NEWELL CREEK WATERSHED
FOREST STEWARDSHIP RECOMMENDATIONS

February 2024

Prepared for:
City of Santa Cruz Water Department

CITY OF SANTA CRUZ

City of Santa Cruz – Newell Creek Watershed Forest Stewardship Recommendations

Prepared for:

City of Santa Cruz Water Department

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List of Abbreviations and Acronyms

ARC	Auten Resource Consulting
BA	Basal Area
CAL FIRE	California Department of Forestry & Fire Protection
CalVTP	California Vegetation Treatment Program
CEQA	California Environmental Quality Act
COSC	City of Santa Cruz
CZU	San Mateo Santa Cruz Unit
CZU Fire	August 2020 CZU Lightning Complex Fire
DBH	Diameter at Breast Height
DF	Douglas-fir
FDR	Forest Density Reduction
FHFR	Forest Health Fuel Reduction
FHG	Forest Health Grant
FR	Fire Resiliency
FRI	Fire Return Interval
FTP	Forest Trend Plot
FVS	Forest Vegetation Simulator
GIS	Geographic Information Systems
HW	Hardwood
IFCC	Impaired Forest Class Condition
IFTDSS	Interagency Fuel Decision Support System
IPR	Integrated Production & Restoration Option
IS	Invasive Species
Lop	Hand cutting of material with chainsaws
LTR	Large Tree Restoration
MBF	Thousand Board Feet
PF	Prescribed Fire
PSA	Project Specific Analysis
RPF	Registered Professional Forester
RW	Redwood
SCWD	City of Santa Cruz Water Department
SOD	Sudden Oak Death
TA	Treatment Access
THP	Timber Harvest Plan
TPA	Trees Per Acre
WLPZ	Watercourse & Lake Protection Zone

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Executive Summary

In 1903, Timothy Hopkins, treasurer of Southern Pacific Railroad, joined forces with A. C. Bassett, president of the California Timber Company, to implement timber harvesting in the Santa Cruz Mountains. The California Timber Company was formed via the consolidation of the Santa Clara Valley Mill & Lumber Company, once owned by James Dougherty, and the Big Basin Lumber Company (previously owned by Henry L. Middleton). Like other mills of this era, their goal was set to "harvest the old growth redwood that still sat within the upper Newell Creek basin. By the end of 1912, the basin was completely bereft of profitable old growth timber. The mill shut down early the next year and was subsequently dismantled, the machinery and *Kitty* (one of the locomotives) shipped elsewhere*". ("Stations-Newell Creek Mill". www.santacruztrains.com. November 2023)* [1].

Beginning with these original harvesting efforts, the Newell Creek watershed was put on a trajectory that would greatly depart from its long-standing environmental conditions. Management in some form would be necessary to conserve, maintain and steward the lands to accommodate both human needs and sensitive resources. These valued resources include water source protection, water production and storage, endangered species, forest health and protection, and recreation. Tending to the watershed to create and maintain a balance of beneficial conditions takes commitment on a decadal scale.

Circa 1959: Construction of the Newell Creek Dam *"Loch Lomond Dam History"* University of California, Calisphere 2023

When the Newell Creek Tract was purchased in 1958 from the San Lorenzo Valley Water District, the City of Santa Cruz Water Department started to build Newell Creek Reservoir between1959 and 1961." In the summer of 1959, while burning material accumulated from the clearing of the reservoir basin, a forest fire was started. The fire raged up both sides of the canyon and did considerable damage to the young timber stand in the drainage". *(Tunheim & Butler 1994)*

[1] https://www.santacruztrains.com/2019/01/stations-newell-mill.html

Beginning in 1968 and following the 1959 fire, a conservative program of selective timber harvesting was implemented to thin dense redwood clumps, remove fire-damaged trees, and provide access into the watershed for management. This program was conducted through one local consulting forestry firm for nearly 30 years. The result was a well-managed and logically administered watershed tract of land that provided the baseline conditions and information for current decision making and priority restoration treatment scheduling. This harvesting regimen predated modern State Forest Practice Rules, and greatly exceeded the environmental protection standards of the time. When eventually codified into a unique set of California Forest Practice Rules developed by local foresters, it remains the primary silvicultural method for the region.

The City of Santa Cruz Water Department (SCWD) has been a long-time steward of watershed lands within its portfolio, including the approximately 2,880 acres of land that now comprise the Newell Creek Tract. This watershed is of critical importance to the City's water supply reliability, which is also an important recreational and open space resource and is the sole raw water storage facility for nearly 100,000 Santa Cruz County residents. A key component to a successful long view approach is periodic assessments and adjustments to management to accommodate changing environmental conditions, review and implementation of new techniques, and recalibrating management focus to protect and foster critical resources.

In the wake of the CZU Fire Complex, SCWD land managers concluded Loch Lomond was at risk of a similar catastrophic event and began steps to re-engage more active management in the watershed. The management focus was directed to improve fire resiliency by managing fuels to develop forests toward larger less-dense structure, improving fuel breaks and infrastructure and generally improving the conditions on city-managed watershed lands.

The City Water Department engaged Sicular Environmental Consulting and City of Santa Cruz's Consulting Forester, Steven M. Butler to evaluate future opportunities, and constraints of forest management while maintaining high level protection for water and other valued resources on watershed lands. A detailed report, Opportunities and Constraints Evaluation of Forest Management Options *(Sicular 2021)* provided an analysis of four management options, with the highest ranking relative to the COSC's goals for water quality, quantity, and resource protection being the "Integrated Production & Restoration Option". This closely resembles the long standing and conservative program of forest management implemented for SCWD, which maintains a high level of resource protection while selectively thinning forest stands.

This Management Option was approved by the City of Santa Cruz Water Commission in October of 2021, and includes commercial selective timber harvest in previously managed areas, thinning of hardwoods and small conifers in previously managed areas with lower

site capacity, and a template for restoration work within a dedicated conservation reserve area with the goal of achieving old growth characteristics more quickly.

In July of 2022, SCWD distributed "Request For Proposals for City of Santa Cruz Watershed Lands Forest Management Project – Newell Creek Tract Phase 1 Plan" and Auten Resource Consulting (ARC) provided a successful proposal detailing important next steps in updating and implementing the SCWD's vision for its watershed lands. The following report addresses the approximately 2,880 acres within the main Newell Creek Tract.

Satellite 65- Acre Parcel: This Recommendations Document did not specifically consider the satellite 65-acre parcel which lies north of the main Newell Creek Tract block. This parcel has existing easements which provide legal access but was not accessible at this time. Future management efforts on this parcel could likely utilize recommendations brought forward in this report.

ARC recommendations and prioritized actions for consideration are at the forefront of the document, followed by a discussion of findings rationale in later sections. The recommended prioritized actions should be considered for prompt implementation and permitting. The implementation of forest management treatments should consider that forest restoration is a long-term process that requires dedication to a focused and strategic effort. Through field investigation and analysis, four key priority recommendations have been identified for consideration.

Priority Recommendations:

- *Two Commercial Harvest Units.*
- *Four distinct management units and prescriptions to Restoration of Old Growth characteristics on the east slopes of Loch Lomond.*
- *Identification of fuel hazard reduction units and treatment prescriptions within the Newell Creek Tract.*
- *Discussion of Forest Health Grants funded by Cal Fire.*

These recommended management actions will work towards the primary watershed lands management goals of protection of water quality, improving forest health and resilience, accelerating a return to Old Growth conditions in portions of the watershed lands and generating a sustainable revenue stream to fund the continued stewardship while and improving watershed conditions to the benefit of downstream beneficial uses. Several City of Santa Cruz policies are under review and in need of updating to allow the stated Newell Creek Tract Phase 1 goals to be fully achieved.

Field Investigation and Data Analysis will highlight some similarities between Newell Creek and similar forest types within the CZU, and through modeling, consider how future fire behavior may change following treatments. The Additional Recommendations section will include discussion regarding the East Loch Lomond Connection Road, a crossing at the

Nelson parcel, and a watershed account to receive and dispense revenue related to watershed restoration projects. Finally, Action Steps will outline priority recommendations for next step decisions that also includes an estimate of treatment costs and values.

Purpose & Goals

The Phase I Project will involve implementation of the two principal strategies for forest management contained in the Integrated Production & Restoration (IPR) option approved by the Water Commission: a commercial timber harvest component, and a forest restoration component. The location of both components of the Phase I Project is within the Newell Creek tract. This project is a priority for early implementation in that it focuses on the City's most important watershed landholdings. Furthermore, the project utilizes existing infrastructure and addresses forest health in relatively unmanaged, densely – stocked urban/wildland interface areas. Therefore, not only is the project merited, but it has a high likelihood of success while also ensuring that it is financially feasible. Future phases of watershed lands management will similarly be focused on addressing forest health conditions in priority areas while also ensuring fiscal solvency in alignment with the IPR management strategy described in the Opportunities and Constraints Evaluation of Forest Management Options *(Sicular 2021*).

Goals for Newell Creek Tract Phase 1 Plan are to protect water quality resources through reducing the risk of catastrophic wildfire, improve forest health and resilience, foster a return to Old Growth conditions in a substantial part of the watershed lands and produce a sustainable revenue stream to cover the cost of intensified land management.

ARC reviewed the approved management option "Integrated Production & Restoration Option" from the Opportunities and Constraints Evaluation of Forest Management Options report generated by Sicular Environmental to provide guidance on priority landscapes and treatments.

Using this selected subset of the Newell Creek Tract outlined in Phase 1, ARC field verified areas to establish basic working boundaries, treatment prescriptions and functional aspects such as current stand conditions, infrastructure condition, treatment access, potential fiscal feasibility of timber harvest areas, identified restoration areas and treatment prescriptions, and fuel reduction opportunities in non-commercial areas.

Four priority recommendations have been identified to achieve the goals of Newell Creek Tract Phase 1 Plan.

Priority Recommendations:

- *Two Identified Commercial Harvest Units.*
- *Four distinct management units and prescriptions for restoration of Old Growth characteristics on the east slopes of Loch Lomond.*
- *Identification of fuel hazard reduction units and treatment prescriptions within the Newell Creek Tract.*

- *Consideration of Forest Health Grants funded by Cal Fire.*

Commercial Harvest Component

Discussion

The commercial component of Phase 1 on the western side of Loch Lomond, has substantial merit when considering the long- term goals set in motion for the Newell Creek Tract, and potentially other managed landscapes in the portfolio of SCWD. This benefit can be utilized in several ways to aid in achieving restoration and management objectives. Revenue can be directly applied to SCWD lands in the form of restoration projects, fuel reduction and fire prevention projects, or function as baseline funding for watershed grant applications and provide match funding to increase ranking of those applications. Providing consistent revenue streams will ultimately aid future restoration project planning and execution. Two areas have been delineated for consideration to fulfill the commercial harvest component of Phase 1. Harvests would remove trees throughout the range of diameter classes to improve spacing and vigor of all trees, while improving watershed health and protection. As with the previous timber harvest program, harvest volume would be less than growth over time, such that the forest over time has more standing timber, larger average tree size, and more carbon sequestered in the living trees. Those units will be discussed in more detail in the Prioritized Recommended Actions section. The proposed treatment methods for both units are designed to achieve Phase 1 goals:

- Forest Density Reduction/Large Tree Restoration (FDR/LTR) treatments will reduce stand density, connectivity, and competition for resources, further increasing the health and vigor of the residual stand through the removal of selected second growth redwoods, promoting the development of larger diameter forest stands.

- Prescribed Fire (PF) treatments could occur in areas of SCWD Watershed lands and could employ pile and burn methods to increase resilience, biological diversity, and reduce the severity of future wildfire.

Lower Newell Creek Unit - 150 acres

The Lower Newell Creek Unit is approximately 150 acres of redwood and Douglas-fir forest with a small component of hardwood dominated forest types. The unit is located in the southwest portion of the watershed (see map on page 5, or Appendix A). Much of this area was previously thinned in 1968 as one of the initial forest management entries into SCWD Watershed lands. Subsequently, portions of this area were harvested in 1988 and 1990. These entries have created a multi-aged forest that aligns with the goals and objectives of Santa Cruz Watershed Lands Forest Management Project – Newell Creek Tract Phase 1 Plan for watershed restoration, sustaining revenue generation and fuel management.

This area was identified as a priority area for density reduction for several reasons:

- It is within the initial forest management area suggested by the Sicular Report and selected by SCWD for a project.
- The project area provides lower to mid-watershed fuel break opportunities encompassing approximately 14 acres.
- Additional fuel treatment opportunities are located appurtenant to the project area.
- Access to an important upper ridgeline located northwest of the dam.
- Includes three high priority crossings as outlined in a Pacific Watershed Associates 2007 Report[2].
- The unit is easily accessible and may serve as a demonstration for displaying Newell Creek Tract management goals.

Bear Creek Divide Unit - 138 acres

The Bear Creek Divide Unit is approximately 138 acres of redwood and Douglas-fir forest with a component of hardwood dominated forest types located in the northeast portion of the watershed, at the ridgeline divide with the Bear Creek Watershed (see map on page 5, or Appendix A). Portions of this area were previously thinned in 1980 and 1992. Approximately 30 acres appear to have been selectively harvested in the early 1970's, prior to ownership by SCWD. No subsequent harvests have been documented on those acres. Prior harvest entries have created a multi-aged forest that aligns with the goals and objectives of Santa Cruz Watershed Lands Forest Management Project – Newell Creek Tract Phase 1 Plan for watershed restoration, sustaining revenue generation and fuel management.

The Bear Creek Divide Unit was not identified as one of the Phase 1 initial treatment areas but has beneficial attributes worth considering, which defined its priority status in this document.

This area was identified as a priority area for density reduction for the following reasons:

- It is within the portion of the Newell Creek Tract designated for forest management, suggested by the Sicular Report, and selected by SCWD for future projects.
- It has supported harvesting in the past and embodies conditions appropriate for continued treatment.
- It provides upper watershed fuel breaks at the divide between two major watersheds.

[2] Pacific Watershed Associates (PWA) generated a report assessing road related erosion on SCWD lands, including prioritizing crossings and drainage features for treatment.

- Due to its location the unit has a high fire risk, and simultaneously, a very high opportunity for strategic fuel treatments.
- Some of the area does not appear to have been harvested under city ownership.
- Adjacent properties conduct regular forest management, which presents the opportunity to utilize an access route that would not pass directly through residential neighborhoods.

For each of these identified priority units, removals would focus on reducing numbers of 2nd growth trees to decrease competition, improve climatic resiliency and provide improved outcomes in the event of wildfire. To achieve this, removals would focus on trees under 40" which represent the highest concentrations per acre, and also require that trees above 40" in diameter be removed to achieve a mosaic of widely spaced large trees where possible, while accelerating the growth of smaller trees, and reducing fuel continuity. Stand structure would primarily consist of a redwood and Douglas-fir overstory, larger hardwoods in the mid-canopy with smaller redwoods and hardwoods present in the understory especially in openings between redwood clumps. Stand diversity would be maintained in both structure and species composition, including retention of large old trees with unique features and snags. The addition of Prescribed Fire as a follow-up treatment would further reduce remaining ground fuel loads.

Forest Restoration Component

Discussion

Four distinct areas have been delineated for consideration to fulfill the forest restoration component of Phase 1, which addresses much of the area on the east side of Loch Lomond. These treatments propose to remove trees throughout the range of diameter classes to improve spacing and vigor of all trees to direct the forest towards those of a pre-disturbance forest. To attain a structure resembling a pre-disturbance forest, removals would focus on trees under 40" in diameter, but also require that larger trees above 40" in diameter also be removed. Douglas-fir and larger hardwoods in the mid-canopy would be retained in openings between redwood clumps. Habitat components such as snags would be retained as part of the forest structure, optimally at 1-2 per acre in openings away from roads. The addition of Prescribed Fire as a follow-up treatment would assist in maintaining a more open understory, while reducing ground fuels.

Restoration units will be discussed in more detail in the Prioritized Recommended Actions section. The proposed treatment methods for all four units are designed to achieve Phase 1 goals utilizing the following treatments:

- Forest Density Reduction/Large Tree Restoration (FDR/LTR) treatments will reduce stand density, connectivity, and competition for resources, further increasing the

health and vigor of the residual stand through the removal of selected second growth redwoods, promoting the development of larger diameter forest stands.

- Forest Health Fuels Reduction (FHFR) understory treatments focus on treating dead and dying trees and live trees (less than 16 inches in diameter) to reduce fuel loading and establish a form of shaded fuel break that can be utilized in Prescribed Fire (PF)treatments and wildfire suppression. Treatments reduce density and connectivity in the understory while retaining a mosaic of understory vegetation. This includes hand lopping where access for equipment is not feasible.

- Prescribed Fire (PF) treatments could occur in areas of SCWD watershed lands and could employ both pile and burn methods to increase resilience, biological diversity, and reduce the severity of future wildfire.

East Loch Lomond Forest Restoration Area

The Phase I Project included a forest restoration component to be applied within an approximately 100-acre area on the east side of the Loch Lomond Reservoir. This is part of a larger area on the east side of Loch Lomond to be managed for the goals of protecting water quality, restoring late seral forest habitat and its ecological and aesthetic attributes, and increasing resilience to climate change, including reducing the threat of catastrophic wildfire. Trees of all species would be selected for retention that, based on their size and form, have the greatest potential for continued growth and longevity. Treatments would be focused on thinning to reduce competition for the retained trees, and to reduce fire hazard and promote biological diversity.

Four distinct management units and prescriptions for the restoration of Old Growth characteristics on the east slopes of Loch Lomond were identified, including two Forest Density Reduction/Large Tree Restoration (FDR/LTR) units with potential for Prescribed Fire (PF) and two Forest Health Fuels Reduction (FHFR) units, one having potential for Prescribed Fire. (see map below, or Appendix A):

East Loch Lomond Exemption Unit (#1) – 18 acres

- Utilize a CAL FIRE Forest Fire Prevention Exemption to remove understory trees.
- Trees must have a stump diameter of less than 30 inches.

East Loch Lomond Density Reduction Unit (# 2) – 17 acres

- Utilize a CAL FIRE Timber Harvest Plan to remove trees in a wider range of diameter classes.
- This should be included as part of a larger Timber Harvest Plan for best economic feasibility.

East Loch Lomond Forest Health Unit (# 3) – 8 acres

- Utilize hand lopping treatment to cut dead and fallen trees to achieve ground contact with a maximum height of 24 inches from the ground.
- No Forest Practice permits are necessary.

East Loch Lomond Forest Health Unit (# 4) – 12 acres

- Utilize mechanical treatment such as mastication or chipping to reduce understory vegetation.
- No Forest Practice permits are necessary.

Beyond the identified treatment units, several other key findings and recommendations are included in this document, discussed in greater detail in following sections.

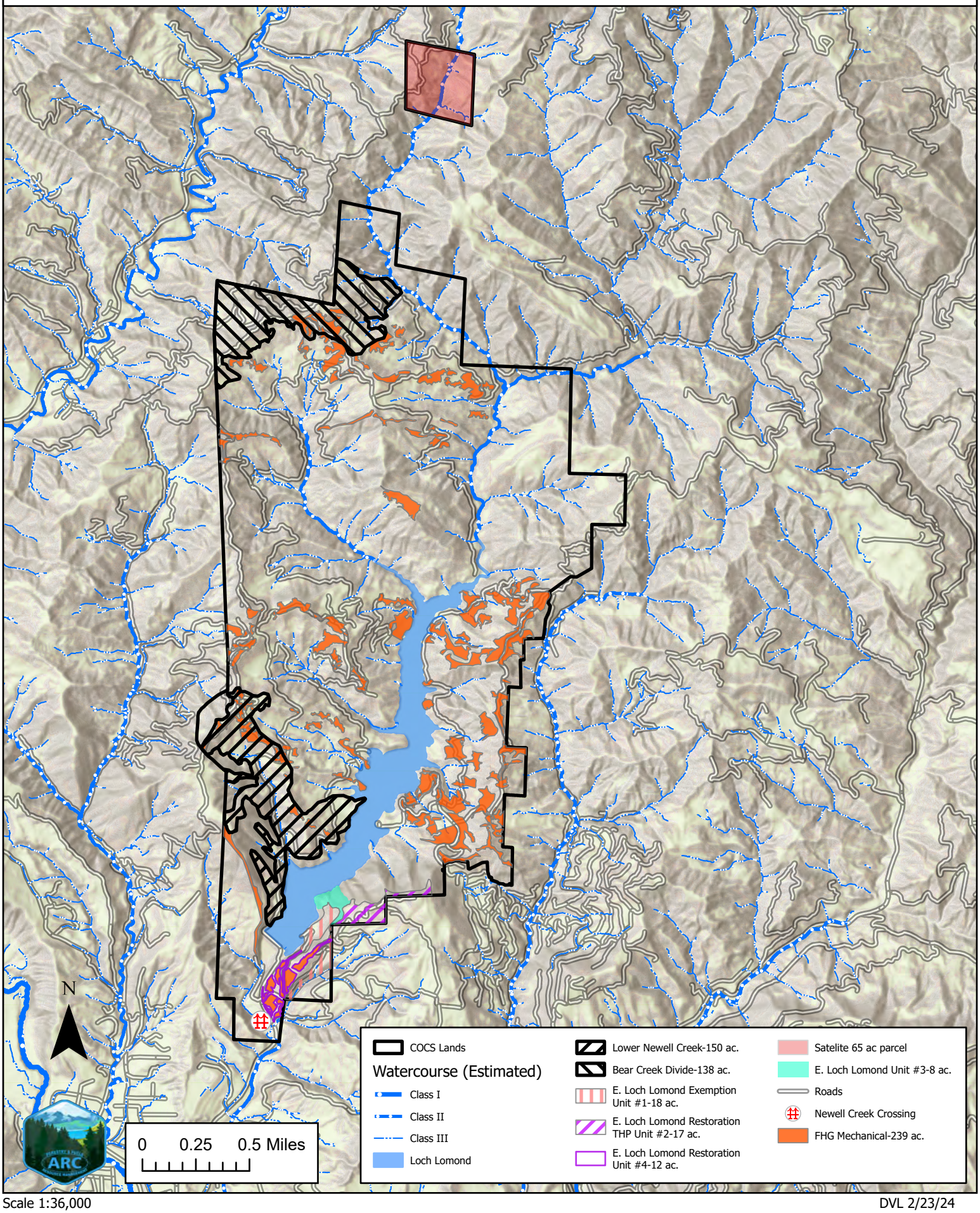
Newell Creek Tract Forest Health Fuels Reduction - Forest Health Grant Application

Consideration should be given to applying for a CAL FIRE Forest Health Grant to aid in funding forest health and restoration efforts. CAL FIRE is engaged in funding active restoration and reforestation activities aimed at providing more resilient and sustained forests. CAL FIRE's Forest Health Program funds active restoration and reforestation activities aimed at providing more resilient and sustained forests to ensure future existence of forests in California. The approximately 239 FHFR acres identified within the Newell Creek Tract are potential grant funded treatments. With additional analysis and field verification, it may be possible to accrue the required 800 unique acres of treatment area required for a Forest Health Grant Application[3].

[3] CAL FIRE – Forest Health Grant Guidelines: https://34c031f8-c9fd-4018-8c5a-4159cdff6b0d-cdn-endpoint.azureedge.net/-/media/calfire-website/what-we-do/natural-resource-management/forest-health/grant_guidelines_fy_2023-2024.pdf?rev=c7c20e014ddb4a9d988989ac977d98d4&hash=C452C472E53B5073FA17878D87FBE38B

Newell Creek Watershed Stewardship Recommendations

Project Overview



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Recommended Management Actions

From Sicular Environmental Consulting and City of Santa Cruz's consulting forester Steven M. Butler, a report was developed to evaluate future opportunities, and constraints to forest management while maintaining a high level of protection for water and other valued resources on watershed lands. Of those, the highest ranking relative to the SCWD goals for water quality, quantity and resource protection was the Integrated Production & Restoration Option (IPR), guiding future management choices and direction; a Timber Harvest Area with a focus on sustainable timber harvesting and watershed health; a Restoration Area designated to implement management tools for the restoration of Old Growth Forest characteristics; and a Recreation area with recreation being the primary use.

Santa Cruz Watershed Lands Forest Management Project – Newell Creek Tract Phase 1 Plan highlights two project goals to begin the implementation of the IPR approved by the Water Commission. The Phase I Project will involve implementation of the two principal strategies for forest management contained in the IPR: a commercial timber harvest component and a forest restoration component.

City of Santa Cruz Watershed Lands Forest Management Project – Newell Creek Tract Phase 1 Plan components:

- *The commercial timber harvest component will consist of a single-tree selection harvest on the west side of Loch Lomond Reservoir with a management approach similar to those practiced prior to 2000 in keeping with the SCWD's primary goal of protecting and improving water source, quality and storage.*

- *The Phase I Project will also include a forest restoration component within an approximately 100-acre area on the east side of the Loch Lomond Reservoir. This is part of the future East Loch Lomond Conservation Reserve, an approximately 900-acre area that will be managed for the goals of protecting water quality, restoring late seral forest habitat and its ecological and aesthetic attributes, and increasing resilience to climate change, including reducing the threat of catastrophic wildfire.*

General Discussion of Restoration Prescriptions

The Forest Restoration treatments discussed below have been grouped into some broad categories for simplicity and continuity across various landscapes. The descriptions are intended to provide a general understanding of activities and treatment outcomes, not to be rigid prescriptions or regulatory mandates. The specific design of these can be adapted

to landowner objectives, funding, access, and site-specific conditions, but generally focus on reducing density and arrangement of fuels and vegetation, increasing spacing of retained vegetation for improved resiliency.

Forest Density Reduction/Large Tree Restoration (FDR/LTR)

FDR/LTR treatments will reduce stand density, connectivity, and competition for resources, further increasing the health and vigor of the residual stand through the removal of selected second growth redwoods. This will promote the development of larger diameter forest stands, fostering the opportunity for more open forest stand characteristics to exist between periodic thinning, while increasing resilience, biological diversity, and reducing the severity of future wildfire. Single-tree selection would be utilized as the silvicultural prescription to achieve FDR/LTR goals.

Forest Health Fuels Reduction (FHFR)

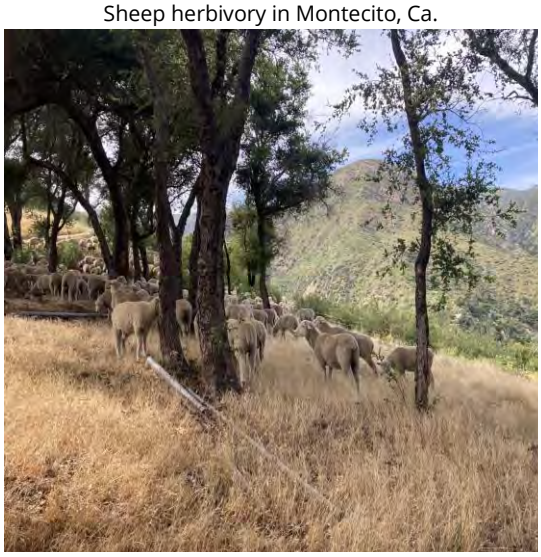
FHFR understory treatments focus on treating dead and dying trees and live trees (less than 16 inches in diameter) to reduce fuel loading and establish a form of shaded fuel break that can be utilized in PF treatments and wildfire suppression. Treatments reduce density and connectivity in the understory while retaining a mosaic of understory vegetation by considering specific retentions for shrubland, snags, herbaceous vegetation, and hydrophytic species. Understory treatments will decrease competition for available resources, like sunlight, water, and nutrients, resulting in a greater allocation of resources for the residual vegetation, ultimately promoting the growth of larger diameter trees over time, while

increasing resilience, biological diversity, and reducing the severity of future wildfire. Mastication, chipping, and hand lopping would be utilized to achieve FHFR goals. Community outreach conducted in planning stages of FHFR treatments would foster a landscape treatment, not limited to property lines.

Prescribed Fire (PF)

PF treatments could occur in areas of SCWD Watershed lands and might employ both pile and burn (pictured) and broadcast burn methods to increase resilience and biological diversity, and to reduce the severity of future wildfire. Treatment details and appropriate locations will continue to be developed and considered in the suite of tools available to achieve primary watershed goals. Community outreach and education surrounding PF planning is an important component and may yield collaborative relationships and watershed partnerships.

Sheep herbivory in Montecito, Ca.



Herbivory (H)

Prescribed herbivory (also known as "targeted grazing"[4]) is the use of domestic livestock to accomplish specific and measurable vegetation management objectives. Those include removing biomass (fine fuel loads), reducing populations of specific plant species, slowing the re-establishment of shrubs on burned or mechanically thinned sites, and improving plant community structure for wildlife habitat values. Planning details will continue to be developed and can be considered as one of the tools available to achieve primary watershed goals. Previous utilization of Herbivory on SCWD

[4] https://forages.oregonstate.edu/oregon/topics/harvest/grazing/targeted-grazing%C2%A0

lands highlighted some areas requiring additional analysis. the use of electrified enclosure fencing, and manure.

Priority Recommended Actions

The Commercial Timber Harvest Component of Phase 1

Directed field investigations and remote sensing efforts established the two priority locations recommended for Forest Density Reduction/Large Tree Restoration (FDR/LTR). These project sites align with the Newell Creek Tract Phase 1 Plan and support the overall goal of protecting drinking water sources. Two distinct areas were delineated at opposite ends of the watershed to provide variable treatment locations and priority options, with more specific details and merits discussed below. Both are well suited for Forest Density Reduction/Large Tree Restoration, have incorporated fuel reduction treatments utilizing Forest Health Fuels Reduction (FHFR), and additional appurtenant FHFR treatment areas which may be added in if desired. It is intended that one unit would be selected as the priority treatment area and serve as the next step.

For both units, single-tree selection would be utilized as the silvicultural prescription to achieve FDR/LTR goals to reduce dense groups of redwoods, increase spacing within stands of Douglas-fir and to improve overall health of the stand by removing damaged or unhealthy conifers. Implementation of single-tree selection involves having individual trees reviewed by a forester and selected for removal based on landowner goals, environmental conditions, safety, and the operational mechanics of timber harvesting with the target of accommodating a 12–15-year re-entry period.

This method has been employed exclusively in the region for decades and served as the baseline for much of the forest structure that is present today in the Newell Creek Tract. Sicular Environmental Consulting provided updated estimates utilizing the 1992 Forest Inventory generated by Ed Tunheim and Steven Butler *(Tunheim & Butler, 1994 cited in Sicular 2021)*. Updated inventory estimates indicate favorable forest growth during the 30-year period and provide a basis for ARC estimates of harvestable volumes by unit. This document compares these values with data gathered from Forest Trend Plots to look for correlating trends[5].Throughout these identified units, necessary infrastructure is in place and functional for management activity. Use of this infrastructure also provides an opportunity for upgrading and improving components such as culverts, and road drainage locations as a function of the harvest review, approval, and implementation process.

[5] Forest Trend Plots utilize a 500’ x 500’ grid layout and systematic random sampling strategy where, at grid intersections, a 1/5th-acre fixed plot is installed in key locations across an arrangement of pre-selected forest types. These “snapshots” of forest trends in sampled areas can be aggregated across larger landscapes to make inferences about current forest conditions.

Prioritized Commercial Timber Harvest Units are as follows:

Lower Newell Creek Unit - 150 acres FDR/LTR, FHFR, PF Treatments

The Lower Newell Creek Unit is approximately 150 acres of redwood and Douglas-fir forest with a small component of hardwood dominated forest types located in the southwest portion of the watershed. Much of this area was previously thinned in 1968 as one of the initial forest management entries into SCWD watershed lands following the 1959 Newell Fire. Portions of this area were thinned again in 1988 and 1990, creating a multi-aged forest that aligns with the goals and objectives of Santa Cruz Watershed Lands Forest Management Project – Newell Creek Tract Phase 1 Plan for watershed restoration, sustaining revenue generation and fuel management. A larger project map is located on the map below, and in Appendix A.

This area of the watershed was identified by Sicular Environmental Consulting and the SCWD as a high priority location to reintroduce harvesting and fuel reduction into The Newell Creek Tract. More specifically the 150-acre Lower Newell Creek Unit contains roughly 136 acres of commercial redwood and Douglas-fir forest, and 14 acres of hardwood and young conifer that could be treated under a FHFR prescription to reduce understory vegetation density, and focus on removing dead and dying trees and small diameter live trees (less than 16 inches in diameter) to reduce fuel loading and establish a form of shaded fuel break. FHFR appropriate areas would not typically be treated during a commercial harvest but would be included in the future Timber Harvest Plan permit to further the Fuel Reduction and Forest Health goals of the Newell Creek Tract Phase 1 Plan. An additional 10-15 acres of suitable FHFR treatments have been identified adjacent to this unit and could be incorporated as part of the Timber Harvest Plan permit.

Specific Considerations for The Lower Newell Creek Unit*:* The Lower Newell Creek Unit has several beneficial attributes that contributed to its priority status in this document.

> *Setting:* This general area of the watershed was identified by Sicular Environmental Consulting and the SCWD as a priority area for initial management and treatment. The area is easily accessible and is a short distance from paved or public roads. The necessary infrastructure exists and is in good serviceable condition.

Site: Estimates from the 1994 Forest Management Report (p 44) classify it as high Site Class IV or site index 126[6]. There is a fair amount of variability within this type including small pockets of pure hardwood and strips of timber near the creek bottoms that approach an RY 22 type[7] (young growth redwood, 50-80% cover of merchantable conifers and of all conifers). There is ample opportunity for Density Reduction of redwood and Douglas-fir, with anticipated gross harvest volume of 680-1,000 MBF (thousand board-feet), with favorable site capacity for release and growth between harvest treatments. Based on values presented in the Forest Inventory update (*Sicular 2020*), project harvest levels would remove approximately 12% -14.7% of the projected volume per acre. This is well below the growth that has accrued in the interval since the last harvest entry.

Fuel Reduction/Fire Prevention: To further the goals of fuel reduction and fire protection, the unit also provides lower, middle, and upper watershed shaded fuel break and fuel reduction opportunities with an important ridgeline access northwest of the dam for fuel break maintenance and improvement. Identified fuel reduction and fire protection treatment areas treated utilizing FHFR would focus on understory treatments for dead and dying trees and live trees (less than 16 inches in diameter) to reduce fuel loading and establish a form of shaded fuel break that can be utilized in PF treatments and wildfire suppression. Treatments reduce density and connectivity in the understory while retaining a mosaic of understory vegetation by considering specific retentions for shrub species, snags, herbaceous vegetation, and hydrophytic species. Treated areas will build on existing shaded fuel break efforts that SCWD has undertaken during its ownership and management of this area. An estimated 14 acres of FHFR prescription lie within the boundary, with an additional 10-15 acres adjacent that could be easily included. PF treatments in the form of pile and burn can be utilized to further reduce ground fuels if desired.

Infrastructure Maintenance and Improvement: As part of the background investigation for this project, a report generated by Pacific Watershed Associates was reviewed that identified transportation related features and watercourse crossings for the Newell Creek Tract and other SCWD owned lands *(Pacific Watershed Associates, July 2007).* This report described and ranked crossings and other transportation features

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[6] Site quality can be determined by using tree height as the indicator, where appropriate **site trees** of each species are selected in a stand. The site trees' heights and ages are measured in the field, and then plotted or *indexed* on species-specific growth curves or tables. For example, for a given species, a tree that is 120 feet tall at age 50 typically has better growing conditions than a tree that is only 80 feet tall at age 50.

[7] Timber Type designations describe total site occupancy, and relative size of conifers in forested area. These were utilized by Tunheim and Butler in their 1994, and caried over by Sicular in 2021.

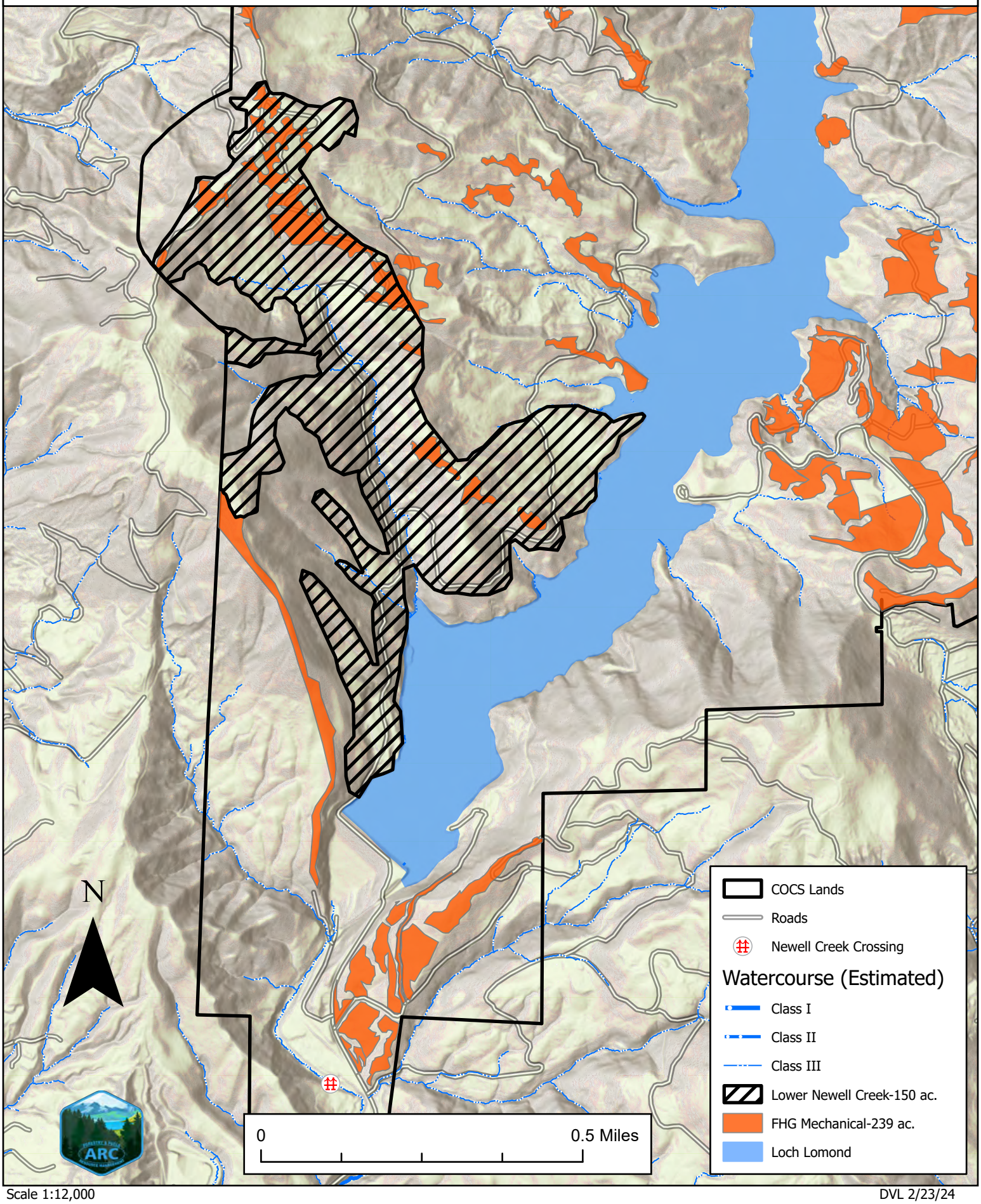
and provided a priority for treatment. Three high priority crossings are identified within the unit and would be addressed through a harvest permit to upgrade the crossings to current standards.

Public Interaction: The logical route for removal of forest products would be down the main watershed road, over the dam and through adjacent neighborhoods of Ben Lomond to Highway 9. This will generate daily interaction with residential, school and Transfer Station traffic which may generate public concern and additional awareness for the project. This can be viewed in two ways; as an opportunity for community outreach and familiarization with future projects utilizing this route, or as generating a negative public experience associated with the initial reintroduction of forest management in the watershed. Based on the design of the current infrastructure in the Newell Creek Tract many of the future projects will need to utilize this route, as done in past management efforts.

Permit pathway: A CAL FIRE approved Timber Harvest Plan (THP) would be necessary to implement Phase 1 goals in this unit. Timber Harvest Plans are considered a functional equivalent to an Environmental Impact Report, certifying compliance with the California Environmental Quality Act (CEQA), and could also cover FHFR treatments. Additional permits such as Streambed Alteration Agreements through the California Department of Fish and Wildlife are typically addressed in the THP process.

Newell Creek Watershed Stewardship Recommendations

Lower Newell Creek Unit



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DVL 2/23/24

Bear Creek Divide Unit - 138 acres FDR/LTR, FHFR, PF Treatments

The Bear Creek Divide Unit is approximately 138 acres of redwood and Douglas-fir forest with a component of hardwood dominated forest types located in the northeast portion of the Newell Creek Tract at the watershed divide with the Bear Creek Watershed. Portions of this area were previously thinned in 1980, and 1992. Roughly 30 acres appears to have been harvested prior to ownership by SCWD, using single tree selection in the early 1970's. No subsequent harvests have been documented on those acres, and they are notably more dense than surrounding stands. Prior harvest entries have created a multi-aged forest that aligns with the goals and objectives of Santa Cruz Watershed Lands Forest Management Project – Newell Creek Tract Phase 1 Plan for watershed restoration, sustaining revenue generation and fuel management. A larger project map is located on the map below, and in Appendix A.

This area of the watershed was not identified by Sicular Environmental Consulting and the SCWD as a high priority location for the reintroduction of management into The Newell Creek Tract but is within the overall area designated for commercially viable harvesting and is in alignment with Phase 1 goals and objectives. This 138-acre Bear Creek Divide Unit contains roughly 128 acres of commercial redwood and Douglas-fir forest, and 10 acres of hardwood dominated forest types that could be treated under a FHFR prescription to reduce understory vegetation density. It appears that several hardwood dominated areas have been thinned for fuel reduction and forest health in the past, and likely generated commercial hardwood products in the form of firewood. These areas would be included in the future Timber Harvest Plan permit and treated with understory FHFR prescription to further the Fuel Reduction and Forest Health goals of the Newell Creek Tract Phase 1 Plan. An additional 12-14 acres of suitable FHFR treatments have been identified adjacent to this unit and could be incorporated as part of the Timber Harvest Plan permit if desired.

Specific Considerations for The Bear Creek Divide Unit: The Bear Creek Divide Unit was not identified as one of the Phase 1 initial treatment areas but has beneficial attributes worth considering which contributed to a its inclusion as priority option in this document.

> *Setting:* This unit occupies upper ridgetops and extends along the property northern boundary, dipping into the Bear Creek Drainage. Some of the area has not been harvested under SCWD ownership, probably last harvested in early 1970's. These stands are overly dense and likely growing below the property average due to crowding. Additionally, these stands are adjacent to privately managed timberlands which have been recently thinned. Extending Forest Density Reduction treatment into SCWD lands in this location could have a compounded benefit regarding fire behavior. Significant ridgeline segments provide opportunities for strategically important Density Reduction and Fuel Reduction treatments at the top of two watersheds. These upper elevations exhibit the more extreme fire conditions of

high temperature and low humidity/fuel moisture, and thus the potential for more intense fire behaviors. They are also prime locations to directly attack or hold a fire. The area is easily accessible from Bear Creek Road with necessary infrastructure in good serviceable condition.

Site: Estimates from the 1994 Forest Management Report (p 44) classify it as high Site Class IV or site index 126, like The Lower Newell Creek Unit *(Tunheim & Butler, 1994).* Field investigation indicates that a significant component of hardwood exists within the general timber type and higher density of Douglas-fir. Based on the elevation, minimal number of watercourses and higher density of hardwood and Douglas-fir, the site index and overall redwood density and growth would be expected to be the lower in this specific location. There is valuable opportunity for Density Reduction of redwood and Douglas-fir, with anticipated gross volume of 640-960 MBF (thousand board-feet), and adequate site capacity for release and growth between harvest treatments. Based on values presented in the Forest Inventory update (*Sicular 2020*), project harvest levels would remove approximately 12% - 13.9% of the projected volume per acre. This is well below the growth that has accrued in the interval since the last harvest entry.

Fuel Reduction/Fire Prevention: To further the goals of fuel reduction and fire protection, the unit also provides opportunity for strategic upper watershed fuel break and fuel reduction opportunities. Identified fuel reduction and fire protection treatment areas will utilize Forest Health Fuels Reduction (FHFR) to focus on understory treatments of dead and dying trees and live trees (less than 16 inches in diameter) to reduce fuel loading and establish a form of shaded fuel break. Treated areas will build on existing shaded fuel break efforts that SCWD has undertaken during its ownership and management of the forest along this predominant ridgeline. An estimated 10 acres of Forest Health Fuels Reduction (FHFR) prescription lie within the unit, with an additional 13 acres adjacent that could be easily included. Prescribed Fire in the form of pile and burn can be utilized to further reduce ground fuels if desired.

Infrastructure Maintenance and Improvement: As part of the background investigation for this project we reviewed a report generated by Pacific Watershed Associates (PWA 2007) which identified transportation related features and watercourse crossings for the Newell Creek Tract and other SCWD owned lands. No transportation related features were identified in this portion of the watershed. However, an existing bridge across Bear Creek would be utilized as part of the access to this unit and would benefit from a collaboration with private landowners to substantially upgrade this critical crossing to a standard that would provide

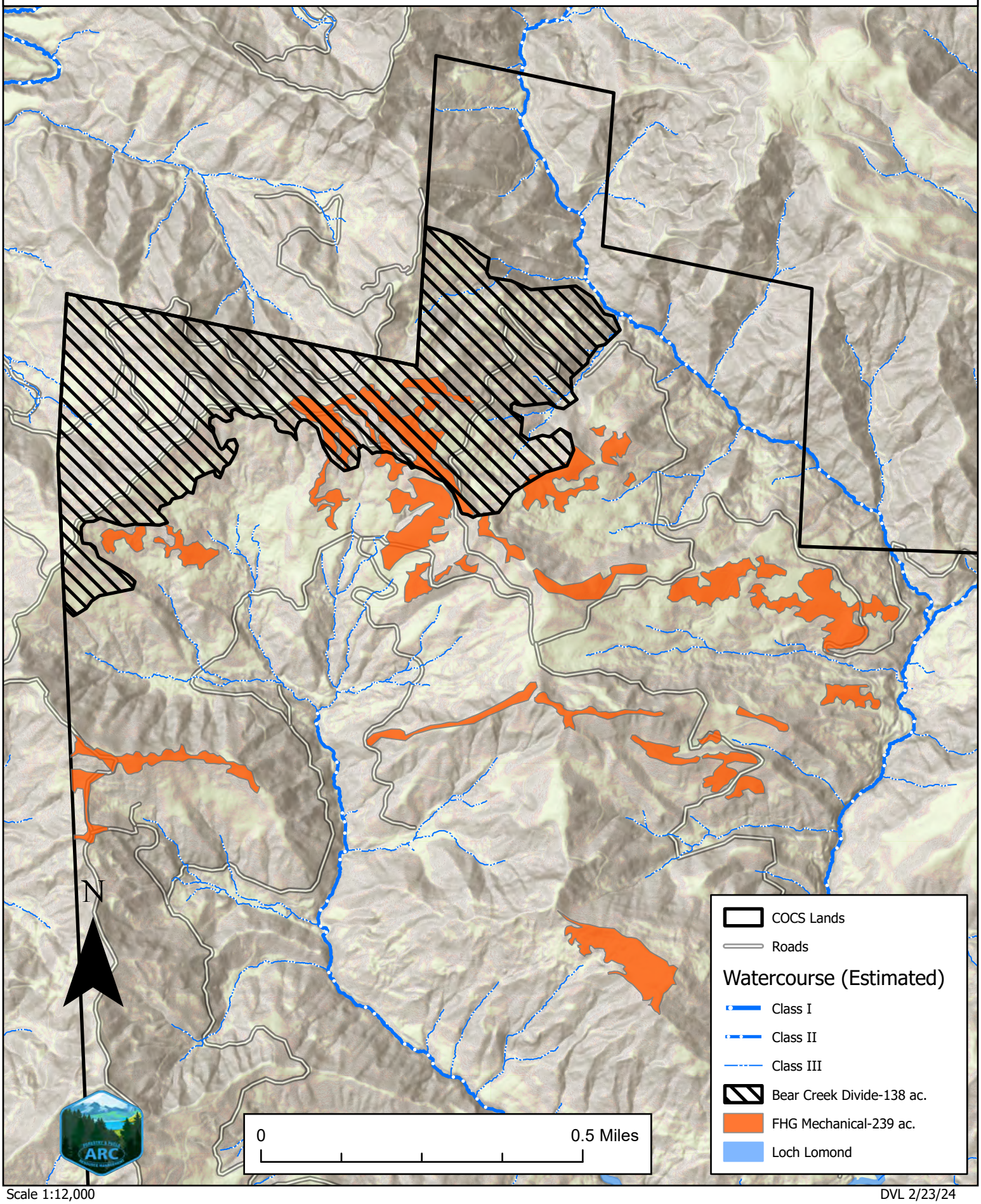
emergency fire equipment access. In its current form, the bridge is too narrow for heavy firefighting equipment such as a bulldozer.

Public Interaction: The logical route for removal of forest products would be down the main access road to Bear Creek Road. This would generate minimal interaction with residential and neighboring residences and may be viewed as an opportunity to minimize negative public interactions for the initial reintroduction of forest management in the watershed. The route is integral to several private Timber Production Zoned parcels and will be the preferred route for many future SCWD projects.

Permit pathway: A CAL FIRE approved Timber Harvest Plan would be necessary to implement Phase 1 goals in this unit. This CEQA-equivalent document could also cover FHFR treatments. Additional permits such as Streambed Alteration Agreements through the California Department of Fish and Wildlife are typically addressed in the THP process.

Newell Creek Watershed Stewardship Recommendations

Bear Creek Divide Unit



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DVL 2/23/24

The Forest Restoration Component of Phase 1

East Loch Lomond Forest Restoration

East Loch Lomond

The initial concept for the Phase I Project also included a forest restoration component within an approximately 100-acre area on the east side of the Loch Lomond Reservoir. This is part of the future East Loch Lomond Conservation Reserve, an approximately 900-acre area that will be managed for the goals of protecting water quality, restoring late seral forest habitat and its ecological and aesthetic attributes, and increasing resilience to climate change, including reducing the threat of catastrophic wildfire.[8] The selected restoration unit has minimal road and trail infrastructure, and includes the west-facing slope of Eagle Dell Peak, extending north to the Loch Lomond Recreation Area. It is roughly coincident with a "Late Seral Management Area" recommended in the 2002 Planning Analysis and Recommendations Report, prepared for the Water Department by Swanson Hydrology and Geomorphology *(Swanson Hydrology and Geomorphology, 2002).* The east side of Loch Lomond Reservoir, including the Phase I restoration area was not included in the previous timber harvest program, and contains a much different forest structure as a result. One of the most profound impacts post-1900's clearcut, was a fire that started during construction of the reservoir in 1959. This fire expanded to approximately 1326 acres, severely damaging much of the east side of the drainage, including the Phase I restoration area. The impacts of that event have resulted in reduced growth, and vigor of the damaged dominant trees, a dense understory, and slowed growth of the post fire regeneration of conifers. A substantial component of dead conifers remain in various positions in the forest ranging from standing snags, to snags falling and entwined in the mid-forest canopy, or crisscrossed at or near ground level. This arrangement of vertical fuel continuity, dense understory and drier site conditions make it a high-risk location for intense wildfire.

[8] Request For Proposals for City of Santa Cruz Watershed Lands Forest Management Project – Newell Creek Tract Phase 1 Plan, 2022.

Forest Restoration Goals

To achieve Phase 1 goals for this portion of the watershed, a prescription was desired to reduce competition among redwoods, and promote the growth of selected healthier conifers. In areas where hardwoods have displaced conifers, the hardwoods may be thinned or removed in patches and replanted with conifers. Understanding the temporal nature of restoration, a second and possibly third entry spaced at 15–25-year intervals is recommended. Treatments applied over several decades can be expected to direct recovery of this area towards the character and ecological function of a pre-disturbance forest, consisting of well-spaced larger trees. Douglas-fir and larger hardwoods would be retained in openings between redwood clumps. Habitat components such as snags would be retained as part of the forest structure, optimally at 1-2 per acre. Fire hazard reduction is also one of the primary goals. Fuel reduction treatments should complement conifer Density Reduction and may include thinning of hardwood-dominated stands, treatment of chaparral dominated vegetation types, and reducing ladder fuels and surface fuel loads. Secondary treatments utilizing Prescribed Fire in the form of pile burning would be appropriate where infrastructure can facilitate access of vehicles and equipment.

Based on our field investigation, we noted a highly variable forest composition with infrastructure limitations that directed our recommendations for beginning restoration of this portion of the future East Loch Lomond Conservation Reserve. Four separate treatment prescriptions were identified in four distinct areas, designed to achieve the Phase 1 goals. Forest Density Reduction/Large Tree Restoration (FDR/LTR) was selected to be applied in two different Restoration units, one unit consisting of a smaller diameter composition, and one with a larger diameter component. These treatment areas were separated based on differing permitting pathways but designed to achieve similar Phase 1 objectives. Forest Health Fuels Reduction (FHFR) was chosen for the two remaining areas to facilitate restoration and reduce fire hazards; one to reduce fuel and fire potential using hand lopping, the other to apply mechanical treatments to reduce dense understory vegetation and provide a potential buffer for adjacent conifer stands. Within three of those four separate treatment units, Prescribed Fire (PF) in the form of pile burning would be an appropriate follow up treatment to further reduce ground fuels when adjacent to infrastructure.

Unit numbers were given to help identify and discuss proposed treatments, not to assign a specific priority or treatment order.

East Loch Lomond Exemption Unit (#1) – 18 acres FDR/LTR, PF Treatments

Unit #1 is split into two separate areas approximately 9 acres each, comprised of redwood and Douglas-fir Forest which would be treated utilizing a Forest Density Reduction/Large

Tree Restoration (FDR/LTR) treatment. The northern portion of the unit has a structure of moderately dense, smaller diameter conifers along the mid-slope road above the lake. This section of the unit exhibits considerable damage from the 1959 fire in the form of unhealed fire scars, insect and pathogen damage and notable standing and suspended dead trees. The access road was built as part of the original transportation system for the construction of the dam and provides good access to the site. The southern part of this treatment unit lies along the road system that climbs the ridgeline at the southernmost part of the property, ending near Eagle Dell Peak. Forest structure in this 9-acre unit contains larger openings dominated by hardwoods, some chaparral, and scattered clumps of redwood. A few larger isolated redwood and Douglas-fir trees also occupy this site. Adequate infrastructure exists to conduct a Forest Density Reduction/Large Tree Restoration treatment on this combined 18-acre unit. A larger project map is located below, and in Appendix A.

Specific Considerations East Loch Lomond Exemption Unit #1: The East Loch Lomond Exemption Unit has several unique attributes that provide direction on how best to initiate restoration treatments.

> *Setting:* This general area of the watershed was identified by Sicular Environmental Consulting and the SCWD as a priority area for restoration and fuel reduction treatments. Unit #1 is located on the southeast corner of the watershed and is predominantly small to medium diameter conifer and hardwood. The existing infrastructure is in good serviceable condition to support Forest Density Reduction/Large Tree Restoration and is a short distance from paved or public roads. Restoration treatments will reduce stand density, fuel connectivity, and competition for resources, further increasing the health and vigor of the residual stand through the removal of selected second growth redwoods and Douglas-fir. This will promote the development of larger diameter forest stands, fostering the opportunity for more open forest stand characteristics to exist between periodic thinning, while increasing resilience, biological diversity, and reducing the severity of future wildfire. Single-tree selection would be utilized as the silvicultural prescription to achieve FDR/LTR goals. Considering Phase 1 goals and the composition of this stand, reduction in stem density of conifers below 30" DBH, and removal of some hardwood would provide a logical initial treatment to begin restoration.

Site: The 1994 Forest Management Report (p 45) describes the area as Site IV, which indicates a lower overall potential for productivity. Areas between redwood clumps are filled with hardwoods such as live oak, madrone, tan oak, and bay laurel. From the 1994 Forest Management Report, the growth rate of the conifers in this type is 1. 7% per year with the main reason for this low growth rate appearing to be excessive competition. This competition exists both between trees within the clumps and between the clumps and the surrounding hardwoods *(Tunheim & Butler, 1994).* The description from 1994 accurately depicts current forest conditions. A Forest Density Reduction/Large Tree Restoration of redwood and Douglas-fir might generate a gross volume of 50-75 MBF (thousand board-feet). This relatively low volume estimate is based on the smaller diameter composition of the stand and anticipated substantial defect in trees to be removed.

Damage from 1959 Fire

Fuel Reduction/Fire Prevention: To further the goals of fuel reduction and fire protection, additional measures could be incorporated such as pile burning, or chipping/mastication of treated areas. These fuel reduction treatments could be done in conjunction with the restoration treatments or separately, following the initial density reduction treatment. California Forest Practice Rules which would regulate this treatment, would mandate that post-treatment ground fuels (slash) be reduced to an 18-inch maximum height in conjunction with this treatment. Additional fuel treatments which improve the standard may be implemented.

Infrastructure Maintenance and Improvement: As part of the background investigation for this project, a report generated to identify transportation related features and watercourse crossings for the Newell Creek Tract and other SCWD owned lands was reviewed *(Pacific Watershed Associates, 2007).* No features were identified within the unit.

Permit pathway: It is proposed that a CAL FIRE Forest Fire Prevention Exemption (FFPE) be used in this Restoration unit. This permit provides coverage under the California Forest Practice Rules, allowing a landowner to be exempted from the specific requirement of a THP. Such permits have considerable limitations and constraints on allowed activities. The function of this ministerial permit is to "facilitate the cutting and removing of trees to eliminate the vertical continuity of vegetative fuels and the horizontal continuity of tree crowns for the purpose of reducing flammable materials to reduce fire spread, duration, and intensity, fuel ignitability, or ignition of tree crowns" *(Cal Fire, 2023).* The permit has several qualifying components to be considered, however the primary qualifiers are the requirement on only removing trees having less than 30 inches stump diameter measured 8 inches above ground level, and the harvest area shall not exceed three hundred (300) acres. Permit language also directs that Timberlands within the most recent version of the Departments Fire Hazard Severity Zone Map, which shows the exemption will occur in areas determined to be moderate, high, or very high fire threat. Nearly the entire Newell Creek Tract carries the designation of High Fire Threat.[9]

East Loch Lomond Density Reduction Unit (# 2) – 17 acres FDR/LTR, PF Treatments

This unit covers approximately 17 acres, comprised of redwood and Douglas-fir Forest which would be treated utilizing a Forest Density Reduction/Large Tree Restoration (FDR/LTR) treatment, but differs from East Loch Lomond Unit #1 in diameter distribution and average tree size. Unit #2 is bounded by the property line to the south and occupies the ridgeline at the southernmost part of the property and ends just east of Eagle Dell Peak. Unit #2 is composed of larger diameter trees in dense clumps, with live oak madrone and tan oak stands with larger Douglas-fir individuals interspersed. This restoration unit also

[9] https://osfm.fire.ca.gov/what-we-do/community-wildfire-preparedness-and-mitigation/fire-hazard-severity-zones

exhibits considerable damage from the 1959 fire, with many of the fire scars closed but visible and evidence of the entombed dead tree protruding from the bole (fire spike). Insect and pathogen damage was also visible as were very high concentrations of standing and suspended dead trees generally interior to the dense clumps of redwood. Infrastructure exists to access this unit but would need work to support a Forest Density Reduction/Large Tree Restoration treatment. This work would not be dissimilar to work commonly done to improve or upgrade typical forest roads after long periods of inactivity. A larger project map is located below, and in Appendix A.

Specific Considerations East Loch Lomond Density Reduction Unit #2: The East Loch Lomond Density Reduction Unit has a much different forest structure than that of Unit #1, which warrants specialized direction on how to best initiate restoration treatments in this stand.

Setting: This general area of the watershed was identified by Sicular Environmental Consulting and the SCWD as a priority area for restoration and fuel reduction treatments. Located at the southeast corner of the watershed, Unit #2 is somewhat typical for second growth redwood stands in size and distribution, having hardwoods interspersed between dense clumps of redwood. Most of the unit is ridgetop, or near ridge with some dense pockets of pure madrone, and live oak. The implementation of restoration treatments will reduce stand density, connectivity, and competition for resources, further increasing the health and vigor of the residual stand through the removal of selected second growth redwoods and Douglas-fir. This will promote the development of larger diameter forest stands, fostering the opportunity for more open forest stand characteristics to exist between periodic thinning, while increasing resilience, biological diversity, and reducing the severity of future wildfire. Single-tree selection would be utilized as the silvicultural prescription to achieve FDR/LTR goals and would remove mid to upper diameter redwoods to focus site resources on the best remaining trees. Understory trees in the lower diameters could also be removed to reduce competition and to improve spacing and overall stand health and vigor. Considering Phase 1 goals and the composition of this stand, reduction of conifer stem density throughout mid and upper and range of diameters would provide a logical initial treatment to begin restoration. Removal of some smaller hardwoods interspersed between redwood clumps or in pure stands would also be a benefit, while retaining larger co-dominant hardwoods.

Site: The 1994 Forest Management Report (p 45) describes the area as Site IV, which indicates a low overall potential for productivity. Areas between redwood clumps are filled with hardwoods such as live oak, madrone, tan oak, and bay laurel. The growth rate of the conifers on this type is 1.7% per year with the main reason for

this low growth rate appearing to be excessive competition. This competition exists both between trees within the clumps and between the clumps and the surrounding hardwoods *(Tunheim & Butler, 1994)*. The description from 1994 accurately depicts current conditions. A Forest Density Reduction/Large Tree Restoration of redwood and Douglas-fir might generate a gross volume of 100-120 MBF (thousand board-feet). This relatively modest volume estimate is based on a light density reduction, and anticipated defect in trees to be removed.

Fuel Reduction/Fire Prevention: To further the goals of fuel reduction and fire protection, additional measures could be incorporated such as pile burning, or chipping/mastication of treated areas. These fuel reduction treatments could be done in conjunction with the restoration treatments or separately, following the initial density reduction treatment. The ridgetop location of this unit increases the strategic importance of work in this area. California Forest Practice Rules which would regulate this treatment, would mandate that post-treatment ground fuels (slash) be reduced to a 30-inch maximum height in conjunction with this treatment. Additional fuel treatments which improve the standard may be implemented.

Infrastructure Maintenance and Improvement: As part of the background investigation for this project we reviewed a report generated which identified transportation related features and watercourse crossings for the Newell Creek Tract and other SCWD owned lands *(Pacific Watershed Associates, 2007).* No features were identified within the unit. Infrastructure exists to access this unit but would need work to support a Forest Density Reduction/Large Tree Restoration treatment. This work would not be dissimilar to work commonly done to improve or upgrade typical forest roads after long periods of inactivity. One segment of road approximately 500 feet in length could be substantially improved by realignment to improve the overall drainage and maintenance of this road system.

Permit pathway: It is proposed that a CAL FIRE Timber Harvest Plan be used in this Restoration unit because the diameter distribution of this unit does not lend well to the parameters set forth in the Forest Fire Prevention Exemption (FFPE). To effectively direct treatment in this stand, trees above 30 inches stump diameter would need to be removed. A 17-acre unit is not likely a feasible stand-alone project, but it could be easily incorporated into a Phase 1 Timber Harvest Plan to be implemented in a separate unit of the Newell Creek Tract.

East Loch Lomond Forest Health Unit (# 3) – 8 acres FHFR, Treatment.

This restoration unit covers approximately 8 acres, comprised of predominantly redwood forest type between part of unit #1 and unit #2 and provides landscape connectivity between other restoration and fuel treatments. Unit #3 would be treated utilizing Forest Health Fuels Reduction (FHFR) focusing on understory treatments of dead and dying trees and live trees (less than 16 inches in diameter) to reduce fuel loading and establish a form of shaded fuel break. Hand lopping would be utilized to achieve FHFR goals and focus on reducing the vertical continuity of fuels and create ground contact. Unit #3 is composed of larger diameter trees, oriented in reasonably spaced clumps, with others growing singularly on the steep slopes above the reservoir. Tanoak, bay laurel, and a few Douglas-firs occupy space between redwoods. This restoration unit also exhibits considerable damage from the 1959 fire with many of the fire scars closed but visible and evidence of the entombed dead tree protruding from the bole (fire spike). Insect and pathogen damage was also present as were concentrations of standing and suspended dead trees. No Infrastructure exists to access this unit, all work would be implemented by hand to treat material to achieve a maximum height of 24" from the ground. The goal is to foster well-spaced larger trees of all species, while reducing the potential severity of fire behavior. Habitat components such as snags would be retained as part of the forest structure, optimally at 1-2 per acre. A larger project map is located below, and in Appendix A.

Specific Considerations East Loch Lomond Forest Health Unit #3: The East Loch Lomond Forest Health Unit #3 has access and other limitations that constrain practical treatment options. During field investigation, the spacing and density of conifers was viewed as acceptable and would only minimally benefit from a density reduction treatment to achieve Phase 1 goals. A manual hand lopping treatment to modify fuel arrangement was selected as the best method to initiate restoration treatments by reducing potential severity of fire behavior.

> *Setting:* This general area of the watershed was identified by Sicular Environmental Consulting and the SCWD as a priority area for restoration and fuel reduction treatments. Located at the southeast corner of the watershed, Unit #3 is somewhat

typical for second growth redwood stands in size and distribution, having hardwoods interspersed between dense clumps. Density of conifer is low, possibly from a lower site potential. Unit #3 is on steep planar slopes above Loch Lomond, with well-spaced clumps of redwood separated by tan oak and occasional Douglas-firs or bay laurel. The implementation of restoration treatments will reduce fuel density and connectivity in the understory, focusing on dead and dying trees and possibly some live trees less than 16 inches in diameter to reduce vertical continuity. Considering Phase 1 goals and the composition of this stand, reducing surface and vertical fuels throughout the stand would provide a logical initial treatment to begin restoration.

Site: The 1994 Forest Management Report (p 45) describes the area as Site IV, which indicates a lower overall potential for productivity. Areas between redwood clumps are filled with hardwoods such as live oak, madrone, tan oak, and bay laurel. The growth rate of the conifers on this type is 1.7% per year with the main reason for this low growth rate appearing to be excessive competition. This competition exists both between trees within the clumps and between the clumps and the surrounding hardwoods. *(Tunheim & Butler, 1994).* The broad forest type description from 1994 accurately depicts current conditions, but competition does not appear to be a limiting factor as much as micro-site potential based on field observations of conditions.

Fuel Reduction/Fire Prevention: This treatment will further the goals of fuel reduction and fire protection. This fuel reduction treatment could be done in conjunction with other restoration treatments or separately, following the initial density reduction treatments in adjacent areas.

Infrastructure Maintenance and Improvement: No infrastructure exists to access this unit.

Permit pathway: Based on the requirements of the California Forest Practice Rules, no permit would be needed to undertake this treatment.

East Loch Lomond Forest Health Unit (# 4) – 12 acres FHFR, PF Treatments

An important component of the Newell Creek Tract Phase 1 Plan is the reduction of fuels and improvement of fire protection. Throughout the Newell Creek tract ARC has identified approximately 239 acres of fuel reduction treatments in total, with 12 of those acres occurring in the East Loch Lomond Restoration Area. This 12-acre unit focuses primarily on the reduction of understory fuels on moderate slopes. Comprised of hardwood and Douglas-fir this unit occupies the southernmost ridgeline of the property, with connectivity to Newell Creek Road extending easterly between the two lobes of East Loch Lomond Exemption Unit #1. Unit #4 has dense understory of young conifer and hardwood which

would be treated utilizing FHFR focusing on understory treatments of dead and dying trees and live trees (less than 16 inches in diameter) to reduce fuel loading and establish a shaded fuel break. Treatments would reduce density and fuel connectivity in the understory and retain a mosaic of understory vegetation by considering specific retentions for shrubland, snags, herbaceous vegetation, and hydrophytic species. Ultimately treatment will promote the growth of larger diameter trees over time, while increasing resilience, biological diversity, and reducing the potential severity of future wildfire. Mechanical treatments such as mastication and chipping would be used to treat the understory and maintain the larger trees. All necessary Infrastructure exists to access this unit, all work could easily be implemented. A larger project map is located below, and in Appendix A.

Specific Considerations East Loch Lomond Forest Health Unit #4: This East Loch Lomond Forest Health Unit is easily accessible for mechanical treatment options and supports the goals of Newell Creek Phase 1. Implementing this treatment will help create a form of shaded fuel break on a larger landscape to aid in overall fire protection and provide important fuel treatment on the edges of adjacent Old Growth restoration treatments.

Setting: This general area of the watershed was identified by Sicular Environmental Consulting and the SCWD as a priority area for restoration and fuel reduction treatments. Located at the southeast corner of the watershed, Unit #4 is dominated by Douglas-fir, hardwoods, and a few scattered redwoods. The density of conifer is low overall and overall site potential for conifer is also low. Unit #4 is on moderate slopes, along an east/west trending ridgeline that has been the focus of fuel reduction effort in the past. The implementation of fuel reduction treatments will reduce fuel density and connectivity in the understory. This area would be maintained as a hardwood and mixed conifer stand, focusing on removing more flammable understory vegetation, in favor of leaving larger trees of all species to create a forest structure like a shaded fuel break.

Site: The 1994 Forest Management Report describes the area as a hardwood dominated site, indicating a low overall potential for productivity. Live oak, madrone, tan oak, and bay laurel are the primary species, with some overstory Douglas-fir and a component of small redwood and Douglas-fir in the understory. Understory conifers may be a combination of planted and natural seed in.

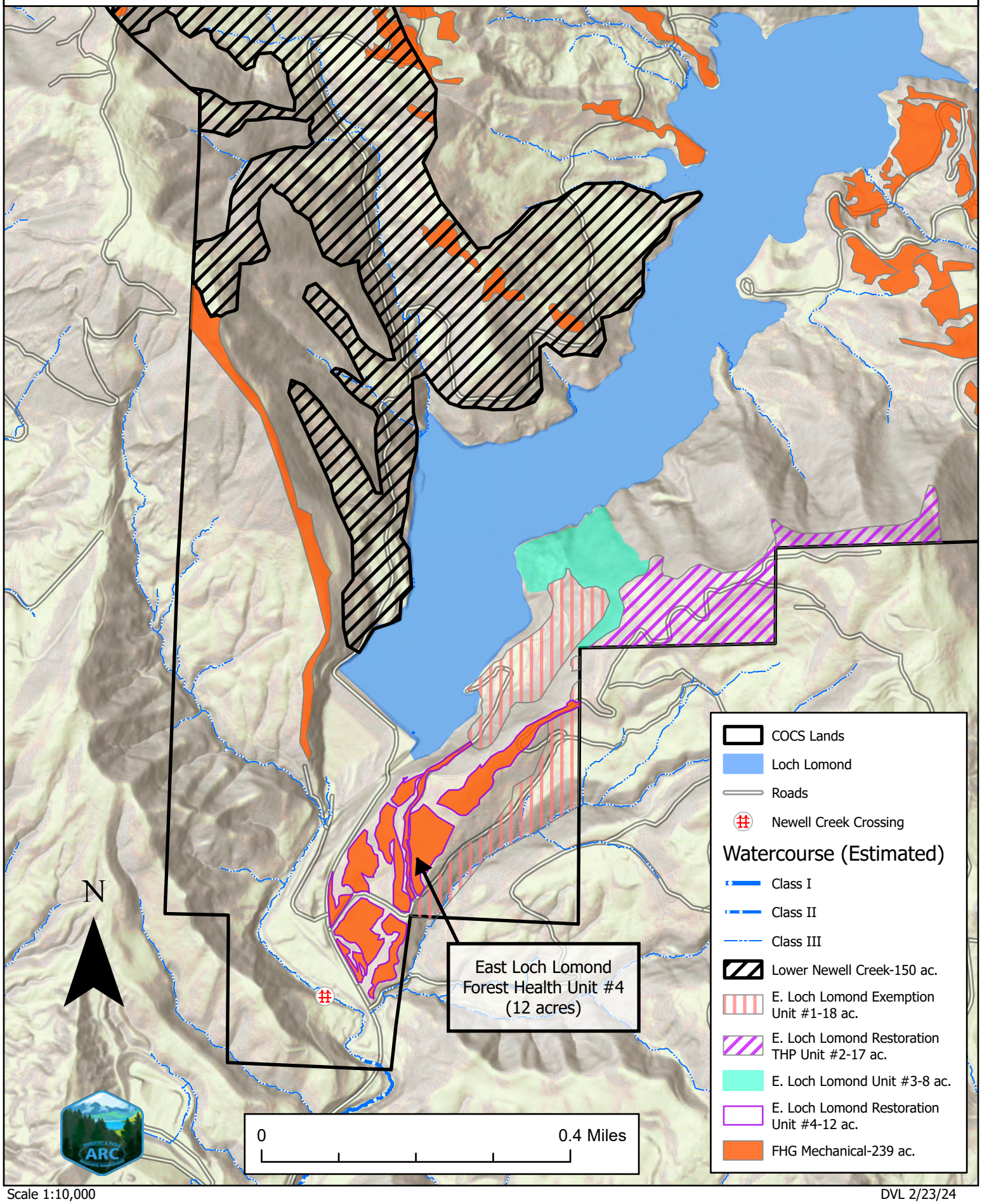
Fuel Reduction/Fire Prevention: This treatment will further the goals of fuel reduction and fire protection and provide treatment on a strategic ridgeline at the southern edge of the property. This fuel reduction treatment could be done in conjunction with adjacent restoration treatments or separately. Prescribed Fire in the form of pile burning could be implemented in conjunction with this treatment or as a follow up for maintenance.

Infrastructure Maintenance and Improvement: All necessary infrastructure exists to support the treatment of this unit. Infrastructure, if connected to other roads systems in the future, this road segment will benefit from reduction of nearby fuels to provide critical access, escape, or important opportunity for direct attack on incoming fire.

Permit pathway: Based on the requirements of the Forest Practice Rules, no CAL FIRE permit would be needed to undertake this treatment as proposed.

Newell Creek Watershed Stewardship Recommendations

East Loch Lomond Restoration Area



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DVL 2/23/24

Newell Creek Tract Forest Health Fuels Reduction - Forest Health Grant Application

Overall, the objective for SCWD's Newell Creek lands was to reduce the intensity of fire behavior in treated areas, improve and expand on existing fuel breaks, and provide opportunities for a better outcome in the event of fire. Fire will likely start outside SCWD lands, will likely have little chance of being contained or compartmentalized without landscape connections between ridges and fuelbreaks. Considerable fuel break work has occurred of the past decades with the goal of compartmentalizing fires. This work can be continued and expanded upon through available grant programs. Please refer to Attachment B for a map depicting past, present and future planned projects.

CAL FIRE's Forest Health Grant (FHG) Program funds active restoration and reforestation activities aimed at providing for more resilient forests while also mitigating climate change, protecting communities from fire risk, strengthening rural economies, and improving California's water and air. Through grants to regionally based partners and collaboratives, CAL FIRE seeks to significantly increase fuels management, fire reintroduction, treatment of degraded areas, and conservation of forests[10].

In alignment with the CAL FIRE FHG program is the comment from Swanson Hydrology and Geomorphology from July 2002, *"The fact that large fires are generally correlated with climatic conditions (low humidity, winds and heat), which may occur each year, should prompt efforts to prepare for the eventuality of a large fire rather than focus strictly on fire prevention."*

ARC has been part of four successful FHG grant applications in the Santa Cruz Mountains since 2020 and is actively involved in helping funded organizations apply treatments on the ground.

In line with the goals of the CAL FIRE FHG Program, an important component of the Newell Creek Tract Phase 1 Plan is the reduction of fuels and fire protection. This supports the overall goal of drinking water source protection and can be implemented in several ways throughout the watershed. ARC has identified 239 acres of treatments in a variety of forest and vegetation types well suited to forest health and fire protection treatments. With

[10] https://www.fire.ca.gov/what-we-do/grants/forest-health

additional analysis and field verification, it may be possible to accrue the required 800 unique acres of treatment area required for a Forest Health Grant Application[11].

The goal of identifying FHFR treatments for Phase 1 is twofold; to identify quality fuel reduction opportunities within and adjacent to proposed THP areas which can be covered with a THP; and to identify easily operable areas on non-commercial ground that could be part of long-term planning.

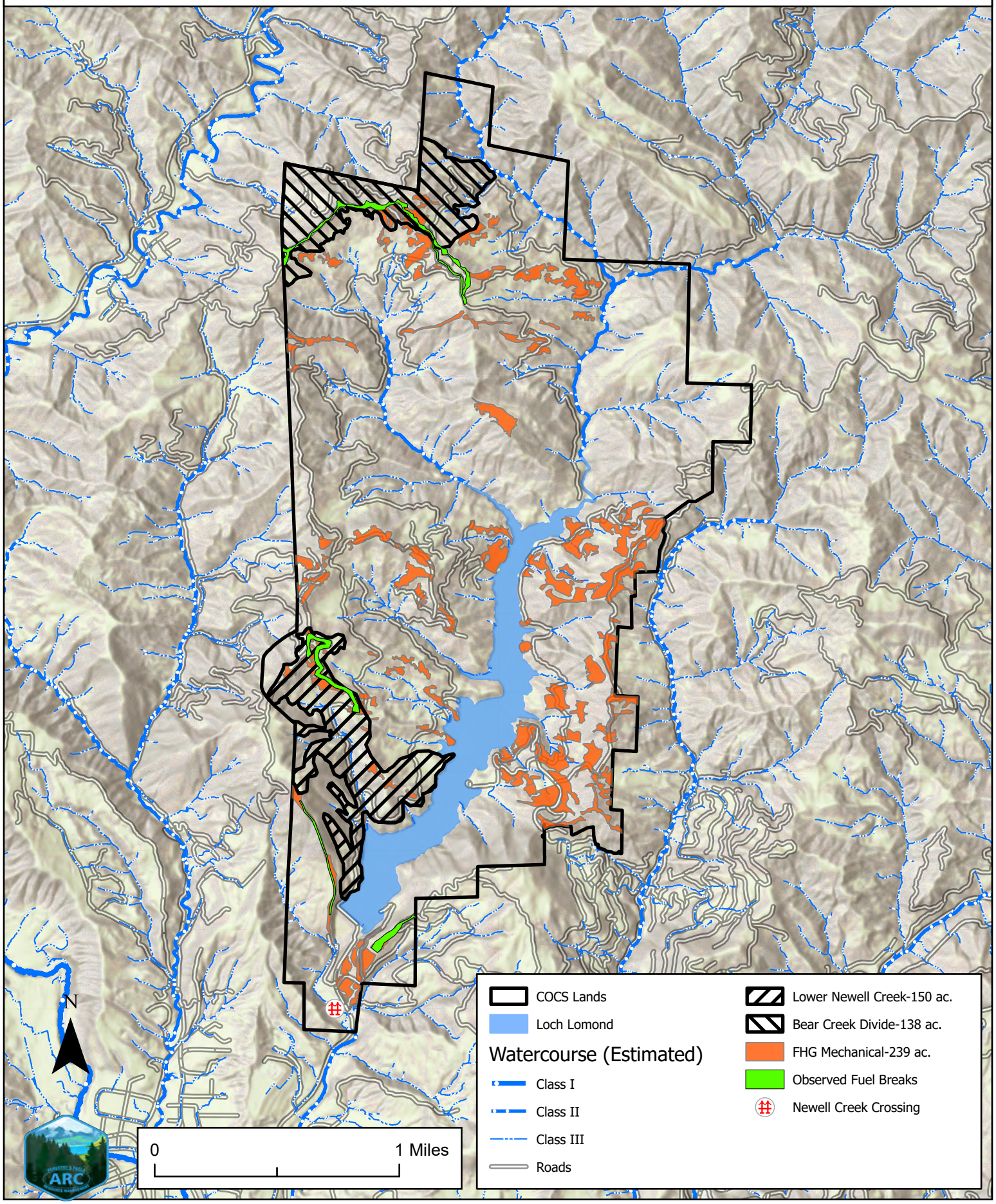
FHFR treatments would take place in areas where commercial timber operations were not available such as vegetation types without commercial timber value, within commercial FDR/LTR areas to improve overall treatment effectiveness, with the goal of connecting treatments across the landscape. These proposed initial treatments are the first steps to beginning ongoing maintenance activities, within and around THP units, and in areas where harvesting is not planned or feasible.

Generally, treatment polygons are located on moderate slopes under 35%, with access for equipment. West slope areas were limited to vegetation types not having a significant commercial conifer component to differentiate between the treatment options, possible treatment methods, and funding options. Those units located within the Loch Lomond Recreation Area can occur in redwood forests, as those locations were not identified as being managed commercially. Treatments can be implemented in concert with revenue generating projects on SCWD lands, funded separately from outside funding sources such as grants, or with existing SCWD funds. Conducting FHFR and PF treatments would greatly improve forest health, fire protection goals and the protection of water resources identified for Phase 1. A table of treatment costs to assist with decision making is appended.

[11] CAL FIRE – Forest Health Grant Guidelines: https://34c031f8-c9fd-4018-8c5a-4159cdff6b0d-cdn-endpoint.azureedge.net/-/media/calfire-website/what-we-do/natural-resource-management/forest-health/grant_guidelines_fy_2023-2024.pdf?rev=c7c20e014ddb4a9d988989ac977d98d4&hash=C452C472E53B5073FA17878D87FBE38B

Newell Creek Watershed Stewardship Recommendations

Forest Health Fuels Reduction and Adjacent Fuel Breaks



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Field Investigation and Data Analysis

The *Field Investigation and Data Analysis* section details the field processes and forest modeling efforts involved in generating this recommendations report. Within this section, information related to field surveys and monitoring methodology, collected data and stand metrics used for data analyses, regional management considerations, and forest modeling results produced from stand dynamic projection models and landscape fire behavior comparison assessments can be found. Additional in-depth information on any of the items discussed here may be available upon request.

Methodology

The following outlines the methods and procedures employed by ARC to investigate field conditions, conduct Forest Trend Monitoring, and verify known resources or conditions within a proposed project area.

Field Mapping

ARC developed internal maps as part of the initial phases of project scoping and development through the use of existing data, such as Fine Scale Vegetation and Digital Terrain Models. The mobile app software, *Avenza Maps*® (*Avenza*®), supports the use of offline georeferenced maps to locate the user's location and drop georeferenced pins, or field verification points. ARC utilized *Avenza*® to drop georeferenced pins with notes and photo data to verify known features such as infrastructure, management access, fire history, forest type, and other existing conditions while identifying additional features such as sensitive resources, forest health, and potential treatment options when appropriate.

Field Verification and Forest Trend Monitoring

ARC installed nine Forest Trend Plots (FTPs) in priority areas of the Newell Creek Watershed in an effort to quantify general trend metrics across known forest types within City of Santa Cruz property. FTPs utilize a 500' x 500' grid layout and systematic random sampling strategy where, at grid intersections, a 1/5th-acre fixed plot is installed in key locations across an arrangement of pre-selected forest types. These "snapshots" of forest trends in sampled areas can be aggregated across larger landscapes to make inferences about current forest conditions. FTPs are not equivalent to the sample size of a detailed forest inventory, but provide an opportunity to measure structural, conditional, and other landscape-level trends across broad forest types. FTPs are designed to appreciate as plots are resampled over time to track longer-term forest stand changes.

The primary considerations involved when conducting a Forest Trend Plot are as follows:

Forest Type and Site Quality

Forested stands are classified by their dominant vegetation type and respective site quality classification.

Forest type	Description
OGRW	Contiguous **Old Growth Redwood** stand that may also have old growth Douglas-fir components
RW II	**Redwood Site II** - occupied by 75% second growth redowood with the capability of growing a redwood tree 155-179 feet tall in 100 years
RW III	**Redwood Site III** - occupied by 75% second growth redwood with the capability of growing a redwood tree 130-154 feet tall in 100 years
CHRW	**Conifer-Hardwood, Redwood Dominant** - over 50% and less than 75% redwood, the remainder being hardwood or Douglas-fir
CHDF	**Conifer-Hardwood Douglas-fir Dominant** - over 50% and less than 75% Douglas-fir, the remainder being hardwood or redwood
HW	**Hardwood** - greater than 50% hardwoods
DF	**Douglas-fir** greater than 75% Douglas-fir
MP	**Monterey Pine** - greater than 50% Monterey Pine

Figure 3 Forest Types and descriptions used for FTP monitoring.

Recent Wildfire or Natural Disturbance Information

Where applicable, assessments within recent or observable burn scars provide dynamic and valuable insight into the current and former stand conditions that influence localized fire severity variables.

Plot Photos

Five photos were taken at every plot in each cardinal direction from plot center including one overhead photo to capture existing canopy.

Tree Count

Seedlings and saplings from 1-12 inches Diameter at Breast Height (DBH) within the 1/5th-acre FTP are tallied to provide an estimation of stand densities, volume, growth rates, and mortality trends associated with each forest type.

Tree Measurements

Trees greater than 12 inches DBH within the 1/5th-acre FTP are assessed by species, DBH, live or dead status, and height. Vigor and general structural attributes are also noted.

Radial Growth Measurements

Radial core samples are extracted from a minimum of one representative conifer tree within an FTP, or within associable proximity to an FTP, and closely examined for tree or stand age, historic wildfire occurrence, growth rates, history of suppression and stand release, major geologic events, and potential harvest history.

Understory Vegetation

Understory vegetation composition and structure is variable and used to further determine the representative species for FTP stratification as needed for data analysis. The arrangement of understory vegetation within a stand may also be indicative of the specific vegetative alliances present in these locations.

Forest Modeling Evaluation, Results, and Discussion

Regional Monitoring Approach and Data Considerations

Forest Trend Plot (FTP) data collected within the Newell Creek Watershed primarily serves to associate existing forest conditions at this location with similar datasets collected across other forested landscapes in the Santa Cruz Mountains by corresponding methods.

Between August 2021 and June 2022, ARC installed a total of 264 FTPs at regional California State Parks properties following the 2020 CZU Fire. Big Basin Redwoods State Park (BBRSP), Año Nuevo State Park (ANSP), and Butano State Park (BSP) were respectively delineated into 300 total subwatershed units for the purposes of effective monitoring coverage and the 264 FTP records collected at these properties were eventually stratified by plot position on slope and burn severity for each forest type observed. This landscape-level trend monitoring effort resulted in various Forest Vegetation Simulator (FVS) modeling outputs and an extensive regional dataset that can be referenced with corresponding data from other properties that host similar ecological conditions.

The key findings produced from these regional datasets are as follows:

- Fewer trees per acre (TPA) and larger diameter trees indicate increased tree resilience to wildfire.
- High TPA in smaller diameter trees (less than or equal to 12-inches) indicate increased susceptibility to tree mortality, including tree mortality in a component of larger diameter trees.
- Higher severity burns produce increased tree mortality across all forest types and all diameters. These areas, among other burn severities, involve a significant regenerative basal sprouting response from coastal coppice sprouting species.

Modeling assessments conducted from FTP data collected in the Newell Creek Watershed indicate a level of forest stand dynamics similar to those observed at State Parks properties

in 2021 and 2022. While FTP data collected at City of Santa Cruz property is limited in terms of landscape sample size, some inferences can still be considered. When comparing, existing conditions through the use of FVS of those in Newell Creek to post-wildfire conditions observed across a greater landscape scale at BBRSP, ANSP, and BSP, FTP data suggests the pre-fire forest conditions on State Parks lands that led to observed post-fire mortality in larger diameter trees is also present in Newell Creek. This observed mortality in larger diameter trees is believed to be, in part, the function of higher densities of understory vegetation contributing to intensified fire behavior.

As effective and informative as forest modeling may be, consideration should be maintained that the following results are presented as generalities surrounding the Newell Creek Watershed landscape. Many factors and dynamics affect the ecological response following forest health fuels reduction treatments and how those treatments influence natural disturbance mechanisms.

The purpose of these assessments is to consider alternative disturbance scenarios based on the existing conditions at Newell Creek and the general efficacy of prudent vegetation management as it relates to watershed and municipal resource protection. The following sections contain detailed information relating to the Interagency Fuel Decision Support System (IFTDSS) and Forest Vegetation Simulator (FVS), the two primary forest modeling programs utilized for this recommendations report.

Interagency Fuel Decision Support System (IFTDSS)

The Interagency Fuel Treatment Decision Support System (IFTDSS)[12] is a comprehensive tool designed to assist land managers and natural resource professionals in making informed decisions regarding fuel treatment strategies for wildfire risk reduction and natural resource protection. Developed collaboratively by various federal agencies in the United States, including the Bureau of Indian Affairs, U.S. Forest Service, the Bureau of Land Management, the U.S. Fish and Wildlife Service, and the National Park Service, IFTDSS integrates spatial data, modeling capabilities, and decision support tools to enhance the planning and implementation of fuel treatments across diverse landscapes.

Key Features of IFTDSS and Applications

IFTDSS serves as a valuable decision support tool for natural resource managers, enabling them to make informed and data-driven decisions to address wildfire risks and promote the sustainable management of ecosystems. Aspects of IFTDSS include:

- Spatial Data Integration

[12] https://iftdss.firenet.gov/landing_page/about.html

- Treatment Modeling Capabilities
- Alternative Treatment Scenario Analysis
- Decision Support Tools
- Wildfire Risk Reduction Assessment
- Ecosystem Restoration and Resource Allocation

IFTDSS facilitates a comparative analysis between a vegetation treatment scenario and a "no treatment" scenario by integrating spatial data, fire behavior models, and decision support tools. Additional processes and tools considered by IFTDSS are:

- Spatial Data Inputs
- Fire Behavior Modeling
- Treatment Scenarios
- No-Treatment Scenario
- Simulate Fire Behavior
- Compare Results
- Cost-Benefit Analysis
- Refine Strategies
- Decision-Making

By employing IFTDSS for these efforts, land managers can systematically assess the impacts of vegetation treatment versus no treatment, aiding in the development of evidence-based strategies for effective natural resource management and wildfire risk reduction.

IFTDSS facilitates a comparative analysis between a vegetation treatment scenario and a "no treatment" scenario by integrating spatial data, fire behavior models, and decision support tools.

Additional information and detailed descriptions of IFTDSS processes and its applications can be found in Appendix B.

IFTDSS Results

In an effort to quantify and visualize the landscape-level changes in wildfire behavior prior to and following initial treatment implementation, the Interagency Fuel Treatment Decision Support System (IFTDSS) modeling system was utilized to assess the proposed treatment areas and produce projected outputs for a variety of metrics. This general assessment focuses on three important wildfire behavior metrics – *Flame Length, Rate of Spread,* and *Crown Fire Activity*.

While IFTDSS offers an array of modeling outputs and reports, the following summary focuses on pre- and post-treatment fire behavior comparative analyses developed using modeling parameters calculated for 97th percentile fire weather conditions in the Newell Creek Watershed. These parameters reflect the weather and fuel moisture conditions that may be present at the time of complex, high-intensity fires where initial attack may often fail. The purpose for modeling these high percentile wildfire scenarios is to consider the indirect influence the proposed treatments may have on municipal water, resource, and infrastructure protection in the event of a rare, but not unprecedented disturbance event such as the 2020 CZU Complex Fire.

The following model outputs depend primarily on 2014 LANDFIRE[13] data, which is the most recent data version available in IFTDSS for comparative analysis. To compare existing conditions ["COSC_Rx_Mechanical_Pre Treatment (2)"] in the Newell Creek Watershed to simulated post-treatment conditions [COSC_Rx_Mechanical_1YR Post Treatment (1)"], a general treatment rule involving moderate understory thinning by mastication where treated material is left onsite was applied; approximately 25% of the present understory density remains. This assessment considers fire behavior dynamics present after one year following proposed treatments. A full version of the Fire Behavior Comparison Summary Report can be found in Appendix C.

Flame Length

As defined, *Flame Length*[14] considers the distance between the average tip of a flame to the middle of the flaming zone at the base of the fire. This metric is useful when considering fire line intensity or the spacing between residual vegetation. Figure 4 outlines the comparison of flame lengths across the proposed treatment area prior to treatment implementation and after one year following initial treatments.

The primary finding is that flame length is greatly reduced in upper ranges following treatment. Flame lengths greater than 4 feet and up to 25 feet which can be expected in a

[13] https://landfire.gov/
[14] https://www.nwcg.gov/course/ffm/fire-behavior/84-flame-length-spread-distance

pre-treatment landscape are virtually reduced entirely to less than 4 feet in a post-treatment landscape. In a wind-driven wildfire event, flame length becomes an important metric when considering rate of spread and crown fire activity, as well as when developing operational specifications and retention standards following treatment implementation.

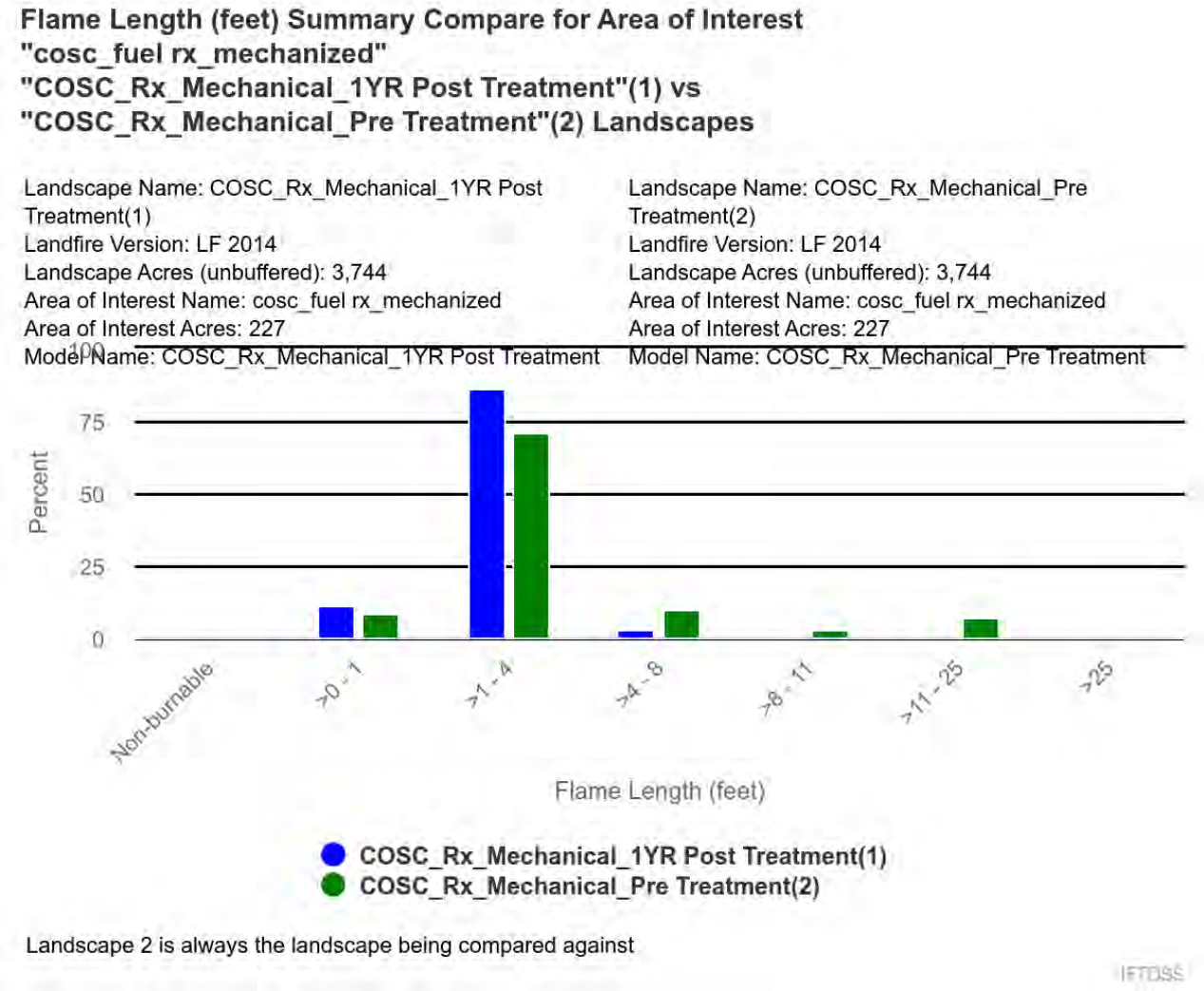


Figure 4 Flame Length summary output (IFTDSS)

Figure 5 offers an additional graphical comparison between pre- and post-treatment flame lengths. These charts delineate measurement ranges for flame activity throughout an active, simulated wildfire event and quantify each range as a proportion of overall flame occurrence. Greater proportions of overall flame activity in shorter length classes is preferable as this suggests less torching of individual trees and reduced propagation to adjacent fuels in a well-spaced, residual stand.

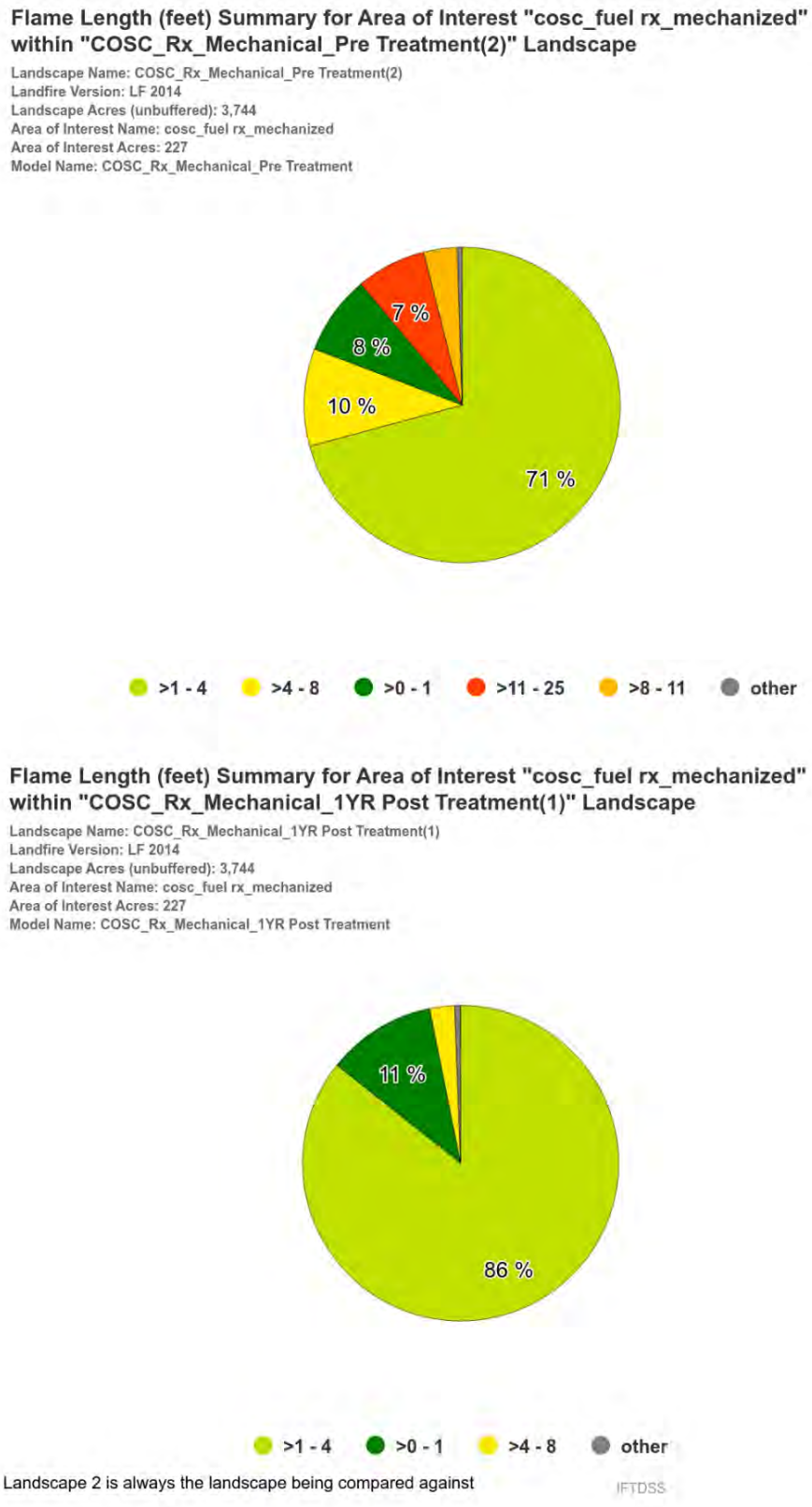


Figure 5 Flame Length proportional summary comparison (IFTDSS)

Rate of Spread

Rate of Spread[15] considers the speed at which a wildland fire moves away from the original ignition site. Rate of Spread is a product of the wind, fuel conditions, and slope that influence its movement. While weather and terrain are uncontrollable factors that can directly affect the rate at which a fire moves, reduced low-moisture fuel loading on the forest floor is expected to have a mitigating effect on a how fast a burn can spread over the landscape in units of chains[16] per hour or *chains/hr*.

Figure 6 suggests that after one year following a moderate level of thinning by way of proposed mastication in the dense understory at Newell Creek Watershed, changes or differences in the Rate of Spread during a simulated, high-intensity event are expected to be most measurable in the 0-2 chains/hr range. The projected increase in spread at lower rates is a direct result of the reduction in rate of spread at faster rates; predominantly in the 2-5 and 5-20 chains/hr classes. In consideration of municipal water resource and infrastructure protection, slower wildland fire movement in post-treatment areas is expected to provide fire suppression resources with more opportunities to access, attack, and manage a high intensity wildfire event.

[15] https://www.nwcg.gov/course/ffm/fire-behavior/83-rate-of-spread

[16] *Chain* - Unit of linear measure (length) commonly used in forestry and equal to 66 feet (80 chains = 1 mile)

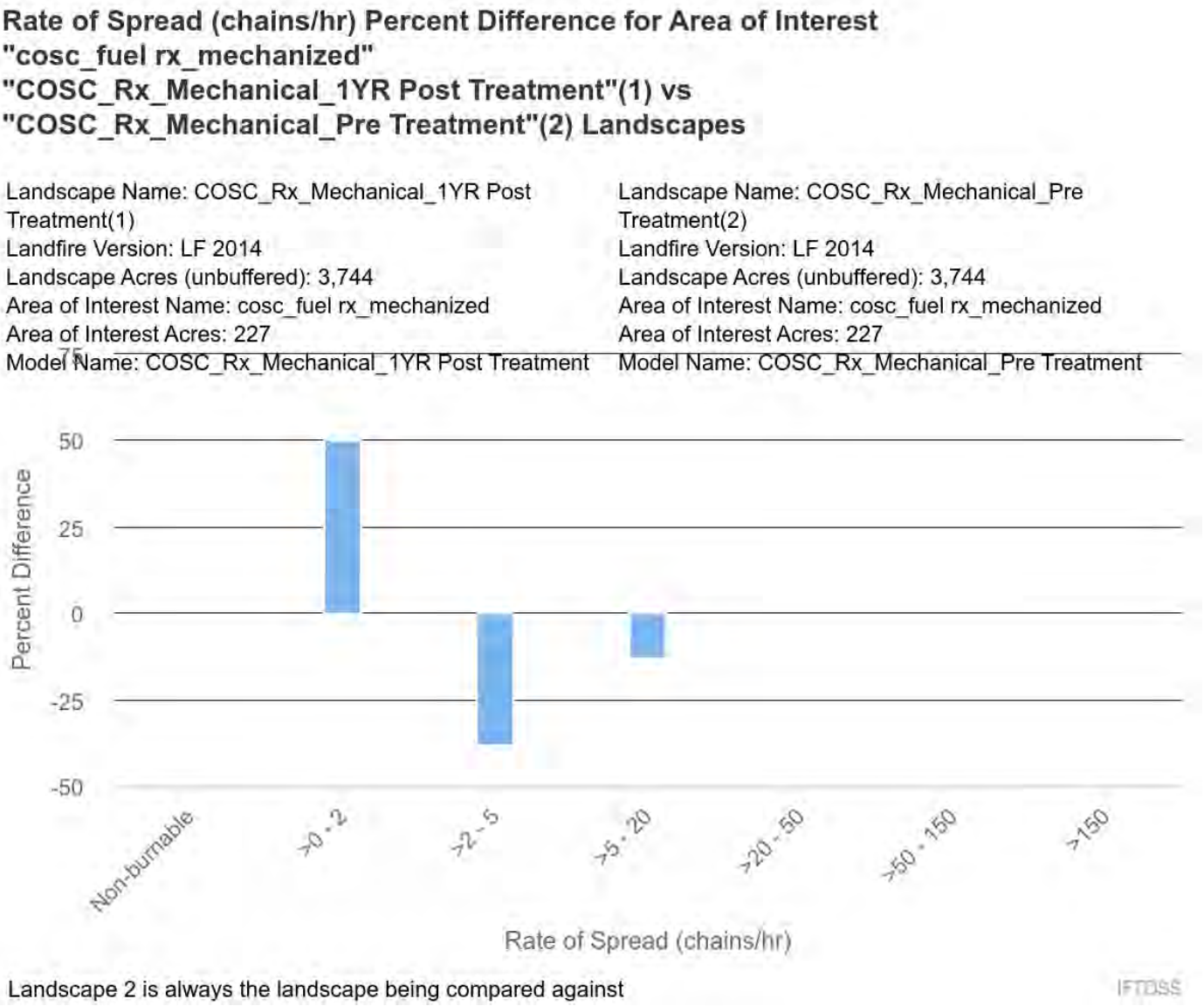


Figure 6 Rate of Spread summary output (IFTDSS)

Figure 7 presents additional supporting graphical context related to simulated Rate of Spread following proposed initial treatments. As described above, higher Rates of Spread can be expected to decrease, and lower rates to increase following initial treatments as a function of more favorable fuel arrangements. The predominant rate at which a fire is expected to travel following implementation is within the 0-2 chains/hr. range, which is roughly equivalent to 0-132 feet per hour or approximately 2 feet per minute as opposed to pre-treatment conditions which may result in a burn spreading as quickly as 330-1,320 feet per hour or 5.5-22 feet per minute.

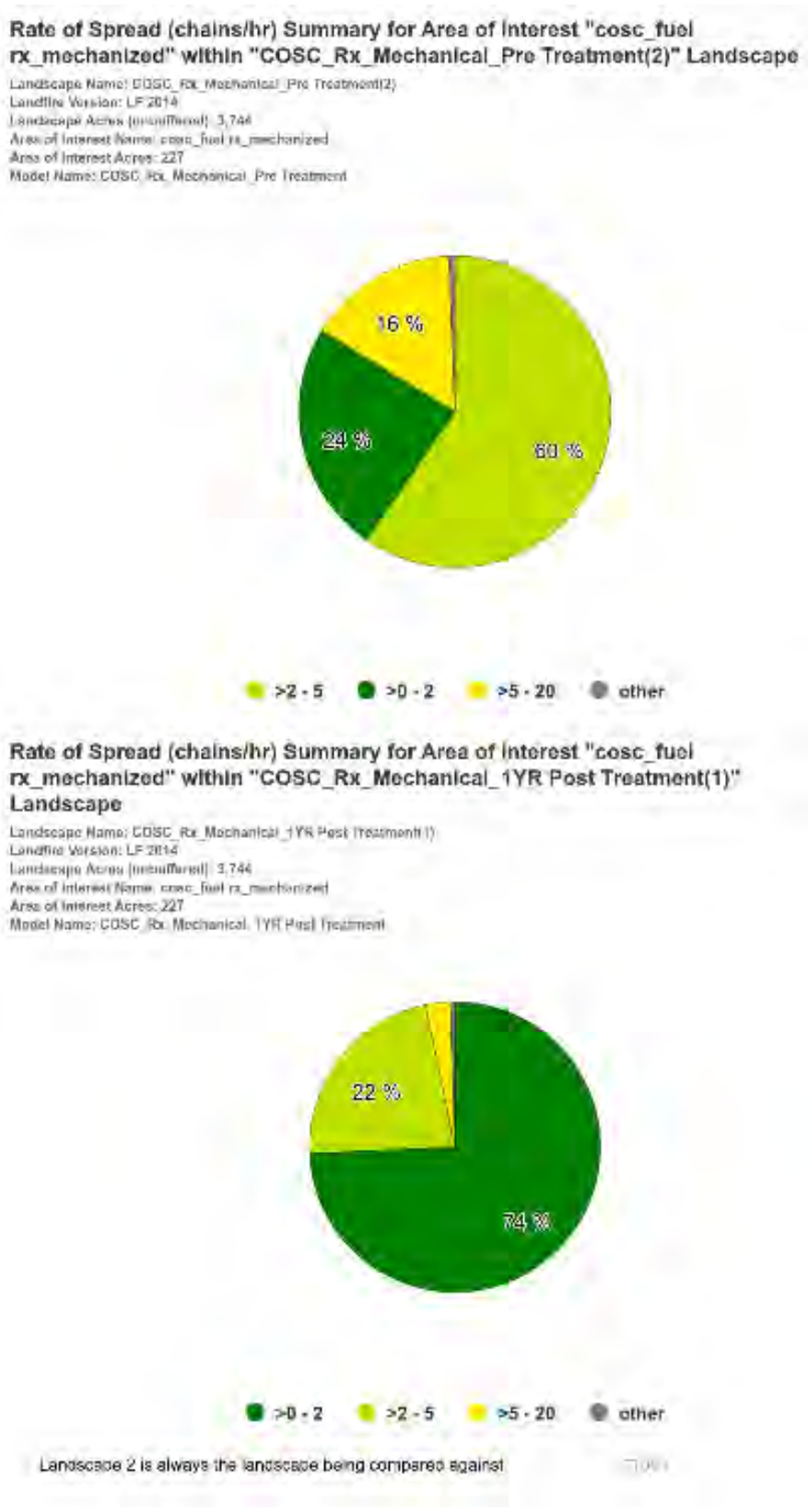


Figure 7 Rate of Spread proportional summary comparison (IFTDSS)

Crown Fire Activity

The importance of assessing *Crown Fire Activity*[17] corresponds to how a wildland fire that has traveled into a forest canopy may behave and move at landscape-level scales. Simulations suggest that after one year following proposed mastication treatments at SCWD, crown fire behavior may be reduced almost entirely. This reduction is a function of change from conditions that predominantly support *Passive Crown Fire* to those that promote *Surface Fire*.

Passive Crown Fire occurs where surface fire devlops enough intensity to travel up into the canopy of an individual tree or group of trees, yet propogation to adjacent trees is low due to reduced wind conditions. In higher wind conditions or gusts, the onset of an *Active Crown Fire* may develop from individual torching of trees. In extreme fire weather conditions, an *Independent Crown Fire* may occur during which active fire travel across the forest canopy moves independent of the surface burn. While considered rare, Independent Crown Fires are becoming more common In the western landscape at larger scales and intensities and are often the product of high-rate surface burns and dense horizontal and vertical fuels continuities; this was most recently evidenced in the Santa Cruz Mountains by way of the 2020 CZU Complex Fire.

Figures 8 and 9 present the quantifiable, modeled crown fire activity changes prior to and after one year following proposed treatments. The key consideration related to crown fire activity for this model is treatments that mitigate the conditional factors which serve as a catalyst for the development of catastrophic crown fire. In sequence, surface burns that do not lead to torching do not lead to active or independent crown fires. Generally, reduced stand-level mortality among larger diameter trees is expected if heavy, dead fuel load continuities are disconnected in the understory (Stephens, 2018)[18].

[17] https://www.nwcg.gov/publications/pms437/crown-fire/active-crown-fire-behavior

[18] Scott L Stephens, et al., (2018). Drought, Tree Mortality, and Wildfire in Forests Adapted to Frequent Fire, *BioScience*, Volume 68, Issue 2, Pages 77–88.

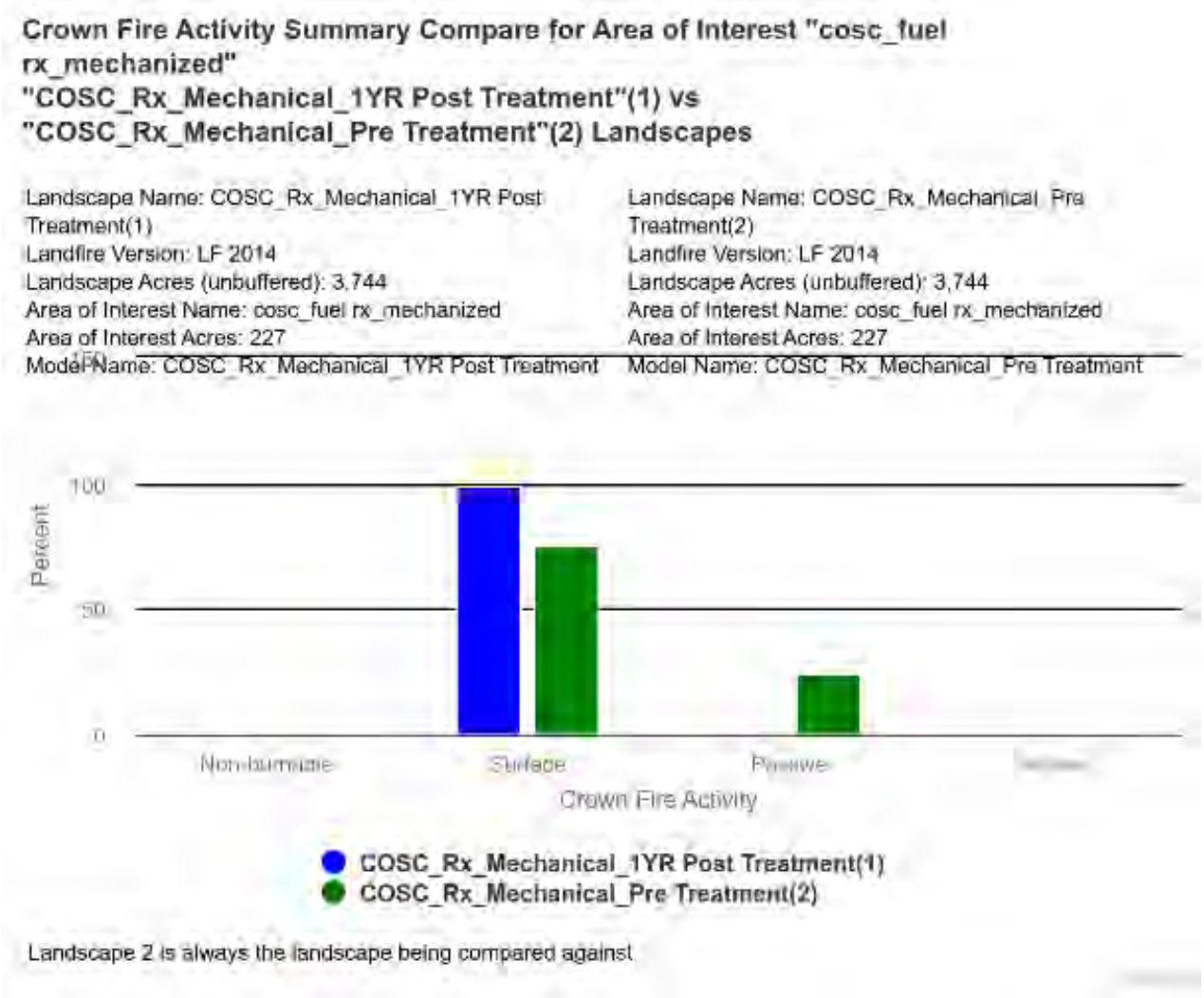


Figure 8 Crown Fire Activity summary output (IFTDSS)

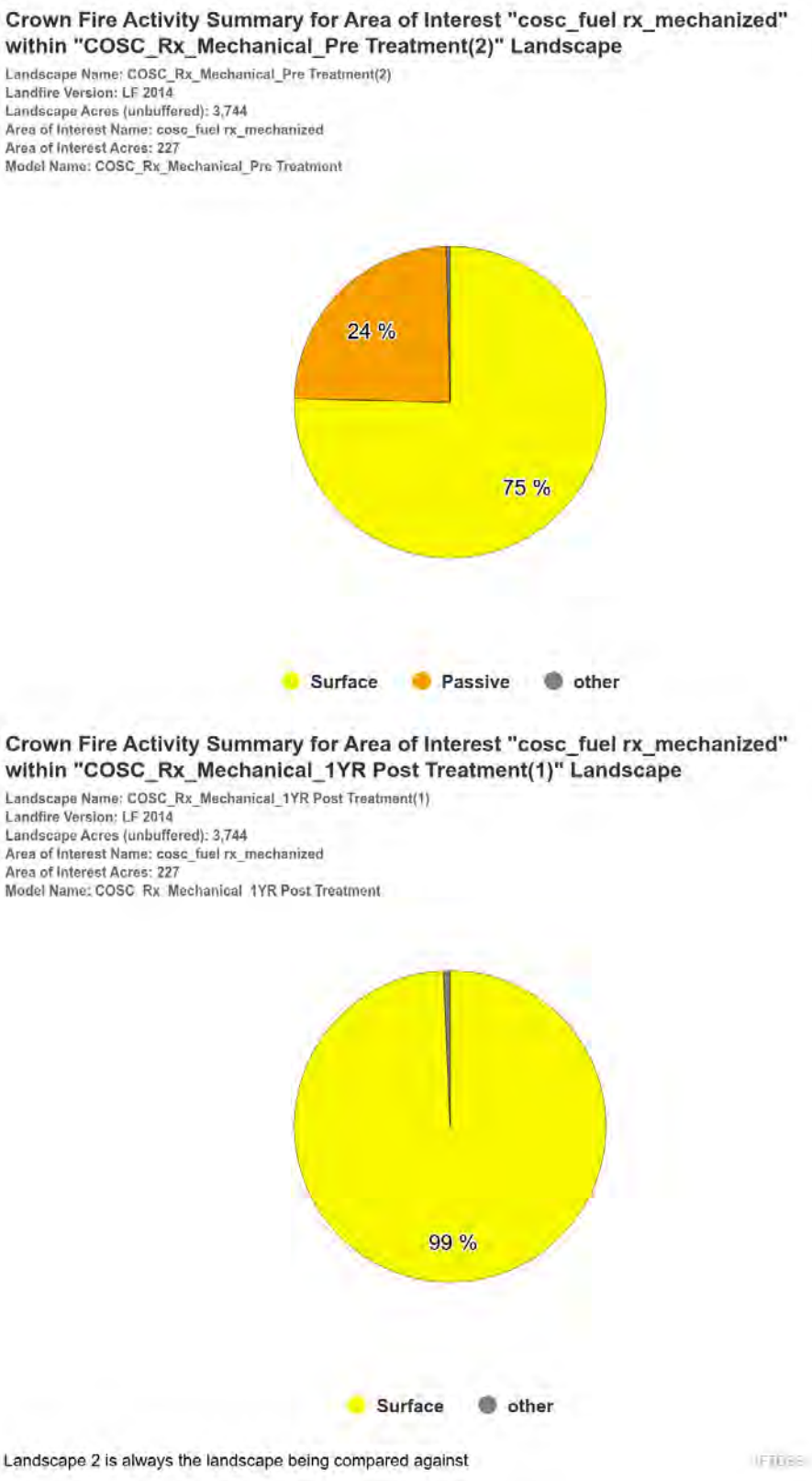


Figure 9 Crown Fire Activity proportional summary comparison (IFTDSS)

Key aspects and considerations from IFTDSS modeling assessments include:

- Flame lengths are expected to be greatly reduced by up to 20 feet in post-treatment forest health stands in RW III forest types as soon as one year following moderate thinning and understory fuel reduction treatment. In the event of a high severity wildfire, reduced flame lengths are likely to lead to lower ignition potential among adjacent vegetation or fuel continuities and avoid high mortality rates among upper diameter trees.
- The rate at which wildfire spreads within the proposed forest health fuels reduction project area following treatments in RW III forest types is expected to be reduced from over 1,300 feet to approximately 130 feet per hour – a spread rate reduction of approximately 90%. Reduced rate of spread allows for more time and more opportunities for fire suppression resources to implement an initial attack in the event of wildland fire, increasing the likelihood of community and municipal resource protection.
- Crown fire activity is expected to be less dynamic following proposed forest health treatments in the Newell Creek Watershed. In the event of a wildland fire, well-spaced and resilient trees and vegetation is expected to promote less active crown fire and maintain conditions where fire is more likely to remain on the surface of the forest floor. Low-intensity, slow moving fire across the floor of a forest stand is easier to manage and it may provide ecological benefits to a system as opposed to high-mortality crown fires resulting as a product of extensive horizontal and vertical fuel continuities.
- An increase in treatment acres beyond the 239-acre FHG mechanized areas and FDR/LTR treatments are expected to expand the beneficial simulated impacts to a greater landscape scale.

Summary

While modeling results only considered treatments on the unique 239 aces identified for this document, connecting those with other proposed treatments such as FDR/LTR will create a broader landscape benefit to with the probable outcome of reduced flame lengths, slower rates of fire spread, and lower occurrence of crown fires throughout both treatment areas. Generally, less severe fire behavior can create increased opportunity for control or less damaging post-fire outcomes in the absence of control.
Projected fire behavior improvements would work toward a more comprehensive approach to watershed protection.

Forest Vegetation Simulator (FVS)

The Forest Vegetation Simulator (FVS)[19] developed by the U.S. Forest Service is a comprehensive and dynamic forest growth and yield modeling tool designed to simulate the growth and development of forest vegetation over time. Its primary objective is to assist forest managers, researchers, and policymakers in making informed decisions regarding forest management and planning. FVS considers a variety of ecological factors, including climate, soil conditions, and management activities, to project how a forest stand will evolve in terms of composition, structure, and growth.

FVS operates on a stand-level basis, meaning it models the characteristics and dynamics of individual forest stands rather than entire landscapes. It incorporates detailed data on tree species, age classes, size classes, and site-specific environmental conditions. The simulation process considers key processes such as tree growth, mortality, regeneration, and response to planned or controlled disturbances such as wildfire or timber harvesting. The model uses this information to project how the forest stand will change over time, often extending several decades into the future.

Applications of FVS

FVS plays a crucial role in supporting sustainable forest management by providing a robust platform for predicting and understanding the complex dynamics of forest ecosystems. Its applications extend to various facets of forestry, from timber production to conservation and climate change adaptation. Key simulations capable of being assessed through FVS include:

- *Forest Management Planning*
- *Climate Change Assessment*
- *Wildfire Risk Assessment*
- *Biodiversity Conservation*
- *Carbon Sequestration Analysis*

Additional information and detailed descriptions of FVS processes and its applications can be found in Appendix B.

[19] https://www.fs.usda.gov/fvs/whatis/index.shtml

FVS Results

The following uses trees per acre (TPA) as a metric to analyze existing stand density trends across the primary forest type observed in the Newell Creek Watershed – Redwood Site III (RW III). Stratifying FTP data into *Forest Type*s, as described in Figure 3 in the *Forest Modeling Evaluation* section above, differentiates stands by their general species composition and allows for comparative analyses against similar ecosystems at regional scales. Stand dynamics observed within the RW III forest type may also be more feasibly extrapolated across the greater extent of the Newell Creek Watershed than those in forest types that occur less often.

FVS Code	Common Name
DF	Douglas-fir
LO	Live Oak
MA	Madrone
RW	Redwood
TO	Tanoak
OH	Other Hardwoods
MP	Monterey Pine
OS	Other Softwoods
CL	CA Laurel
KP	Knob Cone Pine
GC	Chinquapin
DG	Dogwood

Figure 10 FVS vegetation codes

The modeling outputs presented in this evaluation were developed using the U.S. Forest Service's FVS, to simulate current tree volumes, biomass, forest density, and fire effects. Only current stand structural data is examined for this assessment; data displayed does not include any projected stand outputs. Figure 10 outlines the species codes utilized by FVS to analyze data and produce modeling outputs.

Outputs developed for regional State Parks properties (Figures 12 and 13) are introduced in this section to allow for a comparitive assessment between unburned RW III stand densities at Newell Creek and RW III stands within the burn scar of the 2020 CZU Complex Fire – a high severity event analogous to the 97th percentile burn simulation modeled with IFTDSS. Trees surveyed during FTP monitoring were considered dead if the above ground portion of the main stem exhibited cambial death, meaning there was no branch sprouting, bole sprouting, or live leaves or needles. Basal sprouting did not influence live ("LiveTPA"; represented in green) or dead ("MrtTPA"; represented in red) status.

Figure 11 presents a general Live and Dead TPA distribution using all FTP data collected at SCWD in RW III forest types. Paying special attention to the objective shape of the curve, this distribution essentially shows highest TPA densities at lower diameter classes and lowest densities at higher diameter classes. Mortality rates across all diameter classes are generally low in the unburned landscape at Newell Creek, as can be expected. However, consideration of the overall proportional distribution for comparitive purposes is of more importance than the actual aggregate totals shown for each diameter class. TPA averages calculated from the five RW III plots installed at SCWD likely posses a larger standard deviation than those averages taken from 28 RW III plots installed across BBRSP, BSP, and ANSP. In short, fewer dead trees than live trees were observed in all DBH classes at Newell Creek.

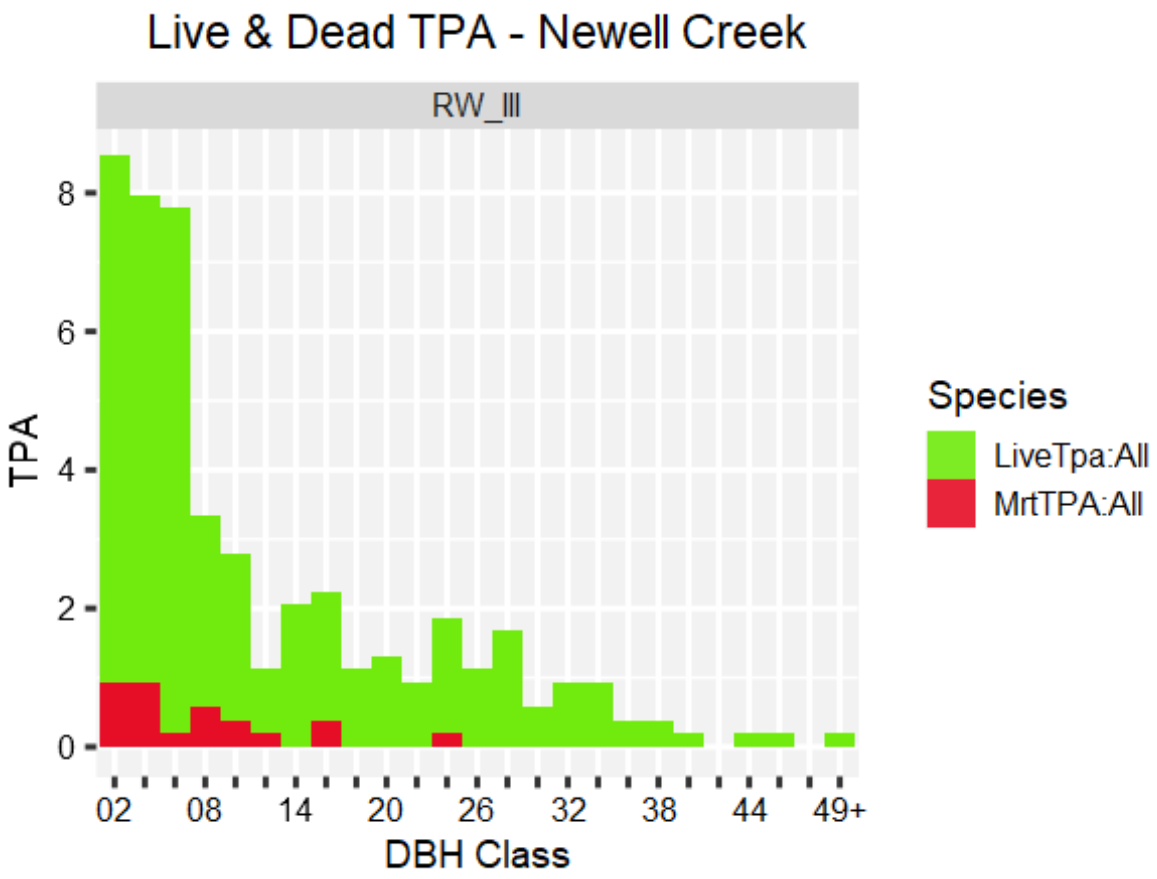
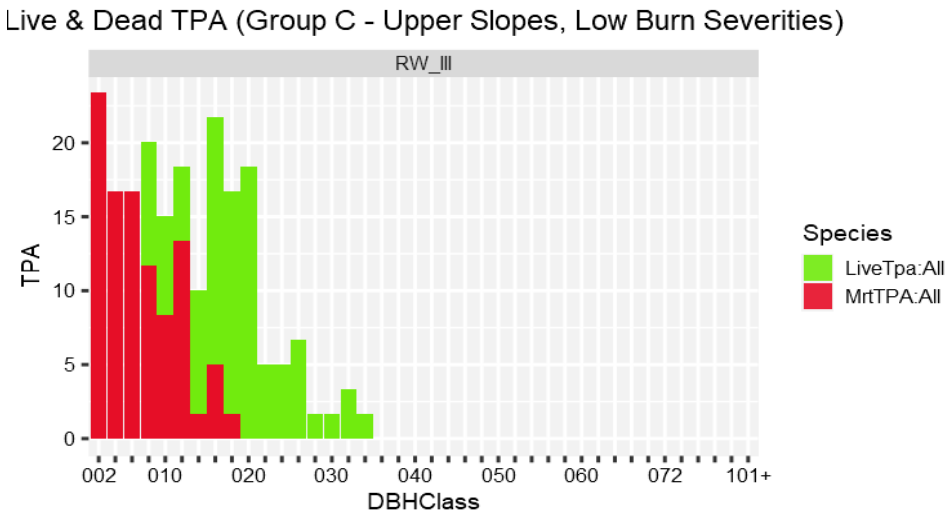
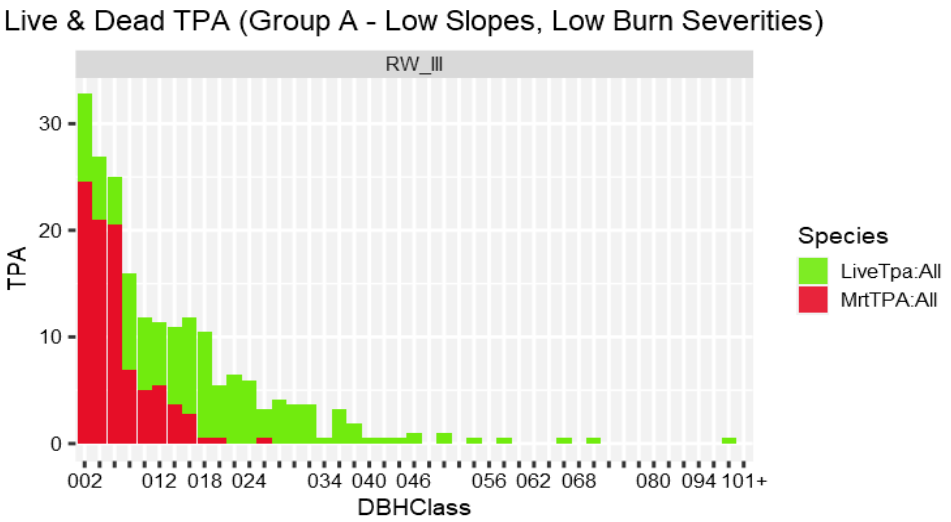
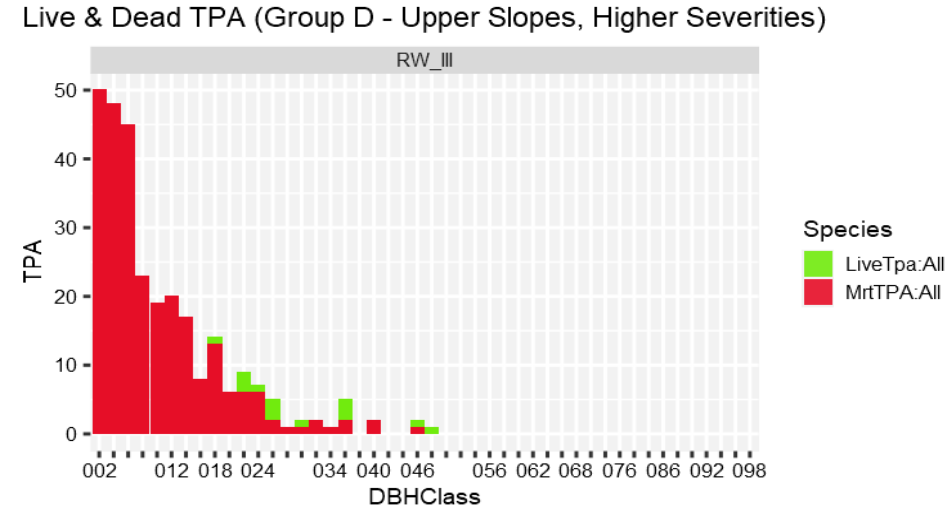


Figure 11 Live and Dead Trees per Acre for all species extrapolated from FTP data collected in the Newell Creek Watershed for RW III Forest Type







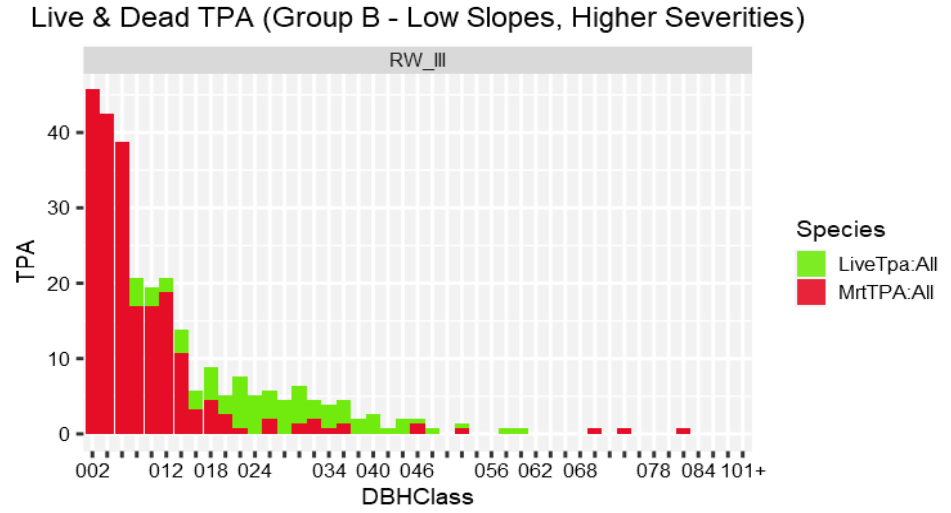


Figure 12 Live and Dead Trees per Acre from data collected in post-CZU Fire RW III stands at BBRSP on Upper Slope positions.

Figure 13 Live and Dead Trees per Acre from data collected in post-CZU Fire RW III stands at BBRSP on Lower Slope positions.

Comparative Impressions and Key Aspects

Figures 12 and 13 allow for meaningful discussion when considering the similarities across distributions developed from burned landscape data taken at State Parks (SP) properties and the RW III distribution produced for SCWD. While State Parks outputs were generated from more intricately stratified datasets – primarily by slope position and burn severity – parallels can be observed when examining, again, the overall distribution of tree densities in these stands.

Across both the Newell Creek plots and SP properties, model outputs suggest that the majority of stand's TPA density in the RW III forest type resides in smaller to mid-diameter ranges. Dense understories, typically represented in the 1-12" and 12-24" DBH classes, experienced high percent mortality at SP properties following the CZU Fire, indicating that concentrations of high understory TPA appear more susceptible to high mortality rates regardless of burn severity. A high TPA of smaller and mid-range diameter trees creates more intense ground fire and connectivity into the overstory canopies, likely contributing to the higher TPA mortality rates across all diameters.

Comparatively, where there are fewer TPA, as seen in the larger diameter classes (greater than 24 inches DBH), there is a lower TPA mortality rate, generally due to larger diameter trees improved resistance to fire, and a probable lack of fuel connectivity in direct proximity to those trees. These trends suggest there are two important correlations to consider; the relationship between less TPA, larger diameter trees, and lower TPA mortality rates; and inversely, the correlation between more TPA, smaller diameter trees, and increased TPA mortality rates.

To summarize key aspects of this investigation:

- Smaller diameter classes in RW III stands possess increased susceptibility to high mortality rates following low- to high-severity wildfire.
- Decreasing fuel connectivity in the understory by reducing high TPA counts among smaller and mid-range diameter trees may, in turn, reduce mortality rates among large diameter trees.
- Promoting the growth and spacing of all trees is expected to increase stand resiliency and long-term forest health.
- Healthy, resilient forests improve ecosystem services and resource protection.

The Treatments being considered under Phase 1 are designed to reduce smaller and mid-range DBH stems in the understory, reduce the density of overstory trees, and reduce overall fuel loading in treated areas.

Permit Framework Consideration

This section is designed to provide some information on potential permitting pathways that may be desired or required to provide regulatory coverage for forest restoration, fuels reduction, fire break or other treatment considerations.

In the context of considering different treatment types.

Forest Density Reduction/Large Tree Restoration (FDR/LTR): These treatments will likely generate revenue and require permitting through the Cal Fire Forest Practice Program. Permit pathways include Timber Harvest Plans (THP's) and Exemptions. THP's are equivalent to an Environmental Impact Report (EIR) for purposes of compliance with the California Environmental Quality Act (CEQA). Frequently other permits are required, many of which are part of the THP process, such as Streambed Alteration Agreements issued by California Department of Fish and Wildlife.

Forest Health/Fuel Reduction (FHFR): These treatments do not always require specific permitting to be implemented but could receive CEQA coverage in a variety of ways.

- Coverage from the California Vegetation Treatment Program (CalVTP) EIR with a Project Specific Analysis (PSA).
- Stand-alone EIR, Mitigated Negative Declaration or Negative Declaration.
- Reviewed and Implemented under a Routine Maintenance Program complying with existing environmental documents, agreements, or MOUs.
- Timber Harvest Plan.

Prescribed Fire (PF): Pile and Burn treatments should comply with local and Cal Fire regulations, and those that may be required by regional Air Quality Management Districts. Burn or Smoke Management Plans may be required. Though not specifically a permit requirement, community outreach and education surrounding PF planning can improve community perceptions and concerns.

Herbivory (H): Although there are many best management practices to be considered, no known permitting is required for implementing herbivory. Herbivory is a covered practice in the CalVTP PSA program. Additional considerations regarding manure and electrified fencing should be considered.

A flowchart demonstrating some permitting examples is included below. (Figure 14)

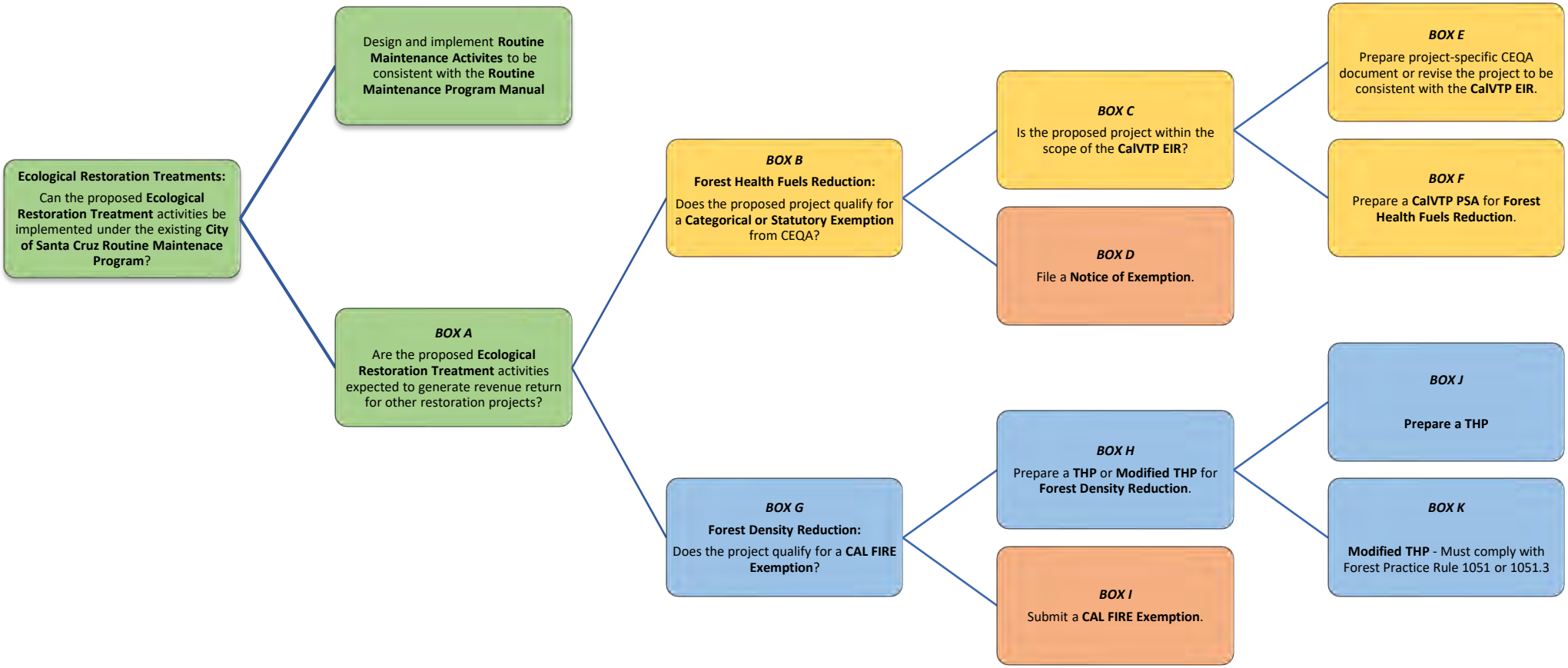


Figure 14 Permit and Project Implementation

Additional Recommendations

As part of the Phase 1 Plan, it was requested that two infrastructure-related items be included in the field analysis and final report. Both address the purposeful addition or upgrading of access needs to achieve watershed goals. Within areas having a history of management, it is frequently necessary to realign, update or relocate previous road and crossing locations to meet current standards, provide new access, or reflect changes in infrastructure needs. As active management proceeds, opportunities to improve, remove or decommission unnecessary infrastructure will be examined.

East Loch Lomond Connection Road

Background

The Phase 1 Project also involves the development of a new road to connect existing roads in the southeast portion of the watershed near the dam, to the Loch Lomond Recreation Area Road systems. This new road would be used for SCWD administrative access to implement restoration, for fire suppression between the watershed lands and the Lompico community, for improved access to the dam and west side areas from the ranger station, and for emergency egress for visitors and for Lompico residents.

SCWD engaged their consulting forester, RPF Steven Butler, to locate a proposed connection road to adjacent private lands which might potentially utilize an existing SCWD easement over those private lands to connect to West Drive. This easement is reportedly documented but has not been used or formalized with the current landowner[20]. It is recommended that this connector road should have the documented right of way location confirmed and staked out by a licensed surveyor well in advance of planned work in this area. Survey work and confirmation of easement should be followed by dialogue with the affected landowner.

It was requested by SCWD that ARC locate and review the road location in the context of feasibility and potential inclusion into other proposed permits for Phase 1. The alignment was flagged by Butler, and easily located. The proposed road alignment is located within part of the East Loch Lomond Density Reduction Unit #2, and is approximately 1,200 feet in length.

East Loch Lomond Connection Road Discussion

Based on field review of the suggested road alignment, it appears to be feasible and could be constructed with conventional forest road construction equipment and techniques.

[20] Personal conversation with Steven M. Butler.

Topography is moderate, with cross-slopes generally less than 40%. A finished road grade of 10-12% can be reasonably expected, and entirely functional for the stated future uses, which have been described as forest management, emergency access, and seasonal administrative access for City staff. The mapped road segment is a representation of the flagged location, and intended as an initial field effort to determine if a connection was possible. The final location would be similarly located, with some adjustments and refining necessary prior to proposing in any permit application.

Permit pathway

Due to the length and construction techniques this road segment would be most appropriate to include as part of a Timber Harvest Plan and could be built during proposed restoration treatments in this location also requiring a Timber Harvest Plan. The final road could be constructed to support a suite of forest restoration projects, fire protection and at a minimum, seasonal administrative access for City staff.

East Side Road Improvements

During our investigation of the East Loch Lomond Forest Restoration Area, we noted several locations where road realignment would be necessary to support restoration treatments, and to improve hydrologic disconnection with watercourses. Many of these are very minor changes on the ridgelines, and one would be more substantive. A cursory field review was conducted to generally determine realignment potential at a lower road segment which as currently located collects water for several hundred feet and is difficult to drain effectively. A revised alignment would involve road construction, similar to the Loch Lomond East Connection Road, and is more involved than other minor improvements in this area. As this road network becomes more functional for management and access, SCWD may wish to consider realigning this segment as a long-term improvement.

Newell Creek Crossing at the Nelson parcel

Background

The Phase 1 Project also involves the development of a new crossing over Newell Creek, located on the Nelson parcel. This crossing would re-establish a usable connection between Newell Creek Road below the dam, to the “Nelson Truck Trail” and ultimately connecting Vineland Road. Access would provide fire and management access to southwestern portions of watershed lands that are currently difficult to access.

It was requested that ARC review the crossing location and provide input on feasibility and crossing options in the context of cost feasibility and potential inclusion into other proposed permits for Phase 1. The identified crossing location was reviewed on the initial bid tour and subsequently to further assess site specific details.

Nelson Parcel Crossing Discussion

The proposed crossing location is on the Nelson parcel, below the old residence, at the southern edge of an alluvial flat that appears to have been an orchard or similar use. An existing road was noted approaching the creek crossing from the north and exiting to the south. No structure such as a bridge or culvert currently exists at this location, but a low water crossing has been utilized to allow emergency equipment to cross and is generally useable in this capacity. A more functional crossing is desired.

The northern approach to the crossing is an old road grade, not usable without reconstruction to align with the crossing in its final form. It parallels Newell Creek for approximately 150 feet, generally within 75 feet or closer to the active channel. The creek channel is 30 feet wide, and the crossing is at a slight angle to the creek creating a 45-foot width of channel to be crossed.

The crossing is an estimated 1,800 feet downstream of the dam, with about 100 acres of drainage area above. The metering effect of the dam generally moderates flow, but when dam overflow is spilling, reported flows exceed 1000 cubic feet per second (CFS). Crossing design would need to accommodate this capacity, or be removed entirely, then re-installed when needed.

Option 1- Preferred

Installation of a permanent bridge is the recommended preferred option for this location. This option could be in the form of a modular bridge, possibly prefabricated, or fabricated on site, or a suitable railcar which has been prepared as a bridge. In either form, a steel bridge with steel decking would provide a crossing with a long service life, little to no maintenance and a very low impact to instream resources. These designs can easily support forest management projects and emergency fire equipment. The initial cost is higher than alternatives but may have a lower amortized cost over its lifetime. Estimated materials cost $100,000-125,000 for a 65 to 72-foot span bridge, with negligible anticipated maintenance costs beyond inspections by watershed staff. This configuration could be placed on pre-formed block abutments, or more formal concrete foundations. The use of this type of crossing in Timber Harvest Plans is common,

Newell Creek Crossing

with frequent approval from the California Department of Fish and Wildlife particularly in fish bearing reaches.

Option 2

Installation of a temporary vented low-water ford style crossing. This style of crossing is considered temporary and would be installed when needed and removed prior to winter period flows of that year. A vented ford involves placing pipes or arches in the creek bed and covering them with rock to form a running surface. Water may pass freely through the conveyances, and washed rock used for the base layers of the crossing while vehicles and equipment avoid contact with the flowing water by traveling on rock layers applied over the top. This style of crossing has modest impacts to the crossing location, contained to the footprint of the crossing location. There is very low ongoing interference with overall stream function but will require installation and removal for each season of use. Due to the contact with the stream system, a biological monitor may be needed for use in some situations. Wintertime streamflow will preclude access for parts of the year. Estimated initial cost $5,000-$10,000. Ongoing maintenance cost is negligible, but installation costs would be reoccurring. The use of this type of crossing in Timber Harvest Plans has been very low, in part due to difficulty in gaining approval from the California Department of Fish and Wildlife particularly in fish bearing reaches.

Permitting pathway

Both crossing styles could be proposed in a Timber Harvest Plan and would be subject to the multi-agency review that is conducted as part of that process. Envisioned designs are consistent with those potentially utilized for small private landowners, and not in consideration of public use and requisite design specifications for such use. Additional cost analysis should include crossing approach construction, treatment such as rock for the roads surfaces that approach the crossing within the Watercourse and Lake Protection Zones (WLPZ), and gating to control access.

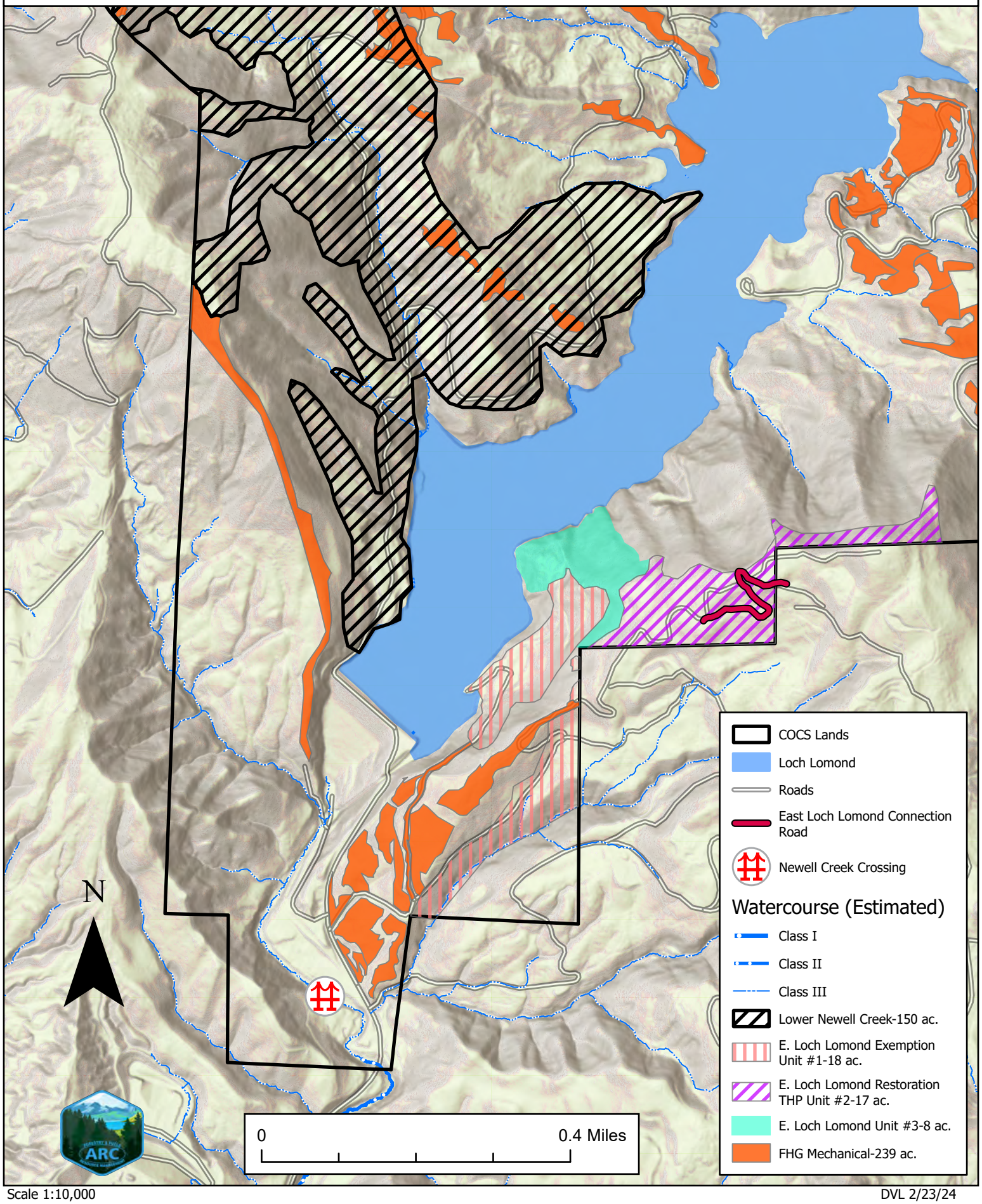
Watershed Account

ARC is currently involved with several large state and municipal landowners in the region who have made similar conclusions about forest health and fire prevention to those made by the City of Santa Cruz Water Department. As the City moves toward the next step for the Newell Creek Tract, maintenance of a dedicated account to hold revenue received from the commercial removal of trees during restoration projects will be important. If timber is to be sold for commercial purposes from the various restoration treatments proposed in this plan, revenue generated from the commercial sale of timber would be placed into this account - whose sole purpose will be funding future Water Department restoration projects. These projects may include fuel management, infrastructure, or other forest health – related actions on the City's watershed lands, in addition to projects that support broader watershed restoration goals.

Notably, these funds can support watershed restoration grant applications and thereby provide match funding which will increase grant proposal ranking, greatly expanding the impact of this revenue. Providing a consistent revenue stream will ultimately aid future restoration project planning and implementation. This account will not be utilized for recreation operations or otherwise used to support Water Department operational expenses.

Newell Creek Watershed Stewardship Recommendations

Proposed Road and Crossing Locations



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Summary of Recommended Actions

Santa Cruz Watershed Lands Forest Management Project – Newell Creek Tract Phase 1 Plan highlighted two primary project goals to begin the implementation of the Integrated Production & Restoration Option approved by the Water Commission.

- *The commercial timber harvest component will consist of a single-tree selection harvest on the west side of Loch Lomond Reservoir with a management approach similar to those practiced prior to 2000 in keeping with the SCWD's primary goal of protecting and improving water source, quality and storage.*

- *The Phase I Project will also include a forest restoration component within an approximately 100-acre area on the east side of the Loch Lomond Reservoir. This is part of the future East Loch Lomond Conservation Reserve, an approximately 900-acre area that will be managed for the goals of protecting water quality, restoring late seral forest habitat and its ecological and aesthetic attributes, and increasing resilience to climate change, including reducing the threat of catastrophic wildfire.*

For consideration, the Prioritized Recommended Actions section of this document outlined two commercially viable Forest Density Reduction/Large Tree Restoration units, four individual treatments to initiate restoration of Old Growth Forest characteristics, and numerous Fuels Reduction/Fire Protection treatment areas throughout the Newell Creek Tract. These treatments embody the two principal strategies for forest management contained in the Integrated Production & Restoration option: a commercial timber harvest component, and a forest restoration component.

Commercial Forest Density Reduction/Large Tree Restoration (FDR/LTR)

Two distinct treatment units have been discussed in the body of this document, each with merits elevating them to a priority status. Each treatment unit as proposed would require a CAL FIRE approved Timber harvest Plan to implement and would generate positive net revenue. It is the intention of this document to have one treatment area identified as a priority for treatment.

1. Lower Newell Creek Unit 150 acres.
2. Bear Creek Divide Unit 138 acres.

Single-tree selection would be utilized as the silvicultural prescription to achieve FDR/LTR goals of reduced stand density, fuel connectivity, and competition for resources. This action will further increase the health and vigor of the residual stand through the removal of selected second growth redwoods, promoting the development of larger diameter forest stands, fostering the opportunity for more open forest stand characteristics, while increasing resilience, biological diversity, and reducing the severity of future wildfire. Each

distinct unit has incorporated Forest Health Fuels Reduction (FHFR) treatments, with additional areas adjacent that can be easily included in a proposed plan.

East Loch Lomond Forest Restoration Area

To achieve Phase 1 Old Growth Restoration goals for this portion of the watershed, a prescription was desired to reduce competition among redwoods, and promote the growth of selected healthier conifers. In areas where hardwoods have displaced conifers, the hardwoods will be thinned or removed in patches and replanted with conifers. Understanding the temporal nature of restoration, a second and possibly third entry spaced at 15–25-year intervals should be anticipated. Treatments applied over several decades can be expected to direct recovery of this area towards the character and ecological function of a pre-disturbance forest.

Four distinct treatment units totaling approximately 55 acres have been discussed in the body of this document, each with unique components and prescription designed to initiate recovery of this area. Unit #1 treatment could be conducted using a ministerial CAL FIRE Forest Fire Prevention Exemption, Unit #2 would require a CAL FIRE approved Timber Harvest Plan to implement, with the remaining Units #3 and #4 not requiring a specific permit to conduct treatments. It is the intention of this document to have at least one treatment area identified as a priority for treatment, however other treatments could be done concurrently or in quick succession.

- East Loch Lomond Exemption Unit #1 – 18 acres
  - Forest Fire Prevention Exemption permit.
  - No expected net revenue.
- East Loch Lomond Density Reduction Unit #2 – 17 acres
  - Included in larger Timber Harvest Plan permit.
  - Expected modest net revenue.
- East Loch Lomond Forest Health Unit #3– 8 acres
  - No permit needed.
  - Expected treatment cost $16,000-$20,000.
- East Loch Lomond Forest Health Unit #4– 12 acres
  - No permit needed.
  - Expected treatment cost $36,000-$48,000.

Public Outreach and Project Messaging

As SCWD considers the next steps for the Newell Creek Tract Phase 1 Plan, it is important to mention the value of public outreach and project messaging. Early communication of goals, and the necessity and rationale for projects will help foster majority support from constituents. ARC is committed to working with SCWD and the City Council to deliver information contained in this report as they consider changes to the City policy regarding

forest stewardship, and to develop public information for a forest stewardship website and series of public meetings to disclose and discuss prioritized actions taken following review of this document.

Policy Updates

Policies regarding the harvesting of trees on City owned watershed lands are being reviewed for contemporary relevance in the light of establishing more fire resilient and climatically adaptable forests.

Two specific policies could benefit from clarification and updating to facilitate the goals set forth by SCWD to establish more resilient forest structures on the City controlled lands.

1. Old Growth Definition under current City of Santa Cruz policy - "*Old Growth Tree" means a tree which is at least 40 inches in diameter at breast height and/or is over 200 years old.*

This policy has been applied to restrict cutting of trees exceeding 40" in diameter on SCDW managed lands, regardless of age or habitat value or function. Older trees typically exhibit structure and physical properties independent of a specific size and can be identified and retained based on their function in the ecosystem. Retention of these important components of the forest can be accomplished with a definition focusing on physical characteristics versus size.
Conversely, there is an abundance of trees exceeding 40" in diameter that do not possess any unique structural features and may be removed to achieve improved spacing and resiliency. For example, redwoods are a coppice sprouting species and frequently grow in tight clumps. Where trees in these groups exceed 40" in diameter, no opportunity for improved spacing would exist. Increased spacing between trees would be expected to increase growth rates of retained trees, reduce competition, and increase resilience to fire and ecological shifts.
Removal of some number of trees over 40" in diameter will be necessary to accomplish goals identified by SCWD.

2. The City of Santa Cruz policy regarding Commercial Harvesting - "*Continue to refrain from timber harvesting for commercial purposes, as it is inconsistent with the primary goal of maintenance of water quality. This is not intended to preclude the cutting of trees for the purposes of restoration, wildlife enhancement or ecosystem management opportunities"*.

As the SCWD re-evaluates contemporary watershed needs considering climatic and probable fire scenarios, the removal of trees for restorative treatments will be necessary and fiscally prudent. Currently, watershed forest conditions exist where trees can and should be removed to forward SCWD watershed goals and can generate revenue to fund future restoration treatments. Tree removals as proposed are considered commercial in

nature, and will require specific permits to be prepared, submitted, and approved by CAL FIRE before work may commence. CAL FIRE and the California Forest Practices Act define commercial in the following way: "Commercial Purposes" includes (A) the cutting or removal of trees that are processed into logs, lumber, or other wood products and offered for sale, barter, exchange, or trade…",[21].
Treatments discussed and recommended in the document will be considered "commercial" pursuant to the California Forest Practices Act, conflicting with the current City policy.
To accomplish the Phase 1 Goals of restoration and watershed protection, some clarification to the policy is needed to allow generated revenue to be utilized for the benefit of SCWD watershed lands. Updating this policy could clarify the intent that generated revenue would be directed to projects which benefit watershed lands.

Recommended Initial Actions

Update City Policies defining Old Growth Trees and Commercial Harvesting.

- Updating of the Old Growth will define important ecological characteristics to be retained within SCWD watershed lands.
- Updating and clarifications on intended commercialization of trees and direction of revenues to fund recommended treatments which benefit SCWD watershed lands.

Approve a Restoration Project on the East Side Loch Lomond.

The East Loch Lomond Exemption Unit (#1) would be an excellent pilot project, which is easily accessible for community outreach and has a short permitting timeline allowing restorative work to begin on Newell Creek quickly.

- East Loch Lomond Exemption Unit (#1) – 18 acres, using a Cal Fire Forest Fire Prevention Exemption.
- Permit could be approved and ready to operate by late summer 2024.
- Anticipated cost for approved permit, including field preparation $40,000-$60,000.
- Gross project revenue estimated to be $30,000-$40,000. Project expected to be revenue negative.

Approve one commercially viable Forest Density Reduction/Large Tree Restoration unit.

- Timber Harvest Permit will be necessary for either selected area, potentially a permit could be completed by Summer of 2025.

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[21] 2024 Z'berg-Nejedly Forest Practice Act, Division 4, Chapter 8, Public Resources Code 4527. "Commercial Purposes".

- Anticipated cost for approved permit, including field preparation $75,000-$100,000.
- Potential gross revenue based on current markets and pricing, $380,000-$600,000. Individual units have different expected volumes, accounting for the wide range in outcomes.

ARC is committed to working with SCWD and the City Council to provide support for information contained in this report to help inform updates to City ordinances or policies as they may relate to forest stewardship.

Conclusion

The Newell Creek watershed lands ("Newell Creek Tract") surround Loch Lomond Reservoir and are of critical importance to the City's water supply quality and reliability. Fire resiliency of the forest and protection of reservoir capacity and water quality are of fundamental importance for SCWD and its water customers, and in the wake of the CZU Lightning Complex Fire, the need for increased focus on fire resiliency was recognized.

From the report Opportunities and Constraints Evaluation of Forest Management Options, the "Integrated Production & Restoration Option" was selected to guide the direction of SCWD lands. The outgrowth of that approved management option is the Santa Cruz Watershed Lands Forest Management Project – Newell Creek Tract Phase 1 Plan, which this report has been compiled specifically to support and further, with specific locations prescriptions and details for next steps.

A key understanding in the process being undertaken by SCWD is the expected negative impacts of wildfire in the Newell Creek Watershed. Below are some of the Key Findings from a document generated in 2023 by ARC, titled "*Prioritized Recommended Actions & Key Findings Following the CZU Lightning Complex Fire, Big Basin, Año Nuevo, and Butano State Parks" that can help inform management decisions for the watershed lands.*

Data collected and compiled in this report provided a once in a lifetime snapshot of post-fire conditions across the Big Basin Redwood State Park (BBRSP), Butano State Park (BSP), and Ano Nuevo State Parks properties within various forest types following the CZU Fire that caused "severe fire damage"[22] and burned approximately 24,230 acres total in the three parks. 264 Forest Trend Plots captured forests conditions that will continue to evolve as the forest stands proceed through the various stages of post-fire succession. The dataset holds a high value for monitoring trends in similar forest types across the CZU Fire footprint that may have great applicability to pre-fire stands in similar conditions in the Santa Cruz Mountains. Below are some key points that relate to SCWD watershed lands and Phase 1 goals.

Mortality Trends

- Fewer trees per acre (TPA) and larger diameter trees indicate increased tree resilience to wildfire.
- High TPA in smaller diameter trees (less than or equal to 12-inches) indicate increased susceptibility to tree mortality, including tree mortality in a component of larger diameter trees.

[22] "State of Redwoods Conservation Report – A Tale of Two Forests" Save the Redwoods League. 2018. https://www.savetheredwoods.org/wp-content/uploads/State-of-Redwoods-Conservation-Report-Final-web.pdf

- Higher severity burns experience increased tree mortality across all forest types and all diameters. These areas, among other burn severities, include a significant regenerative basal sprouting response from coastal coppice sprouting species.

Fire Patterns

- Comparing this study with similar fire-dating studies in the Santa Cruz Mountains suggests that there may have been a large-scale high severity fire between the 1670's and 1680's that has since been followed by a mosaic pattern of smaller-scale fires up until the CZU Fire in 2020 *(Kranich, Auten, and Van Lennep, 2023)*.

Future Forest Stewardship

The mortality trends, evidence of fire patterns, and expectation of more frequent wildfire occurring in the Santa Cruz Mountains provide a rationale for more actively managing these forests in the future and protecting reservoir supplies and water quality, additionally supported by forest trend monitoring data from the California State Parks Recommendations Document *(Kranich, Auten, and Van Lennep, 2023)* following the CZU fire adding the following guidance:

- To achieve increased stand resilience to wildfire, the post-fire mortality data from this report suggests that treatments need to be implemented that promote the growth of larger diameter trees, reduce the stand density, and reduce the connectivity of ladder fuels into overstory canopies.

- Professional observations and collected data indicate that the lack of frequent low severity fires and disturbance regimes resulted in a high accumulation of ground fuels, duff, and ladder fuels. This includes the encroachment of Douglas-fir in the understory, which carry fire into the canopies of many trees, influencing fire behavior and increasing stand susceptibility fire damage and mortality in **all forest types across all diameters**, including redwood dominated forests and the loss of valued old growth trees and marbled murrelet habitat.

- In areas of high mortality, the rapid growth of regenerative sprouts, *Ceanothus spp.* and other shrubs, paired with the inevitable accumulation of downed dead-standing trees exacerbates the risk of extreme fire conditions and is seemingly setting the stage to burn again in the near future. Subjecting forest stands to repeated high severity fires will cause the stands to convert to different vegetation types over time. Without proactive forest restoration treatments, upcoming extreme fire behavior paired with changing climate will be a threat to old growth forests.

The implementation of forest management treatments should consider that forest restoration is a long-term process that requires dedication to a focused and strategic effort – it took over 100 years for this forest system to develop its existing impairments and it will

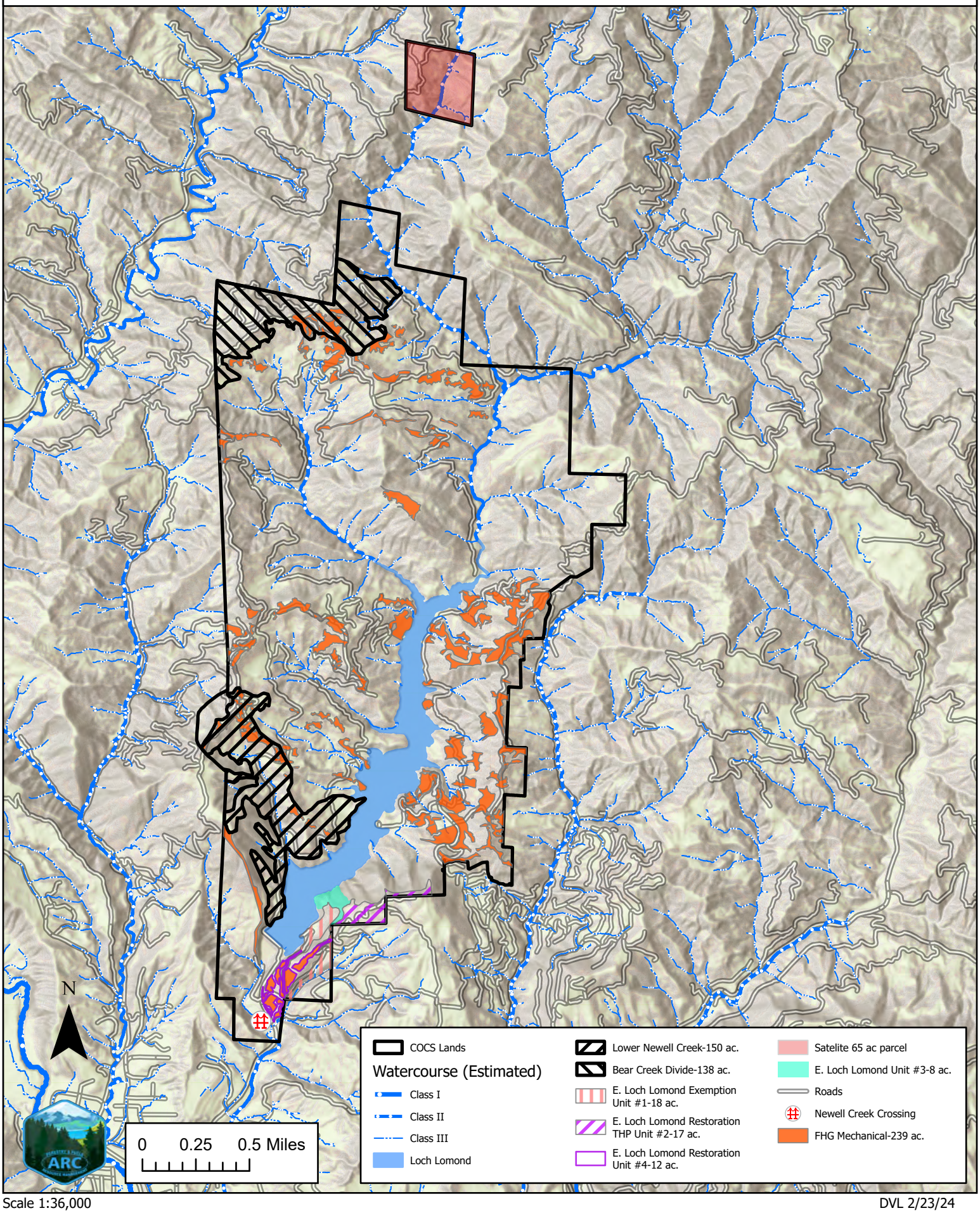
likely take this amount of time, or more, to restore the ecosystem's optimum function and health.

We appreciate the opportunity to provide the City of Santa Cruz Water Department with this assessment and recommended actions for Phase 1 and would be pleased to stay engaged in the stewardship of this important watershed.

Appendix A – Maps

Newell Creek Watershed Stewardship Recommendations

Project Overview



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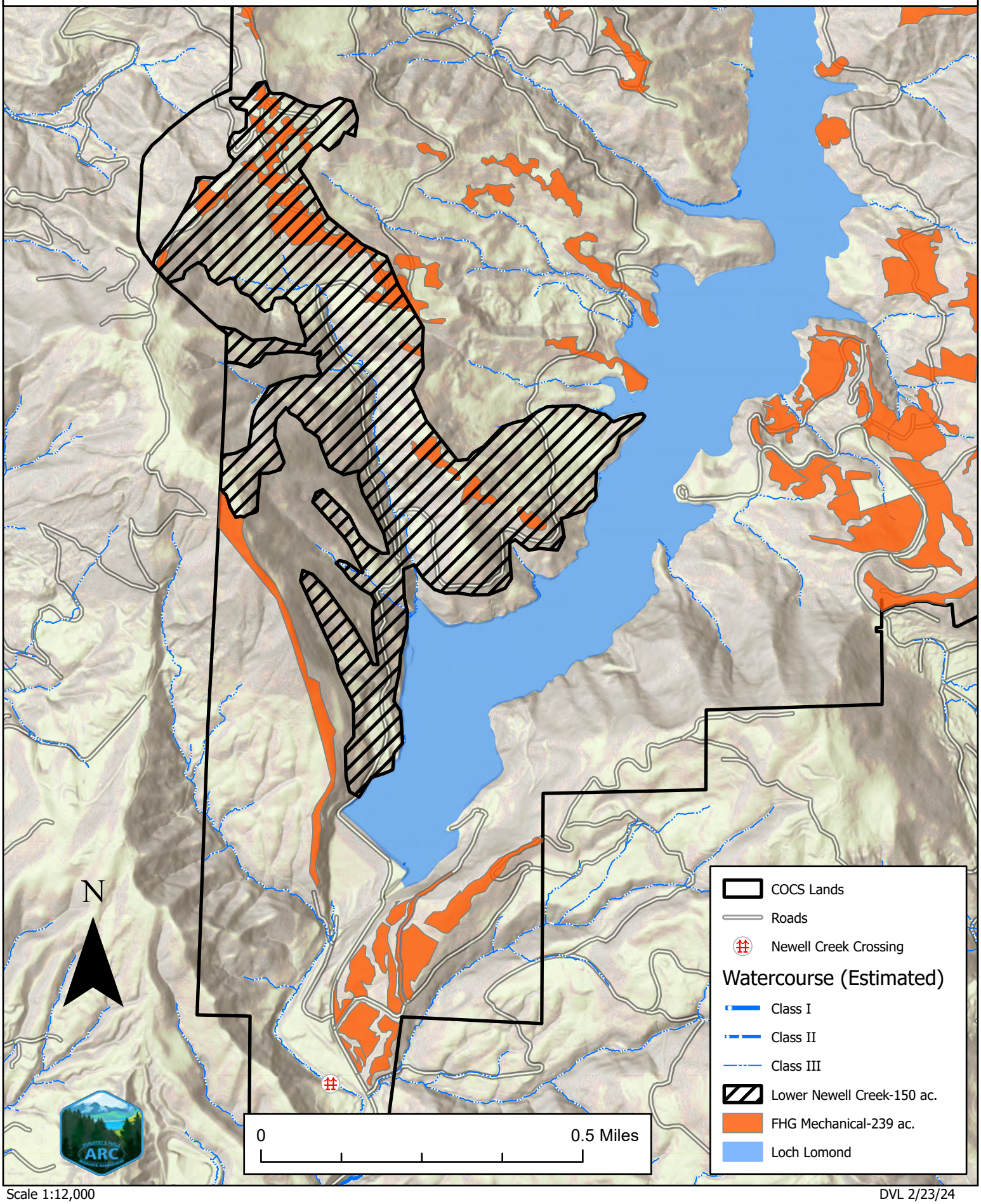
Newell Creek Watershed Stewardship Recommendations

Lower Newell Creek Unit



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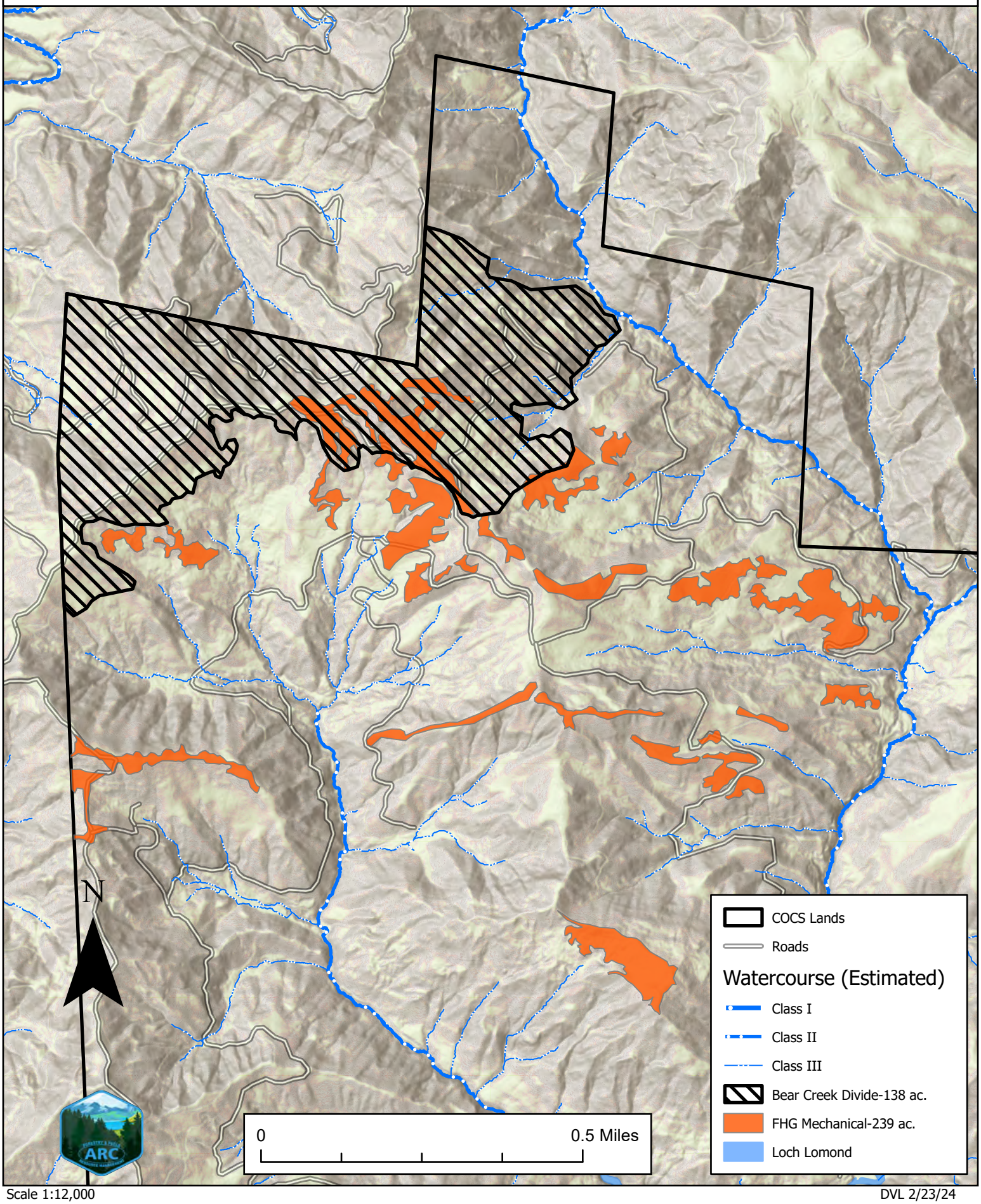
Newell Creek Watershed Stewardship Recommendations

Bear Creek Divide Unit



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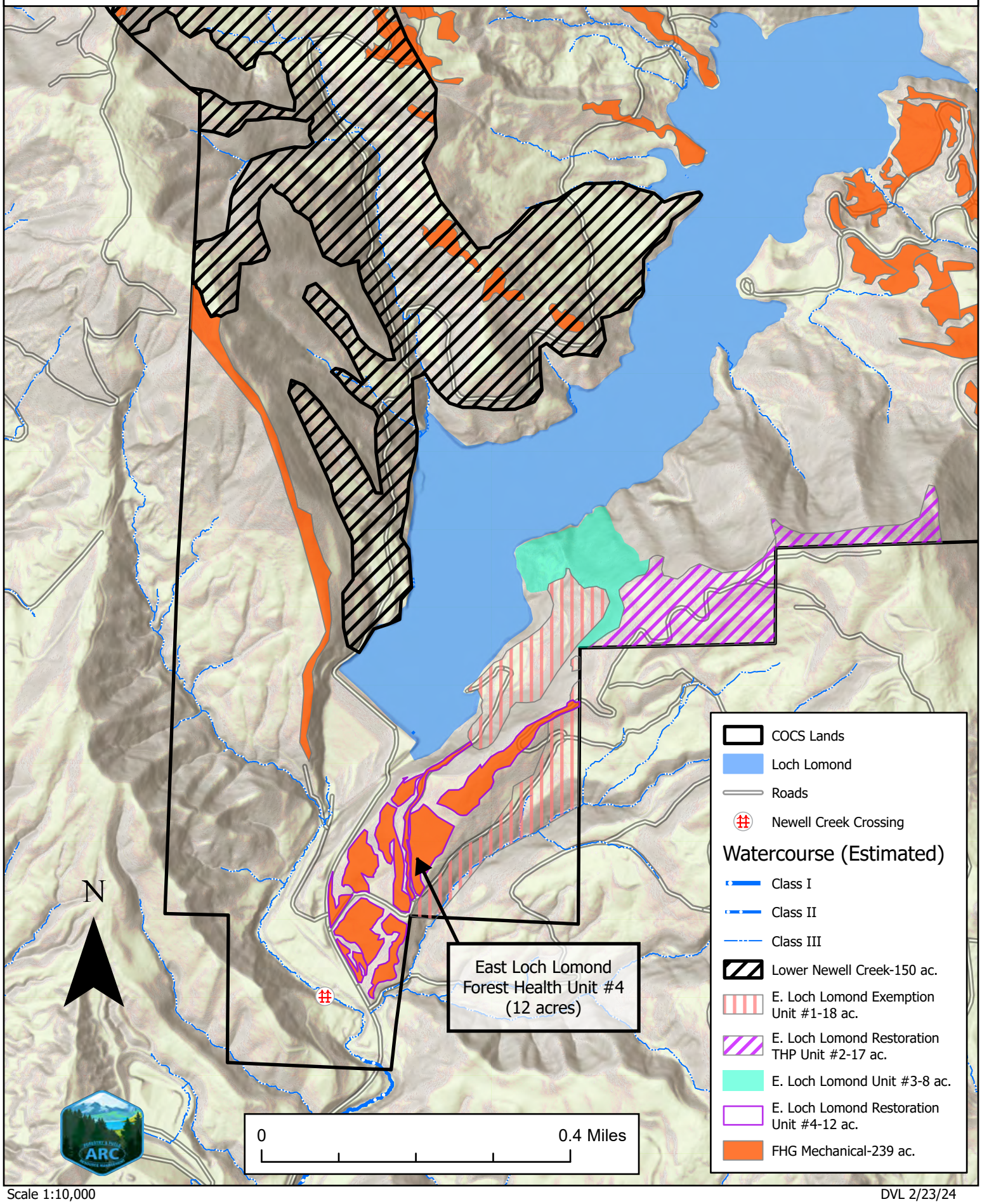
Newell Creek Watershed Stewardship Recommendations

East Loch Lomond Restoration Area



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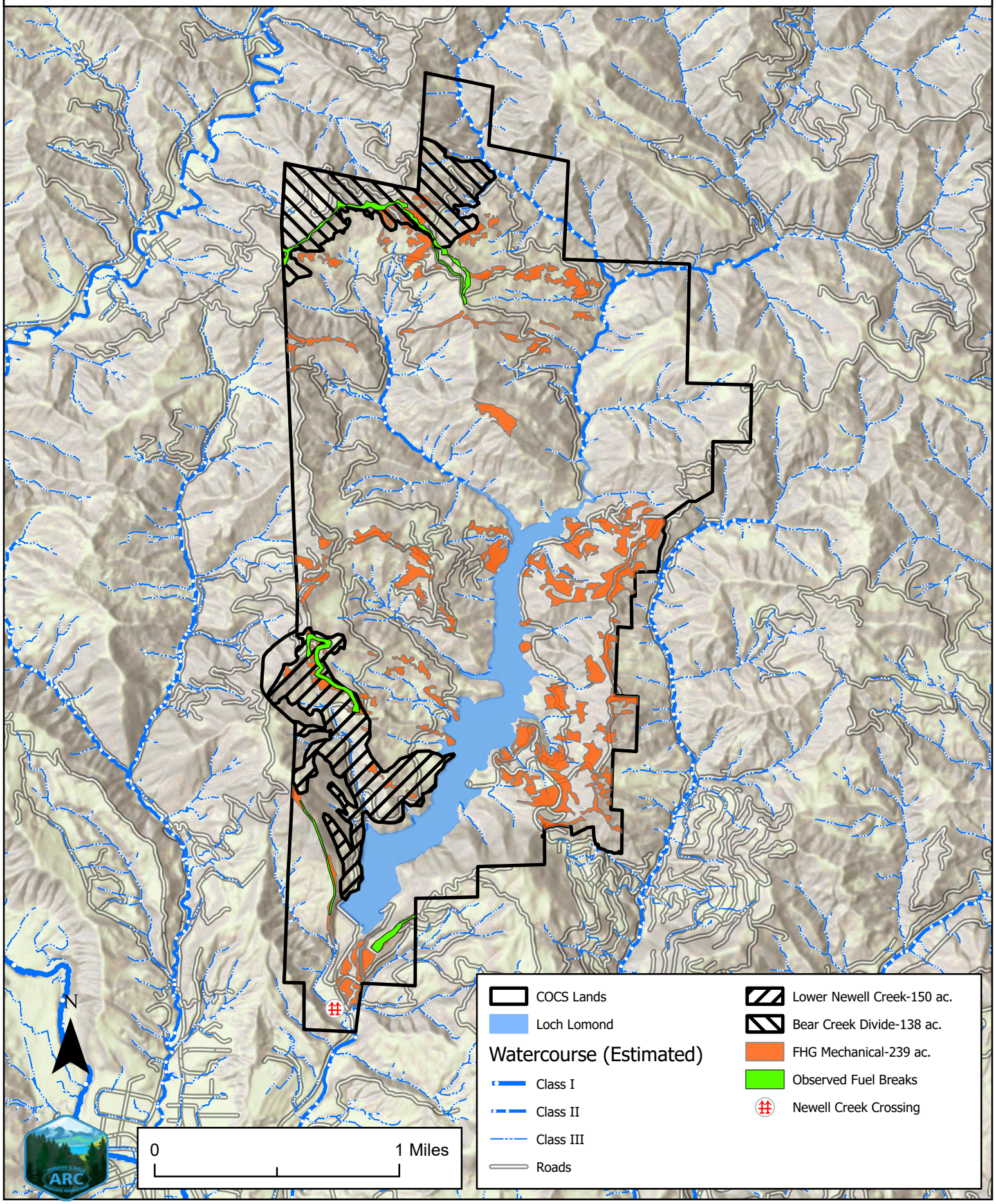
Newell Creek Watershed Stewardship Recommendations

Forest Health Fuels Reduction and Adjacent Fuel Breaks



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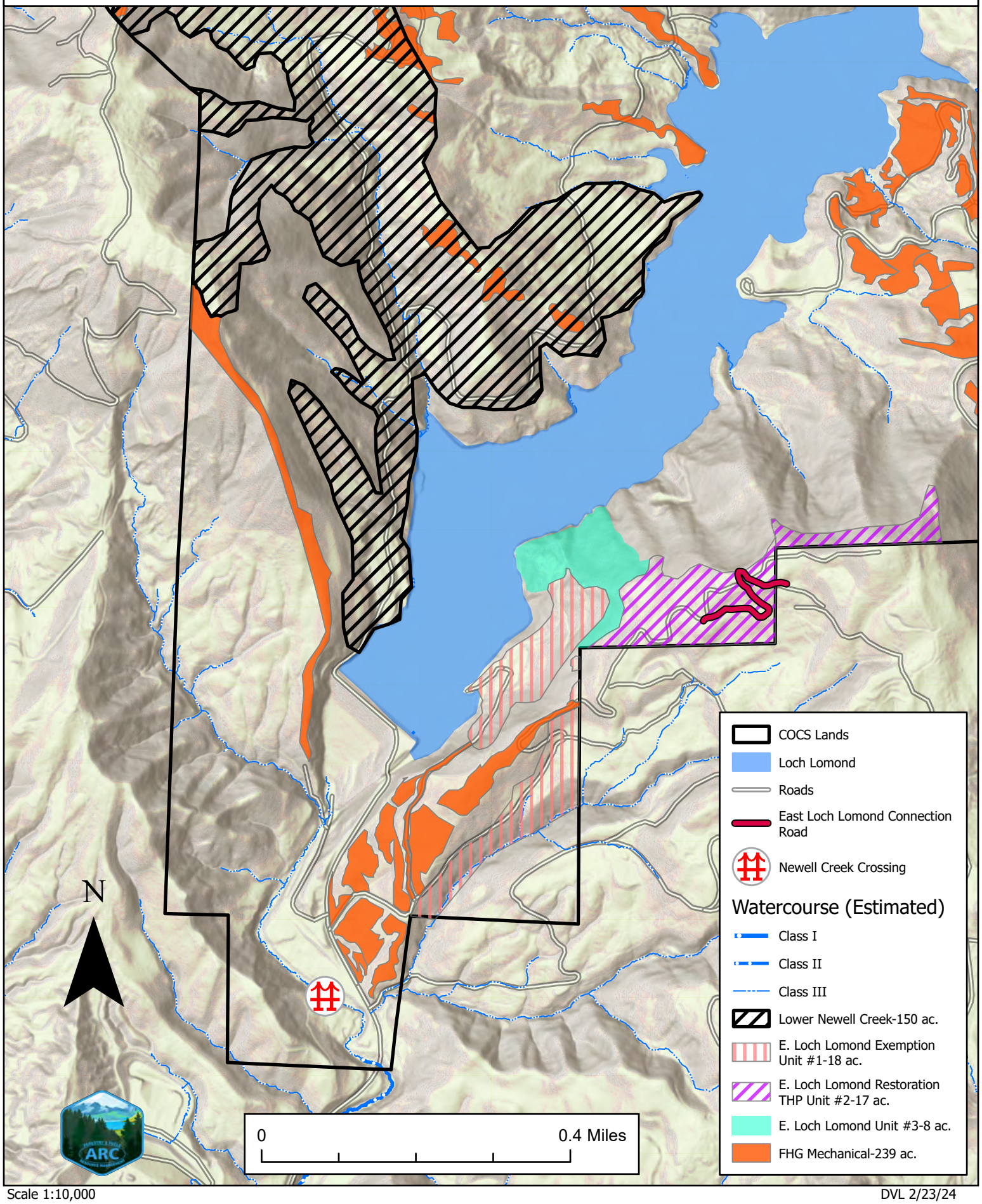
Newell Creek Watershed Stewardship Recommendations

Proposed Road and Crossing Locations



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Appendix B – Attachments

Table 1-Schedule of Estimated Treatment Costs and Values

Schedule of Estimated Treatment Costs Phase

Below are some expected costs for Forest Health and Restoration Treatment similar to those being considered for Newell Creek- Phase 1. These costs are derived from actual projects that have occurred locally in similar vegetation types and terrain. The range of cost per acre is due to the individual project specifications, complexity and specific equipment or crews that would be engaged to conduct the work. This is intended to provide a general scale of potential value and expenditure of projects under consideration and are based on 2022-2023 projects in the region.

Expressed timber values were provided from timber sales late in 2023, and do not necessarily represent future values. Net log values are the return per MBF to the landowner that might be expected, less all costs and defect.

- Mechanical (mastication) $2,300 -5,000 / ac.
- Hand work (lop and scatter) $1,500 -2,000 / ac.
- Hand work (cut understory and chip) $7,500 -10,000 / ac.
- Pile and burn $2,300 -5,000 / ac.
- Excavator (forestry capable) and large track chipper 18” capacity - $7,500 -9,000 / ac.
- Net values for redwood $500/ MBF.
- Net values for Douglas-fir $50/MBF.
- Logging costs 300-350/ MBF. (not including log transportation)

IFTDSS Additional Descriptions of Assessment Tools

Spatial Data Integration: IFTDSS incorporates a wide range of spatial data, including vegetation types, fuel models, terrain characteristics, and wildfire history.

Modeling Capabilities: The system employs sophisticated fire behavior and effects models to simulate the potential impact of wildfires under different scenarios.

Alternative Treatment Scenario Analysis: IFTDSS allows users to explore different treatment scenarios and assess their potential outcomes. This scenario-based approach enables land managers to compare the effectiveness and cost-effectiveness of various fuel treatment options, considering factors such as treatment type, intensity, and spatial distribution.

Decision Support Tools: IFTDSS provides decision support tools that aid in the development of fuel treatment plans. These tools assist users in setting objectives, defining treatment units, and selecting appropriate treatments based on ecological, economic, and social considerations.

Wildfire Risk Reduction: IFTDSS plays a crucial role in developing strategies to mitigate the impact of wildfires on ecosystems and communities. By identifying high-risk areas and simulating the effects of different fuel treatments, land managers can strategically plan and implement actions to reduce the likelihood and severity of wildfires.

Ecosystem Restoration: Beyond wildfire risk reduction, IFTDSS supports ecosystem restoration efforts by helping land managers design fuel treatments that align with broader ecological goals. This includes promoting the health of native vegetation, reducing invasive species, and enhancing overall ecosystem resilience.

Resource Allocation: The system assists in optimizing resource allocation by providing data-driven insights into the potential outcomes of different fuel treatment scenarios. This helps agencies prioritize areas for treatment, allocate budgets efficiently, and maximize the overall impact of fuel management efforts.

Define Study Area: Select the geographic area of interest where vegetation treatment is being considered.

Identify key factors such as topography, vegetation types, and current fuel conditions within the study area.

Spatial Data Input: Input relevant spatial data into IFTDSS, including vegetation types, fuel models, terrain characteristics, and existing infrastructure.

Ensure the accuracy of the input data, as it forms the foundation for subsequent modeling and analysis.

Fire Behavior Modeling: Utilize IFTDSS's fire behavior models to simulate wildfire scenarios under both treatment and no-treatment conditions.

Consider factors such as weather conditions, fuel moisture, and topography to generate realistic fire behavior predictions.

Treatment Scenarios: Design and input scenarios that represent different vegetation treatment options. This may include prescribed burns, mechanical treatments, or a combination of methods.

Specify treatment parameters, such as treatment intensity, timing, and spatial distribution.

No-Treatment Scenario: Create a scenario where no vegetation treatment is applied. This serves as a baseline for comparison and helps assess the natural fire behavior and risk in the absence of active management.

Simulate Fire Behavior: Run simulations for both treatment and no-treatment scenarios using IFTDSS's modeling capabilities.

Analyze the simulated fire behavior outputs, including fire intensity, rate of spread, and potential fire effects under each scenario.

Compare Results: Use the decision support tools in IFTDSS to compare the outcomes of the treatment and no-treatment scenarios.

Evaluate the effectiveness of vegetation treatment in reducing fire risk, protecting critical assets, and achieving ecological objectives.

Cost-Benefit Analysis: Consider economic factors by assessing the costs associated with implementing vegetation treatments and compare them with the potential benefits in terms of reduced fire suppression costs and resource protection.

Refine Strategies: Based on the comparative analysis, refine vegetation treatment strategies to optimize effectiveness and cost-efficiency.

Iteratively adjust parameters and scenarios to explore trade-offs and identify the most beneficial approach.

Decision-Making: Use the insights gained from the comparative analysis to inform decision-making.

FVS Additional Descriptions of Assessment Tools

Forest Management Planning: FVS aids forest managers in developing long-term management plans by providing insights into the future conditions of forest stands. This includes predicting timber volumes, species composition, and the effects of various management practices.

Climate Change Assessment: With its ability to integrate climate data, FVS helps assess the potential impacts of climate change on forest ecosystems. Managers can use the tool to understand how changing environmental conditions might influence vegetation dynamics and inform adaptive management strategies.

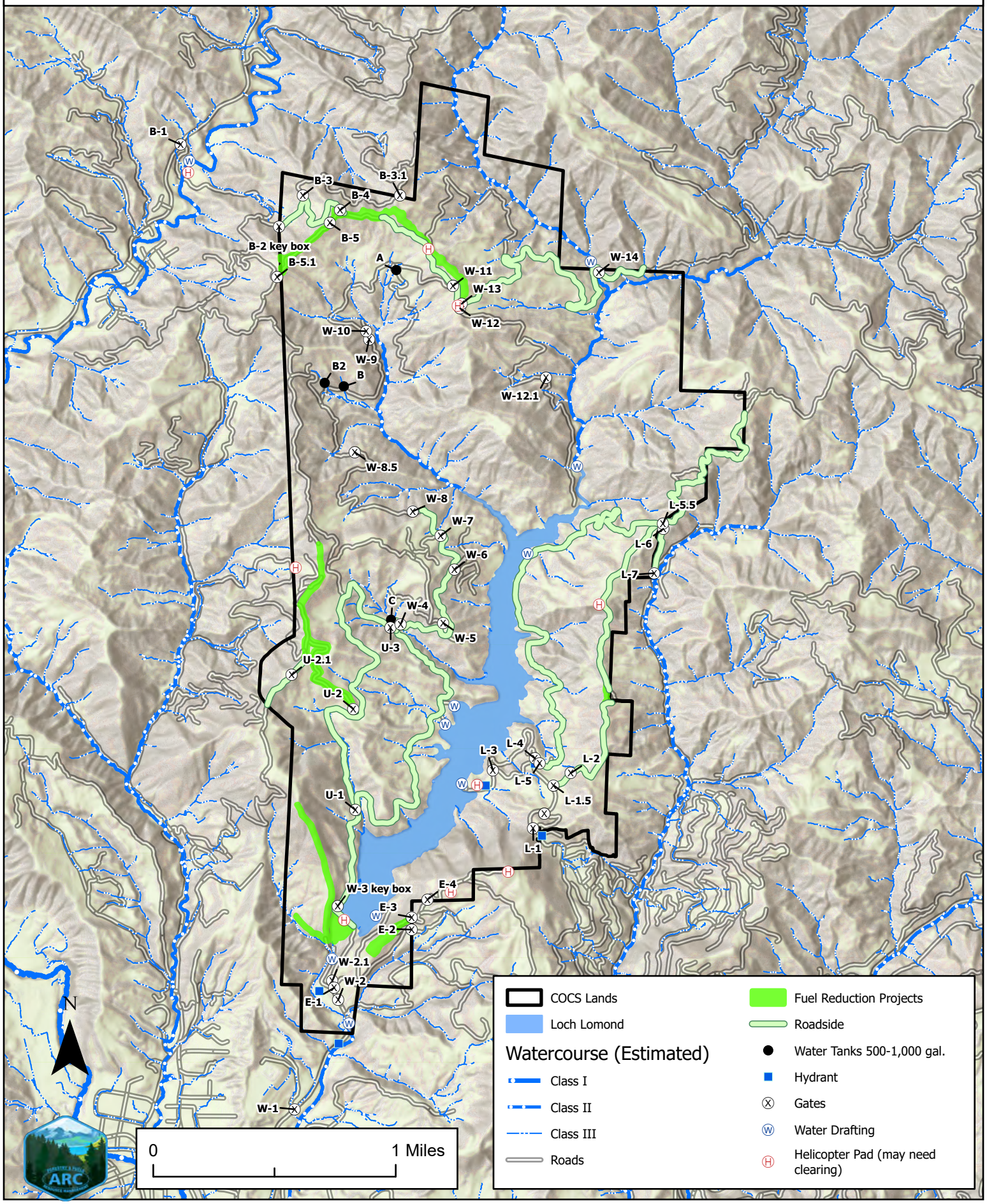
Wildfire Risk Assessment: FVS is valuable for evaluating the risk of wildfires and understanding how different fire management strategies may impact forest ecosystems. It helps in designing strategies to mitigate the effects of wildfires on vegetation.

Biodiversity Conservation: The model contributes to biodiversity conservation efforts by assessing the potential effects of management decisions on the composition of plant and animal species within forest ecosystems.

Carbon Sequestration Analysis: FVS can be used to estimate carbon sequestration potential in forest stands, aiding in the development of strategies for mitigating greenhouse gas emissions and promoting sustainable forestry practices.

Newell Creek Watershed Stewardship Recommendations

SCWD Fire Suppression Map



Scale 1:32,000

DVL 4/11/24

Appendix C – Fire Behavior Comparison Report (IFTDSS)

Fire Behavior Compare Summary Report

COSC_Rx_Mechanical_1YR Post Treatment
vs
COSC_Rx_Mechanical_Pre Treatment

Prepared for: Riley McFarland
1/17/2024, 11:00:11 AM

Model Parameters

Run Name: COSC_Rx_Mechanical_1YR Post Treatment

Model Type: Landscape Fire Behavior (Basic)

Run Date: Jan 17, 2024 1:42:14 PM

Wind Type: Gridded Winds

Wind Speed: 9

Wind Direction: 270

Crown Fire Method: Scott/Reinhardt

Foliar Moisture: 100

Conditioning: On - Extreme - South Central California Foothills and Coastal Mountains

Conditioning start: , NaN/NaN/NaN

Days conditioned:

Conditioning start: 1300, 7/9/2012

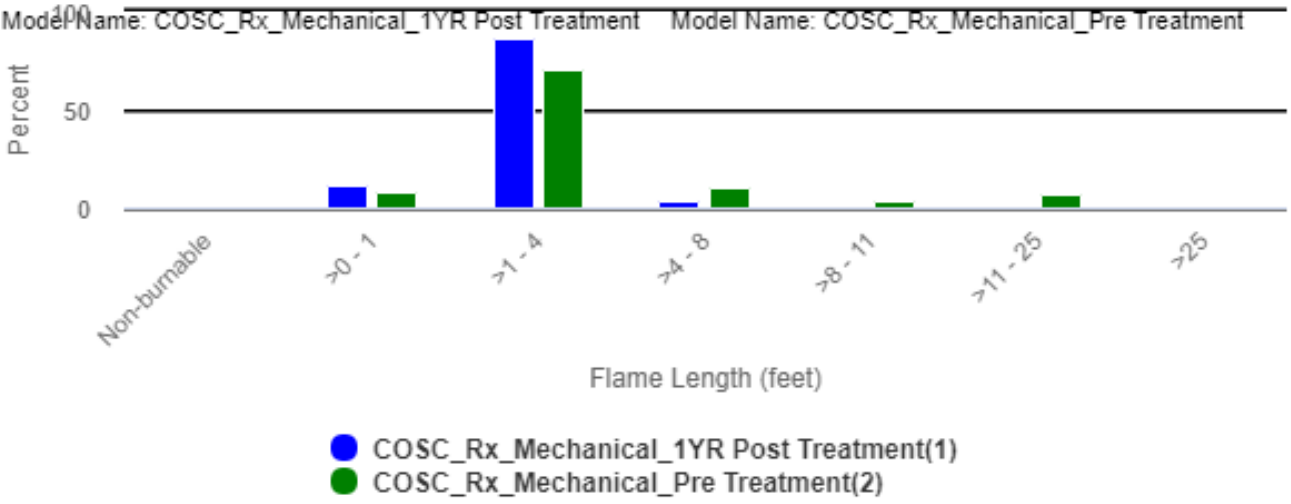
Conditioning end:1600, 7/12/2012

Fuel Model	1 Hr Fuel Moisture	10 Hr Fuel Moisture	100 Hr Fuel Moisture	Live Herbaceous Fuel Moisture	Live Woody Fuel Moisture
All	5	6	12	179	189

Flame Length (feet) Summary Compare for Area of Interest "cosc_fuel rx_mechanized" "COSC_Rx_Mechanical_1YR Post Treatment"(1) vs "COSC_Rx_Mechanical_Pre Treatment"(2) Landscapes

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment



Landscape 2 is always the landscape being compared against

IFTDSS

Flame Length

Flame Length (feet)	Pixel Count COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Pixel Count(2) COSC_Rx_Mechanical_Pre Treatment(2)/AOI	Acres COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Acres COSC_Rx_Mechanical_Pre Treatment(2)/AOI	Percent COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Percent COSC_Rx_Mechanical_Pre Treatment(2)/AOI
Non-burnable	4	4	1	1	0%	0%
>0 - 1	114	83	25	18	11%	8%
>1 - 4	874	722	194	161	86%	71%
>4 - 8	26	102	6	23	3%	10%
>8 - 11	0	35	0	8	0%	3%
>11 - 25	2	73	0	16	0%	7%
>25	0	1	0	0	0%	0%

Flame Length

Flame Length (feet) Summary for Area of Interest "cosc_fuel rx_mechanized" within "COSC_Rx_Mechanical_1YR Post Treatment(1)" Landscape

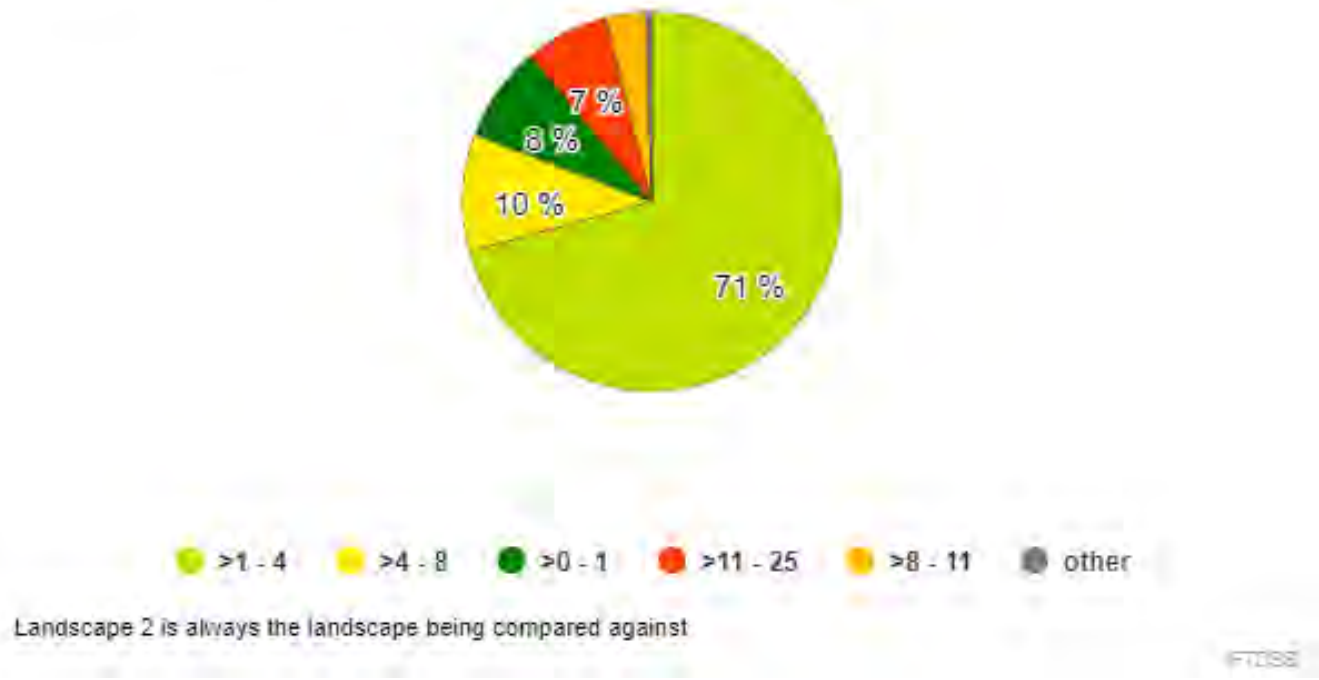
Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape 2 is always the landscape being compared against

Flame Length

Flame Length (feet) Summary for Area of Interest "cosc_fuel rx_mechanized" within "COSC_Rx_Mechanical_Pre Treatment(2)" Landscape

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment

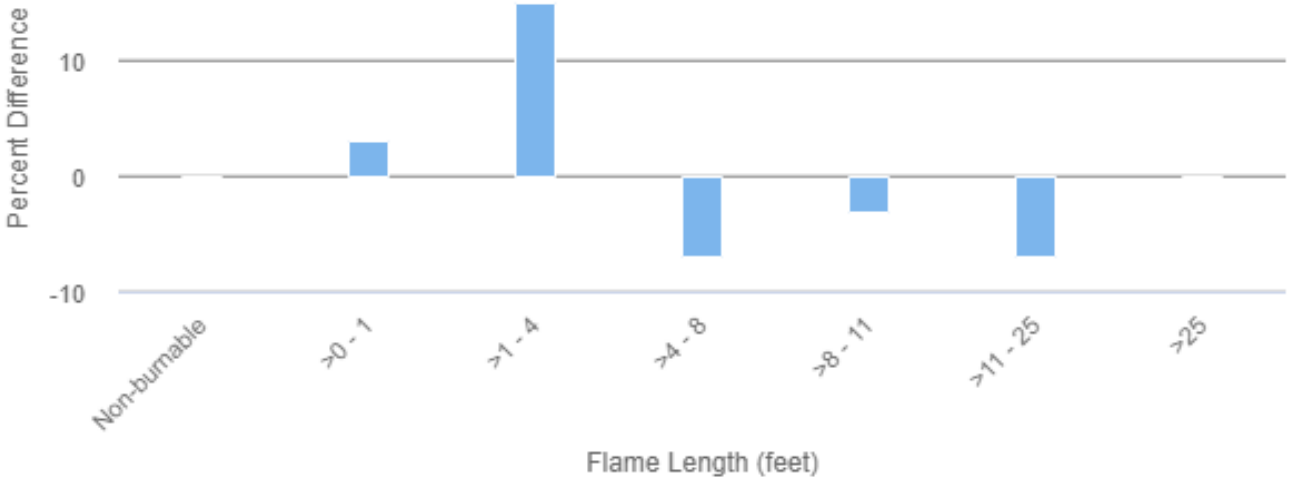


Landscape 2 is always the landscape being compared against

Flame Length (feet) Percent Difference for Area of Interest "cosc_fuel rx_mechanized" "COSC_Rx_Mechanical_1YR Post Treatment"(1) vs "COSC_Rx_Mechanical_Pre Treatment"(2) Landscapes

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment



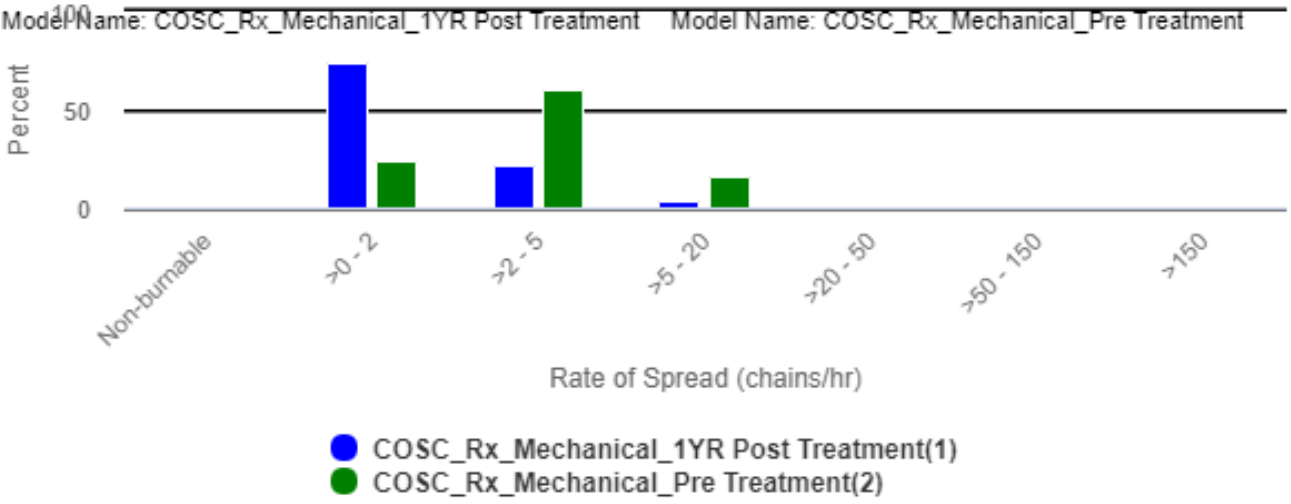
Landscape 2 is always the landscape being compared against

IFTDSS

Rate of Spread (chains/hr) Summary Compare for Area of Interest "cosc_fuel rx_mechanized" "COSC_Rx_Mechanical_1YR Post Treatment"(1) vs "COSC_Rx_Mechanical_Pre Treatment"(2) Landscapes

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment



Landscape 2 is always the landscape being compared against

IFTDSS

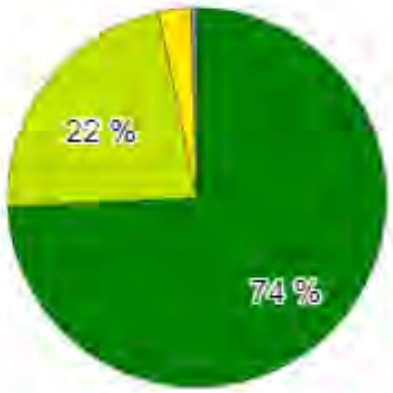
Spread Rate

Rate of Spread (chains/hr)	Pixel Count COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Pixel Count(2) COSC_Rx_Mechanical_Pre Treatment(2)/AOI	Acres COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Acres COSC_Rx_Mechanical_Pre Treatment(2)/AOI	Percent COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Percent COSC_Rx_Mechanical_Pre Treatment(2)/AOI
Non-burnable	4	4	1	1	0%	0%
>0 - 2	758	246	169	55	74%	24%
>2 - 5	229	608	51	135	22%	60%
>5 - 20	28	160	6	36	3%	16%
>20 - 50	1	2	0	0	0%	0%
>50 - 150	0	0	0	0	0%	0%
>150	0	0	0	0	0%	0%

Spread Rate

Rate of Spread (chains/hr) Summary for Area of Interest "cosc_fuel rx_mechanized" within "COSC_Rx_Mechanical_1YR Post Treatment(1)" Landscape

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment



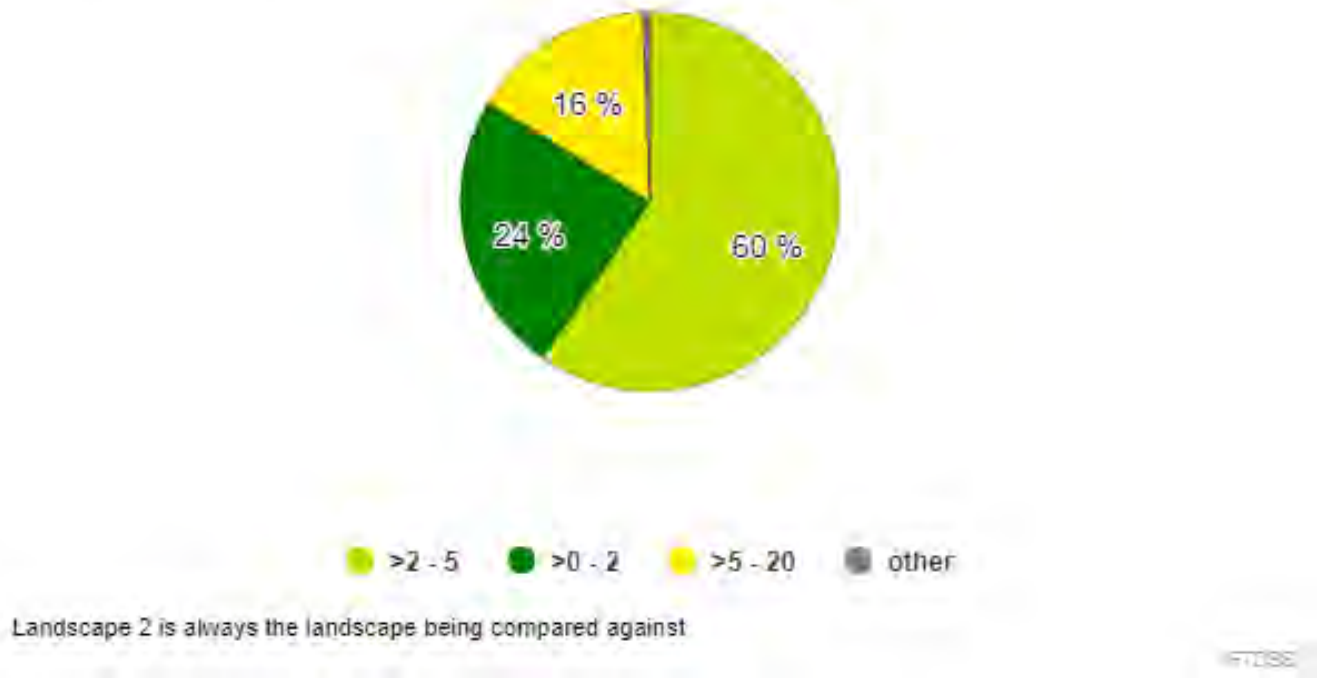
>0 - 2 >2 - 5 >5 - 20 other

Landscape 2 is always the landscape being compared against

Spread Rate

Rate of Spread (chains/hr) Summary for Area of Interest "cosc_fuel rx_mechanized" within "COSC_Rx_Mechanical_Pre Treatment(2)" Landscape

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment

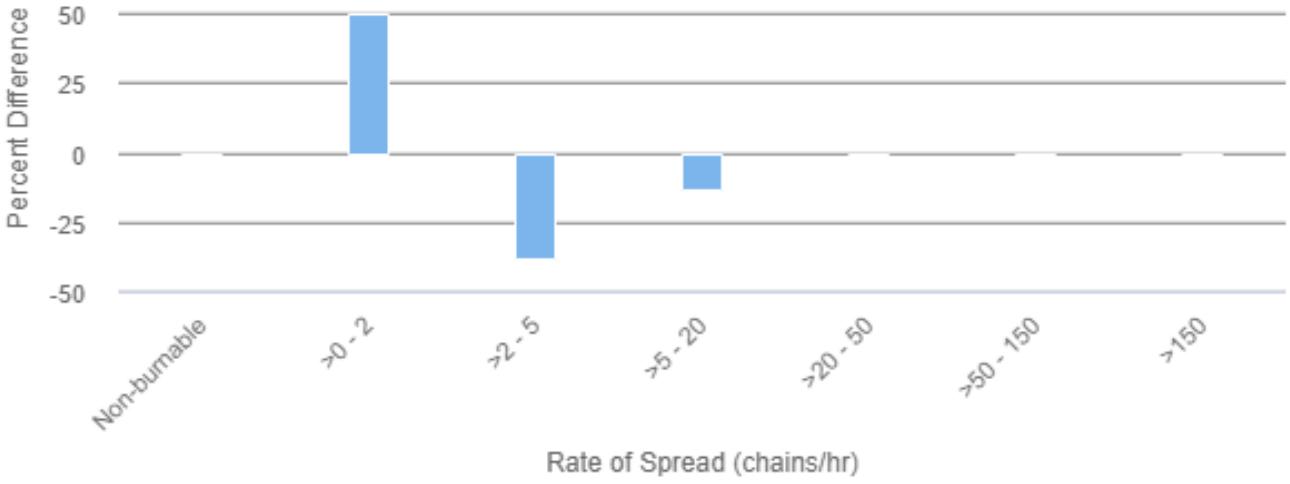


Landscape 2 is always the landscape being compared against

Rate of Spread (chains/hr) Percent Difference for Area of Interest "cosc_fuel rx_mechanized" "COSC_Rx_Mechanical_1YR Post Treatment"(1) vs "COSC_Rx_Mechanical_Pre Treatment"(2) Landscapes

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment



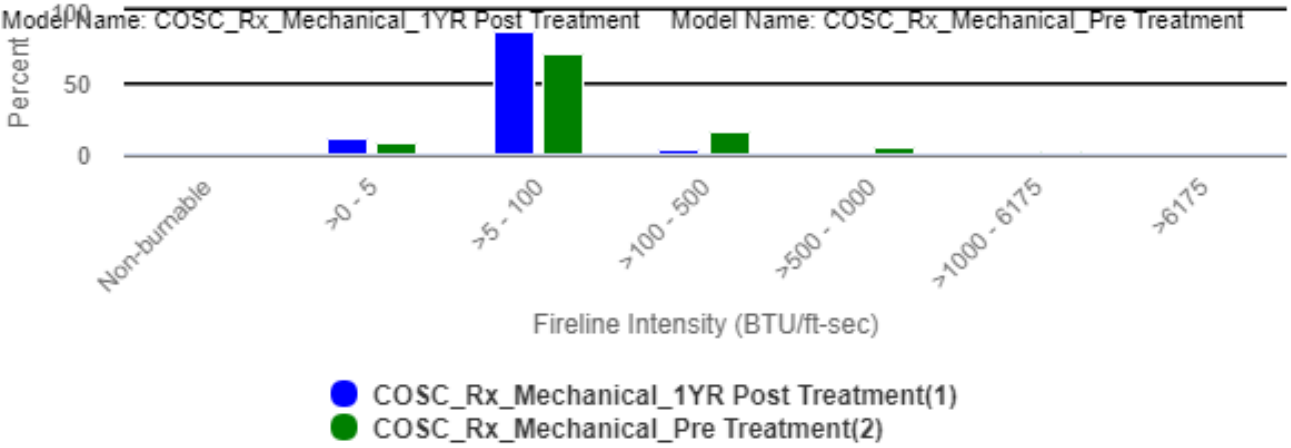
Landscape 2 is always the landscape being compared against

IFTDSS

Fireline Intensity (BTU/ft-sec) Summary Compare for Area of Interest "cosc_fuel rx_mechanized" "COSC_Rx_Mechanical_1YR Post Treatment"(1) vs "COSC_Rx_Mechanical_Pre Treatment"(2) Landscapes

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment



Landscape 2 is always the landscape being compared against

IFTDSS

Intensity

Fireline Intensity (BTU/ft-sec)	Pixel Count COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Pixel Count(2) COSC_Rx_Mechanical_Pre Treatment(2)/AOI	Acres COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Acres COSC_Rx_Mechanical_Pre Treatment(2)/AOI	Percent COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Percent COSC_Rx_Mechanical_Pre Treatment(2)/AOI
Non-burnable	4	4	1	1	0%	0%
>0 - 5	110	83	24	18	11%	8%
>5 - 100	877	718	195	160	86%	70%
>100 - 500	27	167	6	37	3%	16%
>500 - 1,000	2	37	0	8	0%	4%
>1,000 - 6,175	0	11	0	2	0%	1%
>6,175	0	0	0	0	0%	0%

Intensity

Fireline Intensity (BTU/ft-sec) Summary for Area of Interest "cosc_fuel rx_mechanized" within "COSC_Rx_Mechanical_1YR Post Treatment(1)" Landscape

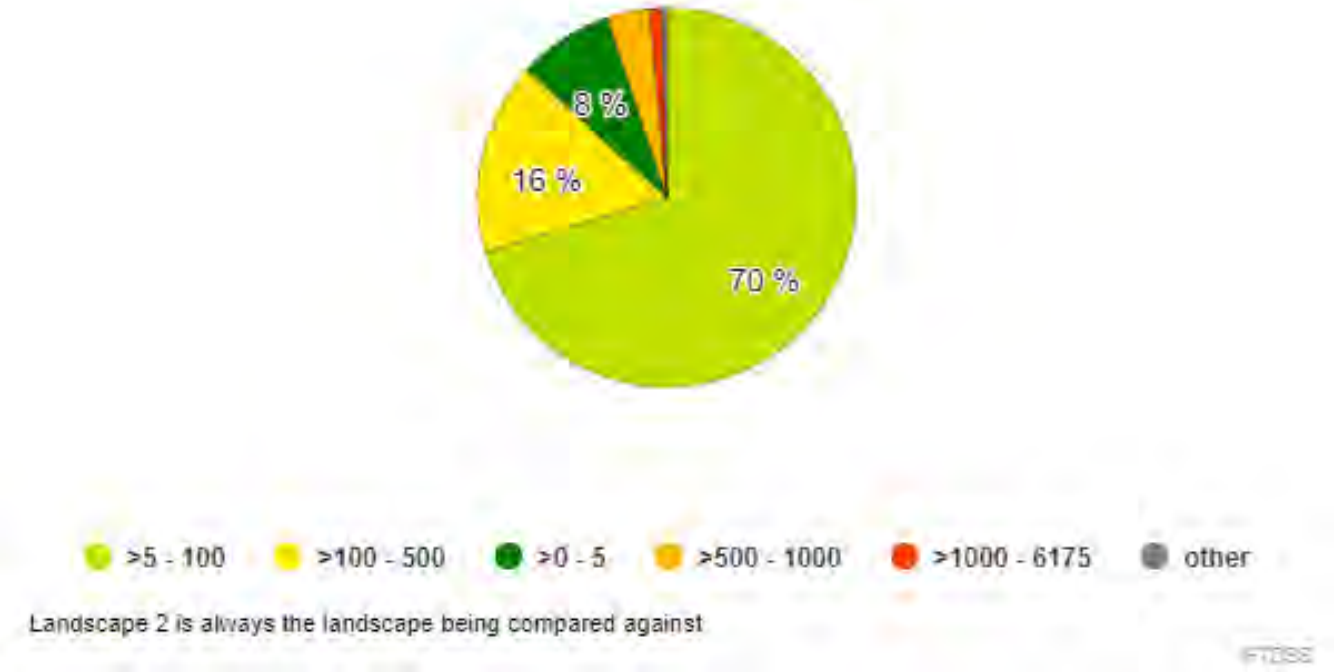
Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape 2 is always the landscape being compared against

Intensity

Fireline Intensity (BTU/ft-sec) Summary for Area of Interest "cosc_fuel rx_mechanized" within "COSC_Rx_Mechanical_Pre Treatment(2)" Landscape

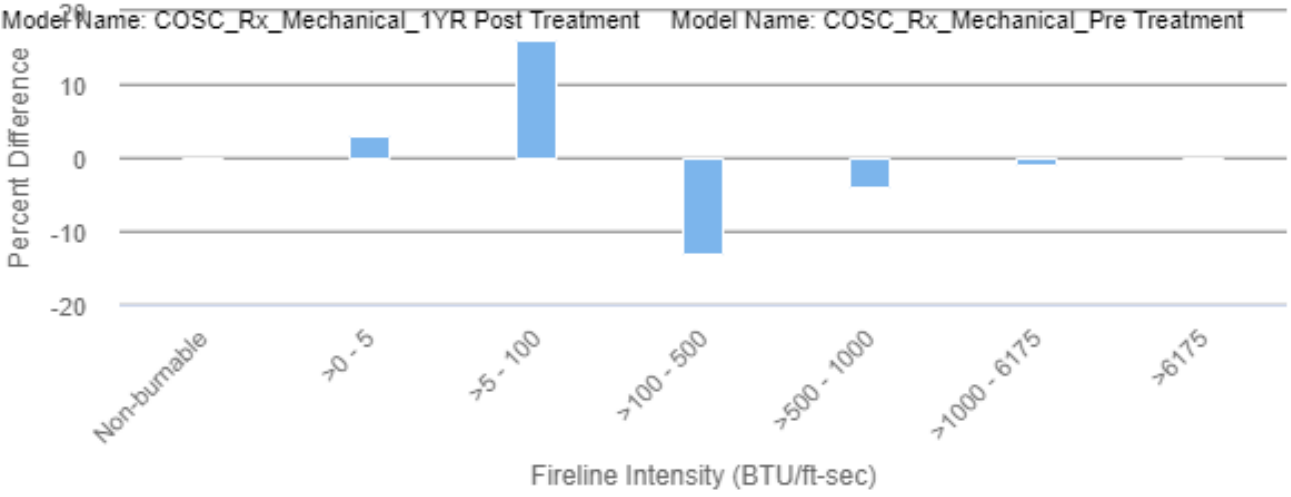
Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment



Fireline Intensity (BTU/ft-sec) Percent Difference for Area of Interest "cosc_fuel rx_mechanized" "COSC_Rx_Mechanical_1YR Post Treatment"(1) vs "COSC_Rx_Mechanical_Pre Treatment"(2) Landscapes

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment



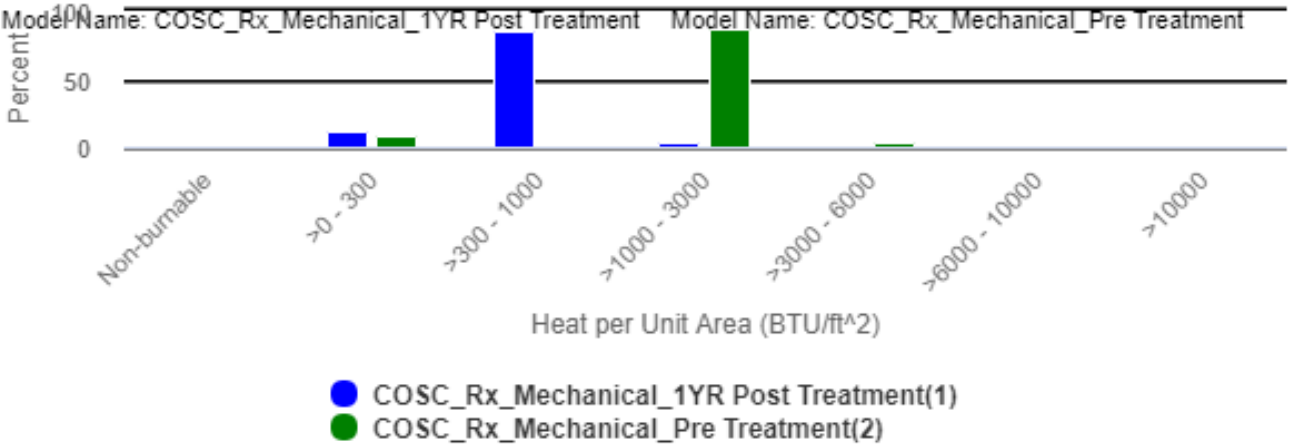
Landscape 2 is always the landscape being compared against

IFTDSS

Heat per Unit Area (BTU/ft^2) Summary Compare for Area of Interest "cosc_fuel rx_mechanized" "COSC_Rx_Mechanical_1YR Post Treatment"(1) vs "COSC_Rx_Mechanical_Pre Treatment"(2) Landscapes

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment



Landscape 2 is always the landscape being compared against

IFTDSS

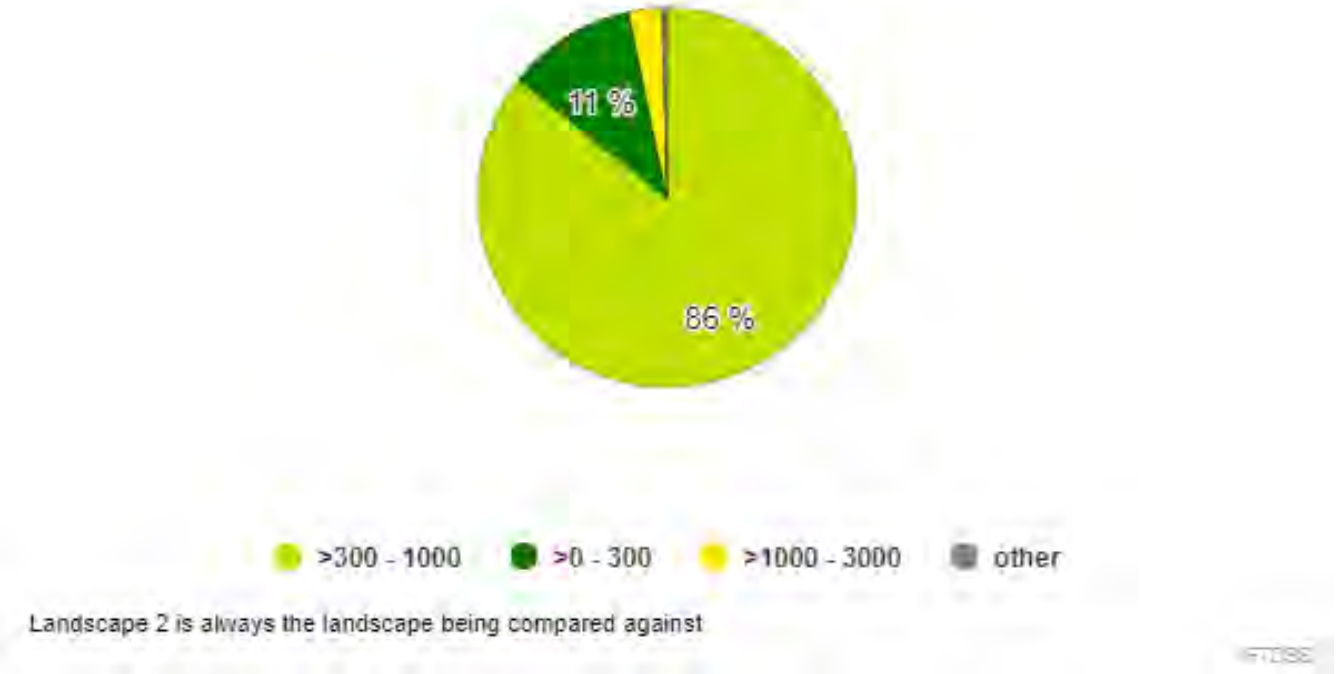
Heat/Area

Heat per Unit Area (BTU/ft ^2)	Pixel Count COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Pixel Count(2) COSC_Rx_Mechanical_Pre Treatment(2)/AOI	Acres COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Acres COSC_Rx_Mechanical_Pre Treatment(2)/AOI	Percent COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Percent COSC_Rx_Mechanical_Pre Treatment(2)/AOI
Non-burnable	4	4	1	1	0%	0%
>0 - 300	113	83	25	18	11%	8%
>300 - 1,000	874	4	194	1	86%	0%
>1,000 - 3,000	29	884	6	197	3%	87%
>3,000 - 6,000	0	45	0	10	0%	4%
>6,000 - 10,000	0	0	0	0	0%	0%
>10,000	0	0	0	0	0%	0%

Heat/Area

Heat per Unit Area (BTU/ft^2) Summary for Area of Interest "cosc_fuel rx_mechanized" within "COSC_Rx_Mechanical_1YR Post Treatment(1)" Landscape

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

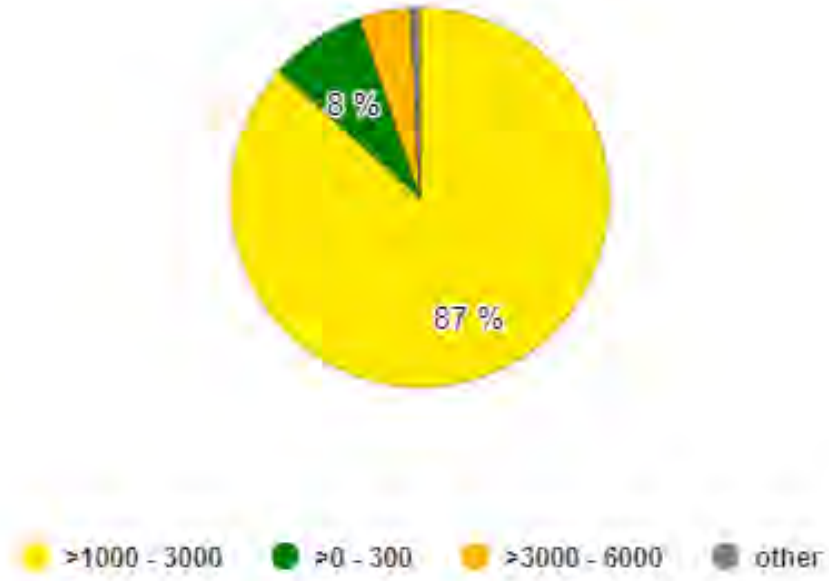


Landscape 2 is always the landscape being compared against

Heat/Area

Heat per Unit Area (BTU/ft^2) Summary for Area of Interest "cosc_fuel rx_mechanized" within "COSC_Rx_Mechanical_Pre Treatment(2)" Landscape

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment

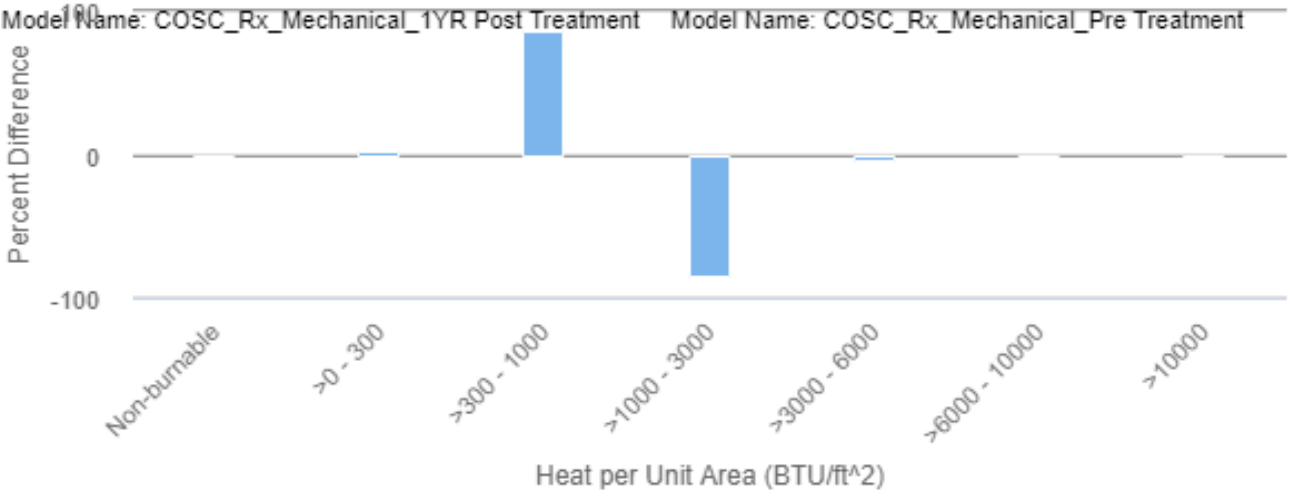


Landscape 2 is always the landscape being compared against

Heat per Unit Area (BTU/ft^2) Percent Difference for Area of Interest "cosc_fuel rx_mechanized" "COSC_Rx_Mechanical_1YR Post Treatment"(1) vs "COSC_Rx_Mechanical_Pre Treatment"(2) Landscapes

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment



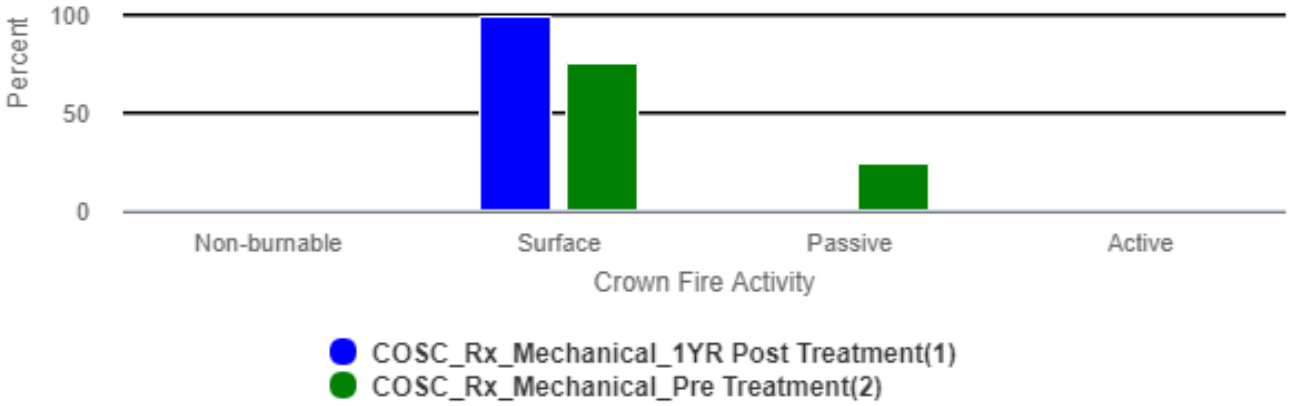
Landscape 2 is always the landscape being compared against

IFTDSS

Crown Fire Activity Summary Compare for Area of Interest "cosc_fuel rx_mechanized" "COSC_Rx_Mechanical_1YR Post Treatment"(1) vs "COSC_Rx_Mechanical_Pre Treatment"(2) Landscapes

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment



Landscape 2 is always the landscape being compared against

IFTDSS

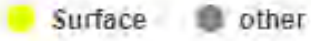
Crown Fire

Crown Fire Activity (n/a)	Pixel Count COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Pixel Count(2) COSC_Rx_Mechanical_Pre Treatment(2)/AOI	Acres COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Acres COSC_Rx_Mechanical_Pre Treatment(2)/AOI	Percent COSC_Rx_Mechanical_1YR Post Treatment(1)/AOI	Percent COSC_Rx_Mechanical_Pre Treatment(2)/AOI
Non-burnable	4	4	1	1	0%	0%
Surface Fire	1013	769	225	171	99%	75%
Passive Fire	3	247	1	55	0%	24%
Active Fire	0	0	0	0	0%	0%

Crown Fire

Crown Fire Activity Summary for Area of Interest "cosc_fuel rx_mechanized" within "COSC_Rx_Mechanical_1YR Post Treatment(1)" Landscape

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

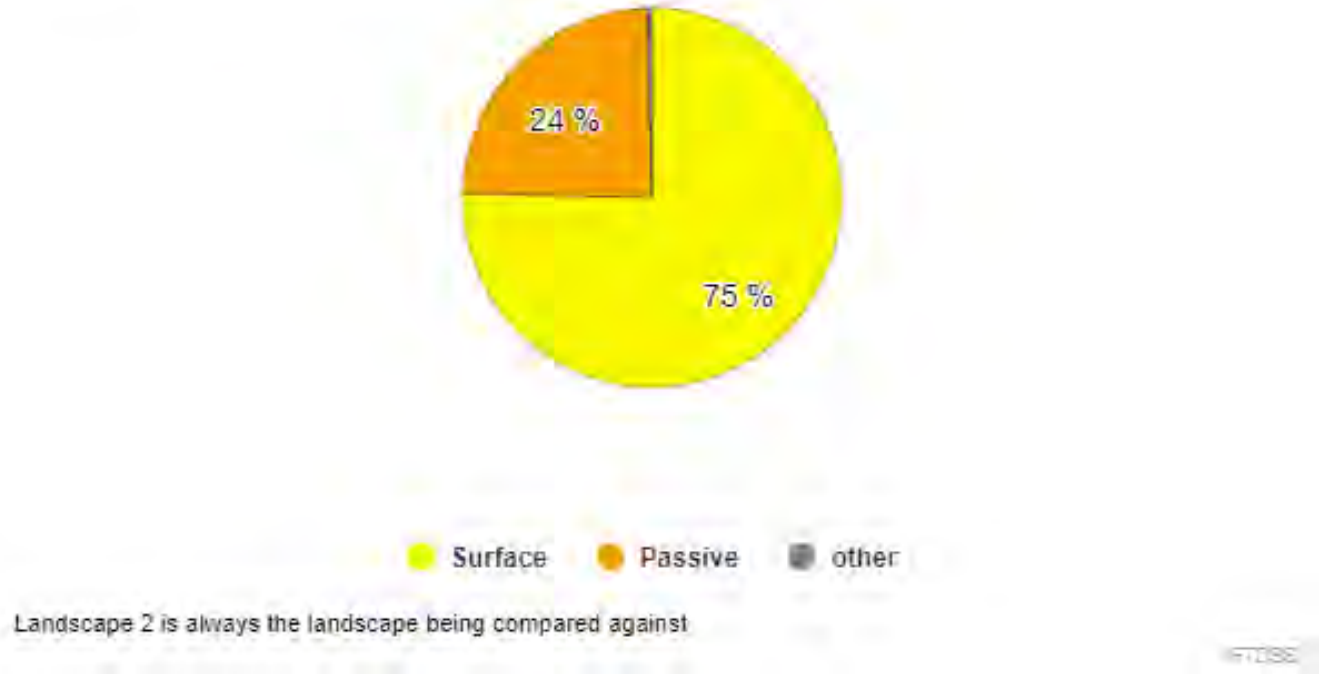


Landscape 2 is always the landscape being compared against

Crown Fire

Crown Fire Activity Summary for Area of Interest "cosc_fuel rx_mechanized" within "COSC_Rx_Mechanical_Pre Treatment(2)" Landscape

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment

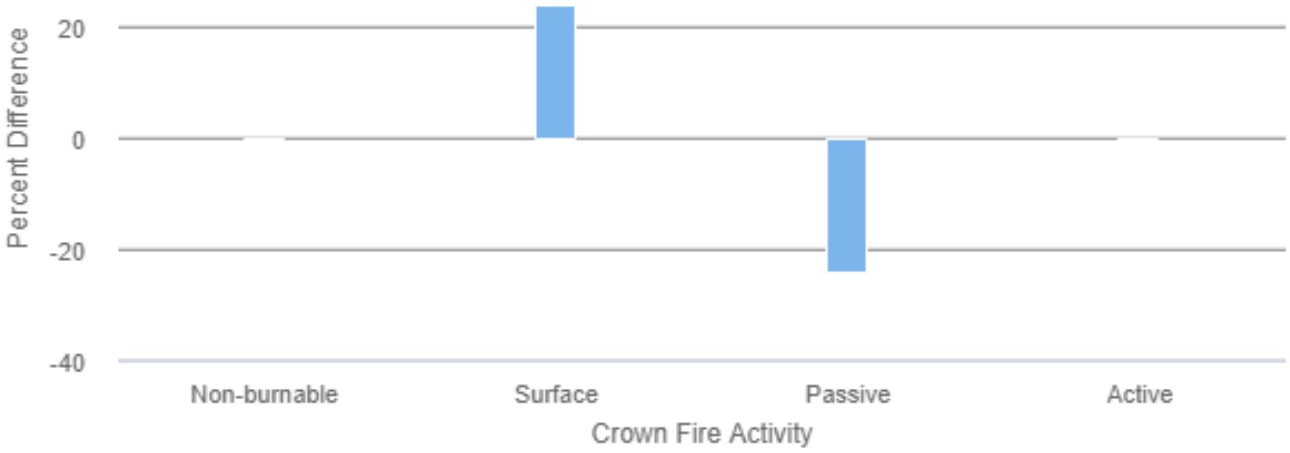


Landscape 2 is always the landscape being compared against

Crown Fire Activity Percent Difference for Area of Interest "cosc_fuel rx_mechanized" "COSC_Rx_Mechanical_1YR Post Treatment"(1) vs "COSC_Rx_Mechanical_Pre Treatment"(2) Landscapes

Landscape Name: COSC_Rx_Mechanical_1YR Post Treatment(1)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_1YR Post Treatment

Landscape Name: COSC_Rx_Mechanical_Pre Treatment(2)
Landfire Version: LF 2014
Landscape Acres (unbuffered): 3,744
Area of Interest Name: cosc_fuel rx_mechanized
Area of Interest Acres: 227
Model Name: COSC_Rx_Mechanical_Pre Treatment



Landscape 2 is always the landscape being compared against

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