State of California
California Environmental Protection Agency
California Air Resources Board
U.S. FOREST OFFSET PROJECT DATA REPORT
INITIAL REPORTING PERIOD - IMPROVED FOREST MANAGEMENT

U.S. FOREST OFFSET PROJECT DATA REPORT INITIAL REPORTING PERIOD - IMPROVED FOREST MANAGEMENT

OPR Staff Use Only	Date Report Received:	OPR Tracking Number:	Date Report Reviewed:	*OPR Staff Use Only*

*Entities submitting the project's first Offset Project Data Report must submit the information requested in both **Initial Reporting Period** and the **Annual Reporting** forms to the appropriate Offset Project Registry. For every reporting year thereafter, submit only the information requested in the Annual Reporting form.*

PART I. ENTITY SUBMITTING REPORT

Is this form being submitted by the Offset Project Operator (OPO) or by the Authorized Project Designee (APD)? *Note: The person completing this form should be an OPO/APD employee.*

☒ **OPO** ☐ **APD**

Name of Person Completing Form:		Organization, if applicable:
Mark Welther		Usal Redwood Forest Company, LLC.
Date Form Completed: November 14, 2016	**Phone Number:** (510) 459-1131	**Email Address:** mark@rffi.org

PART II. OFFSET PROJECT INFORMATION

Offset Project Name:	OPR Project ID#:	ARB Project ID# (if known):
Usal Redwood Forest IFM	CAR1139	CAFR5281

Offset Project Commencement Date:	First Reporting Period Start Date:	First Reporting Period End Date:
June 13, 2007	January 1, 2015	December 31, 2015

Provide an explanation and justification for the commencement date. Specify the action(s) that identify the offset project commencement date.
The Usal Redwood Forest IFM project's commencement date is based on the date the property underlying the Project Area was purchased by the Usal Redwood Forest Company, Inc. (URFC).

Optional: Provide the nearest town/city to the Project Area:

PART III. OPO/APD INFORMATION

A. OPO

OPO Name:			OPO's CITSS ID#:
Usal Redwood Forest Company, LLC.			CA 1882
Mailing Address: 528 South Main St.	**City:** Fort Bragg	**State:** CA	**Zip:** 95437
Contact Person: Mark Welther	**Phone Number:** (510) 459-1131	**Email Address:** mark@rffi.org	

B. APD (if applicable)

☒ **No APD/Not Applicable**

APD Name:			APD's CITSS ID#:
			CA ____
Mailing Address:	**City:**	**State:**	**Zip:**
Contact Person:	**Phone Number:**	**Email Address:**	

PART IV. LAND OWNERSHIP

A. Is the Offset Project Operator (OPO) the owner in fee for the Project Area?
Further documentation is required for all projects. Submit as attachment labeled "Attachment A." See Part X of this OPDR document for more information.

☒ **Yes** ☐ **No**

If "no," explain how the entity identified as the OPO has the right to undertake and list the project.

B. Optional: List all Forest Owners. This includes owners in fee as well as third parties with existing property interests within the Project Area that affect the trees and standing timber located in the Project Area (e.g. mineral rights, timber rights, easements, rights of way, leases, etc.).

The OPO is the only Forest Owner with property interests within the Project Area that affect the trees and standing timber located on the Project Area.

C. Does the offset project occur on public or private lands?

If the project occurs on public lands, proceed to questions C1 and C2. Otherwise, skip to question D. Further documentation is required if project occurs on public lands. Submit copies of documentation demonstrating explicit approval of the project's management activities and baseline, as well as the public vetting process used; attachment should be labeled "Attachment B." See Part X of this document for more information.

☒ **Private**
☐ **Public**

1. **Describe the public process that was used to evaluate the forest management activities and policy decisions concerning the offset project.**
   N/A
2. **Describe the explicit approval process used by the public entity to initiate and maintain this offset project, including the offset project's management activities and baseline.**
   N/A

D. Does the project employ a Qualified Conservation Easement (QCE)?

If employing a QCE, proceed to questions D1, D2, and D3. Otherwise, skip to question E. Supporting documentation for a QCE is required. Submit as attachment labeled "Attachment C." See Part X of this document for more information.

☐ **QCE**
☐ **Public Ownership**

1. **Date that the QCE was recorded.**
   N/A
2. **Optional:** Is the project located in a state that requires third-party beneficiaries to sign the easement (i.e., to "accept and record that acceptance"), such as Arizona, Pennsylvania, or West Virginia? ☐ **Yes** ☐ **No**
3. **Provide the terms within the easement that affect forest management.**
   N/A

E. Does the offset project occur on any of the following categories of land? (check all that apply)

☐ **Land that is owned by, or subject to, an ownership of possessory interest of a Tribe**
☐ **Land that is "Indian lands" of a Tribe as defined by 25 U.S.C. §81(a)(1)**
☐ **Land that is owned by any person, entity, or Tribe, within the external borders of such Indian lands**
☒ **None of the above**

If "none of the above," skip to Part V. Otherwise, proceed to Optional questions E1 and E2. Further documentation is required for projects occurring on land listed in the first three categories. Submit supporting documents as attachments labeled "Attachment D." See Part X of this document for more information.

1. **Optional:** Does a limited waiver of sovereign immunity between ARB and the governing body of the Tribe exist? ☐ **Yes** ☐ **No**
2. **Optional:** Provide a description of land ownership within the Project Area.
   N/A

PART V. OFFSET PROJECT AREA

Maps depicting specific elements of the Project Area are required for all projects.
Submit supporting documentation as attachments labeled "Attachment E." See Part X of this document for more information.

Latitude of Offset Project Location:	Longitude of Offset Project Location:	Project Area Total Acreage:
39.9108	-123.8599	47,981.54

A. Identify the assessment area (or assessment areas, if project crosses more than one) that contain Project Area lands and list the acreage of project lands within each assessment area.
See Addendum to OPDR for the Initial Reporting Period V.A.

B. Identify and describe the governing jurisdiction(s) applicable to the Project Area.
See Addendum to OPDR for the Initial Reporting Period V.B.

C. Describe how the Project Area was determined.
See Addendum to OPDR for the Initial Reporting Period V.C..

D. Describe the existing land cover, and land use of the Project Area.
See Addendum to OPDR for the Initial Reporting Period V.D.

E. Describe the forest vegetation types within the Project Area boundary.
See Addendum to OPDR for the Initial Reporting Period V.E.

F. Describe the site classes within the Project Area boundary.
See Addendum to OPDR for the Initial Reporting Period V.F.

G. Describe the land pressures and climate zone/classification applicable to the Project Area.
See Addendum to OPDR for the Initial Reporting Period V.G.

H. Describe the historical land uses, current zoning, and projected land use within the Project Area and surrounding areas.
See Addendum to OPDR for the Initial Reporting Period V.H.

I. Describe the forest conditions within the Project Area, including species composition, age class distribution, and management history.
See Addendum to OPDR for the Initial Reporting Period V.I.

PART VI. OFFSET PROJECT ELIGIBILITY

A. Does the Project Area have a canopy cover that is greater than 10 percent?
Supporting documentation is required. Submit as attachment labeled "Attachment F." See Part X of this document for more information.
See Addendum to OPDR for the Initial Reporting Period VI.A.

☒ **Yes** ☐ **No**

B. Optional: Are the associated project lands currently in compliance with all local, state, and federal regulatory requirements?

☒ **Yes** ☐ **No**

Optional: If no, provide an explanation of the non-compliance.
N/A

C. Does the entity submitting this report declare that the offset project has not and does not employ broadcast fertilization?

☒ **Yes** ☐ **No**

D. Indicate how the offset project meets the definition of Natural Forest Management per Table 3.2 in the U.S. Forest protocol:

1. Native species:

a) Does the project consist of at least 95% native species based on the estimated sum of carbon in the standing live carbon pool? Improved Forest Management Projects are assessed using estimates of basal area per acre.
If "no," proceed to question 1b. Otherwise, skip to question D2.
See Addendum to OPDR for the Initial Reporting Period VI.D.1(a).

☒ **Yes** ☐ **No**

b) Describe how the project will meet this requirement.
N/A

2. Composition of native species:

a) Does the Project Area naturally consist of a mixed species distribution where no single species' prevalence, measured as the percent of basal area of all live trees in the Project Area, exceeds the percentage value of standing live carbon shown under the heading 'Species Diversity Index' in the Assessment Area Data File?
If "no," proceed to questions 2b and 2c. Otherwise skip to question D3.
See Addendum to OPDR for the Initial Reporting Period VI.D.2(a).

☒ **Yes** ☐ **No**

b) Explain how the project will demonstrate a trend toward achieving the Species Diversity Index of native species and meet this requirement within 25 years.
N/A

c) If the Project Area does not naturally consist of a mixed species distribution: Will or have you provided a written statement from the government agency in charge of forestry regulation in the state where the project is located stipulating that the Project site is not capable of meeting the requirement of mixed species distribution?

☐ **Yes** ☐ **No** ☒ **N/A**

3. Distribution of age classes/sustainable management:

a) Indicate how the project will meet the requirement for sustainable management if regeneration or commercial harvesting is either planned or initiated within the Project Area demonstrating sustainable long-term harvesting practices. This applies to all forest landholdings of the Forest Owner(s)
(check one of the boxes).

☐ **Not applicable; no commercial harvesting is occurring within the Project Area.**
☒ **Third party certification under the Forest Stewardship Council, Sustainable Forestry Initiative, or Tree Farm System, whose certification standards require adherence to and verification of harvest levels which can be permanently sustained over time.**
☐ **Adherence 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.**
☐ **Employ uneven-aged silvicultural practices and maintain canopy retention averaging at least 40% across the forest, as measured on any 20 acres within the entire forestland owned by the Forest Owner, including land within and outside of the Project Area (areas impacted by Significant Disturbance may be excluded**

from this test).

See Addendum to OPDR for the Initial Reporting Period VI.D.3(a).

b) On a watershed scale up to 10,000 acres (or the Project Area, whichever is smaller), projects must maintain, or make progress toward maintaining, a maximum of 40% of the project's forest lands in ages that are less than 20 years old. (Areas impacted by Significant Disturbance are exempt from this test until 20 years after reforestation of such areas.) Does the acreage within this project meet this requirement?

If "no," proceed to question 3c. Otherwise, skip to question D4.

☒ Yes ☐ No

See Addendum to OPDR for the Initial Reporting Period VI.D.3(b).

c) If the project does not meet the age class requirement at this time, explain how the project intends to demonstrate progress to meet this requirement over time; such that forest lands in ages less than 20 years old are reduced and make up no more than 40% of the Project Area.

N/A

4. Structural elements (standing and lying dead wood):
How does the project ensure that structural elements are retained in sufficient quantities throughout the project life?

See Addendum to OPDR for the Initial Reporting Period VI.D.4.

E. Describe the management activities that will result in increased carbon stocks in the Project Area, compared to the baseline.

See Addendum to OPDR for the Initial Reporting Period VI.E.

F. Is this project being implemented and conducted as the result of any law, statute, regulation, court order, or other legally binding mandate?
If "yes," explain:

☐ Yes ☒ No

N/A

G. Does the offset project take place on land that was part of a previously listed and registered Forest Offset Project?

This question is applicable to both voluntary and compliance markets. If "yes" proceed to questions G1 and G2. Otherwise, skip to Part VII.

☒ Yes ☐ No

1. Optional: Was the previous Forest Offset Project terminated due to an Unintentional Reversal?

☐ Yes ☒ No

2. Optional: Has this project transitioned to the Compliance Offset Protocol U.S. Forest Projects after previously being listed as an early action offset project?

☒ Yes ☐ No

PART VII. CARBON STOCK INVENTORY

A. Provide a description of the inventory methodology used to quantify carbon stocks for each required carbon pool in the forest project's offset boundary. The inventory methodology must describe the information required in Appendix A.3 of either the Compliance Offset Protocol U.S. Forest Projects, October 20, 2011 or the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014.

IFM-1 Standing Live:

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM-3 Standing Dead:

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM-6 Soil (if applicable):

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM-7 Carbon in in-use forest products:

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM-8 Forest product carbon in landfills (if applicable):

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM- 9 Biological emissions from site preparation:

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside project area:

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM-17 Biological emissions from decomposition of forest products:

See Addendum to OPDR for the Initial Reporting Period VII.A.

B. Describe the calculation methodologies used to determine metric tons per acre for each of the carbon pools included in the Offset Project Data Report.

IFM-1 Standing Live:

See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM-3 Standing Dead:

See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM-6 Soil (if applicable):

See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM-7 Carbon in in-use forest products:

See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM-8 Forest product carbon in landfills (if applicable):

See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM- 9 Biological emissions from site preparation:

See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside project area:

See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM-17 Biological emissions from decomposition of forest products:

See Addendum to OPDR for the Initial Reporting Period VII.B.

C. Provide a summary of the inventory of carbon stocks for each carbon pool (or approach used, if inventory is not applicable).

IFM-1 Standing Live:

See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM-3 Standing Dead:

See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM-6 Soil (if applicable):

See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM-7 Carbon in in-use forest products:

See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM-8 Forest product carbon in landfills (if applicable):

See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM- 9 Biological emissions from site preparation:

See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside project area:

See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM-17 Biological emissions from decomposition of forest products:

See Addendum to OPDR for the Initial Reporting Period VII.C.

D. Provide a summary of inventory confidence statistics.

See Addendum to OPDR for the Initial Reporting Period VII.D.

E. Provide the calculation of the offset project's reversal risk rating and contribution to the Forest Buffer Account.

See Addendum to OPDR for the Initial Reporting Period VII.E.

PART VIII. OFFSET PROJECT BASELINE

A. Required for ALL Improved Forest Management Projects

1. Describe the project's modeling plan, following the requirements and methods in Appendix B, Section B.3 of the U.S. Forest protocol.

Please see the Modeling Plan included as Attachment M.

2. Describe and estimate the project's baseline onsite carbon stocks. Explain any annual changes in baseline carbon stocks over time.

A graph of the baseline onsite carbon stocks, labeled "Attachment G," must be portrayed depicting time on the x-axis and metric tons CO2-e on the y-axis. Include a written characterization describing any annual change in baseline carbon stocks over time. See Part X of this document for more information. A diagram of the baseline incorporating all required carbon stocks, labeled "Attachment H," is also required.

This information is contained in the Modeling plan included as Attachment M.

3. Optional: Identify the approved growth model that will be used for the project.

FORSEE

4. Harvest Planning **a. Is harvesting planned in the Project Area?** *If "yes," proceed to question 4b. Otherwise, skip to question A5.*	☒ **Yes** ☐ **No**
b. **Optional:** Does the project use a harvest schedule model? *If "yes," proceed to question 4c. Otherwise, skip to question A5.*	☐ **Yes** ☒ **No**

c. **Optional:** Explain how you are addressing age class and stratification as part of your harvest scheduling?
N/A

5. Provide an estimate of carbon that will be stored long-term in harvested wood products in the baseline.
See Addendum to OPDR for the Initial Reporting Period VIII.A.5.

6. Provide a projection of baseline and actual harvesting volumes from the Project Area over 100 years.
A projection may be provided in an attachment, labeled "Attachment I". Include a narrative with a clear explanation of how the OPO/APD arrived at the baseline and actual harvest volumes is determined

B. Required for Improved Forest Management Projects on Private Lands ONLY

1. Provide the initial above ground standing live carbon stock (per acre) for the project.
164.38

2. Provide the Common Practice statistic (per acre) associated with the Project Area.
181.38

3. Summarize how the Project's initial above-ground standing live carbon stock compares to Common Practice.
At the Project's commencement date of 06/13/2007, the Project's initial above-ground standing live carbon stocks were below the Common Practice statistic listed above.
Are the initial above-ground standing live carbon stocks above or below Common Practice?

☐ **Above**
☒ **Below**

If below Common Practice, what is the High Stocking Reference for the Project Area? Describe the Project Area's live tree carbon stocks over the previous 10 years.
Further documentation is required if project is below Common Practice. Submit supporting documents as attachments labeled "Attachment J." See Part X of this document for more information. An affidavit must be submitted testifying that the inventory depicted over the past 10 years is reasonably accurate.
See Addendum to OPDR for the Initial Reporting Period VIII.B.3.

4. Optional: Does the Forest Owner(s) and its affiliate(s) own land in fee or hold timber rights on land outside the Project Area?
If "no," skip to question B.5.

☒ **Yes**
☐ **No**

Optional: If "yes" does the Protocol require the use of a weighted average carbon stock on lands in the same Logical Management Unit (LMU, as defined in Section 6.2.1.1)?
If "no," skip to question B.5.

☒ **Yes**
☐ **No**

Optional: If "yes," is inventory data available for the LMU or will the OPO use a stratified vegetation analysis?
If "no," skip to question B.5.

☒ **Data available for LMU**
☐ **Stratified Vegetation Analysis**

Optional: Identify the Minimum Baseline Level for above-ground standing live carbon stocks for the Project Area:
See Addendum to OPDR for the Initial Reporting Period VIII.B.4.

5. Provide a description of any and all legal constraints affecting forest management activities in the Project Area. Include documentation of legal constraints and a description of each constraint (referring to Section 6.2.1.2); for each constraint provide a narrative that constraint has on forest management.
Submit supporting documents as attachment labeled "Attachment K". See Part X of this reporting document for more information.
This information is contained in the Modeling plan included as Attachment M.

6. Provide a description of the modeling techniques used to simulate the effect of any constraints on carbon stocks.
This information is contained in the Modeling plan included as Attachment M.
Optional: Provide a description of the modeling techniques used to simulate forest management activities that may affect carbon stocks.

7. How does the OPO demonstrate financial feasibility of the growth and harvesting regime assumed for the baseline? (check one of the boxes)

☒ **Conducting a financial analysis of the anticipated growth and harvesting regime that captures all relevant costs and returns, taking into consideration all legal, physical, and biological constraints, using regional norms or documented costs and returns for the project area or other properties in the Forest Project's Assessment Area**

☐ **Providing evidence that activities similar to the proposed baseline growth and harvesting regime have taken place on other properties within the Forest Project's Assessment Area within the past 15 years**

Supporting documentation is required. Submit as attachment labeled "Attachment L." See Part X of this listing document for more information.
See Addendum to OPDR for the Initial Reporting Period VIII.B.7.

C. Required for Improved Forest Management Projects on Public Lands ONLY

1. **Provide a projection of future changes to Project Area forest carbon stocks extrapolating from historical trends.**
   N/A

2. **Explain how current public policy affects onsite carbon stocks and how the baseline modeling incorporates constraints imposed by all applicable statutes, regulations, policies, plans, and activity-based funding.**
   N/A

3. **Have carbon stocks in the Project Area been increasing or declining over the preceding ten-year period?** ☐ Increasing ☐ Declining

PART IX. OTHER OFFSET PROGRAMS

A. Have any GHG reductions or GHG removal enhancements associated with the Project Lands ever been listed or registered with, or otherwise claimed by, another registry or program, or sold to a third party prior to listing? ☒ Yes ☐ No
If "yes," identify the registry or program and provide details on the issued credits below.

B. Have any lands within the Project Area ever been listed or registered with an offset project registry or program in the past? ☒ Yes ☐ No
If "yes," identify the registry or program and provide details on the issued credits below.

C. Have greenhouse gas emission reductions or removal enhancements associated with lands within the Project Area been credited or claimed for the purpose of greenhouse gas mitigation or reduction goals, whether in a voluntary or regulatory context? ☒ Yes ☐ No
If "yes," identify the goal(s) and provide details on the reductions and removal enhancements (under "Number of Credits Issued") below.

Registry / Program / Goal(s):	Reporting Period(s):	Vintage(s):	Number of Credits Issued:
Climate Action Reserve	2007	2007	1,801,449
Climate Action Reserve	2008	2008	270,507
Climate Action Reserve	2009	2009	280,060
Climate Action Reserve	2010	2010	289,883
Climate Action Reserve	2011	2011	299,983
Climate Action Reserve	2012	2012	313,477
Climate Action Reserve	2013	2013	324,298
Climate Action Reserve	2014	2014	339,125

PART X. ATTACHMENTS

A. If the answer to Part IV.A is "yes," provide documentation (e.g., deed of trust, title report, etc.) showing the OPO's ownership interest in the property and its interest in the trees and standing timber on the property. If the answer to Part IV.A is "no," provide documentation supporting the explanation of the OPO's right to undertake and list the project.

B. If the answer to Part IV.C is "public," provide documentation demonstrating explicit approval of the offset project's management activities and baseline including any public vetting processes necessary to evaluate management and policy decisions concerning the offset project. If the project is a private lands project, mark "N/A" in the box below. The OPO may provide an "Attachment B" page with a "This Page Left Intentionally Blank - Private Lands Project" notation on the page. ☒ N/A

C. If a Qualified Conservation Easement (QCE) has been recorded, provide a copy. The information contained in this form and the documents attached to it will be submitted to ARB so submitting a copy of the QCE as an attachment to this document fulfills the requirement in 9.1.1.1(18)(a) of the U.S. Forest protocol to provide ARB with a copy. ☒ N/A

D. If the project is located on one of the categories of Tribal land listed in Part IV.E, provide documentation demonstrating that the land within the Project Area is owned by a tribe or private entity. Also provide documentation that demonstrates the existence of a limited waiver of sovereign immunity between ARB and the governing body of the Tribe entered into pursuant to section 95975(l) of the Cap-and-Trade Regulation. ☒ N/A

E. Attach map(s) of the Project Area including:
1. **Public and private roads**
2. **Towns**
3. **Major watercourses (4th order or greater), water bodies, and watersheds**
4. **Topography**
5. **Townships, ranges, and sections or latitude and longitude**
6. **Existing land cover and land use (optional)**
7. **Forest vegetation types (optional)**
8. **Site classes (optional)**

9. **Land pressures and climate zone/classification (optional)**
10. **Historical land uses, current zoning, and projected land use within the Project Area (optional)**
11. **A georeferenced shape file (or other electronic file that can be read in a geographic information system) that clearly identifies the Project Area and boundaries.** *Note that the georeferenced shape file may constitute the required map if it includes the required map information listed above.*

F. **Provide supporting documentation demonstrating that the offset project takes places on land that has greater than 10 percent tree canopy cover.**

G. **Attach a graph portraying the baseline onsite carbon stocks with time depicted on the x-axis and metric tons CO_2e depicted on the y-axis.**

H. **Attach a diagram of the final baseline incorporating all required carbon stocks.**

I. **Provide a projection of baseline and actual harvesting volumes from the Project Area over 100 years.**

J. **For IFM projects on private lands ONLY: If the Project Area's initial above-ground standing live carbon stocks are below Common Practice, submit an affidavit testifying that the inventory depicted over the past 10 years (used to determine the High Stocking Reference for the Project Area) is reasonably accurate. Also include a summary of volume harvested over the past 10 years.** ☐ **N/A**

K. **For IFM projects on private lands ONLY: Attach supporting documentation identifying the legal constraints within the Project Area. A 'constraints' table with the following categories may be provided for simplicity with the following information: narrative of legal constraint, identification of specific governing law guiding the constraint, acreage, silviculture method, retention strategy.** ☐ **N/A**

L. **For projects on private lands ONLY: Provide a description and supporting evidence, if applicable, that the growth and harvesting regime assumed for the baseline is financially feasible based on the qualifications in Section 6.2.1.3 of the Protocol.** ☐ **N/A**

PART XI. OPO/APD SIGNATURE

Note: The person signing this Initial Reporting Period report should be the same person signing the accompanying U.S. Forest Offset Project Data Report Annual Reporting Period – All Project Types report.

In signing this form, I certify under penalty of perjury of the laws of California that the information contained in this form is true, accurate, and complete. I further certify that I am an Account Representative of the Offset Project Operator (OPO).

SIGNATURE:	**PRINTED NAME:**
Mark Welther	Mark Welther
TITLE:	**DATE:**
Primary Account Representative	November 14, 2016

Background for U.S. Forest Offset Project Data Report Initial Reporting Period – Improved Forest Management

Section 95976(d) of the Cap-and-Trade Regulation specifies reporting requirements for offset projects participating in the Compliance Offset Program. Offset Project Operators (OPO) or Authorized Project Designees (APD) are required to submit an Offset Project Data Report (OPDR) within four months of the end of each (annual) Reporting Period. The Compliance Offset Protocol U.S. Forest Projects, October 20, 2011 and Compliance Offset Protocol U.S. Forest Projects, November 14, 2014 both require additional information to be included with the initial OPDR. This form is designed to help OPOs and APDs provide the extra information required for an initial OPDR by U.S. Forest offset projects. The information in this form is submitted to the approved Offset Project Registry that is listing the offset project and should also be provided to the ARB-accredited verification body that will be verifying the Offset Project Data Report.

The information to be provided in this form closely mirrors information provided in the application for listing a U.S. Forest offset project. OPOs and APDs may wish to copy the information in their project's application for listing to the extent that the information provided at the time of that application has not changed.

Where to Submit Information Contained in This Form

Please complete the information on the form using your computer. Then print, sign, and scan the form. The completed and signed information and all supporting documentation should be submitted to the appropriate Offset Project Registry.

Copies of this form can be downloaded from the ARB website at:
http://www.arb.ca.gov/cc/capandtrade/offsets/forms/forms.htm

Detailed Instructions for U.S. Forest Offset Project Data Report Initial Reporting Period – Improved Forest Management

This form is protected with restricted editing to facilitate completing the form. If the applicant wishes to unprotect the form, the password is "form".

Part I. Entity Submitting Report:

- Indicate whether the Offset Project Operator (OPO) or Authorized Project Designee (APD) is submitting the Offset Project Data Report.
- List the name, organization, phone number, and email address of the person submitting the information. This person should be an employee of the OPO or APD, whichever entity is making the submission. The person submitting the information need not be the same person as the contact person listed for the OPO or APD in Part III and also need not be the person signing the form in Part XI.
- The person submitting the information should indicate the date the form is completed.

Part II. Offset Project Information:

- Provide the name for the offset project. Also provide the project's identification number from the approved Offset Project Registry listing the project. The ARB project identification number may also be provided if known.
- Indicate the offset project commencement date and the start and end dates of the first reporting period. Unlike with the listing form, approximations are no longer acceptable for these dates since precise dates should be known.
- Project commencement for an Improved Forest Management Project must be linked to a discrete, verifiable action that delineates a change in practice that increases sequestration and/or decreases emissions relative to the forest project's baseline. This date could be triggered by the transfer of property ownership, recordation of a conservation easement on the Project Area, or when submitting the offset project listing information.

Part III. OPO/APD Information:

- Enter contact information for the OPO and APD submitting the report. Every offset project will have an OPO. If an offset project does not have an APD, please mark the box indicating the Offset Project does not have an APD and leave the remaining fields blank.

- For both the OPO and, if applicable, the APD, enter the entity's name, its mailing address, and the name, phone number, and email address of a contact person for the entity. Also include its CITSS ID number. The CITSS ID is six characters in length, with two letters followed by four numbers (e.g., "CA1234"). **DO NOT PROVIDE THE CONFIDENTIAL CITSS ACCOUNT NUMBER**, which begins with the CITSS ID number followed by a hyphen and more numbers.

Part IV. Land Ownership:

- This part includes questions regarding land ownership and property interests.
- Further documentation is required based on the responses to some questions. See Part X of this report for more information on the precise requirements.

Part V. Offset Project Area:

- This part asks for qualitative descriptions of the offset Project Area.
- Maps are required to complement the descriptions provided in this part. See Part X of this report for more information on the precise requirements.
- The Project Area should be determined following the requirements of Section 4 of the U.S. Forest protocol.
- Assessment areas shall be determined by referencing the Assessment Area Data File available at: http://www.arb.ca.gov/cc/capandtrade/protocols/usforestprojects.htm

Part VI. Offset Project Eligibility:

- The questions in this part are designed to facilitate the determination of project eligibility for Improved Forest Management Projects.
- Further documentation is required based on the responses to some questions. See Part X of this report for more information on the precise requirements.
- Details on the eligibility requirements for Improved Forest Management Projects can be found in Sections 2.1.2, 3.1, and 3.8 of the U.S. Forest protocol.
- Details on the Natural Forest Management criteria can be found in Table 3.2 in the U.S. Forest protocol.

Part VII. Carbon Stock Inventory:

- Projects are required to have completed a full carbon stock inventory for the initial Offset Project Data Report. Unlike the inventory provided at the time of listing, a general description of the project's inventory methods with preliminary best estimates is no longer sufficient to meet the regulatory requirements. If the project's inventory methodology changed between the time of listing and submission of the initial OPDR, this change should be reported as a change to the information submitted at project listing when submitting the first OPDR.
- Section 6.2 of either the Compliance Offset Protocol U.S. Forest Projects, October 20, 2011 or the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014 outlines the approved quantification methodologies for Improved Forest Management Projects. Further details on completing a forest project carbon inventory can be found in Appendix A of the Protocol. (There are some differences in section 6.2 and Appendix A between the two versions.)
- Follow the steps in Appendix D of the U.S. Forest protocol to quantify the project's reversal risk rating.
- The project's expected contribution to the Forest Buffer Account is determined annually based upon the project's risk of reversal and is calculated by multiplying the project specific reversal risk rating by the total net GHG reductions/removals achieved by the project. Unlike the listing application, for this OPDR an approximation of the contribution to the Forest Buffer Account is not acceptable.

Part VIII. Offset Project Baseline:

- For this OPDR, unlike the project listing application, projects are required to have a finalized baseline. A modeling plan with preliminary best estimates is no longer sufficient to meet the regulatory requirements. If the project's modeling plan or baseline estimates changed between the time of listing and submission of the initial OPDR, this change should be reported as a change to the information submitted at project listing when submitting the first OPDR.
- Note that IFM projects located on public land must present documentation demonstrating explicit approval of the offset project's management activities and baseline. These projects may report changes to the baseline within the initial OPDR if the changes have gone through a public review process and meet the Protocol requirements regarding explicit approval of the project's baseline.
- This part is divided into three sections: questions required for all Improved Forest Management Projects; questions for Improved Forest Management Projects on private lands; and questions for Improved Forest Management Projects on public lands. Answer the questions applicable to the project.

- A diagram and graph are required to complement the descriptions provided in this part. See Part X of this report for more information on the precise requirements.
- Section 6.2 of either the Compliance Offset Protocol U.S. Forest Projects, October 20, 2011 or the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014 outlines the approved quantification methodologies for Improved Forest Management Projects. Instructions for considering legal and financial constraints can be found in Sections 6.2.1.2 and 6.2.1.3, respectively. Further details on modeling carbon stocks can be found in Appendix B. (There are some differences in section 6.2 and Appendix B between the two versions.)
- ARB approved growth models can be found in Appendix B, Section B.1 of either the Compliance Offset Protocol U.S. Forest Projects, October 20, 2011 or the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014. (There are some differences in Appendix B between the two versions.)

Part IX. Other Offset Programs:

- Answer all questions. If the answer to any question is "yes," identify the registry or program and provide details on the issued credits in the space provided.

Part X. Attachments:

- Provide each attachment on a separate sheet of paper and submit along with the completed Initial Reporting Period-Offset Project Data Reporting Form.
- To aid with tracking each attachment, it is recommended that the attachments are labeled to correspond with the letter in Part X that they refer to (e.g. "Attachment B").
- When an attachment is not applicable to the project being listed, please select the "N/A" (Not Applicable) checkbox next to the requirement so that it is clear that the attachment was not inadvertently left off.

Part XI. OPO/APD Signature:

- The individual signing the document must be registered in CITSS as the OPO's Primary Account Representative or Alternate Account Representative for the entity submitting the information. The individual signing the document may be an APD employee and/or representative; but to sign the document, the individual must be an Account Representative on the OPO's CITSS account.
- Please provide the individual's signature, printed name, corporate title, and date signed.
- There are no attestations for this report. The attestations required for the Offset Project Data Report are included in the form U.S. Forest Offset Project Data Report Annual Reporting Period – All Project Types.

Please contact your Offset Project Registry with any questions regarding the OPDR.

Usal Redwood Forest IFM

CAR1139, CAFR5281

Addendum to OPDR for the Initial Reporting Period Form

Under

Air Resources Board

Compliance Offset Protocol – U.S. Forest Projects

Adopted: November 14, 2014

Prepared November 14, 2016

Offset Project Operator

Usal Redwood Forest Company, LLC.
528 South Main St.
Fort Bragg, CA 95437

Reporting Period

The reporting period for this Initial OPDR is from 1/1/2015 to 12/31/2015.

Protocol Version

Air Resources Board
Compliance Offset Protocol – U.S. forest Projects
Adopted: November 14, 2014

The OPDR and all other project documentation and reports that reference carbon stocks have been prepared and submitted by James D. Clark, California Registered Professional Forester (No. 2528).

Introduction

Usal Redwood Forest Company, LLC ("URFC") is a wholly owned subsidiary of the Redwood Forest Foundation, Inc. URFC manages the Usal Redwood Forest totaling approximately 49,571 acres; located in the Coast Range of Mendocino County. Usal Redwood Forest is an Improved Forest Management (IFM) Project that is seeking registration under the California Air Resources Board Compliance Offset Protocol – U.S. Forest Projects Adopted: November 14, 2014. The Usal Redwood Forest IFM project is an Early Action project that was initially listed under the Climate Action Reserve's Forest Project Protocol Version 3.2. With this initial OPDR, the Usal Redwood Forest Project is seeking to transition to the Compliance Offset Protocol and has registered the Project as an early action project.

The Offset Project Operator is Usal Redwood Forest Company, LLC.

V.A.

The Project is located within the Northern California Coast Supersection, and within the Coast Redwood/Douglas-fir Mixed Conifer Assessment Area. The Project area is classified as either site class II or III timberland. The Project Area distribution within the "Low" "Site Class" and "High" "Site Class" portion of the above referenced Assessment Area is as follows:

Table 1: Assessment Area Acres

Supersection	Assessment Area	Site Class	Acres
Northern California Coast	Coast Redwood Douglas-fir Mixed Conifer	High	34,181.36
Northern California Coast	Coast Redwood Douglas-fir Mixed Conifer	Low	13,800.18
Total			**47,981.54**

V.B.

The Project Area is subject to the governing jurisdiction of the County of Mendocino, the State of California, and the United States of America.

V.C.

The Project Area has been determined based on the best available data representing the legal description described in the title reports included as Attachment A. The Project Area boundary is derived from the gross property acreage after removing non-timbered areas, slope instability areas that are not capable of growing a crop of trees, large watercourse channels, and road acres.The Project Area boundary is described and represented by the maps included as Attachment E, and the GIS data supplied in a geodatabase as a part of this Project submission. For the purpose of calculating GHG stocks, the Project Area acreage is taken from the GIS data provided with the application. The final Project Area acreage of 47,981.54 acres.

V.D.

URFC purchased approximately 50,526 acres in June of 2007. In October 2011, approximately 957 acres in the southwestern portion of the ownership were sold to the Save the Redwoods League resulting in the current configuration of the property. In conjunction with this sale in 2011, a Conservation Easement was granted to The Conservation Fund through a grant from the California Wildlife Conservation Board. In December of 2014, the Conservation Easement transferred to CAL FIRE. The Usal Redwood Forest Project encompasses approximately 47,981.54 timbered acres of the larger property. The existing land cover on the Usal Redwood Forest IFM Project Area is generally timberland with small areas of brush land, grasslands and rock outcroppings. It supports a healthy, diverse forest community comprised, predominantly, of Douglas-fir and coastal redwood, as the dominant conifer species, and hardwoods, consisting of tan oak, Pacific madrone, and true oak (i.e. *Quercus*); it is bordered by properties containing the same. The Usal Redwood Forest IFM property is zoned Timber Production (TP). The

permitted uses on TP land are timber production, row crops (including vineyard) and one single-family residence per legal parcel.

V.E.

The following Wildlife Habitat Relationship (WHR) vegetation types occur on the Usal Redwood Forest IFM:

RDW	REDWOOD
DFR	DOUGLAS FIR
AGS	ANNUAL GRASS
COW	COASTAL OAK WOODLAND
MHW	MONTANE HARDWOOD
CRC	CHAMISE-REDSHANK CHAPARRAL

The majority of the Project Area is classified as the DFR "Douglas fir" type. Primary conifer species are coast redwood and Douglas-fir. The principal hardwood species is tanoak with a mixture of madrone, true oak, and other native hardwoods. On most sites redwood would likely dominate if vegetation succession were allowed to proceed naturally.

V.F.

The Project Area is generally characterized as moderate (site class III) to highly (site class II) productive timberland. Please see the Modeling Plan included as Attachment M for a more detailed description of the determination of site index.

V.G.

The Usal Redwood Forest IFM Project Area as well as much of the surrounding land is utilized for timber production, recreation, agriculture and rural residential uses. Land pressures associated with these uses are typically conversion of timberland to home sites and fragmentation of larger blocks into smaller tracts. With recordation of the Conservation Easement the Usal Redwood Forest ownership has been merged into a single parcel, cannot be subdivided and the residential development rights have been extinguished. Any industrial,

commercial, or residential use of any kind is prohibited, except for permitted forest management and as otherwise permitted in the easement. Prior to recordation of the Conservation Easement, the Usal Redwood Forest's previous owner obtained Certificates of Compliance for the 92 separate legal parcels comprising the Project Area, thus allowing for the sale and development of these parcels to rural residential home and/or vineyard sites. Residential uses would involve the development of home sites while road use and human activity on the property would increase. Historically, increased human activity has resulted in the disruption and displacement of native plants and animals.

The Usal Redwood Forest IFM Project Area consists of both Maritime & Mediterranean climates influenced by the proximity to the Pacific Ocean and topography. Summers are warm and winters are mild and wet. The cooling pacific fog follows the path of the Eel River and Usal Creek onto the property where temperatures range from an average of low of 32 degrees F in January to an average high of 85 degrees F in August. Average annual rainfall for the property is approximately 60 inches per year.

V.H.

The Project Area is zoned Timber Production (TP). Land use on the Project Area and in the vicinity is timber production, grazing, and rural residential uses. These uses are expected to continue into the foreseeable future.

Upon the acquisition of the property, URFC changed the management goals for the property to that of a working community forest whereby the property's environmental attributes will be maintained and restored over time while providing economic benefits to the local community in terms of jobs, property taxes and forest products.

Commercial harvesting is planned within the Project Area; and since 2007 commercial harvest activity has taken place in 2012, 2013, 2014 and 2015. The conservation easement placed a

restriction on the entire property limiting conifer harvest volume removals to no more than 2.9% of total standing conifer inventory volume on an annual average basis over the length of each consecutive, non-overlapping 5-year period. The conservation easement also requires that the Usal Redwood Forest to be managed under a third party, forest management certification program, such as that of the Forest Stewardship Council (FSC) standards and to transition from even-age to uneven-age management; however, the easement specifies a goal for even-age silviculture to be employed to replace tanoak dominated stands with a more desirable and productive ecological condition of mixed conifers and hardwoods within 61 years of easement recordation.

V.I.

The Usal Redwood Forest IFM Project Area is characterized by a mix of coast redwood, Douglas-fir, tanoak, true oak, and other native hardwoods and conifers. It is estimated that the Project Area is composed of approximately 28% Douglas-fir, 26% redwood, less than 0.2% other conifers, 38% tanoak, 5% Pacifics madrone, and 3% other hardwoods by basal area. The Usal Redwood Forest Company intends to manage to reduce the hardwood component and increase the component of redwood.

The timber stands that comprise the Project Area developed as the result of past harvesting activities including a mix of even-aged and uneven-aged harvest practices. These timber stands include stands of mixed age classes primarily ranging from 10 years to 80 years in age.

VI.A.

The Usal Redwood Forest IFM Project Area meets condition 1 under section 2.1.2 (page 10) of the Compliance Offset Protocol by maintaining greater than 10% tree canopy cover. Compliance is substantiated by the Orthophoto map of the Project site, that may be found in Attachment F, clearly showing canopy closure for the Project Area and, will be substantiated by the results of the carbon stock inventory.

VI.D.1.(a)

Approximately 99.99% of the Project's biomass is in native species, and thus the Project meets the 95% criteria for carbon in native species. Regeneration activities proposed under the Project will utilize only native species.

VI.D.2.

(a) The Usal Redwood Forest IFM Project Area is characterized by a mix of redwood, Douglas-fir, tanoak, madrone and other native hardwoods and conifers. It is estimated that, as of 12/31/2015, the Project Area is composed of approximately 28% Douglas-fir, 26% Redwood, less than 0.1% other conifers, 38% tanoak, 5% Pacific madrone, and 3% other hardwoods by basal area. The Usal Redwood Forest Company intends to manage the timber stands to reduce the hardwood component and increase the confier component of redwood while ensuring that the Project continues to meet the requirements for composition of native species under Table 3.2 (page 20) of the Compliance Offset Protocol by maintaining species' basal area percentage below 60%, the Species Diversity Index from the Assessment Area Data File.

VI.D.3.

(a) The Usal Redwood Forest is Forest Stewardship Council (FSC) certified as of September 3, 2015. FCS certification is a third party forest management program that will be used to meet the sustainable long-term harvesting requirements per the Forest Project Protocol for this initial and future reporting periods. Harvesting on the Project Area has been limited to approximately 12,000 MBF since the Project's initiation in 2007. Growth during the same time is conservatively estimated to be 130,000 MBF. Silvicultural prescriptions associated with harvest have been limited to uneven-aged prescriptions and Special Prescriptions in the form of variable retention as defined by section 913.4 of the California Forest Practice Rules while also maintaining canopy

cover averaging at least 40 percent across the entire forestland owned by the Forest Owner in the same Assessment Area covered by the Project Area. The Forest Owner owns no other forestland within the Assessment Area covered by the Project Area. As such, the Usal Redwood Forest Project has met the requirement for sustainable long-term harvesting for the initial reporting period by satisfying the first option under Section 3.8.1 of the Forest Project Protocol.

(b) As the Project Area is larger than 10,000 acres, the Project Area has been split by CALWATER planning watershed in order to determine compliance with the above requirement. As shown in Table 2 below, the Project is located within 20 CALWATER planning watersheds comprising the South Fork Eel River and Usal Creek watersheds with a relatively small area drained by Cottaneve and Jackass Creeks. Currently no more than 40% of the forested area in each watershed described above is less than 20 years in age.

Table 2: Project Age Class Distribution in 2015

CALWATER Watershed	IDNUM	Project Acreage	Project Acreage < 20 Years Old	% of Acreage < 20 Years
Bear Pen Creek	1111.320404	3,844.51	35.81	0.9%
Big Dann Creek	1111.320203	8.05		0.0%
Bridges Creek	1111.320405	60.72		0.0%
Cedar Creek	1111.320204	9.78		0.0%
Cottaneva Creek	1113.120101	119.66		0.0%
Jackass Creek	1113.110200	63.35	1.62	2.6%
Low Gap Creek	1111.320202	2,048.92		0.0%
Lower Hollow Tree Creek	1111.320302	3,849.61	436.69	11.3%
Lower Indian Creek	1111.320504	5,989.45	503.62	8.4%
Lower Usal Creek	1113.110101	5,286.37	60.45	1.1%
McCoy Creek	1111.320505	189.86		0.0%
Middle Hollow Tree Creek	1111.320301	548.94		0.0%
Mill Creek	1111.320401	1,859.33	28.48	1.5%
Piercy Creek	1111.320502	2,128.81	341.38	16.0%
Red Mountain Creek	1111.320403	0.44		0.0%
Standley Creek	1111.320501	5,046.45	34.01	0.7%
Upper Indian Creek	1111.320503	2,811.67	507.39	18.0%
Upper Sproul Creek	1111.320703	6.47		0.0%
Upper Usal Creek	1113.110102	9,970.90	235.72	2.4%
Wildcat Creek	1111.320402	4,138.25	164.66	4.0%
Grand Total		**47,981.54**	**2,349.82**	**4.9%**

VI.D.4.

URFC does not actively remove lying dead wood as a part of its stand management activities. It is expected that the accumulation of lying dead wood will be commensurate with recruitment from standing dead trees. URFC is committed to maintaining and increasing, the number of standing dead trees within the Project Area as a component of its forest management objectives. URFC has not recently conducted any salvage operations, nor does it intend in the future to actively pursue aggressive salvage operations on its timberlands. URFC may conduct salvage harvesting in the future, but with the goal of maintaining a component of standing dead trees in the post treatment stands.

In the case of the Usal Redwood Forest IFM, the Project Area has not undergone any recent salvage harvesting. Therefore, all that must be demonstrated is that the greater of one metric ton of carbon per acre or 1% of standing live carbon stocks is present in standing dead wood, or that progress towards these targets is ongoing. The project currently contains an average of 1.33 Mg C per acre and 1.86% of standing live carbon stocks in standing dead wood. Therefore, the project currently meets the aforementioned standing dead wood target.

VI.E.

The Usal Redwood Forest is a wholly owned subsidiary of the Redwood Forest Foundation and is managed as a community forest for multiple environmental, social and economic purposes. These purposes include restoration to historical reference ecological characteristics, restoration and maintenance of fish and wildlife habitat and improved water quality. Ensuring the long-term sequestration of carbon has been and continues to serve as a foundation for these and other management decisions.

The Foundation acquired the property in June 2007 and immediately made significant changes to management that have and will continue to sequester carbon. These include:

- Prohibiting forest subdivision or conversion;
- Creating management standards that precluded industrial harvest;
- Completing watershed restoration projects and
- Choosing to forgo any harvest during the recessionary period (2008-2012) as opposed to increasing harvest to meet economic objectives

In October 2011, the Foundation sold a conservation easement that included a primary silvicultural limitation on conifer harvest of 2.9% of inventory that will permanently guarantee carbon sequestration in perpetuity. The Foundation continues to also implement management practices that sequester additional carbon. For example, the Foundation's current silvicultural approach will continue to build forest inventory above and beyond the harvest limitations

imposed by the easement. The Foundation also achieved Forest Stewardship Council (FSC) certification in September of 2015.

Finally, to achieve its goals as described above, the Usal Redwood Forest has developed a long range growth and harvest scenario that meets the terms of the recorded conservation easement while ensuring an economic return from the forest while at the same time increasing carbon stocks over time. This projected harvest scenario includes harvest levels significantly lower than those forecasted under the baseline harvest scenario described herein.

VII.A.

IFM-1 Standing Live:

Standing live carbon was inventoried based on sample plots installed as part of a forest inventory in 2015. The inventory specifications are included as Attachment N. The cruise design consists of the installation of sample points randomly selected from a systematic grid 5 chains by 5 chains in size anchored with a random starting location.

The sample design includes the installation of fixed area plots to measure both live and dead conifers and hardwoods. A 1/100th acre fixed area plot was installed at each sample point to sample trees 1" DBH to 3.5" DBH; a 1/50th acre fixed area plot was installed at each sample point to sample trees 3.6" DBH to 10.5" DBH; and, a 1/10th acre fixed area plot was installed at each sample point to sample trees 10.6" DBH and larger.

Attachment N describes the procedures for collecting field measurements, specific criteria pertaining to data collection, stratification rules, and documentation on quality assurance and quality control. Documentation of analytic methods and biomass equations used to translate field measurements into volume or biomass carbon estimates is included in Part B below.

Cruise data from field cards were reviewed for completeness and entered into an Access database. Plot data within the database was extensively sorted and queried to look for data entry errors. This process has resulted in a final data set for cruise processing. The Access database serves as the repository for inventory data and is accessed by the growth and yield model during growth and yield simulations.

Inventory monitoring and update procedures are described in Attachment N.

IFM-3 Standing Dead:

As described above, and in Attachment N, standing dead trees were sampled in conjunction with standing live trees.

IFM-6 Soil (if applicable):

Excluded because the conditions in Table 5.2 of the Protocol that would require inclusion of this pool (site preparation involving deep ripping, furrowing, or plowing where soil disturbance exceeds 25 percent of the Project Area over the Project Life, or mechanical site preparation activities not conducted on contours) are not planned.

IFM-7 Carbon in in-use forest products:

Carbon in in-use forest products have been generated by the Project as harvesting occurred in 2015. Part B below will include documentation of analytic methods and biomass equations used to translate future harvest volumes delivered to the mill into appropriate carbon in in-use forest products values. Harvest records from scale tickets or summaries from the landowner will be used to determine the volume of wood delivered to the mill.

IFM-8 Forest product carbon in landfills (if applicable):

Carbon in landfills is a component of carbon related to forest products. Part B below will include documentation of analytic methods and biomass equations used to translate future harvest volumes delivered to the mill into appropriate forest products carbon in landfill values.

IFM-9 Biological emissions from site preparation:

As IFM-6 is an excluded carbon pool, IFM-9 is also an excluded pool.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside Project Area:

Part B below will include documentation of analytic methods and biomass equations used to translate future harvest volumes delivered to the mill into appropriate values for the calculation of this carbon pool.

IFM-17 Biological emissions from decomposition of forest products:

This is quantified as a component of IFM-7 and IFM-8 per Appendix C of the Protocol.

VII.B.

IFM-1 Standing Live:

Above-ground standing live carbon in trees 1" DBH and larger were calculated using the appropriate biomass equation by species taken from the Compliance Offset Protocol U.S. Forest Offset Projects page on ARB's website. The current biomass equation documentation provided by ARB is included as Attachment O . The equations referenced below are not reproduced here for the sake of minimizing redundancy. These equations are used to generate biomass estimates for the above-ground portion of standing live trees, and hard snags. These equations will be referred to as the "FIA equations" herein.

Each species can have as many as three FIA equations in order to calculate tree biomass. The FIA equations used by species are as follows:

Species	Bole Cubic Ft Volume	Bark Biomass	Live Branches Biomass
Redwood	Equation 24	Equations 13 & 17	Equation 10
Douglas-fir	Equation 3	Equation 8	Equation 6
Grand fir	Equation 23	Equation 2	Equation 1
Western Hemlock	Equation 6	Equation 15	Equation 12
California Nutmeg	Equation 8	Equation 13	Equation 10
Other Conifer	Equation 17	Equation 21	Equation 17
Tanoak	Equation 34	None	None
Pacific madrone	Equation 40	None	None
Live oak	Equation 42	None	None
California laurel	Equation 33	None	None
Golden chinkapin	Equation 32	None	None
Bigleaf maple	Equation 37	None	None
Red Alder	Equation 26	Equation 20	Equation 16
Willow	Equation 40	None	None
Eucalyptus	Equation 31	None	Equation 28
Other hardwood	Equation 41	None	None

Tonnes of standing live biomass per sample plot are calculated as follows:

For equations that use total tree height in meters, tree height is calculated by multiplying the trees total height in feet by 0.3048. Trees per hectare are calculated by multiplying trees per acre by 2.471. Tree diameter at breast height ("DBH") in centimeters (cm) is calculated by multiplying its DBH by 2.54.

Bole Biomass:

The Cubic foot volume of each tree is calculated as the volume of the total stem from ground to tip (includes the top and stump). FIA refers to this value as CVTS. Bole biomass is calculated by multiplying the cubic volume by the wood density, and then dividing by 2.20462 to calculate weight in kilograms (kg). Above-ground biomass in kilograms (Kg) per acre is calculated by multiplying the FIA calculated kg per tree by each tree's per acre value.

Bark and Live Branches Biomass:

The above referenced FIA equations produce biomass in kg for the various parts of the above-ground portion of each tree. Above-ground biomass in kilograms (Kg) per acre is calculated by multiplying the FIA calculated kg per tree by each trees per acre value.

Total percent carbon defect of each tree is defined as the total percent cubic foot defect of a bole both inside and outside the board foot scaling cylinder from and including the stump to the tip. It is recorded as a percentage of missing portions of the entire bole. The total rebuilt heights of trees with broken tops were estimated by the cruisers and then used to estimate percent missing volume based on table 4-8 (Forest Data Collection Procedures and Standards included in Attachment N) which provided percent stem cubic volume by 1/3 of total height. The total percentage of the bole that is missing was applied to the total biomass (including various biomass components of the tree) as calculated above to calculate the net biomass of the tree. By applying this percent missing volume estimate to all portions of the tree, it is felt that the resulting net biomass value is conservative.

The net kg per acre value of each tree on the plot is summed to derive above-ground live biomass kg per acre for the plot. This value is used to calculate the respective below-ground live biomass component for the plot. Total standing live carbon values presented herein are for trees 1" DBH and larger.

The net Kg per acre value of each tree on the plot is summed to derive above-ground live biomass Kg per acre for the plot. This value is used to calculate the respective below-ground live biomass component for the plot.

Below-ground live carbon is calculated at the plot level using the model provided by Cairns et. al. specified on page 89 of Appendix A of the Protocol. The formula has as its input,

above-ground live biomass in Mg per hectare, and outputs below-ground biomass in Mg per hectare. Total net above-ground live carbon in Kg per acre for each plot is converted to Mg of biomass per hectare by multiplying by 2.471, and then dividing by 1000. After calculating the below ground component in Mg per hectare using the Cairns model, the results are converted to Kg per acre by multiplying by 1000 and dividing by 2.471.

Total standing live biomass for each plot is the sum of the above-ground and below-ground live biomass Kg per acre. Mg of carbon (Mg C) per acre per plot is then calculated by multiplying by 0.5 to estimate carbon biomass. Mg C per acre is converted to CO2-equivalent by multiplying by 3.664.

IFM-3 Standing Dead:

Data on standing dead trees were collected as a part of the 2015 Usal Redwood Forest IFM inventory. In general, the amount of carbon stored in a standing dead tree is based on the proportion of the tree remaining standing, and the condition of the tree, or its decay class. The standing dead carbon pool includes trees 5" DBH and larger, with a minimum height of 15'.

Standing dead trees from the inventory data are classified into five decay classes based on descriptions contained in Research Paper NRS-15 (Harmon et al, 2011). These decay classes are generally described as follows:

Class 1 All limbs and branches are present; the top of the crown is still present; all bark remains; sapwood is intact, with minimal decay; heartwood is sound and hard.

Class 2 There are few limbs and no fine branches; the top may be broken; a variable amount of bark remains; sapwood is sloughing with advanced decay; heartwood is sound at base but beginning to decay in the outer part of the upper bole.

Class 3 Only limb stubs exist; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay in upper bole and is beginning at the base.

Class 4 Few or no limb stubs remain; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay at the base and is sloughing in the upper bole.

Class 5 No evidence of branches remains; the top is broken; <20 percent of the bark remains; sapwood is gone; heartwood is sloughing throughout.

Biomass for standing dead trees includes the bole and bark components calculated using the FIA biomass equations described above and following the same procedures as for live trees other than the manner in which missing volume is calculated.

Total percent carbon defect of each tree is defined as the total percent cubic foot defect of a bole both inside and outside the board foot scaling cylinder from and including the stump to the tip. It is recorded as a percentage of missing portions of the entire bole. The total rebuilt heights of trees with broken tops were estimated by the cruisers and then used to estimate percent missing volume based on table 4-9 (Forest Data Collection Procedures and Standards included in Attachment N) which provided percent stem cubic volume by 1/3 of total height. The total percentage of the bole that is missing was applied to the total biomass (including various biomass components of the tree) as calculated above to calculate the net biomass of the tree. By applying this percent missing volume estimate to all portions of the tree, it is felt that the resulting net biomass value is conservative.

The net kg per acre value of each tree on the plot is summed to derive above-ground live biomass kg per acre for the plot. This value is used to calculate the respective below-ground live biomass component for the plot. Total standing live carbon values presented herein are for trees 1" DBH and larger.

Once the net biomass of each tree has been calculated, a relative density is applied by species and decay class. The relative density is in relation to the green density of sound wood, or the tree's wood density. The table below lists the relative densities applied by species and decay class taken from Differences Between Standing and Downed Dead Tree Wood Density Reduction Factors (Harmon et al, 2011).

Relative Density by Species and Decay Class:

	Decay Class (DC)				
Species	**DC1**	**DC2**	**DC3**	**DC4**	**DC5**
Redwood	0.994	0.951	0.902	0.605	0.605
Douglas-fir	0.892	0.831	0.591	0.433	0.433
Grand fir	1.013	0.966	0.855	0.574	0.574
California Nutmeg	0.994	0.951	0.902	0.605	0.605
Western Hemlock	1.040	1.080	0.848	0.525	0.525
Other Coastal Conifers	.990	0.980	0.830	0.598	0.598
California-laurel	0.982	0.793	0.618	0.525	0.525
Canyon live oak	1.02	0.841	0.705	0.591	0.591
Pacific madrone	0.982	0.793	0.618	0.525	0.525
Bigleaf maple	0.979	0.766	0.565	0.450	0.450
Tanoak	0.982	0.793	0.618	0.525	0.525
Eucalyptus	0.982	0.793	0.618	0.525	0.525
Golden Chinkapin	0.982	0.793	0.618	0.525	0.525
Red alder	1.030	0.903	0.535	0.393	0.393
Willow (spp)	0.982	0.793	0.618	0.525	0.525
Other Coastal Hardwoods	1.020	0.700	0.858	0.591	0.591

Below-ground standing dead carbon is calculated at the plot level using the model provided by Cairns et. al. specified on page 88 of Appendix A of the Protocol. The formula has as its

input, above-ground biomass in Mg per hectare, and outputs below-ground biomass in Mg per hectare.

Total standing dead biomass for each plot is the sum of the above-ground and below-ground standing dead biomass Mg per acre. Mg of carbon (Mg C) per acre per plot is then calculated by multiplying by 0.5 to estimate carbon biomass. Mg C per acre is converted to CO2- equivalent by multiplying by 3.664.

IFM-6 Soil (if applicable):

Excluded because the conditions in Table 5.2 of the Protocol that would require inclusion of this pool (site preparation involving deep ripping, furrowing, or plowing where soil disturbance exceeds 25 percent of the Project Area over the Project Life, or mechanical site preparation activities not conducted on contours) are not planned.

IFM-7 Carbon in in-use forest products:

Wood products delivered to the mill in any period is calculated beginning with the cubic volume of harvested conifer trees 10” DBH and larger. Conifers smaller than 10" DBH are not included as they are too small to be delivered to the mill. The dry weight of wood products in pounds is calculated by multiplying the wood density in lbs/cubic foot by the cubic volume for each softwood species harvested based on the CV6 values derived from the FIA equations listed above. Bark and branch biomass are not included in the volume harvested. The wood densities utilized are those for the Redwood Forest Type and are included in Table C.1 of Appendix C of the Protocol. The dry weight is multiplied by 0.5 to convert the weight to carbon weight only. The weight of carbon in lbs is divided by 2,204.6 to get the carbon weight in metric tonnes (Mg).

Mg of carbon by species is then multiplied by either 0.675 for softwoods, or 0.568 for hardwoods to account for mill efficiencies, taken from the Compliance Offset Protocol U.S. Forest Offset Projects page on ARB's website.

The resulting Mg carbon value after accounting for milling efficiencies is then passed to the wood products worksheets for calculating long-term in-use wood products storage. The wood products carbon is separated into product classes and multiplied by the respective 100-year average storage factor. The tables below list the assignment of wood products by class per the most current Assessment Area Data File taken from the Compliance Offset Protocol U.S. Forest Offset Projects page on ARB's website, as well as the 100-year average storage factors applied to each wood product class per table C.2 of Appendix C of the Protocol.

Wood Products by Class	**Northern California Coast**
% Softwood Lumber	97.067%
% Hardwood lumber	0.002%
% Softwood Plywood	1.874%
% Oriented Strandboard	0.000%
% Non Structural Panels	0.244%
% Miscellaneous Products	0.095%
% Paper	0.717%

100-year Storage Rates Average Values from Appendix C, In-Use Table C.2

Softwood Lumber	0.463
Hardwood lumber	0.250
Softwood Plywood	0.484
Oriented Strandboard	0.582
Non Structural Panels	0.380
Miscellaneous Products	0.176
Paper	0.058
Weighted Average	0.310

Average carbon stored in in-use wood products is calculated using equation C.1. Carbon is converted to CO_2-equivalent by multiplying by 3.664. This value is combined with IFM-8 using equation C.3 to represent $WP_{total, y}$ for the reporting period.

$WP_{total, y}$ for the reporting period represents $AC_{wp,y}$ in equation 6.1. Average in-use wood products produced by the baseline analysis ($BC_{wp, y}$) are deducted from actual wood products produced each reporting period ($AC_{wp,y}$) in equation 6.1 and the resulting calculation is multiplied by 80% to account for the "Market Response".

IFM-8 Forest product carbon in landfills (if applicable):

Wood products delivered to the mill in any period is calculated beginning with the cubic volume of harvested conifer trees 10" DBH and larger. Conifers smaller than 10" DBH are not included as they are too small to be delivered to the mill. The dry weight of wood products in pounds is calculated by multiplying the wood density in lbs/cubic foot by the cubic volume for each softwood species harvested. The wood densities utilized are those for the Redwood Forest Type and are included in Table C.1 of Appendix C of the Protocol. The dry weight is multiplied by 0.5 to convert the weight to carbon weight only. The weight of carbon in lbs is divided by 2,204.6 to get the carbon weight in metric tonnes (Mg).

Mg of carbon by species is then multiplied by either 0.675 for softwoods, or 0.568 for hardwoods to account for mill efficiencies, taken from the Compliance Offset Protocol U.S. Forest Offset Projects page on ARB's website.

The resulting Mg carbon value after accounting for milling efficiencies is then passed to the wood products worksheets for calculating long-term landfill wood products storage. The wood products carbon is separated into product classes and multiplied by the respective

100-year average storage factor. The table below lists the 100-year average storage factors applied to each wood product class per table C.3 of Appendix C of the Protocol.

Wood Products by Class	
% Softwood Lumber	97.067%
% Hardwood lumber	0.002%
% Softwood Plywood	1.874%
% Oriented Strandboard	0.000%
% Non Structural Panels	0.244%
% Miscellaneous Products	0.095%
% Paper	0.717%

100-year Storage Rates Average Values from Appendix C, In Landfill Table C.3

Softwood Lumber	0.298
Hardwood lumber	0.414
Softwood Plywood	0.287
Oriented Strandboard	0.233
Non Structural Panels	0.344
Miscellaneous Products	0.454
Paper	0.178
Weighted Average	0.199

Average wood products carbon stored in landfills is calculated using equation C.2. Carbon is converted to CO_2-equivalent by multiplying by 3.664. This value is combined with IFM-7 using equation C.3 to represent $WP_{total,\ y}$ for the reporting period.

$WP_{total,\ y}$ for the reporting period represents $AC_{wp,y}$ in equation 6.1. Average in-use wood products produced by the baseline analysis ($BC_{wp,\ y}$) are deducted from actual wood products produced each reporting period ($AC_{wp,y}$) in equation 6.1 and the resulting calculation is multiplied by 80% to account for the "Market Response".

IFM-9 Biological emissions from site preparation:

As IFM-6 is an excluded carbon pool, IFM-9 is also an excluded pool.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside Project Area:

The Protocol refers to this carbon pool as Secondary Effects which are calculated using equation 6.10 of the Protocol. Secondary Effects of harvesting less than the average wood products produced by the baseline growth and yield analysis are calculated by subtracting the average carbon in harvested trees prior to delivery to a mill (PDM) generated by the baseline analysis from the actual carbon in harvested trees prior to delivery to a mill, and then multiplying the difference by 20%. As Secondary Effects are only calculated in years when actual wood products produced are less than the annual average under the baseline analysis, the resulting calculation is either zero, or a negative number.

The PDM calculation each annual reporting period will be calculated based on a ratio between the average volume of wood delivered to the mill generated by the baseline analysis, and the average PDM value generated by the baseline analysis. Each reporting period, this ratio will be applied to the actual volume of wood delivered to a mill.

IFM-17 Biological emissions from decomposition of forest products:

This is quantified as a component of IFM-7 and IFM-8 as described above.

VII.C.

IFM-1 Standing Live: This carbon pool will be calculated each year as described in parts A and B above. The current standing live carbon pool is 12,569,706 $MgCO_2e$.

IFM-3 Standing Dead: This carbon pool will be calculated each year as described in parts A and B above. The current standing dead carbon pool is 233,696 $MgCO_2e$.

IFM-6 Soil (if applicable): N/A

IFM-7 Carbon in in-use forest products: This carbon pool will be calculated each year as described in parts A and B above. As timber harvesting occured during this initial reporting period, this carbon pool is calculated as 6,733 MgCO2e.

IFM-8 Forest product carbon in landfills (if applicable): This carbon pool will be calculated each year as described in parts A and B above. As timber harvesting occured during this initial reporting period, this carbon pool is calculated as 4,350 MgCO2e.

IFM-9 Biological emissions from site preparation: N/A

IFM-14 Biological emissions/removals from change in harvesting on forestland outside Project Area: This carbon pool will be calculated each year as described in parts A and B above. Timber arvesting has occurred during the initial reporting period, and as such this pool is calculated as -18,617 $MgCO_2e$ for the initial reporting period.

IFM-17 Biological emissions from decomposition of forest products: This is quantified as a component of IFM-7 and IFM-8 as described above.

VII.D.

Stratified random sampling formulas taken from Shiver and Borders (1996) were used to calculate the sampling error for the Usal Redwood Forest IFM Project carbon stock inventory as of the end of the reporting period. Estimates of the inventory confidence statistics, based on the carbon stock inventory estimate as of 12/31/2015, are as follows:

Mean standing live and standing dead pools	72.83	Mg C per acre
SE of mean	1.81	Mg C per acre
SE of mean as %	2.48	1.81 ÷ 72.83
Sampling Error of 90% CI	4.08	(2.48%) * 1.645
Inventory Confidence Deduction	0%	4.1*% - 5.0%

*4.08 rounds to 4.1

VII.E.

The risk ratings shown on the next page assume that the Project will not employ a Qualified Conservation Easement.

Project Area Reversal Risk Rating:

Risk Category	Contribution to Reversal Risk Rating
Financial Failure	5.0%
Conversion	2.0%
Over-harvesting	2.0%
Social	2.0%
Wildfire	4.0%
Disease/Insect	3.0%
Other Catastrophic	3.0%
Total Buffer Pool Contribution	19.2%

The Project's reversal risk rating is calculated as follows:

100% - (((1-0.05)*(1-0.02)*(1-0.02)*(1-0.02)*(1-0.04)*(1-0.03)*(1-0.03)*100)) = 19.2%

The contribution to the Forest Buffer Account during the initial reporting period is 59,051 ROCs.

VIII.A.5.

Following the calculation methodologies described in section VII B above, the baseline modeling presented in the Modeling Plan (Attachment M) generates an average annual value for each of the above described wood products carbon pools. Actual wood products values for In-use, Landfill, and Prior to Delivery to the Mill ("PDM") are calculated based on a flow of wood products over the 100-year planning period. The table below presents an estimate of the average wood products stored long-term values that were generated by the baseline analysis.

Woods Products Class	Mg C/ acre	Total Mg CO2e
Average Annual Carbon 100-year In-Use	0.123	21,626.63
Average Annual Carbon 100-year Landfill	1.079	13,972.22
Average Annual Carbon in Harvested Trees Prior to Delivery to the Mill	0.769	135,167.53

VIII.B.3

Based on the information available to the Offset Project Operator at this time, the highest value for above-ground standing live carbon stocks per acre within the Project Area during the 10-year period preceding the Project commencement date was equal to the above-ground standing live carbon stocks at the end of the last year of this 10-year period, which is equal to the Project's initial above-ground standing live carbon stocks (ICS). Therefore, the "High Stocking Reference" (HSR) is equal to 80% of the Project's ICS value of 164.38 MgCO2e per acre as reported in Part VIII.B.1 of this OPDR, or 131.50 MgCO2e per acre. Please see Attachment J for supporting documentation.

VIII.B.4.

Because the Project's initial above-ground standing live carbon stocks were below Common Practice, the MBL is determined using Equation 6.6 in the Forest Project Protocol:

MBL = MAX (MAX(HSR, ICS), MIN(CP, WCS))

Where,

MAX = The highest value in the set of values being evaluated.

MIN = The lowest value in the set of values being evaluated.

MBL = Minimum baseline level (above-ground standing live carbon stocks).

HSR = The "High Stocking Reference" for the Project Area. The High Stocking Reference is defined as 80 percent of the highest value for above-ground standing live carbon stocks per acre within the Project Area during the preceding 10-year period.

CP = Common Practice (as determined above).

ICS = Initial above-ground standing live carbon stocks per acre within the Project Area.

WCS = The weighted average above-ground standing live carbon stocks per acre for all Forest Owner (and affiliate) landholdings within the same logical management unit (LMU) as the Project Area.

WCS is calculated using Equation 6.7:

$$If \left|1 - \frac{ECS}{ICS}\right| \leq 0.2, then\ WCS = ICS$$

$$If \left|1 - \frac{ECS}{ICS}\right| > 0.2, then\ WCS = \frac{ICS \times PA + ECS \times EA}{PA + EA}$$

Where,

WCS = Same as described above

ICS = Same as described above

PA = Size of the Project Area in acres

ECS = Above-ground standing live carbon stocks per acre within the LMU but excluding the Project Area (EA), as determined from existing inventory data

EA = Size of the LMU in acres, excluding the Project Area

A "logical management unit" or "LMU" is defined as all land that the Forest Owner and its affiliate(s) either own in fee or hold timber rights on, and which it or they manage as an explicitly defined planning subunit. LMUs are generally characterized by having unique biological, geographical, and/or geological attributes, are generally delimited by watershed boundaries and/or elevational zones, and contain unique road networks.

The Usal Redwood Forest has been identified as one LMU, approximately 55 net acres of timberland for which URFC owns the timber rights on in the northwest quarter of section 15 T23N R17W are within the LMU but have been excluded from the Project Area.

The Usal Redwood Forest's variables are as follows:

CP = 181.38 Mg CO_2e per acre

ICS = 164.38 Mg CO_2e per acre

HSR = 131.50 Mg CO_2e per acre

PA = 47,981.54 acres

ECS = 177.70 Mg CO_2e per acre[1]

EA = 54.97 acres

Based on the data above, the first if-then expression of equation 6.7 = 0.08, and is true, and:

WCS = ICS , or,

WCS = 164.38 MgCO_2e per acre

Equation 6.6 then becomes:

MBL = MAX (MAX (131.50, 164.38), MIN (181.38, 164.38))

MBL = MAX (164.38, MIN (181.38, 164.38))

[1] ECS is calculated based on acres by stratum from the property subject to timber rights expanded to an average per acre value from the Project's current carbon stock estimates by stratum as of the Project Start date.

MBL = MAX (164.38, 164.38)

MBL = 164.38 $MgCO_2e$ per acre

The averaged modeled baseline results, expressed as above-ground standing live carbon stocks per acre, must not fall below the MBL of 164.38 $MgCO_2e$ per acre.

VIII.B.7.

In modeling the baseline for standing live carbon stocks, the Forest Owner must incorporate financial constraints that could affect baseline growth and harvesting scenarios. The Usal Redwood Forest - Compliance Project utilizes a financial analysis of the baseline harvesting regime that captures all relevant costs and returns, taking into account all legal, physical, and biological constraints. This financial analysis has been included as Attachment L of this OPDR. Cost and revenue variables included in the financial analysis are based on documented costs and returns for the Project Area, and on other properties in the Assessment Area. This financial analysis illustrates that the baseline harvest scenario is financially feasible.

X Attachments

The following attachments are included as a part of this OPDR:

Attachment A - Title Report.

Attachment E – Maps of the Project Area, including an ESRI Geodatabase that represents the Project Area.

Attachment F – Orthophoto Maps of the Project Area.

Attachment G – A Graph Portraying the Project's Baseline.

Attachment H – A Diagram of the Project's Baseline.

Attachment I – Baseline and Actual Harvest Volumes

Attachment J - High Stocking Reference Affidavit

Attachment K - Legal Constraints Affecting Forest Management Activities on the Project Area

Attachment L – Financial Analysis of the Baseline Scenario

Attachment M –Modeling Plan

Attachment N –Inventory Specification

Attachment O – Volume and Biomass Equations

ATTACHMENT A

OWNER'S POLICY OF TITLE INSURANCE

ISSUED BY

First American Title Insurance Company

Any notice of claim and any other notice or statement in writing required to be given to the Company under this policy must be given to the Company at the address shown in Section 18 of the Conditions.

COVERED RISKS

SUBJECT TO THE EXCLUSIONS FROM COVERAGE, THE EXCEPTIONS FROM COVERAGE CONTAINED IN SCHEDULE B AND THE CONDITIONS, FIRST AMERICAN TITLE INSURANCE COMPANY, a California corporation (the "Company") insures, as of Date of Policy and, to the extent stated in Covered Risks 9 and 10, after Date of Policy, against loss or damage, not exceeding the Amount of Insurance, sustained or incurred by the Insured by reason of:

1. Title being vested other than as stated in Schedule A.
2. Any defect in or lien or encumbrance on the Title. This Covered Risk includes but is not limited to insurance against loss from
   (a) A defect in the Title caused by
      (i) forgery, fraud, undue influence, duress, incompetency, incapacity, or impersonation;
      (ii) failure of any person or Entity to have authorized a transfer or conveyance;
      (iii) a document affecting Title not properly created, executed, witnessed, sealed, acknowledged, notarized, or delivered;
      (iv) failure to perform those acts necessary to create a document by electronic means authorized by law;
      (v) a document executed under a falsified, expired, or otherwise invalid power of attorney;
      (vi) a document not properly filed, recorded, or indexed in the Public Records including failure to perform those acts by electronic means authorized by law; or
      (vii) a defective judicial or administrative proceeding.
   (b) The lien of real estate taxes or assessments imposed on the Title by a governmental authority due or payable, but unpaid.
   (c) Any encroachment, encumbrance, violation, variation, or adverse circumstance affecting the Title that would be disclosed by an accurate and complete land survey of the Land. The term "encroachment" includes encroachments of existing improvements located on the Land onto adjoining land, and encroachments onto the Land of existing improvements located on adjoining land.
3. Unmarketable Title.
4. No right of access to and from the Land.
5. The violation or enforcement of any law, ordinance, permit, or governmental regulation (including those relating to building and zoning) restricting, regulating, prohibiting, or relating to
   (a) the occupancy, use, or enjoyment of the Land;
   (b) the character, dimensions, or location of any improvement erected on the Land;
   (c) the subdivision of land; or
   (d) environmental protection
   if a notice, describing any part of the Land, is recorded in the Public Records setting forth the violation or intention to enforce, but only to the extent of the violation or enforcement referred to in that notice.
6. An enforcement action based on the exercise of a governmental police power not covered by Covered Risk 5 if a notice of the enforcement action, describing any part of the Land, is recorded in the Public Records, but only to the extent of the enforcement referred to in that notice.
7. The exercise of the rights of eminent domain if a notice of the exercise, describing any part of the Land, is recorded in the Public Records.
8. Any taking by a governmental body that has occurred and is binding on the rights of a purchaser for value without Knowledge.
9. Title being vested other than as stated in Schedule A or being defective
   (a) as a result of the avoidance in whole or in part, or from a court order providing an alternative remedy, of a transfer of all or any part of the title to or any interest in the Land occurring prior to the transaction vesting Title as shown in Schedule A because that prior transfer constituted a fraudulent or preferential transfer under federal bankruptcy, state insolvency, or similar creditors' rights laws; or
   (b) because the instrument of transfer vesting Title as shown in Schedule A constitutes a preferential transfer under federal bankruptcy, state insolvency, or similar creditors' rights laws by reason of the failure of its recording in the Public Records
      (i) to be timely, or
      (ii) to impart notice of its existence to a purchaser for value or to a judgment or lien creditor.
10. Any defect in or lien or encumbrance on the Title or other matter included in Covered Risks 1 through 9 that has been created or attached or has been filed or recorded in the Public Records subsequent to Date of Policy and prior to the recording of the deed or other instrument of transfer in the Public Records that vests Title as shown in Schedule A.

The Company will also pay the costs, attorneys' fees, and expenses incurred in defense of any matter insured against by this policy, but only to the extent provided in the Conditions.

First American Title Insurance Company

BY _____ PRESIDENT

ATTEST _____ SECRETARY

FIRST AMERICAN TITLE INSURANCE COMPANY INCORPORATED SEPTEMBER 24, 1968 CALIFORNIA

EXCLUSIONS FROM COVERAGE

The following matters are expressly excluded from the coverage of this policy, and the Company will not pay loss or damage, costs, attorneys' fees, or expenses that arise by reason of:

1. (a) Any law, ordinance, permit, or governmental regulation (including those relating to building and zoning) restricting, regulating, prohibiting, or relating to
   (i) the occupancy, use, or enjoyment of the Land;
   (ii) the character, dimensions, or location of any improvement erected on the Land;
   (iii) the subdivision of land; or
   (iv) environmental protection;

   or the effect of any violation of these laws, ordinances, or governmental regulations. This Exclusion 1(a) does not modify or limit the coverage provided under Covered Risk 5.
   (b) Any governmental police power. This Exclusion 1(b) does not modify or limit the coverage provided under Covered Risk 6.
2. Rights of eminent domain. This Exclusion does not modify or limit the coverage provided under Covered Risk 7 or 8.
3. Defects, liens, encumbrances, adverse claims, or other matters
   (a) created, suffered, assumed, or agreed to by the Insured Claimant;
   (b) not Known to the Company, not recorded in the Public Records at Date of Policy, but Known to the Insured Claimant and not disclosed in writing to the Company by the Insured Claimant prior to the date the Insured Claimant became an Insured under this policy;
   (c) resulting in no loss or damage to the Insured Claimant;
   (d) attaching or created subsequent to Date of Policy (however, this does not modify or limit the coverage provided under Covered Risks 9 and 10); or
   (e) resulting in loss or damage that would not have been sustained if the Insured Claimant had paid value for the Title.
4. Any claim, by reason of the operation of federal bankruptcy, state insolvency, or similar creditors' rights laws, that the transaction vesting the Title as shown in Schedule A, is
   (a) a fraudulent conveyance or fraudulent transfer; or
   (b) a preferential transfer for any reason not stated in Covered Risk 9 of this policy.
5. Any lien on the Title for real estate taxes or assessments imposed by governmental authority and created or attaching between Date of Policy and the date of recording of the deed or other instrument of transfer in the Public Records that vests Title as shown in Schedule A.

CONDITIONS

1. DEFINITION OF TERMS

The following terms when used in this policy mean:

(a) "Amount of Insurance": The amount stated in Schedule A, as may be increased or decreased by endorsement to this policy, increased by Section 8(b), or decreased by Sections 10 and 11 of these Conditions.
(b) "Date of Policy": The date designated as "Date of Policy" in Schedule A.
(c) "Entity": A corporation, partnership, trust, limited liability company, or other similar legal entity.
(d) "Insured": The Insured named in Schedule A.
   (i) The term "Insured" also includes
      (A) successors to the Title of the Insured by operation of law as distinguished from purchase, including heirs, devisees, survivors, personal representatives, or next of kin;
      (B) successors to an Insured by dissolution, merger, consolidation, distribution, or reorganization;
      (C) successors to an Insured by its conversion to another kind of Entity;
      (D) a grantee of an Insured under a deed delivered without payment of actual valuable consideration conveying the Title
         (1) if the stock, shares, memberships, or other equity interests of the grantee are wholly-owned by the named Insured,
         (2) if the grantee wholly owns the named Insured,
         (3) if the grantee is wholly-owned by an affiliated Entity of the named Insured, provided the affiliated Entity and the named Insured are both wholly-owned by the same person or Entity, or
         (4) if the grantee is a trustee or beneficiary of a trust created by a written instrument established by the Insured named in Schedule A for estate planning purposes.
   (ii) With regard to (A), (B), (C), and (D) reserving, however, all rights and defenses as to any successor that the Company would have had against any predecessor Insured.
(e) "Insured Claimant": An Insured claiming loss or damage.
(f) "Knowledge" or "Known": Actual knowledge, not constructive knowledge or notice that may be imputed to an Insured by reason of the Public Records or any other records that impart constructive notice of matters affecting the Title.
(g) "Land": The land described in Schedule A, and affixed improvements that by law constitute real property. The term "Land" does not include any property beyond the lines of the area described in Schedule A, nor any right, title, interest, estate, or easement in abutting streets, roads, avenues, alleys, lanes, ways, or waterways, but this does not modify or limit the extent that a right of access to and from the Land is insured by this policy.
(h) "Mortgage": Mortgage, deed of trust, trust deed, or other security instrument, including one evidenced by electronic means authorized by law.
(i) "Public Records": Records established under state statutes at Date of Policy for the purpose of imparting constructive notice of matters relating to real property to purchasers for value and without Knowledge. With respect to Covered Risk 5(d), "Public Records" shall also include environmental protection liens filed in the records of the clerk of the United States District Court for the district where the Land is located.
(j) "Title": The estate or interest described in Schedule A.
(k) "Unmarketable Title": Title affected by an alleged or apparent matter that would permit a prospective purchaser or lessee of the Title or lender on the Title to be released from the obligation to purchase, lease, or lend if there is a contractual condition requiring the delivery of marketable title.

2. CONTINUATION OF INSURANCE

The coverage of this policy shall continue in force as of Date of Policy in favor of an Insured, but only so long as the Insured retains an estate or interest in the Land, or holds an obligation secured by a purchase money Mortgage given by a purchaser from the Insured, or only so long as the Insured shall have liability by reason of warranties in any transfer or conveyance of the Title. This policy shall not continue in force in favor of any purchaser from the Insured of either (i) an estate or interest in the Land, or (ii) an obligation secured by a purchase money Mortgage given to the Insured.

3. NOTICE OF CLAIM TO BE GIVEN BY INSURED CLAIMANT

The Insured shall notify the Company promptly in writing (i) in case of any litigation as set forth in Section 5(a) of these Conditions, (ii) in case Knowledge shall come to an Insured hereunder of any claim of title or interest that is adverse to the Title, as insured, and that might cause loss or damage for which the Company may be liable by virtue of this policy, or (iii) if the Title, as insured, is rejected as Unmarketable Title. If the Company is prejudiced by the failure of the Insured Claimant to provide prompt notice, the Company's liability to the Insured Claimant under the policy shall be reduced to the extent of the prejudice.

4. PROOF OF LOSS

In the event the Company is unable to determine the amount of loss or damage, the Company may, at its option, require as a condition of payment that the Insured Claimant furnish a signed proof of loss. The proof of loss must describe the defect, lien, encumbrance, or other matter insured against by this policy that constitutes the basis of loss or damage and shall state, to the extent possible, the basis of calculating the amount of the loss or damage.

5. DEFENSE AND PROSECUTION OF ACTIONS

(a) Upon written request by the Insured, and subject to the options contained in Section 7 of these Conditions, the Company, at its own cost and without unreasonable delay, shall provide for the defense of an Insured in litigation in which any third party asserts a claim covered by this policy adverse to the Insured. This obligation is limited to only those stated causes of action alleging matters insured against by this policy. The Company shall have the right to select counsel of its choice (subject to the right of the Insured to object for reasonable cause) to represent the Insured as to those stated causes of action. It shall not be liable for and will not pay the fees of any other counsel. The Company will not pay any fees, costs, or expenses incurred by the Insured in the defense of those causes of action that allege matters not insured against by this policy.
(b) The Company shall have the right, in addition to the options contained in

Section 7 of these Conditions, at its own cost, to institute and prosecute any action or proceeding or to do any other act that in its opinion may be necessary or desirable to establish the Title, as insured, or to prevent or reduce loss or damage to the Insured. The Company may take any appropriate action under the terms of this policy, whether or not it shall be liable to the Insured. The exercise of these rights shall not be an admission of liability or waiver of any provision of this policy. If the Company exercises its rights under this subsection, it must do so diligently.

(c) Whenever the Company brings an action or asserts a defense as required or permitted by this policy, the Company may pursue the litigation to a final determination by a court of competent jurisdiction, and it expressly reserves the right, in its sole discretion, to appeal any adverse judgment or order.

6. DUTY OF INSURED CLAIMANT TO COOPERATE

(a) In all cases where this policy permits or requires the Company to prosecute or provide for the defense of any action or proceeding and any appeals, the Insured shall secure to the Company the right to so prosecute or provide defense in the action or proceeding, including the right to use, at its option, the name of the Insured for this purpose. Whenever requested by the Company, the Insured, at the Company's expense, shall give the Company all reasonable aid (i) in securing evidence, obtaining witnesses, prosecuting or defending the action or proceeding, or effecting settlement, and (ii) in any other lawful act that in the opinion of the Company may be necessary or desirable to establish the Title or any other matter as insured. If the Company is prejudiced by the failure of the Insured to furnish the required cooperation, the Company's obligations to the Insured under the policy shall terminate, including any liability or obligation to defend, prosecute, or continue any litigation, with regard to the matter or matters requiring such cooperation.

(b) The Company may reasonably require the Insured Claimant to submit to examination under oath by any authorized representative of the Company and to produce for examination, inspection, and copying, at such reasonable times and places as may be designated by the authorized representative of the Company, all records, in whatever medium maintained, including books, ledgers, checks, memoranda, correspondence, reports, e-mails, disks, tapes, and videos whether bearing a date before or after Date of Policy, that reasonably pertain to the loss or damage. Further, if requested by any authorized representative of the Company, the Insured Claimant shall grant its permission, in writing, for any authorized representative of the Company to examine, inspect, and copy all of these records in the custody or control of a third party that reasonably pertain to the loss or damage. All information designated as confidential by the Insured Claimant provided to the Company pursuant to this Section shall not be disclosed to others unless, in the reasonable judgment of the Company, it is necessary in the administration of the claim. Failure of the Insured Claimant to submit for examination under oath, produce any reasonably requested information, or grant permission to secure reasonably necessary information from third parties as required in this subsection, unless prohibited by law or governmental regulation, shall terminate any liability of the Company under this policy as to that claim.

7. OPTIONS TO PAY OR OTHERWISE SETTLE CLAIMS; TERMINATION OF LIABILITY

In case of a claim under this policy, the Company shall have the following additional options:

(a) To Pay or Tender Payment of the Amount of Insurance.
To pay or tender payment of the Amount of Insurance under this policy together with any costs, attorneys' fees, and expenses incurred by the Insured Claimant that were authorized by the Company up to the time of payment or tender of payment and that the Company is obligated to pay.
Upon the exercise by the Company of this option, all liability and obligations of the Company to the Insured under this policy, other than to make the payment required in this subsection, shall terminate, including any liability or obligation to defend, prosecute, or continue any litigation.

(b) To Pay or Otherwise Settle With Parties Other Than the Insured or With the Insured Claimant.
(i) To pay or otherwise settle with other parties for or in the name of an Insured Claimant any claim insured against under this policy. In addition, the Company will pay any costs, attorneys' fees, and expenses incurred by the Insured Claimant that were authorized by the Company up to the time of payment and that the Company is obligated to pay; or
(ii) To pay or otherwise settle with the Insured Claimant the loss or damage provided for under this policy, together with any costs, attorneys' fees, and expenses incurred by the Insured Claimant that were authorized by the Company up to the time of payment and that the Company is obligated to pay.
Upon the exercise by the Company of either of the options provided for in subsections (b)(i) or (ii), the Company's obligations to the Insured under this policy for the claimed loss or damage, other than the payments required to be made, shall terminate, including any liability or obligation to defend, prosecute, or continue any litigation.

8. DETERMINATION AND EXTENT OF LIABILITY

This policy is a contract of indemnity against actual monetary loss or damage sustained or incurred by the Insured Claimant who has suffered loss or damage by reason of matters insured against by this policy.

(a) The extent of liability of the Company for loss or damage under this policy shall not exceed the lesser of
(i) the Amount of Insurance; or
(ii) the difference between the value of the Title as insured and the value of the Title subject to the risk insured against by this policy.

(b) If the Company pursues its rights under Section 5 of these Conditions and is unsuccessful in establishing the Title, as insured,
(i) the Amount of Insurance shall be increased by 10%, and
(ii) the Insured Claimant shall have the right to have the loss or damage determined either as of the date the claim was made by the Insured Claimant or as of the date it is settled and paid.

(c) In addition to the extent of liability under (a) and (b), the Company will also pay those costs, attorneys' fees, and expenses incurred in accordance with Sections 5 and 7 of these Conditions.

9. LIMITATION OF LIABILITY

(a) If the Company establishes the Title, or removes the alleged defect, lien, or encumbrance, or cures the lack of a right of access to or from the Land, or cures the claim of Unmarketable Title, all as insured, in a reasonably diligent manner by any method, including litigation and the completion of any appeals, it shall have fully performed its obligations with respect to that matter and shall not be liable for any loss or damage caused to the Insured.

(b) In the event of any litigation, including litigation by the Company or with the Company's consent, the Company shall have no liability for loss or damage until there has been a final determination by a court of competent jurisdiction, and disposition of all appeals, adverse to the Title, as insured.

(c) The Company shall not be liable for loss or damage to the Insured for liability voluntarily assumed by the Insured in settling any claim or suit without the prior written consent of the Company.

10. REDUCTION OF INSURANCE; REDUCTION OR TERMINATION OF LIABILITY

All payments under this policy, except payments made for costs, attorneys' fees, and expenses, shall reduce the Amount of Insurance by the amount of the payment.

11. LIABILITY NONCUMULATIVE

The Amount of Insurance shall be reduced by any amount the Company pays under any policy insuring a Mortgage to which exception is taken in Schedule B or to which the Insured has agreed, assumed, or taken subject, or which is executed by an Insured after Date of Policy and which is a charge or lien on the Title, and the amount so paid shall be deemed a payment to the Insured under this policy.

12. PAYMENT OF LOSS

When liability and the extent of loss or damage have been definitely fixed in accordance with these Conditions, the payment shall be made within 30 days.

13. RIGHTS OF RECOVERY UPON PAYMENT OR SETTLEMENT

(a) Whenever the Company shall have settled and paid a claim under this policy, it shall be subrogated and entitled to the rights of the Insured Claimant in the Title and all other rights and remedies in respect to the claim that the Insured Claimant has against any person or property, to the extent of the amount of any loss, costs, attorneys' fees, and expenses paid by the Company. If requested by the Company, the Insured Claimant shall execute documents to evidence the transfer to the Company of these rights and remedies. The Insured Claimant shall permit the Company to sue, compromise, or settle in the name of the Insured Claimant and to use the name of the Insured Claimant in any transaction or litigation involving these rights and remedies.
If a payment on account of a claim does not fully cover the loss of the Insured Claimant, the Company shall defer the exercise of its right to recover until after the Insured Claimant shall have recovered its loss.

(b) The Company's right of subrogation includes the rights of the Insured to indemnities, guaranties, other policies of insurance, or bonds, notwithstanding any terms or conditions contained in those instruments that address subrogation rights.

14. ARBITRATION

Either the Company or the Insured may demand that the claim or controversy shall be submitted to arbitration pursuant to the Title Insurance Arbitration Rules of the American Land Title Association ("Rules"). Except as provided in the Rules, there shall be no joinder or consolidation with claims or controversies of other persons. Arbitrable matters may include, but are not limited to, any controversy or claim between the Company and the Insured arising out of or relating to this policy, any service in connection with its issuance or the breach of a policy provision, or to any other controversy or claim arising out of the transaction giving rise to this policy. All arbitrable matters when the Amount of Insurance is $2,000,000 or less shall be arbitrated at the option of either the Company or the Insured. All arbitrable matters when the Amount of Insurance is in excess of $2,000,000 shall be arbitrated only when agreed to by both the Company and the Insured. Arbitration pursuant to this policy and under the Rules shall be binding upon the parties. Judgment upon the award rendered by the Arbitrator(s) may be entered in any court of competent jurisdiction.

15. LIABILITY LIMITED TO THIS POLICY; POLICY ENTIRE CONTRACT

(a) This policy together with all endorsements, if any, attached to it by the Company is the entire policy and contract between the Insured and the Company. In interpreting any provision of this policy, this policy shall be construed as a whole.

(b) Any claim of loss or damage that arises out of the status of the Title or by any action asserting such claim shall be restricted to this policy.

(c) Any amendment of or endorsement to this policy must be in writing and authenticated by an authorized person, or expressly incorporated by Schedule A of this policy.

(d) Each endorsement to this policy issued at any time is made a part of this policy and is subject to all of its terms and provisions. Except as the endorsement expressly states, it does not (i) modify any of the terms and provisions of the policy, (ii) modify any prior endorsement, (iii) extend the Date of Policy, or (iv) increase the Amount of Insurance.

16. SEVERABILITY

In the event any provision of this policy, in whole or in part, is held invalid or unenforceable under applicable law, the policy shall be deemed not to include that provision or such part held to be invalid, but all other provisions shall remain in full force and effect.

17. CHOICE OF LAW; FORUM

(a) Choice of Law: The Insured acknowledges the Company has underwritten the risks covered by this policy and determined the premium charged therefore in reliance upon the law affecting interests in real property and applicable to the interpretation, rights, remedies, or enforcement of policies of title insurance of the jurisdiction where the Land is located. Therefore, the court or an arbitrator shall apply the law of the jurisdiction where the Land is located to determine the validity of claims against the Title that are adverse to the Insured and to interpret and enforce the terms of this policy. In neither case shall the court or arbitrator apply its conflicts of law principles to determine the applicable law.

(b) Choice of Forum: Any litigation or other proceeding brought by the Insured against the Company must be filed only in a state or federal court within the United States of America or its territories having appropriate jurisdiction.

18. NOTICES, WHERE SENT

Any notice of claim and any other notice or statement in writing required to be given to the Company under this policy must be given to the Company at 1 First American Way, Santa Ana, CA 92707, Attn: Claims Department.

POLICY OF TITLE INSURANCE



SCHEDULE A

First American Title Insurance Company

Name and Address of Title Insurance Company:
First American Title Insurance Company
1 First American Way
Santa Ana, CA 92707

File No.: **2303-3715934**
Address Reference: , Usal Area, CA
Amount of Insurance: $20,000,000.00
Date of Policy: October 27, 2011 at 10:17 a.m.

Policy No.: **2303-3715934**

Premium: $ 11,600.00

1. Name of Insured:

   The Conservation Fund, a Maryland non-profit corporation

2. The estate or interest in the Land that is insured by this policy is:

   A Conservation Easement, upon the terms and conditions therein contained

3. Title is vested in:

   The Conservation Fund, a Maryland non-profit corporation

4. The Land referred to in this policy is described as follows:

   Real property in the unincorporated area of the County of Mendocino, State of California, described as follows:

   TRACT ONE-A:

   TOWNSHIP 23 NORTH, RANGE 16 WEST, M.D.M.

   SECTION 19

   THOSE PORTIONS OF LOTS 5, 6, AND 11 LYING WESTERLY OF THE CENTERLINE OF THE SOUTH FORK OF THE EEL RIVER.

   TOWNSHIP 23 NORTH, RANGE 17 WEST, M.D.M.

   SECTION 5

   ALL.

   EXCEPTING THAT PORTION DESCRIBED IN THE DEED TO REX TIMBER INC. RECORDED IN 1644 O.R. 84.

   SECTION 6

   LOTS 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, AND 32; SE ¼;

   EXCEPTING FROM LOTS 13, 14, 15, 18, 19, 20, 24, 27 AND 28, ALL OIL, GAS AND MINERAL

RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSE, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ROBERT H. HASKELL, ET AL, BY DEED RECORDED MAY 26, 1955 IN BOOK 399, PAGE 597 OF OFFICIAL RECORDS.

SECTION 7

LOTS 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, AND 16; E ½;

EXCEPTING FROM THE S ½ SE ¼ ONE HALF INTEREST IN MINERALS AND MINERAL RIGHTS INCLUDING, OIL, GAS AND OTHER HYDROCARBONS.

SECTION 8

ALL.

EXCEPTING THAT PORTION DESCRIBED IN THE DEED TO REX TIMBER INC. RECORDED IN 1644 O.R. 84.

SECTION 9

ALL.

EXCEPTING THAT PORTION DESCRIBED IN THE DEED TO REX TIMBER INC. RECORDED IN 1644 O.R. 84.

SECTION 10

S ½ SW ¼; NW ¼ SW ¼; SW ¼ NW ¼;

ALSO ALL THOSE PORTIONS DESCRIBED AS FOLLOWS:

PARCEL ONE:

BEGINNING AT A POINT ON THE NORTHERLY LINE OF THAT CERTAIN PARCEL OF LAND DESCRIBED IN DEED FROM GORDON E. HUNT, ET UX, TO DON F. GATES AND HENRY M. PAGE, RECORDED DECEMBER 16, 1948, IN BOOK 238 OF OFFICIAL RECORDS, PAGE 454, MENDOCINO COUNTY RECORDS, DISTANT THEREON SOUTH 74° 45 ½' EAST 42.54 FEET FROM THE MOST NORTHERLY CORNER THEREOF, SAID POINT OF BEGINNING BEING 25 FEET DISTANT AT RIGHT ANGLES NORTHEASTERLY FROM THE SOUTHWESTERLY LINE OF SAID LAND; THENCE FROM SAID POINT OF BEGINNING FOLLOWING ALONG THE NORTHERLY LINE OF SAID LAND SOUTH 74° 45 ½' EAST 437.1 FEET TO THE CENTER OF A ROAD; THENCE FOLLOWING THE CENTERLINE OF SAID ROAD AND THE MEANDERS THEREOF SOUTH 23° 37' WEST 290.0 FEET TO A POINT 25 FEET DISTANT AT RIGHT ANGLES NORTHEASTERLY FROM THE SOUTHWESTERLY LINE OF SAID LAND; THENCE PARALLEL WITH AND 25 FEET DISTANT AT RIGHT ANGLES NORTHEASTERLY FROM SAID SOUTHWESTERLY LINE NORTH 38° 46' WEST 488.0 FEET TO THE POINT OF BEGINNING.

BEING A PORTION OF SECTION 10, TOWNSHIP 23 NORTH, RANGE 17 WEST, MOUNT DIABLO BASE AND MERIDIAN.

PARCEL TWO:

BEGINNING AT THE QUARTER CORNER BETWEEN SECTIONS 3 AND 10 IN TOWNSHIP 23 NORTH, RANGE 17 WEST, MOUNT DIABLO MERIDIAN; THENCE ALONG THE NORTHERLY LINE OF SECTION 10, NORTH 89° 38-½' EAST 1706.5 FEET TO THE CENTER OF A ROAD CALLED THE

"PAGE & GATES ROAD"; THENCE FOLLOWING THE CENTER LINE OF SAID ROAD SOUTH 19° 43' WEST A DISTANCE OF 29.6 FEET; SOUTH 35° 57' WEST A DISTANCE OF 290.2 FEET; SOUTH 45° 53' WEST A DISTANCE OF 257.2 FEET; SOUTH 29° 56' WEST A DISTANCE OF 95 FEET TO THE INTERSECTION WITH THE CENTER LINE OF A ROAD CALLED THE "CARVER ROAD", BEING A POINT IN THE SOUTHERLY EXTENSION OF THE EASTERLY LINE OF THAT TRACT OF LAND CONVEYED TO ADOLPH GRASS, ET UX, BY DEED RECORDED APRIL 12, 1949, IN VOLUME 242 OF OFFICIAL RECORDS, PAGE 192, MENDOCINO COUNTY RECORDS; THENCE FOLLOWING THE CENTER LINE OF SAID CARVER ROAD NORTH 13° 48' EAST A DISTANCE OF 221.24 FEET TO THE NORTHEAST CORNER OF SAID GRASS LAND; THENCE NORTH 69° 43' WEST A DISTANCE OF 65.50 FEET; SOUTH 72° 36' WEST A DISTANCE OF 80.36 FEET; SOUTH 61° 50' WEST A DISTANCE OF 138.59 FEET; SOUTH 64° 15' WEST A DISTANCE OF 16 FEET; SOUTH 79° 0' WEST A DISTANCE OF 92.5 FEET; NORTH 83° 15' WEST A DISTANCE OF 120.4 FEET; NORTH 58° 30' WEST A DISTANCE OF 98.3 FEET; SOUTH 74° 30' WEST A DISTANCE OF 94.0 FEET; THENCE LEAVING THE CENTER LINE OF SAID CARVER ROAD SOUTH 32° 20' WEST A DISTANCE OF 728 FEET, MORE OR LESS, TO THE MOST NORTHERLY CORNER OF THAT CERTAIN PARCEL OF LAND DESCRIBED IN DEED FROM GORDON E. HUNT, ET UX, TO DON F. GATES AND HENRY M. PAGE, RECORDED DECEMBER 16, 1948, IN BOOK 238 OF OFFICIAL RECORDS, PAGE 454, MENDOCINO COUNTY RECORDS; THENCE SOUTH 81° 35' WEST A DISTANCE OF 10.9 FEET TO THE CENTER OF A CREEK CALLED MILLBANK CREEK, ALSO KNOWN AS HUNT CREEK; THENCE ALONG THE CENTER LINE OF SAID CREEK THE FOLLOWING COURSES AND DISTANCES: NORTH 70° 45' WEST A DISTANCE OF 75.9 FEET; THENCE NORTH 58° WEST A DISTANCE OF 110 FEET; THENCE NORTH 72° 15' WEST A DISTANCE OF 44.6 FEET; THENCE NORTH 72° WEST A DISTANCE OF 91 FEET, MORE OR LESS, TO A POINT UPON THE QUARTER CORNER SECTION LINE OF SECTION 10 WHICH RUNS NORTH AND SOUTH; THENCE CONTINUING ALONG THE CENTER LINE OF SAID CREEK NORTH 73° WEST A DISTANCE OF 59.3 FEET; NORTH 58-½° WEST A DISTANCE OF 92.9 FEET; NORTH 74-¼° WEST A DISTANCE OF 67.2 FEET; SOUTH 86° WEST A DISTANCE OF 65.4 FEET; NORTH 73-½° WEST A DISTANCE OF 72.4 FEET; NORTH 65-½° WEST A DISTANCE OF 61.1 FEET; NORTH 52-½° WEST A DISTANCE OF 68.9 FEET; NORTH 82° WEST A DISTANCE OF 61.9 FEET; SOUTH 71° WEST A DISTANCE OF 47.5 FEET; NORTH 78° WEST A DISTANCE OF 41.4 FEET; NORTH 69° WEST A DISTANCE OF 51.6 FEET; NORTH 87-¼° WEST A DISTANCE OF 50.8 FEET; NORTH 59° WEST A DISTANCE OF 102.7 FEET; SOUTH 56-½° WEST A DISTANCE OF 155.1 FEET; SOUTH 53-½° WEST A DISTANCE OF 73.4 FEET; SOUTH 47-½° WEST A DISTANCE OF 94.1 FEET; SOUTH 38-¼° WEST A DISTANCE OF 85.6 FEET; SOUTH 71° WEST A DISTANCE OF 133.0 FEET; SOUTH 62° WEST A DISTANCE OF 69.3 FEET; SOUTH 40° WEST A DISTANCE OF 96.7 FEET, MORE OR LESS, TO THE WEST LINE OF THE NE ¼ NW ¼ OF SECTION 10; THENCE NORTH 00° 39' EAST 950.4 FEET, MORE OR LESS, ALONG SAID WEST LINE TO THE WEST 1/16 CORNER ON THE NORTH LINE OF SAID SECTION 10, AS ESTABLISHED BY F.A. MCKEE, LICENSED SURVEYOR; THENCE NORTH 89° 38-½' EAST ALONG THE NORTHERLY BOUNDARY OF SECTION 10, A DISTANCE OF 1318.4 FEET, MORE OR LESS, TO THE POINT OF BEGINNING.

EXCEPTING THEREFROM ALL THAT PORTION THEREOF CONVEYED TO EARL SAMPLES, ET UX, AND TO C.D. VAUGHN, ET UX, BY DEEDS RECORDED IN BOOK 454 OF OFFICIAL RECORDS, PAGES 454 AND 455, MENDOCINO COUNTY RECORDS.

PARCEL THREE:

BEING A PORTION OF THE NE ¼ OF SECTION 10, TOWNSHIP 23 NORTH, RANGE 17 WEST, MOUNT DIABLO MERIDIAN, DESCRIBED AS FOLLOWS:

BEGINNING AT AN IRON SPIKE IN THE CENTER LINE OF A ROAD KNOWN AS THE PAGE AND GATES ROAD, FROM WHICH BEARS A 26" MADRONE TREE SOUTH 35° 40' EAST 29 FEET, WHICH TREE IS SCRIBED "HK RP BT". THE ABOVE-MENTIONED POINT OF BEGINNING IS FURTHER DESCRIBED AS BEING SOUTH 447.5 FEET AND WEST 1281.3 FEET FROM THE NORTHEAST CORNER OF SECTION 10; THENCE ALONG THE CENTER LINE OF SAID PAGE AND GATES ROAD AS FOLLOWS: SOUTH 29° 56' WEST 146.25 FEET; THENCE SOUTH 38° 43' WEST 151.3 FEET; THENCE SOUTH 13° 53' WEST 227.2 FEET; THENCE NORTH 81° 12' WEST 136.7 FEET; THENCE SOUTH 41° 45' WEST 93.1 FEET; THENCE SOUTH 63° 26' WEST 119.95 FEET; THENCE SOUTH 21° 29' WEST TO THE EAST BOUNDARY OF THAT PARCEL OF LAND FORMERLY

DEEDED BY HUNT TO PAGE AND GATES, RECORDED IN BOOK 238 OF DEEDS, PAGE 44, MENDOCINO COUNTY RECORDS; THENCE LEAVING THE CENTER OF SAID PAGE AND GATES ROAD AND FOLLOWING SAID EAST BOUNDARY OF SAID DEEDED PARCEL, WHICH AT THIS POINT BEARS SOUTH 74° 45' 30" EAST TO THE NORTHERLY RIGHT OF WAY OF THE LEGGETT-ROCKPORT HIGHWAY AS CONVEYED TO THE STATE OF CALIFORNIA BY GRANT DEED DATED APRIL 2, 1963, RECORDED JUNE 18, 1963, IN BOOK 629, PAGE 575, OFFICIAL RECORDS, AND BY GRANT DEED DATED JUNE 4, 1963, RECORDED OCTOBER 15, 1963, IN BOOK 640, PAGE 149, OFFICIAL RECORDS, MENDOCINO COUNTY; THENCE ALONG THE NORTHERLY RIGHT OF WAY OF SAID HIGHWAY TO THE CENTER OF THE SOUTH FORK OF THE EEL RIVER; THENCE DOWNSTREAM ALONG THE SOUTH FORK OF EEL RIVER IN A NORTHEASTERLY DIRECTION TO THE INTERSECTION OF A LINE BEARING SOUTH 45° EAST FROM THE POINT OF BEGINNING; THENCE NORTH 45° WEST TO THE POINT OF BEGINNING.

SECTION 15

S ½ NE ¼; N ½ SE ¼; SE ¼ SE ¼; W ½ SW¼; NW ¼; SW ¼ SE ¼,

EXCEPTING FROM SW 1/4 SE 1/4, THE WEST 15 ACRES.

ALSO EXCEPTING S ½ NW ¼; NW ¼ NW ¼; NW ¼ SW ¼.

S ½ SW ¼ NW ¼; NW ¼ SW ¼; SE ¼ NW ¼ EXCEPTING THEREFROM W ½ NW ¼ SE ¼ NW ¼

SECTION 16

S ½ NE ¼; S ½; NW ¼; N ½ NW ¼, EXCEPTING THEREFROM THAT PORTION THEREOF WHICH LIES WITHIN A TRACT DESCRIBED AS FOLLOWS:

COMMENCING AT THE SOUTHEAST CORNER OF SAID SECTION 9; THENCE, NORTH 83° 10' 24" WEST (=NORTH 84° 16' 03" WEST TRUE MERIDIAN), 1682.81 FEET TO ENGINEERS STATION 10+00.00 P.O.T. OF THE DEPARTMENT OF PUBLIC WORKS' SURVEY ABOUT 3.0 MILES WEST OF LEGGETT (STATE HIGHWAY 01-MEN-01, 208) AND BEING THE TRUE POINT OF BEGINNING;

1. THENCE NORTH 10° 25' 33" WEST, 50.00 FEET;

2. THENCE NORTH 72° 06' 14" EAST, 352.89 FEET;

3. THENCE SOUTH 31° 08' 49" EAST, 425.36 FEET;

4. THENCE SOUTH 05° 11' 46" WEST, 458.45 FEET;

5. THENCE SOUTH 20° 39' 49" WEST, 127.23 FEET;

6. THENCE NORTH 69° 20' 11" WEST, 50.00 FEET TO ENGINEERS STATION 20+00.00 P.O.T. OF SAID DEPARTMENT OF PUBLIC WORKS' SURVEY; SAID ENGINEERS STATION BEARS SOUTH 65° 49' 30" WEST (=SOUTH 64° 43' 51" WEST TRUE MERIDIAN), 1378.16 FEET FROM THE NORTHEAST CORNER OF SAID SECTION 16;

7. THENCE NORTH 69° 20' 11" WEST, 50.00 FEET;

8. THENCE NORTH 21° 53' 08" WEST, 766.07 FEET;

9. THENCE SOUTH 79° 34' 27" WEST, 73.41 FEET;

10. THENCE NORTH 10° 25' 33" WEST, 50.00 FEET TO THE TRUE POINT OF BEGINNING.

SECTION 17

ALL.

SECTION 18

LOTS 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 AND 16; E ½;

EXCEPTING FROM LOT 15 ALL MINERALS AND MINERAL RIGHTS INCLUDING OIL, GAS AND OTHER HYDROCARBONS.

SECTION 19

LOTS 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 AND 16; N ½ NE ¼; SW ¼ NE ¼; NW ¼ SE ¼; S ½ SE ¼;

SE ¼ NE ¼ AND THE NE ¼ SE ¼ EXCEPTING THEREFROM THAT PORTION THEREOF WHICH LIES WITHIN A TRACT DESCRIBED AS FOLLOWS:

COMMENCING AT THE EAST ¼ CORNER OF SAID SECTION 19; THENCE SOUTH 88° 41' 27" WEST, 705.69 FEET TO A POINT THAT BEARS NORTH 76° 03' 09" EAST, 120.00 FEET FROM ENGINEERS STATION "0" 103+50.00 P.O.C. OF THE DEPARTMENT OF PUBLIC WORKS' SURVEY BETWEEN 7.9 MILES AND 7.7 MILES WEST OF LEGGETT (STATE HIGHWAY 01-MEN-208-PM 6.8/7.0), SAID POINT BEING THE TRUE POINT OF BEGINNING;

1. THENCE NORTH 42° 23' 29" WEST, 206.96 FEET;

2. THENCE SOUTH 65° 10' 17" WEST, 100.00 FEET;

3. THENCE SOUTH 15° 12' 37" EAST, 119.71 FEET;

4. THENCE SOUTH 06° 00' 10" EAST, 170.90 FEET;

5. THENCE SOUTH 31° 38' 13" WEST, 132.74 FEET;

6. THENCE SOUTH 32° 02' 59" EAST, 100.00 FEET;

7. THENCE NORTH 47° 37' 16" EAST, 279.30 FEET;

8. THENCE NORTH 02° 43' 23" WEST, 184.33 FEET TO THE TRUE POINT OF BEGINNING.

SECTION 20

N ½; N ½ SE ¼; NE ¼ SW ¼.

SECTION 21

N ½.

SECTION 22

N ½; N ½ S ½; S ½ SE ¼; SE ¼ SW ¼.

SECTION 23

ALL.

SECTION 24

N ½ SE ¼; SW ¼ SE ¼; SW ¼; S ½ NW ¼; NW ¼ NW ¼;

THAT PORTION OF THE S ½ NE ¼ LYING SOUTHERLY OF THE CENTER LINE OF THE EEL RIVER.

ALSO THE SE ¼ SE ¼, EXCEPTING THAT PORTION THEREOF LYING SOUTHEASTERLY OF THE CENTER LINE OF THE SOUTH FORK OF THE EEL.

EXCEPTING FROM THE W ½ W ½ ALL OIL, GAS AND MINERAL RIGHTS, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, UPON THE TERMS AND CONDITIONS SET FORTH IN DEED FROM THE ALEXANDER MCPHERSON ESTATE, INC., RECORDED DECEMBER 20, 1950, IN BOOK 262 OF OFFICIAL RECORDS, PAGE 49, MENDOCINO COUNTY RECORDS, AND IN BOOK 282 OF OFFICIAL RECORDS, PAGE 280, MENDOCINO COUNTY RECORDS.

SECTION 25

NW ¼ NE ¼; S ½ NE ¼; S ½; NW ¼; NE ¼ NE ¼, EXCEPTING THEREFROM THAT PORTION THEREOF LYING NORTHEASTERLY OF THE SOUTH FORK OF THE EEL RIVER.

ALSO EXCEPTING FROM THE NE ¼ SE ¼ ALL OIL, GAS AND MINERALS RIGHTS OF EVERY KIND AND NATURE WITH THE RIGHT TO ENTER UPON , EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, UPON THE TERMS AND CONDITIONS SET FORTH IN DEED FROM THE ALEXANDER MCPHERSON ESTATE, INC., RECORDED DECEMBER 20, 1950, IN BOOK 282 OF OFFICIAL RECORDS, PAGE 280 MENDOCINO COUNTY RECORDS.

SECTION 26

E ½; NE ¼ NW ¼.

EXCEPTING FROM THE SW ¼ SE ¼ ALL OIL, GAS AND MINERAL RIGHTS, TOGETHER WITH THE RIGHT TO EXPLORE AND EXPLOIT ALL OIL, GAS AND MINERAL RIGHTS AS RESERVED BY THE ALEXANDER MCPHERSON ESTATE, INC., IN DEED RECORDED IN BOOK 503 OF OFFICIAL RECORDS, PAGE 333, MENDOCINO COUNTY RECORDS.

SECTION 30

LOTS 3, 4, 5 AND 6

SECTION 34

S ½ NE ¼; SE ¼; SE ¼ NW ¼.

EXCEPTING THEREFROM ALL OIL, GAS AND MINERAL RIGHTS, TOGETHER WITH THE RIGHT TO EXPLORE AND EXPLOIT ALL OIL, GAS AND MINERAL RIGHTS AS RESERVED BY THE ALEXANDER MCPHERSON ESTATE, INC., IN DEED RECORDED IN BOOK 503 OF OFFICIAL RECORDS, PAGE 333, MENDOCINO COUNTY RECORDS.

SECTION 35

N ½ NE ¼; SW ¼ SW ¼; N ½ SW ¼; NW ¼.

EXCEPTING THEREFROM ALL OIL, GAS AND MINERAL RIGHTS, TOGETHER WITH THE RIGHT TO EXPLORE AND EXPLOIT ALL OIL, GAS AND MINERAL RIGHTS AS RESERVED BY THE ALEXANDER MCPHERSON ESTATE, INC., IN DEED RECORDED IN BOOK 503 OF OFFICIAL RECORDS, PAGE 333, MENDOCINO COUNTY RECORDS.

SECTION 36

NW ¼ NE ¼; NW ¼ SE ¼; SW ¼; N ½ NW ¼.

TOWNSHIP 23, NORTH, RANGE 18 WEST, M.D.M.

SECTION 1

LOTS 1, 2, 3, AND 4; S ½ N ½; S½.

EXCEPTING FROM THE S ½ NE ¼ AND LOTS 1 AND 2 ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, TOGETHER WITH THE RIGHT TO CENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS UPON THE TERMS AND CONDITIONS SET FORTH IN DEED FROM ALEXANDER MCPHERSON ESTATE, INC., RECORDED DECEMBER 23, 1952, IN BOOK 334 OF OFFICIAL RECORDS, PAGE 240, MENDOCINO COUNTY RECORDS.

SECTION 2

LOTS 1, 2, 3, AND 4; S ½ N ½; S ½.

SECTION 3

LOTS 1, 2, 3, AND 4; S ½ N ½; S ½.

SECTION 4

LOTS 1, 2, 3, AND 4; S ½ N ½; S ½.

SECTION 5

LOTS 1 AND 2; S ½ NE ¼; SE ¼.

EXCEPTING ANY PORTION LYING WEST OF THE CENTERLINE OF USAL-FOUR CORNERS COUNTY ROAD #431.

SECTION 8

ALL.

EXCEPTING S ½ SE ¼; NW ¼ SE ¼; W ½; AND THOSE PORTIONS OF NE ¼ SE ¼; NE ¼ LYING SOUTHERLY AND WESTERLY OF THE USAL-FOUR CORNERS COUNTY ROAD #431.

SECTION 9

ALL.

EXCEPTING THOSE PORTIONS OF THE S ½ AND THE S ½ NW ¼ LYING SOUTHERLY AND WESTERLY OF THE USAL-FOUR CORNERS COUNTY ROAD #431.

SECTION 10

ALL.

SECTION 11

ALL.

SECTION 12

ALL.

SECTION 13

ALL.

SECTION 14

ALL.

EXCEPTING THOSE PORTIONS OF THE NW ¼ SW ¼ AND THE SW ¼ NW ¼ LYING WESTERLY OF THE USAL-FOUR CORNERS OF COUNTY ROAD #421.

SECTION 15

ALL.

EXCEPTING THAT PORTION LYING SOUTHERLY AND WESTERLY OF THE CENTERLINE OF USAL-FOUR CORNERS ROAD #421.

SECTION 16

NE ¼ EXCEPTING THAT PORTION LYING SOUTHWESTERLY OF THE USAL-FOUR CORNERS COUNTY ROAD #431.

SECTION 22

LOTS 1, 2, 3, 4, 5, AND 6, NE ¼; NE ¼ SE ¼ EXCEPTING ANY PORTIONS THEREOF NORTHERLY AND WESTERLY OF THE FOLLOWING DESCRIBED LINE:

BEGINNING AT THE EASTERLY INTERSECTION OF THE CENTERLINE OF USAL COUNTY ROAD WITH THE NORTH LINE OF SAID SECTION 22, THENCE ALONG SAID CENTERLINE 1,800 FEET MORE OR LESS TO THE INTERSECTION WITH A HAUL ROAD WESTERLY; SAID INTERSECTION LYING SOUTHWESTERLY 920 FEET, MORE OR LESS, FROM THE NORTHEAST CORNER OF SAID SECTION 22, THENCE S 48° 47' 28" E, 309.66 FEET; THENCE S 44° 48' 06" E, 268.97 FEET, THENCE S 47° 54' 39" E, 329.88 FEET, THENCE S 25° 41' 37" E, 154.82 FEET, THENCE S 00° 49' 06" W, 92.14 FEET, THENCE S 70° 42' 39" W, 27.89 FEET, THENCE S 58° 07' 13" W, 127.10 FEET, THENCE S 72° 59' 50" W, 166.54 FEET, THENCE S 57° 09' 18" W, 123.76 FEET, THENCE S 51° 57' 59" W, 375.98 FEET, THENCE S 23° 8' 38" W, 730.00 FEET, THENCE S 33° 53' 52" E, 604.14 FEET; THENCE S 24° 11' 44" W, 327.56 FEET, THENCE N 86° 03' 12" W, 344.35 FEET, THENCE S 45° 25' 25" W, 376.94 FEET, THENCE S 84° 58' 19" W, 330.31 FEET, THENCE S 47° 51' 45" W, 74.55 FEET, THENCE S 88° 17' 06" W, 659.70 FEET, MORE OR LESS, TO THE PACIFIC OCEAN.

EXCEPTING THEREFROM ANY PORTION THEREOF LYING WITHIN THAT CERTAIN PARCEL OF LAND DESCRIBED IN THAT NOTICE OF COMPLIANCE RECORDED MARCH 02, 2011, AS DOCUMENT NOS. 2011-02950 AND 2011-02951, OFFICIAL RECORDS OF MENDOCINO COUNTY.

SECTION 23

ALL.

EXCEPTING THEREFROM ANY PORTION THEREOF LYING WITHIN THAT CERTAIN PARCEL OF LAND DESCRIBED IN THAT NOTICE OF COMPLIANCE RECORDED MARCH 02, 2011, AS DOCUMENT NOS. 2011-02950 AND 2011-02951, OFFICIAL RECORDS OF MENDOCINO COUNTY.

SECTION 24

ALL.

SECTION 25

N ½; NW ¼ SE ¼; NE ¼ SW ¼.

EXCEPTING THEREFROM ANY PORTION THEREOF LYING WITHIN THAT CERTAIN PARCEL OF LAND DESCRIBED IN THAT NOTICE OF COMPLIANCE RECORDED MARCH 02, 2011, AS DOCUMENT NOS. 2011-02952, OFFICIAL RECORDS OF MENDOCINO COUNTY.

TOWNSHIP 24 NORTH, RANGE 17 WEST, M.D.M.

SECTION 5

W ½ SW ¼.

SECTION 6

LOTS 9, 10, 11, 12, 13, 22, 23 AND 24; LOT 25,

EXCEPTING THEREFROM THAT PORTION AS DESCRIBED IN DEED TO GEORGE P. FREUND, ET UX, RECORDED AUGUST 29, 1945, IN BOOK 184 OF OFFICIAL RECORDS, PAGE 429, MENDOCINO COUNTY RECORDS.

ALSO THAT PORTION OF THE SW ¼ SE ¼ LYING WESTERLY OF THE WESTERLY LINE OF THE LAND CONVEYED TO THE STATE OF CALIFORNIA BY DEED RECORDED JUNE 9, 1971 IN BOOK 851 OF OFFICIAL RECORDS, PAGE 500, MENDOCINO COUNTY RECORDS. SAID LAND CONVEYED TO STATE BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT A POST IN A STONE MOUND SET FOR THE CENTER OF SAID SECTION 6 AS SHOWN ON THE RECORD OF SURVEY RECORDED IN MAP CASE 2, DRAWER 1, PAGE 5, MENDOCINO COUNTY RECORDS; THENCE, SOUTH 18° 39' 27" EAST (=SOUTH 19° 46' 50" EAST TRUE MERIDIAN), 1823.13 FEET TO A POINT THAT BEARS SOUTH 70° 35' 37" EAST, 120.00 FEET FROM ENGINEERS STATION'S 920+48.01 E.C. OF THE DEPARTMENT OF PUBLIC WORKS' CONTROL LINE SURVEY BETWEEN 0.2 MILES SOUTH OF REYNOLDS INTERCHANGE AND 1.1 MILES SOUTH OF PIERCY (STATE HIGHWAY 01-MEN-101-PM R99.48/R100.36) AS SHOWN ON THE MAP THEREOF RECORDED JANUARY 8, 1970 IN MAP CASE 2, DRAWER 14, PAGE 53, SAID COUNTY RECORDS, SAID POINT BEING THE TRUE POINT OF BEGINNING;

1. THENCE, FROM A TANGENT THAT BEARS THAT BEARS SOUTH 19° 24' 23" WEST, ALONG A CURVE TO THE LEFT HAVING A RADIUS OF 2280 FEET, THROUGH AN ANGLE OF 09° 00' 50", DISTANCE OF 358.69 FEET TO THE WESTERLY LINE OF THE LAND CONVEYED TO THE STATE OF CALIFORNIA BY DEED RECORDED SEPTEMBER 16, 1942 IN BOOK 156 OF OFFICIAL RECORDS, PAGE 273 ET SEQ., SAID COUNTY RECORDS;

2. THENCE, ALONG SAID WESTERLY LINE IN A GENERAL SOUTHERLY DIRECTION, 629.42 FEET TO THE SOUTH LINE OF SAID SW ¼ SE ¼;

3. THENCE, ALONG SAID SOUTH LINE, NORTH 89° 06' 26" WEST, 388.17 FEET TO A POINT THAT BEARS SOUTH 23° 12' 55" EAST FROM A POINT THAT BEARS SOUTH 86° 46' 28" WEST, 375.00 FEET FROM ENGINEERS STATION 911+00.00 P.O.C. OF SAID CONTROL LINE SURVEY;

4. THENCE, NORTH 23° 12' 55" WEST, 23.22 FEET TO SAID POINT THAT BEARS SOUTH 86° 46' 28" WEST, 375.00 FEET FROM SAID ENGINEERS STATION;

5. THENCE, NORTH 22° 07' 40" EAST, 939.81 FEET;

6. THENCE, NORTH 19° 03' 48" EAST, 453.97 FEET TO THE NORTH LINE OF SAID SW ¼ SE ¼;

7. THENCE, ALONG SAID NORTH LINE, SOUTH 88° 47' 56" EAST, 252.02 FEET TO A POINT THAT BEARS NORTH 19° 24' 23" EAST FROM THE TRUE POINT OF BEGINNING;

8. THENCE, SOUTH 19° 24' 23" WEST, 403.60 FEET TO THE TRUE POINT OF BEGINNING.

ALSO THAT PORTION OF THE SW ¼ SE ¼ LYING NORTHERLY AND WESTERLY OF THE NORTHWESTERLY LINE OF THE LAND CONVEYED TO THE STATE OF CALIFORNIA BY DEED RECORDED SEPTEMBER 16, 1942, IN BOOK 156 OF OFFICIAL RECORDS, PAGE 273, AND LYING EASTERLY OF THE EASTERLY LINE OF THE HERETOFORE DESCRIBED LAND AS CONVEYED TO THE STATE OF CALIFORNIA BY DEED RECORDED JUNE 9, 1971, IN BOOK 851 OF OFFICIAL RECORDS, PAGE 500, MENDOCINO COUNTY RECORDS

ALSO THOSE PORTIONS OF THE E ½ SE ½ AND THE SW ¼ SE ¼ LYING SOUTH AND EAST OF CALIFORNIA HIGHWAY #101 AND SOUTH OF THE CENTERLINE OF MCCOY CREEK, AS SAID CENTERLINE WAS DESCRIBED IN DEED RECORDED JUNE 27, 1960, IN BOOK 543 OF OFFICIAL RECORDS, PAGE 357, MENDOCINO COUNTY RECORDS.

EXCEPTING FROM LOT 10, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED MAY 10, 1950 IN BOOK 262, PAGE 421 OF OFFICIAL RECORDS.

EXCEPTING FROM LOTS 12 AND THE N ½ OF LOT 23, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED FEBRUARY 05, 1951 IN BOOK 286, PAGE 49 OF OFFICIAL RECORDS.

ALSO EXCEPTING FROM LOT 11, 13 AND 22, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED IN A DEED FROM ALEXANDER MCPHERSON ESTATE, INCORPORATED RECORDED SEPTEMBER 29, 1952 IN BOOK 327, PAGE 416 OF OFFICIAL RECORDS.

SECTION 7

LOTS 1, 2, 3, 4, 6, AND 7; NE ¼ NE ¼; AND THAT PORTION OF THE REYNOLDS WAYSIDE CAMPGROUND, FURTHER DESCRIBED AS LOTS 5, 8 AND 9, AND THAT PORTION OF THE SOUTH HALF OF LOT 10, THAT PORTION OF THE SOUTHWEST QUARTER OF THE NORTHEAST QUARTER, AND THAT PORTION OF THE WEST HALF OF THE SOUTHEAST QUARTER OF SECTION 7, LYING WESTERLY OF THE CENTER OF THE SOUTH FORK EEL RIVER, TOWNSHIP 24 NORTH, RANGE 17 WEST, MOUNT DIABLO BASE AN MERIDIAN, COUNTY OF MENDOCINO, STATE OF CALIFORNIA.

EXCEPTING A RESERVATION TO THE STATE OF CALIFORNIA THE WATER PIPELINE THAT NOW CROSSES OVER THE SOUTH FORK OF THE EEL RIVER, SUCH PIPELINE BEING THE SOURCE OF WATER FOR THE REYNOLDS WAYSIDE CAMPGROUND, TOGETHER WITH THE RIGHT TO USE, MAINTAIN, REPAIR, MODIFY OR REPLACE THE PIPELINE AND TO ENTER UPON THE ABOVE-DESCRIBED PROPERTY FOR SUCH PURPOSES. SAID LANDS DESCRIBED IN 1485 O.R. 265.

THAT PORTION OF THE N ½ OF LOT 10 LYING WEST OF THE CENTERLINE OF THE SOUTH FORK OF THE EEL RIVER AS THE SAME EXISTED ON OCTOBER 31, 1927.

ALSO THAT PORTION OF THE NW ¼ NE ¼ LYING EASTERLY OF THE EXISTING STATE

HIGHWAY EASTERLY RIGHT OF WAY.

EXCEPTING FROM LOTS 1, 2 AND N ½ LOT 6, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED FEBRUARY 05, 1951 IN BOOK 286, PAGE 49 OF OFFICIAL RECORDS.

ALSO EXCEPTING FROM LOT 4 AND THE N ½ OF LOT 10, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSE, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED BY DEED RECORDED OCTOBER 25, 1951 IN BOOK 301, PAGE 239 OF OFFICIAL RECORDS.

SECTION 17

NW ¼ SW ¼; SW ¼ NW ¼; THAT PORTION OF THE SW ¼ SW ¼ LYING WESTERLY OF THE SOUTH FORK OF THE EEL RIVER.

ALSO THAT PORTION OF LOT 4 LYING WESTERLY OF THE SOUTH FORK OF THE EEL RIVER.

ALSO THE SE ¼ NW ¼, EXCEPTING THEREFROM THOSE PORTION CONVEYED TO THE STATE OF CALIFORNIA BY DEEDS RECORDED IN BOOK 100 OF OFFICIAL RECORDS, PAGE 301, MENDOCINO COUNTY RECORDS, AND BOOK 180 OF OFFICIAL RECORDS, PAGE 134, MENDOCINO COUNTY RECORDS, AND ALSO EXCEPT THE PORTION RESERVED BY ELIZABETH GRAY BUSKE IN DEED RECORDED IN BOOK 436 OF OFFICIAL RECORDS, PAGE 324, MENDOCINO COUNTY RECORDS.

SECTION 18

LOTS 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 AND 18; SE ¼ NE ¼; S ½ SE ¼.

EXCEPTING FROM LOT 2, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSE, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED BY DEED RECORDED OCTOBER 25, 1951 IN BOOK 301, PAGE 239 OF OFFICIAL RECORDS.

ALSO EXCEPTING FROM LOTS 1, 3, 4 AND 5, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED IN A DEED FROM ALEXANDER MCPHERSON ESTATE, INCORPORATED RECORDED SEPTEMBER 29, 1952 IN BOOK 327, PAGE 416 OF OFFICIAL RECORDS.

SECTION 19

LOTS 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 AND 16; E ½.

SECTION 20

SW ¼ NW ¼; SW ¼ LYING WESTERLY OF THE SOUTH FORK OF THE EEL RIVER.

THAT PORTION OF THE NW ¼ NW ¼ LYING WESTERLY OF THE SOUTH FORK OF THE EEL RIVER.

ALSO THAT PORTION OF THE SE ¼ NW ¼ LYING SOUTHERLY AND WESTERLY OF THE SOUTH FORK OF THE EEL RIVER.

ALSO THAT PORTION OF THE SW ¼ NE ¼ LYING SOUTHERLY AND WESTERLY OF THE CENTER LINE OF THE CALIFORNIA STATE HIGHWAY AS IT EXISTED ON JUNE 9, 1955

ALSO THE SE ¼, EXCEPTING THEREFROM ALL THOSE PORTIONS THEREOF CONVEYED TO THE STATE OF CALIFORNIA BY DEED RECORDED IN VOLUME 160 OF DEEDS, PAGE 367, MENDOCINO COUNTY RECORDS AND BY DEED RECORDED IN VOLUME 51, OFFICIAL RECORDS, PAGE 5, MENDOCINO COUNTY RECORDS.

ALSO EXCEPTING FROM THE SE ¼ SE ¼ ALL THAT PORTION THEREOF DESCRIBED AS FOLLOWS:

COMMENCING AT THE 1" IRON BOLT BEING THE WITNESS CORNER TO THE SECTION CORNER COMMON TO SECTIONS 20, 21, 28 AND 29 AS SHOWN ON THE RECORD OF SURVEY RECORDED JULY 30, 1948 IN MAP CASE 1, DRAWER 8, PAGE 37, MENDOCINO COUNTY RECORDS; THENCE; NORTH 26° 17' 04" WEST (= NORTH 27° 23' 24" WEST TRUE MERIDIAN), 803.22 FEET TO A POINT THAT BEARS NORTH 29° 11' 17" WEST, 350.00 FEET FROM ENGINEERS STATION "ML2" 13+50.00 P.O.T. OF THE DEPARTMENT OF TRANSPORTATION SURVEY AT SIDEHILL VIADUCT BRIDGE #10-34, ABOUT 6 MILES NORTH OF LEGGETT (STATE HIGHWAY 01-MEN-101-97.6/98.2, SAID POINT BEING THE TRUE POINT OF BEGINNING:

1. THENCE, SOUTH 60° 48' 43" WEST, 450.00 FEET;

2. THENCE, SOUTH 83° 51' 12" WEST, 260.44 FEET;

3. THENCE, NORTH 00° 24' 45" EAST, 344.08 FEET TO THE EASTERLY LINE OF THE PARCEL OF LAND DESCRIBED AS PARCEL "C" IN EASEMENT DEED TO THE STATE OF CALIFORNIA RECORDED MARCH 4, 1930, IN BOOK 51 OF OFFICIAL RECORDS, PAGE 5, MENDOCINO COUNTY RECORDS.

4. THENCE, IN A GENERAL SOUTHERLY DIRECTION ALONG SAID EASTERLY LINE 923 FEET, MORE OR LESS, TO THE SOUTH LINE OF SAID SECTION 20;

5. THENCE, LEAVING SAID EASTERLY LINE, SOUTH 88° 46' 10" EAST ALONG SAID SOUTH LINE, 769.19 FEET TO THE NORTHWESTERLY LINE OF PARCEL "B" IN SAID DEED ABOVE REFERRED TO;

6. THENCE, IN A GENERAL NORTHEASTERLY DIRECTION ALONG SAID NORTHWESTERLY LINE, 622 FEET, MORE OR LESS, TO THE EAST LINE OF SAID SECTION 20;

7. THENCE, NORTH 01° 52' 32" EAST ALONG SAID EAST LINE, 188.45 FEET TO A POINT THAT BEARS SOUTH 73° 07' 30" EAST FROM THE TRUE POINT OF BEGINNING;

8. THENCE, NORTH 73° 07' 30" WEST, 153.32 FEET TO THE TRUE POINT OF BEGINNING.

THE BEARINGS AND DISTANCES USED IN THE ABOVE DESCRIPTION ARE ON THE CALIFORNIA CO-ORDINATE SYSTEM, ZONE 2. MULTIPLY DISTANCES SHOWN BY 1.0000117 TO OBTAIN GROUND DISTANCES.

ALSO EXCEPTING THAT PORTION OF THE SOUTHEAST QUARTER OF THE SOUTHEAST QUARTER OF SECTION 20, TOWNSHIP 24 NORTH, RANGE 17 WEST, MOUNT DIABLO BASE AND MERIDIAN, DESCRIBED AS FOLLOWS:

BEGINNING AT THE WESTERLY TERMINUS OF THE COURSE DESCRIBED IN DEED TO THE STATE OF CALIFORNIA, RECORDED JUNE 18, 1981 IN BOOK 1310 OF OFFICIAL RECORDS, PAGE 231, MENDOCINO COUNTY RECORDS, AS HAVING A BEARING AND LENGTH OF S 83° 51' 12" W, 260.44 FEET;

(1) THENCE, N 61° 01' 02" E, 539.66 FEET;
(2) THENCE, S 29° 11' 17" E. 100.00 FEET TO THE NORTHERLY LINE OF SAID PARCEL OF LAND CONVEYED TO THE STATE OF CALIFORNIA;
(3) THENCE, S 60° 48' 43" W, ALONG SAID LINE, 300 FEET, TO THE SOUTHWESTERLY TERMINUS THEREOF;
(4) THENCE, S 83° 51' 12" W, 260.44 FEET TO THE POINT OF BEGINNING.

SECTION 29

SW ¼ NE ¼; SE ¼; W ½;

THAT PART OF THE NW ¼ NE ¼ LYING WESTERLY OF THE WESTERLY R/W OF STATE HIGHWAY CONVEYED TO THE STATE OF CALIFORNIA BY DEEDS RECORDED IN VOLUME 51, OFFICIAL RECORDS, PAGE 5, MENDOCINO COUNTY RECORDS, IN BOOK 118 OF DEEDS, PAGE 454, MENDOCINO COUNTY RECORDS, AND IN BOOK 160 OF DEEDS, PAGE 442, RECORDS OF MENDOCINO COUNTY CALIFORNIA.

ALSO THAT PART OF THE SE ¼ NE ¼ LYING SOUTHWESTERLY OF THE SOUTHWESTERLY R/W OF STATE HIGHWAY AS CONVEYED TO THE STATE OF CALIFORNIA BY DEED RECORDED IN BOOK 160 OF DEEDS, PAGE 454, MENDOCINO COUNTY RECORDS, AND BY DEED RECORDED IN VOLUME 64, OFFICIAL RECORDS, PAGE 134, MENDOCINO COUNTY RECORDS.

SECTION 30

LOTS 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 AND 18; NE ¼; N ½ SE ¼.

SECTION 31

LOTS 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 AND 11; NE ¼ NE ¼

SECTION 32

ALL.

TOWNSHIP 24 NORTH, RANGE 18 WEST, M.D.M.

SECTION 1

LOTS 3 AND 4; S ½ SW ¼; NW ¼ SW ¼; SW ¼ NW ¼.

EXCEPTING FROM LOTS 3 AND 4, SW ¼ NW ¼ AND THE NW ¼ SW ¼ , ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED BY DEED RECORDED SEPTEMBER 29, 1952 IN BOOK 327, PAGE 416 OF OFFICIAL RECORDS.

SECTION 2

ALL.

EXCEPTING FROM THE SW ¼ SE ¼ AND THE NE ¼ SE ¼, ONE HALF OF THE OIL AND MINERALS IN OR ON SAID LAND, TOGETHER WITH THE RIGHT TO REMOVE THE SAME AT ANY TIME AS RESERVED IN DEED FROM NETTA C. MCINTOSH, A WIDOW, RECORDED MAY 2, 1951, IN BOOK 286 OF OFFICIAL RECORDS, PAGE 372, MENDOCINO COUNTY RECORDS.

ALSO EXCEPTING FROM LOT 1, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED IN A DEED FROM ALEXANDER MCPHERSON ESTATE, INCORPORATED RECORDED SEPTEMBER 29, 1952 IN BOOK 327, PAGE 416 OF OFFICIAL RECORDS.

SECTION 3

LOTS 1, 2 AND 3; S ½ N ½; SE ¼; S ½ SW ¼; NW ¼ SW ¼;

SECTION 4

LOTS 2, 3 AND 4; SW ¼ NE ¼; SE ¼; SW ¼ SW ¼; N ½ SW ¼; S ½ NW ¼; SE ¼ SW ¼;

SECTION 5

ALL. EXCEPT THAT PORTION OF THE SW ¼ LYING WESTERLY OF INDIAN CREEK.

SECTION 6

THAT PORTION OF THE SE ¼ LYING EASTERLY OF INDIAN CREEK AND COLBORN CREEK.

SECTION 7

THAT PORTION LYING SOUTHEASTERLY OF INDIAN CREEK.

SECTION 8

ALL.

EXCEPTING FROM THE SW ¼ NW ¼, ALL OIL, GAS, MINERAL, RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS, AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES AS RESERVED BY CLAIR MCNEE HOLMES, ALSO KNOWN AS CLAIRE MCNEE HOLMES AND BERTHA MCNEE BY DEED RECORDED FEBRUARY 15, 1952 IN BOOK 309, PAGE 35 OF OFFICIAL RECORDS.

SECTION 9

NE ¼; S ½; W ½ NW ¼; SE ¼ NW ¼; NE ¼ NW ¼

SECTION 10

ALL.

EXCEPTING FROM E ½ SE ¼, ALL OIL, GAS, MINERAL, RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND

PROSPECT FOR ALL SUCH OIL, GAS, AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES AS RESERVED BY CLAIR MCNEE HOLMES, ALSO KNOWN AS CLAIRE MCNEE HOLMES AND BERTHA MCNEE BY DEED RECORDED FEBRUARY 15, 1952 IN BOOK 309, PAGE 35 OF OFFICIAL RECORDS.

SECTION 11

ALL.

EXCEPTING FROM THE S ½ OF NW ¼, ONE HALF OF THE OIL AND MINERALS IN OR ON SAID LAND, TOGETHER WITH THE RIGHT TO REMOVE THE SAME AT ANY TIME AS RESERVED BY NETTA C. MCINTOSH, A WIDOW, BY DEED RECORDED MAY 2, 1951, IN BOOK 286 OF OFFICIAL RECORDS, PAGE 372, MENDOCINO COUNTY RECORDS.

ALSO EXCEPTING FROM THE SE ¼ NE ¼, ALL OIL, GAS, MINERAL, RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS, AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES AS RESERVED BY CLAIR MCNEE HOLMES, ALSO KNOWN AS CLAIRE MCNEE HOLMES AND BERTHA MCNEE BY DEED RECORDED FEBRUARY 15, 1952 IN BOOK 309, PAGE 35 OF OFFICIAL RECORDS.

SECTION 12

ALL.

EXCEPTING FROM THE NE 1/4 NE 1/4, SW ¼ NE ¼, W ½ AND THE SE ¼, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED MAY 10, 1950 IN BOOK 262, PAGE 421 OF OFFICIAL RECORDS.

ALSO EXCEPTING FROM THE NW ¼ NE ¼ AND THE SW ¼, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH ALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSE, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED, IN A DEED RECORDED MAY 10, 1950 IN BOOK 262, PAGE 422 OF OFFICIAL RECORDS.

ALSO EXCEPTING FROM THE SE ¼ NE ¼, ONE HALF OF THE OIL AND MINERALS IN OR ON SAID LAND, TOGETHER WITH THE RIGHT TO REMOVE THE SAME AT ANY TIME AS RESERVED IN DEED FROM NETTA C. MCINTOSH, A WIDOW, RECORDED MAY 2, 1951, IN BOOK 286 OF OFFICIAL RECORDS, PAGE 372, MENDOCINO COUNTY RECORDS.

ALSO EXCEPTING FROM THE NW ¼, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED AUGUST 20, 1951 IN BOOK 297, PAGE 126 OF OFFICIAL RECORDS.

SECTION 13

ALL.

EXCEPTING FROM NE ¼, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED FEBRUARY 05, 1951 IN BOOK 286, PAGE 49 OF OFFICIAL RECORDS.

SECTION 14

ALL.

EXCEPTING FROM THE NE ¼, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSE, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED OCTOBER 25, 1951 IN BOOK 301, PAGE 239 OF OFFICIAL RECORDS.

ALSO EXCEPTING FROM THE NW ¼, SW ¼ SW ¼, AND THE NE ¼ SW ¼, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSE, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED MAY 19, 1952 IN BOOK 316, PAGE 391 OF OFFICIAL RECORDS.

ALSO EXCEPTING FROM NW ¼ SW ¼, SE ¼ SW 1/4, AND THE SE ¼, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED SEPTEMBER 29, 1952 IN BOOK 327, PAGE 416 OF OFFICIAL RECORDS.

SECTION 15

ALL.

EXCEPTING FROM THE E ½ NE ¼ AND THE E ½ SW ¼, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED SEPTEMBER 29, 1952 IN BOOK 327, PAGE 416 OF OFFICIAL RECORDS.

SECTION 16

ALL.

EXCEPTING FROM THE NE ¼ NE ¼ ONE HALF OF THE OIL AND MINERALS IN OR ON SAID LAND, TOGETHER WITH THE RIGHT TO REMOVE THE SAME AS RESERVED BY NETTA C. MCINTOSH, A WIDOW, IN A DEED RECORDED MAY 2, 1951, IN BOOK 286 OF OFFICIAL RECORDS, PAGE 372, MENDOCINO COUNTY RECORDS.

SECTION 17

ALL.

EXCEPTING FROM SE ¼ NW ¼, ALL OIL, GAS, MINERAL, RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS, AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES AS RESERVED BY CLAIR MCNEE HOLMES, ALSO KNOWN AS CLAIRE MCNEE HOLMES AND BERTHA MCNEE IN A DEED RECORDED FEBRUARY 15, 1952 IN BOOK 309, PAGE 35 OF OFFICIAL RECORDS.

SECTION 18

ALL.

EXCEPT LOT 1 AND THAT PORTION OF LOT 2 AND THE SOUTHEAST ¼ OF THE NORTHWEST ¼, ALL IN SECTION 18, TOWNSHIP 24 NORTH RANGE 18 WEST, MDB & M, WITHIN THE FOLLOWING PERIMETER DESCRIPTION:

BEGINNING AT THE NORTHWEST CORNER OF LOT 2 AS PER RECORD OF SURVEY BY DONALD E. BUSHNELL, FILED IN MAP CASE 1, DRAWER 10, PAGE 142, MENDOCINO COUNTY RECORDS;
THENCE SOUTH 00° 40' 00" WEST 32.71 FEET ALONG THE WEST SECTION LINE OF SAID SECTION 18;
THENCE ALONG THE FOLLOWING BEARINGS AND DISTANCES:
SOUTH 54° 15' 18" EAST, 213.36 FEET; NORTH 69° 18' 14' EAST, 360.86 FEET TO THE NORTH LINE OF SAID LOT 2;
THENCE SOUTH 86° 39' 24" EAST, 179.05 FEET ALONG THE NORTH LINE OF SAID LOT 2;
THENCE SOUTH 39° 26' 10" EAST, 197.37 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE SOUTH 35° 33' 10" EAST, 204.52 FEET TO A ¾" REBAR TAGGED 4455;
THENCE SOUTH 55° 46' 22" EAST, 354.90 FEET; NORTH 89° 58' 01" EAST, 223.20 FEET; NORTH 49° 21' 06" EAST, 358.26 FEET; NORTH 28° 50' 09" EAST, 81.15 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE NORTH 10° 43' 00" WEST, 155.65 FEET TO THE NORTHEAST CORNER OF LOT 2 AS PER SAID RECORD OF SURVEY;
THENCE NORTH 86° 39' 24" WEST, 1735.01 FEET ALONG THE NORTH LINE OF SAID LOT 2 TO THE POINT OF BEGINNING.

SECTION 19

ALL.

EXCEPTING ANY PORTION LYING SOUTHERLY AND WESTERLY OF THE USAL-FOUR CORNERS COUNTY ROAD #431.

SECTION 20

ALL.

SECTION 21

ALL.

SECTION 22

ALL.

EXCEPTING FROM THE NW ¼, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED SEPTEMBER 29, 1952 IN BOOK 327, PAGE 416 OF OFFICIAL RECORDS.

SECTION 23

ALL.

EXCEPTING FROM THE S ½, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED SEPTEMBER 29, 1952 IN BOOK 327, PAGE 416 OF OFFICIAL RECORDS.

SECTION 24

ALL.

EXCEPTING FROM THE NE ¼ NE 1/4, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED AUGUST 20, 1951 IN BOOK 297, PAGE 126 OF OFFICIAL RECORDS.

ALSO EXCEPTING FROM THE NW ¼ NW ¼, SW 1/4 NW ¼, SE1/4 NW ¼, SE ¼ SE ¼, NW ¼ NE ¼, SW ¼ NE ¼, SE ¼ NE ¼, NW ¼ SW ¼, NE ¼ SW ¼, NW ¼ SE ¼ AND THE NE ¼ SE ¼, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED SEPTEMBER 29, 1952 IN BOOK 327, PAGE 416 OF OFFICIAL RECORDS.

SECTION 25

ALL.

EXCEPTING FROM THE NW1/4 NW ¼, NE ¼ NW ¼, SE ¼ NW ¼ AND THE NE ¼ SW ¼, ALL OIL, GAS AND MINERAL RIGHTS OF EVERY KIND AND NATURE, IN OR ABOUT SAID PREMISES, TOGETHER WITH THE RIGHT TO ENTER UPON, EXPLORE AND PROSPECT FOR ALL SUCH OIL, GAS AND MINERALS, AND IN CASE ANY SUCH SHALL BE FOUND, TO SECURE AND REMOVE THE

SAME, AND TO DO ANY AND ALL THINGS WHICH MAY PROVE CONVENIENT OR USEFUL TO BE DONE FOR SUCH PURPOSES, ALL WITHOUT UNNECESSARY DAMAGE TO THE ABOVE DESCRIBED PROPERTY AS RESERVED BY ALEXANDER MCPHERSON ESTATE, INCORPORATED IN A DEED RECORDED SEPTEMBER 29, 1952 IN BOOK 327, PAGE 416 OF OFFICIAL RECORDS.

SECTION 26

ALL.

EXCEPTING FROM THE NE ½ SE ¼, NE ¼ NE ¼, ONE HALF OF THE OIL AND MINERALS IN OR ON SAID LAND, TOGETHER WITH THE RIGHT TO REMOVE THE SAME AT ANY TIME AS RESERVED BY NETTA C. MCINTOSH, A WIDOW, IN A DEED RECORDED MAY 2, 1951, IN BOOK 286 OF OFFICIAL RECORDS, PAGE 372, MENDOCINO COUNTY RECORDS.

SECTION 27

ALL.

SECTION 28

ALL.

SECTION 29

ALL.

EXCEPTING THAT PORTION OF W ½ LYING SOUTHERLY AND WESTERLY OF THE USUAL-FOUR CORNERS COUNTY ROAD #421.

SECTION 30

E ½; EXCEPTING THAT PORTION LYING SOUTHERLY AND WESTERLY OF USAL-FOUR CORNERS COUNTY ROAD #431.

SECTION 32

ALL.

EXCEPTING ANY PORTION LYING WESTERLY OF THE USAL-FOUR CORNERS COUNTY ROAD #431.

SECTION 33

ALL.

SECTION 34

ALL.

SECTION 35

ALL.

SECTION 36

ALL.

TOWNSHIP 24 NORTH, RANGE 19 WEST, M.D.M.

SECTION 12

BEGINNING AT THE SOUTHWEST CORNER OF SAID SECTION 12 AS PER RECORD OF SURVEY BY DONALD E. BUSHNELL IN MAP CASE 2, DRAWER 4, PAGE 10, MENDOCINO COUNTY RECORDS;
THENCE NORTH 4° 18' 00" EAST, 161.60 FEET ALONG THE WEST SECTION LINE OF SAID SECTION 12;
THENCE NORTH 65° 49' 59" EAST, 379.06 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE SOUTH 68° 05' 38" EAST, 178.22 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE SOUTH 51° 12' 25" EAST, 120.09 FEET;
THENCE SOUTH 27° 04' 01" EAST, 154.35 FEET TO THE SOUTH SECTION LINE OF SAID SECTION 12;
THENCE SOUTH 86° 54' 15" WEST, 688.15 FEET ALONG SAID SECTION LINE TO THE POINT OF BEGINNING.

SECTION 13

ALL.

EXCEPT THAT PORTION OF THE NORTH ½ OF SECTION 13, TOWNSHIP 24 NORTH, RANGE 19 WEST, MDB&M, WITHIN THE FOLLOWING DESCRIBED PERIMETER:

BEGINNING AT A POINT ON THE NORTH SECTION LINE, SAID SECTION 13, FROM WHICH THE NORTHWEST CORNER OF SAID SECTION 13, AS PER RECORD OF SURVEY BY DONALD E. BUSHNELL IN MAP CASE, 2 DRAWER 4, PAGE 10, MENDOCINO COUNTY RECORDS, BEARS SOUTH 86° 54' 15" WEST, 688.15 FEET;
THENCE ALONG THE FOLLOWING BEARINGS AND DISTANCES:
SOUTH 27° 04' 01" EAST, 158.26 FEET; SOUTH 77° 36' 29" EAST, 163.54 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE SOUTH 17° 21' 35" EAST, 245.32 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE SOUTH 56° 36' 31" EAST, 510.86 FEET; SOUTH 79° 00' 36" EAST, 398.32 FEET; NORTH 55° 42' 18" EAST, 216.66 FEET; SOUTH 31° 26' 10" EAST, 724.84 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE SOUTH 57° 05' 54" EAST, 211.58 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE NORTH 47° 36' 18" EAST, 232.73 FEET; SOUTH 74° 19' 30" EAST, 171.16 FEET; SOUTH 85° 27' 43" EAST, 178.15 FEET; NORTH 33° 07' 52" EAST, 269.66 FEET; NORTH 84° 00' 35" EAST, 250.16 FEET; NORTH 69° 15' 42" EAST, 171.64 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE SOUTH 46° 05' 34" EAST, 433.78 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE SOUTH 73° 29' 23" EAST, 243.50 FEET; SOUTH 56° 13' 54" EAST, 255.04 FEET; NORTH 51° 00' 58" EAST, 335.65 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE NORTH 42° 20' 01" EAST, 378.58 FEET TO A ¾" REBAR TAGGED L.S. 4455;
THENCE SOUTH 49° 42' 04" EAST, 312.79 FEET; SOUTH 54° 15' 18" EAST, 32.65 FEET TO THE EAST SECTION LINE OF SAID SECTION 13;
THENCE ALONG SAID LINE NORTH 00° 40' 00" EAST, 32.71 FEET TO A BRASS CAPPED IRON PIPE MARKING THE SOUTHWEST CORNER OF LOT 1 AS PER RECORD OF SURVEY BY DONALD E. BUSHNELL FILED IN MAP CASE 1, DRAWER 10, PAGE 142, MENDOCINO COUNTY RECORDS;
THENCE CONTINUING ALONG SAID SECTION LINE NORTH 00° 40' 00" EAST, 1360.00 FEET TO THE NORTHEAST CORNER OF SECTION 13 AS PER RECORD OF SURVEY BY DONALD E. BUSHNELL FILED IN MAP CASE 2, DRAWER 1, PAGE 70, MENDOCINO COUNTY RECORDS;
THENCE SOUTH 88° 16' 00" WEST, 2578.03 FEET ALONG THE NORTH SECTION LINE OF SAID SECTION 13 TO THE NORTH ¼ CORNER OF SAID SECTION AS PER SAID RECORD OF SURVEY;
THENCE SOUTH 86° 54' 15" WEST, 1909.18 FEET TO THE POINT OF BEGINNING.

EXCEPTING FROM W ½ NE ¼, ONE-HALF OF THE OIL AND MINERALS IN OR ON THE ABOVE DESCRIBED LAND, TOGETHER WITH THE RIGHT TO REMOVE THE SAME AT ANY TIME HEREAFTER AS RESERVED BY NETTA C. MCINTOSH, A WIDOW BY DEED RECORDED MAY 2, 1051 IN BOOK 286, PAGE 372 OF OFFICIAL RECORDS.

SECTION 24

THAT PORTION LYING NORTHERLY OF THE USAL-FOUR CORNER COUNTY ROAD #431.

TOWNSHIP 5 SOUTH, RANGE 3 EAST, HUMBOLT BASE AND MERIDIAN

SECTION 27

SW ¼; W ½ SE ¼; NW ¼.

SECTION 28

S ½; NW ¼.

SECTION 29

ALL.

SECTION 30

SE ¼.

SECTION 31

LOTS 3 AND 4; E ½ NE ¼; SE ¼; E ½ SW ¼; W ½ NE ¼; E ½ NW ¼.

EXCEPTING ONE HALF INTEREST IN ALL OIL AND MINERAL RIGHTS AS RESERVED IN THE DEED EXECUTED BY ANDERUS J. ANDERSON, ET UX, RECORDED APRIL 19, 1956 IN VOLUME 427 OF OFFICIAL RECORDS, PAGE 548, MENDOCINO COUNTY RECORDS, FROM THE NE ¼ SE ¼ AND THAT PORTION OF THE SE ¼ SE ¼ WHICH LIES WITHIN SECTION 31 IN THE TRACT DESCRIBED AS FOLLOWS:

COMMENCING AT THE COMMON CORNER OF SECTIONS 31 AND 32, ON THE SOUTH LINE OF TOWNSHIP 5 SOUTH RANGE 3 EAST, HUMBOLDT BASE AND MERIDIAN ACCORDING TO THE PUBLIC SURVEYS OF THE GOVERNMENT OF THE UNITED STATES, RUNNING THENCE EAST ON SAID TOWNSHIP LINE 192 LINKS; THENCE SOUTH 30° WEST 445 LINKS; THENCE SOUTH 55° WEST 364 LINKS; THENCE NORTH 48° WEST 330 LINKS; THENCE NORTH 52° EAST 228 LINKS; THENCE NORTH 15° EAST 690 LINKS; THENCE NORTH 06° WEST 446 LINKS; THENCE SOUTH 75° 15' EAST 270 LINKS TO THE EAST LINE OF SECTION 31; THENCE SOUTH 810 LINKS TO THE POINT OF BEGINNING.

SECTION 32

SE ¼; W ½; NE ¼

EXCEPTING FROM THE SE ¼ ALL MINERALS AND MINERAL RIGHTS, INCLUDING OIL, GAS AND OTHER HYDROCARBONS AS RESERVED BY ROSALIND ROSEN, ET AL., IN DEED RECORDED AUGUST 9, 1955, IN BOOK 406 OF OFFICIAL RECORDS, PAGE 33, MENDOCINO COUNTY RECORDS.

ALSO EXCEPTING ON HALF INTEREST IN ALL OIL AND MINERAL RIGHTS AS RESERVED IN THE DEED EXECUTED BY ANDERUS J. ANDERSON, ET UX RECORDED APRIL 19, 1956 IN VOLUME 427 OF OFFICIAL RECORDS, PAGE 548, MENDOCINO COUNTY RECORDS, FROM THAT PORTION OF THE W ½ SW ¼ DESCRIBED AS FOLLOWS:

BEGINNING AT THE SOUTHWEST CORNER OF SAID SECTION 32, TOWNSHIP 5 SOUTH, RANGE 3 EAST, HUMBOLDT BASE AND MERIDIAN; THENCE EAST ALONG THE TOWNSHIP LINE 225 FEET; THENCE NORTH AND PARALLEL WITH THE WEST LINE OF SAID SECTION 32, A DISTANCE OF 1320 FEET; THENCE EAST 400 FEET; THENCE NORTH 300 FEET; THENCE WEST 625 FEET TO THE WEST LINE OF SAID SECTION LINE BETWEEN SECTIONS 31 AND 32, SAID

TOWNSHIP AND RANGE; THENCE SOUTH ALONG SAID SECTION LINE 1620 FEET TO THE POINT OF BEGINNING.

SECTION 33

ALL.

EXCEPTING FROM THE SW ¼ ALL MINERALS AND MINERAL RIGHTS, INCLUDING OIL, GAS AND OTHER HYDROCARBONS RESERVED BY ROMILDA WALLENBERG, ET AL., IN DEED RECORDED AUGUST 9, 1955, IN BOOK 406 OF OFFICIAL RECORDS, PAGE 35, MENDOCINO COUNTY RECORDS.

SECTION 34

NW ¼ NE ¼; S ½ NE ¼; S ½; NW ¼.

TRACT ONE-B:

ALL THAT CERTAIN REAL PROPERTY SITUATED IN THE COUNTY OF MENDOCINO, STATE OF CALIFORNIA, BEING A PORTION OF SECTIONS 22 AND 23, TOWNSHIP 23 NORTH, RANGE 18 WEST, MOUNT DIABLO BASE AND MERIDIAN, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

THE EAST ONE-HALF (E/2) OF THE NORTHWEST ONE-QUARTER (NW/4); THE SOUTHWEST ONE-QUARTER (SW/4) OF THE NORTHWEST ONE-QUARTER (NW/4); AND ANY PORTION OF THE NORTHWEST ONE-QUARTER (NW/4) OF THE NORTHWEST ONE-QUARTER (NW/4) LYING EASTERLY OF THE SINKYONE WILDEMESS STATE PARK; THE SOUTH ONE-HALF (S/2) OF THE NORTHEAST ONE-QUARTER (NE/4); THE NORTH-HALF (N/2) OF THE SOUTHEAST ONE-QUARTER (SE/4) OF SAID SECTION 23; AND ANY PORTION OF THE NORTHEAST ONE-QUARTER (NE/4) OF THE NORTHEAST ONE-QUARTER (NE/4) OF SECTION 22 LYING NORTH AND EAST OF THE SINKYONE WILDERNESS STATE PARK AND BEING DESCRIBED IN THAT CERTAIN CERTIFICATE OF COMPLIANCE RECORDED MARCH 02, 2011, AS DOCUMENT NO. 2011-02950, OFFICIAL RECORDS OF MENDOCINO COUNTY.

TRACT ONE-C:

ALL THAT CERTAIN REAL PROPERTY SITUATED IN THE COUNTY OF MENDOCINO, STATE OF CALIFORNIA, BEING A PORTION OF SECTIONS 22, 23, 26, AND 27 TOWNSHIP 23 NORTH, RANGE 18 WEST, MOUNT DIABLO BASE AND MERIDIAN, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

ALL THAT PORTION OF SAID SECTION 22 LYING SOUTHERLY AND EASTERLY OF THE SINKYONE WILDEMESS STATE PARK AND EASTERLY OF THE MEAN HIGH WATER LINE OF THE PACIFIC OCEAN; THE SOUTHWEST ONE-QUARTER (SW/4); AND THE SOUTH-HALF (S/2) OF THE SOUTHEAST ONE-QUARTER (SE/4) OF SAID SECTION 23; THE NORTH-HALF (N/2) OF SAID SECTION 26; AND THAT PORTION OF THE NORTH-HALF (N/2) OF SAID SECTION 27 LYING EASTERLY OF THE MEAN HIGH WATER LINE OF THE PACIFIC OCEAN AND BEING DESCRIBED IN THAT CERTAIN CERTIFICATE OF COMPLIANCE RECORDED MARCH 02, 2011, AS DOCUMENT NO. 2011-02951, OFFICIAL RECORDS OF MENDOCINO COUNTY.

TRACT ONE-D:

ALL THAT CERTAIN REAL PROPERTY SITUATED IN THE COUNTY OF MENDOCINO, STATE OF CALIFORNIA, BEING A PORTION OF SECTION 25, TOWNSHIP 23 NORTH, RANGE 18 WEST, MOUNT DIABLO BASE AND MERIDIAN, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

THE NORTHWEST ONE-QUARTER (NW/4); THE WEST ONE-HALF (W/2) OF THE NORTHEAST ONE-QUARTER (NE/4); THE NORTHEAST ONE-QUARTER (NE/4) OF THE SOUTHWEST ONE-QUARTER (SW/4); AND THE NORTHWEST ONE-QUARTER (NW/4) OF THE SOUTHEAST ONE-QUARTER (SE/4) AND BEING DESCRIBED IN THAT CERTAIN CERTIFICATE OF COMPLIANCE

RECORDED MARCH 2, 2011, AS DOCUMENT NO. 2011-02952, OFFICIAL RECORDS OF MENDOCINO COUNTY.

EXCEPTING FROM SAID TRACTS OF LAND ABOVE DESCRIBED THE FOLLOWING DESCRIBED LAND;

All that portion of the following Sections 27, 26, 25, 22, and 23 in Township 23 North, Range 18 West, Mount Diablo Base and Meridian in Mendocino County, California, being any and all lands and any and all interest thereto lying within the following described real property more particularly described as follows:

Beginning at the 1/4 Corner common to Sections 27 & 26 in said Township and Range as established by Michael J. Moore L.S. #5160 per Record of Survey filed in Maps, Drawer 80, Page 59, Mendocino County Records; said Corner has California Coordinate System 1983 Zone II Coordinates of 2,428,416.144 North and 6,044,913.025 East; thence S86°55'01"E, 5,523.18' along the East-West centerline of said Section 26 to the 1/4 Corner common to Sections 26 and 25 of said Township and Range marked by a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 with Coordinates of 2,428,119.088 North and 6,050,428.210 East per Record of Survey filed in Maps, Drawer 80, Page 98, Mendocino County Records; thence N85°00'39"E, 1253.68' along the East-West centerline of said Section 25 to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N53°45'07"W, 554.82' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N29°07'39"E, 329.22' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N39°05'31"E, 357.51' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey this meander corner bears N88°50'06"E, 83.89' from USC&GS Station "Hill" and is also 100' distant Northeasterly from the dividing ridge between Dunn Gulch and the Usal Creek drainage; thence continuing Northwesterly and 100' distant more or less Northeasterly from the said dividing ridge, N19°41'21"W, 247.27' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N9°01'45"E, 328.33' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N21°37'07"W, 819.24' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence S83°48'50"W, 201.86' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N50°40'33"W, 256.08' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N77°28'54"W, 219.67' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N52°37'45"W, 170.38' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey marking the Section Corner common to Sections 23/24/26/25 in said Township and Range; thence continuing 100' distant Northeasterly more or less from said dividing ridge between Dunn Gulch and the Usal Creek drainage N52°37'45"W, 128.48' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N35°04'36"W, 233.54' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N67°32'55"W, 404.90' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N10°27'10"W, 476.99' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N41°53'34"W,
243.79' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N21°58'57"W, 459.81' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N41°32'35"W, 239.05' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence S83°54'09"W, 229.46' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N36°32'53"W, 478.49' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey ; thence N68°28'36"W, 175.76' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence maintaining the 100' distance more or less from the ridge top, but now the ridge divides Shady Dell Creek drainage and the Usal Creek drainage; thence proceeding N19°11'06"W, 254.77' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N53°41'38"W, 512.05' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N60°04'23"W, 682.90' to a 5/8" rebar with 1-

1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence S57°22'55"W, 399.89' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence S71°46'06"W, 331.42' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence S51°16'38"W, 280.10' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence S89°25'43"W, 358.98' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N46°19'34"W, 409.29' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N66°11'48"W, 485.62' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N55°55'49"W, 269.36' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence S81°01'18"W, 233.50' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N68°51'05"W, 426.93' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence turning more Easterly from said dividing Ridge N41°07'25"W, 431.07' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence maintaining at least a 100' distance, from the switchback on the Hales Grove Truck Road, proceeding N44°11'33"E, 306.64' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence S54°57'06"E, 238.94' to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N7°26'50"W, 499.27' ((N7°26'14"W,499.77')) per Record of Survey by Mallory mentioned here-in-below to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence N34°32'46"W, 556.52' ((N34°34'26"W,556.29')) per Record of Survey by Mallory mentioned here-in-below to a 5/8" rebar with 1-1/2" dia. Aluminum cap stamped R.C.E. # 25681 per said Record of Survey; thence continuing on this last course of N34°32'46"W, 2.35' to the Southerly Boundary of the Sinkyone Wilderness State Park as surveyed by Douglas C. Mallory LS # 5940 for Usal Redwood Forest Company, LLC in June – August 2011 as shown and delineated on a ((Record of Survey filed in Maps, Drawer 81, Page23, Mendocino County Records)); thence following said Sinkyone Wilderness Boundary Southwesterly through said Section 22 the following bearings and distances as per (Corporation Grant Deed Recorded December 31, 1986 as Document No. 22269 at Book 1599 Page 479 of Mendocino County Records) (S58°07'13"W, 31.50') S58°08'18"W, 31.50' to a 3/4" rebar with aluminum Cap stamped LS 5940 per said Mallory survey; thence (S72°59'50"W, 166.54') S73°00'55"W, 166.55' to a 3/4" rebar with Aluminum Cap stamped LS 5940; thence (S57°09'18"W, 123.76') S57°10'23"W, 123.77' to a 3/4" rebar with Aluminum Cap stamped LS 5940; thence (S51°57'59"W, 375.98') S51°59'04"W,376.00'; thence (S23°08'38"W, 730.00') S23°09'43"W, 730.04'; thence (S33°53'52"E, 604.14') S33°52'47"E, 604.17'; thence (S24°11'44"W, 327.56') S24°12'49"W, 327.58'; thence (N86°03'12"W, 344.35') N86° 02'07"W, 344.37'; thence (S45°25'25"W, 376.94') S45°26'30"W, 376.96'; thence (S84°58'19"W, 330.31') S84°59'24"W, 330.33' to a 3/4" rebar with Aluminum Cap stamped LS 5940; thence (S47°51'45"W, 74.55') S47°52'50"W, 74.55' to a 3/4" rebar with Aluminum Cap stamped LS 5940; thence (S88°17'06"W, 659.70') S88°18'11"W, 659.73' more or less, to the mean high water line of the Pacific Ocean; thence Southerly along said mean high water line to the East-West centerline of said Section 27; thence continuing S88°50'48" E along the East-West centerline of Section 27 to the Point of Beginning.

APN: 011-550-34
012-070-30, 38
012-080-29
012-470-22
012-480-07, 10, 11, 13, 14, 16 TO 20
012-490-20
012-500-15
012-510-02, 12, 13, 16, 17
012-520-01, 09, 10, 11, 17, 26, 28 TO 33, 36 TO 39
012-530-21-00
012-530-55-00
012-550-01, 02, 04, 10, 11, 13 TO 16
012-560-06, 15, 16, 17, 20, 21, 23

012-570-01
012-590-03, 06, 07, 11, 13, 14, 15, 19
012-720-06, 07, 08
052-010-08, 10, 11
052-020-02, 04, 08, 10
052-030-02 TO 08
052-040-01, 02, 03, 06, 07, 08
052-070-07, 08, 09
052-080-01, 02, 03, 06, 07, 09
052-090-01 TO 09, 11
052-100-01, 03 TO 06, 09 TO 15
052-110-01 TO 08
052-120-07, 08, 09
052-130-10
052-160-06, 07
052-170-03 TO 07, 09
052-180-02, 04 TO 12
052-190-01, 02, 03
052-200-01 TO 06
052-210-02 TO 07
052-220-01, 03, 04, 06, 07, 08
052-230-14
052-250-03
052-260-01, 03, 04
052-270-02, 03, 04, 06 TO 10
052-280-03 TO 07
052-290-01, 02
052-300-03
053-130-03, 04
053-140-01
053-150-07, 09
053-160-01, 02, 03, 09, 10
053-170-02, 03, 04
053-180-01, 02, 03
053-190-01, 02, 05, 12, 13
053-200-01, 12
053-230-01, 02, 03
053-240-01, 03, 04
053-250-01
053-260-01, 02
053-270-03, 12
053-280-01, 02, 03, 06
053-310-02 TO 08
053-320-01, 02
053-330-01, 02
053-420-01, 02, 05
053-430-02

SCHEDULE B

File No. **2303-3715934** Policy No. **2303-3715934**

EXCEPTIONS FROM COVERAGE

This Policy does not insure against loss or damage, and the Company will not pay costs, attorneys' fees, or expenses that arise by reason of:

Part One:

1. (a) Taxes or assessments that are not shown as existing liens by the records of any taxing authority that levies taxes or assessments on real property or by the Public Records; (b) proceedings by a public agency that may result in taxes or assessments, or notices of such proceedings, whether or not shown by the records of such agency or by the Public Records.

2. Any facts, rights, interests, or claims that are not shown by the Public Records but that could be ascertained by an inspection of the Land or that may be asserted by persons in possession of the Land.

3. Easements, liens or encumbrances, or claims thereof, not shown by the Public Records.

4. Any encroachment, encumbrance, violation, variation, or adverse circumstance affecting the Title that would be disclosed by an accurate and complete land survey of the Land and not shown by the Public Records.

5. (a) Unpatented mining claims; (b) reservations or exceptions in patents or in Acts authorizing the issuance thereof; (c) water rights, claims or title to water, whether or not the matters excepted under (a), (b), or (c) are shown by the Public Records.

Part Two:

1. General and special taxes and assessments for the fiscal year 2011-2012, a lien not yet due or payable.

2. The lien of supplemental taxes, if any, assessed, subsequent to the date hereof, pursuant to Chapter 3.5 commencing with Section 75 of the California Revenue and Taxation Code.

3. Rights of the public in and to that portion of the land lying within any public road or highway.

4. An easement for poles and wires and incidental purposes, recorded August 18, 1947 as Book 218, Page 210 of Official Records.
   In Favor of: Pacific Gas and Electric Company
   Affects: Section 6, 24 x 17

5. An easement for poles and wires and incidental purposes, recorded July 26, 1948 as Book 236, Page 212 of Official Records.
   In Favor of: Pacific Gas and Electric Company
   Affects: Sections 11 and 14, 23 x 17

6. An easement for poles and wires and incidental purposes, recorded October 3, 1949 as Book 262, Page 4 of Official Records.
   In Favor of: Pacific Gas and Electric Company
   Affects: Section 11, 23 x 17

7. An easement for poles and wires and incidental purposes, recorded March 10, 1953 as Book 339, Page 468 of Official Records.
   In Favor of: Pacific Gas and Electric Company
   Affects: Sections 20, 29 and 32, 24 x 17

8. An easement for water pipe line and incidental purposes in the document recorded December 12, 1957 as Book 474, Page 258 of Official Records.

9. An easement for state highway and incidental purposes, recorded February 14, 1919 in Book 118 of Deeds, Page 454.
   In Favor of: State of California
   Affects: Section 29, 24 x 17

10. A waiver of any claims for damages by reason of the location, construction, landscaping or maintenance of a contiguous freeway, highway or roadway or transit facility as contained in the document recorded February 14, 1919 as Book 118, Page 454 of Deeds.

11. An easement for state highway and incidental purposes, recorded June 04, 1920 in Book 160 of Deeds, Page 42.
   In Favor of: State of California
   Affects: Section 6, 24 x 17

12. A waiver of any claims for damages by reason of the location, construction, landscaping or maintenance of a contiguous freeway, highway or roadway or transit facility as contained in the document recorded June 04, 1920 as Book 160, Page 42 of Deeds.

13. An easement for state highway and incidental purposes, recorded December 09, 1930 in Book 58 of Deeds, Page 5.
   In Favor of: State of California
   Affects: Section 6, 24 x 17

14. A waiver of any claims for damages by reason of the location, construction, landscaping or maintenance of a contiguous freeway, highway or roadway, as contained in the document recorded December 09, 1930 as Book 58, Page 5 of Official Records.

15. An easement for state highway and incidental purposes, recorded September 16, 1942 as Book 156, Page 273 of Official Records.
   In Favor of: State of California
   Affects: Section 6, 24 x 17

16. A waiver of any claims for damages by reason of the location, construction, landscaping or maintenance of a contiguous freeway, highway or roadway, as contained in the document recorded September 16, 1942 as Book 156, Page 273 of Official Records.

17. An easement for state highway and incidental purposes, recorded June 09, 1931 as Book 62, Page 316 of Official Records.
In Favor of: State of California
Affects: Section 20, 24 x 17

18. A waiver of any claims for damages by reason of the location, construction, landscaping or maintenance of a contiguous freeway, highway or roadway, as contained in the document recorded June 09, 1931 as Book 62, Page 316 of Official Records.

19. An easement for state highway and incidental purposes, recorded November 02, 1944 as Book 180, Page 134 of Official Records.
In Favor of: State of California
Affects: Section 17, 24 x 17

20. A waiver of any claims for damages by reason of the location, construction, landscaping or maintenance of a contiguous freeway, highway or roadway, as contained in the document recorded November 02, 1944 as Book 180, Page 134 of Official Records.

21. A waiver of any claims for damages by reason of the location, construction, landscaping or maintenance of a contiguous freeway, highway or roadway, as contained in the document recorded March 25, 1970 as Book 813, Page 332 of Official Records.

22. An easement for right of way for road and incidental purposes in the document recorded May 02, 1951 as Book 286, Page 387 of Official Records.

Terms and provisions contained in the above document.

23. An easement for right to use existing roads and construct and use roads and incidental purposes in the document recorded April 09, 1957 as Book 457, Page 367 of Official Records.

Terms and provisions contained in the above document.

24. The terms and provisions contained in the document entitled "Agreement Fixing Location of Boundary" recorded November 13, 1958 in Book 496, Page 292 and also recorded November 20, 1958 in Book 497, Page 32, both of Official Records.

25. An easement for road and incidental purposes in the document recorded June 22, 1956 as Book 434, Page 263 of Official Records.

26. An easement for road and incidental purposes in the document recorded March 24, 1964 as Book 654, Page 321 of Official Records.

27. An easement for ingress, egress, utility and incidental purposes in the document recorded May 23, 1977 as Book 1090, Page 133 of Official Records.

28. An easement for right to construct and use a road and incidental purposes in the document recorded July 3, 1898 as Book 74, Page 126 of Official Records.

29. An easement for right of way for all purposes and incidental purposes in the document recorded August 16, 1940 as Book 142, Page 351 of Official Records.

30. An easement for 40 foot right of way and incidental purposes in the document recorded September 10, 1941 as Book 152, Page 122 of Official Records.

31. An easement for private road and incidental purposes in the document recorded December 6, 1943 as Book 168, Page 204 of Official Records.

32. An easement for access, ingress, egress, roadway and incidental purposes in the document recorded December 13, 1944 as Book 178, Page 338 of Official Records.

33. An easement for right to take water and private road and incidental purposes in the document recorded January 14, 1946 as Book 194, Page 101 of Official Records.

34. An easement for road and incidental purposes in the document recorded March 25, 1948 as Book 232, Page 295 of Official Records.

35. An easement for road and incidental purposes in the document recorded August 21, 1948 as Book 238, Page 44 of Official Records.

36. An easement for poles, wires and incidental purposes, recorded January 10, 1949 as Book 242, Page 22 of Official Records.
In Favor of: Pacific Gas and Electric Company
Affects: Section 10, 23 x 17

37. An easement for ingress, egress and incidental purposes in the document recorded May 10, 1950 as Book 262, Page 421 of Official Records.

38. An easement for ingress, egress and incidental purposes in the document recorded May 10, 1950 as Book 262, Page 422 of Official Records.

39. An easement for ingress, egress and incidental purposes in the document recorded February 05, 1951 as Book 286, Page 49 of Official Records.

40. An easement for ingress, egress and incidental purposes in the document recorded August 20, 1951 as Book 297, Page 126 of Official Records.

41. An easement for right of way for all purposes and incidental purposes in the document recorded September 21, 1951 as Book 299, Page 191 of Official Records.

42. An easement for ingress, egress and incidental purposes in the document recorded October 25, 1951 as Book 301, Page 239 of Official Records.

43. An easement for ingress, egress and incidental purposes in the document recorded May 19, 1952 as Book 316, page 391 of Official Records.

44. An easement for ingress, egress and incidental purposes in the document recorded February 15, 1952 as Book 309, Page 35 of Official Records.

45. An easement for ingress, egress and incidental purposes in the document recorded September 29, 1952 as Book 327, Page 416 of Official Records.

46. An easement for ingress, egress and incidental purposes in the document recorded December 23, 1952 as Book 334, Page 240 of Official Records.

47. An easement for right of way for passage of vehicles and persons over existing road and incidental purposes in the document recorded July 13, 1953 as Book 348, Page 24 of Official Records.

Document(s) declaring modifications thereof recorded March 07, 1956 as Book 423, Page 250 of Official Records.

48. An easement for right to use and realign road and incidental purposes in the document recorded March 07, 1956 as Book 423, Page 252 of Official Records.

49. An easement for right to use existing road and incidental purposes in the document recorded March 07, 1956 as Book 423, Page 254 of Official Records.

50. An easement for right to use existing road and incidental purposes in the document recorded March 07, 1956 as Book 423, Page 260 of Official Records.

51. An easement for water and television lines and incidental purposes in the document recorded January 27, 1958 as Book 477, Page 82 of Official Records.

52. Rights for non-exclusive use of roads contained in that certain document entitled Mmemorandum of Agreement; and the terms and provisions contained in the agreement referred to,

Recorded: December 6, 1957, in Book 473, Page 578, Official Records
Affects: Sections 19, 20, 27 and 32, 5 x 3

53. Right of way, water rights and rights incidental thereto as contained in that certain deed:

Recorded: April 26, 1943, in Book 162, Page 417, Official Records
Affects: Section 10, 23 x 17

54. Right of way for ingress and egress, water rights, right to lay pipe lines and rights incidental thereto as contained in agreement

Recorded: October 2, 1947 in Book 228, Page 94, Official Records
Affects: A portion of Sections 11 and 14, 23 x 17

55. Right to take water from spring; Right to install and maintain pipeline as contained in the document

Recorded: May 24, 1956, book 431, page 419, Official Records
Affects: Section 6, 24 x 17

56. Abutter's rights of ingress and egress to or from State Highway have been relinquished in the document recorded March 25, 1954 as Book 367, Page 6 of Official Records.

57. An easement for ingress, egress and incidental purposes in the document recorded May 26, 1955 as Book 399, Page 597 of Official Records.

58. An easement for ingress, egress and incidental purposes in the document recorded May 26, 1955 as Book 400, Page 1 of Official Records.

59. An easement for right to use road and incidental purposes in the document recorded August 26, 1957 as Book 467, Page 192 of Official Records.

60. An easement for right of way for all purposes and incidental purposes in the document recorded September 06, 1961 as Book 576, Page 382 of Official Records.

Terms and provisions contained in the above document.

61. Terms, provisions, covenants, restrictions and conditions contained in a document executed pursuant to the California Land Conservation Act of 1965 (Williamson Act) and recorded March 03, 1971 as Book 841, Page 63 of Official Records.

62. An easement for road and incidental purposes in the document recorded April 09, 1976 as Book 1035, Page 526 of Official Records.

Terms and provisions contained in the above document.

63. Permitted encumbrances as contained in the deed from North American Timber Corp. to Hawthorne Timber Company recorded December 15, 1999 as Instrument No. 1999-23469 of Official Records.

LIMITED TO ENCUMBRANCES 35,37,63,64,65,89,91 AND 99.

64. An easement for road and incidental purposes in the document recorded June 28, 2001 as Instrument No. 2001-12075 of Official Records.

Terms and provisions contained in the above document.

65. The terms and provisions contained in the document entitled "Grant Deed" recorded December 06, 1984 as Book 1485, Page 265 of Official Records.

66. A Deed of Trust to secure an original indebtedness of $35,000,000.00 recorded June 13, 2007 as Instrument No. 2007-10986 of Official Records.

Dated:	June 13, 2007
Trustor:	Usal Redwood Forest Company LLC, a Delaware limited liability company
Trustee:	Prlap, inc.
Beneficiary:	Banc of America E-Commerce Holdings, Inc. and Bank of America, N.A.

67. A document recorded October 27, 2011 as inst. no. 2011-15148 provides that the above document was subordinated to Conservation Easement insured herein.

68. A Deed of Trust to secure an original indebtedness of $20,000,000.00 recorded June 13, 2007 as Instrument No. 2007-10986 of Official Records.

Dated:	June 13, 2007
Trustor:	Usal Redwood Forest Company LLC, a Delaware limited liability company
Trustee:	Prlap, inc.
Beneficiary:	Banc of America E-Commerce Holdings, Inc. and Bank of America, N.A.

69. A document recorded October 27, 2011 as inst. no. 2011-15147 provides that the above document was subordinated to Conservation Easement insured herein.

70. An easement for public highway and incidental purposes, recorded April 22, 2009 as Instrument No. 2009-05604 of Official Records.

In Favor of:	State of California
Affects:	Sction 7, T23S, R17W

71. The effect of a document entitled ""Notice of Nonrenewal of Agricultural Preserve Contract"", recorded December 28, 2010 as Instrument No. 2010-18111 of Official Records.

72. The lack of a right of access to and from that portion of the land described as Township 23 North, Range 17 West, Section 36, SW 1/4; NW 1/4 SE 1/4.

73. The terms and provisions contained in the document entitled Notice of Unrecorded Grant Agreement recorded October 27, 2011 as inst. no. 2011-15149 of Official Records.

74. Water rights, claims or title to water, whether or not shown by the public records.

75. Any claim that any portion of the land is tidelands below the line of natural low tide where it was located prior to any artificial changes in the shoreline.

76. Any rights, interests or easements in favor of the public which exist or are claimed to exist over any portion of said land covered by water.

ATTACHMENT E

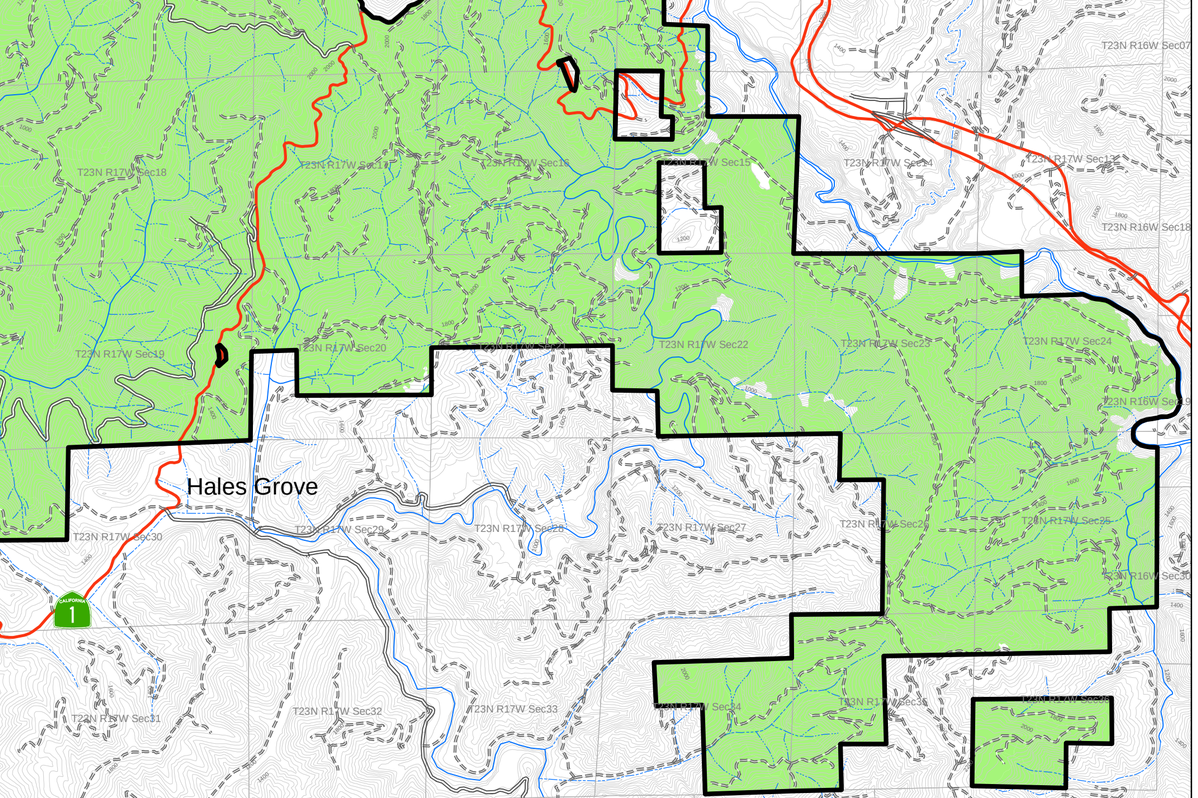
Usal Redwood Forest IFM Topographic Map

Legend

- Usal Redwood Forest Company Ownership
- Usal Redwood Forest Project
- Public Road
- Permanent Road
- Seasonal Road
- Class I Watercourse
- Class II Watercourse
- Class III Watercourse

NCRM Inc.

0 0.5 1 2 3 4 Miles



Usal Redwood Forest IFM
Watershed Boundary Map

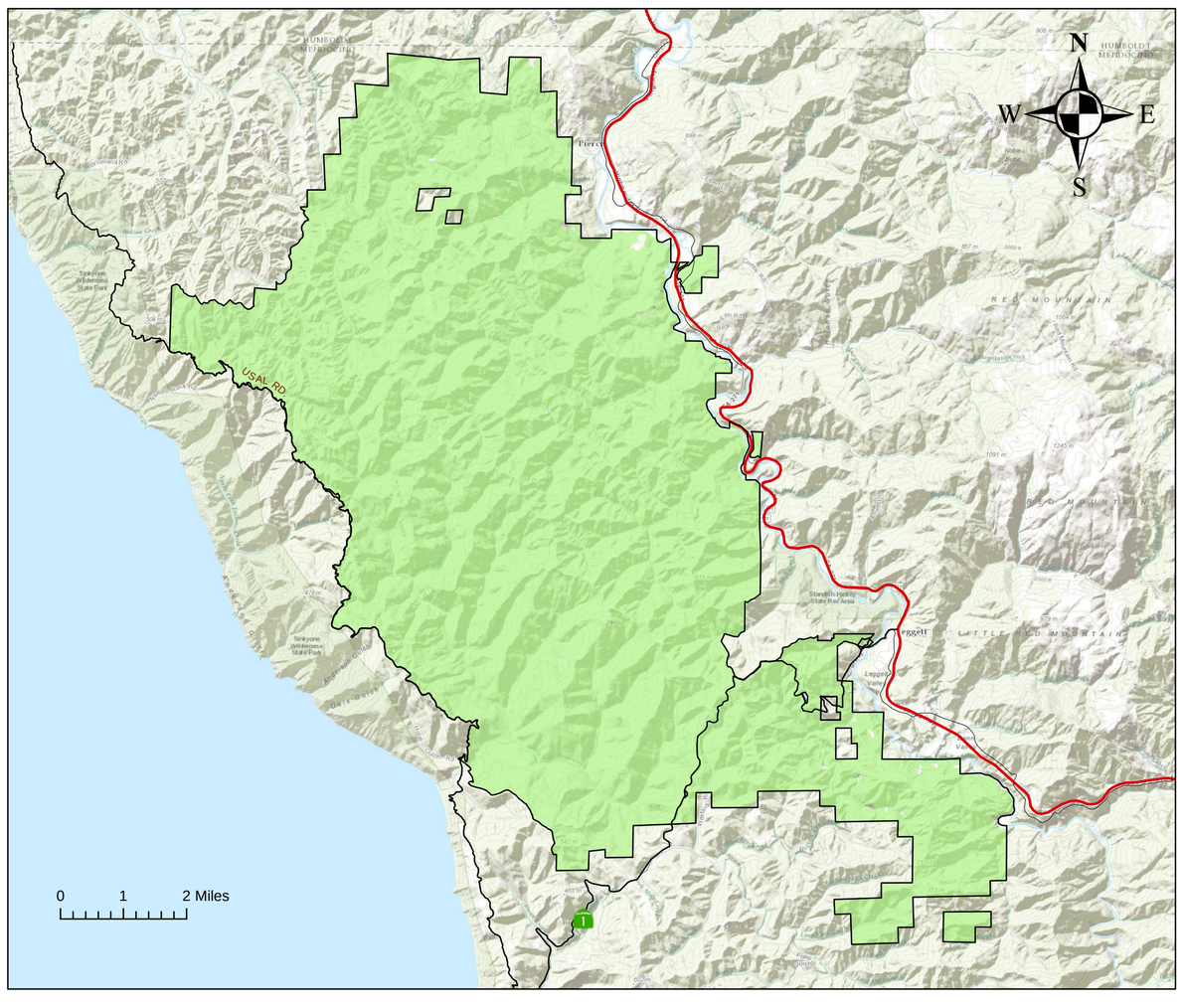
Upper Sproul Creek
Lower Indian Creek
McCoy Creek
Piercy
Upper Indian Creek
Piercy Creek
Standley Creek
Red Mountain Creek
Bear Pen Creek
Wildcat Creek
Bridges Creek
Jackass Creek
Upper Usal Creek
Mill Creek
101
Cedar Creek
Leggett
Big Dann Creek
Lower Usal Creek
Lower Hollow Tree Creek
Hales Grove
Low Gap Creek
Soldier Frank Point
Cottaneva Creek
Middle Hollow Tree Creek

Legend

- Usal Redwood Forest Company Ownership
- Usal Redwood Forest Project
- Watershed Boundary
- Public Road
- Watercourse

NCRM Inc.

0 0.5 1 2 3 4 Miles



ATTACHMENT F

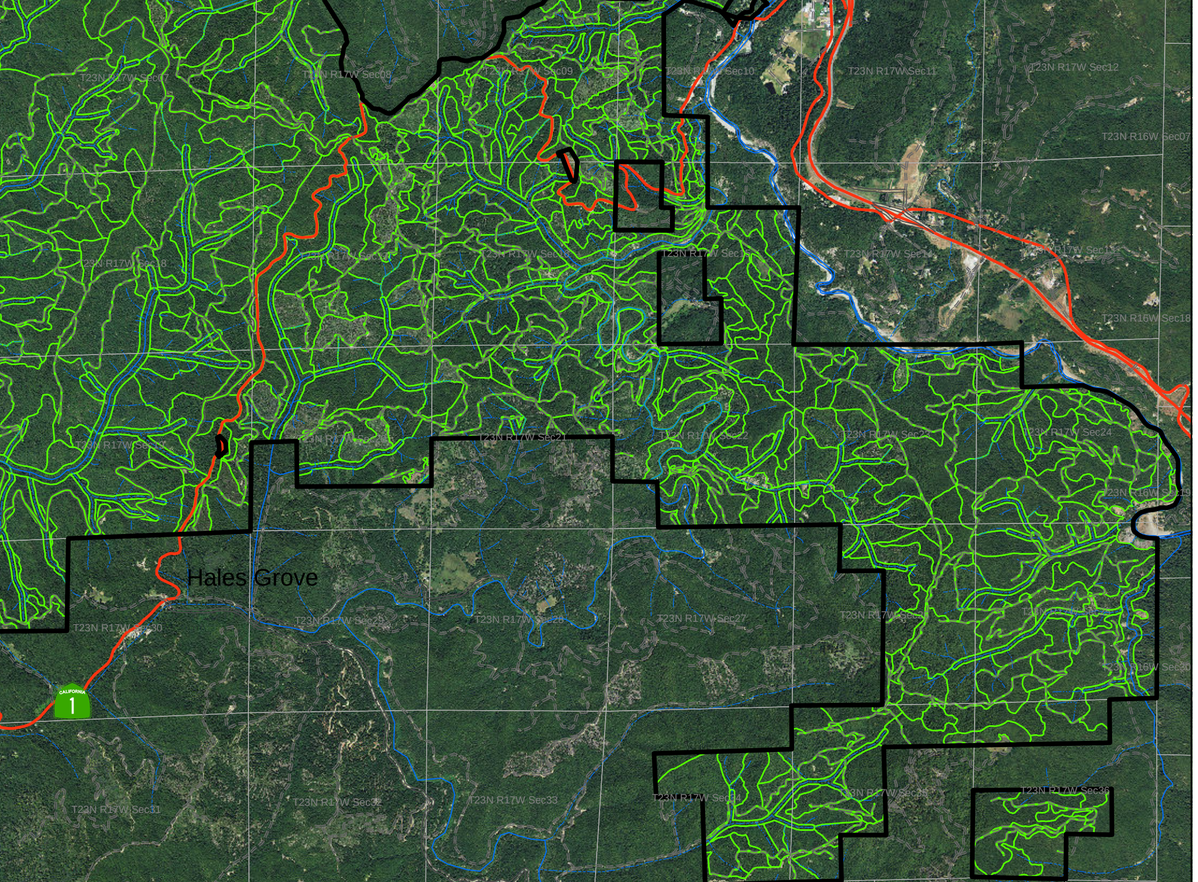
Usal Redwood Forest IFM Orthophoto Map

Legend

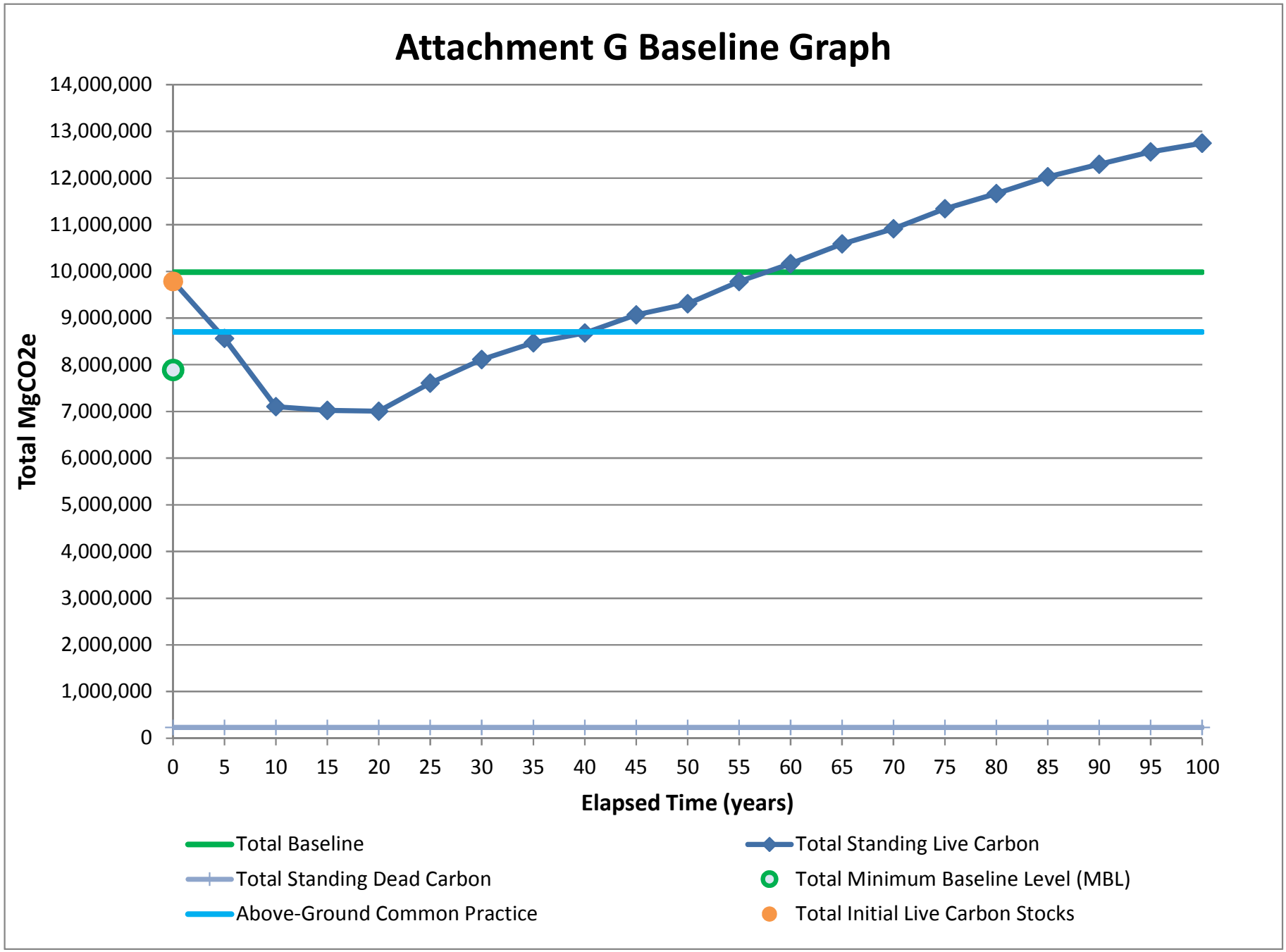
- Usal Redwood Forest Company Ownership
- Usal Redwood Forest Project
- Public Road
- Permanent Road
- Seasonal Road
- Class I Watercourse
- Class II Watercourse
- Class III Watercourse

NCRM Inc.

0 0.5 1 2 3 4 Miles



ATTACHMENT G

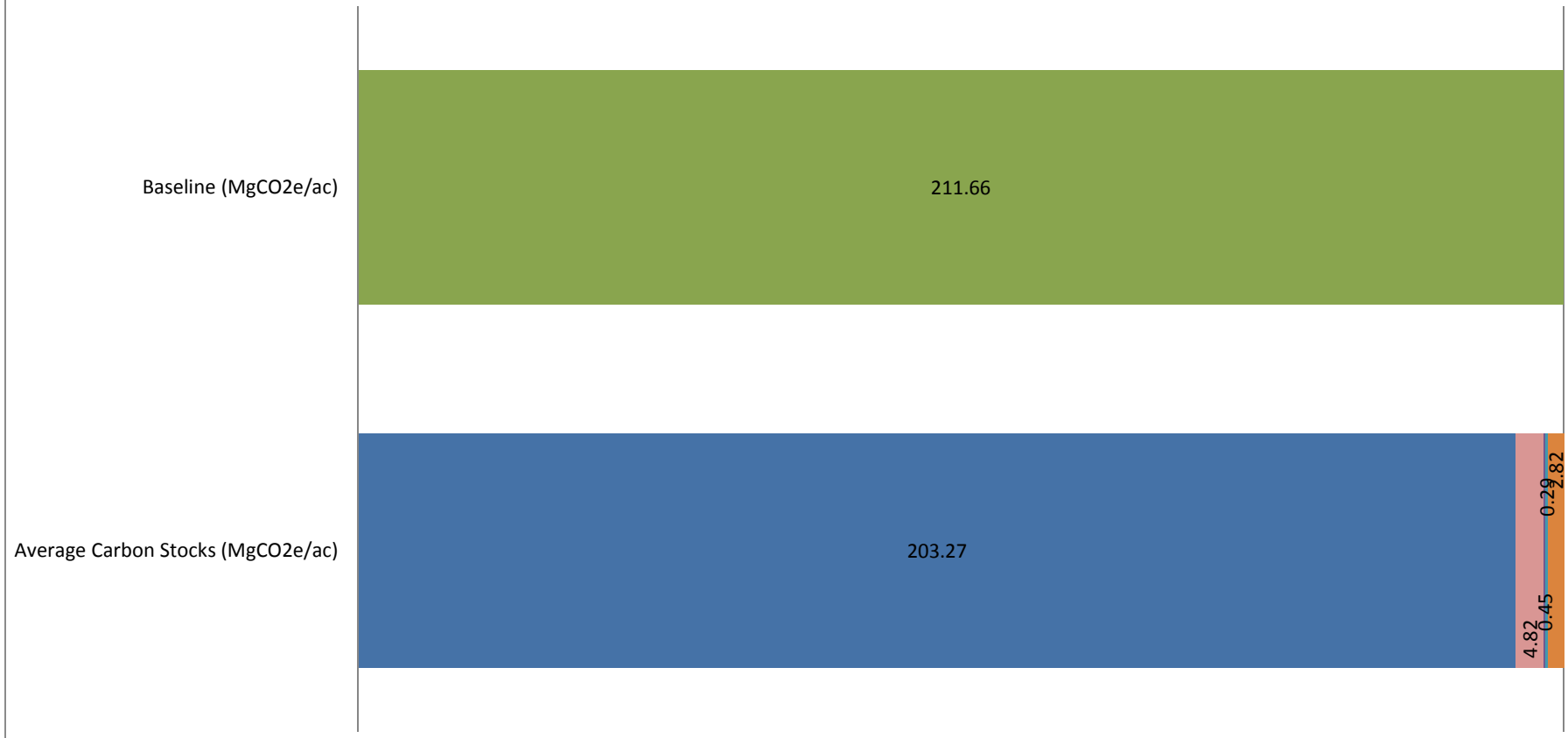

Attachment G Baseline Graph
14,000,000
13,000,000
12,000,000
11,000,000
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Total MgCO2e
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Elapsed Time (years)
Total Baseline
Total Standing Live Carbon
Total Standing Dead Carbon
Total Minimum Baseline Level (MBL)
Above-Ground Common Practice
Total Initial Live Carbon Stocks

Baseline Carbon Stocks ($MgCO_2e$ Total)

Elapsed Time	Standing Live Carbon Pool IFM-1	Standing Live Above Ground	Standing Live Below	Standing Dead Carbon	Baseline	MBL	Above-Ground Common	Initial Live Carbon Stocks
0	9,788,455	7,887,062	1,901,393	231,483	9,984,928	7,887,062	8,703,126	9,788,455
5	8,562,238	6,889,331	1,672,959	231,483	9,984,928		8,703,126	
10	7,103,976	5,691,369	1,412,782	231,483	9,984,928		8,703,126	
15	7,020,958	5,631,455	1,389,640	231,483	9,984,928		8,703,126	
20	7,006,366	5,612,331	1,394,212	231,483	9,984,928		8,703,126	
25	7,605,920	6,105,085	1,500,960	231,483	9,984,928		8,703,126	
30	8,115,079	6,523,758	1,591,402	231,483	9,984,928		8,703,126	
35	8,474,175	6,824,168	1,650,027	231,483	9,984,928		8,703,126	
40	8,682,304	6,998,628	1,683,661	231,483	9,984,928		8,703,126	
45	9,071,336	7,323,628	1,747,631	231,483	9,984,928		8,703,126	
50	9,304,304	7,519,967	1,784,215	231,483	9,984,928		8,703,126	
55	9,782,018	7,914,368	1,867,476	231,483	9,984,928		8,703,126	
60	10,165,799	8,230,523	1,935,065	231,483	9,984,928		8,703,126	
65	10,588,955	8,580,659	2,008,036	231,483	9,984,928		8,703,126	
70	10,914,625	8,850,062	2,064,266	231,483	9,984,928		8,703,126	
75	11,344,073	9,206,075	2,137,647	231,483	9,984,928		8,703,126	
80	11,667,172	9,474,438	2,192,340	231,483	9,984,928		8,703,126	
85	12,026,803	9,773,785	2,252,574	231,483	9,984,928		8,703,126	
90	12,291,343	9,994,373	2,296,486	231,483	9,984,928		8,703,126	
95	12,563,328	10,221,934	2,340,865	231,483	9,984,928		8,703,126	
100	12,746,276	10,375,459	2,370,255	231,483	9,984,928		8,703,126	
Average	9,753,445	7,887,069	1,866,376	231,483	9,984,928		8,703,126	

ATTACHMENT H

Attachment H - Carbon Stocks and Baseline



Attachment H

Baseline Carbon Stocks ($MgCO_2e$ per Acre)

Elapsed Time	Standing Live Carbon Pool IFM-1	Standing Dead Carbon Pool IFM-3	Baseline
0	204.00	4.82	208.10
5	178.45	4.82	208.10
10	148.06	4.82	208.10
15	146.33	4.82	208.10
20	146.02	4.82	208.10
25	158.52	4.82	208.10
30	169.13	4.82	208.10
35	176.61	4.82	208.10
40	180.95	4.82	208.10
45	189.06	4.82	208.10
50	193.91	4.82	208.10
55	203.87	4.82	208.10
60	211.87	4.82	208.10
65	220.69	4.82	208.10
70	227.48	4.82	208.10
75	236.43	4.82	208.10
80	243.16	4.82	208.10
85	250.65	4.82	208.10
90	256.17	4.82	208.10
95	261.84	4.82	208.10
100	265.65	4.82	208.10
Average	203.27	4.82	208.10

Carbon Pool	Mg C/ acre	Mg CO2e/acre	Total Mg CO2e
Average Standing Live and Standing Dead Pools	56.80	208.10	9,984,928
Average Annual Carbon 100-year In-Use	0.12	0.45	21626.63
Average Annual Carbon 100-year Landfill	0.08	0.29	13972.22
Average Annual Carbon in Harvested Trees Prior to Delivery to the Mill	0.77	2.82	135167.53

ATTACHMENT I

Attachment I

Per section 9.2.1 of the protocol, the following table represents the projected actual harvesting volumes from the Project Area over 100 years.

Elapsed Time (Years)	Average Decadal Harvest (Board feet per acre)
10	325
20	485
30	500
40	500
50	500
60	500
70	500
80	500
90	500
100	500

The baseline projection is provided in the Modeling plan included as Attachment M.

ATTACHMENT J

Carbon Stock Estimate Affidavit for the Purpose of Determining The High Stocking Reference

The carbon stock estimates for the 10-year period preceding the Project's commencement date are shown in the table and graph below. These values are derived through the calculation of the Project's average annual percent stock change, approximately 3.51%, from stocks as of the project start date of June 13, 2007 and stocks as of June 13, 2012. June 13, 2012 stocks were calculated by growing the Project's start date database 5 years in FORSEE. Harvest records in the form of board foot volumes delivered to the mill from Campbell Global records were used to calculate the carbon stocks delivered to the mill in each year from 2000 to 2007 for the Usal Redwood Forest IFM project area. Based on a GIS analysis of completed harvests under Timber Harvest Plans (THPs) derived from Cal-Fire GIS data between 1998 and 2007, it is estimated that approximately 11,907 thousand board feet of conifer volume was harvested over the three years between 1997 and 1999. These conifer harvests between 1997 and 1999 were estimated based on the average conifer MBF per acre harvested between 2000 and 2006 multiplied by the acres harvested in each year from 1997 to 1999. Reductions in hardwood volume due to hardwood reduction treatments were assumed to be 35% of the reported or estimated conifer harvests for each year.

Harvested carbon was calculated using the "Harvested Wood Products Worksheet" developed by the Climate Action Reserve. The total MgCO2e in harvested wood delivered to the mill each year calculated using the worksheet was then multiplied by the ratio of carbon in wood delivered to the mill to carbon in trees harvested for wood products (prior to delivery to the mill) derived from the baseline harvested wood products values. This ratio is 1.94 for the Usal Redwood Forest IFM Project.

Carbon Stocks for the 10-year period preceding the Project Start Date

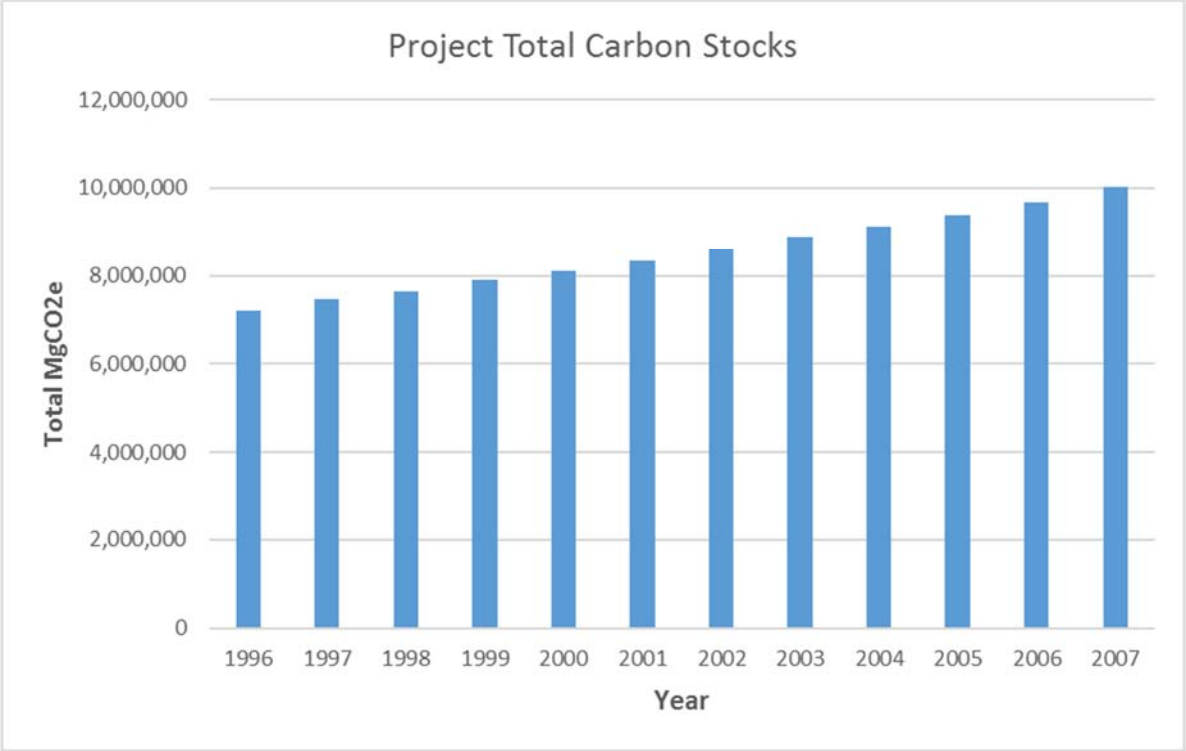
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total MgCO2e[1]	7,207,926	7,458,256	7,651,376	7,895,908	8,113,089	8,341,134	8,605,109	8,882,286	9,134,620	9,395,672	9,679,933	10,019,938
Annual Carbon Growth		253,080	259,633	267,931	275,300	283,038	291,996	301,401	309,964	318,822	328,468	340,005
Adjusted Harvested Carbon[2]		2,749	66,513	23,399	58,119	54,993	28,020	24,225	57,630	57,769	44,207	0
Harvest Carbon[3]		1,416	34,260	12,052	29,936	28,326	14,433	12,478	29,684	29,756	22,770	0
Net Stock Change		3.47%	2.59%	3.20%	2.75%	2.81%	3.16%	3.22%	2.84%	2.86%	3.03%	3.51%

[1]As of the end of June 13th

[2]Harvested Carbon times 1.94 Adjustment Factor

[3]Based on Total Reports from Campbell Global and Cal-Fire THP records

Based on the information available to the Offset Project Operator at this time as presented above, the highest value for above-ground standing live carbon stocks per acre within the Project Area during the 10-year period preceding the Project commencement date was equal to the above-ground standing live carbon stocks on June 13th of the last year of this 10-year period (2007), which is equal to the Project's initial above-ground standing live carbon stocks (ICS). Therefore, the "High Stocking Reference" (HSR) is equal to 80% of the Project's ICS value of 164.38 MgCO2e per acre as reported in Part VIII.B.1 of this OPDR, or 131.50 MgCO2e per acre.



The carbon stock inventory estimates presented above, including the summary of volume harvested over the 10-year period preceding the Project's commencement date are believed to be reasonably accurate and are based on the best available data including actual harvest records where available.

Signed,

James D. Clark
Registered Professional Forester, #2528

ATTACHMENT K

Legal Constraints Affecting Forest Management Activities on the Project Area

- Z'Berg-Nejedly Forest Practice Act of 1973 (California Public Resources Code – Division 4, Chapter 8): Designed to protect, enhance & restore California's timberland.

- California Forest Practice Rules (Title 14, California Code of Regulations, Chapter 4): Regulations used to implement the Forest Practice Act that govern timber operations.

- California Timberland Productivity Act of 1982 (Gov.C. 51100 et seq.): The intent of this Act is to *"encourage investment in timberlands based on reasonable expectation of harvest",* and to *"discourage premature or unnecessary conversion of timberland to urban and other uses".*

- California Environmental Quality Act (CEQA) (Pub.Res.C. 21000 et seq.): statute that requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible.

- Porter-Cologne Water Quality Control Act (California Water Code, Division 7. Water Quality): This is the primary vehicle for implementation of California's responsibilities under the federal 1972 Clean Water Act.

- Clean Water Act of 1972 (33 U.S.C. §1251 et seq.): The Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters.

- California Endangered Species Act (Fish & G.C. 2050 et seq.): Protects and Preserves all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats, that are threatened with extinction.

- Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884): The Act provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend.

ATTACHMENT L

Usal Redwood Forest IFM Project

This analysis is provided per section 6.2.1.3 of the Forest Project Protocol adopted November 14,2014, and is designed to demonstrate that the baseline growth and harvest regime is financially feasible. This analysis is overly conservative given that the test is simply finalcial feasibility. If herbicide treatments, tree planting and logging costs were significantly increased, the analysis would still demonstrate that the baseline growth and harvest is finalcially feasible. Delivered log values are below trended values based on Board of Equalization values, yet still demonstrate financial feasibility.

Model Inputs:

Discount Rate	8.0%	
Inflation	0.0%	
Real price appreciation for delivered log values	0.0%	
Yield Tax	2.9%	MBF

Production Costs:

Item	**Cost per acre**	**Quantity[1]**	**Total Cost**	**Cost per MBF**
THP Preparation	$100	47,982	$ 4,798,154	$19.22
Logging Supervision				$15.00
Property Management				$25.00
Logging and Hauling (Derived from BOE Stumpage Values)				$0.00
Total				**$59.22**

Herbicide Treatment of Hardwoods:

Period	**Cost per acre**	**% of Acres Treated**	**Total Cost**	**Cost per MBF**
1	$ 230.00	65%	$7,173,241	$28.73
2	$ 230.00	33%	$3,641,799	$21.64
3	$ 230.00	20%	$2,207,151	$13.40
4	$ 230.00	20%	$2,207,151	$12.54
5	$ 230.00	20%	$2,207,151	$10.03
6	$ 230.00	20%	$2,207,151	$12.05
7	$ 230.00	20%	$2,207,151	$10.82
8	$ 230.00	20%	$2,207,151	$11.32
9	$ 230.00	20%	$2,207,151	$10.31
10	$ 230.00	20%	$2,207,151	$9.23

Tree Planting: ($1 per tree cost)

Period	**Cost per acre**	**% of Acres Treated**	**Total Cost**	**Cost per MBF**
1	$ 200.00	50%	$4,798,154	$19.22
2	$ 200.00	25%	$2,399,077	$14.25
3	$ 200.00	20%	$1,919,262	$11.65
4	$ 200.00	20%	$1,919,262	$10.90
5	$ 200.00	20%	$1,919,262	$8.72
6	$ 200.00	20%	$1,919,262	$10.48
7	$ 200.00	20%	$1,919,262	$9.40
8	$ 200.00	20%	$1,919,262	$9.84
9	$ 200.00	20%	$1,919,262	$8.96
10	$ 200.00	20%	$1,919,262	$8.02

CALCULATION OF PRESENT NET VALUE
USAL REDWOOD FOREST TIMBERLANDS

Assumptions: Harvest levels are based on Baseline Harvest Scenario
Logging sytem mix estimated as 30% tractor, 70% cable.
Production costs per MBF are estimates based upon logging system mix.
0% Real price appreciation applied to delivered log values.
All calculations in constant dollars without inflation.
Discount Rate 8.0% Real.

	Annual Harvest Volume				Stumpage Values per MBF				Production	Herbicide	Tree	Yield	Net	Total	Present
	RW	DF	OC	Totals	RW	DF	OC	Camprun	Costs	Treatment	Planting	Taxes	Value	Net	Net
Year	MBF	MBF	MBF	MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	Value	Value
2007	15,136	9,793	40	24,970	400.00	100.00	50.00	281.78	59.22	28.73	19.22	8.17	166.44	4,156,047	3,848,191
2008	15,136	9,793	40	24,970	400.00	100.00	50.00	281.78	59.22	28.73	19.22	8.17	166.44	4,156,047	3,563,140
2009	15,136	9,793	40	24,970	400.00	100.00	50.00	281.78	59.22	28.73	19.22	8.17	166.44	4,156,047	3,299,204
2010	15,136	9,793	40	24,970	400.00	100.00	50.00	281.78	59.22	28.73	19.22	8.17	166.44	4,156,047	3,054,818
2011	15,136	9,793	40	24,970	400.00	100.00	50.00	281.78	59.22	28.73	19.22	8.17	166.44	4,156,047	2,828,535
2012	15,136	9,793	40	24,970	400.00	100.00	50.00	281.78	59.22	28.73	19.22	8.17	166.44	4,156,047	2,619,014
2013	15,136	9,793	40	24,970	400.00	100.00	50.00	281.78	59.22	28.73	19.22	8.17	166.44	4,156,047	2,425,013
2014	15,136	9,793	40	24,970	400.00	100.00	50.00	281.78	59.22	28.73	19.22	8.17	166.44	4,156,047	2,245,383
2015	15,136	9,793	40	24,970	400.00	100.00	50.00	281.78	59.22	28.73	19.22	8.17	166.44	4,156,047	2,079,058
2016	15,136	9,793	40	24,970	400.00	100.00	50.00	281.78	59.22	28.73	19.22	8.17	166.44	4,156,047	1,925,054
2017	5,760	11,067	4	16,832	400.00	100.00	50.00	202.66	59.22	21.64	14.25	5.88	101.67	1,711,317	733,954
2018	5,760	11,067	4	16,832	400.00	100.00	50.00	202.66	59.22	21.64	14.25	5.88	101.67	1,711,317	679,587
2019	5,760	11,067	4	16,832	400.00	100.00	50.00	202.66	59.22	21.64	14.25	5.88	101.67	1,711,317	629,248
2020	5,760	11,067	4	16,832	400.00	100.00	50.00	202.66	59.22	21.64	14.25	5.88	101.67	1,711,317	582,637
2021	5,760	11,067	4	16,832	400.00	100.00	50.00	202.66	59.22	21.64	14.25	5.88	101.67	1,711,317	539,478
2022	5,760	11,067	4	16,832	400.00	100.00	50.00	202.66	59.22	21.64	14.25	5.88	101.67	1,711,317	499,517
2023	5,760	11,067	4	16,832	400.00	100.00	50.00	202.66	59.22	21.64	14.25	5.88	101.67	1,711,317	462,516
2024	5,760	11,067	4	16,832	400.00	100.00	50.00	202.66	59.22	21.64	14.25	5.88	101.67	1,711,317	428,255
2025	5,760	11,067	4	16,832	400.00	100.00	50.00	202.66	59.22	21.64	14.25	5.88	101.67	1,711,317	396,533
2026	5,760	11,067	4	16,832	400.00	100.00	50.00	202.66	59.22	21.64	14.25	5.88	101.67	1,711,317	367,160
2027	5,499	10,960	13	16,471	400.00	100.00	50.00	200.11	59.22	13.40	11.65	5.80	110.04	1,812,448	360,053
2028	5,499	10,960	13	16,471	400.00	100.00	50.00	200.11	59.22	13.40	11.65	5.80	110.04	1,812,448	333,383
2029	5,499	10,960	13	16,471	400.00	100.00	50.00	200.11	59.22	13.40	11.65	5.80	110.04	1,812,448	308,688
2030	5,499	10,960	13	16,471	400.00	100.00	50.00	200.11	59.22	13.40	11.65	5.80	110.04	1,812,448	285,822
2031	5,499	10,960	13	16,471	400.00	100.00	50.00	200.11	59.22	13.40	11.65	5.80	110.04	1,812,448	264,650
2032	5,499	10,960	13	16,471	400.00	100.00	50.00	200.11	59.22	13.40	11.65	5.80	110.04	1,812,448	245,046
2033	5,499	10,960	13	16,471	400.00	100.00	50.00	200.11	59.22	13.40	11.65	5.80	110.04	1,812,448	226,895
2034	5,499	10,960	13	16,471	400.00	100.00	50.00	200.11	59.22	13.40	11.65	5.80	110.04	1,812,448	210,088
2035	5,499	10,960	13	16,471	400.00	100.00	50.00	200.11	59.22	13.40	11.65	5.80	110.04	1,812,448	194,526
2036	5,499	10,960	13	16,471	400.00	100.00	50.00	200.11	59.22	13.40	11.65	5.80	110.04	1,812,448	180,116
2037	5,371	12,153	77	17,601	400.00	100.00	50.00	191.33	59.22	12.54	10.90	5.55	103.12	1,814,952	167,005
2038	5,371	12,153	77	17,601	400.00	100.00	50.00	191.33	59.22	12.54	10.90	5.55	103.12	1,814,952	154,634
2039	5,371	12,153	77	17,601	400.00	100.00	50.00	191.33	59.22	12.54	10.90	5.55	103.12	1,814,952	143,180
2040	5,371	12,153	77	17,601	400.00	100.00	50.00	191.33	59.22	12.54	10.90	5.55	103.12	1,814,952	132,574
2041	5,371	12,153	77	17,601	400.00	100.00	50.00	191.33	59.22	12.54	10.90	5.55	103.12	1,814,952	122,753
2042	5,371	12,153	77	17,601	400.00	100.00	50.00	191.33	59.22	12.54	10.90	5.55	103.12	1,814,952	113,661
2043	5,371	12,153	77	17,601	400.00	100.00	50.00	191.33	59.22	12.54	10.90	5.55	103.12	1,814,952	105,241
2044	5,371	12,153	77	17,601	400.00	100.00	50.00	191.33	59.22	12.54	10.90	5.55	103.12	1,814,952	97,446
2045	5,371	12,153	77	17,601	400.00	100.00	50.00	191.33	59.22	12.54	10.90	5.55	103.12	1,814,952	90,227
2046	5,371	12,153	77	17,601	400.00	100.00	50.00	191.33	59.22	12.54	10.90	5.55	103.12	1,814,952	83,544
2047	5,668	16,308	33	22,009	400.00	100.00	50.00	177.18	59.22	10.03	8.72	5.14	94.08	2,070,569	88,250
2048	5,668	16,308	33	22,009	400.00	100.00	50.00	177.18	59.22	10.03	8.72	5.14	94.08	2,070,569	81,713
2049	5,668	16,308	33	22,009	400.00	100.00	50.00	177.18	59.22	10.03	8.72	5.14	94.08	2,070,569	75,660
2050	5,668	16,308	33	22,009	400.00	100.00	50.00	177.18	59.22	10.03	8.72	5.14	94.08	2,070,569	70,056
2051	5,668	16,308	33	22,009	400.00	100.00	50.00	177.18	59.22	10.03	8.72	5.14	94.08	2,070,569	64,867
2052	5,668	16,308	33	22,009	400.00	100.00	50.00	177.18	59.22	10.03	8.72	5.14	94.08	2,070,569	60,062
2053	5,668	16,308	33	22,009	400.00	100.00	50.00	177.18	59.22	10.03	8.72	5.14	94.08	2,070,569	55,613
2054	5,668	16,308	33	22,009	400.00	100.00	50.00	177.18	59.22	10.03	8.72	5.14	94.08	2,070,569	51,493
2055	5,668	16,308	33	22,009	400.00	100.00	50.00	177.18	59.22	10.03	8.72	5.14	94.08	2,070,569	47,679
2056	5,668	16,308	33	22,009	400.00	100.00	50.00	177.18	59.22	10.03	8.72	5.14	94.08	2,070,569	44,147
2057-2106															450,003
														Total	38,115,368

ATTACHMENT M

Usal Redwood Forest IFM Modeling Plan

By Jim Clark, RPF #2528

September 21, 2016

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Introduction

The baseline harvest scenario presented herein is based on the modeling performed for the Usal Redwood Forest Early Action Project, CAR730. Per the transitioning guidance provided by ARB, the baseline has been "recalculated" to be compliant with the Compliance Offset Protocol (COP). This recalculation involved the application of the appropriate biomass equations, and recalculation of Common Practice. Following the recalculation for COP compliance, it was determined that the Project's initial carbon stocks were below Common Practice, and that the average carbon stock generated by the 100-year baseline analysis conducted to the financial and legal requirements pertinent to the Project was below the Project's initial carbon stocks, or the Project's new Minimum Baseline Level (MBL). In order to present a baseline compliant with the COP, where the baseline analysis must result in a baseline that meets or exceeds the MBL, harvest within the R2 prescription (Low Quality Foraging Habitat) was severely restricted. This represented the only modification to the baseline harvest assumptions in comparison to the baseline analysis performed for the Early Action Project, and was performed as a harvest scheduling revision, as the baseline modeling underlying the R2 regime output was not modified.

Growth and Yield Modeling:

The growth and yield modeling described in this modeling plan is performed using the FORSEE model and the AllCA_ResLib resource library, and is based on the following:

Plot Data:

The modeling presented in this document is based on the Usal Redwood Forest inventory, conducted in January and February of 2015 utilizing a random selection of plots located across eight timber strata. Plot locations were determined from a random selection of plots from a 5 chain by 5 chain grid that uniformly covers the entire Project Area. The final inventory design resulted in the installation of 353 plots across the Project Area. The

inventory methodology included as Attachment N to the OPDR provides a detailed description of the data collected as well as the structure of the cruise, including maps showing the cruise plot locations for the Usal Redwood Forest.

Updating the Inventory:

The inventory methodology included as Attachment N to the OPDR provides a detailed description of the method of maintaining an up to date inventory for the Usal Redwood Forest.

Volume Calculations:

Conifer board foot volume calculations presented in Table 5a below utilize the standard FORSEE volume equations. Reported volumes are in board feet Scribner Scale for all conifers 8.5 inches DBH and larger. The FIA volume and biomass equations described in the OPDR are used for the calculation of all carbon stock values presented below.

Biomass Calculations:

Biomass calculations utilized in the modeling are described in detail in the OPDR. The OPDR lists all of the species specific volume and biomass equations utilized which are in compliance with the Forest Project Protocol.

Adjusting the Inventory Data to 6/13/2007 and 12/31/2014:

The OPDR and Inventory Methodology describe the method by which a stratified inventory was constructed for the purpose of identifying timber strata. The cruise data generated by the 2015 inventory has been used to represent the Project's carbon stocks as of 12/31/2014. The database was compiled and grown forward five years to 12/31/2019. The differences in DBHs and heights between 12/31/2019 and 12/31/2014 were then divided by five and multiplied by 7.5, resulting in a seven-and-a-half-year growth increment for each tree. These seven-and-a-half-year growth increments in DBH and height were subtracted from each tree in the 12/31/2014 database. TPA of trees with a DBH less than 1" or heights less than 4 feet after the increment adjustment were adjusted to zero, resulting in a database representing the start date of the project, or approximately June 13, 2007.

For the purposes of calculating additionality for vintages 2007 through 2015, the reporting period will be considered to be seven and a half years in length.

Harvesting has occurred in four years since the Project was initiated, 2012, 2013, 2014, and 2015. In order to estimate the carbon stocks as of the project start date, in addition to adjusting the inventory data backwards seven and a half years, the harvests conducted prior to the 2015 inventory, in 2012 through 2014, must be accounted for. The process of accounting for those harvests and making appropriate adjustments is described in Exhibit A.

Updating the Inventory:

The inventory methodology included as Attachment N to the OPDR provides a detailed description of the methods that will be used to maintain and update the Usal Redwood Forest IFM inventory. FORSEE will be used to project inventory data either forward or backward as needed so that inventory plot data can be adjusted to the appropriate date for reporting of carbon stocks in future OPDRs. The following procedures will apply to inventory updates using average diameter and height increment data derived from 5-year FORSEE projections:

1. Inventory data gathered less than 4 months from the end of the reporting period will not be adjusted to the reporting period date.
2. Inventory data gathered between 4 months and 6 months from the end of the reporting period will be adjusted for one-half year's growth to represent the reporting period date.
3. Inventory data gathered between 6 months and 12 months from the end of the reporting period will be adjusted for one year's growth to represent the reporting period date.

Alternatively, if the inventory data needs to be adjusted in whole year increments, the inventory update feature of FORSEE may be utilized.

Missing Volume:

The inventory data upon which the baseline growth and yield analysis is based gathered data on missing volume from trees with broken tops, or from trees that included defects that reduced the tree's net carbon value. FORSEE outputs all growth and yield results in terms of gross volume or biomass. The carbon stock values presented in the OPDR as of the project commencement date, and the end of the initial reporting period are net of the missing volume recorded in the inventory data. In order to represent this missing volume in the baseline analysis, the average percentage of missing standing live carbon

stocks as of the Project start date are used to reduce the baseline growth and yield output from FORSEE.

Ingrowth:

Ingrowth in FORSEE is handled through the sprouting of species such as tanoak, madrone, black oak and white oak, and the addition of regeneration to bring the stand up to a minimum Forest Practice point count. The sprouting function in FORSEE (FSE.fsprout) was set to sprout 20% of sprouting species, as well as bringing the point count to specific point count levels per acre using the FORSEE point count regeneration function (FSE.fRegen_PtCount). Redwood was not included in sprouting species because the FORSEE point count regeneration function was used to moderate ingrowth.

Site Index:

Douglas-fir and/or redwood site trees are sampled as a part of the Usal Redwood Forest Operational Inventory each inventory for stands at least 30 years old. Douglas-fir is often preferred in mixed stands because of the sureness of counting rings. From the sample, site index is computed for Douglas-fir and redwood following the guidance set forth in "Wensel, L. and Krumland, B. 1986. A Site Index System for Redwood and Douglas-fir in California's North Coast Forest, Hilgardia Vol 54 Number 8, November 1986."

The stand data maintained within the GIS with the exception of the "recent clearcut" stands are assigned a 50-year Douglas-fir site index (DFSI). To calculate the DFSI for each stratum, each stand was weighted by the ratio of its net acreage to the total net acreage of the strata. These stand weights were multiplied by the stands' average DFSIs, then summed to calculate the weighted average Douglas-fir site indices for each stratum. Stands without DFSI values were assigned the average DFSI for the stratum in which they are located. A table of strata and DFSI was constructed as an input to FORSEE and is included as Table 3a below.

Table 3a: Average Douglas-fir Site Index by Stand

Stratum	DFSI
Conifer Low	106
Conifer Medium Low	108
Conifer Medium High	114
Conifer High	116
Hardwood Low	104
Hardwood Medium Low	103
Hardwood Medium High	102
Hardwood High	101

FORSEE adapts missing site tree estimators from the CRYPTOS/CACTOS research notes and the recent site publication of Krumland and Eng (2005-CDF California Forestry Report No. 4) Missing site index estimation uses the qualifying 'control' species, in this case Douglas-fir, with the most site index sample observations as the independent variable in either ratio or simple linear regression estimators.

For the purpose of modeling silvicultural prescriptions as part of the baseline analysis, the entire Project Area is treated as site class III as defined in the California Forest Practice Rules.

Project Acreage:

The Usal Redwood Forest Improved Forest Management Project is comprised of 47,981.54 acres of timberland. The topographic map included in Attachment E of the OPDR shows the Project Area boundary. Attachment E also includes GIS data in the form of a geodatabase that includes the Project Area boundary.

Baseline Modeling:

The baseline modeling utilizes the above-described June 13, 2007 dataset, and an unevenaged management harvesting strategy employing selection, transition, commercial thinning, and rehabilitation of understocked stands combined with small group openings not exceeding 2.5 acres in size. Portions of the Usal Redwood Forest timber stands are dominated by hardwoods species, or are in an understocked condition. The baseline modeling assumes an aggressive treatment of hardwood species in order to release existing

conifer regeneration, and convert areas dominated by hardwoods to conifer occupation. This reduction is accomplished through rehabilitation and hardwood release treatments.

At the Project's initiation on 6/13/2007 there were two approved Timber Harvest Plans (THPs) on the Project Area, 1-04-135MEN, and 1-06-058MEN. Commercial harvesting under these THPs was completed prior to the Project's initiation date by the previous landowner.

- THP 1-04-135MEN had a final completion filed on October 4, 2006. This final completion was rescinded following a completion inspection where some map point work was found to be inadequate. The map point work was completed in 2007 and the final completion re-submitted with the 2007 date. No harvesting occurred in 2007.
- THP 1-06-058MEN had all timber harvesting completed in 2006 as well. There was a partial completion filed in December 2006 which indicated that the only work remaining to do was the treatment of hardwoods to meet stocking requirements in the THP. The treatment of hardwoods was done in 2007 and no harvesting of timber occurred.

Baseline Harvest Strategy:

The baseline harvest strategy relies on the application of a series of harvest regimes across the Project Area timber stands. The regimes are modeled at the plot level and the growth and yield data is converted to stand level data. This group-selection harvest strategy allows for the harvest in small groups of a portion of the property located outside of WLPZs and no-harvest reserve areas within an 80-year period. Table 3b below describes the harvest regimes applied across the Usal Redwood Forest timber stands. The final baseline growth and yield analysis is determined by applying a percentage of each regime to each timber stand type.

The silvicultural prescriptions incorporated into the regimes are designed to best accommodate local timber stand conditions, while complying with the Forest Practice Rules as well as all other legal requirements. To accomplish this, a harvest strategy has been developed that evaluates each plot's stocking status in square feet of basal area per acre and point count stocking. Tables 4a-4c below illustrate the silviculture decision matrix upon which the growth and yield modeling is based. Harvesting under selection and transition, utilizes a BDq harvest strategy.

The "Bdq" formula is commonly used to describe the stand structure of uneven-aged forest stands and has been described extensively in the scientific literature. BDq refers to the stand structure with, in order of relative

importance: B, the residual basal area; D, the maximum retained diameter class; and q, the ratio of the number of trees in adjacent (one inch) diameter classes.

Table 3b: Harvest Regime Descriptions

Regime	Harvest Scenario Description
R1	This regime applies the silvicultural parameters outlined in tables 4a and 4b below. Simulates group selection by assigning plots to be group-selected in a given decade.
R9	No-harvest prescription applied to NSO activity centers, and NSO core areas.
R10	WLPZ harvest / NSO Nesting/Roosting prescription. Performs selection harvest every decade while retaining a minimum of 150 square feet of conifer and hardwood basal area per acre, and 60% canopy.
R2	NSO Low Quality Foraging Habitat prescription. Performs selection harvest every decade while retaining a minimum of 85 square feet of conifer and hardwood basal area per acre, and 40%-100% canopy.

General Harvest Constraints:

Harvest on the Usal Redwood Forest is constrained by several factors. Firstly, the California Forest Practice Rules (FPR) create a minimum set of silvicultural standards below which harvest cannot occur.

Legal requirements include all laws, regulations, and legally-binding commitments applicable to the Project Area at the time of the project's initiation that could affect standing live carbon stocks. The Usal Forest is subject to the Z'berg- Nejedly Forest Practice Act of 1973 (FPA) and the corresponding Forest Practice Rules (FPR). As the Project was initiated in 2007, the Forest Practice Rules in place in 2007 are applicable to the baseline analysis.

The rules that specifically effect the determination of baseline are those that include limits to silviculture activities. This includes the requirements for minimum basal area retention, rotation ages, harvest adjacency restrictions, watercourse buffer widths and sustained yield requirements.

The pertinent rules include the following:

- 14 CCR 913.11(c): Maximum Sustained Production of High Quality Timber Products;

- 14 CCR 913.2: Minimum basal area retention standards for Unevenaged Regeneration Methods;
- 14 CCR 913.2 (a)(2)(B): Group selection harvest limitations;
- 14 CCR 913.2 (b)(6): Minimum post-harvest residual basal area retention standards for the Transition method;
- 14 CCR 913.3 (a): Commercial thinning;
- 14 CCR 913.4 (b): standards for rehabilitation of Understocked Areas;
- 14 CCR 913.1 (c): standards for Seed Tree Seed Step;
- 14 CCR 916.5 Procedure for Determining Watercourse and Lake Protection Zone (WLPZ) Widths and Protective Measures;
- 14 CCR 919.9: Northern Spotted Owl
- 14 CCR 912.7(b): Resource Conservation Standards for Minimum Stocking

The methods by which the Forest Practice Rule constraints listed above as well as other legally binding constraints are incorporated into the baseline harvest scenario are described in the following sections.

Constraints Analysis:

Characterization:

Timber harvesting was modeled over 100 years for the baseline scenario, taking legal constraints, financial feasibility, and physical limitations into consideration while maintaining average live above-ground carbon stocks above the minimum baseline level. Forest stand development was projected using a combination of uneven-aged systems to create multi-aged conditions depending on the arrangement of treatment types over space and time. Forest stands were subject to treatment types based primarily on their forest structure and site attributes as it relates to the California Forest Practice Rules, e.g. Timber Site III vs. Timber Site IV or designated northern spotted owl (NSO) habitat vs. non-designated NSO habitat.

Baseline Legal Constraints:

Constraints that affect land-use specific to forest management activities have been incorporated into the carbon modeling. For this project, legal constraints have the greatest effect on timber harvesting levels, as opposed to what is financially feasible or physically possible. These legal constraints dictate what types of silvicultural activities (treatment types) are allowed, and where (spatial) and when (temporal) they are allowed, that is, there are different legal constraints for different locations of the project area. There are three general constraint types that determine what treatments are operable for any

given area: 1) Timber Site; 2) NSO designated habitat; and 3) Water and Lake Protection Zones. Each constraint, and how it is applied in the modeling, is described below by constraint class.

Northern Spotted Owl:

Twenty-three NSO activity centers are located with 0.7 miles of the Usal Redwood Forest Project Area. Activity center locations are taken from GIS data provided by Campbell Global in comparison to activity center locations stored in the CNDDB system. If is felt that the activity center locations maintained by Campbell Global are more accurate than those within the CNDDB system.

Harvest activity is restricted using the following parameters taken from guidance from the US Fish and Wildlife Service "Northern Spotted Owl Take Avoidance Analysis and Guidance for California Coast Forest District" ("Attachment A"), March 15, 2011.

<u>These restrictions are summarized as follows:</u>

Within the 0.7 mile radius (985 acres) of each Activity Center:

1) Retain habitat to maximize attributes desirable for NSO.

2) Retain at least 500 acres of suitable (Nesting /Roosting/Foraging) NSO habitat, post-harvest, as follows:

    a) Retain 200 acres of Nesting/Roosting habitat within a 0.7 mile radius of the Activity Center consisting of:
        i) 100 acres of the 200 acres of Nesting /Roosting habitat retained should be contiguous, or contiguous as possible with the Activity Center.
        ii) An Additional 100 acres of Nesting/Roosting habitat within the 0.7 mile radius:
            1) If the second 100 acres of Nesting/Roosting habitat is also contiguous with the Activity Center, or within the same drainage, operations should retain a minimum of 66% of the pre-harvest basal area per acre of trees at least 11" DBH.
            2) If the remaining 100 acres of Nesting/Roosting habitat is not contiguous with the Activity Center, retain at least Nesting/Roosting habitat.

b) Retain at least 300 acres of Suitable NSO habitat, post-harvest, of at least Foraging quality.

3) Remove no more than 1/3 of the remaining suitable habitat in excess of 500 acres within 0.7 miles of an Activity Center during the life of timber operations.

NSO Habitat Definitions:

Activity Center (AC): Area of concentrated activity of either a pair of NSO or a single territorial NSO, represented by a mapped location (e.g., usually a nest tree) that occurs within, but not necessarily in the exact center of, the "Core Area," defined below.

Core Area: 100 acres of the 200 acres of Nesting/Roosting habitat retained within a 0.7 mile radius contiguous with the Activity Center. If 100 acres of contiguous Nesting/Roosting is not available, then the highest quality habitat available shall be included.

Foraging Habitat: Habitat that contains ≥40% canopy cover of trees that are ≥ 11" DBH (diameter at breast height), and have a basal area ≥75 square feet per acre of trees ≥ 11" DBH. Trees may be conifer or hardwood.

Nesting/Roosting Habitat: Forested habitat that supports successful nesting and associated roosting behavior by NSO. Habitat with ≥60% canopy cover of trees that are ≥ 11" DBH, and have a basal area ≥ 100 square feet per acre of trees ≥ 11" DBH. Trees may be conifer or hardwood.

Regimes R2, and R10 have been designed to retain the required basal area and tree sizes as described in tables 4a-4c below for each respective NSO habitat type description. A GIS buffer analysis around the NSO activity centers was conducted to ensure that the required acreage of each type of NSO habitat was retained in the required quantity.

Within 1000 feet of each AC, no harvest was modeled and stratum acreage within this 1000' buffer distance are assigned to the R9 regime. Within a 0.7 mile radius of the AC, acreage was assigned to either the R2 or R10 regime while considering historical NSO habitat classification data provided by Campbell Global. Areas classified as the R10 regime were selected from stands in proximity to the 1000' AC buffer that were also attributed as Nest/Roost habitat in the NSO habitat GIS layer. Areas selected as the R2 regime were primarily attributed as foraging habitat in the NSO habitat GIS

layer. Stands classified as WLPZ buffer within the 0.7 mile buffer were not included in the assignment of R2/R10 regimes, but were spatially considered in the selection of stands to be harvested under either the R2 or R10 regime. In general, areas designated as WLPZ were adjacent to stands selected as the R2 or R10 regime.

Stand acres assigned to the R10 regime within the 0.7 mile AC buffer are treated as no harvest as a part of the final NSO harvest constraint analysis. This is felt to be conservative given the fact that some level of harvest is allowed within stands designated as NSO Nest/Roost habitat as long as sufficient acreage is retained.

As a means of adjusting the baseline to meet the MBL requirements of the COP, 96.64% of the acreage in each strata was reassigned from the R2 regime to the R9 regime.

Application of the above listed harvest restrictions associated with NSO activity centers resulted in the application of certain amounts of each timber strata being assigned to regimes R9, R10, and R2. Table 3c below includes a summary of acres by strata included in each of the above listed regimes.

Harvesting WLPZ Areas:

Utilizing the Usal Redwood Forest GIS the acreage associated with class I and II WLPZs was determined primarily from existing stands identified adjacent to class I and II watercourses. The buffering used to delineate these stands was based on a 150' buffer or larger for class I watercourses, and either a 100' or 75' buffer for class II watercourses. These buffer distances are consistent with Table I from 14 CCR 916.5 and 916.9 of the Forest Practice Rules. The resulting buffering analysis resulted in 5,704.67 acres located within class I or class II WLPZs. This represents approximately 11.9% of the net timbered acreage of the Project Area. These WLPZ acres are harvested using the R10 selection silvicultural prescription. Harvest levels within the WLPZ are designed to meet FPR standards for shade canopy retention. FPR requirements for the retention of the largest trees, and restrictions on harvests within the channel zone are addressed by adhering to 14 CCR 916.9 of the Forest Practice Rules.

Adjustment to Baseline due to Title Restriction:

An approximate 195.5 acre portion of the property described as "Township 23 North, Range 17 West, Section 36, SW ¼; NW ¼ SE ¼," is subject to a title

restriction that limits access to the described area. To account for this restriction, acreages on the Project Area within the constrained area were summarized by strata and amount to 190.1 acres. This 190.1 acre portion of the Project Area is subject to the "no-harvest" prescription in the baseline analysis.

Table 3c: Acres by Regime following NSO, and WLPZ Buffer Analysis

Stand	Acres	R9	R10	R2	Constrained Acres
Conifer High	1618.90	543.71	532.67	0.00	1076.37
Conifer Medium High	8686.23	1551.84	2276.99	0.00	3828.82
Conifer Medium Low	12860.67	1677.32	1760.96	0.00	3438.28
Conifer Low	4257.68	222.08	179.40	0.00	401.48
Hardwood High	2151.85	650.62	34.63	0.00	685.25
Hardwood Medium High	7560.21	1568.07	180.23	0.00	1748.30
Hardwood Medium Low	8454.17	1359.25	357.04	0.00	1716.28
Hardwood Low	2391.83	144.94	99.05	0.00	243.98
Grand Total	**47981.54**	**7717.82**	**5420.95**	**0.00**	**13138.77**

Table 3d: Procedures for Determining Watercourse and Lake Protection Zone Widths and Protective Measures[1]

Pursuant to 14 CCR 916.5

Water Class Characteristics or Key Indicator Beneficial Use	1) Domestic supplies, including springs, on site and/or within 100 feet downstream of the operations area and/or 2) Fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning.		1) Fish always or seasonally present offsite within 1000 feet downstream and/or 2) Aquatic habitat for nonfish aquatic species. 3) Excludes Class III waters that are tributary to Class I waters.		No aquatic life present, watercourse showing evidence of being capable of sediment transport to Class I and II waters under normal high water flow conditions after completion of timber operations.		Man-made watercourses, usually downstream, established domestic, agricultural, hydroelectric supply or other beneficial use.	
Water Class	Class I		Class II		Class III		Class IV	
Slope Class (%)	Width Feet	Protection Measure	Width Feet	Protection Measure	Width Feet	Protection Measure	Width Feet	Protection Measure
					[see 916.4(c)] [see 936.4(c)] [see 956.4(c)]		[see 916.4(c)] [see 936.4(c)] [see 956.4(c)]	
<30	75	BDG	50	BEI	See CFH		See CFI	
30-50	100	BDG	75	BEI	See CFH		See CFI	
>50	150[2]	ADG	100[3]	BEI	See CFH		See CFI	

1 - See Section 916.5(e) for letter designations application to this table.
2 – Subtract 50 feet width for cable yarding operations.
3 – Subtract 25 feet width for cable yarding operations.

Unevenaged Silviculture:

All forest stands in the project area are subject to retention standards for uneven-aged silviculture based on their "Timber Site" or site class. Forest stands in the project area of this constraint class must follow these terms at a minimum:

All forest stands where uneven-aged silviculture is applied shall maintain the minimum basal area retention thresholds of 125 square feet per acre for Site I stands and 75 square feet per acre for Site II and III stands and 50 square feet per acre for Site IV and V stands for selection silviculture, and 50 square feet per acre for transition silviculture for Site II and III stands.

Selection:

14 CCR 913.2: Minimum basal area retention standards for Unevenaged Regeneration Methods:

Unevenaged management is utilized to establish and maintain an unevenaged stand structure. Unevenaged management attributes include the establishment and/or maintenance of a multi-aged, balanced stand structure, promotion of growth on leave trees throughout a broad range of diameter classes, and encouragement of natural reproduction.

a) Selection Under the selection regeneration method, the trees are removed individually or in small groups sized from .25 acres to 2.5 acres.

1) Trees to be harvested or trees to be retained shall be marked by or under the supervision of the RPF prior to felling operations. When openings greater than .25 acres will be created, the boundaries of the small group(s) may be designated in lieu of marking individual trees within the small group areas. A sample area must be marked prior to a preharvest inspection for evaluation. The sample area shall include at least 10% of the harvest area up to a maximum of 20 acres per stand type which is representative of the range of conditions present in the area.

2) Post harvest stand stocking levels shall be stated in the THP. The level of residual stocking shall be consistent with maximum sustained production of high

quality timber products. In no case shall stocking be reduced below the following standards:

A. Selection System.

1. On Site I lands at least 125 square feet per acre of basal area shall be retained.

2. On Site II and III lands at least 75 square feet per acre of basal area shall be retained.

3. On Site IV and V lands at least 50 square feet per acre of basal area shall be retained.

4. Unless the plan submitter demonstrates how the proposed harvest will achieve MSP pursuant to 14 CCR § 913.11 (a) or (b), the residual stand shall contain sufficient trees to meet at least the basal area, size, and phenotypic quality of tree requirement specified under the seed tree method.

B. Group Selection.

1. At least 80% of the stocked plots must meet the Basal Area stocking standards of 14 CCR 913.2(a)(2)(A).

2. Not more than 20% of the stocked plots may meet stocking standards utilizing the 300 point count standard with trees that are at least 10 (ten) years old.

3. An RPF or supervised designee may offset up to 8 plots per 40 plots where those plot centers are initially placed within small group clearings created during the current harvest. Unless substantially damaged by fire, the RPF or supervised designee shall not exclude small group clearings created by previous timber harvesting from the stocking survey.

4. Unless the plan submitter demonstrates how the proposed harvest will achieve MSP pursuant to 14 CCR 913.11 (a) or (b), the residual stand shall contain sufficient trees to meet at least the basal area, size, and phenotypic quality of tree requirements specified under the seed tree method.

3) Within any THP, small group clearings under the selection method shall be separated by a logical logging area.

4) Following completion of timber operations (including site preparation) not more than 20 percent of the THP area harvested by this method shall be covered by small group clearings.

Transition:

14 CCR 913.2: Minimum basal area retention standards for Unevenaged Regeneration Methods:

b) Transition. The transition method may be used to develop an unevenaged stand from a stand that currently has an unbalanced irregular or evenaged structure. The transition method involves the removal of trees individually or in small groups from irregular or evenaged stands to create a balanced stand structure and to obtain natural reproduction.

1) Area for determination of preharvest seed tree retention levels shall be no greater than 20 acres in size.

2) This method is to be used to increase stocking and improve the balance of age classes so as to allow the residual stand to be managed by the selection regeneration method. This method shall not be used more than two times for a stand. The RPF shall delineate areas previously treated by the transition method on the plan map.

3) Stands suitable for the transition method contain adequate quantity and quality of seed producing trees to provide adequate regeneration for new age classes. Stands suitable for this method shall have no more than 50 sq. ft. of basal area greater than the selection basal area standards.

4) Trees to be harvested or trees to be retained shall be marked by or under the supervision of a RPF before felling operations. A sample area must be marked before the preharvest inspection for evaluation. The sample area shall include at least 10% of the harvest area up to a maximum of 20 acres per stand type which is representative of the range of conditions present.

5) Immediately following the completion of timber operations, the minimum basal area standards in 14 CCR 932.7(b)(2) shall be met.

6) The post harvested residual stand shall contain at least 15 square feet of basal area per acre of seed

trees at least 12 inches dbh or greater for timber sites I, II or III; or 12 square feet of basal area per acre of seed trees 12 inches dbh or greater for timber sites IV or V. Unless obviously stocked, these basal area requirements will be determined from sampling averaged across each harvested area required in 14 CCR § 933.2(b)(1). Unless the plan submitter demonstrates how the proposed harvest will achieve MSP pursuant to 14 CCR § 933.11(a) or (b) [953.11(a) or (b)], where present in the preharvest stand, disease free, undamaged seed trees 18 inches dbh or greater shall be retained post harvest until the stand exceeds the minimum seed tree requirements of 14 CCR § 933.1(c)(1)(A). The seed trees shall be full crown, capable of seed production and representative of the best phenotypes available in the present stand.

7) Following completion of timber operations (including site preparation) not more than 20 percent of the Plan area harvested by this method shall be occupied by small group clearings.

14 CCR 912.7: Resource Conservation Standards for Minimum Stocking:

The following resource conservation standards constitute minimum acceptable stocking in the Coast Forest District after timber operations have been completed.

b) An area on which timber operations have taken place shall be classified as acceptably stocked if either of the standards set forth in (1) or (2) below are met within five (5) years after completion of timber operations unless otherwise specified in the rules.

2) The average residual basal area measured in stems 1 inch or larger in diameter, is at least 85 square ft. per acre on Site I lands, and 50 square ft. per acre on lands of Site II classification or lower. Site classification shall be determined by the RPF who prepared the plan.

Commercial Thinning:

14 CCR 913.3: Intermediate Treatments:

a) **Commercial thinning.** Commercial thinning is the removal of trees in a young-growth stand to maintain or increase average stand diameter of the residual crop trees, promote timber growth, and/or improve forest health. The residual stand shall consist primarily of healthy and vigorous dominant and codominant trees from the preharvest stand.

1) Post harvest stand stocking levels shall be stated in the THP. The level of residual stocking shall be consistent with maximum sustained production of high quality timber products. Generally stands will develop stand structures with considerably higher levels of basal area than provided in these minimum standards as stand age increases. In no case shall stocking be reduced below the following standards:

A. Where the preharvest dominant and codominant crown canopy is occupied primarily by trees greater than 14 in. DBH:

1. On Site I lands, at least 125 sq. ft. per acre of basal area shall be left.

2. On Site II and III lands, at least 100 sq. ft. per acre of basal area shall be left.

3. On Site IV lands, at least 75 sq. ft. per acre of basal area shall be left.

4. On Site V lands, at least 50 sq. ft. per acre of basal area shall be left.

B. Where the preharvest dominant and codominant crown canopy is occupied primarily by trees less than 14 in. DBH, a minimum of 100 trees per acre over 4 in. DBH shall be retained for site I, II and III. For site IV and V - 75 trees per acre over 4 in. dbh shall be retained.

Rehabilitation of Understocked Areas:

14 CCR 913.3: Special Prescriptions:

The following special harvesting methods are appropriate under certain conditions:

b) **Rehabilitation of Understocked Area Prescription**. For the purposes of restoring and enhancing the productivity of commercial timberlands which do not meet the stocking standards defined in 14 CCR 912.7 prior to any timber

operations on such lands, an area may be harvested provided it is restocked in accordance with Subsections (l) or (2). To facilitate restocking, a regeneration plan must be included in the THP. The regeneration plan shall include site preparation, method of regeneration, and other information appropriate to evaluate the plan.

1) If the area meets the standards of 14 CCR 912.7 within five years of completion of timber operations, the area shall be considered acceptably stocked, or shall be considered acceptably stocked if it contains at least 10 planted countable trees for each tree harvested on sites I, II, and III, and 5 planted countable trees for each tree harvested on site IV and V.

2) On understocked timberlands where no countable conifer trees are to be harvested and the broadleaf species are not designated for management, the area shall be planted to equal or exceed the stocking standards of 14 CCR 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)] and shall be considered acceptably stocked if within five years of completion of timber operations it contains at least an average point count of 150 of Group A species on all site classifications.

This overall constraint is emulated in the baseline by setting a minimum basal area target for uneven-aged stands when they are treated. Approximately 6% of the Project Area is harvested as small groups each decade of the 100-year baseline analysis period during the second period on.

MSP:

All forest stands and baseline activities in the project area are subject to the Maximum Sustained Production (MSP) of High Quality Timber Products section of the California Forest Practice Rules. It is assumed in the baseline model that MSP is achieved pursuant to 14 CCR 913.11(c)(2) and (3), paraphrased below:

2) For uneven-aged management, complying with the seed tree retention standards, meeting minimum stocking and basal area standards for the selected silvicultural methods as contained in the Forest Practice Rules only with group A species, and protecting the soil, air, fish and wildlife, water resources and

other public trust resources through the application of these rules.

3) For intermediate treatments and special prescriptions, complying with the stocking requirements of the individual treatment or prescription.

This overall constraint is emulated in the baseline by requiring that selection and transition harvests retain at least 15 square feet of conifer basal area in trees 18" DBH or larger, and that rehabilitation and commercial thinning harvests meet the minimum stocking standards of the Forest Practice Rules.

Hardwood Harvest:

The Usal Redwood Forest's hardwood reduction program calls for the manipulation of hardwood stocking levels through, manual or mechanical treatments or commercial harvest, or basal herbicide treatments as appropriate. Understocked portions of the Project Area were modeled as a rehabilitation harvest per 14 CCR 913.4(b).

Baseline Harvest Summary:

Treatment types, or silviculture systems, were applied to forest stands in the baseline model such that they followed the silvicultural method objectives in Article 3 of the Forest Practice Rules and as additionally described in this section. Specifically, these treatments included selection, transition, commercial thinning, and rehabilitation of understocked stands. Treatments were selected and scheduled in the baseline based on legal constraint(s) and stocking.

The arrangement of these treatments over time and space create timber product value in both yields and appreciation and provide NSO habitat that is in line with the baseline scenario characterization and legal constraints. The application of the silvicultural regimes described below at the landscape level, yield an acceptable return on investment for the forest owner while maintaining compliance with the California Forest Practice Rules and NSO Take Avoidance protection measures. Overall, the baseline regime reflects maximum sustained productivity and a harvest and growth pattern that indefinitely serves multiple management objectives.

Standing Dead:

The standing dead carbon pool represents approximately 1.72% of the total carbon found on the Project Area, and is above the one metric ton test in the structural elements evaluation criteria under section 3.8.2 (Table 3.2) of the protocol. The standing dead carbon pool is treated as a static pool. As the baseline analysis involves ongoing forest management and maintenance of young and vigorous stands, standing dead levels are expected to be maintained at the estimated level. It could be argued that the baseline harvesting scenario would remove poorly formed and suppressed trees, thus capturing mortality that would have otherwise occurred under a harvest scenario that removed fewer trees and less volume over time.

Silvicultural Prescriptions

The following tables show the silvicultural constraints designed to demonstrate conformance with the requirements of the Forest Practice Rules.

Table 4a: Silvicultural Prescriptions used by the Usal Redwood Forest

Regime	Prescription	Description
R1	Selection	The goal of this prescription is to create and maintain, multistoried, uneven-aged stands with varied diameter classes. Trees are harvested individually, or in small groups up to 2.5 acres in size.
	Transition	The goal of this prescription is to develop uneven-aged stands from stands that have an even-aged or irregular stand structure. Trees are harvested individually, or in small groups up to 2.5 acres in size.
	Rehabilitation	The goal of this prescription is to regenerate stands that are primarily experiencing excessive hardwood competition, and that also do not meet minimum stocking standards. Successive harvests will utilize uneven-aged silviculture.
	Commercial Thinning	To promote timber growth and improve forest health through the harvest of trees in a manner that results in a stand capable of being managed using single tree or group selection.
R9	No Harvest	This prescription is used to account for those portions of the Project Area where harvesting is prohibited.
R10	Single Tree Selection (WLPZ/NSO Nest Roost Habitat)	The goal of this prescription is to create and maintain dense, multistoried, uneven-aged stands with varied diameter classes while meeting the retention standards for NSO Nesting/Roosting Habitat.
R2	Single Tree Selection (NSO Foraging Habitat)	The goal of this prescription is to create and maintain dense, multistoried, uneven-aged stands with varied diameter classes while meeting the retention standards for NSO Foraging Habitat.

Table 4b: Pre-harvest Stand Conditions by Silvicultural Prescription

Regime	Prescription	Pre-Harvest Conifer Basal Area (Square Feet per Acre)		Other Pre-Harvest Considerations
		Lower Limit	Upper Limit	
R1	Selection	125	None	Retain at least 15 square feet of basal area in trees 18" or larger.
	Transition	75	125	Retain at least 15 square feet of basal area in trees 18" or larger.
	Rehabilitation	0	50	Less than 300 point count, at least 100 square feet of hardwood basal area.
	Commercial Thinning	100	None	Greater than 100 square feet if basal area or greater than 75 trees per acre in trees 4" or larger.
R9	No Harvest	None	None	
R10	Single Tree Selection (WLPZ/NSO Nest Roost Habitat)	None	None	>11" QMD
R2	Single Tree Selection (NSO Foraging Habitat)	None	None	> 11" QMD

Table 4c: Post-harvest Stocking by Silvicultural Prescription

Regime	Prescription	Stocking Considerations	Conifer Basal Area Retention (sq. ft. per acre)	Hardwood Basal Area Retention (sq. ft. per acre)	Regeneration Assumptions	Time to Next Treatment
R1	Selection	Less than 20% of stand in group openings, at least 15 sq. ft. >18" DBH	≥80 1st period increasing 5 sq. ft. per decade to 100 in 5th period	10	300 Point Count, Sprout 20%	At Least 10 Years
	Transition	Less than 20% of stand in group openings, at least 15 sq. ft. >18" DBH	≥65 1st period, 75 2nd period	10	300 Point Count, Sprout 20%	Selection within 10-20 Years
	Rehabilitation		≥15where conifer≥15 pre-harvest	10	300 Point Count, Sprout 20%	Selection within 30-40 Years
	Commercial Thinning	Equal to or Greater average stand diameter than pre-harvest stand	>100 if QMD >14" and 100 4"+ trees if QMD <14"	10	300 Point Count, Sprout 20%	Selection within 10-20 Years
R9	No Harvest	None	None		None	
R10	Single Tree Selection (WLPZ/NSO Nest Roost Habitat)	>11" QMD	130	20	300 Point Count, Sprout 20% Hardwoods	At Least 10 Years
R2	Single Tree Selection (NSO Foraging Habitat)	> 11" QMD	75	10	300 Point Count, Sprout 20% Hardwoods	At Least 10 Years

Growth and Yield Analysis:

The baseline growth and yield analysis was modeled using the FORSEE model utilizing the above described harvest strategy. Table 5a shows the results of the growth and yield analysis in terms of conifer yields, while table 5b shows the results in terms of tonnes of live carbon for all species. Table 6 shows the results in terms of average basal area per acre over the 100-year planning horizon.

Table 5a: Average Annual per Acre Conifer Growth and Yield through the Planning Horizon (Scribner Board Feet per Acre)

Elapsed Time (years)	Beginning Inventory (board feet)	Average Decadal Growth (board feet)	Average Decadal Harvest (board feet)	Ending Inventory (board feet)
10	10,313	510	521	10,208
20	10,208	624	352	12,934
30	12,934	641	344	15,908
40	15,908	697	368	19,199
50	19,199	721	459	21,819
60	21,819	718	382	25,173
70	25,173	730	426	28,215
80	28,215	741	407	31,549
90	31,549	733	447	34,412
100	34,412	726	501	36,664

Table 5b: Average Annual per Acre Total Live Carbon Growth and Yield through the Planning Horizon (Mg C per Acre)

Elapsed Time (year)	Beginning Inventory (Mg Carbon)	Average Decadal Growth (Mg Carbon)	Average Decadal Harvest (Mg Carbon)	Ending Inventory (Mg Carbon)
10	56.99	1.74	3.20	42.32
20	50.43	1.66	1.72	49.84
30	49.51	1.50	0.84	56.12
40	56.16	1.47	1.13	59.54
50	59.14	1.39	1.02	62.84
60	62.36	1.33	0.82	67.49
70	67.41	1.31	0.86	71.87
80	71.67	1.27	0.82	76.16
90	75.88	1.22	0.84	79.59
100	79.41	1.18	0.91	82.12

Table 5c: Average Annual Total Live Carbon Growth and Yield through the Planning Horizon (Total Mg C)

Elapsed Time (year)	Beginning Inventory (Mg Carbon)	Average Decadal Growth (Mg Carbon)	Average Decadal Harvest (Mg Carbon)	Ending Inventory (Mg Carbon)
10	2,734,699.31	83,322.34	153,714.83	2,030,774.43
20	2,419,485.33	79,698.25	82,488.56	2,391,582.21
30	2,375,778.28	71,997.35	40,303.19	2,692,719.91
40	2,694,494.66	70,620.75	54,405.80	2,856,644.22
50	2,837,404.32	66,627.05	48,846.28	3,015,212.07
60	2,992,099.58	63,780.68	39,153.61	3,238,370.22
70	3,234,249.07	62,854.86	41,448.58	3,448,311.82
80	3,438,924.95	60,724.11	39,211.46	3,654,051.43
90	3,640,650.70	58,365.79	40,522.95	3,819,079.18
100	3,809,996.87	56,722.38	43,717.48	3,940,045.87

Table 6: Average Basal Area per Acre through the Planning Horizon

Elapsed Time (years)	0	10	20	30	40	50	60	70	80	90	100
Conifer	101	96	94	103	111	115	122	128	133	138	141
Hardwood	96	44	36	41	35	35	36	36	36	36	36
Total	197	140	130	144	146	150	157	164	169	174	177

Table 7 presents the percentage of each silvicultural regime applied to the various timber stands for the entire baseline modeling analysis.

Table 7: Application of Silvicultural Regimes through the 100-year Planning Horizon

	Regime				
Stand	**R1**	**R2**	**R9**	**R10**	**Total**
Conifer High	33.5%	0.0%	33.6%	32.9%	100%
Conifer Medium High	55.9%	0.0%	17.9%	26.2%	100%
Conifer Medium Low	73.3%	0.0%	13.0%	13.7%	100%
Conifer Low	90.6%	0.0%	5.2%	4.2%	100%
Hardwood High	68.2%	0.0%	30.2%	1.6%	100%
Hardwood Medium High	76.9%	0.0%	20.7%	2.4%	100%
Hardwood Medium Low	79.7%	0.0%	16.1%	4.2%	100%
Hardwood Low	89.8%	0.0%	6.1%	4.1%	100%

Baseline Carbon Stocks

The baseline modeling scenario defined in this document follows the guidelines presented in section 6.2 of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014.

Key components of the calculated baseline are as follows:

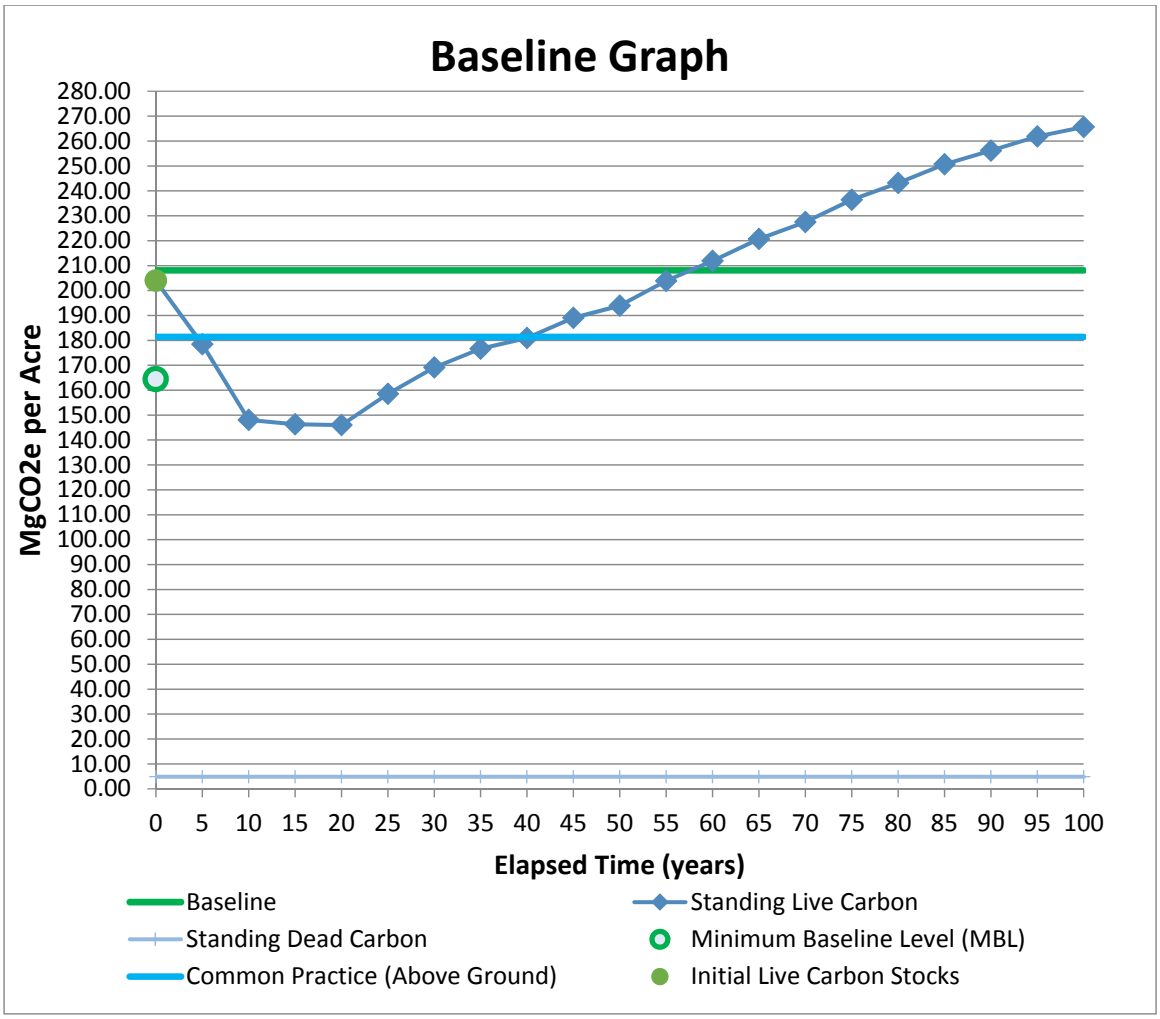
1. Initial Project live carbon stocks are below Common Practice.
2. The Project's MBL is not subject to the High Stocking Reference calculation.
3. Initial live carbon stocks have been modeled subject to all legal and financial constraints for a 100-year period.
4. The average carbon stocks of the 100-year baseline growth and yield modeling scenario have been calculated.
5. The average stocks of standing dead carbon over the 100-year period have been calculated.
6. The average production of In-Use carbon, landfill carbon, and harvested carbon prior to delivery to a mill have been calculated from the 100-year baseline growth and yield scenario.

Table 8 below shows the modeled standing live carbon stocks over the 100-year baseline analysis period, the projected standing dead carbon pool, and the resulting average baseline carbon stocks on a per acre basis. These figures are plotted in Figure 1 as well.

Table 8: Average Baseline Carbon Stocks per acre Generated by the Baseline Harvest Scenario (Mg CO2e per Acre).

Elapsed Time	Standing Live Carbon Pool IFM-1	Standing Live Above Ground	Standing Live Below Ground	Standing Dead Carbon Pool IFM-3	Baseline
0	204.00	164.38	39.63	4.82	208.10
5	178.45	143.58	34.87	4.82	208.10
10	148.06	118.62	29.44	4.82	208.10
15	146.33	117.37	28.96	4.82	208.10
20	146.02	116.97	29.06	4.82	208.10
25	158.52	127.24	31.28	4.82	208.10
30	169.13	135.96	33.17	4.82	208.10
35	176.61	142.22	34.39	4.82	208.10
40	180.95	145.86	35.09	4.82	208.10
45	189.06	152.63	36.42	4.82	208.10
50	193.91	156.73	37.19	4.82	208.10
55	203.87	164.95	38.92	4.82	208.10
60	211.87	171.54	40.33	4.82	208.10
65	220.69	178.83	41.85	4.82	208.10
70	227.48	184.45	43.02	4.82	208.10
75	236.43	191.87	44.55	4.82	208.10
80	243.16	197.46	45.69	4.82	208.10
85	250.65	203.70	46.95	4.82	208.10
90	256.17	208.30	47.86	4.82	208.10
95	261.84	213.04	48.79	4.82	208.10
100	265.65	216.24	49.40	4.82	208.10
Average	203.27	164.38	38.90	4.82	208.10

Figure 1: Baseline Carbon Stocks



Wood Products

The baseline growth and yield modeling produces a flow of wood products over the 100-year planning period. Table 9 below shows the average wood products generated over the 100-year period. Three average wood products numbers are presented: average wood products In-use, average wood products stored in landfills, and the average amount of carbon in standing live carbon stocks prior to delivery to a mill.

Table 9: Average Wood Products Carbon per acre Generated by the Baseline Harvest Scenario.

Woods Products	Mg C/ acre	Total Mg CO2e
Average Annual Carbon 100-year In-Use	0.123	21,626.63
Average Annual Carbon 100-year Landfill	0.079	13,972.22
Average Annual Carbon in Harvested Trees Prior to Delivery to the Mill	0.769	135,167.53

Attachments

Exhibit A - Adjustment of Carbon Stocks from 12/31/2014 to the Project Start Date to Account for Harvest

Exhibit A

Adjustment of Carbon Stocks from 12/31/2014 to the Project Start Date to Account for Harvest

The current carbon stock inventory for the Usal Redwood Forest was conducted in early 2015. In order to estimate the carbon stocks as of the project start date, the inventory data must be adjusted backwards approximately seven and a half years, and the harvest conducted in 2012 through 2014 must be accounted for.

Harvesting has occurred in three years since the Project was initiated, 2012, 2013, and 2014. Table 1 presents the gross board foot harvest volumes for each year.

Table 1: Gross Harvest Volumes by Year

Year	Harvest Volume MBF Scribner Short Log Scale
2012	1,230.97
2013	1,287.48
2014	2,810.72

Harvested carbon was calculated using the "Harvested Wood Products Worksheet" developed by the Climate Action Reserve. The total MgCO2e in harvested wood delivered to the mill each year calculated using the worksheet was then multiplied by the ratio of carbon in wood delivered to the mill to carbon in trees harvested for wood products (prior to delivery to the mill) derived from the baseline harvested wood products values. This ratio is approximately 1.94 for the Usal Redwood Forest Project, and is used to account for the carbon in harvested trees prior to delivery to the mill.

Table 2 shows the calculated carbon associated with the three years of harvest adjusted to account for harvested carbon prior to delivery to the mill.

Table 2: Harvested Carbon by Year

Year	2012	2013	2014	Total
Adjusted Harvested Carbon[1]	7,168	7,497	16,368	31,034
Harvest Carbon[2]	3,695	3,864	8,436	15,995

[1]Harvested Carbon times 1.94 Adjustment Factor

[2]Based on California Board of Equalization Records

Using GIS data that depicts the areas harvested since 2012, approximately 715 acres were harvested. In order to allocate the harvest by timber stratum, the harvested acreage was intersected with the timber strata layer. Table 3 below shows the acreage of harvest by stratum, and the assignment of harvested carbon by stratum.

Table 3: Assignment of Harvest by Stratum

Stratum	Acres	% of Acreage	Harvest Assignment ($MgCO_2E$)	Unadjusted Stratum Total ($MgCO_2E$)	Preharvest Stratum Total ($MgCO_2E$)	Harvest as % of Unadjusted Total
Conifer High	4.6	0.64%	198	439,656	439,854	0.05%
Conifer Low	74.2	10.38%	3,220	591,962	595,182	0.54%
Conifer Medium High	174.9	24.45%	7,588	2,086,891	2,094,478	0.36%
Conifer Medium Low	166.1	23.22%	7,206	2,343,901	2,351,107	0.31%
Hardwood Low	143.0	19.99%	6,203	313,284	319,487	1.98%
Hardwood Medium Low	152.6	21.33%	6,619	1,431,322	1,437,942	0.46%
Grand Total	**715.5**	**100.00%**	**31,034**	**7,207,017**	**7,238,050**	

The Harvest Assignment and Unadjusted Stratum Total $MgCO_2E$ were added together to estimate the Pre-harvest Stratum Total $MgCO_2E$, listed in Table 3. To adjust to inventory records to pre-harvest conditions, the TPAs of all tree records were adjusted uniformly within each stratum by a percentage factor, starting with the "Harvest as % of Total" values listed in Table 3. Since effects of these TPA adjustments on $MgCO_2E$ vary depending on the diameter and height of individual tree records, an iterative process was used to determine the appropriate TPA adjustment factor for each stratum. The final TPA adjustments and resulting adjusted stratum total MGCO2e values are shown in table 4.

Table 4: Adjustments to TPA by Stratum

Stratum	Unadjusted Stratum Total ($MgCO_2E$)	Adjustment % to Start Database TPAs by Stratum	Resulting Adjusted Stratum Total ($MgCO_2E$)
Conifer High	439,656	0.04606937801144%	439,854
Conifer Low	591,962	0.55694737166675%	595,182
Conifer Medium High	2,086,891	0.37192120870961%	2,094,478
Conifer Medium Low	2,343,901	0.31465248763335%	2,351,107
Hardwood Low	313,284	2.02806436463137%	319,487
Hardwood Medium Low	1,431,322	0.47337766336032%	1,437,942
Grand Total	**7,207,017**		**7,238,050**

ATTACHMENT N

USAL REDWOOD FOREST IFM
INVENTORY METHODOLOGY

This document contains specifications for the collection of data in the field for the Usal Redwood Forest Inventory, as well as the data to be collected and the standards for data collection and processing. The Usal Redwood Forest includes approximately 47,982 acres of timberland characterized by Redwood, Douglas-fir, Tanoak and associated hardwood species. The Usal Redwood Forest Offset Project Boundary includes the following GHG emission sources, GHG sinks, and GHG reservoirs (SSRs or Carbon Pools) as defined in table 5.2 of the Compliance Offset Protocol U.S. Forest Projects:

IFM-1	Standing live carbon (carbon in all portions of living trees)
IFM-3	Standing dead carbon (carbon in all portions of standing dead trees)
IFM-7	Carbon in in-use forest products
IFM-8	Forest product carbon in landfills
IFM-9	Biological emissions from site preparation activities
IFM-14	Biological emissions/removals from changes in harvesting on forestlands outside the Project Area
IFM-17	Biological emissions from decomposition of forest products

The inventory data upon which the carbon stock estimates are based includes plot data collected in early 2015. The Usal Redwood Forest inventory was conducted from January through the first week of March 2015 utilizing a random selection of plots located across eight timber stratum. Plot locations were determined from a random selection of plots from a 5 chain by 5 chain grid that uniformly covers the entire Project Area. The final inventory design resulted in the installation of 353 plots across the Project Area.

The standard procedures for collecting field measurements are generally aimed at the collection of tree data pertaining to the quantification of the IFM-1 and IFM-3 carbon pools and are detailed in the enclosed Usal Redwood Forest Carbon Inventory Data Collection Procedures and Standards document. Carbon in carbon pools IFM7, IFM-8, IFM-9, IFM-14, and IFM-17 are calculated as described in the calculation methodologies section below.

Inventory Methodologies

The data collection procedures are described in detail in the attached Usal Redwood Forest Carbon Inventory Data Collection Procedures and Standards (Appendix B).

Calculation Methodologies

A description of the calculation methodologies used to determine metric tons per acre of each of the carbon pools listed above is included in the initial OPDR under section VII(A) and is included herein by reference. Included are the analytic methods and biomass equation references used to translate field measurements into volume and biomass carbon estimates.

Data Management Systems and Data Processing

The inventory data gathered by this inventory methodology is entered into an Access database. Plot data within the database is extensively sorted and queried to look for data entry errors. This process results in a final data set for cruise processing. The Access database serves as the repository for inventory data and is accessed by the growth and yield model during growth and yield simulations and during future inventory updates.

The inventory database is utilized to process the inventory data through the growth and yield model FORSEE, and analyze the modeling outputs. The calculation of volume, biomass and the ultimate conversion to carbon utilizes the inventory data and growth and yield output data and applies the volume formulas and biomass conversion factors described in section VII (B) of the initial OPDR as referenced above.

Management of inventory data over the life of the Project will include archiving of retired inventory data as the data exceeds the maximum plot life requirements prescribed by the Protocol. Archived inventory data will also include a copy of each inventory database used to develop those carbon stock estimates reported in each OPDR submitted for the Project. This series of archived inventory database files will serve as the repository of inventory data as it existed for each reporting period.

Stratification Methodology

For operational purposes, the Usal Redwood Forest maintains a separate set of inventory data collected on a systematic grid across the entire URFC ownership without regard to timber stratification. The inventory is a stand based inventory of all stands at least 15 years of age, and includes data collected from 2000-2014. Using the cruise data from this operational inventory, a stratification methodology based on species composition and biomass density was assigned to each timber stand across the larger Project Area. This inventory data was not used for the purpose of generating carbon stock estimates for the Project Area, and was only used for the purpose of informing proper inventory stratification as described below.

Campbell Global provided plot and GIS stand boundary data for the majority of the Usal Redwood Forest Project Area. There were 74 stands classified as “recent clearcuts” for which no inventory data had been collected. In order to supplement the inventory data, 10 of these uncruised stands were selected for sampling in 2014. This additional cruise data was collected under the direction of Campbell Global, and was incorporated into the final cruise database. Tree data had been grown forward to January 1, 2014 by Campbell Global. Using data from plots inventoried in all years and Campbell Global’s FORSEE tables, basal area by species was calculated for all stands in FORSEE. Equivalent megagrams of carbon dioxide ($MgCO_2e$) per acre were then calculated for all stands using the FORSEE carbon calculation script. Based on these basal areas, stands were classified as hardwood or conifer dominated. Stands were then stratified into four strata in hardwood dominated stands and four strata in conifer dominated stands, based on $MgCO_2E$ per acre, from low to high. Stands were categorized into these strata such that there was the least possible variation in $MgCO_2E$ within each strata and the greatest

possible variation in $MgCO_2e$ between each stratum by using a tool in ArcGIS to establish natural breaks.
Some stands on the property were not inventoried and, therefore, not stratified using the process described above. Out of two stands of manageable brush, one was small and assigned to the strata of the stand surrounding it. The other, viewed in an aerial photograph and found to have very little timber, was included in an "OUT" strata, indicating that it would not be included in the Project Area. The remainder of the un-inventoried stands had slope stability issues or were recently clearcut. The clearcut stands were assigned to one of the eight strata based on aerial photo interpretation. All of the un-inventoried stands with slope stability issues were assigned to the "OUT" strata. Some stands inventoried by Campbell Global included areas off of the property. These areas were removed from the Project Area and were also assigned to the "OUT" strata.

Net acreage for each stand was calculated by geometry in ArcGIS. Road buffer width is based on road status and surface type. A description of the buffering assumptions provided by Campbell Global is included below as Appendix C. Polygons representing the road buffer have been removed from the strata in ARCGIS. The modeling plan describes the process for updating the inventory to the Project's commencement date in 2007, and the end of the initial reporting period in 2014 under the Usal Redwood Forest Early Action Program.

Approximately 1,330 acres of the Project Area was harvested in 2015 under five timber harvest plans. Per the inventory update procedures, the harvested stands were placed into one of the eight stratum based on the stands previous stratum definition, the level of harvest, and a field review of the harvested areas. Ten of the plots installed in 2015 were within the harvested portion of the project area. These harvested plots were removed from the inventory database, and a random selection of ten new plots was performed across the harvested area. The new plot data and updated stratification was incorporated into the inventory database. A map of the strata is included as Appendix D. Table 1 below presents the results of the current stratification.

Table 1: Strata and Plot Summary

Stand	Acres	Plots
Conifer High	1513.09	20
Conifer Medium High	8486.05	76
Conifer Medium Low	12977.01	91
Conifer Low	4505.65	28
Hardwood High	2116.17	19
Hardwood Medium High	7488.99	52
Hardwood Medium Low	8499.85	52
Hardwood Low	2394.73	15
Total	47981.54	353

Quality Assurance/Quality Control (QA/QC)

Procedures for ensuring quality control are explained in section 7 (Inspections) of the attached inventory methodology document.

Inventory Monitoring

Updating the Inventory

Updating the Project's carbon stocks from the end of the last reporting period to the end of the current reporting period will involve the following steps:

1. Any newly installed inventory plots will be incorporated into the inventory estimate. Newly installed plots will be grown forward to the end of the reporting period utilizing FORSEE as described in the modeling plan.
2. Existing inventory plots that are less than 12 years old will be updated using FORSEE as described in the modeling plan. This update process will involve adjusting the plot data one year forward either by using FORSEE's "Inventory Update" tool, or through the application of average annual increment based on diameter and height increment predicted by FORSEE over the next-five-year period.
3. Plots older than 12-years will be replaced in the database by new plot data collected at the same plot location. Retired plot data will be archived as described in the Data Management Systems section above.
4. Updating the forest inventory for harvests or disturbances will involve either the installation of new plots, or adjustments to previous plot data.
    a. If new inventory plots are installed, they will be installed at randomly selected plot locations taken from the 5x5 chain grid within the harvested or disturbed portion of the Project Area. The number of randomly selected plots will be determined based on the size of the area harvested or disturbed, and estimated carbon stock variability within the harvested or disturbed area.
        i. Existing inventory plot data within the harvested or disturbed area will be removed from the inventory database.
        ii. Harvested or disturbed areas will be stratified based on the current inventory stratification, or may be placed into a new stratum representing the harvested or disturbed area.
    b. At the discretion of the OPO, inventory updates may involve adjustments to existing plot data (depletions) that will involve the following steps:
        i. The carbon in harvested wood products delivered to the mill will be calculated using the "Harvested Wood Products Worksheet" provided by CAR, and included as Appendix E herein.
        ii. Using the ratio of harvested wood carbon to harvested tree carbon calculated in Table 8 of the CAR worksheet. The carbon in harvested wood products will be multiplied by this ratio to determine the total amount of carbon subject to harvest. This carbon will be subtracted from the carbon stock estimate derived through the inventory stock estimate generated by updating the existing inventory data as described above.
5. Disturbances related to fire, insect or disease, and unauthorized harvest will be monitored through annual inspections of the Project Area by the OPO. Portions of the Project Area

affected by fire, insect or disease, or unauthorized harvest will be mapped and reported in the OPDR. If the mapped disturbed portion of the Project Area is less than 5 acres in cumulative size, no adjustment to the carbon stock inventory will be performed. For mapped disturbances between 5 and 40 acres of cumulative size, a depletion of the inventory based on the average stocking and acreage of each stratum disturbed will be calculated, or at the discretion of the OPO, new inventory plots may be installed following the procedures described in step 4(a) above. For mapped disturbances larger than 40 acres in cumulative size, new inventory plots will be installed following the procedures described in step 4(a) above.

6. The field collection of updated inventory data following harvest, hardwood reduction or disturbance will be conducted prior to the next field verification, and at a minimum within 36 months of the harvest or disturbance.
7. A revised inventory confidence deduction will be calculated following the update process in years when a verification will be conducted.

Identification of Known or Potential Diseases:

Known or potential diseases that may affect the health of the project's inventory, specifically above-ground standing live and dead trees are listed below:

In Douglas fir the most prevalent disease is Phellinus pini, known as white pocket rot, white speck or red ring rot. This is the most damaging wood rot in the western states. The presence of fruiting bodies or "conks" is the best indicator of infection. The size and frequency of the conks present may provide an indication of the amount of decay, but caution must be exercised until local conditions can be assessed. Infections associated with white speck become established through living and dead branches or branch stubs. The best way to reduce risk of white speck infection is to avoid damaging trees within the stand. This disease does not usually result in the imminent death of the infected tree.

Fomes annosus root rot can attack both the Douglas-fir and/or grand fir present on the project. The sapwood and inner bark of small to medium sized roots and the heartwood of larger roots is infested when the fungus attacks. Frequently, the infection spreads through the roots and into the lower trunk of the host, causing butt rot of the heartwood. Heartwood and root rots often predispose fir trees to wind throw and/or fatal insect attack. Within 2 to 6 years, the disease moves to the tree's root crown and girdles it, thereby killing the tree. The Fomes fungus subsequently acts as a wood decay organism and may remain viable in surrounding soil for as long as fifty years. The disease is spread by spores that colonize freshly cut stumps, growing into the root system and spreading to surrounding areas via root contacts with adjacent trees. Fomes annosus has not been observed during fieldwork on the property. Group killing of trees, with the oldest deaths at the center and more recently dead trees on the periphery, is a common symptom of infection within pine stands. The presence of fruiting bodies on infected trees is the best evidence of disease. These vary in size, but are usually found around the base of the tree just below the duff, or within the hollow of infected stumps. Examination of roots or root crowns can also indicate the presence of the disease.

Another disease present in the Douglas fir is Leptographium wageneri var. pseudotsugae, black stain root disease. Black stain is recognizable by weakening symptoms in the trees such as declining vigor, reduced needle retention, and dull gray/green foliage discoloration. Black stain will occur in the sapwood of the roots, root crown and lower bole. The stain in cross section follows the annual rings in circular pattern and not radially as typical of other stains. Since black stain spreads by root graft (as well as by spores), the disease can be partially controlled by removing all the infected trees from the area of infection as well as adjacent trees not yet displaying symptoms.

Sudden Oak Dealth (SOD) is a plant disease caused by the pathogen Phytophthora ramorum. This disease may be transported to new areas when infected plants, infested soil, or contaminated water are moved. Although SOD is not prevalent on the property to date, the Project Area is within SOD zone of infestation. Tanoak would be the primary species affected by this pathogen but a variety of other species, both hardwood and conifer, can be infected. Information about ongoing research and up to date regulations are available at www.suddenoakdeath.org, a site operated by the California Oak Mortality Taskforce.

Appendices:

A. Inventory Change Log
B. Usal Redwood Forest Carbon Inventory Data Collection Procedures and Standards (**Proprietary**)
C. Road Buffer Assumptions
D. Plot and Strata Map
E. CAR Harvested Wood Products Worksheet

Appendix A

Usal Redwood Forest IFM Inventory Change Log

Date of Change	Note (changes made)
6/17/2016	Biomass Equation for Madrone CVTS updated to include the threshold height.
7/22/2016	61 live trees coded with a damage code for broken top had a carbon defect value calculated based on the difference between the regressed total height, and the total height recorded in the field.
7/22/2016	For standing dead trees coded with a broken top, additional carbon defect should have been added to reflect the difference between the recorded total height, and the regressed total height. This occurred on four trees in the original database. For these trees, additional carbon defect was added to reflect the missing top.
7/22/2016	We found two trees that have questionable heights due to a data processing error in the database, these are trees 9 and 18 on plot 04856045, and the incorrect heights for these trees were set to the heights provided by the cruisers. A number of snags of decay class 4 and 5 have recorded heights that indicate that the cruiser neglected to indicate that the snag had a broken top. These trees have been identified as snags with decay class 4 or 5 that have a height to DBH ratio less than 2.3, and represent 42 trees. These 42 trees have been coded as broken top trees, have had a regressed total height calculated, and a corresponding carbon defect calculated. Thirteen live trees (5 DF, 4 CR, 2 TO, and 2 MA) have had their heights regressed based on height to DBH ratios (<1.5 for CR, TO, and MA, and <2.0 for DF) that indicate that the recorded height is in error.

Appendix B

Usal Redwood Forest Carbon Inventory Data Collection Procedures and Standards (Proprietary)

Usal Redwood Forest

Carbon Inventory Data Collection Procedures and Standards

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1 CRUISE UNIT TYPING

The Usal Redwood Forest carbon inventory, cruise units are the stratum developed from the larger operational inventory.

2 PLOT ESTABLISHMENT

2-1 Plot Layout

Plot locations have been determined from a random selection of plots from a 5 chain by 5 chain grid that uniformly covers the entire Project Area. Maps of these randomly selected plots shall be provided to the contract cruisers. Contract cruisers shall establish the plots as mapped.

2-2 Navigating To Plot Centers

2-2.1 REFERENCE POINT (RP)

The goal of navigating is to place plot centers without bias at their mapped location within the cruise unit of sample (stratum). Follow these guidelines to accomplish the objective.

Cruisers will primarily use GPS units to navigate to and establish plot centers. To establish a GPS RP, stand in an opening not under canopy at least a chain from the intended plot center. Wait for good signal and report that accuracy is within a few feet, then use the GPS unit's "Go To" function to find the direction and distance to plot center. The cruiser shall then measure the distance to the plot center using a hand compass and steel tape, hip chain or electronic device. To avoid bias due to canopy and other factors, NEVER "chase signal" once the plot center above is reached by using distance and bearing indicated above.

2-2.2 NAVIGATION ROUTE DOCUMENTATION

Cruise Maps will be provided for Contractor to use for submitting Navigation Route Documentation. For each plot or group of plots cruised, Contractor shall notate on the Cruise Map:

1. Navigation routes with directional arrows.
2. Locations of plots exceeding a chain from their intended, mapped locations.
3. Cruiser initials.
4. Dates cruised.
5. Date submitted.

2-2.3 HAZARDOUS PLOT LOCATIONS

Plots may occur on hazardous landscapes such as but not limited to: streams, cliffs, and slides. If a plot is judged too unsafe to sample, contractor shall offset the plot 33 feet in a cardinal direction (North-East-South-West) that allows for the plot to stay in the same strata as previously mapped and the location is deemed safe to cruise.

The contractor is required to take a GPS point at the offset plot location and record the latitude and longitude in the plot notes.

2-3 Monuments

2-3.1 MONUMENT MATERIALS

The supplies used in the monumentation of Work are specified in Table 2-1 below.

Table 2-1
Material Specifications for Monuments

Item	Specification	Suggested Supplier
Flagging	Striped red and black vinyl flagging	Pacforest Supply Company http://www.pacforestsupply.com/
Flagging	White vinyl flagging	Pacforest Supply Company http://www.pacforestsupply.com/
Wire Stake Flag	Fluorescent-pink, 15” long wire stake flag having a 2 ½” x 3 ½” flag size	Pacforest Supply Company http://www.pacforestsupply.com/
Rebar plot center Stake	3/8” Rebar stake at least 16” in length with the top 6” painted.	Supplied by Company
Plot Tags	Model 1E34 3” X 4” write-on aluminum tag	Loma Industries http://www.lomaindustries.com/tags.htm

Nails	Aluminum siding plain shank style nail having a 0.128" diameter shank and a 3/8" diameter head	Forestry Suppliers http://forestry-suppliers.com/
Marker used when writing on flagging and wire stake flags	Wide-tip or bullet-tip, black permanent marker	No suggestion
Paint	white paint	Supplied by Company

2-3.2 REFERENCE POINT (RP) MONUMENTS

Three flags hung high, apart, and easily seen from a distance will monument RPs of navigation routes (one white flag, two red and black striped flags). Record on the white flag: (1) the plot number being navigated to; (2) the direction and distance to get there; (3) the cruiser doing the work, and (4) that day's date.

2-3.3 PLOT CENTER MONUMENTS

2-3.3.a Inventory Cruise Plot Center Monuments

Plot Center

Monument plot center with a wire stake flag and 3/8" rebar stake. The rebar stake shall be hammered into the ground such that at least 10" of the stake is below ground, and the top 6" of the plot stake shall be painted.

Flagging

By plot center, and preferably on either side, hang two black and red striped flags high, long, and apart in a way easily seen from a distance. In addition, do the following in these special circumstances.

Failed Inspection. Sometimes work fails inspection and plots must be re-visited for correction. When plots are re-visited for correction, hang high and long an additional flag listing the following information: "RW" (meaning rework); the cruiser doing the work, and that day's date.

Plot Tag

Find an object to attach a plot tag. Prefer choosing an object in the order shown below.

1. Live, healthy, sampled tree at least 6" DBH in size.
2. Largest, live, healthy, sampled tree at least 3.6" DBH in size.
3. Any live, healthy tree near plot center following the 1 and 2 size and preference guidelines above.
4. Any reasonable, nearby object that can be tagged (a snag, a stump, a log) (do not tag brush).

5. If nothing reasonable is present that a tag can be attached to using a nail, do not install a tag. Instead, write tag information on one of the hung flags.

Choose a spot on the object to attach the tag in a location that is (1) facing plot center and (2) preferably below stump height or close to the ground. Determine the direction (azimuth) and horizontal distance (to the nearest 1/10 foot) from the chosen spot of the tag to the plot center then scribe on the tag the information listed below.

1. Eight-digit grid plot number. Plot numbers are shown on cruise maps and begin with a "C".
2. Azimuth (True) and horizontal distance (format example 275d 4.7ft).
3. Cruise date.
4. Cruiser's initials.
5. Optional note (e.g. PC is on stump).

Using a nail, attach the tag at the chosen spot. Allow for growth by sinking the nail only deep enough to secure the tag. When done, the plot tag and stake install should look similar to Figures 2-3.

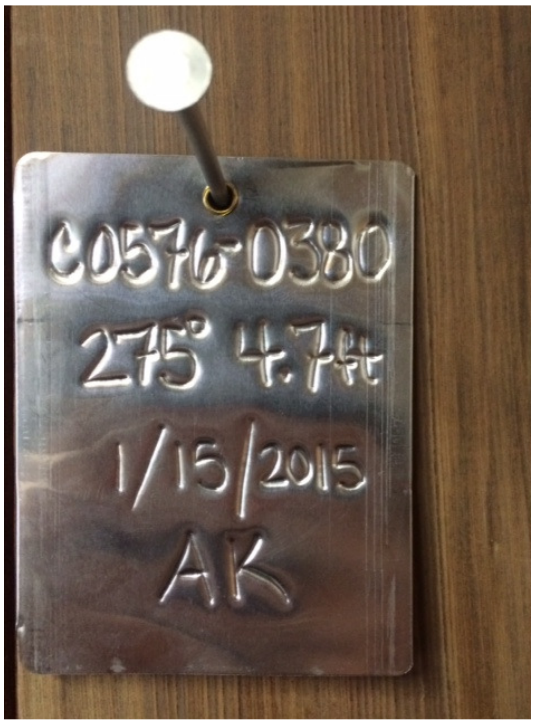


Figure 2-3 Plot Tag. *When attaching the plot tag, allow for growth by sinking the nail only deep enough to make the tag secure. The optional note is omitted from this example.*

3 PLOT SAMPLING PROCEDURES

3-1 Inventory Cruising

3-1.1 TREES SAMPLED

Trees that are sampled are described below.

1. Any live planted or seed-origin tree that has survived on-site at least 1.0" in diameter.
2. Any live stump sprout which is upright (not growing like a lateral branch) and is at least 1.0" in diameter.
3. Dead Trees which are at least 5.0" DBH and at least 15 feet tall.

Like dead trees, live trees have minimum DBH restrictions. See the "*3-1.2 Sample Design*" section below.

3-1.2 SAMPLE DESIGN

Nested, circular fixed area subplots are used when selecting trees. Nested means the different samples taken will all have a common plot (point) center.

Table 3-1
Sample Design for Nested Plot Sampling

Sample Design Code	Nested Subplot by DBH Range		
	Subplot 1 (1.0" – 3.5")	Subplot 2 (3.6" – 10.5")	Subplot 3 (>= 10.6")
1	1/100 Acre	1/50 Acre	1/10 Acre

3-1.3 ORDER OF TALLY

Follow these orders of tally instructions to speed inspections. Sample trees are recorded clockwise from north. Record any nested subplot 1 trees first, then record subplot 2 trees and finally subplot 3 trees. If trees are directly behind one another, start with the closest one from plot center and proceed outward. The contractor has the option to sample subplot 2 and 3 trees together if that process is easier for data collection.

3-1.4 SAMPLING EDGES OF CRUISE UNITS

Sometimes a plot center lands on or near a cruise unit border. Where trees on either side of the border area are clearly similar in size, stocking, spatial arrangement, and species composition (similar typing), tally all the trees within the nested subplots regardless of whether they lie within or outside the cruise unit. In simple words, sample a full plot.

When a nested subplot crosses over the cruise unit border and trees on either side of the border area are clearly not similar (typing is not the same), cruise trees using the walk-through method.

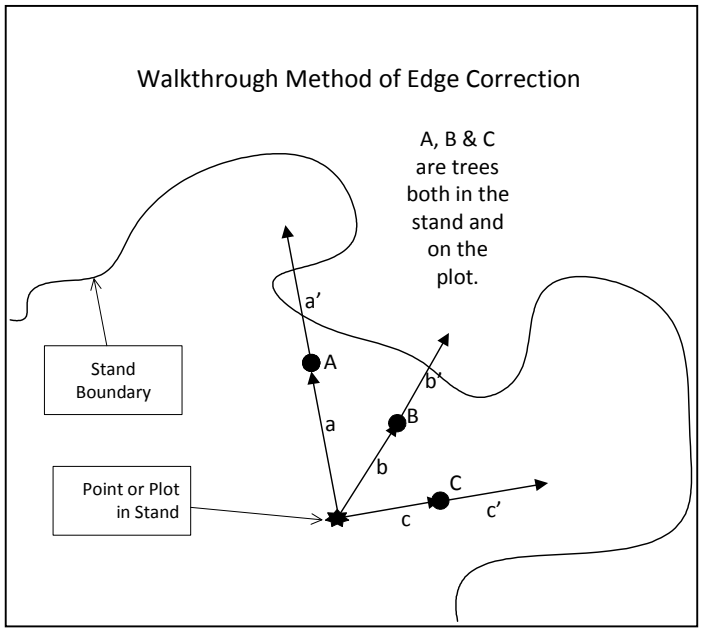
3-1.4.a Watercourses near a Cruise Unit Boundary

For stands whose boundary is a watercourse and a plot falls near the watercourse, cruise the plot as a normal plot so long as the plot coverage does not cross a property boundary.

3-1.4.b Walk-through Method

The walkthrough method has both the advantages of being unbiased in almost all cases and of accommodating uneven stand boundaries. The walkthrough method is simple to implement:

- Establish the point or plot where it falls, and record all 'in' trees within the stand.
- For each tree 'in' the point sample or on the fixed plot that falls between the point and the stand boundary, measure the horizontal distance from the point or plot center to the tree in question.
- Extend the line from the plot center through the tree by the same horizontal distance.
- If the end of the extended line is inside the stand, count the tree once. If the end of the extended line is outside the stand count the tree twice.



The accompanying figure illustrates the walkthrough method as described above. In this case trees A and C would be counted once and tree B will be counted twice.

3-1.4.c Roads

Cruise plots landing on unmapped (legacy) roads, abandoned roads, landings, and trails where they fall, for these components are a part of the unit of sample. Paved, rocked, or dirt roads as shown on the cruise maps are excluded from the Carbon Project Area, and as such are not sampled. Consider the road edges, defined as the top of the cut slope and where road grading ends on the fill slope, a cruise unit border.

Cruise plots having a plot center on the edge of a mapped, un-abandoned road (Figure 3-10). Get to the road edge to install plot center (see the edge definition above). Use an edge sampling method while ignoring trees located across the road.

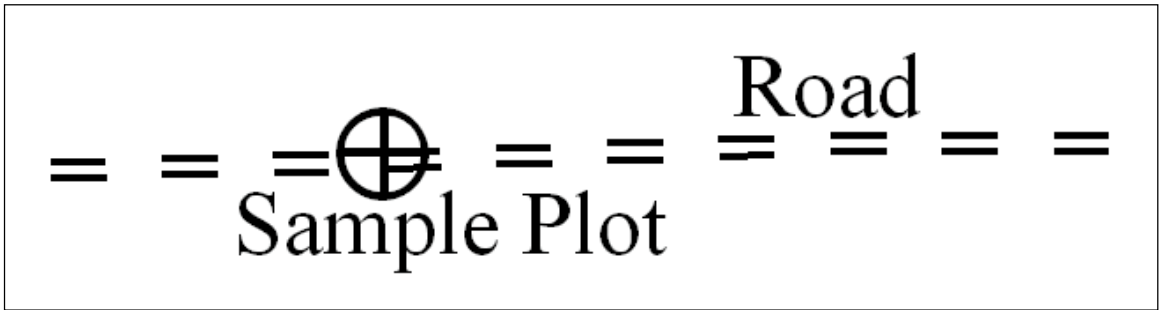


Figure 3-10 Non-Road Plot mapped on the edge of a road. *The plot center (the cross hairs of the sample plot) is on the mapped, un-abandoned, road-edge. Cruise the plot installing plot center at the road corridor edge defined as the top of the cut slope or where road grading ends on the fill slope.*

3-1.5 BORDERLINE CALLS

View trees whose boles of which have grown together as separate trees (do not group them together as one tree having fork damage). Likewise, view each fork emanating from a tree at or below breast height (BH) as a separate tree. BH is defined as the point on a tree's bole 4.5 feet distant from the ground line on the tree's uphill side, or, if a stump sprout, the point on a tree's bole 4.5 feet distant from the sprout's stump origin.

The sampling plane of fixed plots is ground line. Trees are tallied when their center or pith at ground line lies within (inside or on) the fixed plot circle. Where trees are growing off of stumps, the point of reference shall be the center of the tree where the tree is attached to the stump. Round computed fixed plot sizes to the nearest $1/100^{th}$ foot. Table 3-2 lists the horizontal fixed plot sizes used for inventory cruising.

Table 3-2
Fixed Plot Sizes used for Inventory Cruising

Fixed Plot Size in Acres	Horizontal Plot Radius in Feet
1/100	11.78
1/50	16.65
1/10	37.24

It is important to get a tree's borderline call right, for missing or adding trees will cause an inspection to fail. When the horizontal distance of a tree candidate to plot center must be computed for comparison to a given plots radius, prefer computing the distance using the slope correction formula shown in Figure 3-11. Slope correction tables may also be used.

Formula (Form 1) **s = h / cos(Ø)**

or

Formula (Form 2) **h = s [cos(Ø)]**

where

s = slope distance,
h = horizontal distance, and
Ø = angle in degrees

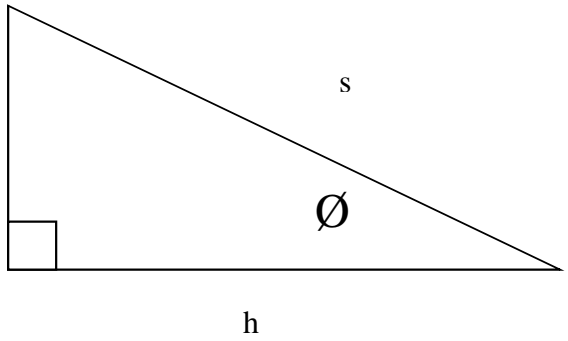
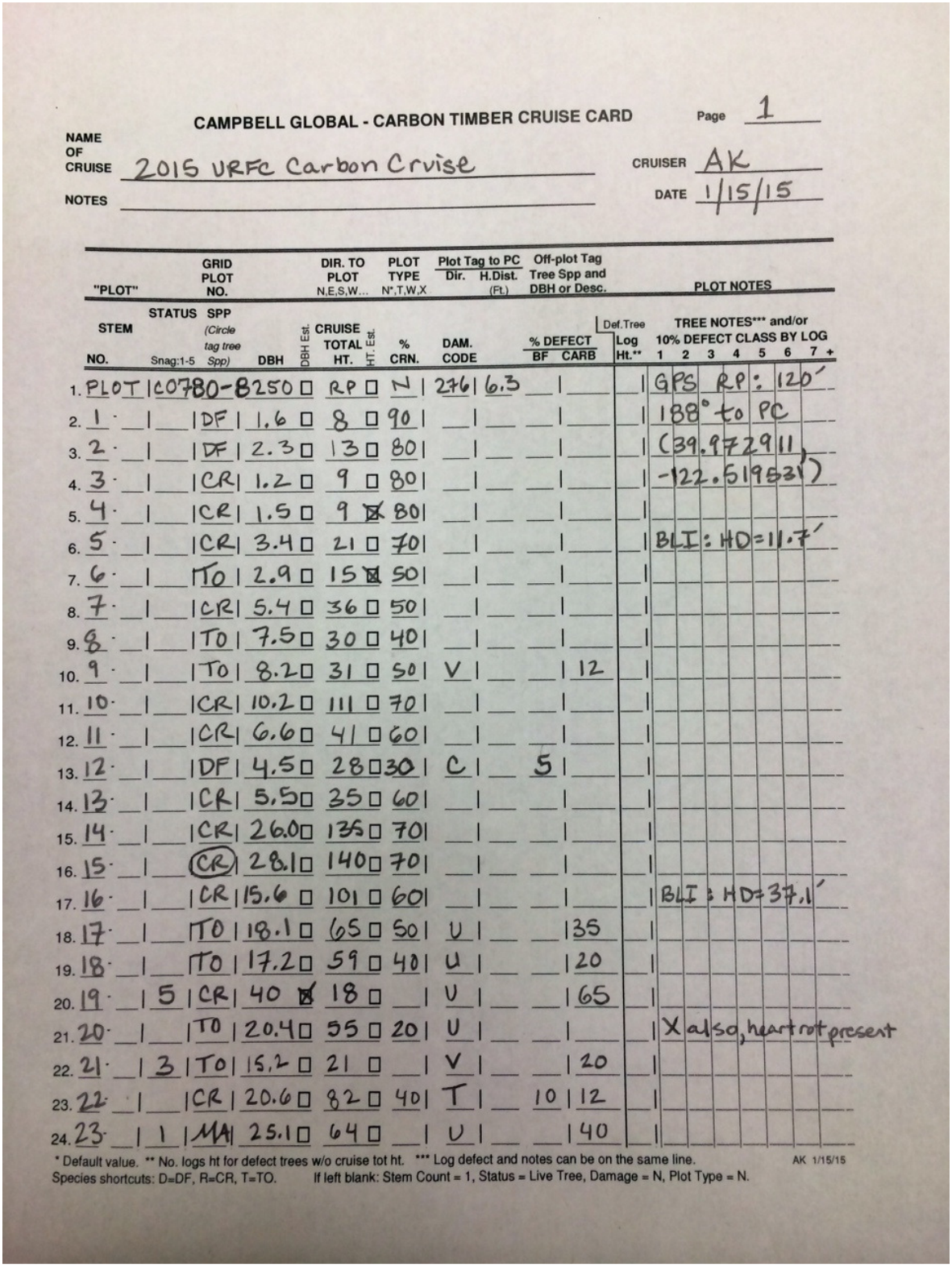


Figure 3-11 Horizontal Distance Formula. *Compute horizontal distance using the slope correction formula above.*

4 COLLECTED DATA

Figure 4-1 shows the cruise card with some sample data. Data recorded on the card are divided into the categories of "Stand", "Plot", and "Stem". The cell where each data is recorded is bounded by the columns of its column heading.



CAMPBELL GLOBAL - CARBON TIMBER CRUISE CARD Page 1

NAME OF CRUISE 2015 URFC Carbon Cruise CRUISER AK

NOTES DATE 1/15/15

"PLOT"	GRID PLOT NO.	DIR. TO PLOT N,E,S,W...	PLOT TYPE N*,T,W,X	Plot Tag to PC Dir.	Plot Tag to PC H.Dist. (Ft.)	Off-plot Tag Tree Spp and DBH or Desc.	PLOT NOTES
1	C0780-8250	RP	N	276	6.3		GPS RP: 120' 188° to PC (39.972911, -122.519531)

STEM NO.	STATUS Snag:1-5	SPP (Circle tag tree Spp)	DBH	DBH Est.	CRUISE TOTAL HT.	HT. Est.	% CRN.	DAM. CODE	% DEFECT BF	% DEFECT CARB	Def.Tree Log Ht.**	TREE NOTES*** and/or 10% DEFECT CLASS BY LOG 1 2 3 4 5 6 7+
2		DF	1.6		8		90					
3		DF	2.3		13		80					
4		CR	1.2		9		80					
5		CR	1.5		9	X	80					
6		CR	3.4		21		70					BLI: HD=11.7'
7		TO	2.9		15	X	50					
8		CR	5.4		36		50					
9		TO	7.5		30		40					
10		TO	8.2		31		50	V		12		
11		CR	10.2		111		70					
12		CR	6.6		41		60					
13		DF	4.5		28		30	C	5			
14		CR	5.5		35		60					
15		CR	26.0		135		70					
16		(CR)	28.1		140		70					
17		CR	15.6		101		60					BLI: HD=37.1'
18		TO	18.1		65		50	U		35		
19		TO	17.2		59		40	U		20		
20	5	CR	40	X	18			U		65		
21		TO	20.4		55		20	U				X also, heart rot present
22	3	TO	15.2		21			V		20		
23		CR	20.6		82		40	T	10	12		
24	1	MA	25.1		64			U		40		

* Default value. ** No. logs ht for defect trees w/o cruise tot ht. *** Log defect and notes can be on the same line. AK 1/15/15

Species shortcuts: D=DF, R=CR, T=TO. If left blank: Stem Count = 1, Status = Live Tree, Damage = N, Plot Type = N.

Figure 4-1 Cruise Card with sample data. *Campbell Global, Cruise Card*

4-1 Plot Data

The Plot data precedes the Stem data collected on a plot. The recorded information is defined below.

1. **"PLOT"**. Write "PLOT" to identify the information written to the right as Plot data.
2. **Plot No**. Record the cruise plot number. This number will be shown on the provided cruise maps.
3. **Direction to Plot**. Record the cardinal direction, bearing, or azimuth used while navigating to plot center. This will be the bearing and distance reported by the GPS unit, prefix the direction with a "G" for GPS then suffix the direction with a period followed by the distance traveled in feet. Syntax examples are listed below. The examples use a distance of 99 feet (1.5 chains) for routes starting from the GPS RP.
    a. Cardinal Direction. e.g. NE; GNE.99.
    b. Bearing. e.g. N45E; GN45E.99.
    c. Azimuth. e.g. 45, G45.99.
4. **Plot Type**. Following the order of prevailing entry listed in Table 4-1, enter the prevailing plot type code or description defining the plot sampled writing all remaining codes in Plot Notes. For example, a plot is a "Walkthrough" AND a "WLPZ" plot. Enter "T" or "Walkthrough" in Plot Type and "W" or "WLPZ" in Plot Notes.
5. **Plot Tag to PC**. These fields are applicable only to inventory cruising
    a. Direction. Record in degrees the bearing or azimuth (e.g. N20W, 340) from the plot tag to the plot center).
    b. Horizontal Distance. Record to tenths the horizontal distance from the point of attachment of the plot tag to the plot center.
6. **Off-plot Tag Description**. When the plot tag is not attached to a plot tree, record a description of the witness object that includes a reference to its size. Follow the syntax <*species*> & <*DBH*> OR <*object description*> & <*size*> (e.g. df9, crstump20in, log20ftlong36indiam). For witnesses that are also plot trees, see the "*4.2.1.c Species*" section.
7. **Plot Notes**. Enter pertinent notes about the plot. Separate notes by the semi-colon ";" delimiter (e.g. WLPZ; No Trees; on slide). Enclose critical notes in curly brackets (e.g. **{**bad typing, move plot to cruise unit 5132**}**).

Table 4-1
Plot Type Codes, Descriptions, and Definitions listed in Prevailing Order of Entry

Order of Prevailing Entry (Ascending)	Plot Type Code	Plot Type Description	Definition
1	T	Walkthrough	An edge sampling plot where some of the tallies may be doubled.
2	W	WLPZ	A plot falling within a Watercourse and Lake Protection Zone.
3	X	No Trees	A plot devoid of samples (can have off-plot site trees).
4	N	Normal	A plot not possessing any of the other plot types listed within the table. This is the default plot type. Leaving Plot Type empty (Null) defaults this value to Company systems. No need to ever record "Normal" in Plot Notes.

4-2 Stem Data

Stem data are a plot's sampled trees. The data immediately follows its Plot data. Kinds of data collected are divided into the categories of samples taken and subsamples taken.

4-2.1 SAMPLES TAKEN

The following data are collected for each tree on the plot.

1. **Stem No.** (Stem Number).
2. **Status.**
3. **Species.**
4. **DBH** (Diameter Breast Height).
5. **DBH Est.** (DBH Estimated).
6. **Total Height to Tip.**
7. **HT Est.** (Height Estimated).
8. **% Crown** (Percent Crown).
9. **Dam. Code** (Damage Code).
10. **% Total Defect – Carb.** (Carbon).
11. **Tree Notes.**

Instructions for their collection are given below.

4-2.1.a Stem

Stem Number is a tree's line (row) number of the plot; (see *3-1.3 Order of Tally*). The stem number is painted onto trees on the 1/50th acre and 1/10th acre plots with white paint facing plot center. No need to paint tree numbers on 1/100th acre subplot; simply paint a dot a DBH where diameter measurement was taken. See the "*4-2.1.d DBH (Diameter Breast Height)*" section for a definition of DBH.

4-2.1.b Status

A tree's status refers to whether or not it is live or dead. The default status code for a tree is to have a blank status code (indicates a live tree). Dead trees are ranked by their hard to soft decay class[i] (Table 4-3) and as such have a numeric status code entered.

For declining, live trees that have been girdled within the last three years of cruise, consider them dead even though they may still have green leaves. Record their status as "Snag Class 1". Trees with green leaves that were girdled longer than three years ago have survived the girdling and are recorded using a live status ranking.

Table 4-3
Dead Tree Status Codes, Descriptions, and Definitions

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

		heartwood is sloughing throughout.

Table 4-4
Species Codes and Description

Species Code	Species
BM	Bigleaf Maple
CQ	Chinkapin
CR	Coastal Redwood
CY	Canyon Live Oak
DF	Douglas-fir
EU	Eucalyptus
GF	Grand Fir
MA	Madrone
MY	Oregon Myrtle
NM	Nutmeg
OC	Other Conifer
OH	Other Hardwood
RA	Red Alder
TO	Tanoak
WH	Western Hemlock
WI	Willow Species

4-2.1.c Species

Enter a species code listed in Table 4-4. If the tree has a plot tag, circle it (Figure 4-1).

4-2.1.d DBH (Diameter Breast Height)

DBH is a tree's diameter at Breast Height (BH). See the "*3-1.5 Borderline Calls*" section for a definition of BH. DBH is recorded to the nearest 1/10th inch. Read the diameter tape by truncating the digits to the right of tenths place. For example, a tree's DBH is 2.59 inches. Read 2.5 and write the 1/10th-inch DBH as 2.5. The point where DBH is measured shall be marked with a stripe of white paint at least 4" in length. Please see Appendix B for special instructions regarding DBH measurements.

4-2.1.e DBH Est. (DBH Estimated)

Check the box if DBH is not measured with a diameter tape, or calipers but estimated using some other means (eye, relaskop, etc.).

4-2.1.f Total Height to Tip

Total height is the total length of bole including the stump. The dominant stem is measured for trees having a fork. For leaning trees, the measurement is made along the lean. If a live tree or snag is broken only measure to the existing tip unless the tree has a recovered leader, do not attempt to measure to the reconstructed top. Trees with previously broken tops are considered recovered when a new leader (dead or alive) is 1/3 the diameter of the broken top at the point where the top was broken (not where the new leader originates from the trunk). Forked trees should be treated the same as unforked trees.

4-2.1.h % Crown (Percent Crown)

Percent crown is sampled on all live trees sampled for total height. It is defined by the equation:

$c = (b/t)\ 100$

where

c = % Crown,
b = length of the visually balanced crown (if sparse, also compact the crown), and
t = total height (height is rebuilt to tip for broken top trees).

Visually estimate the % crown. Enter the estimate as a code as shown in Table 4-5.

Table 4-5
Percent Crown Codes

% Crown	
Code	% Crown
0	< 0
5	1 – 5
10	6 – 10
20	11 – 20
30	21 – 30
40	31 – 40
50	41 – 50
60	51 – 60

70	61 – 70
80	71 – 80
90	81 – 90
100	91 – 100

4-2.1.i Dam. Code (Damage Code)

For all live and dead trees and following the order of prevailing entry listed in Table 4-6 enter damage when present. Leaving the cell empty defaults the entry to "N" meaning "No Damage". The prevailing order of entry is based upon desirable wildlife features and favors listing cavity and agents leading to cavity first before considering other damages. For hardwoods, do not bother recording "Crook/Sweep" or "Fork" damage, for most local hardwood have these features. For this same reason, do not record broken top for hardwoods unless the top is completely sheared off. If a tree is subject to multiple damage codes insert the predominant code in the Damage Code field and write the additional damage codes in the Tree Notes.

Table 4-6
Damage Codes, Descriptions, and Definitions listed in Prevailing Order of Entry

Order of Prevailing Entry (Ascending)	Damage Code	Plot Type Description	Comments
1	U	Basal Cavity	
2	V	Cavity (not basal)	
3	X	Dead Top	
4	T	Broken Top	Generally not recorded for hardwoods.
7	N	No Damage	This is the default damage. Leaving damage empty (Null) defaults this value to Company systems.

Crack. Deduct 30% volume loss for each straight crack occurring by 16-foot log segment. 3 cracks cull a log. Cull a log having spiral crack.

Broken Top. Determine the percent volume loss of the log where the break occurs. Determine the percent volume loss of additional missing, 16-foot log segments above the break. Sum the values to determine the deduction.

Rot, Conks, Punk Knots. Follow the guidelines of Table 4-7 when estimating missing volume of 16-foot log segments for rot, conks, and punk knots.

4-2.1.k % Total Defect – Carb. (Carbon)

Total percent carbon defect is defined as the total percent cubic foot defect of a bole both inside and outside the board foot scaling cylinder from and including the stump to the tip. Record the estimate to the nearest whole percent for all live and dead trees (both conifers and hardwoods). There are differences between live trees and dead trees in how carbon defect is estimated; see below.

Carbon Defect for Live Trees. Using a rebuilt top if broken, record the total percent carbon defect due to missing portions of bole for live trees using Table 4-8 (conifers) or Table 4-9 (hardwoods) as a guide.

Damages affecting volume loss are basal cavity, cavity, heart rot, root rot, cracks, fire, mechanical, and broken tops. Damages *not* affecting volume loss are sweep, crook, fork, dead top, insects and browse.

Burnt and rotten wood are not as dense (lighter) and therefore have less carbon than solid wood. Because both carbon and biomass are sold by weight, when estimating loss due to rot or charcoal, imagine the airspace created (wood missing) if the defected wood were compressed to a solid composition. Defect according to how much airspace is produced.

Table 4-8
Conifer – Percent of Total Stem Volume Above Ground by 1/3 of Total Height (includes stump)

Total Height (ft)	% of Total Stem Cubic Volume		
	Bottom 1/3	Middle 1/3	Top 1/3
<= 4	Treat as 1 piece		
5 to 10	55%	40%	5%
11 to 20	65%	30%	5%
21 to 130	62%	30%	8%
Redwood >131	64%	29%	7%
Other Conifers > 131	66%	28%	6%

Table 4-9

Hardwood – Percent of Total Stem Volume Above Ground by 1/3 of Total Height (includes stump)

Total Height (ft)	% of Total Stem Cubic Volume		
	Bottom 1/3	Middle 1/3	Top 1/3
<= 20	Treat as 1 piece		
21 to 30	72%	23%	5%
>= 31 to 20	65%	30%	5%

Carbon Defect for Dead Trees. Considering the snag only to its actual height (only to the broken top if the tip is gone) as the entire piece (100% of the volume), in percent volume record an ocular, cubic-foot estimate of missing wood (pieces, chunks, slabs, hollows) to the actual height. Company systems will, based upon the actual height of the snag, determine whether the top is broken to compute a volume loss of the missing top.

Do not consider rot as defect as is done with live trees. Rot is quantified by the dead tree's status (see *Table 4-3*) that describes its density degradation from solid wood. Figures 4-5 and 4-6 are examples how to estimate carbon defect for dead trees.

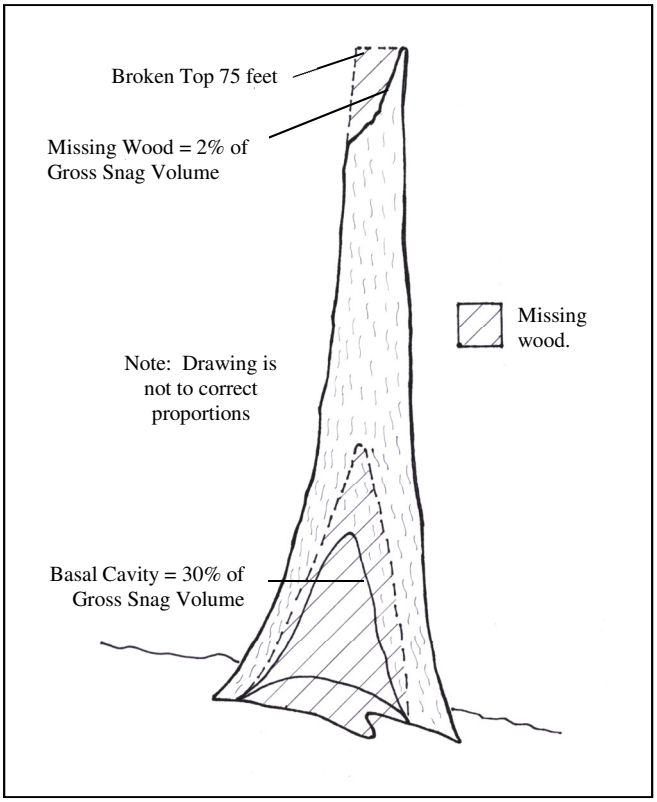


Figure 4-5 Snag Percent Carbon Defect Example 1. Snag Height = 75 feet; Defect = U (Basal Cavity); Carbon Percent Defect = 32%

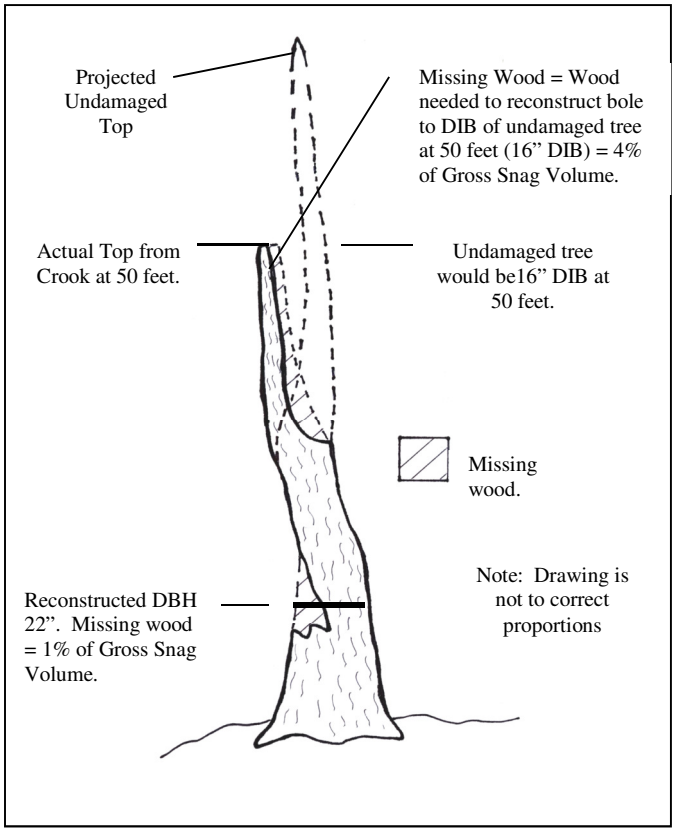


Figure 4-6 Snag Percent Carbon Defect Example 2. Snag Height = 50 feet; Defect = C (Crook); Carbon Percent Defect = 5% (4% + 1%).

4-2.1.l Tree Notes

Record any pertinent notes about the tree (if not recorded under *Dam. Code*) and borderline "IN/OUT" measurements. For these common notes, use the shorthand syntax listed below.

1. **bli**. Border Line In.
2. **blo *species DBH***. Border Line Out – Species Code – DBH to tenths (e.g. blo df 10.2).
3. **sd *feet***. Slope distance to hundredths from the tree's center to plot center (e.g. sd 25.32).
4. **hd *feet*** Horizontal distance to hundredths from the tree's center to plot center (e.g. hd 20.25).
5. ***x%***. Slope in percent used to compute horizontal distance from a tree's center to plot center (e.g. 25%).
6. **s**. Age estimated from a nearby stump ring count.
7. **w**. Age estimated from a whorl count.
8. **#x**. Stem Number (e.g. behind #6).

Separate groups of notes by the semi-colon ";" text delimiter. Following are examples of notes using the shorthand syntax.

1. bli; GROUND BEES AT BASE!
2. blo cr 26.9 hd 35.90; M
3. blo df 5.2 sd 10.62 35%; bear damage; behind #3

5 SUBMITTING WORK

Consultant shall submit completed Work at least bi-monthly to Company. The submitted Work shall be called a Block. A Block is comprised of (1) Work cruise data, (2) Work cruise maps, and (3) Data cards, if they were used for data collection. All Block items must be submitted for inspections to start and they must meet the work's submitted tolerances in Table 5-1.

Table 5-1
Work Submittal Tolerances

Work Submittals	
Item	**Tolerance**
Hand Writing, Printing, and Sketches	Legible and can be reproduced with a copy machine.
Electronic Data	Readable by Company computers and software.
Electronic/Paper Forms and Maps	All required forms and maps are submitted. All required fields are entered.
Company Provided Data	Correctly transferred to submitted forms.
Collected Data	Data content and syntax appear correct.

5-1 Work Cruise Data

There are three forms to Work cruise data:

1. Raw Data.
2. Inspection Data
3. Clean Data.

Consultant shall submit Raw Data and Clean Data to Company and may be required by Company to submit Inspection Data as explained below.

5-1.1 RAW DATA

Raw Data is the original cruise data as collected in the field on electronic, magnetic tape or paper media not altered or edited in any way.

When paper is the media, Company cruise unit data cards shall be used. See Figure 4-1 for an example. Cards will be supplied to the contractor by Company.

Company shall determine whether the submitted Raw Data qualifies to be considered as Inspection Data; (see *5-1.2 Inspection Data*). If the Raw Data does not qualify as Inspection Data, Contractor will be notified by Company and Contractor shall bring the data up to Inspection Data standards and submit Inspection Data.

5-1.2 INSPECTION DATA

Inspection Data is data that does not have any major problems that would prevent the data from being used for the inspection of Work. Inspection Data results from Raw Data. Its form must be electronically entered to the Excel workbook that is supplied by company OR, if agreed to by Company, entered to a different electronic format proposed by Consultant. Company shall use Inspection Data for inspections when making determinations of acceptable Work; (see 6 – *Inspections*). Hot Check Data is Inspection Data from the first day or two of cruising. If the data is being recorded onto paper data cards in the field, then the Hot Check Data may be submitted as the original data cards which will be returned to Contractor.

5-1.3 CLEAN DATA

Clean Data is data that is free of errors. Contractor is required to generate the Clean Data. Generally within four days of raw data submission, Company will process the data and notify the contractor of any deficiencies.. Generating Clean Data may include additional field work when submitted data is found to be deficient for reasons such as, but not limited to: (1) not meeting cruise targets or (2) incomplete data.

5-2 Work Cruise Maps, and Cruise Data Cards

Submit to Company:

1. Either the originals or legible copies of pertinent cruise maps showing all navigation route documentation; (see *2-2.2 Navigation Route Documentation*).
2. If the data was recorded onto paper cards in the field, submit copies of the cards. Company will make one copy of the cruise cards at no cost to the contractor if the originals are brought to the company office.

6 INSPECTIONS

Pursuant to the "*Inspection of Premises and* Work" section of the Agreement, Company reserves the right to inspect Blocks (see *5 – Submitting Work*) to determine compliance with the cruise procedures and standards. For reasons of efficiencies, Company may combine Blocks in the inspection process.

6-1 Conditions of Inspection

Standard. If Company chooses to inspect Blocks for compliance with procedures and standards, the Company representative or designee shall inspect. The Company representative's findings shall be the STANDARD and shall be conclusive for determining compliance to procedures and standards.

Failed Block. Consultant shall rework a failed Block until it complies with procedures and standards at no expense to Company. Issues causing rework shall be corrected across all failed plots of a Block or as directed by the Company representative.

Withholding Payment. A Block must be inspected to determine compliance if Company desires to withhold payment and require rework because Company believes the Block is not in compliance with procedures and standards.

The Inspection. When Company chooses to inspect, the inspection shall be done utilizing: (1) an office review and (2) a field review.

6-2 Inspection Procedures

Inspection consists of three parts:

1. Clean Data Inspection. Generally within four days of data submission, Company will process the submitted data and notify contractor….send the resulting. Contractor is responsible for cleaning the submitted data with edits to resolve problems. More than one round of data fixes may be required to completely clean the data. This may require one or more trips to the field by Contractor to collect the necessary data. Clean data as determined by Company constitutes passing the Clean Data Inspection.

2. Field Inspection. A field inspection will be carried out for an inspection block of 50 plots or all plots in a cruise, whichever is smaller. If data submissions are for less than a full field inspection block, Company has the right to accumulate submitted data and wait to inspect until a full field inspection block is available.

   The field review is a by-cruiser, random inspection of navigation, monumentation, plot location, and data collection. Work shall comply with the tolerances set forth in Table 6-1 and Table 6-2. Data measurements shall be scored using a Check Cruise Score Card. The inspection intensity of plots shall be: 10% for all cruisers. Company reserves the right to expand any inspection to

more than 10% for any reason. A score of 94% on the Inspection Scorecard and adherence to the cruise design constitutes passing the Field Inspection.

If the field review of any cruiser fails, the failed portion of the inspection batch shall be returned to the Contractor for rework.

3. Keypunch Inspection. If at any time Company suspects there are keypunch errors in any submitted data (not just the most recent data submission), Company can require Contractor to verify all keypunching. Keypunch errors are usually detected during Field Inspection. On rare occasions, keypunch errors are detected later when the data is being processed for the timberland inventory; this can be several months after the data was submitted. All data is assumed to provisionally pass the Keypunch Inspection. Final determination of passing the Keypunch Inspection occurs after all data has been submitted and is processed for the inventory.

Table 6-1
Navigation, Monumentation, and Data Collection Tolerances

Navigation and Monumentation		
Item		**Tolerance**
Plot Center Location		Plot centers are within the intended cruise unit, are reasonably close to their mapped location, and bias is not evident.
Flagging Monuments		Correctly hung and labeled most of the time. Referenced items may be located and identified despite labeling errors.
Plot Tag	Object	Correctly selected as stated in the procedures.
	Attachment	Correctly attached to the object as stated in the procedures.
	Horizontal Distance	Within +/- 3/10^{ths} foot most of the time.
	Direction to Plot Center	Within 2 ½ degrees most of the time.
	Label	Correctly labeled most of the time.
Data Collection		
Data Codes		Correct.
Data Measurements		Random sample of the Block's plots (10% sample) achieves a check cruise score of at least 94%.

Table 6-2
Check Cruise Score Card Tolerances

Check Cruise Score Card Tolerances	
Stem Count	1. No trees missing on 1/10th or 1/50th acre plots, and TPA within 30% tolerance for the 1/100th acre plot.
Diameter Breast Height (DBH)	Within +/- 2% for trees less than 24 inches DBH and within +/- 3% for larger trees.
Species	Correct
Total Height to Tip	Height samples within the lesser of +/- 10% or 10ft.
Status	Correct
Damage Code	Correctly chosen as stated in the procedures.
Percent Crown	Within +/- 1 Crown Code
Percent Total Defect (Carbon)	Within +/- 10%.

7 INVOICING

Submitted Block(s) (see *5 – Submitting Work*) forms the basis of payment and may be invoiced per the "*Compensation*" section of the Agreement. Invoices shall clearly show the information listed below.

1. Invoice number.
2. Consultant's business name.
3. Business address.
4. Business phone number.
5. Business fax number.
6. Business e-mail.
7. Company's name and address.
8. Agreement number.
9. Exhibit label.
10. Computer filenames of the Work cruise data.
11. A reasonable detail listing describing the items invoiced.
12. Dollars/item invoiced.
13. Total dollars charged.

7-1 Invoice Approval

Invoices for Submitted Plots. Company has two weeks to approve the invoice once plots pass the Clean Data Inspection, Field Data Inspection and Keypunch Inspection.

7-2 Invoice payment

Payment of invoices by Company generally occurs within two weeks of invoice approval.

APPENDIX A - HARVEST PLAN FLAGGING & PAINT COLORS WITH DEFINITIONS

As of May 14th, 2010

Table A-1. Flagging

Flagging Color/Combination	Meaning
Red 'PROPERTY LINE'	Property Line – Do NOT cross unless directed by RPF
Pink 'THP BOUNDARY'	Boundary of THP. – Don't fell trees outside except for safety.
Lime Glo 'SILVICULTURE'	Silviculture Boundary – may be coincident with WLPZ or Yarding Method.
Yellow/Black Stripe	Yarding Method Boundary.
Blue/White Stripe	Class I and II centerlines. *May not be flagged where obvious.*
Blue/White 'LAKE AND WATERCOURSE PROTECTION ZONE'	Watercourse and Lake Protection Zones, Canopy Retention Zones for Springs. May indicate silviculture boundary as well.
White w/Blue Polka Dots	Class III centerline. Triple flag denotes end of segment. May also serve as perimeter of a wet area.
White w/Blue Polka Dots with Solid Red	Wet Area Equipment Limitation Zone
Red	Tractor Stop Lines, Equipment Limitation Zones, Equipment Exclusion Zones.
Yellow 'SKID TRAIL'	Pre-flagged tractor road. Triple flag denotes end of trail.
Orange/White Stripe 'SPECIAL TREATMENT ZONE'	Special Treatment Zone for Wildlife Protection Zones, Archaeological Protection Zones, unstable areas, botanical protection areas.
Blue	Centerline of proposed roads. May also be present on existing roads which are very brushy.
Orange	Variety, primarily Logging road grades and Cable corridor roads
Blue and Orange hung together	Proposed and/or existing landing in brushy area. May also denote limits of use for existing WLPZ landings.
Orange/White or Green/White Stripe	Older inventory cruisers flagging, not THP related.
Pink/Black Stripe (may have Lime Glo)	Used by Wildlife Crews, not THP related.
Orange with White	Map Points, Instructions
Yellow with White	Road Maintenance Activities
Red with White	RPF message flagging.
White	Reconnaissance flagging, not THP related
Purple	Inventory or Aquatic Monitoring flags, not THP related.

Table A-2. Paint

Paint Color	Meaning
Blue	Harvest Tree, Labels
Orange	Retention Tree, Labels
Yellow	Property Line Blaze, Labels
RETAIN ANY TREE MARKED “NO” IN ANY COLOR PAINT	
CUT ANY TREE MARKED “CUT” IN ANY COLOR PAINT	

APPENDIX B – SPECIAL INSTRUCTIONS FOR DBH MEASUREMENTS

The attached special instructions for DBH measurement are taken from the FIA National Core Field Guide, Version 6.1 dated October, 2014 section 5.9.2. Not all instructions apply to the Usal Redwood Forest Carbon Inventory. For example, where the special instructions refer to multi-stemmed woodland species, no such species as defined in Appendix 3 of the Core Field Guide are found on the Usal Redwood Forest Project Area, and as such, references to multi-stemmed woodland species can be ignored.

5.9.2 DIAMETER AT BREAST HEIGHT (DBH)
Unless one of the following special situations is encountered, measure DBH at 4.5 feet above the ground line on the uphill side of the tree. Round each measurement down to the last 0.1 inch. For example, a reading of 3.68 inches is recorded as 3.6 inches.

Special DBH situations:

1. Forked tree: In order to qualify as a fork, the stem in question must be at least 1/3 the diameter of the main stem and must branch out from the main stem at an angle of 45 degrees or less. Forks originate at the point on the bole where the piths intersect. Forked trees are handled differently depending on whether the fork originates below 1.0 foot, between 1.0 and 4.5 feet, or above 4.5 feet.

   - Trees forked below 1.0 foot. Trees forked below 1.0 foot are treated as distinctly separate trees (fig. 23). Distances and azimuths are measured individually to the center of each stem where it splits from the stump (fig. 26 A-C). DBH is measured for each stem at 4.5 feet above the ground. When stems originate from pith intersections below 1 foot, it is possible for some stems to be within the limiting distance of the microplot or subplot, and others to be beyond the limiting distance. If stems originating from forks that occur below 1.0 foot fork again between 1.0 and 4.5 feet (fig. 26-E), the rules in the next paragraph apply.

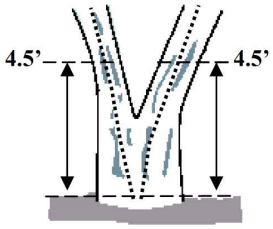


Figure 23. Forked below 1.0 ft.

   - Trees forked between 1.0 foot and 4.5 feet. Trees forked between 1.0 foot and 4.5 feet are also counted as separate trees (fig. 24), but only one distance and azimuth (to the central stump) is recorded for each stem (fig. 26 D-F). Although a single azimuth and distance applies to all, multiple stems should be recorded as they occur in clockwise order (from front to back when one stem is directly in front of another). The DBH of each fork is measured at a point 3.5 feet above the pith intersection. When forks originate from pith intersections between 1.0 and 4.5 feet, the limiting distance is the same for all forks--they are either all on, or all off the plot.

     Multiple forks are possible if they all originate from approximately the same point on the main stem. In such cases, measure DBH on all stems at 3.5 feet above the common pith intersection (fig. 26-F).

     Once a stem is tallied as a fork that originated from a pith intersection between 1.0 and 4.5 feet, do not recognize any additional forks that may occur on that stem. Measure the diameter of such stems just below the base of stem separation as shown in figure 26-E (i.e., do not move the point of diameter the entire 3.5 feet above the first fork).

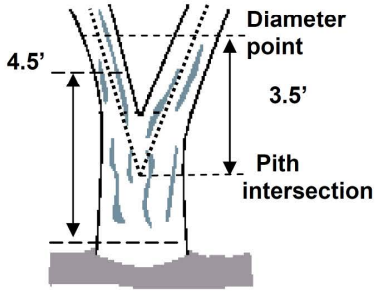


Figure 24. Forked between 1.0-4.5 ft.

- Trees forked at or above 4.5 feet. Trees forked at or above 4.5 feet count as one single tree (fig. 25). If a fork occurs at or immediately above 4.5 feet, measure diameter below the fork just beneath any swelling that would inflate DBH.

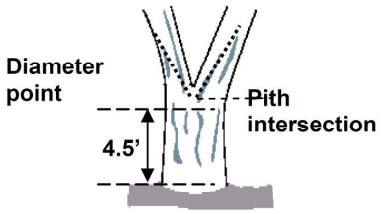


Figure 25. One tree.

2. Stump sprouts: Stump sprouts originate between ground level and 4.5 feet on the boles of trees that have died or been cut. Stump sprouts are handled the same as forked trees, with the exception that stump sprouts are not required to be 1/3 the diameter of the dead bole. Stump sprouts originating below 1.0 foot are measured at 4.5 feet from ground line. Stump sprouts originating between 1.0 foot and 4.5 feet are measured at 3.5 feet above their point of occurrence. As with forks, rules for measuring distance and azimuth depend on whether the sprouts originate above or below 1.0 foot. For multi-stemmed woodland species, treat all new sprouts as part of the same new tree.

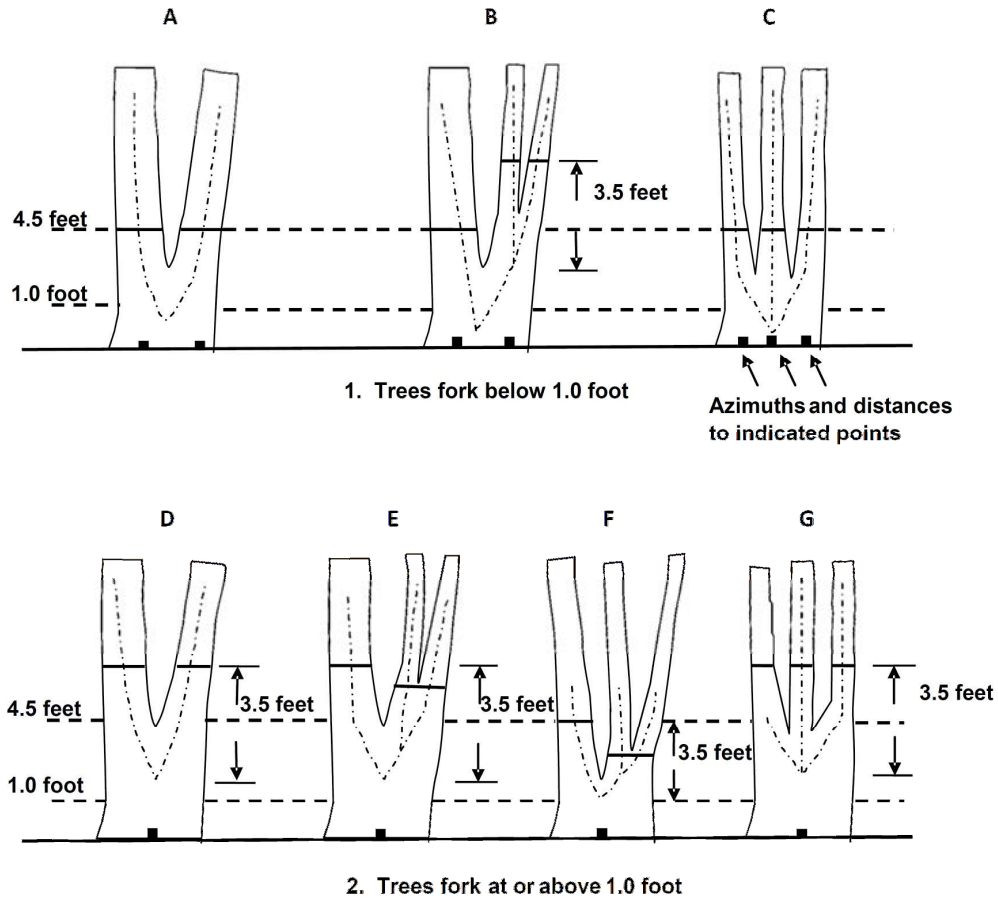


Figure 26. Summary of where to measure DBH, distance, and azimuth on forked trees.

3. Tree with butt-swell or bottleneck: Measure these trees 1.5 feet above the end of the swell or bottleneck if the swell or bottleneck extends 3.0 feet or more above the ground (fig. 27).

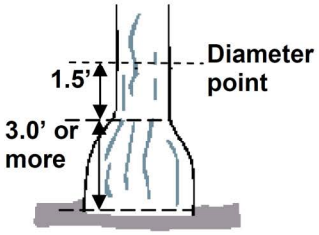


Figure 27. Bottleneck tree.

4. Tree with irregularities at DBH: On trees with swellings (fig. 28), bumps, depressions, and branches (fig. 29) at DBH, diameter will be measured immediately above the irregularity at the place it ceases to affect normal stem form.

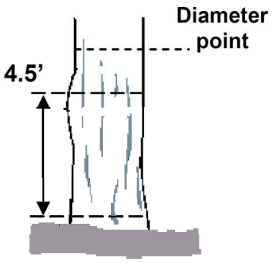


Figure 28. Tree with swelling.

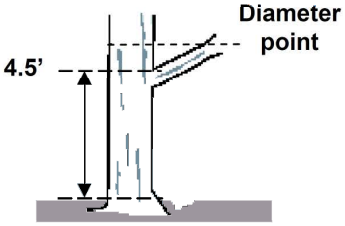


Figure 29. Tree with branch.

5. Tree on slope: Measure diameter at 4.5 feet from the ground along the bole on the uphill side of the tree (fig. 30).

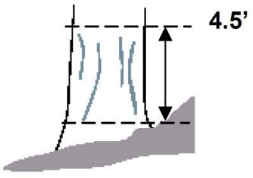


Figure 30. Tree on a slope.

6. Leaning tree: Measure diameter at 4.5 feet from the ground along the bole. The 4.5-foot distance is measured along the underside face of the bole (fig. 31).

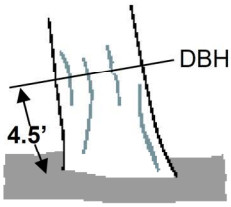


Figure 31. Leaning tree.

8. Independent trees that grow together: If two or more independent stems have grown together at or above the point of DBH, continue to treat them as separate trees. Estimate the diameter of each, set the "DIAMETER CHECK" code to 1, and explain the situation in the notes.

   In this situation use the "half-DBH" method. Take a half tree diameter by estimating two point opposite each other on the stem at the DBH point. Measure the distance between the two marks and double the measurement to determine DBH. Either paint the location of the two marks, or set an aluminum nail at each point. Make a note that the DBH was measured using the "half-DBH" method.

9. Missing wood or bark: Do not reconstruct the DBH of a tree that is missing wood or bark at the point of measurement. Record the diameter, to the nearest 0.1 inch, of the wood and bark that is still attached to the tree (fig. 32). If a tree has a localized abnormality (gouge, depression, etc.) at the point of DBH, apply the procedure described for trees with irregularities at DBH (figs. 28 and 29).

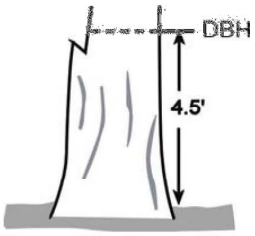


Figure 32. Tree with part of stem missing.

10. Live windthrown tree: Measure from the top of the root collar along the length to 4.5 feet (fig. 33).

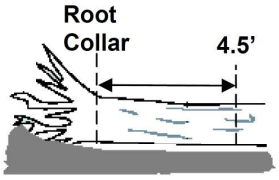


Figure 33. Tree on the ground.

11. Down live tree with tree-form branches growing vertical from main bole: When a down live tree, touching the ground, has vertical (less than 45 degrees from vertical) tree-like branches coming off the main bole, first determine whether or not the pith of the main bole (averaged along the first log of the tree) is above or below the duff layer.

    - If the pith of the main bole is above the duff layer, use the same forking rules specified for a forked tree, and take all measurements accordingly (fig. 34).

    - If the pith intersection of the main down bole and vertical tree-like branch occurs below 4.5 feet from the stump along the main bole, treat that branch as a separate tree, and measure DBH 3.5 feet above the pith intersection for both the main bole and the tree-like branch.

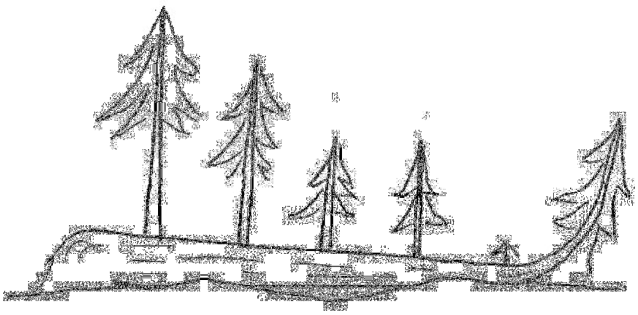


Figure 34. Down tree above duff.

- If the intersection between the main down bole and the tree-like branch occurs beyond the 4.5 feet point from the stump along the main bole, treat that branch as part of the main down bole.

- If the pith of main tree bole is below the duff layer, ignore the main bole, and treat each tree-like branch as a separate tree; take DBH and length measurements from the ground, not necessarily from the top of the down bole (fig. 35). However, if the top of the main tree bole curves out of the ground towards a vertical angle, treat that portion of that top as an individual tree originating where the pith leaves the duff layer.

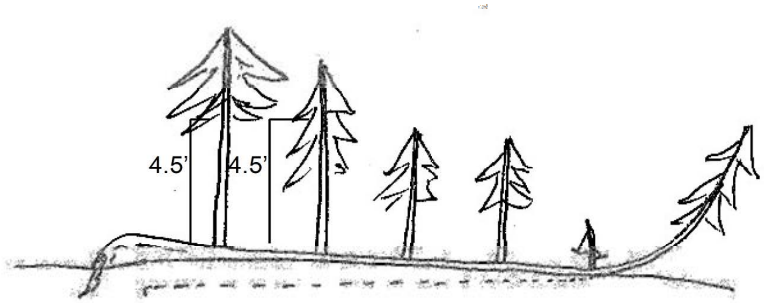


Figure 35. Down tree below duff.

12. Tree with curved bole (pistol butt tree): Measure along the bole on the uphill side (upper surface) of the tree (fig. 36).

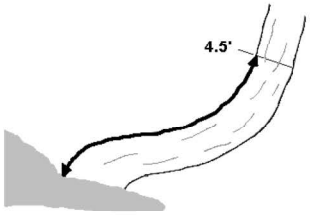


Figure 36. Tree with curved bole (pistol butt tree).

REFERENCES

[i] Harmon, Mark E.; Woodall, Christopher W.; Fasth, Becky; Sexton, Jay; Yatkov, Misha. 2011. Differences between standing and downed dead tree wood density reduction factors: A comparison across decay classes and tree species. Res. Pap. NRS-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 40 p.

List of Tools Used:

Tools typically used to measure heights, diameters and plots include: compass, 75-foot loggers tape (with DBH), clinometer, Releskop, laser range finder, GPS, and calculator.

Appendix C

Road Buffer Assumptions

The Road buffer algorithm uses the WIDTH_SURFACE field in the road layer to buffer the roads for our analytic road buffer layer in SDE. The value is assumed to be the entire width of the treeless surface, so the value is halved.

If no value exists in the WIDTH_SURFACE field, an assumption of width will be applied based on the ROAD_TYPE attribute. If there isn't information for road type, the SURFACE field is used.

Assumptions for all northwest properties are:

Road Type	Width
Highway/State/County/City	50
Mainline	40
Mainline (dirt)	24
Secondary/Spur	24
Paved	40
Rocked	30
Dirt	24

Things that *do not* get buffered, based on the ROAD_TYPE and STATUS field:
ROAD_TYPE: 4WD, Trail
STATUS: Unknown, Legacy, Abandoned

Appendix D

Plot and Strata Map

Usal Redwood Forest IFM Plot and Strata Map

Legend

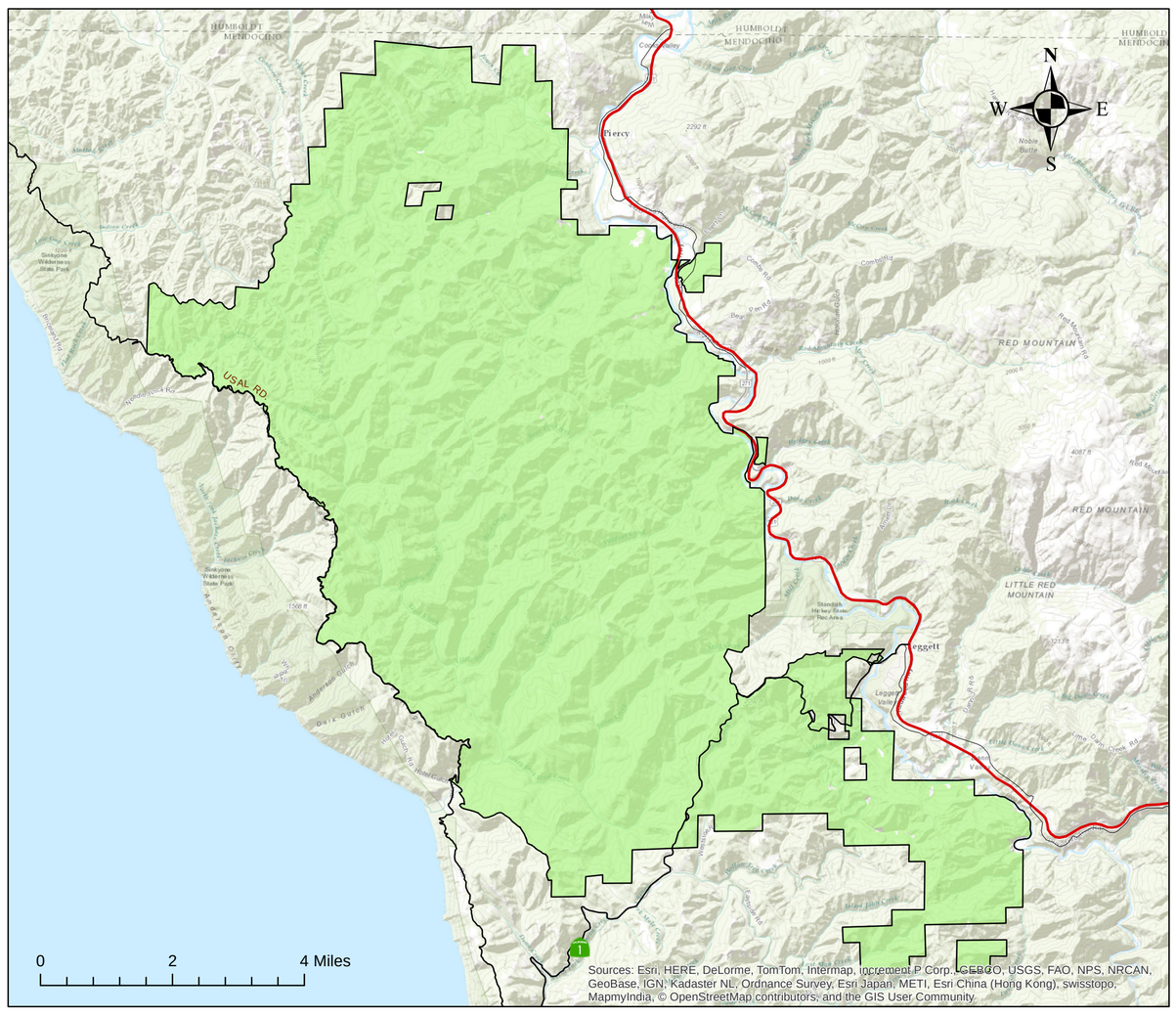
- Usal Redwood Forest Company Ownership
- Inventory Plot
- Permanent Road
- Seasonal Road
- Public Road
- Class I Watercourse
- Class II Watercourse
- Class III Watercourse

Strata

- Conifer High
- Conifer Medium High
- Conifer Medium Low
- Conifer Low
- Hardwood High
- Hardwood Medium High
- Hardwood Medium Low
- Hardwood Low

NCRM Inc.

0 0.5 1 2 3 4 Miles



Appendix E

CAR Harvested Wood Products Worksheet

Harvested Wood Products Worksheet

The Harvested Wood Products (HWP) Worksheet is designed to standardize and facilitate the reporting of harvested wood products for each Reporting Period in the Calculation Worksheet. The HWP worksheet produces standardized outputs that Project Developers must insert into the Calculation Worksheet for the following areas:

1) Actual Project Carbon in Harvested Wood Delivered to Mill (tCO2e)
2) Actual Project Carbon in Trees Harvested for Wood Products (tCO2e)
3) Actual Project Carbon Stored Long-term in Wood Products (tCO2e) - Excl Landfill
4) Actual Project Carbon Stored Long-term in Wood Products (tCO2e) - Incl Landfill
5) Baseline Carbon Stored Long-term in Wood Products (tCO2e) - Excl Landfill
6) Baseline Carbon Stored Long-term in Wood Products (tCO2e) - Incl Landfill

The default values (conversions, mill efficiencies, etc) must be used unless the Project Developer can provide verifiable alternatives. The HWP worksheet is divided into 3 sections (Data Inputs, Estimates of Carbon Storage in Wood Products and Emissions associated with Harvested Trees, and Conversion Assumptions). Project Developers must make a separate copy of the HWP worksheet for each Reporting Period and submit it as part of the Annual Monitoring Report.

Section 1. Data Inputs

Table 1. Key to worksheet inputs

The key below provides a color-coded reference to cells in this worksheet. User action is required wherever a 'Step' is mentioned.

Step Guidance	
Project data entered by Project Developer	
Assumptions and/or data populated automatically	
Default Values	
Data calculated automatically for input into the Calculation Worksheet	

Table 2. Project Characteristics

Step 1. Using the pull-down menus where provided, enter the current reporting period project data into Table 2. If multiple hardwood and/or softwood harvest units were recorded, consolidate into one hardwood and one softwood harvest unit using the values in Table 9.

Region*:	Pacific Southwest (PSW)
Reporting Period:	
Hardwood Harvest Units:	Cubic Feet
Softwood Harvest Units:	MBF-Scribner ("Large" or "Long")

***From the Reserve's Assessment Area Data File.**

Table 3. Default Wood Products Classes; Volume Totals

Step 2. If the default wood products classes are being used, enter the appropriate values from the Assessment Area data file and proceed to **Step 3** if harvesting occurred or **Step 5** if there was no harvest. If the actual distribution of wood products generated from the reporting period harvest is known, skip this step and proceed to **Step 4**.

Softwood Lumber	Hardwood Lumber	Plywood	Oriented Strandboard	Non Structural Panels	Miscellaenous	Paper
0%	0%	0%	0%	0%	0%	0%

Step 3. If the default wood products classes are being used, enter the total amount of wood delivered to the mill(s) and proceed to **Step 5**.

Hardwood		Softwood	
Total	0	Total	
%	#DIV/0!	%	#DIV/0!

Table 4. Volume in Logs Delivered to Mill

Step 4. Enter the name of the mill(s) and the volume of harvested wood sent to the mill(s) during the current reporting period in Table 4. Both the hardwood and softwood volumes must be categorized based on the wood product classes shown below. If wood products class data is only partially available, categorize the unknown wood products as "miscellaneous". If wood products class data is unavailable **or no wood products were harvested in the current reporting period**, refer to **Steps 2 and 3**. Default mill efficiencies are listed in Table 12. These default values may be overwritten if mill-specific data is available and verifiable.

	Hardwood							Softwood							
	Wood Product Classes							Wood Product Classes							
Mill	***Mill Efficiency***	**Lumber**	**Oriented Strandboard**	**Non Structural Panels**	**Misc Products**	***Mill Efficiency***	**Paper**	***Mill Efficiency***	**Lumber**	**Plywood**	**Oriented Strandboard**	**Non Structural Panels**	**Misc Products**	***Mill Efficiency***	**Paper**
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
Gross Total:		-	-	-	-		-	-	-	-	-	-	-		-
Net Total:		-	-	-	-		-	-	-	-	-	-	-		-

Section 2. Estimates of Carbon Storage in Wood Products and Emissions Associated with Harvested Trees

Table 5. Estimates of CO_2-equivalent (CO_2-e) in Harvested Wood Products associated with Project Activities

	Hardwood					Softwood						
Units	Lumber	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	Lumber	Plywood	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	Sum
Project carbon in harvested wood delivered to mills (Cubic Feet)	-	-	-	-	-	-	-	-	-	-	-	-
Project carbon in harvested wood delivered to mills (tCO_2e)	-	-	-	-	-	-	-	-	-	-	-	-
Project carbon transferred to wood products (Cubic Feet)	-	-	-	-	-	-	-	-	-	-	-	-
Project carbon transferred to wood products (tCO_2e)	-	-	-	-	-	-	-	-	-	-	-	-
% Product												0%
Long-term storage in in-use wood products (tCO_2e)	-	-	-	-	-	-	-	-	-	-	-	-
Long-term storage in wood products in landfills (tCO_2e)	-	-	-	-	-	-	-	-	-	-	-	-

Table 6. Estimates of CO_2-equivalent (CO_2-e) in Harvested Wood Products associated with Baseline Activities

	Hardwood					Softwood						
Units	Lumber	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	Lumber	Plywood	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	Sum
tCO2e	-	-	-	-	-	-	-	-	-	-	-	-
% Product	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Long-term storage in in-use wood products (tCO2e)	-	-	-	-	-	-	-	-	-	-	-	-
Long-term storage in wood products in landfills (tCO2e)	-	-	-	-	-	-	-	-	-	-	-	-

Table 7. Calculation Worksheet Information

Calculation Sheet Inputs (for Current Reporting Period)		Row Location in Calculation Worksheet
Actual Project Carbon in Harvested Wood Delivered to Mill (tCO2e)	-	11 (Excel 22)
Actual Project Carbon in Trees Harvested for Wood Products (tCO2e)	-	9 (Excel 20)
Actual Project Carbon Stored Long-term in Wood Products (tCO2e) - Excl Landfill	-	13 (Excel 24)
Actual Project Carbon Stored Long-term in Wood Products (tCO2e) - Incl Landfill	-	14 (Excel 25)
Baseline Carbon Stored Long-term in Wood Products (tCO2e) - Excl Landfill	-	15 (Excel 26)
Baseline Carbon Stored Long-term in Wood Products (tCO2e) - Incl Landfill	-	16 (Excel 27)

Table 8. Ratio of Harvested Wood Carbon to Harvested Tree Carbon

Step 5. Enter the 100-year baseline data to calculate a ratio of carbon in trees harvested for wood products to carbon in harvested wood delivered to the mill.

Baseline Carbon in Trees Harvested for Wood Products (tCO_2e) (from Excel Row 21 of the Monitoring Calculation Worksheet)	
Baseline Carbon in Harvested Wood Delivered to Mill (tCO_2e) (from Row 23 of the Monitoring Calculation Worksheet)	
Multiplier of Carbon in Wood Delivered to Mill to Carbon in Trees Harvested for Wood Products	**0.00**

Section 3. Conversion Assumptions

Table 9. Volume multipliers for converting timber and chip units to Cubic Feet

Unit	Factor
Bone Dry Tons	71.3
Bone Dry Units	82.5
Cords	75
Cubic Feet	1
Cubic Meters	35.3
Cunits-Chips (CCF)	100
Cunits-Roundwood	100
Cunits-Whole tree chip	126
Green tons	31.5
MBF-Doyle	222
MBF-International 1/4"	146
MBF-Scribner ("C" or "Small")	165
MBF-Scribner ("Large" or "Long")	145
MCF-Thousand Cubic Feet	1000
Oven Dried Tonnes	75.8

Source: American Forest & Paper Association, Sustainable Forestry Initiative Program Annual Progress Reporting Form

Table 10. Conversion Factors: to convert volume estimates to CO2-e

		Source
Cubic Feet / Hardwood Harvest Unit	1	Table 9.
Cubic Feet / Softwood Harvest Unit	145	Table 9.
SG of Softwoods by Region	0.399	Table 12.
SG of Hardwoods by Region	0.51	Table 12.
Tree Carbon:Wood Carbon	0.00	Table 8.
Pounds to Metric Tons	0.0004535970	-
Portion of Carbon in Biomass	0.5	-
Carbon to CO2-e	3.67	Reserve FPP
Density of water (lbs/cf)	62.43	-

Table 11. 100-year average storage factors

Wood Product Class	In-Use	Landfills
Softwood Lumber	0.463	0.298
Hardwood Lumber	0.250	0.414
Softwood Plywood	0.484	0.287
Oriented Strandboard	0.582	0.233
Non Structural Panels	0.380	0.344
Miscellaneous Products	0.176	0.454
Paper	0.058	0.178

Source: Reserve Forest Project Protocol, Appendix C.3 & C.4

Table 12. Average regional factors: specific gravity (SG) and mill efficiencies (ME)

	Hardwoods			Softwoods		
Region	**SG**	**Saw Log ME**	**Pulp ME**	**SG**	**Saw Log ME**	**Pulp ME**
Northeast (NE)	0.518	0.614	0.650	0.371	0.569	0.513
Northern Lake States (NLS)	0.473	0.585	0.685	0.360	0.630	0.514
Northern Prairie States (NPS)	0.537	0.585	0.685	0.434	0.630	0.514
Pacific Northwest, East (PWE)	0.424	0.568	0.568	0.396	0.637	0.637
Pacific Northwest, West (PWW)	0.415	0.531	0.531	0.426	0.740	0.500
Pacific Southwest (PSW)	0.510	0.568	0.568	0.399	0.675	0.675
Rocky Mountain, North (RMN)	0.389	0.568	0.568	0.394	0.704	0.704
Rocky Mountain, South (RMS)	0.353	0.568	0.568	0.369	0.704	0.704
Southeast (SE)	0.508	0.609	0.591	0.462	0.636	0.553
South Central (SC)	0.529	0.587	0.581	0.463	0.629	0.570

Sources: USDA Forest Service, Forest Inventory and Analysis Program database of forest surveys (SG) and *Technical Guidelines for Voluntary Reporting of Greenhouse Gas Program* (ME). Average wood specific gravity is the density of wood divided by the density of water based on wood dry mass associated with green tree volume.

ATTACHMENT O

FIA Volume Equation documentation updated on 9-19-2014

Contacts: Karen Waddell, Kurt Campbell, Olaf Kuegler, Glenn Christensen

Volume estimation for PNW- Databases -- NIMS and FIADB

Cubic and board foot volumes (in Scribner and International 1/4" log rules) are calculated for softwood and hardwood trees measured on forest land. A variety of volumes are estimated including gross and net volume of the merchantable stem, gross and net volume of both the sawlog portion and the upper stem portion of the bole, gross total stem volume of the entire bole from ground to tip.

All total stem volumes are calculated on all live trees in the inventory that are >= 1” DIA, and on dead trees that are >= 5” DIA.

All other volumes (gross and net growing stock and sawtimber volumes) are calculated on the merchantable stem, originally for the purpose of providing timber information. This is the most common volume most users will see in published reports. Gross volume from these equations has not been adjusted for the presence of cull (rot and defect). Net volume is gross volume minus an estimate of volume lost due to rot, physical defect, and/or other damage.

Growing stock volume is the volume of a tree, from a 1-foot stump to a 4" top, calculated on all trees >= 5” DIA. Board foot volume (sawtimber volume); for softwoods it is the volume of a tree from a 1-foot stump to a 6" top, calculated for softwood species >= 9” DIA; and for hardwoods, it is the volume of a tree from a 1-foot stump to an 8" top, calculated for hardwood species >= 11” DIA.

Note, that the sawlog and upper stem volumes are the cubic volume of sawtimber-sized trees, not to be confused with sawtimber (boardfoot) volume.

The log length for the log rule used in sawtimber (board-foot) calculations differs by species group and location, as follows:

On the west side of Oregon and Washington--
Scribner volume uses a 32-foot log rule for softwoods, and
a 16-foot log rule for hardwoods;
International 1/4" volume uses a 16-foot log rule for softwoods, and
an 8-foot log rule for hardwoods.

On the east side of Oregon and Washington, and all of California--
Scribner volume uses a 16-foot log rule for softwoods, and
a 16-foot log rule for hardwoods;
International 1/4" volume uses a 16-foot log rule for softwoods, and
an 8-foot log rule for hardwoods.

Board foot equations estimate volume of the fractional log up to the specified top diameter. The fractional log is the last log of the tree, which is less than the log rule specification.

The following volume names are used throughout the equations and are defined below:

CUBIC VOLUME (in cubic feet)

Type of Volume	Calculated on trees with a DIA of:	Volume name in equations
All softwoods and hardwoods:		
Volume of the total stem, ground to tip	>= 1”	CVTS
Volume from a 1-foot stump to the tip	>= 1”	CVT
Volume from a 1-foot stump to a 4-inch top	>= 5”	CV4
Softwood sawlog volume:		
Volume from a 1-foot stump to a 6-inch top	>= 9”	CV6
Hardwood sawlog volume:		
Volume from a 1-foot stump to an 8-inch top	>= 11”	CV8

BOARD FOOT VOLUME (square feet)

Type of Volume	Calculated on trees with a DIA of:	Volume name in equations
Softwoods:		
Scribner volume, 16-foot log rule, 1-foot stump to a 6-inch top (Eastern OR; Eastern WA; CA)	>= 9”	SV616
Scribner volume, 32-foot log rule, 1-foot stump to a 6-inch top (Western OR; Western WA)	>= 9”	SV632
International 1/4" volume, 16-foot log rule, 1-foot stump to a 6-inch top (all states)	>= 9”	XINT6
Hardwoods:		
Scribner volume, 16-foot log rule 1-foot stump to an 8-inch top (all states)	>=11”	SV816
International 1/4" volume, 8-foot log rule, 1-foot stump to an 8-inch top (all states)	>= 11”	XINT8

PROCEDURES

The general procedure used to calculate volume is as follows:

a.) estimate cubic volume first to produce CVTS, CVT, CV4, and the TARIF number;
b.) estimate RATIO's from equations that use DBH and TARIF as inputs;
c.) use the RATIO's to convert cubic volume to Scribner and International 1/4" board-foot volumes;
d.) use the RATIO's to convert the Scribner 16-foot log rule to the Scribner 32-foot log rule.

There are three methods to calculate cubic volume, depending on the equation. Each method produces an estimate for CVTS, CVT, CV4, and TARIF. In cases where volume equations do not exist for a given species, a suitable equation has been chosen and assigned to each species.

After cubic volume is calculated, all species use the same set of equations to develop the RATIO's needed to produce the remaining volumes.

CUBIC VOLUME Method 1: The TARIF number is based on CVTS.
Softwood equations 1, 2, 4, 6-15,17, 21, 22, 24
Hardwood equations 25-31

1. Calculate CVTS from published or documented volume equations for the species.
2. Calculate the TARIF number from CVTS, using the equation in DNR report #24.
3. Calculate CV4 from the TARIF number and tree basal area.
4. Calculate CVT from the TARIF number and DIA.

CUBIC VOLUME Method 2: The TARIF number is based on CV4.
Softwood equations 3, 5, 16, 18, 19, 20, 23

5. Calculate CV4 directly from published equations, using a form factor, DIA and height.
6. Calculate the TARIF number from CV4 and tree basal area.
7. If the tree >= 6" DIA then Calculate CVTS from CV4.
8. If the tree < 6" DIA then adjust the TARIF before calculating CVTS.
9. Calculate CVT from the TARIF number and DIA.

CUBIC VOLUME Method 3: The TARIF number is based on CV8.
Hardwood equations 32 to 44

10. Calculate CVTS, CV4, and CV8 directly from published equations;
11. Calculate TARIF from CV8.
12. Calculate CVT from CV8.

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13. CALCULATE CONVERSION RATIOS:

For all trees:
After CVTS and CV4 have been estimated, use equations to calculate the ratios. These ratios are used to convert cubic to board foot volume, and 16 to 32-foot log rules as follows:

RATIO	Used to convert:
RC6	CV4 to CV6
RC8	CV4 to CV8 (if needed)
RS616	CV6 to SV616
RS816	SV616 to SV816
RS632	SV616 to SV632
RI6	CV6 to XINT6
RI8	XINT6 to XINT8

SOFTWOOD CUBIC VOLUME EQUATIONS

Volume equation numbers

		Halfstate				
Species Code	**Species**	**WOR**	**WWA**	**EOR**	**EWA**	**CA**
11	Pacific silver fir	11	11	10	10	11
14	Bristlecone fir	--	--	--	--	18
15	White fir	23	11	10	10	23
17	Grand fir	11	11	10	10	23
19	Subalpine fir	11	11	10	10	18
20	California red fir	18	--	10	--	18
21	Shasta red fir	18	--	18	--	18
22	Noble fir	11	11	10	10	18
41	Port-Orford-cedar	19	19	19	19	8
42	Alaska-cedar	9	9	8	8	8
50	Cypress	--	--	--	--	19
51	Arizona cypress	--	--	--	--	19
52	Baker cypress	--	--	--	--	19
54	Monterey cypress	--	--	--	--	19
55	Sargent's cypress	--	--	--	--	19
56	McNabb cypress	--	--	--	--	19
62	California juniper	--	--	--	--	14
64	Western juniper	21	21	21	21	21
65	Utah juniper	--	--	--	--	14
66	Rocky mountain juniper	--	--	14.2	--	14.2
72	Subalpine larch	--	22	22	22	--
73	Western larch	22	22	22	22	22
81	Incense cedar	19	19	19	19	19
92	Brewer spruce	13	--	13	13	12
93	Engelmann spruce	13	13	12	12	12
98	Sitka spruce	13	13	13	13	12
101	Whitebark pine	15	15	15	15	20
102	Bristlecone pine	--	--	--	--	16
103	Knobcone pine	15	15	15	--	16
104	Foxtail pine	--	--	--	--	16
108	Lodgepole pine	15	15	15	15	16
109	Coulter pine	--	--	--	--	5
113	Limber pine	--	--	16	--	16
116	Jeffrey pine	5	--	4	--	5
117	Sugar pine	20	--	20	--	20
119	Western white pine	15	15	15	15	20
120	Bishop pine	16	--	16	--	16
122	Ponderosa pine	5	4	4	4	5
124	Monterey pine	--	--	--	--	16
127	Gray pine	--	--	--	--	5
130	Scotch pine	15	--	--	--	--
133	Singleleaf pinyon pine	--	--	--	--	14.1

SOFTWOOD CUBIC VOLUME EQUATIONS

Volume equation numbers
(continued)

		Halfstate				
Species Code	**Species**	**WOR**	**WWA**	**EOR**	**EWA**	**CA**
137	Washoe pine	--	--	--	--	5
142	Great Basin bristlecone pine	--	--	--	--	16
201	Bigcone Douglas-fir	--	--	--	--	3
202	Douglas-fir	1	1	2	2	3
211	Redwood	24	24	24	--	24
212	Giant Sequoia	24	--	24	--	24
231	Pacific yew	9	9	8	8	8
242	Western redcedar	9	9	8	8	8
251	California nutmeg	--	--	--	--	8
263	Western hemlock	6	6	6	6	6
264	Mountain hemlock	17	17	17	17	17
298/299	Unknown Conifer	17	17	17	17	17

There are many equations used to estimate softwood cubic-foot volume. Each equation below has been cross-walked to a particular tree species in the table above.
Click on an equation number to view the actual equation and procedure used to estimate volume.

SOFTWOOD VOLUME EQUATION SOURCES

EQUATION 1	DOUGLAS-FIR	(Brackett, 1973; DNR RPT # 24,1977)
EQUATION 2	DOUGLAS-FIR	(DNR MEMO--SUMMERFIELD,11/7/80)
EQUATION 3	DOUGLAS-FIR	(USDA-FS RES NOTE PNW-266)
EQUATION 4	PONDEROSA PINE	(DNR MEMO--SUMMERFIELD,11/7/80)
EQUATION 5	PONDEROSA PINE	(USDA-FS RES NOTE PNW-266)
EQUATION 6	W.HEMLOCK	(DNR NOTE 27,4/79)
EQUATION 7	W.HEMLOCK	(BROWNE (1962) BC FOREST SERV,P33)
EQUATION 8	REDCEDAR	(REDCEDAR INTERIOR--DNR RPT # 24,1977)
EQUATION 9	REDCEDAR	(REDCEDAR COAST--DNR RPT # 24,1977)
EQUATION 10	TRUE FIRS	(INTERIOR BALSAM--DNR RPT # 24,1977)
EQUATION 11	TRUE FIRS	(COAST BALSAM--DNR RPT # 24,1977)
EQUATION 12	SPRUCE	(SITKA SPRUCE INTERIOR--DNR RPT # 24,1977)
EQUATION 13	SPRUCE	(SITKA SPRUCE MATURE--DNR RPT # 24,1977)
EQUATION 14	Other junipers	(Chojnacky, 1985)
EQUATION 14.1	Singleleaf pinyon	(Chojnacky, 1985)
EQUATION 14.2	Rocky mountain juniper	(Chojnacky, 1985)
EQUATION 15	LODGEPOLE PINE	(LODGEPOLE PINE--DNR RPT # 24,1977)
EQUATION 16	LODGEPOLE PINE	(USDA-FS RES NOTE PNW-266)
EQUATION 17	MTN.HEMLOCK	(BELL, OSU RES.BULL 35)
EQUATION 18	SHASTA RED FIR	(USDA-FS RES NOTE PNW-266)
EQUATION 19	INCENSE CEDAR	(USDA-FS RES NOTE PNW-266)
EQUATION 20	SUGAR PINE	(USDA-FS RES NOTE PNW-266)
EQUATION 21	W.JUNIPER	(CHITTESTER,1984)
EQUATION 22	W.LARCH	(LARCH--DNR RPT # 24,1977)
EQUATION 23	WHITE FIR	(USDA-FS RES NOTE PNW-266)
EQUATION 24	REDWOOD	(Krumland and Wensel 1975; DNR RPT # 24,1977)

Equation 7
Browne, J.E. 1962. Standard cubic-foot volume tables for the commercial tree species of British Columbia. B.C. Forest Service, Victoria. 107 p.

Equations 1, 8, 9, 10, 11, 12, 13, 15
Brackett, M. 1973. Notes on TARIF tree volume computation. Res. Management Report 24. WA Dept. of Nat. Resources. Olympia. 26p.

Brackett, Michael. 1977. Notes on TARIF tree-volume computation. DNR report # 24. State of Washington, Department of Natural Resources, Olympia, WA. 132p. (see Weyerhaeuser Eqn. #4, page 6)

Equations 2, 4
Summerfield, Edward. 1980. In-house memo describing equations for Douglas-fir and ponderosa pine. State of Washington, Department of Natural Resources. On file with the PNW Research Station.

Equations 3, 5,16,18,19,20,23
MacLean, Colin and John M. Berger. 1976. Softwood tree-volume equations for major California species. PNW Research Note, PNW-266. Pacific Northwest Forest and Range Experiment Station, Portland Oregon. 34p. (see page 4)

Equation 6
Chambers, C.J. and Foltz, B. 1979. The TARIF system -- revisions and additions., Resource Management Report # 27. WA Dept. of Nat. Resources. Olympia. (see page 2)

Equations 14, 14.1, 14.2
Chojnacky D.C., 1985. Pinyon-Juniper Volume Equations for the Central Rocky Mountain States.Res. Note INT-339, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

Equation 17
Bell, J.F., Marshall, D.D. and Johnson G.P. 1981. Tarif tables for mountain hemlock: developed from an equation of total stem cubic-foot volume. Research Bulletin #35. OSU Forest Research Lab, School of Forestry, Oregon State University, Corvallis, OR. (see page 6)

Equation 21
Chittester, Judith and Colin MacLean. 1984. Cubic-foot tree-volume equations and tables for western juniper. Research Note, PNW-420. Pacific Northwest Forest and Range Experiment Station. Portland, Oregon. 8p. (see page 4)

Equation 24
Krumland, B.E. and L.E. Wensel. 1975. Preliminary young growth volume tables for coastal California conifers. Research Note #1. In-house memo. Co-op Redwood Yield Research Project. Department of Forestry and Conservation, College of Natural Resources, U of Cal, Berkeley. On file with the PNW Research Station. (see Table 1, page 4)

Softwood cubic volume equations

Equation 1

$$\mathbf{CVTSL} = -3.21809 + 0.04948 \times \log(HT) \times \log(DBH) - 0.15664 \times (\log(DBH))^2 + 2.02132 \times \log(DBH) + 1.63408 \times \log(HT) - 0.16185 \times (\log(HT))^2 \quad (1)$$

CVTS=10**CVTSL (2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 2

$$\mathbf{CVTSL} = -6.110493 + 1.81306 \times ln(DBH) + 1.083884 \times ln(HT) \quad (1)$$

$$\mathbf{CVTS} = exp(CVTSL) \quad (2)$$

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = Natural Log, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 3– (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP
BA = DBH**2 * 0.005454154
BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH
'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.248569 + 0.0253524*(HT/DBH) - 0.0000560175*(HT**2/ DBH)
IF(CF4 < 0.3) CF4 =0.3
IF(CF4 > 0.4) CF4 =0.4
CF4_TMP = 0.248569 + 0.0253524*(HT/TMP_DBH) - 0.0000560175*(HT**2/ TMP_DBH)
IF(CF4_TMP < 0.3) CF4_TMP=0.3
IF(CF4_TMP > 0.4) CF4_TMP=0.4

'----------
'For ease of use and to improve readability of equations, calculate the following term and use it
'in the equations that follow. Note that actual DBH and BA are used for all trees.
'Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)
'----------

IF DBH >= 6.0 THEN
CV4 = CF4 * BA * HT
TARIF = (CV4 * 0.912733) / (BA - 0.087266)
IF (TARIF <= 0.0) TARIF=0.01
CVTS = (CV4 * TERM)/ (BA - 0.087266)
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN
CV4 _TMP = CF4_TMP *BA_TMP * HT
TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)
IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01
'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)
TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))
IF (TARIF <= .0.0) TARIF = 0.01
CVTS = TARIF * TERM
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733
CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL
IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 4

$$\mathbf{CVTSL} = -8.521558 + 1.977243 \times \ln(DBH) - 0.105288 \times (\ln(HT))^2 + \frac{136.0489}{HT} + 1.99546 \times \ln(HT) \quad (1)$$

$$\mathbf{CVTS} = exp(CVTSL) \quad (2)$$

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{((1.033 \times (1.0 + 1.382937 \times exp(-4.015292 \times DBH))) \times (BA + 0.087266) - 0.174533)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = Natural Log (ln), CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 5 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP
BA = DBH**2 * 0.005454154
BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH
'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.402060 - 0.899914 * (1/DBH)
IF(CF4 < 0.3) CF4=0.3
IF(CF4 > 0.4) CF4=0.4
CF4_TMP = 0.402060 - 0.899914 * (1/TMP_DBH)
IF(CF4_TMP < 0.3) CF4_TMP=0.3
IF(CF4_TMP > 0.4) CF4_TMP=0.4

'----------
'For ease of use and to improve readability of equations, calculate the following term and use it
'in the equations that follow. Note that actual DBH and BA are used for all trees.
'Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)
'----------

IF DBH >= 6.0 THEN
CV4 = CF4 * BA * HT
TARIF = (CV4 * 0.912733) / (BA - 0.087266)
IF (TARIF <= 0.0) TARIF=0.01
CVTS = (CV4 * TERM)/ (BA - 0.087266)
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN
CV4 _TMP = CF4_TMP *BA_TMP * HT
TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)
IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01
'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)
TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))
IF (TARIF <= .0.0) TARIF = 0.01
CVTS = TARIF * TERM
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733
CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL
IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 6

$$\mathrm{CVTSL} = -2.72170 + 2.00857 \times \log(DBH) + 1.08620 \times \log(HT) - 0.00568 \times (DBH) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 7

$$\mathbf{CVTSL} = -2.663834 + 1.79023 \times log(DBH) + 1.124873 \times log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 8

$$\mathrm{CVTSL} = -2.464614 + 1.701993 \times \log(DBH) + 1.067038 \times \log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 9

$$\mathbf{CVTSL} = -2.379642 + 1.682300 \times log(DBH) + 1.039712 \times log(HT) \quad (1)$$

(2)

CVTS=10**CVTSL

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 10

$$\mathbf{CVTSL} = -2.502332 + 1.864963 \times log(DBH) + 1.004903 \times log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 11

$$\mathbf{CVTSL} = -2.575642 + 1.806775 \times log(DBH) + 1.094665 \times log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 12

$$\text{CVTSL} = -2.539944 + 1.841226 \times \log(DBH) + 1.034051 \times \log(HT) \quad (1)$$

CVTS=10**CVTSL

$$\textbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\textbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\textbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 13

$$\mathbf{CVTSL} = -2.700574 + 1.754171 \times log(DBH) + 1.164531 \times log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 14

IF (DRC >= 3 AND HT > 0) then Factor = DRC *x* DRC *x* HT;

IF STEMS=1 THEN S = 1
IF STEMS>1 THEN S = 0

VOLUME = (-.13386 + (.133726 *x* (Factor $^{1/3}$)) + (.036329 *x* S)) ^{3}

IF VOLUME <=0 then VOLUME = 0.1

WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter
(includes live wood, dead wood, and bark)

STEMS = number of stems 3 inches and larger within the first foot above DRC. When STEMS=1 it is a single stemmed tree

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

No boardfoot equation is available

Equation 14.1

IF (DRC >= 3 AND HT > 0) then Factor = DRC *x* DRC *x* HT;

IF STEMS = 1 THEN S = 1
IF STEMS > 1 THEN S = 0

VOLUME = (-0.14240 + (. 148190 x (Factor $^{1/3}$)) - (.016712 x S)) ^{3}

IF VOLUME <=0 then VOLUME = 0.1

WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter
(includes live wood, dead wood, and bark)

STEMS = number of stems 3 inches and larger within the first foot above DRC. When STEMS=1 it is a single stemmed tree

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

No boardfoot equation is available

Equation 14.2

IF (DRC >= 3 AND HT > 0) then Factor = DRC *x* DRC *x* HT;

VOLUME = (0.02434 + (0.119106 x (Factor $^{1/3}$))) ^{3}

IF VOLUME <=0 then VOLUME = 0.1

WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter (includes live wood, dead wood, and bark)

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

No boardfoot equation is available

Equation 15

$$\mathrm{CVTSL} = -2.615591 + 1.847504 \times \log(DBH) + 1.085772 \times \log(HT) \quad (1)$$

CVTS=10**CVTSL

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 16 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP
BA = DBH**2 * 0.005454154
BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH
'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.422709 - 0.0000612236 * (HT**2/DBH)
IF(CF4 < 0.3) CF4=0.3
IF(CF4 > 0.4) CF4=0.4
CF4_TMP = 0.422709 - 0.0000612236 * (HT**2/TMP_DBH)
IF(CF4_TMP < 0.3) CF4_TMP=0.3
IF(CF4_TMP > 0.4) CF4_TMP=0.4

'----------
'For ease of use and to improve readability of equations, calculate the following term and use it
'in the equations that follow. Note that actual DBH and BA are used for all trees.
'Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)
'----------

IF DBH >= 6.0 THEN
CV4 = CF4 * BA * HT
TARIF = (CV4 * 0.912733) / (BA - 0.087266)
IF (TARIF <= 0.0) TARIF=0.01
CVTS = (CV4 * TERM)/ (BA - 0.087266)
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN
CV4 _TMP = CF4_TMP *BA_TMP * HT
TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)
IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01
'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)
TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))
IF (TARIF <= .0.0) TARIF = 0.01
CVTS = TARIF * TERM
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733
CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL
IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 17

$$\mathbf{CVTS} = 0.001106485 \times (DBH)^{1.8140497} \times (HT)^{1.2744923} \tag{1}$$

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \tag{2}$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \tag{3}$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \tag{5}$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 18 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP
BA = DBH**2 * 0.005454154
BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH
'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.231237 + 0.028176 * (HT/DBH)
IF(CF4 < 0.3) CF4=0.3
IF(CF4 > 0.4) CF4=0.4
CF4_TMP = 0.231237 + 0.028176 * (HT/TMP_DBH)
IF(CF4_TMP < 0.3) CF4_TMP=0.3
IF(CF4_TMP > 0.4) CF4_TMP=0.4

'----------
'For ease of use and to improve readability of equations, calculate the following term and use it
'in the equations that follow. Note that actual DBH and BA are used for all trees.
'Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)
'----------

IF DBH >= 6.0 THEN
CV4 = CF4 * BA * HT
TARIF = (CV4 * 0.912733) / (BA - 0.087266)
IF (TARIF <= 0.0) TARIF=0.01
CVTS = (CV4 * TERM)/ (BA - 0.087266)
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN
CV4 _TMP = CF4_TMP *BA_TMP * HT
TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)
IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01
'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)
TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))
IF (TARIF <= .0.0) TARIF = 0.01
CVTS = TARIF * TERM
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733
CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL
IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 19 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP
BA = DBH**2 * 0.005454154
BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH
'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.225786 + 4.44236 * (1/HT)
IF(CF4 < .27) CF4=.27
CF4_TMP = 0.225786 + 4.44236 * (1/HT)
IF(CF4_TMP < .27) CF4_TMP=.27

'----------
'For ease of use and to improve readability of equations, calculate the following term and use it
'in the equations that follow. Note that actual DBH and BA are used for all trees.
'Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)
'----------

IF DBH >= 6.0 THEN
CV4 = CF4 * BA * HT
TARIF = (CV4 * 0.912733) / (BA - 0.087266)
IF (TARIF <= 0.0) TARIF=0.01
CVTS = (CV4 * TERM)/ (BA - 0.087266)
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN
CV4 _TMP = CF4_TMP *BA_TMP * HT
TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)
IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01
'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)
TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))
IF (TARIF <= .0.0) TARIF = 0.01
CVTS = TARIF * TERM
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733
CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL
IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # .27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 20 – (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP
BA = DBH**2 * 0.005454154
BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH
'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.358550 - 0.488134 * (1/DBH)
IF(CF4 < 0.3) CF4=0.3
IF(CF4 > 0.4) CF4=0.4
CF4_TMP = 0.358550 - 0.488134 * (1/ TMP_DBH)
IF(CF4_TMP < 0.3) CF4_TMP=0.3
IF(CF4_TMP > 0.4) CF4_TMP=0.4

'----------
'For ease of use and to improve readability of equations, calculate the following term and use it
'in the equations that follow. Note that actual DBH and BA are used for all trees.
'Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)
'----------

IF DBH >= 6.0 THEN
CV4 = CF4 * BA * HT
TARIF = (CV4 * 0.912733) / (BA - 0.087266)
IF (TARIF <= 0.0) TARIF=0.01
CVTS = (CV4 * TERM)/ (BA - 0.087266)
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN
CV4 _TMP = CF4_TMP *BA_TMP * HT
TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)
IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01
'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)
TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))
IF (TARIF <= .0.0) TARIF = 0.01
CVTS = TARIF * TERM
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733
CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL
IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # .27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 21

$$\mathbf{CVTS} = 0.005454154 \times \left[0.30708901 + 0.0008615762\ 2 \times HT\text{-}0.0037255243 \times DBH \times \frac{HT}{HT - 4.5} \right] \times DBH^2 \times HT \times \left(\frac{HT}{HT - 4.5} \right)^2 \quad (1)$$

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733 \right)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times \left(BA + 0.087266 \right) - 0.174533 \right)} \quad (2)$$

$$\mathbf{CV4} = \frac{\left(CVTS + 3.48 \right)}{\left(1.18052 + 0.32736 \times exp\left(-0.1 \times DBH \right) \right)} - 2.948 \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5} \right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times \left(BA + 0.087266 \right) - 0.174533 \right)}{0.912733} \quad (5)$$

If CVTS < 0 then CVTS = 2
If CV4 < 0 then CV4 = 1

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 22

Use for dbh>2

$$\mathbf{CVTSL} = -2.624325 + 1.847123 \times log(DBH) + 1.044007 \times log(HT) \quad (1)$$

$$\mathrm{CVTS} = 10.0^{CVTSL} \quad (2)$$

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 23 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP
BA = DBH**2 * 0.005454154
BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH
'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.299039 + 1.91272 * (1/HT) + 0.0000367217 * (HT**2/DBH)
IF(CF4 < 0.3) CF4=0.3
IF(CF4 > 0.4) CF4=0.4
CF4_TMP = 0.299039 + 1.91272 * (1/HT) + 0.0000367217 * (HT**2/TMP_DBH)
IF(CF4_TMP < 0.3) CF4_TMP=0.3
IF(CF4_TMP > 0.4) CF4_TMP=0.4

'----------
'For ease of use and to improve readability of equations, calculate the following term and use it
'in the equations that follow. Note that actual DBH and BA are used for all trees.
'Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)
'----------

IF DBH >= 6.0 THEN
CV4 = CF4 * BA * HT
TARIF = (CV4 * 0.912733) / (BA - 0.087266)
IF (TARIF <= 0.0) TARIF=0.01
CVTS = (CV4 * TERM)/ (BA - 0.087266)
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN
CV4 _TMP = CF4_TMP *BA_TMP * HT
TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)
IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01
'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)
TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))
IF (TARIF <= .0.0) TARIF = 0.01
CVTS = TARIF * TERM
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733
CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL
IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 24

$$\mathbf{CVTS} = exp\left(-6.2597 + 1.9967 \times ln(DBH) + 0.9642 \times ln(HT)\right) \tag{1}$$

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)} \tag{2}$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \tag{3}$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)}{0.912733} \tag{4}$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

SOFTWOOD BOARDFOOT VOLUME EQUATIONS

$$\textbf{RC6} = 0.993 - \left(0.993 \times 0.62^{(DBH - 6.0)}\right)$$

$$\textbf{CV6} = RC6 \times CV4$$

IF CV6 > CV4 THEN CV6 =CV4

$$\textbf{CUBUS} = CV4 - CV6$$

$$\textbf{B4} = \frac{TARIF}{0.912733}$$

$$\textbf{RS616L} = 0.174439 + 0.117594 \times log(DBH) \times log(B4) - \frac{8.210585}{DBH^2} + 0.236693 \times log(B4) - 0.00001345 \times (B4)^2 - 0.00001937 \times DBH^2$$

$$\textbf{RS616} = 10.0^{RS616L}$$

$$\textbf{RS632} = 1.001491 - \frac{6.924097}{TARIF} + 0.00001351 \times DBH^2$$

$$\textbf{SV616} = RS616 \times CV6$$

$$\textbf{SV632} = RS632 \times SV616$$

$$\textbf{SCRIB} = SV632$$

note: West-side Scribner conifer volumes are based on 32 foot logs, for areas other than western Oregon and western Washington SCRIB = sv616

$$\textbf{RI6} = -2.904154 + 3.466328 \times log(DBH \times TARIF) - 0.02765985 \times DBH - 0.00008205 \times TARIF^2 + \frac{11.29598}{DBH^2}$$

$$\textbf{XINT6} = RI6 \times CV6$$

Where:

B4 = BINGO FACTOR
CUBUS = CUBIC FOOT VOLUME, UPPER-STEM PORTION
RC6 = RATIO TO CONVERT CUBIC 4-INCH TOP TO CUBIC 6-INCH TOP
CV6 = CUBIC FOOT VOLUME, 6-INCH TOP (SAWLOG)
RS616 = RATIO TO CONVERT CUBIC 6-INCH TOP TO SCRIB 6-INCH TOP IN 16-FT LOGS
RS632 = RATIO TO CONVERT SCRIB 6-INCH TOP IN 16-FT LOGS TO SCRIB 6-INCH TOP IN 32-FT LOGS (WEST-SIDE ONLY)
SV632 = SCRIBNER VOLUME--6-INCH TOP (IN 32-FT LOGS) (WEST-SIDE ONLY)
SV616 = SCRIBNER VOLUME--6-INCH TOP (IN 16-FT LOGS)
RI6 = RATIO TO CONVERT CUBIC 6-INCH TOP TO INTERNATIONAL ¼ INCH 6-INCH TOP
XINT6 =INTERNATIONAL ¼ INCH VOLUME--6-INCH TOP (IN 16-FT LOGS)

HARDWOOD CUBIC VOLUME EQUATIONS

Volume equation numbers

		Halfstate				
Species Code	**Species**	**WOR**	**WWA**	**EOR**	**EWA**	**CA**
312	Bigleaf maple	37	25	37	25	37
313	Boxelder	37	25	37	25	38
320	Norway maple	37	--	--	--	--
321	Rocky Mountain maple	45	45	45	45	45
322	Bigtooth maple	45	45	45	45	45
333	California buckeye	--	--	--	--	43
341	Tree of heaven	26	--	26	--	--
351	Red alder	25	26	26	26	26
352	White alder	26	26	26	26	26
361	Pacific madrone	40	25	--	--	40
374	Water birch	25	25	25	25	25
375	Paper birch	25	25	25	25	25
431	Golden chinkapin	32	25	32	--	32
475	Curlleaf mountain-mahogany	45	45	45	45	45
492	Pacific dogwood	25	25	25	25	37
500	Hawthorn	25	25	25	25	42
510/511	Eucalyptus	--	--	--	--	31
542	Oregon ash	38	25	38	25	38
547	Velvet ash	--	--	--	--	38
590/591	Holly	25	25	25	25	25
600	Walnut	--	--	--	--	38
603	Northern California black walnut	38	--	--	38	38
604	Southern California black walnut	--	--	--	--	38
611	Sweet gum	--	--	--	--	26
631	Tanoak	34	--	--	--	34
660	Apples	25	25	25	25	42
661	Oregon crabapple	25	25	25	25	42
730	California sycamore	--	--	--	--	42
731	American sycamore	--	--	--	--	42
746	Quaking aspen	25	25	25	25	28
747	Black cottonwood	25	25	25	25	27
748	Fremont poplar	--	--	--	--	27
756	honey mesquite	--	--	--	--	46
758	screwbean mesquite	--	--	--	--	46
760	Cherry	25	25	25	25	26
763	Common chokecherry	25	25	25	25	41
768	Bitter cherry	25	25	25	25	26
771	Sweet cherry	25	--	--	--	--

HARDWOOD CUBIC VOLUME EQUATIONS

Volume equation numbers
(Continued)

		Halfstate				
Species Code	**Species**	**WOR**	**WWA**	**EOR**	**EWA**	**CA**
801	California live oak	--	--	--	--	43
805	Canyon live oak	42	--	--	--	42
807	Blue oak	--	--	--	--	39
811	Englemann oak	--	--	--	--	36
815	Oregon white oak	41	25	41	25	41
818	California black oak	38	--	38	--	38
821	California white oak	35	--	--	--	35
826	Chinkapin oak	--	--	--	--	38
839	Interior live oak	--	--	--	--	44
901	Black locust	37	--	37	25	38
920	Willows	25	25	25	25	40
922	Black willow	40	--	--	--	40
926	Balsam willow	25	--	--	--	--
927	White willow	25	25	--	--	--
929	Weeping willow	--	--	25	--	--
981	California-laurel	33	--	--	--	33
990	Desert ironwood	--	--	46	46	46
997	Russian-olive	37	25	37	25	38
998	Unknown hardwood	25	25	25	25	41
999	Unknown Tree	25	25	25	25	41

HARDWOOD VOLUME EQUATION SOURCES

EQUATION 25	ALDER	(CURTIS/BRUCE, PNW-56 and DNR 24)
EQUATION 26	ALDER	(BC-ALDER--DNR RPT#24,1977)
EQUATION 27	COTTONWOOD	(BC-COTTONWOOD--DNR RPT#24,1977)
EQUATION 28	ASPEN	(BC-ASPEN--DNR RPT#24,1977)
EQUATION 29	BIRCH	(BC-BIRCH--DNR RPT#24,1977)
EQUATION 30	BIGLEAF MAPLE	(BC-MAPLE--DNR RPT#24,1977)
EQUATION 31	EUCALYPTUS	(MEMO,COLIN D. MacLEAN 1/27/83,(REVISED 2/7/83))
EQUATION 32	G.CHINQUAPIN	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION 33	C.LAUREL	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION 34	TANOAK	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION 35	CALIF WHITE OAK	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION 36	ENGELMANN OAK	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION 37	BIGLEAF MAPLE	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 38	CALIF BLACK OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 39	BLUE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 40	PACIFIC MADRONE	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 41	ORE WHITE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 42	CANYON LIVE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 43	COAST LIVE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 44	INT LIVE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 45	MTN. MAHOGANY	(Chojnacky, 1985)
EQUATION 46	MESQUITE	(Chojnacky, 1985)

Equation 25
Curtis, Robert O., Bruce, David, and Caryanne VanCoevering. 1968. Volume and taper tables for red alder. US Forest Serv. Res. Pap. PNW-56. PNW Forest & Range Exp. Sta., Portland, Oregon. 35p.

Equations 26,27,28,29,30
Brackett, Michael. 1977. Notes on TARIF tree-volume computation. DNR report #24. State of Washington, Department of Natural Resources, Olympia, WA. 132p. (see page 5)

Equation 31
Colin MacLean and Tom Farrenkopf. 1983. Eucalyptus volume equation. In-house memo describing the volume equation for CVTS, to be used for all species of Eucalyptus. The equation was developed from 111 trees. On file at the PNW Research Station,Portland,OR

Equations 32 - 44
Pillsbury, Norman H. and Michael L. Kirkley. 1984. Equations for Total, Wood, and Saw-log Volume for Thirteen California Hardwoods. PNW Research Note, PNW-414. Pacific Northwest Research Station, Portland Oregon. 52p.

Equations 45, 46
Chojnacky D.C., 1985. Pinyon-Juniper Volume Equations for the Central Rocky Mountain States. Res. Note INT-339, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

HARDWOOD CUBIC VOLUME EQUATIONS

EQUATION 25

If HT < 18 then set HT = 18

$$\mathbf{F} = 0.3651 \times Z^{2.5} - 7.9032 \times Z^{2.5} \frac{DBH}{1000.0} + 3.295 \times Z^{2.5} \times \frac{HT}{1000.0}$$
$$- 1.9856 \times Z^{2.5} \times HT \times \frac{DBH}{100000.0} - 2.9668 \times Z^{2.5} \times \frac{HT^2}{1000000.0}$$
$$+ 1.5092 \times Z^{2.5} \times \frac{HT^{0.5}}{1000.0} + 4.9395 \times Z^{4} \times \frac{DBH}{1000.0}$$
$$- 2.05937 \times Z^{4} \times \frac{HT}{1000.0} + 1.5042 \times Z^{33} \times HT \times \frac{DBH}{1000000.0}$$
$$- 1.1433 \times Z^{33} \times \frac{HT^{0.5}}{10000.0} + 1.809 \times Z^{41} \times \frac{HT^2}{10000000.0} \quad (1)$$

Where: $$Z = \frac{\left(HT - 0.5 - \frac{DBH}{24.0}\right)}{HT - 4.5}$$

$$\mathbf{CVT} = 0.00545415 \times (DBH)^2 \times (HT - 4.5) \times F \quad (2)$$

$$\mathrm{TARIF} = \frac{(CVT \times 0.912733)}{\left(\left(0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)}\right) \times \left(\left(\left(1.0330 \times \left(1.0 + 1.382937 \times \exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVTS} = TARIF \times \frac{\left(\left(\left(1.0330 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH-8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

WHERE:
DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH2
CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP
TARIF = TARIF NUMBER EQUATION
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME, 4-IN TOP
CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 26

$$\mathbf{CVTSL} = -2.672775 + 1.920617 \times log(DBH) + 1.074024 \times log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 27

$$\mathbf{CVTSL} = -2.945047 + 1.803973 \times log(DBH) + 1.238853 \times log(HT) \quad (1)$$

CVTS=10**CVTSL (2)

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 28

$$\mathbf{CVTSL} = -2.635360 + 1.946034 \times log(DBH) + 1.024793 \times log(HT) \quad (1)$$

CVTS=10**CVTSL (2)

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 29

$$\mathbf{CVTSL} = -2.757813 + 1.911681 \times log(DBH) + 1.105403 \times log(HT) \quad (1)$$

CVTS=10**CVTSL (2)

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 30

$$\mathbf{CVTSL} = -2.770324 + 1.885813 \times log(DBH) + 1.119043 \times log(HT) \quad (1)$$

CVTS=10**CVTSL (2)

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 31

$$\mathbf{CVTS} = 0.0016144 \times DBH^2 \times HT \tag{1}$$

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \tag{2}$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \tag{3}$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \tag{4}$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \tag{5}$$

$$\mathbf{CV4X} = CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 32

$$\text{CVTS} = 0.0120372263 \times DBH^{2.02232} \times HT^{0.68638} \quad (1)$$

$$\textbf{CV4} = 0.0055212937 \times DBH^{2.07202} \times HT^{0.77467} \quad (2)$$

$$\textbf{CV8} = 0.0018985111 \times DBH^{2.38285} \times HT^{0.77105} \quad (3)$$

$$\text{CVT} = CVTS * RTS \quad (4)$$
$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH - 1.5)}$$

$$\textbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\textbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH - 8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 33

$$\mathbf{CVTS} = 0.0057821322 \times DBH^{1.94553} \times HT^{0.88389} \quad (1)$$

$$\mathbf{CV4} = 0.0016380753 \times DBH^{2.05910} \times HT^{1.05293} \quad (2)$$

$$\mathbf{CV8} = 0.0007741517 \times DBH^{2.23009} \times HT^{1.03700} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$
$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)}$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 34

If HT > 120 feet then set HT = 120 feet

$$\mathbf{CVTS} = 0.0058870024 \times DBH^{1.94165} \times HT^{0.86562} \quad (1)$$

$$\mathbf{CV4} = 0.0005774970 \times DBH^{2.19576} \times HT^{1.14078} \quad (2)$$

$$\mathbf{CV8} = 0.0002526443 \times DBH^{2.30949} \times HT^{1.21069} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$
$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)}$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 35

$$\mathbf{CVTS} = 0.0042870077 \times DBH^{2.33631} \times HT^{0.74872} \quad (1)$$

$$\mathbf{CV4} = 0.0009684363 \times DBH^{2.39565} \times HT^{0.98878} \quad (2)$$

$$\mathrm{CV8} = 0.0001880044 \times DBH^{1.87346} \times HT^{1.62443} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH - 1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH - 8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 36

$$\mathbf{CVTS} = 0.01914531910 \times DBH^{2.40248} \times HT^{0.28060} \quad (1)$$

$$\mathbf{CV4} = 0.00538663530 \times DBH^{2.61268} \times HT^{0.31103} \quad (2)$$

CV8 =CV4 (3)

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 37

$$\mathbf{CVTS} = 0.0101786350 \times DBH^{2.22462} \times HT^{0.57561} \quad (1)$$

$$\mathrm{CV4} = 0.0034214162 \times DBH^{2.35347} \times HT^{0.69586} \quad (2)$$

$$\mathbf{CV8} = 0.0004236332 \times DBH^{2.10316} \times HT^{1.08584} \times FC^{0.40017} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

FC= HARDWOOD FORM CLASS

CVTS= CUBIC FOOT VOLUME, TOP AND STUMP

TARIF= TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 38

$$\mathbf{CVTS} = 0.0070538108 \times DBH^{1.97437} \times HT^{0.85034} \quad (1)$$

$$\mathbf{CV4} = 0.0036795695 \times DBH^{2.12635} \times HT^{0.83339} \quad (2)$$

$$\mathbf{CV8} = 0.0012478663 \times DBH^{2.68099} \times HT^{0.42441} \times FC^{0.28385} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 39

$$\mathbf{CVTS} = 0.0125103008 \times DBH^{2.33089} \times HT^{0.46100} \quad (1)$$

$$\mathbf{CV4} = 0.0042324071 \times DBH^{2.53987} \times HT^{0.50591} \quad (2)$$

$$\mathbf{CV8} = 0.0036912408 \times DBH^{1.79732} \times HT^{0.83884} \times FC^{0.15958} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 40

If HT > 120 feet then set HT = 120 feet

$$\mathbf{CVTS} = 0.0067322665 \times DBH^{1.96628} \times HT^{0.83458} \quad (1)$$

$$\mathbf{CV4} = 0.0025616425 \times DBH^{1.99295} \times HT^{1.01532} \quad (2)$$

$$\mathrm{CV8} = 0.0006181530 \times DBH^{1.72635} \times HT^{1.26462} \times FC^{0.37868} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA= BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 41

$$\mathbf{CVTS} = 0.0072695058 \times DBH^{2.14321} \times HT^{0.74220} \quad (1)$$

$$\mathbf{CV4} = 0.0024277027 \times DBH^{2.25575} \times HT^{0.87108} \quad (2)$$

$$\mathbf{CV8} = 0.0008281647 \times DBH^{2.10651} \times HT^{0.91215} \times FC^{0.32652} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 42

$$\mathbf{CVTS} = 0.0097438611 \times DBH^{2.20527} \times HT^{0.61190} \quad (1)$$

$$\mathbf{CV4} = 0.0031670596 \times DBH^{2.32519} \times HT^{0.74348} \quad (2)$$

$$\mathbf{CV8} = 0.0006540144 \times DBH^{2.24437} \times HT^{0.81358} \times FC^{0.43381} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 43

$$\mathbf{CVTS} = 0.0065261029 \times DBH^{2.31958} \times HT^{0.62528} \quad (1)$$

$$\mathbf{CV4} = 0.0024574847 \times DBH^{2.53284} \times HT^{0.60764} \quad (2)$$

$$\mathbf{CV8} = 0.0006540144 \times DBH^{2.24437} \times HT^{0.81358} \times FC^{0.43381} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 44

$$\mathbf{CVTS} = 0.0136818837 \times DBH^{2.02989} \times HT^{0.63257} \quad (1)$$

$$\mathbf{CV4} = 0.0041192264 \times DBH^{2.14915} \times HT^{0.77843} \quad (2)$$

$$\mathbf{CV8} = 0.0006540144 \times DBH^{2.24437} \times HT^{0.81358} \times FC^{0.43381} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH^2

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 45

IF (DRC >= 3 AND HT > 0) then Factor = DRC *x* DRC *x* HT;

IF STEMS =1 then

VOLUME = (-0.13363 + (0.128222 *x* (Factor $^{1/3}$)) + 0 .080208) ^{3}

ELSE IF STEMS > 1 THEN

VOLUME = (-0.13363 + (0.128222 *x* (Factor $^{1/3}$))) ^{3}

IF VOLUME <=0 then VOLUME = 0.1

WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter (includes live wood, dead wood, and bark)

STEMS = number of stems 3 inches and larger within the first foot above DRC. When STEMS=1 it is a single stemmed tree

DRC (inches) = Diameter at the root collar
HT (feet) = Total height of the tree

No boardfoot equation is available

Equation 46

IF (DRC >= 3 AND HT > 0) then Factor = DRC *x* DRC *x* HT;

```
IF STEMS > 1 then
      if DRC**2 * HT/1000 <=2 then
         VOLUME = 0.020 + 1.8972 * DRC**2*HT/1000 + 0.5756 * (DRC**2*HT/1000)**2
       Else
         VOLUME = 6.927 + 1.8972 * DRC**2*HT/1000 - 9.210 / (DRC**2*HT/1000)

IF STEMS =1 then
      if DRC**2 * HT/1000 <=2 then
         VOLUME = -0.043 + 2.3378 * DRC**2*HT/1000 + 0.8024 * (DRC**2*HT/1000)**2
       Else
         VOLUME =  9.586 + 2.3378 * DRC**2*HT/1000 - 12.839 / (DRC**2*HT/1000)

IF VOLUME <=0  then VOLUME = 0.1
```

WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter (includes live wood, dead wood, and bark)

STEMS = number of stems 3 inches and larger within the first foot above DRC. When STEMS=1 it is a single stemmed tree.

DRC (inches) = Diameter at the root collar
HT (feet) = Total height of the tree

HARDWOOD BOARDFOOT VOLUME RATIOS and EQUATIONS

$$\mathbf{CUBUS} = CV4 - CV8 \quad (1)$$

$$\mathbf{RC6} = 0.993 - 0.993 \times 0.62^{(DBH-6.0)} \quad (2)$$

IF Hardwood Equation Number is 25 to 31 THEN set
CV4X = CVT
TARIFX = TARIF (note that TARIF was calculated in the cubic volume equation)

Otherwise, for all other hardwood equation numbers, calculate CV4X and TARIFX as follows:

$$\mathrm{CV4X} = \mathrm{CVT} \times 0.99875 - \frac{43.336}{\mathrm{DBH}^3} - \frac{124.717}{\mathrm{DBH}^4} + \frac{0.193437 \times \mathrm{HT}}{\mathrm{DBH}^3} + \frac{479.83}{\mathrm{DBH}^3 \times \mathrm{HT}}$$

$$\mathrm{TARIFX} = \frac{\mathrm{CV8} \times 0.912733}{0.983 - 0.983 \times 0.65^{\mathrm{DBH}-8.6} \times \mathrm{BA} - 0.087266}$$

If TARIF or TARIFX are <0 then set them to .01

$$\mathrm{CV6} = RC6 \times CV4X \quad (3)$$

$$\mathrm{B4} = \frac{TARIFX}{0.912733}$$

$$\mathrm{RS616L} = 0.174439 + 0.117594 \times \log(DBH) \times \log(B4) - \frac{8.210585}{DBH^2} + 0.236693 \times \log(B4) - 0.00001345 \times (B4)^2 - 0.00001937 \times DBH^2 \quad (4)$$

$$\mathrm{RS616} = 10.0^{RS616L} \quad (5)$$

$$\mathrm{SV616} = RS616 \times CV6$$

$$\mathrm{RI6} = -2.904154 + 3.466328 \times \log(DBH \times TARIFX) - 0.02765985 \times DBH - 0.00008205 \times TARIFX^2 + \frac{11.29598}{DBH^2} \quad (6)$$

$$\mathrm{XINT6} = RI6 \times CV6 \quad (7)$$

$$RS616 = 0.990 - 0.58 \times (0.484^{DBH-9.5}) \quad (8)$$

$$SV816 = RS816 \times SV616 \quad (9)$$

Calculated on hardwood species only:

$$RI8 = 0.990 - 0.55 \times (0.485^{DBH-9.5}) \quad (10)$$

$$XINT8 = XINT6 \times RI8 \quad (11)$$

WHERE:
B4 = BINGO FACTOR
CUBUS = CUBIC FOOT VOLUME, UPPER-STEM PORTION
RC6 = RATIO TO CONVERT CUBIC 4-INCH TOP TO CUBIC 6-INCH TOP
CV6 = CUBIC FOOT VOLUME, 6-INCH TOP (SAWLOG)
RS616 = RATIO TO CONVERT CUBIC 6-INCH TOP TO SCRIB 6-INCH TOP IN 16-FT LOGS
SV616 = SCRIBNER VOLUME--6-INCH TOP (IN 16-FT LOGS)
RS816 = RATIO TO CONVERT CUBIC 6-INCH TOP TO SCRIB 8-INCH TOP IN 16-FT LOGS
SV816 = SCRIBNER VOLUME--8-INCH TOP (IN 16-FT LOGS)
XINT6 = INTERNATIONAL ¼ INCH VOLUME--6-INCH TOP (IN 16-FT LOGS)
RI8 =RATIO TO CONVERT INTERNATIONAL ¼ INCH 6-INCH TOP TO INTERNATIONAL ¼ INCH 8-INCH TOP
XINT8 = INTERNATIONAL ¼ INCH VOLUME--8-INCH TOP (IN 8-FT LOGS)

REGIONAL BIOMASS EQUATIONS USED BY FIA TO ESTIMATE BOLE, BARK, AND BRANCHES

Updated 09-19-2014

(text in red has been updated since the last version of this document)

BIOMASS OF THE TREE STEM

Tree stem biomass, regardless of whether it is merchantable bole or total stem, is calculated from cubic volume estimates and the wood density factor (in tables below) as follows:

Cubic volume = green cubic volume in cubic feet (ft3)
Wood density = (Specific gravity of a tree species) * (62.4 lbs/ft3)

Weight of water = 62.4 pounds/cubic foot

Biomass of the tree stem (in tons**) =** (cubic foot volume * wood density) / 2000

The tables below contain specific gravity and wood density values for many species.

Softwoods – specific gravity

Code	Species	Specific gravity	Wood density
10	fir spp.	0.36	22.46
11	Pacific silver fir	0.4	24.96
14	bristlecone fir	0.36	22.46
15	white fir	0.37	23.09
17	grand fir	0.35	21.84
19	subalpine fir	0.31	19.34
20	California red fir	0.36	22.46
21	Shasta red fir	0.36	22.46
22	noble fir	0.37	23.09
41	Port-Orford-cedar	0.39	24.34
42	Alaska yellow-cedar	0.42	26.21
50	Cypress spp	0.41	25.58
52	Modoc cypress	0.41	25.58
54	Monterey cypress	0.41	25.58
55	Sargent's cypress	0.41	25.58
62	California juniper	0.45	28.08
64	western juniper	0.45	28.08
65	Utah juniper	0.68	42.43
66	Rocky Mountain juniper	0.45	28.08
72	subalpine larch	0.49	30.58
73	western larch	0.48	29.95
81	incense-cedar	0.35	21.84
90	spruce spp.	0.36	22.46
92	Brewer spruce	0.36	22.46
93	Engelmann spruce	0.33	20.59
98	Sitka spruce	0.33	20.59
100	pine spp.	0.43	26.83
101	whitebark pine	0.43	26.83
102	Bristlecone pine	0.43	26.83
103	knobcone pine	0.39	24.34
104	foxtail pine	0.43	26.83
108	lodgepole pine	0.38	23.71
109	Coulter pine	0.43	26.83
113	limber pine	0.37	23.09
116	Jeffrey pine	0.37	23.09
117	sugar pine	0.34	21.22
119	western white pine	0.36	22.46

Softwoods – specific gravity
(continued)

Code	Species	Specific gravity	Wood density
120	bishop pine	0.45	28.08
122	ponderosa pine	0.38	23.71
124	Monterey pine	0.4	24.96
127	gray pine	0.4	24.96
130	Scotch pine	0.43	26.83
133	singleleaf pinyon	0.43	26.83
137	Washoe pine	0.43	26.83
142	Great Basin bristlecone pine	0.43	26.83
201	bigcone Douglas-fir	0.45	28.08
202	Douglas-fir	0.45	28.08
211	redwood	0.36	22.46
212	giant sequoia	0.34	21.22
231	Pacific yew	0.6	37.44
242	western redcedar	0.31	19.34
251	California torreya	0.41	25.58
263	western hemlock	0.42	26.21
264	mountain hemlock	0.42	26.21
299	Unknown dead conifer	0.41	25.58

Hardwoods – specific gravity

Code	Species	Specific gravity	Wood density
312	bigleaf maple	0.44	27.46
313	boxelder	0.42	26.21
320	Norway maple	0.47	29.33
321	Rocky Mountain maple	0.47	29.33
333	California buckeye	0.33	20.59
341	ailanthus	0.46	28.70
351	red alder	0.37	23.09
352	white alder	0.37	23.09
361	Pacific madrone	0.58	36.19
374	water birch	0.51	31.82
375	paper birch	0.48	29.95
431	golden chinkapin	0.42	26.21
475	curl-leaf mountain-mahogany	0.52	32.45
492	Pacific dogwood	0.58	36.19
500	Hawthorn	0.52	32.45
510	eucalyptus spp.	0.52	32.45
511	Tasmanian bluegum	0.52	32.45
540	ash spp.	0.51	31.82
542	Oregon ash	0.5	31.20
591	American holly	0.5	31.20
600	walnut spp.	0.44	27.46
603	northern California black walnut	0.44	27.46
604	southern California black walnut	0.44	27.46
611	sweetgum	0.46	28.70
631	tanoak	0.58	36.19
661	Oregon crab apple	0.61	38.06
730, 731	California sycamore	0.46	28.70
746	quaking aspen	0.35	21.84
747	black cottonwood	0.31	19.34
748	Fremont cottonwood	0.41	25.58
756,758	mesquite	0.78	48.67
760	cherry and plum spp.	0.47	29.33
763	chokecherry	0.47	29.33
768	bitter cherry	0.47	29.33
771	sweet cherry, domesticated	0.47	29.33
801	California live oak	0.59	36.82
805	canyon live oak	0.7	43.68
807	blue oak	0.59	36.82
811	Engelmann oak	0.59	36.82
815	Oregon white oak	0.64	39.94
818	California black oak	0.51	31.82

Hardwoods – specific gravity
(continued)

Code	Species	Specific gravity	Wood density
821	California white oak	0.55	34.32
826	chinkapin oak	0.59	36.82
839	interior live oak	0.59	36.82
901	black locust	0.66	41.18
920	willow spp.	0.36	22.46
922	black willow	0.36	22.46
926	balsam willow	0.36	22.46
927	white willow	0.36	22.46
981	California-laurel	0.51	31.82
990	desert ironwood	0.52	32.45
997	Russian-olive	0.52	32.45
998	Unknown dead hardwood	0.52	32.45
999	Other or unknown live tree	0.52	32.45

SOFTWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF BARK

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
11	Pacific silver fir	22	22	22	22	22
14	Bristlecone fir	--	--	--	--	2
15	White fir	1	2	1	2	1
17	Grand fir	2	2	2	2	2
19	Subalpine fir	3	3	3	3	3
20	California red fir	4	--	3	--	4
21	Shasta red fir	4	--	4	--	4
22	Noble fir	5	5	5	5	5
41	Port-Orford-cedar	38	13	13	13	13
42	Alaska-cedar	23	23	23	23	13
50	Cypress	--	--	--	--	13
52	Baker cypress	--	--	--	--	13
54	Monterey cypress	--	--	--	--	13
55	Sargent's cypress	--	--	--	--	13
56	Mcnabb cypress	--	--	--	--	13
62	California juniper	--	--	--	--	16
64	Western juniper	16	16	16	16	16
65	Utah juniper	--	--	--	--	16
66	Rocky mountain juniper	--	--	16	--	16
72	Subablpine larch	--	24	24	24	--
73	Western larch	24	24	24	24	24
81	Incense cedar	12	12	12	12	12
92	Brewer spruce	7	--	7	7	7
93	Engelmann spruce	7	7	7	7	7
98	Sitka spruce	6	6	6	6	6
101	Whitebark pine	11	11	11	11	14
102	Bristlecone pine	--	--	--	--	14
103	Knobcone pine	14	14	14	--	14
104	Foxtail pine	--	--	--	--	14
108	Lodgepole pine	14	14	14	14	14
109	Coulter pine	--	--	--	--	9
113	Limber pine	--	--	14	--	14
116	Jeffrey pine	9	--	9	--	9
117	Sugar pine	10	--	10	--	10
119	Western white pine	11	11	11	11	11
120	Bishop pine	14	--	14	--	14
122	Ponderosa pine	9	9	9	9	9
124	Monterey pine	--	--	--	--	14
127	Gray pine	--	--	--	--	9
133	Singleleaf pinyon	--	--	--	--	14
137	Washoe pine	--	--	--	--	14

SOFTWOOD BIOMASS EQUATION ASSIGNMENTS
--continued—

BIOMASS OF BARK

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
142	Great Basin bristlecone pine	--	--	--	--	14
201	Bigcone Douglas-fir	--	--	--	--	8
202	Douglas-fir	8	8	25	25	8
211	Redwood (when DBH > 39.37 inches)	17	17	17	17	17
211	Redwood (when DBH <= 39.37 inches)	13	13	13	13	13
212	Giant Sequoia (when DBH > 39.37 inches)	17	--	17	--	17
212	Giant Sequoia (when DBH <= 39.37 inches)	13	--	13	--	13
231	Pacific yew	38	13	13	38	13
242	Western redcedar	38	13	13	13	13
251	California nutmeg	--	--	--	--	13
263	Western hemlock	26	26	26	26	15
264	Mountain hemlock	21	21	21	21	21
298	Unknown Conifer	21	21	21	21	21

SOFTWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF LIVE BRANCHES

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
11	Pacific silver fir	18	18	18	18	18
14	Bristlecone fir	--	--	--	--	1
15	White fir	1	1	1	1	1
17	Grand fir	1	1	1	1	1
19	Subalpine fir	2	2	2	2	2
20	California red fir	3	--	2	--	3
21	Shasta red fir	3	--	3	--	3
22	Noble fir	3	3	3	3	3
41	Port-Orford-cedar	10	10	10	10	10
42	Alaska-cedar	19	19	19	19	10
50	Cypress	--	--	--	--	10
52	Baker cypress	--	--	--	--	10
54	Monterey cypress	--	--	--	--	10
55	Sargent's cypress	--	--	--	--	10
56	Mcnabb cypress	--	--	--	--	10
62	California juniper	--	--	--	--	13
64	Western juniper	13	13	13	13	13
65	Utah juniper	--	--	--	--	13
66	Rocky mountain juniper	--	--	13	--	13
72	Subablpine larch	--	20	20	20	--
73	Western larch	20	20	20	20	20
81	Incense cedar	10	10	10	10	10
92	Brewer spruce	4	--	4	4	4
93	Engelmann spruce	4	4	4	4	4
98	Sitka spruce	5	5	5	5	5
101	Whitebark pine	9	9	9	9	11
102	Bristlecone pine	--	--	--	--	11
103	Knobcone pine	11	11	11	--	11
104	Foxtail pine	--	--	--	--	11
108	Lodgepole pine	11	11	11	11	11
109	Coulter pine	--	--	--	--	7
113	Limber pine	--	--	11	--	11
116	Jeffrey pine	7	--	7	--	7
117	Sugar pine	8	--	8	--	8
119	Western white pine	9	9	9	9	9
120	Bishop pine	11	--	11	--	11
122	Ponderosa pine	7	7	7	7	7
124	Monterey pine	--	--	--	--	11
127	Gray pine	--	--	--	--	7
130	Scotch pine	11	--	--	--	--
133	Singleleaf pinyon	--	--	--	--	11
137	Washoe pine	--	--	--	--	7
142	Great Basin bristlecone pine	--	--	--	--	11

BIOMASS OF LIVE BRANCHES

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
201	Bigcone Douglas-fir	--	--	--	--	6
202	Douglas-fir	6	6	22	22	6
211	Redwood	10	10	10	--	10
212	Giant Sequoia	10	--	10	--	10
231	Pacific yew	10	10	10	10	10
242	Western redcedar	10	10	10	10	10
251	California nutmeg	--	--	--	--	10
263	Western hemlock	23	23	23	23	12
264	Mountain hemlock	24	24	24	24	17
298	Unknown Conifer	24	24	24	24	17

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF BARK

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
312	Bigleaf maple	--	29	--	29	--
313	Boxelder	--	29	--	29	--
320	Norway maple	--	--	--	--	--
321	Rocky Mountain maple	--	--	--	--	--
333	California buckeye	--	--	--	--	--
341	Tree of heaven	20	--	20	--	--
351	Red alder	20	20	20	20	20
352	White alder	20	20	20	20	20
361	Pacific madrone	--	34	--	34	--
374	Water birch	27	27	27	27	27
375	Paper birch	27	27	27	27	27
431	Golden chinkapin	--	32	--	--	--
475	Curlleaf mountain-mahogany	--	--	--	--	--
492	Pacific dogwood	29	29	29	29	--
500	Hawthorn	37	37	37	37	--
510/511	Eucalyptus	--	--	--	--	--
542	Oregon ash	--	39	--	39	--
547	Velvet ash	--	--	--	--	--
590	Holly	27	27	27	27	27
600	Walnut	--	--	--	--	--
603	N. California black walnut	--	--	--	--	--
604	S. California black walnut	--	--	--	--	--
611	Sweetgum	--	--	--	--	20
631	Tanoak	--	--	--	--	--
660	Apple	37	37	37	37	--
661	Crab apple	37	37	37	37	--
730/731	California sycamore	37	37	37	37	--
746	Quaking aspen	18	18	18	18	18
747	Black cottonwood	28	28	28	28	28
748	Fremont poplar	--	--	--	--	18
756	Honey mesquite	--	--	--	--	--
758	Screwbean mesquite	--	--	--	--	--
760	Cherrys	27	27	27	27	27
763	Common chokecherry	27	27	27	27	35
768	Bitter cherry	27	27	27	27	27
771	Sweet cherry	27	--	--	--	--

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF BARK

(continued)

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
801	California live oak	--	--	--	--	--
805	Canyon live oak	--	--	--	--	--
807	Blue oak	--	--	--	--	--
811	Englemann oak	--	--	--	--	--
815	Oregon white oak	--	35	--	35	--
818	California black oak	--	--	--	--	--
821	California white oak	--	--	--	--	--
826	Chinkapin oak	--	--	--	--	--
839	Interior live oak	--	--	--	--	--
850	Oak-evergreen	--	--	--	--	--
901	Black locust	--	--	--	29	--
920	Willows	34	34	34	34	--
922	Black willow	--	--	--	--	--
926	Balsam willow	34	--	--	--	--
927	White willow	34	34	--	--	--
929	Weeping willow	--	--	34	--	--
981	California-laurel	--	--	--	--	--
990	Desert ironwood	--	--	--	--	--
997	Russian-olive	--	29	--	29	--
998	Unknown hardwood	20	20	20	20	--
999	Unknown Tree	39	39	39	39	--

Hardwood volume for SPECIES 312, 313, 320, 333, 361, 431, 492, 542, 600, 603, 604, 631, 801, 805, 807, 811, 815, 818, 821, 826, 839, 901, 920, 922, 981, 997 are calculated with Pillsbury equations in western Oregon, western Washington and California; this means that total stem volume includes branches and bark, thus bark biomass and live branch biomass are not available as separate components of biomass. Refer to the Volume Equation document for species assignments to individual equations.

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF LIVE BRANCHES

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
312	Bigleaf maple	--	27	--	27	--
313	Boxelder	--	16	--	16	--
321	Rocky Mountain maple	--	--	--	--	--
333	California buckeye	--	--	--	--	--
341	Tree of heaven	16	--	16	--	--
351	Red alder	16	16	16	16	16
352	White alder	16	16	16	16	16
361	Pacific madrone	--	28	--	--	--
374	Water birch	25	25	25	25	25
376	paper birch	25	25	25	25	25
431	Golden chinkapin	--	29	--	--	--
475	Curlleaf mountain-mahogany	--	--	--	--	--
492	Pacific dogwood	16	16	16	16	--
500	Hawthorn	16	16	16	16	--
510	Eucalyptus	--	--	--	--	28
542	Oregon ash	--	16	--	16	--
590/591	Holly	26	26	26	26	26
600	Walnut	--	--	--	--	--
603	N. California black walnut	--	--	--	--	--
604	S. California black walnut	--	--	--	--	--
611	Sweetgum	--	--	--	--	16
631	Tanoak	--	--	--	--	--
661	Oregon crabapple	16	16	16	16	--
730, 731	California sycamore	--	--	--	--	--
746	Quaking aspen	14	14	14	14	14
747	Black cottonwood	15	15	15	15	15
748	Fremont poplar	--	--	--	--	5
755	Mesquite	--	--	--	--	--
756	Honey mesquite	--	--	--	--	--
758	Screwbean mesquite	--	--	--	--	--
760	Cherry	25	25	25	25	25
763	Common chokecherry	25	25	25	25	16
768	Bitter cherry	25	25	25	25	25
771	Sweet cherry	25	--	--	--	--

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF LIVE BRANCHES

(continued)

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
801	California live oak	--	--	--	--	--
805	Canyon live oak	--	--	--	--	--
807	Blue oak	--	--	--	--	--
811	Englemann oak	--	--	--	--	--
815	Oregon white oak	--	--	--	--	--
818	California black oak	--	--	--	--	--
821	California white oak	--	--	--	--	--
826	Chinkapin oak	--	--	--	--	--
839	Interior live oak	--	--	--	--	--
901	Black locust	--	--	--	--	--
920	Willows	--	--	--	--	--
922	Black willow	--	--	--	--	--
926	Balsam willow	16	--	--	--	--
927	White willow	16	16	--	--	--
929	Weeping willow	--	--	16	--	--
981	California-laurel	--	--	--	--	--
990	Desert ironwood	--	--	--	--	--
997	Russian-olive	--	16	--	16	--
998	Unknown hardwood	16	16	16	16	--
999	Unknown Tree	16	16	16	16	--

Hardwood volume for SPECIES 312, 313, 320, 333, 361, 431, 492, 542, 600, 603, 604, 631, 801, 805, 807, 811, 815, 818, 821, 826, 839, 901, 920, 922, 981, 997 are calculated with Pillsbury equations in western Oregon, western Washington and California; this means that total stem volume includes branches and bark, thus bark biomass and live branch biomass are not available as separate components of biomass. Refer to the Volume Equation document for species assignments to individual equations.

BIOMASS OF BARK

All equations produce Biomass of Bark in Kilograms --- to convert to tons multiply by 0.0011023

Log in the equations is = NATURAL LOG

EQUATION 1 BIOPAK EQUATION 379

$$\mathrm{BB} = \frac{\exp\left(2.1069 + 2.7271 \times \log(DBH)\right)}{1000}$$

EQUATION 2 BIOPAK EQUATION 887

$$\mathrm{BB} = 0.6 + 16.4 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 3 BIOPAK EQUATION 917

$$\mathrm{BB} = 1.0 + 17.2 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 4 BIOPAK EQUATION 382

$$\mathrm{BB} = \frac{\exp\left(1.47146 + 2.8421 \times \log(DBH)\right)}{1000}$$

EQUATION 5 BIOPAK EQUATION 251

$$\mathrm{BB} = \frac{\exp\left(2.79189 + 2.4313 \times \log(DBH)\right)}{1000}$$

EQUATION 6 BIOPAK EQUATION 845

$$\mathrm{BB} = 1.3 + 12.6 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 7 BIOPAK EQUATION 875

$$\mathrm{BB} = 4.5 + 9.3 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 8 BIOPAK EQUATION 5

$$\mathrm{BB} = \exp\left(-4.3103 + 2.4300 \times \log\left(DBH\right)\right)$$

EQUATION 9 BIOPAK EQUATION 705

$$\mathrm{BB} = \exp\left(-3.6263 + 1.34077 \times \log\left(DBH\right) + 0.8567 \times \log\left(HT\right)\right)$$

EQUATION 10 BIOPAK EQUATION 391

$$\mathrm{BB} = \frac{\exp\left(2.183174 + 2.6610 \times \log(DBH)\right)}{1000}$$

EQUATION 11 BIOPAK EQUATION 899

$$\mathrm{BB} = 1.2 + 11.2 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 12 (updated) BIOPAK EQUATION 385

$$\mathrm{BB} = \frac{\exp\left(-13.3146 + 2.8594 \times \log(DBH)\right) * 1000}{}$$

EQUATION 13 BIOPAK EQUATION 461

$$\mathrm{BB} = 0.336 + 0.00058 \times DBH^2 \times HT$$

EQUATION 14 BIOPAK EQUATION 904

$$\mathrm{BB} = 3.2 + 9.1 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 15 BIOPAK EQUATION 174

$$\mathrm{BB} = \exp\left(-4.371 + 2.259 \times \log\left(DBH\right)\right)$$

EQUATION 16 BIOPAK EQUATION 54

$$\mathrm{BB} = \exp\left(-10.175 + 2.6333 \times \log\left(DBH \times \pi\right)\right)$$

EQUATION 17 BIOPAK EQUATION 394

$$\mathrm{BB} = \frac{\exp\left(7.189689 + 1.5837 \times \log(DBH)\right)}{1000}$$

EQUATION 18 BIOPAK EQUATION 942

$$\mathrm{BB} = 1.3 + 27.6 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 19

$$\mathrm{BB} = 0.0$$

EQUATION 20 BIOPAK EQUATION 275

$$\mathrm{BB} = \exp\left(-4.6424 + 2.4617 \times \log\left(DBH\right)\right)$$

EQUATION 21 BIOPAK EQUATION 911

$$\mathrm{BB} = 0.9 + 27.4 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 22 BIOPAK EQUATION 881

$$\mathrm{BB} = 1.0 + 15.6 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 23 BIOPAK EQUATION 923

$$\mathrm{BB} = 1.8 + 9.6 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 24 BIOPAK EQUATION 893

$$\mathrm{BB} = 2.4 + 15.0 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 25 BIOPAK EQUATION 857

$$\mathrm{BB} = 3.6 + 18.2 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 26 BIOPAK EQUATION 455

$$\mathrm{BB} = -0.025 + 0.00134 \times DBH^2 \times HT$$

EQUATION 27 BIOPAK EQUATION 948

$$\mathrm{BB} = -1.2 + 29.1 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 28 BIOPAK EQUATION 930

$$\mathrm{BB} = 1.2 + 15.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 29 (Bigleaf maple)

$$ADBH = \frac{(DBH - 0.21235)}{0.94782} \quad 1$$

$$OUTERVOL = 0.0000246916 \times \left(ADBH^{2.354347} \left(HT^{0.69586} \right) \right) \quad 2$$

$$INNERVOL = 0.0000246916 \times \left(DBH^{2.354347} \left(HT^{0.69586} \right) \right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 30 (California Black Oak)

$$ADBH = \frac{(DBH + 0.68133)}{0.95767} \quad 1$$

$$OUTERVOL = 0.0000386403 \times \left(ADBH^{2.12635}\left(HT^{0.83339}\right)\right) \quad 2$$

$$INNERVOL = 0.0000386403 \times \left(DBH^{2.12635}\left(HT^{0.83339}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 31 (Canyon Live Oak)

$$ADBH = \frac{(DBH + 0.48584)}{0.96147} \quad 1$$

$$OUTERVOL = 0.0000248325 \times \left(ADBH^{2.32519}\left(HT^{0.74348}\right)\right) \quad 2$$

$$INNERVOL = 0.0000248325 \times \left(DBH^{2.32519}\left(HT^{0.74348}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 32 (Golden Chinkapin)

$$ADBH = \frac{(DBH - 0.39534)}{0.90182} \quad 1$$

$$OUTERVOL = 0.000056884 \times \left(ADBH^{2.07202}\left(HT^{0.77467}\right)\right) \quad 2$$

$$INNERVOL = 0.000056884 \times \left(DBH^{2.07202}\left(HT^{0.77467}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 33 (California Laurel)

$$ADBH = \frac{(DBH + 0.32491)}{0.96579} \quad 1$$

$$OUTERVOL = 0.0000237733 \times \left(ADBH^{2.05910}\left(HT^{1.05293}\right)\right) \quad 2$$

$$INNERVOL = 0.0000237733 \times \left(DBH^{2.05910}\left(HT^{1.05293}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 34 (Pacific Madrone)

$$ADBH = \frac{(DBH + 0.03425)}{0.98155} \quad 1$$

$$OUTERVOL = 0.0000378129 \times \left(ADBH^{1.99295}\left(HT^{1.01532}\right)\right) \quad 2$$

$$INNERVOL = 0.0000378129 \times \left(DBH^{1.99295}\left(HT^{1.01532}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 35 (Oregon White Oak)

$$ADBH = \frac{(DBH + 0.78034)}{0.95956} \quad 1$$

$$OUTERVOL = 0.0000236325 \times \left(ADBH^{2.25575}\left(HT^{0.87108}\right)\right) \quad 2$$

$$INNERVOL = 0.0000236325 \times \left(DBH^{2.25575}\left(HT^{0.87108}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 36 (Tanoak)

$$ADBH = \frac{(DBH + 4.1177)}{0.95354} \quad 1$$

$$OUTERVOL = 0.0000081905 \times \left(ADBH^{2.19576}\left(HT^{1.14078}\right)\right) \quad 2$$

$$INNERVOL = 0.0000081905 \times \left(DBH^{2.19576}\left(HT^{1.14078}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 37 (Blue oak)

$$ADBH = \frac{(DBH + 0.44003)}{0.95354} \quad 1$$

$$OUTERVOL = 0.0000204864 \times \left(ADBH^{2.53987}\left(HT^{0.50591}\right)\right) \quad 2$$

$$INNERVOL = 0.0000204861 \times \left(DBH^{2.53987}\left(HT^{0.50591}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 38 BIOPAK EQUATION

$$\mathrm{BB} = 3.3 + 9.0 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 39 BIOPAK EQUATION 936

$$\mathrm{BB} = -1.2 + 24.0 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

WHERE

Log	= NATURAL LOG
DBH	= DIAMETER OF TREE IN CENTIMETERS
HT	= HEIGHT OF TREE IN METERS
DENSFAC	= DENSITY FACTOR FOR SPECIES
BB	= BIOMASS OF BARK, WEIGHT IN KILOGRAMS, OF THE BARK ON THE TREE BOLE
π	= 3.141593

BIOMASS OF LIVE BRANCHES

All equations produce Biomass of Live Branches in Kilograms --- to convert to tons multiply by 0.0011023

Log in the equations is = NATURAL LOG

Log = natural log

EQUATION 1 BIOPAK EQUATION 889

$$\mathrm{BLB} = 13.0 + 12.4 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 2 BIOPAK EQUATION 919

$$\mathrm{BLB} = 3.6 + 44.2 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 3 BIOPAK EQUATION 28

$$\mathrm{BLB} = \exp\left(-4.1817 + 2.3324 \times \log\left(DBH\right)\right)$$

EQUATION 4 BIOPAK EQUATION 877

$$\mathrm{BLB} = 16.8 + 14.4 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 5 BIOPAK EQUATION 847

$$\mathrm{BLB} = 9.7 + 22.0 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 6 BIOPAK EQUATION 2

$$\mathrm{BLB} = \exp\left(-3.6941 + 2.1382 \times \log\left(DBH\right)\right)$$

EQUATION 7 BIOPAK EQUATION 702

$$\mathrm{BLB} = \exp\left(-4.1068 + 1.5177 \times \log\left(DBH\right) + 1.0424 \times \log\left(HT\right)\right)$$

EQUATION 8

$$\mathrm{BLB} = \exp\left(-7.637 + 3.3648 \times \log\left(DBH\right)\right)$$

EQUATION 9 BIOPAK EQUATION 901

$$\mathrm{BLB} = 9.5 + 16.8 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 10 BIOPAK EQUATION 459

$$\mathrm{BLB} = 0.199 + 0.00381 \times DBH^2 \times HT$$

EQUATION 11 BIOPAK EQUATION 907

$$\mathrm{BLB} = 7.8 + 12.3 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 12

$$\mathrm{BLB} = \exp\left(-4.570 + 2.271 \times \log\left(DBH\right)\right)$$

EQUATION 13 BIOPAK EQUATION 51

$$\mathrm{BLB} = \exp\left(-7.2775 + 2.3337 \times \log\left(DBH \times \pi\right)\right)$$

EQUATION 14 BIOPAK EQUATION 944

$$\mathrm{BLB} = 1.7 + 26.2 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 15 BIOPAK EQUATION 932

$$\mathrm{BLB} = 2.5 + 36.8 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 16

$$\mathrm{BLB} = \exp\left(-4.5648 + 2.6232 \times \log\left(DBH\right)\right) - BF$$

where: $$\mathrm{BF} = \left(\exp\left(-4.5648 + 2.6232 \times \log\left(DBH\right)\right)\right) \times \frac{1}{(2.7638 + 0.062 \times DBH^{1.3364}}$$

EQUATION 17

$$\mathrm{BLB} = \exp\left(-5.2581 + 2.6045 \times \log\left(DBH\right)\right)$$

EQUATION 18 BIOPAK EQUATION 883

$$\mathrm{BLB} = 4.5 + 22.7 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 19 BIOPAK EQUATION 925

$$\mathrm{BLB} = 5.3 + 9.7 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 20 BIOPAK EQUATION 895

$$\mathrm{BLB} = 20.4 + 7.7 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 21 BIOPAK EQUATION 446

$$\mathrm{BLB} = 0.626 + 0.00079 \times DBH^2 \times HT$$

EQUATION 22 BIOPAK EQUATION 859

$$\mathrm{BLB} = 12.6 + 23.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 23 Weyerhaeuser Co Equation

$$\mathrm{BLB} = 0.047 + 0.00413 \times DBH^2 \times HT$$

EQUATION 24 BIOPAK EQUATION 913

$$\mathrm{BLB} = 4.2 + 17.4 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 25 BIOPAK EQUATION 950

$$\mathrm{BLB} = -0.6 + 45.1 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 26 BIOPAK EQUATION 938

$$\mathrm{BLB} = 8.1 + 21.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 27 Snell et.al 1983, bigleaf maple

$$\mathrm{BLB} = \exp\left(4.0543553 + 2.1505 \times \log\left(DBH\right)\right)\left(1 - \frac{1}{(4.6762 + 0.0163 \times DBH^{2.039})}\right) \Big/ 1000$$

EQUATION 28 Snell et.al 1983, pacific madrone

$$BLB = \exp\left(3.0136553 + 2.4839 \times \log(DBH)\right)\left(1 - \frac{1}{(1.6013 + 0.1060 \times DBH^{1.309})}\right) \Big/ 1000$$

EQUATION 29 Snell et.al 1983, giant chinkapin

$$BLB = \exp\left(3.1980553 + 2.2699 \times \log(DBH)\right)\left(1 - \frac{1}{1.6048 + 0.2979 \times DBH^{0.6828}}\right) \Big/ 1000$$

WHERE

Log = NATURAL LOG
DBH = DIAMETER OF TREE IN CENTIMETERS
HT = HEIGHT OF TREE IN METERS
BLB = BIOMASS OF LIVE BRANCHES,
WEIGHT IN KILOGRAMS, OF THE WOOD AND BARK OF LIVE BRANCHES IN THE CROWN
π = 3.141593