Midpeninsula Regional
Open Space District

R-22-116
Meeting 22-24
October 12, 2022

AGENDA ITEM 6

AGENDA ITEM

La Honda Creek Preserve Forest Health and Management Plan - Next Steps

GENERAL MANAGER'S RECOMMENDATIONS

1. Direct the General Manager to solicit restoration forestry and engineering services to develop a Timber Harvest Plan and forest management prescriptions consistent with existing Resource Management Policies and the findings of the La Honda Forest Health and Management Plan to improve forest health conditions.

2. Authorize the General Manager to amend a contract with Sicular Environmental Consulting and Natural Lands Management of Berkeley, California, in the amount of $50,000 to provide additional project management, staff support, and oversight. The amendment would bring the contract to a total not-to-exceed amount of $157,293.

SUMMARY

A 1,210-acre forested portion of the La Honda Creek Open Space Preserve (Preserve) is the subject area for the first forest health assessment and management plan on Midpeninsula Regional Open Space District (District) land, referred to as the La Honda Forest Health Management Assessment (Forest Health Assessment). Staff presented the findings of the Forest Health Management Assessment to the Board of Directors (Board) on July 28, 2021 (R-21-103). Staff then held in-person, field, and zoom meetings with conservations organizations and forest management practitioners, including California State Parks, Save the Redwoods League, Peninsula Open Space Trust, and Green Foothills, to review recommendations from the Forest Health Assessment and discuss best management practices (BMP) for forest management in the Santa Cruz Mountains Bioregion. Staff held a meeting with the Allen Road and Bear Gulch neighborhood via Zoom and two general La Honda community in-person meetings at the Cuesta La Honda Guild. Overall, the conservation organizations, members of the public, and neighbors were supportive of the recommendations.

A contract amendment with Sicular Environmental Consulting and Natural Lands Management (Sicular Environmental) in the amount of $50,000 is recommended to provide additional project management, staff support, and oversight (due to the Project Manager's recent departure). The amendment would bring the contract to a total not-to-exceed amount of $157,293. The Fiscal Year 2022-2023 (FY23) budget includes sufficient funds to cover the work.

DISCUSSION

The consultant, Sicular Environmental, reviewed historical information, gathered and analyzed extensive forest data, and prepared draft management options for different portions of the Forest Health Assessment area based on the degree of ecological impairment and the effectiveness of potential stewardship interventions to promote healthy, resilient forest conditions. Staff presented the findings of the La Honda Forest Health Management Assessment (Attachment 1) on July 28, 2021 (R-21-103). Forest impairments include the following: sedimentation from legacy logging roads; Douglas fir encroachment into hardwood forests; sudden oak death in tan oak stands and understory; elevated fuel conditions in select areas; and dense stands of second-growth redwoods. The Forest Health Assessment makes several recommendations based on defined geographic management units and their unique management histories and natural conditions. These recommendations broadly include the following: mechanical fuel reduction work; road rehabilitation and decommissioning; Douglas fir removal in hardwoods; and thinning in overly dense second-growth redwood forests.

Portions of the thinning in the redwood forests that are near existing roads can generate merchantable timber that can be used to defray the costs of the forest health work, and would be consistent with the District's Forest Management Policies, which states that the "*revenue derived from commercial timber sales conducted in conjunction with restoration activities will be used for resource management activities (such as road upgrade projects, weed abatement projects, and long-term monitoring)"*. Potential revenue estimates will be generated in the next phase of the project and once a more detailed treatment has been prescribed. As a comparison, other non-District regional restoration forestry projects that have generated merchantable timber have only minimally offset the total project cost.

The Forest Health Assessment recommends a Timber Harvest Plan (THP) as the preferred permitting and regulatory vehicle to thin the overly dense second-growth redwoods forests and conduct other forest health actions. A THP is required for forest management projects with a commercial component (e.g., timber sales) and is the equivalent of a document generated by the California Environmental Quality Act (CEQA). Additionally, the Forest Health Assessment recommends that the Woodruff Creek parcel, which is discontinuous with the main project area, be managed via the Wildland Fire Resiliency Program's Environmental Impact Report with ecosystem resiliency treatments. The Woodruff Creek parcel is nearly roadless, and the primary recommendation is to manage fuels around existing old growth redwoods through hand labor. While the actions at Woodruff Creek would not be managed via a THP, there may be opportunities to work with the same licensed timber operator to implement the work.

Staff refined the Forest Health Assessment recommendations for the La Honda Creek Preserve, which cover all 1,210 treatment acres, into practical first steps to address forest impairments. These include:

- Sediment reduction work along a former timber haul road in a Conservation Management Unit within upper La Honda Creek Preserve, including road decommissioning and a crossing on Upper La Honda Creek;
- Fuel reduction work along emergency ingress/egress routes for tenants and neighbors;
- Douglas fir removal in hardwood stands;
- Fuel reduction and protection treatments around old growth trees and groves; and

- Fuel reduction and restoration forestry in the former Harmon parcel, Harrington Creek tributary forests, and the upper portions of the Conservation Management Unit area.

The exact extent of these actions is to be refined in the THP development process and is broadly depicted in Attachment 2.

Discussions with conservation organizations (e.g., Green Foothills, Peninsula Open Space Trust, and Save the Redwoods League) on the Forest Health Assessment and forest management recommendations touched on various topics from policy, best management practices, details of the Forest Health Assessment, and the proposed implementation actions. Staff solicited their input through a standardized a set of questions and described the details of the Forest Health Assessment (via Zoom and in the field). District policies, the findings of the assessment, and the proposed implementation project are largely consistent with ongoing work performed or supported by these conservation organizations. It is important to note, however, that each forest has a unique history and ecosystem. Participants recognized the need for site-specific prescriptions for each stand within the forest to determine the best ecological approach. The proposed THP document would provide much of that detail within the bounds established by the District's Forest Management Policies and the findings of the Forest Health Assessment.

Staff also provided an overview of the Forest Health Assessment findings at a meeting with Allen Road and Bear Gulch Road communities, with a focused discussion on the potential hauling operations via Allen and Bear Gulch Roads. The participants noted the varied condition of the roads and that they are narrow. Staff proposes using pilot vehicles, road signs, and timing the hauling to minimize disruptions to the community. This is consistent with similar past operations at the neighboring Djerassi property. The participants expressed concern about the potential impacts to Allen Road (a private road) from heavy equipment. Staff proposed detailed documentation of the road before and after operations in consultation with interested neighbors. The District would repair the road to baseline conditions. One neighbor inquired whether they could partner with the District to conduct similar forest health treatments on their lands. Staff recommended that this concept be revisited during the THP process. Staff also provided a recording of the presentation via email for circulation in the community.

In addition, staff presented the Forest Health Assessment to the La Honda community at Cuesta La Honda at two separate meetings. Staff provided an overview of the assessment and fielded attendee questions and concerns. Broadly, the community was interested in fuel conditions, how forests can be best managed, and the timeline and logistics of the project. Topics like sudden oak death, helicopter logging (which is not recommended), potential revenues, and forest resiliency were also discussed.

With Board approval, staff will solicit the services of a registered professional forester to develop the THP. Additionally, staff will solicit the services of engineering geologists and civil engineers to develop designs for sediment reduction. A THP process generally takes two years from plan development, public review, and CalFire review to approval. Implementation could potentially begin in fall 2024.

FISCAL IMPACT

The FY23 adopted budget includes $366,224 for the Restoration Forestry Demonstration Project MAA05-010. There are sufficient funds in the project budget to cover the recommended action and expenditures.

Restoration Forestry Demonstration Project MAA05-010	Prior Year Actuals	FY23 Adopted	FY24 Projected	FY25 Projected	Estimated Future Years	TOTAL
Total Budget:	**$36,767**	**$366,224**	**$275,199**	**$1,092,605**	**$0**	**$1,770,795**
Spent-to-Date (as of 09/20/2022):	($36,767)	$0	$0	$0	$0	**($36,767)**
Encumbrances:	$0	($28,195)	$0	$0	$0	**($28,195)**
Remainder of Sicular Contract:	$0	($23,375)	$0	$0	$0	**($23,375)**
Sicular Contract Amendment:	$0	($5,000)	($25,000)	($20,000)	$0	**($50,000)**
Budget Remaining (Proposed):	**$0**	**$309,654**	**$250,199**	**$1,072,605**	**$0**	**$1,632,458**

The following table outlines the Measure AA Portfolio 05 La Honda Creek: Upper Area Recreation, Habitat Restoration and Conservation Grazing Projects allocation, costs-to-date, projected future project expenditures and projected portfolio balance remaining.

MAA05 La Honda Creek: Upper Area Recreation, Habitat Restoration and Conservation Grazing Projects Portfolio Allocation:	**$11,733,000**
Life-to-Date Spent (as of 09/20/2022):	(2,962,426)
Encumbrances:	(65,120)
Remaining FY22 Project Budgets:	(1,186,117)
Future MAA05 project costs (projected through FY25):	($2,950,184)
Total Portfolio Expenditures:	**($7,163,847)**
Portfolio Balance Remaining (Proposed):	**$4,569,153**

The following table outlines the Measure AA Portfolio 05 allocation, projected life of project expenditures and projected portfolio balance remaining.

MAA05 La Honda Creek: Upper Area Recreation, Habitat Restoration and Conservation Grazing Projects Portfolio Allocation:	**$11,733,000**
Projected Project Expenditures (life of project):	
05-001 La Honda Creek Land Conservation Opportunities	($1,756,093)
05-002 Upper La Honda Creek Grazing Infrastructure	($297,432)
05-005 La Honda Creek Red Barn Parking Area and Easy Access Trail	($327,514)
05-007 La Honda Creek Phase II Trail Connection	(984,579)
05-008 La Honda Creek White Barn Structural Rehabilitation	(558,446)
05-009 La Honda Creek Redwood Cabin Removal and Site Restoration	(582,375)
05-010 Restoration Forestry Demonstration Project	(1,770,795)
05-011 Lone Madrone Ranch Fence Installation	(257,613)
05-012 Phase 2 - Paulin Bridge Replacements (2)	($629,000)
Total Portfolio Expenditures:	**($7,163,847)**
Portfolio Balance Remaining (Proposed):	**$4,569,153**

BOARD AND COMMITTEE REVIEW

The Board received a presentation from staff on July 28, 2021 (R-21-103, Minutes).

PUBLIC NOTICE

Public notice was provided as required by the Brown Act.

CEQA COMPLIANCE

This item is not a project subject to the California Environmental Quality Act. The THP process is a CEQA-equivalent. CalFire would be the lead agency, with the District acting as the responsible agency.

NEXT STEPS

Should the Board approve the General Manager's recommendations, the General Manager will direct staff to solicit forestry and engineering services to develop a THP. The General Manager would amend the contract with Sicular Environmental to provide additional project management services.

Attachment(s)

1. La Honda Forest Health Management Assessment and Plan
2. La Honda Forest Preferred Alternatives Map

Responsible Department Head:
Kirk Lenington, Natural Resources Manager

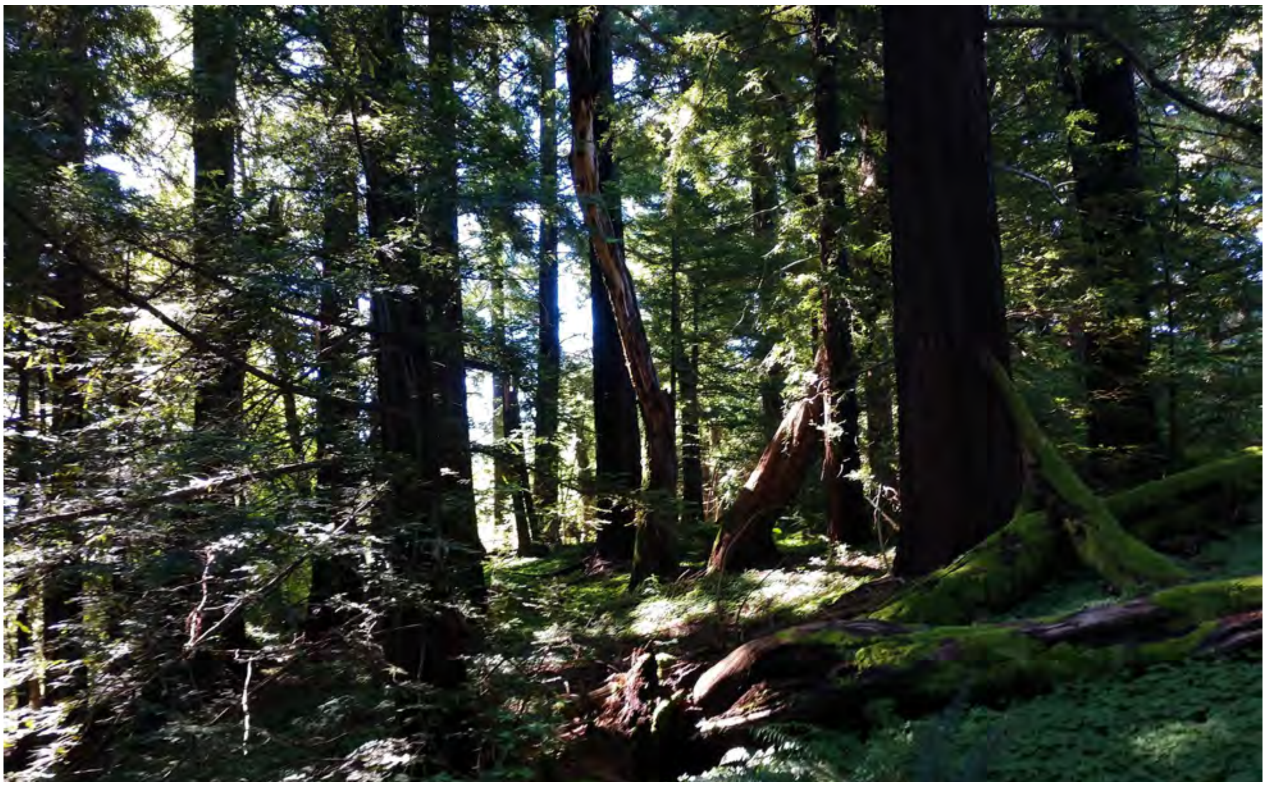
Prepared by:
Aaron Hebert, former Senior Resource Management Specialist

Contact person:
Coty Sifuentes-Winter, Senior Resource Management Specialist

ATTACHMENT 1

LA HONDA CREEK OPEN SPACE PRESERVE

Forest Management Assessment



Prepared for:

Midpeninsula Regional Open Space District

By: **Sicular Environmental Consulting and Natural Lands Management**
Christopher Keyes, Ph.D.
Buena Vista Services, LLC
Timothy Best, CEG
Orange Peel Cartography

June 2021

ATTACHMENT 1

La Honda Creek Open Space Preserve

Forest Management Assessment

Midpeninsula Regional Open Space District

Report preparers:

Dan Sicular, Ph.D.

Christopher Keyes, Ph.D.

Joe McGuire, RPF

Timothy Best, CEG

Kevin McManigal, Cartographer

Sicular Environmental Consulting & Natural Lands Management

P.O. Box 582, Philo, CA 95466 www.sicularconsulting.com (415) 717-6328

ATTACHMENT 1

TABLE OF CONTENTS

Tables

Figures

Appendices

This page intentionally left blank

CHAPTER 1
Introduction

The La Honda Forest is part of Midpeninsula Regional Open Space District's (the District's) La Honda Creek Open Space Preserve (La Honda Creek OSP). It is an approximately 1,770-acre area in the northern part of the La Honda Creek OSP, where native forests make up the majority of the vegetative cover (Figures 1-1 and 1-2). The La Honda Forest Management Assessment (the Assessment) provides a descriptive analysis of current and historic conditions within the La Honda Forest and provides recommendations for management of the forested areas in accordance with the District's Resource Management policies. The Assessment addresses all forest types found within the La Honda Forest, but focuses on approaches to management of the second growth redwood (*Sequoia sempervirens*) forest, with the aim of increasing its resilience to fire and climate change, and restoring its ecological function, as well as its beauty and majesty.

Background

The La Honda Creek Open Space Preserve was established in 1984 with the District's purchase of a 255-acre parcel. Since then, after more than 20 purchases, it has grown to over 6,100 acres. The most substantial addition was the purchase of the former Driscoll Ranch in 2006, which at 3,681 acres more than doubled the Preserve's acreage. This large addition to the Preserve prompted a number of studies to establish baseline conditions within the Preserve and inform the subsequent development of the La Honda Creek Open Space Preserve Master Plan, completed in 2012 (MROSD, 2012).

The Master Plan process was the first comprehensive planning effort for the Preserve. This effort included substantial engagement and outreach of numerous stakeholder groups, including neighbors and community residents; recreational advocacy groups; environmental organizations; and local, state, and federal natural resource management agencies.

Key natural resource management projects identified in the Master Plan include:

- Conducting natural resource inventories;
- Protecting and managing unique and sensitive areas and listed species;
- Restoring and managing riparian zones and aquatic habitat;
- Managing forests;
- Monitoring and preventing Sudden Oak Death;
- Controlling invasive plants;
- Inventorying and executing high priority road and trail treatments to correct drainage issues and address erosion concerns;

- Constructing new fuel breaks and reducing fuel loads, especially in high-risk ignition locations;
- Providing an opportunity for interpretation and education related to natural resource management efforts undertaken by the District.

The forested portions of the Preserve have not previously been inventoried in detail. This need is identified in the Master Plan and is consistent with the District's Resource Management Policies for Forest Management (MROSD, 2021b), and the District's 2014 Vision Plan.

Scope and Purpose

As described in the District's Request for Proposals for preparation of the Plan, the Plan should synthesize, discuss, and contextualize data on existing conditions within the La Honda Forest; identify significant habitat areas for protection and to promote ecological connectivity; and consider opportunities for active management to achieve the District's conservation and restoration goals. The Plan should identify restoration opportunities and provide options and approaches for future projects (MROSD, 2019).

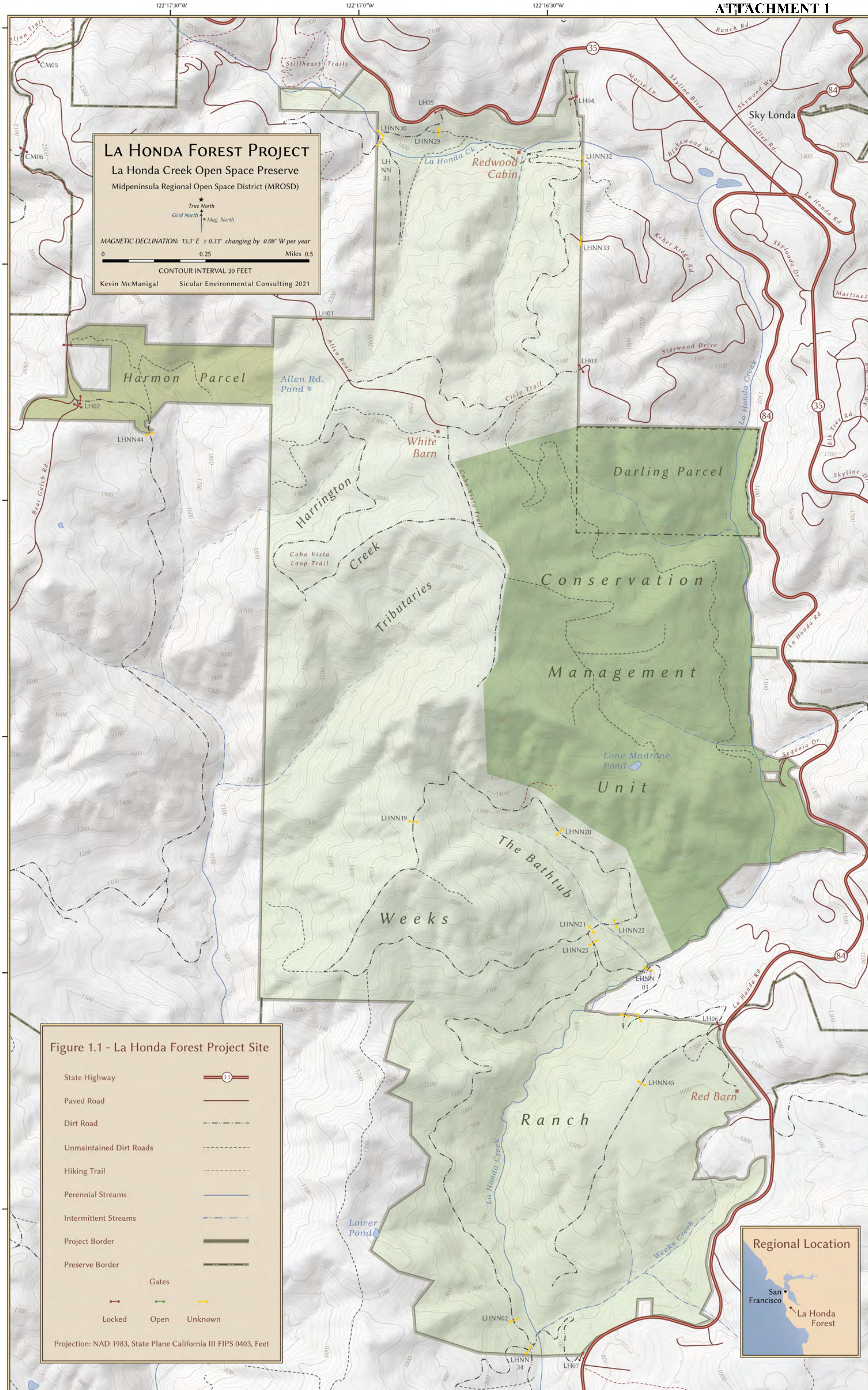
Consistent with this directive, the Plan focuses on management actions to increase the rate of acquisition of late seral or "old growth" forest characteristics, particularly within the redwood forest. The principal method recommended for achieving this is the use of silviculture, that is, the art and science of forestry. Through the active manipulation of forest structure and composition, silviculture focused on restoration can be used to maintain and increase biodiversity, address legacies of past management that impair forest health, and increase resilience in the face of climate change and intensifying wildfire hazard. The recommendations contained in Chapter 4 draw on the experience and results of experimental silvicultural treatments for forest restoration throughout the redwood range, but especially in the Santa Cruz Mountains and in Humboldt County, that are increasingly bearing out the effectiveness of this approach.

Forest Management Goals and Policies

The project goal is to inventory and assess the various components of the La Honda Forest and to inform potential management options to achieve the District's mission of preservation and restoration. The Plan is intended to be consistent with previous and ongoing District plans, policies, and studies, including the La Honda Creek Open Space Preserve Master Plan (MROSD, 2012), the District's Resource Management Policies (MROSD, 2021b), the draft Wildland Fire Resiliency Program (MROSD, 2021a), and the draft Climate Change Vulnerability Assessment of the Santa Cruz Mountains Climate Adaptation Project (Ecologic, 2020a, 2020b).

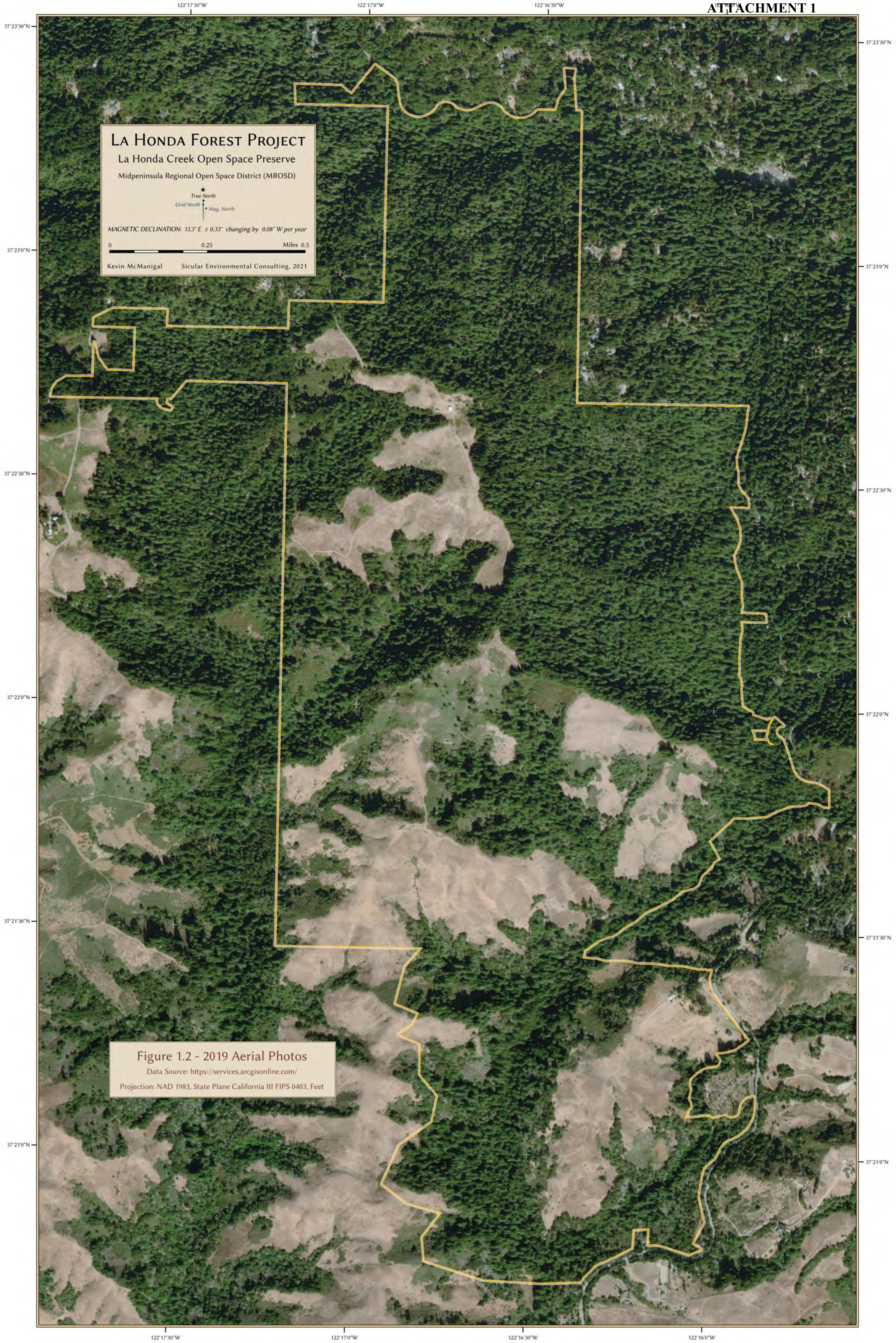
The District's Resource Management Policies, Section XII, Forest Management, includes the following statement:

> The District's conifer dominated Preserves offer the opportunity to manage forest conditions to accelerate late-seral habitat conditions to promote biologically diverse, dynamic forest habitat, increase the extent of this limited habitat, and accelerate the development of forest structure for the benefit of protected species and for improved fire resistance.



La Honda Forest Project
La Honda Creek Open Space Preserve
Midpeninsula Regional Open Space District (MROSD)
True North
Grid North
Mag. North
MAGNETIC DECLINATION: 13.3° E ± 0.33° changing by 0.08° W per year
0 0.25 Miles 0.5
CONTOUR INTERVAL 20 FEET
Kevin McManigal Sicular Environmental Consulting 2021
Harmon Parcel
Allen Rd. Pond
Allen Road
Redwood Cabin
La Honda Ck.
White Barn
Harrington Creek Tributaries
Coho Vista Loop Trail
Cielo Trail
Darling Parcel
Conservation Management Unit
Lone Madrone Pond
The Bathtub
Weeks Ranch
Red Barn
La Honda Creek
Weeks Creek
Lower Pond
Sky Londa
Skyline Blvd.
La Honda Rd.
Starwood Drive
Kebet Ridge Rd.
Sequoia Dr.
Bear Gulch Rd.
Stillheart Trails
Figure 1.1 - La Honda Forest Project Site
State Highway
Paved Road
Dirt Road
Unmaintained Dirt Roads
Hiking Trail
Perennial Streams
Intermittent Streams
Project Border
Preserve Border
Gates
Locked
Open
Unknown
Projection: NAD 1983, State Plane California III FIPS 0403, Feet
Regional Location
San Francisco
La Honda Forest

ATTACHMENT 1



This statement establishes the context for the District's forest management goal:

Goal FM: Manage District land to retain and promote biologically diverse, dynamic forest conditions; maintain and enhance high quality forest and aquatic habitat; encourage and enhance the development of late-seral conifer forest; provide for visitor experiences within diverse forest habitat; and promote District and regional fire management objectives.

Several of the policies and implementing programs that flow from Goal FM are directly relevant to the Plan, as shown in Table 1-1.

Table 1-1
Relevant Forest Management Policies and Implementing Programs

Policy	Implementing Programs
Policy FM-1 Inventory and assess District forest and woodland.	• Inventory and assess existing District forest conditions. Inventories within hardwood stands should include forest age, structure, health, and an evaluation of regeneration (growth of seedlings and young trees). Inventories within conifer stands should have a particular emphasis on forest age and structural characteristics, identification of biological legacies, and the reconnection and restoration of late-seral habitat. Inventories should also include the identification and assessment of any effects of urbanization on the forests. • Inventory District forest to assess fuel loads and forest structure related to fire. Identify access issues and District and community/regional fire concerns.
Policy FM-2 Ensure that forest management activities are compatible with the protection of special status plant and animal species.	• Manage forests to expand critical habitat for sensitive species by restoring forest structure and habitat elements utilized by sensitive species to develop and connect suitable habitat.
Policy FM-3 Ensure that forest management activities are compatible with riparian ecosystem and water resources protection and policies.	• Protect riparian ecosystems and habitat to maintain natural hydrologic process, water quality, and wildlife benefits. Maintain essential riparian functions, and if necessary enhance and restore riparian habitats. • Inventory and assess roads and trails on District forestlands to identify significant erosion and sediment sources. Maintain essential roads to high standards, and eliminate or reduce to trail width all non-essential roads. • Discourage forest management activities within riparian areas unless justified and implemented for the specific purpose of restoring degraded riparian habitat.
Policy FM-4 Manage District conifer forests to sustain and encourage the development of late-seral habitat conditions.	• Prepare Forest Management Plans for high priority District forests to establish habitat goals and appropriate management treatments. Utilize restoration ecologists, forest ecologists, Registered Professional Foresters, or other resource management professionals to prepare plans, as appropriate. • Restore degraded forest habitats to promote the development of late seral habitat, forest habitat complexity, and to enhance biodiversity, where existing stand conditions and access permit. Utilize state of the art silvicultural (forestry) practices to restore degraded forests. • Protect existing residual old growth trees and stands, mature oaks, and most large, older Douglas-fir trees. The conservation of these areas will take precedence over other uses and management practices that are determined to have an adverse effect on these resources. • Maintain and/or create large snags and downed wood for wildlife habitat where not a safety hazard.

Policy	Implementing Programs
	• Foster relationships with educational institutions, forest scientists and forest professionals to inform District forest management decisions based upon sound, current science, and to contribute opportunities for continuing research of late-seral focused management. Seek grant opportunities and partnerships for forest research and monitoring.
Policy FM-5 Provide necessary fire and fuel management practices to protect forest resources and public health and safety. (See WF policies)	• Maintain essential roads for emergency fire access, and forest management activities undertaken to reduce fire hazard. • Evaluate the potential to reduce forest fuel loading through the removal of smaller trees to reduce forest floor fuel buildup and ladder fuels. • Coordinate with fire agencies and local communities to define locations where fire protection infrastructure is desirable and practical. • Reintroduce fire as a resource management tool to reduce forest floor fuels and reestablish fire for ecosystem health where stand conditions, access, and public safety permit. Coordinate with other agencies for planning and implementation.
Policy FM-6 Protect forest health from intense wildfire, pests, and pathogens with high potential to cause damage.	• Evaluate potential for forest loss to intense wildfire, pests and pathogens where effective methods are available and justified. • Limit the scale of clearings and light-gaps in forests to reduce potential for weed establishment. Where activities occur within the forest edges, weed treatments and monitoring will be a component of the treatment plan. • Manage forest diseases when necessary to protect natural biological diversity and critical ecosystem functions. Regarding Sudden Oak Death (SOD): detect, report and monitor infested areas; utilize sanitation and best management practices (BMPs) to control the spread of the SOD pathogen; train staff and educate the public; and support SOD research to guide land management decisions.
Policy WF-4 Manage District vegetation communities to reduce the risk of catastrophic fire and to maintain biological diversity.	• Promote the restoration and development of late-seral forest communities. • Evaluate the potential to reduce forest fuel loading through the removal of smaller trees to reduce forest floor fuel buildup and ladder fuels. • Continue to utilize and expand the District's conservation grazing program to reduce grassland fuels, brush encroachment, and encourage the vigor of native grass and forb species. • Manage forest diseases such as Sudden Oak Death (SOD). • Manage scrub, shrub, and chaparral communities to maintain a mosaic of ages and species within strategic management corridors on roads, ridgetops, and near residential development or other critical infrastructure to compartmentalize preserves and reduce fuel loads.

Source: MROSD, 2021

In addition to Goal FM, the District's goal for wildland fire management (Section XV of the Resource Management Policies) is central to the Plan:

Goal WF: Manage District land to reduce the severity of wildland fire and to reduce the impact of fire suppression activities within District Preserves and adjacent residential areas; manage habitats to support fire as a natural occurrence on the landscape; and promote District and regional fire management objectives.

Policy WF-4 and its implementing programs, shown in Table 1-1, pertain directly to the Plan.

Report Organization

The Plan is organized as follows:

Chapter 1, Introduction, introduces the approach to planning forest management, and describes how the Plan relates to District polices and plans.

Chapter 2, Forest Inventory, presents the results of a forest inventory (or timber cruise) of the La Honda Forest performed in 2020. The inventory is an essential planning tool for forest management. It categorizes the forest into “stand types,” which are distinct combinations of age structure, species composition, and canopy density. Stand types are mapped and statistics are developed for each, including the volume, density, and size distribution of standing trees in the forest. The inventory also estimates forest growth rates, carbon sequestration, and fuel loading.

Chapter 3, Context for Management Planning, includes a land use history of the La Honda Forest, focusing on the history of logging from the clearcut of the late 19th and early 20th century, to the District’s acquisition of the land in the 1980s. The parcels that make up the La Honda Forest were in multiple ownerships, and the discussion in this chapter attempts to explain the variation in current conditions based on what can be reconstructed of the different management history of the forests within each. Chapter 3 also includes a discussion of the factors that shape or constrain approaches to silvicultural forest restoration within the La Honda Forest. Restoration treatment regimes, wildfire hazard, climate change considerations, and watershed restoration objectives are addressed.

Chapter 4, Recommendations for Forest Restoration and Management, discusses current conditions in the La Honda Forest, focusing on legacies of past management that inhibit the ability of the Forest to regain old growth character, and provides options for silvicultural restoration treatments. This chapter provides separate discussions of distinct areas of the La Honda Forest that share a common management history, or that are botanically distinct. For each defined area, restoration options consistent with the District’s Resource Management goals and policies are provided. Also included is a discussion of an approach to a monitoring and adaptive management program.

Appendices

The Plan includes several appendices:

Appendix A: Haul Road Sediment Source Inventory

This report summarizes the findings of a road erosion inventory of a 1.7-mile-long abandoned logging road located on the east side of La Honda Creek OSP in the Conservation Management Unit area (Figure 1-1). This 1960’s era road is in poor condition and actively eroding with multiple washouts, diverted watercourses, and slope failures that both prevent access and which are currently delivering sediment to La Honda Creek.

Appendix B: Forest Inventory Methodology

Contains a description of the field methods used in completing the forest inventory.

Appendix C: Forest Inventory Results

C1 Stand Tables
Compiled data from the inventory

C2 Fuels Data
Plot-based measurements of large woody debris and other indicators of fuel loading.

C2 Carbon Calculations
Spreadsheet containing calculations of sequestered carbon within the forest.

Appendix D: Cost Estimates

Preliminary estimates of the cost of plan implementation.

References

Ecoadapt, 2020a. Climate Change Vulnerability Assessment for the Santa Cruz Mountains Climate Adaptation Project: Coastal Redwood Forest. Draft. Joint project of Midpeninsula Regional Open Space District, the Santa Cruz Mountains Stewardship Network, and Pepperwood Preserve.

______ 2020b. Climate Change Vulnerability Assessment for the Santa Cruz Mountains Climate Adaptation Project: Mixed Evergreen/Montane Hardwood Forests. Draft. Joint project of Midpeninsula Regional Open Space District, the Santa Cruz Mountains Stewardship Network, and Pepperwood Preserve.

Midpeninsula Regional Open Space District (MROSD), 2012. La Honda Creek Open Space Preserve Master Plan. Final, August 2012.

______2014. Vision Plan: Imagine the Future of Open Space.

______ 2019. Request for Proposals for Forest Assessment and Management Planning services for the La Honda Forest portion of the La Honda Creek Open Space Preserve. April 18, 2019.

______ 2021a. Wildland Fire Resiliency Program. Draft, January 2021.

______ 2021b. Resource Management Policies. February 2021.

CHAPTER 2
Forest Inventory

This chapter presents the results of an inventory of the La Honda Forest conducted in the spring and summer of 2020 by Buena Vista Services, LLC. The inventory, or "timber cruise," was designed to obtain information regarding conifer and hardwood forests, with a focus on age structure, species composition, growth rates, and regeneration. Fuels were also measured to support an assessment of the risk of catastrophic wildfire as well as risk to carbon stocks, and to inform application of management tools such as prescribed burning or other fuel reduction techniques.

Project Area

The La Honda Creek Open Space Preserve is approximately 6,100 acres. The project area – the La Honda Forest – covers approximately 1,772 acres. As a first step in planning the inventory, the forested area was stratified into conifer, hardwood, and non-forest cover types, as shown in Figure 2-1, Preliminary Cover Classes and Table 2-1, Preliminary Stratification. As shown in Table 2-1, about 1,210 acres are forested, including about 968 acres of conifer forest and 242 acres of hardwood forest. About 563 acres are unforested, consisting of grassland, brush, and ponds.[1]

The Forest was divided administratively, as shown in Table 2-2, Administrative Divisions, to include separate characterization of two areas of particular interest for this Plan: the Harmon Parcel, and the Conservation Management Unit (CMU); see location of these areas in Figure 2-1.

Methods

The inventory used a sampling method based on fixed radius, 1/5-acre circular plots (52.7' radius) for measurement of larger trees, and with 1/50-acre (16.65' radius) nested subplots for sampling of smaller trees. Plot centers were monumented and numbered, to enable future resampling. Please see Appendix B for details of field methods and measurements.

A preliminary vegetation typing of the inventory area was done using recent orthoimagery, historic maps and photos, and several field visits. Plot locations were randomly distributed in both hardwood types and conifer types, with a lower intensity applied to hardwoods. There were a total of 153 plots, representing approximately 2% of the hardwood area, and 4% of the conifer area (Figure 2-2, Sample Plot Locations). This intensity has been used in forest inventories throughout the Santa Cruz Mountains and generally returns a population estimate standard error term of 5% or lower for gross volume. The results of the La Honda Forest inventory have a standard error term of 4.1% for conifer gross volume (Appendix C1).

[1] All acreages are derived from GIS mapping.

ATTACHMENT 1

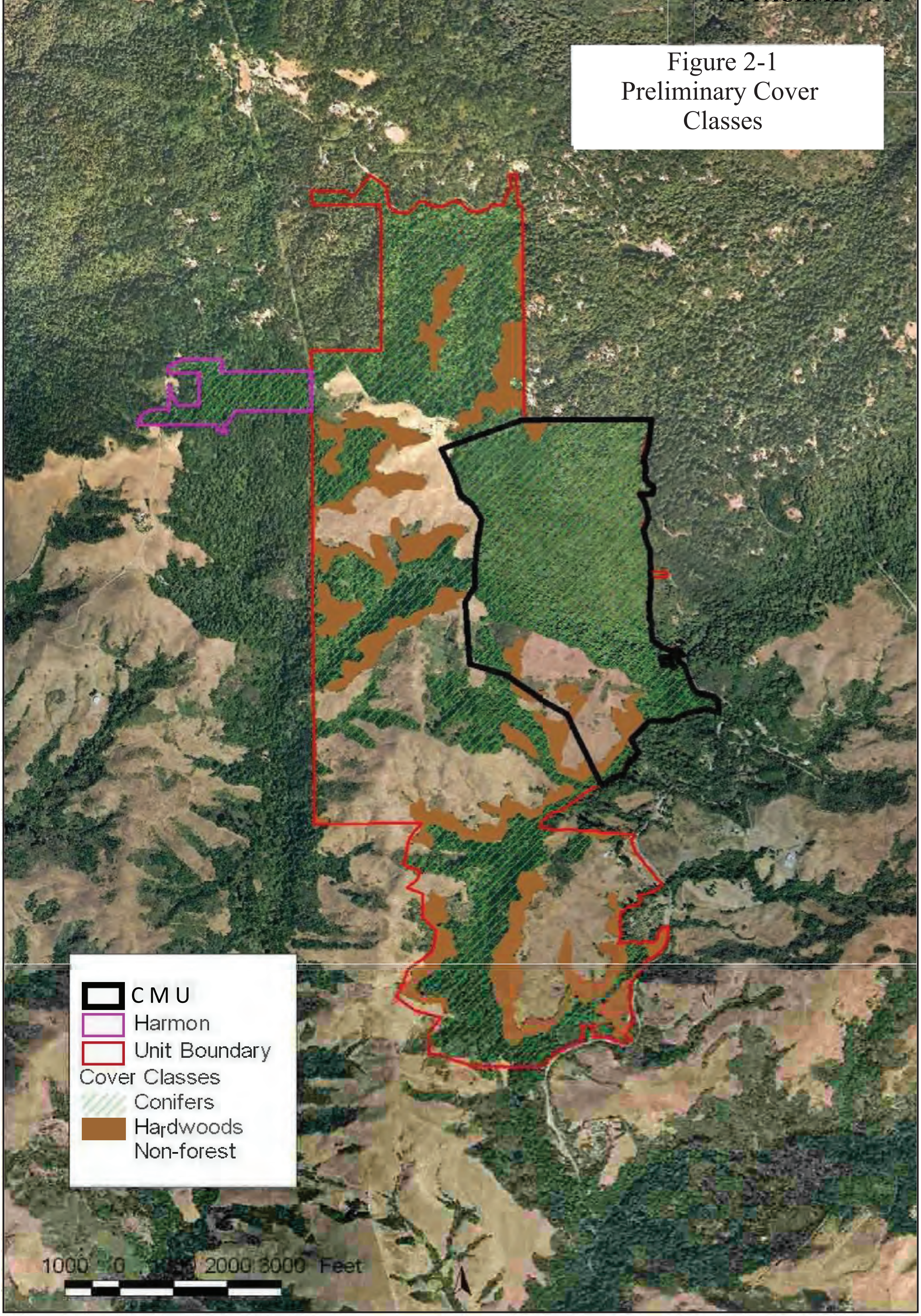


Figure 2-1
Preliminary Cover
Classes

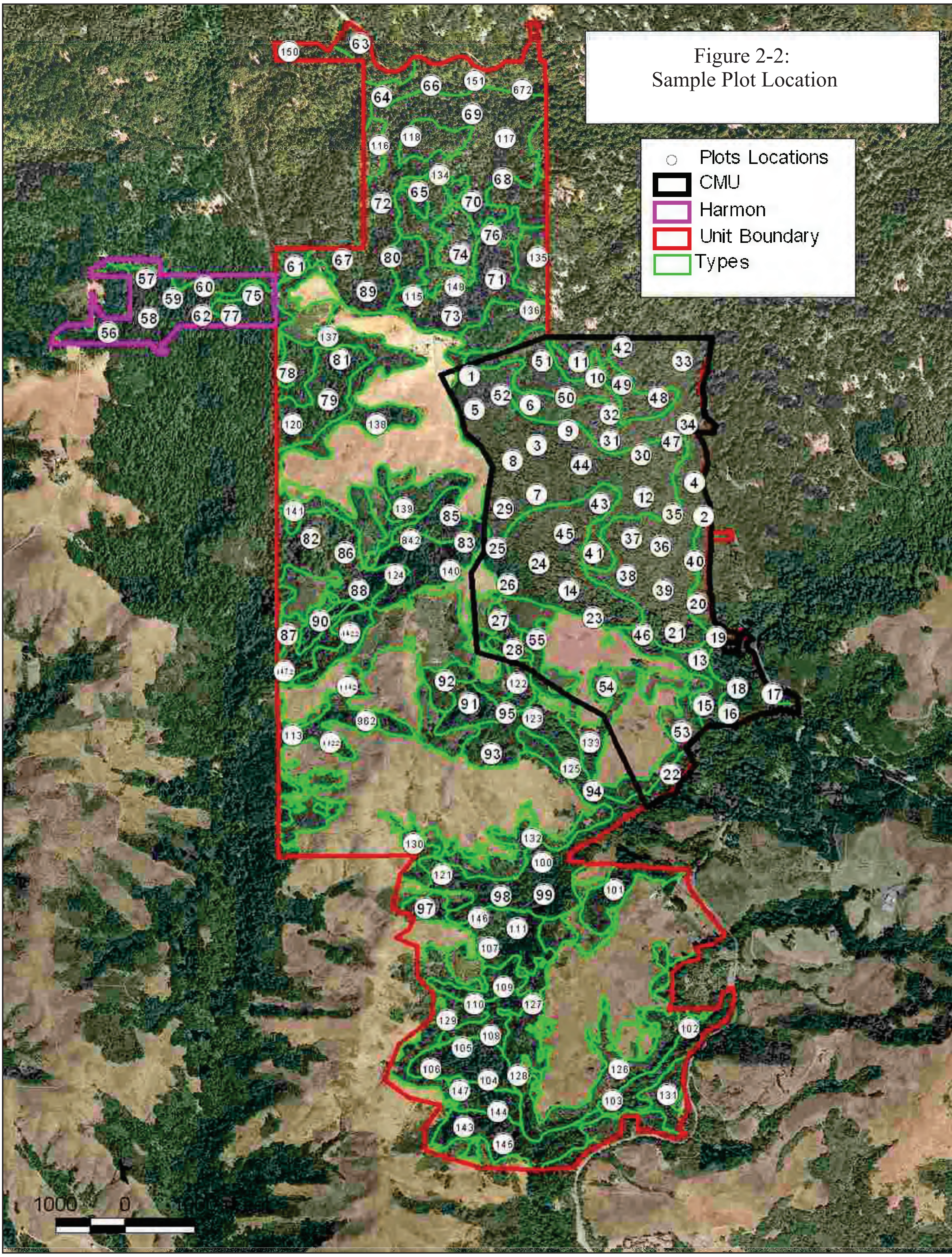


Figure 2-2:
Sample Plot Location
Plots Locations
CMU
Harmon
Unit Boundary
Types
1000
0

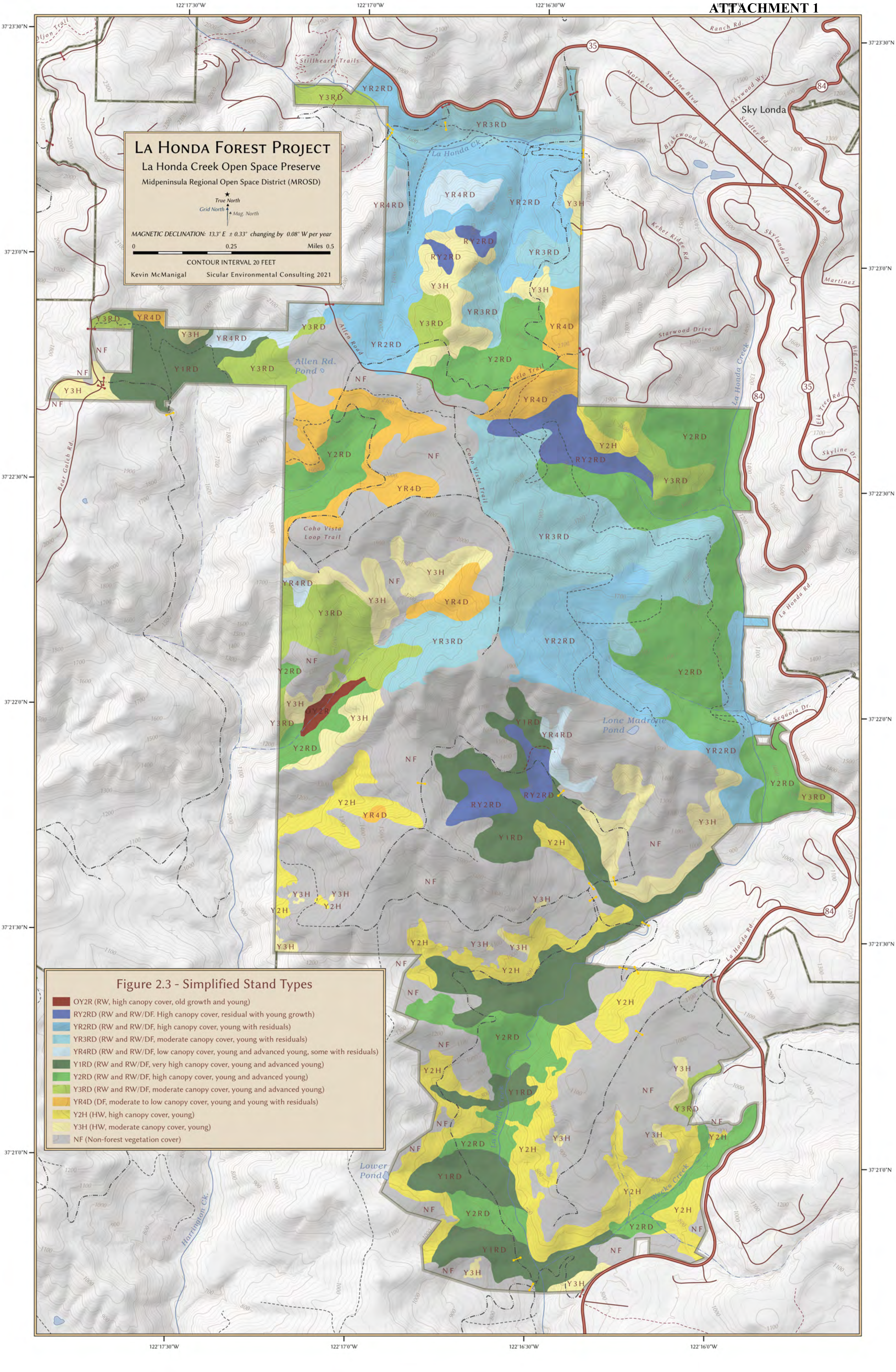

La Honda Forest Project
La Honda Creek Open Space Preserve
Midpeninsula Regional Open Space District (MROSD)
True North
Grid North
Mag. North
MAGNETIC DECLINATION: 13.3° E ± 0.33° changing by 0.08° W per year
0
0.25
Miles 0.5
CONTOUR INTERVAL 20 FEET
Kevin McManigal
Sicular Environmental Consulting 2021
Figure 2.3 - Simplified Stand Types
OY2R (RW, high canopy cover, old growth and young)
RY2RD (RW and RW/DF. High canopy cover, residual with young growth)
YR2RD (RW and RW/DF, high canopy cover, young with residuals)
YR3RD (RW and RW/DF, moderate canopy cover, young with residuals)
YR4RD (RW and RW/DF, low canopy cover, young and advanced young, some with residuals)
Y1RD (RW and RW/DF, very high canopy cover, young and advanced young)
Y2RD (RW and RW/DF, high canopy cover, young and advanced young)
Y3RD (RW and RW/DF, moderate canopy cover, young and advanced young)
YR4D (DF, moderate to low canopy cover, young and young with residuals)
Y2H (HW, high canopy cover, young)
Y3H (HW, moderate canopy cover, young)
NF (Non-forest vegetation cover)
122°17'30"W
122°17'0"W
122°16'30"W
122°16'0"W
37°23'30"N
37°23'0"N
37°22'30"N
37°22'0"N
37°21'30"N
37°21'0"N
Sky Londa
Skyline Blvd.
La Honda Rd.
La Honda Ck.
La Honda Creek
Allen Road
Allen Rd. Pond
Coho Vista Trail
Coho Vista Loop Trail
Cielo Trail
Stillheart Trails
Lone Madrone Pond
Lower Pond
Harrington Ck.
Weeks Creek
Bear Gulch Rd.
Morse Ln.
Skywood Wy.
Stadler Rd.
Blakewood Wy.
Kebet Ridge Rd.
Skylonda Dr.
Starwood Drive
Sequoia Dr.
Elk Tree Rd.
Big Tree Wy.
Skyline Dr.
Martinez
Ranch Rd.
35
84

Table 2-1
Preliminary Stratification

Conifer/conifer dominated forest	968 acres
Hardwood dominated forest	242
Brush/Grass/Non-Forested	563
Total	1,772

Table 2-2
Administrative Divisions

Harmon Parcel	
Conifer/conifer dominated forest	44 acres
Hardwood dominated forest	7
Brush/Grass/Non-Forested	1
Subtotal	52
Conservation Management Unit (CMU)	
Conifer/conifer dominated forest	348
Hardwood dominated forest	21
Brush/Grass/Non-Forested	69
Subtotal	439
Remainder	
Conifer/conifer dominated forest	576
Hardwood dominated forest	214
Brush/Grass/Non-Forested	492
Subtotal	1,282

Post-Stratification and Simplification of Forest Stand Types

After the field measurements were completed, the forest typing was refined. The goal of this post-stratification exercise was to aggregate similar types with similar characteristics to drive down the coefficient of variation within each type. This is done carefully so that important differences are not lost, and so that the inherent variability found naturally within types is preserved.

Using orthoimage sources of different scales and sun angle, combined with field notes and plot data, the project area was further stratified into distinct cover types. The area of each stratum was determined to allow expansion of the tree data (from the means derived from the plot data to the total for each stratum) and estimate error terms. 32 forest strata, or “stand types” were delineated, each representing a distinct combination of age structure, species composition, and canopy density. To reduce this to a number practical for planning purposes, while still retaining the critical distinctions between types, similar types were then combined. The final set of 11 stand types is shown in Figure 2-3, Simplified Stand Types. The eleven final stand types, their acreage, a description, and their component types from the initial post-stratification, are shown in Table 2-3. Acreage of the stand types that occur within each administrative area is shown in Table 2-4.

The stand type labeling system combines age structure, canopy density, and predominant over-story species, in that order, using the following terms:

AGE STRUCTURE	CANOPY DENSITY	PREDOMINANT SPECIES
Y – Young growth	**1 - 70-100%**	**R – Redwood**
YY – Large second growth	**2 - 50-70%**	**D - Douglas-fir**
R – Residual old growth	**3 - 30-50%**	**H – Hardwood**
O - Old growth	**4 - 10-30%**	**B – Shrub**
	5 - <10%	**G – Grassland**

The first one or two letters indicate the age structure, with the first letter indicating the predominant age class. The number which follows indicates canopy density. The final one or two letters indicate predominant species, with the first letter indicating the more prevalent species. For example, stand type YR2RD = Young growth with some residual old growth age structure; 50-70% canopy density; Redwood/Douglas-fir mix (redwood predominant).

Table 2-3
Stand Type Simplification

Simplified Stand Type	Acres	Description	Specific Stand Types Included	Acres
OY2R	4	Old growth and young growth, high canopy cover, redwood	OY2R	4.1
RY2RD	41	Residual old growth with young growth, high canopy cover, redwood and redwood/Douglas-fir	RY1R	9.4
			RY2R	6.7
			RY2RD	20.3
			RY3RD	5.0
YR2RD	174	Young growth with residual old growth, high canopy cover, redwood and redwood/Douglas-fir	YR2R	85.1
			YR2RD	89.1
YR3RD	169	Young growth with residual old growth, moderate canopy cover, redwood and redwood/Douglas-fir	YR3DR	23.6
			YR3R	10.5
			YR3RD	134.8
YR4RD	31	young growth and advanced young growth, some with residual old growth, low canopy cover, redwood and redwood/Douglas-fir	YY4RD	8.3
			YR4R	14.7
			RY4RD	5.9
			Y5RD	1.9
Y1RD	159	Young growth and advanced young growth, very high canopy cover, redwood and redwood/Douglas-fir	Y1R	7.9
			Y1RD	124.2
			YY1R	27.1
Y2RD	242	Young growth and advanced young growth, high canopy cover, redwood and redwood/Douglas-fir	Y2R	43.6
			Y2RD	90.4
			YY2R	108
Y3RD	79	Young growth and advanced young growth, moderate canopy cover, redwood and redwood/Douglas-fir	Y3DR	12.2
			Y3R	3.1
			Y3RD	61.9
			YY3R	1.3

Simplified Stand Type	Acres	Description	Specific Stand Types Included	Acres
YR4D	69	Young growth and young growth with residual old growth, moderate to low canopy cover, Douglas-fir	Y3D	10.9
			Y4D	15.0
			YR4D	42.7
Y2H	137	Young growth, high canopy cover, hardwoods	Y1H	50.1
			Y2H	86.6
Y3H	105	Young growth, moderate canopy cover, hardwoods	Y3H	43.2
			Y4H	61.8
NF	562	Non-forest vegetation cover	GRASSLAND	413.7
			SHRUB	148.1

Table 2-4
Simplified Stand Types within each Administrative Area (acres)

Stand Type	Harmon Parcel	CMU	Remainder
OY2R			4
RY2RD		19	22
YR2RD		77	98
YR3RD		96	73
YR4RD	5	4	22
Y1RD	27	11	121
Y2RD		124	118
Y3RD	11	17	50
YR4D	1		67
Y2H		5	132
Y3H	7	16	82
NF	1	69	492
Total	52	439	1,282

Results

This section presents the results of the inventory, and provides summary statistics for each stand type and administrative area.

Site Classification, Basal Area, and Growth Rate

Site classification is an indicator of the growing conditions for a tree species in a given location, and is generally reflective of soil conditions (including moisture availability), aspect, elevation, terrain, and climate. The site index value is equivalent to the potential height to which a tree can grow in that location over a set time period, usually 50 or 100 years. Index values are grouped into classifications (I-V, with I highest quality site), to provide a general point of comparison between locations. Site classes and corresponding index values are shown for redwood and Douglas-fir *(Pseudotsuga menziesii)* in Table 2-5.

Based on field measurements of recent growth and stand characteristics, site class for each stand type is shown in Table 2-6.

Table 2-5
Timber Site Classification

Site Class	Young Growth Redwood: Height in Feet @ 100 years	Douglas-fir: Height in Feet @ 100 years
I	*180 or more*	*194 or more*
II	*155-179*	*164-193*
III	*130-154*	*134-163*
IV	*105-129*	*103-133*
V	*Less than 105*	*Less than 103*

Sources: Lindquist and Palley, 1963; McArdle and Meyer, 1961.

Table 2-6
Basal Area and Growth Rate, by Stand Type

Stand Type	Basal Area, Conifers (SqFt/Acre)	Basal Area Growth Rate - Redwoods (%/Year)	Basal Area Growth Rate – Douglas-fir (%/Year)	Site Class
OY2R	1,091	2%	NA	III
RY2RD	368	7%	7%	III
YR2RD	216	8%	NA	III
YR3RD	210	11%	10%	II
YR4RD	107	9%	7%	III
Y1RD	346	7%	NA	II
Y2RD	357	8%	10%	II
Y3RD	189	9%	8%	III
YR4D	98	9%	7%	III
Y2H	1	N/A	N/A	N/A
Y3H	34	N/A	N/A	N/A

Table 2-6 also shows basal area and basal area growth rates. Basal area is based on measurements of tree diameter at breast height (DBH), and is the sum of the cross-sectional area of the trees within a unit of land, expressed here as square feet per acre. Basal area growth rates shown in Table 2-6 were estimated using increment cores on a subset of trees within the sample plots. As shown in the table, basal area growth rates are robust, with redwood in most of the stand types growing at a rate of 7-11 percent per year. Note the lower growth rate for the old growth stand type (type OY2R), which is typical for old growth forests: while the growth rate is low, the annual increment of increased volume is great, since the starting point is so large.

Volume

Table 2-7 shows volume of standing trees by stand type, expressed as thousands of board feet per acre (MBF/acre)[2] for conifers and cubic feet per acre (CuFt/acre) for hardwoods. For conifers, both gross volume and net volume is shown. Merchantable volume is the volume of wood that can be sold as

[2] A board foot is a volume measurement for trees and lumber equivalent to a board 1” thick, 12” wide, and 1’ long.

lumber. Gross volume includes the unmerchantable component, consisting of "cull logs" and "defect." As shown in the table, conifer gross volume within the stands where redwood is the dominant species range from a high of 233,000 board feet per acre (233 MBF/acre) in the 4-acres of the old growth stand type OY2R (Old growth and young growth, high canopy density, redwood), to a low of 23,000 board feet per acre in type YR4RD (young growth with residual old growth, low canopy cover, redwood and redwood/Douglas-fir). Hardwood volumes also vary considerably between stand types.

Total gross volume of conifers for all forested acres in the La Honda Forest is estimated at 62,393,000 board feet, averaging 52,000 board feet per acre gross, and 47,000 board feet per acre net. Total gross volume of hardwoods is 1,588,575 cubic feet, averaging 1,313 cubic feet per acre.

Table 2-8 shows conifer and hardwood volume estimates for the CMU and for the Harmon Parcel. The CMU is stocked at an average of 64 MBF/acre gross conifer volume per forested acre (58 MBF net), the Harmon parcel at 54 MBF/acre gross (49 MBF net).

Table 2-7
Wood Volume by Stand Type

Stand Type	Acres	Conifer Net Volume (MBF/Acre)	Conifer Gross Volume (MBF/Acre)	Hardwood Gross Volume (CuFt/Acre)	Total Net Conifer Volume (MBF)	Total Gross Conifer Volume (MBF)	Total Gross Hardwood Volume (CuFt)
OY2R	4.1	215	233	0	884	958	-
RY2RD	41.4	93	99	2,190	3,848	4,097	90,622
YR2RD	174.4	53	58	1,400	9,243	10,115	244,146
YR3RD	169.0	44	49	1,200	7,435	8,280	202,776
YR4RD	30.8	20	23	3,190	617	709	98,348
Y1RD	159.2	73	78	840	11,624	12,420	133,753
Y2RD	242.0	81	88	610	19,598	21,292	147,590
Y3RD	78.5	32	36	1,600	2,513	2,827	125,632
YR4D	68.7	12	14	850	825	962	58,404
Y2H	136.7	0	0	1,990	-	-	271,993
Y3H	105.0	6	7	2,050	630	735	215,312
TOTAL	1,209.8				57,215	62,393	1,588,575
Average per Acre		47	52	1,313			

Table 2-8
Wood Volume by Administrative Area

Unit	Forested Acres	Conifer Net Volume (MBF)	Conifer Gross Volume (MBF)	Conifer Net Vol/Acre (MBF)	Conifer Gross Vol/Acre (MBF)	Hardwood Volume (Gross CuFt)	Hardwood Vol/Acre (Gross CuFt)
CMU	370	21,480	23,615	58	64	453,300	1,225
Harmon Parcel	50	2,448	2,680	49	54	72,905	1,458

Dead and Down Material

Table 2-9 provides a measure of dead and down material in the forest. Pieces inside the inventory plots were measured (Appendix C-2) and those numbers expanded to per acre cubic volumes. Typically, the distribution of dead and down material is highly variable and not always well-correlated with other metrics; this was found to be true within the La Honda Forest as well. The numbers indicate two things: (1) certain cover types have higher average dead and down wood volumes (e.g., types Y2RD and Y3RD) that are likely due to waves of Sudden Oak Death (SOD) and natural understory mortality and tree falls; and (2), levels of down materials vary widely from plot to plot within cover types (e.g., type Y3RD has plots with zero material and plots with over 3,600 cubic feet per acre). Nonetheless, these volumes are present and should be addressed where they represent wildfire concerns in the planning. As part of the down material assessment, a USDA photo series for "forest residue" was consulted and calls were made in the field to match the photo series (Maxwell and Ward, 1980). These calls were generally more consistent (less variable) than the measured data was across the stands. The forest residue calls for each plot are included in Appendix C-2.

Tree Size

Table 2-10 shows, for each stand type, the number of conifers per acre by size category, expressed as diameter at breast height (DBH) for all trees over 2 inches. Of particular interest is the number of trees in the larger size categories. All of the stand types with redwood as one of the dominant species have a substantial number of larger trees over 36 inches DBH. Table 2-11 shows tree size distribution for hardwoods. Tree size distribution for conifers and hardwoods over 11" DBH, for each stand type, is shown graphically in Figures 2-4.1 through 2-4.11. Please note that the charts use the same colors for each stand type as Figure 2-3.

Table 2-12 provides, for each stand type, the average basal area of conifers by size category, expressed as square feet of basal area per acre. This table shows that most of the conifer basal area in most stand types is accounted for by larger trees. Table 2-13 shows the basal area of hardwoods by size category for each stand type.

Table 2-14 provides details on the tree size distribution of individual species of conifers and hardwoods. This table shows the number of trees, by size category, for each species, for each stand type.

Table 2-9
Dead and Down Woody Material Volume by Stand Type

Stand Type	CuFt/Acre	Range
OY2R	234	NA
RY2RD	169	64-347
YR2RD	180	0-430
YR3RD	571	0-2,139
YR4RD	236	0-1,039
Y1RD	276	0-1,021
Y2RD	608	0-1,654
Y3RD	741	0-3,366
YR4D	429	0-858
Y2H	0	NA
Y3H	348	0-994

Table 2-10
Conifer Size Distribution by Stand Type
(DBH 2" classes, average trees per Acre)

				Size	Class	(DBH)				
Stand Type	**2-10"**	**12-16"**	**18-22"**	**24-28"**	**30-34"**	**36-40"**	**42-46"**	**48-58"**	**60+ "**	**TOTAL**
OY2R	200	–	5	–	5	–	5	20	15	250
RY2RD	50	12	14	9	9	13	7	3	1	118
YR2RD	54	14	5	3	6	6	5	3	–	96
YR3RD	88	10	9	9	5	9	2	1	<1	133
YR4RD	29	3	4	4	4	2	2	1	<1	49
Y1RD	148	14	14	11	9	8	5	4	1	214
Y2RD	104	17	12	12	11	10	6	4	<1	175
Y3RD	47	12	12	16	4	2	1	2	<1	95
YR4D	70	11	13	4	–	1	1	1	–	101
Y2H	5	–	1	–	–	–	–	–	–	6
Y3H	6	1	1	1	2	1	–	–	1	12

Table 2-11
Hardwood Size Distribution by Stand Type (DBH 2" classes, average trees per Acre)

				Size	Class	(DBH)				
Stand Type	**2-10"**	**12-16"**	**18-22"**	**24-28"**	**30-34"**	**36-40"**	**42-46"**	**48-58"**	**60+"**	**TOTAL**
OY2R	–	–	–	–	–	–	–	–	–	0
RY2RD	14	16	13	4	–	–	–	–	–	48
YR2RD	123	10	5	2	–	–	–	–	–	140
YR3RD	66	11	7	1	<1	–	–	–	–	85
YR4RD	109	31	14	5	1	–	–	–	–	160
Y1RD	39	5	2	1	2	–	–	–	–	49
Y2RD	75	4	2	1	<1	–	–	–	–	83
Y3RD	106	9	6	6	2	–	–	–	–	128
YR4D	130	14	7	2	–	–	–	–	–	153
Y2H	145	15	15	5	1	1	1	–	–	180
Y3H	40	21	9	7	1	–	–	–	–	77

Table 2-12
Basal Area by Tree Size - Conifers ≥4" DBH (SqFt/Acre)

				Size	Class	(DBH)				
Stand Type	**4-10"**	**12-16"**	**18-22"**	**24-28"**	**30-34"**	**36-40"**	**42-46"**	**48-58"**	**60+"**	**TOTAL**
OY2R	67	–	11	–	28	–	48	348	589	1,091
RY2RD	7	14	30	34	54	103	75	37	14	368
YR2RD	8	16	11	11	33	49	51	36	–	216
YR3RD	13	11	20	32	26	72	18	11	6	210
YR4RD	5	4	7	14	20	17	16	13	12	107
Y1RD	9	16	30	40	48	63	51	65	25	346
Y2RD	13	18	27	43	61	75	59	57	3	357
Y3RD	14	13	25	57	23	15	13	23	6	189
YR4D	11	14	29	15	–	7	10	13	–	98
Y2H	0	–	1	–	–	–	–	–	–	1
Y3H	–	1	2	2	13	4	–	–	12	34

Table 2-13
Basal Area by Tree Size – Hardwoods ≥4" DBH (SqFt/Acre)

				Size	Class	(DBH)				
Stand Type	**4-10"**	**12-16"**	**18-22"**	**24-28"**	**30-34"**	**36-40"**	**42-46"**	**48-58"**	**60+ "**	**TOTAL**
OY2R										0
RY2RD	8	19	27	15	–	–	–	–	–	69
YR2RD	19	12	9	7	–	–	–	–	–	46
YR3RD	13	11	13	5	3	–	–	–	–	45
YR4RD	21	35	27	20	7	–	–	–	–	109
Y1RD	9	5	3	3	9	–	–	–	–	30
Y2RD	11	4	5	4	1	–	–	–	–	25
Y3RD	19	10	13	20	8	–	–	–	–	69
YR4D	17	16	15	7	–	–	–	–	–	56
Y2H	26	14	33	15	2	4	5	–	–	99
Y3H	6	21	19	24	5	–	–	–	–	75

Table 2-14
Tree Size Distribution for All Species for All Stand Types

Stand Type OY2R					**Size Class**					
Species	**2-10”**	**12-16"**	**18-22"**	**24-28"**	**30-34"**	**36-40"**	**42-46"**	**48-58"**	**60+"**	**TOTAL**
Redwood	200	–	5	–	5	–	5	15	15	245
Douglas-fir										
Other Conifer										
Tanoak										
Live Oak										
Madrone										
Bay										
Other Hardwood										

Stand Type RY2RD					**Size Class**					
	2-10”	**12-16"**	**18-22"**	**24-28"**	**30-34"**	**36-40"**	**42-46"**	**48-58"**	**60+"**	**TOTAL**
Redwood	50	11	14	9	9	12	6	2	1	114
Douglas-fir	–	1	–	1	1	1	1	1	–	4
Other Conifer	–									–
Tanoak	14	10	11	2	–	–	–	–	–	38
Live Oak	–	2	1	1	–	–	–	–	–	4
Madrone	–	3	1	1	–	–	–	–	–	4
Bay	–									–
Other Hardwood	–	–	–	1	–	–	–	–	–	1

Stand Type YR2RD					**Size Class**					
	2-10”	**12-16"**	**18-22"**	**24-28"**	**30-34"**	**36-40"**	**42-46"**	**48-58"**	**60+"**	**TOTAL**
Redwood	46	13	4	2	4	5	4	2	–	81
Douglas-fir	8	0	1	1	2	1	1	0	–	14
Other Conifer	–									–
Tanoak	108	7	4	2	–	–	–	–	–	121
Live Oak	–									–
Madrone	8	1	–	0	–	–	–	–	–	9
Bay	8	2	0	–	–	–	–	–	–	10
Other Hardwood	–									–

Table 2-14 (Continued)

Stand Type YR3RD					Size Class					
	2-10”	12-16"	18-22"	24-28"	30-34"	36-40"	42-46"	48-58"	60+"	TOTAL
Redwood	79	9	8	8	3	8	1	0	–	117
Douglas-fir	9	1	1	1	1	1	0	1	0	16
Other Conifer	–									–
Tanoak	55	7	4	0	0	–	–	–	–	67
Live Oak	–	0	1	0	–	–	–	–	–	1
Madrone	9	3	1	1	0	–	–	–	–	14
Bay	–	0	0	–	–	–	–	–	–	1
Other Hardwood										–

Stand Type YR4RD					Size Class					
	2-10”	12-16"	18-22"	24-28"	30-34"	36-40"	42-46"	48-58"	60+"	TOTAL
Redwood	21	2	3	3	2	2	1	0	0	33
Douglas-fir	8	1	1	1	2	0	1	–	–	15
Other Conifer	–									–
Tanoak	59	13	8	2	1	–	–	–	–	82
Live Oak	4	7	4	2	0	–	–	–	–	18
Madrone	42	10	2	2	–	–	–	–	–	55
Bay	4									4
Other Hardwood		0	–	–	–	–	–	–	–	0

Stand Type Y1RD					Size Class					
	2-10”	12-16"	18-22"	24-28"	30-34"	36-40"	42-46"	48-58"	60+"	TOTAL
Redwood	148	14	14	11	9	8	5	4	1	213
Douglas-fir	–	–	–	0	–	0	0	–	0	1
Other Conifer	–									–
Tanoak	17	1	0	0	1	–	–	–	–	20
Live Oak	–	1	–	–	–	–	–	–	–	1
Madrone	–	–	0	–	–	–	–	–	–	0
Bay	15	3	1	1	1	–	–	–	–	20
Other Hardwood		0	–	–	–	–	–	–	–	0

Stand Type Y2RD					Size Class					
	2-10”	12-16"	18-22"	24-28"	30-34"	36-40"	42-46"	48-58"	60+"	TOTAL
Redwood	96	16	12	10	10	9	5	4	–	162
Douglas-fir	8	1	0	1	1	0	0	–	0	13
Other Conifer	–									–
Tanoak	52	3	2	1	0	–	–	–	–	58
Live Oak	–	0	–	–	–	–	–	–	–	0
Madrone	1	0	0	0	–	–	–	–	–	2
Bay	13	0	0	0	–	–	–	–	–	14
Other Hardwood	7	–	–	–	–	–	–	–	–	7

Table 2-14 (Continued)

Stand Type Y3RD					Size Class					
	2-10"	12-16"	18-22"	24-28"	30-34"	36-40"	42-46"	48-58"	60+"	TOTAL
Redwood	31	10	8	13	3	2	1	1	–	67
Douglas-fir	16	3	4	3	2	0	0	0	0	28
Other Conifer	–									–
Tanoak	37	2	3	2	1	–	–	–	–	44
Live Oak	15	2	3	3	–	–	–	–	–	23
Madrone	9	1	0	1	1	–	–	–	–	12
Bay	29	4	–	–	–	–	–	–	–	32
Other Hardwood	16	1	–	0	0	–	–	–	–	17

Stand Type YR4D					Size Class					
	2-10"	12-16"	18-22"	24-28"	30-34"	36-40"	42-46"	48-58"	60+"	TOTAL
Redwood	–	1	4	1	–	1	–	–	–	7
Douglas-fir	70	10	9	3	–	–	1	1	–	94
Other Conifer	–									–
Tanoak	50	1	–	–	–	–	–	–	–	51
Live Oak	30	9	6	1	–	–	–	–	–	46
Madrone	20	2	1	1	–	–	–	–	–	24
Bay	30	2	–	–	–	–	–	–	–	32
Other Hardwood										–

Stand Type Y2H					Size Class					
	2-10"	12-16"	18-22"	24-28"	30-34"	36-40"	42-46"	48-58"	60+"	TOTAL
Redwood	–									–
Douglas-fir	–									–
Other Conifer	–									–
Tanoak	–									–
Live Oak	60	12	10	4	1	1	1	–	–	87
Madrone	–									–
Bay	40	2	5	1	–	–	–	–	–	47
Other Hardwood	45	1	–	–	–	–	–	–	–	46

Stand Type Y3H					Size Class					
	2-10"	12-16"	18-22"	24-28"	30-34"	36-40"	42-46"	48-58"	60+"	TOTAL
Redwood	–									–
Douglas-fir	6	–	1	–	1	–	–	–	1	8
Other Conifer	–	1	1	1	2	1	–	–	–	4
Tanoak	12	4	4	1	–	–	–	–	–	22
Live Oak	17	12	3	4	1	–	–	–	–	37
Madrone	–	2	1	1	–	–	–	–	–	4
Bay	12	1	1	1	1	–	–	–	–	14
Other Hardwood	–	1	–	–	–	–	–	–	–	1

Table 2-15 shows the quadratic mean diameter (QMD) for conifers greater than 11 inches for each stand type. In forestry, QMD is a measure of central tendency, which is considered more appropriate than arithmetic mean for characterizing the group of trees that have been measured. Compared to the arithmetic mean, QMD assigns greater weight to larger trees – QMD is always greater than or equal to arithmetic mean for a given set of trees. QMD is calculated as:

$$\sqrt{\frac{BA}{k*n}}$$

where BA is stand basal area, n is the number of trees, and k is a constant based on measurement units - for BA in square feet and DBH in inches, k=0.005454 (Curtis and Marshall, 2000). As shown in Table 2-15, the QMD of the old growth stand (stand type OY2R) is nearly twice that of any other type.

Carbon Sequestration

Based on current volume of standing live trees on the 1,210 forested acres of the La Honda Forest, and using a forest carbon calculator created by CAL FIRE (CAL FIRE, 2010), the estimated current volume of sequestered carbon is 439,185 metric tonnes of carbon dioxide equivalent ($MTCO_2e$), as shown in Table 2-16. Based on an estimated volume increase of 4% per year (assumed, based on typical volume growth rates in second growth forests in the Santa Cruz Mountains), the annual increment of carbon sequestered in the forest is 16,594 $MTCO_2e$ per year. These figures do not include carbon stored in dead and down material or in the soil.

Table 2-15
Quadratic Mean Diameter of Conifers >11" DBH

Stand Type	QMD
OY2R	61.3
RY2RD	31.1
YR2RD	30.2
YR3RD	28.4
YR4RD	31.0
Y1RD	30.5
Y2RD	29.7
Y3RD	25.7
YR4D	22.7
Y2H	18.0
Y3H	33.2

Table 2-16
Carbon Sequestration

	$MTCO_2e$/ acre	Total $MTCO_2e$
Current	363	439,230
Annual Increase	13.7	16,594

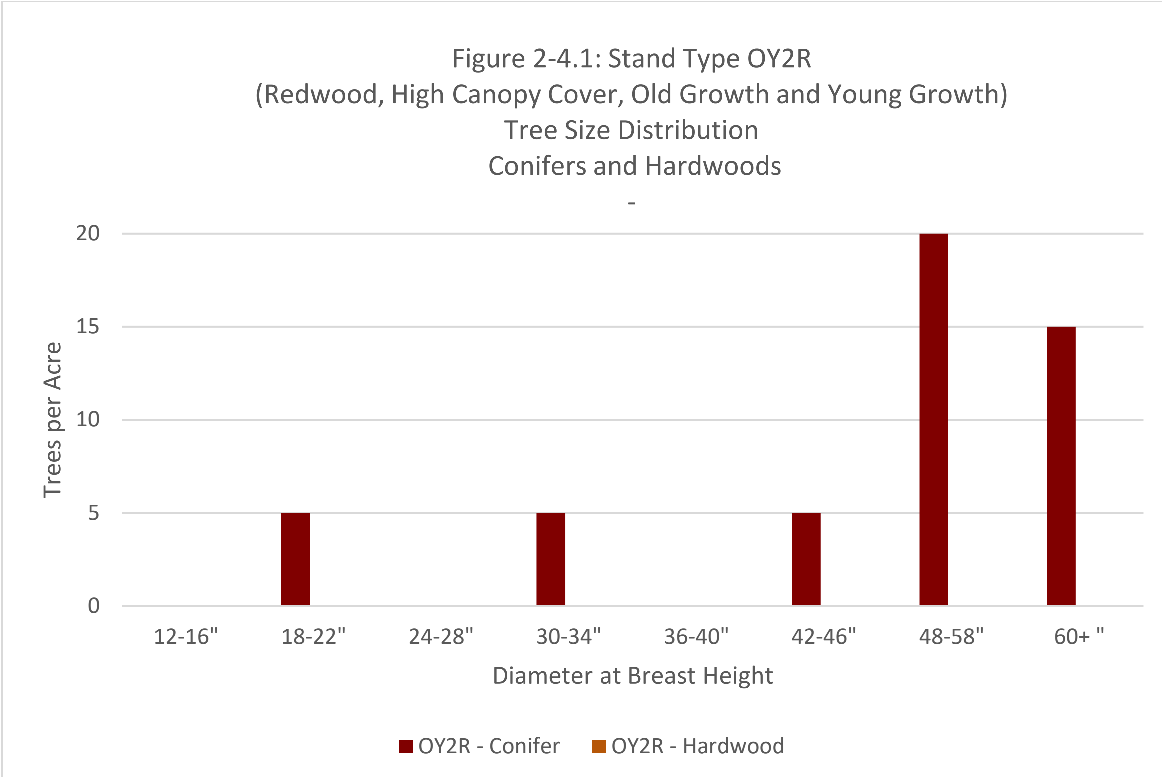


Figure 2-4.1: Stand Type OY2R
(Redwood, High Canopy Cover, Old Growth and Young Growth)
Tree Size Distribution
Conifers and Hardwoods
-
Trees per Acre
20
15
10
5
0
12-16"
18-22"
24-28"
30-34"
36-40"
42-46"
48-58"
60+ "
Diameter at Breast Height
OY2R - Conifer
OY2R - Hardwood

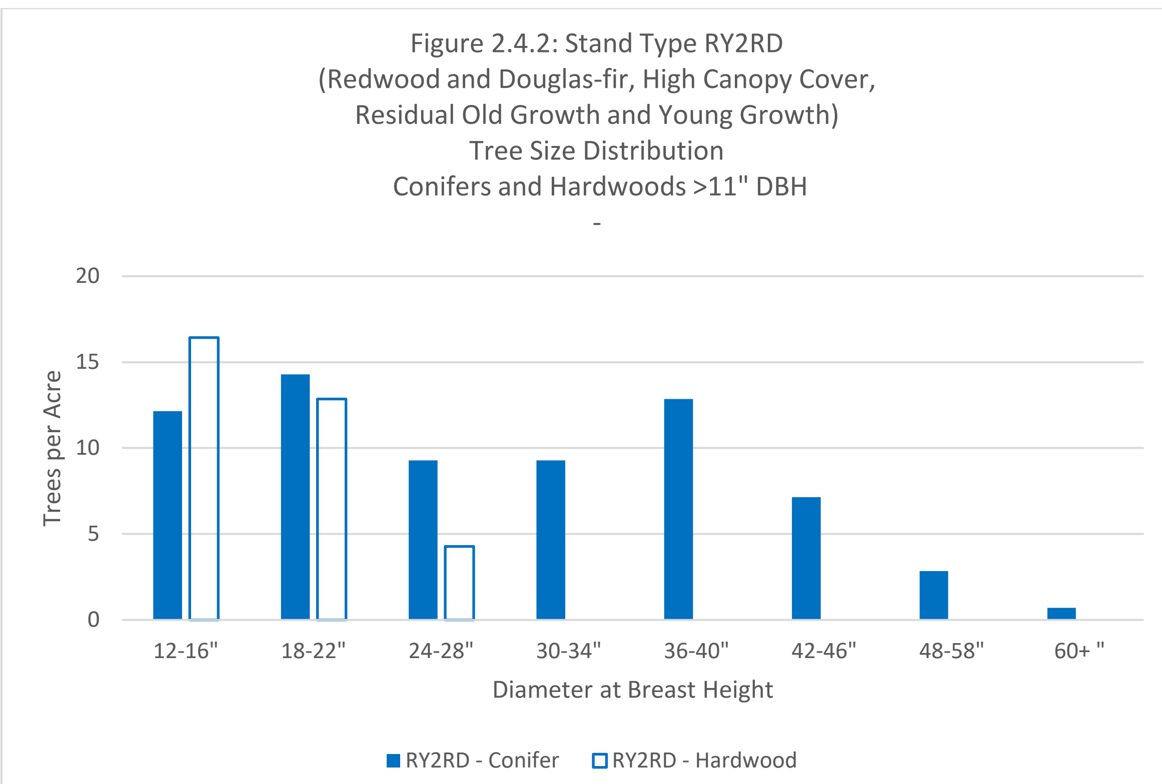


Figure 2.4.2: Stand Type RY2RD
(Redwood and Douglas-fir, High Canopy Cover,
Residual Old Growth and Young Growth)
Tree Size Distribution
Conifers and Hardwoods >11" DBH
-
Trees per Acre
20
15
10
5
0
12-16"
18-22"
24-28"
30-34"
36-40"
42-46"
48-58"
60+ "
Diameter at Breast Height
RY2RD - Conifer
RY2RD - Hardwood

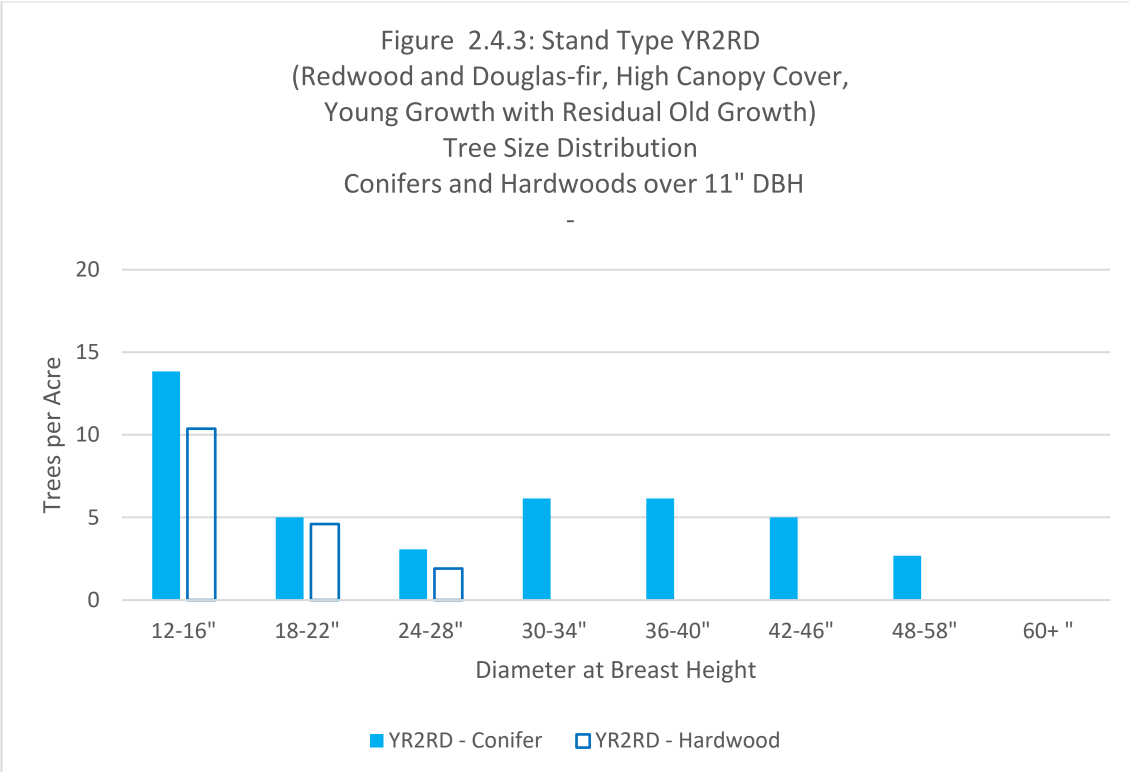


Figure 2.4.3: Stand Type YR2RD
(Redwood and Douglas-fir, High Canopy Cover,
Young Growth with Residual Old Growth)
Tree Size Distribution
Conifers and Hardwoods over 11" DBH
-
Trees per Acre
20
15
10
5
0
12-16"
18-22"
24-28"
30-34"
36-40"
42-46"
48-58"
60+ "
Diameter at Breast Height
YR2RD - Conifer
YR2RD - Hardwood

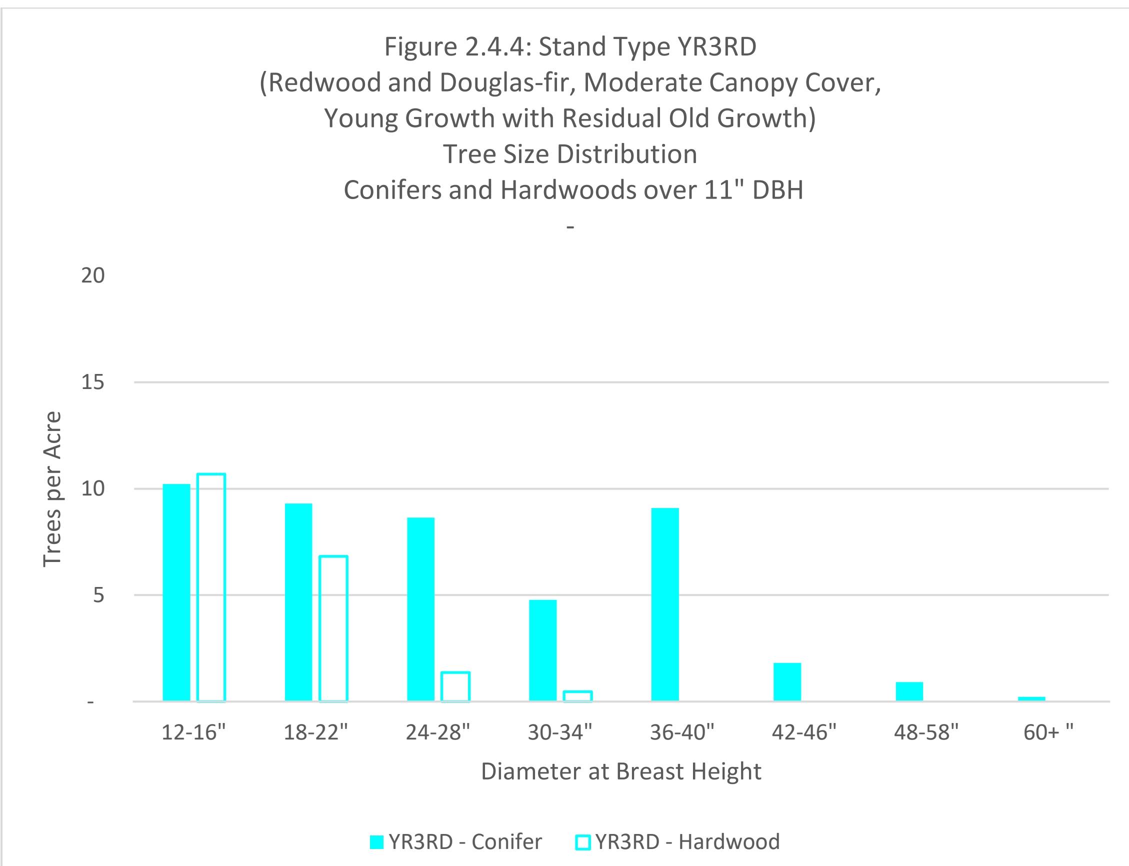


Figure 2.4.4: Stand Type YR3RD
(Redwood and Douglas-fir, Moderate Canopy Cover,
Young Growth with Residual Old Growth)
Tree Size Distribution
Conifers and Hardwoods over 11" DBH
-
Trees per Acre
20
15
10
5
-
12-16"
18-22"
24-28"
30-34"
36-40"
42-46"
48-58"
60+ "
Diameter at Breast Height
YR3RD - Conifer
YR3RD - Hardwood

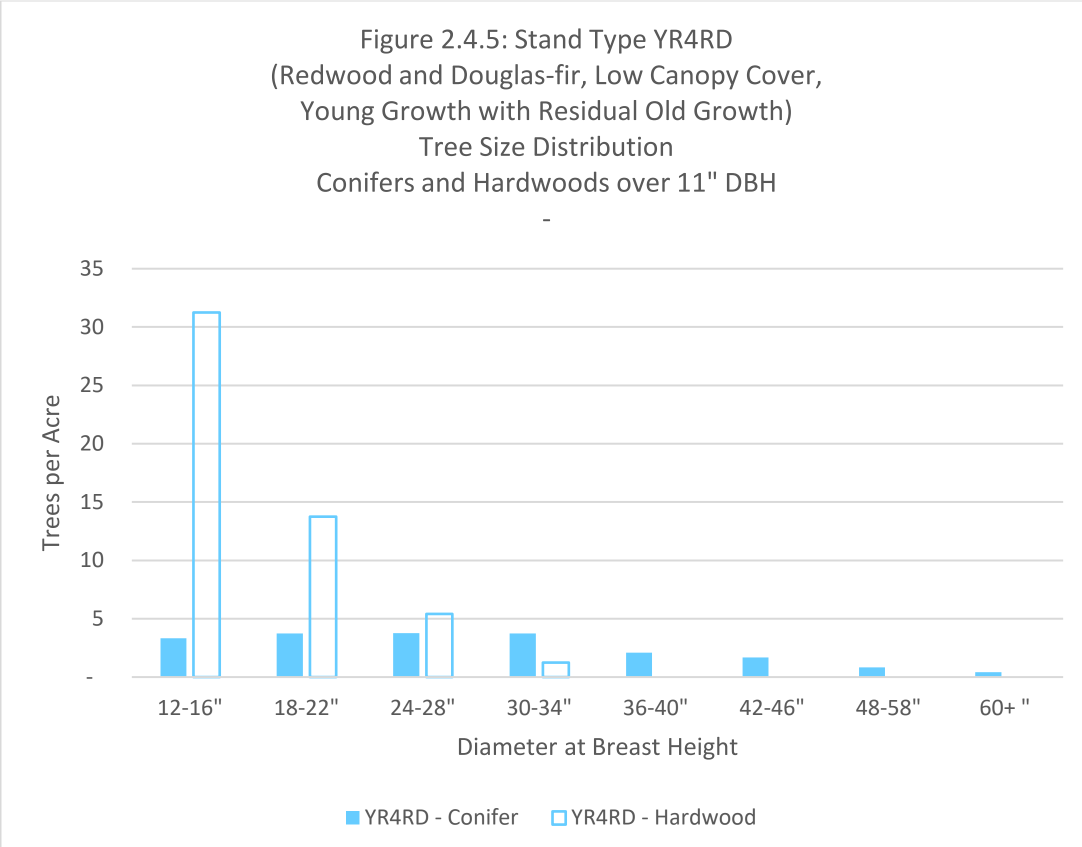


Figure 2.4.5: Stand Type YR4RD
(Redwood and Douglas-fir, Low Canopy Cover,
Young Growth with Residual Old Growth)
Tree Size Distribution
Conifers and Hardwoods over 11" DBH
-
Trees per Acre
35
30
25
20
15
10
5
-
12-16"
18-22"
24-28"
30-34"
36-40"
42-46"
48-58"
60+ "
Diameter at Breast Height
YR4RD - Conifer
YR4RD - Hardwood

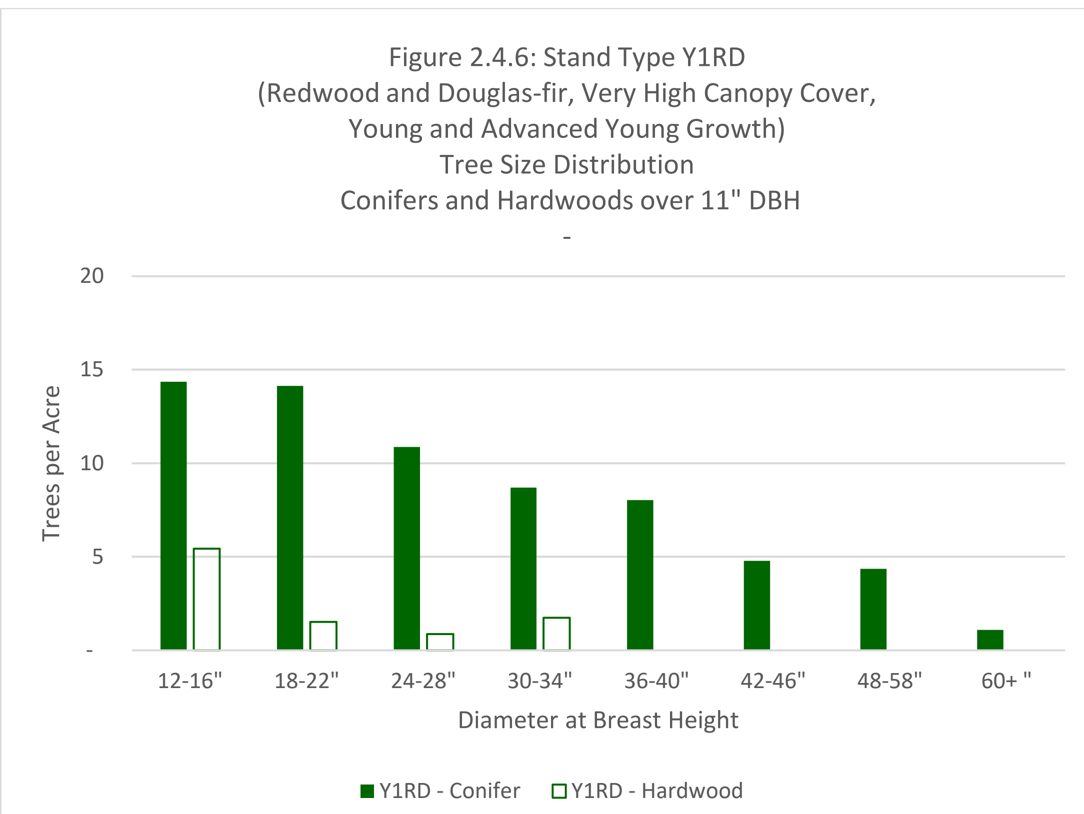


Figure 2.4.6: Stand Type Y1RD
(Redwood and Douglas-fir, Very High Canopy Cover,
Young and Advanced Young Growth)
Tree Size Distribution
Conifers and Hardwoods over 11" DBH
-
Trees per Acre
20
15
10
5
-
12-16"
18-22"
24-28"
30-34"
36-40"
42-46"
48-58"
60+ "
Diameter at Breast Height
Y1RD - Conifer
Y1RD - Hardwood

Figure 2.4.7: Stand Type Y2RD
(Redwood and Douglas-fir, High Canopy Cover,
Young and Advanced Young Growth)
Tree Size Distribution
Conifers and Hardwoods over 11" DBH
-

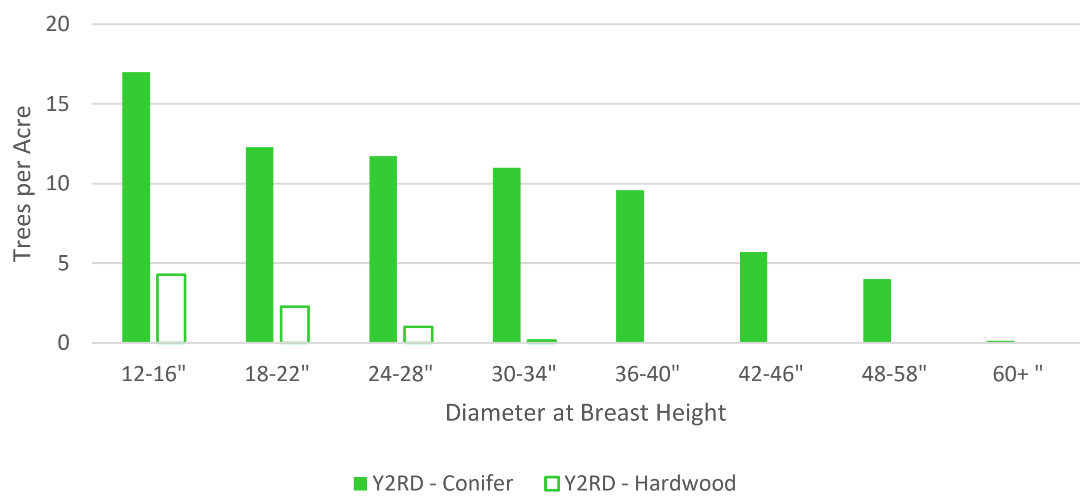
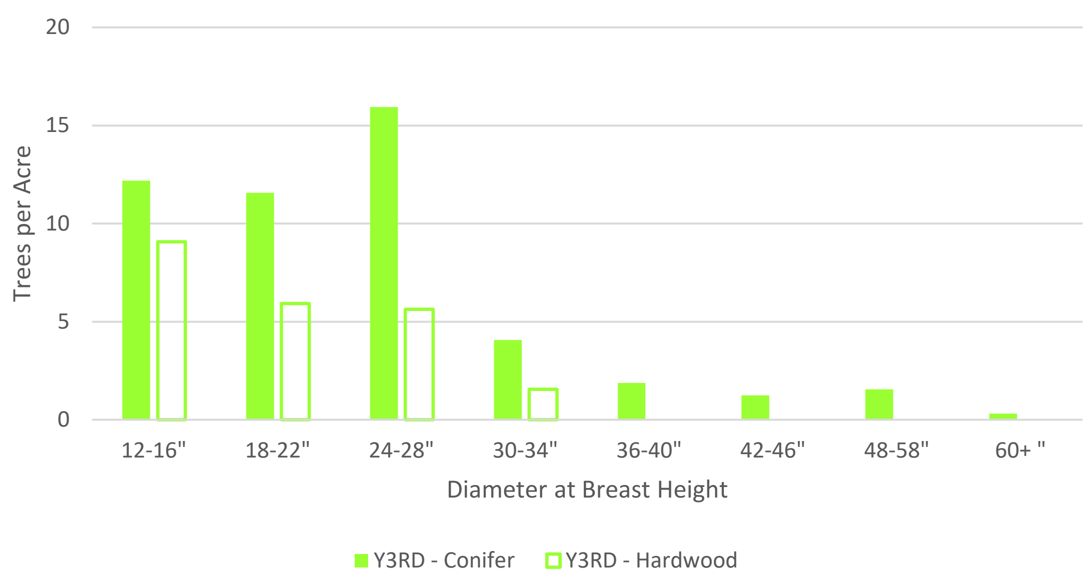


Figure 2.4.8: Stand Type Y3RD
(Redwood and Douglas-fir, Moderate Canopy Cover,
Young and Advanced Young Growth)
Tree Size Distribution
Conifers and Hardwoods over 11" DBH
-



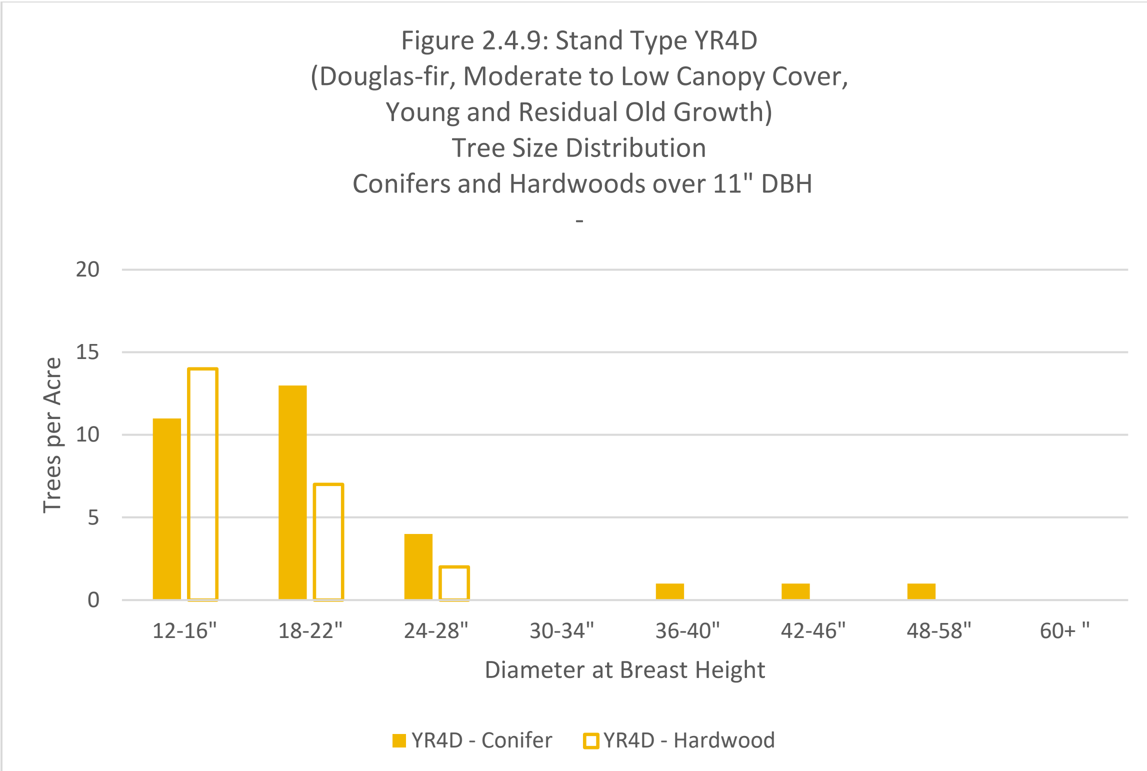


Figure 2.4.9: Stand Type YR4D
(Douglas-fir, Moderate to Low Canopy Cover,
Young and Residual Old Growth)
Tree Size Distribution
Conifers and Hardwoods over 11" DBH
-
Trees per Acre
20
15
10
5
0
12-16"
18-22"
24-28"
30-34"
36-40"
42-46"
48-58"
60+ "
Diameter at Breast Height
YR4D - Conifer
YR4D - Hardwood

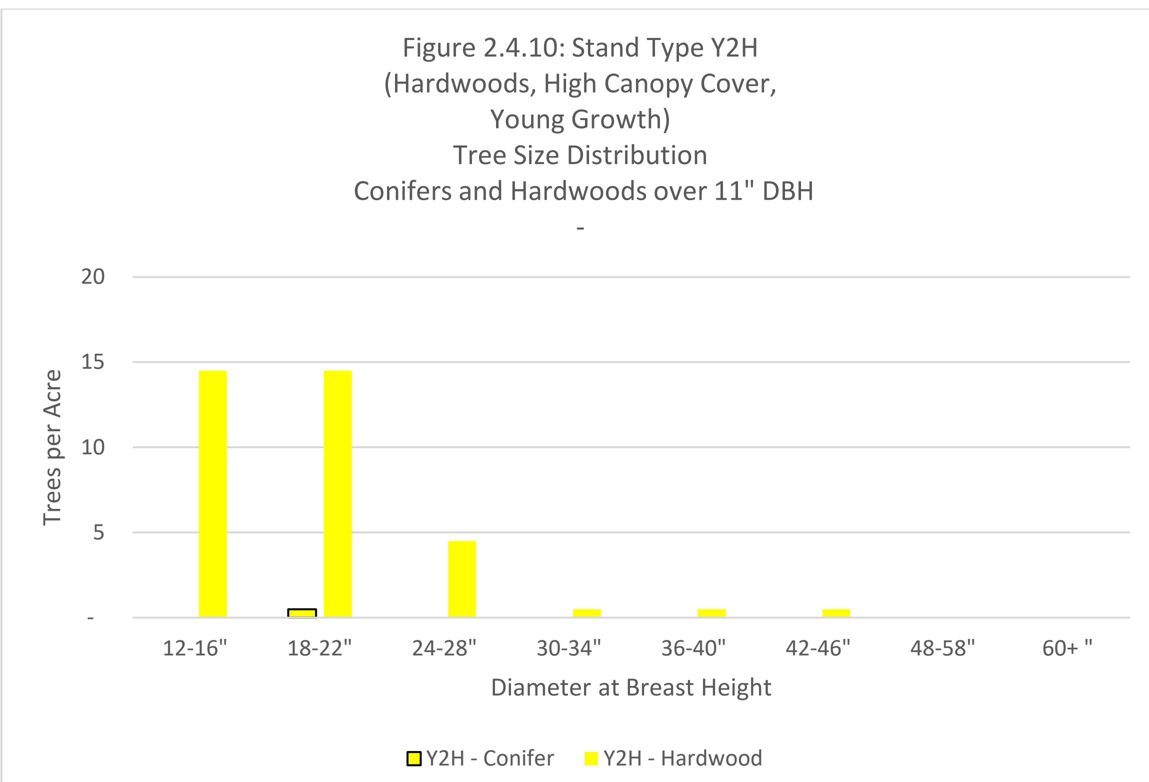
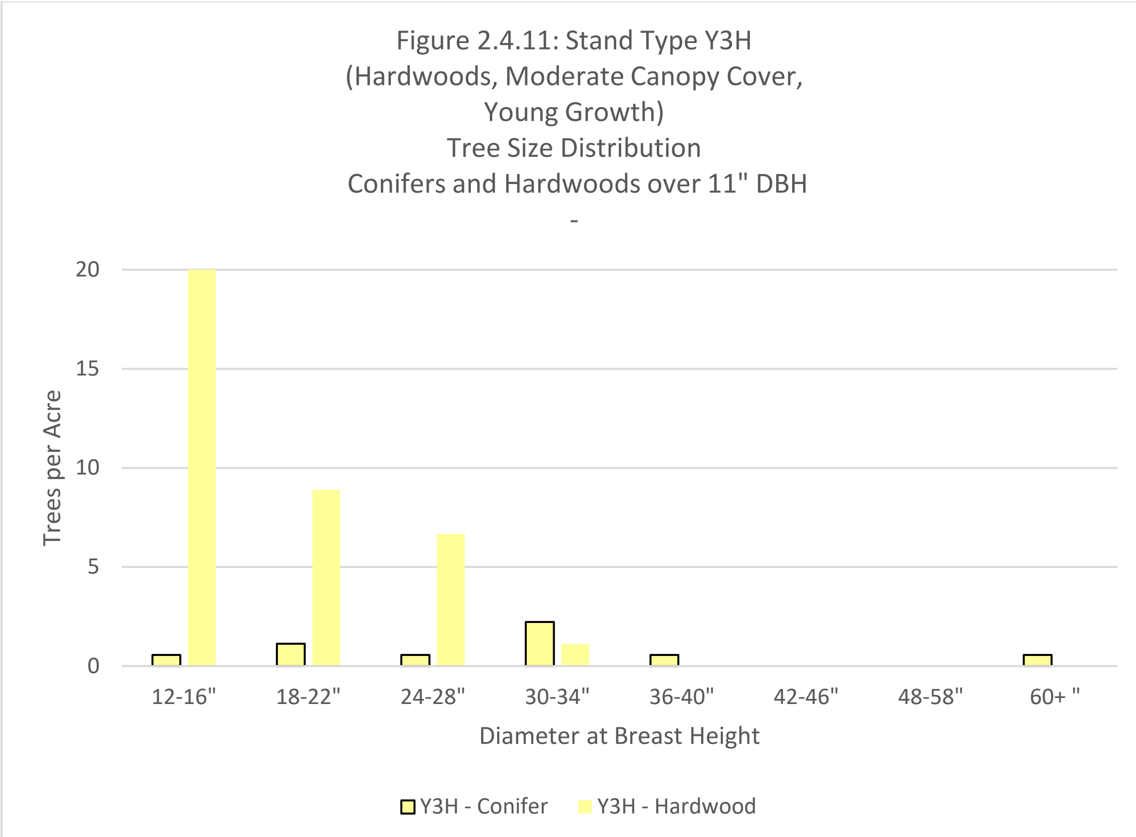


Figure 2.4.10: Stand Type Y2H
(Hardwoods, High Canopy Cover,
Young Growth)
Tree Size Distribution
Conifers and Hardwoods over 11" DBH
-
Trees per Acre
20
15
10
5
-
12-16"
18-22"
24-28"
30-34"
36-40"
42-46"
48-58"
60+ "
Diameter at Breast Height
Y2H - Conifer
Y2H - Hardwood



References

California Department of Forestry and Fire Protection (CAL FIRE), 2010. THP Project Carbon Accounting: Inventory, Growth, and Harvest. Excel spreadsheet and accompanying user guide. Version 6-11-2010.

Curtis, Robert O.; Marshall, David D., 2000. "Why quadratic mean diameter?" Western Journal of Applied Forestry, 15 (3): 137–139, https://www.fs.fed.us/pnw/olympia/silv/publications/opt/436_CurtisMarshall2000.pdf

Lindquist, James L., and Marshall N. Palley, 1963. Empirical Yield Tables for Young-Growth Redwood. Berkeley: Division of Agricultural Sciences, University of California. California Agricultural Experiment Station, Bulletin 296.

McArdle, Richard E., and Walter H. Meyer, 1961. The Yield of Douglas-fir in the Pacific Northwest. USDA Technical Bulletin 201, 74 pps. Rev. 1961

This page intentionally left blank

CHAPTER 3
Context for Management Planning

Land Use History of the Project Area

Pre-disturbance condition

Most of the old growth redwoods of the Santa Cruz mountains were logged in the late 19th and early 20th centuries. Prior to the clearcut, it is likely that the La Honda Forest had a similar range of species composition and stand types as the current day, from redwood-dominated stands in moister areas, grading to mixed evergreen/montane hardwood forests upslope, and with grassland openings on the exposed, south facing hilltops and hill sides. Redwood was – and is – dominant in areas with favorable conditions for this species: areas of deep, moist soils, typically on east and north facing slopes, in the bottoms of side canyons, and along streams. Redwood was present in the drier forest types, but occurring as widely spaced individuals or in small clumps or groves, with Douglas-fir and mixed hardwoods occupying most of the growing space.

Redwood reached its greatest girth and height in the sporadically occurring alluvial benches along portions of mainstem La Honda Creek and its tributaries, and also in the bowl-like headwaters of Harrington Creek, the two Harrington Creek tributaries in the western part of the Forest, and The Bathtub Loop area of the former Weeks Ranch (see Figure 1-1 in Chapter 1, and Figure 4-1 in Chapter 4 for location of these features). Redwoods also reached great size in the seeps and areas of shallow groundwater on the deep soils of the colluvial benches of the Conservation Management Unit (CMU), in some locations growing in "cathedral groves" of several dozen huge trees. In drier locations on steeper slopes and in thinner soils, redwoods were more widely spaced and were typically smaller -- up to about 5-feet diameter at breast height (DBH). Even these smaller trees had expansive crowns, some reaching 80 feet in diameter. It took on the order of only 20 to 30 old growth trees per acre to form a continuous, essentially closed canopy.

In-between and above redwood groves, dryer locations had a mixture of Douglas-fir and large hardwoods with occasional redwoods occurring as large diameter, short stature individuals and in small groves. Hardwood-dominated areas, especially along the flatter ridges, were likely selectively maintained by Native Americans through fire. Mean fire return interval in the redwoods prior to European colonization and settlement has been estimated at between 8-50 years (Lorimer et al, 2009; Stephens and Fry, 2005; Jones and Russell, 2015). Native Americans used fire to maintain hardwoods, particularly tanoak (*Notholithocarpus densiflorus*) and true oaks (*Quercus spp.*), as a food source; to maintain grasslands for ungulate habitat; for ease of movement; and to encourage growth of other plants for fiber, medicine, and food (Anderson, 2005; Lorimer et al, 2009). Fires set by Native Americans would creep into redwood-dominated stands, but typically as low to medium intensity fires, usually resulting in limited mortality, but spurring regeneration, both through seedlings establishing in exposed mineral soils and through stimulation of sprouts from lignotubers (Stephens et al, 2018), and giving rise to basal hollows ("goose pens") and other characteristic features of the old growth forest. Still, fire in redwood duff, when dry, spreads rapidly, and redwood has the potential for torching and crown fires (ibid). While the post-European settlement (1849-1921) fire return interval may have shortened (Jones and Russell, 2015), fire behavior likely changed substantially, from predominantly low intensity fires pre-disturbance to mixed (Stephens et al, 2004) and high intensity fires, especially following the clearcut. The project area does not appear to have had any known large-scale fires since post-clear cutting fires in the late 1800s (according to CAL FIRE data and a lack of observed fire scars on second growth trees).

Logging History

Early Logging Period

A glimpse into forest conditions in the first half of the 20th century, as well as the early logging history of the area, is provided by a 1939 US Forest Service publication reporting on historical research and a field survey of the forested areas of the Santa Cruz Mountains (Jensen, 1939). The report includes a map of lumber mills, showing that there had been several mills along La Honda Creek and upper San Gregorio Creek in the period 1876-1905, categorized as, "steam-powered sawmills that used ox logging." There were two mills in the upper Corte de la Madera Creek watershed in the period 1906-1935, categorized as "modern mills which used steam-powered logging." The earlier generation of mills, which likely were the destination for most of the old growth timber coming out of the La Honda Forest, relied at first on oxen for yarding logs and hauling them to the mills (McGirk, 2014). After Dolbeer's invention of the steam donkey in 1881, yarding became more mechanized, and less-accessible trees could be dragged out of the forest and taken to the mills. During this period of early mechanized logging, all accessible, merchantable trees were typically taken. Following the clearcut, the early loggers would burn the slash, often starting wildfires that would kill or damage some of the remaining standing trees. These fires inhibited regrowth of the redwood stumps, prevented successful regeneration from seed of both redwood and Douglas-fir, and promoted brushy regrowth, including tanoak, which resprouts aggressively after fire.

As of 1937, there were no mills operating in the La Honda Creek watershed, but elsewhere in the Santa Cruz mountains there were three large industrial mills operating in the areas of remaining old growth timber, and several smaller mills cutting young growth and isolated patches of old growth (Jensen, 1939). Based on the results of his survey conducted in 1935-36, Jensen classifies the redwood forests in the upper La Honda Creek and Harrington Creek watersheds – the area of the CMU, the Redwood Cabin, and the Harmon Parcel – as "young growth timber, principally one age class," and the riparian forest along La Honda creek as "young growth timber, several to many age classes." The report classifies most of the redwood forest in the Santa Cruz Mountains as the one-age-class type, which is further characterized as mostly 21- to 60-year-old stands, with some stands up to 80 years old. This was consistent with Jensen's observation that "extensive logging did not begin until after 1875" (ibid, page 31). These were stands that developed mostly from basal sprouts following the clearcut. The report notes the degraded condition of these young, even-aged forests: of 112,190 acres in the whole of the Santa Cruz Mountains of this type, the survey classified over 50 percent as "poorly stocked," and only 3 percent as "well-stocked," and notes that "…much of the space in these stands is taken up not by the timber, but by hardwoods and shrubs instead" (ibid, page 31). A 1943 air photo series (Figure 3-1) shows the La Honda Forest and surrounding area around this time. As seen in the figure, there is little obvious ground disturbance, other than major roads, and the forested areas appear to be regaining a closed canopy. It is likely, however, that most of the conifers were small and that hardwoods and brush were extensive.

ATTACHMENT 1

This page intentionally left blank

Second and Subsequent Entries – 1940s through 1980s

The era of unregulated tractor logging began in earnest after World War II. Few records of the tractor logging period have emerged, but in 1984, when the District was purchasing the land that now makes up the northern part of the La Honda Creek Open Space Preserve, the District received a letter from neighbors who described their attempt to stop a logging operation, apparently within what is now the CMU, in 1962 (Egger and Egger, 1984). The neighbors describe how the Ocean View Lumber Company trespassed onto their property to build a road, apparently to access the bridge over La Honda Creek that led to the Haul Road through what is now the CMU (see Appendix A). The neighbors recount that their efforts to stop the logging failed, and that the logging operation went forward during the last months of 1962:

> "The La Honda Creek watershed was destroyed. The bridge across the creek collapsed and the logging road has washed out and seriously deteriorated. The collapse of the bridge had stopped the flow of La Honda Creek." (ibid).

The letter also suggests that logging had been occurring for some time in what is now the CMU:

> "At one time when the logging roads were kept up, the loggers had no problems bringing their trucks and equipment across La Honda Creek" (ibid).

It is unclear when, prior to 1962, the haul road was built, or whether it was built or improved for that entry: a review of air photos from the 1940s and 1950s does not show clear signs of logging or other disturbance during this period. Consistent with the Eggers' letter, a 1965 air photo shows extensive disturbance in what is now the southern portion of the CMU, including what appears to be the haul road, as well as extensive bare ground, presumably skid trails (Figure 3-2). The 1965 air photo also shows that logging occurred at this time in the two Harrington Creek tributaries, west of the CMU, though the southern drainage, where there is a remaining patch of old growth (Figure 2-3 in Chapter 2), was only partially cut.

Until 1967, there was little regulation of logging at the State or county level, but State regulations required retention of a minimum of four "seed trees" per acre (Hamey, Baldzikowski, and McGraw, 2014). This requirement appears to have been in place at the time of the 1962 logging entry, as there is currently a cohort of large, older second growth and old growth redwood in this area, within a matrix of younger trees whose size indicates that most are stump sprouts from after the logging. It is likely that in that entry, most merchantable trees, other than the four seed trees per acre, were cut, and that many smaller trees were damaged or destroyed. In addition, the dense network of roads and skid trails, which appears to have been built and then abandoned without concern for erosion control, is still evident, and still contributes an undue share of sediment to La Honda Creek (see Appendix A).

The 69-acre Darling parcel, which makes up the northeastern portion of the CMU, appears not to have been reentered before the time of the 1965 air photo. A 1970 air photo series (Figure 3-3) indicates that there may have been a logging entry between 1965 and 1970, but based on current conditions in the Darling Parcel -- there are numerous very large second growth and residual old growth trees -- it is apparent that this portion of the CMU retains elements of the forest that survived, or regenerated after, the original logging entry in the 19th century or early 20th century. Other records of logging in the 1960s and early 1970s have not come to light, other than a reference in a later Timber Harvest Plan (THP) to selective logging of the Harmon parcel in 1965 and 1975 (THP 1-88-467-SMO). The 1962 Leib fire, which burned about 1,300 acres in the Skylonda area (CAL FIRE et al, 2018), appears to have included a portion of the Darling Parcel, as well as a portion of the adjoining Allen Road-Cielo Trail area (MROSD, 2014), though newspaper records of the time describe the fire occurring west of El Corte de Madera Open Space and down Tunitas Creek Road. No other records of fire in the La Honda OSP have come to light.

There are records of several logging entries into different portions of the La Honda Forest in the 1970s and 1980s, following passage of the Z'berg-Nejedly Forest Practice Act in 1973 and the subsequent promulgation of the Forest Practice Rules, including the requirement that commercial logging operations be conducted pursuant to an approved THP. THPs obtained by the District from CAL FIRE show that logging entries occurred in The Bathtub Loop and the area around the Redwood Cabin in 1978; in the Harmon Parcel in 1988; and in the Weeks-McDonald Ranch/Gate 7 area in the southern part of the La Honda Forest in 1986 (Table 3-1; see also Figure 4-1 in Chapter 4 for location of areas named above).

All the entries during this period were relatively light, single-tree selection harvests (Figure 3-4). Applied to mostly young, even-aged stands, these selective harvests were aimed at achieving more desirable spacing, cutting out poorly formed and damaged trees, and encouraging the development of several age/size classes of "thrifty" (i.e., regularly formed, suitable for milling), fast-growing trees. They were intended to establish a sustainable timber harvest system based on short reentry cycles of 10-15 years. This management system – single tree selection, uneven-aged silviculture on a short reentry cycle – was then a new concept in the redwood forest, having been developed in the regrowth forests of the Santa Cruz Mountains by consulting foresters Jim Greig and Ed Tunheim[1] (both of whom were listed as foresters on THPs referenced above – see Table 3-1) and Big Creek Lumber in the 1960s. The Forest Practice Rules now require use of single tree selection silviculture in the Santa Cruz Mountains[2] and it is increasingly practiced throughout the redwood range by conservation-minded foresters and landowners. After more than 50 years of practice, it has been shown to be a practical means of sustainably managing redwood forests for timber production, with the potential to retain or develop some later seral habitat.

Single tree selection, uneven-aged silviculture also provides a good starting point for restoration, as these stands typically have a cohort of larger, older, vigorous trees. These larger trees can be cultivated as "old growth candidates," as they have the potential to achieve large size relatively quickly, and, because they exhibit good mechanical stability, to live to a great age. This potential can be realized through application of a different silvicultural system, aimed not at growing trees to merchantable size and then cutting them to release the growth potential of smaller trees, but by perpetuating favorable growing conditions by removing nearby trees that are competing for the essential resources of light and soil moisture. Some practitioners use the term 'restoration forestry' to describe this practice of selective logging to remove generally smaller trees and retain and cultivate "old growth candidates" or other trees that provide late-seral habitat.

Also typical of the stands that have been subjected to single tree selection, uneven-aged silviculture is a relative paucity of legacy erosion and sediment issues. These problems were typically addressed in the first entries under this system (as eventually required under the Forest Practice Rules). Since it was to be used again in 10-15 years, the network of roads, skid trails, and landings was maintained and improved over time.

Another feature of many of the stands managed under this system, including those within the La Honda Forest, is a cohort of retained residual old growth and very large "open grown" trees. The foresters who developed this system had a philosophy of retaining relictual forest elements, and of only cutting a tree if it benefitted another. This old forest component adds habitat and aesthetic value, and can serve as a starting point to be built upon in a restoration program.

---

[1] A videotaped oral history interview of Ed Tunheim is available on Youtube: https://www.youtube.com/watch?v=HTQz08_lgpw

[2] 14 CCR § 913.8.

Figure 3.2 - 1965 Aerial Photo (Partial)

Composited from unrectified air photo
Project area boundary is an approximation

Data Source: https://guides.library.ucsc.edu/maps/aerial
Projection: NAD 1983, State Plane California III FIPS 0403, Feet

ATTACHMENT 1

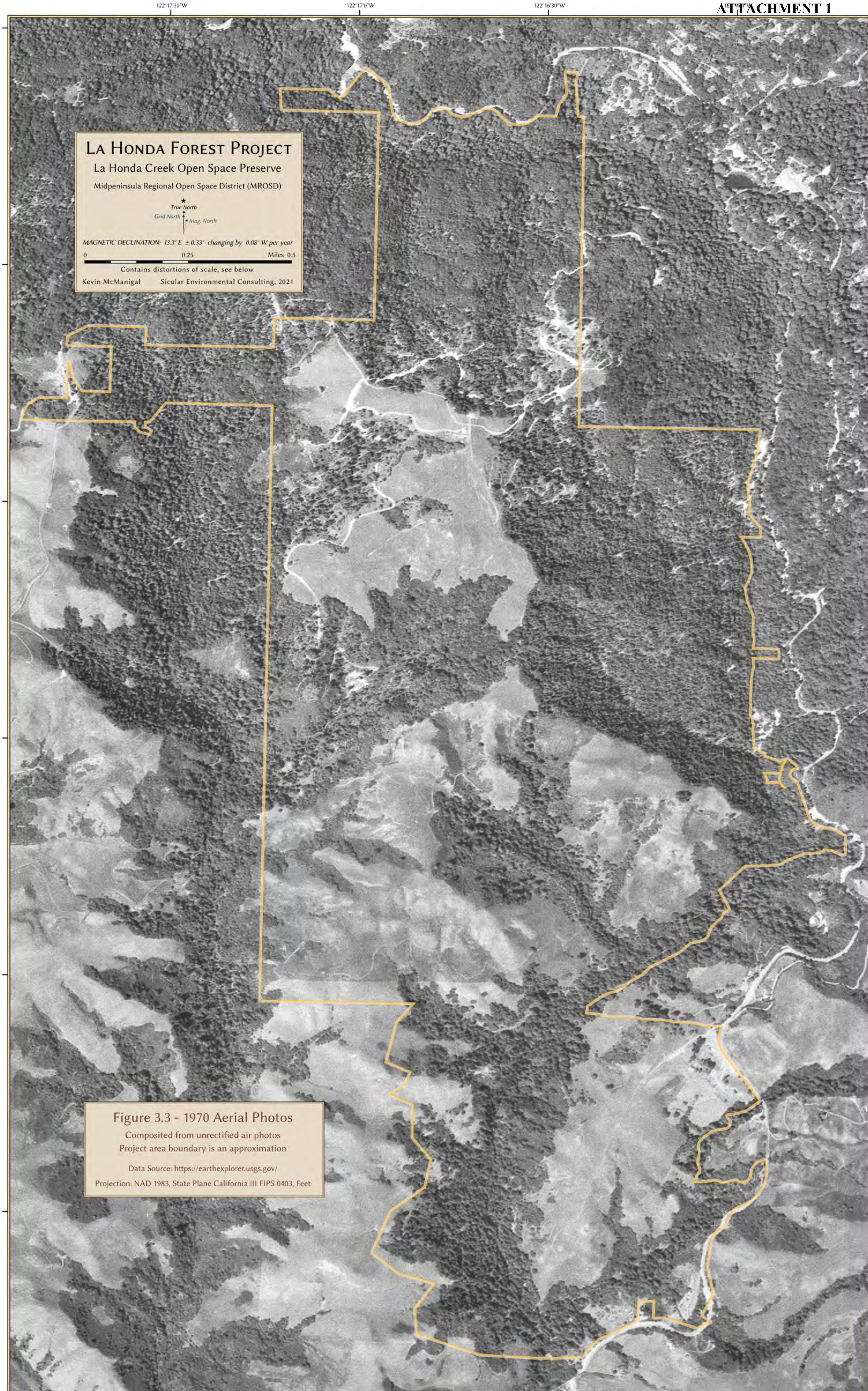
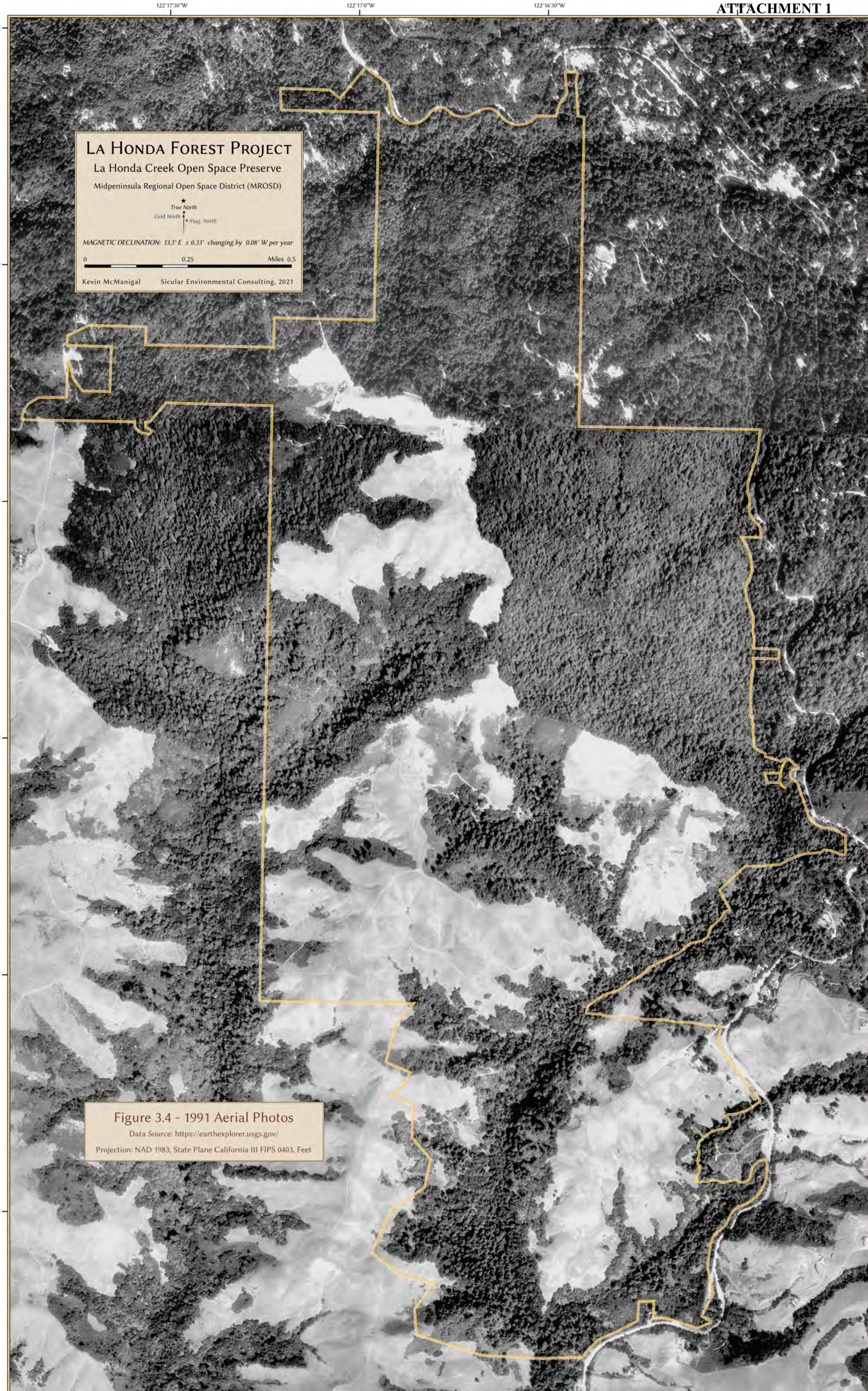


Figure 3.3 - 1970 Aerial Photos

ATTACHMENT 1



This page intentionally left blank

Table 3-1
Historic Logging

Area of Project Site	Harvest date(s)	Acreage	THP	Forester or Logging Company	Silviculture	Notes
Portions of the CMU and Harrington Creek Tributaries	1962	Unknown	N.A.	Ocean View Logging Company	Unknown. Probable retention of 4 seed trees/acre over 18"	Probable access over the La Honda Creek bridge to the Haul Road, subsequently washed out. Did not include Darling parcel or southern part of southern Harrington tributary.
Harmon	1965, 1975, 1988	41	1988: 1-88-467-SMO	Ed Tunheim	Single tree selection	Light selection harvest in 1988, described as 5,000 BF/acre, about 20% of merchantable volume. Tunheim may have been the forester in 1975, as well. 1965 harvest was under previous owner, forester unknown.
Bathtub Loop	1978	120	5-78-43 SM	Dale Holderman/ Big Creek Lumber	Selection	
Weeks Ranch, southern project area	1986	115	1-86-029 SMO	Mike Jani/Big Creek Lumber	Selection	
Redwood Cabin area	1978	62	5-77-11-SM-3	Jim Greig	Selection (<40% of conifers over 18")	Protecting the scenic view from Highway 35 was stated as a goal in the THP.

Opportunities for Forest Restoration and Resilience

This section discusses the factors that shape or constrain approaches to silvicultural forest restoration at La Honda, partly by drawing upon experience from restoration efforts in the redwood region that inform restoration planning. Restoration treatment regimes, wildfire hazard, climate change considerations, and watershed restoration objectives are addressed.

Silvicultural Treatments vs. Treatment Regimes

As a sub-field of the broader field of ecological restoration, forest restoration draws upon silvicultural principles and techniques that were developed over several centuries. Many of those tools were originally developed for conventional stand management applications, but the appropriate selection of tools from that toolbox can ideally serve forest restoration objectives. All silvicultural techniques were devised in order to establish or redirect forest stand development patterns in ways that better achieve management objectives, even if those objectives favored practices now known to be environmentally deleterious.

When a number of silvicultural techniques are prescribed in a sequence over a temporal timeframe – with near-term treatments shaped in part by the treatments that will follow – they are collectively referred to as a treatment regime, typically applied over several decades in this region. Commonly applied treatment regimes that consistently promote the sustainable production of quality wood crops gain the familiar title of a silvicultural system (and sometimes called "sustainable forestry"). Although the silvicultural system does not directly apply to restoration objectives, the treatment regime concept certainly does. Few forest restoration objectives can be met – or met well – with a single-entry treatment; instead, most benefit from a regime of treatments that are scheduled over time. In contrast to some other plant community restoration practices, silvicultural treatments rarely achieve restoration goals by themselves in the immediate term. Instead, they alter stand structure and composition, and thereby produce trajectories of stand development that deviate from the no-treatment trajectory. Sometimes the best strategy is one in which no follow-on treatment occurs until years or decades have passed since the initial treatment. It is that stand development in the years following treatment that determines whether restoration goals have been met, or whether additional treatment is indicated.

Some forms of ecological restoration are indeed well served by a discrete, single-entry treatment phase. That approach is common for some vegetation restoration projects such as riparian corridors, wetland projects, and mine reclamation, but is typically not the case for silvicultural restoration of upland forests. This is especially relevant at La Honda, because the forest is already quite well developed, and the potential benefits of silvicultural restoration treatments are proportionally less than at sites that are younger and more greatly deviated from the range of historic conditions. As a result, the risks of unintended negative consequences should be minimized, in order to constrain the risk/reward ratio. That objective is served by a treatment regime strategy – an adaptive management approach that staggers treatments in phases – rather than pushing the risk envelope with any single entry (see Adaptive Management discussion in Chapter 4). A strategy that relies on more conservative treatments, and staggering of entries over time, is more resilient to unintended consequences.

Forward-Looking Restoration

In North America, the original foundation of forest restoration lies in a focus on pre-settlement or pre-disturbance forest conditions. However, forest restoration – in the redwood region and beyond – has evolved in the past years from a rearward-facing focus on pre-settlement forest structure, or historic range of variability, to a focus on the future and aspects of its uncertainty. To some extent there was always some criticism of projects that overly-emphasized the exact reconstruction of historic conditions as inferred from historic photographs, old growth stump counts, or old growth remnants as restoration archetypes. But the evolution to a more forward-looking forest restoration has been expedited by concerns over the rapid pace of climate change. Simply put, changes in climate may make historic forest reconstruction impossible at worst, and inadvisable at best. As a result, forest restoration planning must increasingly focus on boosting the adaptive capacity of forests to be resilient to climate change.

Western temperate forests, including coast redwood, all regularly face weather-related stresses and disturbances (windsnap, severe droughts, late frosts), and all have evolved with some inherent capacity to absorb them. Climate change is not a fully new concern, but it represents a new paradigm for viewing such agents of abiotic stress and disturbance – changes in precipitation regimes, ambient and soil temperature regimes, relative humidity, and so forth. Treatments that are historically known to improve growth and vigor by increasing the availability of site-limiting resources should also serve to boost tree-scale and stand-scale resilience to changing climate.

The direct effects of climate change on forests are the ones most widely discussed and modeled (e.g., species-site relations, assisted species migration, seed production, and seedling recruitment bottlenecks, etc.). Those direct effects are likely to be manifested in those forest types of narrow distributions at climate fringes, such as whitebark pine at the alpine treeline, or pinyon pine at the desert fringe. Redwood, too, may experience a decline at the edges of its range, both locally and regionally. Unlike montane forests that shift upslope to a more favorable climate, however, redwoods may retreat downslope to the moister canyon bottoms and alluvial plains, ceding marginal slopes to forest types and species more tolerant of drier, hotter conditions (Ecoadapt, 2020a, 2020b). Anticipating and facilitating this transition is an unfortunate but necessary part of restoration planning in the era of climate disruption.

Gaining Resilience through Old Growth Structure

Silviculture that expedites the acquisition of old forest structure should also enhance wildfire resistance. Some reports suggest that mature forests were intrinsically more resistant to fire than are the younger stands that replaced them. However, the science supporting this presumed co-benefit remains limited.

Restoration treatments to promote stand development pathways that expedite the acquisition of old forest attributes are recent and they remain experimental in nature. The post-treatment response period is too short in most cases and robust research, too, is recent and spare. Compared to untreated stands, however, thinned stands exhibit increased growth rates (Teraoka et al, 2016; Soland et al, 2021), and begin to acquire attributes such as large branches (Keyes, 2011) that appear to place them on a trajectory toward regaining old growth stature, complexity, and character. Even without restoration treatment, undisturbed older second growth stands begin to approach metrics, structure, and understory similar to old growth stands, beginning 100 years or so following clearcutting (Iberle et al, 2020; Russell and Michels, 2011). The intent of restoration treatments is to speed that process, particularly by addressing structural impairments that are the legacy of past management.

It is an inevitability that silvicultural treatments that facilitate old growth forest structure over the long term nearly always must increase fire potential in the near term. All silvicultural restoration treatments will generate activity fuels,[3] such as “slash” from branches, at least as a short-term pulse. Those activity fuels, plus the canopy gaps that promote forest floor vegetation rejuvenation, plus the stalling of overstory tree crown recession – all combine to enhance near-term exposure to fire. The quantity of activity fuels, the extent of canopy gaps, and the duration of stalled crown recession are all proportional to the intensity of treatment. If, however, thinned trees are removed and sold, and, as required under the Forest Practice Rules, slash is disposed of, activity fuels remaining in the forest are minimized. Without heavy equipment on site that is part of a commercial timber operation, chainsaws and handwork can be used, though at greater expense, to minimize slash. At La Honda, combining restoration with commercial utilization of the byproducts of restoration operations (i.e., a timber sale) is a feasible option for portions of the property. The role of commercial utilization in abating activity fuels and mitigating fire danger is an important factor that should be considered.

3 Activity fuels: fuels resulting from, or altered by, forestry practices such as timber harvest or thinning, as opposed to naturally created fuels.

Even in the absence of commercial utilization, however, the stand responses to treatment will almost immediately begin offsetting the temporarily heightened near term exposure to fire risk. Canopy bulk density (or crown bulk density) – a crucial element of crown fire behavior – will be reduced proportional to treatment intensity, thus reducing the potential for crown fire spread. Additionally, the accelerated tree growth rates generated by reduced stand densities should concomitantly boost bark growth and thickness, buffering individual trees against cambium scorch from intensive and potentially destructive surface and ground fires. If combined with familiar fuel reduction and fire hazard abatement treatments, such as ladder fuel removal and creation of shaded fuel breaks, fire danger will be further reduced.

Near-term fire danger associated with restoration treatment can be ameliorated at La Honda by: 1) minimizing activity fuel loads either through commercial utilization, slash piling and burning, or some other treatment method; 2) establishing stringent standards for lop and scatter treatment of slash to keep slash heights low, to compact the surface fuels complex (as measured by fuelbed depth and packing ratio) and thereby promote decomposition, and to prevent piling slash next to retained trees; 3) by giving attention to fuel complex contiguity – segregating surface fuel jackpots and spacing large canopy gaps amidst a thinned matrix; 4) combining restoration treatments with fuel reduction and hazard abatement treatments in and around the treated stand.

Relationship of Stand Dynamics to Wildland Fire Hazard

Throughout the West, susceptibility to stand-replacing wildfire is an historic yet increasingly growing concern. Longer fire seasons that are warmer and drier, and that are exacerbated by greater fuel availability elevate that component of fire behavior and increase wildfire hazard. The accelerated encroachment of development into the wildland interface further complicates the situation and raises the stakes of increased fire hazard. Nowhere is this more evident than in the Santa Cruz Mountains, especially after the shocking devastation of the CZU Complex Fire of August 2020 (Santa Cruz Mountains Bioregional Council, 2020).

Wildfire susceptibility is strongly tied to forest structure. As a result, the capacity of silvicultural treatment to abate wildfire hazard by modifying forest stand structure is great. Susceptibility takes two forms, both of which can be adjusted by silvicultural treatment: 1) through vertical contiguity among surface and aerial fuel complexes that facilitates torching and crown fire initiation (high dead and live surface fuel loads, ladder fuels, and low canopy base heights), or 2) through spatial contiguity among canopy fuels that contributes to crown fire.[4] Suppression of fire leads to the accumulation of dead surface and live aerial fuels. Fire is, of course, weather influenced, but so is ‘available fuel.’ Available fuel is the term used to describe that fraction of the total fuel load that is sufficiently dry to engage in the combustion process associated with an expanding flaming front.

Greater amounts of fuel, more contiguity of surface and aerial fuel complexes, and a greater proportional amount of fuel in an available state collectively result in the potential for wildfires of high intensity and severity. The potential for transition of surface fire to crown fire is increased, and the potential to

[4] Common susceptibility metrics corresponding to the former and latter are torching index (TI) and crowning index (CI), which represent the midflame windspeeds at which torching (crown fire initiation) and crowning (crown fire spread) are likely to occur for given stand and fuel conditions. TI and CI are metrics commonly understood and communicated by fire and fuels managers, and they can be modeled readily via the Forest Vegetation Simulator’s (FVS) Fire and Fuels Extension (FFE). Canopy fuel loads and related metrics (Canopy Base Height; Canopy Bulk Density (CBD). However, to distill down to that basic metric requires an inventory of (or data assignment to) all fuel loads, plus slope, wind direction, and assumptions of additional fire weather, which is beyond the scope of the current report.

facilitate the spread from fires initiating elsewhere is increased. Silvicultural treatment that reduces (or even just alters) the structure of fuel complexes disrupts that potential. When strategically located on stand and property boundaries at La Honda, silvicultural treatments can reduce the potential for spread while increasing fire management options and firefighter safety.

Strategically placed fuels treatments that reduce and/or compact dead surface fuel loads, and that artificially elevate canopy base heights, will reduce crown fire initiation potential. In the La Honda Forest, low thinning and pruning will be useful tools, especially along the forest/grassland transition zones, where low crowns meet dense and flashy grass and brush fuels and serve as exceptionally hazardous areas that can catalyze crown fire.

Climate change that results in reduced fog cover and/or later winter rains produces a longer fire season where fuel availability becomes greater, and the duration of its availability increases its period of heightened vulnerability.

Climate Change Informs Restoration Planning

Climate change and its forecasted pace lend greater urgency to restoration efforts. Restoration not only achieves structural and compositional goals, it imparts greater capacity for mitigation of, and adaptation to, uncertain climatic conditions. Existing ('native') stressors are influenced by climate, and projected climate change suggests exacerbation of those existing stressors.

As a working hypothesis, we may postulate that restoration practices that promote old forest attributes will also enhance the likelihood of redwood persistence and impart resilience in a dynamically changing climate. The capacity of stand-driven silvicultural techniques alone to impart resilience is limited. External and abiotic factors exist that cannot be mitigated by the manipulation of stand structure and composition, or by the management of stand type heterogeneity. Invasive species, roads, and multiple landscape considerations – fire ignition and spread potential, fire suppression capacity and infrastructure, land fragmentation – can render stand- and property-scale measures ineffective. Acknowledgement of those factors, however, can inform restoration practices and inform planning to increase resilience to external forces.

The direct influence of Pacific coast microclimate on redwood occurrence is apparent. The historic range of redwood – like all species – is framed by climate history. Past changes in climate have shriveled the species' range to the narrow sliver of the Pacific coast it currently occupies. Climate change threatens (both directly and indirectly) to further restrict that range. Fog incidence may have declined during the past century by as much as one third (Johnstone and Dawson, 2010). Still, incorporating climate as a guiding feature to restoration planning is currently in a nascent phase, and its influence on treatment specifics remains mainly conceptual.[5]

[5] Reflecting both the acceptance of silviculture as a restoration practice, and uncertainty about treatment effects on forest adaptation to potential climate changes, a national network of long-term studies was recently launched called the Adaptive Silviculture for Climate Change project (ASCC; see adaptivesilviculture.org for details). This unique interdisciplinary, interagency project is testing suites of silvicultural techniques that focus on resistance, resilience, and transition – objectives reflecting potential levels of climate change and their implications for forest ecosystems. Experiments are underway at seven locations in the United States (Colorado, Georgia, Minnesota, Montana, New Hampshire) and Canada (Ontario). Sites are located in important forest regions and across a variety of forest types that are emblematic of those geographic landscapes. This research network and its silvicultural planning process, which is highly inclusive and transferable, could help inform forest restoration treatment planning at La Honda and similar sites in the redwood region.

Balancing Watershed and Forest Restoration Objectives

As described previously, the forest management history at La Honda has resulted in an array of current forest conditions; some demand silvicultural intervention in order for forest objectives to be met, whereas others exhibit comparatively lower levels of impairment. For the latter, treatment can expedite and enhance forest development, but is not considered essential to it. In those cases, the relative emphasis on silvicultural forest restoration may be secondary to watershed restoration needs, especially erosion and stream sedimentation associated with legacy forest roads and water crossings. Since strategies for dealing with each of those two objectives – forest restoration and watershed restoration – can take multiple forms, it is worth considering how those objectives affect each other. Management should align with both objectives, or at least serve as the best compromise between them.

Lessons from Redwood National and State Parks

There are valuable lessons to be learned from the experience of Redwood National and State Parks (RNSP) and its watershed restoration and forest restoration programs. Initiated in the 1970s, the RNSP watershed restoration program commenced well in advance of the forest restoration program, which did not begin until several years later (Keyes, 2011).

The watershed restoration strategy was an ambitious one focused on forest roads in those upland second-growth forests, and involved complete road decommissioning and slope recontouring: culvert removal followed by restoration of original stream course morphology and substrate; roadway fill slope material repacked to the original cut slope to replicate the original hillslope; and revegetation and reforestation of the restored landform with native tree species (Coates, 1981). That comprehensive approach to watershed restoration focused exclusively on that program's objectives, and was guided by hydrologists, geologists, fisheries biologists, and road engineers.

Once the watershed restoration program was well underway, focus by the park's biologists spread to the condition (structure and composition) of the second-growth forests themselves. A forester was hired to design and execute a series of silvicultural restoration thinning treatments to reduce densities, shift species compositions, increase spatial complexity, and facilitate the long-term development of old growth structure to those impaired second-growth forests. Many of the objectives and desired future conditions were similar to the District's objectives for the La Honda Forest.

At RNSP, the two restoration programs operated with some coordination but in an asymmetrical form: the tools available to forest restoration were constrained by watershed restoration activities, especially road decommissioning. The latter had not been planned with consideration of forest restoration or other land management concerns, such as fuels treatments, broadcast burning, or wildfire suppression capability.[6] As a result, the tools and timeline available to forest restoration planning were impacted in two major ways:

- First, watershed restoration activity timelines were superimposed on the forest restoration program and forced the latter to follow suit. The prioritization, scale, and timing of forest

[6] Current restoration programs in Redwood National and State Park include Redwoods Rising, a collaborative initiative between Save the Redwoods League, the National Park Service, and California State Parks, whose mission is to protect old growth stands, restore redwood forest ecosystems, and ensure the long-term health of these lands. Redwoods Rising includes both watershed restoration and forest restoration objectives.

restoration project planning followed those of the watershed restoration program, rather than following their own optimal course.

- Second, and more importantly, watershed restoration activities that significantly reduced access, such as road decommissioning and slope recontouring, greatly curtailed the range of available forest restoration strategies, effectively limiting those strategies to single-entry restoration treatments.

Applicability to the La Honda Forest

The takeaway lesson from the RNSP experience for the La Honda Forest is that watershed restoration activity planning requires a decision in direction that by association will expand or contract the tools available for silvicultural forest restoration. Where road impairments require remediation (notably the CMU, but to a lesser extent in other areas as well), a decision must be made whether to reestablish and improve functional roads and their water crossings, or else decommission them to address erosion and mass wastage threats, and to reestablish original stream courses.

If the former approach is taken to watershed restoration, and roads and crossing are improved, then improvements can and probably should occur prior to silvicultural intervention, because they will widen the range of treatment possibilities, including potential for commercial timber harvest. They will also enable a temporal spread of silvicultural treatments over time that can reduce the risk of unintended consequences. In addition, they can activate the potential of employing an adaptive management framework that is informed by monitoring of silvicultural treatment effectiveness.

If the latter approach is taken to watershed restoration, and roads and crossings are decommissioned, then the range of silvicultural tools will likely be limited by equipment access and log hauling capability. The potential for commercial timber harvest may be voided in some locations. Broadcast burning and wildfire control potential will be limited by the same restricted access by fire suppression equipment, and silvicultural treatments will need to take additional care to avoid elevating potential wildfire behavior by focusing more intently on minimizing activity fuels. The temporal distribution of silvicultural intervention techniques will be limited, requiring all efforts to be initiated and completed early in the process, concentrating treatment activity to a narrow temporal window, and necessarily increasing the risk of unintended consequences by concentrating treatment impact to that tight window.

References

Anderson, M. Kat, 2005. Tending the Wild: Native American Knowledge and the Management of California’s Natural Resources. Berkeley: University of California Press.

California Department of Forestry and Fire Protection (CAL FIRE), San Mateo County Resource Conservation District, and Santa Cruz County Resource Conservation District, 2018. Santa Cruz County San Mateo County Community Wildfire Protection Plan. Prepared by: CAL FIRE, San Mateo — Santa Cruz Unit, Resource Conservation District for San Mateo County and Resource Conservation District for Santa Cruz County, April 2018.

Coats, Robert N., ed., 1981. Proceedings of a Symposium on Watershed Rehabilitation in Redwood National Park and Other Pacific Coastal Areas. Proceedings of a symposium held August 24-28, 1981. Sponsored by National Park Service, US Geological Survey, US Forest Service, California Department of Forestry, California Department of Water Resources, State Water Resources Control Board.

Ecoadapt, 2020a. Climate Change Vulnerability Assessment for the Santa Cruz Mountains Climate Adaptation Project: Coastal Redwood Forest. Draft. Joint project of Midpeninsula Regional Open Space District, the Santa Cruz Mountains Stewardship Network, and Pepperwood Preserve.

______ 2020b. Climate Change Vulnerability Assessment for the Santa Cruz Mountains Climate Adaptation Project: Mixed Evergreen/Montane Hardwood Forests. Draft. Joint project of Midpeninsula Regional Open Space District, the Santa Cruz Mountains Stewardship Network, and Pepperwood Preserve.

Egger, Eugene, and Alice Egger, 1984. Letter to L. Craig Britton, Midpeninsula Regional Open Space District, July 8, 1984.

Hamey, Nadia, Matt Baldzikowski and Jodi McGraw, 2014. History of Timber Harvests within the Midpeninsula Regional Open Space District. Midpeninsula Regional Open Space District, December, 2014.

Iberle, Benjamin G., Robert Van Pelt, Stephen C. Sillett, 2020. "Development of mature second-growth Sequoia Sempervirens forests." Forest Ecology and Management 459.

Jensen, Herbert A., 1939. Vegetation Types and Forest Conditions of the Santa Cruz Mountains Unit of California. Berkeley: USDA Forest Service, California Forest and Range Experiment Station, Forest Service Release no. 1.

Jones, Gregory A., and Will Russell, 2015. "Approximation of Fire-Return Intervals with Point Samples in the Southern Range of the Coast Redwood Forest, California, USA." Fire Ecology, vol. 11, no. 3.

Johnstone, James, and Todd E. Dawson, 2010. "Climatic context and ecological implications of summer fog decline in the coast redwood region. "PNAS, vol. 107, no. 10, March 9, 2010, pp. 4533–4538

Keyes, C.R., 2011. "Thinning promotes the restoration of branch structure in second-growth redwoods at Redwood National Park." Ecological Restoration Vol. 29, pp. 325-327

Lorimer, Craig G.; Daniel J. Porter, Mary Ann Madej, John D. Stuart, Stephen D. Veirs Jr., Steven P. Norman, Kevin L. O'Hara, and William J. Libby. "Presettlement and modern disturbance regimes in coast redwood forests: Implications for the conservation of old-growth stands." Forest Ecology and Management, vol. 258 (2009), pp. 1038–1054.

McGirk, Jan, 2014. "Lumbering with the bull and jerk teams: 'mean strength and awkwardness.'" In Lisa Robinson, ed., Redwood Logging and Conservation in the Santa Cruz Mountains: a Split History. Santa Cruz: Santa Cruz Museum of Art and History at the McPherson Center.

MidPeninsula Regional Open Space District (MROSD), 2014. 2014 Vision Plan Conservation Atlas.

Russell, Will, and Kristin Michels, 2011. "Stand Development on a 127-yr Chronosequence of Naturally Regenerating Sequoia sempervirens (Taxodiaceae) Forests," Madroño 57(4), 229-241.Santa Cruz Mountains Bioregional Council, 2020. Redwood forest impacts of the CZU lightning fire complex: climate change hits home with catastrophic results. October 19, 2020. https://www.scmbc.org/news

Soland, Kevin A., Lucy P. Kerhoulas, Nicholas J. Kerhoulas, and J.R. Teraoka, 2021. “Second-growth redwood forest responses to restoration treatments.” Forest Ecology and Management 496, Sept. 2021.

Stephens, Scott L, and Danny L. Fry, 2005. “Fire History in Coast Redwood Stands in the Northeastern Santa Cruz Mountains, California.” Fire Ecology, vol. 1, no. 1.

Stephens, Scott L; Douglas Piirto, and Domenico Caramagno, 2004. “Fire regimes and resultant forest structure in the native Año Nuevo Monterey pine (*Pinus radiata*) forest, California.” The American Midland Naturalist, vol. 152, pp. 25-36.

Stephens, Scott L., Jeffrey M. Kane, and John D. Stuart, 2018. “North Coast Bioregion.” In Jan W. Van Wagtendonk, Neil G. Sugihara, Scott L. Stephens, Andrea E. Thode, Kevin E. Shaffer, and Jo Ann Fites-Kaufman, eds., *Fire in California’s Ecosystems*. Berkeley: University of California Press. Second edition.

Teraoka, Jason R., Phillip J. van Mantgem, and Christopher R. Keyes, 2017. “Low Thinning and Crown Thinning of Two Severities as Restoration Tools at Redwood National Park.” In Standiford, Richard B. and Yana Valachovic (technical coordinators), Proceedings of the Coast Redwood Science Symposium-2016: Past Successes and Future Direction. General Technical Report PSW-GTR-258. Albany, CA: USDA Forest Service, Pacific Southwest Research Station.

This page intentionally left blank

CHAPTER 4
Forest Restoration and Management

This chapter discusses current conditions in the La Honda Forest and provides options for forest restoration and management, consistent with the District's relevant resource management goals and polices for forest management and wildland fire management, as described in Chapter 1. Because the La Honda Forest has had a varied management history, as described in Chapter 3, and contains a range of forest stand types (Figure 2-3 in Chapter 2), this chapter provides separate discussions of distinct areas of the La Honda Forest, shown in Figure 4-1, that share a common management history, or that are botanically distinct. For each defined area, restoration options consistent with the resource management goals and policies recounted in Chapter 1 are provided, and preceded by a discussion of current conditions.

Approach to Forest Restoration

As discussed in Chapter 3 and further detailed below, the La Honda Forest has been profoundly altered, primarily through logging, from its pre-disturbance condition. Our analysis of restoration opportunities focuses on the identification of "impaired forest condition classes" (IFCCs; Keyes, 2005). IFCCs are derived from field observation and a reconstruction of historic stand structure and management history. They classify current stand conditions, including species composition, tree size, spacing, density, and form, and describe how they differ from historic reference conditions. The descriptive analysis of classifications focuses on stand structures and growth dynamics that can predictably inhibit or impair the forest's recovery from past disturbance. Restoration then focuses on silvicultural treatments to address impairments and redirect the growth trajectory of the stand toward the desired condition. The objective of the restoration treatments is to alter structural and/or compositional attributes in a fashion that will realign stand development patterns so that they more closely mimic natural patterns of stand development. If treatment is successful, the stand's own growth dynamics then return the stand, over time, to the desired condition, including a restoration of its ecological function.

While in some cases altered forest stands may eventually achieve desired conditions without intervention, active silviculture can realign stand development trends with restoration objectives more quickly. In some cases, the forest has been altered to the extent that it is unlikely to grow back to its pre-disturbance condition without intervention, and passive management cannot be considered restoration, but only perpetuation of the altered condition. Recognition that a stand has been profoundly altered from its pre-disturbance condition, or that the future climate may no longer support the same type of forest that once grew there, may prompt consideration of "restoring" a stand to a different type more compatible with the site's current potential and likely future conditions.

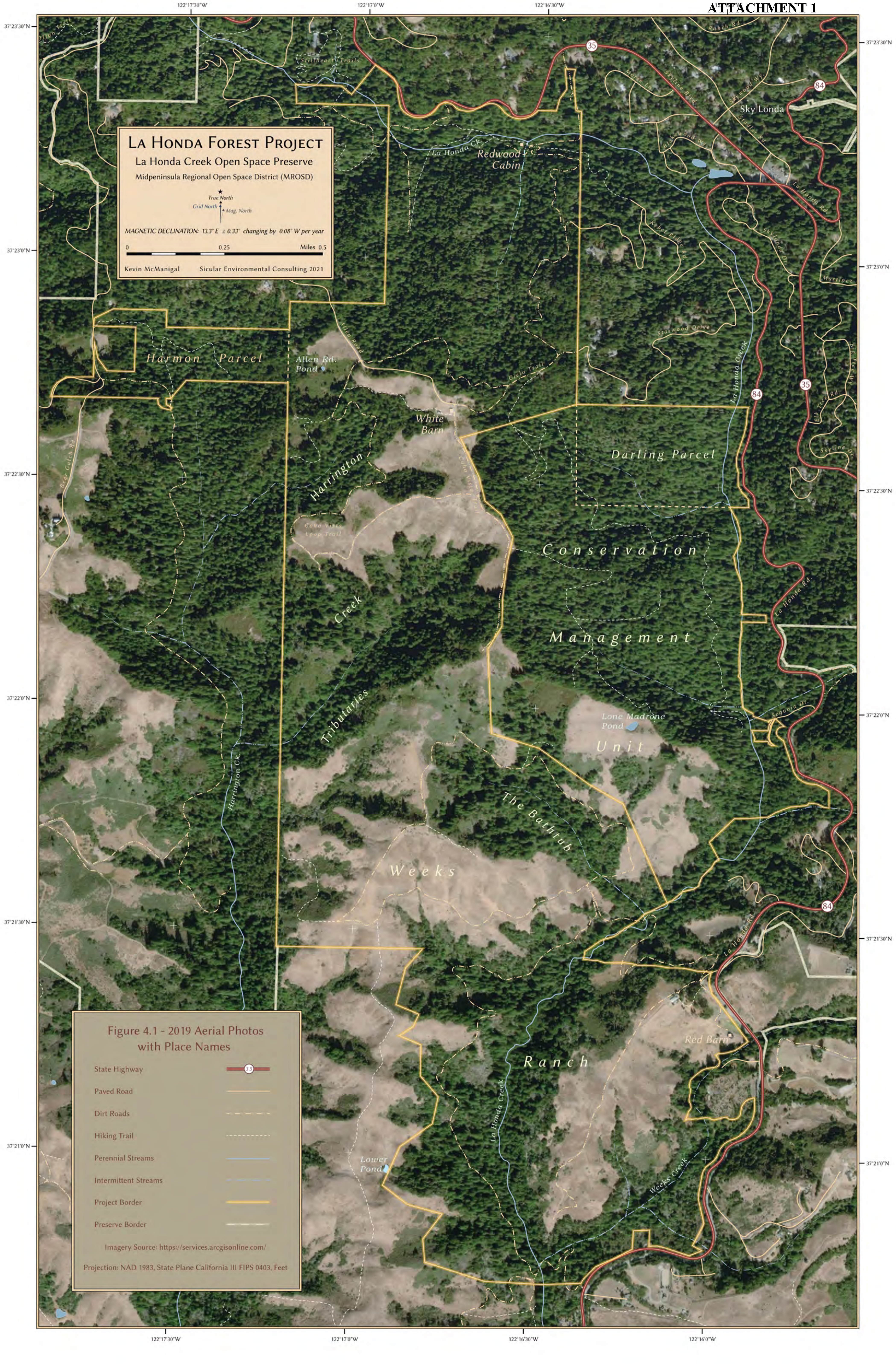
In the La Honda Forest, we have identified the following IFCCs:

IFCC-1: High density of redwood regrowth stands. In areas of advanced second growth redwood, there is generally a desirable range of age/size classes and species composition, but high stem density (expressed as trees per acre; see Chapter 2) results in competition that inhibits the stand's development toward regaining old growth character, and leaves the stand more vulnerable to climate-induced stresses. The high density of medium and larger diameter trees results in competition for canopy position and shading of the lower branches of the largest trees. As the shaded foliage becomes inefficient, the shaded branches become abscissed and are culled from the live crown. As the tree continues to gain height, this results in "upward crown recession," the continued development of crown at the apex of the tree, even as it is losing its lower branches. Loss of the lower portion of the crown equates to a decrease in the crown's leaf area, lowered potential for photosynthesis, and decreased growth potential. This inhibits the increase in girth and development of old growth characteristics, such as large branches and expansive, complex crowns, and may also adversely affect mechanical stability. Because trees are also competing for soil resources, the high density may also increase the stand's susceptibility to adverse effects of climate change, including drought and heat-induced stress and mortality. Climate change-induced stress may be most felt at the drier margins of these redwood stands (Ecoadapt, 2020a), which typically include areas higher on slopes, and in the transitional areas between canyon bottoms and side slopes.

IFCC-2: Redwood isolates. On canyon side slopes, the narrow bands of continuous conifer canopy along moister swales, sometimes referred to as "stringers," has fragmented, with hardwoods, especially tanoak, occupying interstices between regrowth redwood clumps. Tanoak sprouted aggressively after the clearcut, outcompeting redwood in the short-term, especially where fire following the clearcut damaged or killed redwood sprouts and incinerated Douglas-fir seeds and seedlings: Douglas-fir is typically reduced in abundance or absent from these stands. The tanoak tends to hem-in the redwood, inhibiting radial crown expansion that would lead to redwood reoccupying canopy space and eventually regaining the continuity of the conifer canopy corridors. Tanoak also likely competes with redwood for dry season soil moisture, shortening redwood's growing season and overall growth rate, and decreasing vigor.

IFCC-3. Douglas-fir and brush encroachment in mixed hardwood stands. The mixed conifer-hardwood stands are a diverse, dry forest type, composed mostly of live oak, madrone, tanoak, and Douglas-fir. It is likely that current species composition and vegetation patterns reflect long management by Native Americans. Frequent, low-intensity fire prevented encroachment of brushy growth and fire-prone trees, especially Douglas-fir, and tended to maintain the forest in a perpetual mid-seral stage of development. Through fire suppression, Douglas-fir that have sprouted within the dripline of the hardwoods eventually grow through the crowns of the hardwoods, shading them out and killing them. High fuel loading and hazardous fuel structure are common, with an abundance of brushy species and small trees resulting in a high degree of both horizontal and vertical fuel continuity. Where these stands occur adjacent to unmanaged grasslands, there is the potential for rapidly spreading, high-severity fire.

In addition to these structural impairments to forest recovery, which indicate silvicultural restoration treatments, we have observed several non-structural impairments as well. These are due to past management, including fire suppression and unregulated logging, that has resulted in conditions that raise the risk of catastrophic wildfire or otherwise threaten forest health and ecosystem integrity, and that may be remediated through non-silvicultural management actions. We include in this category Sudden Oak Death (SOD), which is evidently spreading throughout the La Honda Forest, causing a die-off of tanoak in some areas, and potentially affecting other species as well.



La Honda Forest Project
La Honda Creek Open Space Preserve
Midpeninsula Regional Open Space District (MROSD)
True North
Grid North
Mag. North
MAGNETIC DECLINATION: 13.3° E ± 0.33° changing by 0.08° W per year
0
0.25
Miles 0.5
Kevin McManigal
Sicular Environmental Consulting 2021
Figure 4.1 - 2019 Aerial Photos with Place Names
State Highway
Paved Road
Dirt Roads
Hiking Trail
Perennial Streams
Intermittent Streams
Project Border
Preserve Border
Imagery Source: https://services.arcgisonline.com/
Projection: NAD 1983, State Plane California III FIPS 0403, Feet
122°17'30"W
122°17'0"W
122°16'30"W
122°16'0"W
37°23'30"N
37°23'0"N
37°22'30"N
37°22'0"N
37°21'30"N
37°21'0"N
Sky Londa
Redwood Cabin
La Honda Ck.
Harmon Parcel
Allen Rd. Pond
White Barn
Darling Parcel
Harrington
Creek
Tributaries
Conservation
Management
Unit
Lone Madrone Pond
The Bathtub
Weeks
Ranch
Red Barn
Lower Pond
La Honda Creek
Harrington Ck.
Weeks Creek
La Honda Rd
35
84

This page intentionally left blank

Non-structural impairments to forest recovery that we have observed within the La Honda Forest include the following:

- In redwood-dominated conifer stands with high canopy closure, thick duff accumulation inhibits development of an herbaceous layer and adds to wildfire hazard. Thick duff layers pose a hazard in the form of surface and ground fire severity. Severe smoldering ground fires lack the dynamism of surface and crown fires, but their long residence times can make them capable of lethal root scorch and mortality levels that rival fast-spreading, high-intensity fires. In some locations with high duff loads, wildfire hazard is increased by presence of ladder fuels.
- Erosion and stream sedimentation above natural background levels persist, due mostly to the legacy of early tractor logging, leading to loss of topsoil, gullying and other scarring of the land, and degradation of aquatic habitat and water quality.
- At the margin of some conifer stands bordering on grasslands, including stands containing a substantial number of old growth trees, grass and brush encroaching into the conifers poses the risk of rapid spread of fire from grasslands into the conifer stand, raising the potential for conifer damage or mortality in the event of wildfire.
- Rapid die-off of tanoak infected with SOD leaves canopy openings, heavy fuel loads, and an uncertain development trajectory.

Restoration and Management Options

The remainder of this chapter examines current conditions, identifies IFCCs and non-structural impairments, and provides options and recommendations for forest restoration of the following areas, which are shown in Figure 4-1:

- Harmon Parcel
- Allen Road/White Barn Area
- Conservation Management Unit
- Northern/Redwood Cabin Area
- Weeks Ranch/Red Barn Area, including the Bathtub Loop
- Harrington Creek Tributaries

Harmon Parcel

Current Conditions

Following the original clearcut, the 50-acre Harmon parcel was managed for timber production and reentered at least 3 times, in 1965, 1975, and 1988 (THP 1-88-467-SMO), using uneven-aged, single-tree selection silviculture. Ed Tunheim was the forester of record for the 1988 THP, and the forest here bears his stamp: well-spaced (but not uniformly spaced), vigorous, second-growth redwoods, a high degree of canopy closure, with some scattered residual old growth trees. There is a good component of larger trees throughout the parcel: dominant trees with well-developed crowns, good mechanical stability, and large girth. Most of the Harmon Parcel is classified as stand type Y1RD (young growth, very high canopy closure, redwood and Douglas-fir), which averages 18 trees per acre over 35” diameter at breast height (DBH). Conifer volume averages approximately 54,000 board feet per acre (bf/acre) gross over the 50-

acre Harmon parcel, but is higher within the Y1RD type. Annual growth is vigorous, at 7% (basal area, per year) within the Y1RD type, indicating very good site quality. Within the Harmon parcel, the ground is moderately steep to low gradient, with headwaters of Harrington Creek flowing through it. The stand grades quickly to drier, sparser types upslope (particularly the northern portion of the parcel), where there is a higher component of Douglas-fir and hardwoods. A former logging road extends from the parking lot at Bear Gulch Road, winds down to and across the creek, then continues east along the north side of the creek. Preliminarily, few erosion and sedimentation problems appear to be associated with this road, or with other old skid trails and landings within the Harmon parcel.

Harmon Parcel Structural Impairments

IFCC-1: High density of redwood regrowth stands

IFCC-3: Douglas-fir and brush encroachment into mature hardwood and mixed hardwood/conifer stands

Non-Structural Impairments

- **Heavy duff layer in redwood stands**

The current structure and composition of the redwood-dominant areas of the Harmon parcel have been formed through single-tree selection, uneven-aged silviculture, consisting of low-severity cuttings and short cutting cycles. Left to its own, the stand is likely to develop more old growth character over time, as the larger, dominant trees with superior canopy position continue to gain size and dominance, and stand density slowly decreases through stem exclusion (i.e., shading and mortality of the smaller trees in inferior canopy positions). Current stem density, however, is undesirably high, placing this area into the IFCC-1 classification. Most of the redwood area in the Harmon parcel is stand type Y1RD (young growth redwood and Douglas-fir, very high canopy cover), which has about 200 stems per acre, with 66 larger than 11 inches, and 130 ingrowth stems between 5 and 11 inches DBH. The potential for the stand to regain old growth character and ecological function is constrained by that stem density.

Fuel loading in the Harmon parcel is moderate in the low-lying, redwood-dominated areas, which generally exhibit a light understory and lack of ladder fuels, but a thick duff layer. Surface fuel loading increases upslope in the drier forest types, particularly along the northern edge of the parcel, at the base of the slope that leads up to Allen Road. This area fits the IFCC-3 classification: there is a brushy understory, more flammable species, including Douglas-fir and hardwoods, and presence of ladder fuels.

Restoration Treatment Rationale

Left untreated, the redwood stands within the Harmon parcel can be expected to gradually regain old-growth character, including large tree size and attendant large tree features, wide spacing, and resulting habitat value. Silvicultural treatments, however, have the potential to accelerate recovery substantially, and at the same time increase resilience in the face of climate change.

Restoration Goals

Restoration goals for the Harmon parcel are to facilitate the recovery of a late seral, old growth redwood forest, to reduce fire hazard, and to increase the forest's resilience in the face of climate change.

Restoration and Management Options

Option 1: Restoration thinning, with timber sale (recommended)

The recommended option is to undertake a restoration thinning program to accelerate the acquisition of old growth redwood forest character in the Harmon Parcel. This would begin by identifying a cohort of "old growth candidate" trees for retention, around which thinning treatments would be focused. Restoration thinning would reduce stand density through low thinning of ingrowth, and crown release thinning targeting for removal those subdominants that are competing with the old growth candidates for canopy position. Prescriptions would be applied in at least two cycles, 15-20 years apart: the first cycle to reduce density from the current 200 trees per acre to about 100 trees per acre, targeting primarily suppressed ingrowth and subdominants up to about 30" DBH, and the subsequent entry or entries to reduce density to about 50 stems per acre, retaining approximately 30 trees >36" DBH, plus a scattering of smaller trees and ingrowth.

Thinning treatments are likely to produce a substantial volume of timber, and the Harmon Parcel is well suited for a timber sale: a haul road winds through the parcel and connects to Bear Gulch Road; there is a skid trail network; and Bear Gulch Road, though narrow and windy and used by residents, provides access to State Highway 35. The parcel is zoned Timber Preserve Zone (TPZ). Conducting the work under a THP, and selling the timber from the thinning treatments, is therefore feasible, and the recommended option. Because of these favorable conditions, there is the potential that revenue from sale of thinned trees may offset or exceed costs of the forest treatments. Slash from harvested trees will include tops and poor-form boles (or cull wood) that can contribute to coarse woody debris habitat. In the last entry, some number of the larger trees targeted for thinning may be deliberately felled to function as large coarse woody debris, if it is determined that the forest is still lacking in this important habitat element. Otherwise, commercial utilization of the merchantable components of thinned trees, and treatment of slash per the Forest Practice Rules will reduce activity fuels and limit a post-treatment spike in fire hazard.

Recommended treatment also includes a fuel reduction program to reduce duff accumulations and to address the issues of brush encroachment and ladder fuels in the northern, drier part of the Harmon parcel. If feasible, this could include a prescribed burn program, particularly in the bottom lands within the logging road loop, which could serve as a control line. The northern, drier part of the parcel would benefit from prescribed burning, but given the lack of a control line, and the presence at the top of the slope of residences, this appears infeasible. Instead, mechanical treatment, and, where feasible, piling and burning of slash, is recommended.

Option 2: Restoration thinning, no timber sale

This option would employ the same silvicultural restoration treatments and fuel reduction treatments as the recommended option, but without a timber sale (i.e. trees would be felled but not removed from the site). It appears that no permit would be required to undertake this option (a San Mateo County tree removal permit would not be required, as the two Assessor's parcels that make up the Harmon parcel are zoned Timber Preserve). This option would require strict protocols for management of slash and cut trees left on the ground, to reduce post-treatment fire hazard. Managing the logs and slash as fuels that result from leaving the trees on site is a significant undertaking. If not done properly, the benefits of reduced competition between trees may be offset by increased fire hazard.

Option 3: Manage for sustainable timber production

The Harmon parcel could be managed for sustainable timber production, under a return to the short-cycle single-tree selection silvicultural system previously employed. Entries would be spaced 10-15 years apart, and in each entry about half of the incremental growth from the last entry would be cut. This would ensure increasing stocking over time, as the average tree diameter increases, while the density remains roughly the same. Larger second growth trees that would be retained as “old growth candidates” in a restoration thinning treatment would instead be considered eligible for harvest to release (that is, to concentrate growth on) the next generation of younger and smaller trees. The stand already likely meets CAL FIRE’s definition of “late seral” forest, and increasing average tree size would, over time, enhance the habitat value of the stand. Logging entries could be combined with fuel reduction treatments. This option would provide the opportunity for the District to demonstrate a “conservation working forest” approach to management.

Option 4: No silvicultural treatment

Given the current uneven-aged structure, and the presence of a cohort of residual old growth and larger second growth trees exhibiting good form and vigor, no treatment is a viable restoration strategy. Over time, the forest is likely to develop more old growth characteristics, though at a slower rate than if silvicultural restoration treatments were applied. Without thinning treatments, climate change may further slow stand development. Fuel treatments could be applied opportunistically, as part of the District’s overall wildfire risk reduction program.

Potential Next Steps

Options 1 and 3 would require the preparation of a THP that would build on the data and management recommendations in this report. A THP must be prepared by a Registered Professional Forester (RPF). The cost for preparation of a THP is estimated at about $65,000. THPs have their own public process, are equivalent to the California Environmental Quality Act (CEQA), and are administered by CAL FIRE as the lead agency. The RPF would evaluate fine-scale forest structure and composition metrics (down to the level of each stand) to develop site-specific prescriptions and associated marking rules for each harvest. This would be the basis for a cost and revenue estimate. Under a restoration regime (option 1), revenues generated from the sale of timber may cover or exceed the costs of the treatment, including developing the THP. The other important consideration is that a THP can be used to conduct other forest management activities in addition to commercial harvest, including fuels treatment, road upgrades, and other needed work. Therefore, a THP that applies to a broader area of the La Honda Forest beyond the Harmon Parcel may provide the most benefit from the perspective of cost, efficiency, and process (these efficiencies are discussed in greater detail below with each administrative area). Option 1 would add to the growing number of projects in the Santa Cruz Mountains that are applying this technique to manage redwood forests.

Option 2 would not require a THP, but would likely require a CEQA finding by the District as the Lead Agency, even if no permit is required by San Mateo County. District staff have relayed a recent range of costs for Initial Studies and Mitigated Negative Declarations in the $60,000+ range. Additional stand-scale prescriptions would need to be developed and implementation overseen by a RPF, at additional cost.

Allen Road/White Barn Area

Current Conditions

The Allen Road/White Barn area includes the area around Allen Road, Coho Vista Trail, Coho Vista Trail Loop, and Cielo Trail. The historic White Barn is located within this area, which was part of the Dyer Ranch. For the purposes of restoration planning, this area is bordered on the east by the CMU, on the north by Allen Road and the Cielo Trail, and on the west and south by the break in slope (corresponding to the edge of the grassland) into the wooded drainages that are tributary to Harrington Creek. Public use (hiking) is by permit only. It is characterized by mixed dry conifer-hardwood forests along the ridgelines within a matrix of rolling grasslands. The approximately 24 acres of forest include stand type YR4D (young growth and residual old growth Douglas-fir, low canopy density) and Y3H (young growth hardwoods, moderate canopy density). The understory appears to be botanically rich in the hardwood-dominated stands. Some previously forested areas may have been cleared for pasture or flax production, and are now returning to forest cover. The grasslands may have been dry-farmed for flax in the mid-20th century, and are now unmanaged. Through fire suppression, areas of mature mixed hardwood/conifer stands have developed a dense understory of shrubs, hardwoods, and Douglas-fir sprouts, placing these stands in the IFCC-3 classification. In some areas, vigorous Douglas-fir have grown through the hardwood canopy and are shading out the hardwoods as their crowns expand. These areas exhibit high surface and aerial fuel loads, and the fire hazard is exacerbated by the presence of ladder fuels. Because of their location along travelled roads in proximity to neighboring residences, they are at high risk of ignition.

The grasslands of the Allen Road/White Barn area are largely unmanaged. They are not included in the District's conservation grazing program due to lack of infrastructure, such as cross-fencing and water sources. These ruderal annual grasslands grow to several feet in height. They are being encroached upon by brushy species, particularly coyote bush *(Baccharis pilularis*). The proximity of the unmanaged grasslands to forested areas that they border, including the mixed conifer-hardwood stands described above, as well as conifer stands at the top of the CMU, poses a particularly high fire hazard. Grasses and shrubs grow up to and into the margin of the forest stands, presenting a risk of fire spreading into the trees. There is a relatively high density of residual old growth redwood and Douglas-fir along the top of the CMU, as well as in the conifer stand to the west of the southern end of the Coho Vista Trail. Fire spreading into these stands could damage or kill some of these ecologically important forest elements.

Allen Road/White Barn Area Structural Impairments

IFCC-3: Douglas-fir and brush encroachment into mature hardwood and mixed hardwood/conifer stands

Non-Structural Impairments

- **Grass and brush encroachment into adjacent conifer stands**

Restoration Treatment Rationale

Left untreated, and in the absence of wildfire, the hardwood stands are likely to continue the successional process toward replacement by Douglas-fir, with an attendant loss of biodiversity. Fuel loading and hazardous fuel structure can both be expected to increase. If a wildfire does occur, there is a high potential for initiation of stand-replacing high-intensity crown fire and its spread to adjacent redwood and mixed conifer forest.

Restoration Goals

The goals of restoration treatment are to reduce fire risk and hazard; to maintain mid-seral ecological conditions and promote biodiversity; and to simplify future maintenance.

Restoration and Management Options

Option 1: Shaded fuel breaks, prescribed burning (recommended)

The recommended restoration treatment option is creation of shaded fuel breaks in the hardwood and Douglas-fir stands throughout the Allen Road/White Barn area through low thinning, followed by piling and burning or chipping of slash. Treatments should be laid out along roads, extending as far into the stand as budget allows; fire hazard reduction declines with distance from roads, but ecological benefits do not. Per the draft Wildland Fire Resiliency Program, shaded fuel breaks are limited to 200-foot width, and then transition to “Fuel Reduction Areas, ” (FRA). Douglas-fir removal should target stems that are entangled in or overtopping and shading the crowns of mature hardwoods selected for retention, and those smaller trees growing within their dripline. In general, larger Douglas-fir, particularly those entangled in or emerging above the crowns of hardwoods, should be girdled instead of felled, to reduce damage to retained hardwoods. Older, larger Douglas-fir individuals, particularly those with large, “wolfy” branches, established Douglas-fir groves, and a sparse cohort of younger Douglas-fir growing in canopy openings between hardwoods, should be retained.

Following initial treatment, it may become feasible to maintain these stands through a prescribed burn program. In addition to reducing accumulated fuels, periodic burning would prevent encroachment by brushy species and Douglas-fir, and would spur regeneration of a botanically diverse understory. If prescribed fire is infeasible due to Air District regulations or proximity of residences, then periodic mechanical treatment using hand crews, masticators, or goats may be substituted, though with less ecological benefit.

Prescribed burning is also recommended to manage the grasslands of the Allen Road/White Barn area, both to reduce fire hazard and to reverse brush encroachment. Prescribed burning should be timed to consume brushy species, but to avoid spread of the fire into the heavier fuels of the adjacent forest stands, especially those with an old growth component. If prescribed fire is infeasible due to Air District restrictions or proximity to residences, alternatives could include conservation grazing, though this would require development of grazing infrastructure; or mechanical treatment, such as mowing. Brush in the understory at the margin of the CMU could be reduced with hand crews, and either chipped or piled and burned.

Option 2: No treatment

Without treatment, fire hazard can be expected to increase over time, and succession of the hardwood stands would proceed, resulting in a loss of biodiversity.

Potential Next Steps

No commercial utilization of forest products would occur under recommended option 1, and so a THP would not be necessary for implementation. A THP could, however, be used as the permitting umbrella, and may be cost effective if the Allen Road/White Barn treatments are part of a larger project within the Preserve. Since the recommended treatments are all focused on fuel reduction, option 1 could also be undertaken through the District's Wildland Fire Resiliency Program.

Conservation Management Unit

Current Condition

The Conservation Management Unit (CMU) is a 440-acre area in the central eastern portion of the La Honda Forest, of which 350 acres are predominantly conifer forest, mostly redwood; another 20 acres are hardwood, and the remainder are grassland with patches of hardwood. Topographically, the CMU extends from the ridgeline along which the Cielo Trail and Coho Vista Trail run, down to and in some areas across La Honda Creek, an elevation difference of about 1,200 feet. There are two unnamed tributaries to La Honda Creek that drain the CMU. In the southern portion of the CMU, there is a high density of skid trails, and there are at least two old logging roads, all in varying states of decay (see Figure 3-2 in Chapter 3, and Appendix A, Road Inventory). There are also remnants of a washed-out bridge and a partially washed-out Humboldt crossing on La Honda Creek. These are legacies of past logging operations (see historical logging discussion in Chapter 3).

The original, first-entry logging of the CMU in the late 19th or early 20th century was incomplete: throughout the area, there remains a substantial, though dispersed, cohort of large old growth and smaller residual old growth redwood, as well as some old growth Douglas-fir, with a concentration of these large old trees along the ridge at the top of the unit. As discussed in Chapter 3, the 1962 logging, which logged the southern part of the CMU very heavily, appeared to adhere to the State requirement then in effect to retain at least four 18-inch diameter or greater "seed trees" per acre. The 1962 loggers may have used some of the remaining old growth to fulfill this requirement, but there is now also a cohort of large second growth trees that may also have been seed trees. These are likely sprouts from after the original entry, and so now are well over 100 years old. The remainder of the conifer stands in the southern CMU consist mostly of third-growth redwood that regenerated from stump sprouts after the 1962 logging entry. There are also numerous young growth redwoods with broken tops. These may have been small trees at the time of the 1962 logging that were left standing but were damaged by falling and yarding operations, or perhaps were damaged in a windstorm since then.

The 69-acre Darling parcel, which makes up the northeastern part of the CMU, has a different logging history. It was likely entered first around the same time as the rest of the CMU in the late 19th or early 20th century, but appears not to have been subjected to logging since then, or perhaps only a partial and light entry. It was not included in the 1962 logging. There is a paucity of abandoned roads and skid trails compared to the rest of the CMU, and the conifer stands here include both residual old growth and very large second-growth trees that likely regenerated after the original cut: in some areas, it is difficult to distinguish the second growth trees from the residual old growth.

With the exception of one area of oak grassland in the southern portion of the CMU and a small hardwood patch in the northern portion, this area is mapped as a nearly solid block of conifer forest (see

Figure 2-3 in Chapter 2). Upon closer examination, however, patterns emerge in the distribution of species and growing conditions. At a broad scale, along a roughly north-south axis parallel to La Honda Creek, the land dips into and out of the tributary canyons, alternating between moister swales and drier ridges, corresponding to stands that tend more to conifer or to hardwood. At a finer scale, the conifer-dominated areas exhibit a range of site quality. This appears to be related to the benchy topography, caused by mass wasting and colluvial deposits, which create locally deep soils on the benches, and thin soils on the landslide-steepened slopes. In addition, shallow or emergent groundwater occurs frequently, and there are small alluvial benches located sporadically along the tributary channels. While much of the redwood-dominated area contains practically no understory, there are patches of redwood sorrel (*Oxalis oregana*) in some of the wetter areas. In some of these favored locations, the presence of a high density of very large redwood stumps, and in some places remaining old growth trees of extraordinary girth, attests to remarkable site quality. Some of these areas were evidently formerly "cathedral groves" – concentrations of old growth trees of large girth and no doubt great height. Even now, there are scattered trees over 200' height, especially concentrated in the riparian corridor along La Honda Creek and around the confluence of the northern tributary and La Honda Creek; see Figure 4-2.

On the drier ridges between the swales, the forest tends more to hardwood and lower canopy density. These areas have a more abundant and diverse understory. Some of these drier areas were, until recently, occupied primarily by tanoak, which in places has died off, apparently from SOD.

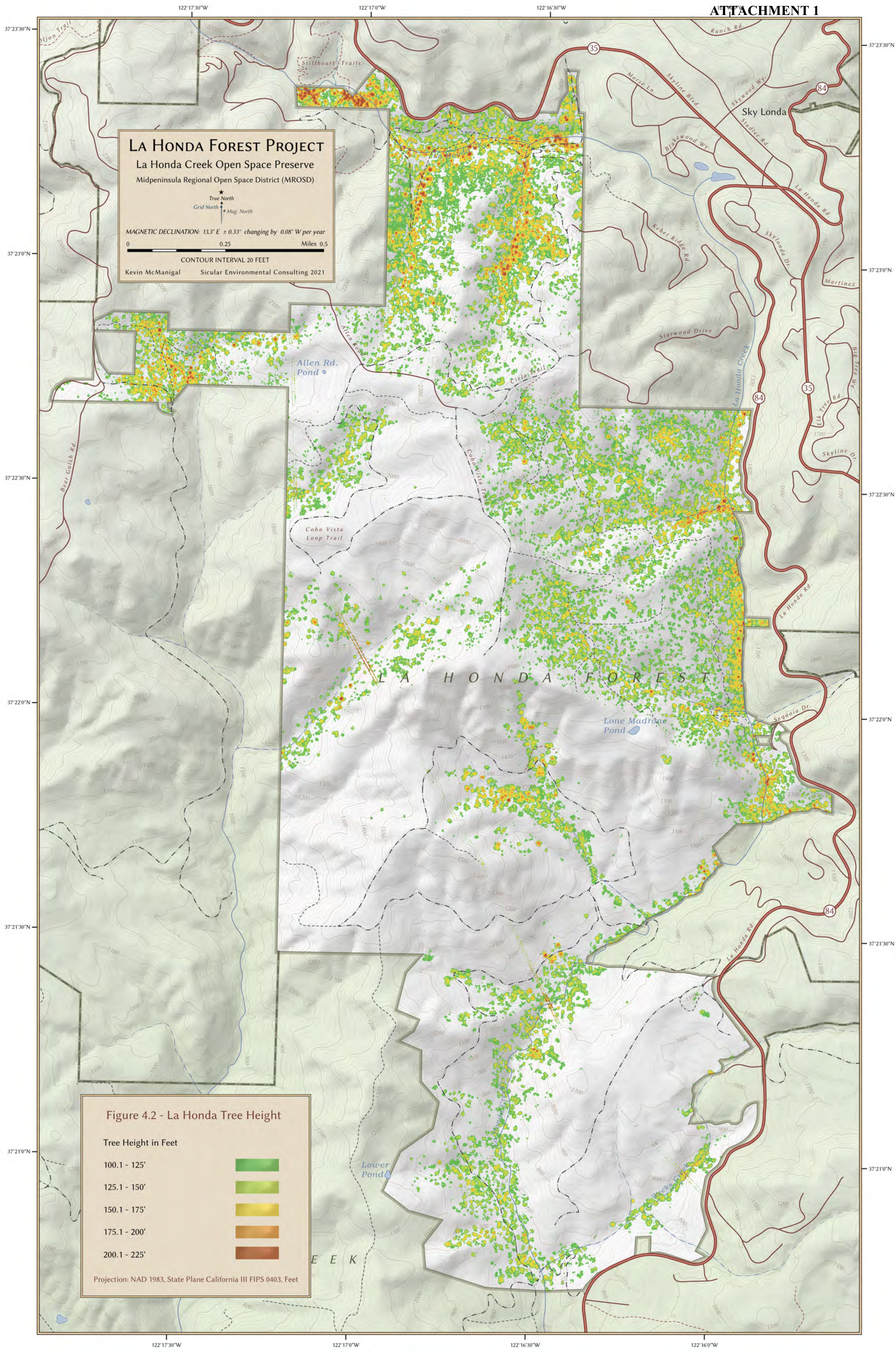
Fuel loading in the CMU is generally moderate. There is a deep duff layer in much of the redwood-dominated area, some presence of ladder fuels, and in some areas a high density of small trees and brush. The dying tanoak patches have large accumulations of heavy down and dead fuels, though limited in extent. The unaffected hardwood stands tend also to have a brushy understory. As previously noted, the unmanaged grasslands that abut the CMU at the top of the ridge along the Coho Vista Trail, and the brushy fringe at the margin that has undergrown the conifers, present a particularly high risk of destructive wildfire, imperiling the old growth trees that occur there.

Overall, the 370 forested acres of the CMU contain over 23 million board feet (gross) of standing timber, or about 64,000 board feet per acre (gross), reflective of the advanced regrowth of this forest (old growth redwood stands typically contain 100,000 board feet per acre or more). The forest inventory (Chapter 2) classifies the conifer areas of the CMU as several stand types: RY2RD (residual old growth and young growth redwood and Douglas-fir, high canopy cover), YR2RD (young growth and residual old growth redwood and Douglas-fir, high canopy cover), YR3RD (young growth and residual old growth redwood and Douglas-fir, moderate canopy cover), Y2RD (young growth redwood and Douglas-fir, high canopy cover), and Y3RD (young growth redwood and Douglas-fir, moderate canopy cover).

CMU: Structural Impairments

IFCC-1: High density of redwood regrowth stands

IFCC-1 is prevalent throughout the CMU, though not uniformly so. Much of the CMU is nearly pure redwood, and there is a desirable range of age/size classes, including a substantial cohort of old growth and old second growth trees. Stem density, however, is higher than desirable, as trees compete for canopy position, thereby inhibiting radial and vertical crown development and overall growth rate of the dominant trees. The stem density may also render these stands more vulnerable to drought and heat stress, as trees compete for seasonally limited soil moisture.


La Honda Forest Project
La Honda Creek Open Space Preserve
Midpeninsula Regional Open Space District (MROSD)
True North
Grid North
Mag. North
MAGNETIC DECLINATION: 13.3° E ± 0.33° changing by 0.08° W per year
0
0.25
Miles 0.5
CONTOUR INTERVAL 20 FEET
Kevin McManigal
Sicular Environmental Consulting 2021
Figure 4.2 - La Honda Tree Height
Tree Height in Feet
100.1 - 125'
125.1 - 150'
150.1 - 175'
175.1 - 200'
200.1 - 225'
Projection: NAD 1983, State Plane California III FIPS 0403, Feet
LA HONDA FOREST
Sky Londa
Allen Rd. Pond
Lone Madrone Pond
Lower Pond
Coho Vista Loop Trail
Stillheart Trails
122°17'30"W
122°17'0"W
122°16'30"W
122°16'0"W
37°23'30"N
37°23'0"N
37°22'30"N
37°22'0"N
37°21'30"N
37°21'0"N

This page intentionally left blank

Non-Structural Impairments

- **Fuel accumulation.** The absence of fire has resulted in thick duff accumulation. The duff layer inhibits development of an herbaceous layer and adds to wildfire hazard. In some locations, wildfire hazard is increased by presence of ladder fuels, which is also linked to the absence of frequent, low-intensity fire.
- **Erosion and sedimentation.** As noted above, and as detailed in Appendix A, there is a high density of old logging roads and skid trails within the CMU that were left to decay after the last logging entry. There are numerous diverted stream crossings, gullies, partially washed-out Humboldt crossings, and fill failures that continue to contribute sediment to La Honda Creek, degrading water quality and aquatic habitat, including inhibiting productivity of the salmonid fishery. San Gregorio Creek, to which La Honda Creek is a major tributary, is impaired for sediment with a 303(d) listing from the Regional Water Quality Control Board. That agency is currently evaluating its regulatory options to improve water quality.
- **Grass and brush encroachment.** At the western margin of the CMU, bordering on the grasslands in the Allen Road/White Barn area, grass and brush encroaching into the conifers pose the risk of rapid spread of fire from grasslands into the conifer stand, raising the potential for conifer damage or replacement in the event of wildfire.
- **SOD infestation.** SOD appears to have infested and is rapidly killing enclaves of tanoak within the CMU, leaving behind large canopy openings and fuel accumulations. In the short term, this poses a high fire hazard, though these patches do not occur close to high-risk ignition sources; in the longer term, it is unclear what will grow into the vacated space.

Restoration Treatment Rationale

Left untreated, the redwood stands within the CMU can be expected to regain old growth character gradually, including large tree size and attendant large tree features, wide spacing, and resulting habitat value. Silvicultural treatments, however, have the potential to accelerate recovery substantially, and at the same time to increase resilience in the face of climate change. Climate change stresses may be most felt at the margins of the redwood-dominated stands, in the transition to drier forest types. With increased summer heat, decreased summer fog, a shortened rainy season, and deeper and more frequent droughts, redwood may decline and eventually fail in some of these marginal areas, while it persists in the moister canyon bottoms and benches. These marginal areas may, however, become more suitable for Douglas-fir, which is more tolerant of drier conditions. Silvicultural treatments, including favoring retention of existing Douglas-fir, and, where absent, planting Douglas-fir seedlings, may facilitate this transition, while avoiding a lengthy period of ecological disruption, including a diminution of the extent of the conifer forest, until a new dynamic equilibrium is reached.

The legacy of the 1960s logging entry is still seen in extensive scarring of the landscape, altered hydrology, and increased sedimentation of La Honda Creek. While much of the erosion and sediment delivery potential has already been realized, many features continue to erode and contribute sediment to the stream system (see Appendix A, Haul Road Sediment Source Inventory). San Gregorio Creek, to which La Honda Creek is tributary, is listed under the federal Clean Water Act as an Impaired Water

Body for high sediment levels. Moderate fuel loading, and hazardous fuel structure along the upper margin of the CMU where brush is encroaching into the conifer stand, pose substantial fire hazards.

Restoration Goals

Restoration goals for the CMU are to facilitate the recovery of late seral, old growth conditions, in particular restoring the apparent former majesty of the cathedral groves; to address legacy logging features that continue to degrade aquatic habitat; to reduce the risk of wildfire and protect remaining old growth trees; and to increase the forest's resilience in the face of climate change.

Restoration and Management Options

Option 1: Protect existing old growth and old second growth individuals; accelerate development of old growth character in favored, high-site locations; inventory and address high priority legacy erosion problems (recommended)

The CMU has a substantial component of old growth and advanced second growth trees, some well over 100 years old and 200 feet tall (Figure 4-2). These trees should of course be retained and protected. Recommended treatment includes judicious thinning around the old growth and large second growth individuals, to reduce competition and fire hazard. Recommended restoration thinning treatments are also aimed at recreating cathedral groves in portions of the CMU where the presence of large stumps and vigorous regrowth indicate extraordinary growing conditions for redwood. This would involve thinning to the approximate number and spacing of the original stand, and retaining those trees with the best form and vigor as well as a cohort of trees with unusual characteristics, such as reiterated trunks, melded boles, large branches, and exaggerated burls. Thinning treatments would preferably be applied over two or three entries, 10-15 years apart, to avoid large canopy openings and to allow retained trees to exhibit a release response before selecting the next cohort for thinning. In more marginal areas, particularly in the transition between moister canyon bottoms and drier canyon sidewalls, and also higher on slopes where redwood-dominated stand types transition to hardwood or hardwood/Douglas-fir types, thin redwoods and favor retention of Douglas-fir, if present. If no Douglas-fir is present, plant Douglas-fir seedlings into canopy gaps at an initial rate of 950 per acre (6.5' spacing), then thin as the planting matures, but maintain a closed conifer canopy once established. This managed transition to Douglas-fir should be undertaken on an experimental basis and monitored closely.

The recommended option includes initiation of a prescribed burning program to reduce the duff layer and burn out brush and overcrowded and suppressed small trees. Prior to a prescribed burn, a mechanical pre-treatment is recommended to set-up a successful low-intensity burn. Details of the pre-treatment would be developed as part of a stand-specific prescription. The prescribed burning program should encompass pure coniferous stands with thick duff accumulations, as well as drier areas with more hardwood. If practical, prescribed burning could include SOD-decimated tanoak patches, which could then be planted with mixed hardwoods and Douglas-fir. Prescribed burning may have the co-benefit of spurring regeneration of the herbaceous layer, which is absent from much of the redwood-dominated area, and which is fire-dependent in the hardwood areas. The most likely location to begin prescribed burning is from the upper edge of the CMU along the Coho Vista Trail, which can serve as a control line, down to the two cross-slope logging roads, which can be used for firing operations. The logging roads can then serve as the next control line for continued burning down the slope.

The recommended option also includes completing the assessment of sediment sources and treating higher priority sites to reduce erosion and stream sedimentation. Appendix A is a sediment source inventory of the main logging haul road through the CMU, now deteriorated and mostly impassable, particularly in the lower half of the road. The inventory analyzes numerous road failures, failed crossings, stream diversions, and other road problems, many of which continue to erode and contribute sediment to La Honda Creek. The upper portion of the road is still accessible for earth-moving equipment, but the lower part is not. There is a second logging road to the south of the main road, which has not been assessed, along with numerous spur roads and a dense network of old skid trails, all left from the 1962 logging entry. Recommended treatment begins with completing the inventory of these legacy features, including an assessment of their future sediment contribution potential and accessibility for treatment. This would be followed by treatment of the higher priority sites that can reasonably be accessed. As noted in Appendix A, reestablishing access to lower portions of the road would involve substantial disturbance and a short-term increase of sedimentation during construction and restoration. The benefit of mitigating these less accessible sediment sources is thus less than other similar sites. District staff have suggested the relatively high added expense of mitigating that sediment would better be allocated towards more accessible sediment sources elsewhere in the San Gregorio watershed, though the District could revisit this later. Portions of the road system could be upgraded and retained for fire access and/or as recreational hiking trails. If the District is considering opening the CMU to recreational use, treatments should also include opportunistic recontouring of road cuts, filling of dewatered gullies, and other landscape repair to achieve a more natural, less disturbed appearance.

Option 2: Restoration thinning with timber sale

Same as recommended treatment, but with a timber sale component. Under a Timber Harvest Plan (THP), thinned trees could be extracted and sold for lumber. A THP could also provide permitting authority for road upgrades or road abandonment.

Option 3: Prescribed burning program only

There is ample justification for passive restoration of this older, heterogenous redwood forest. With time, and in the absence of stand-replacing wildfire or decline from the effects of climate change, the forest can be expected to continue to develop, acquiring more old growth character, including some reduction in density from stem exclusion (shading out and mortality of suppressed trees) and persistence of those large trees that have already achieved a dominant canopy position. As discussed in the road inventory report in Appendix A, the inventoried failure sites along the main logging road continue to erode and, in some instances, deliver sediment to La Honda Creek. However, nearly 60 years after their last use, much of the potential damage has already been done, and the remaining sediment delivery potential is relatively low for most of the sites. District staff's visual reconnaissance suggests that this is likely true of the other roads, skid tails, and stream crossings within the CMU that have not yet been inventoried. If it is consistent with the District's obligations under the forthcoming San Gregorio Creek Water Quality Improvement Plan or TMDL, the District could allow the old road network to continue to deteriorate on its own and focus on higher priority sediment reduction sites elsewhere in the watershed. In this option, then, active treatment would focus on reducing the risk of high-intensity wildfire, through the prescribed burning program described above.

Potential Next Steps

Because the CMU is zoned Resource Management, a tree removal permit from San Mateo County is not required for thinning treatments or mechanical fuels reduction work prior to starting a prescribed fire program. Sediment reduction work could be undertaken pursuant to a County grading permit or a Timber Harvest Plan. The THP could be a “road-only” plan, that does not involve a timber sale, or, per option 2, could include a timber sale of trees felled in the restoration thinning treatments.

If the District wishes to phase in the restoration thinning in the CMU, it may opt to conduct the road work and other fuels treatments in the CMU under a THP that also includes a smaller scale restoration thinning pilot in the Harmon Parcel, for example. Then later, as the District gains experience with restoration thinning, expand the thinning treatment to include the CMU via a new THP or THP amendment.

The prescribed burning program could be undertaken as part of the District’s Wildland Fire Resiliency Program.

Northern/Redwood Cabin Area

Current Condition

The Northern/Redwood Cabin area includes the northern “peninsula” of the La Honda Forest, encompassing the area north of Allen Road and the Cielo Trail, and extending north to State Highway 35 (Skyline Boulevard) (Figure 4-1). This area includes the c. 1927 Redwood Cabin, a hunting and retreat lodge located near La Honda Creek, constructed of redwood timbers (ESA, 2015). Much or all of this area was formerly owned by the Allen family and their descendants, the Paulin family. The District acquired the property in 1988 (ibid). The mainstem of La Honda Creek runs through this area, roughly parallel to Highway 35, with two tributary channels, running roughly south to north. Except for scattered small hardwood stands and Douglas-fir stands north of Cielo Trail, the area is redwood-dominated conifer forest, most of it with a residual old growth component. Stand types include YR2RD, YR3RD, and YR4RD (young growth and residual redwood and Douglas-fir, high, moderate, and low canopy cover); RY2RD (residual and young growth redwood and Douglas-fir, high canopy cover), and Y2RD (young growth redwood and Douglas-fir, high canopy cover). The La Honda Forest’s greatest concentration of trees over 200’ tall occurs in the “bird’s beak” in the extreme northwest portion of this area, with additional tall trees downstream along La Honda Creek and the two tributary channels (Figure 4-2). In addition to being very tall, the forest along La Honda Creek consists of generally well-spaced, large second growth and residual old growth trees, with the largest trees growing in the alluvial flats along the creek. This stand appears to be recovering well from an incomplete first entry logging, which likely occurred in the 19th century and took the largest, best formed trees, leaving smaller and damaged trees standing. Another logging entry covering 62 acres encompassing main stem La Honda Creek and portions of the western tributary canyon occurred in 1978. Jim Greig was the forester, and the silvicultural method was single tree selection, with removal of no more than 40 percent of trees over 18” DBH (see Table 3-1 in Chapter 3). Protecting the scenic view from Highway 35 was stated as a goal in the THP. This entry likely targeted mostly smaller merchantable trees, improving spacing for the remaining largest trees, which now have achieved impressive size.

The tributary canyons also contain tall, large, advanced second growth and residual old growth redwoods concentrated in the canyon bottoms along the streams. The forest grades quickly to drier types upslope from the canyon bottoms. On these canyon side slopes, the redwoods tend to be clumpy, with the clumps well-separated from one another within a matrix consisting primarily of tanoak. This is a pattern typical of second growth redwood stands on lower quality site that have regenerated from an original stand characterized by widely spaced, moderate-sized individuals and small groups of old growth redwood. The redwood often formed a roughly contiguous, though narrow, conifer canopy stretching from the canyon bottom up the moister side canyons and swales, with mixed hardwoods and Douglas-fir occupying the higher and drier areas of the canyon slopes. Currently, SOD appears to be ravaging the tanoak within the tributary canyons: in October 2020, most of the tanoak observed was either dead and down or dying.

Structural Impairments in the Northern/Redwood Cabin Area

IFCC-2: Redwood isolates

The tributary canyons have moderately to widely spaced, advanced regrowth redwood clumps, with tanoak predominant in the spaces between clumps. While regrowth is advanced – much of this area may not have been cut since the original logging entry – the redwood canopy is still discontinuous.

Non-Structural Impairments

- **SOD infestation.** On the tributary canyon sideslopes, SOD appears to be killing much of the tanoak growing between redwood clumps, leaving behind large canopy openings and heavy fuel accumulations. In the short term, this poses a high fire hazard; in the longer term, it is unclear what will grow into the vacated space.

- **Invasive Species.** Slender false brome (*Brachypodium sylvaticum*) is a new and potentially destructive invasive species that is present in this area of the La Honda OSP. In Oregon, slender false brome has spread to over 10,000 acres and is a major environmental problem. In California, slender false brome has been given the highest rating as a Class A Noxious Weed. A perennial bunch grass originally from Europe, Asia, and North Africa, slender false brome is capable of achieving over 90% ground cover, inhibiting the growth of tree seedlings, and replacing native vegetation.

  The District is managing slender false brome in its OSPs, including Thornewood OSP and La Honda OSP. There are, however, infestations within surrounding private properties. Working together with the local community, the District hopes that slender false brome can be eradicated before it spreads throughout the state, becomes unmanageable, and alters the area's redwood forests and natural environment.

- **Double Culvert Crossing at La Honda Creek**. Access to this portion of the property from the north is via a gate (LH04) off Highway 35, Skyline Boulevard. This is the primary ingress and egress from this portion of La Honda OSP, though it is also accessible from Allen Road and the Cielo Trail. PG&E accesses their power lines via gate LH04, as well. The main crossing over La Honda creek is over a double culvert beneath a sandwiched retaining wall. The culverts appear undersized (per Midpen staff's evaluation and prior assessments from Tim Best) and the outlets are shotgunned and eroding in a headcut. The crossing is also narrow compared to normal bridge standards and without guardrails. While this is a low-traffic area, there is a risk of a culvert failure, resulting in substantial sediment input to the creek, as well as loss of access. The risk of sedimentation from the crossing would come from plugging or the culverts' further corrosion. The size of the crossing and the watershed above it make it unlikely to be suitable for an in-kind replacement. Either an arched culvert or a bridge is likely warranted. Further assessment is needed from a civil engineer or other qualified professional.

Restoration Treatment Rationale

Reestablishment of the contiguity of the canopy of the narrow conifer corridors, and development of large trees with old growth features, would restore late seral habitat to suitable areas of otherwise marginal steep canyons, likely establishing a moister microclimate and reducing the vulnerability of redwoods to climatic stresses and wildfire.

Restoration Goals

Reestablish conifer occupation of side canyons, eventually achieving contiguity of narrow corridors of conifer canopy in moister swales.

Restoration and Management Options

Option 1: No immediate treatment (recommended)

The redwood-dominated stands along the mainstem and tributary streams are recovering from past disturbance and are likely to persist as riparian redwood forest and continue to develop old growth character and characteristics without intervention: no IFCCs are identified in these areas, and no restoration treatments are recommended. The IFCC-2 areas on the sidewalls of the tributary canyons are already undergoing a rapid and profound transition, due to a heavy SOD infestation that is decimating tanoaks; typically, IFCC-2 indicates thinning of tanoaks that have displaced Douglas-fir and that are competing with redwood for canopy space, but here, SOD is having the same result. With the tanoak die-off, the future of this area is uncertain. Presumably, the disappearance of the tanoak canopy will enable the sprouting of other species (as well as tanoak, though the tanoak will likely succumb to SOD before reaching maturity). There may be a transitional period during which brushy growth, potentially including invasive species, raises the fire hazard to unacceptable levels, prompting some fuel reduction treatments to protect redwoods and upslope areas. The existing redwood may exhibit an increased growth rate, due to greater availability of light and less competition for soil moisture and nutrients. Planting Douglas-fir and mixed hardwoods may be beneficial to reestablish a closed canopy forest, and to mimic the presumed pre-disturbance species composition, particularly since a seedbank for Douglas-fir and hardwoods other than tanoak may be absent.

Potential Next Steps

As no immediate treatment is recommended for the Northern/Redwood Cabin area, next steps may include monitoring of the progress of the SOD infestation, and the forest’s response to it, to ascertain whether active management, such as fuel reduction or planting of native trees, is warranted. Continued slender false brome management is recommended, as well as the assessment/replacement of the double culvert. The culvert work could be undertaken within a THP (potentially saving permitting costs) or through standard County, State, and federal permitting efforts.

Weeks Ranch/Red Barn Area

Current Conditions

This area includes the southern portion of the La Honda Forest, and encompasses portions of the historic Weeks Ranch, including the area around the Red Barn (Figure 4-1) (also known as the McDonald Ranch and, briefly, the Rockin Martini Ranch). There are three conifer areas: the Bathtub Loop and, to the south, riparian redwood corridors along La Honda Creek and Weeks Creek. The La Honda Creek riparian corridor extends upslope away from the creek a considerable distance, especially on the right (western) bank. The Bathtub Loop and the La Honda Creek riparian corridor were both logged selectively in the 1970s and 80s (Table 3-1 in Chapter 3), but there is no record of logging of Weeks Creek, except for the area near the confluence with La Honda Creek in 1986. This area was not included in the 1962 logging (Figure 3-2 in Chapter 3). The conifer areas are limited in extent, but where they occur, site quality is high, as is canopy closure. Stand Types include extensive areas of Y1RD, plus Y2RD (young redwood and Douglas-fir, very high to high canopy closure) and, in the Bathtub Loop, RY2RD (residual and young redwood and Douglas-fir, high canopy closure). The Weeks Creek riparian corridor is type Y2RD (young redwood and Douglas-fir, high canopy closure). Multiple age/size classes are typical in these stands, since they were previously managed under the single tree selection, uneven-aged system. Typically, the conifer transitions to hardwood-dominated stands upslope, then to grasslands. The grasslands are grazed under the District's Conservation Grazing Program, and the conditions of unmanaged grasslands on the forest edge and brush encroachment into the grasslands found in the Allen Road/White Barn area are not seen here. Fuel loading is generally light in this area. The Bathtub Loop is an extraordinary forest, though limited in extent: a large spring is located at its upslope end, and the area is very wet, contains a substantial residual old growth component, and very large second growth trees. There are several trees approaching 200' tall (Figure 4-2). The combination of factors – low fire hazard in the grasslands adjacent to the stands, low surface fuel availability due to proximity to springs and riparian corridors, and limited spatial connectivity among stands – collectively results in a modest wildfire threat to stands in this area.

Structural impairments in the Weeks Ranch/Red Barn Area

IFCC-1: High density of redwood regrowth stands

Most of the conifer stands were selectively logged in the 1970s and 80s. These stands are uneven-aged, with generally good spacing and exhibiting good vigor. While stem density is much higher than it was in the pre-disturbance forest, the limited size of these stands means that they have a high ratio of edge to area, which reduces competition for light, compared to similar stands with greater extent. The Bathtub Loop was evidently not clearcut, retains a substantial component of the old forest, and is well on its way to recovery of old growth character. While the IFCC-1 condition is evident in this area, the impairment is minor, and unlikely to substantially inhibit stand development along a desirable trajectory.

Non-Structural Impairments

None observed.

Restoration Treatment Rationale

Reducing the density of the conifer stands through retention of the residual old growth and large second growth trees, and thinning smaller trees, would accelerate reacquisition of old growth character.

Restoration Goals

Restoration goals for the Weeks Ranch/Red Barn area are to facilitate the recovery of a late seral, old growth redwood forest, and to increase the forest's resilience in the face of climate change.

Restoration and Management Options

Option 1: No treatment (recommended)

Though somewhat higher density than desirable, the relatively narrow conifer stands in the Weeks Ranch/Red Barn area have otherwise favorable species composition and structural characteristics, and can be expected to continue to develop old growth stature and character, without intervention (i.e. active intervention is not needed to adjust the trajectory of the stand towards a desirable condition). If the adjoining grasslands are burned periodically under the Conservation Grazing Program, the burns could include the goal of managing brushy ingrowth at the margins of the conifer stands.

Option 2: Restoration Thinning

Reduce stem density of redwood stands through selective cutting of smaller trees, particularly those competing with larger trees for dominant canopy position. Apply treatment through two or more cutting cycles, 15-20 years apart. Thinning could occur under a THP, in which case the logs could be sold. If it is determined that the salmonid habitat in La Honda Creek and Weeks Creek is degraded by a lack of large woody debris, or if simplified stream channels have undesirable sediment transport characteristics, trees in the riparian may be felled across the creek to add complexity and important habitat elements, under the Accelerated Wood Recruitment provision of the Forest Practice Rules (14 CCR § 916.9 [936.9, 956.9] (v)(2)). Prior studies have indicated La Honda Creek has a relative abundance of large wood in the stream, although site-specific conditions along these reaches have not been evaluated and further investigation is warranted.

Potential Next Steps

Next steps for the Weeks Ranch/Red Barn area include surveying La Honda Creek and Weeks Creek to determine whether large woody debris recruitment is warranted. A restoration thinning program (option 2) could be undertaken and included as part of a larger THP, or under a stand-alone THP.

Harrington Creek Tributaries

Current Conditions

There are two tributary drainages to Harrington Creek in the western portion of the La Honda Forest (Figure 4-1). The northern drainage borders on the Coho Vista Loop Trail. Both have substantial areas of redwood forest in the canyon bottoms and lower sidewalls (stand type Y2RD and Y3RD in Figure 2-3 in Chapter 2). The southern drainage contains the only continuous old growth grove within the La Honda Forest, a 4.1-acre redwood stand (stand type OY2R) that contains numerous trees greater than 5-feet

DBH, and a several above 8-feet DBH. The steep tributary canyon where this grove is located was previously logged, but incompletely: based on reconnaissance observation of this stand, about half of the old growth trees were cut. Old growth occur both along the stream channel on narrow alluvial benches, and up the steep side slopes of the canyon. Upstream, the southern drainage transitions to a sparse, upland redwood-Douglas-fir forest with a residual old growth component that extends to the western border of the CMU, near Coho Vista Point (stand type RY3RD). Elsewhere, both drainages tend to transition upslope to Douglas-fir-dominated stands, also with a substantial residual old growth component (stand type YR4D) or to hardwood-dominated stands (stand type Y3H), and then to the grasslands of the Allen Road/White Barn area. While old road alignments are present in both drainages, none appear to be usable without substantial repair and upgrade. Both drainages support ephemeral tributaries to Harrington Creek, which is itself tributary to San Gregorio Creek.

The Northern drainage and the northern part of the southern drainage were logged heavily, likely in 1962 at the same time as the CMU (Figure 3-2 in Chapter 3), and likely with the same seed tree retention requirement. (The Weeks Ranch property line apparently went through the southern drainage, so the southern portion was spared in 1962). There is no record of logging the southern drainage, but based on the presence of a logging road into and through the old growth stand, it was likely logged in the post-war, pre-Forest Practice Act tractor logging period.

Structural Impairments

IFCC-1: High density of redwood regrowth stands

The IFCC-1 condition is seen in the Y2RD stand in the northern drainage, just west of the Coho Vista Loop Trail, and is also likely present (though not seen) in the Y2RD and Y3RD stands in the southern drainage. Some areas of regrowth within the old growth stand contain a high number of small stems. Thinning would accelerate the recovery of the disturbed portions of this stand, and, to the extent that it reduces fuel loading and continuity, would protect the old growth trees.

IFCC-3: Douglas-fir and brush encroachment into mature hardwood and mixed hardwood/conifer stands

The hardwood-dominated stands at the margins of the grasslands at the top of the northern drainage, and to a lesser extent the southern drainage, have high fuel loads and, in some locations, Douglas-fir intruding into mature hardwoods. They are at risk of stand replacement from wildfire or, in the absence of fire, succession to another type. The YR4D stands may contain areas of IFCC-3, but the mature Douglas-fir groves are not considered impaired, and should be retained as a distinct type.

Non-Structural Impairments

- **Fuel accumulation.** Thick duff accumulation in redwood stands inhibits development of an herbaceous layer and adds to wildfire hazard. In some locations, wildfire hazard is increased by presence of ladder fuels and brushy undergrowth.
- **Erosion and sedimentation.** There is likely a high density of old logging roads and skid trails within the northern drainage and the northern portion of the southern drainage left after the logging entry in the early 1960s.

- **Brush encroachment.** At the upper margins of both drainages, brush encroaching from the grasslands into the conifer and mixed conifer-hardwood stands poses the risk of rapid spread of wildfire.

Restoration Treatment Rationale

The Harrington Creek Tributaries have a high incidence of old growth trees, including, in the southern drainage, the only relatively intact old growth redwood grove within the La Honda Forest. These old forest elements should be preserved and protected, including, where indicated, by thinning smaller, younger trees that are competing with the old growth. This would also have the co-benefit of improving the aesthetics of these stands, some of which are adjacent to publicly accessible trails. The drier forest types in the upper parts of both drainages are at risk of stand-replacing wildfire. If protected through reduction of wildfire hazard, they may provide a buffer against climate change by providing a seedbank that can enable this type to move downslope into the drainages, if redwoods retreat to the moister canyon bottoms.

Restoration Goals

Restoration goals for the Harrington Creek Tributaries are to preserve and enhance the existing old growth trees, to facilitate the development of young growth stands toward late seral, old growth character, to decrease fire hazard, and to increase the forest’s resilience in the face of climate change.

Restoration and Management Options

Option 1: Restoration Thinning with Timber Sale (recommended)

Similar to the CMU, the recommended treatment for the Harrington Creek Tributaries is to embark on a program of restoration thinning within the conifer-dominated stands, particularly the Y2RD and Y3RD types. These types lack a residual old growth component, so thinning treatments would target for retention advanced second growth trees, particularly those deemed good old growth candidates, and remove smaller, competing trees (low thinning and crown-release thinning). Thinning to improve aesthetics in the stands with an old growth component, particularly along the Coho Vista Trail, would be intentionally aimed at increasing the average size of standing trees. Thinning treatments could also be undertaken in the old growth grove in the southern drainage, to reduce small trees competing with the old growth. Thinning should be accompanied by general fuel reduction treatments, such as brush reduction, ladder fuel removal, and prescribed burning to reduce the duff layer and the brushy understory. Portions of the Harrington Creek Tributaries have good access, and the sale of thinned logs for lumber is likely a viable option. The Y2RD stand in the northern drainage, in particular, is very well-stocked (this type averages 81 mbf/acre net), contains many smaller trees of merchantable size that would be targeted in the restoration thinning, and is easily accessed from the Coho Vista Trail loop.

The IFCC-3 condition in the drier forest types in the upper portions of both tributary drainages should be addressed by creating shaded fuel breaks, through mechanical treatment to reduce horizontal and vertical fuel continuity, and by removal of encroaching brush and Douglas-fir. This should be followed by a prescribed burning program, if it is feasible, to maintain the reduced fire hazard condition, or periodic mechanical treatment if it is not. Mature Douglas-fir groves should be retained.

A sediment source inventory should be performed in the Harrington Creek Tributaries, to determine whether erosion and sediment control work is indicated. If so, this work should be coordinated with entry for thinning treatments. Both the thinning and the sediment reduction work could be permitted through a THP.

Option 2: Restoration Thinning without Timber Sale

This option is the same as Option 1, but without a timber sale and with thinned trees left on the forest floor. Consideration of this option should follow completion of the recommended sediment source inventory; it may still be advantageous to undertake erosion and sedimentation work with a THP, even without a timber sale. Slash management would be a major consideration under this option. Potential approaches include pile and burn, lop and scatter, and, in more accessible areas, chipping or biochar production.

Option 3: No Treatment

Portions of the Harrington Creek Tributaries avoided past stand-replacing disturbance, or have recovered well from it, and, in the absence of catastrophic fire, will likely retain and further develop old growth character without treatment. Passive restoration is therefore a viable option. This area, however, presents good opportunities for enhancing forest health, resilience, and beauty through silvicultural restoration, and for protection of the diversity and integrity of the several distinct forest stand types through fuel reduction treatments and, if feasible, the reintroduction of fire.

Potential Next Steps

Next steps for the Harrington Creek Tributaries include a sediment source inventory in both drainages, and development of a THP, either stand-alone for this area, or combined with other areas of the OSP. If road work is warranted, a THP may be the most efficient permitting vehicle, even without a timber sale (option 2). Fuel reduction treatments could proceed on a separate track as part of the District’s Wildland Fire Resiliency Program, or in conjunction with thinning treatments.

Adaptive Management and Monitoring

Forest restoration treatments should be considered within the context of an adaptive management framework (Rist et al, 2012), where the results of periodic monitoring, compared to baseline or previous data, are used to assess treatment effectiveness, and then the results of that assessment used to determine whether adjustments are needed to the treatment regime in order to meet previously stated goals, or in some cases, to reassess the goals themselves.

The forest inventory (Chapter 2) provides a robust dataset that will serve well for generally characterizing baseline conditions, and as a reference for future comparison to ascertain landscape-level changes. This can be easily accomplished through periodic repeats of measurements using the same sampling plots and methods. Since, however, silvicultural restoration treatments are to some extent experimental, specialized monitoring schemes for each treatment type should be developed to determine treatment effectiveness.

Treatment effectiveness takes various forms. Treatments rarely directly or immediately achieve a restoration goal; more commonly, they alter forest conditions and shift trajectories of vegetation dynamics and stand development in ways that – over time – more closely approximate a restoration target. Success therefore requires effectiveness at several levels. First, success requires that the specifics of the restoration treatment – the prescription - have been implemented essentially as planned. This cannot be assumed; the reality of prescription implementation under field conditions leads inevitably to transgressions of prescription details. Second, success requires that the residual stand responds to treatment as expected, and that unintended or unforeseen consequences of treatment are minimal. Those responses may be at the stand level (e.g. percent species composition, stand density, spatial heterogeneity), the tree level (e.g. growth rate, growth form, length of growing season), or sub-tree level (e.g. crown dimension, branch diameter, bark thickness).

The monitoring scheme for each treatment type, therefore, should include both implementation monitoring, which should occur during or immediately following implementation; and response monitoring, which should include specialized baseline monitoring prior to treatment implementation, and the response monitoring itself periodically following treatment. Typically, a 10-year period is sufficient to detect a response in the redwood forest.

Monitoring schemes should be developed for each treatment type. For example, the restoration thinning treatments recommended for IFCC-1 (high density of redwood regrowth stands) may be designed around the following treatment-specific questions: for implementation monitoring, have the old growth and old growth candidate trees been retained and left undamaged, and have competing trees been removed? Has the stand been thinned to the targeted density, in terms of spacing between individuals, and number of trees per acre? For response monitoring, are the old growth candidates exhibiting a release response in the form of robust growth (greater increase in DBH, expansion of vertical and lateral crown extent, compared to untreated but otherwise similar stands)? Have canopy gaps closed, indicating that it is time to continue the silvicultural treatment with another round of thinning? Are there unintended consequences of the treatment, or changed conditions not attributable to the treatment, that call into question the continued applicability of the treatment or suggest an altered management strategy – that is, should management be adapted based on new information?

The foregoing is intended only to help guide future considerations of monitoring of silvicultural restoration treatments. A more detailed adaptive management program, including detailed design of baseline and subsequent monitoring methods, should be developed as the District approaches implementation of silvicultural treatments.

Conclusion

Each administrative area delineated with the La Honda Forest has its own unique opportunities and constraints to improve the forest. This plan has been developed foremost with the intention of understanding the structure and character of the forest, largely through the forest inventory, identifying impairments, and developing appropriately detailed restoration strategies in each of the areas and forest types therein. The related issues of watershed management through sediment reduction and fuels management to mitigate stand replacing fires also inform the approach. The options given in this report are intended to provide the District with a rigorous, informed perspective to select projects to implement through subsequent contracting. This report is also intended to provide the District's constituents with information about forests and forest management. The concepts, data, and figures developed in this report are therefore intended to facilitate a conversation between District staff, its Board of Directors, and interested members of the community. Once a project or set of projects are selected, the appropriate regulatory vehicle can be selected (County permitting or a THP) that has its own public process. How to lump or split the various options herein is a complex matter, but we encourage the District to "think big" as the consequences of climate change, including greater potential for stand-replacing wildfire, are upon us.

References

Ecoadapt, 2020a. Climate Change Vulnerability Assessment for the Santa Cruz Mountains Climate Adaptation Project: Coastal Redwood Forest. Draft. Joint project of Midpeninsula Regional Open Space District, the Santa Cruz Mountains Stewardship Network, and Pepperwood Preserve.

______ 2020b. Climate Change Vulnerability Assessment for the Santa Cruz Mountains Climate Adaptation Project: Mixed Evergreen/Montane Hardwood Forests. Draft. Joint project of Midpeninsula Regional Open Space District, the Santa Cruz Mountains Stewardship Network, and Pepperwood Preserve.

Keyes, C.R. 2005. Forest Restoration and Reforestation Strategies for Humboldt Redwoods State Park: Impaired Forests in the Bull Creek Watershed. Report on File at North Coast Sector Headquarters. California State Parks, Eureka, California.

Lorimer, Craig G.; Daniel J. Porter, Mary Ann Madej, John D. Stuart, Stephen D. Veirs Jr., Steven P. Norman, Kevin L. O'Hara, and William J. Libby. "Presettlement and modern disturbance regimes in coast redwood forests: Implications for the conservation of old-growth stands." Forest Ecology and Management, vol. 258 (2009), pp. 1038–1054.

Rist, Lucy, Bruce M. Campbell, and Peter Frost. "Adaptive management: where are we now?" Environmental Conservation, 40(1):5-18, August 2012.

This page intentionally left blank

ATTACHMENT 1

LA HONDA CREEK OPEN SPACE PRESERVE

Forest Management Plan

Volume 2: Appendices

Prepared for:

Midpeninsula Regional Open Space District

By: **Sicular Environmental Consulting and Natural Lands Management**
Christopher Keyes, Ph.D.
Buena Vista Services, LLC
Timothy Best, CEG
Orange Peel Cartography

June 2021

ATTACHMENT 1

VOLUME 2: APPENDICES

This page intentionally left blank

APPENDIX A

Haul Road Sediment Source Inventory

ATTACHMENT 1

TIMOTHY C. BEST, CEG
ENGINEERING GEOLOGY AND HYDROLOGY

1002 Columbia Street, Santa Cruz, CA 95060
(831) 425-5832 ● cell: (831) 332-7791 ● e-mail: timbest@coastgeo.com

February 9, 2021

Sicular Environmental Consulting
and Natural Lands Management
1500 Grant St. #4
Berkeley, CA 94703

JOB: SICULAR-LAHONDA-871

RE: 2020 ROAD EROSION INVENTORY OF AN OLD LOGGING ROAD, LA HONDA CREEK OSP

INTRODUCTION

This report summarizes the findings of a road erosion inventory of a 1.7-mile-long abandoned logging road located on the east side of La Honda Creek OSP (Figure 1). This 1960's era road is in poor condition and actively eroding with multiple washouts, diverted watercourses, and slope failures that both prevent access and which are currently delivering sediment to the San Gregorio watershed.

Purpose and Scope

The purpose of this inventory is to assess the overall condition of the road, identify and map locations where the road is currently or potentially delivering sediment to the stream network, evaluate the geologic and geotechnical feasibility to both stabilize and reconstruct the road for potential fire, land management, ATV and/or recreational trail access, develop preliminary and conceptual treatment alternatives at each problem site, and prioritize treatment based on sediment impacts to streams.

The approach follows a simplified version of a field-based methodology that we have employed on previous road inventories on District lands, including in our earlier 2007 Road Erosion Inventory of La Honda Open Space Preserve.

Our work included: review of published and unpublished literature relevant to the site and vicinity, analysis of LiDAR imagery, site reconnaissance, data analyses, and preparation of this report. Site specific slope stability analysis and subsurface exploration were beyond our scope of work.

PHYSICAL SETTING

The subject site is located along an unnamed tributary and east facing slopes above La Honda Creek in La

Honda Creek OSP, about 1 mile from the community of Sky Londa, in unincorporated San Mateo County.

The area is characterized by moderate to very steep mountainous terrain with slope gradients ranging from 20% along the ridge top, midslope benches and local colluvial filled valleys to greater than 90% along steep streamside slopes and other areas (Figures 1 and 2). The hillslopes are slightly convex, rounded toward the ridge tops with local steep streamside slopes found towards the base of the hillsides. La Honda Creek and its larger tributaries are deeply incised into the landscape with steep streamside and inner gorge slopes extending 50 to more than 500 feet from the valley bottoms. The ground is locally benchy consistent with deep-seated landsliding. Elevations range from 1000 feet along the valley bottom of La Honda Creek to 2100 feet along the ridge top.

The climate is Mediterranean, with cool, rainy winters and dry, warm summers. Vegetation is mainly advanced second growth redwood, Douglas-fir and a scattered understory of hardwood and brush. The property has historically been used for timber production. The subject road appears to have been constructed and the area heavily tractor logged in the mid to late 1960's. The District acquired the property in 1984.

GEOLOGIC SETTING

The project area is located in the central portion of the Coast Ranges Physiographic Province of California, a series of coastal mountain chains paralleling the pronounced northwest-southeast structural grain of northwest California. The area is geologically active with the geology dominated by the northwest-southeast trending San Andreas Fault Zone (SAFZ) located about 2 miles northeast of the project.

Bedrock Geology

The project area is underlain by a sequence of tightly folded and faulted Tertiary-age marine sediments (Brabb et al., 2000).The majority of the subject road is mapped as underlain by Butano Sandstone (Tb) consisting of massive medium to coarse-grained sandstone with local siltstone and shale interbeds (Brabb et al., 2000). A small sliver of Twobar shale (Tst) is mapped along the southern portion of the road. The bedrock units have undergone a complex structural history and are strongly deformed by faults and folds associated with the SAFZ.

Soil

Mantling bedrock is a thin to thick veneer of weathered bedrock, late Pleistocene to Holocene age colluvium and soils and artificial fill. Colluvial deposits are found nearly everywhere across the hillside, however, they are thickest toward the axes of swales and toe slopes. The steeper slopes tend to be underlain by more competent bedrock at shallower depth.

A wedge of undocumented fill was found along the outer edge of the road with locally thick fill prisms typically found at watercourse crossings. We do not know the manner in which the road was constructed or the equipment that was used in construction. Based on field observations, it is likely that some spoils were simply side casted without the benefit of a keyway or being benched to support the fill embankment.

Regional Faults and Seismicity

The subject property is located within a highly seismically-active region of California with the active SAFZ located about 2 miles to the northeast of the project site. The site is subject to severe seismic shaking in the event of a large magnitude earthquake on the San Andreas Fault. When it occurs, seismic shaking has the potential to induce landsliding or cause ground cracking or movement of weak surficial soils, including fill and colluvium.

Landsliding

Regional landslide mapping (Wentworth et al., 1997) and review of LiDAR imagery reveal portions of the project area to be underlain by a series of relatively slow moving deep-seated translational block slides. These failures are characterized by benched topography and are formed by translational movement of a relatively intact mass with a failure plane that extends below the colluvial layer into the underlying bedrock. The slides consist of several smaller blocks that coalesce together to form a larger landslide complex. Based on interpretations made from the LiDAR derived topography, we estimate the failure to be greater than 50 feet deep.

The deep-seated landslides that underlie the site exhibit irregular and benched topography with small weathered but distinct nested scarps and an overall “youthful” appearance consistent with a "dormant-young" morphological age classification of Keaton and DeGraff (1996). The majority of trees are straight and appear undisturbed by slope displacements. The overall morphology of the slides, however, strongly suggests the slides are periodically active and are subject to reactivation in the event of a large seismic event or prolonged rainfall.

Shallow-seated landslides are also present within the preserve. These include debris slides, debris flows, channel bank failures, and road/trail fill failures characterized by rapid, shallow (generally less than 10 feet thick) downslope movement of surficial soil, colluvium, and weathered bedrock. Most observed failures are found along the steep streamside slopes of incised watercourses.

SUMMARY OF ROAD CONDITIONS

The subject road descends 1.7 miles from the ridge top to La Honda Creek, traversing moderate to steep 30% to 90+% slopes (Figure 2). The road appears to have been constructed at a 15 to 20-foot width on balanced cut and fill. The resulting cut locally exceeds 15 feet in height and is inclined at steeper than a 1:1 slope. The depth of the original fill is unknown but estimated to be on the order of 5 to 10+ feet with the fill embankment oversteepened at 1.5H:1V slope. The method of road construction is unknown and it is quite possible that the fill was sidecasted without the benefit of a keyway, which was the standard of practice for early forest road construction. There are seven watercourse crossings along the road with nearly all being unimproved fill crossings without the benefit of a culvert. The road grade is steep, averaging 12% with several segments having sustained grades of 20+%.

The road is in very poor condition with multiple stream diversions, washouts and slope failures. Portions of the road are actively eroding resulting in ongoing sediment delivery to the stream system. Road improvements are significantly constrained by the locally very steep slopes the road crosses and the multiple fill failures that have encroached most of the way into the road prism, limiting access.

The following is a general discussion of road conditions and constraints. A more in-depth description and photos of each inventoried site are found in Appendix 1.

For the purpose of this assessment the road is divided into two segments, **Upper** and **Lower**, based on site topography and feasibility of upgrades (Figures 1 and 2). The Upper segment crosses mainly moderate gradient slopes and while there are multiple stream crossing problems the road can be readily upgraded for future road use. The Lower segment traverses steeper gradient ground of up to 90% for most of its length with multiple slope failures that have damaged or destroyed the road bed and which significantly constrain the feasibility of future access. Because of the poor condition of the road and unstable ground the road crosses we do not recommend reopening the Lower Road. The amount of ground disturbance required to reopen the road will likely offset any environmental benefit of upgrading it.

UPPER ROAD SEGMENT:

The upper road segment is about 3,900 feet long traversing mostly moderate 20% to 50% gradient ground. The road is locally steep at 12% to 20+% sustained grade. The road tread is overgrown though largely intact and relatively stable. A summary of each inventoried site along the roadway is found in Table 1 with a more detailed description found in Appendix 1.

Watercourse Crossings: The road crosses seven ephemeral and intermittent streams with an eighth watercourse crossing found on an adjacent skid trail. Four of the watercourse crossings are diverted resulting in local deep gullying of the road and hillside, and three others have partially washed out. Abandoning or repairing these crossings is necessary to both reduce sediment loading and to allow for future vehicle access if desired.

Slope Failures: There is one large and a couple of small cutbank failures that have partially blocked the road, but the road can be reopened past these by clearing or ramping over the slide debris. There are no significant fill failures. The road also crosses several dormant deep-seated landslides, though these do not constrain future road use.

Water Quality and Sediment Loading: We estimate that the diverted and partially washed out crossings watercourses have resulted in approximately 1,400 to 2,400 cy of erosion over the past 50 years (48 cy/yr) with nearly all of that material delivered to a watercourse. The rate of future erosion (cy/yr) has decreased somewhat over time as gullies have downcut to a more stable configuration and the eroded areas have revegetated. We estimate approximately 660 cy of additional erosion could occur over the next 20 years (33 cy/yr) if the crossings are left unmitigated.

General Recommendations – Upper Road

To reduce road related erosion and associated impacts to water quality, we recommend that all stream diversions be corrected and stream crossings either abandoned or upgraded to accommodate a design 100-year flow event.

Because the Upper Road Segment is located on relatively moderate gradient slopes with the majority of the road tread intact, the road can be reopened down to Site **MP 11** for temporary or permanent vehicle access. Reopening the road will require clearing vegetation from the overgrown road, backfilling the eroded gullies, regrading the road prism, upgrading or abandoning all stream crossings, and ramping over or clearing cutbank debris from the roadway. For permanent access, all of the stream crossings will need to be upgraded to permanent culverts or rock fords, and all diversions corrected. If the road is reopened for temporary use, all crossings will then need to be pulled (decommissioned) by excavating all of the crossing fill from the channel to native channel grade. Surface road drainage will also need to be improved.

TABLE 1: SUMMARY OF INVENTORY SITES ON UPPER ROAD SEGMENT						
SITE	**FEATURE**	**DESCRIPTION**	**RECOMMENDATION**	**FUTURE EROSION (CY/20 YR)**	**DEGREE OF ROAD DAMAGE**	**TREATMENT PRIORITY**
1	**Diverted watercourse crossing**	Class III watercourse diverted at three separate locations (**MP 1, 2 and 8**) resulting in deep gullying of the road.	Abandon or upgrade to permanent culvert or rock ford.	240+	MOD	HIGH
2	**Diverted watercourse crossing**	Class III watercourse initially diverted at MP 1 again is diverted, this time by an old skid trail	Abandon and correct diversion at MP 1.	See MP 1	HIGH	HIGH
3	**Watercourse crossing**	Old fill crossing on a Class III watercourse that presently receives limited flow due diversion at MP 1	Abandon or upgrade to permanent culvert or rock ford.	See MP 1	LOW	HIGH
4	**Slope Failure**	Undifferentiated cutbank failure / debris flow deposited 4 to 8 feet of debris onto a roughly 100-foot-long segment of the old roadway.	Ramp over slide debris.	0	MOD	LOW
5	**Watercourse crossing**	Partially washed out fill crossing on Class III watercourse. Stream had previously been diverted but no longer. Currently receives limited flow due to diversion at MP 1	Abandon or upgrade to permanent culvert.	200	MOD	HIGH
6	**Swale crossing**	Minor gully at outlet of swale from past diversion originating at MP 5.	Dip road.	0	LOW	LOW
7	**Watercourse crossing**	Partially washed out fill crossing. Small cutbank and fill slope failure on right bank	Abandon or upgrade to permanent culvert.	75	MOD - HIGH	MOD
8	**Gully from MP 1 diversion and diverted watercourse**	Diverted runoff from MP 1 and MP 2 drains over road cutbank resulting in deep 18-foot-deep gully. Stream is then further diverted down the roadway	Correct diversion at MP 1 and 2.	See MP 1	MOD	HIGH
9	**Watercourse crossing**	Partially washed out fill crossing on Class III watercourse. Additional gully from diverted stream at MP 8. Crossing overtopped by debris flow extending down channel.	Abandon or upgrade to permanent culvert or rock ford.	100	MOD - HIGH	MOD
10	**Diverted watercourse crossing**	Class III watercourse diverted down road to MP 11 crossing resulting in 3 to 4-foot-deep gully.	Abandon or upgrade to permanent culvert.	50	MOD	HIGH
11	**Diverted watercourse crossing**	Second Class III watercourse diverted down roadway resulting in deep gullying of road prism at MP 12, where the road is impassable.	Abandon or upgrade to permanent culvert.	500	MOD	HIGH

LOWER ROAD SEGMENT:

The Lower road segment is about 5,000 feet long descending across steep to very steep (60% to 90%) gradient ground for over half its length before reaching La Honda Creek. The road grade is steep with 12% to 20% sustained grade. The road has failed or eroded out at multiple locations from fill instability and gullying making reopening the road for vehicle or large equipment access questionable. Potentially significant and expensive road reconstruction will be required to reopen the road for vehicles or large equipment. As will be discussed in further detail, the resulting ground disturbance associated with road reconstruction will likely offset any environmental benefit associated with correcting the existing erosion problems. A summary of each inventoried site along the roadway is found in Table 2 with a more detailed description found in Appendix 1.

Gullying and Fill Slope Failures: There are a couple of deep gullies and multiple fill failures along this segment of road. The most significant problems exist at **12**, **13A**, **13C**, **13D** and **13L** where the majority of the road prism has failed or eroded out narrowing the road tread to 0 to 9 feet in width and resulting in a steep escarpment that encroaches to the edge of the remaining road prism.

Because of the steep slopes, reopening the road past **12**, **13A**, **13C**, **13D** and **13L** would be challenging. Often the least expensive and easiest means to widen a road past a fill failure is to widen the road by cutting into the hillside, laying the cut back to a stable grade, and endhauling the excavated spoils to a stable location. However, at sites **12**, **13A**, **13C**, and **13D** the road crosses very steep side slopes with little of the original road prism remaining. Because of these steep slopes, it will not be feasible to gain much, if any, extra road width by cutting further into the hillside without undercutting the hillside. Therefore, at these locations, the outer edge of the roadway will likely need to be reconstructed and supported on 180+ LF of 10 to 15-foot-high retaining walls. There are several retaining wall designs that could be employed, including a soldier pin wall, gravity wall, and reinforced earth wall. Each of these have their pros and cons. A reinforced earth wall using geogrid or Hilfiker materials would likely be the most cost-effective option if a retaining wall is selected. The transition zones at the ends of the wall will be difficult to implement due to the potentially unstable undocumented fill that borders the slide areas. The costs of retaining structures will be expensive. Additional engineering work will be required to further evaluate the feasibility of retaining wall options at these locations.

At site **13L** the entire road prism has failed apparently due to fill instability and possible deep-seated slide movement. It may be possible to steeply ramp a 10-foot-wide road down across the displaced slide block, though whether this will be suitable for vehicle access is unknown. Moreover, the long-term stability of this is questionable as additional instability of the larger landslide block is expected which could further damage or destroy any reconstructed road. Depending on the depth of the slide, it may also be possible to reconstruct the road and stabilize the hillside with retaining structures, though this will likely be expensive.

At the remaining fill failures, **13F**, **13G**, **13H**, **13I**, **13J** and **13K**, the failures do not appear to have encroached as far into the road prism and/or the native slopes are not as steep. It may be possible to gain suitable road width at these locations by cutting into the hillside on a full bench and endhauling spoils to a stable location, though additional geologic and geotechnical work will be required to confirm this. It should be understood that widening the road inboard at these locations will increase the potential for cutbank instability. While we expect future cutbank failures to be retained on the road surface, a higher-than-average level of maintenance will be required to keep the road open. If suitable road width does not exist, then the outer edge of the road would need to be supported on a retaining wall.

Possible unstable slopes may also exist at **14** where there is equivocal evidence of a couple of short displacement (< 6 inch high) subdued escarpments cutting across a bench of colluvial sediments within an ephemeral drainage. It is unknown if these questionable escarpments define a potentially unstable slide block or if they are simply an artifact of old grading. In addition, it also is unknown if the construction of the road had any significant impact on site stability through the placement of fill. While we believe that the potential for road related slope instability is most likely very low, it cannot be ruled out with certainty. Future instability at this site could be possible in the event of a large magnitude storm or earthquake resulting in local ground cracking or, a worst-case scenario, generate a large 500 to 1,000 cy slope failure. Mitigating slope stability hazards at this site will be very difficult due to the lack of access.

It should be understood that the remaining unfailed segments of roadway also contain locally thick fill sidecasted onto steep slopes. While there are few signs of active instability (e.g. ground cracking), the nature of the thick fill embankments on steep slopes places them at potential risk for future failures, especially if water is allowed to concentrate and discharge over the fill.

With respect to future erosion and sediment delivery. Presently the rate of erosion appears relatively low and the majority of high-risk sites that could have failed have likely already done so. Future fill instability will likely occur, however there is uncertainty in predicting how large the failures will be, how much will be delivered to a watercourse, and exactly where the failures are most likely to occur. It is not feasible to pull back all of the fill along the outer edge of the roadway.

Cutbank Failures: Raveling and cutbank instability are also prevalent along the road. The most significant failures occurred at **13A**, **13E** and **13G** depositing debris onto the roadway. Generally, the road can be reopened past these features by removing the failed debris or ramping over the mass. Continued cutbank instability should be expected if the road is to be reopened requiring a higher-than-average level of effort to clear the roadway.

Watercourse Crossings: The road crosses two ephemeral (**MP 14** and **15**) and one intermittent (**MP 16**) watercourses. Site **14** is a fill crossing at a Class III watercourse. We have not reviewed this crossing in detail. Site **15** is a 150 cy fill crossing where the fill embankment is unstable and has down dropped. We estimate 150 cy of future erosion is possible though this would likely take a long time.

MP 16, located near the end of the road, is a partially washed out 500 cy to 750 cy Humboldt log crossing at a Class II watercourse. At one time the Class II watercourse had likely been diverted down the road eroding a 500+ foot gully but has been redirected back into its natural channel as a result of debris flow that extended down a Class III tributary and pushed the watercourse to the opposite side of the valley. The small Class III watercourse is currently diverted down the old road; the Class II watercourse is not diverted and is confined to its natural channel. We estimate that about 300 to 500 cy of material is subject to erosion with the current rate of erosion appearing low.

Water Quality and Sediment Loading: We estimate over 2,000 cy of erosion has resulted from fill instability, though most of this material appears to have been retained on the hillside with relatively limited sediment delivery. An additional 1,400 cy of erosion and sediment delivery has occurred at watercourse crossings **15** and **16** over a 50-year time span. The average erosion rate from the larger failures is estimated at greater than 70 cy/yr for the past 50 years, though not all of this material was delivered to a watercourse. The rate of erosion has decreased due to the majority of high-risk fill prisms having already failed and at Site **16** the Class II watercourse being no longer diverted.

Future fill instability and erosion will likely occur, though at a lower rate than in the past. We roughly estimate that about 460 cy of erosion could occur over the next 20 years (23 cy/yr) which is about 33% of the historic rate with less than half of that being delivered to a watercourse.

Some limited benefit would be achieved by pulling back excess unstable fill at sites **15** (failing ford crossing) and **13K** (failing landing fill), and by installing drain dips to break up any runoff, however, to accomplish this the road would need to be reopened past the problem sites **12**, **13A**, and **13C** and **13D**. The amount of ground disturbance that would be needed to reopen the road would probably offset any benefit, making it impracticable as well as cost prohibitive.

General Recommendations – Lower Road

The 5,000 foot long Lower Road was constructed across locally very steep slopes and in a manner that resulted in multiple failures of the road fill. Significant road reconstruction will be required to reopen this segment of road past these failures. Any road improvements are constrained by the steep slopes and confined working conditions.

There are five locations **12**, **13A**, **13C**, **13D** and **13L** where the majority of the road prism has failed or eroded out, and where significant road reconstruction will be required to reopen the road at a 10 to 12 foot width for safe temporary or permanent vehicle or equipment access. These reconstruction efforts will be challenging and expensive due to the steep slopes, confined working conditions, and need for retaining structures. It should be possible to reopen the road at a narrower 5 foot width for recreational trail use by ramping steeply through the larger failures and skirting the edge of the smaller failures.

There are 3 partially washed-out watercourse crossings along this segment of road. We estimate that there is about 450 cy of material still residing at these crossings. Continued slow erosion of the residual fill prisms is to be expected, though this will very likely take a long time.

The big question is whether it is worth reopening the road past the slide areas. Some limited benefit could be achieved by pulling back excess unstable fill at **13J** (failing landing fill – <100 cy), and by abandoning the stream crossings at sites **14** (<500 cy), **15** (150 cy) and **16** (750 cy). However, to accomplish this work the road would need to be reopened past the major problem sites **12**, **13A**, **13C**, **13D** and **13L**, as well as past several other smaller sites. The amount of ground disturbance that would be needed to reopen the road would probably offset any environmental benefit, making it impracticable as well as cost prohibitive.

In summary, we do not recommend reopening the lower road for vehicle access. To mitigate future erosion at the watercourse crossings we recommend evaluating the feasibility of obtaining temporary truck and/or equipment access via an alternative route. This may include linking one or more of the upslope skid trails. It is not feasible to access this site from the bottom over La Honda Creek. It may be possible to reopen the road at a 5-foot width using a small excavator, though additional work and review of the site by the excavator operator will be required. If a 5-foot wide trail can be opened past the problem sites, then some restoration work could be implemented.

TABLE 2: SUMMARY OF INVENTORY SITES ON LOWER ROAD SEGMENT						
SITE	FEATURE	DESCRIPTION	RECOMMENDATION	FUTURE EROSION (CY/20 YR)	DEGREE OF ROAD DAMAGE	TREATMENT PRIORITY
12	**Gullies from diverted watercourses**	These are two deep gullies from stream diversions at MP 10 and 11 that have eroded out most of the road prism for a distance of about 350 feet.	ABANDON: Through non-use (preferred). ROAD: Reconstruct road prism on engineered fill with 60+ LF on 10 to 15-foot-high retaining wall. TRAIL or ATV: Reconstruct at 5-foot width on full bench.	See MP 10 and 11	HIGH	LOW
13A	**Cut and fill failure**	100 LF combined cut and fill failure on 90% slopes has narrowed the road to less than 2 feet	ABANDON: Through non-use (preferred). ROAD: Reconstruct 80+ LF of failed roadway on 10 to 15-foot-high retaining wall, clear slide debris from roadway. TRAIL or ATV: Reconstruct at 5-foot width on full bench.	<20	HIGH	LOW
13B	**Cut and fill failure**	90 LF combined cut and fill failure on 90% slopes has narrowed the road to a 5-to-10-foot width.	ABANDON: Through non-use (preferred). ROAD: It should be possible to reopen the road by blading failed cutbank material. TRAIL or ATV: Reconstruct at 5-foot width on full bench.	<10	MOD	LOW
13C	**Fill failure**	35 LF fill failure on 90% slopes narrows road to 8 feet. Outer 2 to 3 feet of remaining road prism may be unstable. Multiple cutbank failures in this area.	ABANDON: Through non-use (preferred). ROAD: Reconstruct 35+ LF of failed roadway on 10 to 15+ foot-high retaining wall, clear slide debris from roadway. TRAIL or ATV: Reconstruct at 5-foot width on full bench.	<20	HIGH	LOW
13D	**Fill failure**	50 LF fill failure on 90% slopes within swale, narrows 18-foot-wide road to 10 feet. Outer 3 feet of remaining road prism may be unstable.	ABANDON: Through non-use (preferred). ROAD: It may be possible to reopen the road by removing failed cutbank material and cutting into the bank 2 feet to gain extra width. Otherwise, the outer edge of road will need to be reconstructed and supported by a retaining wall. TRAIL or ATV: Reconstruct at 5-foot width on full bench.	<20	MOD - HIGH	LOW

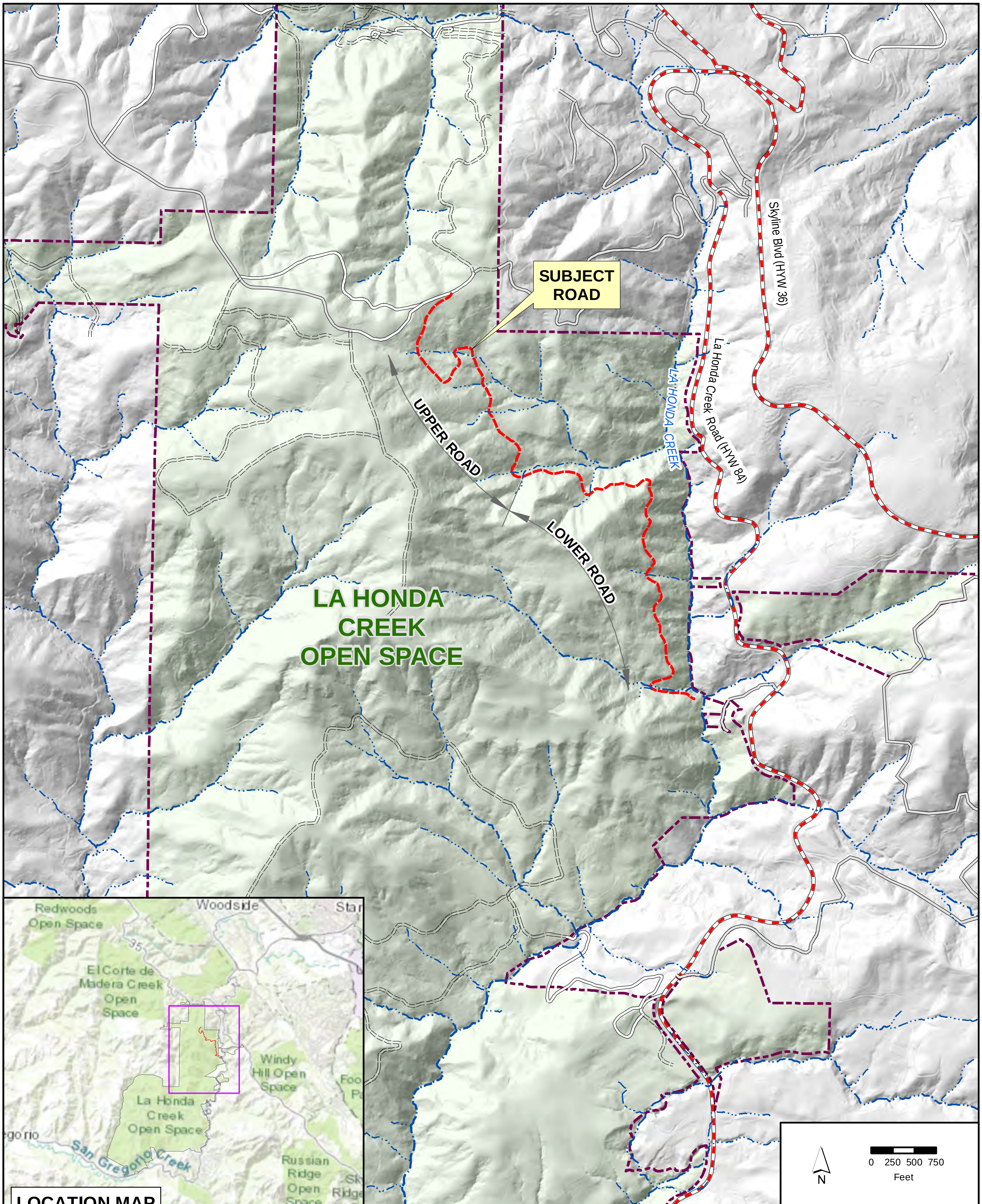
TABLE 2: SUMMARY OF INVENTORY SITES ON LOWER ROAD SEGMENT						
SITE	**FEATURE**	**DESCRIPTION**	**RECOMMENDATION**	**FUTURE EROSION (CY/20 YR)**	**DEGREE OF ROAD DAMAGE**	**TREATMENT PRIORITY**
13E	**Cutbank failure**	40 LF cutbank failure deposited 3 to 5 feet of debris on roadway.	ABANDON: Through non-use (preferred). ROAD and TRAIL: Ramp over slide debris. Endhaul excess debris.	0	MOD	LOW
13F	**Fill failure**	25 LF fill failure on 60% slopes narrows road to 9 feet.	ABANDON: Through non-use (preferred). ROAD: Widen road 3 to 4 feet into bank on full bench. TRAIL or ATV: None required.	<20	MOD - HIGH	LOW
13G	**Fill and cutbank failure**	30 to 40 LF combined cut and fill failure. Fill failure narrows road slightly; 5 to 10 feet of debris and multiple large stumps deposited on roadway	ABANDON: Through non-use (preferred). ROAD and TRAIL: Ramp over slide debris. Endhaul excess debris. TRAIL or ATV: None required.	<20	MOD	LOW
13H	**Fill failure**	60 LF fill failure on 75% to 90% slopes narrows road to 10 feet. Outer 3 feet of remaining road is potentially unstable. Located immediately adjacent to failing Class III watercourse crossing (MP 14).	ABANDON: Through non-use (preferred). ROAD: It may be possible to widen road slightly into bank, otherwise the outer edge of road will need to be supported on retaining wall. Correct instability at crossing MP 14. TRAIL or ATV: None required.	<20	MOD - HIGH	LOW
13I	**Fill failure**	40 LF fill failure on 100% slopes narrows road to 12 feet. 30-foot-high road cut.	ABANDON: Through non-use (preferred). ROAD: Reopen at 10-foot width by clearing debris from roadway. TRAIL or ATV: Reopen at 5-foot width by clearing debris from trail tread.	<20	MOD	LOW
13J	**Fill failure**	25 LF fill failure on 90% slopes narrows road to 10 feet.	ABANDON: Through non-use (preferred). ROAD: Road appears to be passable at 8-10 foot width by vehicles. Additional failure will require retaining structures to support outer edge of roadway. TRAIL or ATV: Reopen at 5-foot width by clearing debris from trail tread.	<20	MOD - HIGH	LOW

TABLE 2:
SUMMARY OF INVENTORY SITES ON LOWER ROAD SEGMENT

SITE	FEATURE	DESCRIPTION	RECOMMENDATION	FUTURE EROSION (CY/20 YR)	DEGREE OF ROAD DAMAGE	TREATMENT PRIORITY
13K	**Fill failure**	40 LF failure of old landing fill on 50% slopes narrows road to 12 feet. 7-foot-high scarp on outer edge of road.	ABANDON: Through non-use (preferred). ROAD: Road appears to be passable at 10-foot width. Extra road width can be obtained by cutting into the bank on full bench. TRAIL or ATV: None required.	<20	MOD	LOW
13L	**Fill and hillslope failure**	90 LF of roadway crossing 70% to 90% slopes has down dropped 9 feet due to combined cut and fill slope instability. None of the original road prism is remaining.	ABANDON: Through non-use (preferred). ROAD: It may be possible to steeply ramp a 10-foot-wide road down across the displaced slide block, though the long-term stability of this is questionable. TRAIL or ATV: Ramp trail at 5 foot width across slide.	<20	HIGH	LOW
14	**Class III watercourse crossing; Questionable unstable slopes**	Minor to moderate gully at outfall of an earth ford. Questionable unstable slopes.	GENERAL: Engineering geologic / slope stability review if additional clarification on site stability is required. ABANDON: Excavate crossing fill and unstable fill material if access is obtained. If no access, abandon through non-use (preferred). ROAD: Excavate unstable fill, upgrade to permanent rock ford or culvert. TRAIL or ATV: Excavate unstable fill if possible; add rock ford.	<500	LOW	MOD
15	**Watercourse crossing & Unstable fill**	50 LF partial fill failure and unstable fill at Class III watercourse crossing.	ABANDON: Excavate crossing fill if access is obtained. ROAD: Upgrade to permanent culvert. TRAIL or ATV: Abandon and add puncheon.	<50	MOD - HIGH	LOW - MOD

TABLE 2: SUMMARY OF INVENTORY SITES ON LOWER ROAD SEGMENT						
SITE	**FEATURE**	**DESCRIPTION**	**RECOMMENDATION**	**FUTURE EROSION (CY/20 YR)**	**DEGREE OF ROAD DAMAGE**	**TREATMENT PRIORITY**
16	**Humboldt Crossing**	Partially washed-out Humboldt log crossing at Class II watercourse. 500 LF of gullied road from past diversion of the watercourse. Upstream debris flow diverts small Class III watercourse.	ABANDON: Excavate crossing fill if access is obtained. ROAD: Upgrade to permanent culvert. TRAIL or ATV: Abandon and add puncheon.	200	HIGH	MOD - HIGH

ATTACHMENT 1

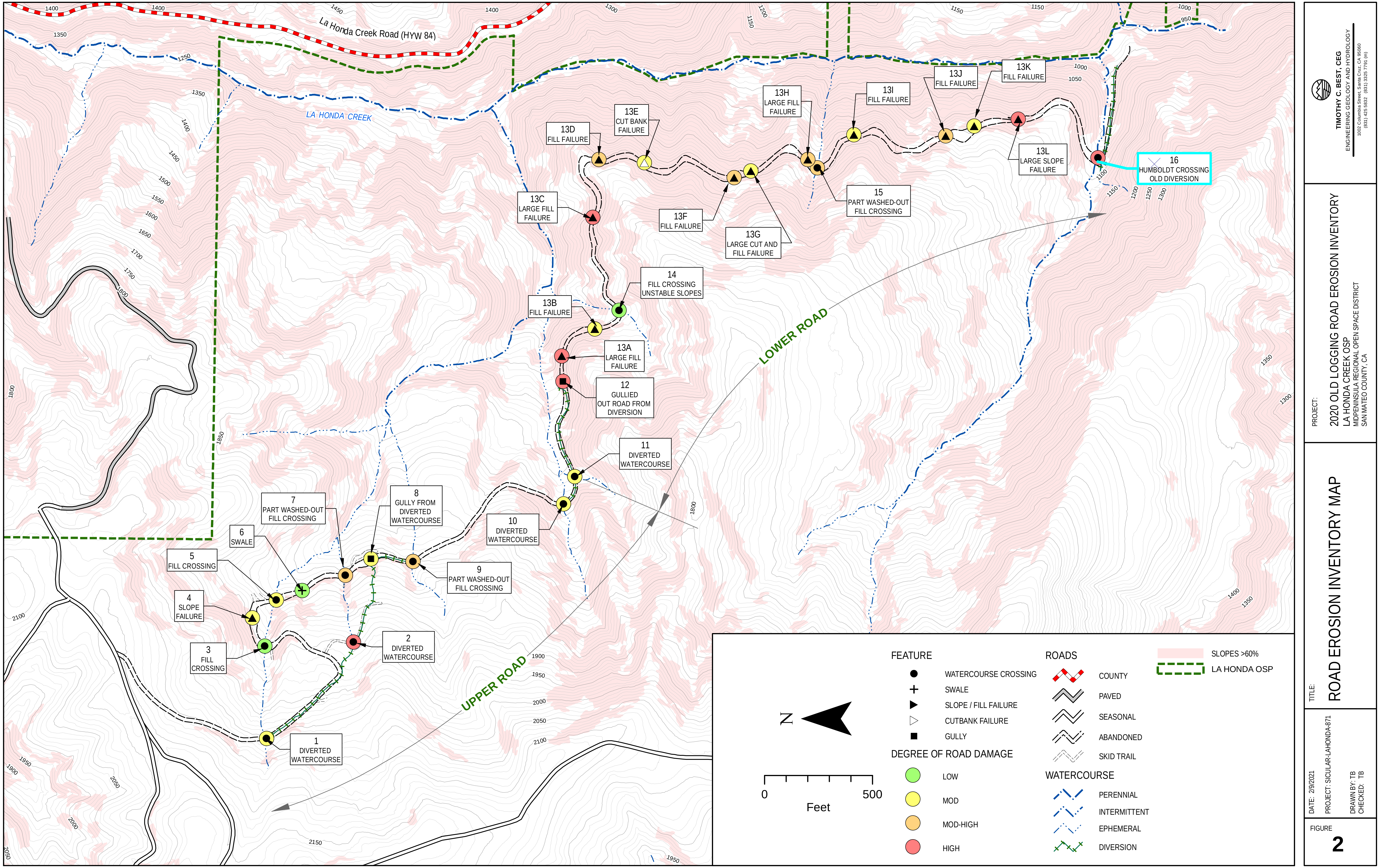


TIMOTHY C. BEST, CEG
ENGINEERING GEOLOGY AND HYDROLOGY
1002 Columbia Street, Santa Cruz, CA 95060
(831) 425 5832 (831) 425 5830 (fax)

LOCATION MAP
2020 OLD LOGGING ROAD EROSION INVENTORY
LA HONDA CREEK OSP
MIDPENINSULA REGIONAL OPEN SPACE DISTRICT

FIGURE 1
Job: SICULAR-LAHONDA-871
Date: 12/17/2020

ATTACHMENT 1



APPENDIX 1: ROAD LOG

SITE	**1**	**Future Erosion (cy/20 yr)**	240
FEATURE	**DIVERTED CLASS III WATERCOURSE**	**Road Damage**	MOD
ROAD	UPPER ROAD	**Treatment Priority**	HIGH

Description

MP 1 is a fill crossing where a small Class III watercourse is diverted down the road. This watercourse is ultimately diverted at three separate locations for a distance of more than 1,200 feet resulting in deep gulling of both the road prism(s) and hillslope. The first diversion is located on the main road at **MP 1**, the second on an old skid trail at **MP 2** and the third on a downslope segment of the main road at **MP 8**.

At the **MP 1** crossing, the Class III watercourse drains a roughly 5-acre forested watershed. Slopes are moderately steep with a stream having a roughly 30% channel gradient. The crossing consists of about 20 cy of fill placed about 4 to 5 feet deep. The road grade is 10%. There does not appear to have been any drainage structures installed at the crossing which is likely why the stream was diverted.

At this crossing the stream is diverted 500 feet down the old haul road to a point where the road makes a broad switchback on a gently sloping bench. The diverted watercourse has eroded a 2 to 3-foot-deep gully into the road prism. The gully walls are moss covered indicating a current low rate of erosion.

At the switchback the diverted stream then flows across the bench for a short distance before draining into the head of a second small Class III watercourse. At this point the drainage area of the watercourse has nearly tripled in size to 15 acres resulting in much greater flow volumes.

The stream the drains about 100 feet down the second-Class III watercourse before being diverted again at **MP 2** by an old skid trail where there is a 6-inch diameter steel pipe. From here stream flow is diverted 200+ feet down the old skid trail, gullying the road prism 2 to 4 feet deep, before discharging onto the open hillside.

After discharging off of the tractor road the stream flows down the hillside in shallow bifurcating channel for an additional 250 feet before draining over the steep road cut of the main roadway at **MP 8**. At this location the stream has eroded a large 80-foot-long, 15-foot-deep gully into the hillside.

After discharging back onto the main road at **MP 8**, the stream is again diverted down the road for a distance of 150 feet to a partially washed out stream crossing at **MP 9**. There is little erosion of the road prism, though gulling is evident below **MP 9**.

We estimate that the stream diversion has cumulatively resulted in a 500 to 1,000+ cy of erosion over the roughly past 50+ years (est 10 to 20 cy/yr). We suspect that most of this erosion occurred early on and has decreased over time as the gullies have down cut to more stable material. Continued erosion is expected unless the diversion is corrected. Based on field observations, we estimate the current erosion rate to be approximately 8 to 15 cy/yr or about 75% of the historic average.

Correcting the diversion at **MP 1** is straightforward and can be readily accomplished by abandoning the crossing (excavating fill), installing a culvert, or installing a rock ford. Which of these three alternatives to be implemented is dependent upon the long term use of the road. If the road is no longer required, then the crossing can be abandoned by excavating fill to native grade. If the road is required, then either install a culvert or rock ford. It should be noted that because the stream has been diverted for quite a while, the native stream has infilled with sediment and debris. Restoring flow back into the native channel will likely result in some erosion of this material, though how much is difficult to quantify.

Regardless of which of the three alternatives is employed, correcting the diversion and redirecting streamflow back into the natural channel will also requiring upgrades to the crossings at **MP 3** and **MP 5** located downstream on the same channel. The diversion on the old tractor road should also be corrected.

Preliminary Recommendations

Alternative 1: Abandonment

- Excavate crossing to native channel grade
  - Minimum 3-foot wide channel bottom with smooth uniform grade
  - Lay channel banks back to 2H:1V or flatter
  - Estimate 20 to 50 cy of excavation

Alternative 2: Permanent Culvert

- Install permanent 24 inch x 40 ft culvert.
  - Align culvert with native grade.
  - Install a critical dip

- *Alternative 3: Permanent Rock Ford*
  - Dip road minimum 1 foot through crossing
  - Rock armor outer edge. Additional work will be required to size the rock.

Both Alternatives

- Improve road drainage leading to crossing by installing reverse grade dips or waterbars.
- Upgrade crossings **MP 3** and **MP 5**
- Correct the stream diversion and remove the 6-inch steel pipe at **MP 2**

SITE	**2**	**Future Erosion (cy/20 yr)**	See MP1
FEATURE	**DIVERTED CLASS III STREAM ON SKID TRAIL**	**Road Damage**	HIGH
ROAD	Skid Trail	**Treatment Priority**	HIGH

Description

At this location the Class III watercourse initially diverted at MP 1 again is diverted, this time by an old skid trail where there is a plugged 6-inch diameter steel pipe. The streams is diverted 200+ feet down the old skid trail, gullying the road prism 2 to 4 feet deep, before discharging onto the open hillside. Erosion appears to be active and ongoing.

The problem at this site can be easily corrected by removing the culvert and remaining crossing fill and redirected streamflow back into its natural channel. To the extent practicable, drain dips should also be installed along the old tractor road to further control runoff, though this will be somewhat difficult due to the entrenched nature of the road prism.

Preliminary Recommendations

Abandonment

- Remove steel pipe
- Excavate crossing to native channel grade
  - Minimum 3-foot wide channel bottom with smooth uniform grade
  - Lay channel banks back to 2H:1V or flatter
  - Estimate 20 to 50 cy of excavation
- Install drain dips two drain dips at 100 foot spacings along the entrenched skid trail

Photo 1: Looking downstream on diverted watercourse at skid trail crossing.


Photo 2: Gully from diverted watercourse down skid trail

SITE	**3**	**Future Erosion (cy/20 yr)**	See MP1
FEATURE	**CLASS III WATERCOURSE**	**Road Damage**	LOW
ROAD	UPPER ROAD	**Treatment Priority**	HIGH

Description

This is an old fill crossing on a Class III watercourse that presently receives limited flow due to the upper segment of the stream being diverted at **MP 1**. Correcting the diversion at **MP 1** will increase runoff at this site resulting in renewed erosion and necessitate treatment.

At the crossing the Class III watercourse drains a 15-acre forested watershed. The crossing consists of about 120 cy of fill placed about 7 to 8 feet deep. The road grade is 18%. There does not appear to have been any drainage structures installed at the crossing and a small gully has formed at the crossing outlet from the diminished stream flow.

There is an old gully along the portion of the road leading down into the crossing from the southeast, which we believe was from a past stream diversion originating at **MP 1**.

The current rate of erosion is low. However, correcting the stream diversion at **MP 1** will result in increased flows and renewed erosion. To mitigate for this the crossing should be either abandoned or upgraded with a permanent culvert. Because of the steep road grade, a rock ford is not practicable.

Preliminary Recommendations

Alternative 1: Abandonment

- Excavate crossing to native channel grade
  - Minimum 4-foot wide channel bottom with smooth uniform grade
  - Lay channel banks back to 2H:1V or flatter
  - Estimate 120 cy of excavation
  - Excavated fill will need to be endhauled up the road and placed on the midslope bench in a stable configuration.
- Improve road drainage leading to crossing by installing reverse grade dips or waterbars.

Alternative 2: Permanent Culvert

- Install permanent 30-inch x 60 ft culvert.
  - Align culvert with native grade.
- Install a critical dip
- Improve road drainage leading to crossing by installing reverse grade dips or waterbars.

SITE	**4**	**Future Erosion (cy/20 yr)**	0
FEATURE	**UPSLOPE LANDSLIDE**	**Road Damage**	MOD
ROAD	UPPER ROAD	**Treatment Priority**	LOW

Description

At this location an old, undifferentiated cutbank failure / debris flow deposited 4 to 8 feet of debris onto a roughly 100-foot-long segment of the old roadway. The failure initiated where the road was constructed at a roughly 18-foot width across steep 75% to 80% gradient slopes. There was little to no sediment delivery. The slide currently well vegetated with hardwood and appears relatively stable.

No treatment of this site is required for sediment savings. The road can be reopened for both temporary and permanent use by ramping over the slide debris with minimal cut and fill. The resulting road, however, would be steep at nearly a 25% grade.

Preliminary Recommendations

- Reopen the road at a minimum 12 to 14-foot width
  - Ramp over the slide debris with minimal cuts and fill.
  - Install a drainage dips at the upper and lower ends of the work area.
  - Consider rocking the road surface for added traction as needed.

SITE	**5**	**Future Erosion (cy/20 yr)**	200
FEATURE	**CLASS III WATERCOURSE**	**Road Damage**	MOD
ROAD	UPPER ROAD	**Treatment Priority**	HIGH

Description

This is as partially gullied out thick fill crossing on a Class III watercourse draining a 16.5-acre forested watershed. The watercourse currently receives limited flow due to the upper segment of the stream being diverted at **MP 1**.

At this site the old road ramps down through the incised watercourse at a 20% grade on what appears to be a thick fill prism. There is a 6-inch diameter culvert lying on the ground which if used to drain the stream was seriously undersized and was easily plugged. We estimate the crossing consist of 500 cy of fill placed 12 to 15 feet deep, though subsurface exploration would be required to confirm this. An unknown amount of additional sediment has backed upstream of the crossing for distance of 60 feet. The fill used to construct this crossing was probably generated by cutting into the hillside at **MP 4** where the undifferentiated cutbank failure / debris flow was observed.

The stream had, at one time, been diverted down the road to MP 5 where it had eroded a shallow gully or rut into the road prism. The diverted channel appears old and weathered. Presently, streamflow discharges over the fill embankment where it has eroded a 40-foot-long, 10-foot-wide and 2- to 6-foot-deep gully. Based on the inferred age of a leaning redwood within the gully, we estimate that the gully formed about 30 years ago. This gully is actively eroding, but at a low rate due to the stream diversion at **MP 1**.

There is also a second older and more weathered gully that has partially incised into the fill embankment. This gully may have been associated with road runoff, past diversion, or the dewatering of the slide at **MP 4**. Presently this gully appears stable and is not eroding.

Photo 3: Partial washed out fill crossing

Based on our field review we estimate that there may be 500 cy of fill material still residing at the crossing. Because of site geometry this is a rough estimate and subsurface exploration would be required to confirm this estimate. We estimate that the two gullies indenting the fill embankment combined have eroded approximately 50 to 70 cy of material over the past 50 years (1.4 cy/yr). The low rate of erosion is due, in part, to the ongoing diversion at **MP 1**.

The amount of future erosion is difficult to quantify. While there is 500 cy of material still residing at the crossing, we believe that based on the historic rate of erosion and the continued diversion at **MP 1** it would take a long time (centuries) for all of this material to ultimately eroded out. For the purpose of this study we have assumed an average erosion rate of 1.0 cy/yr which is about 75% of the historic average historic average.

We recommend that the crossing be either abandoned or upgraded with a permanent culvert. Because of the thickness of fill at this location, a rock ford is not a practicable alternative.

Preliminary Recommendations

Alternative 1: Abandonment

- Excavate crossing to native channel grade
  - Minimum 4-foot wide channel bottom with smooth uniform grade
  - Lay channel banks back to 1.5H:1V or flatter
  - Estimate 120 cy of excavation. The 500 cy of fill is a rough estimate. Subsurface exploration will be required if greater certainty as to the amount of material need to be excavated is required. Alternatively, the limits of excavation can be determined at the time of crossing abandonment.
  - Excavated fill will need to be placed along the inside edge of the road below the crossing of endhauled up the road and placed on the midslope bench in a stable configuration. Because of the amount of fill to be removed and the steep (25%) road grade we recommend that off-haul trucks be used to transport the fill material.
- Improve road drainage leading to crossing by installing reverse grade dips or waterbars.

Alternative 2: Permanent Culvert

- Install permanent 30-inch x 80 ft culvert (or larger).
  - Align culvert with native grade (~ 20%)
- Install a critical dip
- Improve road drainage leading to crossing by installing reverse grade dips or waterbars.

SITE	**6**	**Future Erosion (cy/20 yr)**	0
FEATURE	**SWALE**	**Road Damage**	LOW
ROAD	UPPER ROAD	**Treatment Priority**	LOW

Description

This is a fill crossing on a steep gradient swale. Runoff from a past diversion at **MP 5** has eroded 2 small gullies into the outer edge of the fill without sediment delivery. Currently runoff from MP 5 is no longer discharged to the site. The swale crossing consists of approximately 40 cy of fill placed 7 feet deep. The road grade is about 12%.

Preliminary Recommendations

- Install a reverse grade dip.

SITE	**7**	**Future Erosion (cy/20 yr)**	75
FEATURE	**CLASS III WATERCOURSE**	**Road Damage**	MOD-HIGH
ROAD	UPPER ROAD	**Treatment Priority**	HIGH

Description

This is a partially washed out fill crossing on a steep (30%) Class III watercourse draining a 16-acre forested watershed. There does not appear to have been any drainage structures installed at this crossing and as a result stream flow has eroded 40-foot-long, 6-foot-wide and 5-foot-deep gully most of the way through the fill prism. Immediately east of the crossing is a second gully or fill failure. It is unknown if this failure is due to past stream flow being directed over the fill embankment at this location or instability of the oversteepened fill prism.

Photo 4: Partially washed out fill crossing

The fill crossing consists of 150 to 250 cy of fill placed about 9 feet deep. Of this material, we estimate that 40 to 60 cy of this material (25% of total) has eroded out over the past 50 years (1.25 cy/yr). Most of this erosion likely occurred early on and has decreased significantly due to the diversion of stream flow at **MP 2** which results in only limited flow reaching the **MP 7** crossing. For the purpose of this study we have assumed an average erosion rate of 0.65 cy/yr which is about half the historic average.

We recommend that the crossing be either abandoned or upgraded with a permanent culvert. It may be possible to install a rock ford though this would likely be more expensive than installing a culvert due to the large amount of rock required.

Preliminary Recommendations

Alternative 1: Abandonment

- Excavate crossing to native channel grade
    - Minimum 4-foot wide channel bottom with smooth uniform grade
    - Lay channel banks back to 1.5H:1V or flatter
    - Estimate 200 cy of excavation.
    - Excavated fill will need to be placed along the inside edge of the road or on the landing near **MP 8**.
- Improve road drainage leading to crossing by installing reverse grade dips or waterbars.

Alternative 2: Permanent Culvert

- Install permanent 30-inch x 60 ft culvert (or larger).
  - Align culvert with native grade (~ 35%)
- Install a critical dip
- Improve road drainage leading to crossing by installing reverse grade dips or waterbars.

SITE	**8**	**Future Erosion (cy/20 yr)**	See MP1
FEATURE	**GULLY FROM DIVERTED CLASS III WATERCOURSE**	**Road Damage**	MOD
ROAD	UPPER ROAD	**Treatment Priority**	HIGH

Description

At this location runoff diverted from crossings **MP 1** (road) and **MP 2** (skid trail) discharges over the steep road cut of a small, narrow landing on the main road where it has eroded a 40-foot-long, 12-foot-wide and up to 18-foot-deep gully into the hillside. Erosion of the gully is active and ongoing.

The landing is about 80 feet long and 35 feet wide, and constructed by cutting in to the 45% gradient hillside on cut and fill. A narrow tractor road traverses the hillside just below the landing. Currently streamflow is diverted 200 feet down the road to the east where it discharges into the eroding fill crossing at **MP 9**. In the past, stream flow had drained across the landing and lower skid trail where it had eroded narrow gullies into the fill embankments. We observed a couple of small sink holes in the tread of the skid trail indicating some subsurface soil piping may be occurring.

Photo 5: Gully in steep cutbank from diverted stream flow originating from MP 1 and MP2

Photo 6: Sinkhole due to subsurface soil piping

Preliminary Recommendations

- Correct the stream diversions at Crossings **MP 1** and **MP 2**
- No treatment of the two gullies is required unless the road is to be reopened.

SITE	**9**	**Future Erosion (cy/20 yr)**	100
FEATURE	**PARTIALLY WASHED OUT CLASS III WATERCOURSE CROSSING**	**Road Damage**	MOD - HIGH
ROAD	UPPER ROAD	**Treatment Priority**	MOD

Description

This is a partially eroded out fill crossing at a narrow and steep gradient Class III watercourse that has experienced historic debris flow activity.

The Class III watercourse drains a 13-acre forested watershed. The active stream channel is approximately 2 to 3 feet wide with an average 25% channel grade. The crossing consists of approximately 120 to 250 cy of fill placed about 6 to 8 feet deep. The crossing is overtopped by 5 to 6 feet (~120 cy) of landslide debris originating from an upslope debris flow.

Photo 7: Two gullies at partially washed out watercourse crossing. The upper gully is from diverted stream flow coming down from MP8. The lower gully is from the watercourse.

Photo 8: Looking upstream and slide debris deposited in the crossing. The stream is located right of center in the photo.

There are two separate gullies that have eroded into the road prism. The first is from the Class III watercourse draining over the fill embankment. This gully is 50- to 80-foot-long, 4- to 6-foot-wide, and 2- to 3-foot-deep. We estimate 30 cy of material has eroded out over the past 50 years resulting in an average erosion rate of 0.7 cy/yr. The second gully is from diverted stream flow originating from **MP 8**. This gully is approximately 60 to 80 feet long, 4 to 8 feet wide and 2 to 5 feet deep. Erosion from this second gully has been included in the total for MP 1.

We estimate about 60 to 190+ cy of fill material still residing at the crossing and is expected to slowly erode out due to the combine flows from the Class III watercourse and the diverted stream originating at **MP 1**. For analysis purposes we assume an average erosion rate of 0.7 cy/yr which is the historic average.

To mitigate erosion at this site the crossing should be either abandoned or upgraded to a permanent crossing by installing a culvert or rock ford. In addition, the diversions at **MP 1**, **MP 2** and **MP 8** will need to be corrected.

<u>Preliminary Recommendations</u>

Alternative 1: Abandonment

- Excavate crossing to native channel grade
  - Minimum 4-foot wide channel bottom with smooth uniform grade
  - Lay channel banks back to 2H:1V or flatter
  - Estimate 200 cy of excavation.
  - Excavated fill will need to be placed along the inside edge of the road or on the landing near **MP 8**.
- Improve road drainage leading to crossing by installing reverse grade dips or waterbars.

Alternative 2: Permanent Culvert

- Install permanent 30-inch x 80 ft culvert (or larger).
  - Remove some of the landslide debris at the culvert inlet (~ 50 cy)
  - Align culvert with native grade (~ 20%)
- Install a critical dip

Alternative 3: Rock Ford

- Install a rock ford
  - Dip the crossing out to form a broad 2-foot-deep dip with the outfall inclined at 2H:1V.
  - Armor the outer edge of the road with rock rip rap. Rock to be sized.

All Alternatives

- Correct the stream diversions at **MP 1**, **MP 2** and **MP 8**
- Upgrade road drainage by installing drain dips

SITE	**10 AND 11**	**Future Erosion (cy/20 yr)**	550
FEATURE	DIVERTED CLASS III WATERCOURSE CROSSINGS	**Road Damage**	MOD
ROAD	UPPER ROAD	**Treatment Priority**	HIGH

Description

At this site the road makes a sweeping turn through the upper portion of a broad moderate gradient colluvial filled valley where it crosses two separate Class III watercourses (**MP 10** and **11**) just upstream of their confluence. Both Class III watercourses crossings are diverted several hundred feet down the road where their combined flow has resulted in extensive gullying of the road prism and rendering the road impassable.

MP 10: At this location the road crosses a finger of the colluvial filled valley with the upstream Class III watercourse draining a 10-acre watershed. The majority of the road was constructed across valley bottom with minimal cut and fill. There does not appear to have been any drainage structures at this location. The small watercourse drains over the road cut before being diverted 120 feet down the road to **MP 11**, eroding a 3- to 5-foot-wide, 3-foot-deep gully (50 cy).

MP 11: At this location the road crosses a second finger of the colluvial filled valley with the upstream Class III watercourse draining a 7.5-acre watershed. The road was constructed across the colluvial filled valley bottom of the Class III watercourse with minimal cut and fill. The road grade is about 10% to 12%. The area appears to have been heavily disturbed by old tractor operations.

The upstream active stream channel is about 2 to 4 feet wide with 10% to 15% channel gradient. Below the road is a broad flat area that was more than likely constructed within the Class III watercourse as an instream landing. Prior to the construction of the landing the stream had flowed about 60 feet the confluence of the Class III watercourse draining **MP 10**. The native stream channel on the downstream side of the crossing, however, is no longer apparent due to the area being heavily disturbed by old tractor operations.

The combination of a lack of drainage structures at **MP 11** and the construction of the downstream landing resulted in the combined streamflow from **MP 10** and **11** to be diverted 450 feet down the road resulting in locally extensive gullying of the road prism. For the first 250 feet of the diversion the gully is modest in size averaging about 4 to 6 feet in width and 2 to 4 feet in depth. After this location at **MP 12**, the road grade steepens slightly and the gully becomes much more deeply incised at 10 to 20 feet in width and 7 to 12 feet in depth, and with little of the road tread remaining. As will be discussed at **MP 12**, the combination of the deep gullying and very steep (90%) sideslopes significantly constrains the feasibility of reopening the road past this location.

Photo 9: Diverted stream at MP 12. The left channel is the watercourse at MP12, the right channel extending up the road is from diverted flow from MP 10.

Overall, we estimate there has been 800 to 1,200 cy of combined erosion over the past 50+ years (15 to 25+ cy/yr) from **MP 10**, **11** and **12** with the rate of erosion having decreased as the gullies have down cut into more stable material. We estimate the rate of future erosion at 10 to 15 cy/yr or about 2/3 the historic rate.

At **MP 10** the diversion should be corrected by abandoning the crossing by removing all of the crossing fill to native grade which will be relatively straight forward. For permanent road use a rock ford or culvert will need to be installed.

At **MP 11** the mitigation measures are slightly more complicated due to site topography and the existence of the instream landing that obscures the original channel location. To correct the stream diversion will require excavating a roughly 100-foot-long, 14-foot-wide and 3-foot-deep channel across the landing to redirect streamflow to the main valley bottom. A 3+ foot high earthen berm will need to be constructed on the downroad side of the crossing to direct streamflow into the new channel.

Reopening the road for permanent access past **MP 11** is not recommended due to the degree of road damage that has occurred beyond this location and the difficulty in implementing stable treatment measures

Preliminary Recommendations

MP 10

Alternative 1: Abandonment

- Abandon the stream crossing to native grade by excavating all of the crossing fill and old slide debris (less than 100 cy).
  - The excavation should result in a 3-foot-wide flat channel bottom with channel banks laid back to 2H:1V or flatter.
  - Excavated fill can need to be placed along the inside edge of the road below the crossing

Alternative 2: Permanent Culvert

- Install permanent 30-inch x 60 ft culvert (or larger).

Alternative 3: Rock Ford
- Install a rock ford
    - Dip the crossing out to form a broad 2 foot deep dip with the outfall inclined at 2H:1V.
    - Armor the outer edge of the road with rock rip rap. Rock to be sized.

MP 11

Alternative 1: Abandonment (preferred)
- Excavate 50 lf channel to convey stream flow across road
    - 4-foot-wide, 3-foot-deep channel bottom with smooth uniform channel grade.
    - Lay channel banks back to 2H:1V
    - Location of excavated channel to by flagged by the project engineering geologist or engineer.
- Construct a 3-foot-high earthen berm on down road side of crossing to direct flow into channel.

Alternative 2: Permanent Culvert
- Install permanent 30-inch x 40 ft culvert.

Alternative 3: Rock Ford
- Install a rock ford
    - Dip the crossing out to form a broad 2 foot deep dip with the outfall inclined at 2H:1V.
    - Armor the outer edge of the road with rock rip rap. Rock to be sized.

SITE	**12**	**Future Erosion (cy/20 yr)**	See MP10/11
FEATURE	**GULLY**	**Road Damage**	HIGH
ROAD	LOWER ROAD	**Treatment Priority**	LOW

Description

Diverted stream flow from crossings **MP 10** and **11** have eroded two deep gullies into the road prism. The first and currently active gully extends along the roadway for a distance of 140 feet before discharging off of the road. This gully is about 8 to 15-foot-wide, 5 to 10-foot-deep with less than 2 feet of roadway remaining where flow is discharged off of the roadway. Erosion is active and ongoing (See **MP 11** for erosion rates). The second, older and inactive gully is found about 40 feet further down the roadway. This gully has completely eroded out a 40-foot-long segment of roadway, 20 feet wide by roughly 12 feet deep.

Photo 10: Looking up the road at the first gully. The second gully located in the opposite direction from how photo was taken is much larger.

Reopening the road past these two gullies, and past site **13A** (combined fill and cutbank failure) located just past the gullies, is significantly constrained by the 70 to 90% slopes the road traverses. Reopening the road for permanent vehicle access will require reconstructing the outer edge of roadway on engineered fill with about 50+ feet of the fill supported by a 10 to 18-foot-high engineered retaining wall. The cost of these measures would likely be expensive, and could ultimately be found to be economically infeasible. Additional geologic and geotechnical work will be required to further asses the feasibility of a retaining wall and to developed design criteria.

It may be possible to temporarily open the road past this location at an 8-foot width for heavy equipment (e.g. small excavator and dozer) to undertake remedial work further down the road. However, before that avenue is pursued, we recommend that other alternatives for access be evaluated. There is a relatively high density of old tractor roads crossing the hillside and it may be possible to link one or more of these together to gain equipment access to the lower portion of the property.

It may also be possible to develop a narrow 4-foot-wide trail past this location, though again, additional work will be required. Because of the relatively steep grade (12% to 20%) the alignment is not ideal.

Preliminary Recommendations

The District shall evaluate the need for access past **MP 12**. This includes an assessment of permanent vs temporary, truck vs small equipment, and road vs trail access.

Alternative 1: Abandonment (Preferred)

- Abandon road through nonuse.

Alternative 2: Permanent Truck access

- Reconstruct 60+ feet of roadway on a 10 to 18+ foot high engineered retaining wall
- Additional geotechnical and geologic work will be needed to provide design criteria for any wall

Alternative 3: Temporary Small Equipment Access

- Reopen the road at a narrow 5 to 8-foot width by ramping down through the gullies on temporary fill with the fill removed at the end of operations.
- Additional work will be required to further evaluate the feasibility of temporary access.

SITE	**13**	**Future Erosion (cy/20 yr)**	--
FEATURE	**MULTIPLE CUT AND FILLSLOPE FAILURES**	**Road Damage**	HIGH
ROAD	LOWER ROAD	**Treatment Priority**	LOW

Description

Approximately 5,000 feet of the old truck road traverses steep 60% to 90% and locally unstable slopes with multiple cut and fillslope failures that have narrowed the road prism to less than 10 feet in a couple of locations. Most of the fillslope failures appear old. Treatment of this road segment is significantly constrained by the steep slopes. No treatment is required if the road is not reopened. Significant road reconstruction will be required at several locations if permanent truck access is desired. The following is a general discussion of site conditions, constraints, and recommendations.

The original road appears to have been constructed at an 18 to 24-foot width using cut and fill techniques with fill likely sidecasted onto the steep slopes as was the standard of practice in forest road construction decades ago. The resulting cut is 10 to 30 feet high exposing sandstone and shale of the Butano Formation. There are multiple old and recent small cutbank failures along the road that have deposited several feet of debris onto the roadway. Nearly all of these failures were retained on the road surface without sediment delivery to streams. In nearly all cases the road could be at least temporarily reopened past these failures by simply ramping over the failed slide debris.

The fill embankment along the road is estimated to be 5 to 7 feet deep with the embankment face inclined at greater than 1:1 slope in most locations. The fill appears to have been loosely sidecasted onto the steep sideslopes without the benefit of a keyway or benches.

There are multiple fill failures along this segment of road which have narrowed portions of the road prism to less than 10 feet in places, and has contributed to a large deep-seated landslide at one location where none of the original road prism remains. Most of the fill failures appear old and likely occurred within the first few decades after construction with the road prism having weathered and somewhat stabilized since then. The failures are generally 25 to 100 feet wide and appear to be constrained to mainly fill and overlying colluvial sediments with the remaining portion of the road prism on native bedrock. Commonly a steep crownscarp encroaches to the edge of the remaining roadway. Failures are attributed to thick fill loosely sidecasted onto steep slopes, though poor road drainage could have been a contributing factor. Unfailed portions of the roadway could be at risk for failure.

The following is a brief description of the more significant fill and cutbank failures along the roadway:

A: LARGE CUTBANK AND FILL FAILURE: 100-foot-wide combined cut and fill slope failure on 90+% sideslopes has narrowed the road to less than 2 feet. The failure appears to be constrained to fill and overlying colluvial sediments, though it is unknown as to how much of the original road surface that is buried by cutbank slough remains.

Treatment: Reopening the road for vehicle access will be very challenging and require supporting ~80 feet of roadway on a 10 to 15-foot-high retaining wall. Due to steep slopes, even temporarily reopening the road on temporary fill will be challenging. It may be possible to construct a 5 foot wide trail across this slope by cutting partway into the bank.

B: CUTBANK AND FILL FAILURE: 90-foot-wide combined cut and fill slope failure on 90+% sideslopes has narrowed the road to 5-to-10-foot width. The failure appears to have occurred along a relatively wide section of road.

Treatment: If required the road can be reopened by blading through some of the failed cutbank debris.

C: FILL FAILURE: 35-foot-wide fill failure on 90% sideslopes resulting in a 3-foot-high vertical scarp and narrowing the road prism to about 8 feet. The majority of the fill embankment appears to have failed with the remaining road prism located mainly on bedrock. The outer 2 to 4 feet of the remaining road prism is oversteepened and potentially unstable.

Treatment: Reopening the road for vehicle access will likely require supporting ~40+ feet of roadway on a 10 to 15+ foot-high retaining wall. It may be possible to construct a 5 foot wide trail across this slope by cutting partway into the bank.

D: FILL FAILURE: 50-foot-wide old fill failure on 90% slopes narrowing the 18-foot-wide road to about 10 feet. Outer 2 to 3 feet of remaining road is potentially unstable.

Treatment: It may be possible to reopen the road by cutting into the bank a couple of feet, though additional geologic and geotechnical work will be required to confirm this. Otherwise, the outer edge of the failed roadway shall be reconstructed and supported by a retaining wall.

E: CUTBANK FAILURE: 40-foot-wide cutbank failure deposited 3 to 5 feet of debris and redwood stump onto the roadway.

Treatment: If required, the road can be reopened by ramping over this slide and feathering out some of the material to either side. The remaining material will need to be endhauled to a stable location.

F: FILL FAILURE: 25-foot-wide fill failure on 60% side slopes near the axis of a swale narrowing the road to 9 to 10 feet. The failure may be situated at the outlet of an old dip, which could have contributed to the failure. Currently no flow observed. The steep road cut is experiencing small scale raveling and instability.

Treatment: It should be possible to widen the road a couple of feet on a full bench if the road is to be reopened and additional road width required.

G: CUTBANK AND FILL FAILURE: 30 to 40-foot-wide combined cut and fill slope failure. About 25 LF of the outer edge of road has failed as a thin debris slide, narrowing the road slightly. In addition, about 30 feet of the steep road cut has failed depositing 5 to 10 feet of debris onto the roadway. Failed debris incorporated several large redwood stumps / root balls.

Treatment: If required, the road can be reopened by ramping over the cutbank failure without side casting. Some of the material will need to be endhauled up the road to a stable location.

H: FILL FAILURE: 60-foot-wide fill failure on 75% to 90% sideslopes and adjacent to a Class III watercourse narrows the road prism to about 6 feet. The failure resulted in a 4-foot-high near vertical scarp that encroaches to the edge of the road prism. The majority of the fill embankment appears to have failed with the remaining road prism located mainly on bedrock. The outer 3+ feet of the remaining road prism is oversteepened and potentially unstable. The road cut is 10 to 15 feet high and raveling.

Treatment: It may be possible to reopen the road by cutting into the bank a couple of feet, though additional geologic and geotechnical work will be required to confirm this. Otherwise, the outer edge of the failed roadway shall be reconstructed and supported by a retaining wall.

I: FILL FAILURE: 40-foot-wide fill failure on 100% side slopes narrows the road to about 12 feet. The 30-foot-high road cut exposes bedded Butano Sandstone that appears mostly competent. There is some sloughing of the cutbank.

Treatment: If required the road could be reopened at a 10-foot width by removing the cutbank slough.

J: FILL FAILURE: 25-foot-wide fill failure on 90% side slopes narrows the road to about 10 feet. Some recent instability.

Treatment: Road appears passable at 8 to 10-foot width. It may be possible to gain a foot or two by cutting into the bank, otherwise the outer road edge will need to be supported on a retaining wall.

K: FILL FAILURE: 40-foot-wide old fill failure located on the outer edge of a small landing. The landing appears to have been constructed on a natural bench (deep-seated landslide) within a broad swale with potentially thick fill pushed to the outer edge. Natural slope gradients range between 30% to 50%. The road is vegetated with straight conifers. The failure resulted in a 7-foot-high near vertical scarp that narrowed this portion of the landing to 12 feet. The ground below the landing near the toe of the fill appears seasonally wet which may have contributed to the failure. Failed debris appears to have been retained on the hillside without much, if any, sediment delivery. Outside of the old fill failure, no evidence of recent or active instability was observed during our field reconnaissance. There is the possibility for additional fill instability at this site, though we expect such failures to be small and most likely be retained on the hillside.

Treatment: Road appears to be passable at 10-foot width. Extra road width can be obtained by cutting into the bank on full bench.

L: FILL AND HILLSLOPE FAILURE: At this site about 90-feet of roadway has down dropped 9 feet due to combined fill and deep-seated instability, with the failure extending the full distance into the road prism. None of the original road remains. The failure occurred where the 20-foot-wide road traversed 50% to 70% slopes across what appears to be a pre-existing deep-seated landslide. A portion of the deep-seated landslide appears to have reactivated causing this section of the road bed to break apart and down drop. The down dropped block is well vegetated with straight second growth redwood, suggesting the failure is relatively old. The cause of the deep-seated landslide is unknown, though it is quite possible that fill placement was at least a contributing factor.

In addition to the down dropped block, portions of the residual fill on the left (north) flank of the slide have cracked narrowing the road to 7 feet. The age of the cracks is unknown but based on visual observations appear old. There is also a small 20-foot-wide old fill failure on the right (south) flank of the larger slide.

The failure did not appear to result in any sediment delivery.

Treatment: Reconstructing the road past this slide will be challenging due to steep slopes and the unstable nature of the hillside. It may be possible to steeply ramp a 10-foot-wide road down across the displaced slide block, though the long-term stability of this is questionable as additional instability of the larger landslide block is expected. Depending on the depth of the slide, it may also be possible to reconstruct the road and stabilize the hillside with retaining structures. A geologic and geotechnical investigation will be required to further evaluate stability at this location. Because the site is currently inaccessible, obtaining required subsurface data will prove challenging and may require reopening the road to this location for a small drill rig. Reopening a narrow ATV or trail past this site is much more feasible, though may still be at risk for instability.

Discussion

The Lower Road was constructed across locally very steep slopes and in a manner that resulted in multiple failures of the road fill. Significant road reconstruction will be required to reopen this segment of road. Reconstructing the road at a 10 to 12-foot width for vehicle access will be challenging and likely very expensive due to the steep slopes, confined working conditions and need for retaining structures. It may be possible, however to construct a narrow 5-foot wide ATV or recreational trail with much less effort.

The most significant problems exist at **12**, **13A**, **13B** and **13K** where the majority of the road prism has failed or eroded out narrowing the road to 0 to 9 feet in width and resulting in a steep escarpment that encroaches to the edge of the remaining road prism. We find the crown scarps to be unstable with a moderate to high potential for an undermined wedge of material along the remaining road edge to fail or erode. If the road is to be reopened it will need to be offset a suitable distance from the edge of the escarpment or built upon an engineered retaining wall.

At Sites **13A** and **13B** we do not believe it will be feasible to gain much, if any, extra road width by cutting further into the hillside. Therefore, at these sites the outer edge of the roadway will likely need to be reconstructed and supported on 180+ LF of 10 to 15-foot-high retaining walls. There are several retaining wall designs that could be employed, including a solider pin wall, gravity wall, and reinforced earth wall. Each of these have their pros and cons. A reinforced earth wall using geogrid or Hilfiker materials would likely be the most cost-effective option if a retaining wall is selected. The transition zones at the ends of the wall will be difficult to implement due to the potentially unstable undocumented fill that borders the slide areas.

At site **13K**, it may be possible to steeply ramp a 10-foot-wide road down across the displaced slide block, though the long-term stability of this is questionable as additional instability of the larger landslide block is expected. Depending on the depth of the slide, it may also be possible to reconstruct the road and stabilize the hillside with retaining structures, though additional work will be required to further evaluate this.

At the remaining fill failures, **13C**, **13E**, **13F**, **13G**, **13H**, **13I** and **13J**, the failures do not appear to have encroached as far into the road prism and/or the native slopes are not as steep. It may be possible to gain suitable road width at these locations by cutting into the hillside on a full bench and endhauling spoils to a stable location, though additional geologic and geotechnical work will be required to confirm this. If suitable road width does not exist, then the outer edge of the road would need to be supported on a retaining wall.

It should be understood that the remaining unfailed segments of roadway also contain thick fill sidecasted onto steep slopes. While there are few signs of active instability (e.g. ground cracking), the nature of the thick fill embankments on steep slopes places them at potential risk for future failures, especially if water is allowed to concentrate and discharge over the fill.

The steep road cut is also subject to cutbank instability with large failures having occurred at **13A**, **13D** and **13F** depositing debris onto the roadway. Generally, the road can be reopened past these features by removing the failed debris or ramping over the mass. Continued cutbank instability should be expected if the road is to be reopened potentially requiring a higher than average level of effort to clear the roadway.

With respect to future erosion and sediment delivery, the current rate of erosion appears relatively low and the majority of high-risk sites that could have failed have likely already done so. Future fill instability will likely occur, however there is uncertainty in predicting exactly where that is most likely to occur. Some limited benefit may be achieved by pulling back excess fill at **13J** (failing landing fill) and by installing drain dips to break up any runoff. However, the amount of ground disturbance that would be needed to reopen the road probably makes this impracticable and cost prohibitive.

<u>Preliminary Recommendations</u>

Alternative 1: Abandonment (Preferred)

- We do not recommend reopening the road. The road can be abandoned by non-use.
- Evaluate the feasibility of obtaining temporary truck and/or equipment access to sites 15 and 16 via an alternative route. This may include linking one or more of the upslope skid trails. It is not feasible to access this site from the bottom over La Honda Creek.

Alternative 2: Truck Access

- Offset road inboard from 1:1 slope extending from base of slide escarpments bounding the edge of the road.
- Where less than 10 feet of road width remains then:
  - Reconstruct and retain the outer edge of road. We estimate a minimum of 180 LF of 10 to 15-foot-high retaining walls are required
  - Where approved by the engineering geologist and/or geotechnical engineer, widen the road a couple of feet by cutting into the hillside on a full bench and endhauling all spoils. We estimate that over 200 feet of roadway will need to be widened. It some areas it may not be possible to gain sufficient width by grading and in these areas additional retaining structures may be required.
- Ramp over cutbank failures and/or clear debris from roadway by excavating and endhauling. Do not side cast.
- **MP 13K**
  - It may be possible to steeply ramp a 10-foot-wide road down across the displaced slide block, though the long-term stability of this is questionable as additional instability of the larger landslide block is expected. Depending on the depth of the slide, it may also be possible to reconstruct the road and stabilize the hillside with retaining structures.

Alternative 3: Temporary Small Equipment Access

- Reopen the road at a narrow 5 -foot width by ramping down through the gullies on temporary fill with the fill removed at the end of operations.
- Additional work will be required to further evaluate the feasibility of temporary access.

SITE	**14**	**Future Erosion (cy/20 yr)**	<500
FEATURE	EARTH FORD CROSSING UNSTABLE FILL	**Road Damage**	LOW - MOD
ROAD	LOWER ROAD	**Treatment Priority**	MOD

Description

This is a slowly eroding earth ford crossing located within the drainage of a small colluvial filled Class III watercourse draining a 9-acre forested watershed. The site is characterized by a small moderately sloping topographic bench located toward the downslope end of a thick deposit of colluvium and old landslide debris. There is equivocal evidence to suggest that the outer edge of this bench may be inherently unstable.

Upstream of the crossing the watercourse occupies a 30% to 40% gradient colluvial filled drainage that appears to have been impacted by old tractor operations and possible shallow debris flow landslides resulting in a shallow and somewhat disrupted drainage channel. Downstream of the crossing below the bench, slope gradients steepen to greater than 65% for a short distance.

It appears that only limited grading was required to construct the road across the bench, though fill generated from the construction of the road across the steeper side slopes may have been pushed over the edge within the axis of the drainage. It is unknown how much fill material resides at the site, if any, but could be as much as 100 to 500 cy. Subsurface exploration will be required to more precisely determine the amount and level of stability of the fill material.

Photo 11: Looking east across bench. The gully at the outer edge of the road is barely visible behind the trees on the left side of the photo. The very subtle arcuate escarpment is also barely visible in the middle of the photo.

Photo 12: Looking east across the head of the gully eroded into the edge of the bench.

No drainage structures were installed at the crossing with a small to moderate size gully having eroded into the steep hillside below the road. This gully is approximately 50 to 60 feet long, 10+ feet wide and about 6 to 8 feet deep forming a well-defined incised channel. The channel bend and banks are partially duff covered indicating a low rate of erosion. We estimate that about 75 to 100 cy of material has eroded from this gully over the past 50+ years, with most of that having likely occurred early on. We estimate the current average rate of erosion to be less than 1 cy/yr.

Upstream of the crossing is a second, smaller gully measuring about 35 feet long, 7 to 10 feet wide and 3 to 6 feet deep. This gully appears to be the result of diverted stream flow, possibly from old tractor operations along the valley bottom of the colluvial filled drainage. As previously mentioned, this area had been impacted by tractor operations contributing to a shallow and somewhat disrupted drainage channel. Eroded sediment from the gully is deposited onto the bench where the road is located with likely only limited sediment delivery. Ongoing erosion in the gully is likely but at a low rate. In our opinion, only limited benefit would be achieved by redirecting stream flow.

During our field review we observed equivocal evidence of two subtle and weathered arcuate escarpments with less than ½ foot of vertical displacement extending 50 to 60 feet across the outer edge of the bench and 10 to 30 feet back from the outer edge of the bench. It is unknown if these escarpments define a potentially unstable slide block located within the colluvial deposits and possibly within old road fill or if they are simply an artifact of old grading. In addition, it also is unknown if the construction of the road had any significant impact on site stability through the placement of any fill. Future instability resulting from a large magnitude storm or earthquake may be possible and could potentially result in small scale local ground cracking or, in a worst-case scenario, generate a large 500 to 1,000 cy slope failure. A more in-depth slope stability analysis would be required to better quantify the landslide hazard at this location. Mitigating slope stability hazards at this site will be very difficult due to the lack of access.

<u>Discussion</u>

The existing road has not been significantly damaged and, if equipment can get to the site, can be readily be reopened with only minimal grading. Reopening the road for access is not a significant constraint.

The principal geologic concerns at this site are 1) continued gullying of the steep slope below the road, 2) continued gullying of the upstream gully and 3) stability of the bench which could result in increased sediment delivery to the stream network. Future erosion from the two gullies will likely be slow and limited, and by themselves do not warrant reopening the road for mitigation purposes. If the road is to be reopened, additional review will be required to determine how much, if any, fill still resides at the crossing, which will be necessary to know for the design of any permanent stream crossing.

There is some concern as to the level of stability of the outer edge of the bench on which the road crosses. While we believe that the potential for road related slope instability is most likely very low, it cannot be ruled out with certainty. A more in-depth slope stability hazard analysis would be required to better quantify the landslide hazard at this location and the potential adverse impact of the road, if any. Mitigating any slope stability hazards at this site would be very difficult due to the lack of access across the large slope failure at Site **13A**, where the majority of the road prism is missing.

Preliminary Recommendations

General

- A more in-depth engineering geologic and slope stability investigation should be undertaken if the District requires greater certainty on the stability of this site. This work may include but is not limited to additional field mapping, subsurface exploration, and slope stability modeling.

Alternative 1: Abandonment (Preferred)

- Evaluate the feasibility of obtaining temporary truck and/or equipment access via an alternative route other than the main road. This may include linking one or more of the upslope skid trails. It is not feasible to access this site from the bottom over La Honda Creek.
    - If temporary alternative access is found then abandon the stream crossing to native grade by excavating all of the crossing fill and old slide debris (amount of excavation to be determined).
    - Pull back unstable fill (limits to be determined)
    - If access is not found then no treatment.

Alternative 2: Truck Access

- Excavate and endhaul unstable fill to a stable location. Additional work will be required to determine the amount and limits of excavation.
- Install a rock ford or permanent culvert, or abandon after operations

Alternative 3: Temporary Small Equipment Access

- Abandon crossing after operations. Additional work will be required to determine the amount and limits of excavation.

SITE	**15**	**Future Erosion (cy/20 yr)**	<50
FEATURE	UNSTABLE FILL CROSSING	**Road Damage**	MOD - HIGH
ROAD	LOWER ROAD	**Treatment Priority**	LOW - MOD

Description

This is a 50+/- foot wide partial fill failure at an earth ford crossing on a narrow and steep (50%) gradient Class III watercourse. The crossing is subject to both fill instability and upstream debris flow landsliding.

The ford crossing consists of approximately 150 cy of fill placed 7 to 8 feet deep. The outer 10 to 15 feet of the fill prism has cracked and down dropped about 5 feet with a couple of small failures on the face of the down dropped block. The failure appears old and is revegetating. We estimate less than 30 cy of past sediment delivery from this crossing.

The Class III watercourse drains a steep 4.5-acre forested watershed subject to shallow debris flow landsliding. The active stream gradient is 50%. Past debris flow landsliding has deposited 2 to 5 feet of debris onto the road surface with the watercourse slowly incising through the deposit.

Discussion

Continued instability of the fill prism is to be expected, as is slow incision through the failed debris flow deposit. We estimate that the entire 150 cy of the fill prism could eventually fail or wash out. However, this could take a very long time. The big question is whether it is worth reconstructing a generally poor road across the multiple slope failures, simply to correct erosion at this site. Unless the road is to be reopened for other purposes, we do not believe that any significant benefit would be achieved by removing this crossing given the low rate of erosion and the large amount of ground disturbance required to access the site with equipment.

Preliminary Recommendations

Alternative 1: Abandonment

- Evaluate the feasibility of obtaining temporary truck and/or equipment access via an alternative route other than the main road. This may include linking one or more of the upslope skid trails. It is not feasible to access this site from the bottom over La Honda Creek.
  - If temporary alternative access is found then abandon the stream crossing to native grade by excavating all of the crossing fill and old slide debris (150 cy).
  - If access is not found then no treatment.

Alternative 2: Truck Access

- Excavate and endhaul unstable fill to a stable location. Estimate 100 - 150 cy.
- Install a rock ford or permanent culvert, or abandon after operations

Alternative 3: Temporary Small Equipment Access

- Excavate and endhaul unstable fill to a stable location. Estimate 100 - 150 cy.
- Abandon crossing after operations

SITE	**16**	**Future Erosion (cy/20 yr)**	200
FEATURE	**HUMBOLDT CROSSING AND DIVERTED STREAM**	**Road Damage**	HIGH
ROAD	LOWER ROAD	**Treatment Priority**	MOD - HIGH

Description

This is a partially washed-out Humboldt log crossing where the road makes a sharp turn through a Class II watercourse before descending down the right (south) channel bank to La Honda Creek. The Class II watercourse drains a 100-acre forested watershed. The Humboldt log crossing consists of approximately 800 to 1,000 cy of fill up to 15 feet deep. The crossing probably served as an instream landing for logging operations.

On the south (right) slide of the crossing is a 500+ foot long, 2 to 6 foot deep gully that has eroded into the road prism. This gully is most likely the result of a past diversion the Class II watercourse down the road. The gully presently exhibits steep moss-covered channel banks with a moderate to heavy duff along the channel bottom, the appearance of which suggests the gully is relatively old. Some active erosion was observed along the lower portion of the gully where incision appears to have intercepted some groundwater. Very little active erosion was observed at the bottom of the gully where it eventually discharges into La Honda Creek.

The amount of road gullying observed down the road is greater than would be expected from current drainage patterns. We believe that the Class II watercourse had been diverted down the road at some point eroding much of the gully we see today, but the stream was redirected back to its natural channel as a result of an upstream debris flow. About 300 feet upstream of the crossing a moderate size debris flow had extended down a small steep gradient Class III tributary depositing a thick wad of debris in the valley bottom with debris extending to nearly the Humboldt crossing. The slide pushed the Class II watercourse to the opposite channel bank and redirected it back towards its natural channel.

Presently the Class II watercourse flows in a shallow channel over the debris flow deposit of intermixed wood and sediment before reaching the upstream end of the Humboldt crossing. From there the stream has eroded an 80-foot-long, 5 to 15-foot-wide, 4 to 10-foot-deep channel across the old roadway, before draining underneath a root wad and across some stacked logs at the downstream end of the crossing. The road gully to the south of the crossing currently receives runoff from the small Class III tributary, adjacent sideslopes, and intercepted groundwater. The current rate of erosion within the gully appears low.

Photo 13: looking downstream at the partially washed out Humboldt crossing. Stream flow drains underneath a fallen stump just to the left of the eroded channel.

Photo 14: looking down the road at the eroded channel from diverted stream flow. This photo was taken along the lower portion of the gully where the incision is much greater. Note the heavy duff layer in the channel bottom.

Discussion

We estimate about 250 cy of fill has eroded out of the Humboldt crossing with an additional 1,000 cy along the old diverted road gully over the past 50 years with an average erosion rate of 25 cy/yr. Most of this erosion likely occurred relatively quickly and has decreased overtime as a result of the Class II no longer being diverted and because the gully has down cut to more competent material.

Continued erosion is expected, though at a lower rate than in the past. As much as 750 cy of material could erode out of the Humboldt crossing, but we expect this would likely take a relatively long period of time. Continued slow erosion of the 500 foot long gully where the Class III watercourse is currently diverted is also expected. It is difficult to estimate the long-term rate of erosion from this gully but it is most likely relatively low due to low volume of stream flow currently being diverted and because the gully has likely already eroded down to more competent material. At this time, we roughly estimate that the current average erosion rate from the site to be about 10 cy/yr which is 40% of the 50-year average.

The question is whether this site warrants treatment given its current inaccessibility and the significant amount of road construction and associated costs that would be required to access the site. In our opinion, we do not believe that current low rate of erosion merits level of effort and associated risks to reopen the access road to this site for sediment reduction purposes. If the road is to be reopened for other purposes, then the crossing fill should be removed and the Class III diversion corrected.

There are multiple other skid trail crossing the hillside on the property and it may be possible to temporarily reopen one or more of these trails to get heavy equipment to the site. This alternative should be evaluated.

Preliminary Recommendations

Alternative 1: Abandonment

- Evaluate the feasibility of obtaining temporary truck and/or equipment access via an alternative route other than the main road. This may include linking one or more of the upslope skid trails. It is not feasible to access this site from the bottom over La Honda Creek.
    - If temporary alternative access is found then abandon the stream crossing to native grade by excavating all of the crossing fill (750 cy), redirect the Class III tributary back into the Class II and away from the gully. No treatment of the gully is required.
    - If access is not found then no treatment.

Alternative 2: Truck access

- Install 60 inch by 80 foot culvert
- Redirect the Class III tributary back into the Class II and away from the gully. No treatment of the gully is required.

Alternative 3: Temporary Small Equipment Access

- Dip road through upper end of crossing
- At conclusion of operations abandon the crossing by excavating unstable fill to native channel grade. Estimate 750 cy.
- Redirect the Class III tributary back into the Class II and away from the gully. No treatment of the gully is required.

REFERENCES

Brabb, E. E., Graymer, R. W., and Jones, D. L., 2000, Geologic map and map database of the Palo Alto 30' x 60' quadrangle, California: U. S. Geological Survey, Miscellaneous Field Studies MF-2332, scale 1:24,000.

Keaton, J. R., and DeGraff, J. V., 1996, Surface Observations and Geologic Mapping, *in* Turner, A. K., and Schuster, R., eds., Landslides: Investigation and Mitigation: Transportation Research Board, Special Report 247: Washington D.C., National Academy Press, p. 178-230.

Wentworth, C. M., Graham, S. E., Pike, R. J., Beukelman, G. S., Ramsey, D. W., and Barron, A. D., 1997, Summary distribution of slides and earth flows in San Mateo County, California: USGS Open File Report 97-745 C2.

This page intentionally left blank

APPENDIX B

Forest Inventory Methodology

ATTACHMENT 1

La Honda Forest Inventory 2020 rev 3/13/20

This cruise is intended to support the La Honda Forest Assessment and Management Plan (the Plan), being prepared for Midpeninsula Regional Open Space District by Sicular Environmental Consulting and Natural Lands Management. Buena Vista Resources, L.L.C., is a subcontract to Sicular Environmental Consulting. The cruise is intended as an efficient means to obtain information regarding existing conifer and hardwood forests, with a focus on structure, health and regeneration. A primary component of the Plan will be to identify and characterize "Impaired Forest Condition Classes" (IFCCs) which will indicate silvicultural treatments intended to put these stands back on a track to some stage of their "pre-disturbance" condition. Fuels will also be assessed as a part of an assessment of the risk of catastrophic wildfire, as well as risk to carbon stocks and to inform application of management tools such as prescribed burning or other fuel reduction techniques. The cruise will provide crucial data that will underlie these efforts.

The entire La Honda Creek Open Space Preserve (La Honda OSP) is approximately 6,100 acres. The project area is entirely within the La Honda OSP and is around 1,770 acres.

The project area was preliminarily stratified as follows:

Conifer/conifer dominated forest	970 acres
Hardwood dominated forest	250
Brush/Grass/Non Forested	550
Total	1,770

The subject area was divided administratively as follows:

Harmon Management Unit (HMU)

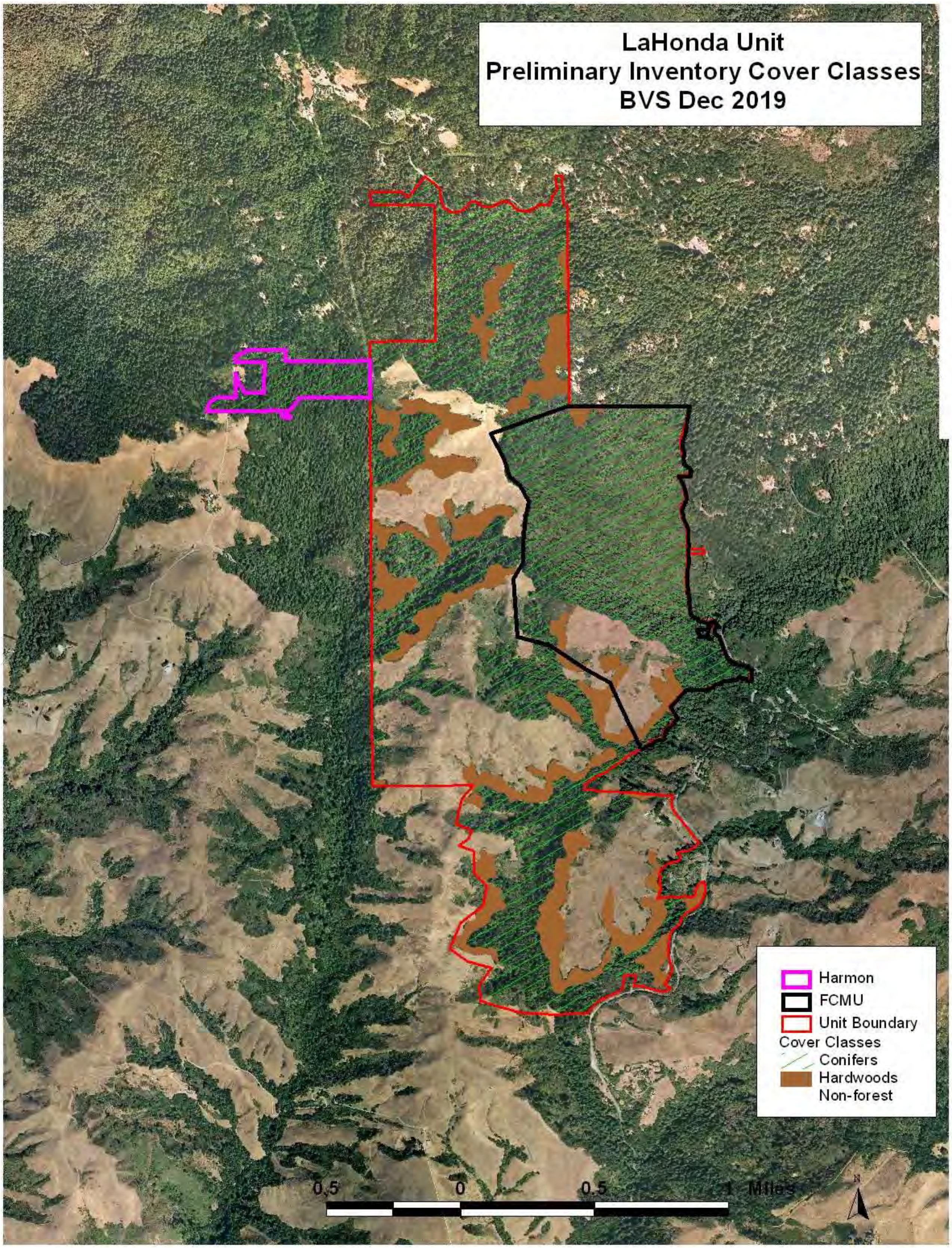
Conifer/conifer dominated forest	50 acres
Hardwood dominated forest	0
Brush/Grass/Non Forested	0
Subtotal	50

Forest Conservation Management Unit (FCMU)

Conifer/conifer dominated forest	350
Hardwood dominated forest	20
Brush/Grass/Non Forested	70
Subtotal	440

Remainder

Conifer/conifer dominated forest	570
Hardwood dominated forest	230
Brush/Grass/Non Forested	480
Subtotal	1,280


LaHonda Unit
Preliminary Inventory Cover Classes
BVS Dec 2019
Harmon
FCMU
Unit Boundary
Cover Classes
Conifers
Hardwoods
Non-forest
0.5
0
0.5
1
Miles

Approximately 150, slope-corrected, 1/5 (0.2) acre 52.7' fixed-radius plots, with 1/50 (0.02) acre 16.65' nested subplots are to be installed ***AND MEASURED AS FOLLOWS:***

Locating the Plot Center:

A-priori plot locations in ArcView will be loaded into GPS units and navigated to in the field. Paper maps showing nominal plot locations on orthophotos and topo maps will also be carried. Once in the approximate location, the GPS unit will be given 5 minutes to settle, and the plot center set.

There will be situations when the GPS signal will not be sufficient, and in those cases the following will be done. The cruiser is to navigate to the plot center using the GPS and the map. If the signal does not settle to within ~20' after 5 minutes, the current location will be captured as the new plot location.
Plot locations will be stored as GIS data and the coordinates will remain available for re-measurement. It is critical that we have reliable location information for plots since they will be "pulled through" orthophotos to help in post-stratification.

Monumenting the Plot:

Plot centers are to be monumented with white 30" x ½" PVC stakes and annotated with flagging. Flagging on the plot centers (PC) to include plot number, date and cruiser's initials. The pipe will also be annotated with plot number. Additional flagging to be hung around each PC at eye height to aid in relocation and for slope correction measurements.

ON EVERY SECOND PLOT ONLY Identify two witness trees per plot for purposes of future plot center relocation. Desirable attributes of witness trees: 1) durable; 2) occurring at roughly right angles; 3) reasonably close to plot center. Label one tree 'X' and other "Y'. For each tree, install a nail (long; aluminum) at the base (below stump height) and facing plot center. Record 1) slope distance (not horizontal distance) and 2) azimuth from the witness tree to plot center. To the nail, affix an impressable aluminum tag with the following labeled: 1) plot number; 2) 'X', or 'Y'; distance and 3) azimuth. On the data sheet, record X and Y witness tree attributes among the plot data (not among tree data).

Once the plot center is set and monumented, the following procedures are performed on each plot.

Top of card: **Job**: LFMP; **Cruiser initials**; **Date**

Plot No.: Enter the plot number loaded in the GPS data. If the GPS unit did not settle after 5 minutes, add the suffix '-gps" to the plot number to indicate that you entered new coordinates.

Slope: Average slope in %, e.g. 65%

Aspect: Compass aspect, e.g. NE or S

Position: See Topographic Position diagram below for abbreviations.

Comments: Note Recent Disturbance:

E – "Major active anthropogenic erosion feature, such as crossing failure, diverted stream, gully, etc."
S – "SOD present".
O – "Other" - include brief description

Also note anything of significance observed in and around the plot regarding landslides, trail/roads/landings, wet areas and stream classes, presence of old growth, old growth stumps, large woody debris, non-natives (such as broom, pampas grass), sensitive plants (including King's Mountain manzanita (*Arctostaphylos regismontana*), Western leatherwood (*Dirca occidentalis*), California bottlebrush grass (*Elymus californicus*), and Choris's popcorn-flower (*Plagiobothrys chorisianus* var. *chorisianus*)), understory condition (describe dominant species, dead and down), sensitive fauna (nests/whitewash, etc.).

Tree measurements**:**

Trees to be measured and recorded in a *generally* clockwise manner starting from true North, but tree sequence may not always be perfectly circular due to on-site factors. The sub-plot should be measured first.

1/50 acre subplot:

- 16.6 foot plot radius. With the plot rope planted on or at the plot center pipe, beginning from true north the cruiser establishes "in and "out" trees, while adjusting for slope. A 75' logger's tape can also be used with the table below.

- All trees (including snags) to be measured are identified by species code (see below for species codes)

- DBH to the nearest 2 inch class on all trees (including snags) >=1" and < 11.0" using a Biltmore stick or tape/caliper as needed. Redwood sprouts: 1/ft of stump diameter to max of 6. Make note if significant regeneration is present (<1" DBH) by species. The designation for the size class is the median of that class. For example, the 8" class includes trees >=7" and <9".

- Total height on all trees (including snags) (TH) to the nearest foot and Live Crown Ratio (LCR) using a clinometer and logger's tape or plot rope, and log height (LH) to appropriate top DIB and log length. Measure TH on all species; see table below for LH specifications.

- ***ON EVERY FOURTH PLOT ONLY***: Conifer closest to plot center >11.1" DBH, also measure DBH to nearest 1/10" using Diameter Tape, take 10 year radial increment at DBH, inner and outer bark thickness. Can use Biltmore to span furrows and measure outer bark thickness. Inner bark thinness can be measured from extracted core. You should take about a 4 inch core to be sure to get 10 past years of growth.

- Defect/Grade by log position (conifers only). Select one:
  X=missing log;
  8=unmerchantable log;
  9=defect (indicate percent e.g. 2 = 20%);
  E=export log (these are DF and pine logs only with minimal sweep, no conk, and few small branches or branch scars. Note: an "E" log must have no visible defect, but other logs in that tree may).

  Watch particularly for conks in DF, butt rot in DF (i.e. Fomes pini which may form a conk on the ground), and grown over firescars/termite damage in RW.

- For snags, record tree class according to diagram and stages below.

- Comment on tree health and type of defect as needed on tree record. Note particularly any diseases. *Watch for: galls and pitch canker in pines, S.O.D. or sudden oak death in hardwoods, conks.*

- Comment on any habitat features observed on tree record, such as presence of goose pen (basal hollow), large branches or wolfy growth habit, broken tops, reiterated trunks, etc.

1/5 acre major plot:

- 52.7 foot plot radius. With the plot rope planted on or at the plot center pipe, beginning from true north the cruiser establishes "in and "out" trees, while adjusting for slope. A 75' logger's tape can also be used with the table below. Be sure to exclude trees measured in subplot.

- All trees to be measured are identified by species code (see below for species codes)

- Cruiser to make stand type call based on preliminary classification scheme (see below).

- Measure diameter at breast height (DBH) to the nearest 2-inch class of all trees (including snags) with DBH >11.1" using a Biltmore stick. Measure diameters twice at 90 degrees and take the average. Snags must be at least 15' tall to be measured. See note above about definition of diameter classes.

- Total height (TH) to the nearest foot and Live Crown Ration (LCR) using a clinometer and logger's tape or plot rope, and log height (LH) to appropriate top DIB and log length. Measure TH on all species; see table below for LH specifications.

- Defect/Grade by log position (conifers only). Select one:
  - X=missing log;
  - 8=unmerchantable log;
  - 9=defect (indicate percent e.g. 2 = 20%);
  - E=export log (these are DF and pine logs only with minimal sweep, no conk, and few small branches or branch scars. Note: an "E" log must have no visible defect, but other logs in that tree may).

  Watch particularly for conks in DF, butt rot in DF (i.e. Fomes pini which may form a conk on the ground), and grown over firescars/termite damage in RW.

- For snags, record tree class according to diagram and stages below.

- Comment on tree health and type of defect as needed on tree record. Note particularly any diseases. *Watch for: galls and pitch canker in pines, S.O.D. or sudden oak death in hardwoods, conks.*

- Comment on any habitat features observed on tree record, such as presence of goose pen (basal hollow), large branches or wolfy growth habit, broken tops, reiterated trunks, etc.

- ***ON EVERY FOURTH PLOT ONLY***: For large woody debris (LWD), measure all pieces greater than 12 inches diameter (average diameter for entire length in plot) and greater than 10 feet long ***WITH A 4" MINIMUM SMALL END*** . Measure diameter to 2 inch class and length (within plot) to two foot class. Record species and decay class (per chart below). Apply snag classes to LWD when feasible.

- ***USING THE FUEL MODEL PHOTOS IN PNW-105 FOR DF-HWD, HWD AND DF-HEM, CHOOSE AND RECORD IN THE PLOTCARD HEADER THE CLOSEST VISUAL MATCH TO THE MAJOR PLOT AREA.***

<u>Species Codes</u>:

Redwood Young Growth	**21**
Redwood Old Growth	**11**
Douglas-fir Young Growth	**29**
Douglas-fir Old Growth	**19**
Knobcone pine	**22**
Monterey pine, bishop pine	**32**
Ponderosa pine-like (e.g. PP, Jeffrey P., Coulter P., JPxCP cross) =	**42**
Other conifer (e.g. cypress, nutmeg; note species on tree record)	**53**
Tanoak	**14**
Live oak (other "true" oaks)	**24**
Madrone	**34**
California bay	**44**
Other hardwoods (e.g. maple, alder, buckeye; note species on tree record)	**54**
Snag (any species; note tree class under "TC")	**00**

Table of Slope Corrections

	Fixed Radius Plot Size			
Slope	**1/5 ac**	**1/50**	**1 chain**	**100'**
0%	**52.7'**	**16.6'**	**66.0'**	**100.0'**
10	**53.0**	**18.3**	**66.4**	**100.6**
20	**53.7**	**19.9**	**67.3**	**101.9**
30	**55.1**	**21.6**	**69.0**	**104.6**
40	**56.7**	**23.2**	**71.0**	**107.6**
50	**58.9**	**24.9**	**73.8**	**111.8**
60	**61.4**	**26.6**	**76.9**	**116.5**
70	**64.4**	**28.2**	**80.7**	**122.2**
80	**67.5**	**29.9**	**84.5**	**128.1**
90	**70.9**	**31.5**	**88.8**	**134.5**
100	**74.6**	**33.2**	**93.4**	**141.6**

Table: Total height ranges for log heights

Log Ht	**16.5' logs**	**20.5' logs**
1	**9-24'**	**11-30'**
2	**25-41**	**31-51**
3	**42-58**	**52-71**
4	**59-74**	**72-92**
5	**75-91**	**93-113**
6	**92-107**	**114-133**
7	**108-124**	**134-154**
8	**125-140**	**155-174**
9	**141-157**	**175-195**
10	**158-173**	**196-215**

Volume Table and Height Specifications

Species	**Log Length**	**Top DIB**	**Measure LH to DIB?**	**Meas. TH?**
YGRW	**16.5'**	**8"**	**YES**	**YES**
OGRW	**20.5'**	**12"**	**YES**	**YES**
YGDF	**16.5'**	**8"**	**YES**	**YES**
OGDF	**16.5'**	**10"**	**YES**	**YES**
Knobcone Pine	**16.5'**	**8"**	**YES**	**YES**
PP-like	**16.5'**	**8"**	**YES**	**YES**
MP	**16.5`**	**8"**	**YES**	**YES**
All hardwoods	**N/A**	**N/A**	**NO**	**YES**
All snags	**N/A**	**N/A**	**NO**	**YES**

Stand Classification Labels

SPECIES

R - Redwood
D - Douglas-fir
H - Hardwood
B - Brush
G - Grass
Q – Quarry

STRUCTURE

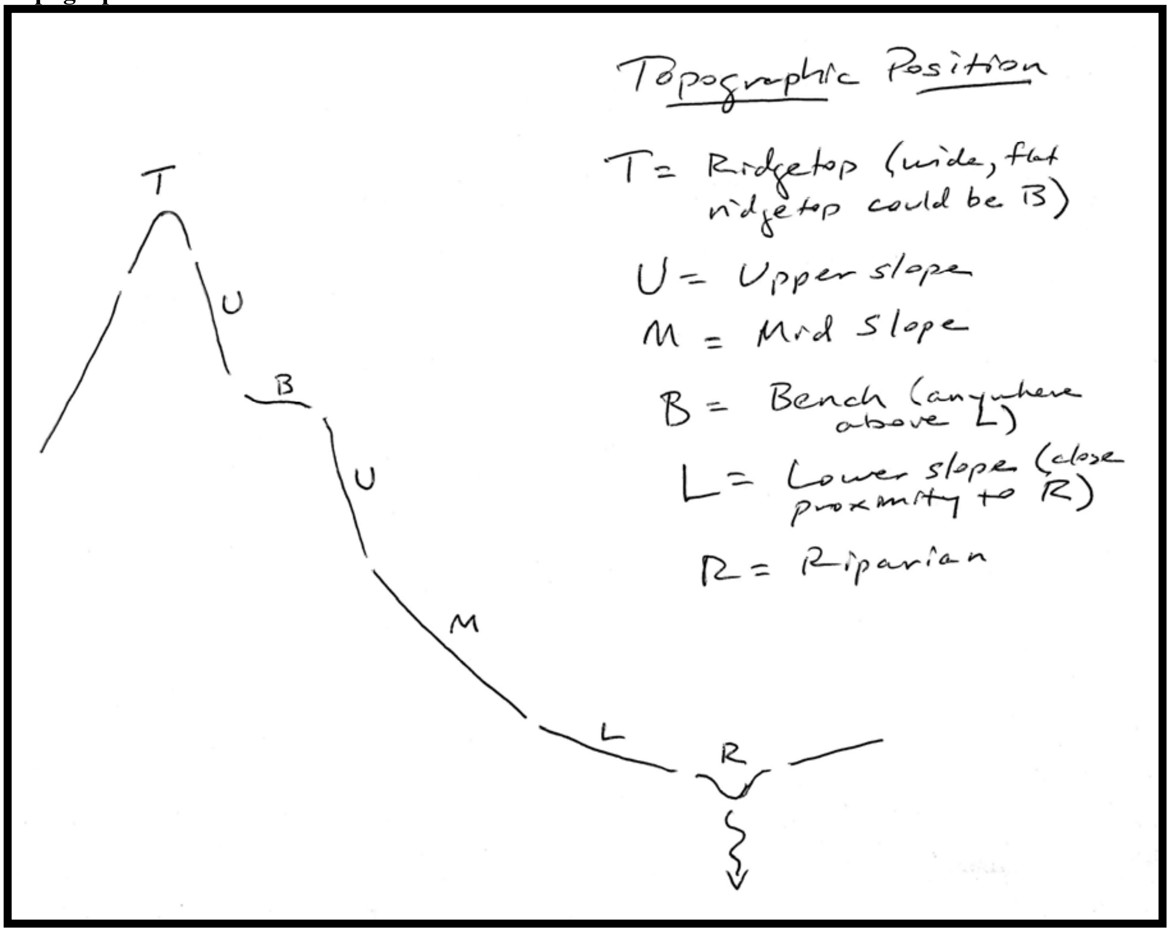
Y – Young growth
YY – Large second growth
R – Residual old growth
O - Old growth

CROWN COVER

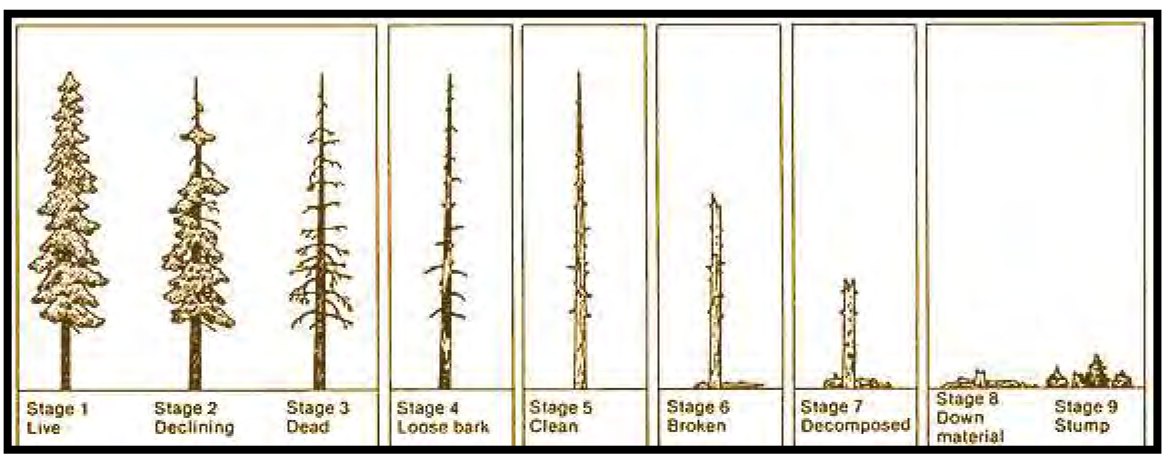
1 70-100%
2 50-70%
3 30-50%
4 10-30%
5 <10%

Example: RD3YRH2 = Redwood/Douglas fir mix (RW dominant), 30-50% crown cover young growth with residuals; with hardwoods 50-70% crown cover.

Topographic Position



Tree Condition Classes



(don't bother to record stages 8 & 9, will be in fuels data)

Some special situations:

Forked tree: Measure as one tree if forked above dbh, two if below.

Leaning tree: Measure (or estimate) height along the lean (not the vertical height of the top above ground)

Broken tree: Estimate total heights and log heights based on similar trees. Insert missing logs as "X's" in defect/grade fields.

ATTACHMENT 1

JOB: **Cruiser:** **Date**

PLOT: **GPS:** **Slope:** **Aspect:** **Position:**

Comments:

TYPE CALL:

FUELS CALL:

WITNESS TREES:

10YR INCREMENT:

Sp	DBH	TH	LH	LCR	TC	LOG and DEFECT									
						1	2	3	4	5	6	7	8	9	10

APPENDIX C

Forest Inventory Results

ATTACHMENT 1

C1 Stand Tables

ATTACHMENT 1

ATTACHMENT 1

TIME: 16:36 DATE: 09-11-2020 HJW (c) 1986,1987 - Volexp 8.026
Stdtbl 8.030

LH17 RUN 1
VOLUME OF STANDING TIMBER
LAHON17

CONS

Scribner Log Rule - 16 Foot Logs
Estimated Volume (Thousands of BOARD Feet)

DBH CLASS (IN)	NUMBER of TREES	1SAWLOG	2SAWLOG	3SAWLOG	4SAWLOG	NET MERCH VOLUME	GROSS VOLUME
10	6796	0	0	36	0	36	44
12	3982	0	0	177	0	177	189
14	3481	0	0	243	0	243	261
16	4912	0	0	655	0	655	689
18	4031	0	0	776	0	776	860
20	2963	0	0	917	0	917	998
22	3190	0	0	1132	0	1132	1220
24	2926	0	0	1622	0	1622	1740
26	2844	0	0	1947	0	1947	2090
28	2595	0	0	2215	0	2215	2422
30	2757	0	0	2944	0	2944	3189
32	1824	0	0	2294	0	2294	2459
34	2177	0	0	3249	0	3249	3476
36	1975	0	0	3428	0	3428	3718
38	2748	0	0	5505	0	5505	5932
40	1954	0	0	4687	0	4687	5064
42	1374	0	0	3476	0	3476	3756
44	1693	0	0	4765	0	4765	5162
46	581	0	0	1814	0	1814	1984
48	1119	0	0	4120	0	4120	4517
50	406	0	0	1540	0	1540	1682
52	394	0	0	1596	0	1596	1702
54	129	0	0	418	0	418	462
56	356	0	0	1629	0	1629	1738
58	188	0	0	925	0	925	1008
60	128	0	0	619	0	619	712
62	124	0	0	461	0	461	645
64	102	0	0	676	0	676	779
68	33	0	0	210	0	210	303
72	42	0	0	366	0	366	404
100+	20	0	0	316	0	316	329
TOTAL	57844	0	0	54758	0	54758	59534

(Net Volume Reflects Deductions for Internal Defect and Breakage)

STANDARD ERROR OF GROSS VOLUME ESTIMATE = 2402.4 OR 4.1%

TIME: 16:36 DATE: 09-11-2020

HJW (c) 1986,1987 - Volexp 8.026
Stdtbl 8.030

LH17 RUN 1
VOLUME OF STANDING TIMBER
LAHON17

HWD
Scribner Log Rule - 16 Foot Logs
Estimated Volume (THOUSANDS of CUBIC Feet)

DBH CLASS (IN)	NUMBER OF TREES	NET MERCH VOLUME	UNMER. VOL.	CULL VOL.	GROSS VOLUME
10	11733	139	0	2	141
12	5639	103	0	0	103
14	3690	103	0	0	103
16	3913	164	0	5	169
18	3454	187	0	5	192
20	2393	171	0	3	174
22	1789	133	0	2	135
24	1847	182	0	4	186
26	733	81	0	2	83
28	821	121	0	3	124
30	492	81	0	1	82
32	231	53	0	2	55
34	40	8	1	0	9
38	69	16	0	0	16
42	69	19	0	0	19
TOTAL	36913	1561	1	29	1591

(Net Volume Reflects Deductions for Internal Defect and Breakage)

STANDARD ERROR OF GROSS VOLUME ESTIMATE = 174.2 OR 10.9%

C2 Fuels Data

ATTACHMENT 1

UPDATED		10/21/2020							
La Honda 2020 FUEL: LWD Measurements and PNW-105 Photo Series Calls									
			LWD Measurements						PNW-105 Fuel Volume
	PNW-105								
PLOT	Fuel Model Call	Simplified Stand Type	Piece Count	Avg Diameter	SQFTarea	Length FT	CUFT/Plot	CUFT/AC	CUFT/AC
1	1DFHD3	YR3RD							218
2	3DFHD4	Y2RD	3	23	3	75	223	1,114	1,023
3	2DFHD3	YR3RD	3	16	1	85	119	593	690
4	3DFHD4	Y2RD							1,023
5	1DFHD4	YR3RD							415
6	2DFHD3	Y2RD							690
7	2DFHD3	YR4RD							690
8	2DFHD3	YR4RD	1	16	1	20	28	140	690
9	2DFHD3	YR3RD							690
10	1DFHD3	YR4RD							218
11	3DFHD4	Y3RD							1,023
12	2DFHD3	YR3RD	2	18	2	85	150	751	690
13	3DFHD4	YR2RD							1,023
14	3DFHD4	Y2RD	3	15	1	63	74	370	1,023
15	3DFHD4	YR2RD							1,023
16	2DFHD4	Y2RD	3	23	3	90	267	1,336	494
17	2DFHD4	Y3RD							494
18	3DFHD4	Y2RD							1,023
19	3DFHD4	YR2RD	2	17	2	35	55	276	1,023
20	3DFHD3	YR2RD	2	15	1	70	86	430	1,403
21	3DFHD3	Y2RD							1,403
22	2DFHD4	Y1RD	4	24	3	65	204	1,021	494
23	3DFHD4	Y2RD							1,023
24	3DFHD3	Y2RD							1,403
25	3DFHD2	YR3RD	3	27	4	105	428	2,139	632
26	3DFHD2	Y2RD							632
27	2DFHD4	Y1RD							494
28	2DFHD3	Y1RD							690
29	3DFHD2	YR3RD	2	18	2	40	71	353	632
30	2DFHD4	YR3RD	2	15	1	58	71	356	494
31	2DFHD4	Y2RD	5	17	2	205	331	1,654	494
32	2DFHD4	Y2RD							494
33	2DFHD2	Y2RD							143
34	3DFHD3	Y2RD							1,403
35	2DFHD3	YR3RD							690
36	3DFHD3	Y2RD							1,403
37	3DFHD4	Y2RD	2	23	3	65	188	938	1,023
38	2DFHD3	Y2RD							690
39	4DFHD4	Y2RD							934
40	3DFHD4	Y2RD							1,023
41	3DFHD3	YR3RD	2	16	1	63	88	440	1,403
42	2DFHD2	Y2RD	1	24	3	40	126	628	143
43	2DFHD4	Y2RD	2	14	1	40	43	214	494
44	2DFHD3	YR3RD							690

UPDATED		10/21/2020								
La Honda 2020 FUEL: LWD Measurements and PNW-105 Photo Series Calls										
			LWD Measurements							PNW-105 Fuel Volume
	PNW-105									
PLOT	Fuel Model Call	Simplified Stand Type	Piece Count	Avg Diameter	SQFTarea	Length FT	CUFT/Plot	CUFT/AC		CUFT/AC
45	2DFHD4	Y2RD								494
46	2DFHD3	YR2RD	1	14	1	25	27	134		690
47	2DFHD4	YR3RD								494
48	2DFHD2	Y3RD								143
49	3DFHD1	Y3RD								632
50	3DFHD3	RY2RD								1,403
51	3DFHD4	RY2RD	1	14	1	12	13	64		1,023
52	1DFHD3	YR3RD								218
53	1DFHD4	Y3H								415
54	BRUSH	Y3H								3,024
55	2DFHD3	YR4RD								690
56	1DFHD4	Y3H	1	16	1	25	35	175		415
57	3DFHD4	Y1RD								1,023
58	3DFHD4	Y1RD								1,023
59	3DFHD4	Y1RD								1,023
60	2DFHD4	YR4RD	3	23	3	70	208	1,039		494
61	5DF4	Y3RD	4	34	6	110	673	3,366		7,952
62	2DFHD4	Y1RD								494
63	3DFHD4	YR2RD	2	15	1	40	49	245		1,023
64	2DFHD3	YR3RD								690
65	3DFHD3	RY2RD	2	14	1	65	69	347		1,403
66	2DFHD3	YR3RD								690
67	2DFHD3	YR3RD	0	-	-	-	-	-		690
68	1DFHD4	YR3RD	3	17	2	105	172	860		415
69	2DFHD2	YR2RD	0	-	-	-	-	-		143
70	2DFHD4	YR2RD	2	13	1	55	51	253		494
71	3DFHD4	Y2RD	1	16	1	40	56	279		1,023
72	2DFHD3	YR2RD								690
73	2DFHD4	Y2RD	3	13	1	55	48	241		494
74	2DFHD2	YR3RD								143
75	3DFHD4	Y3RD								1,023
76	1HD2	Y3H	2	15	1	85	104	522		143
77	2DFHD4	Y3RD								494
78	1DFHD4	RY2RD	1	16	1	15	21	105		415
79	2DFHD4	Y2RD								494
80	4DF4	Y3RD	2	14	1	35	37	187		4,387
81	4DFHD4	Y2RD	1	12	1	20	16	79		934
82	1DFHD4	Y3RD	3	15	1	100	117	587		415
83	2DFHD1	YR2RD								143
84	3DFHD4	YR2RD								1,023
85	2DFHD3	YR4RD								690
86	4DFHD2	Y3RD	2	23	3	50	144	721		1,023
87	4DFHD2	Y3H								1,023
88	4DFHD4	Y3RD	2	8	0	30	10	52		934

UPDATED		10/21/2020								
La Honda 2020 FUEL: LWD Measurements and PNW-105 Photo Series Calls										
			LWD Measurements							PNW-105 Fuel Volume
	PNW-105									
PLOT	Fuel Model Call	Simplified Stand Type	Piece Count	Avg Diameter	SQFTarea	Length FT	CUFT/Plot	CUFT/AC		CUFT/AC
89	1DF3	YR2RD	0	-	-	-	-	-		6,028
90	1DFHD4	OY2R	4	10	0	95	47	234		415
91	3DFHD4	RY2RD								1,023
92	2DFHD3	Y1RD								690
93	1DFHD4	Y1RD								415
94	3DFHD4	Y1RD								1,023
95	3DFHD4	Y1RD								1,023
96	5DFHD4	Y4RD								3,024
97	2DFHD4	Y2H								494
98	2DFHD4	Y1RD	1	28	4	10	43	214		494
99	3DFHD4	Y1RD								1,023
100	4DFHD4	Y1RD								934
101	2DFHD4	Y2H								494
102	3DFHD4	Y3RD								1,023
103	2DFHD4	Y2RD	0	-	-	-	-	-		494
104	2DFHD4	Y1RD								494
105	1DFHD4	Y1RD	0	-	-	-	-	-		415
106	2DFHD4	Y1RD								494
107	2DFHD4	Y2RD								494
108	2DFHD4	Y2RD								494
109	2DFHD4	Y1RD								494
110	4DFHD4	Y4RD	3	22	3	65	172	858		934
111	4DFHD4	Y2RD								934
112	1HD2	Y2H	0	-	-	-	-	-		143
113	2HD2	Y2H	0	-	-	-	-	-		632
114	2HD2	Y3H	0	-	-	-	-	-		632
115	NA	NA								
116	2DFHD4	YR4RD								494
117	1DFHD4	YR2RD	2	12	1	25	20	98		415
118	1DFHD4	YR4RD								415
119	1DFHD4	YR4RD	0	-	-	-	-	-		415
120	2DFHD4	Y2RD	2	12	1	80	63	314		494
121	2DFHD4	Y1RD	2	18	2	60	106	530		494
122	3DFHD3	RY2RD								1,403
123	3DFHD4	Y1RD								1,023
124	4DFHD4	Y3RD								934
125	3DFHD2	Y1RD	1	20	2	15	33	164		632
126	2DFHD4	Y2H								494
127	1DFHD4	Y2H								415
128	2DFHD4	Y3RD								494
129	1DFHD4	Y2H								415
130	2DFHD4	Y2H								494
131	2DFHD4	Y2H								494
132	3DFHD4	Y4RD								1,023

UPDATED		10/21/2020								
La Honda 2020 FUEL: LWD Measurements and PNW-105 Photo Series Calls										
			LWD Measurements							PNW-105 Fuel Volume
	PNW-105									
PLOT	Fuel Model Call	Simplified Stand Type	Piece Count	Avg Diameter	SQFTarea	Length FT	CUFT/Plot	CUFT/AC		CUFT/AC
133	2HD2	Y3H								632
134	2DFHD4	RY2RD	1	14	1	30	32	160		494
135	1DFHD4	Y4RD								415
136	1DFHD4	Y4RD	0	-	-	-	-	-		415
137	1DFHD4	YR4RD	0	-	-	-	-	-		415
138	2DFHD4	YR4RD	0	-	-	-	-	-		494
139	2HD2	Y3H	2	27	4	50	199	994		632
140	2DFHD2	YR3RD								143
141	2DFHD4	YR4RD								494
142	1HD2	Y3H	1	8	0	30	10	52		143
143	3DFHD4	Y1RD								1,023
144	2DFHD4	Y2RD								494
145	2DFHD4	Y1RD								494
146	2DFHD4	Y3RD	0	-	-	-	-	-		494
147	3DFHD4	Y2RD	4	17	2	90	142	709		1,023
148	2DFHD4	Y2H								494
149	NA	NA								
150	2DFHD2	Y3RD	2	17	2	35	55	276		143
151	3DFHD4	YR3RD	1	14	1	30	32	160		1,023
152	2DFHD4	YR3RD								494
672	2DFHD4	YR3RD	1	14	1	10	11	53		494
999	4DFHD4	Y2RD	2	17	2	80	126	630		934

C3 Carbon Calculations

ATTACHMENT 1

ATTACHMENT 1

California Department of Forestry and Fire Protection - THP Project Carbon Accounting: Inventory, Growth, and Harvest Version 6-11-2010

LA HONDA FOREST - Project Carbon Accounting: Inventory, Growth, and Harvest

This worksheet addresses the sequestation and emissions associated with the project area's balance of harvest, inventory, and growth plus any emissions associated with site preparation. Complete the input for Steps 0- 8 on this worksheet.

Forest Type				**Harvest Periods**		**Inventory**		**Growth Rates**		**Harvest Volume**	
Multipliers to Estimate Carbon Tonnes per MBF (Sampson, 2002)				Time of Harvest (years from project approval)		Conifer Live Tree Volume (MBF/Acre) - Prior to Harvest	Hardwood Live Tree Volume (BA square feet/Acre) - Prior to Harvest	Conifer Growth Rate BF/Acre/Year	Hardwood Growth Rate BA/Acre/Year	Conifer Harvest Volume (MBF/acre)	Hardwood Harvested / Treated Basal Area (BA/Acre)
Forest Type	**Step 0.** Identify the approximate percentage of conifers by volume within the harvest plan. Must sum to 100%	Multiplier from Cubic Feet (merchantable) to Total Biomass	Pounds Carbon per Cubic Foot	**Step 1.** Enter the anticipated future harvest entries. The re-entry cycles should be supported by management plan, if available.		**Step 2.** Enter the estimated conifer inventory (mbf/acre) present in project area prior to harvest.	**Step 3.** Enter the estimated hardwood inventory (basal area per acre) present in project area prior to harvest.	**Step 4.** Enter the average annual periodic growth of conifers between harvests based on estimated growth in management plan, if available. Must be entered for each harvest cycle identified in Step 1.	**Step 5.** Insert average annual periodic growth of hardwoods between harvests based on estimated growth in management plan, if available.	**Step 6.** Enter the estimated conifer harvested per acre at current and future entries. The estimate should be based on projections from the management plan, if available.	**Step 7.** Enter estimated hardwood basal area harvested/treated per acre
Douglas-fir	15%	1.675	14.38	**User must enter harvest cycles to 100 years and/or at least three entry cycles.**	0	51.7	75	2068	1.5		
Redwood	85%	1.675	13.42		15	82.72	97.5	2068	1.5	0	0
Pines	0%	2.254	12.14		30	113.74	120	2068	1.5	0	0
True firs	0%	2.254	11.18		45	144.76	142.5	2068	1.5	0	0
Hardwoods	10	2.214	11.76		60	175.78	165	2068	1.5	0	0
		Pounds per Metric Tonne			75	206.8	187.5	0	0	0	0
Conversion of Board Feet to Cubic Feet	0.165		2,204		0	0	0	0	0	0	0
Multipliers to Estimate Total Carbon Tonnes per MBF	Conifer	**1.70**			0	0	0	0	0	0	0
	Hardwoods	**1.95**			0	0	0	0	0	0	0
Multipliers to Estimate Merchantable Carbon Tonnes per MBF	Conifer	**1.02**			0	0	0	0	0	0	0
	Hardwoods	**0.88**			0	0	0	0	0	0	0

Harvest Periods	**Inventory Conversion to Carbon (prior to harvest)**		**Inventory Conversion to Carbon Dioxide Equivalent (prior to harvest)**		**Site Preparation**	
	Conifer Live Tree Tonnes (C/acre)	Hardwood Live Trees Tonnes (C/acre)	Conifer Live Tree Tonnes (CO_2 equivalent/acre)	Hardwood Live Tree Tonnes (CO_2 equivalent/acre)	**Step 8**. Enter the value (in bold) for each harvest cycel that best reflects the site preparation activities, as averaged across the project area:	
from above (Time of Harvest as years from project approval)	**Computed:** MBF * Conifer Multiplier from Step 0.	**Computed:** BA*Volume/Basal Area Ration (to convert to MBF) * Hardwood Multiplier from Step 0.	**Computed:** Conversion of carbon to CO_2 (3.67 tonnes CO2 per 1 tonne Carbon)	**Computed:** Conversion of carbon to CO_2 (3.67 tonnes CO2 per 1 tonne Carbon)	**Heavy**- 50% or more of the project area is covered with brush and removed as part of site preparation or stumps are removed (mobile emissions estimated at .429 metric tonnes CO2e per acre, biological emissions estimated at 2 metric tonnes CO2e per acre) **Medium** - >25% <50% of the project area is covered with brush and removed as part of site preparation (mobile emissions estimated at .202 metric tonnes CO2e per acre, biological emissions estimated at 1 metric tonne per acre). **Light** - 25% or less of the project area is covered with brush and is removed as part of site preparation (mobile emissions estimated at .09 metric tonnes CO2e per acre, biological emissions estimated at .5 metric tonnes per acre). **None** - No site preparation is conducted.	
0	88	11	323	40	**None**	0
15	141	14	516	52	None	0
30	193	18	710	64	None	0
45	246	21	904	76	None	0
60	299	24	1097	89	none	0
75	352	27	1291	101	None	0
0	0	0	0	0	None	0
0	0	0	0	0	None	0
0	0	0	0	0	None	0
	Difference between ending stocks and beginning stocks		968	60.36	Sum of emissions (Metric Tonnes CO2e) per acre	0

Post-Modeling Calculations

	Total Sequestered CO2/acre	Total: 1,210 forested acres
Current (year zero)	363	439,185
Year 15	569	688,090
Difference: Year 15-Current	206	248,904
Sequestration per Year:	13.7	16,594

ATTACHMENT 1

This page intentionally left blank

APPENDIX D

Cost Estimates

ATTACHMENT 1

Appendix D
Cost Estimates

The following provides a preliminary range of cost estimates that might be associated with selection of the different options for forest management and restoration presented in Chapter 4. Actual costs would be developed once a final scope of work is determined and the various phases of the projects are selected. For options that include commercial timber harvest, market conditions drive potential revenues, along with the nature of the cut and the adaptive management approach. The is thus used to guide decision-making with order of magnitude cost estimates for this point in time. Cost efficiencies between activities will also likely affect costs. In general, grouping projects under a single permitting umbrella will likely lower costs; the more that is done under a single THP, the greater the savings might be for any given aspect of it.

Generally Fixed Planning Costs:

- Timber Harvest Plan: $65,000
- Engineering Geologic Review in Support of THP: $15,000
- Sediment Source Evaluation in Southern CMU and Harrington: $15,000
- Design Services for Double Culvert Replacement: $75,000
- Design services for CMU Upper Road Treatment $100,000

Planning Cost Estimate (+20% contingency) : $325,000

Implementation Costs

- Fuels treatments TBD based on plan refinement. $3,500/acre for equipment access acreages and $15,000/acre for remote locations requiring hand-work.
- License Timber Operator Costs for restoration forestry treatments TBD based on plan refinement. Likely net zero when offset by potential revenues.
- Double culvert replacement (arched culvert or bridge): $400,000
- CMU Upper Roads Work: TBD based on plan refinement, likely more than $400,000
- Post-treatment forestry monitoring: TBD based on plan refinement.
- Implementation estimate: $800,000+ for watershed improvements and TBD on the forest and fire resiliency components.

This page intentionally left blank

ATTACHMENT 2