are carbon market incentives a key element in overcoming these barriers? **Yes = Pass; No = Fail**
If the project passes the Regulatory Surplus and Common Practice tests, and at least one Implementation Barrier test, ACR considers the project additional.	

Financial: Carbon funding is reasonably expected to incentivize the project's implementation. The implementation of the carbon project represents an opportunity cost to lost revenue associated with the potential timber harvesting that could legally and feasibly occur on the property in the lifetime of the carbon project. A financial feasibility assessment is provided separately for verification demonstrating the financial barrier carbon funding overcomes in project implementation.

C4. PERFORMANCE STANDARD TEST

The Bluesource – Shafer-Tuuk Improved Forest Management project uses the three-pronged approach; therefore, this step is not required.

D.
MONITORING PLAN

D1. MONITORED DATA AND PARAMETERS

Data or Parameter Monitored	A_1
Unit of Measurement	Acres
Description	Area of IFM Project
Data Source	GIS shape file derived from GPS coordinates
Measurement Methodology	Strata area figures adjusted based on stocking levels and species distribution projected in modeling and verified through inventory updates. Total project area remains fixed through crediting period.
Data Uncertainty	None
Monitoring Frequency	Every 5 years, following with inventory update
Value applied:	3,111.0
Reporting Procedure	Hand held GPS unit, GIS software
QA/QC Procedure	Meta data is kept current and uncorrupted
Purpose of Data	Calculation of project emissions
Calculation method:	Calculated in Arc GIS
Notes	

Data or Parameter Monitored	T
Unit of Measurement	Year
Description	Number of years between monitoring time t and t1 (T = t2 – t1)
Data Source	Monitoring reports
Measurement Methodology	
Data Uncertainty	None
Monitoring Frequency	Yearly
Value applied:	Calendar
Reporting Procedure	
QA/QC Procedure	All calculations double checked for accuracy prior to submission for verification
Purpose of Data	Calculation of project emissions
Calculation method:	Subtraction
Notes	

Data or Parameter Monitored	Diameter at breast height of tree
Unit of Measurement	Inches (to 1/10th an inch)
Description	Tree diameter measure 4.5 feet above ground
Data Source	Field measurement
Measurement Methodology	Measured with Loggers Tape
Data Uncertainty	None
Monitoring Frequency	Every 5 years after the first inventory
Value applied:	
Reporting Procedure	Hand held GPS unit or cruise tally sheet
QA/QC Procedure	Equipment will be maintained in excellent condition. Breast height marked with permanent paint on all record trees >5in in diameter
Purpose of Data	Calculations of project emissions
Calculation method:	N/A
Notes	

Data or Parameter Monitored	H
Unit of Measurement	Feet
Description	Height of tree
Data Source	Field measurement
Measurement Methodology	Measured with clinometer or hypsometer
Data Uncertainty	None
Monitoring Frequency	Every 5 years after the first inventory
Value applied:	
Reporting Procedure	Hand held GPS unit or cruise tally sheet
QA/QC Procedure	Equipment will be maintained in excellent condition. All heights will be double checked for reasonableness prior to submission for verification
Purpose of Data	Calculations of project emissions
Calculation method:	N/A
Notes	

Data or Parameter Monitored	Decay Class
Unit of Measurement	
Description	Qualitative degree of decomposition
Data Source	Forest Inventory
Measurement Methodology	Qualitative assessment of dead tree into 1 of 4 decay classes based on class descriptions
Data Uncertainty	None
Monitoring Frequency	Every 5 years after the first inventory
Value applied:	
Reporting Procedure	Hand held GPS unit or cruise tally sheet
QA/QC Procedure	Equipment will be maintained in excellent condition. All decay classes will be double checked

	for reasonableness prior to submission for verification
Purpose of Data	
Calculation method:	
Notes	

Data or Parameter Monitored	Tree Live/Dead Status
Unit of Measurement	
Description	Live or Dead
Data Source	Forest Inventory
Measurement Methodology	Measured per the Shafer Tuuk Carbon Plot Methodology
Data Uncertainty	None
Monitoring Frequency	Every 5 years after the first inventory
Value applied:	
Reporting Procedure	Hand held GPS unit or cruise tally sheet
QA/QC Procedure	Equipment will be maintained in excellent condition. All tree statuses will be double checked for reasonableness prior to submission for verification
Purpose of Data	
Calculation method:	
Notes	

Data or Parameter Monitored	Defect
Unit of Measurement	
Description	Qualitative percent of missing biomass
Data Source	Forest Inventory
Measurement Methodology	Qualitative assessment of tree assessed by thirds for the % missing biomass from each third. Post-inventory weighting conducted for each third of tree (Bottom 65%, Middle 25%, Top 10%)
Data Uncertainty	None
Monitoring Frequency	Every 5 years after the first inventory
Value applied:	
Reporting Procedure	Hand held GPS unit or cruise tally sheet
QA/QC Procedure	Equipment will be maintained in excellent condition. All tree defects will be double checked for reasonableness prior to submission for verification.
Purpose of Data	
Calculation method:	
Notes	

Data or Parameter Monitored	Species Composition
Unit of Measurement	%
Description	Spp composition as a percentage of basal area
Data Source	Forest Inventory
Measurement Methodology	Derived from basal area calculations from inventory data.
Data Uncertainty	None
Monitoring Frequency	Every 5 years after the first inventory
Value applied:	
Reporting Procedure	
QA/QC Procedure	Species identification is confirmed at verification.
Purpose of Data	Calculation of project emissions
Calculation method:	Basal Area = 0.005454 * DBH^2
Notes	

Data or Parameter Monitored	Harvested Wood Products
Unit of Measurement	Metric tons CO_2
Description	Carbon remaining in stores wood products 100 years after harvest for the project in year t.
Data Source	Harvest slips and reports produced by Shafer Tuuk Tree Farm LLC.
Measurement Methodology	Wood volumes harvested will be monitored using by American Forest Management's internal recordation system.
Data Uncertainty	None
Monitoring Frequency	Annual data summed for the monitoring period, applied as average annual for the monitoring period
Value applied:	
Reporting Procedure	
QA/QC Procedure	Harvest volumes cut and delivered to the mill will be either (1) weighed at the mill on scales tested annually by the state of Tennessee and converted to wood volume in an appropriate software, or (2) directly scaled to volume by log scalers certified by the state of Tennessee.
Purpose of Data	
Calculation method:	
Notes	

Data or Parameter Monitored	Forest Carbon
Unit of Measurement	Metric tons of CO_2
Description	Carbon stores in above and below ground live trees at the beginning of the year t

Data Source	Forest Inventory
Measurement Methodology	Consistent with Shafer Tuuk Carbon Plot Methodology.docx
Data Uncertainty	To be calculated as the mean +/- 90% confidence interval
Monitoring Frequency	Every 5 years or less, or at request for ERT issuance
Value applied:	
Reporting Procedure	
QA/QC Procedure	Consistent with Shafer Tuuk Carbon Plot Methodology.docx. The inventory will use a random sample design and re-measure the same permanent plots established in 2017, which targeted a precision level of +/- 10% of the mean live tree biomass with 90% confidence.
Purpose of Data	
Calculation method:	
Notes	

D2. MONITORING PLAN

Each year, the Project Proponent shall submit a signed Attestation that:

- Confirms the continuance of project activities;
- Confirms that ownership remains clear and uncontested;
- Discloses any negative environmental or community impacts or claims of negative environmental and community impacts, and documents plans to mitigate any reported negative environmental or community impacts;
- Addresses any significant change in external conditions that would affect the quality or environmental integrity of the project.

The following material outlines the monitoring plan to be followed during the decade following the initial project validation and verification.

General Monitoring Method

In the year prior to validation/initial-verification, a representative sample of 70 fixed radius permanent inventory plots were established across the project area. The plot network provided enough data to keep Mean volume estimates (e.g. above ground carbon per acre) for the ownership with a minimum statistical precision of +/– 10% of the mean at the 90% confidence level, thereby avoiding any uncertainty deductions in the quantification process. All permanent plots will be re-inventoried at least twice over the following decade to calibrate forest growth models and improve carbon sequestration projections.

The heavily monumented and well-maintained plot design gives forest managers the opportunity to consistently track the growth and development of specific trees over an extended timeline and allows for

improved ease of plot location during field work and site verifications. All plots will be re-measured in a manner consistent with the Inventory Methodology, provided separately for verification. [3]

In addition to the full inventory update of the entire property that will be conducted on all plots every 5 years, inventories of select portions of the Project Area will be updated periodically in response to natural disturbance or significant forest management activities. Following natural disturbance events, affected project stands will be assessed for damage. If damage is significant, the affected areas will be re-inventoried and project scenario models will be adjusted to reflect onsite carbon stocks.

In the years in which forest plots are not re-inventoried, carbon stocks will be monitored through forest growth and yield modeling.

In addition to inventory sampling, management staff will consistently monitor the general health and condition of the forest throughout the course of normal forest management activities (e.g. road maintenance, ecological studies, boundary marking, etc.), reducing the risk of reversal by disease, pest invasion, and unauthorized timber removal.

Bluesource LLC (Bluesource) will oversee the execution and reporting of all project reporting, modeling, and monitoring activities on behalf of the landowner. Shafer-Tuuk Tree Farm LLC will be responsible for "on the ground" forest management activities on the project area, and American Forest Management will conduct inventory measurements and data collection. After forest inventory data collection, American Forest Management will report results to Bluesource for processing and updating of modeling projections. After processing is complete, Bluesource will house all data and submit the necessary documentation for compliance with ACR standards. Bluesource will ultimately store project data for at least ten years after the conclusion of the project.

Data Processing and Storage

Manually and electronically filed data are stored and archived. Backup copies of all electronically stored data are maintained in a separate data center with scheduled archiving to assure data protection. Future revisions to project documents after initial verification and registration will be clearly identified by saving them as separate files and including the date of revision in any modified documents. All data will be stored on Dropbox or similar online cloud storage service as well as on an external hard drive and kept by Bluesource for a minimum of 15 years.

QA/QC Field Procedures

Field Procedures

At the end of each field day, individual foresters will email their plots from the data recorders (or paper) to the senior forester. The senior forester will then look for irregularities in the data and ask the field crew to confirm the data or remeasure any plots that cannot be reconciled. The senior forester will then add

3 The details of the carbon inventory methodology are considered commercially sensitive material as the methodology is the result of considerable investment of Bluesource resources.

all the data to a master spread sheet.

At least 5% of the plots will be checked by a different forester than the one who cruised the plot, preferably by someone senior to the field crew. This will involve full plot measurement to identify any problems with determining in/out trees, species calls, defect measurements, DBH measurements, and height measurements. Any errors noted during the check cruise will be used to update the master spread sheet file. Any consistent height, species, DBH, or defect errors will be resolved by talking with the foresters and removing crew members, if need be.

Desk Procedures

The following QA/QC approach is designed to ensure that field data, once input, is appropriately managed and maintained, and that subsequent calculations using that data to determine onsite carbon stocks and associated ARBOC issuance are correctly implemented.

A three-stage QA/QC process with a defined review group for the project will be established, engaging both personnel intimately familiar with all project files and documentation, as well as independent reviewers who are able to bring “fresh eyes” to key outputs.

Independent Forester Review: The project implementation team (Bluesource) has a team of foresters with intimate knowledge of the files, models and documents. The development of quantitative components, such as Access databases, FVS model runs and Excel workbooks, are led by one of these foresters. Prior to finalization, a second forester who did not lead development of that component is tasked with a QA/QC review including random examinations and data checks to identify and fix any errors.

Technical Review: Once quantitative outputs are finalized, exported from Access/FVS to Excel, and are ready to be transferred into the GHG Plan and other project documents, an independent manager reviews these outputs. This individual performs data checks by tracing key outputs back from final ARBOC calculations through the chain of Excel documents to the underlying Access/FVS database.

Senior Management Review: Once outputs have been transferred from Excel to the GHG Plan and other project documents, a senior manager reviews these documents and checks that all quantitative elements have been correctly exported from the underlying workbook. At this stage, the senior manager (or other individual not involved in document preparation) also reviews text, grammar and formatting for presentation and accuracy.

E. QUANTIFICATION

E1. BASELINE

The carbon inventory of the project area was conducted during March - April 2017. The inventory employed a systematic random sample of 70 nested, fixed-radius circular plots. Due to the similarity in forest type and structure across the property, the entire project area (3,111.00 acres) was assigned to a single sampling stratum. Inventory methods, including measurement of tree height and diameter and quantification of tree defect, are documented in 'Tuuk_Carbon_Plot_Methodology.pdf'. We reviewed state law and best management practices to identify potential restrictions on timber harvest within the project area. Our review identified no areas within the project boundary subject to such harvest constraints.

Table E1.a Project Acreage.

Strata	Number of plots	Unconstrained Acres	Constrained Acres
1	70	3,111	0

The ACR requires Improved Forest Management (IFM) projects to establish a baseline harvest scenario against which to measure carbon accumulation attributable to the project. The ACR protocol defines this baseline as the mix of silvicultural practices that maximizes the net present value (NPV) of timber revenues over the 100-yr project lifespan. We used the Forest Vegetation Simulator (FVS), an empirical forest growth and yield model developed by the US Forest Service, to project carbon stocks and timber revenues under the range of harvest scenarios considered in the baseline. We selected the (SN) variant of the FVS model, which encompasses Tennessee, with model equations calibrated to Daniel Boone National Forest - Stearns District National Forest (location code: 80216), the US National Forest located nearest to the project.

We also used FVS to 'degrow' the inventory to the project start date (July 29, 2016), because the plots were inventoried 3 months after the project start date. We first initialized FVS with the original inventory and ran the model forward with no harvests in order to estimate tree-level annual growth rates. We ran a single 5-year FVS projection cycle, the default cycle length for the FVS variant. We then computed height and diameter growth for each tree over this 5-year interval and divided by 5 to estimate annual growth. Using a monthly growth schedule derived in consultation with a local forester, we determined the fraction of annual growth that had occurred between the project start date and the inventory date and multiplied annual growth for each tree by this fraction. Finally, we subtracted this estimated height and diameter growth for each tree from the observations recorded in the original inventory. We used this growth-adjusted inventory to determine CO_2e stocks on the project start date (July 29, 2016). Similarly, we estimated CO_2e stocks on the project reporting date (March 29, 2018) by 'growing' the inventory forward in time. We added estimated height and diameter growth according to the months that had elapsed between the inventory and the project reporting date. These calculations are detailed in the 'InvDate', 'IndTreeGrow', and 'TreeList' tabs in 'Tuuk_Start_RP_CO2.xlsx'.

The FVS model requires an individual species code and site index for each forest plot simulated. The site index is a location-specific measure of forest productivity estimated by the US Departent of Agriculture (USDA). These estimates are available from the Web Soil Survey (WSS) maintained by the USDA's Natural Resources Conservation Service (NRCS). Soil classes in the WSS database can encompass multiple sub-classes, each with an associated site index. The site index for each soil sub-class is reported for at least one tree species. We used the R package "soilDB" developed by the NRCS to spatially co-locate inventory plots within the WSS soil classes and extract the associated soil sub-classes along with their species-specific site indices. The result is a soil class assigned to each plot. Within each plot-specific soil class, we averaged site indices by tree species across soil sub-classes. We then merged the list of tree species associated with each plot-specific soil class with the list of species found in each plot. We assigned each plot the site index of the tree species with the highest basal area in the plot found in both lists. If a plot had no species in the soil class species list, we assigned the plot the site index of the tree species in the species list with the highest basal area in the entire project area. If no site index data were available for a soil class, we averaged site indices by tree species across all soil classes and assigned the average site index for the highest basal area tree species in the plot. We detail these steps in 'extractSiteIndex_README.R'. Furthermore, the 'BAsummary' tab in 'Tuuk_Start_RP_CO2.xlsx' summarizes basal area by plot, by species, and by species within each plot. Table E1.b shows the resulting species code and site index assigned to each plot.

Table E1.b Site indices.

Plot	Species common name	Species FIA code	Species FVS code	Site Index	Strata
1	Shortleaf Pine	110	SP	59	1
2	White Oak	802	WO	61	1
3	Chestnut Oak	832	CO	62	1
4	Northern Red Oak	833	RO	75	1
5	Northern Red Oak	833	RO	75	1
6	Northern Red Oak	833	RO	75	1
7	Virginia Pine	132	VP	67	1
8	Chestnut Oak	832	CO	62	1
9	Chestnut Oak	832	CO	62	1
10	Northern Red Oak	833	RO	75	1
11	White Oak	802	WO	71	1
12	Northern Red Oak	833	RO	75	1
13	Shortleaf Pine	110	SP	70	1
14	Northern Red Oak	833	RO	75	1
15	Northern Red Oak	833	RO	75	1

Plot	Species common name	Species FIA code	Species FVS code	Site Index	Strata
16	Chestnut Oak	832	CO	62	1
17	Chestnut Oak	832	CO	62	1
18	Northern Red Oak	833	RO	75	1
19	Chestnut Oak	832	CO	62	1
20	White Ash	541	WA	72	1
21	Northern Red Oak	833	RO	75	1
22	White Oak	802	WO	64	1
23	Shortleaf Pine	110	SP	70	1
24	Shortleaf Pine	110	SP	70	1
25	Chestnut Oak	832	CO	62	1
26	Chestnut Oak	832	CO	62	1
27	Northern Red Oak	833	RO	86	1
28	Northern Red Oak	833	RO	75	1
29	Chestnut Oak	832	CO	62	1
30	White Oak	802	WO	64	1
31	White Oak	802	WO	70	1
32	Northern Red Oak	833	RO	65	1
33	Northern Red Oak	833	RO	75	1
34	Shortleaf Pine	110	SP	70	1
35	Shortleaf Pine	110	SP	70	1
36	Northern Red Oak	833	RO	75	1
37	Northern Red Oak	833	RO	75	1
38	White Oak	802	WO	71	1
39	Chestnut Oak	832	CO	62	1
40	Northern Red Oak	833	RO	75	1
41	White Oak	802	WO	71	1
42	Shortleaf Pine	110	SP	70	1
43	Northern Red Oak	833	RO	75	1
44	Northern Red Oak	833	RO	75	1

Plot	Species common name	Species FIA code	Species FVS code	Site Index	Strata
45	Northern Red Oak	833	RO	75	1
46	Northern Red Oak	833	RO	75	1
47	Shortleaf Pine	110	SP	70	1
48	Northern Red Oak	833	RO	75	1
49	Northern Red Oak	833	RO	75	1
50	Chestnut Oak	832	CO	62	1
51	Northern Red Oak	833	RO	75	1
52	Northern Red Oak	833	RO	75	1
53	Chestnut Oak	832	CO	62	1
54	Chestnut Oak	832	CO	62	1
55	Chestnut Oak	832	CO	62	1
56	White Oak	802	WO	61	1
57	Shortleaf Pine	110	SP	72	1
58	Shortleaf Pine	110	SP	72	1
59	White Ash	541	WA	72	1
60	Northern Red Oak	833	RO	75	1
61	Northern Red Oak	833	RO	75	1
62	Northern Red Oak	833	RO	75	1
63	White Oak	802	WO	71	1
64	White Oak	802	WO	61	1
65	Shortleaf Pine	110	SP	72	1
66	White Ash	541	WA	72	1
67	Northern Red Oak	833	RO	75	1
68	Northern Red Oak	833	RO	75	1
69	White Oak	802	WO	61	1
70	White Oak	802	WO	70	1

FVS also requires specifying post-harvest regeneration rates for species that do not sprout from residual stumps. These non-sprouting species are listed in the FVS-SN overview available at https://www.fs.fed.us/fmsc/ftp/fvs/docs/overviews/FVSsn_Overview.pdf. We derived seedling regeneration rates for non-sprouting species based on field estimates from Nunery & Keeton (2010). They present estimates of post-harvest seedling density relative to pre-harvest density for a range of species

across several harvest types (Nunery & Keeton (2010), Table 4). We computed the ratio of post to pre-harvest seedling density for each species and harvest type. We then scaled observed seedling density from the forest inventory (i.e., pre-harvest density) by these ratios to estimate post-harvest density for each harvest type. We used species-specific ratios when available. Otherwise, we used the average softwood or hardwood ratios reported in Nunery & Keeton (2010). These calculations are detailed in Tuuk_Regeneration_Calcs.xlsx. We assume no post-harvest investments in forest regeneration (e.g., no site preparation, herbicide, or pre-commercial thinning), which is common practice on private, non-industrial forest in Tennessee.

As required by the ACR protocol, we used our inventory measurements to estimate CO_2e stocks in three pools: 1) aboveground live biomass, 2) belowground live biomass, and 3) aboveground standing dead biomass. The ACR conservatively omits belowground dead biomass and dead biomass lying on the forest floor. We estimated aboveground live and dead biomass using the species-specific allometric equations of Jenkins et al. (2003). For trees reported as damaged in the inventory, we applied a deduction to estimated aboveground biomass. The deduction is a weighted average of the fractional defect reported for the top, middle, and bottom thirds of the tree. For live trees, the top, middle, and bottom weights are, respectively, 0.1, 0.25, and 0.65. The respective weights for dead trees are 0.1, 0.25, and 0.65.

For trees with a broken top, we computed the difference between estimated phantom height and measured height. Phantom height is estimated tree height assuming the top were not missing. We computed the ratio of the missing top (phantom height - measured height) relative to the top third of the phantom height. This ratio is the top defect for the tree based on its phantom height ($top_{phantom}$, Eq.1). If the missing top accounts for less than the top third of the phantom height (i.e., $top_{phantom} < 1$), we use $top_{phantom}$ in place of the observed top defect when computing the total weighted defect.

If the missing top accounts for more than the top third of the phantom height, but less than the top two-thirds ($1 < top_{phantom} < 2$), then $top_{phantom}$ equals 1 and the middle defect is renormalized relative to the phantom height ($middle_{phantom}$, Eq.2). If the missing top accounts for more than two-thirds of the phantom height ($top_{phantom} > 2$), then the top and middle defects equal 1 and the bottom defect is renormalized relative to the phantom height ($bottom_{phantom}$, Eq.3). For trees with broken tops, we conservatively reduced aboveground biomass by the larger of the defect estimates based on observed height versus phantom height.

$$(Eq. 1)\ top_{phantom} = \frac{Height_{phantom} - Height_{measured}}{\frac{1}{3}Height_{phantom}}$$

$$(Eq. 2)\ middle_{phantom} = \frac{\frac{2}{3}Height_{phantom} - Height_{measured}}{\frac{1}{3}Height_{phantom}}$$

$$(Eq. 3)\ bottom_{phantom} = 1 - \frac{Height_{measured}}{\frac{1}{3}Height_{phantom}}$$

We also applied deductions to aboveground dead biomass based on tree decay class recorded in the inventory. Table E1.c shows the ACR-defined decay classes corresponding to the decay classes recorded

in the inventory. When computing standing dead biomass in ACR decay class 4, we included only stem wood in our calculations, as required by the ACR protocol. Lastly, we estimated belowground live biomass using ratios of root biomass to aboveground biomass from Jenkins et al. (2003). We applied the root ratios to estimated aboveground biomass unadjusted for defect. We converted all biomass stocks to carbon by multiplying by 0.5, the fraction of carbon in tree biomass. We converted all carbon stocks to CO_2e by multiplying by 3.664, the molar ratio of CO_2 to carbon. All calculations of CO_2e stocks on the project start date and reporting date are detailed in the 'StartDate_Tree_CO2' and 'RP_Tree_CO2' tabs in 'Tuuk_Start_RP_CO2.xlsx'.

Table E1.c Decay classes.

Decay class recorded in field	ACR IFM decay class	Biomass deduction	ACR IFM Description
Decay Class 1: Limbs and branches all present, top pointed, all bark remaining, sapwood intact, heartwood sound, hard, original color.	1	0.97	Tree with branches and twigs that resembles a live tree (except for leaves)
Decay Class 2: Few limbs and no fine branches present, top may be broken, bark variable, sapwood sloughing, heartwood sound at base incipient decay in outer edge of upper bole, hard, light to reddish brown.	2	0.95	Tree with no twigs but with persistent small and large branches
Decay Class 3: Branches absent with only limb stubs, top broken, bark variable, sapwood sloughing, heartwood with incipient decay at base, advanced decay throughout upper bole, fibrous to cubical, soft, dark, reddish brown.	3	0.90	Tree with large branches only
Decay Class 4: Branches absent with few or no stubs, top broken, bark variable, sapwood sloughing, heartwood with advanced decay at base, sloughing from upper bole, fibrous to cubical, soft, dark, reddish brown.	4	0.80	Bole only, no branches
Decay Class 5: No limbs or branches, top broken, bark less than 20 percent, sapwood gone, heartwood sloughing, cubical, soft, dark brown, or fibrous, very soft, dark reddish brown, encased in hardened shell.	4	0.80	Bole only, no branches

The estimated CO_2e stock in live and standing dead trees on the project start date (July 29, 2016) is 624,098 tons CO_2e (624,098 = 200.61 tons CO_2e per acre x 3,111.002 acres).

Table E1.d Total standing CO_2e stocks per acre on project start date.

Total standing stocks (tons CO_2e per acre)	Number of plots
200.61	70

Determining the baseline

The ACR protocol defines the baseline as the mix of harvest prescriptions that maximizes the net present value (NPV) of timber revenues over a 100-year period. We determined this mix by projecting 100-year

timber revenues across a range of common harvest practices in the region (Table E1.e). We consulted with Jake Almond (American Forest Management), a local forester, to identify these harvest practices.

Table E1.e Management prescriptions.

Management prescription	Abbreviation	Management actions	Minimum DBH harvested (inches)	Minimum saw timber DBH (inches)	Minimum pulpwood DBH (inches)	Harvest trigger
Grow	GROW	Allow existing stocks to grow 40 years				
Clearcut	CC	Cut throughout all species and diameter classes; Natural sprouting and regeneration	6	10	6	Stand basal area > 80 square feet per acre; Merchantable timber > 600 cubic feet per acre; Rotation period = 60 years
Diameter limit	DL	Cut throughout all species and diameter classes; Natural sprouting and regeneration	16	10	6	Constrained to occur at most every 10 years; Merchantable timber > 600 cubic feet per acre
Shelterwood	SHW	Residual basal area for shelterwood = 50 square feet; Overstory removal occurs 5 years after shelterwood cut; No residual overstory trees; Natural sprouting and regeneration	6	10	6	Stand basal area > 80 square feet per acre; Merchantable timber > 600 cubic feet per acre; Constrained to occur at most every 40 years

Management prescription	Abbreviation	Management actions	Minimum DBH harvested (inches)	Minimum saw timber DBH (inches)	Minimum pulpwood DBH (inches)	Harvest trigger
Single tree selection	STS	Harvest to basal area of 75 square feet; Q-factor = 1.4; Subsequent removal of all trees > 40 inches DBH; Natural sprouting and regeneration	6	10	6	Constrained to occur at most every 10 years; Merchantable timber > 600 cubic feet per acre
Variable retention	VT_10	Cut throughout all species and diameter classes; Residual basal area = 10 square feet; Natural sprouting and regeneration	6	10	6	Constrained to occur at most every 10 years; Merchantable timber > 600 cubic feet per acre
Variable retention	VT_20	Cut throughout all species and diameter classes; Residual basal area = 20 square feet; Natural sprouting and regeneration	6	10	6	Constrained to occur at most every 10 years; Merchantable timber > 600 cubic feet per acre

Harvest revenues

We used regional timber prices sourced from 'TimberMart-South: A Summary of the US South Stumpage and Delivered Timber Prices, Logging Rates, Biomass & Chip Prices, Timberland Transactions & Forest Product Market Conditions in 2016' prepared by TimberMart-South (Athens, GA) to estimate timber revenue under each harvest prescription. Modeled timber volumes in FVS are based on merchantability standards detailed in the FVS-SN overview. FVS outputs harvested saw timber and pulpwood in units of cubic feet. As saw timber and pulpwood prices were reported in $ per metric ton, we converted all FVS harvest volumes to metric tons, using the specific gravity of each tree species harvested. These price conversions can be found in 'Tuuk_TimberPrices.xlsx'. When available, we applied species-specific prices to compute timber revenue. Otherwise, we applied genus-level prices (e.g., oak, maple, etc.) or average hardwood and softwood prices for species without a reported price (Table E1.f). As the FVS model outputs

harvest volumes at 5-year intervals, we determined annual revenues by evenly distributing revenues over each 5-year interval.

Table E1.f Timber prices.

Species common name	Species FIA code	Species FVS code	Saw timber price ($ per short ton)	Pulp wood price ($ per short ton)
Mixed softwood			20.08	7.17
Oak spp.	855	OK	51.27	
Mixed hardwood			37.48	6.46

Harvest costs

Our consultations with local forester, Jake Almond (American Forest Management), indicated that variable harvest costs of $4.76 per green ton is typical for the region. Our forester consultations also indicated typical fixed management costs of $6.43 per acre. We subtracted these costs from timber revenues prior to computing the net present value of 100-yr baseline cash flows. We computed NPV using a 5% discount rate, the rate specified for private, non-industrial in the ACR protocol.

Maximizing NPV of timber harvest in the baseline

We conducted FVS model runs for each inventory plot across the range of management prescriptions considered in the baseline (Table E1.e). Each plot represents 1/70th of the project area ($\frac{project\ area}{number\ of\ plots}$ = 44.44 acres). We used the Analytic Solver tool in Excel to find the allocation of project acreage across management prescriptions that maximizes the net present value of 100-year cash flows. All baseline calculations are detailed in the 'Financials', 'Harvest Revenues', and 'Baseline' tabs in 'Tuuk_100Yr_Calcs.xlsx'.

Projected CO_2e stocks under the baseline and project scenarios

We used the FVS Fire and Fuels Extension (FFE) to output carbon stocks from each FVS model run. FFE computes live above and below-ground carbon stocks (metric tons) using the allometric equations of Jenkins et al. (2003). To account for damaged trees, we applied average plot-level defects observed in the inventory to the FFE aboveground live carbon stocks. The FFE snag report outputs the volumes of hard and soft dead wood (cubic feet) for each FVS model run. As described in the 'FFE: Updated Model Documentation', the snag report only includes standing dead wood.

We converted dead wood volume as well as harvested wood volume to biomass using species-level specific gravities (US Forest Service Wood Handbook (Table 5-3a), Miles and Smith (2009)). We partitioned above and below-ground portions of dead biomass using the root component ratios of Jenkins et al. (2003). We also applied deductions to dead biomass according the FFE-indicated decay class for each snag. Table E1.g shows the ACR-defined decay classes corresponding to the two FFE decay classes ('FFE: Updated Model Documentation', p.13). We converted dead biomass and harvested biomass to carbon by

multiplying by 0.5, the fraction of carbon in tree biomass. We converted all carbon stocks to CO_2e by multiplying by 3.664, the molar ratio of CO_2 to carbon. All calculations are detailed in 'processFVSoutput.R' and 'computeStandingDead.R'.

Lastly, we note that FFE does not output initial carbon stocks, if a harvest occurs in year 1 of an FVS model run. FFE instead outputs *post-harvest* carbon stocks. We, therefore, set year 1 carbon stocks in all FVS model output to the start date values from the plot inventory.

Table E1.g Dead wood classes.

Fire Fuel Extension (FFE) snag class	Biomass deduction	FVS description
Soft	0.80	Per FVS FFE: "No branches remain." Corresponds to ACR IFM methodology decay class 4.
Hard	0.97	Per FVS FFE: "Soft snags are more decayed and are assumed to have 80% of the wood density of hard snags." Corresponds to ACR IFM methodology decay class 1.

Source: Rebain et al. (2012). *FVS Fire and Fuels Extension*.

Harvested wood products in the baseline

We disaggregated the FVS saw timber and pulpwood harvest into softwood and hardwood species. We then applied mill efficiency values for Tennessee to the four harvest categories - softwood saw timber, softwood pulp, hardwood saw timber, and hardwood pulp - in order to determine the quantity of harvested CO_2e retained in wood products. We sourced mill efficiency values from the Regional Mill Efficiency Database required by the ACR protocol.

Table E1.h Regional mill efficiency.

State	Hardwood saw log	Hardwood pulp	Softwood saw log	Softwood pulp
Tennessee	58.7%	58.1%	62.9%	57.0%

We further disaggregated the four harvest categories into specific wood product classes. We sourced the distribution of wood product classes from the California Air Resources Board (ARB) Assessment Area Data File available at https://www.arb.ca.gov/cc/capandtrade/protocols/usforest/usforest-aadf.htm. Table E1.i presents the distribution of product classes for the Central Interior Broadleaf Forest Eastern Low Plateau and Eastern Broadleaf Forest Cumberland Plateau Assessment Area(s), in which the project is located. We computed a weighted-average wood product distribution using the fraction of the project in each assessment area as weights. We re-normalized this distribution into separate distributions for saw timber and pulpwood, allocating harvested saw timber across lumber, plywood, and non-structural panels and harvested pulpwood across oriented strand board, paper, and miscellaneous products. However, the

100-yr wood product storage factors provided by the ACR protocol do not include hardwood plywood. Therefore, we allocated hardwood saw timber between lumber and non-structural panels only.

Table E1.i Wood product distribution.

Supersection	Softwood lumber	Hardwood lumber	Plywood	Oriented strand board	Non-structural panels	Miscellaneous	Paper
Central Interior Broadleaf Forest Eastern Low Plateau	8.0%	84.0%	0.0%	0.0%	3.0%	2.0%	3.0%
Eastern Broadleaf Forest Cumberland Plateau & Valley	10.0%	65.0%	0.0%	0.0%	4.0%	15.0%	7.0%
area weighted average product class distributions	8.0%	80.0%	0%	0.0%	3.0%	4.0%	4.0%

We allocated CO_2e in wood products between storage in landfills and storage in the wood products themselves (i.e., in-use storage). We used the 100-year storage factors provided in the ACR methodology. We then summed landfill and in-use storage across product classes to determine total long-term CO_2e storage in harvested wood products. All wood product calculations are detailed in 'Tuuk_RP_ERT_HWP.xlsx'.

Baseline harvest mix

Table E1.j presents the baseline mix of harvest practices that maximizes the net present value of 100-year cash flows. **Maximum NPV under the baseline is $2,139,409.**

Table E1.j Baseline and project scenarios.

Strata	Management prescription	Baseline (acres)	Project (acres)
1	CC	1,822	0.00
1	DL	933	0.00
1	GROW	0	2,799.90
1	SHW	89	0.00
1	STS	44	311.10

Strata	Management prescription	Baseline (acres)	Project (acres)
1	VT_10	222	0.00
1	VT_20	0	0.00

Table E1.k shows projected CO_2e stocks under the baseline scenario over the first 20-year crediting period (2016 to 2036). CO_2e stocks in live and standing dead trees represent stocks on July 29 of each year. CO_2e in harvested wood products represents cumulative in-use and landfill CO_2e storage averaged over the 20-year crediting period. **Baseline CO_2e averaged over the 20-year crediting period is 240,147 tons.**

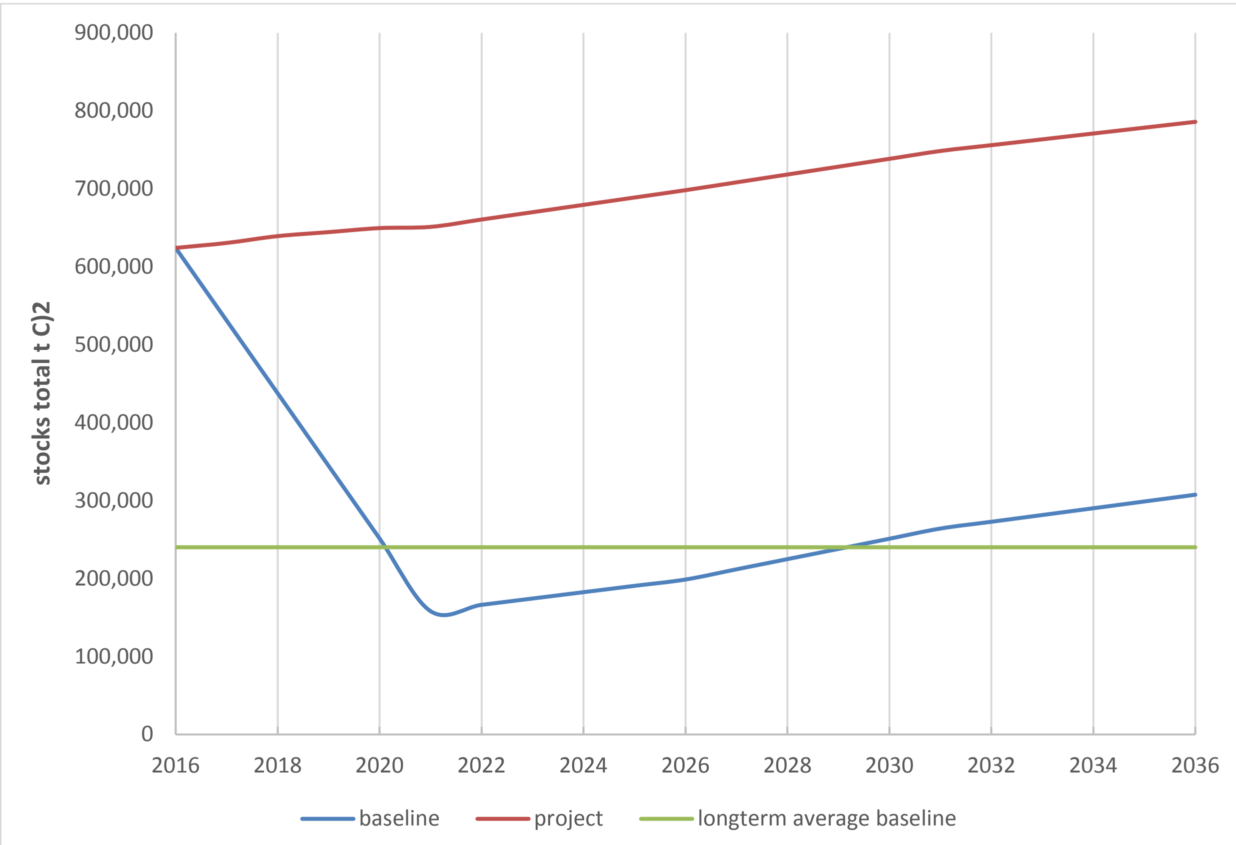
Table E1.k Baseline CO_2e stocks.

Year	Live trees (tons CO_2e per acre)	Standing dead (tons CO_2e per acre)	Harvested wood products (tons CO_2e per acre)
2016	197.5	3.1	1.5
2017	166.6	2.6	1.5
2018	135.6	2.1	1.5
2019	104.7	1.6	1.5
2020	73.7	1.1	1.5
2021	42.8	0.6	1.5
2022	44.0	0.5	1.5
2023	45.2	0.4	1.5
2024	46.4	0.3	1.5
2025	47.6	0.3	1.5
2026	48.8	0.2	1.5
2027	51.5	0.2	1.5
2028	54.2	0.2	1.5
2029	56.9	0.1	1.5
2030	59.7	0.1	1.5
2031	62.4	0.1	1.5
2032	63.7	0.1	1.5
2033	64.9	0.2	1.5
2034	66.2	0.2	1.5
2035	67.5	0.2	1.5

Year	Live trees (tons CO_2e per acre)	Standing dead (tons CO_2e per acre)	Harvested wood products (tons CO_2e per acre)
2036	68.8	0.2	1.5

Figure E1.a plots CO_2e stocks under the baseline and project scenarios. The solid horizontal line indicates 20-year average baseline CO_2e.

Figure E1.a Total standing (Live + Dead) CO_2e under baseline and project scenarios.



E2. PROJECT SCENARIO

Project scenario

The actual project scenario is measured through future inventories over the course of the project lifetime. However, we produce an ex-ante projection of the project scenario assuming the landowner will conduct the following harvest types: single tree selection on 10% of the project area. These calculations are detailed in the 'Project' tab in 'Tuuk_100Yr_Calcs.xlsx'. This ex-ante projection applies in years beyond 2018, as the landowner harvested 5,172 tons of CO_2e in the first reporting period. This harvest is detailed in the 'Actual_RP1_HWP_Step_1' tab of 'Tuuk_RP_ERT_HWP.xlsx'.

E3. LEAKAGE

All forestlands owned by Shafer-Tuuk Tree Farm, LLC have been certified by the Forest Stewardship Council (FSC). To prevent activity-shifting leakage, Shafer-Tuuk Tree Farm, LLC will not conduct harvests on other lands under its ownership that would offset the harvest reductions attributable to the project. Therefore, leakage is limited to market leakage. We conservatively assume market leakage of 40%.

Table E1.l Baseline leakage factors.

Period	Baseline wood products summed over 20-yr crediting period (tons CO_2)	Project wood products summed over 20-yr crediting period (tons CO_2)	Project decrease in wood products relative to baseline (%)	Applicable leakage factor (%)
2016-2036	92,915	7,060	92%	40%

E4. UNCERTAINTY

We computed uncertainty in project and baseline CO_2e according to equations 10 and 18 of the ACR protocol. Error terms for live and dead CO_2e are calculated using the inventory data in the 'Stats_StartDate' tab of 'Tuuk_Start_RP_CO2.xlsx'. As required by ACR equations 10 and 18, these error terms (e_{TREE} and e_{DEAD}), estimated from the most recent inventory data, are used for computing total CO_2e uncertainty in both the project and baseline scenarios. The ACR protocol also specifies that the error term for live CO_2e (e_{TREE}) be used as the uncertainty estimate for CO_2e stored in wood products. As Shafer-Tuuk Tree Farm, LLC does not burn logging slash, expected greenhouse gas emissions (GHG) under both the project and baseline scenarios are zero. Total uncertainty in combined baseline CO_2e stocks (ACR equation 10) is 8.5%. Median uncertainty in combined project CO_2e stocks (ACR equation 18) over the 20-year is 8.5%. Median total uncertainty encompassing both the baseline and project scenarios (ACR equation 19) over the 20-year is 8.5%. These calculations are all found in the 'ACR_IFM_ERT_Calcs' tab of 'Tuuk_RP_ERT_HWP.xlsx'.

Table E1.m Uncertainty in start date CO_2e stocks.

	CO_2e pools							
	AG_Live	BG_Live	Live	AG Dead	BG_Dead	Dead	Total Standing	Acres
Start Date CO2e/acre	165.86	31.69	197.54	3.07	-	3.07	200.61	3,111.0
% AG	100%	19%	119%	2%	0%	2%	121%	
% Live	84%	16%	100%	2%	0%	2%	102%	
% Total	83%	16%	98%	2%	0%	2%	100%	

Pool	No. of Plots	Average CO2e per acre	Standard Deviation (tons per acre)	Standard Error (tons per acre)	Acres	Total CO_2e (tons)
Live	70	197.54	86.02	10.28	3,111	614,558
Dead	70	3.07	9.16	1.09	3,111	9,547

Inventory Confidence Calculations

Pool	Total CO_2e (tons)	No. of Plots	Standard Error (tons)	90% Error Margin (tons)
Live	614,558	70	31,987	52,618
Dead	9,547	70	3,405	5,601

Percentage uncertainty expressed as 90% confidence interval

Live ($e_{TREE,t=1}$)	8.6%
Dead ($e_{DEAD,t=1}$)	58.7%

E5. REDUCTIONS AND REMOVAL ENHANCEMENTS

Table E1.n shows estimated net reductions and removal enhancements attributable to the Shafer-Tuuk Tree Farm, LLC project over the first 20-year crediting period (2016 - 2036). As the annual project-level uncertainty remains below the 10% threshold required by the ACR protocol, no uncertainty deduction was applied to the annual Emission Reduction Tons (ERTs) generated by the project. ERTs presented in Table E1.n incorporate the assumed 40% market leakage. ERTs are dated beginning on July 29, 2016, the project start date. Therefore, annual values in Table E1.n correspond to the 1-year interval ending on July 28 of each year. For example, ERTs in 2017 include GHG reductions and removals occurring between July 29, 2016 and July 28, 2017.

Table E1.n Estimate of net Emission Reduction Tons (ERTs) by year.

Project year	Year	Estimated GHG emission reductions (tons CO_2)
0	2016	Start year
1	2017	59,732
2	2018	61,148
3	2019	59,006
4	2020	59,006
5	2021	951
6	2022	5,646
7	2023	5,646
8	2024	5,646
9	2025	5,646
10	2026	5,646
11	2027	6,032
12	2028	6,032
13	2029	6,032
14	2030	6,032
15	2031	6,032
16	2032	4,487
17	2033	4,487
18	2034	4,487
19	2035	4,487
20	2036	4,487

E6. EX-ANTE ESTIMATION METHODS

Table E1.o shows projected CO_2e stocks under the project scenario described in Section E2.

Table E1.o Project CO_2e stocks.

Year	Live trees (tons CO_2e per acre)	Standing dead (tons CO_2e per acre)	Harvested wood products (tons CO_2e per acre)
2016	197.5	3.1	0.5
2017	199.1	3.1	0.1
2018	201.8	3.1	0.1
2019	203.4	3.1	0.1
2020	204.9	3.1	0.1
2021	205.4	3.1	0.1
2022	208.3	3.1	0.1
2023	211.2	3.1	0.1
2024	214.2	3.1	0.1
2025	217.1	3.1	0.1
2026	220.0	3.1	0.1
2027	223.2	3.1	0.1
2028	226.3	3.1	0.1
2029	229.4	3.1	0.1
2030	232.6	3.1	0.1
2031	235.7	3.1	0.1
2032	238.0	3.1	0.1
2033	240.3	3.1	0.1
2034	242.6	3.1	0.1
2035	244.9	3.1	0.1
2036	247.2	3.1	0.1

F.
COMMUNITY & ENVIRONMENTAL IMPACTS

F1. NET POSITIVE IMPACTS

Community and Environmental Assessment

1. See section A5. Brief Summary of Project Action and A4. Location.
2. See section C1. Regulatory Surplus Test
3. Shafer-Tuuk Tree Farm is privately held property with no public access. Adjacent landowners will be unaffected by project activity as this represents a conservation-based forest management scenario. The landowners maintain good relationships with adjacent neighbors and communicate openly about the benefit of the carbon project.

4.

Impact	Carbon sequestration
Risk Category	Positive
Monitoring Plan (how, how often, by whom)	Forest management activities described in the Forest Management Plan and monitoring for the carbon project is described in Section D2. Monitoring Plan
If negative, describe aversion, reduction, mitigation, or compensation strategy:	n/a

Impact	Habitat protection for wildlife, plant species, and trees in the forested communities.
Risk Category	Positive
Monitoring Plan (how, how often, by whom)	Forest management activities described in the Forest Management Plan and monitoring for the carbon project is described in Section D2. Monitoring Plan.
If negative, describe aversion, reduction, mitigation, or compensation strategy:	n/a

Impact	Water quality protection
Risk Category	Positive
Monitoring Plan (how, how often, by whom)	Forest management activities described in the Forest Management Plan and monitoring for the carbon project is described in Section D2. Monitoring Plan.
If negative, describe aversion, reduction, mitigation, or compensation strategy:	n/a

Impact	Protection from soil erosion and degradation
Risk Category	Positive
Monitoring Plan (how, how often, by whom)	Forest management activities described in the Forest Management Plan and monitoring for the carbon project is described in Section D2. Monitoring Plan.
If negative, describe aversion, reduction, mitigation, or compensation strategy:	n/a

Bluesource – Shafer-Tuuk Improved Forest Management Project has no anticipated negative community or environmental impacts. Annual attestations confirming this assessment will be provided separately for verification purposes.

5. Bluesource – Shafer-Tuuk Improved Forest Management Project is not a community-based project.

F2. STAKEHOLDER COMMENTS

No formal stakeholder consultation was conducted in advance of the project, nor was any required because Shafer-Tuuk Tree Farm LLC is privately held. If Project Proponent is contacted by any persons regarding the project, Project Proponent will provide references to the publicly available documentation for the project.

G.
OWNERSHIP AND TITLE

G1. PROOF OF TITLE

G1.1 Ownership of forestlands
Forestlands included in the project are owned directly by the Project Proponent, Shafer-Tuuk Tree Farm LLC, which holds full legal titles and thus have long term control of the land. Titles and contracts are available for review by verifier in the "Project Supporting Documents.zip".

G1.2 Emission reduction rights
Emissions reductions rights are owned by the Project Proponent.

G2. CHAIN OF CUSTODY
No sales or purchasing of offsets was conducted prior to project registration.

G3. PRIOR APPLICATION

The Bluesource – Shafer-Tuuk Improved Forest Management Project has not previously applied or been registered under any GHG emission trading system or program.

H.
PROJECT TIMELINE

H1. START DATE

The project "Bluesource – Shafer-Tuuk Improved Forest Management Project" has a project start date of July 29, 2016, the date of the contractual signing agreement between the Project Proponent and the Offset Developer. This start date is appropriate and consistent with the ACR Standard v. 5.0 as it occurs after November 1, 1997.

H2. PROJECT TIMELINE

Below is a schedule of the project activities in chronological order for important aspects of the Bluesource – Shafer-Tuuk Improved Forest Management Project (Table H-2.a.)

Table H-2.a. Project Timeline

Project Activity	Date	Source/Notes
Project Start Date (Initiation of project activities)	July 29, 2016	CDMA contract signing
Frequency of monitoring, reporting and verification		Every 5 years after the first verification
Length of First Crediting period	Through July 28, 2036	20 years
Expected project longevity	N/A	In perpetuity