GREENHOUSE GAS EMISSIONS SUPPLEMENT TO 1998 PROGRAM TIMBERLAND ENVIRONMENTAL IMPACT REPORT

HEARST FORESTS
SISKIYOU AND SHASTA COUNTIES, CALIFORNIA

Prepared for

Hearst Forests

Prepared by

VESTRA

VESTRA Resources Inc.
5300 Aviation Drive
Redding, CA 96002

MARCH 2013

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1.0 INTRODUCTION

1.1 Background

The Hearst Forest property encompasses 61,036 acres in southern Siskiyou and northern Shasta Counties. The property is nearly fully regulated silviculturally, and harvest volume is less than or equal to growth volume on a periodic basis. The property is managed under an uneven-aged system of harvest. Between 2,500 and 3,500 acres are treated annually, with an average of approximately 2,900 acres. The cutting cycle varies from 10 to 15 years. The management focus is to develop and maintain an uneven-aged stand structure on the entire ownership over time. Even-aged treatments are used only to respond to disease or fire.

In 2012 the ownership of the property was transferred to the following entities: Wyntoon Estate LLC (approximately 600 acres), Wyntoon Timberlands LLC (approximately 40,000 acres), and Hearst Forests LLC (approximately 20,000 acres). References herein to "Hearst Forests" include the representative ownership of the three legal entities. The general site location is shown on Figure 1. Hearst Forest ownership is shown on Figure 2.

Timber operations in California are regulated under the California Forest Practice Act. These are administered by the California Department of Forestry and Fire Protection (CAL FIRE) through the timber harvest plan (THP) process. Private timber operations require the approval of a discretionary THP permit. The THP process has been certified as being functionally equivalent to the California Environmental Quality Act (CEQA) process. The California Board of Forestry (BOF) adopted the Program Timber Harvest Plan (PTHP) to be used in conjunction with, and tiered to, a certified Program Timberland Environmental Impact Report (PTEIR). Proposed timber operations on Hearst Forests land follow CEQA guidelines regarding subsequent projects tiered to PTEIRs. The proposed timber operations are then reviewed to determine whether they are consistent with the project described in the PTEIR or could result in significant environmental impacts not covered in the PTEIR. If the timber operations are found to be inconsistent with the proposed project as described in the PTEIR or could result in significant environmental impacts, additional CEQA documentation is completed.

A PTEIR was submitted by Hearst Forests and approved by CAL FIRE in 1998. In response to changes in the regulatory environment and guidance, CAL FIRE has requested the preparation of a supplement to the PTEIR to address greenhouse gas (GHG) emissions. This document presents the GHG Emissions Supplement to the PTEIR as requested.

1.2 Purpose of the Supplement

Greenhouse gas legislation was passed from 2006 to 2008. Assembly Bill 97, signed into law in August 2007, required the Office of Planning and Research to prepare guidelines for the mitigation of GHG emissions or effects of GHG emissions. These guidelines were completed and approved in March 2010.

The GHG emissions analysis was not required at the time of the 1998 Hearst Forests PTEIR. This PTEIR Supplement has been prepared in compliance with CEQA guidelines, as amended.

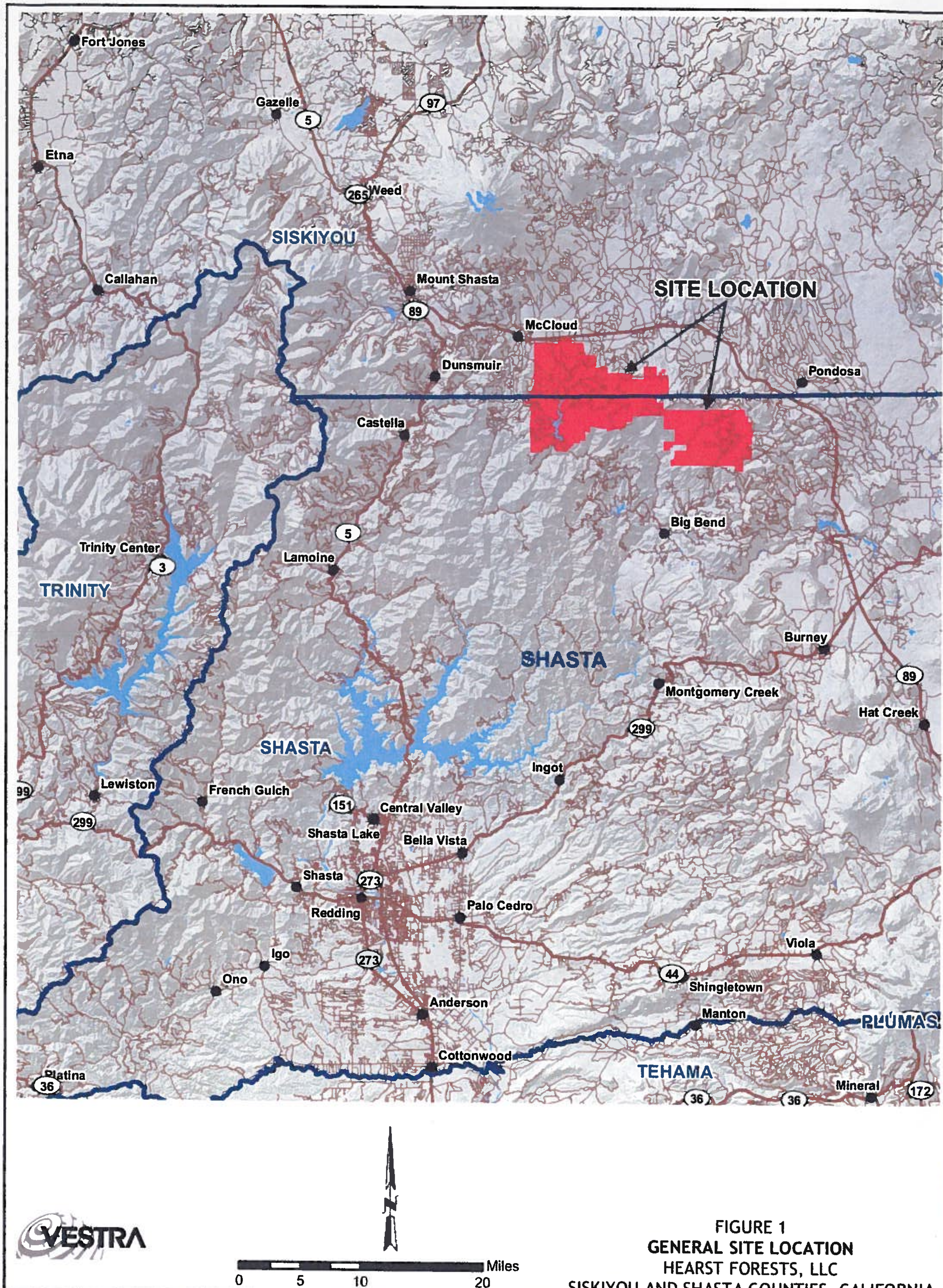

FIGURE 1
GENERAL SITE LOCATION
HEARST FORESTS, LLC
SISKIYOU AND SHASTA COUNTIES, CALIFORNIA

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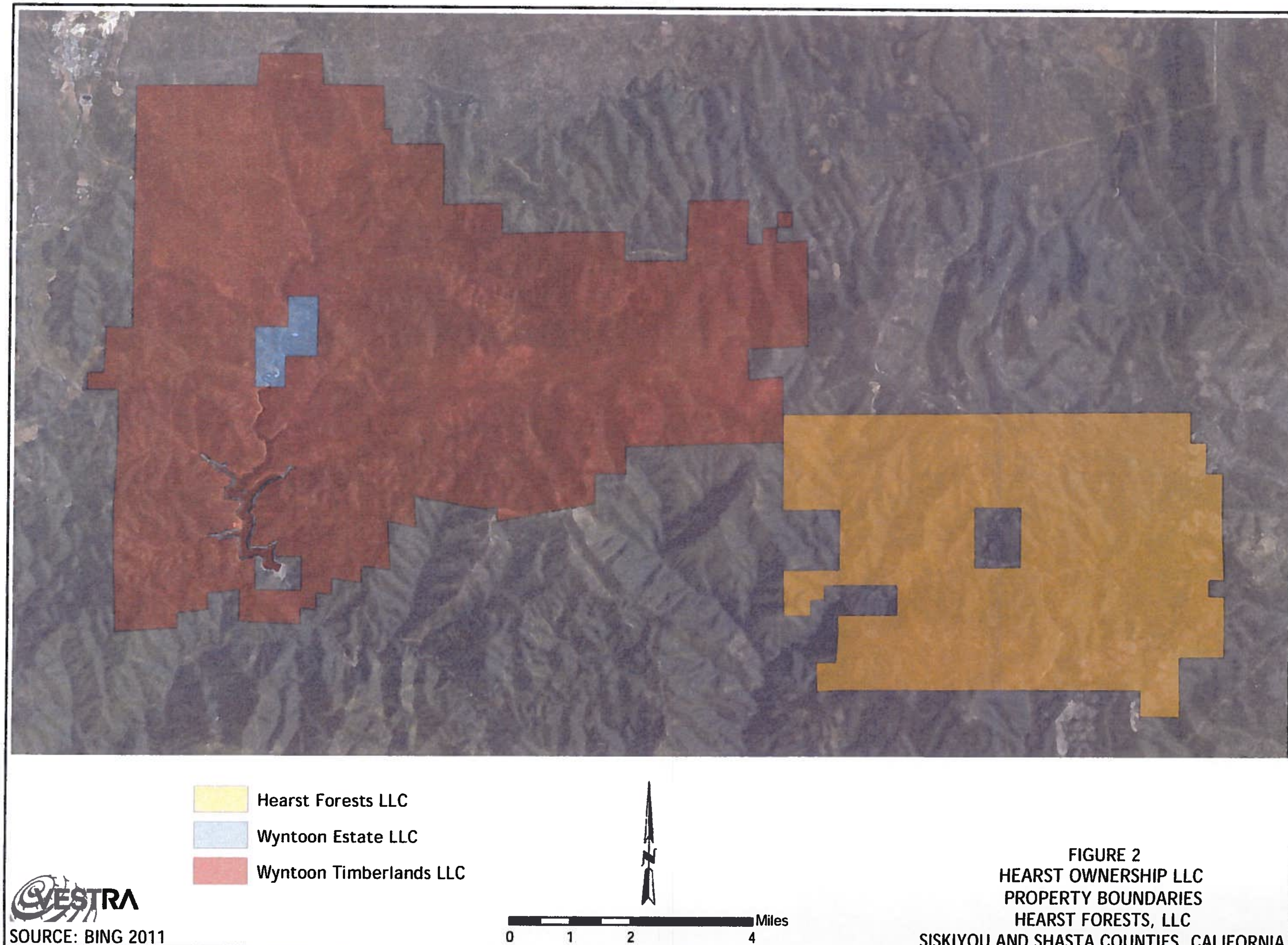

FIGURE 2
HEARST OWNERSHIP LLC
PROPERTY BOUNDARIES
HEARST FORESTS, LLC
SISKIYOU AND SHASTA COUNTIES, CALIFORNIA

P:\GIS\71214\71214_HearstForestsProperties.mxd

In addition to assessing the environmental impacts associated with the uneven-aged management scenario employed by Hearst Forests, this document addresses alternatives to the project in accordance with the CEQA guidelines. The alternatives evaluated and included in Section 5.0 of this document include:

- **No-Action Alternative**: Under the "no-project alternative," no commercial timber harvesting would occur on Hearst Forests land. Because it is used as the baseline for analysis of the proposed project and project alternative, analysis of the no-project alternative does not include levels of impacts and mitigation measures. This no-action alternative is considered custodial management; therefore, Hearst Forests would receive minimal custodial management, including maintenance of the road network and surveillance to minimize wildfire, theft, and vandalism. No commercial timber harvesting, construction projects incidental to timber harvesting, or fuel management would be undertaken. This alternative assumes a significantly reduced growth rate following stand suppression and a high risk of fire due to overstocking that increases with stand age. The likelihood of catastrophic event (forest fire) increases significantly with this alternative. Should a catastrophic fire occur, over 70 percent of sequestered above-ground carbon would be released; below-ground carbon (approximately 20 percent of the sequestered above-ground carbon) (Powers, et al., unpublished manuscript, 2012) would be retained. The alternative assumes catastrophic fire at year 50. Planting would not occur. Natural regeneration is anticipated to require greater than 150 years to reestablish a forest with measurable board-foot growth and carbon-sequestration potential.
- **Intensive (Even-Aged) Alternative**. Under this alternative, timber harvesting and incidental construction occur at the maximum rate consistent with the California Forest Practice Rules (CFPRs), including the provisions addressing maximum sustained production (MSP; 14 CCR 933.11). Regeneration harvests resulting in even-aged stand structures would be implemented on 80 percent of the Hearst ownership. The northern goshawk adaptive management plan, the Memorandum of Understanding (MOU) between Hearst and California Department of Fish and Wildlife (CDFW), and the Best Management Practices (BMPs) would be implemented under this alternative. The northern spotted owl management plan, however, would not be implemented.

The GHG emissions analysis and evaluation was prepared pursuant to the CEQA guidelines for the evaluation for GHG emissions (March 2010) using the CAL FIRE calculator for evaluation of GHG emissions and models developed by Sierra Pacific Industries (SPI). Hearst Forests timberlands are within the same ecological region as much of SPI timberlands and include mixed conifer stands similar to SPI timber stands, including the areas used to measure the site-specific residual values used to develop the SPI model. Because the values are site specific to Northern California timberlands, the model was believed to most accurately reflect Hearst Forests properties. Since a significant portion of Hearst Forests' harvest is milled by SPI, again, the secondary and tertiary numbers would most accurately reflect Hearst Forests' log processing.

The SPI model was developed to be used under Option A, sale-specific analyses, for both even-aged and uneven-aged scenarios. The uneven-aged (non-regeneration) scenario was used for the Hearst applications and was modified to reflect calculated growth rates and to include annual harvest volume rather than individual THP harvest volume.

1.3 Lead Agency

CAL FIRE will serve as Lead Agency. This Supplement to the PTEIR was prepared to provide the public, responsible agencies, and trustee agencies information about the potential environmental effects of implementing the proposed project. As described in CEQA, this is a public information document that assesses potential environmental effects of the proposed project and identifies mitigation measures to the proposed project that could reduce or avoid significant adverse environmental impacts. Public agencies are charged with the duty to consider and **minimize** significant environmental impacts of proposed development, where feasible, and have an obligation to balance a variety of public objectives including economic, environmental, and social factors.

The term "responsible agency" includes all public agencies, other than the Lead Agency, that have discretionary approval power over the project or an aspect of the project (CEQA §15381). For the purpose of CEQA, a "trustee agency" has jurisdiction by law over natural resources that are held in trust for the people of the State of California (CEQA §15386). The following agencies are considered responsible and/or trustee agencies for this project and may be required to issue permits or approve certain aspects of the proposed project:

- Central Valley Regional Water Quality Control Board (RWQCB)
- California Department of Fish and Wildlife (CDFW)
- California Air Resources Board (CARB)

1.4 Levels of Significance

At this point in time, the BOF has not promulgated rules relative to the assessment of GHGs as they relate to timber operations or sustained forest management, although a GHG analysis is required for each THP. The California Forest Practices Act and Forest Practice Rules do have other rules that provide guidance on and influence analysis of GHG impacts. These include the requirement for minimum stocking standards, including reforestation requirements for even-aged management (14 CCR 912.7, 932.7, 952.7) and the requirement for large landowners to demonstrate MSP of high-quality timber products (14 CCR 913.11, 933.11, 953.11). In addition, there is a general requirement that any potentially significant adverse cumulative effect potentially emerging from a timber harvest plan be analyzed.

The inclusion of global warming as a topic in timber management is new, as is the requirement for GHG emissions analysis. Recent analysis and research indicate that well-managed forests provide significant GHG sequestration and benefit (James, 2007).

1.5 Mitigation Measures

Under CEQA, agencies must adopt a program for reporting or monitoring mitigation measures identified in a PTEIR that were adopted or made conditions of project approval (Public Resources Code (PRC) §21081.6). The purpose of the mitigation monitoring program is to ensure compliance with the mitigation measures incorporated into PTEIRs during project implementation and provide feedback to agency staff and decision makers about the effectiveness of their actions and opportunities for improving impact mitigation on future projects. The mitigation monitoring program for Hearst Forests is described in the final PTEIR.

A mitigation monitoring program has been adopted in accordance with PRC §21081.6(a) and CEQA §15097 for mitigation measures that have been incorporated into or imposed upon the project to reduce or avoid significant effects on the environment. The mitigation monitoring program has been designed to ensure that these measures are carried out during project implementation in a manner consistent with the PTEIR.

1.6 Environmental Review Process

The review and certification process for the Supplement to the PTEIR involves the following general procedural steps.

1.6.1 Draft Supplement PTEIR

The Draft Supplement PTEIR contains a description of the project, the environmental setting, project impacts, mitigation measures for impacts found to be significant, analysis of project alternatives, identification of significant unavoidable or irreversible environmental changes, growth-inducing impacts, and cumulative impacts. Upon completion of the Draft Supplement PTEIR, a Notice of Completion (NOC) will be filed with the State Clearinghouse of the Governor's Office of Planning and Research to begin the public review period.

1.6.2 Public Notice/Public Review

Concurrent with the NOC, CAL FIRE will provide a public notice of availability for the Draft Supplement PTEIR and invite comments from the general public, agencies, organizations, and other interested parties. Consistent with CEQA, the minimum review period for the Supplement is 45 days. Public comment on the Supplement will be accepted in written form. Comments or questions regarding the Supplement should be addressed to:

Christopher Browder
CAL FIRE
P.O. Box 944246
Sacramento, CA 94244-2460

Or: sacramentopubliccomment@fire.ca.gov

1.6.3 Response to Comments/Final Supplement PTEIR

Following the public review period, a Final Supplement PTEIR will be prepared. The Final Supplement will respond to written comments received during the public review period.

1.6.4 Certification of the Supplement PTEIR/Project Consideration

CAL FIRE will review and consider the Final Supplement PTEIR. If CAL FIRE finds that the Final Supplement PTEIR is "adequate and complete" and prepared and considered in compliance with CEQA, CAL FIRE will certify the Final Supplement PTEIR in accordance with CEQA. The rule of adequacy generally holds that a PTEIR can be certified if:

1. The PTEIR shows a good faith effort at full disclosure of environmental information, and
2. The PTEIR provides sufficient analysis to allow decisions to be made regarding the proposed project in contemplation of environmental considerations.

2.0 ENVIRONMENTAL SETTING

2.1 GHG Background

Greenhouse gas represents a combination of multiple compounds. Naturally occurring GHGs include water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). Anthropogenic classes of GHGs include halogenated substances that contain fluorine, chlorine, or bromine. Although the direct greenhouse gases CO_2, CH_4, and N_2O occur naturally in the atmosphere, human activities have changed their atmospheric concentrations. Since 1750, concentrations of these three greenhouse gases have increased globally by 36 percent, 148 percent, and 18 percent, respectively (IPCC, 2007). For the most part, forest management affects only CO_2 levels in significant ways (James, 2007). CH_4 and N_2O may be affected at very low levels by open burning of harvest residues or at slightly higher levels by allowing harvest residue to decay onsite (TSS, 2006; Placer County Air Quality Control Board). Greenhouse gas emissions are estimated as carbon dioxide equivalents (CO_2e).

Most environmental impacts under CEQA have a defined geographic assessment area that would be the area of focus for analysis. With respect to GHGs, the relevant area for assessment of impacts, if any, is the entire atmosphere as the gases mix and circulate worldwide. CO_2 is consumed by growing trees that release oxygen and store the carbon as wood fiber. This carbon capture and retention through photosynthesis is also called "carbon sequestration." The other GHGs (CH_4, N_2O) are not affected by the photosynthesis process.

This analysis discusses the release and sequestration of carbon as a result of timber harvesting. The results depend greatly on the forest type, type of forest soils, forest growing conditions, and the past management the forest has received. Management history directly influences a forest's current condition. Active management of the temperate forests of the United States (and California, in particular) removes great quantities of CO_2 out of the atmosphere by sequestering the carbon in wood products. Managed forests create a significant annual net GHG sink (IPCC, 2007).

Due to the difference in types, soils, and management, generalizing about the effects of harvest is problematic. Many of the assertions or studies cited in some comments show this fundamental misunderstanding and the inaccuracy inherent in extrapolation from dissimilar forest types (EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2007). The following table, taken from the U.S. Environmental Protection Agency (EPA) Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2007, demonstrates that the northern temperate forests of the U.S. are a sink and account for 17.4 percent of GHG offsets rather than a source, as the common misunderstanding would have one believe.

The baseline concept in the analysis is the documented fact that CO_2 sequestration by trees is well correlated with the speed at which the trees grow. If trees grow faster, more CO_2 is sequestered; if they grow slower, less CO_2 is sequestered. Trees, when healthy and growing across Hearst Forests lands, will remove the maximum possible amount of CO_2 from the atmosphere.

Land use. land-use change. and forestry activities in 2007 resulted in a net C sequestration of 1,062.6 Tg CO_2 Eq. (289.8 Tg C) (Table 7-1 and Table 7-2). This represents an offset of approximately 17.4 percent of total U.S. CO_2 emissions. Total land use. land-use change. and forestry net C sequestration[141] increased by approximately 26 percent between 1990 and 2007. This increase was primarily due to an increase in the rate of net C accumulation in forest C stocks. Net C accumulation in *Forest Land Remaining Forest Land, Land Converted to Grassland*. and *Settlements Remaining Settlements* increased. while net C accumulation in *Cropland Remaining Cropland, Grassland Remaining Grassland*. and landfilled yard trimmings and food scraps slowed over this period. Emissions from *Land Converted to Cropland* increased between 1990 and 2007.

Table 7-1: Net CO_2 Flux from Carbon Stock Changes in Land Use. Land-Use Change. and Forestry (Tg CO_2 Eq.)

Sink Category	1990	1995	2000	2005	2006	2007
Forest Land Remaining Forest Land[1]	(661.1)	(686.6)	(512.6)	(975.7)	(900.3)	(910.1)
Cropland Remaining Cropland	(29.4)	(22.9)	(30.2)	(18.3)	(19.1)	(19.7)
Land Converted to Cropland	2.2	2.9	2.4	5.9	5.9	5.9
Grassland Remaining Grassland	(46.7)	(36.4)	(51.4)	(4.6)	(4.6)	(4.7)
Land Converted to Grassland	(22.3)	(22.5)	(32.0)	(26.7)	(26.7)	(26.7)
Settlements Remaining Settlements[2]	(60.6)	(71.5)	(82.4)	(93.3)	(95.5)	(97.6)
Other (Landfilled Yard Trimmings and Food Scraps)	(23.5)	(13.9)	(11.3)	(10.2)	(10.4)	(9.8)
Total	**(841.4)**	**(851.0)**	**(717.5)**	**(1,122.7)**	**(1,050.5)**	**(1,062.6)**

Note: Parentheses indicate net sequestration. Totals may not sum due to independent rounding.
[1] Estimates include C stock changes on both *Forest Land Remaining Forest Land* and *Land Converted to Forest Land*.

The regulatory foundation for greenhouse-gas sequestration through forest management is the demonstration of MSP. This document is part of the guarantee of future tree growth across Hearst Forest timberlands and helps ensure the future photosynthesis level from Hearst Forest lands. Laws that require replanting of harvest areas and restrictive timeframes on harvesting adjacent forest stands are also factors ensuring future tree growth. The Hearst Forest program is to protect wildlife, rare plants, riparian function with streamside zones, and archaeological and soil resources. In addition, a primary objective is to maintain a fully forested landscape for visual purposes. The reason is that these other environmental values dictate that growth and regrowth be slowed or impeded as a result of leaving existing trees that are slow growing or decadent and, therefore, prevent the establishment of fast-growing, carbon-scrubbing younger trees.

Important to the analysis of CEQA impacts of GHGs is understanding the threshold of concern for emissions and the significance of any specific measured or estimated emission. The threshold of concern for GHGs, which is the level of potential output of GHG emissions that require a project proponent to conduct an analysis of effects, has not been determined or established for timber-harvesting activities by the BOF. On September 22, 2009, the U.S. EPA approved its "Final Mandatory Reporting of Greenhouse Gases Rule." This rule is available at http://www.epa.gov/climatechange/emissions/ghgrulemaking.html.

The EPA estimates that this limit will require reporting from the sources that account for approximately 85 percent of the total U.S. emissions. The level of assessment for potential emission from forest management is generally less than the EPA newly established threshold for reporting. In the timber management scenario, major portions of the analysis are controlled by other "sectors." For example, emissions from harvesting equipment and trucks contribute to GHG levels, even though all such diesel-engine sources are regulated by the California Air Resources Board (CARB) and will have their own CO_2 emissions controls under Assembly Bill 32 (AB 32). Emissions from the lumber produced from harvested trees is included, but, again, both the manufacturing sector and the construction sector have, or will have, their emissions regulated by CARB under AB 32 (Global Warming Solutions Act of 2006). This analysis, therefore, overestimates emissions.

Carbon is stored in the forest and in the products made from harvested wood. Waste wood can also be used to create electrical energy in a process that largely continues to sequester the carbon by using modern biomass electricity/cogeneration facilities. Wood products that have served out their useful life, if not consumed through biomass energy production, are likely to be buried in landfills, further preventing the oxidation of that carbon and its return to the atmosphere.

Further research indicates that active forest management results in increasing levels of sequestration, and custodial management results in very slow or declining levels of sequestration (James, 2007). The GHG benefits of sustainable forest management are associated with forest regrowth after harvest, reduced risk of wildfire, production of energy-efficient materials and biomass energy, and carbon sequestration in forests and wood products (Schlamadinger and Marland, 1996; Marland and Schlamadinger, 1997; Kurz et al., 2002). In their most recent report, the International Panel on Climate Change (IPCC) concluded *"in the long term, sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual yield of timber, fiber, or energy from the forest, will generate the largest sustained mitigation benefit"* (IPCC, 2007).

The EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007 does not count biogenic fuel sources in the GHG emissions inventory. Both the IPCC and EPA consider biomass fuels to be carbon neutral as long as the source is managed sustainably. Cogeneration is a process by which biomass is burned to make electricity while the cooling steam produced is used to heat and dry lumber (thereby using the steam twice). Using cogeneration to consume the wood-fiber waste material and ultimately to remove and further sequester the carbon in our forests presents a substantial opportunity to go beyond just photosynthesis (atmospheric scrubbing by trees) to help mitigate the problem of rising CO_2 levels in the atmosphere. This biogenic fuel also has direct emission-reduction effects as it replaces fossil fuel burning to create either the process steam or the electricity. Not only does the burning of biogenic-sourced fuels not count as a GHG emission, it produces reduced emissions.

2.2 Hearst Forests Management

Hearst Forest lands have been "actively managed" since 1965 using uneven-aged management techniques and are close to fully regulated in a balanced sustainable condition. Portions of these lands were roaded and harvested by previous owners beginning in around 1900. The remainder of the Hearst Forest lands was used primarily for recreation until 1952, when the property became a certified tree farm and ongoing commercial harvesting and related road construction began. The first woodlands manager was hired in 1965 to supervise land management, and from 1967 to 1986 timber harvesting was conducted by an independent timber company under a long-term contract. Since 1986, management of the property's forest resources has been conducted entirely by Hearst Forests' professional forestry staff.

The property is divided into three management units: Wyntoon Estate LLC, Wyntoon Timberlands LLC, and Hearst Forests LLC. Hearst Forest ownership is included on Figure 2.

The total acreage owned by Hearst Corporation is 61,036 acres, of which 56,356 acres are considered timberland. Each unit is managed for differing objectives.

Wyntoon Estate Tract: This tract is approximately 600 acres and includes the lands directly associated with the estate buildings. The tract is managed as an old-growth seral reserve. Harvesting is limited to the removal of trees posing a safety hazard or for fire protection.

Wyntoon Timberlands LLC: This approximately 40,000-acre tract of land includes property in the McCloud River watershed. The tract is managed for commercial timber production using uneven-aged techniques. The majority of the timberland is Site Class 3 or better and consists of mixed conifer and ponderosa pine stands.

Included in this tract is the McCloud River Preserve. This 1,107-acre tract of land is part of the Hearst Forest late-seral management zone (LSMZ) surrounding the McCloud River. The tract is managed to preserve the existing forest resources.

Hearst Forests LLC: This approximately 20,000-acre tract of land includes the property in the Kosk Creek watershed. The tract is managed for commercial timber production using uneven-aged techniques. The majority of the timberland is Site Class 3 or better and consists of mixed conifer and ponderosa pine stands.

The basic principal of a regulated harvest is to develop a balanced distribution of age classes within the stand, so that all classes of trees, from youngest to rotation age (usually evaluated by size), are represented in appropriate numbers. Under complete uneven-aged-managed scenarios, the areas of individual age classes are so intermixed and scattered to require that the allowable cut must be determined in relation to the annual growth of the stand, which in turn depends on regulating the distribution of numbers and volumes (or basal area) of the trees in different diameter classes. Under the sustainable regulated condition, *the annual growth volume equals the annual harvest volume under a specified period and sustained yield.*

The Society of American Foresters has defined sustained yield management as:

> *"Management of a forest property for continuous production with the aim of achieving, at the earliest practicable time, an approximate balance between net growth and harvest, either by annual or somewhat longer periods."*

Today the concept of sustained yield is concerned not only with the continuity of growth and yield, but also with the continuity of goods and services from the forest. Managing a forest for sustained yield requires that sufficient growing stock be maintained. In the Hearst Forests MSP model, the periodic yields obtained from sustained yield are calculated so that growing stock is not depleted and, in fact, increases over the planning horizon.

With the uneven-aged methods used by Hearst Forests, residual volume remains after all harvest entries. Typical distribution by size is included on Figure 3. This size-class distribution is anticipated to remain consistent over time. During an individual harvest, the number of trees in each size class will be reduced, but no one size class will be completely removed. This is important from a standpoint of GHG emissions, wherein the standing volume is capable of rapid response with the ability to sequester carbon rapidly to offset the volume removed at harvest.

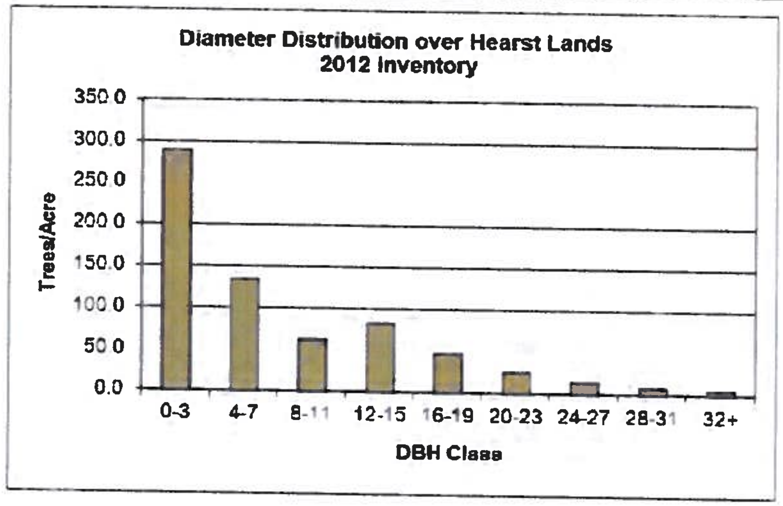

FIGURE 3
DIAMETER DISTRIBUTION OVER HEARST FORESTS LANDS
2012 INVENTORY
HEARST FORESTS

Since the 1998 PTEIR, Hearst Forests has worked to increase growing stock and to stabilize harvest volume at the anticipated growth rate of the forest. Volume of inventory, growth, and harvest by period is displayed graphically on Figure 4.

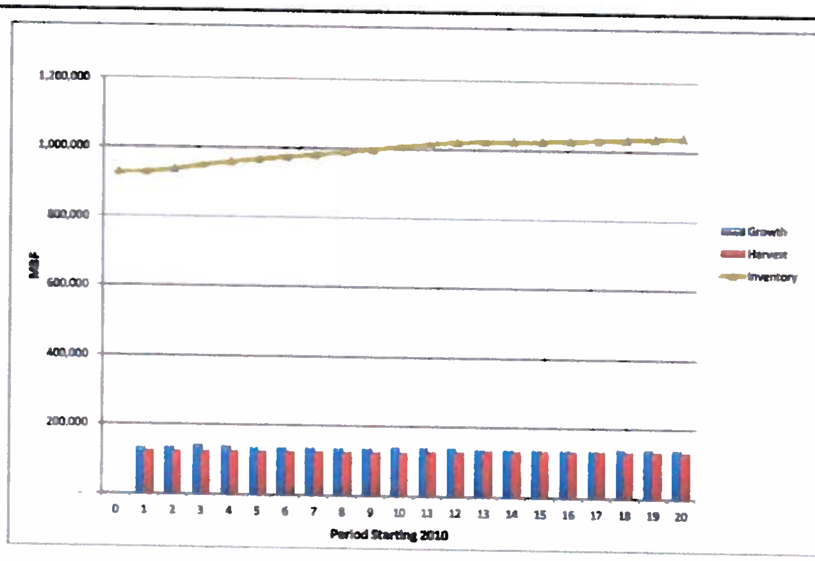

FIGURE 4
SUMMARY OF GROWTH, HARVEST, AND INVENTORY
HEARST FORESTS

Hearst Forests harvests an average of approximately 2,900 acres each year, which is generally consistent with the average harvesting rate on the property over the past three management periods (15 years) under the current PTEIR. Uneven-aged silvicultural harvesting methods (e.g.

selection, group selection, sanitation-salvage, etc.) are used to promote development of uneven-aged stand structures, where the post-harvest stand retains sufficient trees to exceed the minimum stocking standards set by the Forest Practice Act. Stands are reentered for harvesting on cycles ranging from 10 to 15 years.

Up to 2 percent (less than 50 acres per year) of the proposed harvest may consist of even-aged regeneration harvests (e.g. clear-cutting, shelterwood, or seed-tree harvests). Such harvests are most commonly implemented in stands damaged by fires, insects, or diseases. Even in areas receiving regeneration harvests, however, the long-term silvicultural objective is to develop uneven-aged stand structures. Areas receiving even-aged regeneration harvests are restocked within 5 years in conformance with the CFPR (14 CCR 1071). The GHG effect of this potential 2 percent of treated acres is addressed herein.

No timber harvesting is planned to occur in non-timberland areas (4,671 acres) or within the McCloud River Preserve (1,107 acres) and the area surrounding the Hearst Forests residential estate (600 acres) with the exception of the occasional removal of trees that pose safety hazards.

2.3 MSP Summary

Timber harvesting will be scheduled over time consistent with the requirements of the Forest Practice Act and the CFPRs (14 CCR 933.11) to achieve MSP of high-quality timber products for the entire ownership. The MSP was analyzed in the 1998 PTEIR by simulation of growth of forest stands that have been classified into land-stratum types comprising polygons with similar land and timber attributes from throughout the ownership. The MSP was updated in an addendum in 2002 and again in 2005 and will be updated again in 2013.

The MSP section of the original PTEIR was based on a 1984 standard stratification data, with minor adjustments, and a 1996 inventory update. This original 1984 data was based on historical class and type distinctions. An effort was made to develop a "crosswalk" between the old nomenclature and newer Wildlife Habitat Relationship (WHR) typing. Hearst Forests agreed to update the inventory and section of the PTEIR within 5 years of adoption (2000) and again at 10-year intervals.

An update to the MSP was presented to CAL FIRE in 2002. In the 2000 update, the inventory of the entire property was restratified using satellite imagery and WHR classes. Temporary plots were established using the same classes for identification. The direct WHR stratification resulted in the revised volumes presented in the 2002 update.

In 2004, Hearst Forests was requested to reanalyze the 2000-2001 inventory data under additional criteria relating to maximizing sustainable production and increasing late-successional habitat. This document (submitted in 2005) was not regarded as an update pursuant to the PTEIR and was viewed as a monitoring and verification that Hearst Forests met the requirements contained in the PTEIR.

In conformance with the Hearst Forests PTEIR Monitoring Plan, the forest resource inventory was updated in 2010-2011. The update process consisted of the following steps, described in more detail in the following sections of this document:

- The timber strata map was reviewed and updated
- Permanent plots were remeasured
- Additional temporary plots were allocated and established

Subsequent to updating the inventory, Hearst Forests updated its sustained yield plan model. Growth rates were calibrated for use in the new FORESEE growth-and-yield model. The FORESEE model is accepted for use in GHG by the Climate Action Reserve (CAR) Forest Project Protocol Version 3.2, August 31, 2010. Using the updated strata map, mapped harvest constraints, 2010-2011 inventory data, and a set of silvicultural regimes developed in FORESEE, the sustained yield model for Hearst Forests lands was rerun to project stocking, growth, and harvest-volume levels over a 100-year planning horizon. The results demonstrate non-declining harvest with balanced growth and yield. Inventory volumes increase 12 percent over the 100-year horizon. The harvest levels are consistent with the 2002 update. The monitoring analysis completed in 2005 presented larger estimated volumes to be available; however, Hearst Forests had not increased harvest to these levels.

Conformance with MSP was demonstrated by showing that the proposed harvest schedule balances growth and harvest over time, maintaining a timber inventory capable of sustaining the long-term sustained yield (LTSY) for the ownership, and having the projected annual harvest level for all future rolling 10-year periods not exceed the LTSY. This is consistent with harvest regulation presented in the recent updates.

Key points relative to GHG emissions from Hearst Forests:

1. Total inventory and growing stock has increased over 600 million board feet since 1995, resulting in substantial additional carbon sequestration.
2. The portion of the forest in M4 and M5 classes has increased substantially since the last inventory, maximizing the sequestration of carbon.
3. Harvest is equal to or less than forest growth.
4. Management on an uneven-aged basis has resulted in ongoing standing biomass.

3.0 PROJECT IMPACTS

3.1 GHG Method of Analysis Harvest Impacts

This analysis was completed using methodology developed by SPI that was adapted for Hearst Forests. The methodology follows the general guidelines for analysis presented by the CAR Forest Project Protocol and the CAL FIRE GHG Emissions Calculator (GHG Calculator).

Hearst Forests does not own milling facilities and sells on a delivered-log basis, meaning that the ownership of the product and control are surrendered at the entrance to the mill facility. Because the control of the product is relinquished to another sector at this instant, Hearst Forests could have terminated the analysis at this point; however, this analysis includes the three segments of GHG emissions that have been included in previous analyses accepted by CAL FIRE. These include:

- Direct or primary emissions
- Indirect or secondary emissions
- Post-consumer or tertiary emissions

3.1.1 Direct Emissions

Primary (direct) emissions are those releases of CO_2 directly back to the atmosphere caused by either the rotting (leaving slash to decay) or oxidation of woody logging debris (slash) by the processes of burning on the logging site after harvest. The tops, branches, and needles are estimated at 15 percent of the total weight of the main bole (SPI data). Since the harvested logs neither rot nor are burned (oxidized), only harvest residues that are not biomass chipped and taken to a biomass energy plant or cogenerating biomass facility are considered herein. The carbon contained in the harvest residues left onsite are counted as immediate and complete emissions in the analysis, even though when burned onsite or allowed to decay over time, a portion of these residues remain in char or become part of the duff and/or are incorporated into the soil as elemental carbon. This treatment of slash as an immediate emission is also a very conservative estimate since the EPA and IPCC would consider these residues part of the biogenic CO_2 cycle and, thus, not an emission. Backup data used for direct emission analysis is included in Appendix A.

Please note that recent research completed by Powers et al. (Powers, et al., unpublished manuscript, 2012), to be released in the journal of *Forest Ecology and Management*, significantly discounts the emissions from these direct sources, noting no difference in carbon reserves from those sites where residual biomass and duff were removed. Therefore, the estimates presented herein are believed to be additionally conservative as this direct source would no longer be included in a revised methodology.

3.1.2 Indirect Emissions

Secondary, or indirect, emissions are those from equipment consuming diesel fuel employed to harvest, yard, and load and haul the logs to the mill. Total fuel consumption was estimated for each yarding method (mechanized or ground based, cable, or helicopter) and their consumption per thousand board-feet (mbf) of production was calculated. The World Resources Institute (WRI) diesel-fuel carbon calculator was used to convert gallons into CO_2e per mbf. In the case of biomass chipping operations, the diesel fuel per bone dry ton to gather, chip, and haul this biomass carbon-neutral fuel to the biomass plant was also calculated. The "rounding up" of these estimates on a per-mbf basis provided a reasonable and practical way to account for all incidental (de minimis) fossil fuel consumed by foresters and contractors in planning, layout, administering, timber falling, and regeneration activities for the harvest. The analysis is based on an average of two turnaround haul trips per day (4.5- to 5-hour round trip carrying approximately 4.5 mbf per truck), which is consistent with Hearst Forests averages over the last 5 years. The efficiency rating from mills in California for conifers is 0.67 (Department of Energy (DOE) 1605(b)). The WRI tools for GHG emissions from transport or mobile sources are available at the following url: http://www.ghgprotocol.org/calculation-tools/wood-products. The values and assumptions used in this analysis are presented in Appendix A.

The inputs used in this analysis to determine secondary emissions per mbf are:

8.75 U.S. gallons of diesel per mbf for ground-based skidding on board truck (obt)
5.0 U.S. gallons of diesel per mbf for cable yarding (obt)
8.75 U.S. gallons of diesel per mbf to haul logs to the mill
1.43 U.S. gallons of diesel per green ton of biomass chipping and collecting (obt)
1.53 U.S. gallons of diesel per green ton to haul biomass from the woods

Note: 80 percent of the harvesting conducted by Hearst Forests is done with tractor methods and 20 percent is conducted using cable systems. Helicopter logging is uncommon on Hearst Forests property.

3.1.3 Post-Consumer Emissions

Post-consumer, or tertiary, emissions are those produced after the logs are delivered to the sawmill. They include all process losses, immediate-release products like landscape and soil amendments, and all long-lived wood products produced including secondary production in other facilities, like paper and particle-board plants. CAR Harvested Wood Products and Landfill tables were used in the recently approved protocol to reduce these year 1 percentages to the estimated percentages at year 100. These are based upon U.S. Department of Energy 1605(b) tables to determine average in-use lifecycles and percentages deposited into solid waste management sites.

Actual scaled and weighed loads of logs over a 2-year period were used to determine the average green weight per mbf. These weights were determined at state-certified scales, and the log scaling was performed by third-party scaling bureaus. The total of products sold by green weights is included in Appendix A. This confidential proprietary data was made available to CAL FIRE for review by SPI, who also provided permission for use by Hearst Forests. The CAR tables for carbon remaining out of the atmosphere over 100 years are shown in Tables 3-1 and 3-2 and are available at the following url:
http://www.climateactionreserve.org/how/protocols/adopted-protocols/forest/development/.

Table 3-1 **WORKSHEET TO ESTIMATE LONG-TERM CARBON STORAGE IN IN-USE WOOD PRODUCTS**							
	A	**B**	**C**	**D**	**E**	**F**	**G**
Wood Product Class	**Softwood Lumber**	**Hardwood Lumber**	**Softwood Plywood**	**Oriented Strandboard**	**Non-Structural Panels**	**Misc. Products**	**Paper**
Percent in Each Class	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)
Metric Tonnes C in Each Class	(3A)	(3B)	(3C)	(3D)	(3E)	(3F)	(3G)
100-Year Average Storage Factor	0.463	0.250	0.484	0.582	0.380	0.176	0.058

Table 3-2 **WORKSHEET TO ESTIMATE LONG-TERM CARBON STORAGE IN WOOD PRODUCTS IN LANDFILLS**							
	A	**B**	**C**	**D**	**E**	**F**	**G**
Wood Product Class	**Softwood Lumber**	**Hardwood Lumber**	**Softwood Plywood**	**Oriented Strandboard**	**Non-Structural Panels**	**Misc. Products**	**Paper**
Percent in Each Class	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)
Metric Tonnes C in Each Class	(3A)	(3B)	(3C)	(3D)	(3E)	(3F)	(3G)
100-Year Average Storage Factor	0.298	0.414	0.287	0.233	0.344	0.454	0.178

3.1.4 Assumptions in Analysis

The following assumptions specific to Hearst Forests were used in this analysis:

- Uneven-aged forest management system (less than 2 percent of the annual harvest may be undertaken using even-aged techniques).
- An average disturbed acreage of 2,900 per year (with a range of 2,500 to 3,500/year).
- Cutting cycle of 10 to 15 years.
- Annual harvested volume of 25 million board-feet.
- Conversion of carbon CO_2 (tonnes CO_2 per 1 metric ton of carbon) 3.67.
- Average stand growth of 460 board-feet/acre/year using the CAR-estimated values equates to 2.2 metric tonnes/acre/year of CO_2e.
- 60 percent of wood removed to lumber and 40 percent of wood removed to veneer.
- 50 percent of the wood harvested is whole tree and 50 percent is bole only.

- Conversion of board-feet to cubic feet of 0.165.
- 20 percent cable logging techniques with no biomass chipping.
- 80 percent tractor logging techniques
  - 50 percent tractor yarding with biomass chipping (includes 50 acres of even-aged management annually).
  - 50 percent tractor yarding with no biomass chipping.

For the analysis, GHG annual emissions were calculated segregating annual harvesting into:

- 20 percent cable yarding without biomass removal
- 40 percent tractor yarding without biomass removal
- 40 percent tractor yarding with biomass removal (includes 50 acres of even-aged management)

The analysis assumed an average annual harvest volume of 25,000 mbf/year and an annual growth rate per acre of 460 board-feet. The latter is supported by recent estimates from the 2010 inventory shown in Table 3-3.

Table 3-3
2002 SITE AND GROWTH RATE ASSUMPTIONS

Site Class	1	2	3	4	Weighted Average
Acres	13,216	22,615	17,482	2,750	
50-Year Site Index	92	86	82	77	
Average Growth Rate (Board-Feet/Acre/Year)	506	462	445	329	460

The Hearst Forests inventory was updated in 2010. Future growth rates were calculated from measured, unharvested permanent plot clusters. As noted earlier, the current 2012 inventory uses FORESEE for growth projections. FREIGHTS and FORESEE both use the earlier CACTOS and CRYPTOS models as the basis for the growth and yield projection; however, FORESEE is now considered the more appropriate model for use in the Northern California forest area. The mean growth rates for the clusters is shown in Table 3-4.

Table 3-4
MEAN GROWTH RATES

16 Clusters with >65 Basal Area/Acre	438
7 Clusters with <65 Basal Area/Acre	74
All 23 Clusters	327
9 Clusters with Timber Type SMC4M	460

Based on the review of Hearst Forests' permanent plot data, FORESEE was calibrated to an overall average current growth rate of approximately 460 board-feet/acre/year – the same rate that was used in 1996-1997 and 2002.

Growth calibration in FORESEE may be accomplished in at least two ways: either by changing the diameter-at-breast-height and total-height calibrations on the Growth Model Setup page, or by entering "dummy" site trees that generate site index values that are more or less than actual measured site index values. To calibrate this project, dummy site trees were used. Without calibration and with actual Hearst Forests' site tree data, FORESEE produced growth rates that were significantly higher than the 460 board-feet/acre/year target. Dummy site trees were entered in FORESEE that produced site index values of 57, 54, 51, and 48 for site classes 1, 2, 3, and 4, respectively.

The modeled property-wide growth for the first 5-year period is 130,300 mbf / 56,365 acres = 462 board-feet/acre/year. Type SMC4M comprises 60 percent of Hearst Forests timberlands and is the target type for Hearst Forests' uneven-age management program. The average growth rate for those nine SMC4M clusters is 460 board-feet/acre/year. These stands with larger trees and standing residual volume also sequester more carbon. The model used is flexible to allow variables in yarding method (cable or tractor) and biomass removal (either with or without). CO_2e emissions vary with method and biomass percentage. In addition, CO_2e emissions vary by the annual volume handled and acreages covered. These variables constitute the inputs to the model. In the case of Hearst Forests, the assumptions (inputs) used in the emissions model are included in Table 3-5 as inputs.

Table 3-5
INPUTS

Method	Average Annual Harvested Volume	Average Annual Harvested Acres
Tractor Yarding without Biomass Removal	10,152	1,160
Tractor Yarding with Biomass Removal (uneven-aged)	9,746	1,110
Tractor Yarding with Biomass Removal (even-aged)	406	50
Cable Yarding with No Biomass Removal	5,067	580
Total	**25,371**	**2,900**

3.1.5 Calculation of Annual Harvest Emission

The model used in this analysis calculates THP-specific emissions and was modified to present annual emissions from harvest on Hearst Forests ownership. All calculations were reduced to metric tons (tonnes) of CO_2e.

The model estimates direct emissions by calculating the product of expected harvest production in mbf and the 0.7215 metric tons of CO_2e harvest residue. For a biomass chipping harvest where 100 percent of the residue is taken off the project site and used in a cogeneration facility, there are no direct emissions.

Depending on the yarding method, this same mbf produced value is multiplied by the appropriate yarding-specific factor that is adjusted for either (1) biomass chipping and removal to a biomass facility or (2) treating the harvest residue on the ground either by burning or scattering. The biomass factors have been reduced for a credit for reduction in fossil fuel emissions since the carbon-neutral fuel from the biomass offset CO_2e emissions that would have occurred through burning natural gas to produce the same amount of electricity. In the combined primary and secondary factor for biomass operations, the primary emission of 0.7215 metric tons of CO_2e per mbf may be eliminated since that emission originated from the biomass that was hauled away to the power plant. Again, this factor has been scaled to apply per mbf. These factors also include diesel consumption for hauling of logs and hauling biomass chips if produced.

Finally, all tertiary emissions from the sawmilling, particle board, paper, construction, and solid waste disposal site industries that originate from the logs is calculated again by multiplying the total mbf produced by the 0.8142 factor shown as the over-100-year emission factor from all these emission sources.

The model used also addresses uneven-aged calculations for this method. Site-specific residual stand growth rate of the residual timber stand (in board-feet/acre converted to metric tons of CO_2e/acre) is used to calculate the time required for the harvest area to compensate for the predicted releases attributable to the harvest (i.e. to regrow to the same level of sequestration that was present at the time of harvest plus emissions from the harvest). This is sometimes referred to as the "recovery period." The yield table CO_2e per acre value is used to divide into the total emissions/acre to get years to replacement. The yield table conversion to CO_2e/acre is presented as Figure 5.

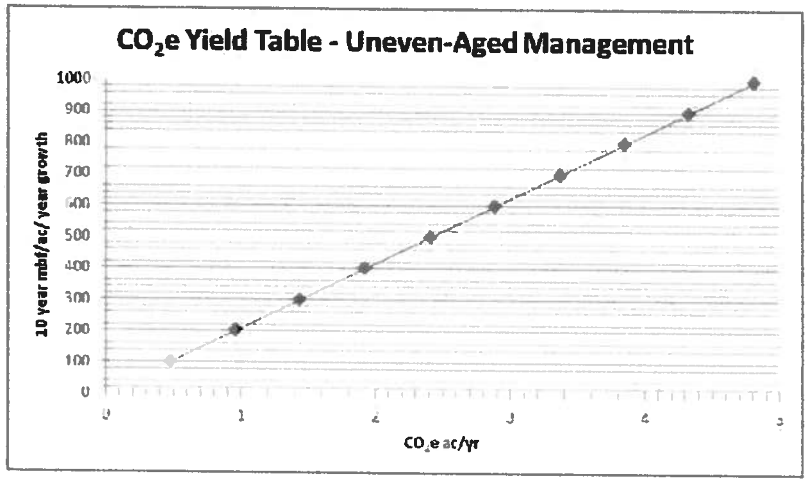

FIGURE 5
YIELD TABLE CONVERSION TO CO_2E/ACRE
HEARST FORESTS

For the Hearst Forests' analysis, the board-feet/acre/year growth rate of 460 was used with a conversion of 2.2 CO_2e metric tons/acre/year. The Hearst Forests' analysis is conducted on an annual estimate basis. The board-feet/acre/year growth rate was calculated from the 2011 inventory update by reevaluation of both permanent and temporary plot data.

3.2 GHG Method of Analysis Cumulative Sequestration

As stated previously, Hearst Forests updated the 1995 inventory used in the 1998 PTEIR in 2012. The FREIGHTS model was used to develop inventory growth and harvest values for the 100-year planning horizon. The modeling demonstrates a regulated non-declining harvest with balanced growth and yield. Inventory volumes increase 12 percent over the 100-year planning horizon.

The whole-tree carbon per mbf ratio was calculated using the assumptions in the CAL FIRE GHG Calculator and the Hearst site-specific data as presented in Table 3-6. Specific species data was obtained from the recent modeling and inventory.

Table 3-6
WHOLE-TREE CARBON PER MBF RATIO INPUTS

Forest Type	**Step 0. Identify the approximate percentage of conifers by volume within harvest plan (must sum to 100%)**	**Multiplier from Cubic Feet (merchantable) to Total Biomass**	**Pounds Carbon per Cubic Feet**
Douglas-Fir	35%	1.675	14.38
Redwood	0%	1.675	13.42
Pines	20%	2.254	12.14
True Firs	45%	2.254	11.18
Hardwoods	1	2.214	11.76
Conversion of Board Feet to Cubic Feet	0.165	Pounds per metric tonne	2,204
Multipliers to Estimate Total Carbon Tonnes per MBF	Conifer	**1.89**	
	Hardwoods	**1.95**	
Multipliers to Estimate Merchantable Carbon Tonnes per MBF	Conifer	**0.94**	
	Hardwoods	**0.88**	

The hardwood component in the Hearst Forest is less than 1 percent of the total standing inventory; the additional contribution from the growth of this component was not included in this calculation. Based on these data, the standing sequestered carbon inventory was calculated by taking the 2012 estimated standing inventory times the multiplier above to convert from carbon tonnes to metric tons of CO_2e. Annual carbon sequestered based on growth was calculated by period for the planning horizon using the same method and confirmed using the GHG Calculator. Results are presented in the following section.

4.0 RESULTS AND CONCLUSIONS

4.1 Harvest Impacts

Results of the GHG analysis in metric tons of CO_2e/year are included by emission category in Table 4-1. Actual modeling sheets are included in Appendix B.

Table 4-1
ANNUAL EMISSIONS ESTIMATED
(metric tons of CO_2e/year)

Method	Primary	Secondary	Tertiary	Total
Tractor Yarding with Biomass Removal (uneven-aged)	1,406	397	7,935	9,738
Tractor Yarding with Biomass Removal (even-aged)	59	17	331	407
Tractor Yarding without Biomass Removal	7,325	1,846	8,266	17,437
Cable Yarding without Biomass Removal	3,656	724	4,126	8,506
Total Annual Emissions	**12,446**	**2,984**	**20,658**	**36,088**

The period based on growth for full replacement (the "recovery period") under each method is included in Table 4-2.

Table 4-2
PERIOD (BASED ON GROWTH) FOR FULL REPLACEMENT

Method	Recovery Period
Tractor Yarding with Biomass Removal (uneven-aged)	3.99 years
Tractor Yarding with Biomass Removal (even-aged)	14-15 years
Tractor Yarding without Biomass Removal	6.83 years
Cable Yarding with No Biomass Removal	6.67 years

The total primary (direct) annual emission from Hearst Forests is approximately 12,500 metric tons CO_2e. This analysis accounts also for downstream uses of the wood produced and the byproducts of that wood production. Almost all of these estimated emissions are not immediate but occur slowly over the next 100 years, at the same time as new forest growth sequestration is occurring. For example, 82 percent of the estimated tertiary emissions are from the decay of the lumber produced as it is used and disposed over the next 100 years; 13 percent from boards; and 6 percent comes from paper produced from the sawmilling byproducts as they go in and out of use and into landfills over the next 100 years (DOE 1605b).

Taking into consideration the entire horizon over a century, the primary, secondary, and tertiary result of harvesting is to release an estimated **36,088 metric tons of CO_2e per year, or 180,440 metric tons over each 5-year planning horizon.** This does not take into account the massive benefits of the accompanying carbon sequestration that occurs annually on Hearst Forests lands over the same 100-year planning period.

In keeping with the conservative nature of this analysis, the total secondary emissions of CO_2 from the harvesting equipment in this harvest plan combined with the primary emissions will be recouped by tree growth of 2.2 CO_2e/ac/yr; such that the total emissions of CO_2 from wood products produced from this annual harvest over the next 100 years (all primary, secondary, and tertiary emissions) will be recouped in between 4 and 7 years.

4.2 Cumulative Sequestration

The current standing inventory on the Hearst property sequesters approximately 6,255,879 tonnes of total carbon that equates to 19,350,375 metric tons CO_2e. A summary of carbon accounting over the planning period is presented in Table 4-3.

The James study (James et al., 2007) on similar lands under similar management showed active forest management will increase sequestration significantly. A demonstration of MSP also shows that, far from being a source of GHGs, Hearst Forests' management is a significant sink of GHGs over the next 100 years. The inventory shows increased average tree diameter, increased total volume, and sustainable harvest volumes while also increasing the habitat for high-canopy-closure, large-tree-dependent wildlife species. Over the next 100 years, total standing inventory steadily increases and sustainable harvest remains consistent.

The combined carbon sequestration potential of Hearst Forests is based on increased forest growth and productivity over time as well as increases in tree volume. The net sequestration over the next 100 years on Hearst Forests' property of 61,036 acres of timberland was based on cumulative board-feet growth volume.

Table 4-3
CARBON ACCOUNTING BY PERIOD

Period	Growth (mbf/period)	Harvest (mbf/period)	Above-Ground Addition (tonnes of carbon) ①	Below-Ground Addition (tonnes of carbon) ②	Total Tonnes of Carbon	Convert to CO_2e③	Calculated Loss by Period	Net Carbon Sequestered in CO_2e
1	130,300	126,892	246,267	49,253	295,520	1,084,560	180,435	904,125
2	137,978	126,908	260,778	52,156	312,934	1,148,468	180,435	968,033
3	142,569	126,864	269,455	53,891	323,346	1,186,682	180,435	1,006,247
4	139,215	126,877	263,116	52,623	315,740	1,158,764	180,435	978,329
5	137,124	126,906	259,164	51,833	310,997	1,141,360	180,435	960,925
6	137,280	126,860	259,459	51,892	311,351	1,142,658	180,435	962,223
7	137,125	126,915	259,166	51,833	311,000	1,141,368	180,435	960,933
8	136,676	126,896	258,318	51,664	309,981	1,137,631	180,435	957,196
9	137,828	126,863	260,495	52,099	312,594	1,147,220	180,435	966,785
10	139,159	126,857	263,011	52,602	315,613	1,158,298	180,435	977,863
11	139,898	130,026	264,407	52,881	317,289	1,164,449	180,435	984,014
12	139,761	129,974	264,148	52,830	316,978	1,163,309	180,435	982,874
13	138,118	132,998	261,043	52,209	313,252	1,149,633	180,435	969,198
14	136,637	133,009	258,244	51,649	309,893	1,137,306	180,435	956,871
15	136,935	132,925	258,807	51,761	310,569	1,139,787	180,435	959,352
16	137,460	132,963	259,799	51,960	311,759	1,144,157	180,435	963,722
17	137,996	132,992	260,812	52,162	312,975	1,148,618	180,435	968,183
18	138,955	132,957	262,625	52,525	315,150	1,156,600	180,435	976,165
19	138,753	132,938	262,243	52,449	314,692	1,154,919	180,435	974,484
20	138,557	132,957	261,873	52,375	314,247	1,153,288	180,435	972,853

[1] Above-ground estimate of mbf to carbon tonnes from Table 3-6; conversion of 1.89 on MBF growth.
[2] Estimated to be 20% of above-ground carbon.
[3] Estimated total carbon tonnes to CO_2e x 3.67.
CO_2e = Carbon dioxide equivalents in metric tons

5.0 ALTERNATIVES

5.1 Alternative Descriptions

The alternatives evaluated include:

No-Action Alternative: Under the "no-project alternative," no commercial timber harvesting would occur on Hearst Forests land. This no-action alternative is considered custodial management; therefore, Hearst Forests would receive minimal custodial management, including maintenance of the road network and surveillance to minimize wildfire, theft, and vandalism. No commercial timber harvesting, construction projects incidental to timber harvesting, or fuel management would be undertaken. This alternative assumes an initial increase in growth rate followed by a reduced growth rate and a high risk of fire due to overstocking that increases with stand age. The likelihood of catastrophic event (forest fire) increases significantly with this alternative.

The alternative assumes that a high-intensity catastrophic fire occurs at year 50. In the fire, 60 percent of the sequestered carbon is immediately released. 29.4 percent would be not volatilized, of which 19.8 percent will remain as charcoal and soot. An additional 9.6 percent would be incorporated as dead wood, which will degrade quickly and is considered lost. 10.6 percent of the vegetation survives (CARB, 2009). This amounts to 70 percent of the total carbon that was sequestered above-ground being released. Below-ground carbon, approximately 20 percent of the above-ground total) would be retained. Planting would not occur. Natural regeneration is anticipated to require greater than 150 years to reestablish a forest with measurable board-foot growth and carbon-sequestration potential.

Intensive (Even-aged) Alternative: Under this alternative, timber harvesting and incidental construction occur at the maximum rate consistent with the CFPRs, including the provisions addressing MSP (14 CCR 933.11). Regeneration harvests resulting in even-aged stand structures would be implemented on the Hearst ownership. The northern goshawk adaptive management plan, the MOU between Hearst and CDFW, and the BMPs would be implemented under this alternative. The northern spotted owl management plan would also be implemented.

5.2 Alternative Discussion

Along with baseline stocking and stand productivity, forest management impacts the rate and type of growth that a forest undergoes, thereby influencing the rate of sequestration, the volume of product removed as usable and residual material, and the amount of carbon storage within the total carbon pool. When considered over a 100-year planning period, the difference in total carbon storage per acre between custodial management, selective harvest management, and intensive even-aged management has been shown to be substantial.

James et al. (2007) evaluated numerous alternative silvicultural methods relative to GHG emissions in *Carbon Sequestration in California Forests: Two Case Studies in Managed Watersheds*. The analysis was initiated to understand how carbon pools and sequestration rates within California forests are affected by forest management strategy. Two of the four management scenarios considered, included custodial management (removal of 1 percent per year) and intensive even-aged management (removal and planting of 12.5 percent per decade). One of the two sites analyzed is located in southern Shasta County having comparable regional characteristics as Hearst Forests lands.

Forest growth models were used to estimate carbon sequestration and total carbon pools over the 100-year planning period. Carbon per acre held in forest carbon pools gradually increased to a stable pattern under custodial management, while a steady increase over time was exhibited under intensive management. It was noted the gradual increase under custodial management is the result of the immature baseline condition of the sample forest. The modeling completed for a second, more mature forest displayed a gradual increase to stable to declining pattern under custodial management. This is due to a decreased growth rate as the forest matures. Under intensive management, the growth of new plantings each decade results in an increasing forest carbon pool over most of the planning period.

By the end of the planning period, forest carbon pools were approximately 124 and 134 tons per acre for the custodial and intensive management scenarios. When considering forest carbon pools, the analysis found little difference in soil carbon, snags, or forest floor debris. For each management scenario, these remained constant. The difference in forest carbon storage was seen in standing biomass.

When the total carbon pool is considered (including wood products and harvest residue), a substantial variance in carbon storage was seen between the two management scenarios. Under custodial management, the increase in carbon storage is approximately 15 tons per acre when comparing the forest carbon pool to the total carbon pool. This difference is over 60 tons per acre under the intensive management scenario. The harvesting and manufacturing of logs resulting in long-term storage of carbon in usable lumber and other products increases the total forest carbon pool.

The models used a regulated uneven-aged management silvicultural system, such as used by Hearst Forests, and resulted in modest increases in sequestered CO_2e over time. More intense management scenarios, such as even-aged management, can result in higher growth rates (James, 2007) and larger sequestration values. Values for wildlife, conservation, and recreation are also important on Hearst Forests lands and are included in objectives relative to silvicultural decisions.

5.3 Alternative Analysis

5.3.1 No-Action Alternative

The no-action alternative defined herein mimics the custodial management alternative in the James et al. study. To quantify the results of this alternative, the growth rate of the Hearst Forests would initially increase due to increased stocking levels but will, by year 75, be reduced to less than 300 board-feet per acre due to overstocking. This scenario initially increases the sequestration potential of the property; however, with the assumption of a catastrophic fire occurring that consumes 70 percent of the ownership and associated volumes (40,000 acres) in year 50. The catastrophic fire assumes no harvesting and no replanting. This scenario assumes 70 percent of the stored carbon in the standing inventory is released.

The FORESEE model was used to grow the Hearst Forest stands for the next 50 years under the "no harvest" prescription. Assuming a "no harvest" prescription for all of the land types, the volume increases to 2,367,000 mbf, growing an average of 510 board-feet per acre per year over the next 50 years. Initially in the first 50 years, carbon sequestration increases as the standing inventory doubles; however, if it is assumed that 70 percent of the 50-year cumulative inventory is lost to catastrophic fire, the cumulative total is reduced significantly. The carbon released in a catastrophic fire event would be in excess of 10,000,000 metric tons of CO_2e. The residual stand 30 percent or 16,800 acres would continue to grow to an estimated 42 mbf/acre, which will result in a carbon sequestration of approximately 9,879,000 metric tons CO_2e through the end of the planning horizon, significantly less than the proposed management scenario over the planning period. Results of the analysis are included in Table 5-1.

Table 5-1
CARBON SEQUESTRATION UNDER "NO HARVEST" ACTIVITIES

	Mbf	Metric Tons CO_2e
Volume Growth to Year 50	2,367,000	+16,418,000
Volume Lost 70% Year 50	1,656,900	-11,492,000
Residual Volume Following Fire	710,106	4,982,000
Residual Forest Year 100	705,600	4,890,000
Total End of Period		**9,879,000**

5.3.2 Intensive Management Alternative

The intensive management alternative assumes that even-aged management is completed on all Hearst Forest property and that all tractor-logging debris is chipped for biomass. Growth rates increase to 750 board-feet per acre.

Returning to the James et al. (2007) analysis, an intensive management scenario results in the forest carbon pool rising consistently throughout the planning period. In both of the watersheds evaluated by James et al., higher amounts of carbon were sequestered when combining the forest carbon pool with carbon stored in wood products harvested within each watershed and carbon stored in harvest residue resulting from timber management activities. The total carbon pool yield is much higher when wood products and harvest residue are included as components of the total carbon pool. Specifically, the study showed a steady climb in the forest carbon pool throughout the entire 100-year planning horizon for the most intensive management scenario. Values under all models used ranged from 134 to 165 tons of carbon per acre.

The custodial management scenario indicated a gradual increase-stable-declining pattern in the forest carbon pool for all models, with a carbon pool ranging from 83 to 142 tons of carbon per acre over the 100-year period for all models. The selective management approach showed a slight increase in the forest carbon pool: up to 5 tons of carbon per acre over the 100-year planning horizon, with carbon yield levels of approximately 110 tons of carbon per acre. The study also noted that the difference between the total carbon pool and the forest carbon pool is 15 to 35 tons per acre at the end of the analysis period for both the custodial management and selection management scenarios. In contrast, the difference between the total carbon pool and the forest carbon pool is over 90 tons of carbon per acre for the intensive management and over 150 tons of carbon per acre for the regulated management scenarios. Clearly, when accounting for carbon stored in wood products manufactured from logs milled from California forests and carbon stored in harvest residue that results from timber harvest operations, there is a large increase in the total forest carbon pool. When wood products and harvest residue are included as sources of carbon in the total carbon pool, the yield is much higher. Therefore, it is determined that the intensive management scenario due to increased harvest volume and addition of volume of materials permanently sequestered provide the greater GHG benefit. However, other forest values associated with wildlife, aesthetics, and recreation would not maintain as high a value nor meet the objectives of the Hearst Forest ownership under this scenario.

6.0 MANDATORY FINDINGS

6.1 Cumulative Impacts

Cumulative impacts in the initial PTEIR were assessed based on the methodology that used a combination of EPA and Washington approaches to establish thresholds. Hearst Forests conducted a 100-year analysis of MSP and LTSY that accounts for known factors that limit productivity and projects harvesting and growth associated with the property over that 100-year period. Total carbon sequestration is correlated with total standing timber inventory (biomass of live and dead trees). Therefore, total standing inventory on the property serves as an accurate proxy for total CO_2e. Any benefit in reducing levels of CO_2 in the atmosphere from forest management will not be limited to the atmosphere of any particular county, state, or country.

The CARB and the California Energy Commission, in their efforts to determine the GHG emissions inventory for California and for the forests lands in California, have determined these lands to be net sequestering between 5 to 17 million metric tons of CO_2e annually. A very detailed baseline analysis for forest GHG emissions and sequestration from and in the forests of Northern California indicates that these forests are net of all emissions sequestering in excess of 8.76 million metric tons CO_2e/year (Brown, 2004).

Harvesting of the tree boles and optionally harvesting the biomass included in tree tops, branches, and submerchantable trees was discussed in the THP-specific analysis. These and the below-ground live and dead carbon pools may be as much as 40 percent of the total carbon in the forest. In the case of the foliage and branches, they are inherently attached to tree boles. Our MSP shows increasing standing bole (tree trunk) volume. Therefore, it is reasonable to assume that the other live portions of trees will continue to be stable or increasing as well. A follow-up to the Garden of Eden experiment indicates that there have been net gains in soil carbon irrespective of roots in the 15 years since the initial sampling (Powers et al., unpublished manuscript, 2012). This analysis assumes it is appropriate to assume that there is no significant emission from the below-ground carbon pool, and that, in fact, more intensive silvicultural management decisions are likely increasing this carbon pool.

Above-ground dead biomass (snags and down logs) is a very small carbon pool in relation to the other pools. A minimum number of snags per acre remain under Hearst Forest management. As these snags age, they eventually fall and contribute to the large woody debris carbon. With continued monitoring of mortality and snag creation, and snag retention policies, little change is expected over time to this carbon pool.

In some sites, there are short-term (approximately 10 years) reductions in the duff and litter components, but this is very short lived as the planted trees soon begin to augment this pool. A recent paper combining data from Pacific Northwest and British Columbia gas flux network sites, relating disturbance (both logging and fire) to age since disturbance is found on most sites, found that net carbon exchange from the atmosphere became negative (the forest site was taking up more carbon than it was releasing to the atmosphere) in 10 years or less (Baldocchi, 2008). This research demonstrates that these other carbon pools, while they may cause some emissions, are overcome and become net-sequestering locations in a very short time as compared to the time between forest harvest disturbances. This time is likely even less if biomass is collected and taken to a biomass power facility, as is the case for Hearst Forest management. The emission calculation accounts for the carbon in tree tops, branches, and needles.

When looking at these issues from a larger social view and drawing a comparison between wood and alternative building products, it is apparent that wood produces fewer GHGs (has a lower carbon footprint) than all other available building materials including concrete, steel, aluminum, or brick (see www.corrim.org). This potential substitution effect of using wood in the place of the other available building materials suggests that the output from this project (harvested wood products) can have a 10- to 30-fold decrease in CO_2 released by replacement of less-carbon-efficient building materials (depending on the specific building material replaced). The analysis of emissions would be substantially reduced and, in fact, likely eliminated if substitution effects could be quantified and included. Again, out of conservativeness, this benefit was not added in the analysis.

At both the Northern California scale and at a global scale, Hearst Forests' management produces significant carbon benefits. Standing inventory absorbs and stores CO_2 until it is turned into products that store it further. To the extent that we can substitute wood for less carbon friendly building materials, these beneficial effects would be further compounded.

6.2 Growth-Inducing Impacts

No growth-inducing impacts are anticipated from the continued management of Hearst Forests relative to GHG emissions. This and other mandatory findings were addressed in the 1998 PTEIR, and this GHG analysis will not result in changes to these findings.

6.3 Unavoidable or Irreversible Changes

No unavoidable or irreversible changes are anticipated from the continued management of Hearst Forests relative to GHG emissions. This and other mandatory findings were addressed in the 1998 PTEIR, and this GHG analysis will not result in changes to these findings.

6.4 Conclusion

After conducting this GHG assessment, we conclude that Hearst Forests' management will not cause a significant adverse impact (individually or cumulatively) on the condition of GHGs; and actually produces a net carbon benefit of considerable magnitude by removing CO_2 from the atmosphere, storing the carbon in forests and wood products, and reducing CO_2 emissions. Site-specific, project-level emission calculations along with the estimated time for actual onsite recovery show minimal short-term impact and no long-term impacts. Estimates of downstream effects, even when not attributable specifically to management, were included. Net emissions were evaluated in a variety of contexts and confirmed, under all circumstances, that there are no adverse impacts.

Finally, the cumulative effects analysis shows Hearst Forests' annual harvesting across the property leads to net benefits and does not lead to any significant adverse impacts. Far from being a source of GHGs, the management creates a significant net sink for atmospheric carbon dioxide by increasing standing carbon inventory in the forest and in safely stored offsite carbon in the form of harvested wood products, and provides a substantial benefit by removing and sequestering CO_2 that has been emitted to the atmosphere.

7.0 REFERENCES

Baldocchi, D. 2008. Breathing of the terrestrial biosphere: lessons learned from a global network of carbon dioxide flux measurement systems. *Australian Journal of Botany* 56, 1–26.

Brown, S., T. Pearson, A. Dushku, J. Kadyzewski, and Y. Qi. 2004. Baseline greenhouse gas emissions and removals for forest, range, and agricultural lands in California. Winrock International, for the California Energy Commission, PIER Energy-Related Environmental Research. 500-04-069F.

CARB. 2009. California Environmental Protection Agency, Air Resources Board. California's 1990-2004 Greenhouse Gas Emissions Inventory and 1990 Emissions Level. State of California, Air Resources Board, Planning and Technical Support Division, May 2009.

DOE (U.S. Department of Energy). 2006. 1605b technical guidelines for voluntary reporting of greenhouse gas program, Chapter 1, Emission Inventories, Part I: Appendix. The material presented in Appendix Section 1 is adapted from a USDA Forest Service General Technical Report (Smith et al. 2006).

EPA (U.S. Environmental Protection Agency). 2009. Inventory of U.S. greenhouse gas emissions and sinks: 1990-2007. Available from World Wide Web: http://epa.gov/climatechange/emissions/downloads09/InventoryUSGhG1990-2007.pdf

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007: mitigation. *Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)]. United Kingdom and New York, NY, USA: Cambridge University Press.

James, C., B. Krumland, and P. J. Eckert. 2007. Carbon sequestration in Californian forests: two case studies in managed watersheds, a Sierra Pacific Industries report. Available from World Wide Web: http://www.spi-ind.com/html/pdf_forests/CARBONSEQUESTRATION.pdf

Kurz, W.A.; M. Apps; E. Banfield; and G. Stinson. 2002. Forest carbon accounting at the operational scale. *The Forestry Chronicle* 78(5):672–679.

Marland, G. and B. Schlamadinger. 1997. Forests for carbon sequestration of fossil fuel substitution. *Biomass and Bioenergy* 13(6):389-397.

Powers, et al. 2012. Unpublished manuscript.

Schlamadinger, B. and G. Marland. 1996. *Forest ecosystems, forest management and the global carbon cycle.* Berlin, Germany: Springer-Verlag.

USCCSP (U.S. Climate Change Science program). 2008. A Report of the Committee on Environment and Natural Resources of the National Science and Technology Council. *Scientific assessment of the effects of global change on the United States.* Available from World Wide Web: http://www.climatescience.gov/Library/scientific-assessment.

Appendix A

Emission Analysis Data

The tables in this appendix were provided by SPI to support the assumptions used in the model that was developed for SPI timber harvests and adapted to Hearst Forests for this evaluation. These include Table 1 – Tertiary Emission Calculation Data and Data Table 2 – Primary and Secondary Emissions Calculation Data, Tertiary Summary.

Data Table 1 - Tertiary Emission Calculation Data

Backup Calculations to Determine Specific Emission in CO_{2e} per MBF

Table 1 provides the backup data used by SPI in the model to determine tertiary downstream product production sequestration and emission rates. Between 2007 and 2008, log loads delivered to SPI mills were weighed to determine actual green weight. The green weight was converted to obtain the value of 4.81 metric tons of Co_{2e} per thousand board-feet (mbf) in delivered logs by assuming 50 percent moisture content and 50 percent of the dry weight as carbon.

Assuming 100 percent starting carbon per mbf (log scale), SPI measured actual lumber and byproduct percentages at their mills from 2007 and 2008. These are included in the second heading in the table. SPI is a primary lumber producer and purchases many of Hearst Forests' log sales. Of logs removed, Hearst estimates that 60 percent of wood is removed for lumber and 40 percent of wood is removed to veneer. An estimated 50 percent of the wood harvested is whole tree and 50 percent is bole only.

Hearst noted that the relative product percentages used to calculate tertiary emission sequestration are slightly different than those used by SPI in the analysis; however, the 60 percent lumber/40 percent veneer correlates to the harvested volume rather than the allocation of total standing carbon. Close to 90 percent of the harvested volume produced by SPI in the model is made into lumber, with the remaining 10 percent made into particle board. The residual amounts shown represent standard mill waste products and are consistent for each board-foot processed. The basis for the calculations are the Tables C.2 (in-use) and C.3 (landfill storage) from the Climate Action Reserve (CAR) Forest Protocol, Version 3.2, included as referenced below.

The percentages only apply to tertiary emissions – those produced after the logs are delivered to the sawmill. They include process losses, immediate-release products like landscape and soil amendments, and all long-lived wood products produced including secondary production in other facilities like paper and particle-board plants. Hearst does not own mills and, therefore, sells to other milling facilities, predominantly SPI; so the numbers used are representative.

The CAR Harvested Wood Products and Landfill tables from the Version 3.2 Protocol were used to make the calculations. These are based upon U.S. Department of Energy 1605(b) tables to determine average in-use lifecycles and percents deposited into solid waste management sites. The CAR tables for carbon remaining out of the atmosphere over 100 years are available at the following url:

http://www.climateactionreserve.org/how/protocols/forest/dev/version-3-2/

The storage coefficients for in-use wood products for softwood lumber is 0.463 and for softwood plywood is 0.484. These numbers are essentially the same. The mill efficiencies table from the CAR Protocol used to make the calculation uses the same efficiency number of 0.675 for all softwood, sawlog, pulp, and veneer. The specific values for the softwoods used in the SPI model are based on harvesting of mixed conifers in Northern California, which should provide a better estimate for Hearst Forests.

The available models do not differentiate between softwood lumber and softwood plywood for efficiencies or hauling in the in-use analysis. The storage coefficient for softwood plywood is higher (0.484) than the storage coefficient for softwood lumber (0.463), which means that the use of the SPI assumptions overestimates the emissions for Hearst Forests.

Hearst determined that recalibration of the models was not necessary due to the similarity in the numbers used as coefficients to make the calculation.

The SPI assumptions in the table are based on post-milling byproducts only and do not address the in-woods chipping. These values are typical of the industry and would reflect the actual values at the mills that receive Hearst Forest logs. Fifty percent of the wood harvested from Hearst Forests is harvested as bole only (no in-woods biomass chipping); fifty percent is chipped for biomass. The model allows for specification of the in-woods chipping method, and the fifty percent allocation was addressed as an input assumption during modeling.

Data Table 2 - Primary and Secondary Emissions Calculation Data, Tertiary Summary

Onsite Emissions, Secondary Emissions, Downstream (Tertiary) Emissions

The documentation for the specific analysis follows:

1). **Primary (direct) emissions** are those releases of CO_2 directly back to the atmosphere caused by either the rotting (leaving slash to decay) or oxidation of woody logging debris (slash) by the processes of prescribed or pile burning on the logging site after harvest. The tops, branches, and needles are estimated at 15 percent of the total weight of the main bole (Smith 2007, Stewart in press). Since the harvested logs neither rot nor are burned (oxidized), SPI only considered the harvest residues that are not biomass chipped and taken to a biomass energy plant or an SPI cogenerating biomass facility. The carbon contained in these harvest residues left onsite are counted as immediate and complete emissions in our analysis, even though when burned onsite or allowed to decay over time, a portion of these residues remain in char or become part of the duff and/or become incorporated into the soil as elemental carbon. This treatment of slash as an immediate emission is also a very conservative estimate since the U.S. Environmental Protection Agency (USEPA) and Intergovernmental Panel on Climate Change (IPCC) would consider these residues part of the biogenic CO_2 cycle and, thus, not an emission.

2). **Secondary emissions** are those from equipment consuming diesel fuel employed to harvest, yard, and load and haul the logs to the mill. For each yarding method (mechanized or ground based, cable or helicopter), SPI measured the total fuel consumed by the diesel engines and calculated their consumption per mbf of production. SPI then used the World Resources Institute diesel fuel carbon calculator to convert these gallons into CO_2e per mbf. In the case of biomass chipping operations, the diesel fuel per bone dry tonne to gather, chip, and haul this biomass-carbon-neutral fuel to the biomass plant was also calculated. In all cases, SPI rounded up the estimates of fuel consumed to be conservative. The rounding up of these estimates on a per-mbf basis provides a reasonable and practical way to account for all incidental (de minimis) fossil fuel consumed by foresters and contractors in planning, layout, administering, timber falling, and regeneration activities. SPI used an average haul of two roundtrips per day, which matches the Hearst Forests' average haul. The WRI tools for GHG emissions from transport or mobile sources are available at the following url:

http://www.ghgprotocol.org/calculation-tools/wood-products

The necessary inputs to determine secondary emissions per mbf are:

8.75 U.S. gallons of diesel per mbf for ground-based skidding on board truck
5.0 U.S. gallons of diesel per mbf for cable yarding on board truck
12.0 U.S. gallons of diesel per mbf for helicopter yarding on board truck
8.75 U.S. gallons of diesel per mbf to haul logs to the mill
1.43 U.S. gallons of diesel per green ton of biomass chipping and collecting on board truck
1.53 U.S. gallons of diesel per green ton to haul biomass from the woods

3). **Tertiary emissions** are those produced after the logs are delivered to the sawmill. They include all process losses, immediate-release products like landscape and soil amendments, and all long-lived wood products produced including secondary production in other facilities like paper and particle-board plants. SPI used the Climate Action Reserve (CAR) Harvested Wood Products and Landfill tables in the recently approved protocol to reduce these year-one percentages to the estimated percentages at year 100. These are based upon U.S. Department of Energy 1605(b) tables to determine average in-use lifecycles and percents deposited into solid waste management sites. They used scaled and weighed loads of logs over two years to determine the average green weight per mbf. These weights were all at state-certified scales, and the log scaling was all by third-party scaling bureaus. They then totaled all products sold by green weights to determine the product percentages shown in Data Table 1. SPI has made these confidential proprietary data available for CalFire review. The CAR tables for carbon remaining out of the atmosphere over 100 years are available at the following url:

http://www.climateactionreserve.org/how/protocols/adopted-protocols/forest/development/

SPI developed these factors all on a thousand board feet basis (mbf). So to estimate the primary (direct) onsite emission, the forester would take the entire expected harvest production in mbf and multiply it by the 0.7215 tonnes of CO_2e factor to estimate the primary emission. If the harvest plan is also biomass chipped and 100 percent of the harvest residue is removed and sent to a biomass to energy facility, the appropriate multiplier would be nearly zero. Thus, for a biomass chipping harvest where 100 percent of the residue is taken off the project site and utilized in a cogeneration facility, there would be no direct emissions. It is common to have biomass efficiencies above 75 to 85 percent.

Depending on yarding method, this same total mbf value would be multiplied by the appropriate yarding specific factor, which is adjusted for either: (1) biomass chipping and removal to a biomass facility or (2) treating the harvest residue on the ground by either burning or scattering. The biomass factors have been reduced for a credit for reduction in fossil fuel emissions, since the carbon-neutral fuel from the biomass will offset CO_2e emissions that would have occurred through burning natural gas to produce the same amount of electricity. In the combined primary and secondary factor for biomass operations, the primary emission of 0.7215 tonnes per mbf has been eliminated since that emission originated from the biomass that was hauled away to the power plant. Again, this factor has been scaled to apply per mbf. These factors also include diesel consumption for hauling of logs and hauling biomass chips if produced.

Finally, all tertiary emissions from the sawmilling, particle board, paper, construction and solid waste disposal site industries that originate from Hearst logs are calculated again by multiplying the total mbf produced by the 0.8142 factor shown as the over 100-year emission factor from all these emission sources.

Data Table 1 - Tertiary Emission Calculation Data
Sierra Pacific Industries

BACKUP CALCULATIONS TO DETERMINE THP SPECIFIC EMISSIONS IN CO_2e per mbf

TERTIARY DOWNSTREAM PRODUCT PRODUCTION SEQUESTRATION AND EMISSIONS

Based upon all log loads delivered to SPI Sawmills in 2007 and 2008

5.2473 metric tonnes per mbf (green weight)

2.6236 metric tonnes (dry weight) (assume 50% moisture content)

1.3118 metric tonnes of C (50% C)

4.8100 metric tonnes of CO_2e per mbf in the delivered log

Based upon all lumber and byproducts produced in 2007 and 2008

41.0% solid lumber

5.7% particle board

9.7% paper chips

12.9% bark and other landscape, soil amendments, livestock bedding

30.7% carbon neutral fuel used in boilers for cogeration / process steam

100.0% total starting carbon per mbf (log scale)

Climate Action Reserve - Harvested Wood Products based upon the DOE 1605b tables of carbon remaining in end use and landfills. (average percent remaining out of the atmosphere at 100 years)
Note: the product percents above were reduced to percent remaining sequestered averaged over 100years

31.2% solid lumber

4.6% particle board

2.3% paper chips

0.0% bark and other landscape, soil amendments, livestock bedding
(assumed emitted to the atmosphere immediately)

30.7% carbon neutral fuel used in boilers for cogeration / process steam
(based upon replacement of fossil fuel used)

14.3% fossil fuel offset carbon not released

83.1% total carbon that remains sequestered and not emitted over 100 years.

Applying these percentages per mbf to the total CO_2e (all stated in metric tonnes of CO_2e)

1.5000 CO_2e remaining sequstered in solid lumber and landfills over 100 years

0.2232 CO_2e remaining sequstered in particle board and landfills over 100 years

0.1103 CO_2e remaining sequstered in paper and landfills over 100 years

0.0000 bark and other landscape, soil amendments, livestock bedding
(assumed emitted to the atmosphere imeadiately)

1.4765 carbon neutral fuel burned in boilers for cogeration / process steam
(based upon sustainable replacement of biogenic fuel used)

0.6858 fossil fuel offset carbon from cogeneration by not creating emissions from burning fossil fuel

3.9958 total carbon that remains sequestered and not emitted over 100 years. 83.1% of original CO_2e

Subtracting carbon remaining sequestered from per mbf from the total CO_2e yields tertiary emissions

4.8100 Metric tonnes of CO_2e per mbf in the delivered log.

3.9958 total carbon that remains sequestered and not emitted over 100 years.

0.8142 Tertiary Emissions over 100 years by sawmilling and downstream users of the products produced

Data Table 2 - Primary and Secondary Emissions Calculation Data, Tertiary Summary

Sierra Pacific Industries

ONSITE EMISSIONS, SECONDARY EMISSIONS, DOWNSTREAM(tertiary) EMISSIONS

Complete Offsite Tertiary Analysis Summary per mbf logged

4.8100 metric tonnes of CO_2e per mbf in the delivered log.

3.9958 total carbon that remains sequestered and not emitted over 100 years. 83.1% of original CO_2e

0.8142 total offsite net tertiary emissions tonnes of CO_2e per mbf harvested (log scale) (over 100 years)

Complete Onsite Primary Emissions Detail per mbf logged

0.7215 potential emissions in small trees, tops, branches and needles (harvest residue - slash)

Secondary emissions tonnes CO_2e per mbf by logging system

0.1819 mechanized obt and haul per mbf produced
0.1429 cable obt and haul per mbf produced
0.2156 helicopter obt and haul per mbf produced

Combined Primary and Secondary emissions tonnes CO_2e per mbf by logging system

0.9034 net onsite primary and secondary emissions for mechanized yarding and hauling
0.8644 net onsite primary and secondary emissions for cable yarding and hauling
0.9372 net onsite primary and secondary emissions for helicopter yarding and hauling

Modifications for Biomass Chipping in the Woods

0.0000 emissions in submerchantable trees, tops, branches and needles (slash)
as a result of converting to carbon neutral fuel source - (depending on collection efficiency)

0.1915 direct add back as fossil fuel offset from biomass electricity production

0.0121 secondary emissions from biomass production obt and haul per mbf logged

After Biomass Analysis - All Secondary Emissions (net of fossil fuel credit) - (No Primary Emissions)

0.0025 adj. net onsite primary and secondary emissions for mechanized yarding & hauling & chipping
-0.0365 adj. net onsite primary and secondary emissions for cable yarding & hauling & chipping
0.0363 adj. net onsite primary and secondary emissions for helicopter yarding & hauling & chipping

This final adjustment for onsite biomass collection includes saving the .7215 ton of primary emission from decay and includes the net secondary emissions from equipment used to collect and chip biomass.

These factors multiplied by THP total volme in mbf will yield total onsite primary and onsite secondary emissions all expressed in tonnes of CO_2e / mbf.

Note:all values are maintained at greater accuracy than displayed thus may appear to be off because of rounding.
Note: obt is shorthand for "on board truck"

Appendix B

Model Scenarios

Unevenaged Management Silivculture

Heart Forest Analysis - Tractor Logging Uneven Aged without Biomass Removal

10152 Total volume in mbf to be logged for each yarding method

1160 Number of acres of thinned stands

Copy the appropriate value for post harvest stand growth from the yield table here: 2.20

All logging methods emissions will calculate below.

Primary Emission - Choose With or Without In-Woods Chipping

Primary Onsite Emissions

7325 Regardless of Yarding method

Primary Onsite Emissions With Biomass Chipping

1465 Regardless of Yarding method

Percent Biomass Efficiency

80%

Logging Method - Choose the associated tonne value and copy and paste in the box below for emissions

Secondary Emissions Without Biomass Chipping

1846 Mechanized Yarding

1451 Cable Yarding

2189 Helicopter yarding

Secondary Emissions With Biomass Chipping - No Primary Emissions

414 Mechanized Yarding

18 Cable Yarding

757 Helicopter yarding

Total Estimated Volume to be Harvested: 10152 mbf

Number of acres of treated stands: 1160 acres

Primary Emissions

7325 metric tonnes of CO_2e emissions

The replacement tonnes per acre for primary emissions will calculate below

7325 divided by 1160 = 6.31 tonnes/ac CO_2e

Replacement will occur 2.87 years after harvest

Secondary Emissions

1846 metric tonnes of CO_2e secondary emissions

The replacement tonnes per acre for all primary, and secondary emissions will calculate below

9171 divided by 1160 = 7.91 tonnes/ac CO_2e

Replacement will occur 3.59 years after harvest

Tertiary Emissions

8266 metric tonnes of CO_2e tertiary emissions (over 100 years)

The replacement tonnes per acre for all primary, secondary and tertiary emissions will calculate below

17437 divided by 1160 = 15.03 tonnes/ac CO_2e

Replacement will occur 6.83 years after harvest

Total Primary, Secondary, & Tertiary Emission

17437 tonnes CO_2e

Unevenaged Management Silivculture

Heart Forest Analysis - Tractor Logging Uneven Aged with Biomass Removal

9746 Total volume in mbf to be logged for each yarding method

1110 Number of acres of thinned stands

Copy the appropriate value for post harvest stand growth from the yield table here: 2.20

All logging methods emissions will calculate below.

Primary Emission - Choose With or Without In-Woods Chipping

Primary Onsite Emissions

7032 Regardless of Yarding method

Primary Onsite Emissions With Biomass Chipping

1406 Regardless of Yarding method

Percent Biomass Efficiency

80%

Logging Method - Choose the associated tonne value and copy and paste in the box below for emissions

Secondary Emissions Without Biomass Chipping

1773 Mechanized Yarding

1393 Cable Yarding

2102 Helicopter yarding

Secondary Emissions With Biomass Chipping - No Primary Emissions

397 Mechanized Yarding

18 Cable Yarding

727 Helicopter yarding

Total Estimated Volume to be Harvested: 9746 mbf

Number of acres of treated stands: 1110 acres

Primary Emissions

1406 metric tonnes of CO_2e emissions

The replacement tonnes per acre for primary emissions will calculate below

1406 divided by 1110 = 1.27 tonnes/ac CO_2e

Replacement will occur 0.58 years after harvest

Secondary Emissions

397 metric tonnes of CO_2e secondary emissions

The replacement tonnes per acre for all primary, and secondary emissions will calculate below

1803 divided by 1110 = 1.62 tonnes/ac CO_2e

Replacement will occur 0.74 years after harvest

Tertiary Emissions

7935 metric tonnes of CO_2e tertiary emissions (over 100 years)

The replacement tonnes per acre for all primary, secondary and tertiary emissions will calculate below

9738 divided by 1110 = 8.77 tonnes/ac CO_2e

Replacement will occur 3.99 years after harvest

Total Primary, Secondary, & Tertiary Emission

9738 tonnes CO_2e

Regeneration Silvicultures

CO_2e Yield Table evenaged mgmt		
Site 100 Age (years)	CO_2e MT/AC	
10	2.42	
11	3.63	
12	4.83	
13	6.04	
14	7.25	
15	8.45	
16	11.17	
17	13.89	
18	16.61	
19	19.33	
20	22.06	
21	27.56	
22	33.07	
23	38.57	
24	44.08	
25	49.58	
26	55.09	
27	60.59	
28	66.10	
29	71.60	
30	77.11	

Hearst Forests Analysis Evenaged Tractor with Biomass Removal

406 Total volume in mbf to be logged for each yarding method

50 Number of acres of plantation to be created

All logging methods emissions will calculate below.

Primary Emission - Choose With or Without In-Woods Chipping

Primary Onsite Emissions
293 Regardless of Yarding method

Primary Onsite Emissions With Biomass Chipping
59 Regardless of Yarding method

Percent Biomass Efficiency
80%

Logging Method - Choose the associated tonne value and copy and paste in the box below for emissions

Secondary Emissions Without Biomass Chipping
74 Mechanized Yarding
58 Cable Yarding
88 Helicopter yarding

Secondary Emissions With Biomass Chipping - No Primary Emissions
17 Mechanized Yarding
1 Cable Yarding
30 Helicopter yarding

Total Estimated Volume to be Harvested: 406 mbf
Number of acres of plantation to be created: 50 acres

Primary Emissions

59 metric tonnes of CO_2e emissions
The replacement tonne per acre for primary emissions will calculate below
59 divided by 50 = 1.18 tonnes/ac CO_2e
Replacement will occur between <10 years after planting

Secondary Emissions

17 metric tonnes of CO_2e secondary emissions
The replacement tonne per acre for all primary, and secondary emissions will calculate below
76 divided by 50 = 1.52 tonnes/ac CO_2e
Replacement will occur between <10 years after planting

Tertiary Emissions

331 metric tonnes of CO_2e tertiary emissions (over 100 years)
The replacement tonne per acre for all primary, secondary and tertiary emissions will calculate below
407 divided by 50 = 8.13 tonnes/ac CO_2e
Replacement will occur between 14-15 years after planting

Total Primary, Secondary, & Tertiary Emissions

407 tonnes CO_2e

Over 80 years these planted acres will sequester: 18,700 tonnes of CO2e

Unevenaged Management Silivculture

Heart Forest Analysis - Cable without Biomass Removal

5067 Total volume in mbf to be logged for each yarding method

580 Number of acres of thinned stands

Copy the appropriate value for post harvest stand growth from the yield table here: 2.20

All logging methods emissions will calculate below.

Primary Emission - Choose With or Without In-Woods Chipping

Primary Onsite Emissions

3656 Regardless of Yarding method

Primary Onsite Emissions With Biomass Chipping

731 Regardless of Yarding method

Percent Biomass Efficiency

80%

Logging Method - Choose the associated tonne value and copy and paste in the box below for emissions

Secondary Emissions Without Biomass Chipping

922 Mechanized Yarding

724 Cable Yarding

1093 Helicopter yarding

Secondary Emissions With Biomass Chipping - No Primary Emissions

207 Mechanized Yarding

9 Cable Yarding

378 Helicopter yarding

Total Estimated Volume to be Harvested: 5067 mbf

Number of acres of treated stands: 580 acres

Primary Emissions

3656 metric tonnes of CO_2e emissions

The replacement tonnes per acre for primary emissions will calculate below

3656 divided by 580 = 6.30 tonnes/ac CO_2e

Replacement will occur 2.87 years after harvest

Secondary Emissions

724 metric tonnes of CO_2e secondary emissions

The replacement tonnes per acre for all primary, and secondary emissions will calculate below

4380 divided by 580 = 7.55 tonnes/ac CO_2e

Replacement will occur 3.43 years after harvest

Tertiary Emissions

4126 metric tonnes of CO_2e tertiary emissions (over 100 years)

The replacement tonnes per acre for all primary, secondary and tertiary emissions will calculate below

8506 divided by 580 = 14.66 tonnes/ac CO_2e

Replacement will occur 6.67 years after harvest

Total Primary, Secondary, & Tertiary Emissions

8506 tonnes CO_2e