

Marin Municipal Water District **Biodiversity, Fire, and Fuels Integrated Plan**

October 2019

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Marin Municipal Water District

Biodiversity, Fire, and Fuels Integrated Plan

October 2019

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ACRONYMS AND ABBREVIATIONS

AIS	Aerial Information System
BFFIP	Biodiversity, Fire, and Fuels Integrated Plan
BIOS	Biogeographic Information and Observation System
BMPs	Best Management Practices
CalEPA	California Environmental Protection Agency
Cal-IPC	California Invasive Plant Council
CalFire	California Department of Forestry and Fire
CCH	Consortium of California Herbaria
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CNDDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CO ₂	carbon dioxide
County	County of Marin
CWPP	Community Wildfire Protection Plan
DBH	diameter at breast height
district	Marin Municipal Water District
DWR	State of California Department of Water Resources
EDRR	Early Detection Rapid Response
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
FAA	Federal Avian Administration
FOHs	Formulated Organic Herbicides
GANDA	Garcia and Associates
GGNPC	Golden Gate National Parks Conservancy
GGNRA	Golden Gate National Recreation Area
GIS	Geographic Information System
IARC	International Agency for Research on Cancer

ACRONYMS AND ABBREVIATIONS

IPM	Integrated Pest Management
LCA	Leonard Charles & Associates
MAB	Man and Biosphere Program
MCFD	Marin County Fire Department
MCP	Marin County Parks
MMWD/District	Marin Municipal Water District
NPS	National Park Service
OEHHA	Office of Environmental Health and Hazard Assessment
PRBO	Point Reyes Bird Observatory
SOD	Sudden Oak Death
SRA	State Responsibility Area
State Parks	California State Parks
TLC	Tamalpais Land Collaborative
UC	University of California
UNESCO	United Nations Educational, Scientific and Cultural Organization
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
VMP	Vegetation Management Plan
WAFRZ	Wide Area Fuel Reduction Zones
WPHIP	Wildfire Protection and Habitat Improvement Plan
WRCC	Western Regional Climate Center
WUI	wildland-urban interface

ES EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The Marin Municipal Water District (MMWD, or District) established the Mount Tamalpais Watershed Management Policy in 2010. The policy states that the overriding management goal for the Mount Tamalpais Watershed is protection of water quality. In accordance with the policy, protecting the integrity of the watershed's water quality and reservoir capacity is best achieved by maintaining natural conditions on watershed lands to the greatest extent possible.

Healthy forests play a large role in preserving and protecting water resources. Managed, healthy forests also reduce the risks of catastrophic wildfire. Wildfire has the potential to degrade forests and watershed processes that could impact water quality. Wildfires increase susceptibility of watersheds to increased overland flows that can result in erosion and can have both short- and long-term impacts on water supplies, such as increased treatment costs, need for alternative supplies, and diminished reservoir capacity (Gould, Liu, Barber, Cherkauer, & Robichaud, 2016). The practice of wildfire suppression in modern times across California (and most of the U.S.) has resulted in increases in forest diseases and spread of invasive species. These conditions reduce a landscape's ability to act as an effective water filter and increase the risks and effects of wildfire on water quality and supply. Improving forest health and managing forests to reduce fuels has the benefit of not only directly improving watershed functions and processes but indirectly reducing the risks of and impacts following wildfire. Forest health improvements can be achieved through habitat restoration planning; through aggressive removal of invasive weeds that outcompete native species, reduce forest diversity, and increase watershed fuel loads; and improving forest resiliency through removal of diseased trees and replanting with disease-resistant species. Wildfire risks can additionally be reduced through fuel reduction and creation of defensible space. Forest management, guided by research, greatly benefits the ecosystem, which in turn, protects the water supply.

The Biodiversity, Fire, and Fuels Integrated Plan (BFFIP, or Plan) describes actions that the District will take over many years to minimize fire hazards and maximize ecological health on its watershed lands. The purpose of the BFFIP is to define and guide the methods to minimize the risk from wildfires while simultaneously preserving and enhancing existing significant biological resources.

The 27 management actions described in this Plan were developed to meet three major goals and 14 corresponding approaches. The management actions described in the BFFIP include analytical planning actions and physical vegetation management actions. The administrative actions include the inventorying of biological resources and threats (e.g., Sudden Oak Death [SOD]), monitoring, and planning. The physical actions related to vegetation management

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include fuelbreak construction and maintenance, weed control, and habitat restoration, which include improvements to forest stand structure, improvements to grasslands and oak woodlands, reintroduction of special-status species, and meadow restoration. The following graphic summarizes the relationship between the BFFIP goals, approaches, actions, and annual work plans:



The BFFIP covers the following topics, which are summarized below:

- Threats, Trends, and Strategies
- Goals and Approaches
- Implementation of Management Actions
- Annual Work Planning Costs
- Anticipated Outcomes

ES.2 BACKGROUND

The District currently maintains vegetation on its watershed lands through the physical methods described in the 1995 Vegetation Management Plan (District 1994): prescribed burning, mowing, and hand removal. After several years of data collection, community outreach, technical studies, review of herbicide risks, and research on the most effective methods of vegetation management, the District developed a new Draft VMP and released it for public comment in September 2012 under the title Draft Wildfire Protection and Habitat Improvement Plan (WPHIP). The 2012 Draft WPHIP received considerable public scrutiny due to its presentation of one alternative for vegetation management that included the limited use of three conventional herbicides. In 2015, the International Agency for Research on Cancer (IARC), a branch of the World Health Organization, classified the herbicide glyphosate as “probably carcinogenic to humans.” In response to increased public concern and regulatory uncertainty resulting from this classification, the District revised its approach and opted to not finalize the 2012 Draft WPHIP with herbicides included in the implementation options. This BFFIP has instead been developed and is largely based on the manual and mechanical methods presented in the 2012 Draft WPHIP. This BFFIP does not include the proposed use of herbicides, but does include forest health and greenhouse gas balance actions, and projects.

ES.3 THREATS, TRENDS, AND STRATEGIES

The BFFIP identifies four threats to water storage and supply facilities as well as other vital infrastructure, human lives, MMWD and private property, and the health of the ecosystem located within or near District lands. The threats include (1) fire, (2) invasive species or weeds,

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(3) forest disease, and (4) climate change. These four threats interact with compounding effects. The trend on District lands is for fewer but larger and more severe fires, expanding invasive species populations, and increases in forest disease.

The BFFIP identifies the methods currently being used by the District, including fuelbreak design, construction, and maintenance; broadcast burning, pile burning, mastication, and mulching; ignition prevention best management practices (BMPs); cooperation among adjoining landowners, and the Early Detection Rapid Response (EDRR) program to control invasive weeds; and SOD research.

The District developed a conceptual zoning of the landscape in the BFFIP to better prioritize the work that will occur. Table ES-1 provides a description of the conceptual zones that will be used to implement the BFFIP.

Table ES-1 Conceptual Zones

Target	Description	Are the District's Targets Met?
Infrastructure		
Optimized Fuelbreak	Optimized fuelbreaks are characterized by the absence of perennial weeds.	The District's wildfire and biological goals are met within these fuelbreaks and the long-term approach is to maintain the existing condition without increasing effort.
Transitional Fuelbreak	Transitional fuelbreaks are characterized by the presence of persistent, yet small populations of perennial weeds that undermine fuelbreak function. These fuelbreaks border or traverse largely intact ecosystems still dominated by native species.	In this zone, the District's wildfire goals and biological goals are compromised by the persistence of perennial weeds. Therefore, the approach is to improve the existing conditions by fully eliminating perennial weeds from this zone, reducing maintenance efforts over time.
Compromised Fuelbreak	Compromised fuelbreaks are characterized by the presence of large, persistent populations of perennial weeds, which resprout and re-establish undesirable fuel hazard conditions quickly.	The District's wildfire goals are only met within this zone through resource-intensive annual effort; there are no ecosystem preservation or improvement goals. Therefore, the approach is limited to abating undesirable fuel loading caused by persistent weeds.
Fuelbreaks Completed by Others	Fuelbreaks completed by others may or may not be on lands owned by the District. In either case, an outside party, such as private landowners, owners of leases or easements, or public landowners have the primary responsibility to maintain the fuelbreaks.	The District's wildfire and biological goals are met within these fuelbreaks and the long-term approach is to continue the existing coordination with other parties that maintain fuelbreaks.

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Target	Description	Are the District's Targets Met?
Natural Areas		
Ecosystem Preservation Zone	Preservation areas are characterized by the presence of largely intact ecosystems dominated by native species, minimal impacts from forest pathogens, and an absence of structures, water supply infrastructure, and picnic areas.	The District's wildfire and biological goals are met within this zone and the long-term approach is to maintain the existing conditions without increasing effort.
Ecosystem Restoration Zone	Restoration areas are characterized by the presence of ecosystems dominated by native species but with diminished ecosystem function due to disease, fire suppression, and/or weed invasion.	The District's biological goals are not met within this zone at this time, but significant gains are possible. Therefore, the long-term approach is to increase effort to achieve measurable improvements in ecosystem health.
Ecosystem Restoration/Wide Area Fuel Reduction Zone (WAFRZ)	Restoration/WAFRZ share many of the same characteristics as the restoration zone, but are distinguished by their proximity to existing infrastructure and the presence of natural resources considered at high risk of permanent degradation in the event of a high intensity wildfire.	The District's biological and wildfire goals are not met within these areas at this time, but significant gains are possible. Therefore, the long-term approach is to increase efforts to achieve measurable improvements in both fuels profile and ecosystem health.
Ecosystem and Fuels Deferred Action Areas	These areas are characterized by the dominance of large, persistent populations of perennial weeds, hard to access stands of diseased trees, lack of special-status species, and diminished ecosystem function.	Neither the District's wildfire goals nor biological goals are likely to be achievable without exponential increases in funding and staff. Therefore, the approach is to defer large-scale action but contain weeds where strategically possible.

ES.4 GOALS AND APPROACHES

The BFFIP focuses on the actions that the District will implement to reduce fire hazards and to maintain and enhance ecosystem functions. Table ES-2 identifies the three goals and 14 approaches of the BFFIP. A set of actions and projects by which these goals and approaches can be achieved are identified in Chapter 5: Implementation of Inventorying, Monitoring, and Planning Management Actions and Chapter 6: Implementation of Vegetation Management Actions.

Table ES-2 Goals and Approaches for the BFFIP

Goal	Approach
Goal 1: Minimize the Risk from Wildfire	Approach 1.1: Prevent destruction of structures and loss of life from wildfires.
	Approach 1.2: Optimize fuelbreak retreatment intervals.
	Approach 1.3: Reduce the potential size and intensity of fires on the watershed.

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Goal	Approach
	Approach 1.4: Reduce the potential for fire ignitions.
	Approach 1.5: Work with other agencies and landowners to reduce fire hazards.
Goal 2: Preserve and Enhance Existing Significant Biological Resources	Approach 2.1: Complete the inventories and mapping of significant vegetation resources and aquatic features (e.g. streams, lakes, wetlands, seeps, springs, marshes).
	Approach 2.2: Detect changes and threats to special-status species populations, other significant resources, and weeds by developing and implementing monitoring programs.
	Approach 2.3: Prevent the loss of special-status plant species, populations, and other sensitive resources.
	Approach 2.4: Restore ecosystem resiliency, functions and values in areas impacted by disease, weed invasion, fire suppression, climate change, and other ecosystem stressors.
Goal 3: Provide an adaptive framework for the periodic review and revision of BFFIP implementation decisions in response to changing conditions and improved knowledge	Approach 3.1: Monitor indicators of stressors of vegetation.
	Approach 3.2: Monitor management activities and, if warranted, revise approaches or actions.
	Approach 3.3: Experiment with emerging invasive species control and restoration techniques and incorporate those that are effective into the BFFIP.
	Approach 3.4: Continue to work with surrounding land management agencies and the public to foster education, research, and volunteer efforts.
	Approach 3.5: Update the District's Integrated Pest Management (IPM) policies and techniques in response to new information.

ES.5 IMPLEMENTATION OF THE BFFIP

The BFFIP describes 27 management actions that will be implemented to fulfill the goals and approaches described in Table ES-2. Table ES-3 summarizes the BFFIP management actions. To implement the inventoring, planning, and monitoring management actions, the District will conduct surveys, manage data, create maps, and communicate findings. To implement the vegetation management actions, the District will use a combination of manual and mechanical techniques. Prescribed burning and grazing will also be used in select locations. Herbicide use is not included in this Plan.

The District will evaluate the effectiveness of its various techniques and modify future actions as necessary to achieve desired outcomes. Success criteria upon which the Plan's success will be based are also presented in Table ES-3. The inventory and monitoring actions are designed to gauge the degree to which the vegetation management actions succeed in meeting the District's goals.

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Table ES-3 BFFIP Management Actions

Management Action No.	Action	Performance Criteria
Inventorying Management Actions		
MA-1	Continue the inventories and mapping of invasive species.	<ul style="list-style-type: none"> Annually update invasive species map.
MA-2	Complete the inventories and mapping of special-status, otherwise rare, and presumed extirpated species of plants (refer to Appendices D and E).	<ul style="list-style-type: none"> Complete report with maps indicating status of all known populations, including CNPS list 4 within 1 year of Plan adoption.
MA-3	Complete inventory of forest pathogens and pests.	<ul style="list-style-type: none"> Complete report that identifies host species, estimates the extent of forest pathogens and pests, assesses the threat, and identifies BMPs to minimize the spread of pathogens within 2 years of Plan adoption.
MA-4	Complete inventory and mapping of grassland communities and identify preservation and restoration projects.	<ul style="list-style-type: none"> Update GIS vegetation layer, revise classifications, and complete project list within 4 years of Plan adoption.
MA-5	Complete the inventories and mapping of wetlands, seeps, and riparian habitat and identify preservation and restoration projects.	<ul style="list-style-type: none"> Complete GIS layer, list of identified projects, and implementation plan within 3 years of Plan adoption.
MA-6	Complete the inventory of bryophytes.	<ul style="list-style-type: none"> Complete annotated species list within 5 years of Plan adoption.
MA-7	Complete the inventories of fungi.	<ul style="list-style-type: none"> Complete annotated species list within 5 years of Plan adoption.
Planning and Monitoring Management Actions		
MA-8	Facilitate vegetation management beneath transmission lines and transformers.	<ul style="list-style-type: none"> Coordinate annually (or more frequently when required) with PG&E to ensure cyclical and emergency vegetation management occurs as needed under transmission lines and transformers.
MA-9	Facilitate vegetation management with other parties that have entered into a lease or easement with the District.	<ul style="list-style-type: none"> Coordinate annually (or more frequently when required) with lessees to ensure cyclical maintenance of fuelbreaks occurs around leased facilities on MMWD lands.

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Management Action No.	Action	Performance Criteria
MA-10	Partner with local fire departments and adjacent owners (private, county, state, and federal) to encourage adequate fuels management along common borders.	<ul style="list-style-type: none"> Attend monthly FIEReSafe Marin meeting and participate in countywide Community Wildfire Protection Plan annual work plans and plan updates. Support local fire departments annually (or more frequently as required) in improving community education regarding defensible space, vegetation maintenance, and emergency response.
MA-11	Maintain operational readiness to respond to fire events.	<ul style="list-style-type: none"> Train staff annually (or more frequently when required) in Red-Flag Day protocols, ignition prevention BMPs, wildland firefighting techniques, and firefighting equipment maintenance.
MA-12	Evaluate the impacts, progress of each preservation and restoration action relative to performance criteria, and cost annually, and modify methods and schedules as needed.	<ul style="list-style-type: none"> Complete as part of annual board report with recommended modifications. First board report to be submitted in late May or June following Plan adoption and annually thereafter.
MA-13	Review and update the Vegetation Management tool box program annually, including selection criteria for tools and techniques.	<ul style="list-style-type: none"> Complete as part of annual board report with recommended modifications. First board report to be submitted in late May or June following Plan adoption and annually thereafter.
MA-14	Revise BMPs to protect special-status and otherwise rare species and sensitive habitats from construction or maintenance actions (refer to Appendix F).	<ul style="list-style-type: none"> Implement annual refresher training for Facilities and Watershed and engineering staff working on Mount Tamalpais or managing contracts for work on Mount Tamalpais, within 1 year of Plan adoption.
MA-15	Revise and implement a project planning, implementation, monitoring and evaluation program for vegetation management actions.	<ul style="list-style-type: none"> Publish standards within 2 years of Plan adoption.
MA-16	Establish a network of plots to monitor plant community change.	<ul style="list-style-type: none"> Initiate monitoring process within 3 years of Plan adoption.

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Management Action No.	Action	Performance Criteria
MA-17	Develop and implement a special-status and otherwise rare plant species monitoring program.	<ul style="list-style-type: none"> Define and implement program and methodology within 4 years of Plan adoption.
MA-18	Update landscape scale vegetation maps cyclically.	<ul style="list-style-type: none"> Complete revised forest disease / SOD map and technical memo once every 5 years with supporting ground data. Complete revised comprehensive watershed vegetation map and classification within 3 years, and thereafter, once every 15 years. Redo comprehensive invasive species map once every 5 years.
MA-19	Monitor effects of forest management actions on greenhouse gas balance and water yield.	<ul style="list-style-type: none"> Initiate monitoring process within 3 years of Plan adoption.

Vegetation Management Actions			Year 5 Implementation Levels
MA-20	Perform cyclical maintenance throughout the Infrastructure Zone with sufficient frequency to maintain design standards.	<ul style="list-style-type: none"> Retreat each fuelbreak once every 1 to 5 years, depending on the site characteristics. 	200 acres
		<ul style="list-style-type: none"> Complete mowing of fine fuels in the most ignition prone areas, including parking lots, picnic areas, and defensible space around structures within the first month of the start of the fire season and repeat if conditions warrant. ^a 	50 acres
		<ul style="list-style-type: none"> Remove all reproductive broom annually in the optimized and transitional fuelbreaks. 	260 acres
		<ul style="list-style-type: none"> Perform cyclical roadside mowing. 	50 acres
		<ul style="list-style-type: none"> Perform cyclical dam maintenance. 	50 acres
MA-21	Construct the remainder of the fuelbreak system (see Figures 3-11 to 3-14).	<ul style="list-style-type: none"> Construct 117 acres of new fuelbreaks with the first 50 acres to be completed within 5 years of Plan adoption. 	15 acres

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Management Action No.	Action	Performance Criteria	
MA-22	Expand the Early Detection Rapid Response (EDRR) program to identify, report, and treat new populations of invasive species.	<ul style="list-style-type: none"> Annually survey 100 percent of roads and newly disturbed areas, and 25 percent of trails. 	150 miles
		<ul style="list-style-type: none"> Control 60 percent of new small weed stands and 30 percent of existing small weed stands per year. 	100 patches ^c (2 acres total)
MA-23	Improve conifer and mixed hardwood forest stand structure and function in the Ecosystem Restoration Zone. ^b	<ul style="list-style-type: none"> Initial reduction in accumulated fuels and brush density in 180 acres of conifer and mixed hardwood stands within 5 years of Plan adoption. 	60 acres
		<ul style="list-style-type: none"> Maintenance of areas where fuels and brush density were reduced and trees planted. 	100 acres
		<ul style="list-style-type: none"> Complete 100 acres of broadcast burning in forest understory within 5 years of Plan adoption. 	Up to two 20-acre projects
MA-24	Improve grasslands and oak woodlands in the Ecosystem Restoration Zone. ^b	<ul style="list-style-type: none"> Conduct Douglas-fir thinning in grasslands and the understory of oak woodlands. 	200 acres
		<ul style="list-style-type: none"> Complete 450 acres of broadcast burning in grasslands and open oak woodlands within five years of Plan adoption. 	Three projects ^d (not to exceed 140 acres combined per year)
		<ul style="list-style-type: none"> Remove 600 acres of reproductive broom. 	505 acres
		<ul style="list-style-type: none"> Reduce goatgrass to less than 5 percent of 2016 mapped levels. 	35 acres
		<ul style="list-style-type: none"> Reduce effort needed to maintain 2016 extent of yellow starthistle by 25 percent. 	120 acres
		<ul style="list-style-type: none"> Control other high priority weeds to prevent expansion beyond spatial extent documented in 2016 and achieve a 25 percent reduction in both weed cover and the level of effort needed to maintain it. 	Covered by patches identified in MA-22

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Management Action No.	Action	Performance Criteria	
MA-25	Reintroduce or enhance historic populations of special-status plant species.	<ul style="list-style-type: none"> Reintroduce at least seven populations of special-status plant species within 5 years of Plan adoption. 	3 projects implemented or maintained (1 acre combined)
		<ul style="list-style-type: none"> Modify at least three habitats for species' benefit within 5 years of Plan adoption. 	3 projects implemented or maintained (11 acres combined)
MA-26	Develop and implement 10-year restoration plans for Potrero Meadow, Sky Oaks Meadow, and Nicasio Island.	<ul style="list-style-type: none"> Develop a 10-year restoration plan for Potrero Meadows (30 acres). 	n/a
		<ul style="list-style-type: none"> Develop a 10-year restoration plan for Sky Oaks Meadow (50 acres). 	n/a
		<ul style="list-style-type: none"> Develop a 10-year restoration plan for Nicasio island (75 acres of native grassland). 	n/a
		<ul style="list-style-type: none"> Begin implementation of at least two of the restoration plans above within 5 years of Plan adoption. 	2 projects not to exceed 125 acres combined
MA-27	Conduct experiments and trials to identify suitable methods for control of invasive species.	<ul style="list-style-type: none"> Conduct field trials to test emerging weed control tools and techniques. 	3 projects implemented or maintained (30 acres combined)
		<ul style="list-style-type: none"> Complete a report that summarizes the results and includes recommendations. Update Plan's vegetation management tool box and District's IPM program as appropriate. 	n/a

Notes:

- ^a CAL FIRE determines the start of the official fire season each year based on weather conditions. Fire season typically starts between mid-May and early- June and extends into mid-November.
- ^b The Ecosystem Restoration Zone includes the WAFRZ.
- ^c An individual EDRR patch is less than or equal to 100 square meters (0.02 acre) in size.
- ^d A project is defined as 38 acres but could vary by year.

ES EXECUTIVE SUMMARY

ES.6 BFFIP COSTS AND ANNUAL WORK PLAN

Management action targets are established in an Annual Work Plan, which allow the District to make the greatest gains toward achieving Plan goals with limited resources.

ES.6.1 Costs

The total cost to fully implement the BFFIP is approximately \$13.5 million over 5 years. The total cost is a combination of the cost to implement 5 years of inventorying, monitoring, and planning management actions (\$936,300), the total 5-year cost to implement the vegetation management actions (\$11,508,840), and the total initial capital cost to implement the Plan (\$1,000,000) (all in 2019 dollars). When fully implemented, annual operational costs are anticipated to be 200 percent greater than current levels.

Table ES-4 summarizes the projected yearly costs of implementing the BFFIP. The costs are based upon the work to be completed in each year, presented in this Plan by management action.

Table ES-4 Yearly BFFIP Costs

Management Actions	Total Associated Cost					Total
	Year 1	Year 2	Year 3	Year 4	Year 5	
Inventorying, Monitoring, and Planning Management Actions	\$137,700	\$107,500	\$161,100	\$246,400	\$283,600	\$936,300
Vegetation Management Actions	\$1,773,100	\$2,134,780	\$2,372,480	\$2,543,500	\$2,778,378	\$11,508,840
Capital Costs	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$1,000,000
Total	\$2,110,800	\$2,442,280	\$2,733,580	\$2,989,900	\$3,261,978	\$13,445,140

ES.6.2 Anticipated Outcomes After Initial 5 Years of Implementation

After the initial 5 years of implementing the BFFIP at the levels identified in the annual work plans, the District expects to accomplish the following:

1. Built linear fuelbreak system and defensible space will expand by 11 percent to approximately 500 acres. Total planned fuelbreak system will be 88 percent complete.
2. Cyclical fuelbreak maintenance actions (brushing and weed suppression) will increase by 33 percent to ensure design standards are maintained throughout the expanded system.
3. Early detection weed patrols will not increase but rapid response treatments of detected small weed patches will increase by 300 percent. It is anticipated this treatment will slow the rate of weed spread throughout the Mount Tamalpais Watershed.

ES EXECUTIVE SUMMARY

4. Approximately 180 acres of diseased forest and oak woodland habitat will be treated to improve wildfire resiliency, reestablish desired stand structure, and enhance ecosystem function. This amount is approximately 5 percent of the anticipated need that occurs in terrain that is operationally accessible.
5. Up to 17 broadcast burns, totaling 550 acres, will be conducted in forest, oak woodland, and grassland habitats as part of multi-benefit projects designed to improve wildfire resiliency, reestablish desired stand structure, and enhance ecosystem function.
6. Douglas-fir encroachment will be managed on approximately 620 acres of oak woodlands and/or grasslands, which will yield both wildfire risk reduction and habitat improvement benefits. A portion of these acres may include repeat treatments of the same sites rather than unique projects.
7. Approximately 505 gross acres of broom in the Ecosystem Restoration Zone will be targeted for complete elimination. This amount is a 72 percent increase over the planned 2017 levels of effort. Presuming EDRR efforts are successful at containing broom to its current extent in the Ecosystem Restoration Zone, the total acres of unmanaged broom will decrease from 690 acres in 2017 to 478 acres in 5 years.
8. The level of effort exerted for yellow starthistle control will increase by 140 percent with the intent of achieving a reduction in cover and preventing further spread.
9. The level of effort exerted for goatgrass control will increase by 9 percent with the infestation likely to remain unchanged or exhibit modest decreases.
10. Ten rare plant populations will be re-established or enhanced.
11. Two wet meadow restoration projects will be initiated.

1 INTRODUCTION

1.1 OVERVIEW OF MARIN MUNICIPAL WATER DISTRICT WATERSHED LANDS

The Marin Municipal Water District (MMWD, or the District) provides water for approximately 190,000 people living in central and southern Marin County. The District established the Mount Tamalpais Watershed Management Policy in 2010. The policy states that the overriding management goal for the Mount Tamalpais Watershed is protection of water quality. In accordance with the policy, protecting the integrity of the watershed's water quality and reservoir capacity is best achieved by maintaining natural conditions on watershed lands to the greatest extent possible. The District manages three natural land areas from which water is supplied. These areas include the Mount Tamalpais Watershed and the shorelines of Nicasio and Soulajule Reservoirs, which total approximately 22,000 acres of publicly accessible wildlands.

These three management areas all support rich, natural ecosystems. The United Nations



Educational, Scientific and Cultural Organization (UNESCO) included the Mount Tamalpais Watershed as one of the thirteen protected areas of the Golden Gate Biosphere Reserve in 1988, recognizing the global significance of its biodiversity (UNESCO 2002). Biodiversity is the short form of “biological” and “diversity.” The term biodiversity is defined as all the variety of life that can be found in an area, including communities, habitats, and species.

Management of these natural areas comes with several challenges for the District. These challenges include potential wildfires that threaten infrastructure, water supplies and reservoir capacities, and surrounding lives and property and the spread of invasive weeds and forest diseases that threaten the natural ecosystems and increase fire risks.

The Biodiversity, Fire, and Fuels Integrated Plan (BFFIP, or Plan) describes actions that MMWD will take over the next several years to minimize fire hazards and maximize ecological health on its watershed lands. The purpose of the BFFIP is to define and guide the methods to minimize the risk from wildfires while simultaneously preserving and enhancing existing significant biological resources. The 27 management actions described in this Plan were developed to meet three major goals and 14 corresponding approaches. The management actions described in the BFFIP include analytical planning actions (or “administrative actions”) and physical vegetation

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management actions. The administrative actions include the inventorying of biological resources and threats (e.g., Sudden Oak Death [SOD]), monitoring, and planning. The physical actions related to vegetation management include fuelbreak construction and maintenance, weed control, and habitat restoration, which include improvements to forest stand structure, improvements to grasslands and oak woodlands, reintroduction of special-status species, and meadow restoration.

The BFFIP has been organized into the following sections:

- **Acronyms and Abbreviations.** This section follows the Table of Contents.
- **Executive Summary.** Provides a summary description of the Plan including threats, trends, and strategies; goals and approaches; management actions to be implemented; annual work plan costs; and anticipated outcomes.
- **Chapter 1: Introduction.** Provides a description of the BFFIP goals, purpose and need, Plan principals and framework, the history of vegetation management in the MMWD watershed lands, and current vegetation management practices.
- **Chapter 2: Environmental Setting.** Presents a description of the infrastructure, biological resources, hydrology, and functions and values on MMWD watershed lands.
- **Chapter 3: Threats, Trends, and Strategies.** Identifies the threats to water storage and supply facilities as well as other vital infrastructure, lives, District and private property, and the health of the ecosystem located within or near District lands, as well as strategies to address these threats.
- **Chapter 4: Goal and Approach Framework for Plan.** Provides the goals and approaches that focus the actions that the District will implement to reduce fire hazards and to maintain and enhance ecosystem functions.
- **Chapter 5: Implementation of Inventorying, Monitoring, and Planning Management Actions.** Provides the inventorying, monitoring, and assessment actions that form the basis for the District’s adaptive management framework and implementation methods.
- **Chapter 6: Implementation of Vegetation Management Actions.** Provides the physical actions related to vegetation management that will be implemented including performance criteria and the techniques and methods needed to achieve individual vegetation management actions. This chapter also provides the framework for a series of projects that will be performed under each management action.
- **Chapter 7: Cost and Preliminary Work Plan.** Provides a summary of the costs and projects anticipated over the 5-year initial BFFIP implementation, as well as the anticipated outcomes following implementation.
- **Chapter 8: References.** Identifies the references cited in the Plan.
- **Appendix A: Marin Municipal Water District Policies**
- **Appendix B: History of Wildfires on MMWD Lands**
- **Appendix C: Reference List of Existing MMWD Data and Research**

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- **Appendix D: Special-Status Species Known to Occur or with Potential to Occur on MMWD Lands**
- **Appendix E: Extirpated Plant Species on MMWD Lands**
- **Appendix F: MMWD Best Management Practices**

1.2 PLAN GOALS

The goals of the BFFIP are:

- **Goal 1:** Minimize the risk from wildfire.
- **Goal 2:** Preserve and enhance existing significant biological resources.
- **Goal 3:** Provide an adaptive framework for the periodic review and revision of BFFIP implementation decisions in response to changing conditions and improved knowledge.

1.3 PLAN PURPOSE AND NEED

The purpose of and need for this Plan is to define and guide the methods used to accomplish the aforementioned goals. Current challenges facing the District that are addressed in this Plan include the following:

1. **Fire hazard.** The Mount Tamalpais Watershed borders eight communities in central and southern Marin County. The urban-wildland interface between this watershed and these communities is subject to ongoing risk of a devastating wildfire similar to the 1991 Oakland Hills Fire (District 2012a). The District, as a good neighbor and public land steward, remains dedicated to reducing the risk of wildfire starting on or crossing the watershed, and has been undertaking actions to reduce fire hazards for many years.
2. **Fire suppression.** Large portions of District land experience a fuel buildup and a loss of biodiversity due to a prolonged national policy of fire suppression. Reintroducing fire, as an important ecological process, back into the landscape while minimizing wildfire hazards remains a challenge.
3. **Broom invasion.** French, Scotch, and Spanish broom (*Genista monspessulana*, *Cytisus scoparius*, and *Spartium junceum*, respectively) pose significant threats to the biodiversity and wildfire risk reduction goals on the District's watershed lands. Despite years of effort, broom populations continue to expand on the watershed.
4. **Expansion of other highly invasive plant species.** Other highly invasive plant species, such as yellow starthistle (*Centaurea solstitialis*), have expanded their range on the watershed and pose ever-increasing threats to biodiversity, habitat quality, and recreational access.

Threats to Biodiversity

Biological diversity is often used as an indicator of ecosystem resilience and environmental goods and services such as clean air and water. On Mount Tamalpais, biodiversity is at risk from the expansion of non-native invasive species, climate change, and Sudden Oak Death and other diseases.

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5. **Spread of forest diseases.** Wide-spread die-off of tanoaks (*Notholithocarpus densiflorus*) and coast live oak (*Quercus agrifolia*) on the Mount Tamalpais Watershed has occurred since SOD was first discovered in 1995. SOD and other forest pathogens pose a significant long-term risk to forest composition, which has caused a decrease in ecosystem function, including reduction in recruitment of replacement trees into the canopy and the loss of acorns and other forage depended on by many species of animals (Moritz et al. 2008, Rizzo and Garbelotto 2003).
6. **Climate change.** While the long-term ramifications of climate change are not fully understood, it is clear that maintaining wildlands in a healthy (resilient) state improves the ability of plants and animals to adapt to current and future changes (Micheli et al. 2010). Researchers are predicting decreases in the extent of redwood forests, and grasslands, and increases in the extent of chamise shrublands over the next 100 years in the central coast of California. The shift may be hastened by changes in fire severity and frequency and will have implications for wildlife as well as emergency response (Ackerly et al. 2016).

1.4 PLAN PRINCIPLES AND FRAMEWORK

1.4.1 Overview

The District's management of the watershed is guided primarily by its Mission Statement. The District's mission is "to manage our natural resources in a sustainable manner and to provide our customers with reliable, high quality water at a reasonable price."

Additionally, the District is committed to:

- Preserving, protecting, restoring, and enhancing biological diversity
- Cooperating with other public and private landowners and managers
- Supporting public involvement and education
- Adhering to the District's Board Policy 7

Board Policy 7, the Mount Tamalpais Watershed Management Policy, states that the District must protect water quality in the watershed. It is the District's policy that any action taken on their lands focuses on retaining the lands in their natural condition (i.e., with minimal human intervention and development), allowing the lands to return to a natural condition, or actively restoring the land. The policy is included in Appendix A.

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1.4.2 Adaptive Management Approach

The key framework for this Plan is adaptive management. Adaptive management emphasizes a “learn by doing” approach that incorporates the results of monitoring, new scientific information, and observations from the work that has been conducted to inform future management decisions. The principal advantage of an adaptive management approach is it allows the District to develop tools for managing the watershed in the context of an uncertain future posed by large-scale threats, including fire, invasive weeds, forest disease, and climate change.

Key Concept

Adaptive Management is the practice of periodically assessing management strategies and, if appropriate, revising them in light of new information.

Figure 1-1 provides a visual representation of the way the District will implement the Plan under an adaptive management framework. The first step in the adaptive management approach is to “plan”. An Annual Work Plan will be established consistent with the BFFIP (see Chapter 7: Cost and Preliminary Work Plan). Management action targets are established in the Annual Work Plan that allow the District to make the biggest gains toward achieving Plan goals with limited resources. The second step is to “do”, which will be completed through the implementation of the projects under the management actions described in the Annual Work Plan. The third step is to “evaluate and learn”. The District will evaluate the effectiveness of annual management actions based on the monitoring results. An annual board report will include the findings from monitoring and any recommendations made by District staff for modifications to methods (i.e., the vegetation management toolbox) and/or to the schedule of preservation and restoration actions. As part of the third step, the annual board report will be presented at a District Board meeting, allowing stakeholders and the community an opportunity for comment on management actions, monitoring results, and recommendations. The fourth and final step is to “adjust”. Based on the lessons learned during the Annual Work Plan implementation, the management actions for the following year(s) will be adjusted and improved. The BFFIP may also be updated or amended on a periodic basis to reflect lessons learned, any reprioritization of projects, and any adjustment of tools and techniques.

1.5 HISTORY OF VEGETATION MANAGEMENT AND CURRENT PRACTICES

1.5.1 History

Virtually the entire Mount Tamalpais Watershed was burned in five major fires occurring between 1881 and 1945. These fires included an 1881 fire that started in Blithedale Canyon and burned about 65,000 acres; an 1891 fire starting in Bill Williams Gulch that burned about 12,000 acres; a 1923 fire that burned about 40,000 acres from Novato to Alpine Lake; and the 1929 Mill Valley Fire that burned about 2,500 acres. The last major fire on the watershed occurred in 1945 and burned approximately 20,000 acres. Several smaller ignitions have occurred historically, even in recent years (District 1994). Additional information on the fire history on MMWD lands is provided in Appendix B.

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In the 1980s, the District began actively working to reduce the risk of another major fire on the watershed. Between 1982 and 1985, the District worked with the Marin County Fire Department (MCFD) and Marin County Parks (MCP) (formerly Marin County Open Space District) to conduct broadcast burns of stands of chaparral on the watershed to reduce fuel loading. Given environmental concerns about the effects of these burns on native chaparral seed banks, the District stopped conducting burns in 1985 until a comprehensive approach combining wildfire risk reduction needs with ecosystem protection goals – The Mount Tamalpais Area Vegetation Plan (District 1994) – was completed.

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Figure 1-1 Adaptive Management Schematic



1 INTRODUCTION

The 1995 VMP took many years to draft and was developed through an extensive public consultation process. The 1995 VMP contained a detailed assessment of fire hazards and recommended a series of fuelbreaks and other vegetation management strategies to address fire hazards. Fuelbreaks were intended to subdivide the Mount Tamalpais Watershed into discrete parts, making it easier to keep a wildfire from moving from one section of the Watershed to another. Fuelbreaks would not stop a major wildfire from occurring under worst-case conditions, but the fuelbreaks would provide safer locations from which to fight a fire under non-extreme conditions. The 1995 VMP also recommended a number of other hazard reduction projects and actions on and off the watershed, including upgrades to fire suppression equipment, staff training, and water distribution lines connected to hydrants.

The 1995 VMP also contained recommendations for mitigating the rapidly expanding invasive weed populations on the watershed. Prior to the adoption of the 1995 VMP, the District's invasive weed control efforts were inconsistent and unfocused. Lakeshore and roadside broom populations were mowed seasonally to maintain recreational and vehicle access, but broom expansion continued largely unabated. With the adoption of the 1995 VMP, the District committed to reducing the spread of broom. Per the 1995 VMP recommendations, the District enacted a largely experimental broom control program of repeated broadcast burning in conjunction with mowing and hand removal. By 2001, the program's success was limited to grassland communities. In woodlands and forested habitat types, the too-frequent burning had adverse effects on trees and other native plants. Broadcast burning also caused substantial weed seed germination, which resulted in an increase in broom as well as other invasive weed species. As a result, the District began limited-scale trials of alternative methods of weed control. The District also tested conventional herbicides, including cut-stump and foliar applications of Pathfinder® (a triclopyr formulation) and Roundup Pro® (a glyphosate formulation), as well as broadcast applications of Transline® (a clopyralid formulation). The District adopted several cultural practices to minimize the spread of invasive weeds including the use of weed-free mulch and other landscape materials, and washing soil off vehicles when moving from known infested sites to uninfested areas (District 1994).

Between 1995 and 1999, the District achieved notable success in reducing non-native trees (eucalyptus, acacia, and pine) and yellow starthistle cover. The reduction was accomplished through a combination of logging, girdling, mowing, prescribed burning, and limited herbicide applications. In 2003, the District adopted an Integrated Pest Management (IPM) program to control and eliminate highly invasive weeds. The IPM program formalized the use of a variety of techniques recommended in the 1995 VMP, and addressed the District's expanding use of

Key Concept

Non-native plants evolved in other geographic regions and were transported to Marin County within recent history. Invasive non-native plants spread rapidly and are likely to cause economic or environmental harm by disrupting native systems.

There are now hundreds of non-native species on the watershed. Many of these species are aggressive invaders, and 30 have been identified as high priority invasive species because of the threat they pose to our economy or our environment. In this plan, these high priority species are also referred to as weeds or invasive weeds.

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herbicides; however, the District suspended the application of herbicides in August 2005 in response to public concerns regarding the safe use of herbicides. That suspension remains in effect as of the publication of this document.

1.5.2 Current Management Practices

The District currently maintains vegetation on the watershed through the physical methods described in the 1995 VMP: prescribed burning, mowing, and hand removal. Methods of fuelbreak maintenance and invasive weed removal are largely variations of mowing, mastication, manual weed removal, and prescribed burning. The District's ability to manage fuelbreaks and invasive weeds has been inhibited by limited resources. As a result, broom and other invasive weeds continue to spread: the 2013 rate of spread for broom was determined to be an average of 56 acres per year (Williams 2014). On the rare occasion that vegetation management actions falling outside the parameters of the 1995 VMP are taken, such as the Resilient Forest study, additional detailed plans and environmental compliance documents are prepared.

1.6 CURRENT PLAN PROCESS

1.6.1 2012 Draft WPHIP

After several years of data collection, community outreach, technical studies, review of herbicide risks, and research on the most effective methods of vegetation management, the District developed a new Draft VMP and released it for public comment in September 2012 under the title Draft Wildfire Protection and Habitat Improvement Plan (WPHIP). The process to prepare an Environmental Impact Report (EIR) pursuant to the California Environmental Quality Act (CEQA) also commenced at that time. The 2012 Draft WPHIP addressed integrated methods for using both limited conventional herbicides and manual and mechanical methods to maintain vegetation on District lands. The 2012 Draft WPHIP presented a toolbox of vegetation management techniques, identified and prioritized actions needed to reach its goals, and identified several individual projects under each prioritized action (District 2012).

The 2012 Draft WPHIP received considerable public scrutiny due to its presentation of one approach to vegetation management that included the limited use of three conventional herbicides. Over the following 3 years, additional evaluation of herbicide risk was undertaken by the District. In 2015, the International Agency for Research on Cancer (IARC), a branch of the World Health Organization, classified the herbicide glyphosate as "probably carcinogenic to humans." In response to increased public concern and regulatory uncertainty resulting from this classification, the District revised its approach and opted to not finalize the 2012 Draft WPHIP with herbicides included in the implementation options.

This BFFIP has instead been developed and is largely based on the manual and mechanical methods presented in the 2012 Draft WPHIP, with the removal of traditional herbicides, and the addition of forest health and greenhouse gas balance actions, and projects.

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1.6.2 Approach to 2019 Draft BFFIP

Use of 2012 Draft WPHIP

The District previously undertook and prepared several background studies and reports to assess watershed management issues during preparation of the 2012 Draft WPHIP. The reports contain background data and were presented to the public at a series of meetings held to gather input during the planning process. Much of the data in these reports remains accurate and is reflective of current conditions and challenges on MMWD's watershed lands. The recommendations in this BFFIP were developed based on the content of District records and data (cited in Chapter 8: References), field trials, and comments received during the development of the 2012 Draft WPHIP.

Next Steps in the Planning Process

The environmental effects of this Draft BFFIP will be assessed in a new Program EIR pursuant to CEQA. The Program EIR also will identify and assess alternatives to the BFFIP, and will be circulated for public review and comment, consistent with CEQA requirements. Any comments received will be addressed and revisions to either the Program EIR or to the Plan may be made to address environmental concerns raised by the public or agencies during the public review period, or other concerns and recommendations that the District believes are warranted. The District will prepare the Final EIR and the final version of this Plan. The Final EIR will be subject to certification by the District's Board of Directors prior to, or concurrent with, the approval of the final BFFIP.

Current Plan Development Team

The 2012 Draft WPHIP was prepared by an interdisciplinary team of independent subject matter experts supported by District staff as well as staff of other public agencies and non-profit organizations.

The consulting team that prepared this 2019 Draft BFFIP included the following:

- Panorama Environmental, Inc.
 - Tania Treis, Principal
 - Caitlin Gilleran, Environmental Scientist
 - Corey Fong, Cartographic Specialist

Substantial support was provided by District staff:

- Shaun Horne, Natural Resources Program Manager
- Andrea Williams, Vegetation Ecologist
- Crystal Yazmen, Facilities and Watershed Division Manager

2 ENVIRONMENTAL SETTING

2.1 DISTRICT LANDS

2.1.1 Plan Area

The BFFIP addresses vegetation management on three administrative units owned by the District: the Mount Tamalpais Watershed, the Nicasio Reservoir, and the Soulajule Reservoir (see Figure 2-1 and Figure 2-2). The term "Watershed" is used in this Plan to describe the administrative unit that includes much of Mount Tamalpais. The term "watershed" using a lower-case "w" refers to a hydro-geographic feature. Reservoirs on the first two units (Mount Tamalpais Watershed and Nicasio Reservoir) provide about 75 percent of the water that the District supplies to its customers. The balance is imported from the Russian River. Soulajule Reservoir is not regularly used for water supply, but is available in the case of a severe drought.

In addition to providing a source of municipal water and preserving important natural resources, District lands serve as a valuable scenic and recreational open space resource. Hikers, horseback riders, joggers, bicyclists, anglers, picnickers, birders, naturalists, and other visitors frequently use District lands, especially the Mount Tamalpais Watershed. District lands are open to the public during daylight hours. The public may access all reservoir shorelines for fishing, including Nicasio and Soulajule Reservoirs.

2.1.2 Mount Tamalpais Watershed

The Mount Tamalpais Watershed lies within the Mediterranean climate region of California that consists of wet, mild winters and warm, dry summers. Located in central Marin County, elevation ranges from 80 feet to 2,571 feet. Topography is characterized by "V"-shaped valleys located between narrow ridge crests, though there are areas with more gently rolling hills, primarily around Bon Tempe and Alpine Lakes. The Watershed supports a rich variety of vegetation communities, ranging from grasslands to chaparral, oak woodland, and redwood forests. Vegetative communities provide habitat for a wide range of wildlife, including a number of plants and animals with regulatory protections. The Watershed supports approximately 40 special-status plant species within 88 distinct plant assemblages as defined by the National Vegetation Classification System (CNPS 2014).

The District owns approximately 18,900 acres of watershed on Mount Tamalpais, (see Figure 2-1). The large swath of MMWD property is adjacent to other large open space and recreational lands including Mount Tamalpais State Park, the Golden Gate National Recreation Area (GGNRA), Point Reyes National Seashore, Muir Woods National Monument, Samuel P. Taylor State Park, several Marin County Open Space Preserves, and numerous other local city

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and county park lands. Taken together, these parklands comprise over 150,000 acres of contiguous protected public lands in central and western Marin County. The many creeks that have their headwaters in the Watershed flow either into San Francisco Bay, Tomales Bay, or directly into the Pacific Ocean. The four land management agencies that protect the Mount Tamalpais watershed (MMWD, Marin County Parks [MCP], California State Parks [State Parks], and National Park Service [NPS]) along with the Golden Gate National Parks Conservancy form a partnership called the Tamalpais Land Collaborative (TLC) (GGNPC 2015). This partnership combines the expertise and resources of those agencies with increased philanthropic capacity to help ensure a healthy future for not only MMWD's Watershed lands, but other county, state, and federal lands in the broader Mount Tamalpais area.

The Mount Tamalpais Watershed contains the drainage areas for five reservoirs, and includes the entire upper watershed of Lagunitas Creek and much of Mount Tamalpais itself. This administrative unit also includes lands just outside or adjacent to the communities of Lagunitas, Forest Knolls, San Geronimo, Woodacre, Fairfax, San Anselmo, Ross, Kentfield, Larkspur, Corte Madera, and Mill Valley (see Figure 2-1). The District's four main water supply reservoirs on the Watershed are located in the Lagunitas Creek watershed (Lagunitas, Bon Tempe, Alpine, and Kent Lakes). Phoenix Lake is located on Ross Creek, which is a tributary of Corte Madera Creek. This small reservoir is rarely used to supply water, but is available in case of severe drought.¹

2.1.3 Nicasio Reservoir

Nicasio Reservoir is located on Nicasio Creek in Nicasio Valley to the north of the Mount Tamalpais Watershed (see Figure 2-2). The 845-acre reservoir is an active component of the District's water supply. The District owns a relatively small 787-acre ring of land bordering the reservoir. Most of the 23,000-acre watershed that drains into the reservoir is in private ownership and includes dairy farms, ranches, and rural residential development. The reservoir is easily accessed by Point Reyes-Petaluma Road and Nicasio Valley Road, and is an important part of the viewshed for nearby landowners and passersby. The topography of the District's land around Nicasio Reservoir is relatively flat with a few small hilly areas, since the reservoir occupies what was once a wide valley bottom. The surrounding lands support grassland and shrub plant communities, as well as several special-status plant species. Recreational use is mainly limited to fishing, although there are some trails for hiking.

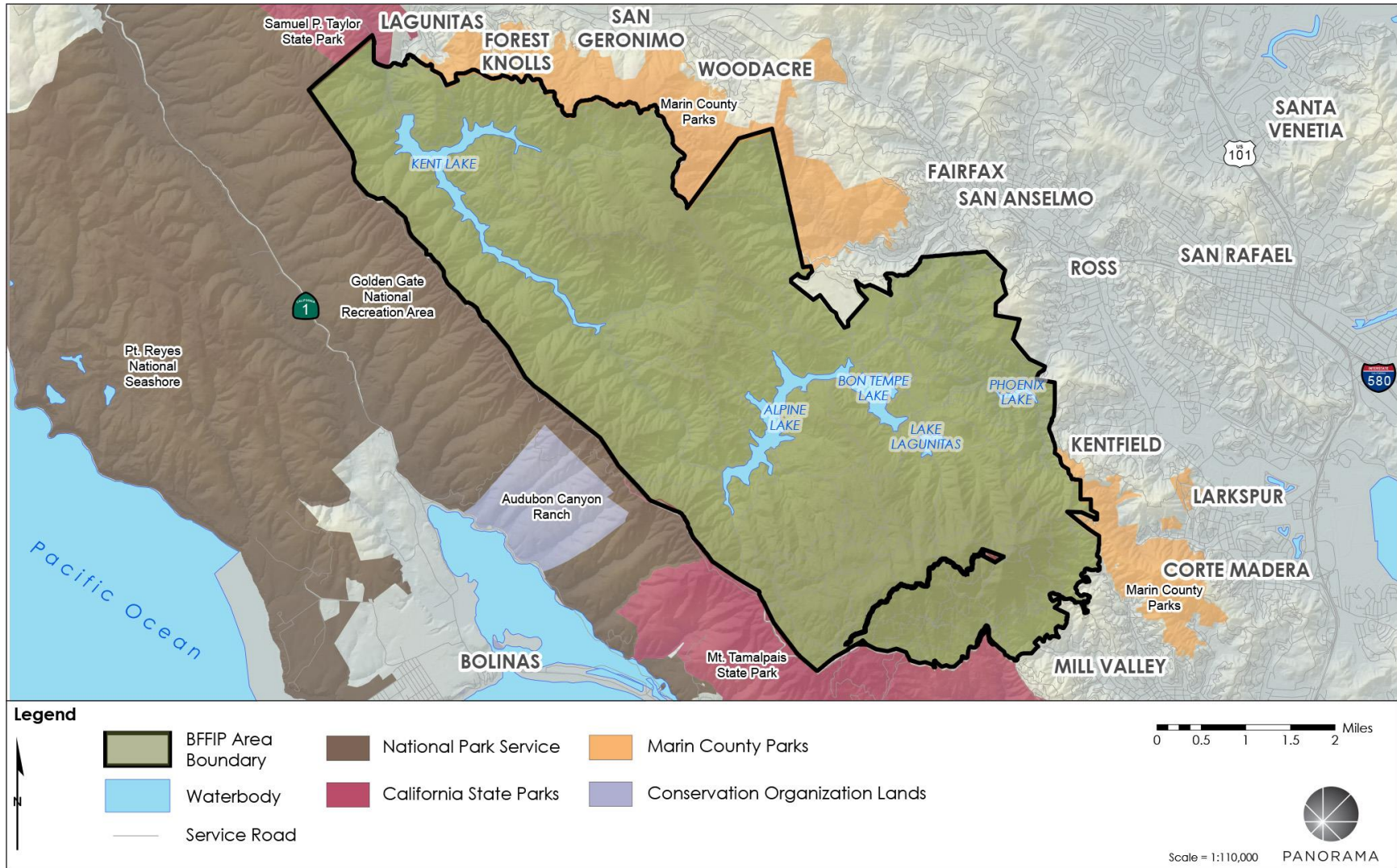
2.1.4 Soulajule Reservoir

Soulajule Reservoir is on the Arroyo Sausal branch of Walker Creek to the north of Nicasio Reservoir (see Figure 2-2). As is the case for the Nicasio Reservoir, the District owns a narrow band of land of about 810 acres surrounding the roughly 290-acre reservoir. Most of the watershed is in private ownership and includes ranching land and scattered rural residential development. The District-owned land is a mosaic of grassland, shrubland, and oak woodland.

¹ Water was drawn from Phoenix Lake in 2012 and 2014.

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Figure 2-1 Lands Managed by Marin Municipal Water District



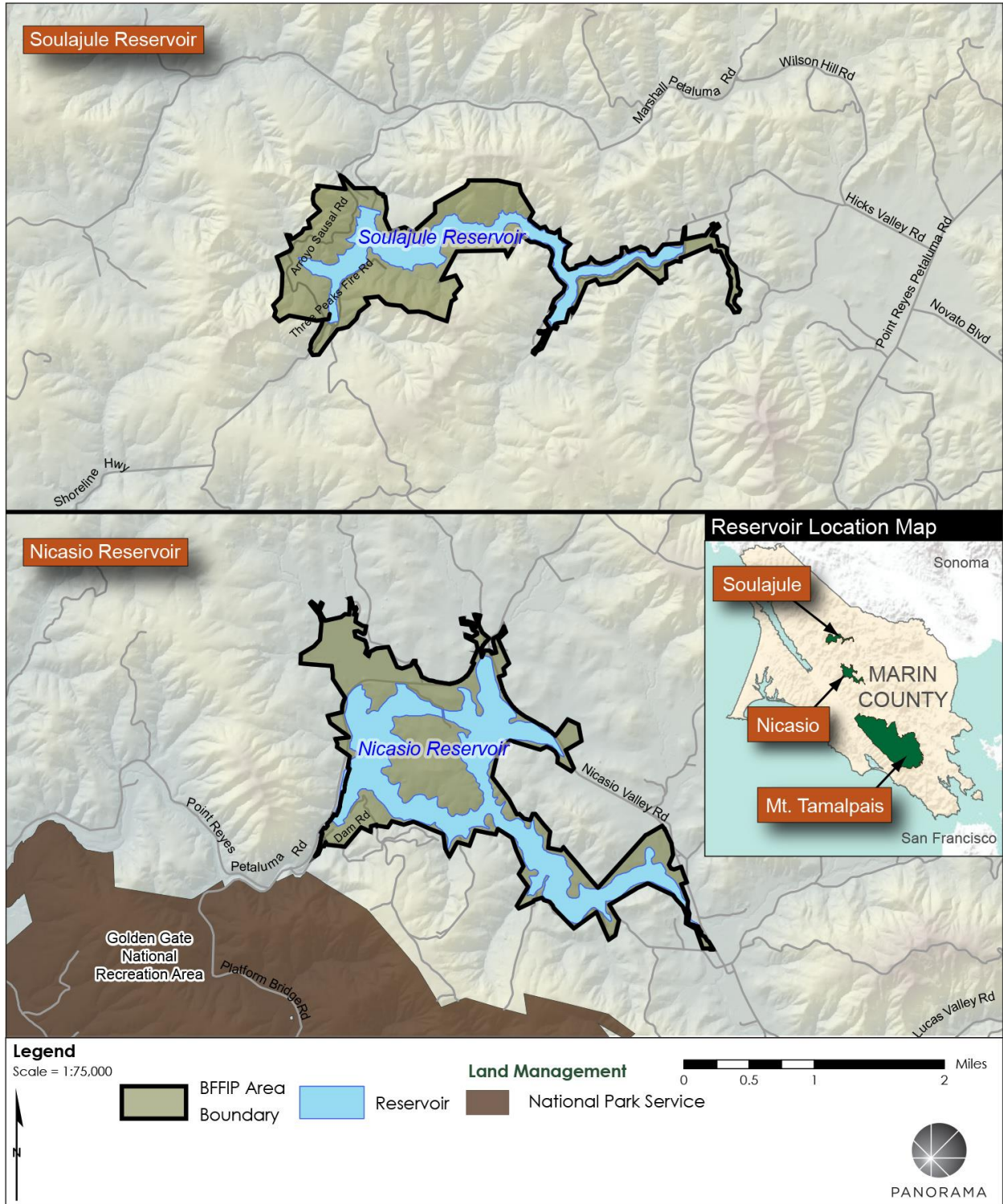
Sources: (Marin County, 2009; ESRI, 2016; USGS, 2016)

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2 ENVIRONMENTAL SETTING

Figure 2-2 Lands Managed by Marin Municipal Water District



Sources: (Marin County, 2009; ESRI, 2016; USGS, 2016)

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The reservoir is located down a gated, partially paved road off Marshall-Petaluma Road. The reservoir is publicly accessible, although its remote location and minimal amenities contribute to its low visitorship. It is not a significant part of the viewshed for many people. It is primarily used by anglers.

2.2 SURROUNDING BUILT ENVIRONMENT

Over 25,000 structures housing approximately 45,000 residents are within 2 miles of the Mount Tamalpais Watershed along a wildland-urban interface (WUI) that has a California Department of Forestry and Fire Protection (CAL FIRE) rating of “High” to “Very High” (CAL FIRE 2007). Six incorporated cities (Corte Madera, Fairfax, Larkspur, Mill Valley, Ross, and San Anselmo) and six unincorporated communities (Forest Knolls, Kentfield, Lagunitas, San Geronimo, Stinson Beach, and Woodacre) are adjacent to Watershed lands (Figure 2-3). Fire can spread rapidly throughout WUI areas through adjacent structures and/or vegetation, or by ember dispersion. As documented in the Marin County Fire Department’s (MCFD) recent Community Wildfire Protection Plan, property owners in the WUI have a responsibility to prepare their property for structure defense by providing adequate defensible space and complying with WUI building codes and ordinances (MCFD and FIRESafe Marin 2016).

Wildland-Urban Interface

The Wildland-Urban Interface, or WUI, refers to the area where houses and other structures are built close to, or intermingled with, undeveloped wildlands.

The WUI poses significant concern, in the event of fire, as it combines the characteristics of wildlands (where larger fires generally occur) and developed areas (where lives, homes, and property are vulnerable).

In Marin, many neighborhoods fall within this interface, making vegetation management to minimize fire hazard a high priority.

2.3 INFRASTRUCTURE ON WATERSHED LANDS

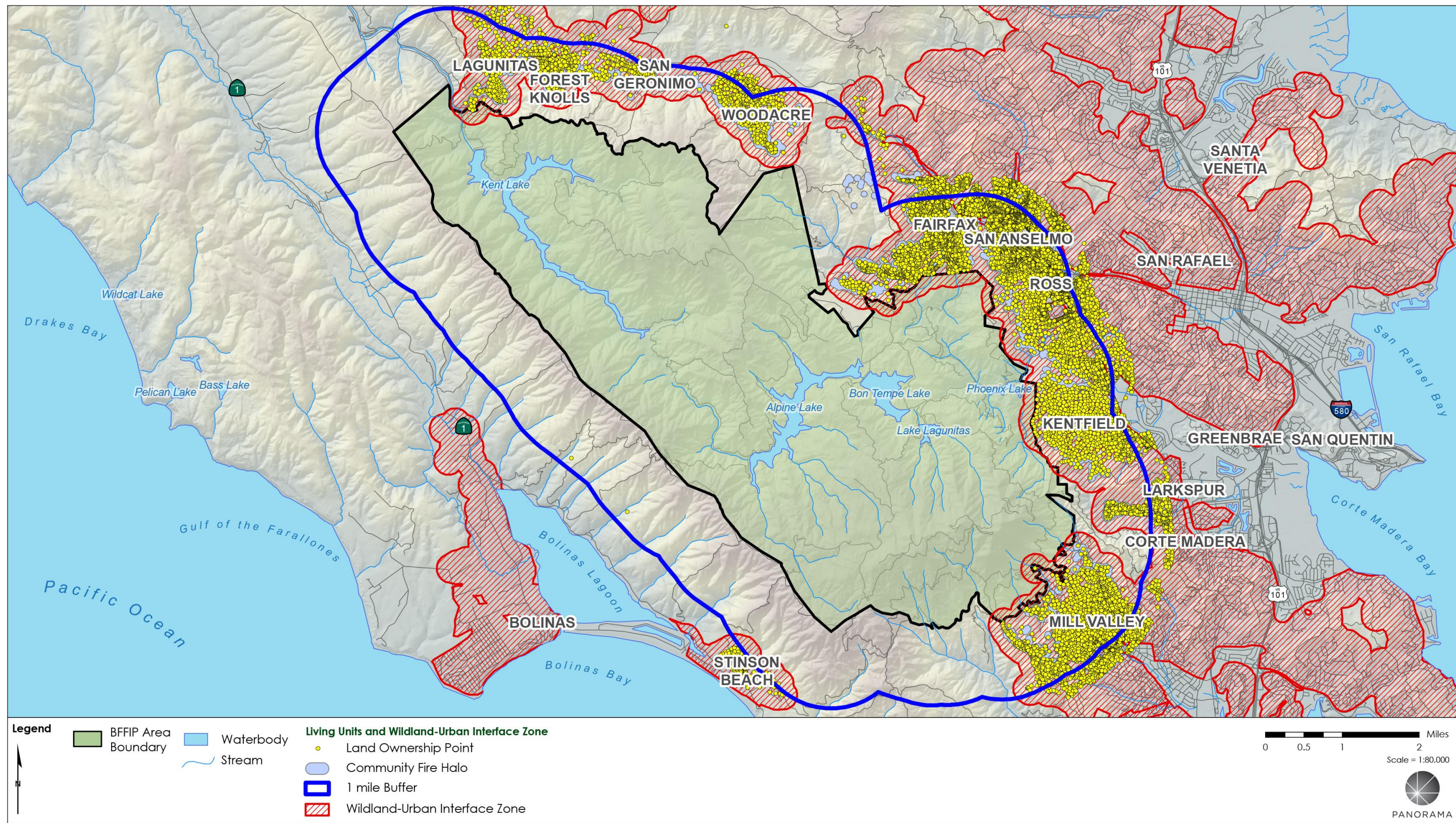
2.3.1 Mount Tamalpais Watershed

Water Supply Infrastructure and Other Facilities

The District owns and manages other water supply, administrative, and recreational infrastructure within the Mount Tamalpais Watershed beyond the five reservoirs. Water supply infrastructure includes the Bon Tempe treatment plant, dams, steel tanks and other facilities for potable water storage, water pumps, compressors, aerators, pipelines, tunnels, water intake and overflow structures, and the buildings associated with that infrastructure. The District also owns visitor serving facilities, administrative and operational facilities, and historic facilities. Visitor serving facilities include picnic areas, convenience stations, parking areas, and

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Figure 2-3 Map of WUI



Sources: (ESRI, 2017; Marin Municipal Water District Sky Oaks Watershed HQ, 2014; USGS, 2012; Fire Departments and Fire Districts in Marin County; California Department of Forestry and Fire Protection, 2017)

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2 ENVIRONMENTAL SETTING

leased visitor serving facilities, including the West Point Inn and the Marin Stables.² Administrative and operation facilities include the Sky Oaks Watershed Headquarters, five ranger residences, buildings for storage and communication, boat ramps, and facilities that are owned by a third party who has entered into a lease or easement with the District, including Federal Aviation Administration (FAA) telecommunication buildings, telecommunication lines, and power lines owned by Pacific Gas and Electric (PG&E).³ Historic facilities include the Porteous Ranch log cabin and old dam buildings.

Figures 2-4 through 2-7 show the location of the water supply infrastructure, other facilities owned by the District, and facilities on District lands that are owned by third parties.

Service Roads and Trails

District lands support nearly 100 miles of service roads and over 110 miles of maintained trails. All roads are open to all user types. All trails are open to hikers. A small number of trails are open to horses. Bikes are restricted to service roads. Figures 2-4 through 2-7 shows the network of service roads and trails.

Built Fuelbreaks and Fuel Reduction Zones

Since the adoption of the 1995 VMP, the District has completed approximately 900 acres of fuel load reduction projects. Nearly half of the acreage is defensible space around MMWD and third party-maintained structures and utilities, as well as reduced fuel corridors along strategic service roads and ridgelines (see Figures 2-4 through 2-7). Vegetation in these infrastructure-associated fuelbreaks is visibly and functionally different from the surrounding unmodified vegetation. To reduce fire intensity and spread in the event of an ignition, the District has removed dead material, thinned canopies, and cleared brush along these permanent fuelbreaks, per 1995 VMP prescriptions (District 1994). These fuelbreaks are subject to regular maintenance brushing (brush cutting).

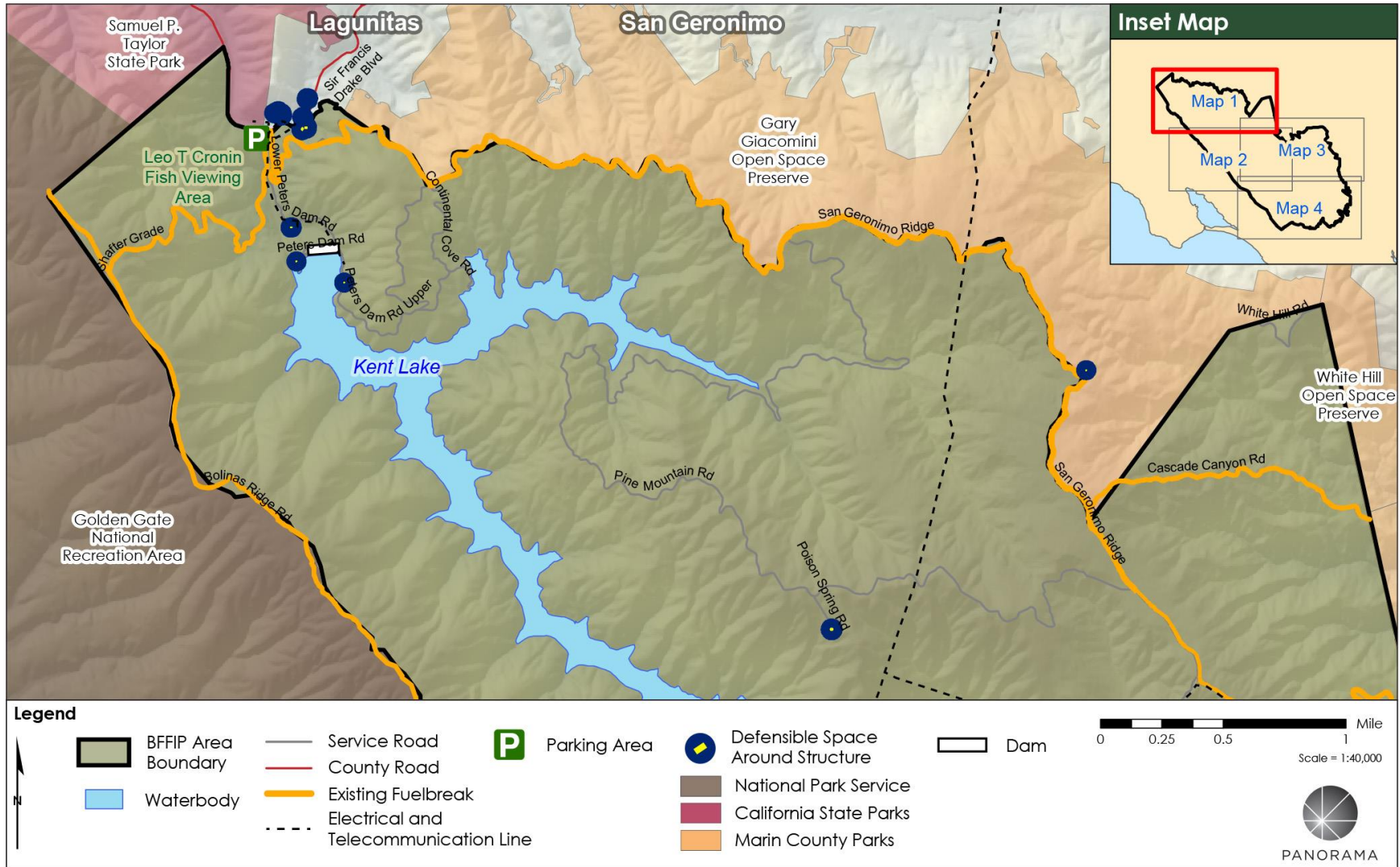
The other half of fuel load reduction acreage includes work conducted within wider areas of habitat and adjacent to infrastructure-bordering fuelbreaks. The District has reduced accumulated fuels across grassland, woodland, and forest habitat in these wider areas to achieve a combination of wildfire risk reduction and habitat enhancement (e.g., invasive weed control).

² The West Point Inn and Marin Stables are owned by the District but are leased to third parties. The responsibility of vegetation management to help protect the leased infrastructure lies with the leaseholder, and the requirement for vegetation management and defensible space would be written into the lease or lease renewal.

³ It is the responsibilities of third parties to operate and maintain their facilities, including the maintenance of fuelbreaks around communication line and power line poles.

2 ENVIRONMENTAL SETTING

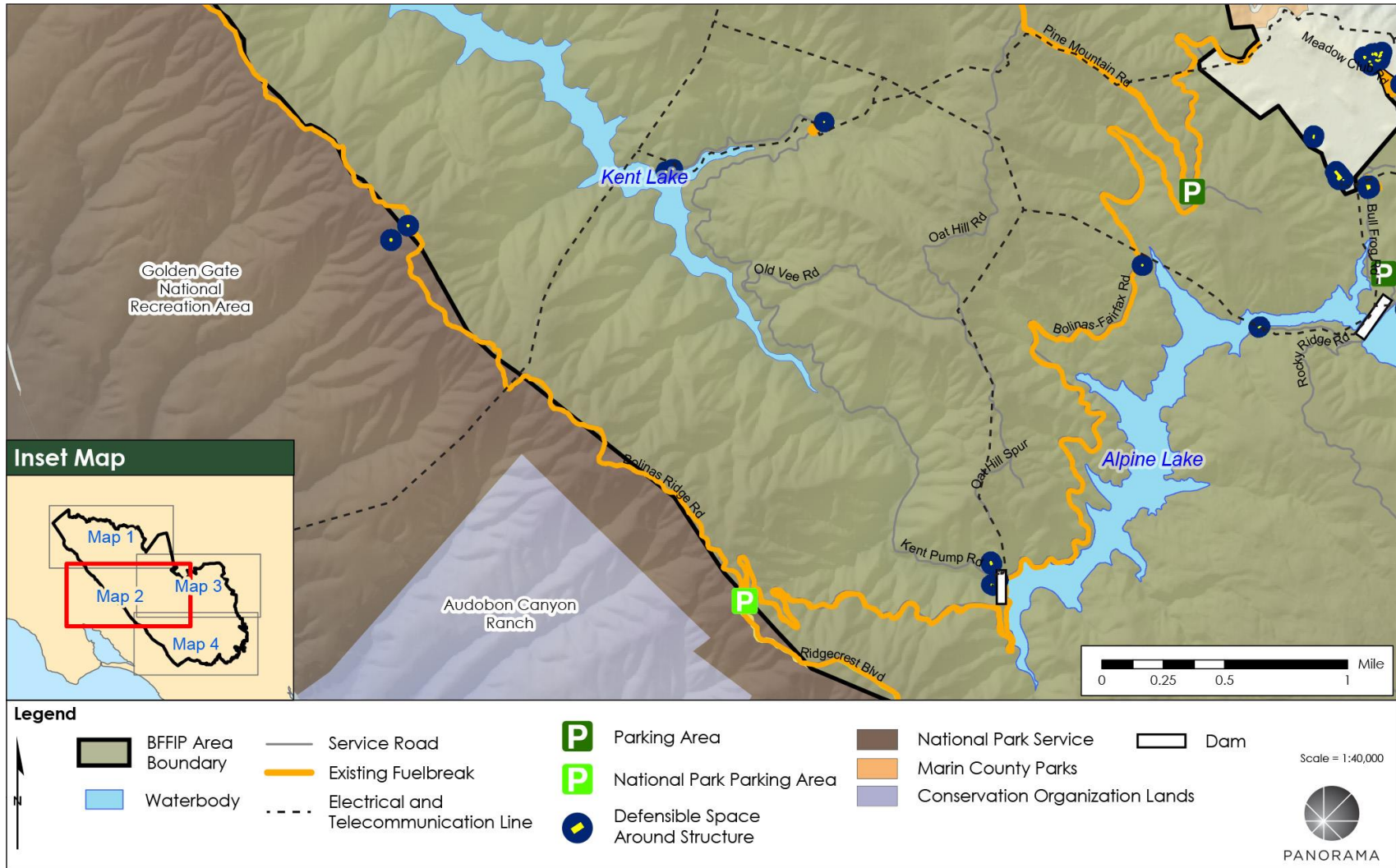
Figure 2-4 Map of Roads, Trails, and Facilities in the Mount Tamalpais Watershed (Map 1 of 4)



Sources: (ESRI, 2016; USGS, 2016; MarinMap (VarGIS), 2009)

2 ENVIRONMENTAL SETTING

Figure 2-5 Map of Roads, Trails, and Facilities in the Mount Tamalpais Watershed (Map 2 of 4)

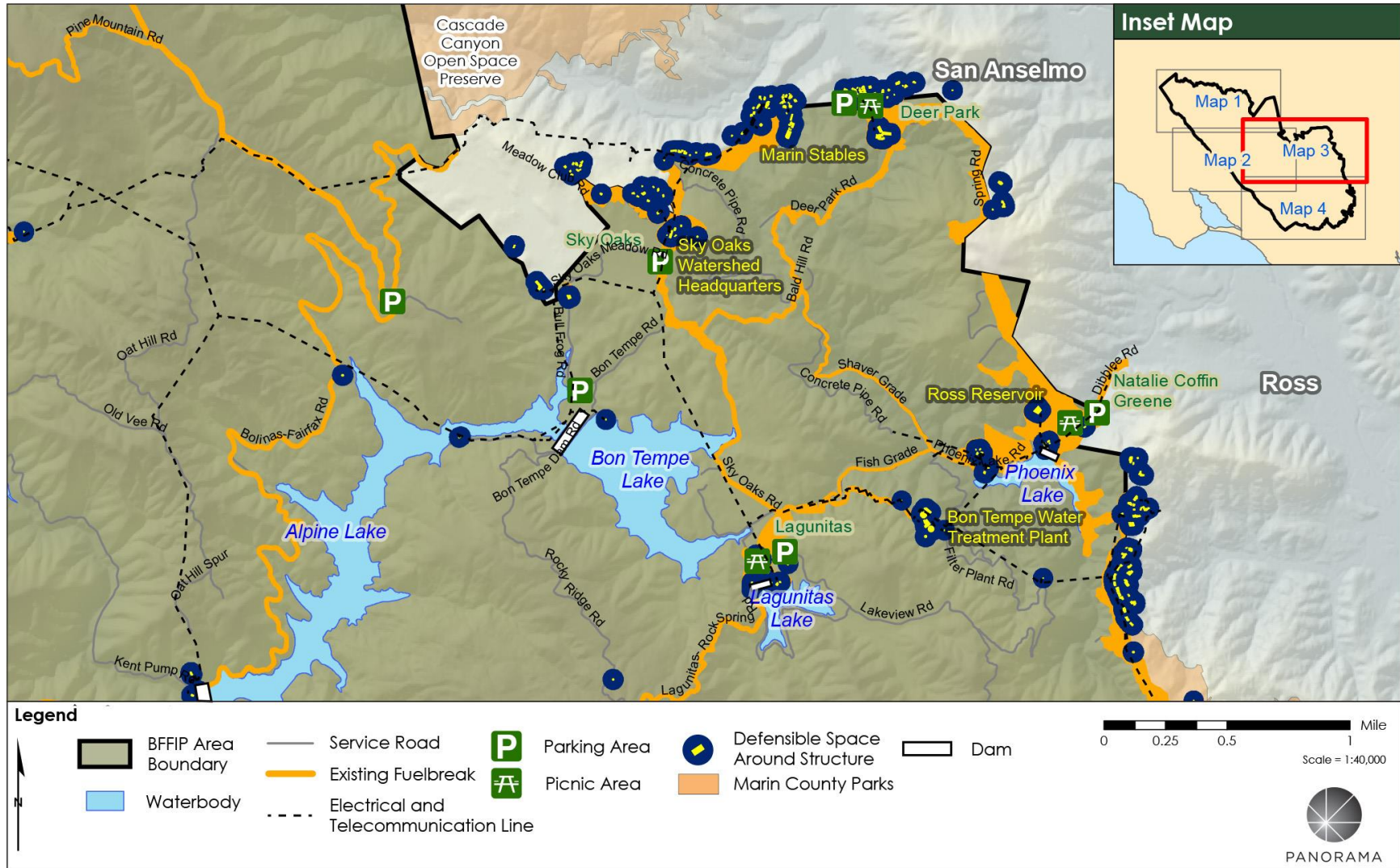


Sources: (ESRI, 2016; USGS, 2016; MarinMap (VarGIS), 2009)

The Bolinas-Fairfax fuelbreak is not District responsibility.

2 ENVIRONMENTAL SETTING

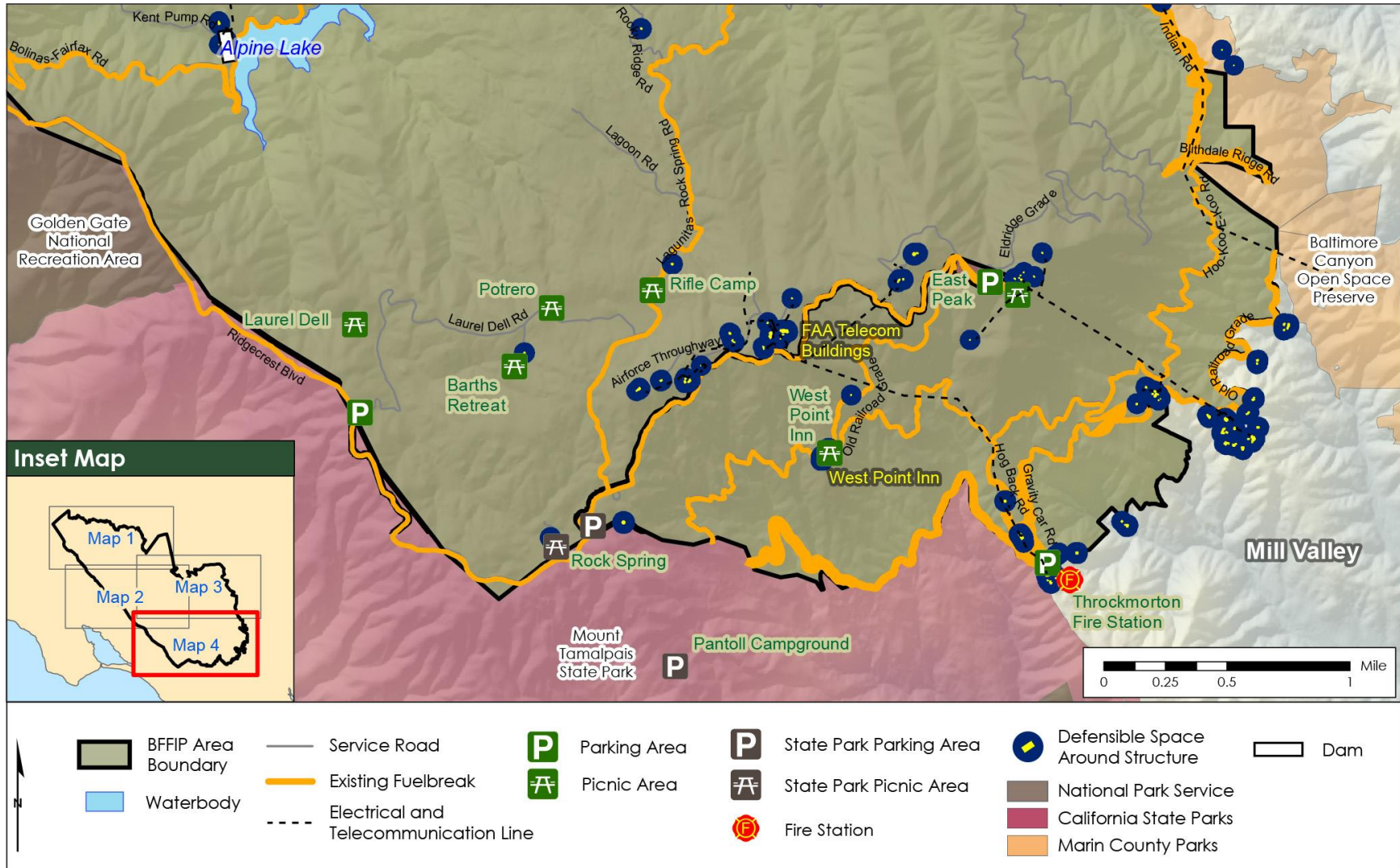
Figure 2-6 Map of Roads, Trails, and Facilities in the Mount Tamalpais Watershed (Map 3 of 4)



Sources: (ESRI, 2016; USGS, 2016; MarinMap (VarGIS), 2009)

2 ENVIRONMENTAL SETTING

Figure 2-7 Map of Roads, Trails, and Facilities in the Mount Tamalpais Watershed (Map 4 of 4)



Sources: (ESRI, 2016; USGS, 2016; MarinMap (VarGIS), 2009)

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2.3.2 Nicasio and SoulaJule Reservoirs

Water Supply Infrastructure and Other Facilities

Most of the District-owned land adjacent to the Nicasio and SoulaJule Reservoirs is composed of natural areas. Water supply infrastructure includes dams, pump stations, compressors, service roads and electrical lines (see Figure 2-8). One parking area is located at SoulaJule Reservoir (see Figure 2-8).

Service Roads and Trails

Nicasio and SoulaJule Reservoirs are mostly served by existing roadways, some of which are not owned or managed by the District. The service roads that are owned by the District and located at the reservoirs are shown in Figure 2-8. At Nicasio Reservoir, the service roads located on District lands are not accessible for public use, except for Point Reyes-Petaluma Road. Some hiking trails are located on District-owned lands adjacent to Nicasio Reservoir (see Figure 2-8). The service roads adjacent to SoulaJule Reservoir are used as hiking trails; however, no official hiking trails are located on District-owned land adjacent to SoulaJule Reservoir.

Built Fuelbreaks and Fuel Reduction Zones

No built fuelbreaks or fuel reduction zones are located on District-owned lands adjacent to the Nicasio Reservoir. The District maintains fuel reduction zones around facilities and the ranger residence at SoulaJule Reservoir.

2.4 BIOLOGICAL RESOURCES, HYDROLOGY, FUNCTIONS, AND VALUES

2.4.1 Introduction

The rich biodiversity on District lands provides vital ecological services, biological resources, and social benefits. These lands provide diverse and high-quality habitat; create an excellent water supply; protect soils and prevent erosion; mitigate climate change with carbon storage;



Grassland along Worn Springs Road with the forested slopes of Mount Tamalpais in the distance (Photo: MMWD).

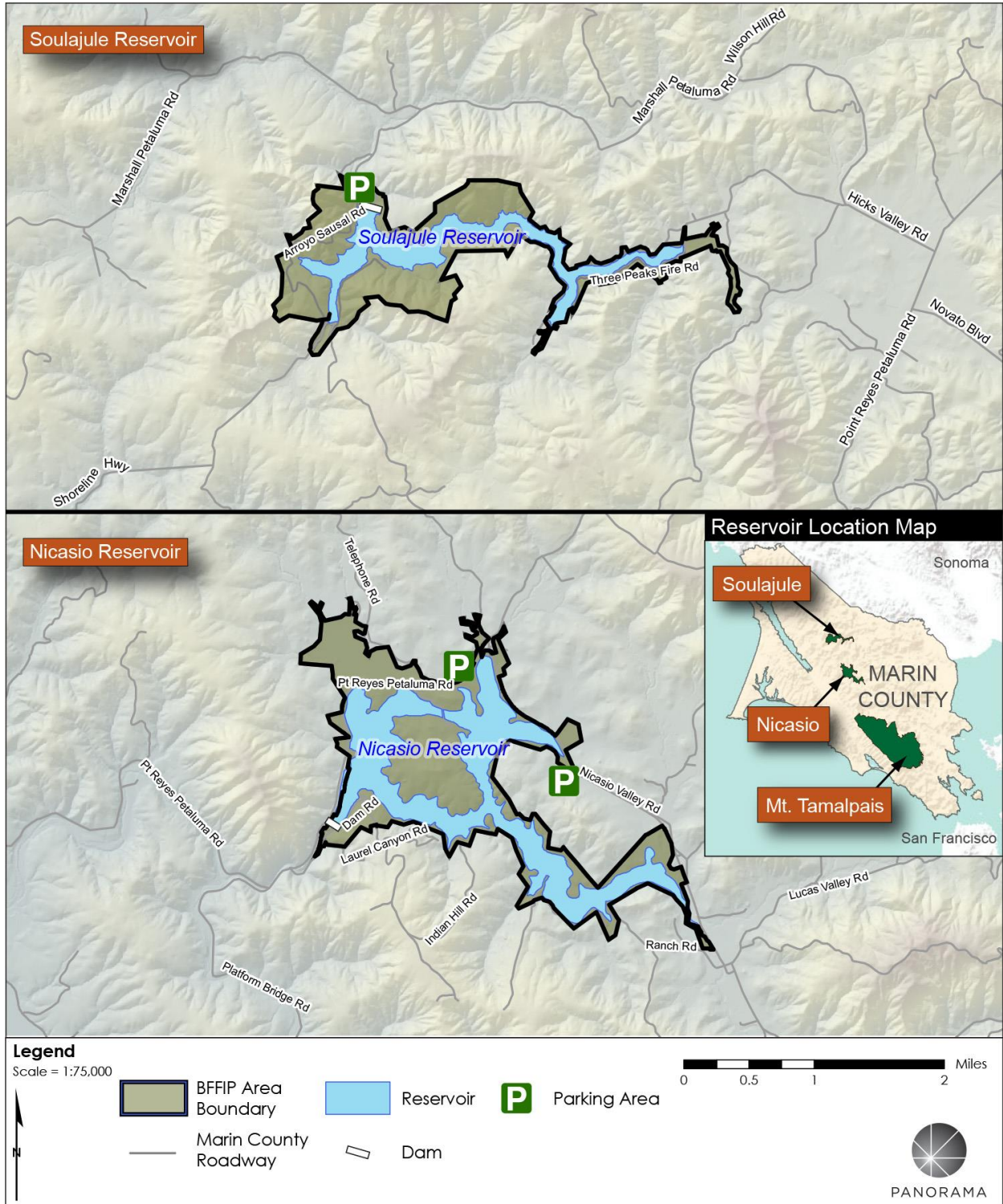
provide a scenic natural landscape for recreation; offer a source for research and education; provide an aesthetically pleasing setting for neighboring towns; and contribute to the biodiversity of the Bay Area region and California as a whole.

The District's knowledge of the natural resources supported by its watershed lands is derived from historic records, museum specimens, and systematically collected field data from the District's extensive inventory and monitoring programs. Field data comes from a combination of researchers, consultants, District staff and skilled volunteers.

To date, the District has systematically inventoried and described its terrestrial vascular flora (both at a species and a community scale), aquatic vegetation, lichens, weeds, song birds, and larger mammals (wood rats and little brown bats through puma). Monitoring programs are in

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Figure 2-8 Map of Roads, Trails, and Facilities at Nicasio and SoulaJule Reservoirs



Sources: (ESRI, 2016; USGS, 2016; MarinMap (VarGIS), 2009)

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place to detect changing conditions for resources of particular interest including vegetation community structure and forest health, song birds, northern spotted owls, osprey, western pond turtles, foothill yellow-legged frogs, and the Lagunitas Creek run of Coho salmon and steelhead trout. A list of summary reports and online datasets can be found in Appendix C.

2.4.2 Biological Resources

The total number of species within District lands is unknown, but it includes over 1,000 species of vascular plants, over 200 species of lichens, and at least 400 species of vertebrate animals. Many more species of fungi, non-vascular plants, and invertebrates such as insects and other arthropods occur within District lands. District lands are included within the Golden Gate Biosphere Reserve, created by UNESCO in 1988, because they support high levels of biodiversity in a large-scale landscape that is protected from development (District 2012a).

Habitats within the District’s lands are very diverse and include (AIS 2015):

- Hardwood forests – approximately 5,099 acres
- Non-redwood conifer forests – approximately 4,035 acres
- Redwood forests – approximately 3,873 acres
- Serpentine chaparral – approximately 810 acres
- Non-serpentine chaparral – approximately 1,530 acres
- Grasslands – approximately 1,344 acres
- Oak woodland – approximately 1,200 acres
- Riparian woodland – approximately 474 acres
- Shrubland – approximately 139 acres
- Wetland – approximately 20 acres

Biological resources of special significance or importance are described briefly in Table 2-1. The table identifies species and habitats currently known to occur or currently listed as sensitive by resource agencies. The numbers and statuses of species may change over the life of the BFFIP, and sensitive species may be present outside of mapped areas. Figures 2-9 through 2-17, provided at the end of this chapter, show the locations of significant biological resources. Appendix D includes a full list of the special-status plant and wildlife species known to occur on District lands.

Table 2-1 Biological Resources on District Lands

Resource	Description
Special-status plants	Forty-four taxa of special-status plants have been documented as occurring or potentially occurring on District lands. Four of these 44 taxa are federally or state listed as rare, threatened or endangered; but only three of these four taxa have been confirmed as being present on District lands.
Special-status vegetation types	A total of 59 alliances and 90 associations have been identified in the Classification of Vegetation Associations from the Mount Tamalpais Watershed, Nicasio Reservoir, and Soulajule Reservoir. Of those, 11 associations were assigned globally rare rankings (G1 or G2) under the Natural Heritage Assessment Methodology.

2 ENVIRONMENTAL SETTING

Resource	Description
Special habitats	In addition to the special-status species and vegetation types, wetlands and aquatic resources previously described, this Plan identifies additional habitats that are defined as either "important" or "high-quality." On District lands, these habitats include oak woodlands, maritime and serpentine chaparral, native grasslands, and old-growth redwood forests.
Wetlands and aquatic resources	Examples of wetland types found on District lands include seasonal wetlands, seeps, springs, and marshes. Aquatic resources include streams, ponds, lakes and reservoirs, and other habitats characterized by open water.
Special-status invertebrates	Nine species of special-status invertebrates have been identified as occurring or potentially occurring on District lands. These invertebrates include one shrimp species, two snail species, two spiders, one butterfly species, and three bee species.
Special-status fish	Three species of special-status fish occur on the District lands, including Coho salmon, steelhead, and Tomales roach.
Special-status amphibians and reptiles	Four special-status amphibians and reptiles occur on District lands, including California giant salamander, California red-legged frog, foothill yellow-legged frog, and western pond turtle.
Special-status bird species	Twenty special-status birds have been identified as using District lands. The entire watershed is listed as Critical Habitat for the northern spotted owl by the USFWS.
Special-status mammals	Ten species of special-status mammals have been identified as occurring or potentially occurring on District lands. These mammals include eight species of bats.

Source: CNPS 2014, CDFW 2016, District 2012b, Ettliger 2012, AIS 2015

2.4.3 Hydrology

The District's lands are located in a Mediterranean climate area, characterized by wet, mild winters and warm, dry summers. The annual average rainfall is 30 inches. Net runoff into the five reservoirs (Lake Lagunitas, Phoenix Lake, Alpine Lake, Bon Tempe Lake, and Kent Lake) on the Mount Tamalpais Watershed is highly variable and has been as high as 220,000 acre-feet 1983 season and as low as 4,100 acre-feet in 1977 season (District 2016).

There are no high-yield groundwater basins under District lands due to a lack of substantial underlying confined groundwater aquifers (District 2016). Groundwater is found in Franciscan Formation (bedrock) fractures and in shallow alluvial deposits in valleys within District lands (District 2016). The District explored the feasibility of groundwater use in the 1970s and 2004 and, in both cases, found the source to be very limited (District 2016).

Surface water hydrology includes:

- Seven reservoirs (Lake Lagunitas, Phoenix Lake, Alpine Lake, Bon Tempe Lake, Kent Lake, Nicasio Reservoir, and Soulajule Reservoir)
- Numerous streams, of which the major resources are Lagunitas Creek, Redwood Creek, Corte Madera Creek, and Arroyo Corte Madera del Presidio

2 ENVIRONMENTAL SETTING

Water quality in the watershed is generally very good (District 2016). Five of the seven reservoirs are located in a District-owned and -protected watershed (Mount Tamalpais Watershed), which substantially reduces the potential for contamination. The other two reservoirs are located in rural areas with low population densities that are maintained by strict zoning requirements and are covered by Watershed Protection Agreements (District 2016).

2.4.4 Functions and Values

Habitat

Within the numerous habitats on District lands are a rich diversity of plants and wildlife that have adapted to the local ecosystem. Native habitat and associated native species offer important functions, including clean water, clean air, and a stable, healthy ecosystem that can recover from destructive events.

Hydrology

The hydrology on the watershed is protected by native vegetation that minimizes erosion. Any pollutants and sediments that make their way into the watershed are processed and filtered from the water as it moves through wetlands and riparian areas. The healthy ecosystem, therefore, benefits and positively impacts hydrology and water quality on the watershed, which in turn benefits plants and wildlife and the drinking water supply.

Greenhouse Gases storage

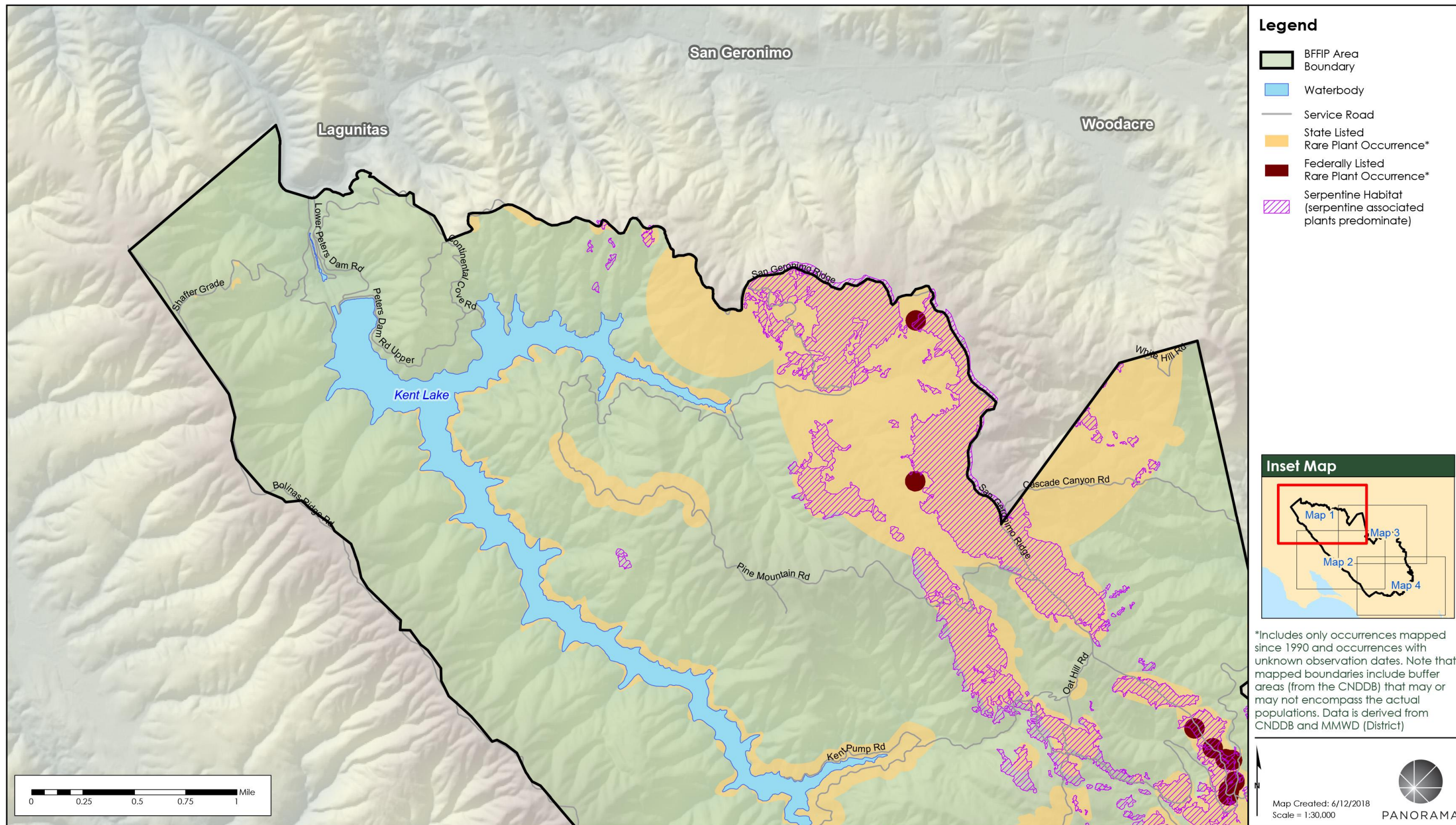
Carbon dioxide (CO₂) is a greenhouse gas associated with climate change. Forests, and to a lesser extent, grasslands convert atmospheric CO₂ into biomass and provide a place to store this greenhouse gas. The forests and grasslands (the biomass) on District lands encompass approximately 18,000 acres and fulfill the important function of storing atmospheric CO₂. Redwood forests also absorb atmospheric methane (CH₄), another potent greenhouse gas.

Resiliency

Resiliency is defined as an ecosystem's ability to absorb shocks or perturbations and still retain desirable ecological functions such as the ability to provide breeding and foraging habitat for wildlife, the ability to support significant biological resources such as rare, threatened, or endangered species, the ability to regenerate desired plant communities following a disturbance, the ability to cycle nutrients, and the ability to protect water quality (Walker et al. 2004). The diverse biological resources summarized in Table 2-1 create a resilient ecosystem with certain processes, functions, and values that have evolved over many years.

2 ENVIRONMENTAL SETTING

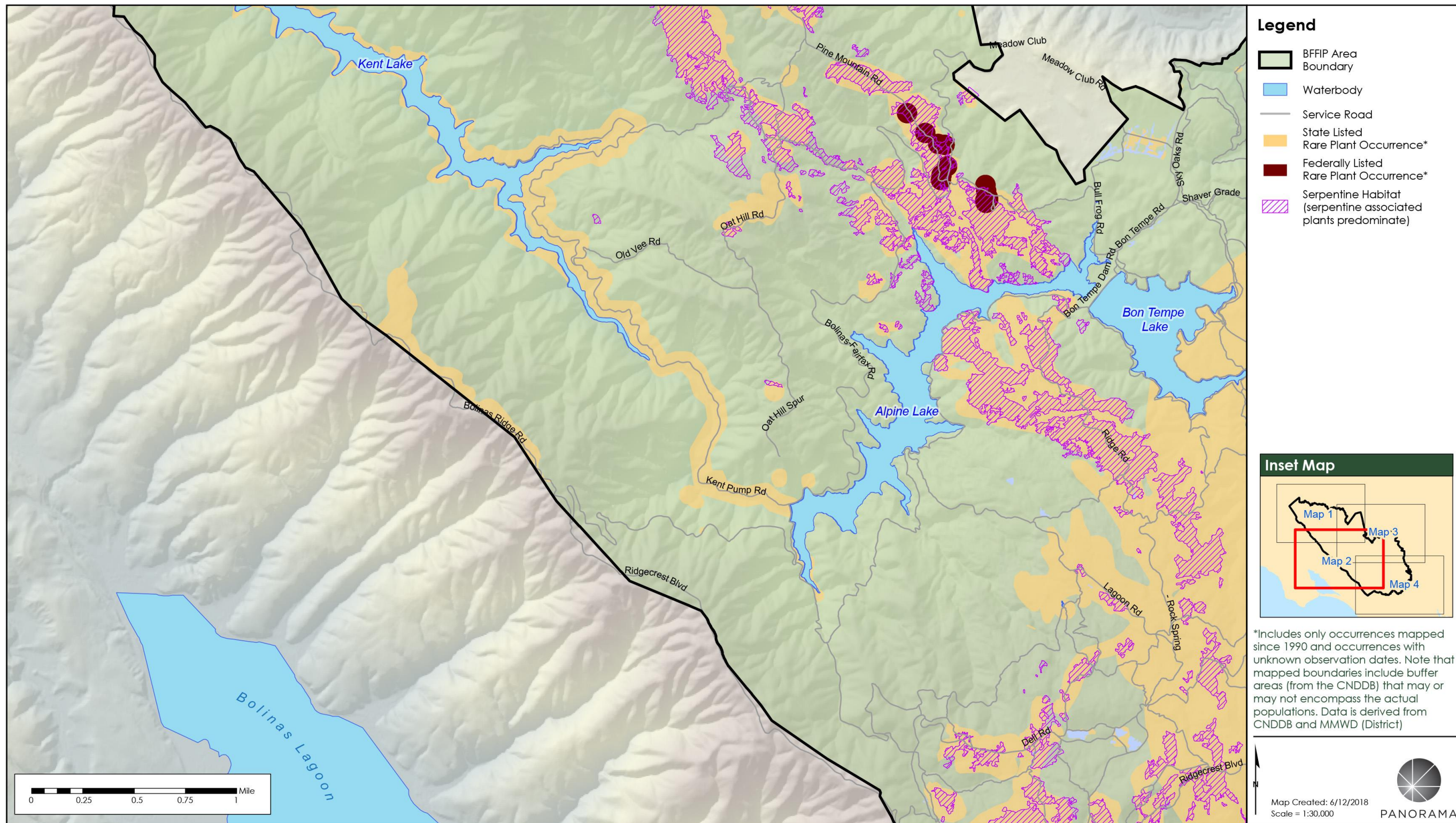
Figure 2-9 Occurrences of Special-Status Plants in the Mount Tamalpais Watershed (Map 1 of 4)



Source: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013a; Marin Municipal Water District Sky Oaks Watershed HQ, 2014a; Marin Municipal Water District Sky Oaks Watershed HQ, 2014c; CDFW, 2014)

2 ENVIRONMENTAL SETTING

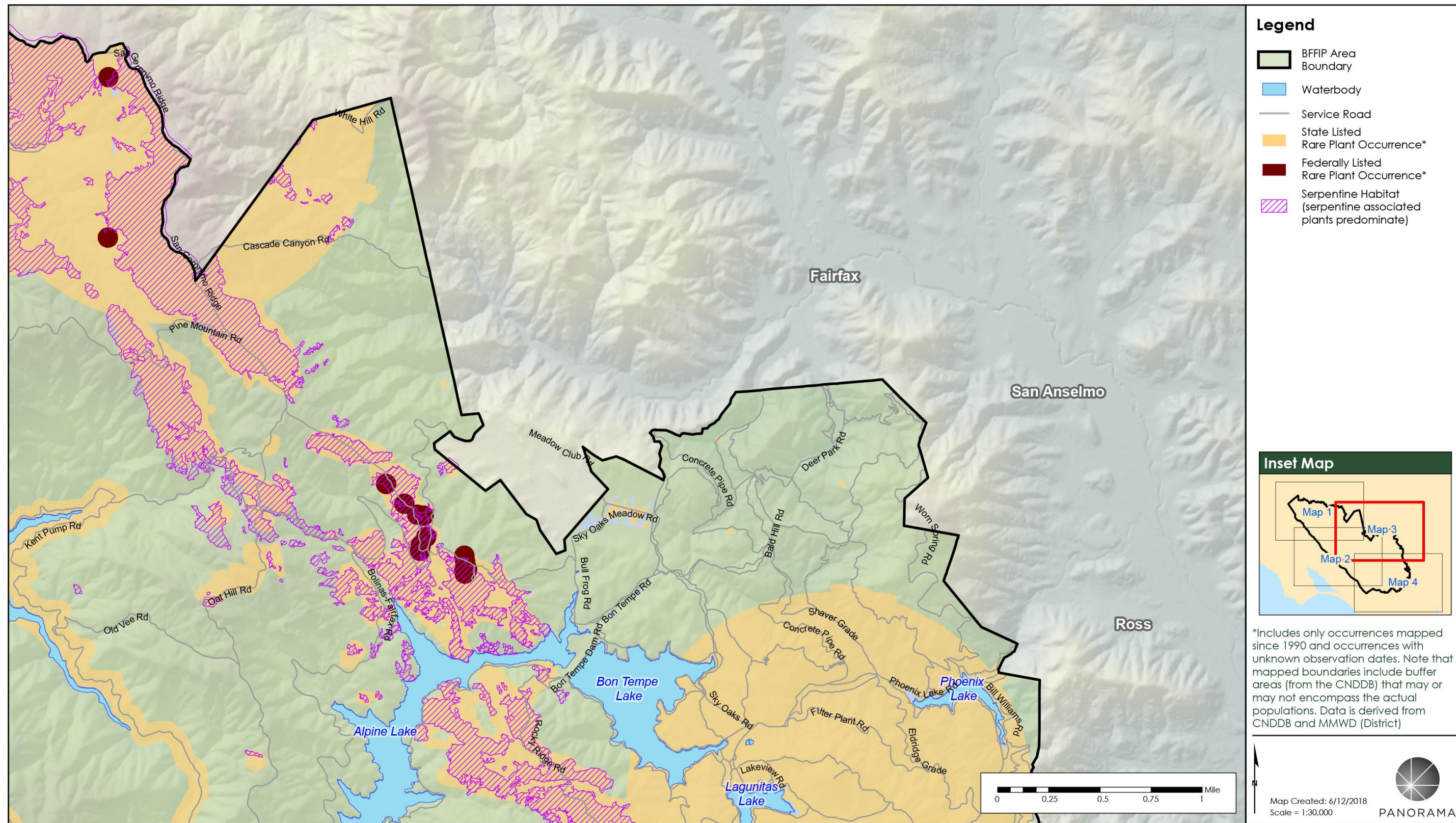
Figure 2-10 Occurrences of Special-Status Plants in the Mount Tamalpais Watershed (Map 2 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013a; Marin Municipal Water District Sky Oaks Watershed HQ, 2014a; Marin Municipal Water District Sky Oaks Watershed HQ, 2014c; CDFW, 2014)

2 ENVIRONMENTAL SETTING

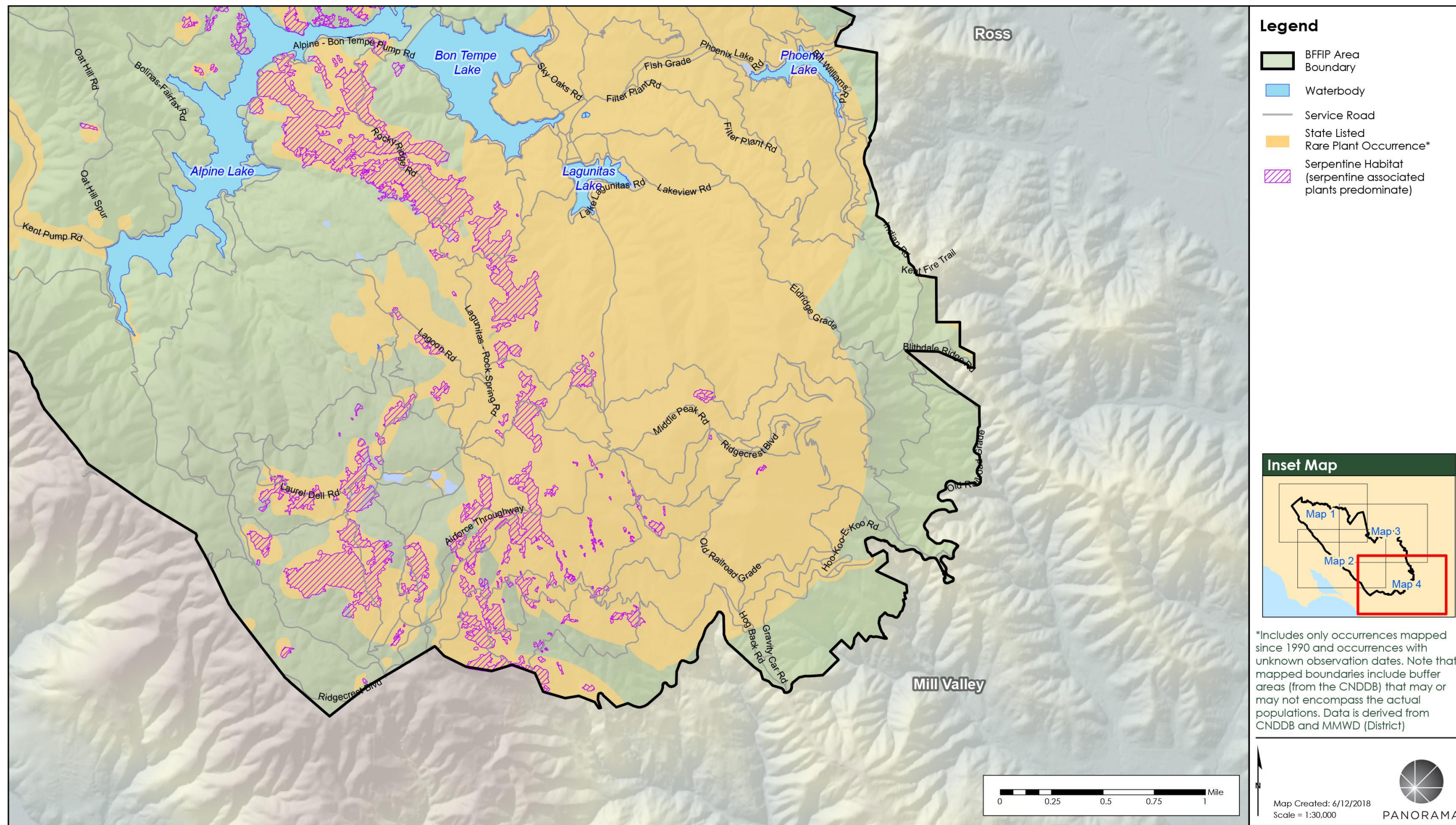
Figure 2-11 Occurrences of Special-Status Plants in the Mount Tamalpais Watershed (Map 3 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013a; Marin Municipal Water District Sky Oaks Watershed HQ, 2014a; Marin Municipal Water District Sky Oaks Watershed HQ, 2014c; CDFW, 2014)

2 ENVIRONMENTAL SETTING

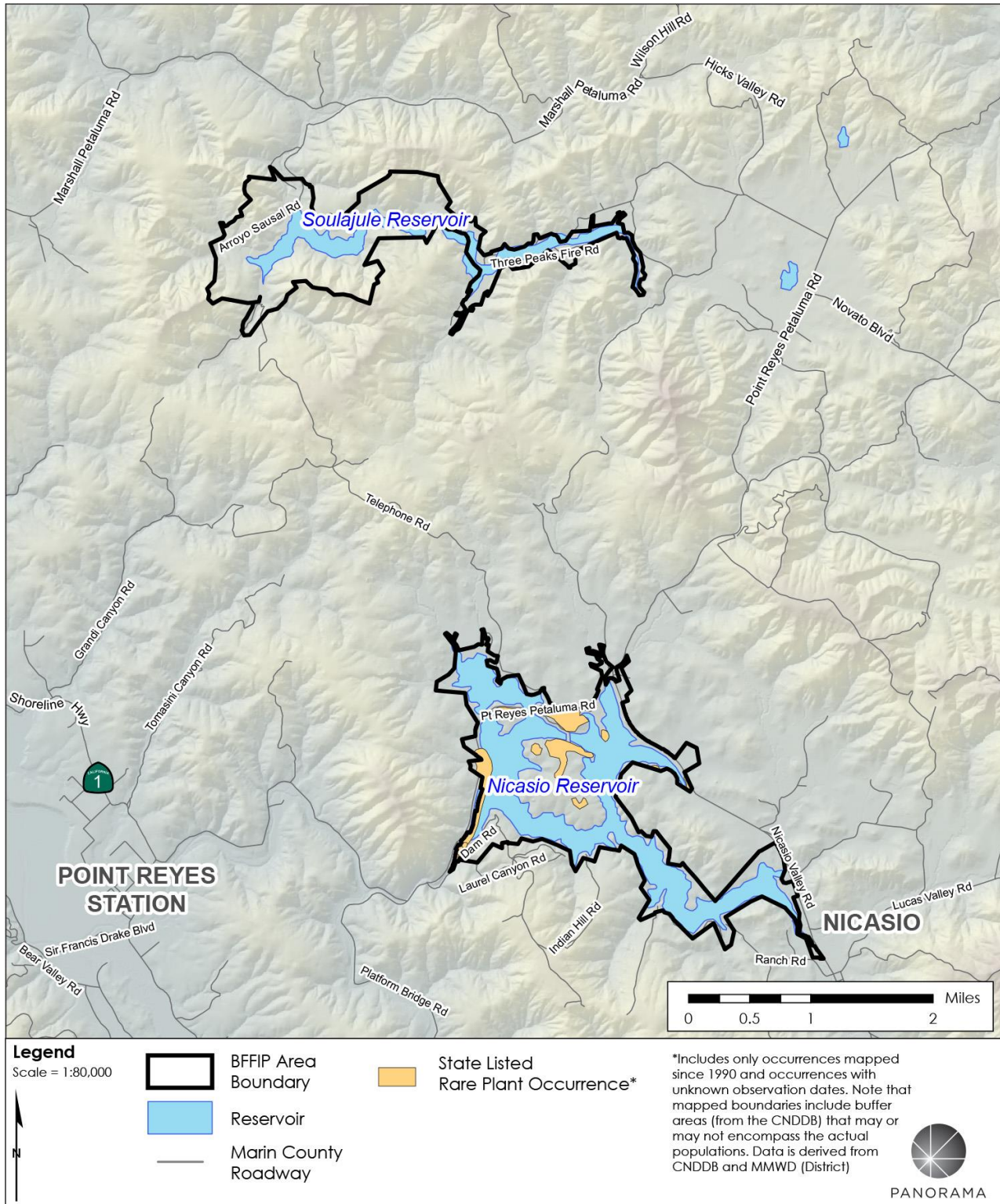
Figure 2-12 Occurrences of Special-Status Plants in the Mount Tamalpais Watershed (Map 4 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013a; Marin Municipal Water District Sky Oaks Watershed HQ, 2014a; Marin Municipal Water District Sky Oaks Watershed HQ, 2014c; CDFW, 2014)

2 ENVIRONMENTAL SETTING

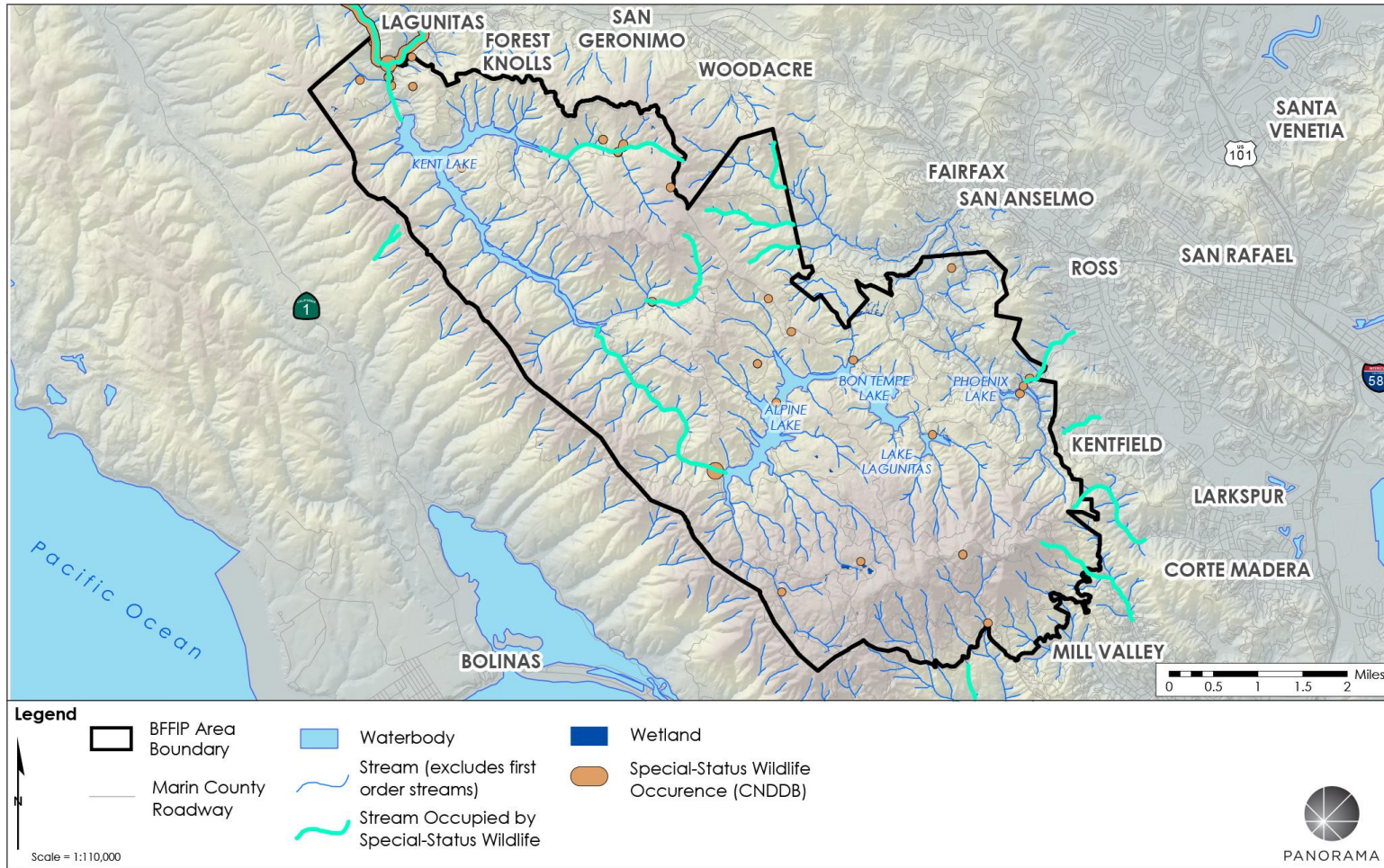
Figure 2-13 Occurrences of Special-Status Plants in the Nicasio and SoulaJule Reservoirs



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013a; Marin Municipal Water District Sky Oaks Watershed HQ, 2014a; Marin Municipal Water District Sky Oaks Watershed HQ, 2014c; CDFW, 2014)

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Figure 2-14 Occurrences of Special-Status Wildlife in the Mount Tamalpais Watershed

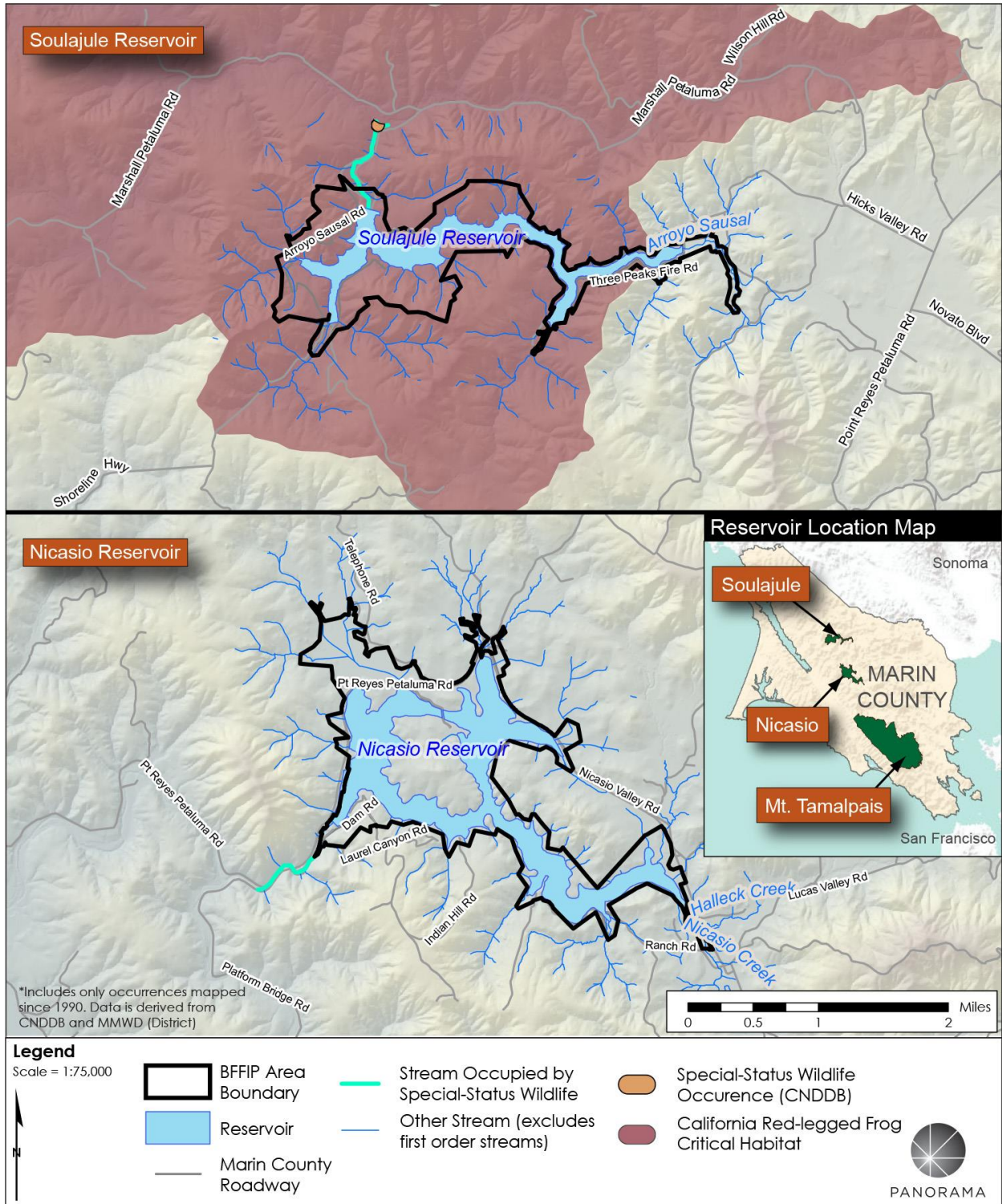


Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2014c; Marin Municipal Water District Sky Oaks Watershed HQ, 2013a; CDFW, 2017b; San Francisco Estuary Institute and the Aquatic Science Center, 2011; USFWS, 2014)

Note: Streams labelled as "Streams Occupied by Special-Status Wildlife" may provide habitat for the following special-status species: coho salmon, foothill yellow-legged frog, steelhead, Tomales roach, western pond turtle. The areas with orange polygons labelled as "Special-Status Wildlife Occurrence (CNDDB)" may provide habitat for the following special-status species: California freshwater shrimp, California red-legged frog, foothill yellow-legged frog, Marin hesperian, steelhead, Tomales roach, and western pond turtle.

2 ENVIRONMENTAL SETTING

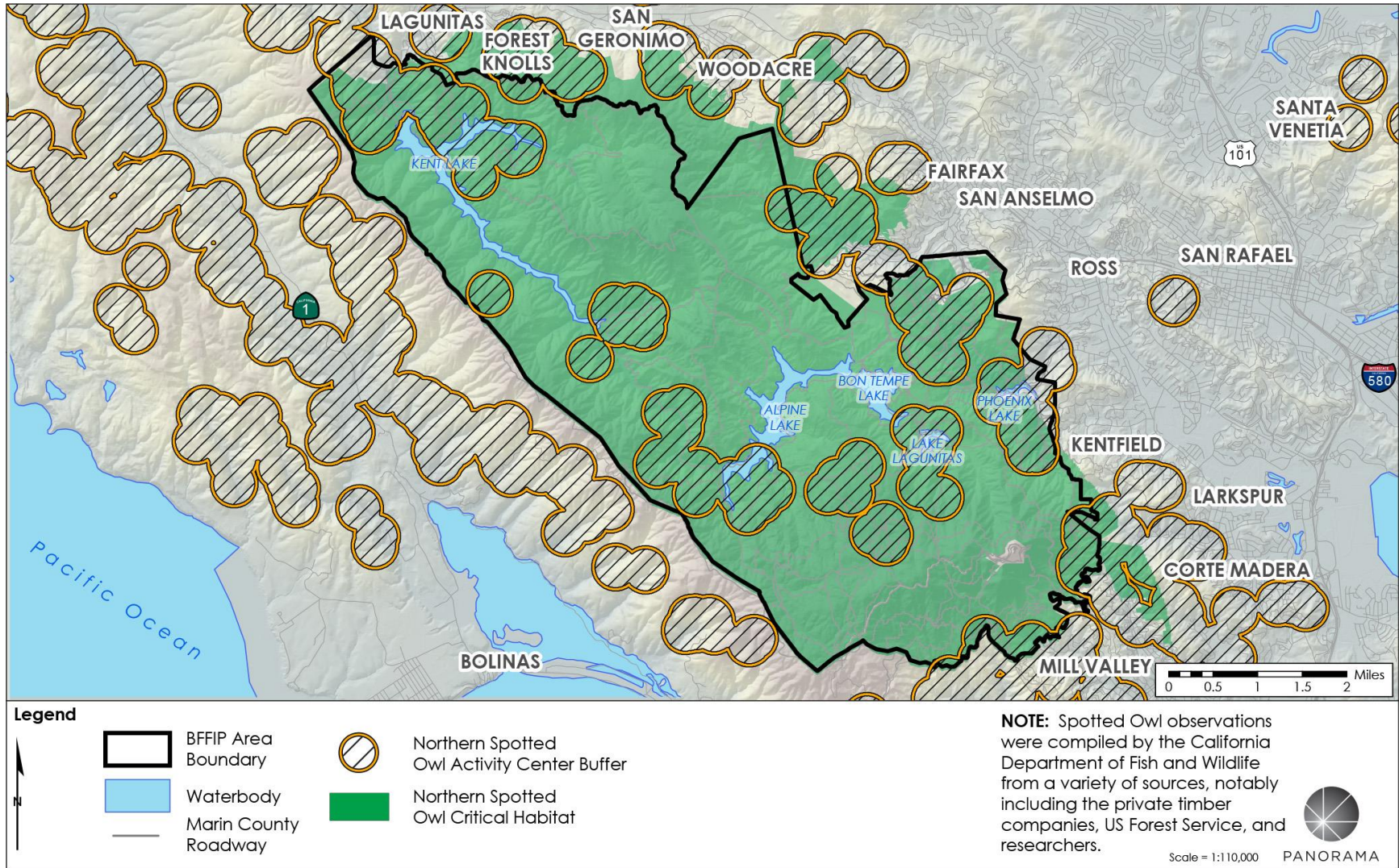
Figure 2-15 Occurrences of Special-Status Wildlife in the Nicasio and Soulajule Reservoirs



Sources: (ESRI, 2017a; CDFW, 2017b; USGS, 2016; San Francisco Estuary Institute and the Aquatic Science Center, 2011)

2 ENVIRONMENTAL SETTING

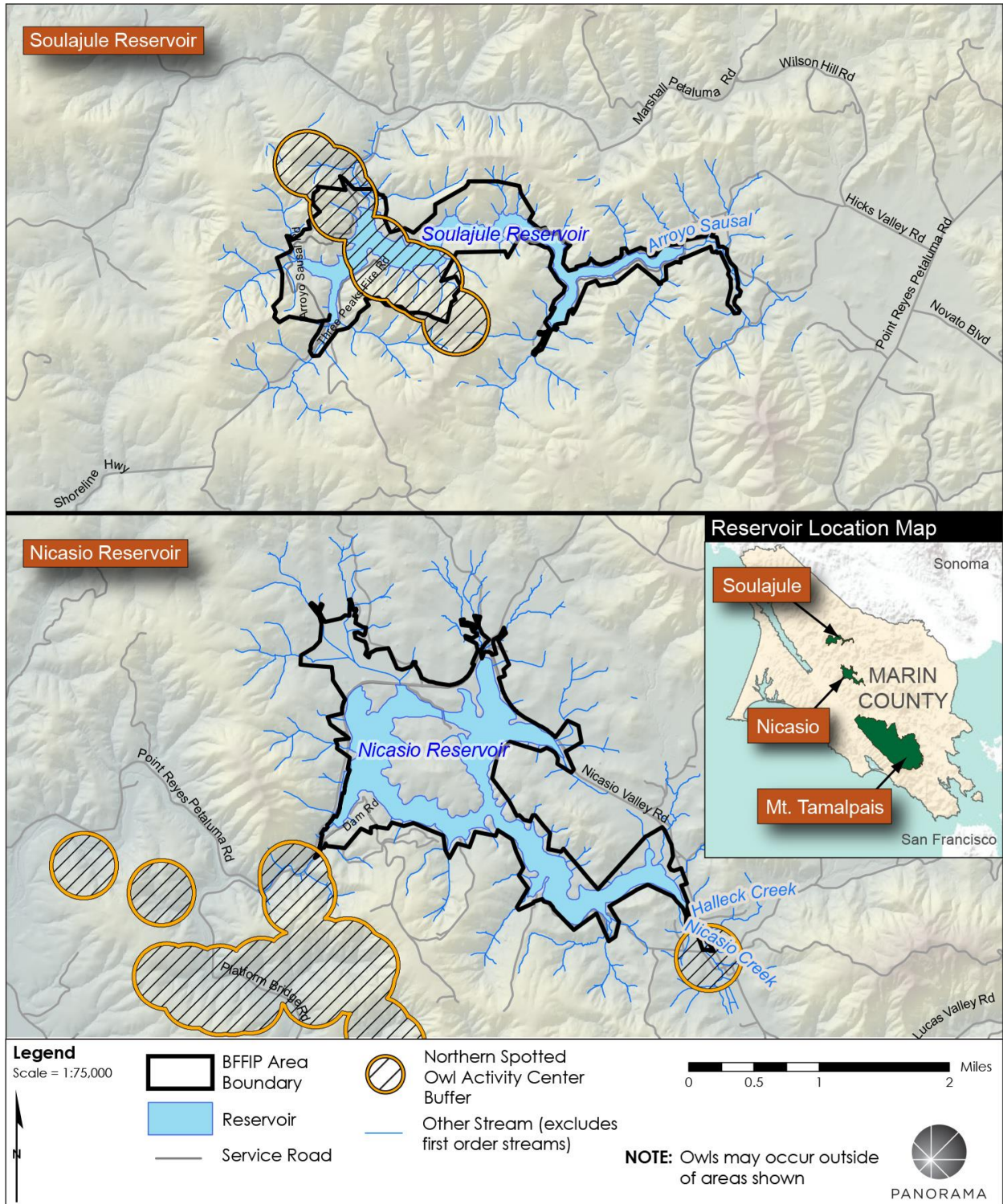
Figure 2-16 Northern Spotted Owl Territory and Critical Habitat in the Mount Tamalpais Watershed



Sources: (USGS, 2016; ESRI, 2016; Natural Resource Geospatial Geodata Systems Development GIS / Information Services and U.S. Fish and Wildlife Service, 2012; CDFW, 2017a)

2 ENVIRONMENTAL SETTING

Figure 2-17 Northern Spotted Owl Territory and Critical Habitat in the Nicasio and Soulaajule Reservoirs



Sources: (USGS, 2016; ESRI, 2016; Natural Resource Geospatial Geodata Systems Development GIS / Information Services and U.S. Fish and Wildlife Service, 2012; CDFW, 2017a)

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3 THREATS, TRENDS, AND STRATEGIES

3.1 INTRODUCTION

Environmental conditions on the Mount Tamalpais Watershed continue to change as does the science and philosophy of fire suppression and weed management. The District has learned many lessons on how to manage vegetation to reduce the risk of wildfires since it began implementing the original 1995 VMP. This section provides an overview of the main threats, trends, and lessons learned since the 1995 VMP was adopted. The strategies that the District uses to address each threat and manage their resources are also presented.

Studies of major changes in the world's ecosystems, such as desertification and deforestation, show that changes stem from synergistic interactions in which the combined effects of multiple causes are amplified by reciprocal actions and feedback loops. Simply put, the sum total of biodiversity losses can be increased when risk factors interact. For this reason, it is important to discuss the potential consequences of climate change interactions with previously identified and reasonably well-understood risk factors, such as weed invasion, forest pathogens, and wildfire.

A forest pathogen may increase tree die-off and fuel loading. Combined with a warmer climate, larger and/or more severe wildfires may result in the removal of large stands of native habitat. Burned areas are at increased vulnerability to colonization by weedy species, which typically are adapted to thrive in disturbed conditions. Increasing temperatures and changing precipitation patterns may make it increasingly difficult for native species to reclaim these colonized landscapes. Figure 3-1 summarizes the interactions of these four threats and shows how threats are compounded when they interact with each other. Each arrow in Figure 3-1 represents an interaction where an increase in one threat increases the other threat (e.g., more SOD increases the threat of invasive weeds).

3.2 ASSETS AND RISKS

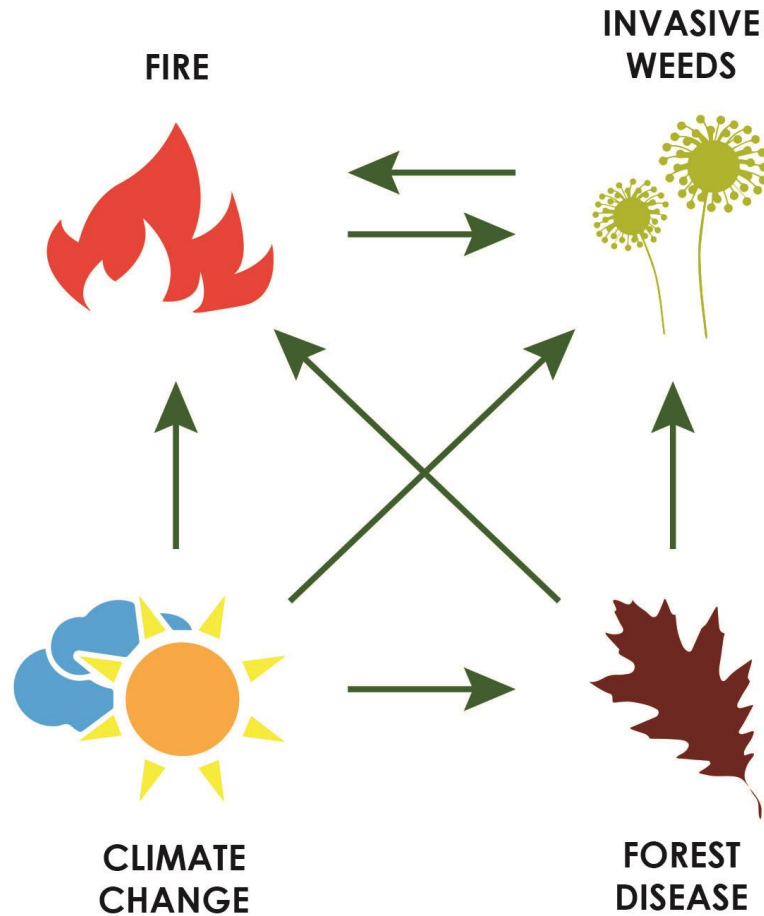
The assets within and adjacent to District lands include lives and property, water supply infrastructure, water quality, and natural resources. These assets are described in Chapter 2: Environmental Setting. Risks to these assets are briefly summarized below.

3.2.1 Lives and Property

The most serious threat that the District faces is the potential injury or loss of human life from wildfire. In the event of a wildfire, District staff, firefighters and visitors on the watershed are at risk, as are people in nearby communities, especially those in the WUI.

3 THREATS, TRENDS, AND STRATEGIES

Figure 3-1 Conceptual Model of Threat Interactions



Wildfires can produce airborne embers that cross fuelbreaks and start fires up to 2 miles away. Fire modeling prepared by the District has shown that a wildfire igniting under worst-case weather conditions could quickly spread off the watershed. The residential areas most at risk are in Mill Valley, Corte Madera, Larkspur, Kentfield, San Anselmo, and Fairfax. More than 25,000 structures are located within 2 miles of the watershed and at least 20,000 of these structures are residences that house over 45,000 people. The value of all of these assets (including the value of the property), is estimated to be over 12 billion dollars (MarinMap 2010, U.S. Census Bureau 2010). Even small fires traveling off the watershed could be potentially devastating. Figure 2-3 shows the location of residences that are within the WUI. Invasive species, climate change, and forest disease increase the threat of fire as shown in Figure 3-1.

3.2.2 Water Supply Infrastructure

Water supply infrastructure is described in Section 2.3.1 and includes pumps, tanks, treatment facilities, pipelines, and equipment, both on District lands and in the surrounding communities. A major wildfire on or adjacent to the Mount Tamalpais Watershed can potentially damage the District's infrastructure.

3 THREATS, TRENDS, AND STRATEGIES

3.2.3 Water

Water on the reservoir is considered an asset for both the drinking water supply and its ecosystem values. Fire poses a threat to the water quality of the waterbodies located within the Mount Tamalpais Watershed. A major wildfire could potentially (1) result in erosion that introduces sediments to waters and results in increased turbidity, which affects water treatment operations and costs; (2) increase nitrates in the waters from burned foliage, which could result in algae growth; (3) introduce heavy metals to waters from soils and geologic sources within the burned areas, such as mercury, arsenic, and selenium; and (4) introduce fire retardant chemicals to waters (USDA 2005) and (3) reduce capacity of water storage. The severity of a wildfire is an important factor in the impact on water quality. The more severe a fire is, the more fuel is consumed and the more susceptible the area affected by wildfire is to erosion and to soil and nutrients entering streams. Large pulses of sediment runoff take years to move through stream systems.

3.2.4 Natural Resources

Fire, invasive species, forest disease, and climate change pose a combined threat to the health of the local ecosystem. The composition of native species, native habitat, and ecosystem functions are threatened by competition with invasive species, loss of food sources for wildlife, reduced recruitment of replacement trees in the canopy, increasing temperatures that drive local extinction, erosion, water quality, and changes in fire frequency and intensity. The combined effects of the interacting threats pose the risk of a cascade of changes that affects the entirety of the ecosystem.

Possible effects of the interacting threats include profound alterations to the species composition and structure of familiar vegetation types, both from the decline and/or range changes of natives, and from range expansions of invasive non-native plant species. Native and non-native animal distributions are also expected to be affected. Extinction of endemics and other species is a strong possibility, as is the loss of some species from vegetation types and ecosystems in which they previously dominated. Through the review of credible historic records and museum vouchers, MMWD staff have documented the localized loss of 44 plant species within the last 50 years (refer to Appendix E).

Much of California has a Mediterranean climate conducive to wildfire, with mild wet winters promoting plant growth, and hot, dry summers with periodic thunderstorms and strong winds. Periodic localized wildfire maintains the integrity and species composition of most terrestrial natural communities in California, especially those with evolutionary adaptations to fire. Fire-adapted plant species are not simply evolved to tolerate fire per se, but are adapted to specific fire cycles within a particular range of frequency, intensity, and seasonality. Human activities have substantially altered historic fire regimes, which has led to cascading ecological effects resulting in vegetation type conversion and species loss. Two anthropogenic mechanisms known to alter fire regimes are on the opposite ends of the spectrum: fire suppression and increased ignitions. Fire suppression results in decreased fire frequency and increased wildfire

3 THREATS, TRENDS, AND STRATEGIES

intensity. Increased ignitions result in abnormally high fire frequencies. Both of these factors can threaten plant species and biological diversity.

Although wildfire has been a defining process in the evolution of California's flora and fauna, it can pose threats to biological resources already negatively impacted by other factors, especially when fires occur at large scales. Native species that are threatened due to critically low population levels, habitat loss, or non-native invasive weeds, can be pushed into local extinction by wildfires or other types of punctuated disturbance. Catastrophic wildfires are attributed to the buildup of fuels associated with fire suppression. Large fires abruptly release resources such as light and nutrients, which can be quickly exploited by non-native invasive weeds if sufficient seeds or other propagules are present.

Firefighting activities can have negative impacts on biological resources. The use of bulldozers, other heavy equipment, and hand crews to cut fire containment lines has the potential to create additional impacts to wildlife habitat and vegetation structure if not adequately mitigated post-fire. These impacts include increased erosion and sediment runoff that creates conditions more conducive for weed invasion.

3.3 THREATS AND TRENDS

3.3.1 Fire

The fire hazard present in the WUI adjacent to the Mount Tamalpais Watershed remains the District's most pressing vegetation management issue. The fire hazard on District lands surrounding the Nicasio and Soulajule Reservoirs is not as significant of an issue because there are few residences and infrastructure near these reservoirs' boundaries. The District does not own much land beyond that bordering the reservoirs, so it has limited authority to manage fuels in a way that can lead to a meaningful reduction in fire hazard in these areas.

Most of the Mount Tamalpais Watershed has a high or very high fire hazard rating, as identified by CAL FIRE. Overall, the fire hazard on the Mount Tamalpais Watershed has increased outside of treated fuel load reduction zones since the 1995 VMP was prepared because of an increased accumulation of dead woody material, particularly from the many thousands of trees that have been killed by SOD since 1995 (see Section 3.3.3) and the spread of invasive species.

The general consensus among climate scientists is that global climate change will result in more and larger fires in California (OEHHA 2008). Climate modelers predict an increase in the number and duration of Red-Flag Days (i.e., days of extreme fire hazard) per year within the next 50 years. Warmer winter temperatures, earlier warming in the spring, and increased summer temperatures are all expected as mean maximum and minimum temperatures increase by 4 to 6 degrees Fahrenheit (PRBO Conservation Science 2011). Models for an area similar to the Watershed (the south San Francisco Bay Area), predict substantial increases in the frequency of fast-spreading fires in grass and moderate increases in brush fires. By influencing fuel

3 THREATS, TRENDS, AND STRATEGIES

moisture and wind speed, climatic change is expected to cause fires to burn with greater intensity, with the number of escaped fires increasing by 51 percent. Contained fires in grass and brush are projected to burn 41 percent and 34 percent more area, respectively, under climate change conditions, as compared to the present climate. Generally in California, increased fire frequency favors grass and shrub vegetation over forests (Fried et al. 2003).

Appendix B provides further information about the history of fire on District lands.

3.3.2 Invasive Species

Overview

Non-native species are those that originated outside of coastal California, have been intentionally or accidentally introduced, and have formed self-sustaining populations without human assistance. A small percentage of non-native species cause great harm to the environment, the economy, and/or human health, and are referred to as invasive species. Globally, invasive species are among the most important direct drivers of biodiversity loss and ecosystem service changes. District lands have been impacted by an increasing number of invasive plant species over the last century. Of the approximately 1,000 plant species on District lands, just over 250 are non-native. Only a few dozens of these species cause major impacts, and even fewer have been identified as targets for vegetation management by the District. Overall, invasive species are spreading at an exponential rate. An overview of the invasive species presenting the greatest challenges to the District is provided in the following sections.

Broom Species

The invasive weeds of most concern are French broom (*Genista monspessulana*), Scotch broom (*Cytisus scoparius*), and Spanish broom (*Spartium junceum*). These three species have infested over 1,400 acres of the Mount Tamalpais Watershed; at least 80 percent of the infestation consists of French broom.

Invasive broom is an ecosystem disruptor. Research demonstrates that broom causes changes in plant community composition by displacing existing vegetation and decreasing local native plant diversity. Broom alters availability or quality of nutrients, food, and physical resources (e.g., living space, water, heat or light) for other plant species. As nitrogen-fixing species, they also enrich soil nitrogen levels and alter nitrogen dynamics in the invaded system. Nitrogen enrichment is unlikely to benefit native plants and may reduce native species diversity in historically nitrogen-poor ecosystems.

Broom grows and spreads rapidly, forming tall, dense, monospecific stands that are inaccessible and/or unpalatable to most wildlife (UC Davis 2016). Such stands occur on District lands where the broom populations have not been controlled for 15 or more years (e.g., stands within the

Broom on the Watershed

Broom species are the most problematic invasive plants on District lands. They currently cover over 1,400 acres, and are spreading at a rate of 56 acres per year.

Not only does broom produce thousands of seeds per plant, but these seeds "explode" out of their seed pods, carrying them beyond the boundaries of the existing patch.

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Phoenix and Deer Park areas). The dense vegetative cover modifies habitat structure, excludes native plant species, and makes tree regeneration difficult or impossible. Broom also has the potential to disrupt fire cycles. As plants grow in dense stands, the inner stems die back, providing copious, flammable fuels that can carry fire to the tree canopy, increasing the intensity of fires.

A significant portion of the fuelbreaks on District lands contains large stands of French and other broom that require an on-going control effort. Almost half of the fuelbreaks are infested with broom and require a minimum of one mowing treatment per year to minimize seed production and adequately reduce fuels. In contrast, mowing is only necessary once every 3 to 5 years in the areas without broom, depending on the vegetation type and precipitation patterns. Hundreds of acres outside the fuelbreak system have also been invaded by broom and require treatment to reduce fire hazard and to protect native species.



Broom invasion on the Bill Williams Fire Road near Phoenix Lake. (Photo by J. Charles)

The broom populations on the watershed are expanding at a rapid rate. Comparing aerial photographs from 2003 and 2010, the boundaries of broom populations have expanded 15 feet in 5 years, which correlates with the expansion rate of three feet per year described by broom researchers. A 2013 remapping effort established that broom has been invading an average of 56 acres per year. Maps of known locations of broom and other invasive species are shown in Figures 3-2 through 3-5. Recent assessment of habitat vulnerability on the Mount Tamalpais Watershed indicates that most of the watershed is susceptible to broom invasion, with the Deer Park and Phoenix Lake areas being the most at risk. MMWD updates its landscape scale broom map once every 5 years.

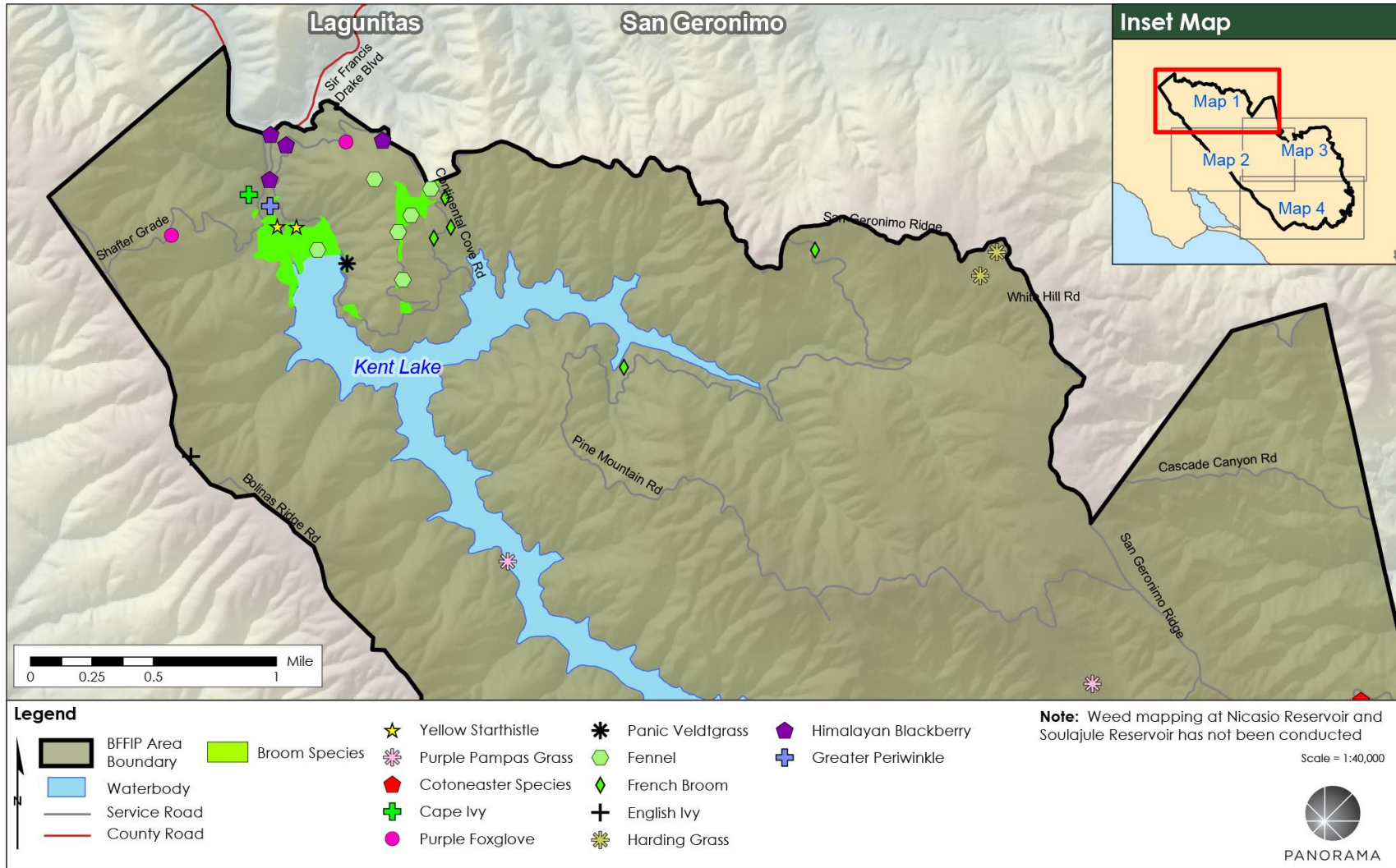
Yellow Starthistle

Yellow starthistle (*Centaurea solstitialis*) is also an invasive weed of concern on District lands. This plant is a deeply taprooted annual thistle that produces many spiny, yellow flower heads from late spring through fall. A single large plant can produce nearly 75,000 seeds. Yellow starthistle invades summer-dry grasslands and rangelands in California and Oregon below 7,000 feet elevation (UC Davis 2016). Introduced in the 1850s, this thistle is now the most widespread invasive plant in California, believed to have infested between 10 and 15 million acres in the state in 2007 (University of California Agriculture and Natural Resources 2007).

On the Mount Tamalpais Watershed, just over 100 acres are known to be infested with yellow starthistle. The main infestation is in areas along Ridgecrest Boulevard, including the Rock Spring picnic area, the Mill Valley Air Force Station, and the Upper Lagunitas-Rock Spring Gate. Additional populations are present near Bon Tempe Reservoir, the Sky Oaks Ranger Station, along Fairfax-Bolinas Road, and below the northern end of Worn Spring Fire Road. Yellow starthistle has a major impact on grassland communities, including native plants and

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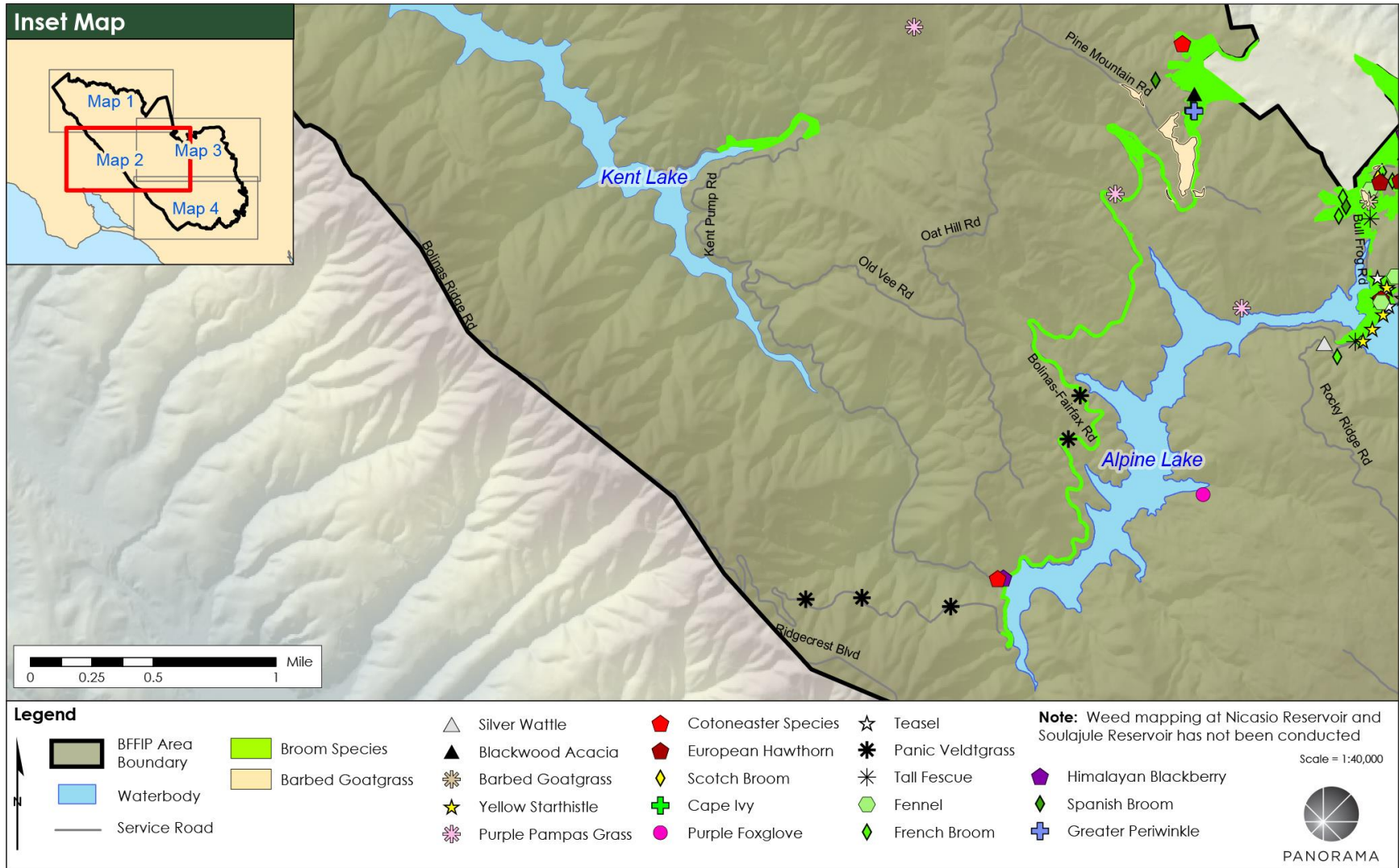
Figure 3-2 Mapped Weed Populations on District Land (Map 1 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016a; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c) Note: This map and the other three maps in this series were developed using data that was collected by the District between 2003 and April 2016. The data was updated periodically to reflect the District's management efforts. This map represents the District's best understanding of the extent of weed populations on District lands. Note that not all weed populations are known and not all areas of District lands are regularly mapped.

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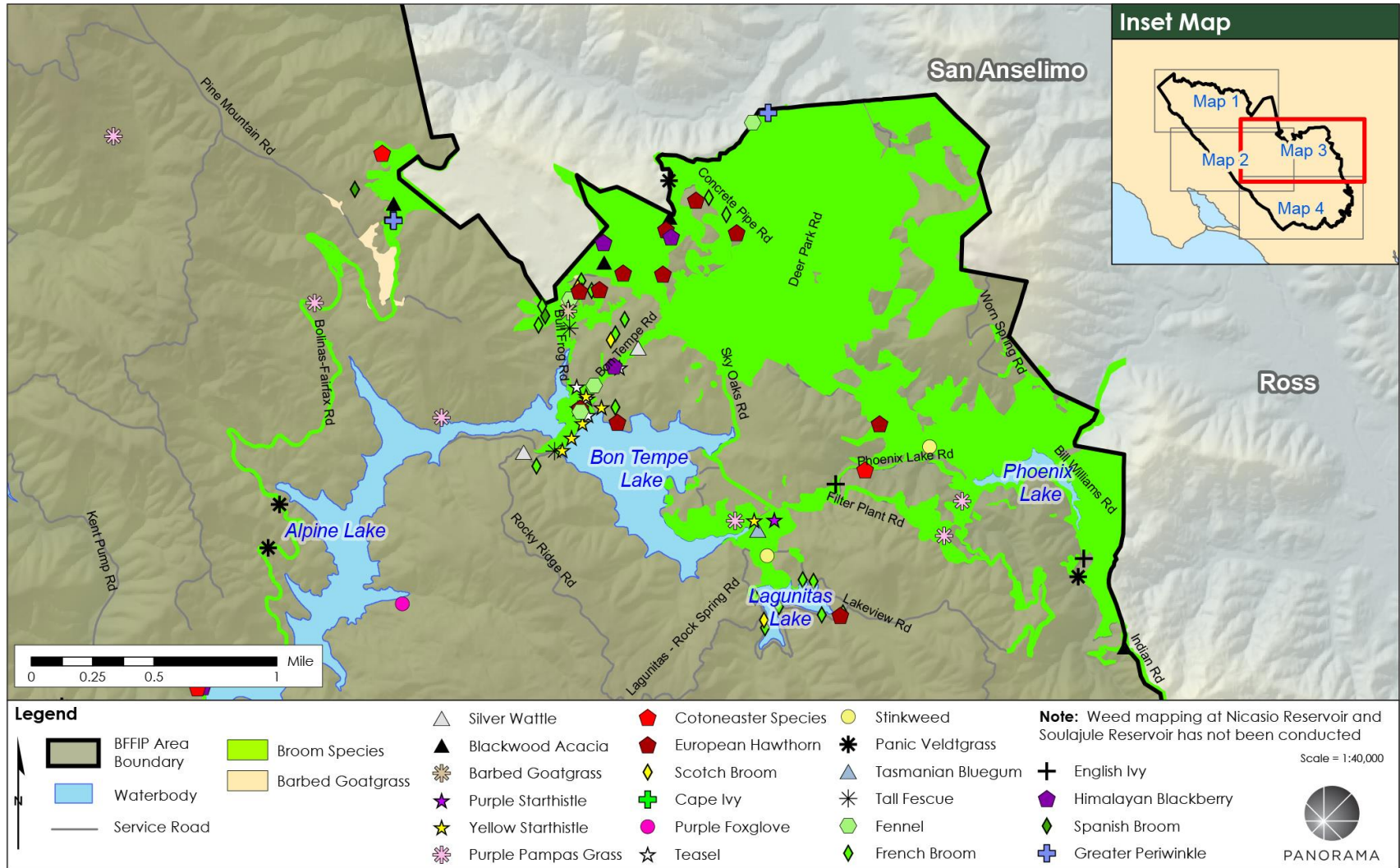
Figure 3-3 Mapped Weed Populations on District Land (Map 2 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016a; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

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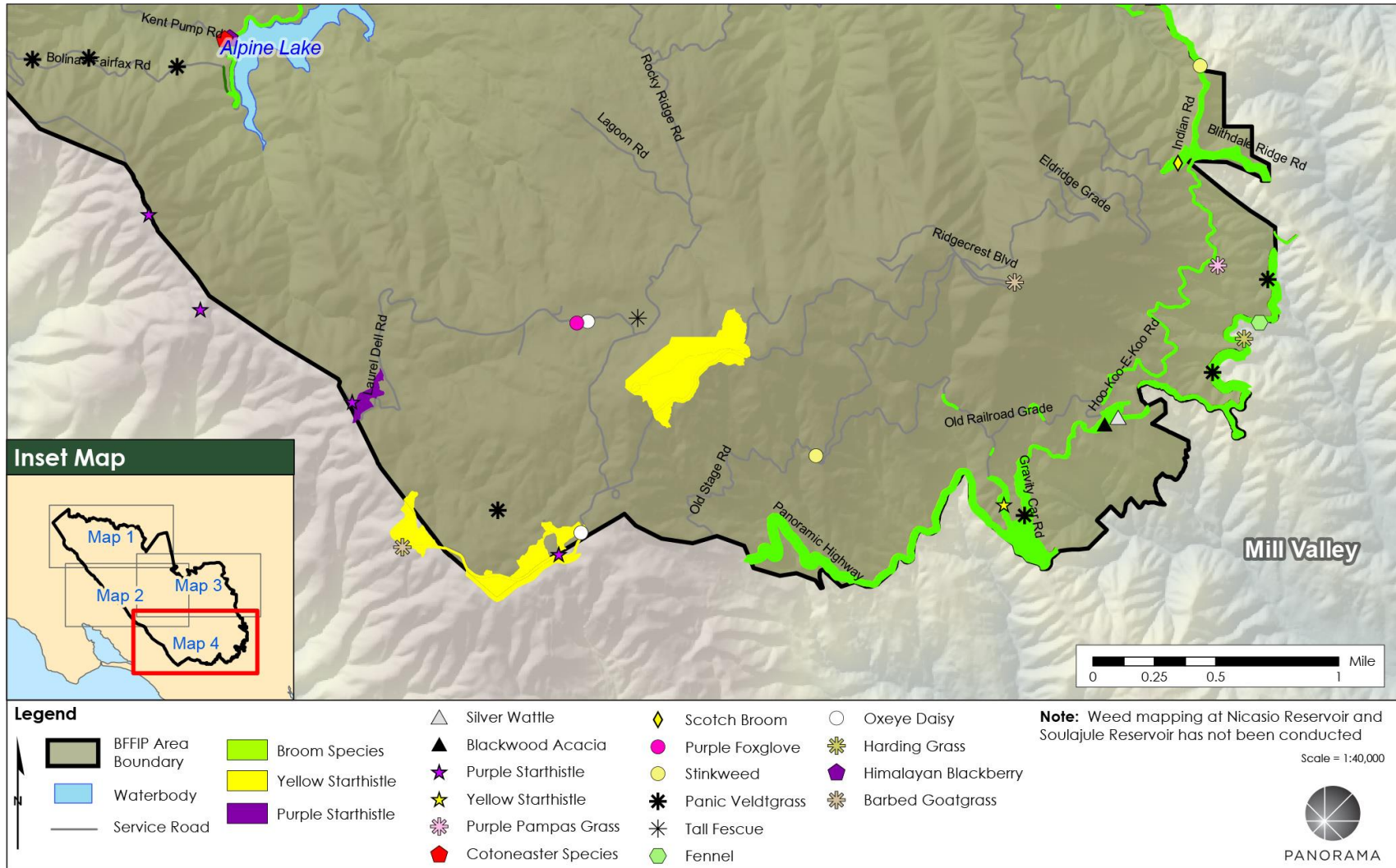
Figure 3-4 Mapped Weed Populations on District Land (Map 3 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016a; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

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Figure 3-5 Mapped Weed Populations on District Land (Map 4 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016a; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

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wildlife, since dense infestations can form nearly monotypic stands, displacing native plants and animals and significantly depleting soil moisture reserves in annual grasslands.

Other Weeds

Dozens of other high priority weed species found on District lands currently do not cover large portions of the watershed, but have the potential to alter wildfire risk, change ecosystem processes, lower habitat quality, reduce local biodiversity, or impede recreational access. Figures 3-2 through 3-5 identify the other weed species located on District lands. Watershed-wide mapping of these weeds is not complete, and may only be done on a case-by-case basis. Most of these species can spread at exponential rates, and, if they are not eliminated or controlled they could cover extensive acreage within the next decade (UC Davis 2016). Additional species of weeds are found annually on District lands. Over 30 new non-natives were found between 2010 and 2015, half of which can be considered invasive, including Portuguese broom, cabbage tree, grass peavine, medusahead, and rosy sand crocus.

The Nicasio Reservoir and Soulajule Reservoir properties also contain populations of weeds. A large and expanding population of teasel (*Dipsacus sp.*) is evident at Nicasio, and Soulajule supports a large and expanding population of distaff thistle (*Carthamus lanatus*).

3.3.3 Forest Disease

Overview

Pathogens can be drivers of substantial change within infested communities. Effects include changes in species composition, changes in ecosystem functions, loss of food sources for wildlife, changes in fire frequency or intensity, poorer water quality due to increased erosion from exposed soil surfaces, and increased opportunities for weed invasion in open sites that result from the death and decline of affected species. Several diseases – most notably SOD – are or may be present on District lands. This Plan identifies approaches for monitoring these diseases and incorporating up-to-date management responses as they are developed. A detailed description of SOD and other forest pathogens are presented in the following sections.

Sudden Oak Death

Marin County is one of the original epicenters of SOD. The disease, which was discovered adjacent to District lands in 1995, is caused by the water mold, *Phytophthora ramorum*. The disease has resulted in the widespread dieback of several native tree species in northern coastal California, including tanoak (*Notholithocarpus densiflorus*), coast live oak (*Quercus agrifolia*) and California black oak (*Quercus kelloggii*) (Moritz et al. 2008). The District has determined that SOD has infested upwards of 10,000 acres of forests in the Mount Tamalpais Watershed alone. In places, the disease has resulted in a nearly complete loss of mature tanoaks and other trees. This loss has, in turn, caused a decrease in ecosystem function, including loss of acorns and other forage depended on by many species of animals. Tanoak-dominated forest types have been the most heavily impacted: as the disease progresses, tanoaks drop out of the canopy resulting in fuel load build up, large openings in the canopy and an overall simplification in forest diversity and structure. Between 2004 and 2014, over 2,500 acres previously dominated by tanoak have transitioned to more degraded forest types (Table 3-1).

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Table 3-1 Declines in Tanoak Dominated Forest Types 2004-2014

Description	2004	2009	2014	% Change 2004 – 2014
Tanoak - California Bay - Canyon Oak Mixed Forest	617	227	168	-72.7%
Madrone - California Bay - Tanoak	1,192	580	585	-51.0%
California Bay - Tanoak	918	285	63	-93.1%
Tanoak Alliance	53	0	0	-100.0%
Redwood / Tanoak	152	14	14	-91.0%
Redwood-Douglas Fir (Mixed Hardwoods)	1,520	1,520	1,483	-2.4%
Redwood - Upland Mixed Hardwoods	1,537	1,273	1,169	-23.9%
Redwood - Riparian	368	368	368	-
Douglas-fir Mixed Hardwoods	3082	3075	3072	-0.3%
Douglas-fir - Tanoak	47	47	47	0.0%
Total Acres	9,486	7,389	6,969	-26.5%

This decline is likely to continue into the future: declines in the level of disease in the canopy are due to the loss of mature tanoak, rather than forest recovery (Figure 3-6). In coast live oak forests and woodlands, disease progression is less advanced and the loss of coast live oak dominance has not yet occurred, although the incidence of disease is increasing (Figure 3-7). Across the Mount Tamalpais Watershed, the fallen dead trees have restricted access in many areas and have had a significant effect on aesthetics and recreational use. Figures 3-8 and 3-9 depict the trend of the increasing spread of SOD on District lands spatially.

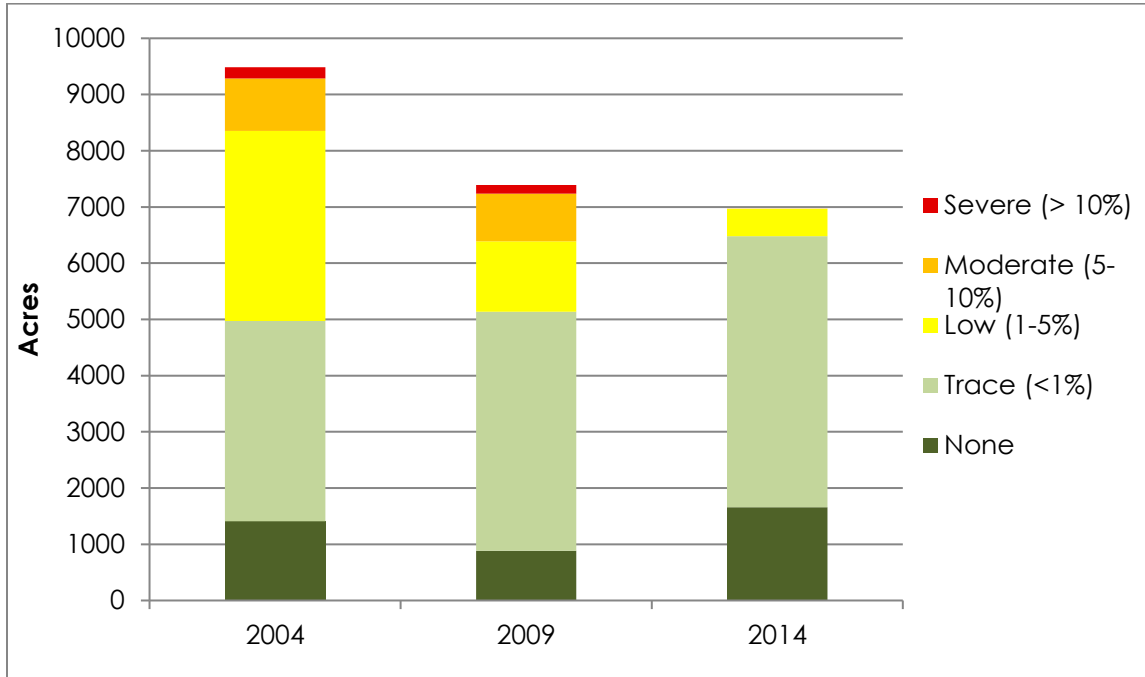
Removing SOD-affected trees that are within fuelbreaks or are hazards to facilities, access roads, and recreation sites such as picnic areas and parking lots significantly increases maintenance costs. Removal of SOD-affected trees on Bolinas-Fairfax Road and Panoramic Highway by Marin County road crews is necessary to keep these vital connections between western and eastern Marin County open. In 2006, the District partnered with PG&E to remove thousands of trees that threatened the Bolinas-Ignacio Transmission Line that crosses District lands. In the past, failures on this line have resulted in power outages, sparked wildfires, and threatened the District's ability to deliver water due to shutdowns of its primary water treatment facility in San Geronimo.

Other Forest Pathogens and Pests

Several other disease-causing forest pathogens may occur on District lands or could invade district lands in the near future. The native plant species Pacific madrone (*Arbutus menziesii*) and chinquapin (*Chrysolepis chrysophylla*) have been dying on district lands, likely due to the pathogens *Phytophthora ramorum* and *P. cinnamomi*, which have been identified on the Watershed.

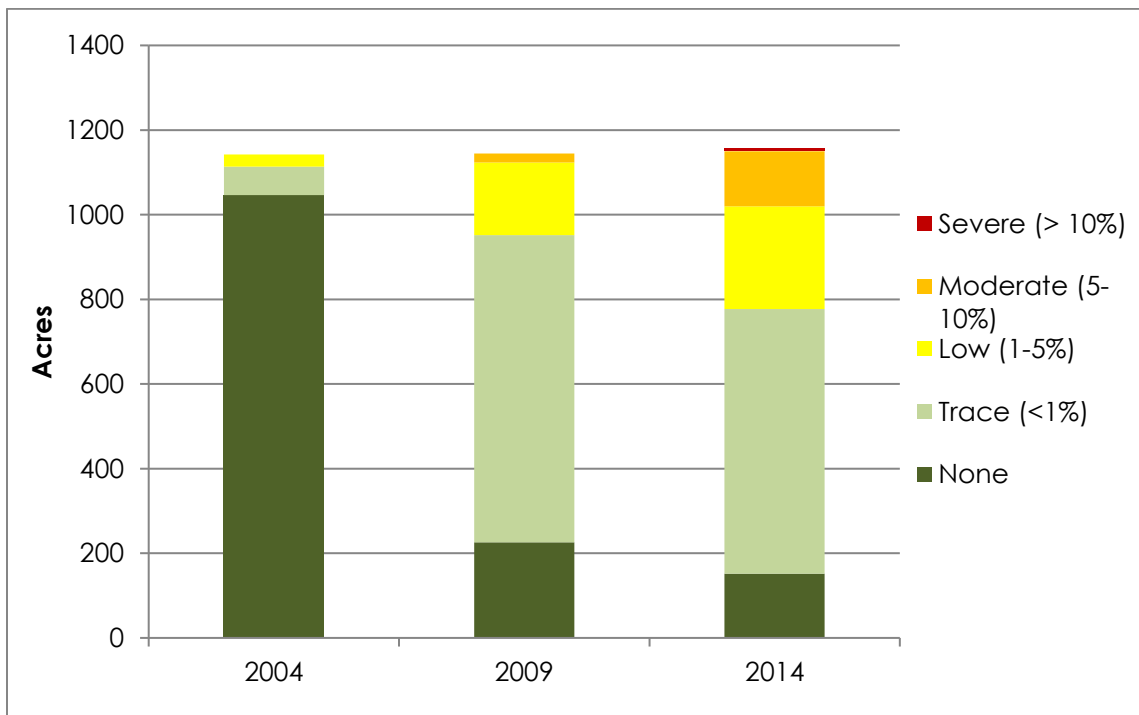
3 THREATS, TRENDS, AND STRATEGIES

Figure 3-6 Canopy Disease Levels in Tanoak Dominated Forest Types 2004-2014



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2004; Marin Municipal Water District Sky Oaks Watershed HQ, 2014b)

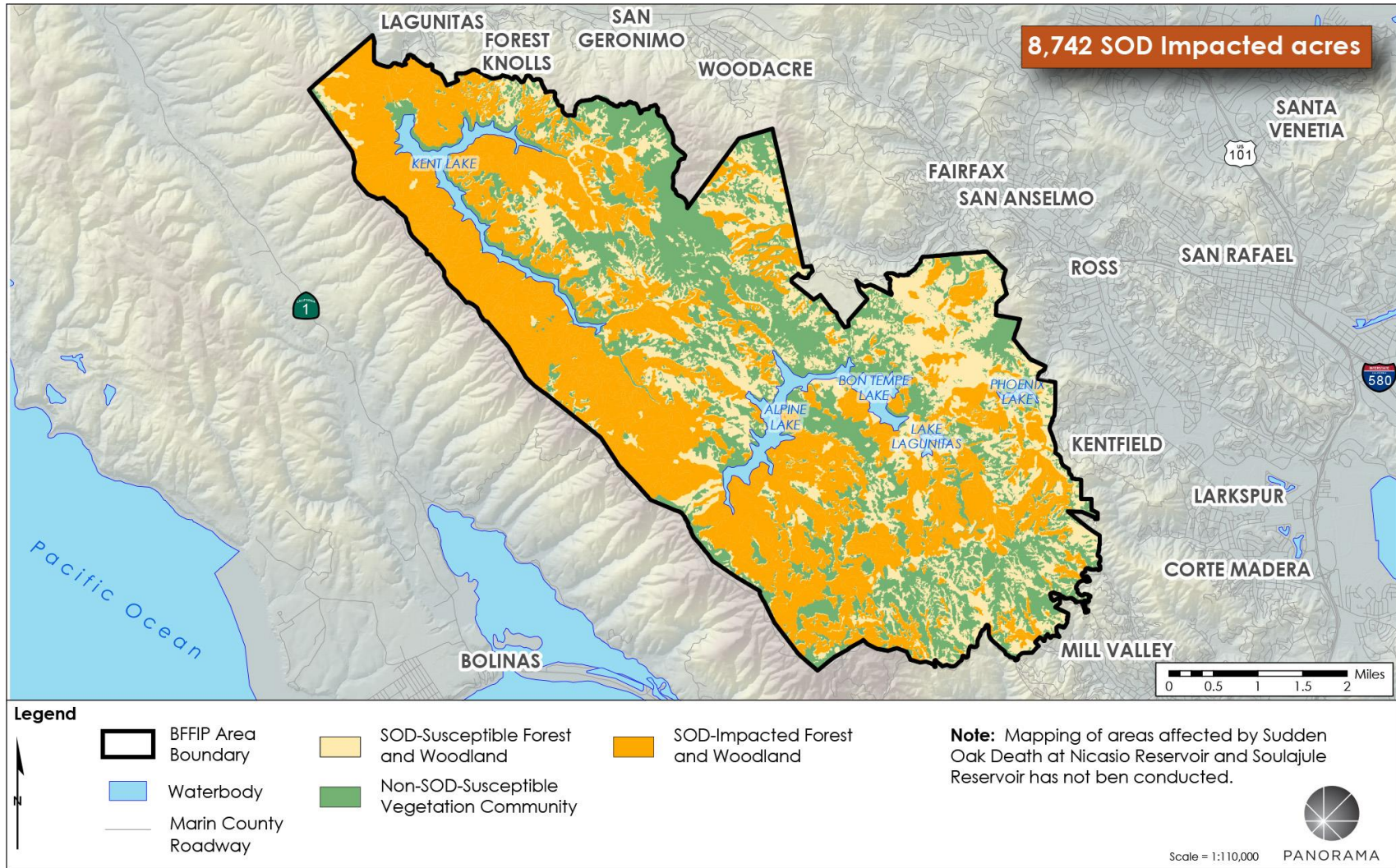
Figure 3-7 Canopy Disease Levels in Coast Live Oak Dominated Woodland and Forest Types 2004-2014



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2004; Marin Municipal Water District Sky Oaks Watershed HQ, 2014b)

3 THREATS, TRENDS, AND STRATEGIES

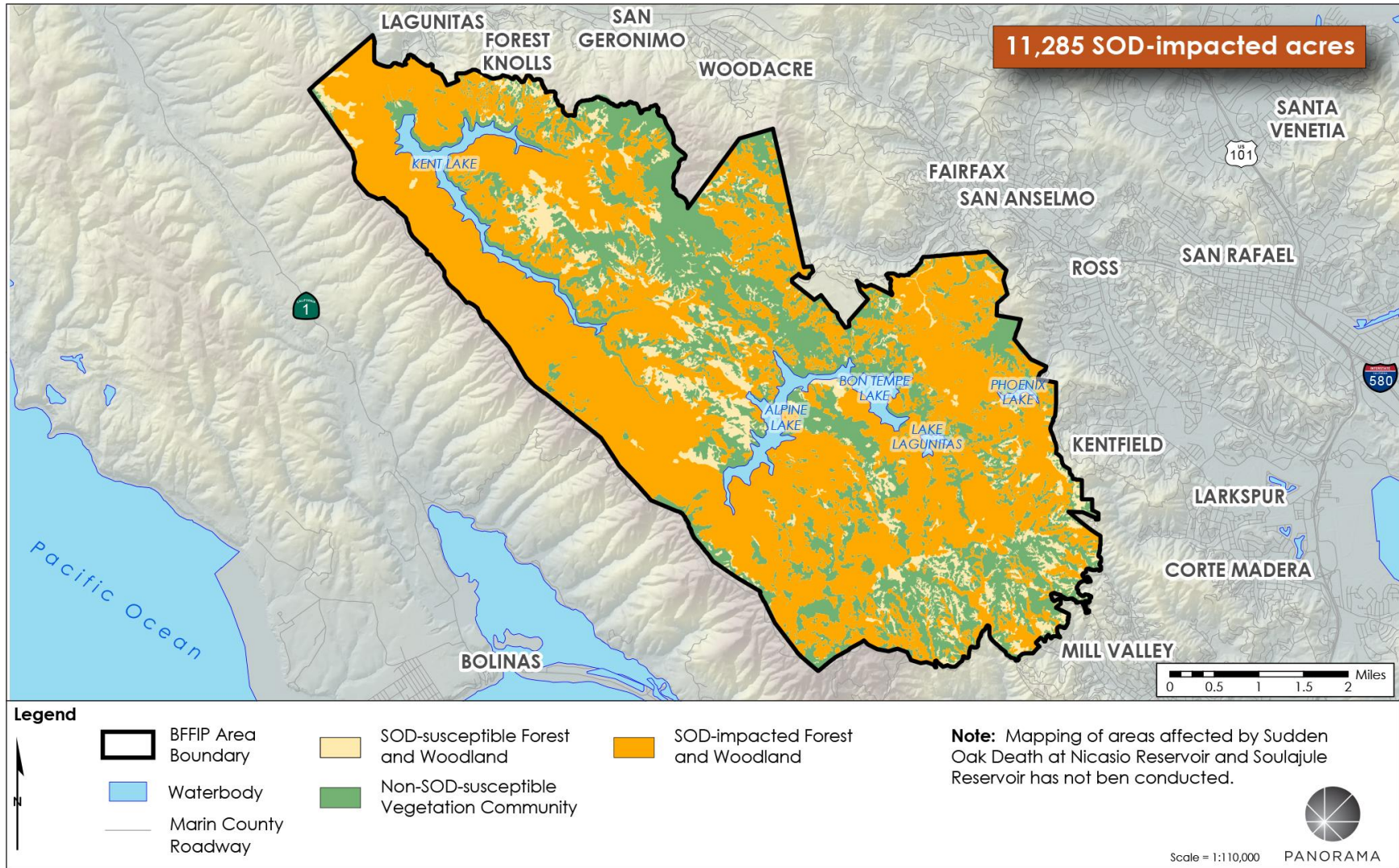
Figure 3-8 Distribution of SOD in 2004



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2004; Marin Municipal Water District Sky Oaks Watershed HQ, 2014b)

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Figure 3-9 Distribution of SOD in 2014



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2004; Marin Municipal Water District Sky Oaks Watershed HQ, 2014b)

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P. cinnamomi has also been implicated in the decline (shoot and tip dieback) of California bay laurel (*Umbellularia californica*) through much of the Watershed. This disease may have been present for decades but only recently appeared pathogenic. This disease needs warm soils, and the loss of canopy trees from SOD may have provided ideal conditions for it to thrive. Other diseases known to be affecting multiple tree species on the Watershed include white pine blister rust and black stain disease. Pine pitch canker may be present as well.

Not all fungal pathogens or other agents causing plant deaths have been identified. Recent research into water molds show there may be between 300 and 600 species of *Phytophthora*, few of which are described or understood. Some may be native, but many are introduced through the nursery trade and native or non-native plantings within or adjacent to wild lands.

Some pathogens may be native, but cause greater-than-normal harm due to threat interactions. Additionally, native pests such as bark beetles may be harming trees stressed by non-native pathogens or drought. Non-native pests such as the gold-spotted oak borer are not known to be present but remain a potentially serious threat.

3.3.4 Fire Suppression

Mount Tamalpais has not seen a large, stand-replacing fire for over 70 years due to fire suppression policies and practices. While fire suppression is important for protecting nearby property, plant communities on Mount Tamalpais are naturally dynamic and largely mediated by fire cycles (LCA 2009). The removal of fire is causing, in part, the succession of grasslands to shrublands, shrublands to woodlands, and woodlands to Douglas-fir (*Pseudotsuga menziesii*) dominated stands. Fire suppression has also reduced reproduction of fire-dependent species such as Sargent cypress (*Cupressus sargentii*), and chaparral and coastal scrub species.

In addition to these direct impacts, changed fire regimes and fire suppression are interacting with other ecological stressors on Mount Tamalpais in a variety of ways. Increases in fuel loads caused by forest systems impacted by SOD may increase the intensity of any fires that do occur. Large fires burn hot, and can kill large numbers of trees over a wide area. This situation both releases nutrients into the soil and increases the amount of light reaching the ground, conditions that can be exploited by non-native, invasive plant species (LCA 2009).

3.3.5 Climate Change

Recent studies in California suggest that global climate change is likely to result in significant alterations in the abundance and distribution of many plant species, especially endemics and species with narrow ecological tolerances. By the year 2099, local average summer temperatures are expected to increase by 6.3 degrees Fahrenheit to 11.2 degrees Fahrenheit. Precipitation is more uncertain, with projections ranging from -11 to +14 inches from a current annual average of 38 inches in the Mount Tamalpais Watershed. Projected temperature increases are sufficiently large to create a functional drought (referred to as Climatic Water Deficit) for many plant species, even if rainfall amounts increase. The frequency and duration of extreme weather

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events including flooding and drought are also expected to increase over the next 100 years (North Bay Climate Adaptation Initiative 2013).

Climate change models predict that in the Central Western Coast of California, there will be a decline of chaparral and oak woodlands and an increase in grasslands (PRBO Conservation Science 2011). Actual reductions range size depend on the magnitude of future CO₂ emissions, the climate changes that ensue, and the ability of species to disperse from their current locations.

Climate change contributes to multiple ecosystem-level changes in that it enhances the interactions between the various types of ecosystem threats (e.g., fire, forest disease, invasive species) as shown in Figure 3-1.

3.4 STRATEGIES

3.4.1 Fire Reduction

Assessment of Fuelbreak Needs

In 1995, the District began construction and maintenance of fuelbreaks per the recommendations of the original VMP. Given the changing conditions and the District's experience in managing the fuelbreaks, in 2006 the District initiated a review of the 1995 recommendations. The focus of the review was to identify what assets were at risk from wildfires and how best to protect them (Leonard Charles Associates and Wildand Resource Management, 2008).

The first step of this risk assessment was to identify those assets where the District either has jurisdiction or where there is a requirement, based on fire codes, to create and maintain defensible space. Using a Geographic Information System (GIS), the District developed a database that identified the WUI on and around the perimeter of the Mount Tamalpais Watershed and about 13,200 structures (i.e., residences and other buildings) located within 1 mile of the watershed boundary. The District then identified and mapped a buffer zone around these assets to show where vegetation should be managed to create defensible space for each structure. Where nearby groups of homes had overlapping defensible space areas, a joint defensible space area was identified (called a community "halo"). These maps helped identify potential neighborhood-level fuelbreak and defensible space systems, enabling the District to better design and coordinate its planned network of fuelbreaks with other management zones that are not located on District land.

The District then focused on the structures that are in close proximity to the Watershed boundary. Of the 13,200 residences and other structures located within 1 mile of the Watershed,

Assets Neighboring the Watershed

There are 310 homes and other structures within 300 feet of the Watershed boundary, and they are likely to derive benefit from fuelbreaks and other vegetation management conducted on district lands.

Homeowner Responsibility

Property owners with structures located in the WUI are obligated to:

- a. Manage vegetation within a minimum of 100 feet of a structure to maintain fire protection
- b. Remove tree limbs within 10 feet of a chimney
- c. Maintain a roof free of litter and other vegetation
- d. Meet current building codes and standards for new construction or remodel work

*California Public Resources Code Section 4290 and 4291

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approximately 310 of them are on or within 300 feet of its boundary. These structures are the assets that could benefit directly from vegetation management on District land (see Figures 2-4 through 2-7). The District determined the use of these structures and whether they were inhabited. They also assessed the vegetation and other conditions in the area surrounding these structures. This information was then used to help design a District fuelbreak system that augments the defensible space that private property owners are responsible for providing.

The District focused on primary containment areas that benefit adjacent structures using (1) the information on assets at risk; (2) additional study of the topography, fuel loads, roads, and other existing fuelbreaks in the WUI; and (3) existing fire or vegetation management plans of other agencies. To further protect the safety of its staff and firefighting personnel, and help protect the District's water infrastructure, the District identified key roads to maintain as safe ingress/egress routes.

Structure Protection and the Wildland-Urban Interface

Over the last 15 years, increasingly stringent fire codes have been adopted by cities and counties that regulate the placement, design, and construction of new structures, as well as requiring the development of "defensible space" around new and existing structures. Defensible space is created through the reduction or removal of vegetation and other flammable material from around existing buildings. Although many factors influence whether a home or other structure survives a fire, the following three factors are identified as the most important for reducing risk: (1) a roof made of any kind of material other than wood, (2) a flammable vegetation clearance of 30 feet or more, and (3) a defensible space sufficient to protect firefighters defending the structure. In many cases, these important factors that enhance structure survival are the responsibility of homeowners and are therefore outside the purview of this BFFIP. Marin County has adopted an amended version of the International Urban-Wildland Code¹ that provides measures for addressing defensible space, ignition resistance, flame spread and ember production for structures in the WUI. In addition to structural, plumbing, and emergency access requirements, the amended code requires new construction to have an approved vegetation management plan that delineates defensible space. The details of each plan are dependent on the property's vegetation and topography, as well as on the designs, uses and ignitability of its structures.

The District's Fire-Flow program enables ongoing replacement of water lines, as well as other improvements that help provide additional water flow for fighting fires and to ensure the integrity of the water distribution system after an earthquake. This program, approved by voters in 1996, improves firefighter safety and increases the ability to fight wildfire in the WUI.

¹ Ordinance No. 3453, Marin County Board of Supervisors, adding Chapter 16.17, July 2006.

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Fuelbreak Design, Construction, and Maintenance

Vegetation management actions that reduce fire intensity immediately adjacent to a structure increase the probability of the structure's survival. Fuelbreak design and construction techniques continue to evolve based on new knowledge of wildland fire behavior, construction tools and techniques, ecological impacts, and cost. Because of this, the District opted not to finish construction on all of the fuelbreaks recommended in the 1995 VMP, particularly those far removed from structures where the economic and ecological cost of construction yield negligible benefits. Other recommended fuels reduction projects were not completed due to resource limitations or, in the case of some proposed broadcast burns, due to safety concerns.

A fuelbreak is a built asset requiring periodic maintenance to operate as intended. If it is not regularly maintained, the level of effort and cost required to re-establish the desired conditions approaches that of new construction. One of the largest impediments to fuelbreak maintenance has been the aggressive invasion of French, Scotch, and Spanish broom into treated areas. This invasion has required more frequent maintenance treatments, thereby limiting the availability of labor resources from other projects. Improving weed management in existing fuelbreak ultimately reduces long-term maintenance costs.

The District has developed design standards and dimensions for fuelbreaks as a strategy to reduce the hazard of wildfire. Design standards and dimensions, are broken into the following categories: Defensible Space, Primary Fuelbreaks, Secondary Fuelbreaks, Ingress/Egress, and Wide Area Fuel Reduction Zones (WAFRZ). All categories, except for WAFRZ, form part of the formal, permanent fuelbreak system; the WAFRZ represent more natural areas where fuel load reduction has been performed to achieve a combination of wildfire risk reduction and habitat enhancement goals. The WAFRZ are discussed further in Section 3.4.3 and the formal, permanent fuelbreak designations are discussed further in this section.

Terminology: Fuel Types

1-hour fuels: very fine fuels (such as needles and leaves) that are easily ignited and burn quickly. Less than 0.25 inch in diameter.

10-hour fuels: larger, less combustible fuels (such as small branches and woody stems). These can readily carry fires when moisture is low. From 0.25 to 1.0 inch in diameter.

Ladder fuels: shrubs or other vegetation that can be ignited at or near the ground level and carry fire into the branches of adjacent trees.

The strategies, design standards, and dimensions are not intended to be a "one-size fits all" standard. To determine the actual vegetation management at each location, District staff consider factors such as: the zoning of the fuelbreak (see Section 3.4.1); whether or not the project is within the WUI; existing vegetation characteristics; topography; the presence or absence of broom; ownership; structure use and ignitability and recommendations from local and County Fire departments. Since the adoption of the 1995 VMP, the District has completed approximately 900 acres of fuel load reduction. Nearly half are part of a formal, permanent fuelbreak system that includes defensible space around structures and utilities as well as reduced

fuel corridors along strategic service roads; the other half of fuel load reduction has occurred within less managed habitat (District 2012a). The designations for the formal, permanent fuelbreak system are presented below.

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Defensible Space

Defensible Space is a zone that is between 100 and 300 feet wide around structures (less wide when around uninhabited structures). The landscape is manipulated immediately adjacent to structures to reduce flame length and reduce ignitability. The target is to remove the most flammable vegetation (i.e., 1-hour fuels) and eliminate ladder fuels that can carry a fire to larger fuels and structures. Reducing vegetation to bare ground is not necessary. The District's fuelbreak system identifies approximately 90 acres of Defensible Space within the District's jurisdictional boundaries. The District has built 70 acres of Defensible Space as of 2015.

Primary Containment

Primary Containment (hereafter called Primary Fuelbreak) is a zone that is between 100 and 200 feet wide located within the WUI and at strategic locations (e.g., next to roads, or adjacent to other low-hazard natural features). This fuelbreak type is designed to control lower intensity fires, to flank higher intensity fires, and to provide for firefighter safety. Vegetation is managed to reduce the continuity of 10-hour fuels both horizontally and vertically. The District's fuelbreak system identifies approximately 200 acres of Primary Fuelbreaks. The District has built 164 acres of Primary Fuelbreaks as of 2017 and has 36 acres left to build.

Secondary Containment

Secondary Containment (hereafter called Secondary Fuelbreak) is a zone that is 60 to 100 feet wide, and typically is constructed next to roads. This type of fuelbreak is designed to provide an anchor point for controlling lower intensity fires and to improve firefighter safety. Vegetation is managed to reduce the continuity of 10-hour fuels both horizontally and vertically. The District's fuelbreak system identifies approximately 230 acres of Secondary Fuelbreaks. The District has built 187 acres of Secondary Fuelbreaks as of 2017, but some additional widening or extension of these fuelbreaks is needed in certain locations. Expansion of Secondary Fuelbreaks is done in conjunction with their cyclical maintenance since crews and equipment are already on site, thereby maximizing the efficiency of District resources. The District has 43 acres of secondary containment left to build.



Secondary Fuelbreak maintenance on Shaver Grade.

Ingress/Egress Fuelbreaks

Ingress/Egress Fuelbreak is a 15-foot zone located on both sides of those roads identified as critical for emergency vehicle passage. Vegetation management in this zone improves access and reduces radiant heat in the worst-case scenario of an extreme wildfire. Due to limited resources, challenging terrain, and variable vegetation patterns, it is not always possible to maintain vegetation at an optimal width related to flame length along all these routes. The District's fuelbreak system identifies approximately 70 acres of Ingress/Egress Fuelbreaks. The

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District has built 56 acres of Ingress/Egress Fuelbreaks as of 2017. The District has 14 acres left to build.

Cyclical Maintenance

Vegetation management to maintain fuelbreak function is performed cyclically. The time between treatments depends on how fast the vegetation in the fuelbreak grows, the likelihood of an ignition, and the proximity to buildings and other high value assets. For example, areas such as defensible spaces around structures with grassy fuels, or ingress/egress road corridors with rapidly growing woody weeds, need to be treated annually. Similarly, areas beneath electric transmission lines and power line transformers or areas adjacent to picnic facilities also require frequent maintenance. Cyclical maintenance is performed using combinations of different treatment techniques to ensure that the maintenance work is efficient and performed in a timely manner while minimizing ecological impacts. Techniques include a combination of cutting with heavy equipment and/or hand tools as well as onsite mastication, mulching, and pile burning. These techniques are described in detail in Section 6.3.

Ignition Prevention Best Management Practices

Preventing accidental ignitions remains one of the best ways to minimize risk from wildfire. To reduce such ignitions, the District employs a number of prevention measures such as reducing fuels in critical ignition areas (e.g., parking areas, picnic facilities, and other sites that the District feels have sufficient public use that there is an ignition risk), keeping suppression equipment on site during certain construction activities during fire season, and preventing certain construction activities and public vehicle access during Red-Flag Days. The District also facilitates PG&E access to electric transmission and distribution lines for the purpose of cyclical fuels management and maintenance of these lines and poles to prevent accidental ignitions. The District also retains staff trained in wildland firefighting and maintains firefighting equipment.

Cooperation Among Adjoining Landowners

Several miles of planned or constructed fuelbreaks on the Mount Tamalpais Watershed run along property lines and span lands owned and managed by other public agencies, including the MCP, the County of Marin (County), State Parks, and the NPS. In other locations, the fuelbreaks area adjacent to private property. Many of these adjoining landowners have approved fire or vegetation management plans and have established fuelbreak programs. Continued collaboration between the District and the adjoining landowners remains important to coordinate on fuelbreak work, as well as to understand and communicate jurisdiction and strategies.

The District values coordination with other stakeholders and organizations that have fire or vegetation management plans. Such cooperation improves the efficiency and effectiveness of wildfire hazard reduction actions. Other fire or vegetation management plans that address wildfire hazard in the vicinity of the Mount Tamalpais Watershed include the Community Wildfire Protection Plan (MCFD and FIRESafe Marin 2016), the Fire Management Plan, Golden Gate National Recreation Area (NPS 2001), the Samuel P. Taylor State Park Vegetation Management Statement (California State Parks pending), the Draft Samuel P. Taylor State Park

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Wildfire Management Plan (California State Parks pending), the Final Mount Tamalpais State Park Vegetation Management Statement, the Draft Mount Tamalpais State Park Wildfire Management Plan (California State Parks pending), and the Vegetation and Biodiversity Management Plan (MCP pending).

3.4.2 Ecosystem Enhancement

Control of Invasive Species

A comprehensive weed control program encompasses prevention, early detection and rapid response, ongoing control, and targeted restoration plantings. On District lands, weeds may be controlled on a species basis, a site basis, or both. Generally, an invasive plant at low levels and targeted for extirpation--total removal from District lands--is an example of "species basis" control. Other weeds are only controlled when growing in high-priority sites. Broom species are an example of both species- and site-based control: generally, broom is targeted for removal, but populations are prioritized based on where they grow. Monitoring, mapping, and data management are essential but often overlooked aspects of a weed management program; additional information on these aspects may be found in Chapter 6: Implementation of Vegetation Management Actions.

Prevention is the "first line of defense" and may be the most critical element of the District's strategy. The District maintains a set of BMPs for weed and pathogen prevention that involve training staff; washing and inspecting sites, equipment and materials; and zoning and routing work to prevent spread from infested to uninfested areas. The BMPs are identified in Appendix F.

Eliminating new colonies of weeds is the most effective action the District can take to preserve biodiversity (as well as reduce fuelbreak maintenance costs). The Early Detection Rapid Response (EDRR) program includes conducting regular surveys of those parts of the watershed where weed invasion is most likely, and periodic surveys in remote areas where new weed invasions are likely to be less frequent. The surveys are performed by trained surveyors including District staff and volunteers. EDRR staff, led by new seasonal aides, pull, cut, or dig out newly discovered invasions. A database of all EDRR populations is maintained and used to facilitate follow-up visits ensuring that the invasion was eliminated. Sites are revisited and retreated annually until 5 consecutive years with no weed observations are recorded. The District's ongoing control of the invasive species population is accomplished through cutting or pulling invasive weeds.

Terminology

Contain: Prevent the spread of an invasive species from a given area, without attempting to reduce the existing population.

Control: Decrease plant density and abundance to an acceptable or defined level; a general term for invasive plant management.

Eliminate: Remove all or nearly all reproductive plants from a specific site or population.

Extirpate: Eliminate all plants from a single site or population, with no plants seen for at least 5 successive years.

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The District's strategy also includes habitat restoration for larger areas where restoration could be effectively implemented and where funding is available. Habitat restoration and rehabilitation differs from weed control by identifying a target plant community or ecosystem function to achieve, rather than simply targeting weed(s) for elimination. Restoration actions include weed control, re-contouring slopes, rerouting trails, removing accumulated thatch, amending soils, and seeding and/or planting native species as needed.

Forest Management

The District proposes to address the threats to natural areas by implementing activities that improve the overall resiliency of forests on District lands by (1) increasing both above ground and soil carbon storage and retention, (2) optimizing water yield, (3) improving natural recruitment of native tree species, and (4) improving wildfire resiliency by reducing the likelihood of crown fires.

Experimental efforts in Oregon to slow down the progression of SOD by removing all hosts from the forest (most species present) have not stopped the disease or prevented its spread. Removal of invasive species may also increase forest health and resiliency; see Section 3.4.3.

SOD Research

Faced with growing wildfire risk and degrading ecosystem values, the District entered into partnership with researchers from University of California (UC) Davis and the U.S. Forest Service (USFS) to identify forestry practices with the potential to mitigate the negative impacts of SOD on a landscape scale. The Mount Tamalpais Resilient Forest Project – Phase 1 Pilot Study was initiated in July of 2015. The intent of the pilot study is to test four alternative approaches to understory brush manipulation and reforestation in large forest gaps² to identify actions that optimize wildfire resiliency, greenhouse gas balance, water yield and revegetation potential.

The study is designed to scale up optimal treatments identified during the pilot phase to a sub-basin scale. By combining forest treatments with measurements of greenhouse gas balance, water yield, fuels, and biodiversity resources, this project will provide critical insights into how management affects tradeoffs across a set of natural resource goals. By situating it inside a planned fuelbreak expansion zone and immediately adjacent to high use recreational areas, the District is evaluating this kind of work within the context of its other watershed management goals and objectives. At the conclusion of the project, the District will have experience implementing alternative treatments and scientific evidence to serve as guidance for future management decisions. The results from this study will inform management of disease

² Field surveys and aerial mapping conducted by MMWD between 2009 and 2014 show approximately 9 percent of MMWD's 3,793 acres of mapped coast redwoods have gaps that have appeared since 2004 and are correlated with the decline of tanoak. Conditions are similar in other mixed hardwood forest types where tanoak were previously a major component of the forest canopy.

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impacted stands throughout the impact range of *P. ramorum* by determining effective measures for forest restoration.

The study is addressing 32 acres of SOD-impacted forest to improve stand structure, wildfire resiliency, greenhouse gas balance, and water yield as measured at the one-acre plot scale. The project will establish no fewer than 1,280 disease-resistant native trees in forest gaps created by SOD. It will provide quantitative, credible assessments of the carbon and water-cycle impacts of active forest management in lands owned by the District. Finally, it will develop data and tools to guide investments and build partnerships in the millions of acres impacted by SOD. As the District conducts its forest management work, the District will adapt its strategies based on lessons learned from experimentation.

The method being evaluated involves thinning and masticating understory brush and diseased trees with a combination of heavy equipment and hand crews where slopes do not exceed 30 percent. Mulch is redistributed evenly on site to maximize soil moisture retention and weed suppression. Stand manipulations are limited to dead and downed trees, standing trees showing advanced disease, and understory brush. To the fullest extent feasible, existing healthy trees and seedlings are retained. The District may plant native trees to facilitate forest restoration with seed and cuttings collected from hotter, drier microclimates on Mount Tamalpais. Understory species with the broadest range of climate tolerances will be favored. Under the hottest, driest climatic futures, several of the current dominant tree species are likely to decline, but an active forest management program is likely to succeed in protecting and expanding other native conifer and hardwood species such as redwood, Douglas-fir or white oaks. The District's strategy is to improve the health and resiliency of forests, such that the forests on District lands retain functions of a healthy ecosystem without annual maintenance.

3.4.3 Integrated Strategies – WAFRZ

WAFRZ have been constructed to achieve a combination of wildfire risk reduction and ecosystem management goals (e.g., oak woodlands adjacent to roads or other facilities where understory fuels and over-topping conifers are removed or grasslands where shrubs are removed). WAFRZ are often constructed or maintained by broadcast burns that are designed to both reduce understory fuels and produce the beneficial effects of fire. Though broadcast burning is the preferred means of maintenance, pile burning and mowing are often employed when the proper conditions for burning do not occur. The District's fuelbreak system identifies about 2,650 acres of WAFRZ, of which approximately 450 acres have been treated between 1995 and 2015.

While not always feasible where structures are present, broadcast burning remains an important, cost-effective fuel reduction technique that the District has successfully used in the past. The technique is particularly useful in grassland and oak woodland habitats, as it can both reduce the fire hazard and meet biological objectives by simulating natural ecological processes. For optimal performance, sufficient resources and tools need to be available after a burn to eliminate weed populations that may expand in response to fire.

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Despite the efficacy of broadcast burning and increased public acceptance of the technique, several factors have made implementing them challenging: more stringent air quality protection measures, increased regulation to ensure firefighter safety, heightened concerns for potential escape, high pre-treatment³ costs, and uncertainties regarding environmental consequences. Additional difficulties come from insufficient firefighting capacity during burn windows, as local fire crews are often called away to combat wildfires in other areas, which has been and will continue to be an increasing problem as outlined in Section 3.3.1. Because of these limitations, the District performs mechanical vegetation management activities such as brushing, mastication, and mulching in combination with pile burning⁴ to achieve the same results as broadcast burning.



Two examples of fuel reduction in WAFRZ: Pine Point (Left) and Sky Oaks Meadow (Right)

3.5 CONCEPTUAL ZONING OF THE LANDSCAPE

3.5.1 Overview

The landscape in the watershed has been zoned in this BFFIP to identify the areas that are minimally and moderately altered as well as the areas that are significantly altered. The conceptual zoning of the landscape will be used to prioritize the work that will occur.

Two primary designations for District lands are defined: infrastructure zone and natural areas. The infrastructure zone encompasses approximately seven percent of watershed lands and consists of a maintained fuelbreak system around buildings, water supply structures, electrical and telecommunications facilities, and recreational facilities. It also includes dam faces and

³ Pre-treatment refers to actions needed before a broadcast burn can be initiated, for example, constructing control lines around the area to be burned.

⁴ Pile burning is a controlled burning method for disposing of accumulated vegetative slash and debris where the material is stacked in piles and burned on-site versus being hauled off-site for disposal.

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roadsides. Vegetation management in the infrastructure zone is focused on maintaining facility access and safety. Design specifications and best management practices are employed to protect ecosystem values to the fullest extent possible, but the high frequency of treatments results in a significantly altered plant community structure in infrastructure zones. The remaining 93 percent of watershed lands have a natural area designation where vegetation management is focused on maintaining or improving ecosystem health (see Figures 3-10 through 3-20 presented at the end of this chapter).

3.5.2 Strategies for Managing Infrastructure Zones

Overview

The types of infrastructure managed by the District under this Plan fall into two categories: fuelbreaks and all other infrastructure not classified as fuelbreaks, including dams and roads.

Fuelbreak Management Strategies

The maintenance requirements of the District's built fuelbreak system are related to the structure and composition of the vegetation retained within and surrounding it. Fuelbreaks with large numbers of perennial, fast-growing weeds in or adjacent to them require more frequent maintenance than those without. Weedy fuelbreaks also compromise surrounding natural areas by serving as a seed source for weeds that may spread into high quality habitat. The District has identified three condition ratings for the fuelbreak system, described below and shown in Figures 3-12 through 3-15. Each type or "condition rating" of fuelbreak has its own set of strategies for maintaining the fuelbreak.

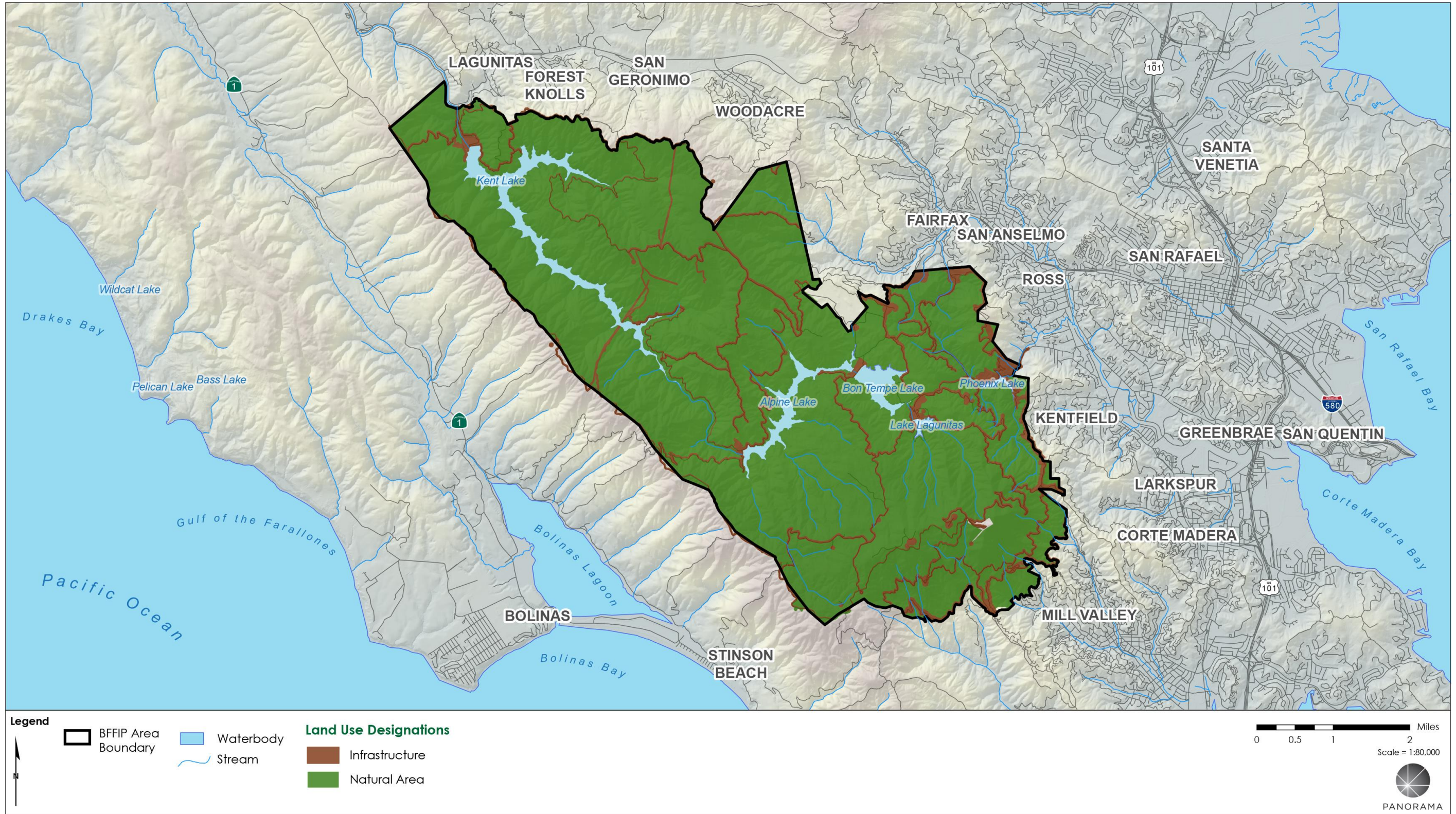
Optimized Fuelbreak

Optimized fuelbreaks are characterized by the absence of perennial weeds. These fuelbreaks border or traverse largely intact ecosystems still dominated by native species. The fuelbreaks can be maintained with low-intensity brushing, performed once every 3 to 7 years. Disposal of the brush material is minimal with larger material (e.g., trees and limbs) sectioned and scattered on-site. Weed spread from this category into surrounding areas is not a significant concern. These fuelbreaks are also treated annually with EDRR (described in more detail in Chapter 6: Implementation of Vegetation Management Actions) to detect and remove any weeds that arise. The District's wildfire and biological goals are currently met within these fuelbreaks, and the long-term strategy is to *maintain the fuelbreaks in their existing condition without increasing effort*.

Transitional Fuelbreak

Transitional fuelbreaks are characterized by the presence of persistent, yet small populations of perennial weeds (i.e., plants that rebloom every year). These fuelbreaks border or traverse largely intact ecosystems still dominated by native species. The fuelbreaks can be maintained with low intensity brushing work performed once every 3 to 7 years. Brush disposal is minimal with large woody material sectioned and scattered on-site. This category requires annual, focused weed control work to maintain weed populations at low levels and to prevent spread.

Figure 3-10 Land Use Designations (Mt. Tamalpais)



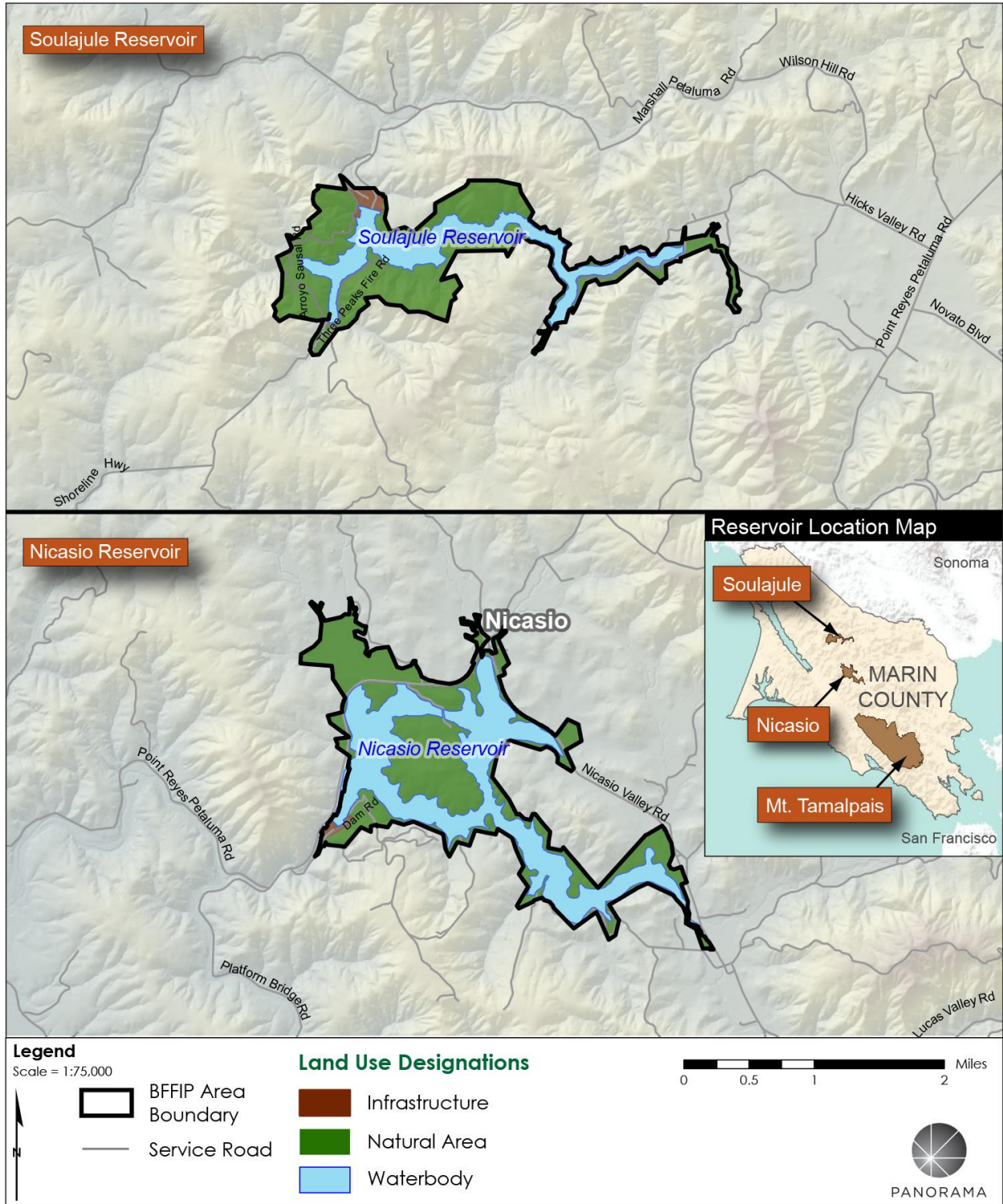
Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2016a; Marin Municipal Water District Sky Oaks Watershed HQ, 2013)

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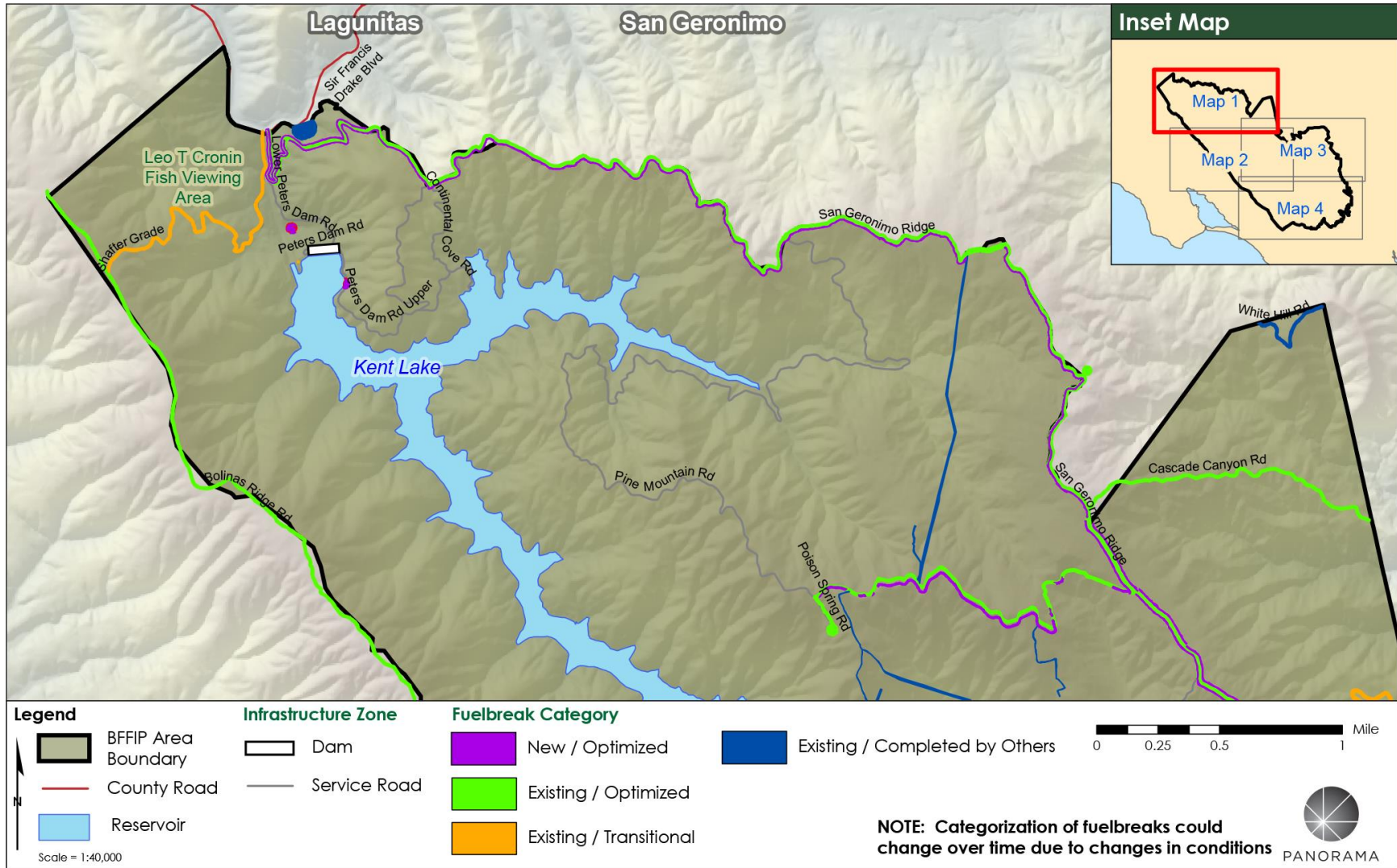
Figure 3-11 Land Use Designations (Soulajule and Nicasio Reservoirs)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

3 THREATS, TRENDS, AND STRATEGIES

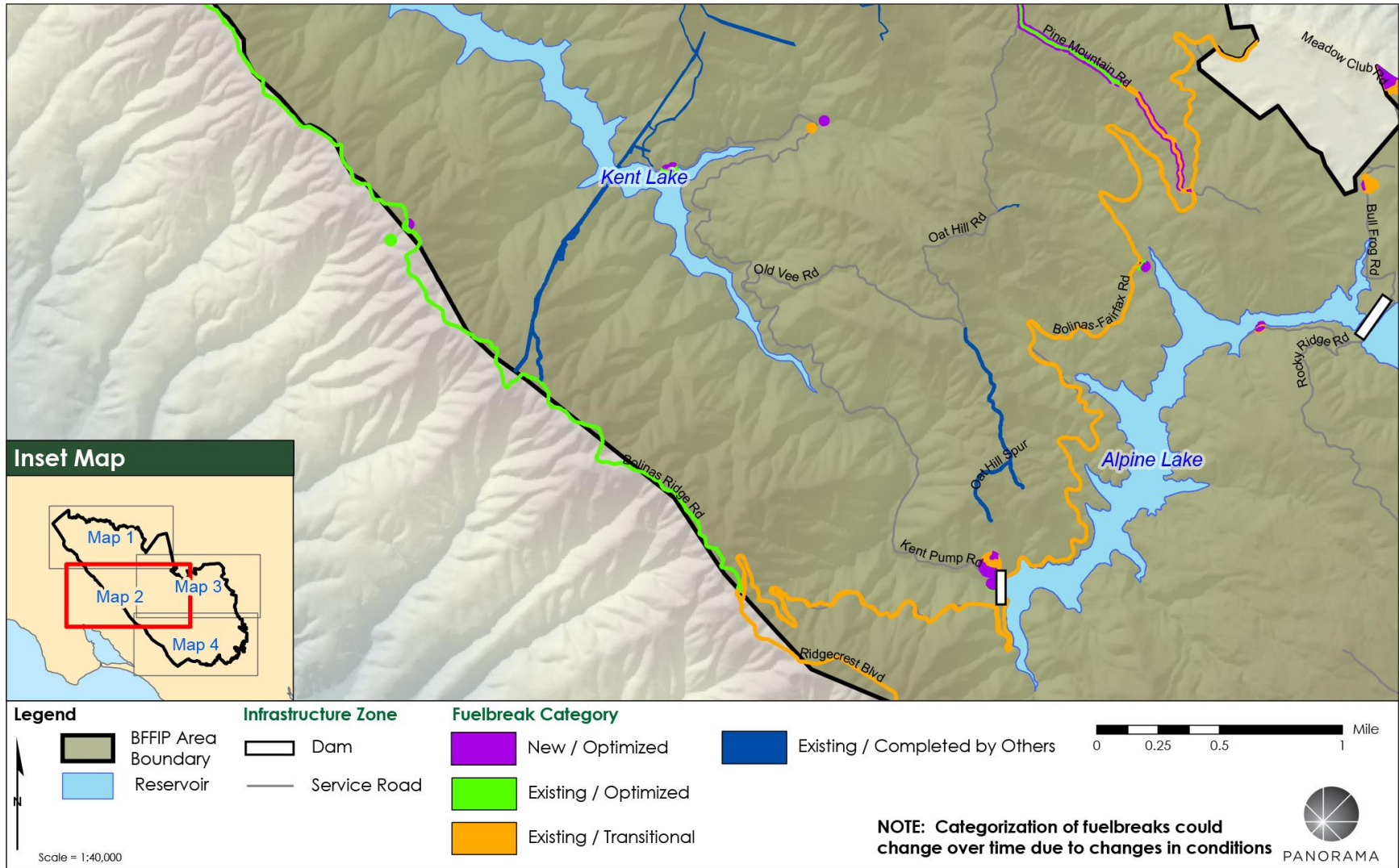
Figure 3-12 Infrastructure Designations (Map 1 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

3 THREATS, TRENDS, AND STRATEGIES

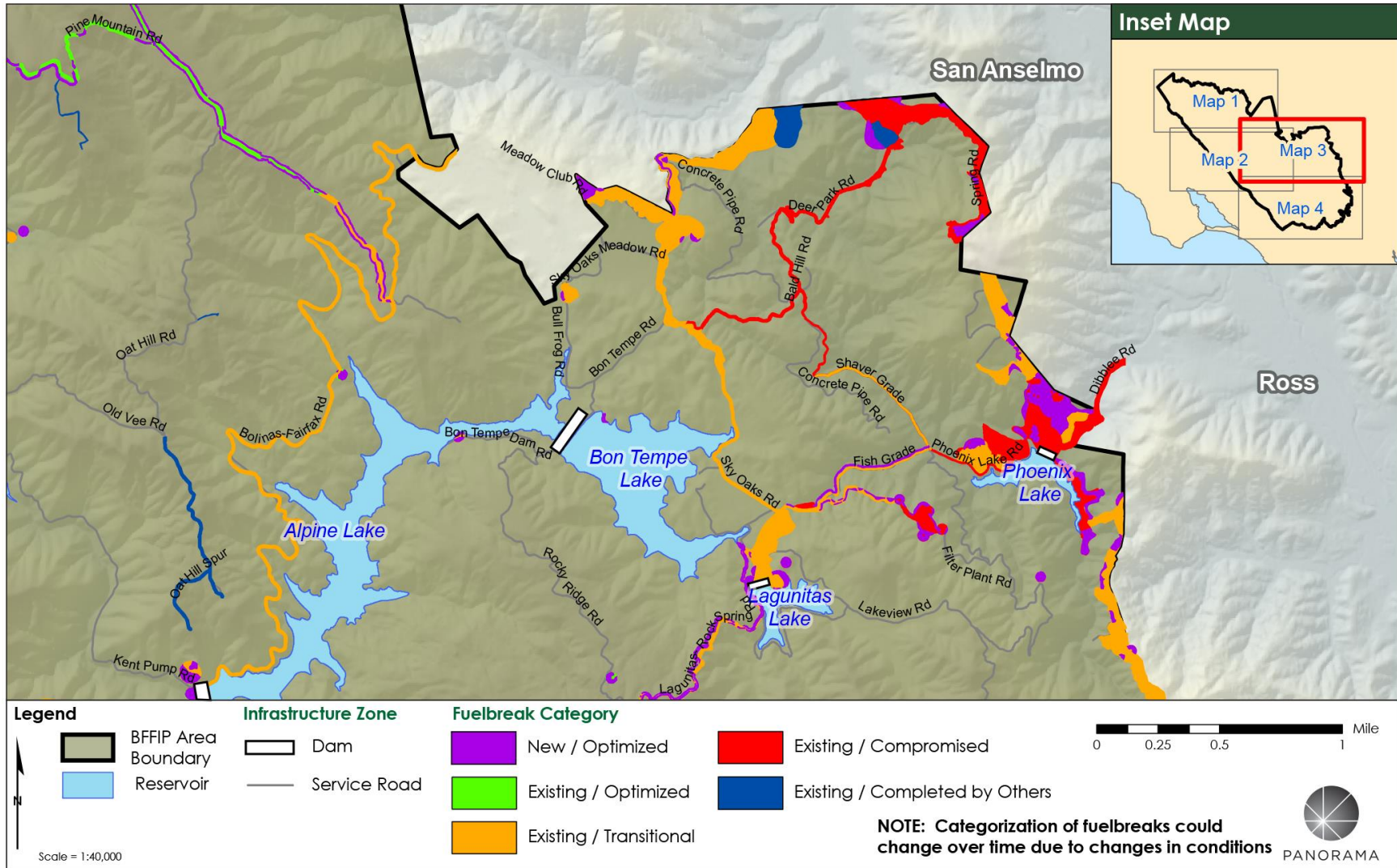
Figure 3-13 Infrastructure Designations (Map 2 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

3 THREATS, TRENDS, AND STRATEGIES

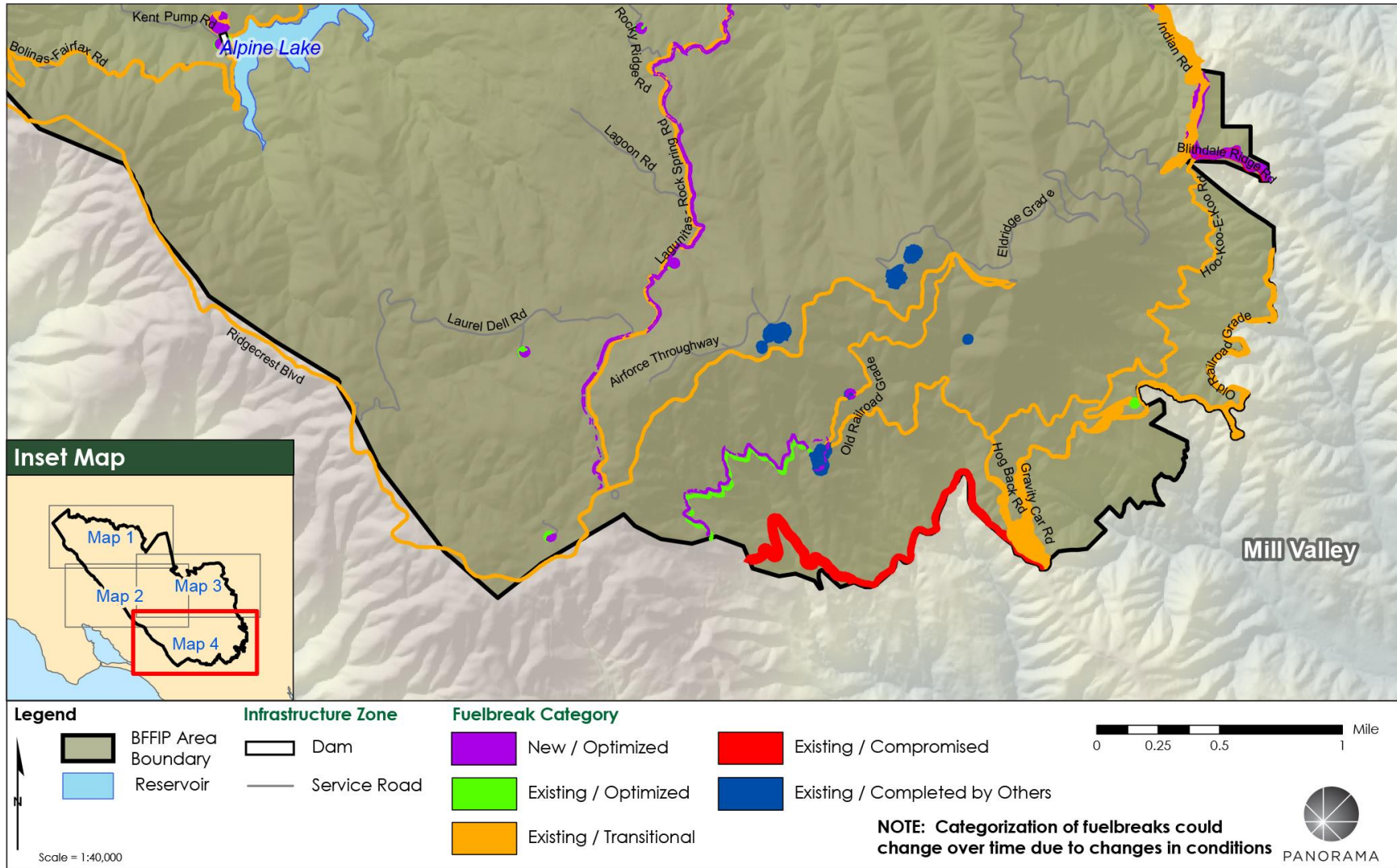
Figure 3-14 Infrastructure Designations (Map 3 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

3 THREATS, TRENDS, AND STRATEGIES

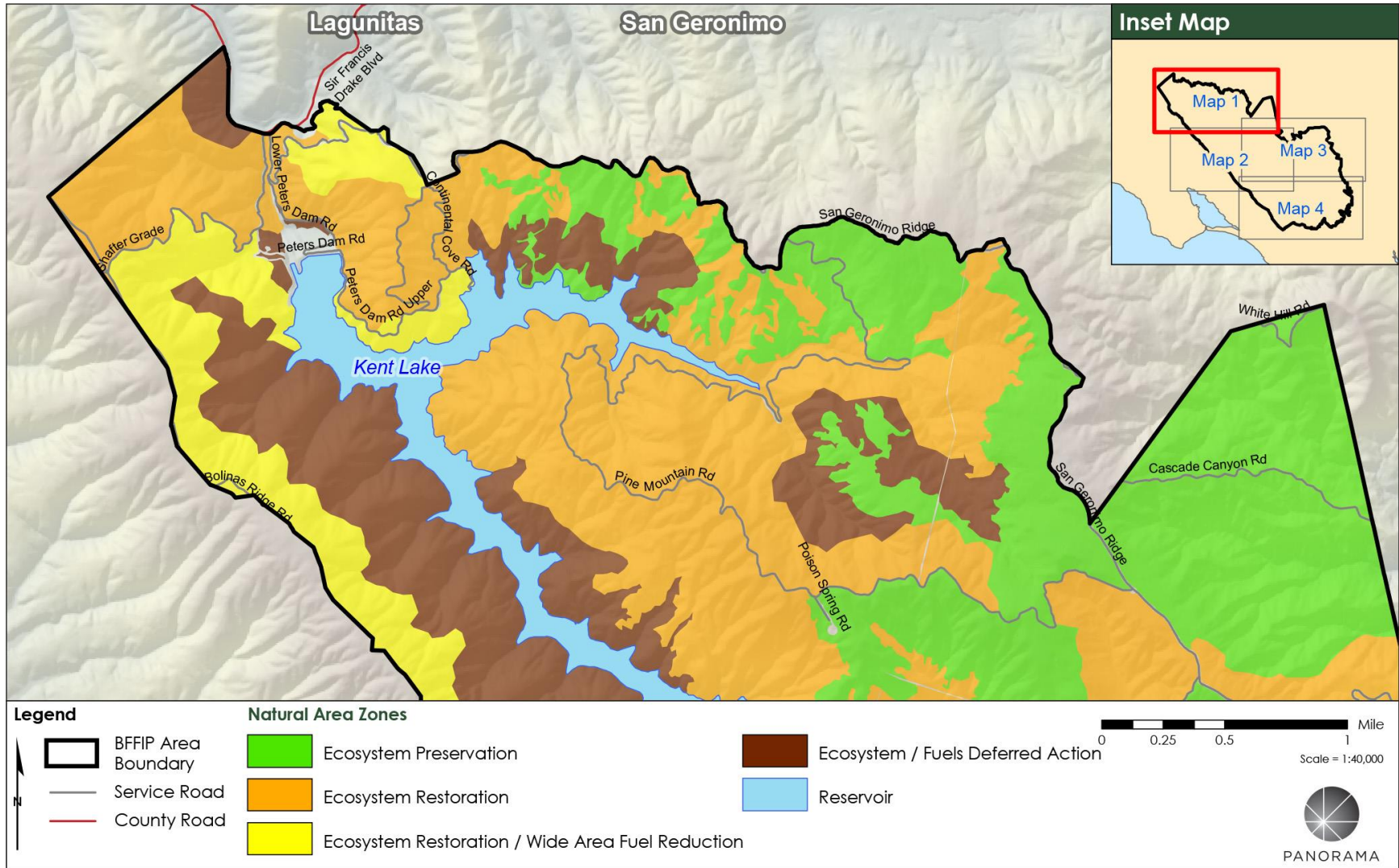
Figure 3-15 Infrastructure Designations (Map 4 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

3 THREATS, TRENDS, AND STRATEGIES

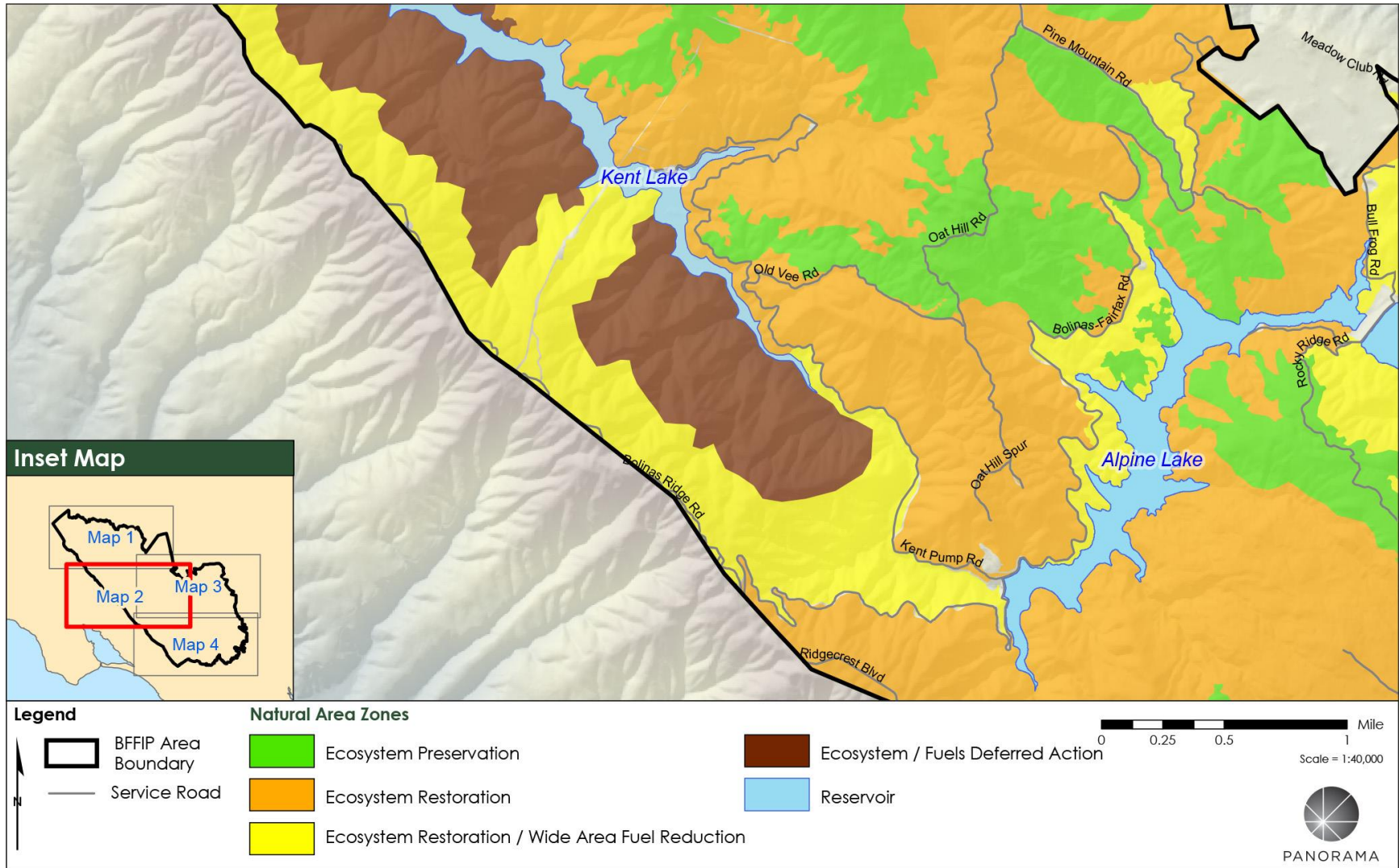
Figure 3-16 Natural Area Designations (Map 1 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

3 THREATS, TRENDS, AND STRATEGIES

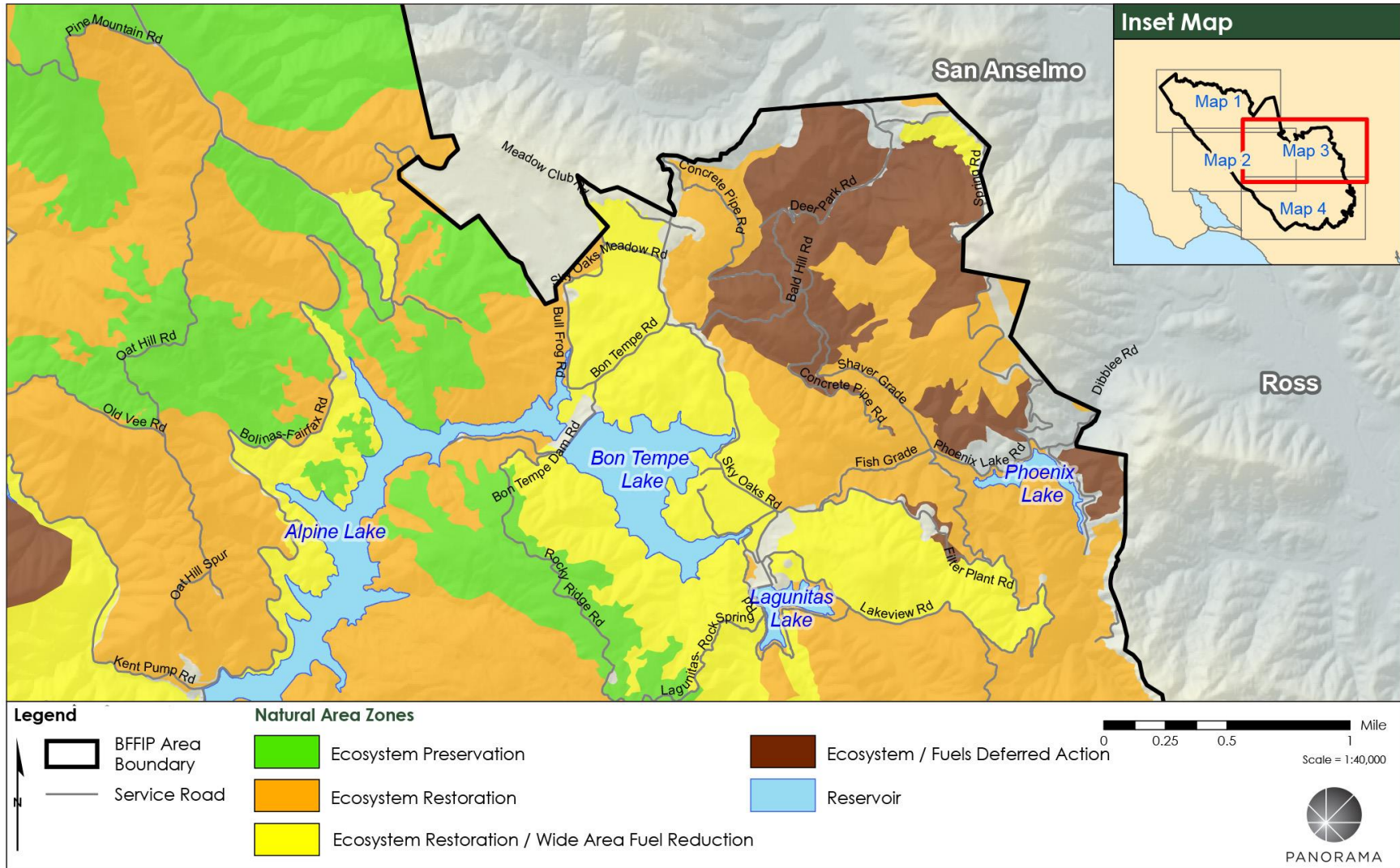
Figure 3-17 Natural Area Designations (Map 2 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

3 THREATS, TRENDS, AND STRATEGIES

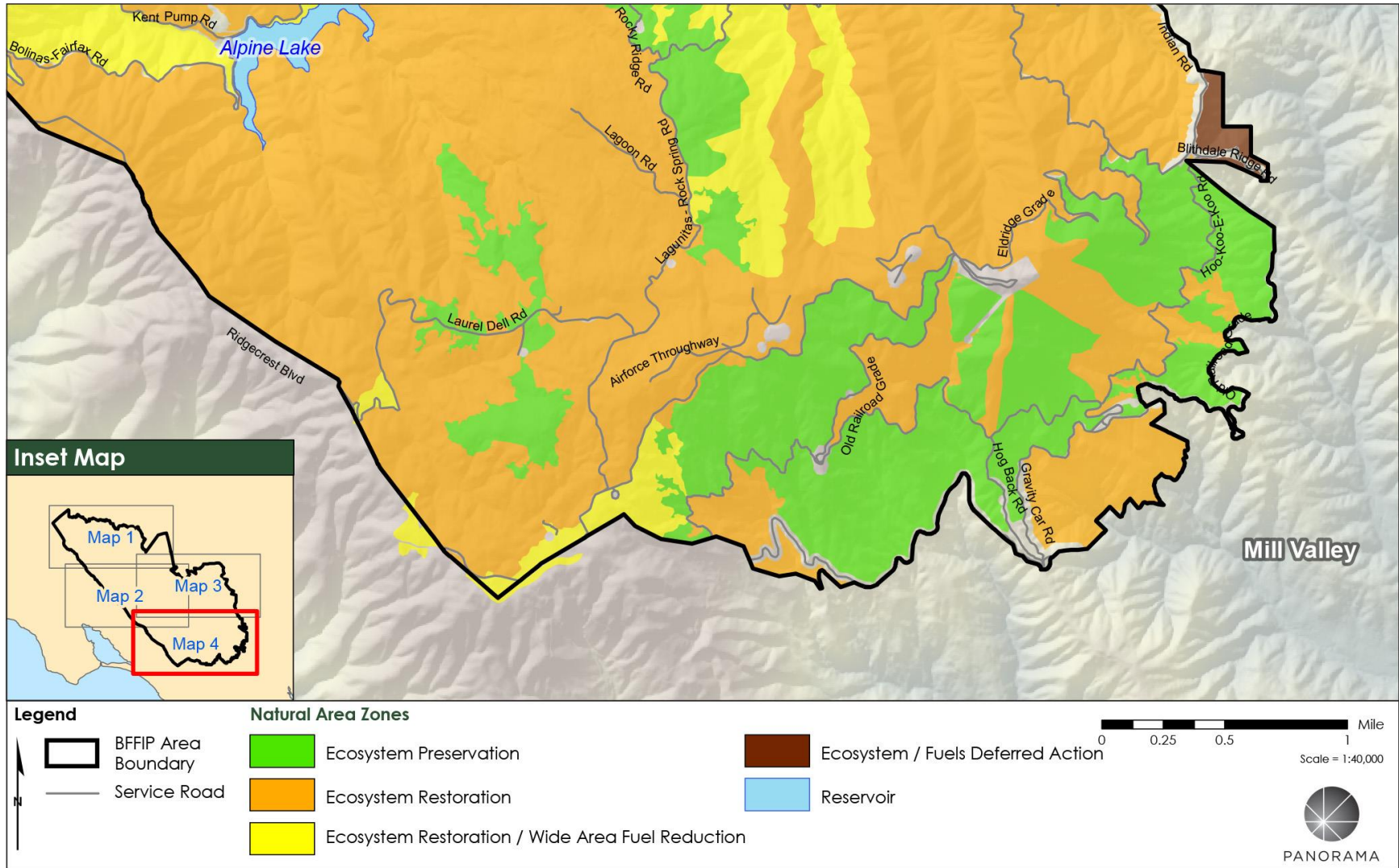
Figure 3-18 Natural Area Designations (Map 3 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

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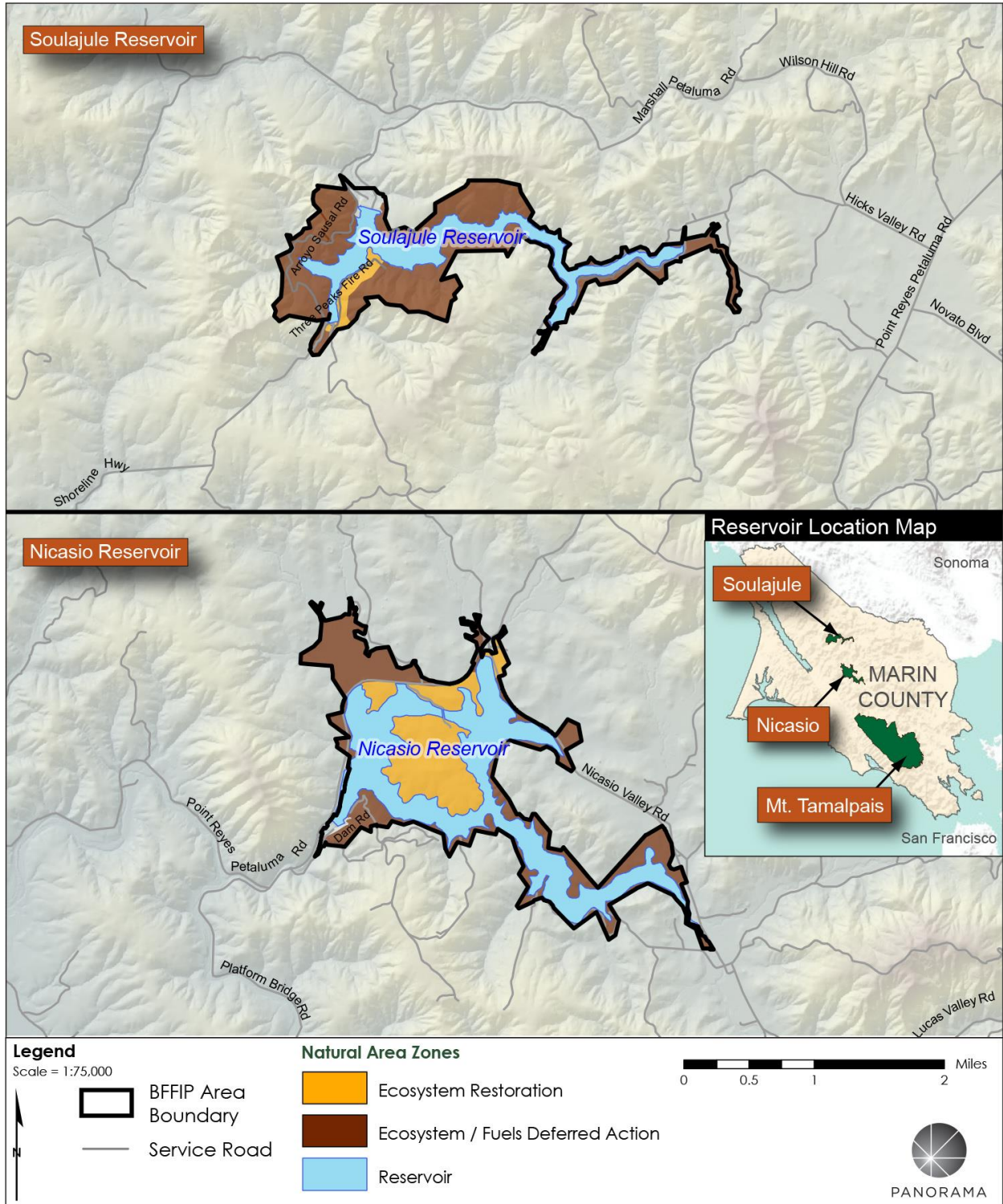
Figure 3-19 Natural Area Designations (Map 4 of 4)



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

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Figure 3-20 SoulaJule and Nicasio Reservoirs Natural Area Designations



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2013; Marin Municipal Water District Sky Oaks Watershed HQ, 2016c)

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In this category, the District's wildfire goals and biological goals are compromised by the persistence of perennial weeds. The strategy is to *improve the existing conditions by fully eliminating perennial weeds from this zone to reduce on-going maintenance efforts over time.*

Compromised Fuelbreak

Compromised fuelbreaks are characterized by the presence of large, persistent populations of perennial weeds, which quickly resprout and re-establish undesirable conditions. The District's focus is limited to wildfire risk reduction because ecosystem values are low and the habitat restoration potential is poor. The fuelbreaks in this category are bordered or traversed by degraded ecosystems dominated by weeds. The fuelbreaks can be maintained only with annual brushing of the dominant weeds; disposal of brush is accomplished via chipping, pile burning, or hauling. Weed elimination efforts are unlikely to succeed because of continual spread back to the site from the adjacent populations of weeds. The District's wildfire goals are only met within this category through resource-intensive annual effort; there are no ecosystem preservation or improvement goals since such goals are too difficult to meet. The strategy is limited to *abating undesirable fuel loading caused by persistent weeds.*

Fuelbreaks Completed by Others

Fuelbreaks completed by others may or may not be on lands owned by the District. An outside party, such as private landowners, owners of leases or easements, or public landowners, has the primary responsibility to maintain the fuelbreaks.

Three types of private landowners adjoin District land: (1) those who have existing assets (i.e., properties or structures) within 300 feet of the District boundary and are within a fuelbreak, (2) those with existing assets within 300 feet but are not within a fuelbreak, and (3) those who have no assets within 300 feet but could propose a new structure within 300 feet. The burden of pre-fire actions to protect assets from wildfires rests mainly with the residents or owners.

The District enters lease and easement agreements with communication companies that have facilities on District land and Pacific Gas and Electric Company (PG&E) that has power lines on District land. The responsibility of vegetation management to help protect these assets lies with the leaseholder, and the requirement for vegetation management and defensible space are written into the lease or lease renewal. In all cases, the leaseholder's vegetation management activities must be reviewed and approved by the District to ensure that they meet District standards for fuel reduction, natural resource protection, and other policies.

Many fuelbreaks along the perimeter of the Watershed span ownership boundaries and are jointly managed by public landowners, including the MCP and NPS. The District manages one side of the road and the adjoining landowner manages the other side, even though the property line may not exactly follow the road. The District and its adjoining land managers would continue to rely on the existing relationships and communication to maintain effective management of these areas.

The District's wildfire and biological goals are met within these fuelbreaks and the long-term strategy is to *continue the existing coordination with other parties that maintain fuelbreaks.*

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Other Infrastructure

The following dams are located within the Watershed: Alpine, Peters (located on Kent Lake), Phoenix, Lagunitas, and Bon Tempe. Seeger Dam is located at Nicasio Reservoir, and SoulaJule Dam at SoulaJule Reservoir. The District performs maintenance, including removal of vegetation other than grasses and rodent control as well as repair of roads and dam appurtenances as needed on these dams to meet the California Department of Safety of Dams regulatory standards. Dam maintenance and repair and rodent control would not be covered under the BFFIP. The District also performs roadside mowing, which is limited to line of sight, hand pulling of weeds, and broadcast burning, as needed to eliminate plant species with deep tap roots that can damage the structural integrity of earthen dams. These activities would be covered under the BFFIP.

3.5.3 Strategies for Managing Natural Areas

Overview

Representing 93 percent of the District's watershed lands, natural areas are distinguished by the relative absence of human-built features other than hiking trails and the continued persistence of native species and relatively intact ecosystems. Several phenomena are producing significant changes in many of these ecosystems, resulting in variable conditions across the administrative units. For management purposes, the District has characterized the natural areas zones by their differing conditions. These sub-classifications of the Natural Areas are shown at a conceptual scale in Figures 3-16 through 3-20, which are generalized maps and within each of the designated areas, there may be smaller pockets of different types of designated areas.

Ecosystem Preservation Zone

Preservation areas are characterized by the presence of largely intact ecosystems dominated by native species, minimal impacts from forest pathogens, and an absence of structures, water supply infrastructure, and picnic areas. The existing fuels profile is within historic norms, and active vegetation management is not considered necessary at this time. The District's focus in this zone is the preservation of ecosystem health, including the persistence of special-status plant species and communities. This zone can remain free of established weed populations with EDRR work and minimization of disturbance. The District's wildfire and biological goals are met within this zone, and the long-term strategy is to *maintain the existing conditions without increasing effort*.

Ecosystem Restoration Zone

Restoration areas are characterized by the presence of ecosystems dominated by native species but with diminished ecosystem function due to disease, fire suppression, and/or weed invasion. No structures, water supply infrastructure, or picnic areas are found in these areas. Established weed populations are present, but site conditions are favorable for long-term containment or localized elimination. The District's goals in this zone focus on ecosystem improvement. The District's biological goals are not met within this zone at this time, but significant gains are possible. Therefore, the long-term strategy is to *increase invasive species removal efforts and*

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implement forest enhancement projects to achieve measurable improvements in ecosystem health.

Ecosystem Restoration/Wide Area Fuel Reduction Zone

The restoration/wide area fuel reduction zone (WAFRZ) shares many of the same characteristics as the restoration zone but is distinguished by its proximity to existing infrastructure and the presence of natural resources considered at high risk of permanent degradation in the event of a high intensity wildfire. The District's goals in this zone include both ecosystem improvement and wildfire risk reduction for both natural resources and human infrastructure. The District's biological and wildfire goals are not met within these areas at this time, but significant gains are possible. Therefore, the long-term strategy is to *increase effort to achieve measurable improvements in both fuels profile and ecosystem health through invasive species removal and forest management.*

Ecosystem and Fuels Deferred Action Areas

This zone is characterized by the dominance of large, persistent populations of perennial weeds, hard to access stands of diseased trees, lack of special-status species, and diminished ecosystem function. Neither the District's wildfire goals nor ecological goals are likely to be achievable in these areas without very intensive and repeat treatment, making it a lower priority than in areas where success can be more readily attained. Therefore, the strategy is to *defer large-scale action but contain weeds where strategically possible.*

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4.1 INTRODUCTION

The BFFIP focuses on the actions that the District will implement to reduce fire hazards and to maintain and enhance ecosystem functions. A set of actions and projects by which these goals and approaches can be achieved are identified in Chapter 5: Implementation of Inventorying, Monitoring, and Planning Management Actions and Chapter 6: Implementation of Vegetation Management Actions.

The three goals of the Plan are to:

1. Minimize the risk from wildfires.
2. Preserve and enhance existing significant biological resources.
3. Provide an adaptive framework for the periodic review and revision of BFFIP implementation decisions in response to changing conditions and improved knowledge.

4.2 PLAN GOALS AND APPROACHES

4.2.1 Goal 1: Minimize the Risk from Wildfires

Overview of Goal 1

The District is responsible for managing its lands, which includes minimizing the risk of wildfires. Over 25,000 structures housing approximately 45,000 residents are within 2 miles of District lands along a WUI that has a CAL FIRE Fire Hazard rating of “High” to “Very High” (CAL FIRE 2007). Wildfire also poses a threat to water quality and distribution, and to the ecosystem functions and values provided by watershed lands. Climate change, forest diseases, and the proliferation of weeds increase the potential for large wildfires. The District has been actively addressing its responsibility for fire protection by implementing many measures that were recommended in its original 1995 VMP, including the completion of approximately 900 acres of fuel load

Terminology

Goal: Expression of a desired outcome; a sought-after end state that is not quantified or time dependent.

Approach: Description of a method MMWD would use to reach the stated goal.

Action: Specific steps or activities designed to accomplish a given goal.

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reduction¹ of the recommended 1,100-acre system (District 1994). The District has also improved regional firefighting capabilities by upgrading water pipelines per its Fire Flow Improvement Program (www.marinwater.org/324/Fire-Flow-Program).

This BFFIP identifies the assets most at risk from a wildfire. The District should complete the infrastructure fuelbreak system as a priority, incorporating the newest standards for fuelbreak design. Per this Plan, the fuelbreaks are divided into Defensible Space, Primary Fuelbreak, Secondary Fuelbreak, Emergency Access Ingress/Egress, and WAFRZ.

Construction and maintenance actions are defined to reduce and, in places, reverse weed spread through the fuelbreak system. This Plan also identifies opportunities for inter-agency and public-private collaboration relative to fire safety.

Approaches Under Goal 1

The approaches that have been identified under Goal 1 focus on three areas: (1) construction and maintenance of defensible space and fuelbreaks, (2) the reduction of fine fuels, weeds, and highly flammable vegetation in the most ignition prone areas adjacent to critical water supplies, electrical, and other infrastructure (such as electrical infrastructure), and (3) interagency collaboration. Each approach is described further, below.

Defensible Space and Fuelbreak Construction and Maintenance

- **Approach 1.1: Prevent destruction of structures and loss of life from wildfires.**
The District will maintain existing fuelbreaks and construct additional fuelbreaks to reduce fire intensity immediately around assets in these strategic locations. Fuelbreak construction and maintenance will limit fire spread and will aid in fire suppression efforts to prevent fires from reaching neighboring communities, critical water infrastructure improvements, or other assets.
- **Approach 1.2: Optimize fuelbreak retreatment intervals.** Fuelbreaks will be maintained in a timely manner to ensure that their function does not become compromised and that the level of effort and impacts of retreatment for those fuelbreaks are minimized. Focusing annual weed control work in optimized and transitional fuelbreaks will improve the existing conditions by fully eliminating perennial weeds and reducing maintenance efforts over time.
- **Approach 1.3: Reduce the potential size and intensity of fires on the watershed.**
Fuel reduction treatment will be undertaken in other strategic locations along roads

¹ Nearly half of the 900 acres fuelbreak system is part of a network of defensible space around structures and utilities as well as reduced fuel corridors along strategic service roads and ridgelines. The other half of fuel load reduction has occurred in more expansive areas adjacent this network, where the District has reduced accumulated fuels across grassland, woodland, and forest habitat to achieve a combination of wildfire risk reduction and habitat enhancement goals.

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and ridgelines to facilitate containment of fires. The District will construct Secondary and WAFRZ in these locations. The District will also implement Ingress/Egress treatments along select roads. These actions will minimize the spread of a fire, maximize firefighter safety, and may restrict fires to areas with few or no assets.

Ignition Reduction

- **Approach 1.4: Reduce the potential for fire ignitions.** The District will reduce the potential for fire ignitions by implementing the following activities: managing vegetation to make it less ignitable in critical ignition areas; converting fuels to very low hazard condition to prevent ignitions in ignition-prone areas such as adjacent to picnic areas; continuing to facilitate PG&E efforts to manage fuels beneath transmission lines and transformers; and incorporating ignition prevention BMPs into hazardous work activities during the fire season and preventing hazardous work activities during Red-Flag Days.

Interagency Collaboration

- **Approach 1.5: Work with other agencies and landowners to reduce fire hazards.** The District will collaborate with private landowners, homeowner's associations, easement and leaseholders such as PG&E, public landowners, FIRESafe Marin, and MCFD to minimize the risks from wildfire. The District's responsibility and the responsibilities of other agencies and landowners are described below.
 - **Private landowners.** The burden of actions to protect assets from wildfires rests mainly with private residents or landowners on their land. The District will support the education/outreach efforts of FIRESafe Marin and the local fire departments to educate owners in the watershed's WUI about their risk and responsibility to participate in local community-based wildfire management planning. The District will continue to share the results of its hazard assessments and modeling efforts with local fire departments and MCFD.
 - **Easement and leaseholders.** The District has entered into a limited number of leases for the operation of different activities on the watershed, including communication facilities and power lines owned by PG&E. Generally, the responsibility of vegetation management lies with the leaseholder, and the requirement for vegetation management and defensible space is written into the lease or lease renewal. In all cases, the leaseholder's vegetation management practices must be reviewed and approved by the District to ensure that the practices meet District standards for fuel reduction, natural resource protection, and other policies. The District will continue to facilitate PG&E's efforts to minimize the potential for ignitions beneath PG&E infrastructure. PG&E will continue to manage vegetation beneath their transmission lines and beneath power poles with transformers.
 - **Public landowners.** Many fuelbreaks along the perimeter of the Mount Tamalpais Watershed span ownership boundaries and are jointly managed. In most cases, the District manages one side of the road and the adjoining

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landowner manages the other side, even though the property line may not exactly follow the road. The District and its adjoining land managers will continue to rely on the existing relationships and communication to maintain effective management of these areas.

- **MCFD.** The District will continue to collaborate with the MCFD to realize their mutual goal of reducing wildfire hazards. MCFD and the District have a high degree of coordination, including training, sharing of resources, and public safety response for fire, medical aid, and search and rescue. A county wide Community Wildfire Protection Plan (CWPP) produced by FIRESafe Marin and MCFD in collaboration with all stakeholders was produced in 2016 and provides a framework for determining location, width, or management of fuelbreaks in at risk locations. The current CWPP, reflects the District’s plan. The District will continue to work with MCFD to ensure that the CWPP is consistent with the District's mission to manage its natural resources in a sustainable manner.

4.2.2 Goal 2: Preserve and Enhance Existing Significant Biological Resources

Overview of Goal 2

Another major focus of the BFFIP is to protect important biological resources and ecosystem functions on the District’s lands. Enhancing ecosystem resiliency is a key strategy for the District to pursue. Resiliency is defined as an ecosystem’s ability to absorb shocks or perturbations and still retain desirable ecological functions, such as the abilities to provide breeding and foraging habitat for wildlife; to support significant biological resources such as rare, threatened, or endangered species; to regenerate desired plant communities following a disturbance; to cycle nutrients; and to protect water quality. Primary ways to enhance resiliency are to minimize unnatural disturbance, mimic lost or diminished ecosystem processes such as naturally occurring wildfire, restore native plant communities, and eliminate or reduce weed populations. The goal of establishing resiliency is to foster conditions where the plant community can function without annual maintenance (Walker et al. 2004). The Plan also includes development and/or improved use of BMPs to protect sensitive plant species and habitats.

Approaches Under Goal 2

The approaches that have been identified under Goal 2 focus on three areas: (1) understanding the resources and ecosystem values on District lands, (2) protecting existing resources that are currently of high value, and (3) enhancing areas where ecosystem values have been damaged through the spread of weeds and forest pathogens. Each approach is described further, below.

Inventorying and Monitoring to Understand Resource Values

- **Approach 2.1: Complete the inventories and mapping of significant vegetation resources and aquatic features (e.g. streams, lakes, wetlands, seeps, springs, marshes).** To manage significant biological resources, it is important that they be thoroughly cataloged and mapped. The District currently is using vegetation community maps to identify potentially suitable habitat for special-status species, to

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map and model the spread of invasive weeds, to show patterns of wildfire risk levels to landowners whose lands are adjacent to those of the District, and to modify construction and maintenance activities. The special-status plant inventory has not been comprehensively updated since 1990, and the existing GIS-based maps need periodic resurveying to capture the changing environment. No inventories of bryophytes or fungi have been conducted on District lands; therefore, it is currently unknown whether there are species of bryophytes or fungi occurring on District lands that are considered special-status species. No comprehensive inventory of wetlands on District lands has been conducted. It is necessary to know where these important components are located to adequately protect them. Additionally, an inventory and mapping of forest pathogens and pests needs to be completed to allow staff to make informed management decisions.

- **Approach 2.2: Detect changes and threats to special-status species populations, other significant resources, and weeds by developing and implementing monitoring programs.** Monitoring helps the District understand the condition of resources and allows staff to make informed management decisions. The extent of the weed populations must be regularly updated to properly prioritize and plan projects that will address the weed populations.

Protection of Existing Resources

- **Approach 2.3: Prevent the loss of special-status plant species, populations, and other sensitive resources.** The District will strive to avoid damage to sensitive resources when conducting activities on the watershed. Where maintenance requirements will potentially affect significant resources, the District will conduct needed actions while implementing measures to avoid or reduce impacts to the degree feasible. To prevent the loss of special-status plants, the District will enhance existing habitat or reintroduce historic populations of special-status plant species where suitable habitat can be identified.

Enhancement of Ecosystem Functions

- **Approach 2.4: Restore ecosystem resiliency, functions, and values in areas impacted by disease, weed invasion, fire suppression, climate change, and other ecosystem stressors.** The District will eliminate or contain weed growth and spread across the watershed; treat degraded sites to restore high quality habitat according to detailed restoration plans; restore ecosystem functions and values in areas heavily impacted by SOD; undertake small pilot studies and experiments to treat forest disease; and where broadcast burning is feasible, safe, and ecologically desirable, the District may use this tool to reintroduce fire's positive functions, such as germinating seeds of fire-dependent species, removal of weeds and biomass, and opening up habitat for species dependent on grassland or more open woodland communities.

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4.2.3 Goal 3: Provide an Adaptive Framework for the Periodic Review and Revision of BFFIP Implementation Decisions in Response to Changing Conditions and Improved Knowledge

Overview

This BFFIP is intended to be periodically updated based on monitoring results' annual board report analysis, and recommendations reflecting lessons learned, any reprioritization of management actions, or any adjustment of tools and techniques. Conditions will change over time and new information will be derived from the success or failure of past actions and research completed elsewhere. As condition changes occur, the recommendations of this Plan will need to be revised accordingly. The District will employ *adaptive management*, which emphasizes a “learn by doing” approach that incorporates the results of monitoring and scientific information to inform future management decisions. This ongoing process consists of implementing field actions to manage natural resources, monitoring ecosystem and human responses to these actions, comparing the results against expectations, and adjusting future actions. These feedback loops give managers information about which actions are effective, and which are not, so that any need for a new approach or different management action is quickly identified.

The BFFIP identifies specific areas where the District needs to proactively seek out or generate new information and respond accordingly. These areas include: climate change, treatment of forest disease, species migration, and weed control tools and techniques. Similarly, the District will need to be continually responsive to changes in laws and regulations pertaining to endangered species protections, noxious species quarantines, greenhouse gas emissions, and worker safety. The District, finally, needs to conduct sufficient monitoring of both its natural resources and the effects of District actions to detect and respond to critical changes.

Approaches under Goal 3

The adaptive management approaches under Goal 3 focus on five areas: (1) stressors of vegetation; (2) management activities; (3) emerging invasive species control and restoration techniques; (4) education, research, and volunteer efforts; and (5) integrated pest management. Each approach is described further, below.

- **Approach 3.1: Monitor indicators of stressors of vegetation.** Recognizing that large-scale changes, such as SOD and global climate change, are occurring, the District will study these macro-processes to develop and adopt appropriate long-term management strategies.
- **Approach 3.2: Monitor management activities and, if warranted, revise approaches or actions.** The District will update its activity monitoring methods to include the identification of measurable outcomes or success criteria, identification of minimal monitoring requirements needed to assess those outcomes, cost tracking, mid-project and post-project evaluations, and implementation of follow-up actions, as needed. District staff will produce an annual summary of actions conducted and the results of those actions (i.e., the Annual Board Report). This summary will be presented to the District Board for review. Included will be a

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list of actions, locations and acreage treated, as well as labor and equipment requirements. The Annual Board Report will indicate whether the District is meeting the targets of this BFFIP, and, if not, what additional work or resources are needed. The Annual Board Report will include the findings from monitoring including information on effects from BFFIP actions and any recommendations made by District staff for modifications to methods (i.e., the vegetation management toolbox) and/or to the schedule of preservation and restoration actions. The Annual Board Report would be presented at a District Board meeting, allowing stakeholders and the community an opportunity for comment on management actions, monitoring results, and recommendations.

- **Approach 3.3: Experiment with emerging invasive species control and restoration techniques and incorporate those that are effective into the BFFIP.** To provide the best approaches for invasive species treatment, restoring degraded habitats, treating forest disease, and improving ecosystem functions, the District will experiment with promising new techniques or facilitate research by others. The District will continue to encourage ecological research and the development of management tools by permitting relevant research and trials on all its watershed lands, including working in collaboration with partners such as (but not limited to) the Tamalpais Lands Collaborative, the U.S. Forest Service, Cal-IPC, UC Cooperative Extension, Point Blue Conservation Science, the Oak Mortality Task Force, and the North Bay Climate Adaptation Initiative partners.
- **Approach 3.4: Continue to work with surrounding land management agencies and the public to foster education, research, and volunteer efforts.** The District has an active volunteer program, which includes working with schools, groups, and individuals interested in learning about the watershed and its resources. The District also coordinates with many biological researchers to conduct studies and research. With the recent formation of the Tamalpais Lands Collaborative, there has been an increase in both staff-supported and volunteer restoration work, and the District believes these opportunities will continue to expand. The District will continue to encourage these programs and relationships.
- **Approach 3.5: Update the District's Integrated Pest Management (IPM) policies and techniques in response to new information.** The District will continue to be committed to integrated pest management. The District has experimented with combinations of mowing, broadcast burning, mechanical removal, and cultural practices, as well as smaller scale and experimental methods, all with varying degrees of success. The District will continue to examine the various tools and techniques, including new technologies available for treating and managing vegetation. The District will use techniques that prove effective, sustainable, and result in the least harm to the environment, District employees, watershed visitors, and District customers.

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5 IMPLEMENTATION OF INVENTORYING, MONITORING, AND PLANNING MANAGEMENT ACTIONS

5 IMPLEMENTATION OF INVENTORYING, MONITORING, AND PLANNING MANAGEMENT ACTIONS

5.1 INTRODUCTION

The District has identified management actions that will be performed as a part of the Plan that do not involve direct physical work in the environment. These administrative actions will include inventorying and monitoring resources, partner collaboration, and planning for various District activities. Table 5-1 summarizes the inventorying, monitoring, and planning management actions that form the basis for the District's adaptive management framework. The goals and approaches are identified in Chapter 4: Goal and Approach Framework for Plan.

Terminology

Inventory: A point-in-time measurement of the resource to determine location or condition.

Monitor: The collection and analysis of repeated observations or measurements to evaluate changes in condition and progress, towards meeting a management objective.

Many of the management actions listed in Table 5-1 are ongoing or will occur on a regular or annual basis. Some actions have specified timelines for completion identified in their performance criteria. For example, all of the inventory actions are anticipated to be completed within the first 5 years of Plan implementation, after which they will occur as needed in response to annual monitoring and adaptive management of the watershed. The implementation of management actions will be evaluated in the Annual Board Report, which will include any District staff recommendations to the Board and stakeholders for adjusting, improving, or reprioritizing individual management actions in years following based on lessons learned in the prior year of Plan implementation.

5.2 SUMMARY OF INVENTORYING MANAGEMENT ACTIONS

5.2.1 MA-1: Continue the Inventories and Mapping of Invasive Species

To support the vegetation management actions that will be conducted by the District, the District will first need to properly understand the location of invasive species and the extent that invasive species have spread on District lands. The District will update invasive species maps as populations are found during EDRR or other surveys. The target is to annually present maps of invasive species reflecting that year's mapping efforts. Comprehensive updating will occur as part of MA-18.

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Table 5-1 Inventorying, Monitoring, and Planning Management Actions

Management Action No.	Action	Performance Criteria	Goals	Approaches
Inventorying Management Actions				
MA-1	Continue the inventories and mapping of invasive species.	<ul style="list-style-type: none"> Annually update invasive species map. 	2, 3	2.2, 3.1
MA-2	Complete the inventories and mapping of special-status, otherwise rare, and presumed extirpated species of plants (refer to Appendices D and E).	<ul style="list-style-type: none"> Complete report with maps indicating status of all known populations, including CNPS list 4 within 1 year of Plan adoption. 	2	2.1
MA-3	Complete inventory of forest pathogens and pests.	<ul style="list-style-type: none"> Complete report that identifies host species, estimates the extent of forest pathogens and pests, assesses the threat, and identifies BMPs to minimize the spread of pathogens within 2 years of Plan adoption. 	2	2.1
MA-4	Complete inventory and mapping of grassland communities and identify preservation and restoration projects.	<ul style="list-style-type: none"> Update GIS vegetation layer, revise classifications, and complete project list within 4 years of Plan adoption. 	2	2.1
MA-5	Complete the inventories and mapping of wetlands, seeps, and riparian habitat and identify preservation and restoration projects.	<ul style="list-style-type: none"> Complete GIS layer, list, identified projects, and implementation plan within 3 years of Plan adoption. 	2	2.1
MA-6	Complete the inventory of bryophytes.	<ul style="list-style-type: none"> Complete annotated species list within 5 years of Plan adoption. 	2	2.1
MA-7	Complete the inventories of fungi.	<ul style="list-style-type: none"> Complete annotated species list within 5 years of Plan adoption. 	2	2.1

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Management Action No.	Action	Performance Criteria	Goals	Approaches
Planning and Monitoring Management Actions				
MA-8	Facilitate vegetation management beneath transmission lines and transformers.	<ul style="list-style-type: none"> Coordinate annually (or more frequently when required) with PG&E to ensure cyclical and emergency vegetation management occurs as needed under transmission lines and transformers. 	1	1.4, 1.5
MA-9	Facilitate vegetation management with third parties that have entered into a lease or easement with the District.	<ul style="list-style-type: none"> Coordinate annually (or more frequently when required) with leasees to ensure cyclical maintenance of fuelbreaks occurs around leased facilities on MMWD lands. 	1	1.4, 1.5
MA-10	Partner with local fire departments and adjacent owners (private, county, state, and federal) to encourage adequate fuels management along common borders.	<ul style="list-style-type: none"> Attend monthly FIRESafe Marin meeting. Support local fire departments annually (or more frequently as required) in improving community education regarding defensible space, vegetation maintenance, and emergency response. 	1	1.5
MA-11	Maintain operational readiness to respond to fire events.	<ul style="list-style-type: none"> Train staff annually (or more frequently when required) in Red-Flag Day protocols, ignition prevention BMPs, wildland firefighting techniques, and firefighting equipment maintenance. 	1	1.4, 1.5
MA-12	Evaluate the impacts, progress of each preservation and restoration action relative to performance criteria, and cost annually, and modify methods and schedules as needed.	<ul style="list-style-type: none"> Complete as part of Annual Board Report with recommended modifications. First board report to be submitted in late May or June following Plan adoption and annually thereafter. 	3	3.2
MA-13	Review and update the Vegetation Management toolbox program annually, including selection criteria for tools and techniques.	<ul style="list-style-type: none"> Complete as part of Annual Board Report with recommended modifications. First board report to be submitted in late May or June following Plan adoption and annually thereafter. 	3	3.3, 3.5

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Management Action No.	Action	Performance Criteria	Goals	Approaches
MA-14	Revise BMPs to protect special-status and otherwise rare species and sensitive habitats from construction or maintenance actions (refer to Appendix F).	<ul style="list-style-type: none"> Implement annual refresher training for Facilities and Watershed and engineering staff working on Mount Tamalpais or managing contracts for work on Mount Tamalpais, within 1 year of Plan adoption. 	2	2.3
MA-15	Revise and implement a project planning, implementation, monitoring, and evaluation program for vegetation management actions.	<ul style="list-style-type: none"> Publish standards within 2 years of Plan adoption. 	3	3.1, 3.2, 3.3
MA-16	Establish a network of plots to monitor plant community change.	<ul style="list-style-type: none"> Initiate monitoring process within 3 years of Plan adoption. 	3	3.1
MA-17	Develop and implement a special-status and otherwise rare plant species monitoring program.	<ul style="list-style-type: none"> Define and implement program and methodology within 4 years of Plan adoption. 	3	3.1
MA-18	Update landscape scale vegetation maps cyclically.	<ul style="list-style-type: none"> Complete revised forest disease / SOD map and technical memo once every 5 years with supporting ground data. Complete revised comprehensive watershed vegetation map and classification within 3 years, and thereafter, once every 15 years. Redo comprehensive invasive species map once every 5 years. 	3	3.1
MA-19	Monitor effects of forest management actions on greenhouse gas balance and water yield.	<ul style="list-style-type: none"> Initiate monitoring process within 3 years of Plan adoption. 	2	2.1

5 IMPLEMENTATION OF INVENTORYING, MONITORING, AND PLANNING MANAGEMENT ACTIONS

5.2.2 MA-2: Complete the Inventories and Mapping of Special-Status, Otherwise Rare, and Presumed Extirpated Species of Plants

To support the District's goal to preserve existing significant biological resources including significant plant resources, the District will first need to properly understand the location of these resources. The District will map the locations of special-status or otherwise rare plant species, as well as represent searched historic locations of plants presumed to be extirpated from Watershed lands.

The target is to have complete maps that indicate the location and status of all known special-status or otherwise rare species of plants, including CNPS list 4 species, within 1 year of Plan adoption. An additional map will show areas searched for extirpated plants.

5.2.3 MA-3: Complete Inventory of Forest Pathogens and Pests

To better support the District's vegetation management actions and the District's goal to preserve and enhance significant biological resources, the District will first need to understand the location and extent of forest disease. The District will complete an inventory of forest pathogens and pests located on District lands.

The target is to complete a report that identifies host species for forest pathogens and pests; estimates the extent of forest pathogens and pests; assess the threat of forest pathogens and pests; and identifies BMPs to minimize the spread of pathogens within 2 years of Plan adoption.

5.2.4 MA-4: Complete Inventory and Mapping of Grassland Communities and Identify Preservation and Restoration Projects

To support the District's goal of preserving existing significant biological resources, including grassland communities, the District will first need to properly understand the location of grassland communities within District lands. The District will complete the inventory and maps of grassland communities within District lands. The District will also identify projects to preserve and restore grassland communities. Restoration methods may include, but are not limited to:

- Removal of encroaching Douglas-fir and coyote brush to maintain or slightly expand existing grassland
- Identification and preservation of patches with 15 percent cover of native bunch grasses
- Increased in thatch removing activities such as broadcast burning, mowing, and grazing

The target is to update the maps of grassland communities, revise classifications, and complete a list of preservation and restoration projects within 2 years of Plan adoption.

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5.2.5 MA-5: Complete the Inventories and Mapping of Wetlands, Seeps, and Riparian Habitat and Identify Preservation and Restoration Projects

To support the District's goal to preserve existing significant biological resources, including wetlands, seeps, and riparian habitat, the District will first need to properly understand the location of wetlands, seeps, and riparian habitat within District lands. The District will complete the inventory and maps of wetlands, seeps, and riparian habitat. The District will also identify projects to preserve and restore wetlands, seeps, and riparian habitat.

The target is to update the map data for wetlands, seeps, and riparian habitat; revise classifications; and complete a list of preservation and restoration projects within 3 years of Plan adoption.

5.2.6 MA-6: Complete the Inventory of Bryophytes

To support the District's goal to preserve existing significant biological resources, the District will first need to understand the location of significant bryophytes. This group of non-vascular plants is composed of mosses, hornworts, and liverworts and includes several state-recognized rare species. The District will complete the inventories of bryophytes within District lands.

The target is to complete an annotated list of bryophytes species within 5 years of Plan adoption, with special attention given to habitats with the potential to support species of special concern.

5.2.7 MA-7: Complete the Inventories of Fungi

To support the District's goal of preserving existing significant biological resources, including fungi, the District will first need to understand the location of significant fungi. The District will complete the inventories of fungi within District lands. The target is to complete an annotated list of fungal species within 5 years of Plan adoption.

5.2.8 MA-8: Facilitate Vegetation Management Beneath Transmission Lines and Transformers

As described in Chapter 2: Environmental Setting, PG&E-owned transmission lines and transformers are located within District lands. PG&E is responsible for maintaining clearance around transmission lines to minimize the potential for wildfires. The District will facilitate PG&E access for the purpose of vegetation management associated with their distribution and transmission lines and transformers. The target is to coordinate annually (or more frequently, as needed) with PG&E to ensure cyclical and emergency vegetation management occurs as needed under power lines and transformers.

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5.3 SUMMARY OF PLANNING AND MONITORING MANAGEMENT ACTIONS

5.3.1 MA-9: Facilitate Vegetation Management with Other Parties that have Entered into a Lease or Easement with the District

As described in Chapter 2: Environmental Setting, the District has entered into leases or easements with other parties that own facilities that are located within District lands. It is the responsibility of these other parties to conduct vegetation management activities around those facilities.

The target is to coordinate annually (or more frequently as needed) with other parties that have entered into a lease or easement with the District, to ensure cyclical maintenance of fuelbreaks and other vegetation management activities occur around these facilities on District lands.

5.3.2 MA-10: Partner with Local Fire Departments and Adjacent Owners (Private, County, State, and Federal) to Encourage Adequate Fuels Management along Common Borders

As described in Chapter 2: Environmental Setting, the District is located adjacent to lands that are managed by other agencies, including private, county, state, and federal agencies. The District will partner with these agencies and local fire departments to encourage the adequate management of fuels along common borders. The target is for District personnel to attend monthly FIRESafe Marin meetings and participate in countywide Community Wildfire Protection Plan annual work plans and plan updates. An additional target is the ongoing support (annually or more frequently as needed) of local fire departments in improving community education regarding defensible space, ongoing vegetation maintenance, and ongoing emergency response.

5.3.3 MA-11: Maintain Operational Readiness to Respond to Fire Events

Small fire events have occurred on District lands between 2006 and 2015 (see Appendix B). It is, therefore, imperative that the District be prepared to respond to fire events that occur on District lands. The District will prepare by maintaining operational readiness.

The target is to regularly (annually or more frequently, as needed) train staff in Red-Flag Day protocols, ignition prevention BMPs, wildland firefighting techniques, and firefighting equipment maintenance.

5.3.4 MA-12: Evaluate the Impacts, Progress of each Preservation and Restoration Action Relative to Performance Criteria, and Cost Annually, and Modify Methods and Schedules as Needed

As described in Chapter 1: Introduction, the Plan will be implemented using an adaptive management framework. The District will learn what works and what does not work for preservation and restoration actions while conducting those actions. To ensure that those “lessons learned” are incorporated into the implementation of the Plan, the District will

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evaluate the impacts, progress, and cost of each preservation and restoration action annually, and modify the methods and schedules as needed.

The target is to submit any recommended modifications to the management actions, methods, and schedule of preservation and restoration actions in an Annual Board Report before the end of each fiscal year in late May or June.

5.3.5 MA-13: Review and Update the Vegetation Management Toolbox Program Annually, including Selection Criteria for Tools and Techniques

Similar to MA-12, the District will learn which tools in the vegetation management toolbox work and do not work as those tools are implemented (see Chapter 6: Implementation of Vegetation Management Actions). To ensure that those “lessons learned” are incorporated into the implementation of the Plan, the District will review and update management actions and vegetation management methods annually.

The target is to identify changes in the plan in an Annual Board Report before the end of each fiscal year in late May or June.

5.3.6 MA-14: Revise BMPs to Protect Special-Status and Otherwise Rare Species and Critical or Sensitive Habitats from Construction or Maintenance Actions

Implementation of construction or maintenance actions, such as the construction of a fuelbreak or conducting vegetation management within habitat could potentially affect special-status species, rare species, or sensitive habitat. The District will revise BMPs as needed to protect special-status species, rare species, and sensitive habitats from construction and maintenance actions, consistent with the mitigation requirements of the BFFIP Final EIR and current regulatory agency regulations. The special-status and rare species that would be specifically addressed would include but would not be limited to northern spotted owls, western pond turtles, foothill yellow frogs, Coho salmon, steelhead, and select rare plants.

The target is to implement annual refresher training for Facilities and Watershed and engineering staff working on Mount Tamalpais or managing contracts for work on Mount Tamalpais within 1 year of Plan adoption.

5.3.7 MA-15: Revise and Implement a Project Planning, Implementation, Monitoring, and Evaluation Program for Vegetation Management Actions

The District will plan, implement, monitor, and evaluate the vegetation management actions that are to be conducted on District lands. The District will revise and implement a project planning, implementation, monitoring, and evaluation program for vegetation management actions. The target is to publish standards for the project planning, implementation, monitoring, and evaluation program within 2 years of Plan adoption.

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5.3.8 MA-16: Establish a Network of Plots to Monitor Plant Community Change

To better understand the way in which the plant communities located within the District lands are changing and responding to threats, the District will establish a network of plots on District land to monitor plant community change. The target is to initiate the monitoring process within 3 years of Plan adoption.

5.3.9 MA-17: Develop and Implement a Special-Status and Otherwise Rare Plant Species Monitoring

Program to properly protect special-status and rare species populations on District lands, it is important for the District to monitor those special-status and rare species. The District will, therefore, develop and implement a special-status and otherwise rare species monitoring program. The target is to define and implement the monitoring program and methodology for special-status and otherwise rare species within 4 years of Plan adoption.

5.3.10 MA-18: Update Landscape-Scale Vegetation Maps Cyclically

The District uses landscape-scale vegetation maps to monitor the extent of forest disease and vegetation community change on District lands. Landscape-scale vegetation maps are important for the planning of vegetation management. The District will update landscape-scale vegetation maps cyclically.

The target is to complete the revised forest disease and SOD map with a technical memo and supporting ground data once every 5 years, and prepare a revised comprehensive watershed vegetation map and classification within 3 years of Plan adoption, and thereafter, once every 15 years. An additional target is to revise the comprehensive invasive species map once every 5 years.

5.3.11 MA-19: Monitor Effects of Forest Management Actions on Greenhouse Gas Balance and Water Yield

To better understand the greenhouse gas balance and water yield effects of forest management actions on District lands the District will monitor greenhouse gas balance and water yield through pre-treatment and post-treatment data collection. A pilot study is currently underway. The target is to integrate the monitoring process into future forest management actions within 3 years of Plan adoption.

5.4 METHODS TO IMPLEMENT ACTIONS

The District will conduct surveys, manage data, create maps, and communicate findings to implement the management actions described in this chapter.

5.4.1 Surveying

Inventorying of biological resources, forest pathogens, and invasive species on District lands will be accomplished by completing various surveys. Prior to conducting any in-the-field

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ground surveys, the District will review background information, including scientific literature, databases, database mapping information, and aerial photography. The District will also consult with local knowledgeable persons or agencies for further information about the biological resources, forest pathogens, and invasive species on District lands.

The District will use the results from the review of background information to plan where, when, and for what species, surveys should be conducted. Field surveys will be completed by the District's trained natural resource staff using established methodologies for the resource or pathogens/pests that are being investigated. For example, surveys for special-status and otherwise rare plants will be conducted according to policies established by the United States Fish and Wildlife Service (USFWS 2000), California Department of Fish and Wildlife (CDFW) (CDFW 2000), and California Native Plant Society (CNPS 2001).

5.4.2 Data Management and Mapping

The results from surveys and monitoring will generate a substantial amount of data that will require management by District staff. The District will continue to manage the data from surveys and monitoring according to protocols that the District is currently implementing. The District will continue to update its databases and maps.

5.4.3 Communication

The final method that the District will use to implement the management actions described in this section is to communicate the results from surveys and monitoring. The District will ensure that communication of results occur through the publication of an Annual Board Report.

The District will also work to publish vetted data to central repositories that are accessible to other land managers, researchers and the general public. Examples include the California Natural Diversity Database (CNDDDB), the California Department of Fish and Wildlife Biogeographic Information and Observation System (BIOS), and the Calflora database.

6 IMPLEMENTATION OF VEGETATION MANAGEMENT ACTIONS

6.1 INTRODUCTION

Previous chapters define the challenges that the District faces and the strategies available to address these challenges. Three goals and 14 approaches are presented to guide the content of this Plan in Chapter 4: Goal and Approach Framework for Plan. This implementation chapter describes the physical actions related to vegetation management. Some actions address more than one approach and/or goal. Under each action, several performance criteria are identified. Finally, the techniques and methods needed to achieve the vegetation management actions are described. This section provides the framework for a series of projects that will be performed to achieve each management action. The projects will be identified by the District in an Annual Work Plan. An initial draft of the Annual Work Plan is provided in Chapter 7: Cost and Preliminary Work Plan. A draft of the anticipated Best Management Practices for the vegetation management actions below can be found in Appendix F.

6.2 VEGETATION MANAGEMENT ACTIONS

The District will undertake the vegetation management actions as listed below in Table 6-1. The table identifies the performance criteria for the actions, so that the District can assess the likelihood of success and effectiveness of Plan implementation. Each action is described in detail, including the actions that will be performed to achieve the performance criteria. These management actions are numbered continuing from the actions identified in Chapter 5: Implementation of Inventorying, Monitoring, and Planning Management Actions. Goals and approaches identified in the table can be found in Chapter 4: Goal and Approach Framework for Plan.

The performance criteria (e.g., implementation frequency and total acres treated within a set time period) for each vegetation management action listed in Table 6-1 varies depending on what District staff believe is achievable in the initial 5 years of Plan implementation with limited resources. The implementation of vegetation management actions will be evaluated in the Annual Board Report, which will include any District staff recommendations to the Board and stakeholders for adjusting, improving, or reprioritizing individual vegetation management actions in years following based on lessons learned in the prior year of Plan implementation.

6 IMPLEMENTATION OF VEGETATION MANAGEMENT ACTIONS

Table 6-1 Vegetation Management Actions

Management Action No.	Action Description	Performance Criteria	Year 5 Implementation Level	Goal	Approach
MA-20	Perform cyclical maintenance throughout the Infrastructure Zone with sufficient frequency to maintain design standards	<ul style="list-style-type: none"> • Retreat each fuelbreak once every 1 to 5 years, depending on the site characteristics. 	200 acres	1	1.1, 1.2, 1.3, 1.4
		<ul style="list-style-type: none"> • Complete mowing of fine fuels in the most ignition prone areas, including parking lots, picnic areas, and defensible space around structures within the first month of the start of the fire season and repeat if conditions warrant. ^a 	50 acres		
		<ul style="list-style-type: none"> • Remove all reproductive broom annually in the optimized and transitional fuelbreaks. 	260 acres		
		<ul style="list-style-type: none"> • Perform cyclical roadside mowing. 	50 acres		
		<ul style="list-style-type: none"> • Perform cyclical dam maintenance. 	50 acres		
MA-21	Construct the remainder of the fuelbreak system (see Figures 3-12 to 3-15)	<ul style="list-style-type: none"> • Construct 117 acres of new fuelbreaks with 50 acres to be completed within 5 years of Plan adoption. 	15 acres	1	1.1
MA-22	Expand the Early Detection Rapid Response (EDRR) program to identify, report, and treat new populations of invasive species	<ul style="list-style-type: none"> • Annually survey 100 percent of roads and newly disturbed areas, and 25 percent of trails. 	150 miles	2	2.1, 2.2, 2.4
		<ul style="list-style-type: none"> • Control 60 percent of new small weed stands and 30 percent of existing small weed stands per year. 	100 patches ^c (2 acres total)		

6 IMPLEMENTATION OF VEGETATION MANAGEMENT ACTIONS

Management Action No.	Action Description	Performance Criteria	Year 5 Implementation Level	Goal	Approach
MA-23	Improve conifer and mixed hardwood forest stand structure and function in the Ecosystem Restoration Zone ^b	<ul style="list-style-type: none"> Initial reduction in accumulated fuels and brush density in 180 acres of conifer and mixed hardwood stands within 5 years of Plan adoption. 	60 acres	1, 2	1.1, 1.3, 2.3, 2.4
		<ul style="list-style-type: none"> Maintenance of areas where fuels and brush density were reduced and trees planted. 	100 acres		
		<ul style="list-style-type: none"> Complete 100 acres of broadcast burning in forest understory within 5 years of Plan adoption. 	Up to two 20-acre projects		
MA-24	Improve grassland and oak woodlands in the Ecosystem Restoration Zone ^b	<ul style="list-style-type: none"> Conduct Douglas-fir thinning in grasslands and the understory of oak woodlands. 	200 acres	1, 2	1.1, 1.3, 2.3, 2.4,
		<ul style="list-style-type: none"> Complete 450 acres of broadcast burning in grasslands and open oak woodlands within 5 years of Plan adoption. 	Three projects ^d (not to exceed 140 acres combined)		
		<ul style="list-style-type: none"> Remove 600 acres of reproductive broom. 	505 acres		
		<ul style="list-style-type: none"> Reduce goatgrass to less than five percent of 2016 mapped levels. 	35 acres		
		<ul style="list-style-type: none"> Reduce effort needed to maintain 2016 extent of yellow starthistle by 25 percent. 	120 acres		
		<ul style="list-style-type: none"> Control other high priority weeds to prevent expansion beyond spatial extent documented in 2016 and achieve a 25 percent reduction in both weed cover and the level of effort needed to maintain it. 	Covered by patches identified in MA-22		

6 IMPLEMENTATION OF VEGETATION MANAGEMENT ACTIONS

Management Action No.	Action Description	Performance Criteria	Year 5 Implementation Level	Goal	Approach
MA-25	Reintroduce or enhance historic populations of special-status plant species	<ul style="list-style-type: none"> Re-introduce at least seven populations of special-status plant species within 5 years of Plan adoption. 	Three projects implemented or maintained (1 acre combined)	2	2.3
		<ul style="list-style-type: none"> Modify at least three habitats for plant species' benefit within 5 years of Plan adoption. 	Three projects implemented or maintained (11 acres combined)		
MA-26	Develop and implement 10-year restoration plans for Potrero Meadow, Sky Oaks Meadow, and Nicasio Island.	<ul style="list-style-type: none"> Develop a 10-year restoration plan for Potrero Meadows (30 acres). 	n/a	2	2.3, 2.4
		<ul style="list-style-type: none"> Develop a 10-year restoration plan for Sky Oaks Meadow (50 acres). 	n/a		
		<ul style="list-style-type: none"> Develop a 10-year restoration plan for Nicasio island (75 acres of native grassland). 	n/a		
		<ul style="list-style-type: none"> Begin Implementation of at least two of the above restoration plans within 5 years of plan adoption. 	Two projects not to exceed 125 acres combined		
MA-27	Conduct experiments and trials to identify suitable methods for control of invasive species.	<ul style="list-style-type: none"> Conduct field trials to test emerging weed control tools and techniques. 	Three projects implemented or maintained (30 acres combined)	2	2.4, 3.3, 3.5
		<ul style="list-style-type: none"> Complete a report that summarizes the results and includes recommendations. Update Plan's vegetation management toolbox and District's IPM program as appropriate. 	n/a		

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Management Action No.	Action Description	Performance Criteria	Year 5 Implementation Level	Goal	Approach
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Notes:

- a CAL FIRE determines the start of the official fire season each year based on weather conditions. Fire season typically starts between mid-May and early- June and extends into mid-November.
- b The Ecosystem Restoration Zone includes the WAFRZ.
- c A patch is defined as a maximum of 100 square meters (0.02 acre).
- d A project is defined as 38 acres but could vary by year.

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6.2.1 MA-20: Perform Cyclical Maintenance Throughout the Infrastructure Zone with Sufficient Frequency to Maintain Design Standards

Overview

MA-20 includes vegetation management on permanent fuelbreaks adjacent to structures, utilities, and service roads. It includes activities such as retreating fuelbreaks, mowing in the most ignition-prone areas, eliminating broom from fuelbreaks, and mowing dam faces and roadsides.

Retreat Fuelbreaks

The retreatment of existing fuelbreaks is intended to maintain reduced fuel loads and stand structure that will slow fire spread and reduce flame lengths. Fuel reduction areas will be maintained by re-cutting vegetation as warranted. Fuelbreaks are linear in nature. As such, vegetation management activities will move along the fuelbreak in a linear manner. The target is for each fuelbreak to be re-treated on a cyclical basis, as needed to maintain desired fuel characteristics; each fuelbreak will be re-treated at least once every 5 years. Compromised fuelbreaks, which have dense broom populations, and defensible space with grassy fuels will be treated every year.

The District is currently maintaining approximately 450 acres of infrastructure fuelbreaks. The District will continue to maintain these fuelbreaks. In addition, the District will construct, as a part of this Plan, approximately 50 additional acres by the end of 5 years following Plan adoption, resulting in a total of 500 acres of fuelbreak, and an additional 67 acres over the lifetime of the Plan for a total of 567 acres of fuelbreak. The District will maintain 200 acres of constructed fuelbreak annually. Treatment methods are described in Section 6.3.2.

Complete Mowing of Fine Fuels in the Most Ignition Prone Areas

Managing vegetation in the most risk-prone areas, including parking lots, picnic areas, and defensible space around structures is a top priority. These areas, which are most risk-prone, are currently maintained by the District, and will continue to be maintained by re-cutting vegetation as warranted. Hazard trees would be removed as necessary.

The target is for each ignition-prone area to be mowed within the first month of the start of the fire season. The California Department of Forestry and Fire Protection (CAL FIRE) determines the start of the official fire season each year based on weather conditions. The official fire season typically starts between mid-May and early June and extends into mid-November. The District currently mows 10 acres of fine fuels annually; this will increase to 50 acres per year within 5 years of Plan adoption.

Perform Cyclical Roadside Mowing and Dam Maintenance

Vegetation management around roadsides and dams is necessary to ensure the integrity of the infrastructure. The District will continue to conduct roadside mowing on an as-needed basis to maintain unobstructed access for District vehicles and a clear line of sight for both District staff and recreationists. The District will also continue to conduct dam maintenance on an as-needed

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basis to meet regulatory requirements for dams: lines of sight for spillways and groins must be clear (vegetation and debris removed) so visual inspections may occur; for earthen dams, woody vegetation of all kinds will continue to be removed to prevent the growth of deep taproots that can impair the structural integrity of the dam. Pile burning of accumulated brush may occur in combination with mowing as part of the dam maintenance regime. The work is performed with a combination of heavy equipment with cutting or masticating heads mounted on articulating arms and with power tools including chainsaws and brushcutters. Slash is typically scattered on-site. The target is to perform ongoing roadside mowing and dam maintenance. The District currently performs approximately 10 acres of roadside mowing and 20 acres of dam maintenance annually. The target is to perform 50 acres of roadside mowing and 50 acres of dam maintenance annually at peak implementation levels.

Remove Reproductive Broom from Optimized and Transitional Fuelbreaks

Implementation of this management action is restricted to Optimized Fuelbreaks and Transitional Fuelbreaks. The intent is to eliminate broom in these fuelbreaks. To accomplish this goal, broom plants would be removed annually before any are mature enough to flower and replenish the seedbank (i.e., reproductive broom). The District would annually remove all reproductive-aged broom in 260 acres of Optimized and Transitional Fuelbreaks. Treatment methods are described in Section 6.3.2.

6.2.2 MA-21: Construct the Remainder of the Fuelbreak System

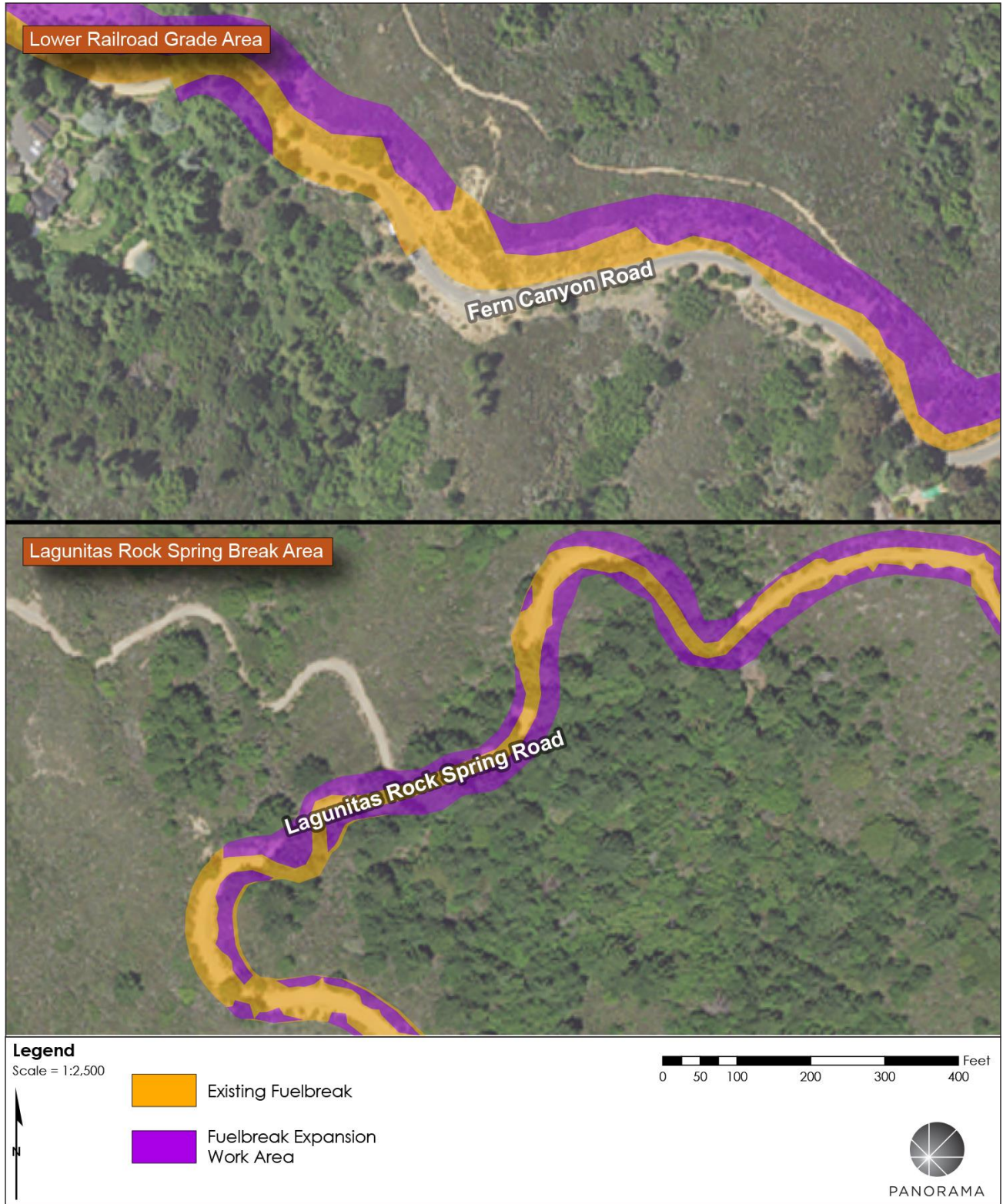
The proposed future construction of new fuelbreaks will predominantly include the widening or expansion of existing fuelbreaks to maximize their utility. Fuelbreak widening will be performed as crews are in the area performing cyclical maintenance in the existing system. The District will expand the formal fuelbreaks by nearly 117 acres under this Plan. The target is to complete approximately 50 percent of the proposed fuelbreak expansion (50 acres) within 5 years of BFFIP adoption. Figures 3-12 through 3-15 show the whole permanent fuelbreak system, including the existing fuelbreaks and the planned fuelbreaks to be constructed. Figure 6-1 shows a representative example of a fuelbreak expansion area. Pile burning of accumulated brush may occur during fuelbreak widening. Treatment methods are described in Section 6.3.2.

6.2.3 MA-22: Expand the EDRR Plan to Identify, Report and Treat New Invasions of Invasive Species

Eliminating new colonies of weeds is the most effective action, aside from prevention, that the District can take to preserve biodiversity (as well as reduce fuelbreak maintenance costs). EDRR includes regular surveys of parts of the watershed where weed invasion is most likely, and periodic surveys in remote areas where new weed invasions are likely to be less frequent. The surveys are performed by trained District staff and volunteers. EDRR staff pull, cut, or dig out newly discovered invasions that are less than 100 square meters (0.02 acre) in size; larger populations are flagged for later treatment. A database of all EDRR populations will be maintained and used to facilitate follow-up visits ensuring that the invasion was eliminated. Sites will be revisited and retreated annually until the District records 5 consecutive years with

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Figure 6-1 Example of Fuelbreak Expansion



Sources: (Marin Municipal Water District Sky Oaks Watershed HQ, 2016a; Marin Municipal Water District Sky Oaks Watershed HQ, 2013; ESRI, 2016; USGS, 2016)

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no aboveground plants of the target weed. Many sites (but not all) are located adjacent to roadsides.

The survey target is to annually patrol at least 100 percent of all roads and newly disturbed areas and 25 percent of all trails. The target is to annually control 60 percent of new small weed stands and 30 percent of existing small weed stands. It is estimated 100 patches will be treated annually within 5 years of Plan adoption. Complete elimination is an unrealistic target since there will be some new invasions that escape notice until they are too large for EDRR response, the stands will be too difficult to access, or control is not feasible given existing constraints. Priority will be given to removing new and existing small invasions in Optimized Fuelbreaks, Preservation Natural Areas, Transitional Fuelbreaks, Restoration Natural Areas, and WAFRZ.

6.2.4 MA-23: Improve Conifer and Mixed Hardwood Forest Stand Structure in the Ecosystem Restoration Zone/WAFRZ

Reduce Accumulated Fuels and Brush Density in Conifer/ Mixed Hardwood Stands

The District will reduce accumulated fuels and brush density in conifer and mixed hardwood forest to reduce wildfire risk and improve overall forest function. Thinning brush is an established means of promoting the growth of retained native trees by reducing the competition for light, nutrients, and water. Mid-canopy Douglas-fir trees may require thinning by felling or girdling. During treatment site selection, the emphasis will be placed on the following types of sites, in the following order:

1. Sites with stands located in areas adjacent to formal fuelbreaks and/or where disease combined with decades of fire suppression have severely compromised forest functions and values.
2. Sites where the reduction in accumulated fuels and brush density meet both fire risk reduction objectives and ecosystem restoration objectives, such as WAFRZ.
3. Sites where impacts from SOD can be mitigated and greenhouse gas balance and water yield can be improved.
4. Sites where the potential impact to sensitive resources is minimal.

The District will treat approximately 60 acres per year (in the fifth year of implementation), that have previously not been treated. By the fifth year of BFFIP implementation, the District will also conduct follow-up maintenance on approximately 100 acres, assuming that some areas will only require one treatment and no follow up. Treatment methods are described in Section 6.3.2.

Forest Stand Enhancement

Sites where trees affected by SOD are removed and remaining natural regeneration is below target levels may be revegetated with disease-resistant native conifer or hardwood seeds or seedlings. Seeding and seedlings installation will occur on the sites. Any tanoaks that resprout on these sites will be removed.

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Prescribed Burning

The District will conduct broadcast burning in the understory of conifer and mixed hardwood forests located within the Ecosystem Restoration Zone/WAFRZ as part of the follow-up maintenance described above. Broadcast burning will help improve the forest stand structure by suppressing the re-establishment of brush in the understory that competes with native trees and by stimulating seed germination of fire-dependent native species. A description of how the District will conduct broadcast burning is described later in this document, in Section 6.3.3. The target is to complete broadcast burning on 100 acres of forest understory in the Ecosystem Restoration Zone within 5 years of Plan adoption with individual burn projects limited to 20 acres in size. Pile burning of accumulated brush is also included under prescribed burning.

6.2.5 MA-24: Improve Grassland and Oak Woodland in the Ecosystem Restoration Zone

Douglas-Fir Thinning

The District will conduct thinning of Douglas-firs located within the Ecosystem Restoration Zone to improve grassland and oak woodland habitat. Priority is given to grasslands and oak woodlands where Douglas-firs are small, restricted to the margins, and/or are present in small numbers. The target is to annually thin Douglas-firs from 200 acres of grasslands or oak woodland in the Ecosystem Restoration Zone within 5 years of Plan implementation. The vast majority of Douglas-firs removed will be less than 12 inches DBH; limbs will be removed and piled for burning and trunks left in contact with the ground to decompose. Some larger Douglas-firs (up to 24 inches), or conifers that will damage oaks if felled, may be girdled and left as habitat trees.

Prescribed Burning

The District will conduct broadcast burning in grasslands and oak woodlands within the Ecosystem Restoration Zone. Broadcast burning will help improve grassland and oak woodland by minimizing the spread of invasive species. Broadcast burning would also be used to treat some areas of weeds, including starthistles and goatgrass. These weeds occur in grasslands but also could be burned in chaparral. A description of how the District will conduct broadcast burning may be found in Section 6.3.3. The target is to complete broadcast burning on 450 acres of grasslands and open oak woodlands (and potentially chaparral) in the Ecosystem Restoration Zone within 5 years of Plan adoption. The District will conduct one to three broadcast burns per year; individual burn projects range from 30 to 100 acres in size. Pile burning of accumulated brush is also included under prescribed burning.

Broom Removal

Broom elimination in the Ecosystem Restoration Zone will protect the rich assemblage of species and communities that provide both habitat and migration corridors. The District will take a site-based approach when eliminating broom. Broom removal projects in the Ecosystem Restoration Zone may be done simultaneously with fuelbreak maintenance in a specific area or as part of a restoration project. Broom removal requires the complete uprooting of the plant. Because soil disturbance stimulates germination of broom seeds lying dormant in the soil, initial

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clearing usually leads to a flush of new broom plants and the need to perform annual clearing at a level of effort commensurate with the initial clearing. The period of high-frequency, high-intensity pulling typically lasts between 5 and 7 years. Eventually, the level of effort needed to prevent seed production decreases, and there is a corresponding decrease in soil disturbance. District Watershed staff, based on their experience, consider broom “removed” from an area when there is a zero seed set for 7 consecutive years and when the effort needed to maintain zero seed set is reduced by 90 percent from the point of initial clearing. In the Ecosystem Restoration Zone, the District currently has 88 acres of broom in the initial phase of removal and an additional 205 acres in the long-term maintenance phase. The target is to have 505 acres of broom in management (300 in the initial clearing phase) within the Ecosystem Restoration Zone within 5 years of Plan adoption. Treatment methods are described in Section 6.3.2.

Reduce Barbed Goatgrass

At present, barbed goatgrass is restricted to three known locations, and though one is large, it remains discrete enough to fully manage. Extirpating these populations while still feasible will benefit watershed biodiversity and reduce future management costs. The goatgrass infestation on District lands is centered on the intersection of Bolinas-Fairfax Road and Pine Mountain Road, though two additional populations were found within the last 5 years: one near Bullfrog Quarry and the other off Ridgecrest Boulevard. The target is to treat all 35 acres of infestation annually to achieve a 90 percent reduction in percent cover and a 50 percent reduction in effort in 5 years following Plan adoption. The long-term target is extirpation (total removal) of this species within 15 years. Treatment methods are described in Section 6.3.2.

Reduce Yellow Starthistle

Yellow starthistle is second only to broom in the amount of the watershed that it has invaded, aside from weedy grasses. Eliminating this weed before it spreads further will benefit biodiversity and reduce future management costs. The District will treat 120 acres of infested areas twice a year to achieve 25 percent reduction in percent cover at existing infested sites and the District will eliminate incipient populations as detected. The target is to achieve containment at the 2015 extent of yellow starthistle and a 10 percent reduction in the level of effort needed to prevent seed set. Treatment methods are described in Section 6.3.2.

Contain Other High-Priority Weeds

Invasions of other high-priority weeds are limited and generally are scattered throughout the watersheds. The additional invasive weeds that the District is concerned about are shown in Figures 3-2 through 3-5. The EDRR program is the major tool that will be used to control these weeds. The overall target is to contain high priority weeds to levels documented in 2015. Treatment methods are described in Section 6.3.2.

6.2.6 MA-25: Reintroduce or Enhance Historic Populations of Special-Status Plant Species

Several special-status plant species are in decline on the watershed and multiple localized populations are known to have disappeared within the last 50 years. Where suitable habitat can

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be identified, especially at or near known historic sites, rare species, such as but not limited to Mount Tamalpais thistle (*Cirsium remotifolium*) and thin-lobed horkelia (*Horkelia tenuiloba*), will be reintroduced from other nearby populations. Also, existing populations will be augmented and/or habitat will be improved to benefit remaining rare species. Habitat modification may include collecting and planting seeds of native plants, conducting on-site germination, and hand-pulling weeds and removing brush or trees under 16 inches DBH using hand tools or chainsaws.

The target is to reintroduce at least seven populations of special-status plant species and to modify three habitats for species' use within 5 years following Plan adoption. Work will occur in the Ecosystem Restoration Zone and Ecosystem Restoration/WAFRZ.

6.2.7 MA-26: Develop and Implement 10-year Restoration Plans for Potrero Meadow, Sky Oaks Meadow, and Nicasio Island

The District will restore habitat that has been degraded by weed invasions or altered by other environmental processes such as fire suppression and/or hydrological diversions at Potrero Meadow, Sky Oaks Meadow, and Nicasio Island. The scale and complexity of each of these projects is sufficiently large as to warrant individualized multi-year restoration plans. The target is to develop a restoration plan for each of the three sites and initiate work on at least two of the sites within 5 years following Plan adoption. Restoration will not exceed 125 acres by the end of 5 years. Priority in planning and implementation may be influenced by the availability of grants or by the complexity of permit requirements.

6.2.8 MA-27: Conduct Experiments and Trials to Identify Suitable Methods for Control of Invasive Species

To strategically analyze the suitability of methods for control of invasive species, the District will conduct a set of experiments and trials. The District will experiment with other invasive species control tools to identify their efficacy. One of the invasive species control tools that the Plan will experiment with is animal grazing. The District will conduct grazing trials and identify the suitability of this control method. The District will also conduct experiments on Nicasio Reservoir to identify suitable methods for control of the invasive weed, teasel. Individual trials may be up to 10 acres in size, depending on site conditions and the overall objective. The projects could occur anywhere within District lands.

The target is to update the Plan's vegetation management toolbox and the District's IPM program as additional effective, environmentally safe, and efficient methods are identified. Goats or other livestock will be used. Areas treated by grazing will generally be at least an acre in size. If goats are used, the areas to be grazed will be fenced with temporary fencing. The areas will not cross any waterbodies, including lakes, streams, riparian areas, or wetlands, nor will they cross roads. The results of grazing trials can be compared against other methods for costs, efficacy, and environmental impacts. Tools and techniques that are added to the IPM program or that prove to be more efficient, cost-effective, and less environmentally impactful may then be used at a larger scale. It should be noted that grazing can also have benefits related

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to carbon health and increasing carbon sequestration. The expanded use of grazing could be incorporated into the plan to enhance these benefits.

6.3 METHODS TO IMPLEMENT ACTIONS

6.3.1 Vegetation Management Toolbox

The tools available for vegetation management are fundamentally the same, regardless of the purpose of any given project, be it fuelbreak construction, fuelbreak maintenance, forest enhancement, or habitat restoration. Project-specific differences arise in the use of those tools, with the timing, scale, intensity, and frequency of their use driven by site conditions and desired outcome. The District has an extensive history working with various tools and techniques and now uses primarily those that have been demonstrated to be both efficient and cost-effective for the specific project needs.

Manual and mechanical approaches as well as prescribed burning will be used to manage vegetation under this Plan. Herbicide use is not included in this Plan. Table 6-2 identifies the tools and techniques available in the District's vegetation management toolbox. The techniques and methods are described in greater detail in this chapter. The District will also employ a series of BMPs for each management activity undertaken. An anticipated draft set of BMPs are identified in Appendix F.

6.3.2 Vegetation Management Strategies

Fuelbreak Construction and Maintenance in Grasslands

Fire fuels treatment (grass mowing) will generally be limited to defensible space areas immediately adjacent to structures. Grasses will be reduced in height to less than 4 inches but not cleared to mineral soil to minimize soil erosion. Non-native shrubs and trees, decadent native trees and shrubs (i.e., old plants with a substantial number of dead limbs and twigs), and conifers under 12 inches DBH (diameter at breast height) will be removed entirely. Cyclical mowing of grasses in defensible space areas and other ignition zones (parking lots and picnic areas) will typically be performed annually; elsewhere grasses will not be mowed.

Removal of encroaching woody material will occur once every 3 to 5 years (5 to 10 years in WAFRZ) depending on the rate of regrowth. The work will be accomplished by top-cutting with power tools such as string trimmers and brushcutters with the infrequent use of chainsaws and heavy equipment with mower heads mounted on articulating arms. Disposal of woody cut material (slash) less than 1-inch DBH will be performed by lopping and scattering. Larger stemmed material will be chipped on-site and removed or piled and burned on-site after curing for a minimum of 60 days. Herbaceous vegetation is not mowed during the creation of WAFRZ.

Fuelbreak Construction and Maintenance in Shrublands

Shrubs will be removed or thinned until spacing between individual shrubs or shrub islands is more than double the height of the canopy (e.g., for shrub canopies 6 feet in height, 12-foot gaps

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will be created). In order to create or maintain the required gap size, all target weed species, dead shrubs, conifers, and chamise will be removed as well as other native species as necessary. Rare native species may be pruned but not removed in their entirety. Removal will be accomplished by top-cutting with hand tools such as chainsaws and brush cutters, and with cutting or masticating heads mounted on heavy equipment. All stumps will be flush cut as low as possible parallel to the slope of the ground surface. Only resprouting target weed species will be completely uprooted; this uprooting will be minimized on steep slopes. Disposal of the cut material will be done by chipping, pile burning or lopping and scattering. Cyclical maintenance in shrublands will typically be performed once every 3 to 4 years (once every 5 to 10 years in WAFRZ), though high densities of weeds may necessitate annual maintenance. When appropriate, the District will encourage conversion of shrublands to open canopy woodlands and forest.

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Table 6-2 Vegetation Management Toolbox

		MA 20	MA 21	MA 22	MA 23	MA 24	MA 25	MA 26	MA 27
Technique		Infrastructure Zone Maintenance	Fuelbreak Construction	Early Detection Rapid Response	Forest Stand Structure Improvement	Grasslands and Oak Woodland Improvement	Reintroduce or Enhance Species	Restoration Plans	Weed Control Trials
Prescribed Burning	Broadcast burning	-	-	-	infrequent	infrequent	infrequent	infrequent	infrequent
	Pile burning	infrequent	often	-	often	often	infrequent	infrequent	-
Propane flaming		-	-	infrequent	-	-	Infrequent	infrequent	infrequent
Cutting	Cutting with heavy equipment - Mechanical	often	infrequent	infrequent	often	often	infrequent	often	infrequent
	Cutting with power hand tools - Mechanical	often	often	infrequent	often	often	infrequent	often	infrequent
	Cutting with non-power hand tools - Manual	often	often	infrequent	often	often	infrequent	often	infrequent
Girdling - Manual and Mechanical		-	-	infrequent	infrequent	infrequent	infrequent	infrequent	infrequent
Pulling	Pulling with heavy equipment- Mechanical	-	-	infrequent	infrequent	infrequent	infrequent	infrequent	infrequent
	Pulling by hand or with non-power tools- Manual	often	infrequent	often	Infrequent	often	often	infrequent	-
Scalping	Scalping with heavy equipment- Mechanical	-	-	infrequent	infrequent	infrequent	-	infrequent	infrequent
	Scalping with power tools- Mechanical	-	-	infrequent	infrequent	infrequent	-	infrequent	infrequent
	Scalping with hand tools - Manual	-	-	infrequent	-	-	-	-	infrequent
Covering	Mulching/ Chipping/ Mastication	often	often	infrequent	often	-	infrequent	infrequent	infrequent
	Solarization	-	-	infrequent	-	-	-	infrequent	infrequent
Grazing		-	-	-	-	-	-	-	infrequent
Planting - Manual		-	-	-	infrequent	infrequent	often	often	infrequent

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Fuelbreak Construction and Maintenance in Oak Woodlands and Mixed Hardwood Forests

Understory shrubs, target weeds, and conifers less than 12 inches DBH will be removed by the means described above. Depending on the site, more trees may need to be removed, as described below. For retained trees, dead limbs up to 10 feet above ground will be removed. Live limbs up to 10 feet above the ground or up to 1/3 of the tree's total live foliage will also be removed. Select snags (standing dead trees) may be retained for wildlife habitat, but snags that pose a fall hazard or are judged to pose a high risk of firebrand production in a fire event may be removed. In WAFRZ, large Douglas-firs may be girdled and left standing to provide habitat for birds, bats, and other wildlife. Fuel reduction will be accomplished with hand tools and with cutting or masticating heads mounted on heavy equipment. Disposal of the cut material will be performed by chipping, pile burning, or scattering. Downed trees over 6 inches in diameter will be bucked in place; limbs will be removed; and the main trunk will be cut into lengths sufficient to ensure contact with the ground. Cyclical maintenance in woodlands or forests will typically be performed once every 3 to 5 years (5 to 10 years or more in WAFRZ), though high densities of weeds may necessitate annual maintenance.

These treatments are aimed at removing the flammable understory vegetation to reduce the overall fuel load, as well as to decrease the chance of a crown fire and to preserve the woodland by removing ladder fuels. This treatment type creates a more open, shaded site as shrubs are removed and smaller herbaceous plants and ferns are retained.

Fuelbreak Construction and Maintenance in Coniferous Forests

In some coniferous areas, mainly in dense Douglas-fir and mixed hardwood forests, reducing the fuel load may require thinning of mid-canopy trees. In these cases, the trees will be felled and their branches removed for chipping, hauling, or pile burning. The trunks, if small enough, will be chipped, hauled, or pile burned as well, but the larger trunks will be left on the ground. The number of trees to be removed will depend upon that particular location and site characteristics. Canopy-level tree removal will be limited to those trees that pose a hazard to infrastructure or workers.

Hazard Tree Removal in the Infrastructure Zone

Individual tree removal may be called for in specific locations to reduce production of firebrands and spotting during wildfires, prevent the downing of powerlines, reduce the risk of injury to District staff and recreationists, or maintain road and trail access. For example, scattered pines and Douglas-fir or SOD-killed trees may be removed at ridgetop locations vegetated mainly by grass or chaparral. The removal and disposal of these trees will be conducted as previously described.

Conifer and Mixed Hardwood Forest Stand Enhancement

The methods and tools used to improve stand structure to achieve multiple benefits include those described above. Mechanical methods will be used to remove dead and diseased trees and understory brush such as tanoak resprouts that perpetuate undesirable fuel loading conditions

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and suppress the growth of desired native species. It will also include mulching and masticating in-place, and hand planting new seedlings or spreading seed.

Understory brush and diseased trees will be thinned and masticated with a combination of heavy equipment (excavators of various sizes and/or skidsteers with various mulching heads) and hand crews with chainsaws or brushcutters where slopes do not exceed 30 percent. Mulch will be redistributed evenly on site to maximize soil moisture retention and weed suppression. In areas cut by hand crews, material may be piled and burned. Stand manipulations will be limited to dead and downed trees, standing trees showing advanced disease, and understory brush. To the fullest extent feasible, existing healthy trees and seedlings will be retained. After initial work, there will be at least two rounds of follow-up brushing with heavy equipment to temporarily suppress resprouting tanoak, followed by planting of native trees. Maintenance work will be performed as needed to ensure trees establish, with a goal of transitioning to a minimal or no management regime within 5 years.

Revegetation efforts will be designed with an end goal of establishing new trees in areas where disease has resulted in a discontinuous canopy with gaps large enough to contribute to hotter, drier soil conditions and natural regeneration is insufficient. A combination of disease-resistant native conifer and hardwood species may be used including Douglas-fir, redwood (*Sequoia sempervirens*), California nutmeg (*Torreya californica*), valley oak (*Quercus lobata*), and Oregon white oak (*Quercus garryana*). Both direct seeding and seedling installation may be used, and both will employ regionally appropriate material that incorporates genotypes from hotter and drier locations on Mount Tamalpais in anticipation of future climatic conditions. Natural regeneration of Douglas-fir, redwood and other desired tree species will be encouraged through the installation of protective flagging and structures ahead of any secondary treatment of resprouting tanoaks.

Control of Invasive Species

The methods used to control weeds include prevention, early detection and rapid response, ongoing control, and targeted restoration plantings. On District lands, weeds will be controlled on a species basis, a site basis, or both. Eliminating new colonies of weeds is the most effective action the District can take to preserve biodiversity (as well as reduce fuelbreak maintenance costs). The EDRR program includes conducting regular surveys of those parts of the watershed lands where weed invasion is most likely, and periodic surveys in remote areas where new weed invasions are likely to be less frequent. The surveys are performed by trained surveyors including District staff and volunteers. EDRR staff, led by new seasonal aides, pull, hoe, or dig out newly discovered invasions. A database of all EDRR populations is maintained and used to facilitate follow-up visits ensuring that the invasion was eliminated. Weeds are eliminated through pulling or cutting.

Weed removal sites are revisited and retreated annually until five consecutive years with no weed observations are recorded. The District's ongoing control of the invasive species population is accomplished entirely through pulling invasive weeds.

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Habitat Restoration

Habitat restoration as a strategy for ecosystem enhancement includes restoring degraded habitats as well as planting to encourage growth of native species, SOD resistant-species, and restoring meadow and/or wetland habitats. Methods used include broadcast burning, weed removal, and planting.

6.3.3 Techniques to Implement Management Actions

Prescribed Burning

Overview

Prescribed burning includes broadcast burning and pile burning. Permits from the Bay Area Air Quality Management District (BAAQMD) are required for all burns, as burning is only allowed on designated burn days during a specific time of the year.

Broadcast Burning

Broadcast burning is a specific activity in which fire is applied to most or all of a well-defined area with discrete boundaries for the combined purpose of fuel load reduction and habitat improvement. Burn units are generally selected to take advantage of natural breaks such as reservoirs and service roads. Broadcast burning occurs in four distinct phases: pre-treatment, the burn event, mop-up, and rehabilitation.

Pre-treatment includes:

- Removal of live limbs of trees up to 10 feet above the ground in order to minimize the potential for fire to spread to the canopy
- Scattering and/or mastication of accumulated dead and decadent woody brush
- Top-cutting and on-site scattering of green brush (particularly broom) a minimum of 60 days before the burn event to cure, which facilitates horizontal fire spread during the event and reduces smoke production
- Installation of control lines (approximately 1- to 3-foot-wide bands where vegetation has been cleared to expose mineral soil) where natural control lines such as roads, trails, or water bodies are unavailable

Limbing, scattering, and masticating dead material and top-cutting of green material may occur many months to days prior to the burn event, depending on the larger project goals and site conditions. The work is accomplished with a combination of heavy equipment, power tools, and hand tools. Control line installation occurs within a few weeks or days of the burn event and may be accomplished with heavy equipment or hand tools.

The burn event is a half-day activity when fire is intentionally applied at one or more ignition points and allowed to run between control lines across the designated unit. It is typically conducted in the morning when temperatures and wind are low. The Marin County Fire Department or CAL FIRE provide oversight for all broadcast burns conducted on District lands. Ignitions are achieved using drip torches with a 1:4 mix of gasoline and diesel. Up to four drip torches may be used in a single event, expending no more than 10 total gallons of fuel mix. Fire

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apparatus on-site will include multiple Type III fire engines and one or more water tenders to provide control and on-scene safety. Tenders and fire engines typically stay on existing service roads to provide pumped water via hose-lays which can be deployed for hundreds of feet as needed.

Mop-up begins immediately following the main burn event and may continue for 1 to 3 days depending on the site conditions and weather. Mop-up crews typically remain on-site continuously for a minimum of 48 hours following the burn event. Mop-up crews patrol the burn unit to extinguish smoldering logs (using hose lays and backpack-mounted water pumps as well as hand tools and chainsaws), break up embers with hand tools, and fell hazard trees or limbs with chainsaws.

Rehabilitation consists of the decommissioning of control lines as well as follow-up weed control. Control line decommissioning is generally limited to the manual re-distribution of duff and brush back into the previous cleared lines. This spreads native seed back into the lines to facilitate natural revegetation. It also provides erosion control and discourages the formation of social trails. Because some weed seeds are stimulated by fire or become readily established in post-fire settings, broadcast burn sites will be patrolled by EDRR crews for 1 to 5 years as needed following a burn event.

Broadcast burning will be used to achieve desired outcomes under MA-23 and MA-24. Burns are conducted between June and October to achieve the benefits of mimicking the historic fire regime, and when vegetation is dry enough to carry a fire with minimal smoke production and minimal damage to the seed bank. Broadcast burning may be used under MA-25, MA-26, and MA-27.

Pile Burning

Pile burning is a method of biomass disposal which uses fire to eliminate piles of dried plant material. Piles vary in size from 5 to 10 feet in diameter and 4 to 6 feet in height. Piles are constructed in concert with brush or weed removal and are placed in openings away from power lines and tree canopies to allow for safe ignition at a later date. The composition of piles varies with vegetation type. Under MA-20 and MA-21, piles will consist of chaparral species, broom, as well as hardwoods and conifer limbs. Under MA-23, piles will consist largely of tanoak resprouts. Under MA-24 piles will be composed of conifers, broom, diseased hardwoods, and a limited amount of bay. Pile burning may be used under MA-25 and MA-26. The total volume of material burned in a year will not exceed 117 tons.

Pile burning occurs between November and May under the direction of District staff on days when weather conditions meet the specifications of the BAAQMD permit. Multiple piles may be burned on a single day. Drip torches are used to start ignitions, with fuel use limited to 10 gallons or less per day. District staff remain on-site with fire suppression equipment including Type III engines and a water tender to ensure safety and to extinguish embers by each workday's end.

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Propane flaming

Propane flaming would be conducted to remove weeds. Propane flaming (“green flaming”) uses a propane torch attached to a cylinder to heat seedling or annual plants until their cells burst and wilting occurs, but not to the point of ignition. Propane flamers come in hand-held models as well as on ATV mounts. Propane flaming is restricted to the winter months when surrounding vegetation is unlikely to burn. It may occur under MA-22, MA-25, MA-26, and MA-27. It cannot be used to manage woody vegetation, vines, or herbaceous vegetation with corms or tubers.

Cutting

Overview

Cutting refers to the removal of the above ground portions of target vegetation. It includes pruning and limbing activities, designed to leave trees and shrubs alive but reduced in size; brushing and mowing activities, which remove all above ground parts of a plant but leave the roots intact below ground; and tree felling. Depending on the species and the specific technique used, cutting may result in mortality or it may simply reduce the height or seeding capacity of vegetation for one or more seasons.

Heavy Equipment

Motorized heavy machinery are mounted with various mowing, mulching, and masticating heads for larger scale vegetation removal projects and cyclical maintenance tasks. Heavy, diesel-powered equipment used by the District includes excavators, backhoes, skidsteers, and tracked chippers. Equipment operates both on-road and off-road; any equipment used off-road is track-mounted to minimize soil disturbance and compaction. The mowing or grinding heads and chippers reduce material to a size that pile burning is unnecessary. Articulating arms are used to extend reach both outward and up so equipment can stay on existing roads. Heavy equipment is typically transported to an access point along an existing service road.

Construction of temporary access roads is exceedingly rare. Use of heavy equipment is restricted to sites with 30 percent slopes or less and to unsaturated soils. To maintain public safety, road guards, signage, and temporary closures (between 15 minutes to 6 hours in length) are used when equipment operates in close proximity to recreational roads and trails.

The most frequent use of heavy equipment cutting occurs under MA-20, as well as MA-23 and MA-24. For infrastructure maintenance, cutting is done with a backhoe or excavator working adjacent to existing roads and using articulating arms with cutter heads. The majority of the work occurs within 30 feet of the road margin. Under MA-23 and MA-24, skid steers and excavators with mulching heads may work off-road to masticate brush on-site. This may include mulching access routes along former skid roads and grinding of biomass into mulch across a work site to a depth exceeding 4 inches. It does not include scraping or ground disturbance beyond what tracked equipment may make traveling across sites with gentle slopes.

Heavy equipment use will be infrequent under MA-21, because most new fuelbreak construction will occur more than 30 feet from an existing road surface where slopes are greater

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than 30 percent. Heavy equipment may also be infrequently used for MA-22, MA-25, and MA-27. In these cases, equipment may be used to cut target weeds or other vegetation on a highly localized level with projects not exceeding 1 acre in size.

Power Hand Tools

The power hand tools used for cutting are most commonly brushcutters (metal blade), string trimmers (monofilament plastic line), and chainsaws, but may also include power pole saws and hedge trimmers. These tools are powered by two-stroke engines that use a mix of gas and engine oil.

Under MA-20, MA-21, MA-23, and MA-24, power hand tools are in frequent use. Ground crews of 3 to 15 persons with brushcutters and chainsaws work where heavy equipment cannot reach, generally more than 30 feet from a road edge and on slopes exceeding 30 percent. Chainsaws are used to limb trees or remove individual trees or shrubs or girdle trees. Brushcutters are used where stem diameters are less than 5 inches at cut level or the vegetation is predominantly herbaceous. Cutting of herbaceous vegetation, including grasses and very young seedlings, is done with string trimmers.

Power hand tools may be used infrequently for MA-22 to remove weeds, MA-25 to improve rare plant habitat, MA-26 during restoration, or MA-27 to test new weed control methods.

Non-Power Hand Tools

Non-powered hand tools used for cutting are most commonly loppers, hand pruners, hand saws, and hatchets, but may also include pulaskis, machetes, brush hooks or brush axes. Tasks include lopping, pruning, and girdling trees or large single-stem shrubs that do not resprout at the base. Hand tools are used in virtually all management actions to perform fine-scale tasks and finishing work behind heavy equipment. Non-power hand tools will be used under similar circumstances as power hand tools.

Girdling

Girdling refers to removing a strip of bark from the entire circumference of a tree, which results in death in many species. Girdling will generally be conducted with a hatchet or chainsaw and will occur infrequently under all actions.

Pulling

Overview

This activity refers to the complete removal, via uprooting, of target vegetation. It is primarily reserved for the removal of high priority weeds where the intent is long-term elimination of the species.

Heavy Equipment

Although heavy equipment can completely uproot vegetation, its use is limited under the BFFIP to protecting soil structure and minimizing erosion. A backhoe or excavator may push or pull down individual non-native trees, either with the arm or with a cable or chain attached to the arm. A backhoe or excavator may be used to dig out large weeds such as acacias (*Acacia sp.*),

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blue gum eucalyptus (*Eucalyptus globulus*), or pampas grasses (*Cortaderia sp.*). A clamshell loader bucket (or 4-in-1 bucket), attached to a backhoe or skid steer, may be used to pull shrubs. A winch attached to a truck may be used to pull individual broom or pampas grass, or other appropriate weeds.

Heavy equipment may be used to pull weeds, shrubs, and trees infrequently for MA-22, MA-23, MA-24, MA-25, or MA-27.

Pulling by Hand or With Non-Power Tools

Non-power tools used for pulling plants are primarily Weed Wrenches (trade name, similar to the Extractigator, Rootjack, or Pullerbear) for taprooted woody plants, hand-picks for tenacious herbaceous species, or occasionally dandelion poppers (curved short-forked metal rod attached to a handle) for levering rosettes out of the ground. Hand-pulling is often employed for any weed type, if it is small enough. Shovels or pulaskis may be used for pampas grass, particularly tenacious broom, or other weedy shrubs. Digging with shovels or pulaskis is usually limited to about 4 inches deep around individual root crowns, but may rarely go deeper.

Hand-pulling is the primary means of weed elimination under MA-20, MA 22, MA-24, and MA-25. Hand-pulling may also be used infrequently under MA-21 and MA-23. For herbaceous weeds without viable seed heads, or woody weeds with small diameter twigs, the slash is scattered on-site. Larger diameter woody material or very large volume of seedless herbaceous material may be piled for burning. State-regulated noxious weeds with viable seeds including goatgrass and the starthistles are bagged and either solarized on-site or landfilled off-site. Vining weeds such as periwinkle and cape ivy may be bagged and landfilled off-site or piled between tarps and solarized to prevent re-rooting while the vegetation decomposes.

Scalping

Overview

Scalping involves cutting plants at or just below the soil surface (1 to 2 inches). It is used to completely eliminate target vegetation for the purpose of weed control or to create control lines for broadcast burning.

Heavy Equipment

A backhoe or excavator will be used to scrape weeds from already disturbed sites (e.g., Sludge Pond) for EDRR (MA-22) or experimentally (MA-27), or rarely for weeds in disturbed grasslands. A skidsteer may be used to create control lines ahead of a broadcast burn (MA-24).

Power Tools and Hand Tools

A brushcutter, chainsaw, or a hoe or McLeod may be used to scalp weeds for similar purposes as heavy equipment but in areas where the equipment cannot or should not go.

Covering

Mulching

Mulch material includes on-site brush, tree limbs, or imported material. It is accomplished with masticating heads attached to excavators or skid steers and with tracked chippers fed by the

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material generated by hand crews as they thin dead or diseased vegetation. Mulching involves the spreading of ground-up woody material—generally wood chips, but sometimes shredded bark or compost—over an area to reduce weed prevalence, suppress resprouting woody species, and increase soil moisture.

Mulching to suppress resprouting and improve soil moisture occurs under MA-23. Mulch will be distributed across treated sites at a uniform depth of 6 to 8 inches.

Mulching for weed suppression purposes occurs under MA-20, MA-22, MA-25, MA-26, and MA-27. Individual projects are typically less than 0.1 acre in size. An initial weed removal action is performed first, and mulch may be spread over the exposed soil or a semipermeable layer such as weed fabric or cardboard (sheet mulching). Imported mulch will most likely be deposited along a road and taken to a site using wheelbarrows, tarps, or non-mechanized equipment. A mechanized wheelbarrow may be used to deliver material to a site.

Chipping

Chipping is another method of biomass disposal that uses a chipper to reduce branches and other woody material to chips (usually 1 to 2 inches long and less than an inch thick). Most chippers are tow-behind models, but a tracked chipper may be used as a standalone piece of equipment as needed. Chippers vary in size and weight, largely depending on the maximum diameter of material it can chip, but all are diesel equipment. Chipping differs from mulching in two ways: chips are generally larger in size than mulch and are dispersed widely and shallowly with no intent to smother or suppress vegetation.

District best management practices prohibit piling of chips more than 4 inches deep in most instances, and do not allow chips to be placed in drainages, grasslands, or against tree trunks. Chipping occurs under MA-20 and MA-21 where the quantity and size of slash generated requires biomass reduction but site conditions are unsuitable for pile burning.

Solarization

Solarization (tarping) involves laying clear or black plastic across a site or around a stump to kill weeds. The tarp may be weighted down with sandbags, rocks, or other material, or the perimeter may be buried or secured with stakes. Tarps typically stay in place for 6 weeks to 6 months depending on site conditions, weather, and the target species. A solarization area may be a single tree stump but could be as large as 0.1 acre. Solarization will occur infrequently under MA-22, MA-24, MA-26, and MA-27.

Grazing

Grazing includes the use of livestock (sheep, goats, or cattle) to achieve vegetation management objectives including fuel load reduction, weed suppression, and habitat enhancement. To date, the District has utilized both sheep and goats on a small-scale experimental basis for weed control purposes with limited success. The activity requires the installation of temporary electrified fencing and water facilities as well as the deployment of guard animals and/or a round-the-clock shepherd. Grazing may occur on a small scale under MA-27 with projects limited to 10 acres or less in size. Larger scale grazing projects will require a written grazing

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plan that identifies the project purpose, duration, stocking loads, and protective measures for sensitive resources. As part of MA-27, grazing may occur to achieve the restoration and reintroduction objectives under MA-25 and MA-26.

Planting

Planting involves digging holes and planting native plants and seeding, which will consist of broadcasting native seed across a site. Raking thatch over exposed soils is an indirect form of seeding. Because of the risk of importing soil-borne pathogens, direct seeding is preferable to the installation of nursery-produced seedlings. In anticipation of a changing climate, planting materials may incorporate regionally appropriate genotypes from a broad range of conditions, including some that are hotter and drier than Mount Tamalpais is currently. Planting is accomplished with hand tools. A hole of up to 6 feet deep may be dug for 1-gallon plants.

Planting will occur under MA-23, MA-24, and MA-25, and may occur under MA-26 and MA-27. Forest management plantings will include the installation of SOD-resistant tree seedlings or seeds. Sites may be several acres in size. Grasslands and oak woodland improvement may involve planting native species, particularly oaks and grasses. Seeding sites may be larger, but planting is unlikely to occur on more than 0.1 acre per site. Competitive planting may be used experimentally.

Planting sites may require the temporary installation of fencing or irrigation lines.

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7 COST AND PRELIMINARY WORK PLAN

7.1 INTRODUCTION

This chapter identifies the yearly management actions, by acreage, that would be performed over the initial 5 years of Plan implementation. This list comprises the annual work plans. Costs that would be required to implement the Annual Work Plans are identified by management action.

The performance criteria for the management actions have been identified in Chapter 5: Implementation of Inventorying, Monitoring, and Planning Management Actions and Chapter 6: Implementation of Vegetation Management Actions; these performance criteria were developed to meet as many goals and approaches (see Chapter 4: Goal and Approach Framework for Plan) as possible while taking into account the realistic limitations of funding and available resources. Setting these realistic targets allows the District to monitor its success in implementing the actions, and potentially adapt the actions and implementation methods over time as part of its evaluation and adaptive management approach.

The acreages treated and associated costs identified in this chapter are preliminary and may be updated yearly, depending on the work that is completed, the available funding, and the work that remains to be completed.

7.2 SUMMARY OF COSTS AND ACTIVITIES

7.2.1 Cost and Activity Summary

Table 7-1 provides a summary of the annual and total costs for implementing the inventorying, monitoring, and planning management actions (MA-1 to MA-19). The total cost to implement 5 years of inventorying, monitoring, and planning management actions is approximately \$936,300.

Table 7-2 provides a summary of the yearly costs and total costs that would be required to implement the vegetation management actions (MA-20 to MA-27). Table 7-2 also identifies the amount of work that would be conducted per management action every year (i.e., the number of acres, patches, projects, hours, or miles of work to be conducted). The total 5-year cost to implement the vegetation management actions is approximately \$11,500,000. Additionally, full implementation of the BFIPP will require an investment in capital equipment with an annual expenditure of approximately \$200,000 per year for the initial 5 years. Capital equipment purchases would include crew vehicles, a multi-purpose skidsteer with forestry attachments, a tracked chipper, a weed wash station, all-terrain vehicles, field radios, and office work stations for supervisors. The total initial capital cost to implement the BFFIP is approximately \$1,000,000 over 5 years.

7 COST AND PRELIMINARY WORK PLAN

The annual cost tables below are predicated on the assumption that the work will be phased in gradually, with the full implementation level achieved in the 5th year after Plan adoption. When fully implemented, annual operational costs are anticipated to be 350 percent greater than current levels.

7.2.2 Assumptions

The cost to implement the inventorying, monitoring, and planning management actions (MA-1 to MA-19) was calculated by estimating the effort that would be required to complete the management actions using a combination of internal staff and independent contractors. In general, internal staff would perform monitoring and planning tasks that must be performed on an on-going basis and benefit from a consistent protocol, an in-depth knowledge of the terrain, and the specifics on the on-the-ground actions described in Chapter 5: Implementation of Inventorying, Monitoring, and Planning Management Actions. Independent contractors will be retained for projects that require temporary increases in staffing levels and/or highly technical knowledge. Internal labor cost estimates were determined by reviewing the internal payroll records from 2013 through the first three quarters of 2016. Contractor cost estimates are based on a review of vegetation-related inventory, monitoring, and planning projects undertaken by contractors at the request of the District between 2003 and 2016.

The cost to implement the vegetation management actions (MA-20 to MA-27) was calculated by multiplying an average per-unit cost (acres, miles, projects, patches, hours) by the number of units to be implemented each year. Table 7-2 includes the average cost per unit for each of the performance criteria, the number of units that would be treated each year, and the resulting extended cost. The average cost per unit was derived from a review of internal work order data collected between 2003 and 2016. Per-unit treatment costs were calculated based on person-hours and labor rates and the relative proportion of percent heavy equipment hours to hand or manual tool hours needed to perform specific tasks.

Costs associated with the MA-24 performance criteria, to control other high priority weeds to prevent expansion beyond levels documented in 2015 and to achieve a 25 percent reduction in cover, are folded into the costs for MA-22 (EDRR) and MA-25 (habitat modifications). MA-26 is not listed in the Table 7-2. Costs associated with MA-26 (meadow restoration) are dependent on project-specific variables that are not yet designed; therefore, the costs for MA-26 are not included in the BFFIP.

In addition to Performance Criteria related costs, Table 7-2 includes costs for two support functions that must be undertaken on an annual basis: project management and pile burning. Implementation of MA-20 through MA-27 would necessitate tens of thousands of hours of work in the field, which in turn requires supervision, training, and safety and quality inspections. The annual work generates many thousands of cubic yards of woody slash that poses a fire hazard if left in the field; slash is scattered whenever possible and aggregated and burned in piles where large volumes and site conditions warrant.

7 COST AND PRELIMINARY WORK PLAN

Table 7-1 Summary of Costs for Inventorying, Monitoring, and Planning Management Actions

MA No.	Management Action	Total Associated Cost					Total
		Year 1	Year 2	Year 3	Year 4	Year 5	
MA-1	Continue the inventories and mapping of invasive species	\$14,000	\$14,000	\$14,000	\$14,000	\$14,000	\$70,000
MA-2	Complete the inventories and mapping of special status, otherwise rare, and presumed extirpated species of plants	\$41,600	-	-	-	-	\$41,600
MA-3	Complete inventory of forest pathogens and pests	-	\$52,800	-	-	-	\$52,800
MA-4	Complete inventory and mapping of grassland communities and identify preservation and restoration projects	-	-	-	\$28,400	-	\$28,400
MA-5	Complete the inventories and mapping of wetlands, seeps, and riparian habitat and identify preservation and restoration projects	-	-	\$42,400	-	-	\$42,400
MA-6	Complete the inventory of bryophytes	-	-	-	-	\$32,800	\$32,800
MA-7	Complete the inventory of fungi	-	-	-	-	\$32,800	\$32,800
MA-8	Facilitate vegetation management beneath transmission lines and transformers	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$7,000
MA-9	Facilitate vegetation management with third parties that have entered into a lease or easement with the District	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$7,000
MA-10	Partner with local fire departments and adjacent owners (private, county, state, and federal) to encourage adequate fuels management along common borders	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$7,000
MA-11	Maintain operational readiness to respond to fire events	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$7,000
MA-12	Evaluate the impacts, progress of each preservation and restoration action relative to performance criteria, and cost annually, and modify methods and schedules as needed	\$18,800	\$18,800	\$18,800	\$18,800	\$18,800	\$94,000
MA-13	Review and update the Vegetation Management tool box program annually, including selection criteria for tools and techniques	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$7,000

7 COST AND PRELIMINARY WORK PLAN

MA No.	Management Action	Total Associated Cost					Total
		Year 1	Year 2	Year 3	Year 4	Year 5	
MA-14	Revise BMPs to protect special status and otherwise rare species and sensitive habitats from construction or maintenance actions	\$1,400	-	-	-	-	\$1,400
MA-15	Revise and implement a project planning, implementation, monitoring and evaluation program for vegetation management actions	-	\$4,200	-	-	-	\$4,200
MA-16	Establish a network of plots to monitor plant community change	-	-	\$14,000	\$14,000	\$14,000	\$42,000
MA-17	Develop and implement a special status and otherwise rare species monitoring program	-	-	-	\$14,000	\$14,000	\$28,000
MA-18	Update landscape scale vegetation maps cyclically	\$54,900	-	-	\$150,200	\$150,200	\$355,300
MA-19	Monitor effects of forest management actions on greenhouse gas balance and water yield	-	\$10,700	\$64,900	-	-	\$75,600
Total Annual Cost		\$137,700	\$107,500	\$161,100	\$246,400	\$283,600	\$936,300

7 COST AND PRELIMINARY WORK PLAN

Table 7-2 Summary of Costs for Vegetation Management Actions

Action No. ^a	Action	Performance Criteria	Avg. Cost per Unit	Unit	FY 2017 Baseline		Year 1		Year 2		Year 3		Year 4		Year 5		Cumulative Increase from Baseline
					Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	
MA-20	Cyclical maintenance of linear fuelbreaks and defensible space, high ignition areas, dams, and roadsides	Retreat fuels in existing fuelbreaks	\$1,700	acre	150	\$255,000	150	\$255,000	170	\$289,000	180	\$306,000	190	\$323,000	200	\$340,000	33%
		Cyclical mowing of fine fuels	\$360	acre	10	\$3,600	20	\$7,200	25	\$9,000	30	\$10,800	40	\$14,400	50	\$18,000	400%
		Cyclical removal of broom in Optimized and Transitional Zones	\$360	acre	240	\$86,400	240	\$86,400	260	\$93,600	260	\$93,600	260	\$93,600	260	\$93,600	8%
		Roadside mowing	\$2,000	acres	10	\$20,000	10	\$20,000	30	\$60,000	40	\$80,000	50	\$100,000	50	\$100,000	400%
		Dam maintenance	\$2,000	acres	20	\$40,000	30	\$60,000	40	\$80,000	40	\$80,000	45	\$90,000	50	\$100,000	150%
MA-21	Fuelbreak Construction	New fuelbreak construction	\$10,000	acre	0	\$-	5	\$50,000	10	\$100,000	10	\$100,000	10	\$100,000	15	\$150,000	-
MA-22	Early Detection Rapid Response	Annual surveys	\$30	mile	150	\$4,500	150	\$4,500	150	\$4,500	150	\$4,500	150	\$4,500	150	\$4,500	0
		Weed control treatments	\$600	patch ^b	25	\$15,000	75	\$45,000	100	\$60,000	100	\$60,000	100	\$60,000	100	\$60,000	300%
MA-23	Forest Stand Structure improvement	Initial reduction in accumulated fuels and brush	\$12,300	acre	8	\$98,400	60	\$738,000	60	\$738,000	60	\$738,000	60	\$738,000	60	\$738,000	650%
		Maintenance/ Planting	\$360	acre	0	\$-	8	\$2,880	28	\$10,080	48	\$17,280	70	\$25,200	100	\$36,000	-
		Prescribed broadcast burning	\$18,000	project ^d	0	\$-	0	\$-	1	\$18,000	1	\$18,000	1	\$18,000	2	\$36,000	-
MA - 24	Grassland and Oak woodland improvement	Douglas-Fir thinning	\$480	acre	20	\$9,600	30	\$14,400	100	\$48,000	140	\$67,200	150	\$72,000	200	\$96,000	900%
		Prescribed broadcast burning	\$18,000	project ^e	0	\$-	1	\$18,000	2	\$36,000	3	\$54,000	3	\$54,000	3	\$54,000	-
		Broom: Initial removal	\$1,500	acre	88	\$132,000	100	\$150,000	150	\$225,000	225	\$337,500	260	\$390,000	300	\$450,000	241%
		Broom: Long term maintenance	\$360	acre	205	\$73,800	205	\$73,800	205	\$73,800	205	\$73,800	205	\$73,800	205	\$73,800	0%
		Goatgrass	\$360	acre	32	\$11,500	32	\$11,500	35	\$12,600	35	\$12,600	35	\$12,600	35	\$12,600	10%
		Yellow Star-thistle	\$1,200	acre	50	\$60,000	100	\$120,000	100	\$120,000	110	\$132,000	120	\$144,000	120	\$144,000	140%
		Other Priority Weeds ^c	\$-	patch	-	\$-	-	\$-	-	\$-	-	\$-	-	\$-	-	\$-	-
MA-25	Reintroduce or Enhance Species	Planting	\$600	project	1	\$600	1	\$600	2	\$1,200	2	\$1,200	2	\$1,200	3	\$1,800	200%
		Habitat modification	\$600	project	0	\$-	1	\$600	2	\$1,200	2	\$1,200	2	\$1,200	3	\$1,800	-
MA-27	Weed Control trials	Implementation	\$6,000	project	1	\$6,000	1	\$6,000	2	\$12,000	2	\$12,000	3	\$18,000	3	\$18,000	200%
Additional Costs																	
Crew Supervision			\$42	hours	900	\$37,800	1,600	\$67,200	2,300	\$96,600	3,000	\$126,000	3,700	\$155,400	4,519	\$189,800	402%

7 COST AND PRELIMINARY WORK PLAN

Action No. ^a	Action	Performance Criteria	Avg. Cost per Unit	Unit	FY 2017 Baseline		Year 1		Year 2		Year 3		Year 4		Year 5		Cumulative Increase from Baseline
					Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	
	Pile Burning		\$42	hours	800	\$33,600	1,000	\$42,000	1,100	\$46,200	1,200	\$50,400	1,300	\$54,600	1,440	\$60,500	80%
Totals						\$887,820		\$1,773,100		\$2,134,780		\$2,372,480		\$2,543,500		\$2,778,378	313%
Total 5-year Cost																\$11,508,840	

Note:

- ^a The details regarding units to be treated for MA-26 will be determined separately after the BFFIP approval.
- ^b A patch is defined as a maximum of 100 square meters (0.02 acre).
- ^c MA-22 will be used to control "other priority weeds".
- ^d A project is defined as 20 acres but could vary by year.
- ^e A project is defined as 38 acres but could vary by year.

7 COST AND PRELIMINARY WORK PLAN

7.3 ANTICIPATED OUTCOMES AFTER INITIAL 5 YEARS OF IMPLEMENTATION OF THE BFFIP

After the initial 5 years of implementing the BFFIP at the levels identified in the Annual Work Plans, the District aspires to have the following accomplishments. These outcomes are targets upon which the program will be evaluated. If these targets are not being reached, the reasons will be documented in the Annual Board Reports and the success criteria may need to be modified or levels of effort to implement the Plan increased to more closely align what is actually being accomplished with what is planned. A balance between the costs and the benefits is inherently part of the evaluation and adaptive management strategy.

1. Built linear fuelbreak system and defensible space will expand by 11 percent to approximately 500 acres. Total planned fuelbreak system will be 88 percent complete.
2. Cyclical fuelbreak maintenance actions (brushing and weed suppression) will increase by 33 percent to ensure design standards are maintained throughout the expanded system.
3. Early detection weed patrols will not increase but rapid response treatments of detected small weed patches will increase by 300 percent. It is anticipated this treatment will significantly slow the rate of weed spread in the Mount Tamalpais Watershed, outside of the Deferred Action Zone.
4. Approximately 180 acres of diseased forest and oak woodland habitat will be treated to improve wildfire resiliency, reestablish desired stand structure, and enhance ecosystem function. This amount is approximately 5 percent of the anticipated need that occurs in terrain that is operationally accessible.
5. Up to 17 broadcast burns, totaling 550 acres, will be conducted in forest, oak woodland, and grassland habitats as part of multi-benefit projects designed to improve wildfire resiliency, reestablish desired stand structure, and enhance ecosystem function.
6. Douglas-fir encroachment will be managed on approximately 620 acres of oak woodlands and/or grasslands, which will yield both wildfire risk reduction and habitat improvement benefits. A proportion of these acres may include repeat treatments of the same sites rather than unique projects.
7. Approximately 505 acres of broom in the Ecosystem Restoration Zone will be targeted for complete elimination. This amount is a 72 percent increase over the planned 2017 levels of effort. Presuming EDRR efforts are successful at containing broom to its current extent in the Ecosystem Restoration Zone, the total acres of unmanaged broom will decrease from 690 acres in 2017 to 478 acres in 5 years.
8. The level of effort exerted for yellow starthistle control will increase by 140 percent with the intent of achieving a reduction in cover and preventing further spread.
9. The level of effort exerted for goatgrass control will increase by 9 percent with the infestation likely to remain unchanged or exhibit modest decreases.
10. Ten rare plant populations will be reestablished or enhanced.
11. Two wet meadow restoration projects will be initiated.

7 COST AND PRELIMINARY WORK PLAN

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**APPENDIX A:
MARIN MUNICIPAL WATER DISTRICT POLICIES**



**MARIN MUNICIPAL
WATER DISTRICT**

BOARD POLICY

No.: 7

DATE: 9-01-10

SUBJECT: MT. TAMALPAIS WATERSHED MANAGEMENT POLICY

Overview

The Mt. Tamalpais Watershed is one of Marin's most valuable natural resources, providing and protecting the major source of domestic water for Marin Municipal Water District ("District") residents. Besides this primary purpose, the watershed is held in trust as a natural wildland of great biological diversity, as scenic open space and as an area for passive outdoor recreation for Marin and much of the Bay Area. Passive outdoor recreation is defined as those activities that are based on nature and that require little or no development or facilities.

Protection of water quality is the overriding goal for the management of the Mt. Tamalpais Watershed. Protecting the integrity of the watershed's water quality and reservoir capacity is best achieved by maintaining natural conditions on watershed lands to the greatest extent possible. The District is committed to sustaining, and restoring where needed, native biological diversity on District lands through active management and careful coordination with other resource management agencies and the research community. We realize that achieving an ideal situation is not always possible. However, it is the District's policy that control over land uses focuses on retaining the lands in their natural condition, allowing them to return to a natural condition, or actively restoring them. No activities will be allowed that jeopardize this resource.

The purpose of this policy is to maintain and improve the character of the watershed and water supply, and to discourage commercialization and misuse of the natural resources of Mt. Tamalpais watershed. Of specific concern are the quality and supply of potable water and the storage capacity of the reservoirs.

Of the 18,570 acres of Mt. Tamalpais Watershed properties owned by the District, 13,870 are in the Lagunitas Watershed, 1,350 in the Phoenix/Ross Creek Watershed; and 3,350 are adjacent watershed and buffer properties which serve both as protection to the watershed lands used for water supply and for their value as important scenic open space and recreational lands.

Water storage and distribution facilities on the Mt. Tamalpais Watershed properties include five storage reservoirs (Alpine, Bon Tempe, Kent, Lagunitas and Phoenix), miles of service roads and transmission pipelines, the Bon Tempe Treatment Plant and other related facilities. Recreation facilities include several picnic areas and miles of equestrian, bicycling and hiking routes.

PART 1 - General Use and Management of the Mount Tamalpais Watershed

1.1 Goals

The watershed lands shall be retained in perpetuity for water supply, natural wildland, scenic open space and limited passive recreational purposes, and managed in a manner that will maintain and protect their:

- A. Ability to serve as water-producing lands;
- B. Integrity as natural wildlands and as scenic open space; and,
- C. Capacity to provide passive daytime recreation activities in keeping with potable water production and preservation as natural wildlands.

1.2 Policies

- A. Land Use - Lands and facilities will be managed to protect the character of the water supply, sustain and restore the natural wildland and wildlife characteristics, and allow for limited passive recreational experiences, as defined in Title 9 of the Marin Municipal Water District Code.
- B. Commodity Use of Natural Resources - The District shall not harvest and sell any natural resources from the Mount Tamalpais watershed except for the sale of water in the normal course of the District's responsibilities to provide drinking water through its infrastructure or where sound watershed preservation decisions result incidentally in the availability of excess resources.
- C. Facilities Development - Any new facilities, uses or leases, or improvements to existing facilities proposed for these lands will be:
 - ❖ Limited to essential public services and shall not be attractions in themselves, but incidental to the primary purpose of the watershed or enjoyment and conservation of Mt. Tamalpais in its natural condition;
 - ❖ Designed, constructed and maintained to assure conformity to the District Watershed Management Policy;
 - ❖ Reviewed by an appropriate citizens group and technical advisors if controversial in nature or posing a significant impact on District lands; and approved only if impacts on the water supply and natural environment are insignificant or can be adequately mitigated. Exceptions will be limited to water-related facilities and are subject to environmental assessment and public hearings and will only be granted where alternatives have been carefully evaluated and the public benefit outweighs the anticipated impact to the watershed; and

- ❖ Existing uses, leases and facilities will be reviewed annually to assure compliance with good watershed management practices and preservation of natural wildland characteristics.
- D. Revenues - All revenues from Watershed Fees and Leases will be administered in accordance with Board Policy No. 35.
- E. Adaptive Management - The District will implement an adaptive management strategy, using inventory, management, monitoring and evaluation. The District will assemble baseline inventory data describing the natural resources under its stewardship and monitor those resources at regular intervals to detect or predict changes. Visitor use levels and patterns will also be monitored. The resulting information will be analyzed to detect changes that may require intervention and to provide reference sites for comparison with other impacted areas. The District will encourage and support research that addresses resource management issues on the watershed.
- F. Regional Cooperation – The District is committed to working cooperatively with federal, state, and local agencies, user groups, local communities, adjacent landowners, and others in the protection of the water supply, and the management of natural resources and recreational uses. In order to better achieve the District's management objectives, the District will continue to foster formal and informal lines of communication and consultation.
- G. Staffing - The District will evaluate staffing levels to ensure adequate personnel are available to maintain its facilities, roads and trails, and natural resources, manage visitor use and to enforce its regulations.
- H. Memorials on Watershed Lands - Individuals are prohibited from building any structure, monument or facility.

(1) Any person, group, or organization may make application to the District for placement of a memorial plaque to be affixed to any existing bench or picnic table or any other appropriate facility on watershed lands or in combination with a replacement or addition of new benches, tables, or other facility as approved by the District.

(2) All memorial furniture and plaques must conform to the standard approved style, size, material and color determined in advance by the District. Wording contained on plaques must be approved in advance by the Watershed Manager.

(3) Cost to the applicant for a memorial plaque and associated furniture or facilities will be determined by staff and will be periodically reviewed by the Board of Directors. Fees must be paid upon approval. Applicants with completed applications will be placed on a first come, first serve waiting list if there are no suitable current memorial opportunities. Funds received for memorials shall be deposited in the Mt.

Tamalpais Watershed Fund or any similar fund dedicated to the protection and enhancement of watershed lands.

(4) Memorials may only be constructed within developed areas herein described as developed picnic areas, dams, parking lots and other buildings. This policy specifically excludes memorials placed on trail sides, trail bridges, or any other location outside of developed areas. Staff will maintain a list of appropriate locations for memorials.

(5) Nothing herein prohibits the District from considering and accepting proposals for memorials and donations not set out above. Such proposals will require substantial justification for consideration, shall be considered on a case-by-case basis and must be approved by a majority vote of the Board of Directors.

- I. Water Quality Protection – Land or facility management activities on the watershed, such as the use of chemicals, must be evaluated so that uses are restricted to specific targets or areas and will cause no harm to water quality.

PART 2 - Biological Diversity

2.1 Goals

Protecting the integrity of the watershed is best achieved through maintaining natural conditions on watershed lands consistent with District policies and federal and state laws. The District is committed to restoring and sustaining native biological diversity on District lands, in particular the variety of living organisms, the genetic differences among them, and the natural communities and ecosystems providing their habitat.

2.2 Policies for Biological Diversity

- A. Species and Habitats -The District will protect and restore species richness and complexity of habitats on District lands, and seek to preserve or restore natural habitats to the fullest extent possible.
- B. Rare Species - The District will identify and promote the conservation of all special status plant and animal species especially those listed under federal and state Endangered Species Acts.
- C. Adverse Impacts - The District will minimize adverse impacts to spatial and temporal patterns of native species for reproduction, feeding, migration and dispersal.
- D. Genetic Preservation - The District will wherever possible, ensure that revegetation and landscaping efforts in and immediately adjacent to natural areas will use seeds, cuttings, or transplants representing species and gene pools native to the watershed.

- E. Population Management - The District will act to perpetuate viable populations of native plant and animal life within District lands. Natural processes will be relied on to govern populations of native species to the greatest extent possible. Unnatural concentrations of native species caused by human activities may be controlled where they present a threat to public health and safety or where they threaten to disrupt ecosystem processes. The District may seek to control animal populations, in coordination with the California Department of Fish and Game (DFG) and according to applicable DFG codes, when such animals present a direct threat to visitor's health and safety and in developed areas when necessary to protect property or landscaping.
- F. Natural Disturbances - The District will ensure that landscape conditions caused by natural phenomena, (e.g. landslides, earthquakes, floods, natural fires, or windstorms) will not be modified unless required for public safety or operations of the water delivery facilities. The District will seek to restore the effects of fire as an ecosystem process by the careful, planned use of prescribed burning.
- G. Exotic Species - The District will give high priority to the control of exotic species (exotic species are those that are not native to District lands and that bring about changes in species composition, community structure, and/or ecosystem function) that substantially impact native natural resources. The overall approach will be in keeping with the principles of Integrated Pest Management (IPM). A variety of methods including mechanical removal, chemical application, the introduction of biological control agents, and the use of prescribed burns may be used as practicable to achieve the desired results as long as these methods do not jeopardize water quality or cause harm to non-target organisms. Nonnative plants and animals will not be introduced into the District lands except in rare cases where:
- ❖ They are the nearest living relatives of extirpated native species;
 - ❖ There are improved varieties of native species that cannot survive current environmental conditions;
 - ❖ They are used to control established exotic species; or
 - ❖ The District is legally required to do so.
- H. Release of Native Wildlife that has been Rescued and or Raised in Captivity - Release onto District lands of native wildlife that has been rescued from other sites and/or raised in captivity will be allowed only on a case by case basis upon written approval from the Superintendent of Watershed Resources. Approval may be granted when it appears doing so would benefit released animals without significantly disrupting existing native wildlife and vegetation and after consideration of the following:
- ❖ The characteristics of the species, the number of individuals, and the health of the released animals;

- ❖ The likelihood of the proposed release sites being already occupied by individuals of the same species;
 - ❖ The potential for acute predation of, or competition with, other species in the proposed release location; and
 - ❖ The proximity of the release site to areas of human habitation where the released animals may pose a nuisance.
- I. Post-fire Revegetation and Erosion Control Response - The District's post-fire watershed and vegetation recovery and restoration goals include: making every reasonable effort to ensure the protection and natural recovery of natural communities and protecting rare and sensitive animals, plants, and habitats in fire zones during rehabilitation efforts. The District will seek to allow natural reestablishment of vegetation, only using mechanical methods or seeding to reduce erosion in selected areas. Determining rehabilitation strategies for any site should take into account the following:
- ❖ Fire intensity and timing;
 - ❖ Past fire frequency and its effect on the vegetation of the site;
 - ❖ Effects of fire suppression activities on the vegetation;
 - ❖ Potential for natural recovery of the vegetation;
 - ❖ Potential for expansion and establishment of exotic plants; and
 - ❖ Available information on sensitive species and habitats in the area.

Seeding is appropriate only if there is clear, scientific evidence that a given seeding mix will more effectively establish ground cover than the remaining viable seeds in the natural seedbank, and seeding has been demonstrated to be an effective restoration technique in relation to that specific incident's conditions (e.g. slope, soil-type, soil and duff damage, etc.). The District believes that seeding may be appropriate in areas where fire suppression activity has removed or destroyed the natural seedbank (e.g., bulldozing). The District acknowledges that seeding is appropriate when human safety is an issue and it would help stabilize the watershed.

During or following a fire event, the Incident Commander will establish a team to make recommendations for post-fire rehabilitation. The team should evaluate the availability of seed mixes and the site-specific appropriateness of available seed. If no appropriate seed is available, non-vegetative erosion techniques should be employed. Natural recovery of plant communities and the success of rehabilitation treatments will be monitored and the results will be integrated into future management plans.

J. Fishery Management –

Reservoirs: The District will manage its reservoirs for recreational fishing, including non-native fish species, in cooperation with the Department of Fish and Game. The goal of the Lake Lagunitas program is to manage for a self-sustaining population of rainbow trout. The District recognizes the habitat value of opportunistic lakeshore vegetation. Lakeshore vegetation removal to improve access for anglers may be accomplished in limited areas under the guidance of a written plan. The protection and management of vegetation in the lakes should not over ride the District's water management responsibilities.

Streams: The District will take actions to protect native fishery resources, in streams within the District's sphere of influence, consistent with California public trust doctrine and Fish and Game Code. The District will be an active partner in stream protection and enhancement efforts that other agencies and groups are pursuing in streams within the District's sphere of influence. The District's sphere of influence includes those streams that are directly affected by the District's land or water management activities. Fishery protection and enhancement activities in Lagunitas Creek, below Kent Lake, complies with California State Water Resource Control Board mandates related to the raising of Peters Dam.

K. Pest Management - Strategies for managing pest populations (pests are animals or plants that threaten important resources on the watershed) will be influenced by whether the pest is an exotic or native species. Many fungi, insects, rodents, diseases, and other species are native organisms that perform important functions in a natural ecosystem. Native pests will be allowed to function unimpeded except where control is desired to:

- ❖ Prevent the loss of the host or host-dependent species from the ecosystem;
- ❖ Prevent outbreaks of the pest from spreading to forests, trees, other plant communities, or animal populations outside the watershed;
- ❖ Conserve threatened, endangered, or unique plant specimens or communities; or
- ❖ Protect against a significant threat to public safety.

Proposed pest control measures must be included in a District-approved resource management plan. All Plans must adopt a strategy that includes clear objectives, monitoring, research, and evaluation.

PART 3 - Erosion Control

3.1 Goals

Erosion resulting from roads and trails and other human development of the watershed will be controlled in order to maintain a high quality of water, prevent displacement of water storage capacity, and to maintain and enhance the stream habitat.

3.2 Policies

- A. Road and Trail Management - All trails and roads on the watershed will be managed according to District standards established to reduce erosion, especially into the streams and reservoirs.
- B. Management of Other Facilities - All other watershed facilities will be designed, constructed and maintained to reduce or control erosion.
- C. Stabilizing Natural Erosion - Erosion resulting from natural events may be stabilized where feasible and where there are clear benefits to water quality, reservoir capacity and/or stream habitat.

PART 4 - Fire Management

4.1 Goals

The District will manage its lands to prevent loss of watershed resources from uncontrolled wildfire, will carefully restore the role of fire in ecosystem management, and will use fire as a tool for specific management objectives.

4.2 Policies

- A. Fire Management – The District classifies all fires as prescribed fires or wildfires. Prescribed fires are those intentionally set for specific purposes and under controlled circumstances. All other fires are wildfires and will be suppressed. The District will work closely with local, state, and federal fire departments and land management agencies to develop effective programs to manage fire risks and benefits on a regional basis, and to meet vegetation management goals for the watershed.
- B. Wildfire Prevention and Suppression - The District will maintain staff, equipment, and prepare and keep current protocols to ensure its ability to respond quickly and suppress fires on the watershed. The methods used to suppress all wildfires will be those that minimize the impact of fire fighting effort on the watershed.
- C. Fuel Breaks - The District will maintain a system of fuel breaks on District-owned watershed lands to improve suppression capabilities in the event of a wildfire. These fuel breaks shall be designated in the District's most current Vegetation Management

Plan. Where appropriate, the District will work with municipalities, fire districts, and local communities to seek grants and otherwise share costs in the construction and management of fuel breaks.

The District may allow fuel breaks on District lands to be constructed and maintained by neighboring private landowners immediately adjacent to the Watershed. These fuel breaks, when identified to be of no value to the District's fire management strategy as expressed in the Vegetation Management Plan, will be constructed and maintained at the expense of the private landowner consistent with specifications contained in a written agreement with the District. Agreements will specify, at a minimum, the location of the fuel break, vegetation to be removed, timing, and maintenance requirements.

D. Prescribed Fires - The District recognizes the importance of prescribed fire as a tool for managing watershed lands. Prescribed fires (commonly referred to as prescribed burns or controlled burns) are fires deliberately ignited by District land managers to achieve predetermined resource management objectives, such as controlling exotic species, maintaining specific vegetation types (e.g. meadows, open woodlands), and reducing hazardous fuel accumulations. To ensure that these objectives are met:

- ❖ Each prescribed fire will be conducted according to a detailed written plan. The plan and its elements will be developed in coordination with, and under the approval of, appropriate fire agencies.
- ❖ All prescribed fire management plans will consider effects on air quality, visibility, and health along with other resource management objectives. Management actions to minimize the production and accumulation of smoke will be included in every written plan.
- ❖ All prescribed fires will comply with state and local smoke management and air quality regulations.
- ❖ All prescribed fires will be monitored to:
 - Record the significant fire behavior and operational decisions;
 - Determine whether specified objectives were met; and
 - Assess fire effects.

PART 5 - Recreational Use

5.1 Goals

The District will ensure that public recreation activities on watershed lands are consistent with the District's mission to safeguard water quality and protect natural resources. This will be accomplished by fostering public stewardship of the natural values of the watershed through safe and responsible use, volunteerism, and community participation in watershed management programs. The District will provide visitors with the appropriate information to inspire, educate, and encourage safe and lawful use of the watershed, and to minimize adverse impacts on natural resources.

5.2 Policies

- A. Regulation of Recreational Use - The District will manage visitor use, regulating extent, type, duration, and location of visitor activities. A use or activity may be restricted or prohibited when it is inconsistent with the District's watershed management goals and policies and /or violates a state or federal law. Where practical, such determinations will be based on the results of study or research, including natural and social sciences, visitor use surveys and environmental impacts. Periodic monitoring of visitor use patterns will be conducted. Restrictions and/or regulations will be reviewed periodically by District staff to determine consistency with the District's general watershed management goals and policies. The public will be notified of restrictions on use(s) of watershed lands.
- B. Recreation Use Criteria - The District will consider the purpose of the watershed and the effects on the natural resources and visitors when determining the appropriateness of a specific recreational activity in a specific area. The District will prohibit on watershed lands and discourage on adjacent lands those activities that may result in:
- ❖ Impacts detrimental to wildlife, vegetation or other watershed resources or natural processes;
 - ❖ Consumptive use of watershed resources (e.g. mushroom collection, hunting, etc.);
 - ❖ Impacts to sensitive habitats or special status species (e.g. increased sedimentation impacts to anadromous fish or loss of riparian habitat);
 - ❖ Impacts on visitors from conflicting types of recreational use; and
 - ❖ Danger to the welfare or safety of the public.
- C. Management Approaches - Appropriate tools for managing recreational activities may include:
- ❖ General or special regulations;
 - ❖ Permit and reservation systems;
 - ❖ Local restrictions;
 - ❖ Public use limits;
 - ❖ Closures

- ❖ Public outreach and education (through signs, maps, notices, displays, and interpretive programs); and
- ❖ Limited and/or improved public access points necessary to control and minimize visitor impacts.

PART 6 - Watershed Commercial Use

6.1 Goals

The District's will prevent the exploitation of the watershed for commercial gain.

6.2 Policies for Commercial Use

- A. Commercial Use - The District will discourage commercial use of the watershed, especially those uses that may damage or impair natural features of the watershed. The District will prohibit organized recreational activities or competitive events that involve commercialization, advertising or publicity by the participants and/or organizers. The District may permit those commercial uses or services that do not negatively impact watershed lands and are consistent with the goals and policies in the Watershed Management Policy.
- B. Fund Raising Events - Fund raising events that generate revenue for watershed purposes will be considered and may be allowed on a case-by-case basis upon approval by the Board of Directors.

This Policy will be in effect upon adoption and until subsequently amended by action of the Board of Directors.



**MARIN MUNICIPAL
WATER DISTRICT**

BOARD POLICY

No.: 47

DATE: 5-16-07

SUBJECT: Precautionary Principle

The Precautionary Principle requires a thorough exploration and a careful analysis of a wide range of alternatives. Based on the best available science, the Precautionary Principle requires the selection of the alternative that presents the least potential threat to human health and the environment. Public participation and an open and transparent decision making process are critical to finding and selecting alternatives.

Where threats of serious or irreversible damage to people or nature exist, lack of full scientific certainty about cause and effect shall not be viewed as sufficient reason for the District to postpone cost effective measures to prevent the degradation of the environment or protect the health of its customers. Any gaps in scientific data uncovered by the examination of alternatives will provide a guidepost for future research, but will not prevent protective action being taken by the District. As new scientific data become available, the District will review its decisions and make adjustments when warranted.

Where there are reasonable grounds for concern, the precautionary approach to decision-making is meant to help reduce harm by triggering a process to select the least potential threat. The essential elements of the Precautionary Principle approach to decision-making include:

1. **Anticipatory Action:** There is a duty to take anticipatory action to prevent harm. Government, business, and community groups, as well as the general public, share this responsibility.
2. **Right to Know:** The community has a right to know complete and accurate information on potential human health and environmental impacts associated with the selection of products, services, operations or plans. The burden to supply this information lies with the proponent, not with the general public.
3. **Alternatives Assessment:** An obligation exists to examine a full range of alternatives and select the alternative with the least potential impact on human health and the environment including the alternative of doing nothing.
4. **Full Cost Accounting:** When evaluating potential alternatives, there is a duty to consider all the reasonably foreseeable costs, including raw materials, manufacturing, transportation, use, cleanup, eventual disposal, and health costs even if such costs are not reflected in the initial price. Short-and long-term benefits and time thresholds should be considered when making decisions.
5. **Participatory Decision Process:** Decisions applying the Precautionary Principle must be transparent, participatory, and informed by the best available information.

**APPENDIX B:
HISTORY OF WILDFIRES ON MMWD LANDS**

B HISTORY OF FIRE ON MMWD LANDS

B.1 VEGETATION MANAGEMENT PRIOR TO 1995

The following summarizes a detailed discussion of the historic land management practices for the Mount Tamalpais Watershed.

Prior to human inhabitation of the area, the types of vegetation and habitats on the watershed were the result of many factors, including topography, soil types, underlying geological conditions, climate, lightning-caused fires, and evolutionary processes. At the time of human inhabitation of the area, likely more than 10,000 years ago, the basic vegetation communities were probably similar to current types - a mosaic of evergreen forest, hardwood woodland, chaparral, and grassland vegetation types. The individual species making up these communities and the distribution of the types and species across the landscape has probably changed, but these changes are thought to have been slow and incremental. Wildfires ignited by lightning would burn grasslands, chaparral, and woodland understories. Infrequently, conditions on the watershed would lead to large, stand-replacing wildfires. Most species on the watershed were likely fire tolerant and would resprout or reseed after both large and small burns.

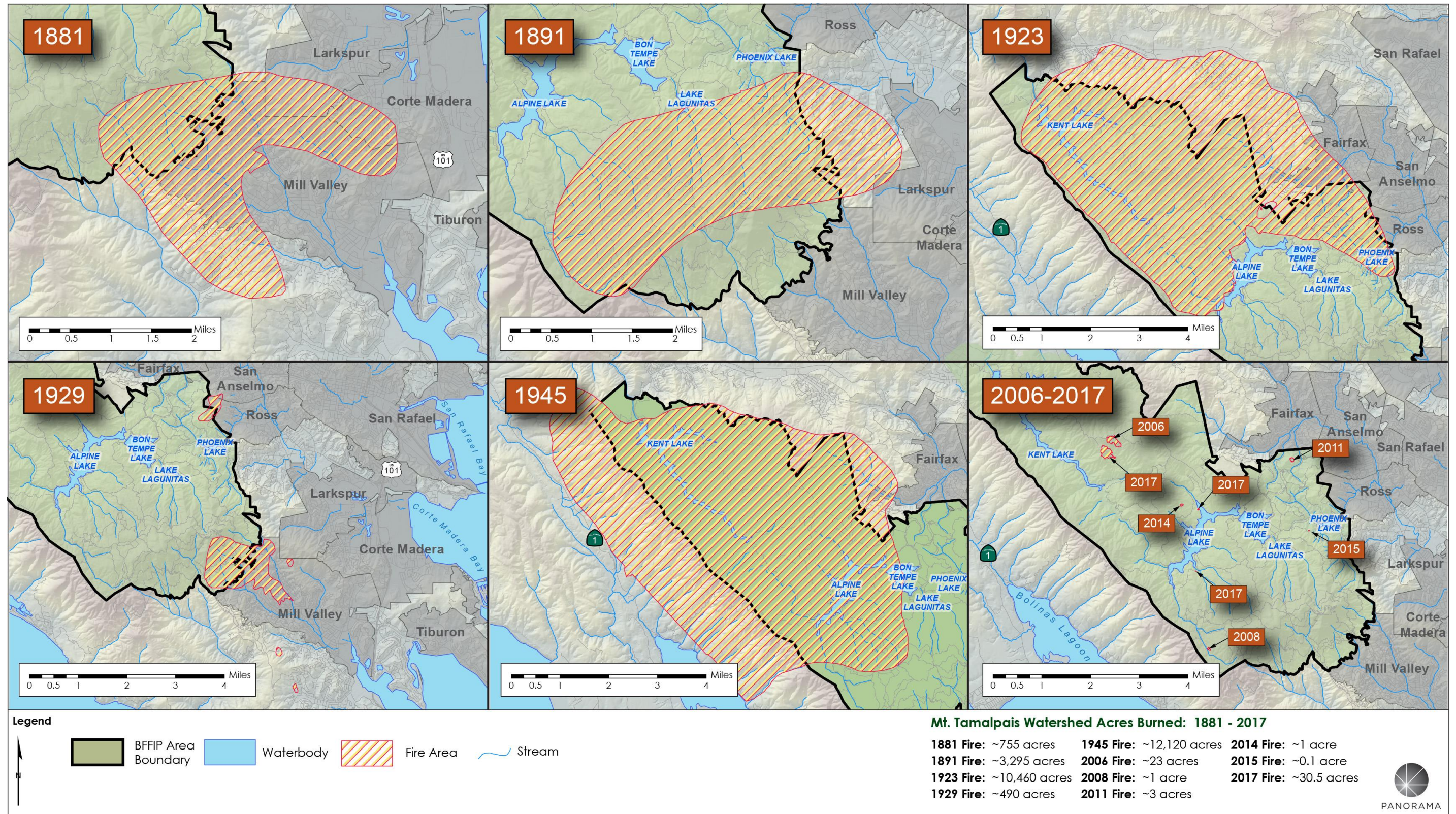
With the migration of Native Americans into the area, fire became a more frequent event, as these earliest human settlers used fire to facilitate travel, provide additional browse for deer, facilitate access to acorns, stimulate the growth of grasses and forbs whose seeds and bulbs were used as food sources, and for other purposes. One of the major results of Native American burning was that the fire history of the watershed became more cyclic and predictable than was the case during pre-human times. Fires were frequent and relatively small. Through frequent ignitions, the vegetation was "managed" so that fuel loadings were reduced. This prevented the establishment of heavy fuel loads capable of supporting large catastrophic wildfires such as those that have become increasingly frequent in California over the past 25 years.

This historic landscape changed again after the Mexican and European settlement of the area. Beginning about 1800, the watershed's vegetation and wildlife was influenced by a number of actions including the introduction of livestock; extermination of many native grazing animals such as elk; elimination of grizzly bears, black bears, and most other fur-bearing carnivores; and introduction of non-native grasses. The Spanish-Mexican and early American settlers continued a periodic burning regime similar to that of the Native Americans as they sought to clear brush and wooded areas to provide additional habitat for their livestock. However, as the area became more settled, the widespread use of fire became a hazard (or nuisance) to many residents. As was the case throughout much of the United States, the historic fire regime was increasingly replaced by a policy of fire suppression. As fire suppression became an accepted public stance and suppression agencies improved their equipment and techniques, fire intervals became longer, fuel accumulated, and the size of the fires, when they did occur, became larger. As shown in Figure B-1, virtually the entire watershed was burned in five major fires occurring

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Figure B-1 Map of Fires on District Lands



Source: (ESRI, 2017; Marin Municipal Water District Sky Oaks Watershed HQ, 2014; Marin Municipal Water District Sky Oaks HQ, 2017; USGS, 2012) Note: Many small-scale fires occurred between 1994 and 2015 that do not appear as dataset is not complete.

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between 1881 and 1945. These included an 1881 fire that started in Blithedale Canyon and burned about 65,000 acres; an 1891 fire starting in Bill Williams Gulch that burned about 12,000 acres; a 1923 fire that burned about 40,000 acres from Novato to Alpine Lake; and the 1929 Mill Valley Fire that burned about 2,500 acres. The last major fire on the watershed occurred in 1945 and burned approximately 20,000 acres. Although there have not been no recent major fires, there have been periodic small fires on the watershed. Between 2006 and 2015, approximately 28 acres have been burned by five small fires on the Mount Tamalpais Watershed. In 2017, three additional fires broke out. One fire occurred in June of 2017 and burned 38 acres of grassland near Pine Mountain Fire Road and Poison Spring Road, north of Kent Lake. The other two were small fires (1 acre or less) and located near Alpine Lake. Both occurred in August of 2017.

Beginning in the 1980s, the District began actively working to reduce the risk of another major fire on the watershed. Between 1982 and 1985, it worked with the Marin County Fire Department (MCFD) and the Marin County Parks (MCP) to conduct prescribed burns of stands of chaparral on the watershed. Given environmental concerns about the effects of these burns, the District stopped conducting burns in 1985 until such time as a comprehensive Vegetation Management Plan (VMP) was completed.

B.2 1995 VEGETATION MANAGEMENT PLAN

The District and its consultants began preparation of baseline studies of vegetation and management conditions on the Mount Tamalpais Watershed in 1987. In 1992, the District consultants began preparation of the original VMP. The Draft VMP was circulated for public review in June 1993. A Draft EIR was circulated for public review in April 1994, and a Final EIR was certified in September 1994. The Final Management Plan was adopted in February 1995.

At the time the first VMP was developed, reducing fire hazard on the Mount Tamalpais Watershed while creating the minimum possible impacts on the watershed's natural resources was the chief management concern for the District and MCOSD. The fire management portion of the VMP recommended the creation of a series of fuelbreaks along major ridges and access roads, and described how the fuelbreaks would be created and maintained. These fuelbreaks were intended to subdivide the watershed into discrete parts, making it easier to keep a fire from moving from one section of the watershed to another. These fuelbreaks would not stop a major wildfire occurring under worst-case conditions, but they would provide safer locations from which to fight a fire under non-extreme conditions. The VMP also recommended a number of other hazard reduction projects and actions on and off the watershed.

Although the 1995 VMP focused on fire hazard reduction, it also contained many recommendations on managing vegetation to maintain or improve watershed biodiversity. The VMP identified specific actions to control the spread of invasive weeds when preparing the fuelbreak system, remove broom where feasible, restore meadow and oak woodland habitats, and protect special-status plant species.

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The District has successfully implemented many parts of the 1995 VMP, especially the fire hazard reduction components. Control and elimination of broom and other highly invasive weeds have proven less successful.

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**APPENDIX C:
REFERENCE LIST OF EXISTING MMWD DATA AND
RESEARCH**

C REFERENCE LIST OF EXISTING MMWD DATA AND RESEARCH

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**APPENDIX D:
SPECIAL-STATUS SPECIES KNOWN TO OCCUR OR WITH
POTENTIAL TO OCCUR ON MMWD LANDS**

APPENDIX D

APPENDIX D: SPECIAL-STATUS SPECIES KNOWN TO OCCUR OR WITH POTENTIAL TO OCCUR ON MMWD LANDS

This appendix includes a list of special status plant and animal species with the potential to occur on the District's lands. The scientific names, common names, and habitat notes presented in this table are from Baldwin et al. (2012) and CNPS (2014). The potential for occurrence of each species is derived from CNDDDB (CDFW 2016), CNPS (2014), CalFlora (2014), and District Rare Plant Data. When not otherwise noted, the distribution and population trend information presented in the table was provided by the District's staff. Other references for wildlife species and potential for occurrence are presented at the end of Table D-2.

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Table D-1 Special-Status Plants Known to Occur or with Potential to occur on MMWD Lands

Scientific name	Common name (Life form)	Listing Status			Habitat Preferences	Potential to Occur on District Lands
		Federal/State/CRPR				
<i>Amorpha californica</i> var. <i>napensis</i>	Napa false indigo (Perennial deciduous shrub)	-	-	1B.2	Broadleaved upland forest, chaparral, cismontane woodland. Moist sites.	Multiple occurrences in the Watershed. The Mount Tamalpais population is abundant and stable. Not documented in the Soulajule or Nicasio Reservoir administrative units
<i>Amsinckia lunaris</i>	Bent-flowered fiddleneck (Annual herb)	-	-	1B.2	Coastal bluff scrub, cismontane woodland, valley and foothill grassland.	Not documented in the Watershed, and occurrence is unlikely. More likely to occur on District lands in the Soulajule or Nicasio Reservoir administrative units, but not documented in these areas.
<i>Arabis blepharophylla</i>	Coast rockcress (Perennial herb)	-	-	4.3	Broadleaved upland forest, coastal bluff scrub, coastal prairie, coastal scrub; rocky outcrops, serpentine barrens.	Historic occurrences (pre-1947) documented within the Watershed. Two previously undocumented populations observed in the Watershed in 1990; a known "historic" population was also noted at the time. In 2014, one population was found and confirmed stable, but the second population and the known "historic" population both were not found. Mount Tamalpais population considered rare and declining. Not documented in the Soulajule or Nicasio Reservoir administrative units.
<i>Arctostaphylos montana</i> ssp. <i>montana</i>	Mount Tamalpais manzanita (Perennial evergreen shrub)	-	-	1B.3	Chaparral, valley and foothill grassland; rocky serpentine slopes.	Abundant, stable and widespread through serpentine chaparral habitats in the Watershed. Not documented in the Soulajule or Nicasio Reservoir administrative units.
<i>Arctostaphylos virgata</i>	Marin manzanita (Perennial evergreen shrub)	-	-	1B.2	Broadleaved upland forest, closed-cone conifer forest, chaparral, North Coast conifer forest; on sandstone or granitic soils.	Rare and declining in the Watershed due to fire suppression. Not documented in the Soulajule or Nicasio administrative units.

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Scientific name	Common name (Life form)	Listing Status			Habitat Preferences	Potential to Occur on District Lands
		Federal/State/CRPR				
<i>Aspidotis carlotta-halliae</i>	Carlotta Hall's lace fern (Perennial rhizomatous herb)	-	-	4.2	Chaparral, cismontane woodland; generally, on serpentinite outcrops.	Several occurrences documented in Marin County, including from Mount Tamalpais and the Tiburon Peninsula. One known population is in the Watershed. Not documented in the Soulajule or Nicasio administrative units.
<i>Astragalus breweri</i>	Brewer's milk-vetch (Annual herb)	-	-	4.2	Cismontane woodland, chaparral, valley and foothill grassland; usually associated with serpentinite or volcanic substrates.	One known population is in the Watershed. Not documented in the Soulajule or Nicasio administrative units.
<i>Calamagrostis ophitidis</i>	Serpentine reed grass (Perennial herb)	-	-	4.3	Chaparral, lower montane conifer forest, meadows and seeps, valley and foothill grassland; on serpentine balds and in serpentine grasslands.	Abundant, stable, and widespread through serpentine chaparral habitats in the Watershed. Not documented in the Soulajule or Nicasio administrative units.
<i>Calandrinia breweri</i>	Brewer's calandrinia (Annual herb)	-	-	4.2	Chaparral, coastal scrub; sandy or loamy soils; seen on disturbed sites and after fire.	Several occurrences have been documented within the Watershed, but not mapped by the District. Due to fire suppression, presumed to be declining in distribution. Not documented in the Soulajule or Nicasio administrative units.
<i>Calochortus umbellatus</i>	Oakland star-tulip (Perennial bulbiferous herb)	-	-	4.2	Broadleaved upland forest, chaparral, cismontane woodland, lower montane conifer forest, valley and foothill grassland; often on serpentine.	Abundant and stable in Watershed. Not documented in the Soulajule or Nicasio administrative units.
<i>Calochortus uniflorus</i>	Pink star-tulip (Perennial bulbiferous herb)	-	-	4.2	Coastal prairie, coastal scrub, meadows and seeps, North Coast coniferous forest.	Uncommon, but stable in the Watershed. Not documented in the Soulajule or Nicasio administrative units.

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Scientific name	Common name (Life form)	Listing Status			Habitat Preferences	Potential to Occur on District Lands
		Federal/State/CRPR				
<i>Calystegia collina</i> ssp. <i>oxyphylla</i>	Mt. St. Helena morning-glory (Perennial rhizomatous herb)	-	-	4.2	Chaparral, lower montane conifer forest, valley and foothill grassland; on open serpentine slopes.	Relatively common and population stable in serpentine areas within the Watershed. Not documented in the Soulagule or Nicasio administrative units.
<i>Castilleja ambigua</i> var. <i>ambigua</i>	Johnny-nip (Annual herb [hemiparasitic])	-	-	4.2	Coastal bluff scrub, coastal prairie, coastal scrub, marshes and swamps, valley and foothill grassland, vernal pools margins.	Single documented occurrence in the Watershed. Uncommon, and fluctuating annual population size. Not documented in the Soulagule or Nicasio administrative units (District Rare Plant Data, CNDDDB).
<i>Ceanothus gloriosus</i> var. <i>exaltatus</i>	Glory brush (Perennial evergreen shrub)	-	-	4.3	Chaparral; sandy or rocky substrates.	Known to occur in the Watershed on Bolinas Ridge. Species is rare and declining on District land. Not documented in the Soulagule or Nicasio administrative units.
<i>Ceanothus masonii</i>	Mason's ceanothus (Perennial evergreen shrub)	-	SR	1B.2	Chaparral; on rocky serpentine ridges or slopes in chaparral or transition zone between chaparral and woodland.	Known to occur in the Watershed on Bolinas Ridge. Also known from the Soulagule Reservoir area. Species is rare and declining on District land.
<i>Cirsium hydrophilum</i> var. <i>vaseyi</i>	Mount Tamalpais thistle (Perennial herb)	-	-	1B.2	Broadleaved upland forest, chaparral, cismontane woodland, meadows and seeps; in serpentine seeps.	Multiple but highly localized populations restricted to serpentine influenced seeps in the Watershed. Most known populations are declining and several have not been relocated since 1990 survey. Not documented in the Soulagule or Nicasio Reservoir administrative units.
<i>Delphinium bakeri</i>	Baker's larkspur (Perennial herb)	FE	SE	1B.1	Broadleaved upland forest, coastal scrub, valley and foothill grassland; on decomposed shale, often mesic sites.	One reintroduction location within District lands at Soulagule Reservoir. Population established in 2010 and enhanced in 2011; numbers decreasing.

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Scientific name	Common name (Life form)	Listing Status			Habitat Preferences	Potential to Occur on District Lands
		Federal/State/CRPR				
<i>Dirca occidentalis</i>	Western leatherwood (Perennial deciduous shrub)	-	-	1B.2	Broadleaved upland forest, closed-cone conifer forest, chaparral, cismontane woodland, North Coast conifer forest, riparian forest and woodland; brushy slopes in mesic sites.	Two populations are present and stable in the Watershed. Nicasio populations are declining due to broom encroachment. Not documented in the Soulajule Reservoir administrative units.
<i>Elymus californicus</i>	California bottle-brush grass (Perennial herb)	-	-	4.3	Broadleaved upland forest, cismontane woodland, North Coast coniferous forest, riparian woodland.	Multiple documented occurrences in the Watershed. Populations are abundant and stable. Not documented in the Soulajule or Nicasio Reservoir administrative units.
<i>Eriogonum luteolum</i> var. <i>caninum</i>	Tiburon buckwheat (Annual herb)	-	-	1B.2	Chaparral, cismontane woodland, coastal prairie, valley and foothill grassland; sandy to gravelly serpentine slopes.	Abundant, wide spread and stable in the Watershed. Not documented in the Soulajule or Nicasio Reservoir administrative units.
<i>Erysimum franciscanum</i>	San Francisco wallflower (Perennial herb)	-	-	4.2	Chaparral, coastal dunes, coastal scrub, valley and foothill grassland/often serpentinite or granitic, sometimes roadsides.	Several documented occurrences in Marin County, but no confirmed occurrences in the Watershed or other District lands. Considered potentially present.
<i>Fissidens pauperculus</i>	Minute pocket moss (Moss)	-	-	1B.2	North coast coniferous forest (damp coastal soil)	Documented on District lands (outside of areas to be affected by the BFFIP) but likely to occur elsewhere in the Watershed.
<i>Fritillaria lanceolata</i> var. <i>tristulis</i>	Marin checker lily (Perennial bulbiferous herb)	-	-	1B.1	Coastal bluff scrub, coastal prairie, coastal scrub.	Only known population on District land is at Nicasio Island; this population is very small. Not known to occur in the Watershed; CNDDDB records in this area are likely misidentifications of <i>Fritillaria affinis</i> var. <i>affinis</i> . Also not known from Soulajule Reservoir administrative unit.

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Scientific name	Common name (Life form)	Listing Status			Habitat Preferences	Potential to Occur on District Lands
		Federal/State/CRPR				
<i>Fritillaria liliacea</i>	Fragrant fritillary (Perennial bulbiferous herb)	-	-	1B.2	Cismontane woodland, coastal prairie, coastal scrub, valley and foothill grassland; often on serpentine.	On Nicasio Island in the Nicasio Reservoir administrative unit, but not documented in the Watershed or Soulajule Reservoir area.
<i>Hesperolinon congestum</i>	Marin western flax (Annual herb)	FT	ST	1B.1	Chaparral, valley and valley and foothill grassland; serpentine.	Three known populations on the Mount Tamalpais Watershed. Not documented in the Soulajule or Nicasio Reservoir administrative units.
<i>Horkelia tenuiloba</i>	Thin-lobed horkelia (Perennial herb)	-	-	1B.2	Broadleaved upland forest, chaparral, valley and foothill grassland; in sandy soils, mesic openings.	Several populations reported in the Watershed in 1990 plant survey; these populations have not been observed in recent years and are presumed extirpated. One remaining population is near Gravity Car Road (near Mill Valley); this population is increasing in extent. Not documented in the Soulajule or Nicasio Reservoir administrative units.
<i>Hosackia gracilis</i>	Harlequin lotus (Perennial rhizomatous herb)	-	-	4.2	Moist/wet soils within numerous vegetation types.	Common within wet grasslands within Sky Oaks Meadow, Potrero Meadow, and on Nicasio Island.
<i>Iris longipetala</i>	Coast iris (Perennial rhizomatous herb)	-	-	4.2	Coastal prairie, lower montane conifer forest, meadows and seeps.	Several Marin County locations are within District land in the Nicasio Reservoir administrative unit. Not known to occur in the Watershed or Soulajule Reservoir administrative unit.
<i>Kopsiopsis hookeri</i>	Small groundcone (Perennial rhizomatous herb)	-	-	2B.3	North Coast coniferous forest, open woodland.	Two occurrences documented in the Watershed. Not documented in the Soulajule or Nicasio Reservoir administrative units.

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Scientific name	Common name (Life form)	Listing Status			Habitat Preferences	Potential to Occur on District Lands
		Federal/State/CRPR				
<i>Leptosiphon acicularis</i>	Bristly leptosiphon (Annual herb)	-	-	4.2	Chaparral, cismontane woodland, coastal prairie, valley and foothill grassland.	Several occurrences within the Watershed. Not documented in the SoulaJule or Nicasio Reservoir administrative units.
<i>Lessingia hololeuca</i>	Woolly-headed lessingia (Annual herb)	-	-	3	Broadleaved upland forest, coastal scrub, lower montane conifer forest, grassland; often on serpentine, clay.	Historic occurrence from San Geronimo Ridge from 1971; no recent documented occurrences from District lands. Considered potentially present. Not documented in the SoulaJule or Nicasio Reservoir administrative units.
<i>Lessingia micradenia</i> var. <i>micradenia</i>	Tamalpais lessingia (Annual herb)	-	-	1B.2	Chaparral, valley and foothill grassland; usually on serpentine, often roadsides. Life form: annual herb	Multiple occurrences within the Watershed. Populations are widespread, abundant, and stable. Not documented in the SoulaJule or Nicasio Reservoir administrative units.
<i>Mielichhoferia elongata</i>	Elongate copper moss (Moss)	-	-	4.3	Cismontane woodland (metamorphic, rock, usually vernal mesic).	Suitable habitat present, but focused searches have not been conducted.
<i>Navarretia rosulata</i>	Marin County navarretia (Annual herb)	-	-	1.B.2	Serpentinite, rocky habitats within closed-cone coniferous forest or chaparral.	Multiple occurrences within the Watershed. Not documented in the SoulaJule or Nicasio Reservoir administrative units.
<i>Perideridia gairdneri</i> ssp. <i>gairdneri</i>	Gairdner's yampah (Perennial herb)	-	-	4.2	Broadleaved upland forest, chaparral, grasslands, vernal pools; vernal mesic soils.	Two populations currently known on District lands - one single population with subpopulations at Bon Tempe Valves, adjacent to sludge pond, and in meadow near Lake Lagunitas. Populations rare but stable.

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Scientific name	Common name (Life form)	Listing Status			Habitat Preferences	Potential to Occur on District Lands
		Federal/State/CRPR				
<i>Pityopus californicus</i>	California pinefoot (Perennial herb)	-	-	4.2	Broadleaved upland forest, lower/upper montane conifer forest, North Coast conifer forest; mesic sites.	Two historic occurrences from pre-1958 have been documented within the Watershed. Although not confirmed since 1958, suitable habitat is present and it is still presumed likely to be present based on verbal reports and ambiguous photos. Not documented in the Soulajule or Nicasio Reservoir administrative units.
<i>Pleuropogon hooverianus</i>	North coast semaphore grass	-	SI	1B.1	Broadleaved upland forest, meadows and seeps, North Coast conifer forest understory, wet sites, grassy and sometimes shaded areas	Known to occur. Of the 4 documented Marin County sites, one population occurs in the Mt. Tamalpais watershed near Lagunitas Meadows but was presumed extirpated until re-found in 2019.
<i>Quercus parvula</i> var. <i>tamalpaisensis</i>	Tamalpais oak (Perennial evergreen)	-	-	1B.3	Lower montane conifer forest understory.	Occurs in the Watershed. This species is difficult to distinguish from other oaks in the area and its taxonomy is in dispute.
<i>Sidalcea calycosa</i> ssp. <i>calycosa</i>	Annual checkerbloom (Perennial rhizomatous herb)	-	-	-	Seeps and wetlands	Two known occurrences in the Watershed.
<i>Sidalcea hickmanii</i> ssp. <i>viridis</i>	Marin checkerbloom (Perennial herb)	-	-	1B.3	Chaparral; in serpentine or volcanic soils on dry ridges; sometimes appears after burns.	Not detected on District lands since 1950's. This is a fire-associated species and is not expected to appear in the absence of wildfire. While not recently observed, it is presumed to be present in seed bank.
<i>Stebbinsoseris decipiens</i>	Santa Cruz microseris (Annual herb)	-	-	1B.2	Broadleaved upland forest, closed-cone coniferous forest, chaparral, coastal prairie, coastal scrub, valley and foothill grassland; open areas, sometimes serpentine.	Has not been documented on District lands, but suitable habitat is present and the species could occur.

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Scientific name	Common name (Life form)	Listing Status			Habitat Preferences	Potential to Occur on District Lands
		Federal/State/CRPR				
<i>Streptanthus batrachopus</i>	Tamalpais jewelflower (Annual herb)	-	-	1B.3	Closed-cone conifer forest, chaparral; serpentinite barrens.	Known to occur in the Watershed. Populations are rare but stable. Not documented in the SoulaJule or Nicasio Reservoir administrative units.
<i>Streptanthus glandulosus</i> ssp. <i>pulchellus</i>	Mount Tamalpais jewelflower (Annual herb)	-	-	1B.2	Chaparral, valley and foothill grassland; serpentinite.	Known to occur in the Watershed. Populations are common and stable. Not documented in the SoulaJule or Nicasio Reservoir administrative units.
<i>Trifolium amoenum</i>	Two-fork clover (Annual herb)	FE	-	1B.1	Coastal bluff scrub, valley and foothill grassland; sometimes on serpentinite.	No known locations on District land. Only known extant location is in coastal Marin County. Suitable habitat is present but the species is not expected to occur.
<i>Toxicoscordion fontanum</i>	Marsh zigadenus (Perennial bulbiferous herb)	-	-	4.2	Chaparral, cismontane woodland, lower montane conifer forest, meadows and seeps, marshes and swamps; in wet meadows and along streams, often on serpentinite.	Known to occur on District lands. Populations are abundant and stable.

Notes:

U.S. Fish and Wildlife Service designations:

FE Endangered: Any species that is in danger of extinction throughout all or a significant portion of its range.

FT Threatened: Any species likely to become Endangered within the foreseeable future.

California Department of Fish and Wildlife designations:

SE Endangered: Any species that is in danger of extinction throughout all or a significant portion of its range.

ST Threatened: Any species likely to become Endangered within the foreseeable future.

SR Rare: Species that are not Threatened or Endangered at present, but could become so if conditions change.

California Rare Plant Ranking (CRPR):

1B Plants rare, Threatened or Endangered in California and elsewhere.

2 Plants rare, Threatened or Endangered in California, but more common elsewhere.

3 Plants for which more information is needed – a review list.

4 Plants of limited distribution – a watch list. (CRPR List 4 species are not mapped by the CNDDDB and District's rare plant data is less detailed for List 4 species)

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Scientific name	Common name (Life form)	Listing Status Federal/State/CRPR	Habitat Preferences	Potential to Occur on District Lands
given their relatively low sensitive status ranking. Therefore, the level of knowledge regarding distribution for List 4 species is often less than for List 1 and 2 species.)				
CRPR threat code extensions:				
.1 -- Seriously Endangered in California.				
.2 -- Fairly Endangered in California.				
.3 -- Not very Endangered in California.				
? -- Not determined.				

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Table D-2 Special-Status Wildlife Known to Occur or with Potential to occur on MMWD Lands

Scientific Name	Common Name	Listing Status			Habitat	Potential to Occur within District Lands
		Federal/State/Other				
Mammals						
<i>Antrozous pallidus</i>	Pallid bat	-	CSC	WBWG H	Variety of habitats; prefer open dry lands with rocky areas for roosting.	Roosts in buildings within the Watershed; may occur elsewhere on District lands.
<i>Aplodontia rufa phaea</i>	Point Reyes mountain beaver	-	CSC	-	Friable soil in densely vegetated conifer forests	Occurs on adjacent Point Reyes Peninsula; possible along Lagunitas Creek.
<i>Corynorhinus townsendii</i>	Townsend's big-eared bat	-	CSC	WBWG H	Variety of woodland and forest habitats, but prefers conifers. Roosts primarily in caves, mines, tunnels, and sometimes in buildings, bridges, or other human made structures.	Roosts in buildings on Watershed; may occur elsewhere on District lands.
<i>Lasiurus blossevillii</i>	Western red bat	-	CSC	WBWG H	Edges of open to moderately dense deciduous foothill woodlands along streams. Roosts in moderately dense foliage.	Likely roosts on District lands.
<i>Lasiurus cinereus</i>	Hoary bat	-	SA, SOLI (2)	WBWG M	Forested habitat	Roosts in dead snags and perhaps abandoned buildings.
<i>Myotis evotis</i>	Long-eared myotis	-	SA	WBWG M	Variety of woodland and forest habitats, but prefers conifers. Roosts in crevices, buildings, snags, and under bark.	Likely roosts on District lands.
<i>Myotis thysanodes</i>	Fringed myotis	-	SA	WBWG H	Roosts in mines, caves, trees and buildings.	Likely roosts on District lands.

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Scientific Name	Common Name	Listing Status			Habitat	Potential to Occur within District Lands
		Federal/State/Other				
<i>Myotis volans</i>	Long-legged myotis	-	SA	WBWG H	Montane conifer forests, pinyon-juniper woodland, and Joshua tree woodland. Roosts in hollow trees, rock crevices and buildings.	Likely roosts within District lands.
<i>Myotis yumanensis</i>	Yuma myotis	-	SA	WBWG LM	Woodland and open forest with freshwater sources over which to feed.	Likely roosts within District lands.
<i>Taxidea taxus</i>	American badger	-	CSC	-	Suitable habitat is characterized by herbaceous, shrub, and open stages of most habitats with dry, friable soils.	Documented on District lands and burrows have been noted on grassy slopes above Kent and Bon Tempe Lakes.
Birds						
<i>Accipiter cooperi</i>	Cooper's hawk	-	WL	-	Mature forests, open woodland, riparian forest. Nests in coast live oak and other forest habitats.	Nests on District lands.
<i>Accipiter striatus</i>	Sharp-shinned hawk	-	WL	-	Mixed woodlands and forests. Nests in conifers or deciduous trees in dense woodlands or mountain forests.	Occurs as a winter migrant on District lands. Very localized nesting on east slope of Bolinas Ridge (Kent Lake Watershed) and Point Reyes Peninsula.
<i>Ammodramus savannarum</i>	Grasshopper sparrow	-	CSC	-	Nests in grasslands; especially moist coastal prairie.	Nests on District lands. Absent during winter months.
<i>Amphispiza belli belli</i>	Bell's sage sparrow	FCC	WL	-	Homogenous stands of chaparral dominated by chamise.	Nests on District lands, with very limited distribution, confined to south-facing slopes in the Carson Ridge/Pine Mountain area.
<i>Aquila chrysaetos</i>	Golden eagle	FCC	WL, CFP	-	Frequents open woodlands and less populated areas.	Known to occur on District lands, but nesting status unknown.

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Scientific Name	Common Name	Listing Status			Habitat	Potential to Occur within District Lands
		Federal/State/Other				
<i>Ardea herodias</i>	Great blue heron	-	SOLI (4)	-	Nests in large stands of trees near water	Nests (or formerly nested) within District lands at Lake Nicasio and Alpine Lake.
<i>Baeolophus inornatus</i>	Oak titmouse	FCC	-	-	Nests in tree cavities in oak-woodlands.	Nests on District lands.
<i>Chaetura vauxi</i>	Vaux's swift	-	CSC	-	Nests in hollow trees and snags in heavily forested areas.	Known to occur on District lands, but nesting status is unknown.
<i>Circus cyaneus</i>	Northern Harrier	-	CSC	-	Nests on ground in swales and low-lying grasslands	Known to occur on District lands, but nesting status unknown.
<i>Contopus cooperi</i>	Olive-sided flycatcher	FCC	CSC	-	Nests in trees, with preference for conifers, but also eucalyptus.	Nests on District lands, relatively common around Phoenix Lake and Kent Lake.
<i>Dendroica petechial brewsteri</i>	Yellow warbler	FCC	CSC	-	Nests in deciduous saplings or shrubs in riparian habitats.	Nests on District lands, along Lagunitas Creek riparian corridor, though sparingly.
<i>Elanus leucurus</i>	White-tailed kite	-	FP	-	Generally, nests in trees near fields, open groves, grasslands, or marshes.	Nests on District lands.
<i>Eremophila alpestris actia</i>	California horned lark	-	WL	-	Nests in grasslands.	Nests on District lands, most reliably in the vicinity of Nicasio and Soulajule reservoirs.
<i>Geothlypis trichas sinuosa</i>	San Francisco Common Yellowthroat	FCC	CSC	-	Freshwater marsh, swale, etc.	Likely occurs on District land, but nesting status unknown.
<i>Haliaeetus leucocephalus</i>	Bald eagle	FCC	SE, CFP	-	Wide-ranging in coastal California; often near water.	Nests on District lands at Kent Lake.

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Scientific Name	Common Name	Listing Status			Habitat	Potential to Occur within District Lands
		Federal/State/Other				
<i>Lanius ludovicianus</i>	Loggerhead shrike	FCC	CSC	-	Semi-open country with lookout posts, wires, trees, scrub. Nests in dense tree or shrub foliage.	Nests on District lands, though decreasing in recent decades.
<i>Pandion haliaetus</i>	Osprey	-	WL	-	Uses snags and large trees for nesting. Forages mainly in lakes and the ocean.	Nests on District lands at Kent Lake.
<i>Parus rufescens neglectus</i>	"Marin" Chestnut-backed Chickadee	-	SOLI (3)	-	Oak woodlands and riparian corridors.	Nests on District lands.
<i>Progne subis</i>	Purple martin	-	CSC	-	Nests in large standing snags with cavities near open foraging areas.	Nests on District lands; several colonies active at Kent Lake each season.
<i>Strix occidentalis caurina</i>	Northern spotted owl	FT	ST	-	In Marin County resides in second growth conifer, mixed conifer-hardwood, and evergreen hardwood forests.	Nests on District lands.
Reptiles						
<i>Actinemys marmorata</i>	Western pond turtle	-	CSC	-	Perennial ponds, deep slow-moving streams, marshes and lakes are habitat for this species at 6,000 feet and below in elevation. However, eggs are laid in loose soil on land in oak woodlands, mixed coniferous forests, broadleaf forests and grasslands, usually within 400 ft. of ponds, lakes, slow streams and marshes with vegetated borders, rocks, or logs. Logs, rocks, cattail mats, and exposed banks are required for basking.	Present in the Watershed in Phoenix Lake, Lake Lagunitas, Bon Tempe Reservoir, Alpine Reservoir, and within connected creeks. Also present outside of the plan area in Soulajule Reservoir, Lagunitas Creek, Walker Creek, and possibly Corte Madera Creek.

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Scientific Name	Common Name	Listing Status			Habitat	Potential to Occur within District Lands
		Federal/State/Other				
Amphibians						
<i>Dicamptodon ensatus</i>	California giant salamander	-	CSC		Larvae usually inhabit clear, cold streams, but are also found in mountain lakes and ponds. Adults are found in humid forests under rocks and logs.	Present in the Watershed. Frequently seen in Lagunitas Creek, in small creeks draining the south side of Mount Tamalpais, and expected to occur in other areas with suitable habitat.
<i>Rana draytonii</i>	California red-legged frog	FT	CSC	-	Marshes, stream pools, reservoirs, ponds. Uses both riparian and upland habitats for foraging, shelter, cover, and non-dispersal movement (Recovery Plan 2010)	Present on adjacent federal land, and on District lands downstream from Kent Lake. Very infrequent observations of individual California red-legged frogs in Lagunitas Creek. Documented offsite at a location 0.75-mile due west of Peters Dam, and in Olema Creek (Not on District lands)
<i>Rana boylei</i>	Foothill yellow-legged frog	-	SPT/CSC	-	Foothill woodlands and chaparral near streams and ponds, riparian woodlands, wet meadows, also inhabits mixed conifer forest streams, slow streams and rivers with sunny, sandy and rocky or gravelly banks at 6,000 ft. and below in elevation.	Present in the Watershed and breeding in Little Carson Creek and Big Carson Creek. Also observed in Walker Creek, <u>Cascade Creek</u> , <u>San Anselmo Creek</u> , <u>Carey Camp Creek</u> and Salmon Creek (downstream of SoulaJule Reservoir).
Fish						
<i>Lavinia symmetricus</i> ssp.	Tomales roach	-	CSC	-	Freshwater tributaries to Tomales Bay.	Occurs on District lands in Lagunitas Creek below Peters Dam, also in downstream locations. Present in Walker Creek downstream of SoulaJule Reservoir, and in Devils Gulch. Also present in Ross Creek (below Phoenix Lake) and Corte Madera Creek.

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Scientific Name	Common Name	Listing Status			Habitat	Potential to Occur within District Lands
		Federal/State/Other				
<i>Oncorhynchus kisutch</i>	Central California coast coho salmon	FE	SE	-	Anadromous; migrates through San Francisco Bay and spawns in coastal rivers and creeks.	Occurs on District land in Lagunitas Creek below Peters Dam, also in downstream locations. Low likelihood of occurrence in other waters within District lands. Present in Redwood Creek, Walker Creek (downstream from Soulaajule Reservoir), Devils Gulch, San Geronimo Creek, and Olema Creek (all on State Parks Land). Found outside of BFFIP area but receives water from within BFFIP area.
<i>Oncorhynchus mykiss irideus</i>	Central California coast steelhead	FT	-	-	Anadromous, migrates through San Francisco Bay spawns in coastal rivers and creeks.	Lagunitas Creek and most of its perennial tributaries. Arroyo Sausal downstream from Soulaajule Reservoir. Other creeks include: Corte Madera Creek, Redwood Creek, Walker Creek, San Geronimo Creek, Devils Gulch, Arroyo Corte Madera del Presidio, Tamalpais Creek, Larkspur Creek, and Miller Creek.
Invertebrates						
<i>Bombus caliginosus</i>	Obscure bumble bee	-	SA		Inhabits open grassy coastal prairies and Coast Range meadows. Nesting occurs underground as well as above ground in abandoned bird nests.	Species documented on the Watershed in 1983 and earlier dates. May occur in areas containing suitable habitat.

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Scientific Name	Common Name	Listing Status			Habitat	Potential to Occur within District Lands
		Federal/State/Other				
<i>Bombus occidentalis</i>	Western bumble bee	-	SA		Typically nests underground in abandoned rodent burrows or other cavities. Most reports of <i>B. occidentalis</i> nests are from underground cavities such as old squirrel or other animal nests and in open west-southwest slopes bordered by trees, although a few nests have been reported from above-ground locations such as in logs among railroad ties.	Species documented on the Watershed in 1916 and earlier dates. May occur in areas containing suitable habitat.
<i>Calicina diminua</i>	Marin blind harvestman	-	SA	-	Rocky serpentine grasslands.	Possible in serpentine areas but not observed on District lands. Type location is Mt. Burdell in Novato; specimens collected from location between 1968-1986.
<i>Callophrys mossi marinensis</i>	Marin elfin butterfly	-	SA	-	North-facing slopes near redwood forest. Larval host plant is stonecrop (<i>Sedum spathulifolium</i>).	One specimen has been recorded from the Watershed in 1971, at the confluence of Lagunitas Creek and San Geronimo Creek. Possible on other District lands with suitable habitat.
<i>Pomatiopsis binneyi</i>	Robust walker	-	SA	-	Freshwater springs and seeps.	1978 specimen from Potrero Meadow, in the Watershed. Possible on other District lands with suitable habitat.

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Scientific Name	Common Name	Listing Status			Habitat	Potential to Occur within District Lands
		Federal/State/Other				
<i>Syncaris pacifica</i>	California freshwater shrimp	FE	SE	-	Shallow pools away from main streamflow. Winters under exposed underwater roots; may be found in summer under leafy branches touching water.	Known to occur downstream of District land in Lagunitas Creek and Walker Creek, outside the BFFIP area. Only 17 coastal creeks known to support this species endemic to Marin, Sonoma and Napa Counties. Does not occur in the BFFIP area.
<i>Talanites ubicki</i>	Ubick's gnaphosid spider	-	SA	-	Moist, rocky serpentine.	Possible in serpentine areas but not observed on District lands. Type location is Mt. Burdell in Novato; specimens collected from location between 1982-1992.
<i>Trachusa gummifera</i>	A leaf-cutter bee	-	SA	-	Unknown – chaparral?	1962 specimen from Carson Ridge, in the Watershed. Possible on other District lands with suitable habitat.
<i>Vespericola marinensis</i>	Marin hesperian	-	SA	-	Moist brushy areas or grasslands, around springs or seeps, in riparian forest.	1991 specimen from Lagunitas Creek below Alpine Dam, in the Watershed. Possible on other District lands with suitable habitat.

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Scientific Name	Common Name	Listing Status		Potential to Occur within District Lands
		Federal/State/Other	Habitat	

Notes:

U.S. Fish and Wildlife Service designations:

FE Endangered: Any species that is in danger of extinction throughout all or a significant portion of its range.

FT Threatened: Any species likely to become Endangered within the foreseeable future.

California Department of Fish and Wildlife designations:

SE Endangered: Any species that is in danger of extinction throughout all or a significant portion of its range.

ST Threatened: Any species likely to become Endangered within the foreseeable future.

SPT Proposed for State listing as Threatened

Western Bat Working Group (WBWG) designations:

H High Priority

M Medium Priority

ML Medium/Low Priority

Other:

FCC Federal Bird of Conservation Concern

CSC California Species of Concern

CFP Fully Protected

SA Included on CDFW Special Animals List

SOLI Tomales Bay Watershed Species of Local Interest

WL Watch List

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**APPENDIX E:
EXTIRPATED PLANT SPECIES ON MMWD LANDS**

E EXTIRPATED PLANT SPECIES ON MMWD LANDS

This draft Likely Extirpated Plant Species List includes native species historically found within the Mount Tamalpais Watershed but that have not been seen in over 50 years, or their last known locations have been searched more recently and the population is gone. This list contains some species that require fire to germinate, and these species may be present in the seedbank but are not observable and therefore effectively absent. The longer they go without fire, the higher the likelihood that their seeds in the soil will no longer be able to grow if a fire does occur.

Historic presence was established primarily by comparing the MMWD species list with the 2007 Marin Flora (Howell et al. 2007) where specific locations were well described. Taxa indicated as growing at an identifiable location in the book, but not listed as present on the current species list, were compared against herbarium records (CCH 2016) and recent observations within the online databases Calflora (Calflora 2016). District staff and supporting local expert botanists then conducted species specific field surveys in the appropriate season to confirm the absence. The list has been peer reviewed by regional land manager, the California Native Plant Society (local and state level), and the botanical department of the California Academy of Science.

Table E-1 Extirpated Plant Species on MMWD lands

No.	Family	Scientific Name	Common Name	Habitat	Recent Specimen
1	Apiaceae	<i>Apiastrum angustifolium</i>	Wild celery	Chaparral	Undated ^a
2	Apocynaceae	<i>Asclepias speciosa</i>	Showy milkweed	Grassland	N/A
3	Asteraceae	<i>Lasthenia glaberrima</i>	Smooth goldfields	Grassland	N/A
4	Asteraceae	<i>Pentachaeta alsinoides</i>	Tiny pygmy daisy	Grassland	N/A
5	Asteraceae	<i>Pseudognaphalium stramineum</i>	Cottonbatting plant	Open Areas	1907
6	Blechnaceae	<i>Blechnum spicant</i>	Deer fern	Forest	N/A
7	Boraginaceae	<i>Cryptantha micromeres</i>	Small flowered cryptantha	Chaparral	1910
8	Boraginaceae	<i>Heliotropium curassavicum</i> var. <i>oculatum</i>	Seaside heliotrope	Open Areas	N/A
9	Boraginaceae	<i>Phacelia suaveolens</i>	Sweet scented phacelia	Chaparral	1946

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No.	Family	Scientific Name	Common Name	Habitat	Recent Specimen
10	Caprifoliaceae	<i>Lonicera involucrata</i> <i>var. ledebourii</i>	Coast twinberry	Riparian	1929
11	Cornaceae	<i>Cornus nuttallii</i>	Mountain dogwood	Forest	1950
12	Datisceae	<i>Datisca glomerata</i>	Durango root	Chaparral, Riparian	1890
13	Equisetaceae	<i>Equisetum laevigatum</i>	Smooth scouring rush	Chaparral, Riparian	N/A
14	Ericaceae	<i>Pityopus californicus</i>	N/A	Forest	1957
15	Euphorbiaceae	<i>Euphorbia crenulata</i>	Chinesecaps	Grassland	Undated ^a
16	Fabaceae	<i>Lathyrus jepsonii</i> <i>var.</i> <i>californicus</i>	California tule pea	Wetland	1947
17	Fabaceae	<i>Trifolium amoenum</i>	Showy indian clover	Grassland	1933 ^b
18	Fabaceae	<i>Trifolium</i> <i>depauperatum</i> <i>var.</i> <i>depauperatum</i>	Dwarf bladder clover	Grassland	1915 ^b
19	Fagaceae	<i>Quercus dumosa</i>	Scrub oak	Chaparral	1947
20	Geraniaceae	<i>Geranium bicknellii</i>	Bicknell's geranium	Chaparral	N/A
21	Geraniaceae	<i>Geranium</i> <i>carolinianum</i>	Carolina geranium	Woodland	N/A
22	Grossulariaceae	<i>Ribes malvaceum</i>	Chaparral currant	Chaparral	1935
23	Limnanthaceae	<i>Limnanthes douglasii</i> <i>ssp. douglasii</i>	Common meadow foam	Grassland	1899
24	Lythraceae	<i>Lythrum californicum</i>	Common loosestrife	Wetland	1881
25	Montiaceae	<i>Lewisia rediviva</i>	Bitter root	Rock Outcrops	N/A
26	Onagraceae	<i>Circaea alpina</i> <i>ssp.</i> <i>pacifica</i>	Pacific enchanter's nightshade	Forest	1939
27	Onagraceae	<i>Clarkia purpurea</i> <i>ssp.</i> <i>viminea</i>	Large godetia	Grassland	1892
28	Onagraceae	<i>Epilobium hallianum</i>	Hall's willowherb	Wetland	N/A
29	Ophioglossaceae	<i>Sceptridium multifidum</i>	Leather grape- fern	Wetland	1924
30	Orchidaceae	<i>Cypripedium</i> <i>californicum</i>	California lady's slipper	Wetland	1917

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No.	Family	Scientific Name	Common Name	Habitat	Recent Specimen
31	Papaveraceae	<i>Eschscholzia caespitosa</i>	Tufted eschscholzia	Chaparral	1892
32	Plantaginaceae	<i>Callitriche trochlearis</i>	Water starwort	Wetland	N/A
33	Plantaginaceae	<i>Lindernia dubia</i>	False pimpernel	Wetland	N/A
34	Plantaginaceae	<i>Penstemon heterophyllus</i> ssp. <i>purdyi</i>	Purdy's foothill penstemon	Open Areas	1937
35	Poaceae	<i>Agrostis microphylla</i>	Little leaf bentgrass	Grassland	1962
36	Poaceae	<i>Festuca octoflora</i>	Sixweeks grass	Chaparral	1947
37	Poaceae	<i>Pleuropogon hooverianus</i>	North coast semaphore grass	Grassland	1943
38	Poaceae	<i>Torreyochloa pallida</i> var. <i>pauciflora</i>	Mannagrass	Wetland	1943
39	Ranunculaceae	<i>Ranunculus lobbii</i>	Lobb's aquatic buttercup	Wetland	1903
40	Ranunculaceae	<i>Ranunculus orthorhynchus</i> var. <i>bloomeri</i>	Bloomer's buttercup	Grassland	1899
41	Rosaceae	<i>Potentilla rivalis</i> var. <i>millegrana</i>	Brook cinquefoil	Wetland	Undated ^a
42	Rosaceae	<i>Prunus virginiana</i> var. <i>demissa</i>	Western choke cherry	Chaparral, Riparian	1936
43	Rubiaceae	<i>Galium trifidum</i>	Three petaled bedstraw	Wetland	Undated ^a
44	Verbencaeeae	<i>Verbena lasiostachys</i>	Western vervain	Wetland	N/A

Notes:

- ^a All species are supported by sightings in the 2007 version of the Marin Flora (Howell et al. 2007), which is an update of the 1949 version.
- ^b Specimen exists but is undated.
- ^c Species were added based on other evidence.

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References

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**APPENDIX F:
MMWD BEST MANAGEMENT PRACTICES**

F WEED PREVENTION AND PLANT PATHOGEN CONTROL BEST MANAGEMENT PRACTICES

F.1 WEED PREVENTION AND PLANT PATHOGEN CONTROL BMPs

This appendix includes the Best Management Practices (BMPs) that are applicable to the Biodiversity, Fuel, and Fire Integrated Plan (BFFIP). These measures will be updated after completion of an Environmental Impact Report (EIR) pursuant to the California Environmental Quality Act (CEQA).

Federal Executive Order 13112 defines an invasive species as an alien (non-native) species whose introduction does or is likely to cause economic or environmental harm, or harm to human health. While the majority of non-native plants do not pose a threat to natural or human systems, the California Invasive Plant Council (Cal-IPC) Invasive Plant Inventory identifies 200 species, approximately 3 percent of the plant species growing in the wild in California, as invasive (Cal-IPC 2006). These plants have the capacity to alter ecosystems, with potential detrimental implications for wildlife communities, fire regimes, water flow, and nutrient cycling.

Best Management Practices (BMPs) are methods or techniques found to be the most effective and practical in achieving an objective, such as preventing or reducing invasive plant spread, while making optimal use of resources. Prevention BMPs can help:

- Reduce future maintenance needs and cost
- Reduce fire hazards
- Enhance access and safety
- Limit liability for the governing agency or lessee
- Maintain good public relations
- Protect existing wildlife habitat, native plant populations, beneficial insects, as well as threatened and endangered species

This appendix identifies several BMPs to minimize the spread of both weeds and forest pathogens.

F.1.1 Weed Prevention

Introduction

The least expensive, most effective way to manage highly invasive plant species is through prevention, early detection, and rapid response. The practices identified in this document allow

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the District to save time and money over the near- and long-term by avoiding the increased mowing burden and fire danger brought on by weed infestations.

BMPs identified here are specific to the planning phases of projects to minimize invasive species introduction and spread.

Weed Prevention Goals and Guiding Principles

Weed prevention programs shall be designed considering eight overarching goals. Each of the BMPs provided in this document ties directly to meeting one or more of these goals:

1. Avoid introducing weed seeds and propagules
2. Avoid moving weeds from infested areas into uninfested areas
3. Avoid creating soil conditions that promote weed establishment (e.g., unnecessary disturbance)
4. Avoid creating canopy conditions that promote weed establishment (i.e., maintain natural levels of canopy closure whenever possible)
5. Establish and maintain the framework for early detection of weed introductions and rapid response to control them
6. Increase awareness of weed prevention practices in all District programs
7. Be prepared to adapt management to changes in expectations and conditions
8. Strive for new levels of cooperation, communication, and information-sharing

BMP-1: Routine Operations and Project/Activity Implementation

District operations encompass a variety of management activities ranging from day-to-day road maintenance to Incident Command emergency situations. The following measures shall be implemented:

1. Prior planning may avoid the introduction and/or spread of weed species, such as by:
 - a. Implementing a periodic monitoring program for detecting new weed infestations in highly susceptible locations such as pull outs, trailheads, picnic areas, parking lots, and concessionaire locations.
 - b. Defining “zero tolerance” zones in vulnerable, high-risk areas within the watershed which you commit to keeping weed-free through frequent monitoring and weed control efforts.
2. Minimize the extent and severity of soil disturbance, by:
 - a. Setting up staging areas and equipment in a way that will minimize soil disturbance and avoid loss of desirable native vegetation.
 - b. When working in vegetation types with relatively closed canopies, retaining shade to the extent possible to suppress weeds and prevent their establishment and growth.
3. Maintain facilities by implementing the following techniques:
 - a. Maintain long-term staging areas, such as boneyards, dumps, and quarries in weed-free condition if possible, or contain weeds therein. If necessary, treat sites

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annually for weeds, and assign this duty to an appropriate, trained staff person. Consider ways of hardening these sites, such as deep mulching or scraping and tamping.

- b. Maintain trailheads, picnic areas, roads leading to trailheads, and other areas of concentrated public use in a weed-free condition. Make high-use recreation areas a high priority for weed detection and eradication if not already heavily infested.

BMP-2: Pre-Work Assessments and Planning

Prevention begins with pre-work assessments and planning. The following are guidelines for general construction and maintenance activities:

1. Inspect all potential and current permitted activity sites. Incorporate invasive plant prevention and containment practices such as mowing, flagging or fencing invasive plant patches, designating invasive plant free travel routes and washing equipment. Where possible, avoid permitting activities that would result in the transfer of weed materials from an infested site to a non-infested site. Consider routes of travel, transport, and equipment use and address pathways and spread concerns with permittees.
2. Before ground-disturbing activities begin, inventory and prioritize weed infestations for treatment in construction sites and along access routes. Identify what weeds are on site or within the project's vicinity and do a risk assessment accordingly. Control these weed infestations. Ideally, weeds should be managed prior to the planned disturbance to minimize weed seeds in the soil.
3. Begin project operations in non-infested areas. Restrict movement of equipment or machinery from weed-contaminated areas to non-contaminated areas.
4. Locate and use weed-free project staging areas. Avoid or minimize travel through weed-infested areas, or restrict travel to those periods when spread of seed or propagules is least likely, such as prior to seed development.

BMP-3: Imports: Fill, Rock, Plant Material

Knowing the sources of imported material is critical to prevent the introduction of invasive plants. If a project involves moving plants or soil, consider the following:

1. Make sure plants and soil are not contaminated with weed seeds – use a certified weed free source or sterilize soil prior to use.
2. When possible, get the plants and soil from the worksite, which is less likely to introduce foreign material.
3. Inspect materials at the source to ensure that they are weed-free before transport and use. If sources of sand, gravel, and fill are infested, eradicate the weeds, then strip and stockpile the contaminated material for several years, if possible, to further deplete the soil seed bank. Check regularly for weed re-emergence and treat as needed.

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4. Maintain stockpiled, non-infested material in a weed-free condition by preventing weed seed contamination with physical barriers and by frequently monitoring and quickly eradicating new weeds prior to seed production.
5. Use fill within the project area, or stockpile clean fill on-site for local use. Dispose of excess excavation or spoils in a way that won't spread weeds within the watershed or to neighbors.
6. Work with the weed specialist to develop guidelines for where earth materials can be moved within the watershed.
7. For routine purchase of material, such as rock used for drain or road base, work with the weed specialist to evaluate the risk, and if necessary develop a procedure for procuring weed-free material and/or inspecting materials sources.
8. Maintain stockpiled, non-infested material in a weed-free condition by preventing weed seed contamination with physical barriers (e.g. tarps) and by frequently monitoring and quickly eradicating new weeds prior to seed production.
9. Survey for, document, and treat weeds on construction sites (or wherever fill/material is brought in) annually for at least 3 years after project completion to ensure that any weeds transported to the site are promptly detected and eradicated. For on-going projects, continue to monitor until reasonably certain that weeds will not reappear. Plan for follow-up treatments based on inspection results.
10. Seed and mulch to be used for burn rehabilitation or slope stabilization (for wattles, straw bales, dams, etc.) all need to be inspected and certified that they are free of weed seed and propagules. Follow-up inspections of straw treated sites should be performed to insure any undetected source seed are treated.
11. Revegetation may include topsoil replacement, planting, seeding, and weed-free mulching as necessary. Use native material to the greatest extent possible. Consider stockpiling chipped local brush or cut and bale local weed-free grass for mulch – an added benefit is that mature seeds in the grass or brush can help restore local vegetation on the site.
12. Periodically inspect roads, trails, and rights-of-way for invasive plants. Train staff to recognize weeds and report locations to the local weed specialist. Inventory weed infestations and schedule them for treatment.

F.1.2 Plant Pathogen Control

Introduction

The objective of these BMPs is to avoid contaminating restoration sites with exotic pathogenic *Phytophthora* species or other plant pathogens during activities related to planting. Three general routes for the spread of *Phytophthora* and other soil borne plant pathogens are addressed in these BMPs. These routes include (1) contamination of planting inputs, including clean nursery stock and other materials installed at the site, (2) introduction of pathogens to a planting area, and (3) potential movement of undetected contamination within the planting area.

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Note that alternative methods may be acceptable if they are supported by published data or other valid test results showing that the methods are effective.

BMP-4: Prevent Contamination of Clean Nursery Stock or other Clean Plant Materials.

Planting stock shall be protected from potential contamination from the point that it leaves the production nursery or collection site until it has been planted. Note that container nursery stock has a high risk of infection by *Phytophthora* species if exposed to these pathogenic agents.

Exclusion of these pathogens provides the only viable option for maintaining nursery plants free of *Phytophthora*.

Maintaining Nursery Stock in a Holding Facility

By definition, nursery stock produced by the District should be free of exotic *Phytophthora* to the maximum degree attainable. If such material is held for a period after delivery and before planting, the following clean nursery practices must be followed to prevent contamination of the nursery stock with *Phytophthora*:

1. Water used for irrigating plants shall comply with standards listed below.
2. Delivered nursery plants that will be held before planting shall be transferred to cleaned and sanitized raised benches and maintained as described below under Handling and Transporting Nursery Plants BMPs.

Handling and Transporting Nursery Plants

3. Nursery plants shall be transported on or in vehicles or equipment that has been sanitized before loading the stock. Truck beds, racks, or other surfaces will be cleaned (swept, blown with compressed air and/or power washed as needed) to be free of soil and plant detritus. Cleaned surfaces shall be sanitized as described below under Procedures for Sanitizing Tools, Surfaces, and Footwear.
4. Keep plants in sanitized vehicles or on sanitized carts, trailers, etc. until delivered to their planting sites.
5. At the job site, plants shall be handled to prevent contamination until delivered to each planting site. Nursery stock shall not be staged on the soil or other potentially contaminated surfaces except that plants may be placed on the soil surface at their specific planting sites.
6. If it is necessary to offload plants at the job site, plants may be placed on clean waterproof plastic tarps or other clean, sanitized surfaces. If tarps are used for holding plants, one surface will be dedicated for contact with nursery stock and will be cleaned and sanitized as needed to maintain phytosanitary conditions.

Other Planting Site Inputs

7. Washing, soaking, or irrigation of plant material shall be conducted using clean water sources as specified below under Clean Water Specifications. Untreated surface waters shall not be used for these purposes.
8. Mulch, compost, soil amendments, inoculants, and other organic products shall be pre-approved for use before delivery to the planting site. Materials shall be free of pathogen contamination due to composition, manufacturing conditions, or

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through effective heat treatment and subsequently handled and maintained in a manner to prevent contamination. If appropriate, testing may be required as specified by the District. At the job site, delivered materials shall be handled to prevent contamination until delivered to each planting site in the same manner specified above under Handling and Transporting Nursery Plants.

9. All other materials to be installed at the site shall be of new material that has not been stored in contact with soil, untreated surface waters, or other potentially contaminated materials. This includes irrigation supplies (such as pipe, fittings, valves, drip line, emitters, etc.), erosion control fabrics, fencing, stakes, posts, and other planting site inputs.

BMP-5: Cleaning and Sanitation Required Before Entering Planting Area to Prevent Introducing Contamination from Other Locations

Phytophthora contamination can be present in agricultural and landscaped areas, in commercial nursery stock, and in some infested native or restored habitat areas. Contamination can be spread via soil, plant material and debris, and water from infested areas. Arriving at the site with clean vehicles, equipment, tools, footwear, and clothing helps prevent unintentional contamination of the planting site from outside sources.

Vehicles, Equipment, and Tools

1. Equipment, vehicles and large tools must be free of soil and debris on tires, wheel wells, vehicle undercarriages, and other surfaces before arriving at the planting area. A high pressure washer and/or compressed air may be used to ensure that soil and debris are completely removed. Vehicles that only travel and park on paved roads do not require external cleaning.
2. Contractors will comply with this provision by demonstrating that the equipment has been cleaned at a commercial vehicle or appropriate truck washing facility
3. The interior of equipment (cabs, etc.) must be free of mud, soil, gravel and other debris. Interiors may be vacuumed or washed.
4. Small tools and other small equipment (including hoses, quick couplers, hose nozzles, and irrigation wands) must be washed to be free of soil or other contamination and sanitized as described below in Procedures for Sanitizing Tools, Surfaces, and Footwear.
5. Hoses shall be new or previously used only for clean water sources as described below in Clean Water Specifications.

Footwear and Clothing

6. Soles and uppers of footwear must be free of debris and soil before arriving at the planting area. Clean and sanitize footwear as described in Procedures for Sanitizing Tools, Surfaces, and Footwear.
7. At the start of work at each new job site, worker clothing shall be free of all mud, soil or detritus. If clothing is not freshly laundered, all debris and adhered soil should be removed by brushing with a stiff brush.

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BMP-6: Prevent Potential Spread of Contamination within Planting Areas

Phytophthora can also be spread within plantings areas if some portions of the site are contaminated. However, it is not possible to identify every portion of a planting area that contains or is free of *Phytophthora*. Because *Phytophthora* contamination is not visible, working practices should minimize the movement of soil within the planting area to minimize the likelihood of spreading contamination.

The District may designate specific portions of a planting area as having high or low risk of contamination. Areas with higher risk of contamination typically include areas adjacent to planted landscaping, areas previously planted with *Phytophthora*-infected stock, areas with existing or recently removed woody vegetation, areas directly along watercourses. Areas with low risk of contamination typically include upland sites with only grassy vegetation or sites where surface soils have been removed.

Worker Training and Site Access

1. Before entering the job site, field workers and contractors shall receive training that includes information on *Phytophthora* diseases and how to prevent the spread of these and other soil borne pathogens by following approved phytosanitary procedures.
2. Do not bring more vehicles into the planting area than absolutely necessary. Within the planting area, keep vehicles on surfaced or graveled roads whenever possible to minimize potential for soil movement.
3. Travel off roads or on unsurfaced roads should be avoided when such roads are wet enough that soil will stick to vehicle tires and undercarriages.

Minimize Unnecessary Movement of Soil and Plant Material within the Planting Area, Especially from Higher to Lower Risk Areas

4. Brush off substantial soil contamination from tools and gloves when moving between successive planting sites to prevent repeated collection and deposition of soil across multiple sites.
5. Avoid contaminating clothing with soil during planting operations. Use nonporous knee pads that are cleaned between planting sites if kneeling is necessary.
6. When possible, plant nursery stock from a given block in the same local area rather than spreading it widely. If a problem is associated with a given block of plants, it will be easier to detect and deal with it if the plants are spatially grouped.
7. Phase work to minimize movement between areas with high and low risk of contamination. Where possible, complete work in low risk areas before moving to higher risk areas. Alternatively, restrict personnel to working in either high or low risk areas exclusively to reduce the need for decontamination.
8. Clean soil and plant debris from large equipment and sanitize hand tools, buckets, gloves, and footwear when moving from higher risk to lower risk areas or when moving between widely separated portions of the planting area.

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9. All non-plant materials to be installed at the site (irrigation equipment, erosion control fabric, fencing, etc.) shall be handled to prevent movement of soil within the site, especially movement from higher risk to lower risk areas. Materials should be kept free of soil contamination by maintaining them in sanitized vehicles or on sanitized carts, trailers, etc., or stockpiling in elevated dry areas on clean tarps until used.

BMP-7: Procedures for Sanitizing Tools, Surfaces, and Footwear

Surfaces and tools should be clean and sanitized before use. Tools and working surfaces (e.g., potting benches) should be smooth and nonporous to facilitate cleaning and sanitation. Wood handles on tools should be sealed with a waterproof coating to make them easier to sanitize. Before sanitizing, removal all soil and organic material (roots, sap, etc.) from the surface. If necessary, use a detergent solution and brush to scrub off surface contaminants. The sanitizing agent may also be used as a cleaning fluid. Screwdrivers or similar implements may be needed to clean soil out of crevices or shoe treads. Brushes and other implements used to help remove soil must be cleaned and sanitized after use.

REFERENCES

California Invasive Plant Council (Cal-IPC). 2006. California Invasive Plant Inventory. February 2006. Available at: <http://www.cal-ipc.org/ip/inventory/>. Accessed April 1, 2016.