

CAFR5382: Forest Carbon Partners - Seldovia Native Association Forest Carbon Project

Initial Offset Project Data Report, Version 1.3

19 March 2020

*Air Resources Board
Compliance Offset Protocol
U.S. Forest Projects
Adopted: June 25, 2015*

1-A. REPORTING PERIOD 1:

December 31, 2017 to March 29, 2019

1-B. PROTOCOL VERSION:

Air Resources Board
Compliance Offset Protocol – U.S. Forest Projects
Adopted: June 25, 2015

1-C. REGULATION VERSION:

April 2019

1-D. ATTESTATION

I certify under penalty of perjury under the laws of the State of California the GHG reductions and/or GHG removal enhancements for Forest Carbon Partners - Seldovia Native Association Forest Carbon Project from December 31, 2017 to March 29, 2019, are measured in accordance with the Compliance Offset Protocol U.S. Forest Projects, June 25, 2015, and all information required to be submitted to ARB in the Offset Project Data Report is true, accurate, and complete.

Name: **Brian Shillinglaw**

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Date: 2020.03.23 19:18:08 -07'00'

Title: President, New Forests Advisory Inc., its General Partner

Date: March 23, 2020

1-E. NOTE TO READER ON ATTACHMENTS TO THE OPDR

This version of the OPDR includes the necessary information required in attachments G, H, I, and K; thus, these attachments are not being provided separately. Attachments A, E, F and L are included as separate attachments to this document. Attachments B, C, D and J are not applicable to this project.

1-F. NOTE TO READER REGARDING DIFFERENCES BETWEEN OPDR AND LISTING DOCUMENTS

If there are differences between the listing documents and this OPDR, the differences are enumerated in the following table.

Table 1. Listing Documents to OPDR Changes

Line	Item	OPDR Location	Listing Documents	Description
1	Reporting Period	1-A: Reporting Period	Listing Form pg. 1	Reporting Period was extended.
2	APD contact information	7: OPO/APD Information	Listing Form pg. 1	Updated APD contact person.
3	OPO contact information	7: OPO/APD Information	Listing Form pg. 1	Updated OPO contact person and contact information
4	Project Area	8-C: Location & 8-D Vicinity Map	Listing Form pg. 2	Project Area changed; maps, acreage and other project information modified to reflect revised Project Area.
5	Assessment Areas	13-H: Identification of Supersections & Assessment Areas	Listing Form pg. 2 & 3	Acreages allocated to the Assessment Areas changed as a result of revisions to the Project Area.
6	Inventory	Various	Listing Form pg.3	Inventory changed due to updated project area and stratification.
7	Summary of onsite carbon stocks	11-H: Actual Onsite Carbon Stocks	Listing Form pg. 6	Onsite carbon stock estimates changed because of revised project area and carbon calculations.
8	Baseline carbon stocks	11-F: Final Baseline	Listing Form pg. 7	Baseline carbon stock estimates changed because of revised FVS modeling, updated project area, and revised carbon calculations.

2. TABLE OF CONTENTS

1-A. Reporting Period 1:.....	ii
1-B. Protocol Version:	ii
1-C. Regulation Version:.....	ii
1-D. Attestation.....	ii
1-E. Note to Reader on Attachments to the OPDR.....	ii
1-F. Note to Reader Regarding Differences between OPDR and Listing Documents.....	iii
2. Table of Contents	iv
3. List of Tables	ix
4. List of Figures	x
5. Offset Project Information	11
5-A. Offset Project Name	11
5-B. Offset Project ID.....	11
5-C. Offset Project Type	11
5-D. Commencement Date & Justification	11
5-E. Listing Date Completion	11
6. OPO/APD Information.....	12
6-A. Offset Project Operator.....	12
6-B. Authorized Project Designee	12
6-C. Submitted By.....	13
6-D. Technical Consultants.....	13
7. Land Ownership	14

7-A. Name & Mailing Address of All Forest Owners, including third parties with existing property interests.....	14
7-B. Name & Mailing Address of Parties with a Material Interest.....	14
7-C. Location.....	14
7-D. Location/Vicinity map of Property	15
7-E. Physical Address of Project Site (if available).....	17
7-F. Qualified Conservation Easement(s).....	17
8. Offset Project Area.....	18
8-A. Forest Conditions within the Project Area.....	18
i. Tree species & age-class distribution	18
ii. Management history	18
iii. Planned Management Activities.....	18
iv. Potential Risks to Tree Health	19
8-B. Project Area Governing Jurisdictions & Project Coordinates	19
8-C. Project Area Site Classes	19
8-D. Land Pressure(s) and Climate Zone Classification.....	20
8-E. Current & Historical Land Use	20
8-F. Current Zoning	20
9. Offset Project Eligibility	21
9-A. Canopy Cover.....	21
9-B. Broadcast Fertilization	21
9-C. Natural Forest Management Criteria.....	21
9-D. Regeneration Cut/Commercial Harvest	22

9-E. Sustainable Management	23
9-F. Age Class Requirement	23
9-G. Structural Elements (Standing & Lying Dead Wood)	23
9-H. Management Activities Leading to Increased Carbon Stocks	24
9-I. Additionality: Legal Requirement Test	24
9-J. Regulatory Compliance.....	24
9-K. Additionality: Performance Standard Evaluation	25
9-L. Previous Registration as Forest Offset Project.....	25
10. Carbon Stock Inventory	25
10-A. Project Area Forest Vegetation Types	25
10-B. Project Boundary Delineation.....	26
i. Seldovia Native Association Ownership	26
ii. Mature timber identified: pre-stratification.....	27
10-C. Stratification	28
10-D. Project's Risk Reversal Calculation	29
10-E. Offset Project Boundary Description & List of Onsite Carbon Pools Included	31
10-F. Inventory Design and Sampling Process.....	33
i. Systematic Random Sample	33
ii. Plot Establishment:.....	34
iii. Plot Measurements:.....	34
iv. Tree Measurements:.....	34
v. Inventory Equipment:.....	35
vi. Plots on Project Boundaries	35

vii. Updating/Replacing Sample Plots & Inventory	35
10-G. Data Management Systems & Processes	36
10-H. Quality Assurance/Quality Control (QA/QC) Procedures	37
i. Data collection.....	37
ii. Data processing.....	37
iii. Data management	38
10-I. Change Log of Inventory Methods or Volume & Biomass Equations.....	38
10-J. Procedures for Updating the Forest Carbon Inventory	38
10-K. Initial Above-Ground Standing Live Tree Carbon Stocks	39
10-L. Common Practice (CP) Value	39
i. Identification of Supersections & Assessment Area(s) by Area	39
ii. Common Practice Site Class Stratification.....	41
iii. Single Common Practice Value.....	41
iv. Common Practice Compared to Above-Ground Standing Live	41
v. Weighted-Average Above-Ground Standing Live Tree Carbon Stocks	41
10-M. Carbon Quantification Methods – Modeling Carbon Stocks	42
i. Biomass and Carbon Equations.....	42
11. Baseline and Project Models	43
11-A. Legal Constraints.....	44
11-B. Financial Constraints.....	50
11-C. FVS Modeling.....	50
11-D. FVS Prescriptions	50
11-E. Baseline Onsite Carbon Stocks.....	55

11-F. Final Baseline Incorporating All Required Onsite Carbon Pools.....	60
11-G. Baseline Carbon in Harvested Wood Products.....	61
11-H. Determining Actual Onsite Carbon Stocks	61
11-I. Determining Actual Carbon in Harvested Wood Products.....	63
11-J. Calculating Secondary Effects	64
12. Other Offset Programs	64
13. GHG Reductions and Removals	64
14. Attachment E	68
15. Attachment F	68
16. Appendix I: Inventory Manual	68
17. Appendix II: Python Libraries Used.....	68
18. References	69

3. LIST OF TABLES

Table 1. Listing Documents to OPDR Changes.....	iii
Table 2. Species composition.....	21
Table 3. Age of project mashup strata (inventory timber types combined with post strata).	23
Table 4. Riparian spatial data	27
Table 5. Strata summary information at the beginning of the reporting period.....	29
Table 6. Project contribution to Buffer Account based on risk analysis.....	29
Table 7. Carbon pools/sources that must be accounted for	31
Table 8. Project area by supersection and assessment area.....	40
Table 9. Common practice calculation.....	41
Table 10. Legal constraints to baseline model.....	44
Table 11. FVS Prescriptions	50
Table 12. FVS regeneration parameters used in Natural keyword	53
Table 13. Baseline Acreage Allocation by prescription and strata.....	55
Table 14. Carbon (CO ₂ e) Reported from the Baseline Harvest Schedule.....	55
Table 15. Forest Offset Protocol Table A.2 Summarizing Total Carbon by Carbon Pool and Stratum.....	62
Table 16. Forest Offset Protocol Table A.3 Summarizing Carbon Pools and Total MT CO ₂ e/acre by Carbon Pool.....	62
Table 17. Carbon (CO ₂ e) reported from the Project Activity harvest schedule	63
Table 18. GHG reductions and removals worksheet.....	64

4. LIST OF FIGURES

Figure 1. Vicinity map of property	15
Figure 2. Watershed boundary map of property	16
Figure 3. Sitka spruce forest near a riparian area	18
Figure 4. Supersection Map	40
Figure 5. Onsite Baseline Stocking as Modeled	58
Figure 6. Final Baseline Results Averaged	59

5. OFFSET PROJECT INFORMATION

5-A. OFFSET PROJECT NAME

Forest Offset Protocol §7.1.1(a)(1)

Forest Carbon Partners - Seldovia Native Association Forest Carbon Project

5-B. OFFSET PROJECT ID

Forest Offset Protocol §7.2.1(a)(2)

ARB Project ID: CAFR5382

Registry Project ID: CAR1292

5-C. OFFSET PROJECT TYPE

Forest Offset Protocol §7.1.1(a)(2)

Improved Forest Management

5-D. COMMENCEMENT DATE & JUSTIFICATION

Forest Offset Protocol §3.6(a)(2), §7.1.1(a)(16)

12/31/2017, date listing information was submitted

5-E. LISTING DATE COMPLETION

Forest Offset Protocol §7.1(a)

1/4/2018, date listing information was approved

6. OPO/APD INFORMATION

6-A. OFFSET PROJECT OPERATOR

Forest Offset Protocol §7.1(a)(3)(A)

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Anchorage, AK 99515

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CITTS ID Number: CA2684

6-B. AUTHORIZED PROJECT DESIGNEE

Forest Offset Protocol §7.1(a)(3)(B)

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Email Address: bshillinglaw@newforests-us.com

CITTS ID Number: CA1403

6-C. SUBMITTED BY

Forest Offset Protocol §7.1(a)(3)(C)

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6-D. TECHNICAL CONSULTANTS

Forest Offset Protocol §7.2.1(a)(4)(D)

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Physical Address: 1840 Bragaw Street, Suite 110, Anchorage, AK 99508

Email Address: Nathan@Chugachmiut.org

7. LAND OWNERSHIP

7-A. NAME & MAILING ADDRESS OF ALL FOREST OWNERS, INCLUDING THIRD PARTIES WITH EXISTING PROPERTY INTERESTS

(Forest Offset Protocol §7.1.1(a)(8))

The Seldovia Native Association is the owner of fee title to the real property included in the Project Area. Based on a title review and inquiry with the Offset Project Operator, property interests held by third parties such as easements and rights of way are not expected to affect the trees and the standing timber located within the Project Area.

Name	Address	Interest
Seldovia Native Association	237 E. Fireweed, Suite 200 Anchorage AK, 99403	Fee interest in the land and standing timber
Chugach Alaska Corporation	3800 Centerpoint Dr, Suite 1200, Anchorage, AK 99503	subsurface rights affect portions of the project area

7-B. NAME & MAILING ADDRESS OF PARTIES WITH A MATERIAL INTEREST

Forest Offset Protocol §7.1.1(a)(9)

N/A

7-C. LOCATION

Forest Offset Protocol §2.2(b)(2), §3.1(a)(2), §7.1.1(a)(11), Regulation §95975(l)

The project takes place on private land located in the United States. Figure 1 shows the vicinity and location of the property. Detailed maps of the vicinity of the property including topography and watercourses are attached separately as Attachment E.

Seldovia Native Association is the sole private owner in fee of the trees and the standing timber located within the Project Area. The offset project area is not located 1) on land that is owned by, or subject to an ownership or possessory interest of a Tribe; 2) on Indian Land as defined in 25 U.S.C. §81(a)(1); or 3) on land that is owned by any person, entity, or Tribe within the external borders of such Indian Lands.

Property interests held by other parties such as easements and rights of way are not expected to affect the trees and standing timber located within the Project Area.

7-D. LOCATION/VICINITY MAP OF PROPERTY

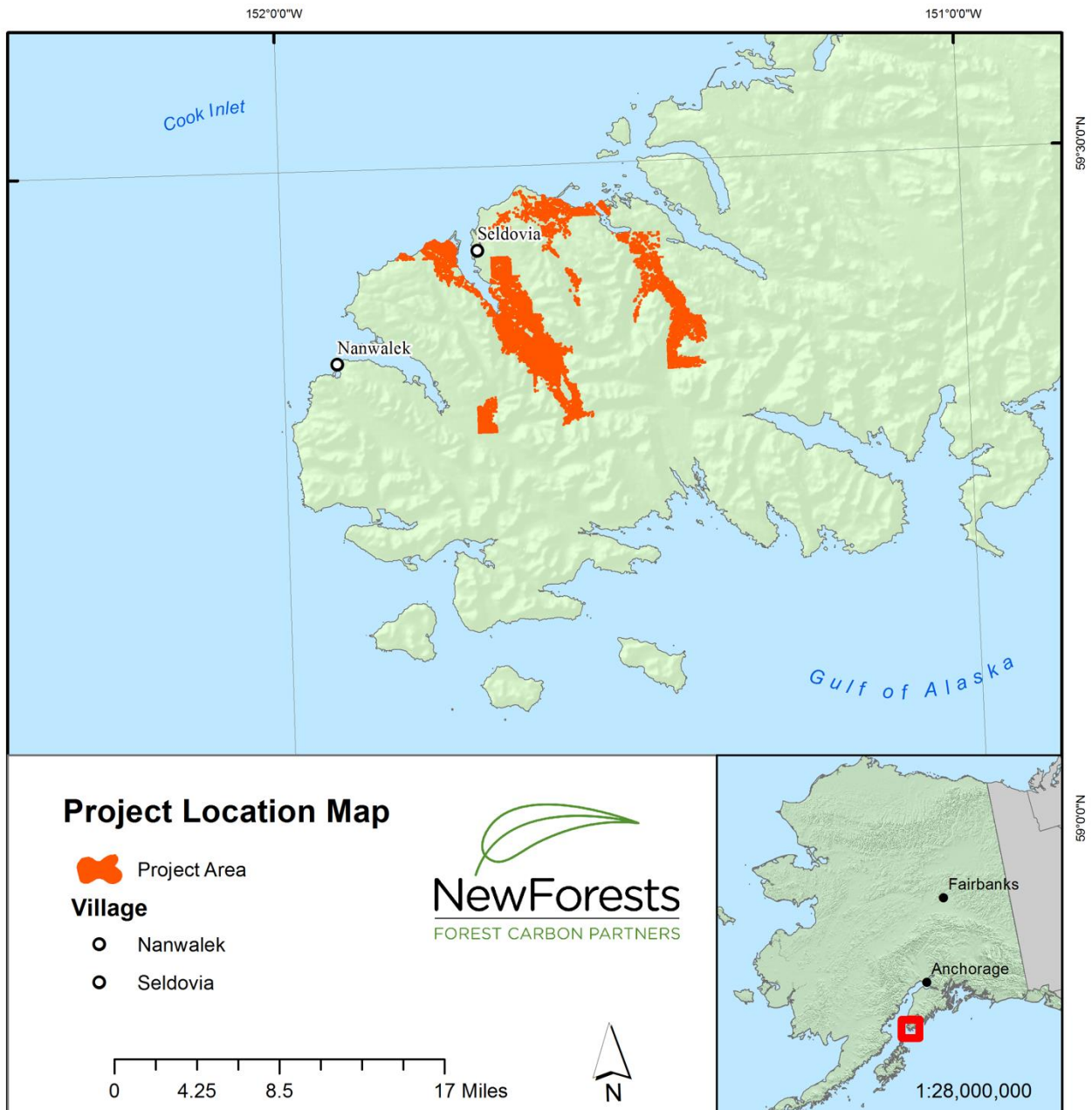


Figure 1. Vicinity map of property

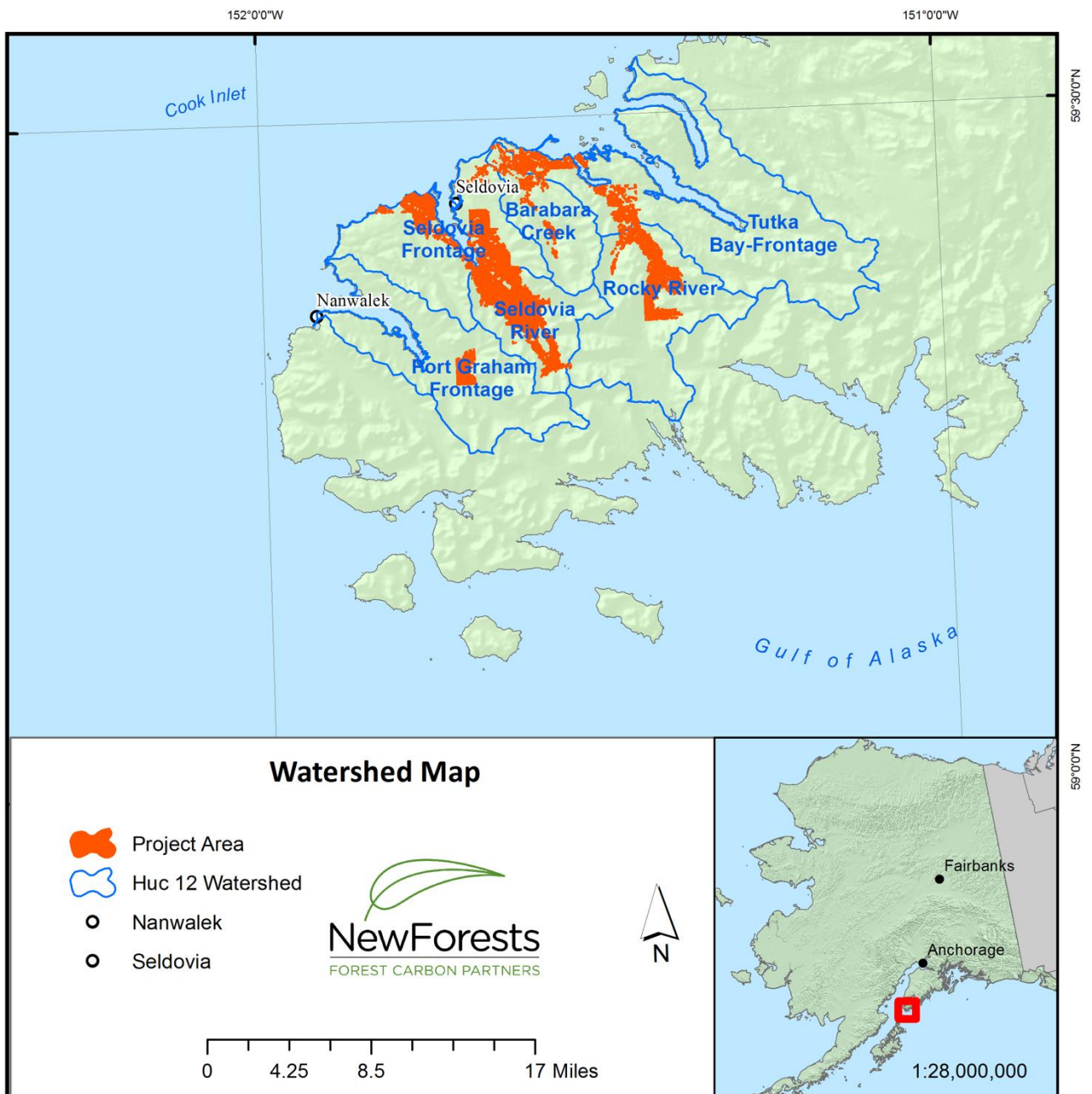


Figure 2. Watershed boundary map of property

7-E. PHYSICAL ADDRESS OF PROJECT SITE (IF AVAILABLE)

(Forest Offset Protocol §7.1.1(a)(10))

The Project Site has no physical address. It is located adjacent to the community of Seldovia, Alaska on the southern end of the Kenai Peninsula.

7-F. QUALIFIED CONSERVATION EASEMENT(S)

(Forest Offset Protocol §7.1.1(a)(20))

There are no conservation easements on the property.

8. OFFSET PROJECT AREA

8-A. FOREST CONDITIONS WITHIN THE PROJECT AREA

Forest Offset Protocol §7.1.1(a)(19), Appendix A(a)(8)

i. TREE SPECIES & AGE-CLASS DISTRIBUTION

Forest vegetation is coastal rainforest, primarily Sitka spruce. Hardwoods are present in riparian areas adjacent to the Project Area. Several areas of old, late seral forest are included in the project area. Forest inventory data for the project show that over 99% of the basal area within the project is Sitka spruce, which is a natural condition for this region and forest type as indicated in a written statement from the government agency in charge of forestry regulation in Alaska.



Figure 3. Sitka spruce forest near a riparian area

ii. MANAGEMENT HISTORY

Subsistence lifestyles have been practiced around the Project Area for thousands of years by Seldovia Native Association shareholders and their ancestors. European traders and settlers arrived in the area in the 1700s. Modern industrial timber harvest was conducted in the region from the 1960s through the 1990s. The project area includes several old forest areas that have never been logged.

iii. PLANNED MANAGEMENT ACTIVITIES

Projected land use is a combination of hunting, fishing, and non-timber forest product collection along with recreation, tourism and cultural uses. Some roads, bridges, cabins, and utilities are maintained. Forest inventory plots will be re-measured periodically as required. Timber stand improvement and harvest may occur in the future according to market conditions and Seldovia Native Association shareholder priorities.

iv. POTENTIAL RISKS TO TREE HEALTH

The primary disturbance agents in the Seldovia Native Association project area are Spruce Bark Beetle (*Dendroctonus rufipennis*), windthrow, and landslides. The project area consists of forest dominated by Sitka spruce with minor components of black cottonwood. Seldovia is at the northern extreme of the Sitka spruce range and common insect pests such as the white pine weevil (*Pissodes strobe*) are not present in the project area or the northern range of the Sitka spruce. Throughout the Sitka spruce range fire is not a prominent cause of mortality (McClelland et al 1990). An analysis of fire records dating back to 1939 by Lojewski (2015) on nearby Port Graham Corporations lands showed that no fires have been reported and only two fires nearby, each human caused by debris burning and less than one acre in size.

8-B. PROJECT AREA GOVERNING JURISDICTIONS & PROJECT COORDINATES

Forest Offset Protocol §7.1.1(a)(15)(A)

The project is located in the Kenai Peninsula Borough in the State of Alaska, United States of America.

8-C. PROJECT AREA SITE CLASSES

Forest Offset Protocol §7.1.1(a)(15)(I)

Site classes are productivity classes defined by ranges of site index. Site index is measured as the height of a tree at a given age (50 years is the typical standard base age used in the western US, although 100 years used to be more common).

The commercial forest included in the project area has site index (Farr 1984) ranging from 33 to 80 feet tall at 50 years old based on site index trees in the carbon inventory. More productive forests and soils are located on valley bottoms with deeper soils and milder weather.

8-D. LAND PRESSURE(S) AND CLIMATE ZONE CLASSIFICATION

Forest Offset Protocol §7.1.1(a)(15)(J), Appendix A(a)(5,6)

The maritime climate of the Kenai Peninsula has abundant precipitation in both rain and snow. Summer days are long, and daylight hours are short in winter. Land pressures include timber harvest, mining, and development of houses and tourism. The Project Area covers a wide range of elevations, aspects, and coastal exposure, which strongly influence the microclimate and vegetation.

8-E. CURRENT & HISTORICAL LAND USE

Forest Offset Protocol §7.1.1(a)(15)(K)

Forest conditions are coastal rainforest of pure Sitka spruce. Willows, cottonwoods, and tall shrubs such as Sitka alder intermingle in riparian and mountainous areas. The current age class distribution reflects the history of the harvests and disturbances that have taken place. Mature Sitka spruce stands on the project area have mixed ages and are often dominated by 100-150 year old trees, with some large trees that are hundreds of years old. Younger trees are present in areas that have been harvested in the past half-century.

The project area has been covered in forestland for the past several hundred years or longer (Lojewski 2015). Commercial timber harvesting has been practiced in the project area as evidenced by decaying stumps, logging roads, and residual timber damage from past operations. Management history varies between selective harvest units and old forest stands that have never been intensively treated. Although records are limited from earlier periods, there was likely land management by the Alutiq people including use of trees and timber for thousands of years since glaciers retreated. Europeans arrived in the area in the 1700s. Large old stumps suggest that some individual trees were cut for timber over the next several hundred years (Lojewski 2015). Modern intensive forest management began in the 1960s when the land was controlled by the State of Alaska. Further harvest accompanied by road building and natural or artificial reforestation were carried out when Seldovia Native Association obtained title in the 1970s and continued intermittently through the 1990s (Lojewski 2015). The majority of Seldovia Native Association harvest was done using ground based logging systems and old clear cuts are present on the Seldovia Native Association ownership.

8-F. CURRENT ZONING

Forest Offset Protocol §7.1.1(a)(15)(K)

The Project Area is located in the Kenai Peninsula Borough, which does not have zoning restrictions outside of municipal areas.

9. OFFSET PROJECT ELIGIBILITY

9-A. CANOPY COVER

(Forest Offset Protocol §2.2(b)(3), §7.1.3(1))

The project takes place on land that has greater than 10-percent tree canopy cover. There are no improved or permanent roads on the property which are large enough to have less than 10 percent canopy cover to exclude from the project.

9-B. BROADCAST FERTILIZATION

Forest Offset Protocol §3.1(b)(3), §7.1.1(a)(21)

No broadcast fertilization has been used in the Project Area since the Project Commencement Date and there are no plans to employ broadcast fertilization in the future in the Project Area.

9-C. NATURAL FOREST MANAGEMENT CRITERIA

Forest Offset Protocol §3.1, §7.1.1(a)(23)

Management activities that occur on the project area will be designed to maintain and increase carbon stocks, improve natural ecosystem processes, enhance native tree species and adhere to the Natural Forest Management practices required by the Forest Offset Protocol.

The project must consist of at least 95% native species based on the sum of carbon in the standing live pool. Project Area species composition has been measured using basal area per acre. One hundred percent of the project is comprised of native species based on the 2018 inventory. Table 2 provides the quantification required to show that at least 95% of the carbon in the standing live carbon pool is composed of native species.

The project area naturally consists of pure Sitka spruce stands. An understory of tall alder shrubs occurs in many stands, and willow and black cottonwood are found in adjacent riparian areas. All species are native to the region. A written statement has been obtained from Hans Rinke, Kenai Kodiak Area Forester, Alaska Division of Natural Resources State of Alaska supporting that the project area is a coastal spruce forest that does not naturally consist of a mixed species distribution.

Table 2. Species composition

Species				
---------	--	--	--	--

Common Name	Scientific Name	FVS Code	FIA Code	Basal Area Per Acre (ft ²)	Comp by Basal Area (%)	Native species	Percent by Native
Sitka spruce	Picea sitchensis	SS	98	199.2	99.8%	Yes	99.8%
black cottonwood	Populus balsamifera ssp. trichocarpa	CW	747	0.5	0.2%	Yes	0.2%
Total				199.6	100.0%		100.0%

Source: Schedules workbook, Tables tab.

9-D. REGENERATION CUT/COMMERCIAL HARVEST

Forest Offset Protocol §7.1.1(a)(22)

When harvesting is planned or implemented, sustainable long-term harvesting practices must be demonstrated through one or a combination of the following options:

1. The forest owner(s) must be certified under the Forest Stewardship Council, Sustainable Forestry Initiative, or Tree Farm System certification programs. The terms of certification must require adherence to and verification of harvest levels which can be permanently sustained over time;
2. The forest owner(s) must adhere to a renewable long-term management plan that demonstrates harvest levels which can be permanently sustained over time and that is sanctioned and monitored by a state or federal agency; or
3. The forest owner(s) must employ uneven-aged silvicultural practices (if harvesting occurs) on all of the forest owner's landholdings within the assessment area containing the project and maintain canopy cover averaging at least 40 percent across all of the forest owner's landholdings within the assessment area containing the project as measured on contiguous 20 acre areas within the forest owner's landholdings found in any of these assessment areas, including land within and outside of the project area (areas impacted by significant disturbance may be excluded from this test);

Commercial harvesting is not currently planned or occurring within the project area. Also, no harvesting is planned elsewhere on the forest owner's landholdings. Therefore, the OPO meets the sustainable harvesting requirement.

9-E. SUSTAINABLE MANAGEMENT

Forest Offset Protocol §3.1(a)(1)

Not applicable; no commercial harvesting is occurring within the Project Area.

9-F. AGE CLASS REQUIREMENT

Forest Offset Protocol §3.1(a)(1), Table 3.1

Field data collected during the 2018 and 2019 inventory was used to analyze the distribution of age classes in the Project Area. Age class was based on gathering age from potential site trees at 67 plots within the project area to determine an average age for each stratum. All trees bored for age were used in the calculation of average stand age. The average age of the strata ranged from 72 to 89 years old; no stands were less than 20 years old. Therefore, the project meets the criteria of the Forest Offset Protocol. Table 3 shows the average age by inventory sampling cruise code and post-strata derived from field data collected within the project area. The project area clearly meets the requirement in Table 3.1 of the protocol that no more than 40% of the forested acres on a watershed scale are in age classes of less than 20 years.

Table 3. Age of project mashup strata (inventory timber types combined with post strata).

Strata	Average Strata Age	Site Tree Count
LD	79	54
LS	72	11
SS	89	2

9-G. STRUCTURAL ELEMENTS (STANDING & LYING DEAD WOOD)

Forest Offset Protocol §3.1(a)(1), Table 3.1

No salvage logging has occurred in the past year within the project area. No active removal of down dead wood is conducted on the project area. Therefore, the project must maintain or demonstrate ongoing progress toward an average of at least:

- one (1) metric ton of carbon (C) in standing dead wood per acre; or
- 1% of standing live carbon stocks, in standing dead wood, whichever is higher.

The current standing dead wood stocks are 2.34 metric tons of carbon per acre, which is higher than 1% of standing carbon stocks (0.60 metric tons carbon/acre) and is above the target of one (1) metric ton. Since the current carbon stocks in standing dead exceed the minimum requirements, the project must maintain an average of at least one (1) metric ton of carbon (C) in standing dead wood per acre or 1% of standing carbon stocks, whichever is higher.

Standing dead wood was estimated by sampling standing dead trees in the inventory and applying the biomass calculations as described in the inventory calculation section.

9-H. MANAGEMENT ACTIVITIES LEADING TO INCREASED CARBON STOCKS

Forest Offset Protocol §7.1.1(a)(18)

The Project will produce greenhouse gas (GHG) reductions by managing the project forest for increased stocking and carbon sequestration when compared to the project baseline. This will be accomplished in the near term by allowing the forest to grow and reducing commercial scale timber harvest.

Overall stocks will never drop below the level of standing live carbon stocks at the initiation of the project. Stocks will be maintained at a level that assures all credited standing live carbon stocks are permanently maintained.

9-I. ADDITIONALITY: LEGAL REQUIREMENT TEST

Forest Offset Protocol §3.4.1, Regulation §95973(a)(2) & §95975(k)

The primary legal constraint to forest management on the Project Area is the Alaska Forest Resources and Practices Act. The national Endangered Species Act, Bald and Golden Eagle Protection Act, and Clean Water Act also apply. The baseline for this project was modeled using applicable provisions of state and federal law. These constraints are examined more closely in the Legal Constraints section of this document.

Since 1) the project activities are not legally required, and 2) modeling of the forest project's baseline carbon stocks reflects all legal constraints, the emission reductions or removals enhancements achieved by the forest project exceed those required by any law, regulation, or other legally binding mandate and thus the project satisfies the legal requirement test.

9-J. REGULATORY COMPLIANCE

(Forest Offset Protocol §3.8, §7.2.1(8), Regulation §95973(b))

The project complies with applicable provisions of the following state and federal laws:

- a) Federal Endangered Species Act

- b) Federal Clean Water Act as regulated by the State Water Resources Control Board
- c) Bald and Golden Eagle Protection Act
- d) Archaeological Resources Protection Act
- e) Alaska Forest Resources and Practices Act

The Forest Project and associated Project Lands have met and been in compliance with all local, state, and federal regulatory requirements during the reporting period.

9-K. ADDITIONALITY: PERFORMANCE STANDARD EVALUATION

Forest Offset Protocol §3.4.2, Regulation §95973(a)(2)

An Improved Forest Management Project automatically satisfies the performance standard evaluation, since the project activities produce GHG emission reductions and GHG removal enhancements in excess of those that would have occurred under a conservative business-as-usual scenario (i.e. the baseline).

9-L. PREVIOUS REGISTRATION AS FOREST OFFSET PROJECT

Forest Offset Protocol §3.1(a)(5)

None of the land within the Project Area has ever been listed or registered with an offset project registry or program, nor have greenhouse gas emission reductions or removal enhancements associated with the Project Area been credited or claimed for the purpose of greenhouse gas mitigation or reduction goals, either in a voluntary or regulatory context.

10. CARBON STOCK INVENTORY

(Forest Offset Protocol §4.2, §7.1.1(a)(24, 27, 28, 31), Appendix A)

10-A. PROJECT AREA FOREST VEGETATION TYPES

(Forest Offset Protocol §Appendix A(a)(2))

The forests within the Seldovia Native Association ownership are comprised principally of Sitka spruce and occasional hardwoods in riparian areas. Forest within the Seldovia Native Association ownership was delineated based on aerial imagery prior to the carbon inventory, and sample plots were randomly allocated across the forest area for sampling. The project area was also post-stratified into several strata following inventory based on the initial strata but including new areas and aerial imagery data. These strata were used for carbon quantification and harvest scheduling.

10-B. PROJECT BOUNDARY DELINEATION

The project boundary was determined by delineating mature, harvestable timber stands within the property ownership of the Seldovia Native Association. Riparian buffer areas were excluded from the project areas. The following steps used to determine the project boundary are detailed in the sections below.

1. Map acreage owned by Seldovia Native Association.
2. Remove anadromous habitat riparian buffers.
3. Heads-up digitization of forest area, used as the sampling frame for plot layout, is clipped by the product of steps 1 and 2.

i. SELDOVIA NATIVE ASSOCIATION OWNERSHIP

Ownership was mapped using available BLM PLSS data in combination with a comprehensive ownership tile report. Riparian areas excluded

Riparian areas with legal constraints to harvest were excluded from the project area. The Alaska Forest Resources & Practices Act (FRPA) organizes waterbody setback standards by region and stream type. An assessment of the FRPA regulations indicates that the property occurs within Region 1 (Coastal Sitka Spruce/Hemlock Unit) and includes Type1-A and 1-B waterbody standards. All Type 1-A and 1_B anadromous streams regardless of stream type have 66-foot buffers excluded from the project area.

All anadromous fish habitat features were buffered and removed from the project area. Features within the Alaska Department of Fish and Game (ADFG) Anadromous Waters Catalog (AWC) GIS layer were intersected with water features within data obtained from the National Hydrologic Dataset (NHD, NHD24kwb_a_AK ponded). The NHD features were buffered when it was coincident or matched the AWC feature geometry. When the AWC features were present, but no NHD feature matched, the AWC layer was buffered. The water features that intersect the AWC feature layer were buffered on either side by 66 feet. Buffers were created from both line and polygon features. Streams occurred as line features within the water feature layers. These line features were buffered from either side of the line, while larger water features mapped as polygons were buffered from the edges of the polygon extent. The streams and other water features were given a 66-foot buffer for all anadromous stream classifications.

a) *ANADROMOUS WATERBODIES*

Waterbodies (streams, ponds, and other waterbodies that salmon may migrate through) meeting anadromous (salmon habitat) criteria are considered Type 1-A and Type 1-B. A 66-foot no-cut buffer is required for all Type 1-A and 1-B waterbodies. Additionally, consideration for slope stability standards are required within 100 feet of the water body; however, slope stability standards do not restrict timber harvest. Therefore, 66' was used as the buffer for all Type 1-A and 1-B waterbodies.

Methods:

1. Selected all streams from the ADFG anadromous streams (AWC) layer.
2. Selected ponded (lakes, ponds, etc.) waterbodies from NHD24Kwb_a_AK - included all polygons that intersected AWC lines.
3. All AWC stream segments that were not included in NHD layers remained as lines.
4. 66-foot buffers were applied to streams and ponded features.

b) Non-Anadromous Tributaries to Anadromous Waterbodies

Non-anadromous streams were not buffered as regulation does not require a no cut buffer. These waterbodies need to be protected for slope stability but cutting can occur to the stream edge.

c) *SOURCE DATA*

Table 4. Riparian spatial data

Source Data Name	Description	Location
SNA_Project_Area.shp	Stratified project area	FINAL_ProjectArea.zip
NHD24kwb_a_AK	N24K polygon features	NHD_Layer.zip
AWC_SKenai_66ftBuff.shp	Anadromous Waters Catalog stream line layer (2016)	AWC.zip

ii. MATURE TIMBER IDENTIFIED: PRE-STRATIFICATION

The inventory sampling frame included all timber stands identified using a heads-up GIS digitization of forest cover created prior to the carbon project. This analysis was completed using QGIS and the ESRI Satellite basemap obtained from [Quick Map Services](#) at varying scales. This basemap consists of satellite imagery collected at different resolutions but all within a resolution of 15m. It is in the WGS 84 coordinate system (EPSG:3857). A zoomed-out scale was used to determine forest nonforest area and then the map was zoomed in to determine precise boundaries. After consulting with ARB on acceptable minimum mapping units, polygons were kept larger than 0.05 acres (the size of an inventory plot).

10-C. STRATIFICATION

Strata were defined based on similar satellite-derived variables. Specifically, cloud free LandSat 8 scenes from snow free periods in 2014 -2016 were obtained from [earthexplorer.usgs.gov](#) of the project area. Five scenes were selected that fit the criteria of no snow and at most 10% cloud cover. A principle components analysis (PCA) was used on bands 1-7 for all 5 scenes producing 11 predictor variables. Separately, Normalized Difference Vegetation Index (NDVI) and Normalized Burn Ratio (NBR) layers were created using LandSat Bands 4, 5, and 6.

Strata were defined using the Jenks Natural Breaks algorithm. Jenks Natural Breaks is a non-parametric approach to classifying continuous data. The paradigm for assigning breaks is the minimization of variance between members of a class. In this way 'natural' breaks in the data were used as breaks and strata are thus defined such that the variability in above-ground biomass is minimized.

The Jenks algorithm requires exogenous definition of the number of breaks (strata) to create (N). Practically, fewer strata mean that long-term project management is less complex. Partitioning the variability effectively to reduce sampling error was a second a factor in deciding the number of breaks. Due to the nature of the Jenks algorithm, a larger magnitude of N will result in lower variance within the class with diminishing return as the number of breaks approaches the number of values. A third factor was ensuring sufficient representation by plots within strata to facilitate sequential sampling.

The total aboveground live biomass estimates from inventory plots were used as the values to classify in the Jenks step. Once the breaks were established, the predictor variables, NDVI and NBR layers were fit to a set of nonparametric (random forest) models that related the remote sensing data and the strata definitions. All models were fit using the classification algorithms in the random Forest package in R statistical software. The random forest classified the project ownership boundary into the bins described in the Jenks algorithm. Following this analysis, we had 5 distinct strata, 3 of which comprise the project area as they represent the mature standing timber that would be economically feasible to harvest. The accompanying r-scripts provide processing steps used to develop the strata.

Table 5. Strata summary information at the beginning of the reporting period.

Strata	No. of Plots	Carbon (CO2/acre)			Acres	Total Carbon (CO2)
		Avg. Live AG	Avg. Live BG	Avg. Dead		
LD	193	186.0	43.8	8.9	14,143	3,376,288
LS	53	109.5	26.7	5.5	1,468	208,013
SS	14	125.0	31.3	7.4	295	48,312
Total	260				15,906	3,632,612
Average		177.83	41.98	8.57		

10-D. PROJECT'S RISK REVERSAL CALCULATION

(Forest Offset Protocol Appendix D)

Table 6. Project contribution to Buffer Account based on risk analysis

Risk Type	Risk Category	Contribution from Risk Descriptions	
		Source	Forest Project without a Qualified Conservation Easement and/or Public Ownership

Financial	Financial Failure	Default Risk	5%
Management	Illegal Forest Biomass Removal	Default Risk	0%
	Conversion	Default Risk	2%
	Over-harvesting	Default Risk	2%
Social	Social	Default Risk	0%
Natural Disturbance	Wildfire	Default Risk	4%
	Disease or Insect Outbreak	Default Risk	3%
	Other Catastrophic Events	Default Risk	3%
Appendix D Calculation: =1-((1-0.05)*1*(1-0.02)*(1-0.02)*1*(1-0.04)*(1-0.03)*(1-0.03))		Overall Contribution Based on Appendix D.1 Calculation	17.6%

10-E. OFFSET PROJECT BOUNDARY DESCRIPTION & LIST OF ONSITE CARBON POOLS INCLUDED

Forest Offset Protocol Appendix A(b)(1)

Table 7. Carbon pools/sources that must be accounted for

Carbon Pool or Source (Forest Offset Protocol, §5.2)	Included or Optional (Forest Offset Protocol, §5.2)	Included in this project?	Justification/Quantification Method
Primary Effect Sources, Sinks, and Reservoirs			
IFM-1 Standing Live Carbon (living trees)	Included	Included	Mandatory pool for measurement – Baseline modeled using initial field inventory measurements; Project measured by field measurements and updating forest carbon inventory.
IFM-2 Shrubs and Herbaceous Understory	Excluded	Excluded	NA
IFM-3 Standing dead carbon (carbon in all portions of dead, standing trees)	Included	Included	Mandatory pool for measurement – Baseline modeled using initial field inventory measurements; Project measured by updating forest carbon inventory.
IFM-4 Lying dead wood carbon	Excluded	Excluded	NA
IFM-5 Litter and duff carbon (carbon in dead plant material)	Excluded	Excluded	NA
IFM-6 Soil Carbon	Included/ Excluded	Excluded	It is not necessary to quantify soil carbon in this project in accordance with the Protocol, as deep ripping, furrowing, plowing, soil disturbance exceeding 25% of the project area and mechanical site preparation not on contour will not be permitted on the project area.
IFM-7 Carbon in in-use forest products	Included	Included	Baseline estimated from modeled harvesting volumes. Project estimated from measured harvest volumes.

Table 7. Carbon pools/sources that must be accounted for

Carbon Pool or Source (Forest Offset Protocol, §5.2)	Included or Optional (Forest Offset Protocol, §5.2)	Included in this project?	Justification/Quantification Method
Primary Effect Sources, Sinks, and Reservoirs			
IFM-8 Forest product carbon in landfills	Included or Excluded	Included	Excluded when project harvesting exceeds baseline. Included when project harvesting is below baseline. Baseline estimated from modeled harvesting volumes. Project estimated from measured harvest volumes.
Secondary Effect Sources, Sinks, and Reservoirs			
IFM-9 Biological Emissions from site preparation activities	Included	Included	Biological emissions from site preparation activities are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs.
IFM-10 Mobil combustion emissions from site preparation activities	Excluded	Excluded	N/A
IFM-11 Mobile combustion emission from ongoing project operation and maintenance	Excluded	Excluded	N/A
IFM-12 Stationary combustion emissions from ongoing project operation and maintenance	Excluded	Excluded	N/A
IFM-13 Biological emissions from clearing of forestland outside of the Project Area	Excluded	Excluded	N/A
IFM-14 Biological emission/ removals from changes in harvesting on forestland outside the project area.	Included/ Excluded	Included	Not estimated for baseline. Estimated for project by using a default 20% “leakage” factor applied to the difference in harvest volume relative to baseline.

Table 7. Carbon pools/sources that must be accounted for

Carbon Pool or Source (Forest Offset Protocol, §5.2)	Included or Optional (Forest Offset Protocol, §5.2)	Included in this project?	Justification/Quantification Method
Primary Effect Sources, Sinks, and Reservoirs			
IFM-15 Combustion emissions from production, transportation, and disposal of forest products	Excluded	Excluded	N/A
IFM-16 Combustion emission from production, transportation, and disposal of alternative materials to forest products	Excluded	Excluded	N/A
IFM-17 Biological emissions from decomposition of forest products	Included	Included	For baseline, quantified as a component of calculating carbon stored for 100 years in wood products (SSR #IFM-7) and landfills (SSR #IFM-8) For project, quantified as a component of calculating carbon stored for 100 years in wood products (SSR #IFM-7) and landfills (SSR #IFM-8)

10-F. INVENTORY DESIGN AND SAMPLING PROCESS

Types of Sample Plots, Plot Layout, Plot Location, and Plot Monumenting Description
Forest Offset Protocol §7.1.1(a)(24), Appendix A(3)(4)(5)

Forest carbon quantification is based on a systematic random sample of plots measured across the project area. The inventory took place from May to June 2018 and in March 2019.

i. SYSTEMATIC RANDOM SAMPLE

The location of plots used in the inventory was determined by establishing a plot grid with a randomized origin and plot spacing that resulted in the target number of plots. The plot casting was accomplished using the accompanying Python library (`nfgeotools`, see Appendix 2). Specifically, the `layoutPlots` function was used with a target of 300 plots in the sampling frame.

ii. PLOT ESTABLISHMENT:

The inventory established permanent plots with a fixed radius 1/20th acre, and a nested 1/200th acre micro plot. All trees greater than 5.0 inches DBH were measured on the plot and all live trees 1.0-4.9 inches DBH were measured on the micro plot. Only trees 5.0 inches and greater were counted in the carbon stock calculations; smaller trees were used for modeling ingrowth over time.

Plots were established using GNSS location. Cruisers navigated using GNSS unit to within approximately 30' of plot center. Using the distance and bearing from the GNSS unit, cruisers completed navigation and plot establishment using a compass and tape or laser. The location of plot center was recorded using sub-meter GNSS units. Plot centers were monumented with galvanized steel conduit painted orange, and pink flagging hung at eye level above plot center. Trees measured on plot were marked with numbered aluminum tree tags.

Up to five witness trees were selected per plot to aid in future relocation. Witness trees were painted with an orange band 1.0 foot above DBH. Witness trees were nailed at 4.5 feet above ground level facing plot center, from this point cruisers recorded: slope distance from face of the witness tree at nail to 4.5 feet above plot center, slope percent from 4.5 feet above plot center to nail on witness tree and azimuth from plot center to nail on witness tree.

iii. PLOT MEASUREMENTS:

Plot measurement methods are detailed in the project's Inventory Manual. Plot data variables collected include: Plot Status, Plot Non-Sampled Reason Code, Plot Boundary Status, Distance to Plot Boundary, Plot Weight, Slope, Aspect, and Forest Type.

iv. TREE MEASUREMENTS:

Tree measurement methods are detailed in the Inventory Manual. Live and standing dead trees 5.0 inches DBH or larger were recorded on the plot. Standing dead trees require an actual height of 15.0 feet or greater while leaning no more than 45 degrees from vertical. Live trees 1.0-4.9 inches (saplings) were recorded on the microplot. Field measurements

include: Tree Tag Number, Present Tree Status, Species, Diameter, Total Height, Height to Break, Diameter Inside Bark at Break, Length Method, Crown Class, Compacted Crown Ratio, Defect, and Decay Class (standing dead only). Site trees were recorded on every fourth plot, Age at breast height was recorded for all site trees.

v. INVENTORY EQUIPMENT:

Field data were collected on Juniper Allegro 2 handheld field computers. Data were entered into a customizable software program for tabular data entry, DataPlus. Geographic data collected using EOS Arrow 100 sub-meter GNSS units and ESRI ArcPad software, using the GeoBullseye extension to capture GNSS metadata.

Plot and tree measurements conducted using: Suunto MC-2 compass and PM-5 clinometer, Laser Technology TruPulse 200/200X/360 laser hypsometer, Laser Technology Criterion RD1000, Spencer logger's tapes and Lufkin carpenter's tapes using the English Engineering scale.

vi. PLOTS ON PROJECT BOUNDARIES

Plots were established at the pre-determined location and not offset for any reason. Plots intersecting a hard boundary with plot center falling within the project area were sampled. To qualify as a hard boundary, a digitized project boundary must have a corresponding visual boundary differentiating the project area from the area outside the project (examples of visual boundaries include: clearcuts, blazing, survey markers, projected water protection boundaries, and ocean shoreline). Plots intersecting a hard boundary have data weighted proportionally using the methods from Practical Correction of Boundary Overlap (Beers 1977). Edge effect was not modeled for plots that appear to occur on project boundaries in GIS but did not have a distinct boundary discernible in the field.

vii. UPDATING/REPLACING SAMPLE PLOTS & INVENTORY

Annual monitoring of the Project is required to ensure up-to-date estimates of project carbon stocks and provide assurance that GHG reductions achieved by the project have not been reversed. A re-inventory will comply with the requirement that no field inventory data will be more than 12 years old; as such the project plots will be re-inventoried no later than 2030. Because the plots are permanently located, it is anticipated that the inventory re-measurement will use the existing plot locations as the basis for updating project stocks in the future. For future measurements, the inventory methodology may be updated to include new and improved specifications. In particular, remote sensing may be used for inventory and stratification. In addition, plot density may be reduced in future years. In such case, plots will be dropped in an unbiased manner such that the inventory continues to meet sampling error requirements.

10-G. DATA MANAGEMENT SYSTEMS & PROCESSES

Analytic Methods, Calculation Methodologies, Volume & Biomass Equations and Models
Forest Offset Protocol Appendix A(7)

All planning and analyses, including inventory, growth and yield modeling, and harvest scheduling required for this report had oversight by Emily Warms, Society of American Foresters Certified Forester, ID #60970. Thus, this report has been prepared with the oversight of a Professional Forester as required in Section 7.2(e) of the Protocol.

The data were analyzed in Microsoft Excel, SQLite, PostgreSQL with PostGIS spatial extension, the Python programming language (see Appendix II: Python Libraries Used), and the Forest Vegetation Simulator (FVS) SE Alaska variant (Keyser 2018). The Suppose user interface for FVS V2.08 (Crookston 1997) was used as well. The FVS model runs were run using OpenFVS¹ (AK FVS VARIANT -- RV:20180108).

All data, growth and yield simulation results, and carbon calculations remain stored on cloud-based and physical storage back-up drives.

¹ The Forest Vegetation Simulator (FVS) is a widely used forest growth model developed by the USDA Forest Service. This open-fvs project makes the source code and related files available so that university, private, and other government organizations who wish to participate in enhancing FVS can do so without the impediments caused by restricted access to the Forest Service's internal repository. (<https://sourceforge.net/projects/open-fvs/>)

10-H. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PROCEDURES

Assessing & Insuring Data Quality, Transfer & Archiving of Field Data, Data Entry & Analysis Procedures, Data Maintenance & Archiving, Other Relevant Procedures
Forest Offset Protocol Appendix A(8)

Quality was assessed at every step of the data collection, processing and reporting process during initial project development. Going forward, these or similar procedures will be used as inventory plots are re-measured to update the inventory and monitor and report on carbon stocks over time. In addition, all documents used to prepare the OPDR will be retained for a minimum of 15 years (or other time limit if Cap and Trade Regulation specifications are updated) following issuance of ARB Offset Credits.

- i. **DATA COLLECTION:** Inventory plot installation was conducted by trained inventory crews to the specifications and tolerances described in the Inventory Manual and the previous sections of this document. Data were recorded on field computers using custom parameter files, that aided in data collection quality control and automated plot identification link to the data collection software. Check cruising was conducted on a portion of the plots following the parameters in the inventory manual to ensure quality measurements and feedback to field crews during data collection. For future re-measurements, if the crews conducting inventory re-measurements have not utilized the inventory methodology before, check cruising will be conducted on at least 5 percent of the plots. If applicable, timely on-site feedback of the issues found on each of the checked plots will be provided to the cruisers.
- ii. **DATA PROCESSING:** Inventory data underwent extensive internal review by qualified foresters while it was collated and processed. All plot data was combined in Excel to perform error checking and ensure consistency in coding and formatting. Further data quality checking was done while formatting the data for processing in FVS and while creating the silvicultural prescriptions within FVS (e.g. by checking FVS output summary tables). Going forward, similar procedures will be utilized for future re-measurements and modeling, and a QAQC checklist will be implemented to minimize the risk of missed steps or inadvertent errors throughout data processing and transfer.

- iii. DATA MANAGEMENT: All data files used for reporting calculations within the OPDR follow naming and dating conventions to allow for data tracing and version control. All digital files are stored in a digital filing system and backed up on remote servers for data archiving and security. Physical files will also be maintained and stored.

10-I. CHANGE LOG OF INVENTORY METHODS OR VOLUME & BIOMASS EQUATIONS

Forest Offset Protocol Appendix I(9)

To be filled in once changes occur.

10-J. PROCEDURES FOR UPDATING THE FOREST CARBON INVENTORY

Documented Procedures to Account for Harvest, Growth, Mortality, Disturbance, Incorporating New Inventory & Plot Data, Retiring Older Sample Plots, Changes in Modelling, Appropriate Confidence Deduction

Forest Offset Protocol Appendix A(10)

For reporting stocks on an annual basis until the next inventory, when no harvesting is expected, the inventory update procedure will rely on growth projections. FVS 10-year “Let Grow” projections are interpolated to derive an annual growth increment. If any timber harvesting occurs in the project area, the timber harvest area will be re-inventoried within 3 years of completion of the harvest. A simulation of the harvest to update the inventory may be utilized in the interim. Timber harvests in the project area shall be designed to treat plots the same as the surrounding stand. Effort will be made to limit knowledge of exact plots locations from the foresters designing and implementing timber harvests, so that the risk of bias is minimized during harvest planning. In addition, a post-harvest review of recent harvested areas shall be conducted by a forester and if a plot appears, based on professional judgment, to no longer be representative of the surrounding stand due to being treated differently than prescribed in the harvest plan, then the plot will be moved to a random distance and direction within a 2.5-acre area around the original plot.

Disturbance events will be monitored as part of normal management activities, as well as through an annual review of aerial imagery and local and state disturbance reports (e.g. fire maps) if available and applicable. At the occasion of a disturbance event other than planned timber harvest, such as fire or windthrow, that appears to alter a significant portion of the project acreage, or results in a reversal under the protocol, then the plots in the affected area will be re-measured within one year of the end of the disturbance to determine whether or not a reversal occurred. If the disturbance appears to meet the specified threshold but does not affect any of the permanent plots in the inventory, new plots will be established in the affected area in sufficient quantity and distribution to account for the disturbance.

The newly measured plots will be installed consistent with the inventory manual used to establish the original inventory; any improvements or changes to inventory methods or calculations would be documented and justified in the change log. Once new plot data has been gathered, a new calculation of the Actual On-Site Carbon Stocks will be completed in order to revise the GHG Reductions and Removals as well as re-calculate the confidence deduction. The effects of disturbances on the carbon stocks of the project area will be estimated by monitoring the acreage affected utilizing the average per acre carbon stocks for the applicable strata. If the disturbance affects a significant portion of the strata acreage, then a new stratum will be delineated, and the project stocks and confidence deduction calculated using the new strata. If, in the process of re-measuring plots, the plots cannot be relocated, new plots will be established in the same locations as the old plots. The replacement plot data will replace the old plot data for the purposes of calculating project carbon stocks.

10-K. INITIAL ABOVE-GROUND STANDING LIVE TREE CARBON STOCKS

Forest Offset Protocol §5.2.1(b)

The weighted average initial carbon stocks (ICS) of the aboveground live tree component of the project are estimated to be 177.83 tonnes CO₂e per acre.

10-L. COMMON PRACTICE (CP) VALUE

Forest Offset Protocol §5.2.1(c), Forest Offset Protocol §7.1.1(a)(14), Appendix F(a-c)

i. IDENTIFICATION OF SUPERSECTIONS & ASSESSMENT AREA(S) BY AREA

The project area is located entirely within the Southeast and South Central Alaska Supersection and North Coast Mountains, Chugach-St. Elias Mountains and Gulf of Alaska Assessment Area.

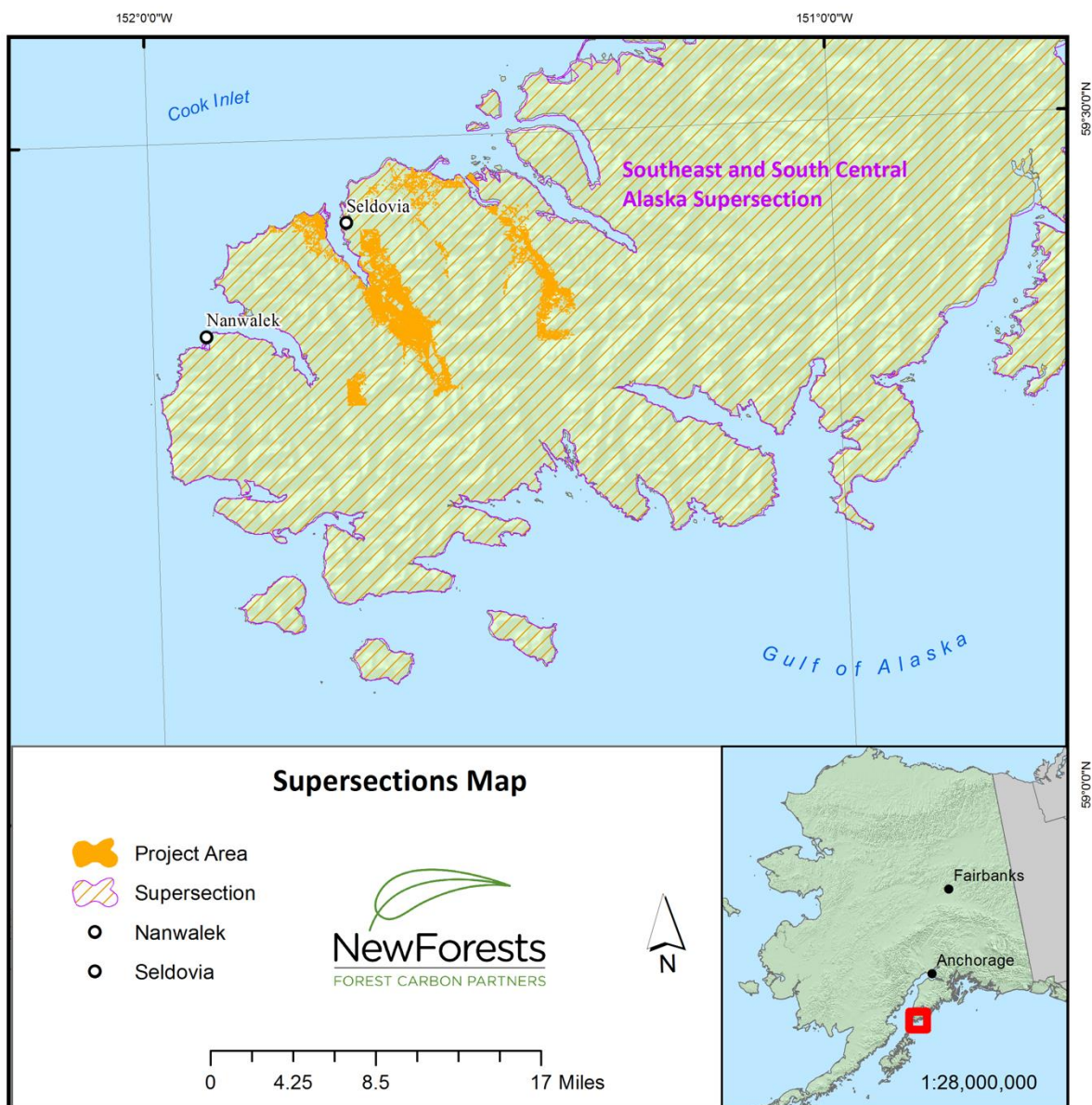


Figure 4. Supersection Map

Table 8. Project area by supersection and assessment area

Supersection	Assessment Area	Site Class	Area (acres)
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Southeast and South Central Alaska	North Coast Mountains, Chugach-St. Elias Mountains and Gulf of Alaska Assessment Area	n/a	15,906
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ii. COMMON PRACTICE SITE CLASS STRATIFICATION

Forest Offset Protocol Appendix F(d-f)

Since the assessment area is not divided into High and Low site class, no stratification was necessary to determine the Common Practice value.

iii. SINGLE COMMON PRACTICE VALUE

Forest Offset Protocol Appendix F(h)

Table 9. Common practice calculation

Supersection	Assessment Area	Site Class	Area (acres)	Common Practice Above-ground CO ₂ e (tonnes/ac)
Southeast and South Central Alaska	Gulf-North Coast-Chugach Assessment Area	n/a	15,906	84.9

iv. COMMON PRACTICE COMPARED TO ABOVE-GROUND STANDING LIVE

Forest Offset Protocol §5.2.1(d)

When ICS is above CP, which is the case for this project, it is not necessary to estimate the High Stocking Reference (HSR). Because the project area is a distinct geographical area defined by the biological criteria of the above-ground biomass density of different timber size classes, which impacts management objectives, it is managed differently and is thus considered its own Logical Management Unit (LMU). Because the LMU and the project area are one and the same, the weighted average above-ground standing live tree carbon stocks per acre within the LMU (WCS) equals the initial above-ground standing live carbon stocks per acre within the project area (ICS) and thus MBL = CP.

v. WEIGHTED-AVERAGE ABOVE-GROUND STANDING LIVE TREE CARBON STOCKS

Equation 5.5

$$\text{MBL} = \text{MAX}(\text{CP}, \text{MIN}(\text{ICS}, \text{CP} + \text{ICS} - \text{WCS})) = \text{MAX}(\text{CP}, \text{MIN}(\text{ICS}, \text{CP})) = \text{MAX}(\text{CP}, \text{CP}) = \text{CP}$$

10-M. CARBON QUANTIFICATION METHODS – MODELING CARBON STOCKS

Forest Offset Protocol §5.2.1(e), §7.1.1(a)(25, 26, 27), Appendix B

Carbon in individual trees (live and standing dead) was calculated for all plots using the ARB-approved equations using a Python script. Plot level live and standing dead carbon was derived as the summation of carbon in all trees on a given plot. Below-ground live and dead carbon was derived using the stipulated equation (Cairns et al. 1997) based on the total above-ground (live + standing dead). Below-ground live and dead carbon was derived by applying the ratio of above-ground live to aboveground standing dead.

i. BIOMASS AND CARBON EQUATIONS

a) *ABOVE-GROUND STANDING LIVE*

The above-ground standing live tree portion was calculated using the approved species-specific regional biomass equations as required by ARB (Alaska Biomass Equations). For broken top trees, net bole biomass was deducted to account for the missing volume of the broken top. This method assumes that 10%, 25%, and 65% of the tree volume is in the top, middle and bottom third of the tree, respectively. This missing biomass was then subtracted from the gross intact bole volume of the tree as if the tree were not broken.

All calculations for live trees were done through a series of scripted Python queries. These queries were applied to the individual tree records at each 10-year time period for the 100-year projection period for each strata/prescription/timing choice combination.

b) *ABOVE-GROUND STANDING DEAD*

Above ground standing dead wood was estimated using the snag data collected in the inventory for all standing dead trees greater than 5" DBH and 15' in height. Carbon was quantified using the approved species-specific regional biomass equations as required by ARB (Alaska Biomass Equations). For broken top trees, net bole biomass was calculated to account for the missing volume of the broken top. This method assumes that 10%, 25%, and 65% of the tree volume is in the top, middle and bottom third of the tree, respectively. This missing biomass was then deducted from the gross intact biomass calculated as if the tree were not broken. Biomass deductions were also applied for percent defect and decay class using density reduction factors from Harmon et al. (2008, 2011).

c) *BELOW-GROUND STANDING LIVE AND DEAD*

The same approach for calculating tree, plot and project level biomass and carbon was used on initial inventory and model year projections from the output of growth and yield model runs.

Tree level live and dead biomass and carbon calculations were done using the equations specified in the Protocol. Plot level aggregate above-ground live and dead values served as input into the protocol stipulated Cairns equation (Cairns et al. 1997) calculating total below-ground live and dead biomass. The total below-ground biomass was divided between live and dead based on the ratio between alive and dead above ground. Plot level measures were expanded to per acre values using the trees/acre (TPA) in the FVS output database.

All biomass estimates were converted to carbon by multiplying by 0.5 and to CO₂e by multiplying by 3.667, which are the conversion factors specified in the Protocol.

d) *HARVESTED WOOD PRODUCTS*

Harvested wood products pools require an estimate of the average amount of carbon that remains stored in wood products over a 100-year period. This was done according to the steps outlined in Appendix C of the protocol, which utilize the average DOE (2007) wood products factors for accounting for the long-term storage of wood products. The procedure begins with an estimate of the total harvested carbon that will be delivered to a mill to be turned into wood products (row 11 of the Offset Credit calculation worksheet). Next, the series of worksheets from Appendix C in the Protocol were used to determine the amount transferred to wood products, the amount stored in in-use wood products, and the amount stored in landfills. The carbon stored in wood products and landfills are summed to determine the total average annual carbon storage in wood products over 100 years.

For the calculation of secondary effects, the above and below-ground carbon of all harvested live trees is determined using the same equations and methods for determining standing live tree carbon over time. This was done by running the biomass calculations used for live trees on the tree list output tables for all harvested live trees for each strata/prescription/timing choice combination.

11. BASELINE AND PROJECT MODELS

The baseline above-ground standing live carbon stocks were determined by modeling above-ground standing live carbon stocks through a series of growth and harvesting scenarios over 100 years and averaging the model results over the 100-year timeframe, so that the baseline is expressed as a single (average) value for above-ground standing live carbon stocks. The baseline simulation incorporates all legal and financial constraints.

11-A. LEGAL CONSTRAINTS

Forest Offset Protocol §3.4.1(c)(2), §5.2.1(e)(1), §7.1.1(a)(25)

The silvicultural prescriptions modeled in the baseline include let grow with no treatments and clearcutting with various rotation lengths and timing choices. Modeling incorporated all legal constraints including the Alaska Forest Resources and Practices Act the national Endangered Species Act, Bald and Golden Eagle Protection Act, and the Clean Water Act.

Table 10. Legal constraints to baseline model

Regulation	Description	Geographic Range	Agency	Narrative of Effect on Forest Management	Modeling
Zoning	The project area is zoned as "rural," therefore land use is not restricted.	Borough Jurisdictions	Boroughs	None	No constraints.

Regulation	Description	Geographic Range	Agency	Narrative of Effect on Forest Management	Modeling
Alaska Forest Resources and Practices Act and The Federal Clean Water Act	I-A Water Bodies "An anadromous water body that meets the follow criteria: (A) is a stream or river of any size having an average gradient of eight percent or less, with banks held in place by vegetation, channels that are not incised, and a substrate composed of rubble, gravel, sand, or silt; (B) consists of wetlands and lakes, including their outlets; (C) is an estuarine area delimited by the presence of salt-tolerant vegetation"	Region I Alaska Forest Resources & Practices	Alaska Department of Natural Resources, Division of Forestry	"Harvest of timber may not be undertaken within 66 feet of the water body."	Constrain modeling by removing no cut buffers.
Alaska Forest Resources and Practices Act and The Federal Clean Water Act	I-B Water Bodies "An anadromous water body that does not meet the definition of a Type I-A water body."	Region I Alaska Forest Resources & Practices	Alaska Department of Natural Resources, Division of Forestry	"Harvest of timber may not be undertaken within 66 feet of the water body or to the break of the slope, whichever area is smaller."	Constrain modeling by removing no cut buffers.

Regulation	Description	Geographic Range	Agency	Narrative of Effect on Forest Management	Modeling
Alaska Forest Resources and Practices Act and The Federal Clean Water Act	I-C and I-D Water Bodies"A water body that is not anadromous, that is a tributary to a Type I-A or Type I-B water body."	Region IAlaska Forest Resources & Practices	Alaska Department of Natural Resources, Division of Forestry	No prohibition on commercial logging that would constrain baseline modeling. "Where prudent, retain low value timber within 25 feet of the water body, or within 100 feet of the water body or to the break of the slope, whichever area is smaller, if the water body is greater than 13 feet at the ordinary high-water mark or greater than eight feet at the ordinary high-water mark if the channel is incised."	No constraints.

Regulation	Description	Geographic Range	Agency	Narrative of Effect on Forest Management	Modeling
Federal Endangered Species Act	Several federally threatened or endangered marine species may potential be near the project area. The Steller's Eider and Short-tailed Albatross are both marine birds that would most likely not be affected by logging. If the Steller's Eider was found in the project area, logging would have seasonal restrictions. The Northern Sea Otter can also be found in marine waters near the project area, but would not impose any restrictions on logging.	See source for range map.	US Fish and Wildlife Service	Steller's Eider: Potential seasonal restrictions if found Albatross: None Northern Sea Otter: None	No constraints.
Federal Endangered Species Act	Alaska has two endangered whales species and one endangered sea loin species. Their protection does not impose restrictions on logging.	Alaska's Marine Waters	National Oceanic and Atmospheric Administration	None	No constraints.

Regulation	Description	Geographic Range	Agency	Narrative of Effect on Forest Management	Modeling
Bald and Golden Eagle Protection Act	Bald eagle nests can be found on the project area, and there are timber harvest restrictions around nesting areas. If needed, a take permit to remove nests can be obtained.	National	US Fish and Wildlife Service	Clear cutting and removing overstory trees within 330 feet of the nest should be avoided. During the breeding season timber harvesting should be avoided within 660 feet of the nest.	Riparian buffers excluded from project and additional acres conservatively allocated to "let grow".
Alaska Forest Resources and Practices Act	"To the fullest extent practicable, harvested forest land shall be reforested naturally or artificially, so as to result in a sustained yield of merchantable timber from that land." "Timber harvesting is limited to areas where data and information demonstrate that natural or artificial reforestation techniques will result in the production of a sustained yield of merchantable timber from that area."	Alaska	Alaska Department of Natural Resources Division of Forestry	Planting, regeneration monitoring may be required post-harvest.	Constraint modeled by modifying sprouting and planting settings to simulate activities in-line with the regulation.

Regulation	Description	Geographic Range	Agency	Narrative of Effect on Forest Management	Modeling
Archaeological Resources Protection Act	This law protects archaeological sites on Federal and Tribal Lands. The project area is considered to be privately owned, therefore this law has no impact on forest management in the project area. The Alaska Historic Preservation Act protects archaeological sites on state lands, which also has no impact on forest management in the project area.	National	National Park Service U.S., Department of the Interior	None	No constraints.

11-B. FINANCIAL CONSTRAINTS

Forest Offset Protocol §5.2.1(e)(2)(B), §7.1.3(4), Appendix A(a)(10)

Option B was chosen to demonstrate that the proposed baseline is financially feasible. As stated in the protocol, Option B provides “evidence that activities similar to the proposed baseline growth and harvesting regime have taken place within the past 15 years on at least three other properties within the forest projects assessment area”. Additional information is provided in Attachment L of this OPDR.

11-C. FVS MODELING

The Southeast Alaska variant of the Forest Vegetation Simulator (FVS) was used to model forest growth, mortality and harvest over time (Keyser 2018). FVS is an individual tree growth model that accepts direct input of the inventory data, including measured diameter and height data, and is approved by ARB. Site index for each plot was based on the site index for the plot where site data was collected. Plots without a measured site index were modeled with the average site index for their strata.

The large tree growth models of the FVS-AK variant were calibrated for the baseline prescriptions based on FIA data for a similar geographic region and species as the Seldovia project. Calibration factors were developed for 4 species by comparing the annual growth of re-measured FIA plots to the annual growth predicted by the FVS variant. Only diameter growth was calibrated as height growth uses diameter growth as a predictor.

11-D. FVS Prescriptions

The silvicultural prescriptions used in FVS modeling are described in the table below.

Table 11. FVS Prescriptions

Strata	Rx ID	Rx Description	Minimum Commercial Harvest Volume	Criteria	Regeneration	Sprouting (on/off)
ALL STRATA	GROW	Let grow with no treatments				

Strata	Rx ID	Rx Description	Minimum Commercial Harvest Volume	Criteria	Regeneration	Sprouting (on/off)
ALL STRATA	CC2023_RL70_M08	Clearcut on 70-year rotation, years of harvest specified, first harvest in first decade	Minimum 8 MBF/Acre	Year = 2023 for first cut, Year = 2093 for second cut	Natural regeneration of seedlings using FVS native establishment model	On
ALL STRATA	CC2023_RL80_M08	Clearcut on 80-year rotation, years of harvest specified, first harvest in first decade	Minimum 8 MBF/Acre	Year = 2023 for first cut, Year = 2103 for second cut	Natural regeneration of seedlings using FVS native establishment model	On
ALL STRATA	CC2028_RL70_M08	Clearcut on 70-year rotation, years of harvest specified, first harvest in first decade	Minimum 8 MBF/Acre	Year = 2028 for first cut, Year = 2098 for second cut	Natural regeneration of seedlings using FVS native establishment model	On
ALL STRATA	CC2033_RL70_M08	Clearcut on 70-year rotation, years of harvest specified, first harvest in second decade	Minimum 8 MBF/Acre	Year = 2033 for first cut, Year = 2103 for second cut	Natural regeneration of seedlings using FVS native establishment model	On
ALL STRATA	CC2033_RL80_M08	Clearcut on 80-year rotation, years of harvest specified, first harvest in second decade	Minimum 8 MBF/Acre	Year = 2033 for first cut, Year = 2113 for second cut	Natural regeneration of seedlings using FVS native establishment model	On
ALL STRATA	CC2043_RL70_M08	Clearcut on 70-year rotation, years of harvest specified, first harvest in third decade	Minimum 8 MBF/Acre	Year = 2043 for first cut, Year = 2113 for second cut	Natural regeneration of seedlings using FVS native establishment model	On

Strata	Rx ID	Rx Description	Minimum Commercial Harvest Volume	Criteria	Regeneration	Sprouting (on/off)
ALL STRATA	CC2043_RL80_M08	Clearcut on 80-year rotation, years of harvest specified, first harvest in third decade	Minimum 8 MBF/Acre	Year = 2043 for first cut, Year = 2123 for second cut	Natural regeneration of seedlings using FVS native establishment model	On
ALL STRATA	TB2023_CY10_M01	Thin from below every year there is harvest starting in the first decade	Minimum 1 MBF/Acre	Year = 2023 for first thin, Must harvest at least 1 MBF/Acre, Basal Area must be above 75ft ²	Natural regeneration of seedlings using FVS native establishment model	On

Source: Schedules workbook, RX tab

A combination of field survey data, model results and professional judgement were used to inform the regeneration parameters (Table 12).

Table 12. FVS regeneration parameters used in Natural keyword

regeneration event parameters	years after regeneration event	species	regeneration TPA	survival (%)	average seedling age	average seedling height
((ABA GT 75) AND (ABA LT 100) AND (ABA LT BBA))	10	Other Hardwoods (cottonwood)	1	100	10	9.24
((ABA GT 75) AND (ABA LT 100) AND (ABA LT BBA))	10	Sitka Spruce	14	100	10	7.7
((ABA LE 75) AND (ABA GT 40) AND (ABA LT BBA))	10	Other Hardwoods (cottonwood)	2	100	10	9.24
((ABA LE 75) AND (ABA GT 40) AND (ABA LT BBA))	10	Sitka Spruce	58	100	10	7.7
((ABA LE 40) AND (ABA GT 10) AND (ABA LT BBA))	10	Other Hardwoods (cottonwood)	3	100	10	9.24
((ABA LE 40) AND (ABA GT 10) AND (ABA LT BBA))	10	Sitka Spruce	97	100	10	7.7
((ABA LE 10) AND (ABA LT BBA))	10	Other Hardwoods (cottonwood)	1	100	10	9.24

((ABA LE 10) AND (ABA LT BBA))	10	Sitka Spruce	484	100	10	7.7
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11-E. BASELINE ONSITE CARBON STOCKS

Forest Offset Protocol §5.2.1, Appendix A

The results of the baseline harvest schedule are shown in the table and figures below. Onsite carbon pools reported are graphically represented by the bar graphs in Figure 5. The harvested carbon pools are represented in Figure 6 where the static horizontal lines represent 100-year averages for those pools. Table 13 below shows the carbon pools by 10-year period for the baseline simulation.

Table 13. Baseline Acreage Allocation by prescription and strata

Strata	Prescription	Acres
LD	GROW	114
	CC2023_RL70_M08	13,528
	TB2023_CY10_M01	500
	Subtotal	14,143
LS	GROW	-
	CC2043_RL80_M08	1,468
	Subtotal	1,468
SS	GROW	-
	CC2043_RL80_M08	295
	Subtotal	295
Total		15,906

Table 14. Carbon (CO₂e) Reported from the Baseline Harvest Schedule

Year	AG Live Tree	BG Live Tree	Standing Dead	Cut-All	Cut-Merch
2018	2,828,533	667,701	136,378	-	-

2028	419,903	105,330	136,378	2,464,053	1,646,346
2038	470,132	116,925	136,378	27,874	18,743
2048	264,262	69,133	136,378	273,010	182,167
2058	551,944	149,650	136,378	-	-
2068	988,740	260,771	136,378	-	-
2078	1,465,971	375,464	136,378	-	-
2088	1,901,215	475,508	136,378	6,735	4,502
2098	1,644,213	408,353	136,378	561,367	368,432
2108	1,985,290	483,080	136,378	1,308	852
2118	2,334,515	559,985	136,378	1,906	1,264

The following figures show the final baseline modeling and resulting average onsite and harvested pools. The first figure displays the total onsite CO₂e tonnes per period for the baseline harvest schedule. The pattern over time is largely a function of the periodicity of the harvests modeled. The harvest schedule meets all feasibility tests and is a likely scenario without a carbon project. The horizontal lines in the second figure are the annual averages across the planning period, which are used in the carbon credit calculations. Modeling the baseline stocking yields an average onsite above ground standing live tree stocking of 1,350,429 total tonnes of CO₂e for the 100-year baseline modeling scenario, or 84.9 tonnes CO₂e per acre, which is equal to the CP value and thus does not fall below the MBL as required by the Protocol.

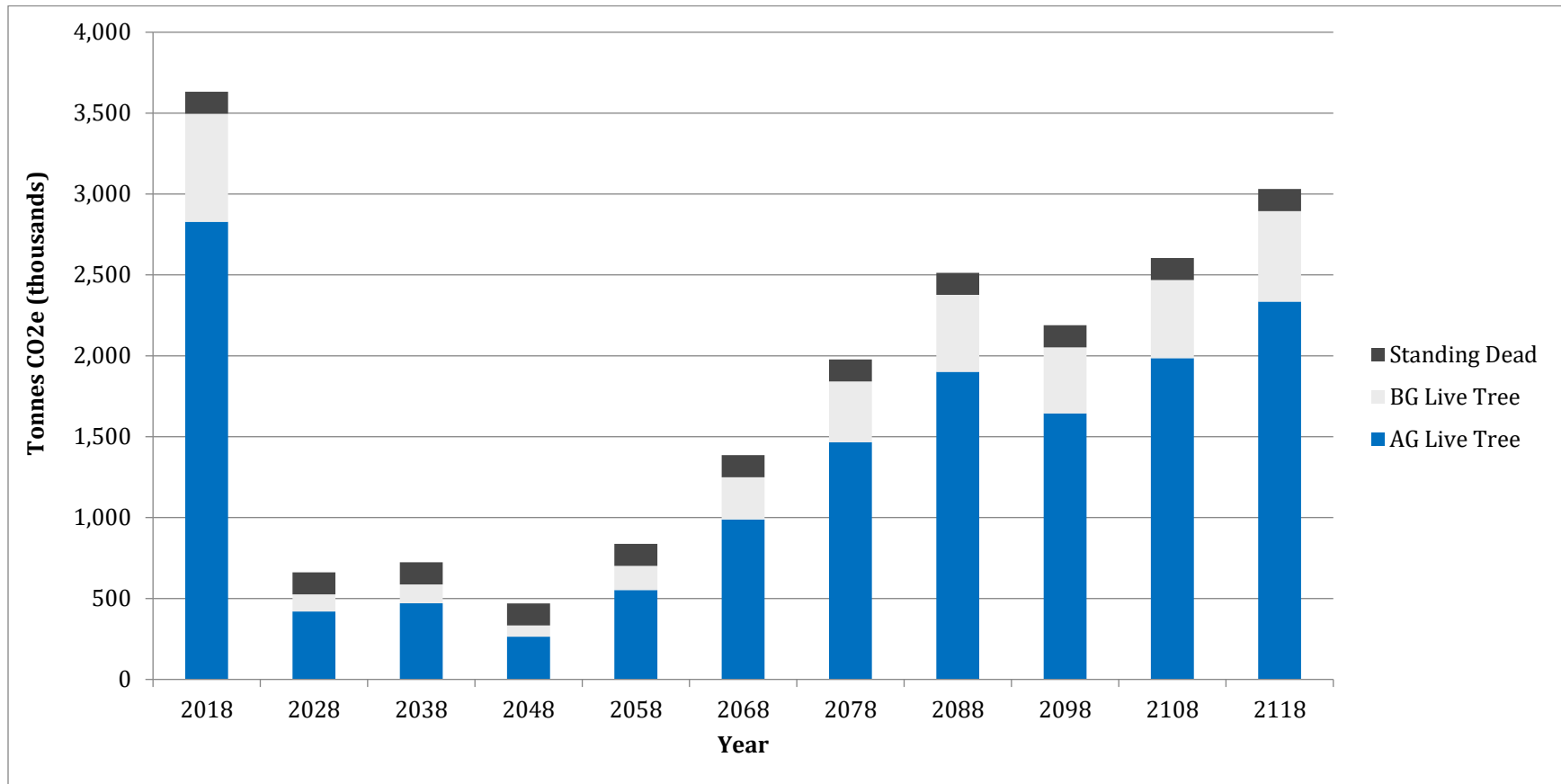


Figure 5. Onsite Baseline Stocking as Modeled

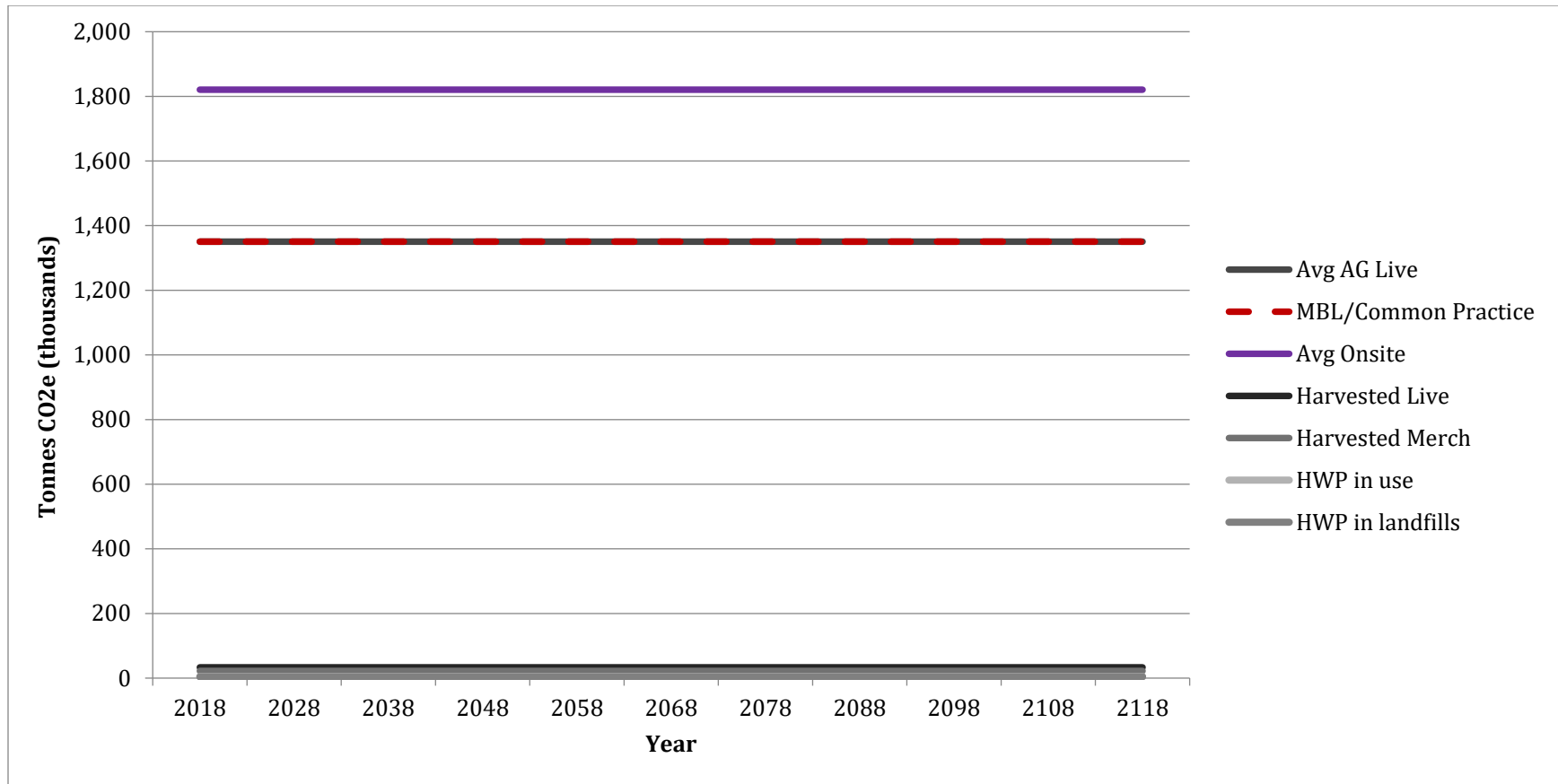


Figure 6. Final Baseline Results Averaged

11-F. FINAL BASELINE INCORPORATING ALL REQUIRED ONSITE CARBON POOLS

Forest Offset Protocol §5.2.1(g)

There are no optional carbon pools in this Project. Standing live (IFM-1), standing dead (IFM-3), and in-use forest products carbon (IFM-7) are required pools. Forest products carbon stored in landfills (IFM-8) is also required when baseline harvesting exceeds project harvesting. In order to determine the amount of carbon stored in harvested wood products (HWP) the cut trees are further divided into Harvested Live and Harvested Merch. Harvested Live is defined as the carbon in all portions of live trees removed from the project during a harvest (including belowground carbon). Harvested Merch is defined as the carbon in the merchantable portions (bole without bark) of the commercially harvested trees that are sent to mills to be processed into wood products. The average annual values of the relevant baseline carbon pools are:

Standing Live (IFM-1): 1,350,429 tonnes CO₂e

Standing Dead (IFM-3): 136,378 tonnes CO₂e

Harvested Live: 33,363 tonnes CO₂e

Harvested Merch: 22,223 tonnes CO₂e

HWP in-use (IFM-7): 5,431 tonnes CO₂e

HWP in landfills (IFM-8): 3,946 tonnes CO₂e

Since Reporting Period 1 is more than one year long, the harvested carbon values used in credit calculations were prorated by the reporting period length, 453 days. The baseline values which were used in credit calculations for Reporting Period 1 are as follows:

Standing Live (IFM-1): 1,684,238 tonnes CO₂e

Standing Dead (IFM-3): 136,378 tonnes CO₂e

Harvested Live: 41,370 tonnes CO₂e

Harvested Merch: 27,557 tonnes CO₂e

HWP in-use (IFM-7): 6,734 tonnes CO₂e

HWP in landfills (IFM-8): 4,893 tonnes CO₂e

11-G. BASELINE CARBON IN HARVESTED WOOD PRODUCTS

(Forest Offset Protocol §5.2.3, Appendix B)

The average amount of merchantable carbon harvested each year was calculated from the baseline modeling. This was done by using the harvest yields from FVS for each strata/prescription/timing choice combination. Appendix C of the Protocol requires a different methodology for calculating the carbon in harvested wood than it does for live trees. First, the merchantable dry biomass of all species that will be delivered to a mill are selected from the harvest yields. Harvested wood biomass excluding bark was calculated for softwood and hardwood, sawtimber and pulp. The minimum merchantable DBH for hardwood was 11" DBH and the minimum merchantable DBH for softwood was 9 inches DBH as described in the FVS variant documentation. Biomass was converted to CO₂ equivalent multiplying by 0.5 to convert to carbon. A weighted average mill efficiency value was used to arrive at the total carbon transferred into wood products based on the regional factors for Alaska by sawlog/pulpwood/export categories as provided from the ARB website, weighted by the percentage of merchantable carbon in these categories. Next, the table C.2 worksheet was used to calculate the long-term carbon storage in In-Use wood products. Long-term storage in landfills was determined using the table C.3. worksheet and also used the same default product class percentages.

11-H. DETERMINING ACTUAL ONSITE CARBON STOCKS

(Forest Offset Protocol §5.2.4)

No harvesting occurred between the start of the project and the end of the initial reporting period. The carbon inventory was collected in late May - June 2018 and in March 2019. Inventories were grown backwards to the start of the reporting period to account for the difference in dates inventoried and to represent a common starting point for the 100-year baseline projection. Data was then grown forward 1.24 years (453 days in RP1 divided by 365 days per year) to account for the growth that occurred during the projects initial reporting period from December 31, 2017 to March 29, 2019.

A summary of the required carbon pools at the end of the reporting period is as follows:

- Standing Live (IFM-1): 3,567,927 tonnes CO₂e
- Standing Dead (IFM-3): 136,378 tonnes CO₂e
- HWP in-use (IFM-7): 0 tonnes CO₂e
- HWP in landfills (IFM-8): 0 tonnes CO₂e

The results of the volume and biomass calculations discussed earlier in this OPDR were analyzed to calculate the statistics for live and standing dead carbon pools for each stratum.

The sampling error at the 90% level is calculated by multiplying the standard error by the t value of 1.645. The standard error was determined using an unstratified random sample formula.

The following table summarizes the data and statistics for each of the strata and the pooled sampling error for all the strata combined.

Table 15. Forest Offset Protocol Table A.2 Summarizing Total Carbon by Carbon Pool and Stratum

Strata	No. of Plots	Carbon (CO ₂ /acre)			Acres	Carbon (CO ₂) Total	Percentage Carbon (CO ₂) Total
		Avg	Std. Dev	Std. Error			
LD	193	243.1	149.4	10.75	14,143	3,438,578	92.8%
LS	53	146.7	128.5	17.65	1,468	215,480	5.8%
SS	14	170.2	76.9	20.54	295	50,248	1.4%
Total	260				15,906	3,704,305	100.0%

Sampling Error at 90% level = 6.9%

Confidence Deduction = 1.9%

Table 16. Forest Offset Protocol Table A.3 Summarizing Carbon Pools and Total MT CO₂e/acre by Carbon Pool

Carbon Pool	Source	Gross MT CO ₂ e per Acre
Standing Live Tree Above- and Below-ground Carbon Stocks	From sampling results of trees	232.89

Standing Dead Tree Above- and Below-ground Carbon Stocks	From sampling results of standing dead biomass	8.57
Shrubs and Herbaceous Understory Carbon (if required)	From sampling results of shrubs and herbaceous understory	0
Soil Carbon (if required)	From sampling results of soil	0
Sum of MT CO ₂ e from Required Pools		

The following table shows the carbon pools by 10-year period for the project simulation.

Table 17. Carbon (CO₂e) reported from the Project Activity harvest schedule

Year	AG Live Tree	BG Live Tree	Standing Dead	Cut-All	Cut-Merch
2018	2,828,533	667,701	136,378	-	-
2028	3,302,345	772,059	136,378	-	-
2038	3,845,221	886,793	136,378	-	-
2048	4,371,144	996,043	136,378	-	-
2058	4,868,185	1,097,621	136,378	-	-
2068	5,336,194	1,192,079	136,378	-	-
2078	5,766,621	1,278,046	136,378	-	-
2088	6,167,575	1,357,328	136,378	-	-
2098	6,543,944	1,431,165	136,378	-	-
2108	6,888,583	1,498,305	136,378	-	-
2118	7,211,722	1,560,870	136,378	-	-

11-I. DETERMINING ACTUAL CARBON IN HARVESTED WOOD PRODUCTS

(Forest Offset Protocol §5.2.5)

The FVS simulation of project activity was used to estimate the wood products carbon for the next 100 years. Since all project acres were allocated to the “let grow” scenario, no

harvest is currently projected for the 100-year period. If any harvesting does occur at some point in the future, the actual harvested amount will be reported and used as determined from truck, or other, scale tickets. Reported harvests can be converted to carbon using the methodology in Protocol Appendix C (C.1). The calculation for the wood products storage is identical to the methods used for the baseline but will be based on these actual harvested amounts rather than projections.

For the initial reporting period, there was no harvest, and thus no estimate of merchantable harvest volume or associated carbon in harvested wood products, as demonstrated in the table and the credit calculation worksheet copied below.

11-J. CALCULATING SECONDARY EFFECTS

(Forest Offset Protocol §5.2.6)

Secondary effects include changes in emissions due to unintended changes in regional carbon stocks that may result from the Forest Project and are always negative. Secondary effects include activity shifting leakage that results from changes in forest management activity resulting from the Forest Project activity. The calculation itself is 20% of the difference between actual and baseline carbon in harvested wood. For the first year of the project this is $20\% \times (0 - 41,370) = -8,274$ tonnes CO₂e.

12. OTHER OFFSET PROGRAMS

(Forest Offset Protocol §7.1.1(a)(33 – 34)

No GHG emission reductions associated with land within the project area have ever been listed or registered by another registry or program, credited or claimed by another registry or program, or sold to a third party prior to listing.

13. GHG REDUCTIONS AND REMOVALS

(Forest Offset Protocol §5)

Equation 6.1 was used for estimating the first reporting period GHG reductions and removals. This was implemented using a modified version of the Forest Project calculation worksheet provided by the Climate Action Reserve and is provided along with the project input data. This process included the changes in onsite stocks, long-term average wood product storage, and secondary effects.

Table 18. GHG reductions and removals worksheet

Type of Project:		
<i>Improved Forest Management</i>		
Reporting Periods	Commencement Date	1
Offset Project Commencement Date	31-Dec-17	
Reporting Period Begin Date		31-Dec-17
Reporting Period End Date		29-Mar-19
Reporting Date		10-May-19
Calculating GHG Reductions/Removals for Onsite Carbon Stocks - All Project Types - all data should be entered as the end of the Reporting Period		
Initial Carbon Stocking Value	2,828,532.7	
Sampled Onsite Carbon Stocks (metric tons CO2e)		3,704,305
Confidence Deduction		1.9%
Adjusted Sampled Onsite Carbon Stocks (adjusted for confidence deduction) (metric tons CO2e)		3,633,924
Soil Carbon Emissions		-
Increment in Actual Onsite Carbon Stocks (metric tons CO2e)		3,633,924
Baseline Onsite Carbon Stocks (metric tons CO2e)	2,828,533	1,820,616
Increment in Baseline Onsite Carbon Stocks (metric tons CO2e)		
Quantified GHG Reductions / Removals for Onsite Carbon Stocks (metric tons CO2e)		1,813,307
Calculating Carbon Stored in Wood Products Including Market Effects and Leakage - All Project Types - all data should be entered as the end of the Reporting Period		
Actual Carbon in Trees Harvested for Wood Products (metric tons CO2e)		-
Baseline Carbon in Trees Harvested for Wood Products (metric tons CO2e)		41,370

Actual Carbon in Harvested Wood Delivered to Mills (metric tons CO2e)		-
Baseline Carbon in Harvested Wood Delivered to Mills (metric tons CO2e)		27,557
Actual Carbon Stored Long-term in Wood Products (tonnes CO2e) - Excl Landfill		-
Actual Carbon Stored Long-term in Wood Products (tonnes CO2e) - Incl Landfill		-
Baseline Carbon Stored Long-term in Wood Products (tonnes CO2e) - Excl Landfill		6,734
Baseline Carbon Stored Long-term in Wood Products (tonnes CO2e) - Incl Landfill		11,627
Diff Between Actual and Baseline Carbon in Harvested Wood (tonnes CO2e) - Excl Landfill		(6,734)
Difference Between Actual and Baseline Carbon in Harvested Wood (tonnes CO2e) - Incl Landfill		(11,627)
Difference in Actual and Baseline Carbon Stored in Wood Products (tonnes CO2e) - Landfill Adj		(11,627)
GHG Reductions / Removals for Carbon Stored in Wood Products (tonnes CO2e) w/ mkt response		(9,302)
Calculating Other Secondary Effects - Improved Forest Management Projects		
Difference Between Actual and Baseline Carbon in Trees Harvested for Wood Products (metric tons CO2e)		(41,370)
Other Secondary Effects Emissions (shifting activities/materials) IFM Projects (metric tons CO2e)		(8,274)
Quantified GHG Reductions and Removals		
Annual GHG Reductions/Removals Net of Discounts and Secondary Effects (metric tons CO2e)	0	1,795,732
Cumulative GHG Reductions/Removals; not incl.neg. carryover or reversals (metric tons CO2e)	0.00	1,795,732

Cumulative Negative Carryover from Prior Year (metric tons CO2e)		
Offset Credits Issued - Net of Negative Carryover, bef. adjust for Reversals (metric tons CO2e)	0	1,795,731
Calculation of Buffer Pool Contribution - all data should be entered as end of Reporting Period		
Project Specific Reversal Risk Rating		17.6%
Buffer Pool Contribution	-	316,049
Accounting for Reversals - all data should be reported as sum during Reporting Period		
Annual Reversals (metric tons CO2e)		-
Total "Intentional Reversals" to be compensated by the Offset Project Operator (metric tons CO2e)		
Compensating for Intentional Reversals - all data should be reported as sum during Reporting Period		
"Intentional Reversals" compensated by retirement of Offset Credits in the Offset Project Operator's CITSS Account (metric tons CO2e)		
Carryover "Intentional Reversals" which need to be compensated by Offset Project Operator (metric tons CO2e)		-
Offset Credits Issued to Offset Project Operator		
Annual Offset Credits Issued to Offset Project Operator (metric tons CO2e)	-	1,479,682
Vintage I-Calendar year of Reporting Period end date (Vintage)		2019
Cumulative Offset Credits Issued to Offset Project Operator (metric tons CO2e)		1,479,682

14. ATTACHMENT E

(Forest Offset Protocol §7.1.1(a)(15))

Relevant maps and shapefiles generated in ArcGIS are available for distribution to the Verification Body and the Offset Project Registry.

15. ATTACHMENT F

(Forest Offset Protocol §7.1.1(a)(15))

Relevant maps and shapefiles generated in ArcGIS are available for distribution to the Verification Body and the Offset Project Registry.

16. APPENDIX I: INVENTORY MANUAL

Provided separately.

17. APPENDIX II: PYTHON LIBRARIES USED

Provided separately.

18. REFERENCES

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