Bluesource – Hawk Mountain Improved Forest Management Project

[November 6, 2018]

ACR 375

Hawk Mountain Sanctuary Association

and The Nature Conservancy

Prepared by: Bluesource LLC

Table of Contents

A.
PROJECT OVERVIEW

A1. PROJECT TITLE

The project title is "Bluesource – Hawk Mountain 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 the ACR Standard Version 5.0 and the Improved Forest Management Methodology for Quantifying GHG Removals and Emission Reductions through Increased Forest Carbon Sequestration on Non-Federal Forestlands, Version 1.3.

The Bluesource - Hawk Mountain Improved Forest Management 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	Hawk Mountain is certified under the Forest Stewardship Council.	See also section A5.1. Background Information
Project area meets the definition of Forestland condition as per USFS FIA program definition	Per the ACR Standard 5.0, 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 March 17, 2017 complies with the ACR Standard Version 5.0.	See also section H1. START DATE.

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

[2] ACR. 2018. *Improved Forest Management Methodology for Quantifying GHG Removals and Emission Reductions through Increased Forest Carbon Sequestration on Non-Federal Forestlands*, Version 1.3, April 2018, American Carbon Registry, Arlington, VA, USA.

	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 and ACR Standard Version 5.0 (February 2018) and the Improved Forest Management Methodology for Quantifying GHG Removals and Emission Reductions through Increased Forest Carbon Sequestration on Non-Federal Forestlands, Version 1.3 (April 2018), 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	See also appendix A. Land Owner and Contracts.

	uncontested.	
Direct Emissions/ Offset Title	GHG emission reductions generated by the project activity are generated from forest carbon sources and sinks over which Hawk Mountain Sanctuary Association has all management and ownership rights. Hawk Mountain Sanctuary Association holds offset 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 (attestation provided separately for verification purposes).	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, "HMS_Boundary_5_1_18.shp" 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, nearby urban areas, and latitude/longitude coordinates. The project is located across Berks and Schukyll counties, 1700 Hawk Mountain Rd, Kempton, PA 19529.

Figure A-2. shows Hawk Mountain 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. A topographic map (Figure A-4.) is also provided as a reference. The roads map (Figure A-5.) shows the public and private roads near and on the property as well as the hiking trail network in the northern portion of the property. The ownership map (Figure A-6.) shows the parcels owned by Hawk Mountain Sanctuary Associations in Berks and Schukyll counties and relative to the project area.

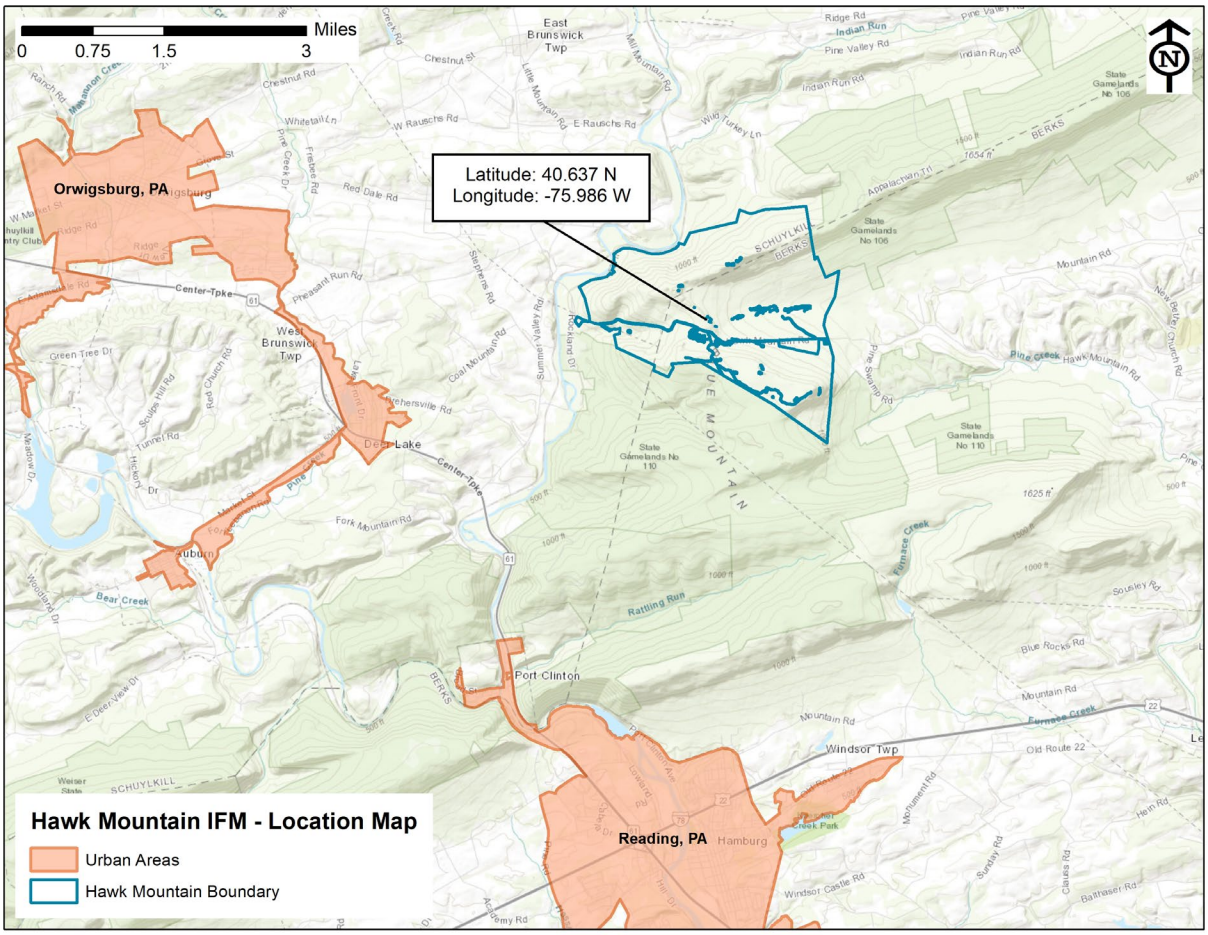


Figure A-1. Vicinity Map with Latitude and Longitude

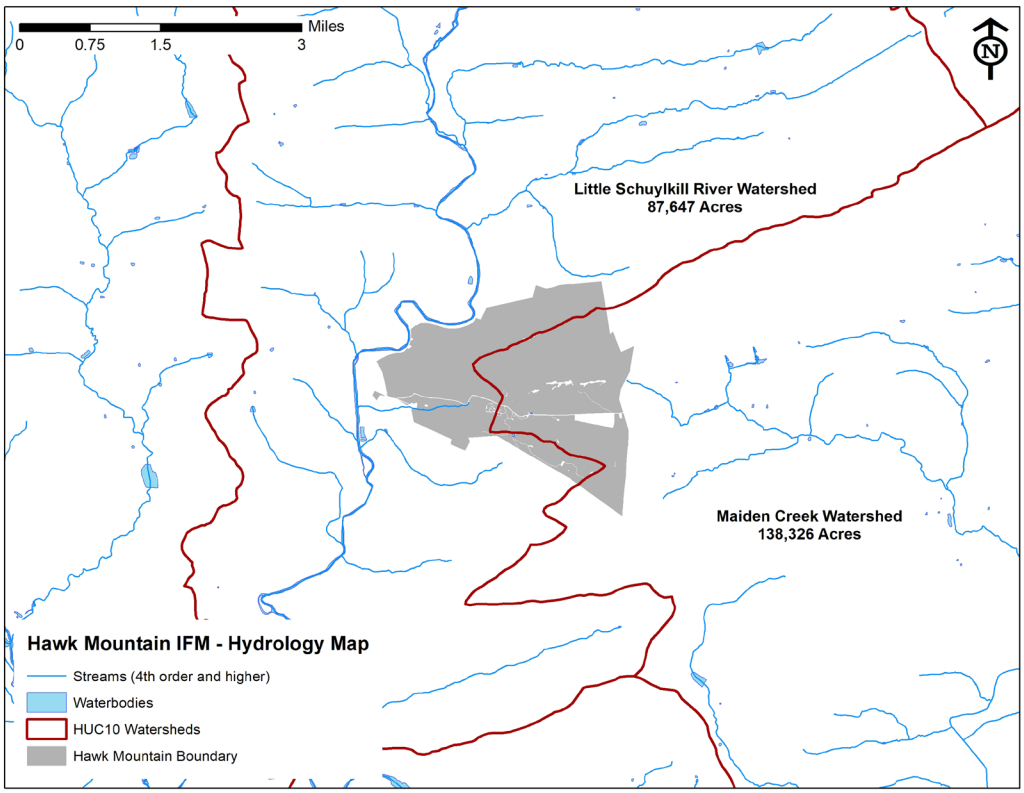


Figure A-2. Regional Hydrology Map

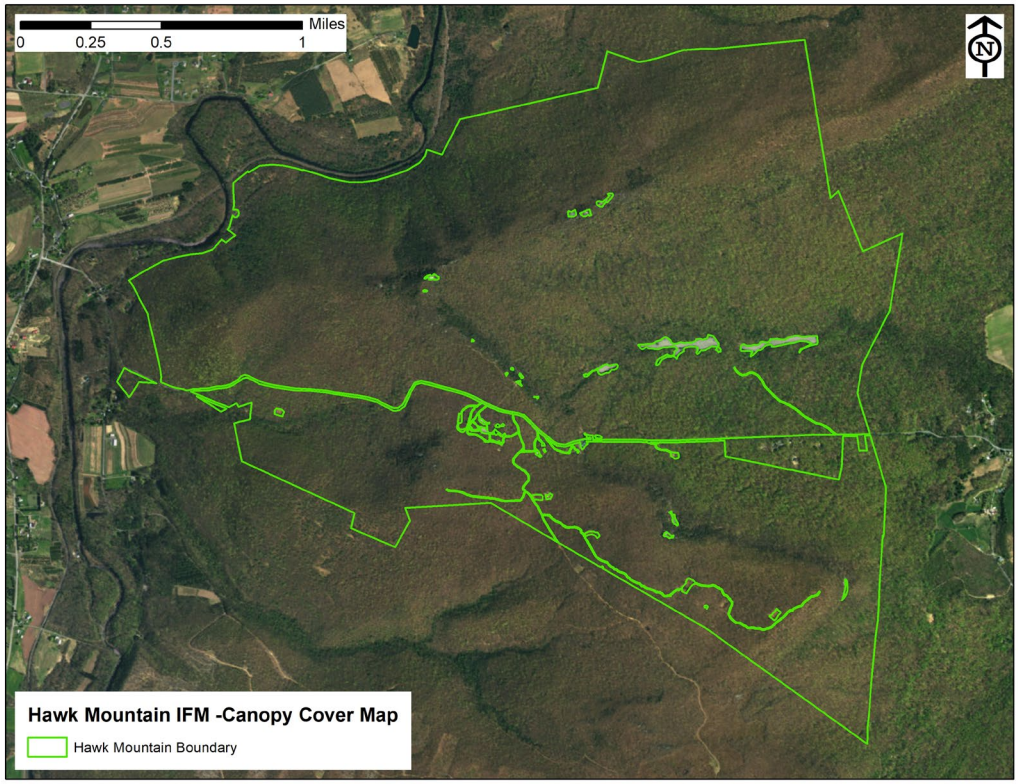


Figure A-3. Canopy Cover Map depicting greater than 10% canopy cover

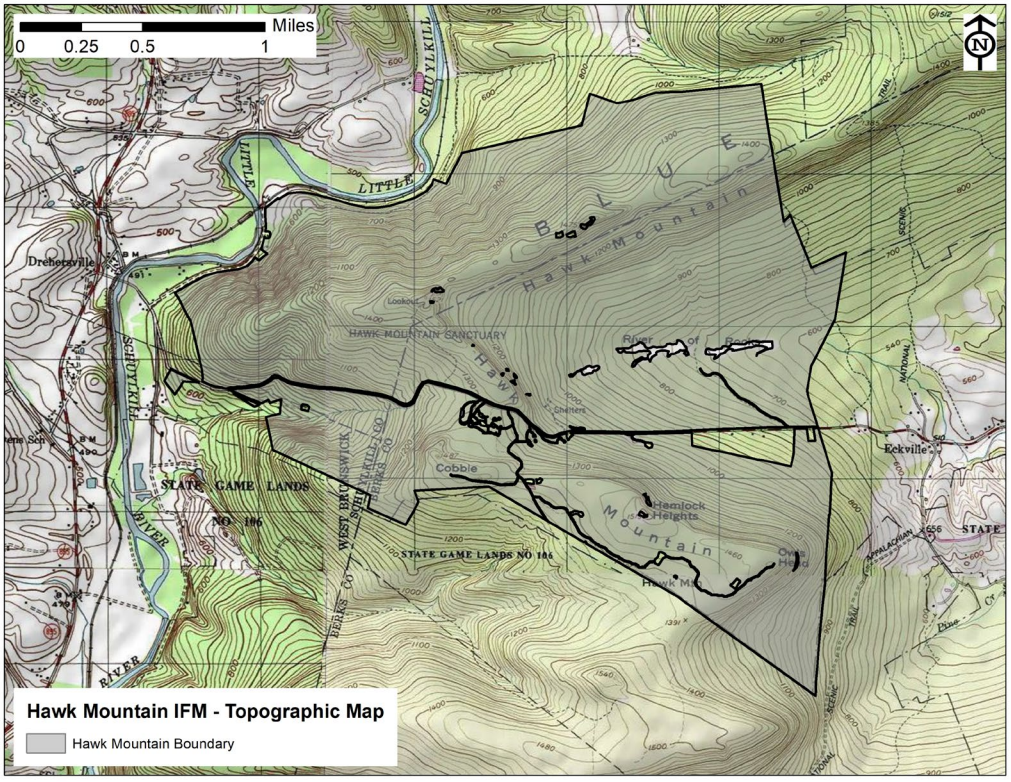


Figure A-4. Topography Map

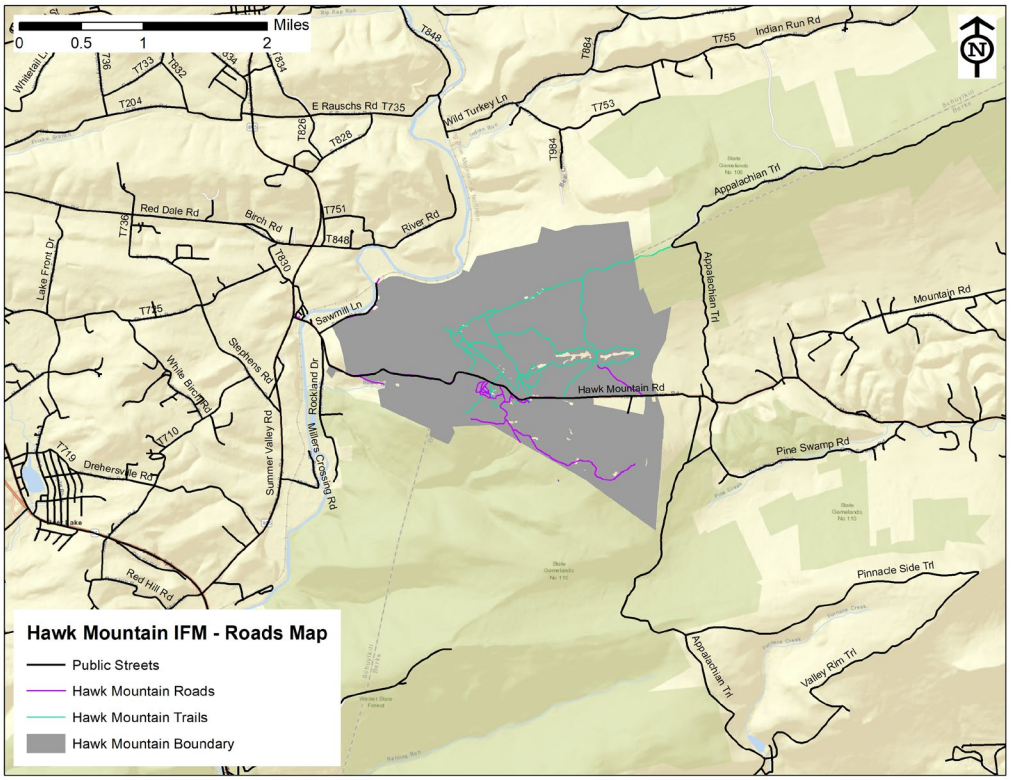


Figure A-5. Roads Map

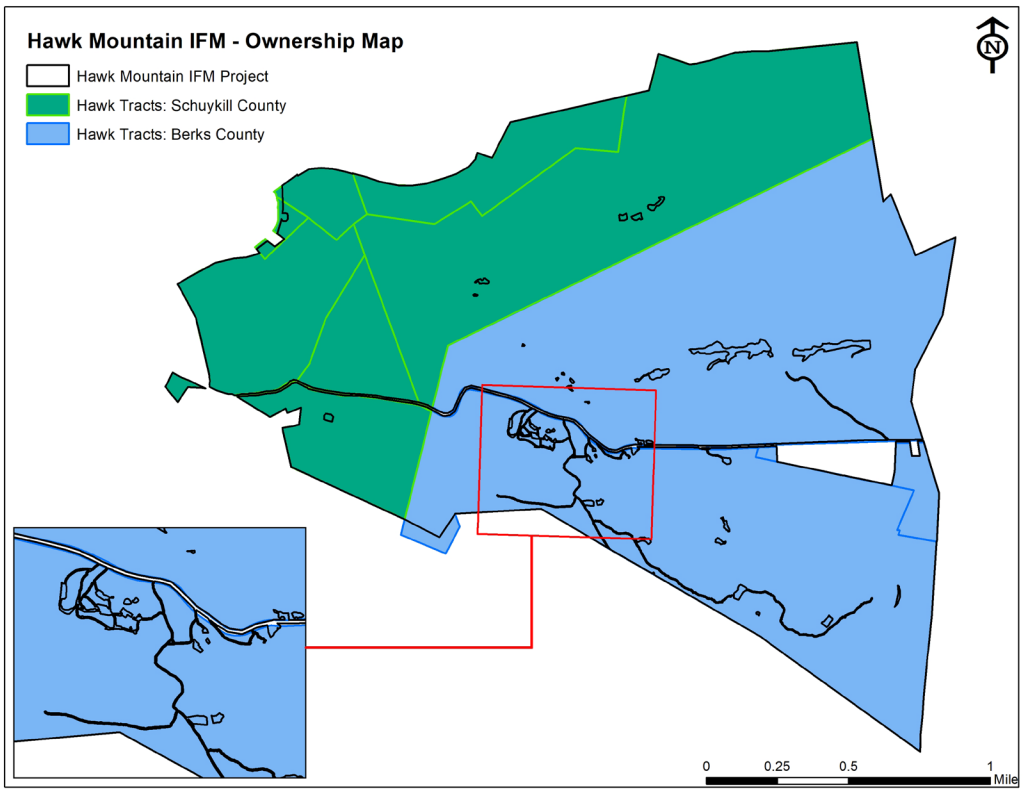


Figure A-6. Ownership Map

A5. BRIEF SUMMARY OF PROJECT

A5.1 Background Information

The Bluesource – Hawk Mountain Improved Forest Management Project is located on 2,380.13 acres of mixed hardwood forest in Pennsylvania.

The following outlines the regional and site-specific land use history and context, drawn from the Hawk Mountain Sanctuary Forest Management Plan (HMS-FMP) developed by the Nature Conservancy and Green Leaf Consulting Services:

> "The regional landscape is highly fragmented due to its agricultural history and ongoing development pressure in the valley bottomlands. The Sanctuary however is within one of the largest blocks of contiguous forest in Southeastern Pennsylvania. Adjoining public lands, both State Forest and Gamelands combined with the Sanctuary creates a large expanse of forest cover along the ridge of the Blue Mountain. This [privately owned] forest provides important wildlife habitat through its size and diversity as well as protection of water quality of the Little Schuylkill River and its associated tributaries.
>
> More raptors use the Kittatinny Ridge during the fall migration than the other parallel ridges of the Appalachians… Early conservation efforts of the Sanctuary focused on stopping the shooting of birds of prey along the ridge and throughout the region. Considerable time was spent

educating the public about birds of prey, their migration biology, and integral role in the environment. Since then, the Sanctuary has become a world renown educational and research site which is visited by over 80,000 people each year, mostly during the fall migration.

Blue Mountain is forest dominated but quickly transitions to agriculture and residential development in the nearby valleys and lowlands. A high percentage of Hawk Mountain Sanctuary is adjoined by heavily forested State Gamelands 106 that is open to public access. Other adjoining parcels are primarily private, non-industrial forest and farm lands of smaller acreages ranging from 2 to 250 acres in size… Historically, this region of the state was known for its rural farming communities along with natural resource-based employment opportunities associated with mining and lumbering."

A5.2 Description of Project Activity

The project activity is improved forest management, with Hawk Mountain Sanctuary Association'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 with a large degree of commercial high grading. 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 on the USDA plant hardiness zone map. Average annual extreme minimum temperatures for 6b are -5 to -0 degrees Fahrenheit.

Ecosystem/Vegetation.
"Hawk Mountain Sanctuary is part of the Appalachian Oak Forest that covers most of Pennsylvania. This forest community type is also known as the mixed oak forest and is found in the Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow ecoregion and Eastern Broadleaf Forest (oceanic) ecoregion. It is common habitat on rolling hills and slopes with soils ranging from moderately well-drained and acidic to highly fertile. It is dominated by various oaks in association with maple, hickory, tuliptree, birch and pine. The specific oak dominant and associated species at any particular site is

largely determined by elevation, hydrology, and aspect. Although most of the Sanctuary is dominated by hardwood forest, there are areas with conifer cover and open rock scree terrain." – HMS-FMP

Forest Pests and Diseases.
"Forests of eastern Pennsylvania, including Blue Mountain have experienced severe defoliation cycles caused primarily by gypsy moth outbreaks over the past 45 years. The Sanctuary's 1998 Forest Stewardship Plan cites repeated defoliation by gypsy moths having occurred in 1971, 1973, 1981, 1982, and 1990. Additional defoliation events followed averaging one major incidence per decade. Reports from PA DCNR Forest Health Specialists identify Hawk Mountain as being on the edge of a 'hot spot' of recent caterpillar outbreaks that spanned multiple years. These events cause significant stress to trees, particularly the oak resource which dominates much of the region. Combine the stress of defoliation with drought conditions experienced in 2016 and the results are noticeable oak mortality, especially among chestnut oak." – HMS-FMP

Land Use History.
The local land use history is well recorded in the Hawk Mountain Sanctuary Forest Management Plan: "Before the turn of the century, much industrial activity took place on what is now Sanctuary lands. Excavation of sand for building purposes and for glassware went on for many years. Originally the sand was carted to Drehersville. Later, perhaps about 1890, the area came into the ownership of the J.D. Stone Company. This company built a track on the extremely steep north slope of the mountain and cars were loaded and pushed through the cut to a level area at the head of the tracks where huge drums with steel cables stood. A blacksmith shop also stood nearby.

Not long thereafter, during the early 1900's, the area was logged and burned over. The demise of the American Chestnut (which on average made up a third of the Eastern forest) in the early 20th century fostered the current dominance of oak species within the state and present-day Sanctuary. Despite several infestations by the introduced Gypsy Moth over the last few decades, oak still dominates the upper forest canopy stratum.
Since the founding of the Sanctuary, it has been passively managed, maintained as a relatively untouched preserve, essentially left to its own devices to evolve after the last sequences of human disturbance.

Although human influences have been minimized, the Sanctuary has experienced an array of stress factors and agents including native and non-native defoliating insects, pests and diseases, along with periodic drought conditions that have collectively resulted in overstory tree mortality. Furthermore, decades of high deer populations have had a profound impact on understory plant diversity and have shifted species composition away from the traditional suite of species associated upland oak hardwoods." – HMS-FMP

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

According to the Forest Management Plan, "Hawk Mountain Sanctuary's mission to protect and steward a healthy, dynamic forest Sanctuary that functions to produce a myriad of values aligns well with The Nature Conservancy's Working Woodlands program. Unfortunately, a passive, no-management approach is not going to realize these objectives, however neither is traditional sylvicultural applications viewed as acceptable to Hawk Mountain Sanctuary staff, donors, and members. Enrollment into the Working Woodlands program will enable access and participation in ecosystem markets, which can help to generate a new revenue stream by demonstrating improved forest management. Forest carbon markets have stimulated a renewed focus on uneven-aged silviculture and non-traditional treatment applications that enhance carbon storage while providing other co-benefits, such as late-successional biodiversity and improved stand structure; all of which resonates with this owner.

Forest management considerations for Hawk Mountain Sanctuary will center on vegetation and brush management, invasive species control, and sophisticated timber stand improvement prescriptions, all of which will come at a cost, either in the form of internal staff time and labor, or contractual work to qualified vendors with reputations for being open-minded to new concepts." – HMS-FMP

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 – Hawk Mountain Improved Forest Management Project will achieve GHG removals by sequestering more atmospheric CO_2 than a baseline scenario in live aboveground biomass, belowground biomass, and dead wood.

A7. *EX ANTE* OFFSET PROJECTION

Total projected GHG removal is 242,438 $mtCO_2e$ (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	2017	Start Date
1	2018	47,996
2	2019	46,223
3	2020	46,223
4	2021	46,223

5	2022	1,094
6	2023	3,825
7	2024	3,825
8	2025	3,825
9	2026	3,825
10	2027	3,825
11	2028	3,950
12	2029	3,950
13	2030	3,950
14	2031	3,950
15	2032	3,950
16	2033	3,161
17	2034	3,161
18	2035	3,161
19	2036	3,161
20	2037	3,161

A8. PARTIES

The project was implemented by Hawk Mountain Sanctuary Association, the land owner, The Nature Conservancy, a project partner, and Bluesource, LLC, a carbon offsets developer and technical modeler. Project verification was completed by SCS Global Services and the forest carbon inventory was conducted by Woodland Management Services.

Table A-3. Project Partners & Responsibilities

Project Parties	Personnel/Point of Contact	Roles and Responsibilities	Contact Information
Hawk Mountain Sanctuary Association	Laurie Goodrich, Director of Long-term Monitoring	Project Proponent – financing and implementation of long-term project management, landowner and title holder	Hawk Mountain Acopian Center for Conservation Learning 410 Summer Valley Rd, Orwigsburg, PA 17961 570-943-3411 x106
The Nature Conservancy	Josh Parrish, Director of Working Woodlands Program, Nature Conservancy	Project Partner – liaison to the landowner, manager of Working Woodlands program in which the landowner is enrolled	The Nature Conservancy 2101 N. Front Street, Building 1, Suite 200 Harrisburg, PA 17110 717-919-1686
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	Christie Pollet-Young, Director, Greenhouse Gas Verification	Verifier	SCS Global Services 2000 Powell Street Emeryville, CA 94608 Phone: 510-452-8000
Woodland Management Services	Robin Wildermuth, President	Contractor- Forest Inventory	Woodland Management Services 308 Egypt Road Tafton, PA 18464 Phone: 570-390-4286

B.
METHODOLOGY

B1. APPROVED METHODOLOGY

The methodology used for the Bluesource - Hawk Mountain 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 1.3. (April 2018)

(hereinafter called the "methodology")

B2. METHODOLOGY JUSTIFICATION

All applicability criteria of the selected methodology are fulfilled by the Bluesource - Hawk Mountain Improved Forest Management Project:

1. Hawk Mountain Sanctuary Association is non-federally owned forestland.
2. Hawk Mountain Sanctuary Association controls the timber rights on the forestland and can legally harvest (see 'Titles and Deeds').
3. Hawk Mountain Sanctuary Association 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.
4. N/A. Bluesource - Hawk Mountain Improved Forest Management Project is not on tribal lands.
5. N/A. Bluesource - Hawk Mountain Improved Forest Management Project is not on public non-federal lands.
6. There is no use of non-native species where adequately stocked native stands were converted for forestry or other land uses after 1997.
7. There is no draining or flooding of wetlands on or after the project Start Date.
8. See attached Deeds (appendix I2. Land Owner and Contracts).
9. 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 2,380.13 acres of forestland, shown in the maps in section A4. Location and in the shapefile "HMS_Boundary_5_1_18".

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

B4. IDENTIFICATION OF GHG SOURCES AND SINKS

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 - Hawk Mountain 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 - Hawk Mountain 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 of 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 6% discount rate, typical of ca. 2017 practices in the project region on private lands. Baseline practices involve large scale clearcuts and high grading. Derivation and justification for the baseline is detailed in Section E.

B6. PROJECT SCENARIO

The project scenario consists of growing the forestland through sustainable, natural forest growth and maintenance harvests for essential activities and forest health 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 commercial thinning, intermediate treatments, variable retention, and 2- or 3-step shelterwoods, on lands that otherwise could be heavily cut in the baseline scenario. The existing carbon stocks will be preserved through timber stand improvement, pest management, and small levels of low-grade harvesting.

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 + -3) + Section 2 (2 + 8 + 0 + 2) = 19%

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

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

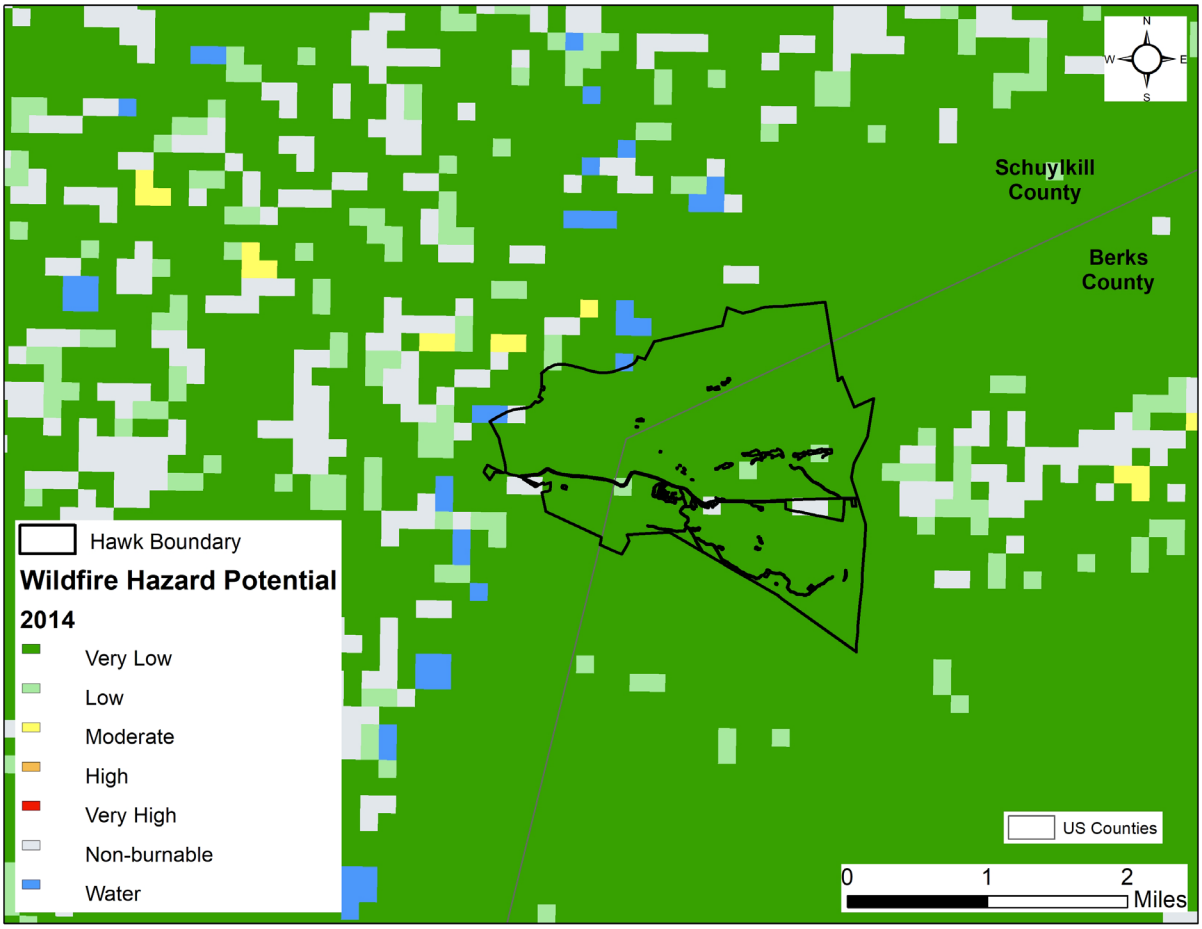


Figure B-1. Bluesource – Hawk Mountain IFM Project Wildfire Hazard Map

Buffer Pool Contribution

Total Risk score % * Total ERTs generated for crediting period = Buffer pool contribution in ERTs at time of issuance.

19% * 242,438 = 46,063 credits of buffer pool contribution

C.
ADDITIONALITY

C1. REGULTORY SURPLUS TEST

Demonstrate how the project passes the regulatory surplus additionality test described in the ACR Standard v5.0. Include a summary and references to any relevant local laws and regulations related to the project and provide of demonstration of compliance with them.

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.

Department of Environmental Protections (DEP) Chapter 102 Erosion and Sediment Control Regulations
DEP's Chapter 105 Dam Safety and Waterway Management Regulations
Chapter 189, Road Bonding Regulations
Right to Practice Forestry Act of 1992

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 2017 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 surrounding the Hawk Mountain project includes Pennsylvania (southeast, northeast, and southwest), New Jersey, New York, and Maryland. Wood products, especially hardwood sawtimber and some softwood sawtimber and pulp are distributed to mills throughout this region. The forest type for this project is most similar to 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, often through clear-cutting and high-grading, and is managed to maximize NPV of the forestland investment. If the Bluesource – Hawk Mountain 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

- ***Financial***
- *Technological*
- *Institutional*

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.	

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 – Hawk Mountain 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
Monitoring Frequency	Every 5 years, following with inventory update
Value applied:	2,380.13
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	yr
Description	Number of years between monitoring time t and t1 (T = t2 – t1)
Data Source	Monitoring reports
Measurement Methodology	
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 or calipers
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
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 Hawk Mountain 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 40 years after harvest for the project in year t.
Data Source	Harvest slips and reports produced Hawk Mountain Sanctuary Association.
Measurement Methodology	Wood volumes harvested will be monitored using the whichever recordation system is appropriate for the harvest (lump sum v. pay as cut).
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 Pennsylvania and converted to wood volume in an appropriate software, or (2) directly scaled to volume by log scalers certified by the state of Pennsylvania.
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 Hawk Mountain 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 Hawk Mountain 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 2017, prior to validation/initial-verification, a representative sample of 72 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 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. The landowner will be responsible for "on the ground" forest management activities on the project area, and Woodland Management Services will conduct inventory measurements and data collection. After forest inventory data collection, Woodland Management Services 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

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

add all the data to a master spread sheet.

At least 5% of the plots will be checked by a different forester than 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 calculations though 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 relevant project documentation, a senior manager reviews these documents and checks that all quantitative elements have been correctly exported from the underlying workbook. At this stage, final checks will be conducted by 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 on April 1, 2017. The inventory employed a systematic random sample of 72 nested, fixed-radius circular plots. Due to the similarity in forest type and structure across the property, the entire project area (2,380.13 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 'HawkMountain_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	72	2,380.13	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 Northeastern (NE) variant of the FVS model, which encompasses Pennsylvania, with model equations calibrated to Allegheny National Forest National Forest (location code: 919), the US National Forest located nearest to the project.

We also used FVS to 'degrow' the inventory to the project start date (March 17, 2017), because the plots were inventoried 1 month 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 Northeastern 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 (March 17, 2017). We, similarly, estimated CO_2e stocks on the project reporting period end date (March 17, 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 period end

date. These calculations are detailed in the 'InvDate', 'IndTreeGrow', and 'TreeList' tabs in HawkMountain_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 HawkMountain_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	Northern Red Oak	833	RO	68.00	1
2	Northern Red Oak	833	RO	66.00	1
3	Northern Red Oak	833	RO	68.00	1
4	Northern Red Oak	833	RO	70.50	1
5	Northern Red Oak	833	RO	70.50	1
6	Northern Red Oak	833	RO	70.50	1
7	Northern Red Oak	833	RO	66.00	1
8	Northern Red Oak	833	RO	71.75	1
9	Northern Red Oak	833	RO	70.50	1
10	Northern Red Oak	833	RO	66.00	1
11	Northern Red Oak	833	RO	71.75	1
12	Northern Red Oak	833	RO	71.75	1
13	Northern Red Oak	833	RO	71.75	1

Plot	Species common name	Species FIA code	Species FVS code	Site Index	Strata
14	Northern Red Oak	833	RO	72.00	1
15	Northern Red Oak	833	RO	72.00	1
16	Northern Red Oak	833	RO	68.00	1
17	White Oak	802	WO	80.00	1
18	Northern Red Oak	833	RO	71.75	1
19	Northern Red Oak	833	RO	71.75	1
20	Northern Red Oak	833	RO	68.00	1
21	Northern Red Oak	833	RO	68.00	1
22	Northern Red Oak	833	RO	68.00	1
23	Northern Red Oak	833	RO	72.00	1
24	Northern Red Oak	833	RO	72.00	1
25	Northern Red Oak	833	RO	72.00	1
26	Northern Red Oak	833	RO	71.75	1
27	Northern Red Oak	833	RO	71.75	1
28	Northern Red Oak	833	RO	71.75	1
29	Northern Red Oak	833	RO	68.00	1
30	Northern Red Oak	833	RO	68.00	1
31	Northern Red Oak	833	RO	68.00	1
32	Northern Red Oak	833	RO	68.00	1
33	Northern Red Oak	833	RO	68.00	1
34	Northern Red Oak	833	RO	63.00	1
35	Northern Red Oak	833	RO	72.00	1
36	Northern Red Oak	833	RO	72.00	1
37	Northern Red Oak	833	RO	71.75	1
38	Northern Red Oak	833	RO	68.00	1
39	Northern Red Oak	833	RO	68.00	1
40	Northern Red Oak	833	RO	68.00	1
41	Northern Red Oak	833	RO	80.00	1
42	Northern Red Oak	833	RO	73.80	1

Plot	Species common name	Species FIA code	Species FVS code	Site Index	Strata
43	Northern Red Oak	833	RO	71.50	1
44	Northern Red Oak	833	RO	72.00	1
45	Northern Red Oak	833	RO	72.00	1
46	Northern Red Oak	833	RO	72.00	1
47	Northern Red Oak	833	RO	72.00	1
48	Northern Red Oak	833	RO	72.00	1
49	Northern Red Oak	833	RO	68.00	1
50	Northern Red Oak	833	RO	68.00	1
51	Northern Red Oak	833	RO	68.00	1
52	Northern Red Oak	833	RO	68.00	1
53	Northern Red Oak	833	RO	68.00	1
54	Northern Red Oak	833	RO	68.00	1
55	Eastern White Pine	129	WP	90.00	1
56	Northern Red Oak	833	RO	72.00	1
57	Northern Red Oak	833	RO	72.00	1
58	Northern Red Oak	833	RO	72.00	1
59	Northern Red Oak	833	RO	72.00	1
60	Northern Red Oak	833	RO	71.75	1
61	Northern Red Oak	833	RO	71.75	1
62	Northern Red Oak	833	RO	68.00	1
63	Northern Red Oak	833	RO	68.00	1
64	White Oak	802	WO	80.00	1
65	Northern Red Oak	833	RO	72.00	1
66	Northern Red Oak	833	RO	72.00	1
67	Northern Red Oak	833	RO	67.33	1
68	Northern Red Oak	833	RO	71.00	1
69	White Oak	802	WO	80.00	1
70	Northern Red Oak	833	RO	72.00	1
71	Northern Red Oak	833	RO	72.00	1

Plot	Species common name	Species FIA code	Species FVS code	Site Index	Strata
72	Northern Red Oak	833	RO	72.00	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-NE overview available at https://www.fs.fed.us/fmsc/ftp/fvs/docs/overviews/FVSne_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 HawkMountain_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 non-governmental organizations forest in Pennsylvania.

Estimation of $CO2_e$ stocks on start and reporting dates

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, 0.65. The respective weights for dead trees are 0.1, 0.25, 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 HawkMountain_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 (March 17, 2017) is 447,394 tons CO_2e (447,394 = 187.97 tons CO_2e per acre x 2,380.13 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
187.97	72

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 Robin Wildermuth, 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

Management prescription	Abbreviation	Management actions	Minimum DBH harvested (inches)	Minimum saw timber DBH (inches)	Minimum pulpwood DBH (inches)	Harvest trigger
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
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

Harvest revenues

To estimate timber revenue under each harvest prescription, we used regional timber prices sourced from a 2017 Quarterly Stumpage Price Report (2nd quarter) for Pennsylvania produced by Penn State Extension services. Modeled timber volumes in FVS are based on merchantability standards detailed in the FVS-NE overview. FVS outputs harvested saw timber and pulpwood in units of cubic feet. We, therefore, converted reported saw timber and pulpwood prices to $ per cubic foot. These price conversions can be found in HawkMountain_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 MBF International 1/4 inch)	Pulp wood price ($ per 100 ft^3)

Species common name	Species FIA code	Species FVS code	Saw timber price ($ per MBF International 1/4 inch)	Pulp wood price ($ per 100 ft^3)
Larch	70		52.43	
White pine	114	WP	85.45	
Table Mountain pine	123	TM	75.00	
Pitch pine	126	PP	89.14	
Virginia pine	132	VP	60.82	
Hemlock	261	EH	113.99	
Black maple	314	BM	406.00	
Red maple	316	RM	323.42	31.11
Silver maple	317	SV	307.00	
Sugar maple	318	SM	427.39	
Yellow birch	371	YB	185.52	
Sweet birch	372	SB	148.93	
Hickory	409	MH	272.96	
Misc			85.98	
Mixed hardwood			134.00	13.46
American beech	531	AB	66.07	
Mixed softwood			84.00	15.06
White ash	541	WA	391.37	
Black walnut	602	WN	136.31	
Yellow poplar	621	YP	219.43	
Cucumber	651	CT	105.53	
Black gum	693	BG	139.90	
Aspen	743	BT	58.54	
Black cherry	762	BC	941.55	
Mixed oak	800	OK	326.00	38.19
White oak	802	WO	460.88	
Scarlet oak	806	SO	305.96	
Red oak	812	SK	584.51	
Chestnut oak	832	CO	380.43	

Species common name	Species FIA code	Species FVS code	Saw timber price ($ per MBF International 1/4 inch)	Pulp wood price ($ per 100 ft^3)
Northern red oak	833	RO	453.00	
Black oak	837	BO	293.36	
Sassafras	931	SS	110.65	
Basswood	951	BW	131.17	

Harvest costs

Our consultations with local forester, Robin Wildermuth, indicated that variable harvest costs of 0.15% of total revenue are typical for the region. 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 6% discount rate.

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 1/72th of the project area ($\frac{project\ area}{number\ of\ plots}$ = 33.06 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 HawkMountain_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 belowground 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 belowground 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 Pennsylvania 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
Pennsylvania	61.4%	65.0%	56.9%	51.3%

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 Allegheny & North Cumberland Mountains Assessment Area(s), in which the project is located. 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
Allegheny & North Cumberland Mountains	4.0%	69.0%	0.0%	12.0%	5.0%	3.0%	7.0%

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 HawkMountain_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 $4,070,815.**

Table E1.j Baseline and project scenarios.

Strata	Management prescription	Baseline (acres)	Project (acres)
1	CC	1,818.15	0.00
1	DL	0.00	0.00
1	GROW	0.00	2,261.12
1	SHW	561.98	0.00
1	STS	0.00	119.01

Table E1.k shows projected CO_2e stocks under the baseline scenario over the first 20-year crediting period (2017 to 2037). CO_2e stocks in live and standing dead trees represent stocks on March 17 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 141,351 tons.**

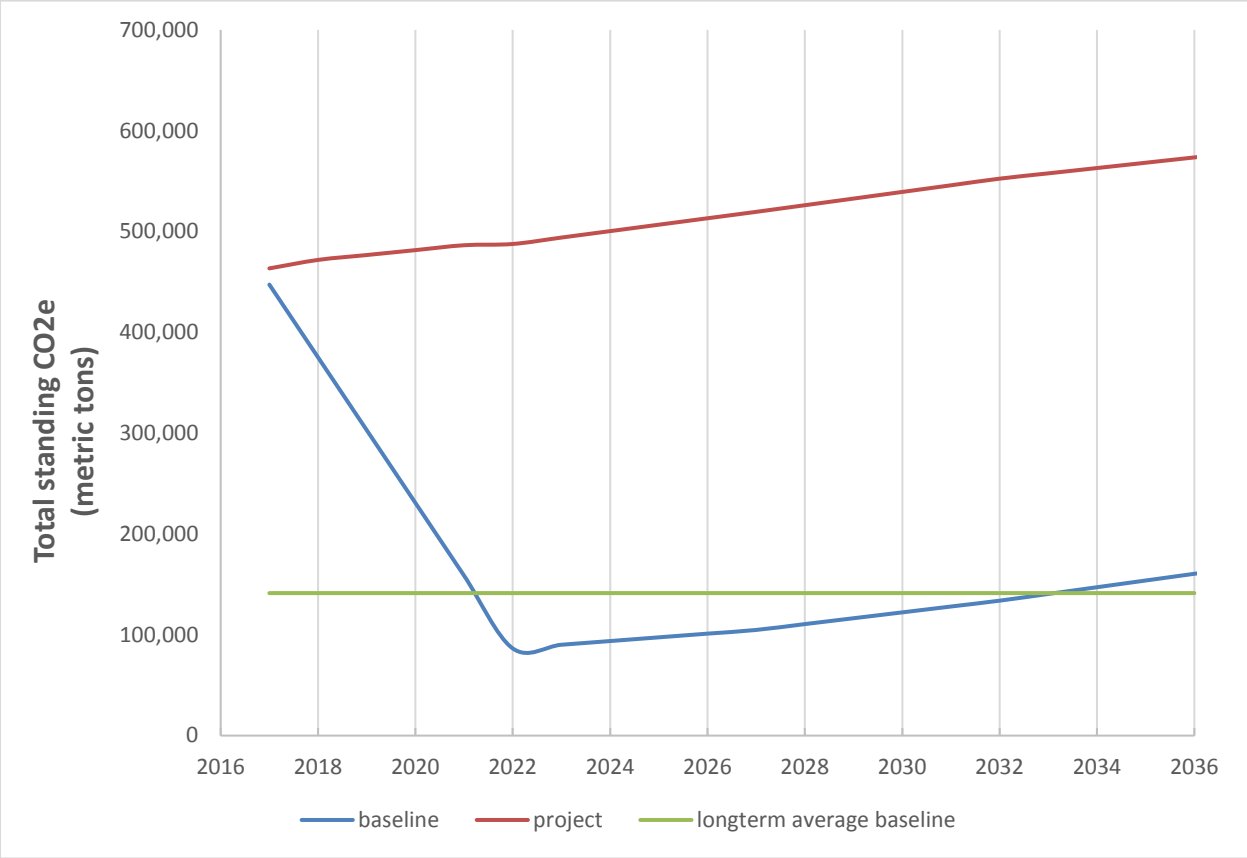
Table E1.k Baseline CO_2e stocks.

Year	Live trees (tons CO_2e per acre)	Standing dead (tons CO_2e per acre)	Harvested wood products (tons CO_2e per acre)
2017	155.7	32.3	1.2
2018	127.8	28.6	1.2

Year	Live trees (tons CO_2e per acre)	Standing dead (tons CO_2e per acre)	Harvested wood products (tons CO_2e per acre)
2019	100.0	25.0	1.2
2020	72.2	21.3	1.2
2021	44.4	17.6	1.2
2022	16.5	13.9	1.2
2023	17.9	13.0	1.2
2024	19.2	12.0	1.2
2025	20.5	11.0	1.2
2026	21.9	10.0	1.2
2027	23.2	9.1	1.2
2028	25.2	8.3	1.2
2029	27.2	7.6	1.2
2030	29.2	6.9	1.2
2031	31.2	6.2	1.2
2032	33.2	5.4	1.2
2033	35.4	4.8	1.2
2034	37.7	4.2	1.2
2035	40.0	3.5	1.2
2036	42.2	2.9	1.2
2037	44.5	2.3	1.2

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 5% of the project area. These calculations are detailed in the "Project" tab in HawkMountain_100Yr_Calcs.xlsx. This ex-ante projection applies in years beyond 2018, as the landowner harvested no timber in the first reporting period.

E3. LEAKAGE

All forestlands owned by Hawk Mountain Sanctuary Association have been certified by the Forest Stewardship Council (FSC). To prevent activity-shifting leakage, Hawk Mountain Sanctuary Association 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 (%)
2017-2037	56,067	1,496	97.3	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 HawkMountain_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 Hawk Mountain Sanctuary Association 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 7.3%. Median uncertainty in combined project CO_2e stocks (ACR equation 18) over the 20-year is 7.3%. Median total uncertainty encompassing both the baseline and project scenarios (ACR equation 19) over the 20-year is 7.3%. These calculations are all found in the "ACR_IFM_Calcs" tab of HawkMountain_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	130.65	25.02	155.66	32.31	-	32.31	187.97	2,380.1
% AG	100%	19%	119%	25%	0%	25%	144%	
% Live	84%	16%	100%	21%	0%	21%	121%	
% Total	70%	13%	83%	17%	0%	17%	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	72	155.66	63.14	7.44	2,380	370,499
Dead	72	32.31	31.47	3.71	2,380	76,895

Inventory Confidence Calculations

Pool	Total CO_2e (tons)	No. of Plots	Standard Error (tons)	90% Error Margin (tons)
Live	370,499	72	17,710	29,133
Dead	76,895	72	8,827	14,520

Percentage uncertainty expressed as 90% confidence interval

Live ($e_{TREE,t=1}$)	7.9%
Dead ($e_{DEAD,t=1}$)	18.9%

E5. REDUCTIONS AND REMOVAL ENHANCEMENTS

Table E1.n shows estimated net reductions and removal enhancements attributable to the Hawk Mountain Sanctuary Association project over the first 20-year crediting period (2017 - 2037). 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 March 17, 2017, the project start date. Therefore, annual values in Table E1.n correspond to the 1-year interval ending on March 16 of each year. For example, ERTs in 2018 include GHG reductions and removals occurring between March 17, 2017 and March 16, 2018.

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

Project year	Year	Estimated GHG emission reductions (tons CO_2)
0	2017	Start Date
1	2018	47,996
2	2019	46,223
3	2020	46,223
4	2021	46,223
5	2022	1,094
6	2023	3,825

Project year	Year	Estimated GHG emission reductions (tons CO_2)
7	2024	3,825
8	2025	3,825
9	2026	3,825
10	2027	3,825
11	2028	3,950
12	2029	3,950
13	2030	3,950
14	2031	3,950
15	2032	3,950
16	2033	3,161
17	2034	3,161
18	2035	3,161
19	2036	3,161
20	2037	3,161

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)
2017	155.7	32.3	0.0
2018	158.9	32.3	0.0
2019	161.0	32.3	0.0
2020	163.0	32.3	0.0
2021	165.0	32.3	0.0
2022	165.7	32.3	0.0
2023	168.3	32.3	0.0

Year	Live trees (tons CO_2e per acre)	Standing dead (tons CO_2e per acre)	Harvested wood products (tons CO_2e per acre)
2024	171.0	32.3	0.0
2025	173.6	32.3	0.0
2026	176.3	32.3	0.0
2027	178.9	32.3	0.0
2028	181.7	32.3	0.0
2029	184.4	32.3	0.0
2030	187.1	32.3	0.0
2031	189.9	32.3	0.0
2032	192.6	32.3	0.0
2033	194.8	32.3	0.0
2034	197.0	32.3	0.0
2035	199.1	32.3	0.0
2036	201.3	32.3	0.0
2037	203.5	32.3	0.0

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. Hawk Mountain is privately held property with fee-based and time-restricted publicly available access. Hawk Mountain holds no obligation to inform private individuals who may visit the property about the Bluesource – Hawk Mountain Improved Forest Management Project, nor were any stakeholder groups beyond the Hawk Mountain Sanctuary Association included in the decision-making process. Hawk Mountain Sanctuary Association itself serves as the representative of all relevant Hawk Mountain stakeholders including staff and researchers at Hawk Mountain, the board of HMSA, supporters and donors to Hawk Mountain, etc. Communication to stakeholders regarding the project is conveyed though HMSA at the board's discretion.

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 (especially for hawks and other migratory or local birds), 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

Impact	Protects area as community resource for education, research, and recreation
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 – Hawk Mountain 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 – Hawk Mountain 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 Hawk Mountain Sanctuary Association is privately-held property. 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, Hawk Mountain Sanctuary Association, 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 – Hawk Mountain 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 – Hawk Mountain Improved Forest Management Project" has a project start date of March 17, 2017, the date of the project listing on the American Carbon Registry website. This start date is appropriate and consistent with the ACR Standard v. 5.0 as it occurs after January 1, 2000.

H2. PROJECT TIMELINE

Below is a schedule of the project activities in chronological order for important aspects of the Bluesource – Hawk Mountain Improved Forest Management Project.

Project Activity	Date	Source/Notes
Project Start Date (Initiation of project activities)	March 17, 2017	Date of Listing
Frequency of monitoring, reporting and verification		Every 5 years after the first verification
Length of First Crediting period	Through March 16, 2037	20 years
Expected project longevity	N/A	In perpetuity