



# Muir Woods National Monument

Water/Wastewater Service Rehabilitation



Golden Gate NRA, Park Archives, Muir Woods Collection, GOGA 32470

## Draft Environmental Assessment

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## CHAPTER I

# Purpose and Need

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## Introduction

The National Park Service (NPS) is proposing to rehabilitate the Muir Woods National Monument (managed by the Golden Gate National Recreation Area - GGNRA) water and wastewater service lines, improve visitor experience and safety, and enhance preservation of natural and cultural resources. This environmental assessment (EA) analyzes the impacts that could result from taking no-action and the impacts that could result from one action alternative.

This EA has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, and implementing regulations, 40 Code of Federal Regulations (CFR) Parts 1500–1508:

*Protection of Environment*, 43 CFR Part 46: *Implementation of the National Environmental Policy Act of 1969*, Director's Order 12: *Conservation Planning, Environmental Impact Analysis, and Decision-making* (NPS 2011a) and its accompanying handbook (NPS 2001, 2015a), section 106 of the National Historic Preservation Act of 1966, and section 7, *Interagency Cooperation*, of the Endangered Species Act.

## Background

Muir Woods National Monument (Monument) consists of approximately 554 acres of land located on the Marin Peninsula, a large and mountainous stretch of land north of San Francisco, in Marin County, California (See Figures 1 and 2). This area is included in the nine-county region generally referred to as the Bay Area and has a population of more than 7 million. Development is largely restricted to the eastern half of the Marin Peninsula along San Francisco Bay, a region traversed by highways leading north from San Francisco over the Golden Gate Bridge. The monument is approximately 2 miles inland of the Pacific Ocean, 10 miles northwest of the Golden Gate Bridge, and near other protected public lands, such as Point Reyes National Seashore, Mount Tamalpais State Park, and the Marin Municipal Water District.

Visitors traveling to the monument in vehicles use Muir Woods Road, a winding two-lane county road that connects on the east with Panoramic Highway and Mill Valley and on the southwest with State Highway 1. The main entrance to the monument is located roughly in the middle of Muir Woods Road, at the southern end of Redwood Canyon. Adjoining the entrance are parking lots, restrooms, and a small visitor center. Muir Woods receives very heavy visitation during the peak season (April through September) and in the off season on holidays and during periods of good weather. Demand for parking often exceeds the capacity of the monument's lots during peak visitation, and informal overflow parking occurs on the shoulders of Muir Woods Road.

Water Service (Waterline): The current water service provides potable domestic water service and a storage tank is required to provide fire flow service to the Monument. NPS water service connects to MMWD system at a meter near the Tourist Club, which is located on Ridge Avenue off of Panoramic Highway. MMWD recently upsized the old 2" galvanized steel piping with a new 6" ductile iron waterline that extends down the hillside from a water main on Ridge Avenue to deliver water to the service meter.

Wastewater (Sewer Line): The current wastewater sewer mains collect wastewater from the public comfort stations, employee and concessions restrooms, concessionaire cafe, and the permanent employee residence. The wastewater flows north to south via gravity parallel to Redwood Creek. The sewer mains are primarily 6” diameter (with most of the current main line having been reduced to a 5” inside diameter using HDPE slip lined piping) with 4” service laterals. The gravity main flows to Lift Station #1, which pumps wastewater through a 4” force main to Lift Station #2. Lift Station #2 pumps wastewater through a 4” ductile iron and 4” pvc force main to a gravity system that connects to the Sausalito Marin City Sanitary District (SMCSD) via the Tamalpais Community Services District’s (TCSD’s) Sanitation Department. This project would not change the overall flow from the Monument to the TCSD. Instead, it only increases the capacity of the Monument’s gravity collection system pipes based on modeling of existing usage, i.e., the current wastewater lines are undersized.

## Purpose, Need and Objectives

### Purpose

The purpose of the project is to provide reliable water and wastewater services at Muir Woods to meet current codes for water and waste water collection services; and to address fire flow demands, potable water quality issues, visitor and employee health and safety, and locating wastewater infrastructure out of the Redwood Creek corridor.

### Need for Action

#### NEED FOR WATER SERVICE / WATER LINE REPLACEMENT

<b>Deteriorating System</b>
Components of the existing infrastructure are past their service life and show signs of corrosion and structural deterioration, and the water tank no longer meets code requirement for three day storage capacity for domestic potable water use and National Fire Protection Agency (NFPA) code requirements for fire storage.
The galvanized steel water line is past its life-cycle and cannot perform as an adequate delivery system for fire flows without a fire storage tank. In addition, pressure in the supply line would need to handle a static pressure as high as 350 psi plus any pressure surges. A rupture in the water supply line could cause significant damage including natural resources damage and may not be detected right away due to remote alignment of the waterline through Mt. Tamalpais State Park. Installation of a pressure relief valve at the site of the existing tank would help protect against system and environmental damage in the event of an upstream Pressure Reducing Valve failure. This pipeline is the Monument’s sole source of water and a prolonged shut down to address break would have significant impacts on the Monument.
<b>Excessive Maintenance</b>
The existing water line needs to be replaced because it requires an excessive amount of maintenance effort and resources in order to maintain potable water. Currently, maintaining potable water requires frequent disinfection of the water tank and uses a significant quantity of water to flush the lines.
<b>Fire Protection</b>
The water storage tank is undersized to adequately provide for fire storage per National Fire Protection Agency (NFPA) 1142 code requirements including an additional three-day storage capacity for domestic potable water use. The Fire Flow and Water Storage Requirements Report (see Appendix F – Final



Preliminary Design Report - Appendix I) states that the minimum required water supply in gallons for firefighting purposes following NPFA 1142 is 30,000 gallons. Design average day demand of the water system is 5,000 gallons based on monthly MMWD service meter flow records. Peak day (maximum day) demand of the water system is estimated at 15,000 gallons, with an assumed peaking factor of 3.0 times the average day demand. Therefore, useable water storage of 45,000 to 75,000 gallons is necessary to meet combined fire storage and potable domestic requirements, with one to three days storage of potable peak day demand. Water Engineering Option 1(not selected) replaced the existing 40,000-gallon tank with a 60,000-gallon tank to meet combined domestic and fire flow needs. Alternative 1 was not selected because it required, at a minimum, 40 feet of cut into the State Park property at the current tank site. This would have impacted many Redwood and Coastal Oak trees in the vicinity. The preferred engineering Alternative 2 includes a new dedicated fire flow service from MMWD, removing the requirement for the fire flow storage. This alternative was preferred by Park and Marin Fire staff as it provides the full firefighting capacity of the MMWD system versus that which can be stored in a tank onsite.

#### **Potable Water / Water Quality**

Poor water quality exists due to a large storage piping volume relative to water usage that exists with the long distance between MMWD treatment facility and the points of use. The long hydraulic residence time in the system, conditions made worse within the existing tank, is contributing to poor water quality and requires operators to routinely conduct significant flushing of the system and maintain the tank partially full to maintain chlorine residuals. Flushing is labor intensive and expensive since the Monument pays for water by the gallon from MMWD and the State of California has been experiencing a prolonged drought of 10 years. As such, the Park is working diligently to eliminate excess water usage and waste. Having to flush a system within a drought prone region is bad practice and creates a poor perception with the public regarding good water conservation practices.

Water quality would be improved without the storage tank by reducing hydraulic residence time within the system. There is potential for water quality to remain an issue under the preferred engineering alternative, as recent water quality analysis modeling has been performed using water quality characteristics obtained from current water sampling. Modeling shows that an additional disinfection system should be installed for low demand periods of the year. MMWD uses chloramines as a water disinfectant intended to be the final disinfectant treatment that meets minimum chlorine residual levels to the downstream user.

#### **NEED FOR WASTEWATER/SEWER LINE REPLACEMENT**

##### **Deteriorating System**

The existing wastewater line is deteriorated requiring high levels of maintenance.

The existing manholes are at the end of their life-cycle and have not been rehabilitated since installed. They show evidence of infiltration with vegetation growth in cracks of the concrete.

##### **Outdated Design**

Around 1989, the sewer mains upstream of Manhole #13 were slip lined with 5" inside diameter HDPE pipe, reducing interior diameter and capacity of the system. There are no as-built drawings or calculations to support the reduction in size of the sewer main. With the inside diameters of the piping

established sewer hydraulic modeling has been performed that indicates the system has plenty of capacity for current use along the northern portion of collection system to be re-utilized/rehabilitated. Review of closed caption television video (CCTV) performed on the Northern portion of the system to be rehabilitated in 2008 shows piping generally to be in good condition with isolated defects of a moderate level and confirms the limits of its installation within the existing system. The remainder of the system is shown to be undersized for current needs.

### **Unsuitable Location**

The northern section discussed above is delineated by the Visitor Center. The portion of the existing wastewater collection system south of the visitor center is in close proximity to Redwood Creek making it susceptible to erosion or scour from flood flows. Relocation of the wastewater line would ensure it is safe distance from Redwood Creek and would safeguard public health and protect water quality important to sensitive natural resources including Coho salmon, and steelhead trout. Eighty percent (80%) of the wastewater collection system that runs parallel to the Redwood Creek is in a critical risk area for future exposure and damage due to the changing creek watershed if all creek riprap was removed. Several sections of the gravity sewer main are within feet of the current Redwood Creek bank and there are several locations where the sewer main is exposed having no cover over the piping. Nearly the entire gravity sewer main located upstream of Manhole #13, situated adjacent to the lower parking area, is located within the channel migration and erosion hazard zone. (Site Planning Study Report)

## **Objectives**

A successful project would achieve the following objectives:

### **PROJECT OBJECTIVES**

<b>Water Service (Water Line)</b>	<b>Wastewater (Sewer Line)</b>
Provide reliable, code compliant water system with most resilient fire protection and highest potable water quality.	Relocate sewer line infrastructure to provide sewer separation located at an environmentally safe distance from Redwood Creek to help safe guard public health and protect sensitive natural resources including Coho salmon, and steelhead trout may be negatively affected by Sewer System Overflow (SSO).
Rehabilitate and/or replace waterlines without the storage tank infrastructure to provide adequate fire flow demands.	Maintain current sewer alignment within the greater surrounding critical infrastructure such as the visitor's center and the boardwalk where the National Park Service (NPS) has significant interest in preserving these existing infrastructures and avoid adding an additional lift station.
Reduce the amount of operation and maintenance by removing storage tank, which would eliminate the need for hand dosing disinfection requirements and time to perform flushing of water to maintain quality.	Maintain current sewer alignment outside but within proximity of areas scheduled for upcoming infrastructure improvements where NPS has significant interest in adding infrastructure with sewer facilities.
Remove the need to flush significant quantities of water to maintain water quality.	

## Scope of Environmental Assessment

Although there are a number of projects being considered in the Muir Woods area, this EA is limited to those actions described in Chapter II – Alternatives. This project is related in geographic area, but not connected to the projects described in the cumulative effects section described in Chapter III.

The actions described herein:

- do not trigger another action;
- can proceed independent of other actions occurring;
- is not interdependent on the implementation of any of the projects described in the cumulative effects section (Chapter III);
- and does not depend on any of the projects described in the cumulative effects section (Chapter III) for its implementation;

The actions described herein meet the "independent utility" test in that it could be implemented with or without the implementation of any other project taking place in the Muir Woods area.

## Land Management Guidance Document

The Record of Decision for the Golden Gate National Recreation Area and Muir Woods National Monument Final General Management Plan / Environmental Impact Statement provides comprehensive direction for resource preservation and visitor use and a basic foundation for decision making for Golden Gate National Recreation Area and Muir Woods National Monument for the next 20 years. The plan prescribes the resource conditions and visitor experiences to be achieved and maintained over time. A review of the purpose, significance, and special mandates for the park and monument clarifies relevant law and policy requirements (NPS 2014a). This EA is consistent with the General Management Plan.

## Project Area

Muir Woods National Monument is dedicated to preserve the native character and ecological integrity of the old-growth redwood forest for its scientific value and inspiration (NPS 2015b). It preserves the last remnant old-growth redwood forest near San Francisco. The establishment of the monument is an important demonstration of early 20th century conservation history and continues to inspire stewardship actions today (NPS 2015b).

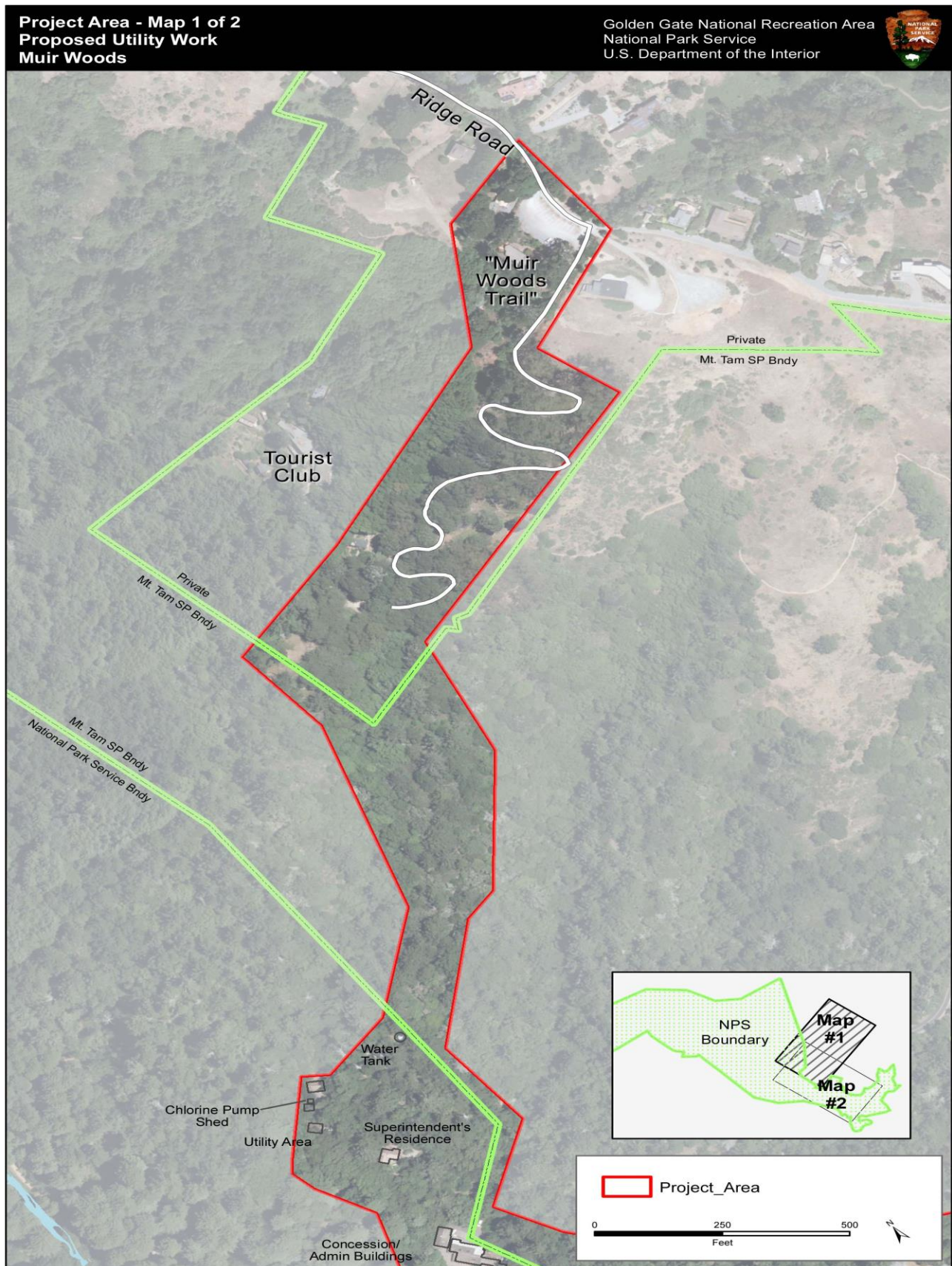
The area of analysis includes from the point of the MMWD connection at the Tourist Club, Mt. Tamalpais State Park land west of the Tourist club, and from the existing tank site above the historic Superintendent's Residence to the southern end of the monument. Although the total project area is approximately 32 acres, actual ground disturbance from construction activities and staging would be approximately 2 acres (see Project Area maps in Figures 1 and 2 below).

## Scoping and Public Involvement

Public scoping was open from February 24 to March 17, 2017 through a notice posted on the NPS Planning, Environment, and Public Comment (PEPC) website. The park received comments from three local residents and three Bay Area organizations. The majority of comments had to do with potential conflicts with other proposed Muir Woods and county projects, potential impacts to Tamalpais Community Services District, and local MMWD water users. Commenters also provided input on issues concerning resource impacts, including recommended avoidance and mitigation measures.

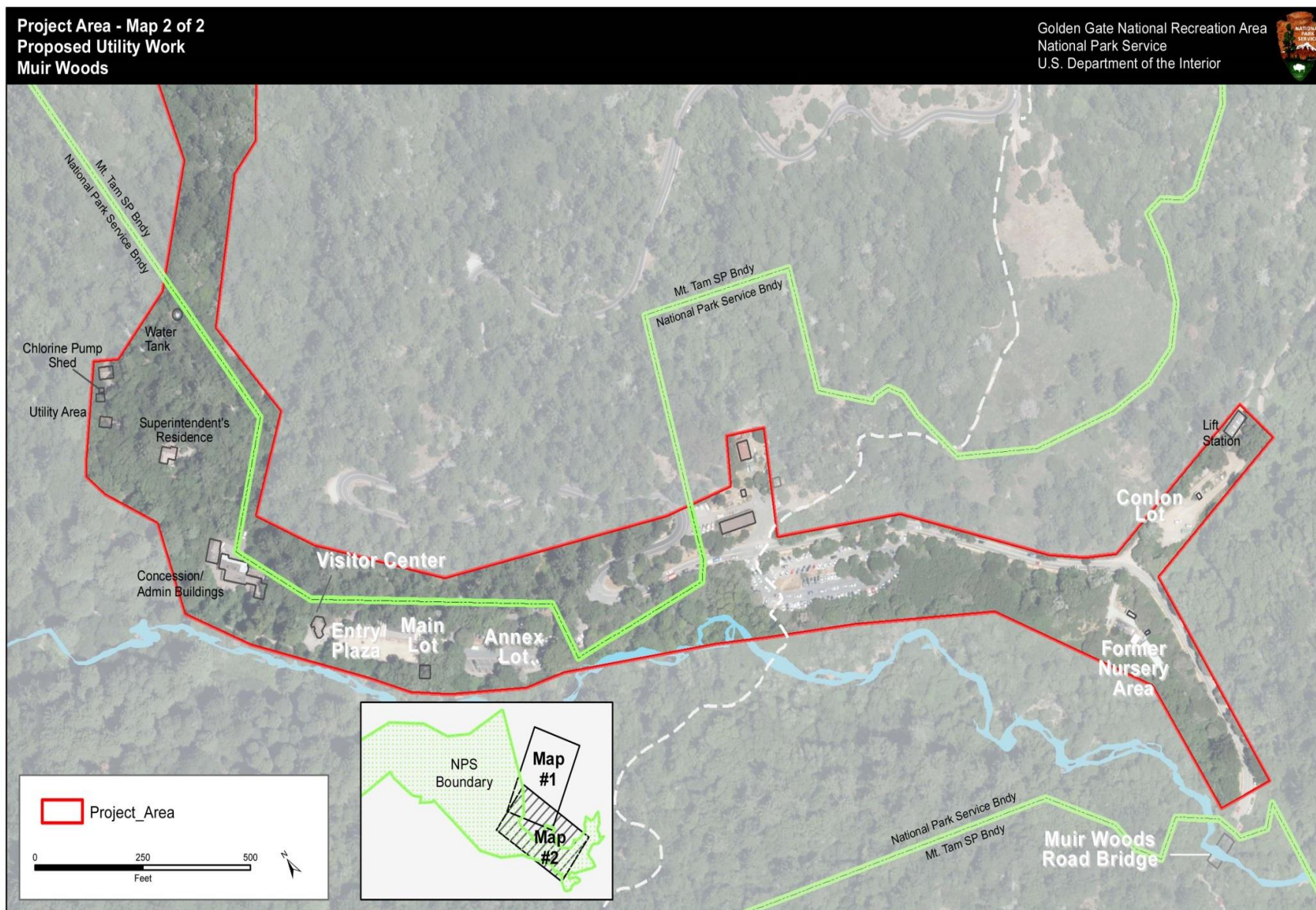


FIGURE 1. PROJECT AREA - MUIR WOODS, MT. TAMALPAIS SP, TOURIST CLUB





**FIGURE 2. PROJECT AREA - MUIR WOODS DEVELOPED AREA, MT. TAMALPAIS SP**



## Impact Topics

NEPA regulations require an “early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action” (40 CFR Part 1501.7). An issue describes the relationship between actions and environmental resources (natural, cultural, and socioeconomic). Issues are usually problems that either the no-action alternative or current situation has caused or that any of the proposed action alternatives might cause. They also may be questions, concerns, problems, or other relationships, including beneficial ones.

Impact topics are resources or values analyzed for each of the alternatives and are discussed because issues have been identified. During internal scoping, NPS staff identified potential issues that could result from implementation of the action alternatives. Resources or values that could be affected include: visitor use and experience; transportation; geology and soils; vegetation; water quality; threatened and endangered species; cultural resources; and climate change. The impact topics identified during scoping are discussed and analyzed in greater detail in “Chapter 3: Affected Environment and Environmental Consequences.”

### Impact Topics Retained for Further Analysis

Impact topics are the resources or values of concern that could be affected, either beneficially or adversely, by the proposed alternatives. The following impact topics are analyzed in this EA:

- Cultural Resources
- Geology and Soils
- Soundscapes
- Wildlife and Habitat
- Threatened or Endangered Species
- Water Resources and Hydrologic Processes
- Vegetation
- Visitor Use, Experience, and Safety
- Transportation and Parking

### Impact Topics Considered and Dismissed from Further Consideration

In accordance with CEQ regulations 1500.1(b) and the *NEPA Handbook* (NPS 2015a), the National Park Service determines whether impact topics are evaluated in detail or dismissed from further evaluation to concentrate on the issues of concern. This section provides an evaluation and explanation as to why the National Park Service dismissed the following impact topics from further consideration. Impact topics are dismissed from further evaluation if they:

- do not exist in the project area
- would not be affected by the alternatives or the likelihood of impacts are not reasonably expected
- would result in impacts that, through the application of mitigation measures, would be minimal, and

- there is little controversy on the subject or few reasons to otherwise include the topic

### **Air Quality**

Section 118 of the Clean Air Act requires the National Park Service to meet all federal, state, and local air pollution standards (42 USC 7401 et seq.). The project would not increase vehicle trips to the monument, and all alternatives include the same number of available parking spaces. Implementation of either action alternative would result in localized emissions and fugitive dust at the monument during construction activities; however, emissions and fugitive dust would occur only during the construction period and would dissipate quickly. No long-term impacts on air quality are expected. Furthermore, air quality data recorded between 2004 and 2013 has shown improved conditions at the monument. Therefore, the topic was dismissed from further analysis in this document.

### **Environmental Justice**

Executive Order 12898, “General Actions to Address Environmental Justice in Minority Populations and Low-income Populations”, requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. Disproportionate health or environmental effects on minorities or low-income populations or communities as defined in the US Environmental Protection Agency’s *Environmental Justice Guidance* (1998) would not occur from the construction activities under the action alternatives. Therefore, this topic was dismissed from further analysis in this document.

### **Dark Night Skies**

In accordance with NPS *Management Policies 2006*, the National Park Service strives to preserve dark night skies and would “minimize light that emanates from park facilities, and also seek the cooperation of park visitors, neighbors, and local government agencies to prevent or minimize the intrusion of artificial light into the night scene of the ecosystems of parks” (NPS 2006). No construction activities would occur at night and no permanent area lighting or lamp posts of any kind would be installed. Therefore, the topic was dismissed from further analysis in this document.

### **Indian Trust Resources**

In accordance with the Environmental Compliance Memorandum 97-2 by the US Department of the Interior, the National Park Service must ensure that it explicitly addresses any anticipated effects on Indian trust resources in an environmental compliance document. If any effects are identified, the National Park Service must consult with the affected tribe(s) on a government-to-government basis with respect to the impact from the proposed project or action. However, if the project or action is expected to have either an insignificant impact or no impact on any Indian trust resources, the environmental compliance document must state the reason for dismissal. Since no Indian trust resources exist in the project area, the topic was dismissed from further analysis in this document (NPS, Terzis, pers. comm. 2016a).

### **Indian Sacred Sites**

In accordance with Executive Order 13007, the National Park Service must accommodate access to, and ceremonial use of, Indian sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of such sacred sites. Continued access to, and use of, these sites is often essential to the survival of family, community, or regional cultural systems, including patterns of belief and

sociocultural and religious life. However, no Indian sacred sites are found in the project area (NPS, Terzis, pers. comm. 2016a). Therefore, the topic was dismissed from further analysis in this document.

### **Socioeconomics**

Construction activities associated with the action alternative would not adversely affect local businesses or other agencies. However, a decision to make sustainable access improvements would provide beneficial impacts on the local economy as a result of minimal increases in employment for the construction workforce and revenues for the businesses engaged in the construction process. Any increase in workforce and revenue, however, would be temporary, lasting only as long as construction. Because the impact on the socioeconomic environment would be minimal, this topic was dismissed from further analysis in this document.

### **Visual Resources**

The NPS *Management Policies 2006* state that the monument's scenery and scenic features are included among the resources and values to be protected and conserved unimpaired for enjoyment by current and future generations. Visual impacts from construction activities would be short term and localized. There would be negligible long-term visual impacts following construction since most of the rehabilitation would be underground. Therefore, this topic was dismissed from further analysis in this document.



## CHAPTER II

# Alternatives

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## Introduction

This environmental assessment analyzes two alternatives, a no action alternative and one action alternative. Under the action alternative, several other alternatives for providing potable water were considered, but not carried through for full analysis.

## Alternatives

### Alternative 1: No Action

#### Water and Wastewater Services/Current Management

A no action alternative is defined as either “no project” or a continuation of existing conditions and management. The existing condition and management of the water and wastewater service include the current underground water and wastewater pipe and alignment, related infrastructure, and existing storage, collection, and distribution systems.

Under the no action alternative the only source of potable and fire water to the Monument would continue to be the 60+ year old steel 1.5-inch diameter pipe. No new infrastructure would be installed nor would any existing infrastructure be removed. The existing fire storage code-deficient steel water tank would remain in service. However, it would eventually need to be decommissioned as the effects of hand dosing with chlorine is causing the steel to rust and deteriorate. Resulting in the loss of fire protection in the Monument as the 1.5” steel line cannot provide fire flows on its own. The volume of water in the storage tank would remain at about 20,000 gallons which is only half of the possible 40,000 gallons of storage available. Volume is kept at 20,000 gallons to reduce the amount of water needed to be flushed to maintain water quality. Operators would continue to hand carry buckets of chlorinated water to the tank and hand chlorinate the water as needed. Water would continue to be flushed as needed to maintain water quality. Within the Monument, fire and potable water would continue to be supplied from the same 6” main distribution pipe, which is all supplied by the existing 1.5” steel line through the Tourist Club and State Park lands. The large volume of water stored in the 6” diameter pipe in the Monument is another source of water quality issues.

Under the no action alternative for the wastewater the main components of the gravity collection system would remain in the Redwood Creek Migration Zone. No new pipe or manholes would be installed. Existing pipeline route remains adjacent to the Northern edge of the Redwood Creek. Back-ups in the system due to insufficient pipe size and capacity would continue to threaten Redwood Creek. Infrastructure could become exposed and/or undermined at the creeks edge leading to a failure and contamination of the creek. Periodic flushing of the collection system to clear accumulation before they become blockages would continue (see Figure 3 for existing water and wastewater service lines that would be maintained under the No Action Alternative).

## Alternative 2: Preferred Action Alternative

### Water Service (Water Line Rehabilitation)

#### *Summary of Actions*

Remove existing water tank and provide new 6" domestic service connection from MMWD; construct single 6" water main down hillside to connect to existing 6" water main; separate fire flow water main from domestic water main at road below tank site. Install supplementary disinfection pump in existing shed to be rehabilitated. The shed is located amongst the existing storage buildings below and northwest of the Superintendent's Residence.

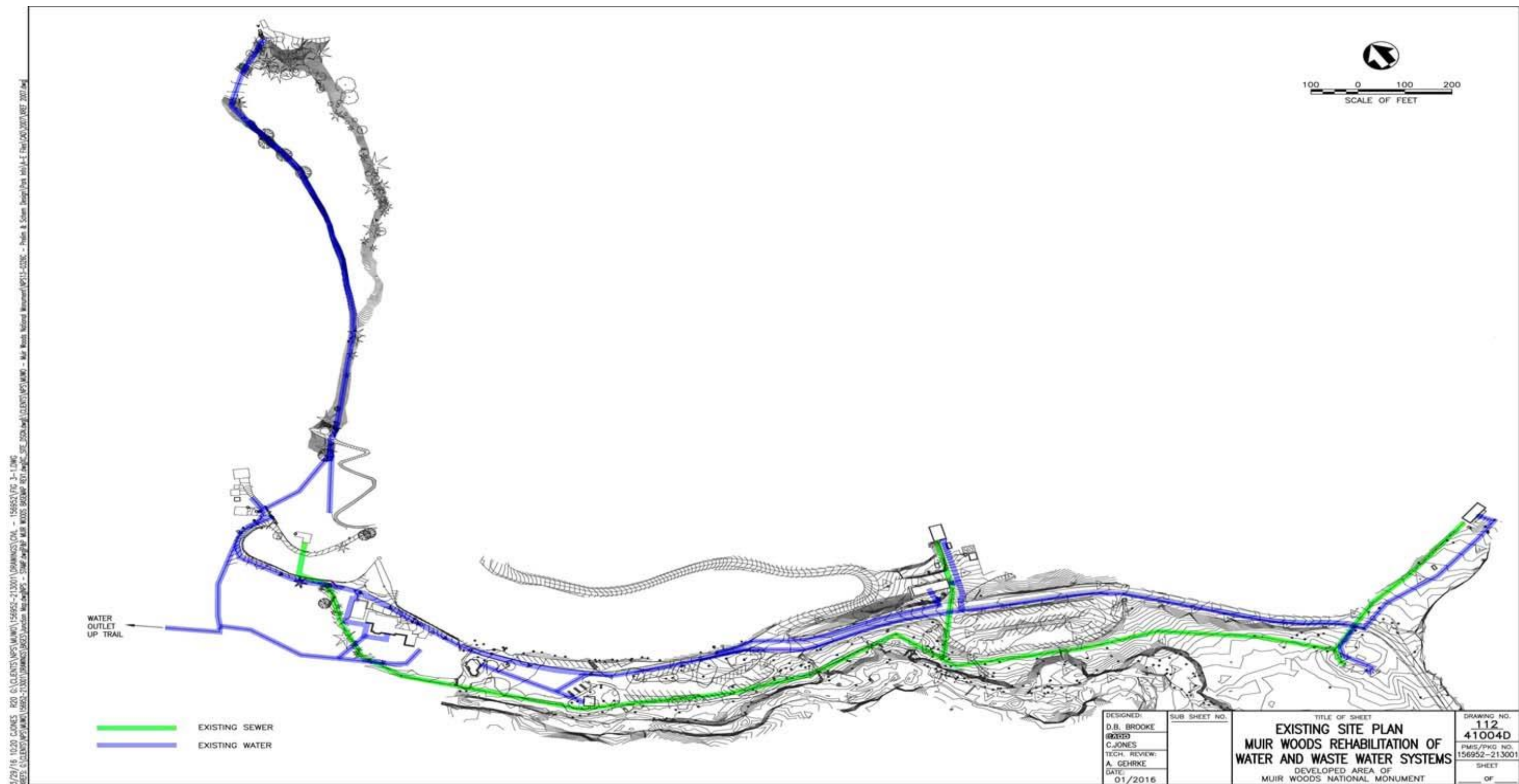
MMWD recently completed a construction project to replace the 2" galvanized steel pipe that extends down the hillside from a water main on Ridge Avenue with approximately 1,100 lineal feet of 6" welded steel pipe. With this project completed, MMWD now has a new 6" main ending at approximately the location of the existing service connection meter. The project would replace the existing MMWD domestic service connection and upgrade from a 1" to a 6" domestic water meter that would be used to supply all water needs, including domestic and fire flows. A 2" or larger domestic water meter would require a demand calculation and special approval by MMWD. This service connection would not be classified as a 6" fire service connection because dedicated fire service connections cannot be used for domestic potable water uses. Also, MMWD policy does not allow, without special permission, a fire service connection to be used to fill a storage tank, even if the tank is dedicated for fire storage. A fire service uses a bypass meter, not a regular water service meter, so volume used for fire flow needs is not tracked and billed the same way as a domestic service.

Downstream of the new 6" MMWD domestic water meter, a new 6" Pressure Reducing Valve (PRV) station, new backflow assembly, and an 8" HDPE water main would be constructed down the hillside to the location of the existing 40,000 gallon tank. The tank would be removed and another 6" PRV station with pressure relief valve would be constructed at this location. The 8" HDPE water main would be extended from the lower PRV station to the connection point with the 6" water main that was constructed between 2004 and 2006 (approximately 80 feet from tank pad).

In order to eliminate aged and poorly functioning system components; reduce the amount of operation and maintenance by removing tank; reducing disinfection requirements; and to remove the need to flush significant quantities of water to maintain water quality, replacing the water line includes the following elements (see Figures 4 and 5) for the proposed Rehabilitated Water Line under Alternative 2) :

- Establish a new easement for a new water line corridor coordinated with and Mount Tamalpais State Park and the Tourist Club.
- Replace existing 2" water pipeline with a 8" high-density polyethylene (HDPE) water line (Interior Diameter (ID) of pipe is 6") to connect domestic water service to the Marin Municipal Water District (MMWD) system at the Tourist Club and with MMWD approval upgrade the current 1" domestic water meter to a 4" meter to supply all water needs, including domestic and fire flows.
- Remove the existing 40,000 gallon water tank and replace with a 6" Pressure Reducing Valve (PRV) station (during construction, the water tank would remain in service to reduce system outages/shut downs) to reduce pressure from approximately 176 psi to 20 psi.

FIGURE 3. EXISTING WATER AND WASTEWATER CONFIGURATION



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- Construct backflow assembly at the point of connection to MMWD.
- Extend the 8" high-density polyethylene (HDPE, ID= 6" ) water main pipeline downhill in new easement from the MMWD service connection on the Tourist Club Road to the new PRV station to reduce system friction loss and meet fire flow requirement.
- Extend the 8" water main from the PRV station to an existing 6" water main, approximately 80 feet from the tank pad
- Construct a 2" domestic service connection with NPS water meter at the paved access road below the former tank site. The domestic water main would be separated from the fire main at this point, with the existing 6" water main becoming a dedicated fire main
- Construct 2" HDPE domestic water main from NPS water meter to the existing 2" water main in the entry plaza and reestablishing all domestic water services within. Separate all domestic water services from the 6" fire main since it would now be classified as a non-potable, dedicated fire main. Maintain minimum horizontal separation requirements between new domestic main and sewer mains
- Install secondary chlorine analyzer at end of use point located inside the maintenance building to determine in-line supplemental dosing of upstream injection pump
- Extend 6" fire main approximately 500 feet from existing end fire hydrant to maintenance building using 8" HDPE (this is not required for fire code compliance and may not be included with this project depending on funding)
- For improved life safety, the NPS Fire Marshal along with Marin County Fire officials, who are the first responders, both support a municipal supply fire service, which is by definition a supply service without dependency on a limited storage tank supply volume

The existing waterline is only 2" in diameter and is heavily tuberculated (constricted on the inside) therefore it cannot be pumped full of concrete and would be abandoned in place. Accessing the site to remove the pipe would be far more invasive to the environment than abandoning it in place and capping both ends.

Telecommunications - A telecommunications conduit would be installed along the same route as the new sewer line to provide telecommunications to the Maintenance Area. This would be connected to the conduit installed with the 2" potable waterline to provide one continuous conduit system from the Superintendent's Residence to the Maintenance Area for telecommunications. Conduit would not be installed through the Annex Lot to the lift station area nor along the boardwalk.

### ***Construction Timing and Methods***

The project is estimated to begin in the summer of 2018 and completed by the winter of 2018. The contractor would be required to present and obtain approval for traffic and pedestrian control plans within the monument and adjacent lands as necessary. The project would make use of a main storage area and "rolling" staging areas near the active work site. The new parking reservation system for Muir Woods would be in operation when this project begins. As part of that contract there a minimum number of parking spaces that must always remain open. This project would allow partial closures and re-routes of parking lots while maintaining this minimum number of parking spaces accessible access would be maintained throughout the project.



FIGURE 4. ALTERNATIVE 2 PROPOSED WATER LINE TOURIST CLUB, MT TAMALPAIS SP

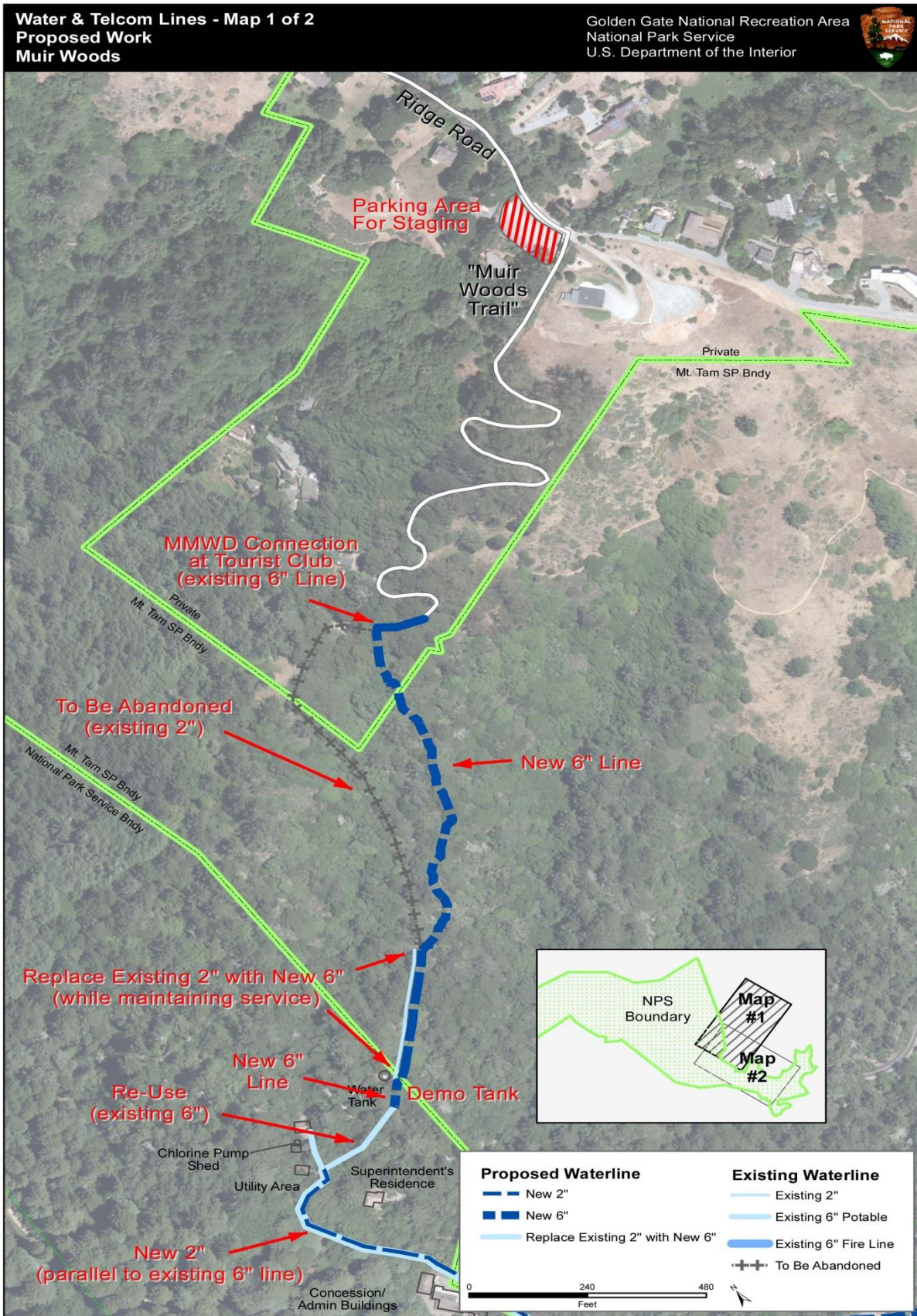
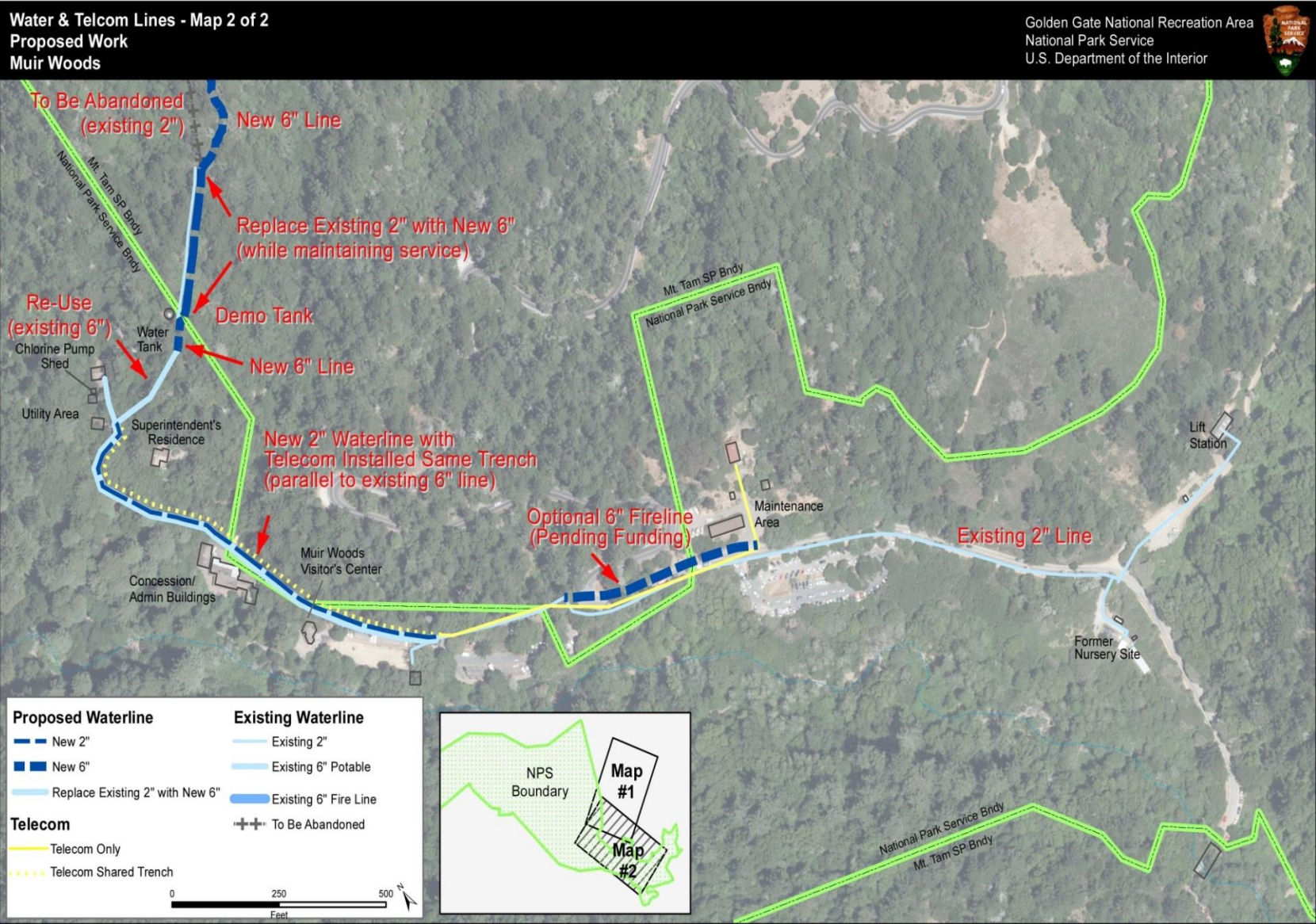




FIGURE 5. ALTERNATIVE 2: PROPOSED WATER LINE IN MUIR WOODS AND MT. TAMALPAIS STATE PARK399



Construction activities, including pipe installation, staging, stockpiling, and transport of materials would take place on California State Parks and Tourist Club land. This includes the installation of a new water system connection in an MMWD easement on Tourist Club Land. The NPS would obtain Right-of-Entry construction permits and easements from the Tourist Club and State Parks for the sections of pipeline that would be installed on their properties. The NPS would conduct an investigation of the land prior to obtaining the easements.

Below is a description and anticipated schedule, by land management section, for replacing the Water line.

#### Tourist Club and State Park Land

##### *Removal of existing Water Tank (2-3 weeks).*

The new waterline would enter Muir Woods adjacent to the existing waterline where it currently connects to the existing steel water tank. A Pressure reducing station would be installed to reduce the high pressure gained by coming down the hill from the Tourist Club. The new waterline would then travel approximately 80 feet beyond the existing water tank and tie into an existing 6" water main serving the Monument. Once the new pipeline is online the tank would be removed and the site would be prepared for revegetation.

As the project approaches the Tank site, the staging area would move to the hardscape surface area near the existing garages and former Superintendent's Residence. Material and equipment would be stored here while work proceeds in this area.

Equipment to be used is at the discretion of the contractor as long as the contractor can meet the constraints placed upon the work. However, the equipment anticipated to be used in this area would be mini size excavators, haul carts (e.g., Wacker DW50), a skid steer, sheeps foot or whacker for compaction, HDPE pipe welder. The skid steer and/or mini-ex would perform the trench excavation with a spotter watching for roots. If roots are encountered hand digging would commence.

##### *New two inch potable waterline. (4-5 weeks)*

In addition, to replacing the existing deteriorated water supply pipe to the Monument this project also addressed water quality issues experienced at the Monument. Smaller diameter pipes store less water which increases water turnover and promotes better water quality. Below the existing tank site, the existing 6" pipe would be disconnected and a new 2" potable waterline would be connected. A cross-connection control device (CCCD) would be installed to separate the 6" waterline from the 2" potable water line. The 6" line would be disconnected from all potable services throughout the Monument and become a dedicated fire line from the CCCD on. The new 2" potable water line would be routed through a supplemental disinfection station that can provide supplemental disinfection to the water during periods of low water quality. The disinfection pump would be housed in an existing shed that would be rehabilitated and is located below and northwest of the Superintendent's Residence. The new 2" potable line would continue to be installed below the existing asphalt admin road running from the Superintendent's Residence behind the concession and administration buildings to the entry plaza. This new 2" line would then connect with an existing 2" potable water line that conveys water to all of the facilities south of the main parking lot. All potable services disconnected to the existing 6" line would be



connected to the new 2" potable line. To maximize efficiency and resources a new telecommunications conduit would be installed along with the 2" potable water line. This is to support the Parks effort to remove all overhead wiring in the Monument. The potable line would be shifted from the road corridor and accessible parking area to just off the edge of the pavement and into the entry plaza to allow accessible parking to remain open and access for staff and deliveries to the concession begin again. Upon completion of installation the road asphalt and other surfaces would be returned to previous conditions or repaired.

While working in this area the staging area would be the hardscape surface area near the existing garages and former Superintendent's Residence. Material and equipment would be permitted to be stored here while work proceeds in this area. Staging would also be permitted behind the administration building where there is currently parking for concession and NPS staff. As the work approaches the visitor center and entry plaza area staging would be allowed along a portion of the entry plaza with fencing protecting visitors from construction activity.

Equipment to be used is at the discretion of the contractor as long as the contractor can meet the constraints placed upon the work. However, the equipment anticipated to be used in this area would be excavators, mini size excavators, haul carts, a skid steer, soils compactor, HDPE pipe welder, pick-up trucks, and pavement equipment for trench patching, Four-wheel drive utility Vehicles, pavers, saws, concrete pumps. The skid steer and/or mini-ex/excavator would perform the trench excavation with a spotter watching for roots. If roots are encountered, digging around the roots would be by hand.

#### NPS Land

After the pipeline exits State Park land, the pipeline then proceeds through a route, approved by NPS and State Parks, until it reaches the Monument's administrative area. Check dams would be installed along the pipeline route to mitigate water conveyance along the pipe route.

### **Wastewater (Sewer Line Replacement)**

#### ***Summary of Actions***

In order to eliminate aged and poorly functioning components; relocate sewer line infrastructure to provide sewer separation located farther from Redwood Creek to help safe guard public health and protect sensitive natural resources including Coho salmon, steelhead trout, and California red-legged frogs; and to maintain current sewer alignment within the greater surrounding critical infrastructure such as the visitor's center and the boardwalk where the NPS has a significant interest in preserving these cultural resources, the new waste water lines would include the following wastewater elements for **Zone 1A** (see Figures 6 and 7 for Proposed Configuration of Wastewater Lines and Zone Elements)

- Pipe burst (a method of inserting pipe without excavating) existing 6" sewer main located between road corridor up by NPS residence down to the Muir Woods Visitor's Center with 8" HDPE then open cut trench install new 8" sewer main over to road corridor to connect with Zone 2 sewer improvements.
- Rehabilitate or replace 5 manholes; and install 1 new manhole
- Perform spot repairs to address pipe sags.

- Install approximately 205 linear feet of 8" PVC sewer main from manhole at Visitor Center to connection to zone 2
- Maximum bury depths of approximately 6 feet in the 8" PVC gravity sewer main
- Abandonment in place of existing gravity sewer main downstream of visitor's center to entry plaza comfort station

The following are wastewater elements for **Zone 2**:

- New sewer main located in same road corridor as water main. Provide new lateral connection to Lower Comfort Station
- Install approximately 8 manholes
- Install approximately 989 linear feet of 8" PVC gravity sewer main
- Maximum bury depths of approximately 14 feet in the main road below the NPS Maintenance building.
- Abandonment in place of existing gravity sewer main except portion used for connection to Lower Comfort Station.

The following are wastewater elements for **Zone 3B**:

- New sewer main located though portion of Lower Parking Lot to connect to existing sewer main alignment with pipe bursting to upsize to 8" main to Lift Station #1
- Provide new lateral connection to existing NPS Maintenance building and residence.
- Install approximately 2 manholes.
- Install approximately 700 linear feet of 8" PVC gravity sewer main.
- Install approximately 400 linear feet of 8" HDPE pipe bursting to upsize existing 6" gravity sewer main.
- Maximum bury depths of approximately 7 feet in the Annex lower parking lot.
- Abandonment in place of existing gravity sewer main.

**Note:** During trenching and asphalt repairs for the new water and wastewater systems, the project includes installation of telecommunication conduits, pull boxes, and cable. The installed conduit would terminate in a box at the exterior of each building to receive telecommunications in a later project to rehabilitate the current Muir Woods telecommunications system.

Existing wastewater infrastructure along the creek would be abandoned in place by pumping the pipes full of low strength concrete slurry. The manholes would also be filled with the same material. The manhole lids would then be sealed and marked "ABANDONED." This infrastructure would not be removed at this time as the possible impacts to the creek outweigh the benefits of removal. The pipe can be removed at a later time if it becomes exposed and is a threat to the creek.



FIGURE 6. ALTERNATIVE 2: PROPOSED REHABILITATED WASTEWATER LINE CONFIGURATION

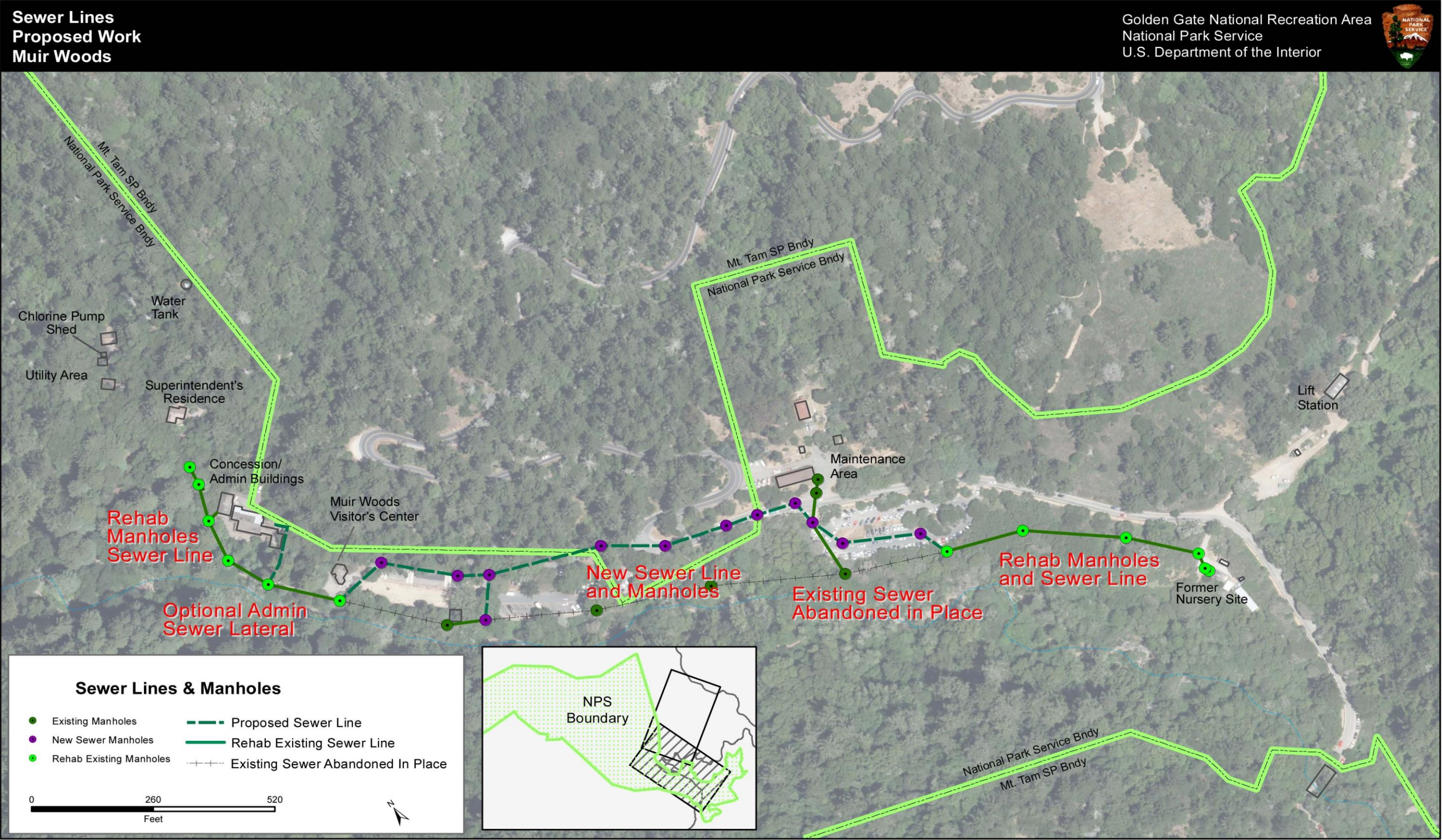
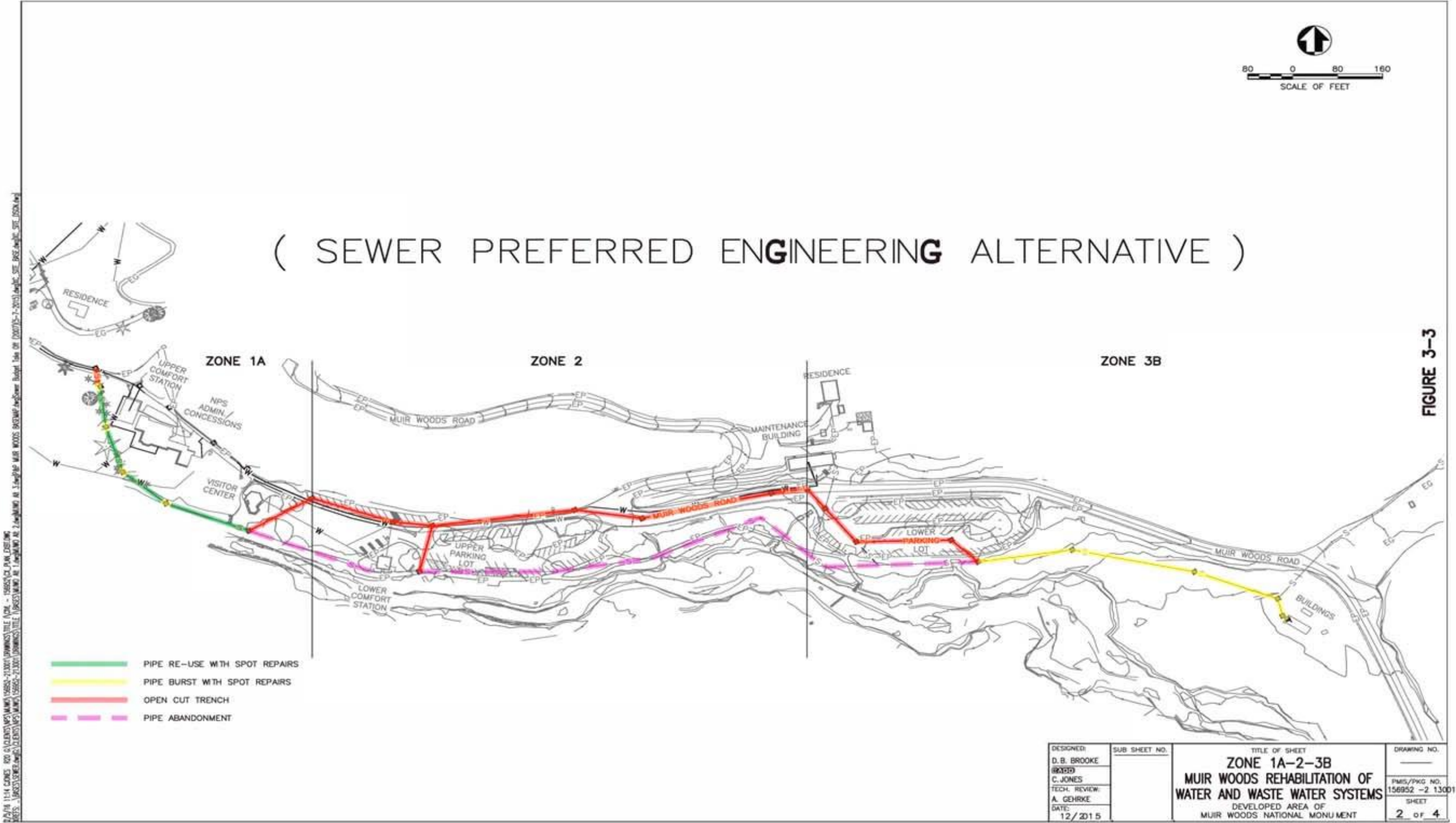




FIGURE 7. ALTERNATIVE 2: PROPOSED REHABILITATED WASTEWATER LINE ZONE ELEMENTS



### ***Construction Timing and Methods***

Construction activities, including pipe installation, staging, stockpiling, and transport of materials would take place on Marin County Roads and Muir Woods Road. This includes the installation of new manholes and gravity sewer conveyance pipe beneath the road. The NPS would comply with all County requirements for obtaining and maintaining access to this infrastructure. Construction is anticipated to begin in the summer of 2018 and be completed by the winter of 2018. All constraints stated previously would apply throughout all project actions. Rehabilitation of the wastewater lines for each of the following sections is described below with approximate project duration.

#### **Annex Parking Lot and South to the Lift Station (3-4 weeks)**

New Manholes and sewer pipe would be installed through the Annex lot to tie into existing sewer system infrastructure south of the annex lot. The pipes south of the annex lot would be replaced using open trench methods up until the Buckeye trees are encountered. At that point trenchless pipe bursting technology would be used to increase the size of the pipes. This would be done to protect the roots of the Buckeyes. The new sewer pipe and manholes would be installed in the annex parking lot with open trenching and excavation. The parking lot would be trench patched upon completion. To maintain the minimum number of required parking spaces only a portion of the Annex Lot would be closed to perform this work. Temporary striping and traffic control would be required as needed. All ground disturbances from where the sewer line leaves Muir Woods/Frank Valley Road and enters the Annex Lot through to the lift station would be monitored for potential subsurface archeological deposits due to the potential for buried deposits in this area.

The manholes installed in the Annex Lot would be of a type that allows for easy raising and lowering of the top through use of pre-fabricated collars. This would be done to allow the SAP project to adjust the heights of manholes to the new finished grade while the parking lot is rehabilitated in 2019. This is best practice and is preferred over building the parking lot and then having to cut the new asphalt and trench through the new base and sub base material parking lot.

While working in the Annex Parking lot the staging area would be the closed portion of the annex parking lot.

#### **Muir Woods Road (3-4 weeks)**

Sewer installation in the south bound lane of Muir Woods Rd and until entering the Main Parking lot entrance. One-way traffic control would be required during this portion of work. The new sewer pipe and manholes would be installed in Muir Woods Rd. with open trenching and excavation. The road would be trench patched upon completion.

While working along Muir Woods Rd the staging area would be either the Entrance area of the Main Parking Lot or the Annex Lot. This would be determined based on the needs of the contractor and the field constraints at the time of construction. However, minimum parking would always be maintained.

### Main Parking lot to Visitor Center (3-4 weeks)

Once within the Main Parking lot the entrance would be closed and parking would only be permitted on the western side of the main parking lot with entrance and exit permitted through the current parking lot exit. Temporary striping and traffic control would be required as needed. The sewer line would be installed off of the accessible parking/admin road pavement so that these can remain open during construction. As the new sewer line approaches the Visitor Center, it would turn west and connect to the existing system at a manhole located at the base of the flagpole. The new sewer pipe and manholes would be installed with open trenching and excavation. The road would be trench patched upon completion and the entry plaza surface would be rehabilitated.

While working through the main lot and pavilion area the staging area would be the main parking lot while maintaining access through the current exit to the admin road and accessible parking.

### Visitor Center to Upper Comfort Station (3-4 weeks)

From the visitor center on, the sewer system runs beneath the boardwalk. The park is committed to maintaining the boardwalk and other infrastructure in this area. Therefore this section of sewer pipe is not at risk of being exposed as the Redwood Creek is allowed to migrate. The sections downstream of this point (described previously) are in the Migration Zone and that is why the NPS is pre-emptively relocating those sections. The pipeline in this area is of adequate size and therefore only spot repairs would be made as necessary to address sags in the line. Manholes would be replaced due to deterioration of the existing manholes. During this portion of the work some of the boardwalk boards would have to be removed. Half of the boardwalk would remain open to the greatest extent possible. However, if it becomes too constrained to ensure visitor safety a re-route of pedestrian traffic would occur on existing established routes or pedestrian traffic would be controlled through the site. The staging area for the boardwalk portion of the work would be either a portion of the pavilion, or near the garage and Superintendent's Residence, as was used during the waterline portion of the project.

### **Equipment**

Equipment to be used is at the discretion of the contractor as long as the contractor can meet the constraints placed upon the work. However, the equipment anticipated to be used in this area would be excavators, mini size excavators, haul carts (e.g., Wacker DW50), a skid steer, sheeps foot or whacker for compaction, HDPE pipe welder, pick-up trucks, and pavement equipment for trench patching, Four-wheel drive utility Vehicles, saws, concrete pumps, pavers. The skid steer and/or mini-ex/excavator would perform the trench excavation with a spotter watching for roots. If roots are encountered hand digging would commence.

### **Schedule Summary**

Water and wastewater construction actions are anticipated to begin in the summer of 2018; approximately June 1, 2018. Work would be completed by the start of the rainy season or mid-November 2018. As required, vegetation removal would occur prior to nesting season, March 1, 2018. A SWPPP would be required on this project and the costs associated with carrying out that SWPPP

during rain events are very high. It is the goal of this project to start in the summer of 2018 and be completed by December 1, 2018 to minimize costs and potential unintended impacts to the creek due to large rain events. Work would be scheduled to avoid impacts within the Monument during the high visitation summer events to the greatest extent possible. Before Mid-August work would be constrained to the Tourist Club, State Park and Admin Areas, Muir Woods Road, the main Parking lot, Annex parking lot and boardwalk work would begin after mid-August. The boardwalk work would begin as late as possible but complete before Thanksgiving to avoid any high visitation periods and minimize impacts with boardwalk work.

Service must remain in operation with only minor interruptions for cut over to the new infrastructure. When work cannot be completed in a sequential order due to the above constraints service must remain and temporary provisions may be necessary but this would be minimized by detailed scheduling of the required tasks.

## Best Management Practices

There are many constraints to traditional construction methods at Muir Woods and Mt. Tamalpais State Park. Equipment access is limited by narrow access roads and working among forest. The forest floor is sensitive, due to both redwood root systems and understory vegetation. Visitor use is heavy within the park, and visitors use trails 7 days per week. Additionally, there are multiple biological constraints and work windows, including the salmonid spawning season, northern spotted owl (NSO) nesting season, songbird nesting season, and marbled murrelet (MM) nesting season.

The National Park Service places strong emphasis on avoiding, minimizing, and mitigating potentially adverse environmental impacts. To help ensure the protection of natural and cultural resources and the quality of the visitor experience, the National Park Service would implement the following Best Management Practices as listed below in Table 4 for all actions of the proposed Preferred Alternative 2.

**TABLE 1: BEST MANAGEMENT PRACTICES**

<b>BEST MANAGEMENT PRACTICES</b>
<b>GENERAL</b>
Clearly state all resource protection measures in the construction specifications, and instruct workers to avoid conducting activities outside the project area.
Hold a preconstruction meeting to inform contractors about sensitive areas, including natural and cultural resources.
Delineate construction zones outside of existing disturbed areas with flagging, and confine all surface disturbances to the construction zone.
Site staging and storage areas for construction vehicles, equipment, materials, and soils in previously disturbed or paved areas approved by the National Park Service. These areas would be outside of high visitor use areas and clearly identify them in advance of construction.

Require contractors to properly maintain construction equipment to minimize noise, and do not allow construction vehicle engines to idle for extended periods.

Remove all tools, equipment, barricades, signs, and surplus materials from the project area upon completion of the project.

Vehicles and equipment entering the Monument would be inspected for leaking oil and fluids. Any leaking vehicles or equipment would be required to be fixed before entering.

If necessary, all servicing of equipment done at the job site would be conducted in a designated, protected area to reduce threats to water quality from vehicle fluid spills. Designated areas would not directly connect to the ground, surface water, or the storm drain system. The service area would be clearly designated with berms, sandbags, or other barriers. Secondary containment, such as a drain pan, to catch spills or leaks would be used when removing or changing fluids. Fluids would be stored in appropriate containers with covers and properly recycled or disposed of offsite.

#### AIR QUALITY

To limit dust, criteria pollutants, and precursor emissions associated with project construction, the following Bay Area Air Quality Management District (BAAQMD)-recommended Basic Construction Measures shall be required:

Water all active construction areas with exposed soil surfaces (e.g., parking areas, staging areas, soil piles, graded areas, and unpaved access roads that have not been stabilized with soil binder, mulch, gravel, vegetation or other cover) sufficiently to prevent dust from becoming airborne.

All trucks transporting soil, sand, or other loose material offsite shall be covered.

Vehicle speeds on unpaved areas shall be limited to 15 mph.

Idling times for construction equipment (including vehicles) shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to 30 seconds, except for situations allowed under California's commercial vehicle idling regulations. California's Clear signage of this requirement shall be provided for construction workers at all access points to construction areas.

#### CULTURAL RESOURCES

All ground disturbance from where the sewer line leaves Frank Valley Road and enters the Annex Lot through the areas for the new lift and comfort station (as proposed in the Sustainable Access Project) would be monitored for potential subsurface archeological deposits due to the potential for buried deposits in this area. Any change in alignment from the main parking lot to the Annex Lot entrance from the current alignment within Frank Valley Road to the south would also be monitored, if necessary.

The Archeological site, CA-MRN-722H (the Annex Lot), would be avoided by routing the sewer line through the parking lot for the Annex Lot.

If buried cultural resources are inadvertently discovered during ground-disturbing activities, work shall



immediately stop in that area and within a 100-foot radius of the find until the Park Archeologist can assess the significance of the find. Inadvertent discoveries would be treated in accordance with 36 CFR 800.13 (Protection of Historic Properties: Post-review discoveries). The archaeological resource would be assessed for its eligibility for listing on the NRHP in consultation with the SHPO (and a Native American monitor from the Federated Indians of Graton Rancheria, if it is an indigenous archaeological site) and a determination of the project effects on the property would be made. Work within the area may not resume until the NPS Archeologist has determined all interested parties have been consulted and an appropriate mitigation strategy has been developed.

If human skeletal remains are encountered, all work shall stop in the vicinity of the discovery, and the find would be secured and protected in place. The Marin County coroner and Park Archaeologist would both be notified immediately. If a determination finds that the remains are Native American, and that no further coroner investigation of the cause of death is required, they would be treated in accordance with the Native American Graves Protection and Repatriation Regulations at 43 CFR 10.4 (Inadvertent discoveries). The coroner would also contact the NAHC (pursuant to Section 7050.5[c] of the California Health and Safety Code) and the County Coordinator of Indian Affairs.

#### GEOLOGY, MINERAL RESOURCES, AND SOILS

Avoid or minimize disturbance to soils as much as possible.

Evaluate existing topsoil for invasive, nonnative plant infestations.

Remove topsoil heavily infested with invasive, nonnative plants. Salvage non-infested topsoil, store according to soil conservation guidelines, and replace once construction is complete.

Implement erosion control measures that provide for soil stability and prevent movement of soils during rain events (i.e., silt fences and tarps).

Aerate any ground surface temporarily disturbed during construction and replant with native vegetation to reduce compaction and prevent erosion.

All BMPs from the SWPPP would be implemented as required by the Construction General Permit.

#### SOUNDSCAPE

Contractors would ensure that power equipment (vehicles, heavy equipment, and hand equipment such as chainsaws) is equipped with original manufacturer's sound-control devices. No equipment would be operated with an unmuffled exhaust.

Idling times for construction equipment (including vehicles) shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to 30 seconds as noted above under Air Quality.

Except when required for safety or to ensure the integrity of a project component, no work would be conducted on weekends or holidays. The hours specified in the Marin County Noise Ordinance would be

adhered to as general guidance: general construction would be limited to the hours of 7 am to 6 pm Monday through Friday and 9 am to 5 pm Saturdays; loud noise generating equipment operation would be limited to 8 am to 5 pm Monday through Friday.

#### THREATENED AND ENDANGERED SPECIES

Prior to any construction-related activities, a training session would be required for all contractors, partners, and NPS staff participating in Project-related activities in the Project area. Training would be conducted by a qualified biologist to familiarize personnel about sensitive resources in the Project area. Personnel would be provided with a brief life-history and physical description of Coho salmon, steelhead, NSO, MM, and other sensitive wildlife in the area. Training would include staff resource contact information, identification of sensitive resources, the limits of the work area, general BMPs, and appropriate actions to take upon encountering species status species or other wildlife. All attendees would sign an attendance sheet along with their printed name, company or agency, email address, and telephone number.

The contractor will be required to keep all waste and contaminants contained and remove them daily from the work site.

Within NSO habitat, disturbance to native trees greater than 10 inches in diameter at breast height would be avoided where feasible.

Within MM habitat, disturbance to native trees greater than 10 inches in diameter at breast height would be avoided where feasible.

#### VEGETATION

All on- and off-road vehicles, boots, equipment, and tools must be power washed to remove soil and plant fragments before entering GGNRA property to avoid spreading pathogens or exotic/invasive species. Equipment also must be cleaned when moving between work zones. NPS staff will inspect equipment upon arrival in the Monument and only allow clean equipment into the project area.

All boots, equipment, and tools must be disinfected using a 10% bleach solution, 70% isopropyl alcohol, or other NPS-approved disinfectant method prior to entering the site, as well as between work areas, to prevent pathogen spread.

NPS would identify invasive plants, particularly panic veldt grass (*Ehrharta erecta*), within the work and access route areas prior to Project implementation. A qualified vegetation ecologist or botanist would plan treatments to prevent the spread of invasive species, and implementation of these treatments would be under the supervision of a qualified vegetation ecologist or botanist. The final treatment prior to Project implementation would occur close to initiation of Project work.

Avoid working under the dripline of redwoods and coast live oak to the extent possible. Where that is unavoidable, use flexible materials to navigate the pipe above/below roots. Minimize all root cutting and do not cut any roots >1" diameter when working under the dripline of oaks and redwoods.

Because of the presence of large individuals of Buckeye (*Aesculus californicus*), the stretch of water line between the old Nursery site and the next manhole to the north will use the “pipe-burst” method rather than trenching to minimize any negative impacts on roots. The remaining stretches towards the annex lot may be trenched.

No Coast Redwood (*Sequoia sempervirens*) individuals may be removed, but small diameter Douglas fir (*Pseudotsuga menziesii*) (<6 inch DBH) may be cut within the footprint.

If possible, downed logs should be moved out of the project footprint rather than be cut.

Minimize disturbance to vegetation. Cut only the minimal amount of vegetation required to perform the task at hand.

Evaluate compaction both before and after work and de-compact using hand methods, if needed.

NPS would avoid impacts to special status and locally rare plants to the extent feasible. If the NPS determines that impacts could not be completely avoided, then Vegetation staff would collect seed and transplant unavoidable individuals prior to any construction.

A small patch of the rare species, California bottle brush (*Elymus californicus*) is present along and within the trail leading up to the water tank, and is likely to be impacted. Vegetation staff would collect seed and attempt to transplant imperiled individuals prior to any construction.

All areas disturbed by this project would be revegetated with native species grown in the park nurseries.

#### VISITOR USE, EXPERIENCE, SAFETY

Inform visitors in advance of construction activities via a number of outlets, including the monument’s website, various signs, the visitor center, and by bus and shuttle drivers.

Review the tour bus permit system to develop a process that requires a permit for all tour buses wishing to service the monument.

To the extent practical, schedule work to avoid construction activity and construction-related delays during peak visitation times.

Limit construction-related traffic delays resulting from work at pull-offs, within parking lots, and along Muir Woods Road to a maximum of 15 minutes in each direction.

Develop provisions for emergency vehicle access through construction zones.

#### WATER RESOURCES, WETLANDS, AND HYDROLOGIC PROCESSES

Implement best management practices for drainage and sediment control to prevent or reduce nonpoint source pollution and minimize soil loss and sedimentation in drainage areas. These practices may include, but are not limited to, silt fencing, filter fabric, temporary sediment ponds, check dams of

pea gravel-filled burlap bags or other material, and/or immediate mulching of exposed areas to minimize sedimentation and turbidity impacts as a result of construction activities. Use no plastic materials. Leave erosion control measures in place at the completion of construction to avoid adverse impacts on water resources, after which time NPS staff would be responsible for maintenance and removal.

#### WILDLIFE AND HABITAT

The following measures would be implemented to minimize potential adverse effects to non-federally listed nesting birds:

- To the extent feasible, and for large scale vegetation clearing, vegetation clearing would be conducted outside the landbird nesting season from March 1-July 31. Vegetation maintained at low stature, typically less than 8" in height would not need to be resurveyed prior to additional work.
- If vegetation clearing or ground disturbing activities commence between March 1 and July 31, a qualified biologist would conduct a survey for nesting birds within 5 days prior to starting work. If a lapse in Project-related work of 2 weeks or longer occurs, another focused survey would be conducted before Project work can be initiated.

If nesting birds are found, a buffer would be established around the nest and maintained until the young have fledged. Appropriate buffer widths are 300 feet for non-listed raptors and 100 feet for non-listed passerines. A qualified biologist may identify an alternative buffer based on a site-specific evaluation. Work would not commence within the buffer until fledglings are fully mobile and no longer reliant upon the nest or parental care for survival.

#### STORMWATER

Preparation of a stormwater pollution prevention plan (SWPPP) is required for this project. Erosion control and sedimentation best management practices (BMPs) would be implemented per the SWPPP.

#### TRANSPORTATION AND PARKING

Post signs on Muir Woods Road warning traffic of the pedestrian crossing at the Conlon Lot both before the intersection and at the intersection (following the latest standards published in the Manual on Uniform Traffic Control Devices).

The contractor would be required to present and obtain approval for traffic and pedestrian control plans within the monument and adjacent lands as necessary.

Schedule work that affects parking to begin in mid to late august to avoid peak visitation.

Temporary striping, traffic/pedestrian control, and other features would be utilized to reduce confusion and congestion within the monument. A traffic and pedestrian control plan would be required as part of the construction contract.

## Other Alternatives Considered, but Dismissed from Further Analysis

The NPS considered, but dismissed the following alternatives to rehabilitate the water and wastewater service lines:

### Water Engineering Option 1 - Remove existing water tank and replace with larger water tank

Tank storage capacity should be 60,000 gallons in order to meet fire storage (30,000 gallons) plus two days of maximum day demand potable supply (30,000 gallons). The Geotechnical Report contains slope stability analysis showing the existing tank site is not suitable for this larger replacement tank without additional improvements at the tank pad site. Due to the location of the tank pad, additional excavation into the hillside does not appear to be feasible. Geotechnical improvements at the existing tank pad to address slope stability would significantly increase the cost of this option.

With a new 60,000 gallon tank, the average residence time within the tank is anticipated to increase by a factor of three times, or more, assuming at least 30,000 gallons would be retained in the tank at times to meet fire storage requirements. In addition, the current replacement of the 2" MMWD main on Ridge Avenue with a new 6" main would increase the average residence time within this portion of water main by a factor of nine times, if demands remain the same. A supplemental disinfection and recirculation system would add significant cost and operational complexity to the system. The tank site is the preferred location for the supplemental disinfection and recirculation system. However, the site does not currently have electrical power service and does not have safe access for chemical delivery.

With this option, a tank water level measurement system is required in order to monitor the tank water level that would include a low water level alarm. The existing tank does not have a level measurement system and there is no electrical power supply at the tank site. A pair of buried electrical conduits are visible below the tank site at the connection point of the recent 6" water main constructed in the 2004-2006 project. Therefore, it may be possible to extend the conduits up to the tank pad and potentially utilize these for a level measurement system. However, the downhill termination point of the conduits is unknown and should be determined prior to design. Alternatively, the level measurement system design may be able to utilize a call-out system instead of a hardwired signal. Option 1 includes the following elements:

- Retain existing MMWD domestic service connection with 1" water meter.
- Repair/replace PRV immediately downstream of MMWD service meter to reduce pressures from approximately 176 psi to 20 psi. This is referred to as the "upper pressure reducing valve with pressure relief valve".
- Construct new 2" domestic main down hillside in easement to existing tank site to replace existing 2" galvanized steel main.
- Remove existing 40,000 gallon steel water storage tank and altitude valve.
- Construct new 60,000 gallon steel water storage tank and altitude valve.

- Replace PRV at tank site to reduce pressures from approximately 180-190 psi and replace related piping and valves to new tank altitude valve. This is referred to as the “lower pressure reducing valve with pressure relief valve”.
- Construct supplemental disinfection and recirculation system at tank site.
- Construct tank water level measurement system.
- Construct 8” fire main from the new tank outlet to the connection point with recent 6” water main constructed in 2004-2006 project (approximately 80 feet from tank pad).
- Construct 2” domestic main from new tank outlet to all domestic water services within with the value of providing lower supplemental chlorine dosing quantities and decreased domestic water turnover time that is associated with larger diameter piping and a low potable water volume demand. Separate all domestic water services from the 6” fire main since it would now be classified as a non-potable, dedicated fire main. Maintain minimum horizontal separation requirements between new domestic main and sewer mains.
- Extend fire main approximately 500 feet from existing end fire hydrant to maintenance building using 8” HDPE to meet the minimum fire flow of 1,000 gpm.
- For new 2” nominal pipe size, use of 2” HDPE iron pipe size (IPS) DR 9 (250 psi for 4710) pipe with 1.815” inside diameter as analyzed in the water model is recommended.
- For new 8” nominal pipe size, use of 8” HDPE ductile iron pipe size (DIPS) DR 9 (250 psi for 4710) pipe with 6.917” inside diameter as analyzed in the water model is recommended.

For improved life safety, the NPS Fire Marshal along with Marin County Fire officials, who are the first responders, both support a municipal supply fire service, which is by definition a supply service without dependency on a limited storage tank supply volume. For this reason, Option 1 has been dismissed from further consideration.

### **Water Engineering Option 3 – Rehabilitate Water Tank.**

Rehabilitate existing water tank for non-potable fire storage; retain single water service connection from MMWD to meet both domestic potable and fire flow water needs.

Option 3 is a hybrid of Options 1 and 2. It retains the existing 40,000 gallon water tank to meet non-potable fire storage volume requirements, currently estimated at 30,000 gallons. Option 3 separates the domestic system from the fire system immediately upstream of the 40,000 gallon tank, so that potable domestic water would not flow through the tank. This would help address existing water quality concerns and would not require a separate fire service connection from MMWD or construction of a large diameter water main from the MMWD service meter down to the tank site.

Tank rehabilitation would consist of repairing corrosion, recoating, and adding cathodic protection. A tank water level measurement system is required by the NPS Fire Marshal. Bearing capacity and slope stability analysis may indicate that the existing tank site is not suitable for the existing tank or that additional improvements at the tank pad site would be necessary in order to make the site suitable.

Option 3 includes the following elements:

- Retain existing MMWD domestic service connection and upgrade from 1" water meter to 1.5" water meter. Upsizing to 1.5" is recommended for this alternative because the storage tank would no longer act as a buffer for domestic demands.
- Repair or replace PRV immediately downstream of the MMWD service meter to reduce pressures from approximately 176 psi to 20 psi.
- Construct new 2" domestic main down hillside in easement to existing tank site to replace existing 2" galvanized steel main.
- Rehabilitate existing 40,000 gallon steel water storage tank and altitude valve. Rehabilitation would include corrosion repair, recoating tank interior and exterior, and cathodic protection, which may require electrical power service to the tank site.
- Construct tank water level measurement system.
- Construct 8" HDPE fire main from the new tank outlet to the connection point with the 6" water main recently constructed with the 2004-2006 project (approximately 80 feet from tank pad).
- Repair or replace the pressure reducing valve and pressure relief valve at tank site to reduce pressures from approximately 180-190 psi and replace related piping and valving to fire storage tank altitude valve.
- Construct a domestic system bypass and check valve upstream of tank altitude valve so that domestic flows do not enter tank.
- Provide piping and inlet to fill tank from the top to provide an air gap.
- Construct a 2" domestic main from tank bypass to all domestic water services. Separate all domestic water services from the 6" fire main since it would now be as a non-potable, dedicated fire main. Maintain minimum horizontal separation requirements between new domestic main and sewer mains.
- Extend a 6" fire main approximately 500 feet from the existing end of the fire hydrant to maintenance building using 8" HDPE.
- For new 2" nominal pipe size, a 2" HDPE iron pipe size (IPS) DR 9 (250 psi for 4710) pipe with 1.815" inside diameter would be used
- For new 8" nominal pipe size, an 8" HDPE ductile iron pipe size (250 psi for 4710) with 6.917" inside diameter would be used.

For improved life safety, the NPS Fire Marshal along with Marin County Fire officials, who are the first responders, both support a municipal supply fire service, which is by definition a supply service without dependency on a limited storage tank supply volume. For this reason, Option 3 has been dismissed from further consideration.

### **Wastewater Engineering Option Zone 1B**

Re-route section of sewer main identified in the Redwood Creek high risk zone. New sewer main would be located in the same road corridor as water main. New lateral connections would be provided to each facility, including a lift station near the upper comfort station where a connection cannot be achieved through gravity flow. Option Zone 1B includes the following elements:

- Package lift station near upper comfort station with short force main.

- Install approximately 7 manholes.
- Install approximately 472 linear feet of 8" PVC gravity sewer main.
- Maximum bury depths of approximately 10 feet in the main road above the NPS Administrative / Concessions building.
- Abandonment in place of existing gravity sewer main except portions used for lift station overflow return.

Option Zone 1B was dismissed from further consideration for the following reasons:

- Although Option Zone 1B lies outside the Redwood Creek migration zone, it would substantially increase the cost of improvements compared with Option Zone 1A because there is more trenching, with deeper manholes, and additional capital expense and life cycle costs associated with operating and maintaining a lift station. I would also increase the risk of SSO from lift station failures.
- There would be more disruption to resources, concessionaires and visitors during construction.

### **Wastewater Option Zone 3A**

New sewer main located through lower parking lot to reduce excavation depths then routed back to Muir Woods Road corridor to Lift Station #1. Provide new lateral connection to existing NPS Maintenance building and residence. Option Zone 3A includes the following elements:

- Install approximately 9 manholes.
- Install approximately 1,106 linear feet of 8" PVC gravity sewer main.
- Maximum bury depths of approximately 15 feet in Muir Woods Road downstream of the lower parking lot.
- Abandonment in place of existing gravity sewer main.

Option Zone 3A was dismissed from further consideration for the following reasons:

- Although it lies outside of the wetlands area, it does not support the transportation program.
- It would not accommodate plans for a future comfort station located in the nursery parking lot area.
- It would significantly disrupt traffic during construction
- Would include 15 foot deep manholes that are difficult and costly to construct and maintain.



## CHAPTER III

# Affected Environment and Environmental Consequences

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## Methodology

In accordance with CEQ regulations, direct, indirect, and cumulative impacts are described (40 CFR 1502.16) and the impacts are assessed in terms of context and intensity (40 CFR 1508.27). Where appropriate, mitigating measures for adverse impacts are also described and incorporated into the evaluation of impacts.

The Affected Environment section for each resource topic describes existing conditions as they pertain to the resource. This description is followed by an Environmental Consequences section, which describes potential impacts from the two alternatives considered. For each alternative, the Environmental Consequences section describes the direct, indirect, and cumulative impacts to the resource from the actions proposed under the alternatives and reaches a conclusion regarding impacts. The Environmental Consequences section also analyzes any impairment to park resources.

The following topics analyzed below include: Air Quality; Cultural Resources; Geologic Resources and Soils; Soundscapes; Wildlife and Habitat; Threatened or Endangered Species; Visitor Use, Experience, Safety, and Transportation; Vegetation; and Water Resources and Hydrologic Resources.

Direct, indirect, and cumulative effects are analyzed for each resource topic carried forward. Potential impacts are described in terms of type, context, duration, and intensity.

General definitions are as follows, while more specific impact thresholds are given for each resource topic in the resource section.

**Type** describes the classification of the impact as beneficial or adverse, direct or indirect:

- Beneficial: A positive change in the condition or appearance of the resource or a change that moves the resource towards a desired condition.
- Adverse: A change that moves the resources away from a desired condition or detracts from its appearance or condition.
- Direct: An effect that is caused by an action and occurs in the same time and place. All impacts identified in this document are “direct” unless otherwise stated.
- Indirect: An effect that is caused by an action but is later in time and farther removed in distance, but is still reasonably foreseeable.

**Context** describes the area or location in which the impact would occur. Are the effects site-specific, local, regional, or even broader?

**Duration** describes the length of time an effect would occur, either short-term or long-term. Because definitions of duration can differ by resource topic, definitions are provided separately for each impact topic.

**Intensity** describes the degree, level, or strength of an impact. For this analysis, intensity has been categorized into negligible, minor, moderate, and major.

## Cumulative Impacts

Cumulative impacts are defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present, or reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions” (40 CFR 1508.7/8). The temporal scale for the cumulative impacts analysis includes past actions from the reservation system through reasonably foreseeable future actions.

Cumulative impacts are determined for each impact topic by combining the impacts of the alternative being analyzed and other past, present, and reasonably foreseeable actions that would also result in beneficial or adverse impacts. Because some of these actions are in the early planning stages, the evaluation of cumulative impacts is based on a general description of the projects. Other past, present, and reasonably foreseeable actions located in the vicinity of the monument to be included in the cumulative impacts analysis were identified through the internal and external project scoping processes and are summarized below.

## Sustainable Access Project

The National Park Service proposes to modify the Entry Plaza, Main Lot, Annex Lot, Conlon Lot, and the former Nursery Area, but maintain 232 parking spaces for privately owned vehicles. The National Park Service would remove all parking from the Entry Plaza, although administrative vehicular access would remain, and would rehabilitate approximately 0.4 acre of the plaza with native riparian vegetation. Existing roadside parking would be eliminated on the east side of Muir Woods Road between Conlon Avenue and the Muir Woods Road Bridge, and the area would be revegetated with plants native to the monument (NPS 2017a).

The former Nursery Area would be developed into a parking lot and contain 48 parking spaces for privately owned vehicles. The two lift stations located in the former Nursery Area and northeast of the Conlon Lot would be replaced with a single modern 40,000 gallon lift station located near the Nursery Lot entrance. The new lift station would be designed to accommodate a new restroom. The structures in the former Nursery Area would be removed, and the area would require less than 0.4 acre of development.

The segment of existing pedestrian trail along Muir Woods Road between the Main and Nursery Lots would be decommissioned and revegetated with plants native to the monument. A new woodland pedestrian trail between the Annex Lot and Nursery Lot would be developed. The Dipsea Trail would be realigned and new footbridge over Redwood Creek constructed near the Annex Lot.

## Muir Woods Reservation System

The *Muir Woods National Monument Reservation System*, approved December 2015, focuses on improving the visitor experience at the monument. The reservation system would reduce peak visitation levels at the monument by managing motorized vehicle access and allowing the NPS staff to control

parking both within the monument's lots and on Muir Woods Road (owned and managed by Marin County). In accordance with a memorandum of understanding between the National Park Service and Marin County, the approved reservation system would also ensure that parking on Muir Woods Road would support a phased elimination of parking south of the Muir Woods Road Bridge, located south of the monument (NPS 2015e). Both the reservation system and the memorandum of understanding were informed through public involvement.

Phase 1 of the reservation system established a parking barrier system along Muir Woods Road. This system involved placing posts and cables along the narrow Muir Woods Road shoulder to improve traffic safety and prevent parking along the shoulder. Approximately a mile of the post system with reflective markers was installed both north of the monument entrance and south towards Kent Canyon. White edge striping was added to the roadway to better define the edge of pavement. Additional No Parking Zone signage and erosion and sediment control measures were also installed. The construction of this project was completed at the end of February 2016.

Phase 2 of the reservation system would reduce peak visitation levels at the monument by managing motorized vehicle access and allowing monument staff to control parking both within the monument's lots and on Muir Woods Road (which is owned and managed by Marin County). The reservation system includes two separate, but coordinated systems. Reservations for privately owned vehicles and for the Muir Woods Shuttle would be made directly through a reservation system operated by a third-party operator. Commercial carriers would be required to obtain a reservation for one of the parking spaces designated for commercial carrier use through another, separately managed system. The reservation system would also ensure that parking on the Muir Woods Road shoulder would not initially exceed 80 vehicles south of the Muir Woods Road Bridge (NPS 2015a). By 2021, no vehicles would be allowed to park on the shoulder downstream of the bridge.

### **Muir Woods Road Bridge Replacement Project**

Marin County received federal funding to replace local bridges that were identified as structurally deficient and functionally obsolete. Muir Woods Road Bridge over Redwood Creek is one of the bridges identified for replacement, and a project was recently initiated to conduct environmental studies and begin design work. Protecting the riparian habitat and maintaining traffic are expected to be high priorities for the project.

The Muir Woods Road Bridge is located just south of the monument boundary. Muir Woods Road is a two-lane roadway that connects Muir Beach, Mill Valley, and the monument. The existing bridge was built in 1946 and is a single-span, reinforced concrete T-beam structure. The bridge needs to be replaced for the following reasons:

- The structure has deficiencies in the structural concrete and structural steel.
- The existing bridge alignment does not meet current road geometry standards.
- Bridge railings do not meet current safety standards.
- Scour from the creek has caused undermining of the structure.

The project improvements are anticipated to extend from 400 feet west of the bridge to 600 feet east of the bridge along Muir Woods Road, which would involve realigning the roadway to correct the current “S” curve. Access to the monument would be maintained at all times. The design stage for this project is expected to begin in 2017 with construction anticipated in 2019.

### **Muir Woods Road Rehabilitation Project**

Through a Federal Land Access Program Grant, this project would repair road slides at various locations, and approximately 36 culverts, 2 of which are located in the project area, would be repaired or replaced to decrease sediment loading into Redwood Creek. As part of this project, 2.48 miles of new asphalt would be resurfaced along Muir Woods Road. The planning stage for the project is expected to be completed in 2017 with construction beginning in 2019 (NPS 2015b).

### **Muir Woods Salmon Habitat Enhancement and Bridge Replacement Project**

The Muir Woods Salmon Habitat Enhancement and Bridge Replacement Project would restore habitat in Redwood Creek for aquatic life, including the federally threatened Coho salmon, and replace aging pedestrian bridges in the monument. As part of this project, selected large boulders (i.e., riprap) that were placed on the banks of Redwood Creek more than 80 years ago to stabilize the stream bank would be removed. Following the riprap removal, large woody debris (LWD) would be installed in the creek. These two actions would substantially improve the conditions needed to help young fish survive. Four aging pedestrian bridges on Redwood Creek that are reaching the end of their lifespan would also be replaced. The new bridges would provide accessible creek crossings and be designed with a longer span and more durable materials to improve both public safety and enhance the way water flows in the creek to support ongoing habitat restoration efforts (NPS 2017b). The project is anticipated to begin in 2017 and be completed in 2019.

### **Redwood Creek Trail Realignment and Dias Ridge Trail Extension Project**

The National Park Service proposes to reconstruct the existing Redwood Creek Trail segment between Muir Woods Road and the Miwok Trail, including a bridge replacement; decommission the existing segment of the Redwood Creek Trail from the Miwok Trail to the vicinity of Santos Meadow and replace the decommissioned segment with a new trail to the east, out of the floodplain; improve the trail tread from Santos Meadow south to the southern trailhead; and construct an extension of the Dias Ridge Trail from the Golden Gate Dairy on Highway 1 to the Redwood Creek Trail’s southern trailhead (NPS 2015c).

## **AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES**

### **Cultural Resources**

#### **Methodology and Assumptions**

Cultural resources that could be affected are the national register-listed Muir Woods Historic District, two national register-eligible archeological sites, and areas of archeological sensitivity east of the Annex Lot and around the Conlon Lot.

The analysis of impacts is based on a review of existing literature, data, maps, information provided by NPS staff, and professional judgment. Impacts are defined as activities that affect any character-defining features of the historic and archeological resources within the area of potential effects. Impacts could come from removing historic materials and activities that change the nature of the resource, adding

new trails, excavating in areas of archeological sensitivity, and visual impacts that detract from the natural setting of the Dipsea Trail and the Muir Woods Historic District.

## **Affected Environment**

### ***Area of Potential Effects***

As required under section 106 of the National Historic Preservation Act of 1966, an area of potential effects must be established to determine and define the “geographic area or areas within which an undertaking may directly or indirectly cause alterations to the character or use of historic properties, if such properties exist and is influenced by the scale and nature of an undertaking. It encompasses both those areas where proposed actions might occur that would directly impact cultural resources, as well as adjacent areas that contain resources that might be indirectly affected” (36 CFR 800.16(d)).

To assess the effects of this undertaking on all historic resources that might be affected, the area of potential effects includes the entire Muir Woods Historic District. The areas that the project could directly affect are the monument entrance area, existing parking areas, the Conlon Lot, and the historic Superintendent’s Residence and adjacent utility area. A detailed map of the area that is directly affected by the area of potential effects (APE), including known resources and areas of indirect impact, are indicated in Figures 8 and 9.

### ***Properties Listed on the National Register***

Muir Woods National Monument: It is one of the great examples of the early development of the conservation movement in the late 19th and early 20th centuries to preserve an old-growth forest of coast redwoods. Theodore Roosevelt declared it a national monument in 1908 under the provisions of the Antiquity Act of 1906. The portion of the monument as it existed at the end of the period of significance (1907–1947) was entered on the National Register in 2008 as a historic district. For a property to be eligible for the National Register, it must meet at least one of four main criteria.

- Criterion A. The property is associated with events that have made a significant contribution to the broad patterns of our history; or
- Criterion B. The property is associated with the lives of persons significant in our past; or
- Criterion C. The property embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components may lack individual distinction; or
- Criterion D. The property has yielded or may be likely to yield, information important in prehistory or history.

The monument was found to be nationally significant under criterion A and criterion C for the contributions of William Kent and the conservation movement, its use of rustic park architecture, and as an example of Emergency Conservation Work / Civilian Conservation Corps programs in the 1930s, as well as its association with the signing of the United Nations Charter in 1945. Five buildings and 22 structures (dating 1922–1940) are significant under Criterion C as representative examples of pre-World War II-era rustic design characteristic of NPS buildings built during that era. The project would not affect contributing structures in the monument.



The Dipsea Trail: The trail extends from the town of Mill Valley, over Mount Tamalpais, to Stinson Beach, and is the course for the Dipsea Race that passes through the monument and ends at GGNRA's Stinson Beach parking lot. It is the oldest cross-country trail race in the country. In 2010, the trail was listed on the National Register for the Dipsea Race's influence on the development of other foot races and as a manifestation of America's concern for physical fitness (Criterion A). Significant built features include the trail bed, 19th century roadbeds, wooden bridges and steps, and stone steps. The project would not affect contributing structures along the trail.

### ***Properties with a Formal Determination of Eligibility for the National Register***

Camino Del Canyon: The Camino Del Canyon tract was added to the monument as a buffer zone to protect the redwood groves and the visitor experience in the monument. This area is not within the Muir Woods Historic District. It includes the Conlon Lot, which is within the area of potential effects. In 2007, the National Park Service submitted a determination of eligibility for the area. One property within the tract was found to be eligible for listing on the National Register – the Hillwood Camp. This property is outside the zone where visual or auditory impacts are expected and was excluded from the area of potential effects.

Parking Lot Tract: Just outside the monument entrance, the Parking Lot Tract was excluded from the Muir Woods Historic District because it was not a part of the monument during the period of significance and because a loss of historic integrity resulting from modern alterations and additions from the construction of parking lots.

Muir Woods Inn: The Inn site was initially surveyed by Faith Duncan in 1988 and recorded as part of site form CA-MRN-568H. It was further evaluated in 2015 and submitted to the California State Historic Preservation Office in early 2016. The site consists of the former Muir Woods Inn and various outbuildings, including the restroom facility, two small cabins, and an architecturally undistinguished house built in 1965 after the period of significance, by the Schlette family, the last owners of the Inn.

The Muir Woods Inn and outbuildings are located on the north side of the Muir Woods Road, directly across from the Annex Lot. Joe Landgraff originally built the Inn around 1930 as a refreshment shop, which he named Coffee Joe's. In 1945, Coffee Joe's was sold to the Schlette family, who renamed it "Muir Woods Inn." The National Park Service acquired the property in 1972 and the Inn was subsequently remodeled on the interior and exterior. It now serves as an office, storage space, a small machine shop, and a conference room for the monument. The National Park Service determined that the building was not eligible for the National Register because it is highly altered and lacks the necessary physical elements required under the National Register program.

### ***Archeology***

An archeological survey was conducted within the project area, along the northeastern side of Redwood Creek between the creek and Muir Woods Road. The 10-acre survey began near the Annex Lot, continued southeast along Muir Woods Road to the bridge crossing and then back up to the Annex Lot along Redwood Creek. The survey documented two new historic sites and one historic isolated find. One of the newly recorded historic sites, CA-MRN-723H, is outside the project area (see Figures 10 and 11).

The other historic site, CA-MRN-722H (the Annex Lot) is within the project area. Several factors suggest that the site is eligible under Criterion D, because it has yielded, and may be likely to further yield,

FIGURE 8. CULTURAL RESOURCES AREA OF POTENTIAL EFFECTS (APE), MAP 1 OF 2

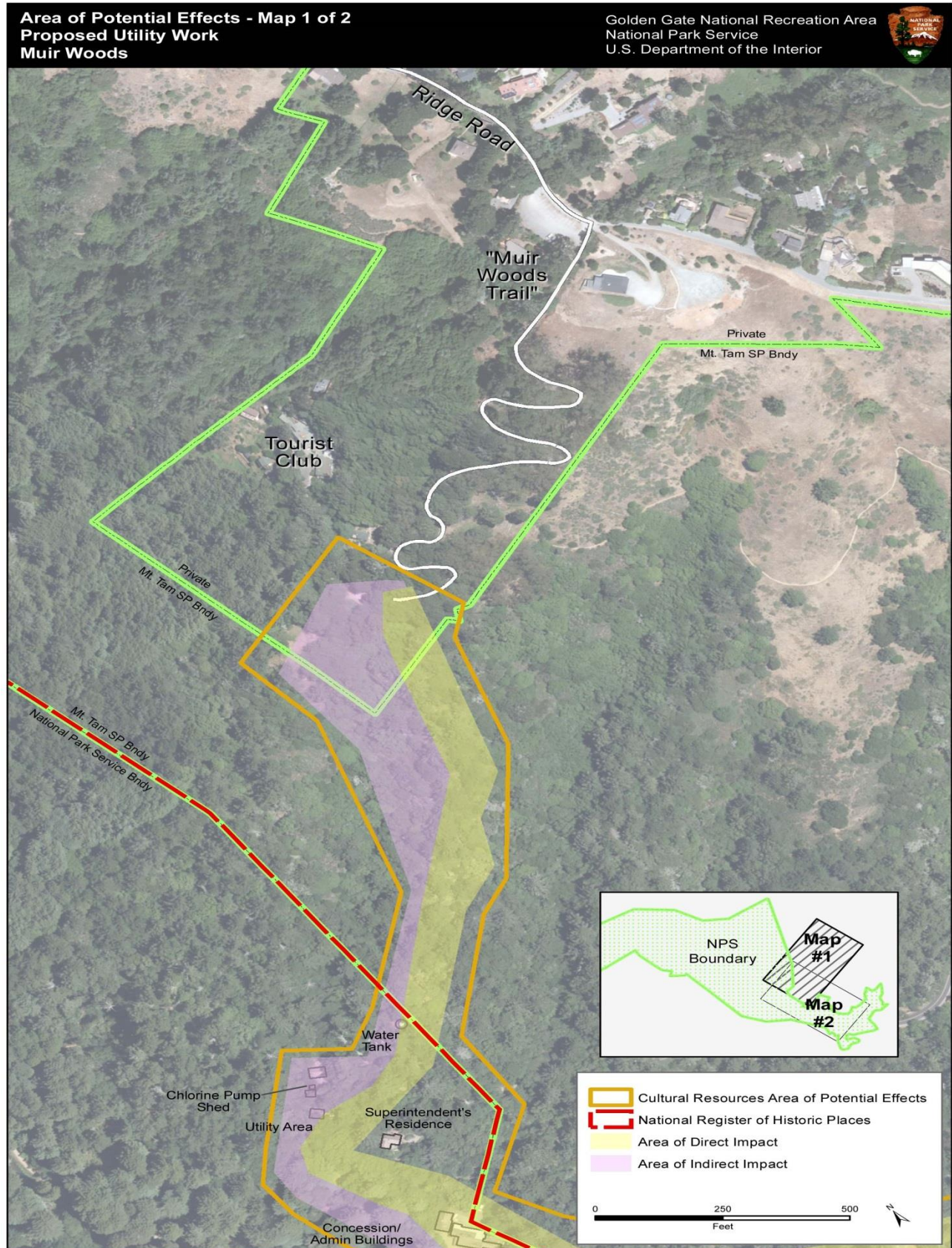
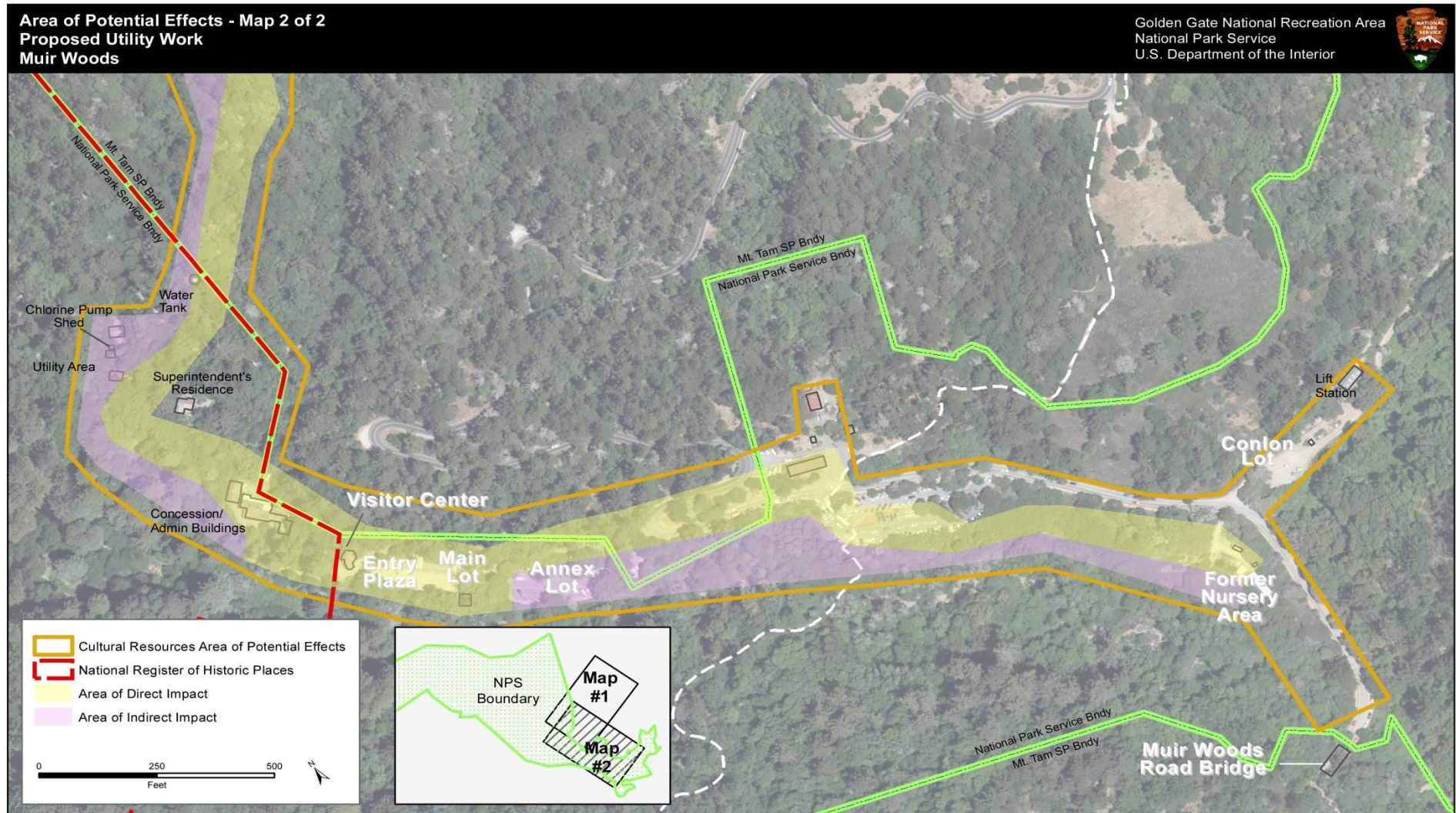




FIGURE 9. CULTURAL RESOURCES APE, MAP 2 OF 2



information important to early 20th-century public recreation and tourism at Muir Woods. Two other areas within the direct area of potential effects have a high potential for as yet unknown subsurface deposits: the former Nursery Area and the Conlon Lot, which are the former locations of the Second Lodge of Camp Kent (1910–1924), and the original Camp Kent campgrounds (1898–1923), respectively.

### **Tribal Consultation**

To date, the Federated Indians of Graton Rancheria have not indicated that properties of traditional cultural association are within the APE of this proposed project.

## **Environmental Consequences**

### ***Impacts of Alternative 1***

Under Alternative 1, maintenance and operations of the existing water and wastewater services would continue, and no additional construction or ground disturbance would be required. There would be no new adverse or beneficial impacts on cultural resources. Consequently, the No Action Alternative would have no adverse effects.

### ***Impacts of Alternative 2***

Construction impacts to cultural resources could result from ground-disturbing activities during trenching, as well as removal of the 40,000 gallon water tank, replacement with a pressure reducing and relief station, and the installation of 13 new manholes and rehabilitation of seven existing manholes within the monument.

Trenching for installation of new water and wastewater lines would occur throughout the monument, including within the utility area adjacent the Superintendent's Residence, around the Administration Area, the entry plaza, the Parking Lot Tract and the Former Nursery site. However, the earth disturbing activities would be monitored to avoid any impacts to archeological resources and known archeological sites would be avoided. With the implementation of the appropriate Avoidance and Mitigation Measures listed above, impacts to cultural resources from construction activities would be avoided or minimized. The trenching may reveal previously unidentified cultural resources which would be managed and recorded as required by the impact reduction measures. No adverse impacts are anticipated from this activity.

The 40,000 gallon stainless steel water tank was installed uphill from the Superintendent's Residence in 1957, ten years after the end of the period of significance. Removal of the non-historic water tank would have a beneficial impact on the cultural landscape.

The installation of approximately 13 new manholes would introduce new features into the cultural landscape. However, the very nature of such utilities assures minimal intrusion into the visual resources of the Monument. Similarly, rehabilitation of existing manholes would introduce minimal visual intrusion. Therefore, minimal impacts are anticipated from this activity.

### **Cumulative Impacts**

Alternative 2 could result in minimal, direct, short- and long-term impacts in some archeologically



FIGURE 10. ARCHEOLOGICAL MAP 1 OF 2

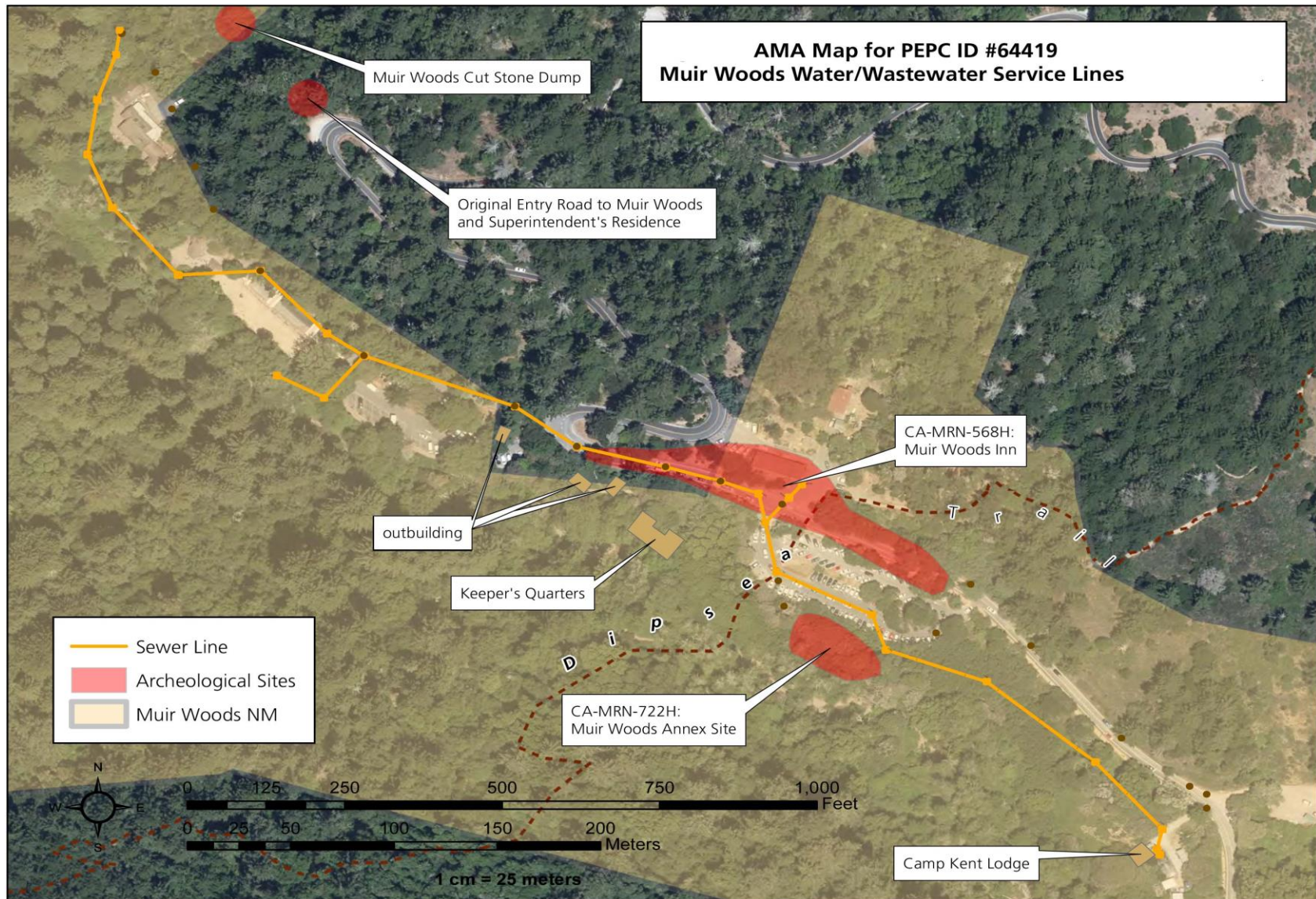
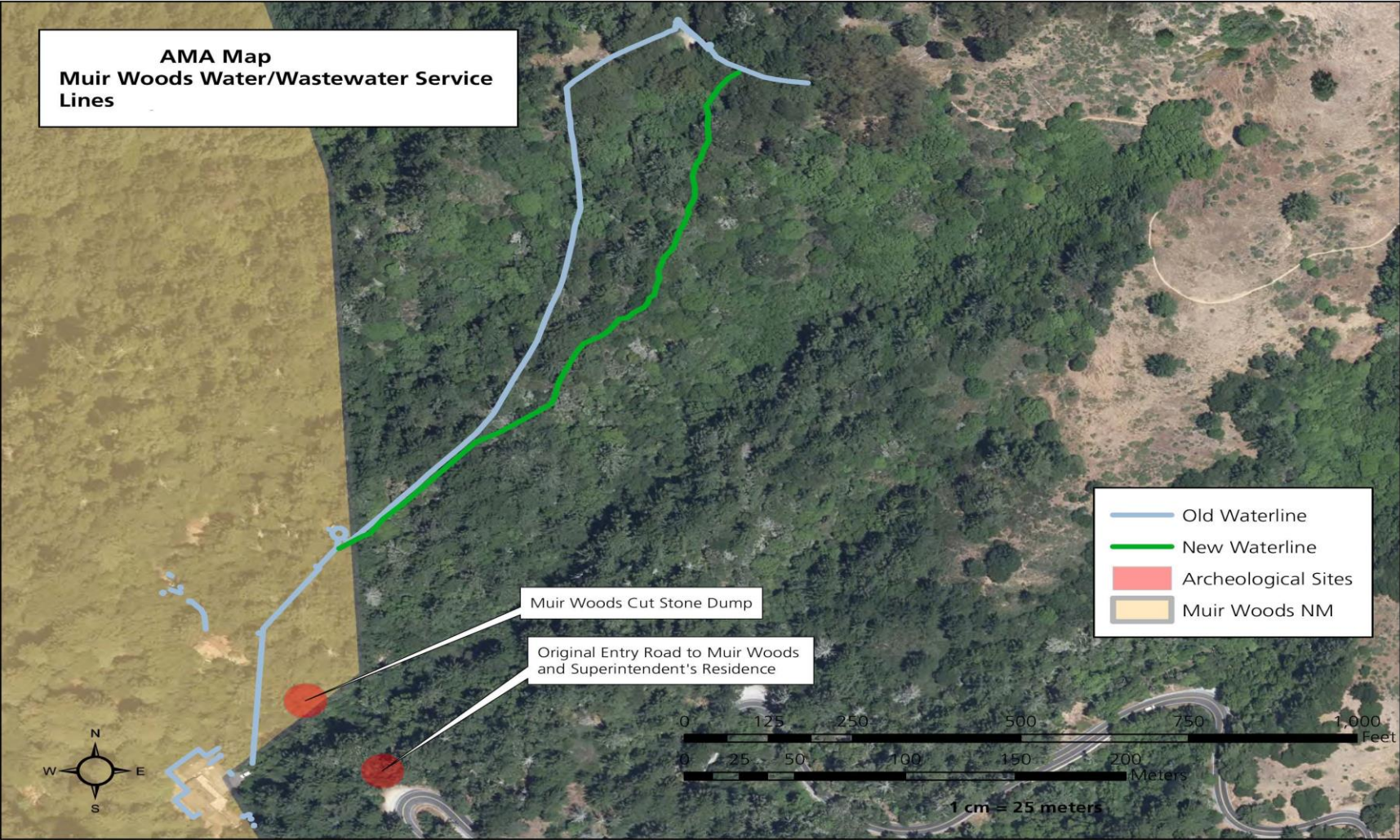




FIGURE 11. ARCHEOLOGICAL MAP 2 OF 2



sensitive areas. However, it is expected that most of these impacts would be avoided through monitoring, and compliance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (NPS 1995). Known archaeological sites would be avoided, areas of archaeological sensitivity would be monitored. Most of the activities proposed under alternative 2 A/B would occur within the Muir Woods Historic District; however much of the trenching would occur in areas already previously disturbed and would have no adverse impact; removal of the non-historic steel water tank would have a beneficial impact; the new chlorinator station would be housed in an existing shed that is to be rehabilitated after sustaining damage in a recent storm when a tree fell nearby. The shed would be repaired and rehabilitated to match the historic materials and appearance of this utility area. Rehabilitation of the shed would follow the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (NPS 1995). New and rehabilitated manholes would introduce a minimal visual intrusion into the cultural landscape. When the impacts of Alternative 2 are combined with the effects of cumulative actions in the project area, overall minimal short and long-term direct impacts are expected.

## Geology and Soils

### Methodology and Assumptions

Impacts on soils are considered in this analysis through four measures: soil removal, soil compaction, soil erosion, and disturbance relative to the project area. Activities that may result in impacts on soils include accessing non-paved surfaces for installation and excavation of soil to install below ground infrastructure. The development of engineered stormwater management infrastructure would also affect soils. These impacts were assessed by examining soil information and mapping for the monument.

### Affected Environment

The Monument is located in southern Marin County, west of San Francisco Bay, within the northern Coast Range of California's geomorphic provinces. The physical landscape and topography of the Mt. Tamalpais and Muir Woods area reflect a history of tectonic forces, active since the Mesozoic Era initiation of plate collision and subsequent subduction of the Pacific Plate beneath the North American Plate (California Geological Survey [CGS] 2002). Regionally, the northwestern trending ranges of southern Marin run generally parallel to the northwest/southeast trending San Andreas Fault, located in the Pacific Ocean just off-shore the Marin Headlands (CGS 1991). However, more locally in the Mt. Tamalpais area, ridges and crestlines radiate around the mountain peak in all directions, with Muir Woods located in the Redwood Creek watershed southeast of the Mt. Tamalpais peak.

Proximity to the San Andreas Fault Zone results in a high degree of bedrock fracturing and deformation. At Muir Woods, most of the underlying rock is of the Franciscan assemblage, a highly deformed mixture of sedimentary, metamorphic, and igneous rocks of late Jurassic and Cretaceous marine origin that reflect the tectonic compressional and subduction processes of the region (Wahrhaftig 1994 and Blake et al. 2000 as cited in NPS 2011). More specifically within the Muir Woods, incoherent shale and sandstone dominate the monument, with relatively steep slopes that tend to be highly susceptible to mass wasting (Graymer et al. 1991).

Soil is the unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants (U.S. Department of Agriculture [USDA], National Resources Conservation Service [NRCS] 2017). Soils are influenced by several environmental factors

including climate (precipitation, temperature, available moisture, etc.), macro- and microorganisms, topographic relief, parent rock material, land use practices, and time.

Bedrock is overlain with loam to very gravelly loam soils from the Centissima-Barnabe complex (USDA, NRCS 2016). The Centissima-Barnabe complex primarily derives from weathered soft sandstone, shale, and chert. This soil is typically the most commonly encountered soil type within the monument and supports all of the slope redwood stands (McBride and Jacobs 1978). Soils generally range in thickness from 20 to 33 inches above bedrock. This soil unit exhibits high runoff and a moderate susceptibility to erosion.

Settlement and development in the watersheds draining Mt. Tamalpais and Muir Woods began as early as 1841 (Auwaerter and Sears 2006). Intensification of land uses in the watershed for logging and agricultural purposes in the 19<sup>th</sup> century changed vegetation and land cover conditions resulting in other hydrologic and geomorphic effects. Erosion and sediment transport increased with these land use changes and the creeks likely enlarged or incised to accommodate increased runoff and sediment loads (Stillwater Sciences 2004).

Substantial development for access roads and visitor amenities for Muir Woods began in the mid-1880s (Auwaerter and Sears 2006). Expanding public use led to further road improvements and other developments during the first half of the 20<sup>th</sup> century, resulting in continued soil disturbance and increased erosion within Muir Woods and the project area.

More recently, a natural resources assessment completed in 2011 ranked the soil conditions as fair because of historic logging, grazing, farming, residential development, and compaction from pedestrians (NPCA 2011). In recent years, efforts have been made to restore and improve soil conditions by removing paved trails in favor of raised boardwalks and fencing sensitive areas prone to erosion to protect soil from compaction from pedestrian traffic (see Soils Maps in Figures 12 and 13).

## **Environmental Consequences**

### ***Impacts of Alternative 1***

Since there would be no construction activities as proposed in Alternative 2, under Alternative 1, the only ground disturbing activities that would take place would be routine maintenance activities associated with any required pipe repair or replacement for both the existing water and wastewater service lines.

### ***Impacts of Alternative 2***

Construction activities would not disturb local geologic formations within the project area, however approximately 24,000 square feet of soils would be impacted from trenching, backfilling, and related construction activities to rehabilitate the water and wastewater service lines as proposed in Alternative 2. Soil mixing from the use of fill materials would disrupt the soil structure, adversely affecting native soils over the long term. Staging and stockpiling of construction equipment and fill material would result in direct, short-term, adverse impacts on soils. Overall, impacts on soils would be direct, short and long-term, and adverse from removal, back filling, compaction, and soil structure modification. Direct, long-term, beneficial impacts from the alternative include decreased turbidity and sedimentation in Redwood Creek, and native plant revegetation.



FIGURE 12. SOILS MAP 1 OF 2

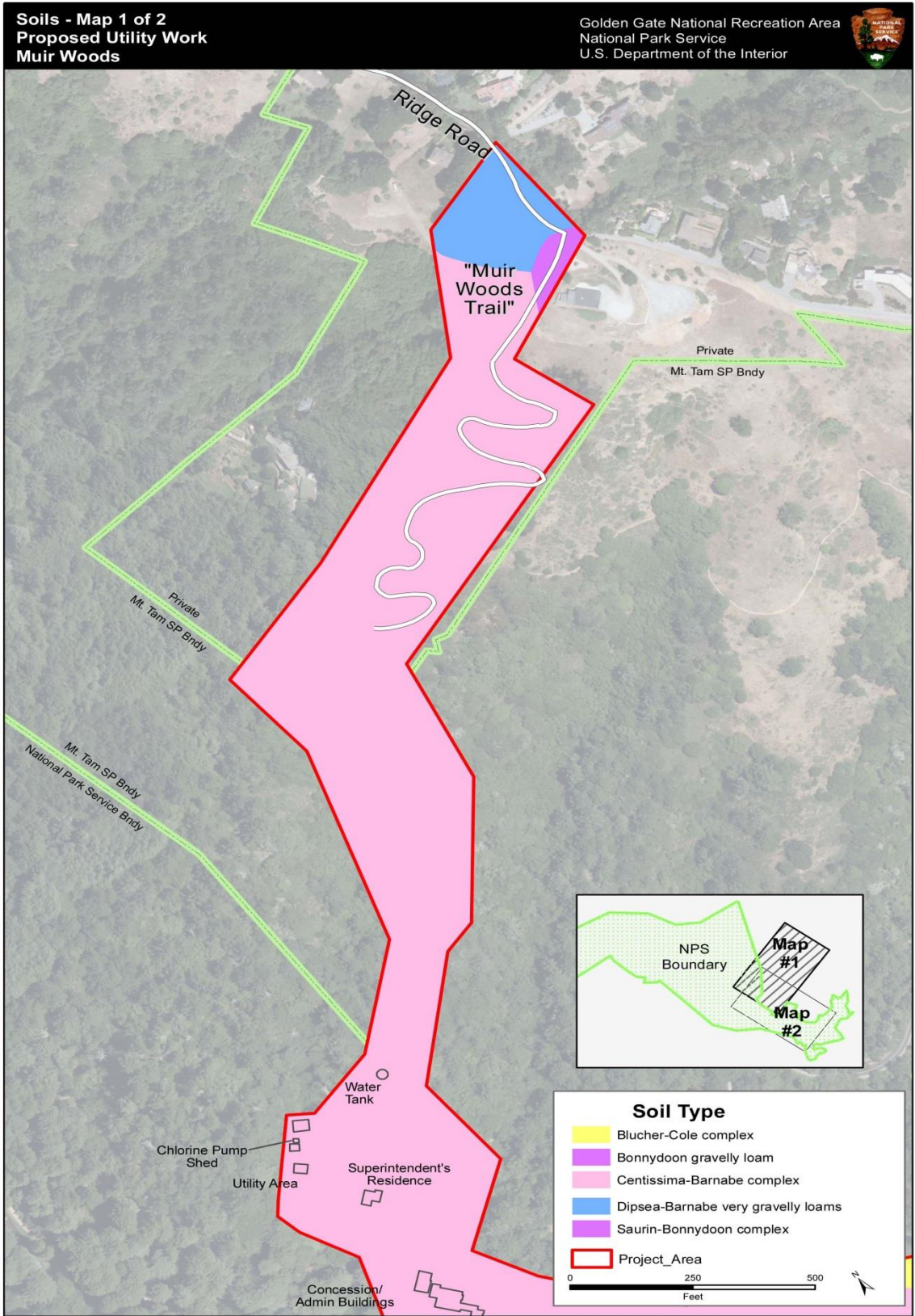
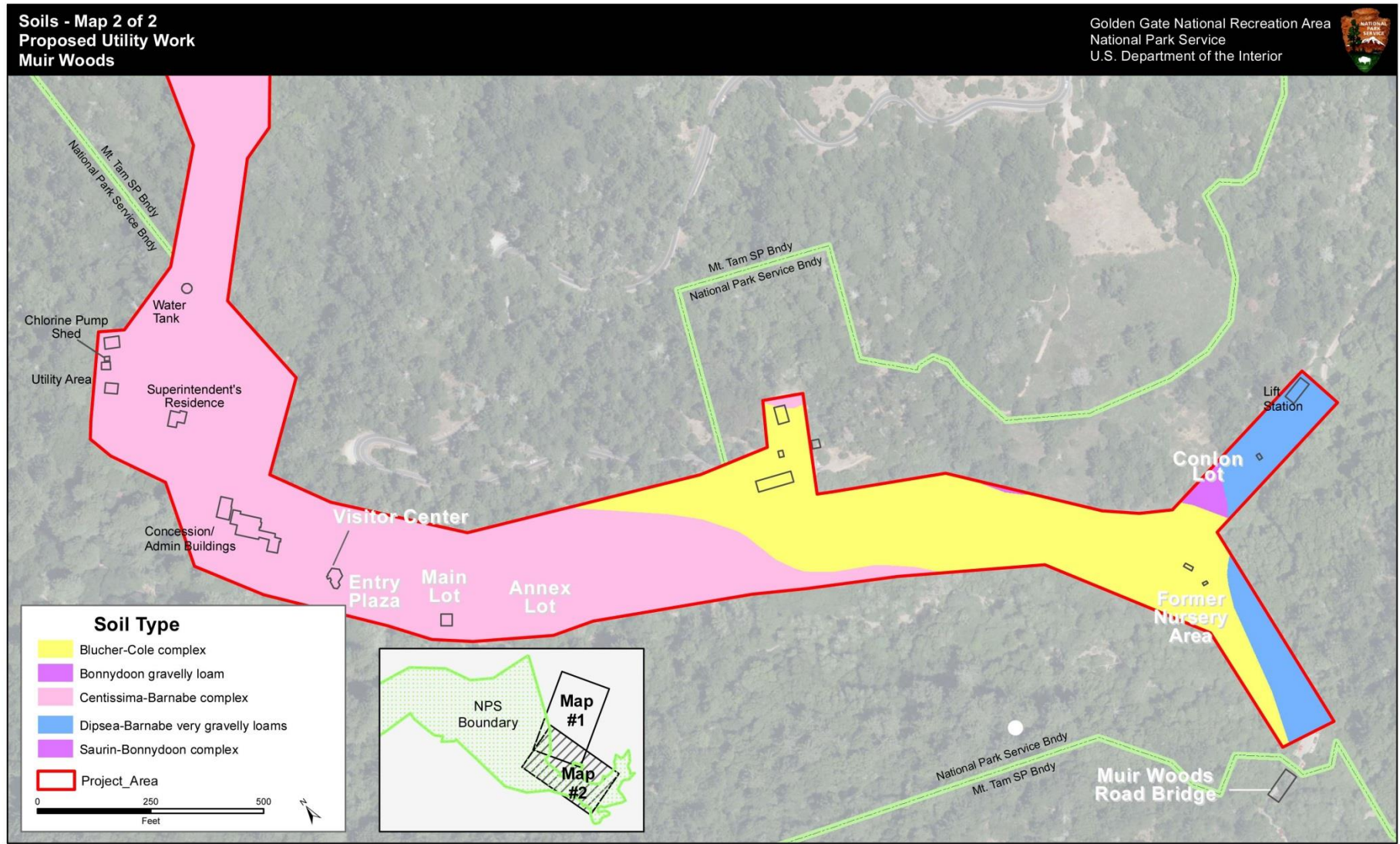


FIGURE 13. SOILS MAP 2 OF 2





## **Cumulative Impacts**

Actions when added to the no-action or proposed action activities that could have cumulative effects on soil and geologic resources in the analysis area includes temporary construction activities associated with parking area improvements and additions, lift station replacement, stormwater infrastructure improvements, roadside parking closures, Muir Woods Road rehabilitation, bridge replacements or additions, trail reroutes and improvements, and stream habitat restoration. Most of these activities would cause a minimal loss of soil productivity because they have occurred or would occur on or near developed areas that have been previously disturbed.

The no-action alternative would cause less short-term impacts, but the increasingly frequent failure and repair of water and wastewater lines would disturb soil on small areas adding to the long-term cumulative impacts of the other projects. Best management practices have been or would be carried out during and after all construction projects to stabilize soils and minimize erosion.

## **Soundscapes**

### **Methodology and Assumptions**

The soundscapes analysis relied on published studies that detailed the monument's current soundscapes in addition to considering sources of noise related to the Proposed Action. Equipment anticipated to be used during construction include mini size excavators, haul carts (e.g., Wacker DW50), a skid steer, sheeps foot or whacker for compaction, HDPE pipe welder. The types of equipment that would be used for these activities typically produce noise levels of 70 to 80 dBA at a distance of 50 feet which could be perceived as annoyingly loud by visitors, but would not pose a risk of hearing damage over expected periods of exposure (Federal Transit Authority 2006). Impact severity descriptions took into consideration that many areas of the Monument are typically very quiet in terms of manmade noise sources and that manmade noises have been shown to be a source of irritation for visitors hoping to experience a more peaceful, natural soundscape.

### **Affected Environment**

The current soundscape within the Monument includes both natural and manmade sounds. Natural sounds from flowing water, wildlife, and wind are generally perceived as pleasing and a positive part of the visitor experience, while manmade noise from vehicles, people talking, etc. is typically perceived negatively. Research conducted in the Monument showed that large percentages of visitors were exposed to, and annoyed by, visitor-caused noises such as loud groups and children.

Ambient noise levels are typically low, with summer season daytime averages ranging from roughly 30 dBA in the more remote backcountry areas to 40 dBA near the road and Entry Plaza. Due to higher rainfall and streamflows, winter season daytime averages are a bit higher at approximately 40 and 55 dBA for backcountry and entrance area, respectively. Noise levels at night tend to be lower. In quieter areas of the monument, noise from manmade sources like aircraft is more noticeable.

During the summer, in the less busy sections of the monument, natural soundscapes devoid of aircraft, vehicle, or other manmade noises are audible about a third of the time, while in the busier areas of the monument near the road, noise from other visitors and vehicles is audible most of the time and largely natural soundscapes are only audible a small percent of the time. Natural sounds are more predominant during the less busy winter months.

The park has implemented “quiet zones” in an attempt to improve soundscapes in certain areas, such as in Cathedral Grove. Upcoming changes to parking and transportation at the monument may decrease manmade noise levels in the monument as well.

## **Environmental Consequences**

### ***Impacts of Alternative 1***

Since there would be no construction activities as proposed in Alternative 2, the only activities under Alternative 1 that would impact the Monument’s current soundscape would be routine maintenance activities associated with any required pipe repair or replacement for both the existing water and wastewater service lines. The impacts of routine maintenance and repair would be short-term temporary adverse impacts on soundscapes during these construction activities.

### ***Impacts of Alternative 2***

Heavy equipment and hand tools would be used to complete the work which would have temporary, adverse impacts on soundscapes. After work is completed, this alternative would not have any long-term impacts on soundscapes.

## **Cumulative Impacts**

Existing vehicle traffic, aircraft overflights, and visitor-caused noises such as loud groups are the primary sources of noise in the monument. Noise levels are highly variable from location to location and the time of day and year. The cumulative impacts would be greatest when visitors are in areas removed from other vehicle traffic and visitor noise. Managing traffic and parking under the reservation system and sustainable access projects would lower peak traffic numbers, place time limits at parking lots, and encourage visitors to shift from privately owned vehicles to shuttles and busses that would help reduce noise levels lowering the overall long-term cumulative impacts on natural soundscapes. The no action and proposed action activities would not add to these long-term cumulative impacts.

Construction to implement the no-action and proposed action plus the improvements under the other projects would involve the use of noise producing heavy equipment and would cause temporary adverse cumulative impacts on the surrounding natural soundscape. These short-term cumulative impacts would be greatest and readily perceptible in the most noise sensitive areas in the monument that are removed from areas affected by existing traffic and visitor noise.

## **Wildlife and Habitat**

### **Methodology and Assumptions**

Discussion of habitat for salmonids, NSO, and MM is covered in Section , *Threatened and Endangered Species* below. Impacts on other wildlife habitat are considered below.

### **Affected Environment**

Several types of wildlife habitat are present within the areas where the Proposed Action may occur, including riparian habitat along the creek, redwood forest, and wetland habitat adjacent to the creek.

Amphibians such as California giant salamander (*Dicamptodon ensatus*) and Pacific chorus frog (*Pseudacris regilla*) are present in the Monument (Stillwater and Horizon 2011). California giant salamander larvae are found in a variety of aquatic habitats, and adults are found in surface litter in terrestrial habitats, as well as underground (Fong and Howell 2006). Although California red-legged frogs

(*Rana draytonii*) are present approximately 1.6 miles south of Muir Woods (CDFW 2016), they are not expected in the Monument because there have been no documented adults or juveniles in upper Redwood Creek and suitable breeding habitat is not present in the Monument (Stillwater and Horizon 2011).

The monument provides nesting and foraging habitat for many bird species. The bird species most commonly observed include Pacific-slope Flycatchers (*Empidonax difficilis*), Pacific Wrens (*Troglodytes pacificus*), Chestnut-backed Chickadees (*Parus rufescens*), Golden-crowned Kinglets (*Regulus satrapa*), Brown Creepers (*Certhia americana*), and Dark-eyed Juncos (*Junco hyemalis*) (Gardali and Geupel 2000).

Bats are known to both forage and roost in the Monument (Heady and Frick 2004). Bat species detected include California myotis (*Myotis californicus*), Yuma myotis (*Myotis yumanensis*), silver-haired bat (*Lasiurus noctivagus*), big brown bat (*Eptesicus fuscus*), western red bat (*Lasiurus blossevillii*), hoary bat (*Lasiurus cinereus*), and Townsend's big-eared bat (*Corynorhinus townsendii*) (Heady and Frick 2004). Most bat activity occurs in the riparian corridor (Heady and Frick 2004). In a study by Heady and Frick (2004), silver-hair bats have been captured in the redwood habitats but not in the downstream hardwood riparian habitat, while Yuma myotis showed an opposite pattern of being present in hardwood riparian habitat and absent in redwood grove. Several species of bats have been observed using redwood hollows as maternity roosts, day roosts, or night feeding roosts, and bats also use other features such as bark crevices as roosting habitat (Heady and Frick 2004). The majority of the species detected are found there year-round (Heady and Frick 2004).

## Environmental Consequences

### *Impacts of Alternative 1*

Under the No Action Alternative, no impacts to wildlife or habitat would occur.

### *Impacts of Alternative 2*

Implementation of the proposed action would result in minor, short-term adverse impacts to wildlife habitat.

### Cumulative Impacts

Actions when added to the no-action or proposed action activities that could have cumulative effects on wildlife habitat would include the direct long-term modification of habitat and indirect disturbance caused by temporary construction activities with parking area improvements and additions, culvert replacements, roadside parking closures, Muir Woods Road rehabilitation, bridge replacements or additions, trail reroutes and improvements, and stream habitat restoration. The effects of these activities are negligible because a relatively small area of wildlife habitat would be affected, plus the park service would avoid doing construction during periods when wildlife is most sensitive. Over the long term, the majority of these projects would improve wildlife habitat.

## Threatened or Endangered Species

### Affected Environment

Three species federally listed as threatened or endangered are present within Muir Woods: Coho salmon, steelhead, and NSO. Additionally, Muir Woods contains potentially suitable habitat for the MM, which is federal listed as threatened. These species are described below.

## ***Coho Salmon***

Coho salmon in Redwood Creek belong to the Central California Coast ESU, which was upgraded from threatened to endangered in June 2005 (70 CFR 37160). Critical habitat for this ESU is present within Redwood Creek and includes the creek and adjacent riparian habitat (70 CFR 52488).

Habitat characteristics required for successful Coho salmon development include (1) clean loose gravels free of fine sediment, needed for spawning and egg development; (2) adequate pools and natural instream cover for juveniles; (3) connected alcoves and off channel habitats for juveniles to survive winter flows; (4) clean cool water; and (5) unimpaired passage to and from the ocean (NOAA 2012). Redwood Creek within Muir Woods provides spawning and limited rearing habitat for this species. Spawning typically occurs between December and February, and juveniles emerge in March and April. Juveniles remain in fresh water for approximately 15 months before migrating to the Pacific Ocean. As described above, habitat for juvenile Coho salmon has deteriorated over the years due to past management practices such as installation of riprap along the channel and removal of LWD which resulted in loss of pools and predominance of shallow water habitats in the stream (Fong et al. 2016). Population levels are well below thresholds identified by NMFS for the recovery of the species (NMFS 2012). Recent declines put the Redwood Creek population at risk for extirpation. CDFW (formerly California Department of Fish and Game [CDFG]) identified Redwood Creek as a priority restoration area for the recovery of this species (CDFG 2004).

A 3-year Coho salmon captive rearing program was initiated to address poor adult survivorship. This program entails capturing a portion of the juvenile Coho Salmon present in Redwood Creek and rearing them in captivity at Warm Springs Fish Hatchery, located at Lake Sonoma. Captive rearing is a temporary measure to prevent extirpation of Coho salmon in Redwood Creek. Juvenile Coho salmon were collected from Redwood Creek in 2014, 2015, and 2016. Three- to four-year-old adults would be released into Redwood Creek to spawn; the first round of adults was released into Redwood Creek in December 8 2016. The last planned release would be in the winter of 2018. This program is a collaboration between the CDFW, NMFS, U.S. Army Corps of Engineers, California Department of Parks and Recreation, NPS, Golden Gate National Parks Conservancy, and the Friends of Lake Sonoma.

## ***Steelhead Trout***

Steelhead trout within the Redwood Creek watershed belong to the Central California Coast Distinct Population Segment (DPS) (NOAA 2015). This DPS was originally federally listed as threatened in 1997 (63 FR 32996) and reaffirmed as threatened in 2006 (71 FR 834). Critical habitat for this DPS is present within Redwood Creek, encompassing the lateral extents of the creek up to the ordinary high water line (70 FR 52488).

Habitat requirements for juvenile steelhead are similar to those of Coho salmon (NPS 2005). ). Spawning typically occurs in late winter or spring. The amount of time steelhead trout rear in freshwater and marine/estuarine habitats is variable, ranging between one to three years (NPS 2014a). Unlike other species of salmon, steelhead trout do not necessarily die after spawning and are able to spawn more than once (USFWS 2016).

### ***Northern Spotted Owl***

The NSO is federally listed as threatened in Washington, Oregon, and California (55 CFR 26114). This species is known to occur (Gardali and Geupel 2000). Marin County is the southernmost limit of this species range (USFWS 2011) No critical habitat for NSO is present. The nearest designated critical habitat is north of Highway 1, approximately 0.7 mile north of the project area.

NSOs in Marin County inhabit a variety of forest types including second-growth and old-growth Douglas fir (*Pseudotsuga menziesii*), coast redwood (*Sequoia sempervirens*), bishop pine (*Pinus muricata*), mixed conifer-hardwood, and evergreen hardwood forests (Ellis and Harrigan 2016). Range expansion of BARO (BARO; *Strix varia*) is a threat to NSOs (USFWS 2011). BAROs were first documented to breed in the Monument in 2007 (Ellis and Harrigan 2016).

Currently, there are no confirmed BAROs in Marin County. Two BAROs were collected in coordination with researchers from the California Academy of Sciences and UC Berkeley in 2015, while another radioed BARO was found dead that same year. A recent assessment of NSOs in Marin concluded that they were in good condition, with an unchanging trend, and high confidence in the assessment (Merkle and Klein 2016). This assessment was based on territory occupancy, which remains high in Marin, relatively high fecundity, and having no confirmed BAROs. Other threats to NSO in Marin County include habitat loss, structural changes in forest heterogeneity due to Sudden Oak Death (SOD), genetic isolation, disturbance from human recreational pressures, and West Nile virus (Press et al. 2010).

NSOs in and adjacent to Muir Woods are monitored on an annual basis. Three NSO territories are within or adjacent to the proposed project in Muir Woods. NSO territories in Kent Canyon and from Camp Eastwood extending to the northwest are both over 0.5 miles away from all project activities and would not be affected by project actions. The Muir Woods territory was previously centered near the Visitor Center and moved up into Camino del Canon, while a pair of BAROs occupied much of the Redwood Creek corridor of Muir Woods. With the BAROs gone, it appears the NSOs are moving back towards their previous activity center along Redwood Creek by the Visitor Center, as confirmed by detections in 2016 (these birds did not nest), and an early detection of the pair this year. In other areas where BAROs have been removed, NSOs have been shown to quickly return to previous activity centers. The Muir Woods territory of NSOs has the potential to be affected by project actions.

### ***Marbled Murrelet***

The MM is federally listed as threatened in Washington, Oregon, and California (57 FR 45328), and is listed as endangered under CESA. This species is a seabird which spends the majority of its life on the ocean, but nests in old-growth forests up to 50 miles inland (USFWS 1997). Portions of Mt. Tamalpais State Park and County-owned land directly adjacent to the Monument are designated critical habitat for this species. However, designated critical habitat for MMs does not include Muir Woods.

Although Muir Woods fits the description of breeding habitat for MMs (i.e. old-growth character forests within 50 miles of the Pacific Coast), no adult birds have been observed foraging in nearshore coastal waters during the (breeding) period 2 May – 30 June and no inland records exist for this species in Marin County (Paton and Ralph 1990, Shuford 1993, Ralph and Miller 1995, Gardali and Geupel 2000). MM surveys from 1997-1999 resulted in no evidence that Marbled Murrelets were breeding in Muir Woods; including two years monitoring inland observation points, and one year each of surveying for egg shell



fragments around potential nest trees and shore-based surveys of the nearshore waters (Gardali and Geupel 2000).

A review of eBird observations for MMs in Marin County indicates no inland observations and a handful of offshore observations from May through June. Some of these offshore observations are identified as immatures, with others not specified. Only one checklist had photo documentation of an immature MM. Inland breeding would be characterized by larger, persistent concentrations of adult MMs offshore of drainages leading to Muir Woods during this time period (Ben Becker, personal communication).

The nearest known breeding areas for MMs are to the south in San Mateo County and Mendocino County to the north.

### ***California Red-Legged Frog***

The California red-legged frog (CRLF) has not been documented at the monument, and is not likely to be present because of a lack of suitable breeding habitat. Furthermore, the project area is more than 1.6 miles from the nearest breeding site making any occurrence of California red-legged frogs in the project area very unlikely.

## **Environmental Consequences**

### ***Impacts of Alternative 1***

Under the No Action Alternative, no impacts to NSOs or MMs would occur. There would be, therefore, no effect to these T&E species. Under the No Action Alternative, no impacts to CRLF would occur. Under the No Action Alternative, Coho and Steelhead would be at a higher risk from the effects of potential sewage contamination than the action alternative.

### ***Impacts of Alternative 2***

Some project actions may occur during the NSO breeding season. Due to the location of work, the only spotted owls with the potential to be affected would be the Muir Woods territory. Project actions including staging, stockpiling and transport of materials, trenching operations, new pipeline installation, and tank removal and access would potentially create noise and some understory habitat disturbance within ¼ mile of an active nest site.

Vegetation removal would be done outside the landbird nesting season (March 1-July 31), so these activities could affect some territorial establishment and pre-nesting activities of spotted owls in this area, but would not affect actual nesting behaviors or active nest sites. No large trees would be cut during the NSO breeding season, avoiding potential for large impacts to nesting spotted owls and spotted owl habitat. In addition due to the dense forested vegetation and topographic relief at Muir Woods, some of the noise and disturbance from project actions would be dissipated even for work within ¼ mile of active nesting. Furthermore, Muir Woods with high visitation and vehicle traffic already exposes Spotted Owls to some noise and disturbance.

MMs have not been documented as breeding in Muir Woods or the rest of Marin County. Though, a two-year breeding clearance for this species has not been conducted recently, so that we cannot conclude these birds are not present in the project area. Based on previous survey work, and the high number of birders in Marin County, including coverage of nearshore areas, it is unlikely that MMs are

breeding in Muir Woods. If they are, they would be in very small numbers. Project actions including staging, stockpiling and transport of materials, trenching operations, new pipeline installation, and tank removal and access would create noise and disturbance that could affect nesting MMs, if they were present. No large trees would be cut during the MM breeding season avoiding large impacts to a nest tree or nesting habitat. Vegetation clearing for this project would occur prior to the MM breeding season. In addition due to the dense forested vegetation and topographic relief at Muir Woods, some of the noise and disturbance from project actions would be dissipated even for work within ¼ mile of active nesting. The Muir Woods soundscape is not pristine, so MMs attempting to nest in Muir Woods would be exposed to some noise and disturbance.

Implementation of Alternative 2 may affect, but would not likely adversely affect NSOs or MMs. Project actions would not affect critical habitat for NSOs. Critical habitat for MMs is present on the small portion of this project on Mt. Tamalpais State Park. Project Actions would not result in adverse modifications of critical habitat for MMs.

Project actions including vegetation removal and trenching operations would disturb the ground surface. Activities adjacent to the creek or within a close proximity to a drainage feature could result in increased, short-term turbidity during the winter-spring following construction. However, no construction activity within the active channel will occur and the only activity within the riparian corridor (Coho critical habitat) would be in the developed areas there (boardwalk and paved areas). Increased turbidity in the creek could have indirect effects including siltation of redds and impairment of recruitment. Short-term increases in instream turbidity would affect the ability of juvenile fish to feed successfully (Everest et al. 1987). Prolonged release of fine sediments from instream construction activities into downstream areas could reduce the number of invertebrate species and their densities (Wiederholm 1984).

Project actions would end by the start of the rainy season or December 1. Following construction activities, BMPs required by the SWPP will include sediment and erosion control measures to minimize losses of fine sediments to the channel. If both construction window and proper implementation of sediment BMPs are implemented, no measurable increases in turbidity during the rainy season are expected. Therefore, there would be no effect to Coho salmon and steelhead and no adverse modification of designated critical habitat.

Because California red-legged frogs are not present in the project area due to the absence of breeding habitat and the distance from existing breeding areas, project actions would have no effect on the species. Because no critical habitat for California red-legged frogs has been designated for this area, there would be no adverse modification to designated critical habitat.

### **Cumulative Impacts**

Coho Salmon and Steelhead Trout: Actions when added to the no-action or proposed action activities that could have cumulative effects on Coho or Steelhead includes temporary construction activities associated with parking area improvements and additions, culvert replacements, roadside parking closures, Muir Woods Road rehabilitation, bridge replacements or additions, trail reroutes and improvements, and stream habitat restoration. Potential short-term impacts on salmonid habitat from these activities include polluted runoff caused by soil erosion and instream channel work.

The proposed action could add short-term impacts of the other projects from polluted runoff caused by soil erosion from areas disturbed by construction. But best management practices for controlling runoff pollution and protecting hydrologic processes would be applied during all construction projects to avoid and minimize cumulative impacts to stream habitat. The no-action alternative would cause less short-term impacts, but the increasingly frequent failure and repair of water and wastewater lines would result in sewage contamination and runoff pollution adding to the cumulative impacts of the other projects.

Collectively, these projects would have long-term beneficial cumulative effects on salmonid habitat by improving parking and road drainage systems to capture runoff pollutants; closing and rehabilitating roadside parking areas and removing trail segments from erosion prone areas; and promoting natural stream stability by removing channel revetment, adding woody debris, and restoring streamside areas by removing and reclaiming part of the Entry Plaza, replacing the Dipsea Trail crossing with a footbridge, and replacing the Muir Woods Road Bridge and footbridges with wider-span bridges across Redwood Creek floodplain.

NSO: Actions when added to the no-action or proposed action activities that could have cumulative effects on NSOs would include the direct long-term modification of potential prey habitat and indirect disturbance of nesting birds caused by temporary construction activities with parking area improvements and additions, culvert replacements, roadside parking closures, Muir Woods Road rehabilitation, bridge replacements or additions, trail reroutes and improvements, and stream habitat restoration. The impacts of these activities are negligible because a relatively small area of prey habitat is affected, plus the park service would avoid doing construction work near any nesting areas during the breeding season.

Marbled Murrelet: The MM has never been documented at the monument, although old-growth forest habitat, which is suitable for nesting, does exist at the monument. The proposed action and no-action activities would not result in the destruction or degradation of MM habitat. Therefore, these alternatives would have no cumulative impacts on this species.

California Red-Legged Frog: The CRLF has not been documented at the monument, and is not likely to be present as described previously.

## **Water Resources and Hydrologic Processes**

### **Methodology and Assumptions**

This analysis of potential impacts on water resources and hydrologic processes focuses on impacts on groundwater, surface water, wetlands, water quality, and floodplains within the monument and water resources that are hydrologically connected, including the upstream and downstream reaches of Redwood Creek. Potential impacts on these resources could result from alterations or disturbance to each resource, including changes to quality, quantity, or associated functions and values. Analysis of potential impacts includes direct and indirect impacts to wetlands from trenching and potholing activities associated with the proposed rehabilitation of the water and wastewater service lines. Project actions were compared to existing wetland literature, data, maps, and professional judgment to evaluate the potential for impacts.

## **Affected Environment**

Muir Woods lies within the 8.8-square-mile Redwood Creek watershed. The headwaters of Redwood Creek include the Fern Creek, Spike Buck Creek, and upper Redwood Creek tributaries that originate on the steep southern slopes of Mt. Tamalpais (elevation of 2,571 feet). The headwater tributaries flow south and southeastward coalescing at the confluence of Redwood Creek and Fern Creek at an approximate elevation of 230 feet. Downstream of this confluence point, Redwood Creek flows at the bottom of Redwood Canyon, a northwest trending gorge characterized by steep, densely wooded slopes and a relatively narrow fluvial floodplain. Redwood Creek runs adjacent to the Redwood Creek Trail toward the main gate and entrance to Muir Woods. Topography in the Action Area generally slopes toward Redwood Creek, perpendicular to the flow direction of the creek. The Action Area ranges in elevation from approximately 140 to 300 feet above mean sea level.

Downstream of Muir Woods, Redwood Creek runs in a more southwesterly direction as it opens up to Frank Valley, which is a wider riparian corridor and alluvial floodplain than the more confined creek alignment found upstream in the Muir Woods. Kent Creek joins Redwood Creek 0.9 miles downstream of the Muir Woods. Downstream of Santos Meadow, approximately 0.7 miles downstream of the Kent Creek confluence, Redwood Creek bends to a more southerly alignment as it heads towards the Big Lagoon estuary and the Muir Beach river mouth at the Pacific Ocean.

The Redwood Creek watershed is largely undeveloped, with protected forest land managed by the Marin Municipal Water District, California State Parks (Mt. Tamalpais State Park), and NPS (Golden Gate National Recreation Area [GGNRA] at Muir Beach). The contributing watershed area upstream of the Action Area is approximately 1.9 square miles.

## ***Hydrology***

Redwood Creek is the primary hydrologic feature and resource near the Action Area. As described above, the creek's headwaters originate approximately 2.5 miles northwest of the action area on the southwestern slopes of Mt. Tamalpais. As Redwood Creek enters Muir Woods, the longitudinal profile of the creek flattens considerably, with bed slope decreasing to less than 2 percent slope.

Stream flows in Redwood Creek vary greatly. During the spring and summer dry season, flows are shallow and low in magnitude. During the late fall, winter, and early spring months, flows can be quite large responding to winter precipitation events. Base flow, the flow in the creek fed by groundwater and deeper soil moisture, and not specifically related to a single storm event, generally increases over the wet season months and then recedes into the spring and summer.

Measurements taken in the late-1980s and 2003–2004 at the Redwood Creek Bridge located at the downstream end of the action area, showed summer flows of less than 1 cubic foot per second (cfs) and peak winter flows of approximately 30 to 170 cfs, varying with different storm events. More recent measurements from a monitoring station on Redwood Creek approximately 1.5 miles downstream from the action area showed the daily discharge ranged from periods of no flow to a maximum of 431 cfs. Older records show a high flow of 2,150 cfs.

## ***Groundwater***

The underlying Franciscan bedrock in Muir Woods is relatively impermeable and non-water bearing. This results in a “perched” groundwater table where water contained in the soil and weathered rock pools

above the bedrock, accumulating during the wet season and diminishing during the dry season. Some of this water may eventually percolate downwards into the bedrock or flow laterally along the top of the bedrock until finding water-bearing sedimentary units or until daylighting in the banks or bed of creeks, ponds, springs, or other surface waters. As such, there are no operating groundwater wells in Muir Woods.

### ***Floodplains***

Executive Order 11988, “Floodplain Management,” requires an examination of impacts on floodplains and potential risk involved in placing facilities in floodplains. NPS *Management Policies 2006* and Director’s Order 77-2: *Floodplain Management* (NPS 2003) provide guidelines for proposals in floodplains.

The Action Area historically contained more overbank floodplain and terrace areas that would be inundated by larger streamflows on a more frequent basis than under current conditions. Channel inundation of historic overbank areas of Redwood Creek within Muir Woods has been reduced through modification of the channel shape, removal of in-channel LWD, streambank stabilization structures, dams, and placement of fill. These have contributed to historic channel incision. Redwood Creek is held within more rigid banks by these structures and not allowed to meander and flood historic overbank areas. Streambed incision has also contributed to the creek being hydrologically disconnected from its historic floodplains, which are now located on terraces above the stream channel.

According to Federal Emergency Management Agency (FEMA) flood insurance rate maps, no floodplains have been identified within Muir Woods. However, some areas are designated as “areas in which flood hazards are undetermined, but possible.” Hydraulic analysis indicates that the current channel generally contains 10-year peak-flood flow in most of the Monument’s developed area with limited overbanking occurring near Bridge 3, Bridge 2, and adjacent to the Entry Plaza. Under 100-year peak flood flow, flooding is extensive throughout the Monument’s developed area. Various climate models predict either increases or decreases in regional precipitation by 2080, however, there is a consensus that storm intensity and frequency, as well as flood events would be expected to increase, including scouring events.

### ***Wetlands***

The US Army Corps of Engineers (USACE) is charged with regulating the discharge of dredged or fill materials in wetlands or other “waters of the United States” under section 404 of the Clean Water Act. The US Army Corps of Engineers considers areas that are dominated by hydrophytic vegetation, contain hydric soils, and display indicators of hydrology to be a wetland. The NPS definition of wetlands is similar to that of the US Environmental Protection Agency and the US Army Corps of Engineers; however, the NPS definition is broader in scope and affords a greater jurisdiction than that of the US Army Corps of Engineers. The National Park Service classifies wetlands based on the USFWS Classification of Wetlands and Deepwater Habitats of the United States, also known as the Cowardin classification system (Cowardin et al. 1979). Based on the Cowardin classification system, a wetland must have one or more of the following attributes:

- The habitat at least periodically supports predominantly hydrophytic (wetland) vegetation
- The substrate is predominantly undrained hydric soil



- The substrate is nonsoil and saturated with water or is covered by shallow water at some time during the growing season

Site-specific wetland delineations were conducted in the project area in January to March 2013 and in December 2015 (Ryan 2016). The surveys determined that Redwood Creek is a perennial stream that is permanently flooded and interspersed with intermittently flooded in-channel vegetated islands (Ryan 2016). Ryan determined that the tributaries were seasonally flooded and/or well-drained habitat (Ryan 2016). According to the Cowardin classification, five types of wetlands occur within the project area. Redwood Creek is classified as palustrine, forested, permanently flooded (PFOH), and its tributaries are palustrine, forested, seasonally flooded/well-drained (PFOD) or palustrine, forested, temporarily flooded (PFOA). Palustrine, forested, intermittently flooded (PFOJ) wetlands are adjacent to Redwood Creek between the Main Lot and the Annex Lot and much of the lower reaches of the creek. Palustrine, forested seasonally flooded/seasonally saturated wetlands (PFOE) are located adjacent to Muir Woods Road, approximately 75 feet southeast of the Annex Lot (figure 10) (Ryan 2016). This area is considered part of the historic floodplain. The tributaries draining to Redwood Creek are classified as intermittent riverine habitats that are temporarily flooded (see Water Resource Maps in Figures 14 and 15).

## **Environmental Consequences**

### ***Impacts of Alternative 1***

Under Alternative 1, the no-action alternative, the existing water and wastewater service lines would remain the same. As a result, there would be no direct or indirect adverse impacts on surface water, water quality, and hydrologic processes. The no-action alternative would cause less short-term impacts, but the increasingly frequent failure and repair of water and sewer line could result in sewage contamination and runoff pollution.

### ***Impacts of Alternative 2***

Because the proposed project is restricted to upland areas and avoids wetlands, there are no direct impacts to wetlands. However, elements of the work would require trenching and/or potholing which would lead to the exposure of soils. These actions could result in indirect effects to hydrology and wetlands if appropriate measures are not taken to contain surface runoff and prevent the erosion of soils from work areas.

This impact would be reduced through the implementation of sedimentation and erosion control BMPs and mitigation measures to prevent the runoff of water or sediment from work areas to wetlands. Further, ground-disturbing activity would be confined to the dry season which would further minimize the potential for runoff to wetlands.

## **Cumulative Impacts**

Actions added to the no-action or proposed action activities that could have cumulative adverse effects on water resources and hydrologic processes include temporary construction activities with parking area improvements and additions, lift station improvement, stormwater infrastructure improvements, roadside parking closures, Muir Woods Road rehabilitation, bridge replacements or additions, trail reroutes and improvements, and stream habitat restoration. Short-term impacts on water resources from these activities include polluted runoff caused by soil erosion and instream channel work.

FIGURE 14. WATER RESOURCES MAP 1 OF 2

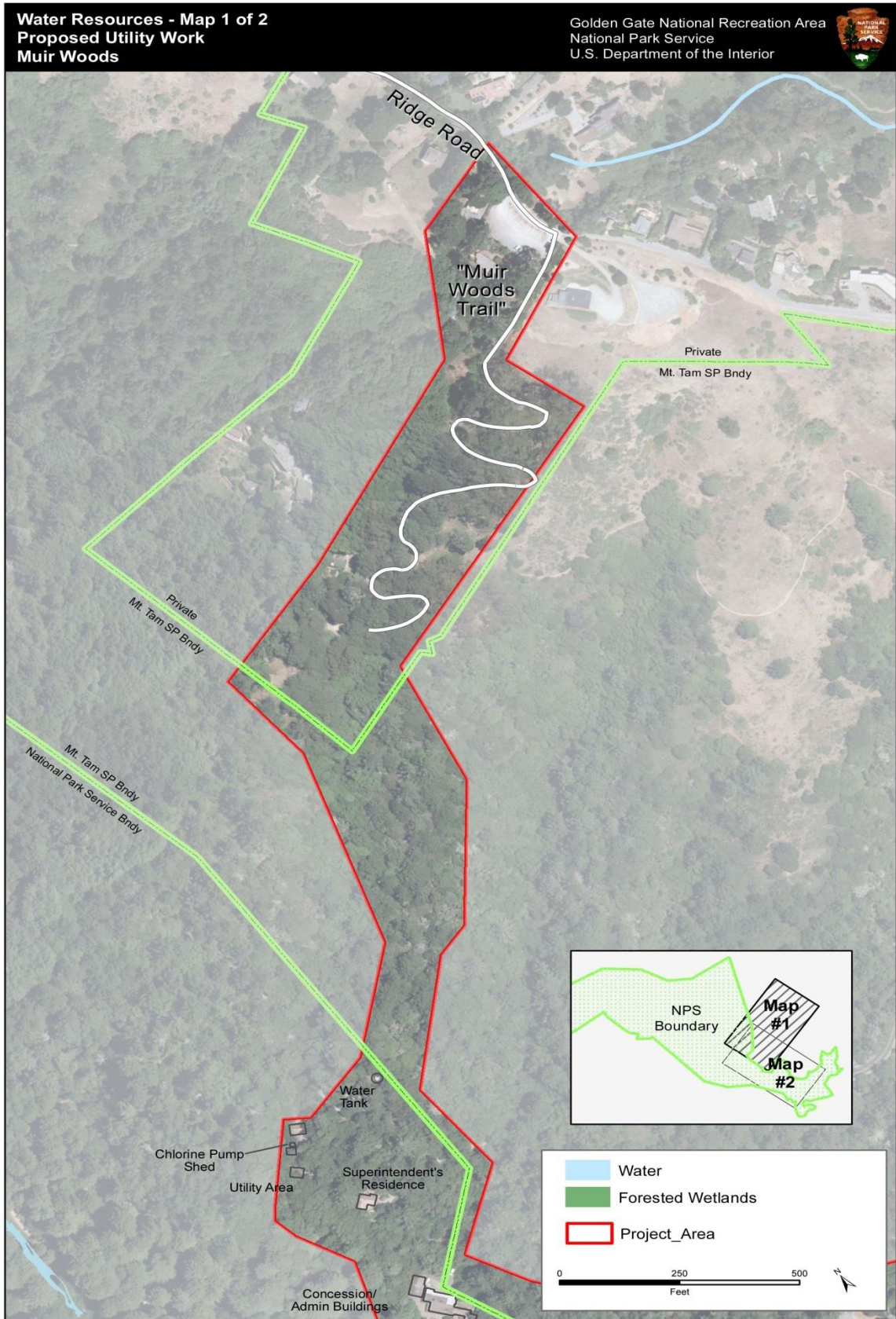
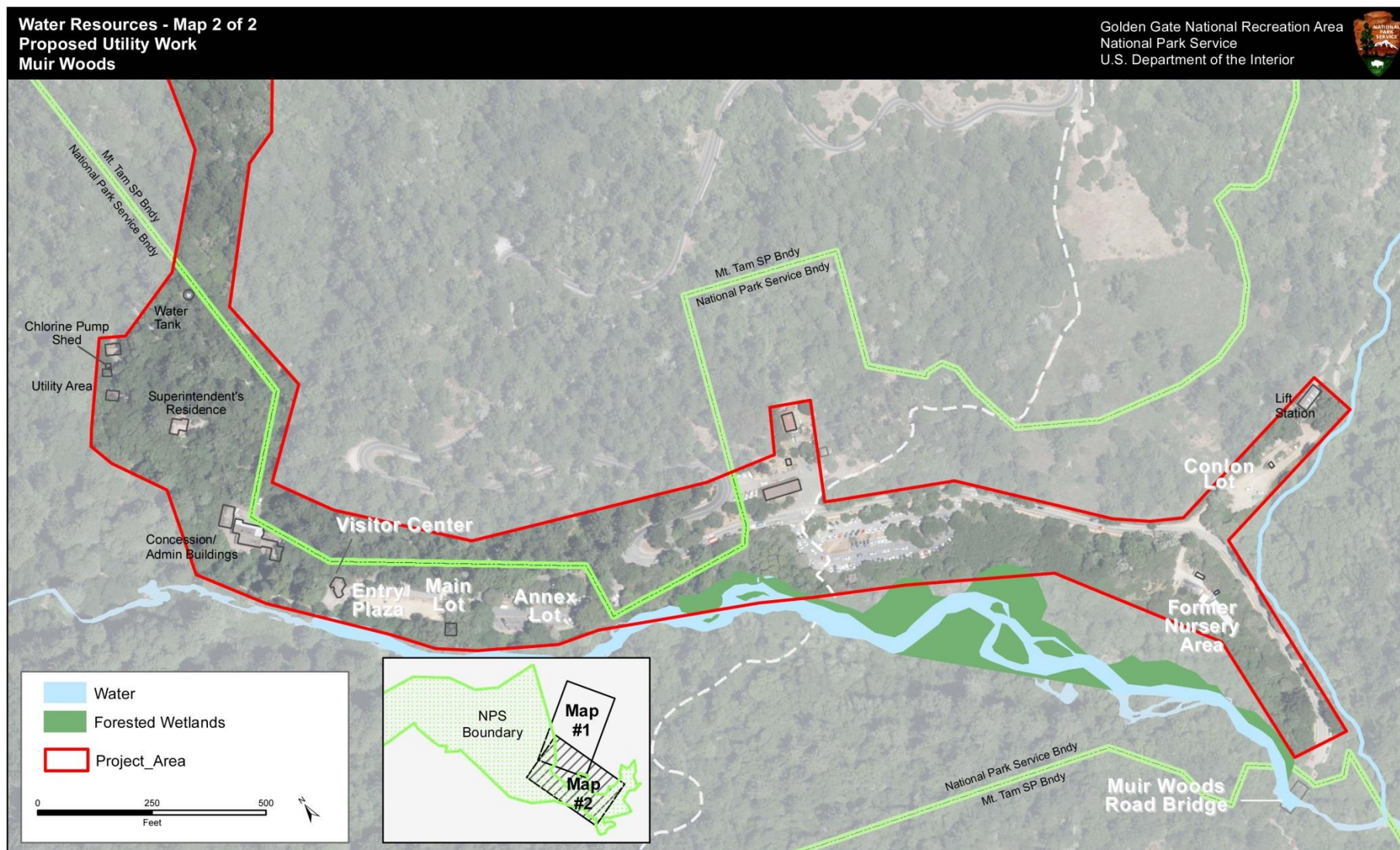




FIGURE 15. WATER RESOURCES MAP 2 OF 2



Collectively, these projects would have substantial long-term beneficial cumulative effects on water resources and hydrologic processes by improving parking and road drainage systems to capture runoff pollutants; closing and rehabilitating roadside parking areas and removing trail segments from erosion prone areas; and promoting natural stream stability by removing channel revetment, adding woody debris, and restoring streamside areas by removing and reclaiming part of the Entry Plaza, replacing the Dipsea Trail crossing with a footbridge, and replacing the Muir Woods Road Bridge and footbridges with wider-span bridges across Redwood Creek floodplain.

The proposed action could add short-term impacts of the other projects from polluted runoff caused by soil erosion from areas disturbed by construction. But best management practices for controlling runoff pollution and protecting hydrologic processes would be applied during all construction projects to avoid and minimize cumulative impacts. The no-action alternative would cause less short-term impacts, but the increasingly frequent failure and repair of water and sewer lines could result in sewage contamination and runoff pollution adding to the cumulative impacts of the other projects.

## Vegetation

### Methodology and Assumptions

Impacts considered in this analysis include vegetation disturbance from trenching operations, tank removal and access. Existing information on vegetation within the Monument was consulted and a site walk of the project area was conducted by an NPS botanist.

### Affected Environment

#### ***Redwood and Mixed Evergreen Forest***

Redwood forest is the dominant plant community in Muir Woods. Coast redwoods (*Sequoia sempervirens*) are the dominant tree species, covering approximately two-thirds of the land area. The largest redwood trees grow along the valley floor of Redwood Canyon. In addition to redwood trees, Douglas-fir (*Pseudotsuga menziesii*), California bay laurel (*Umbellularia californica*), and tanoak (*Notholithocarpus densiflorus*) are also common in the redwood forest. The herbaceous understory in the redwood forest is dominated by various ferns including western sword fern (*Polystichum munitum*) and lady fern (*Athyrium filix-femina* var. *cyclosorum*), and redwood sorrel (*Oxalis oregana*). Old-growth redwood forests have been found to store more carbon above ground than any other forest type.

Much of the project area is also comprised of mixed evergreen forest dominated by a mixed overstory of Douglas-fir and coast redwood. Other species include California bay laurel (*Umbellularia californica*), tanoak (*Notholithocarpus densiflorus*), coast live oak (*Quercus agrifolia*), and madrone (*Arbutus menziesii*). Scrub species include Eastwood manzanita (*Arctostaphylos glandulosa*), coffeeberry (*Frangula californica*), and pink honeysuckle (*Lonicera hispidula*) (Reyes, 2017).

#### ***Riparian Forest***

Riparian forests in the project area include both Red alder (*Alnus rubra*) and arroyo willow (*Salix lasiolepis*) dominated forests. These forests are found directly along Redwood Creek as well as on the flood plain terraces and surrounding areas. Other species found in the riparian forests include big leaf maple (*Acer macrophyllum*), California bay laurel, California blackberry (*Rubus ursinus*) and western sword fern.

### ***Hardwood Forest***

The project area includes buckeye (*Aesculus californica*) and coast live oak dominated hardwood forests. Other species in these forests include California bay laurel, California blackberry and coyote bush (*Baccharis pilularis*). Hardwood forests dominated by mature buckeyes such as those found in the project area are locally rare and are not represented anywhere else on park service lands in the San Francisco Bay Area. Buckeye-dominated woodlands are especially uncommon in coastal regions and likely have a high number of unique associated taxa compared to buckeye stands elsewhere (Steers et al. 2013).

### ***Special Status Plants***

The only CNPS-ranked plant known to occur within Muir Woods is California bottlebrush grass (*Elymus californicus*) (Integrated Resource Management Applications [IRMA] 2005). This species has a California Rare Plant Rank of 4.3, a rank described as “Plants of Limited Distribution” with a threat rank of “Not very threatened in California (less than 20 percent of occurrences threatened / low degree and immediacy of threat or no current threats known)” (California Native Plant Society [CNPS] 2017). This species has been mapped in multiple locations within the project area. Leopard lily (*Lilium pardalinum* spp. *pardalinum*) has also been mapped near the project area. This species has no federal, state, or CNPS listing, but is considered locally rare and is believed to have been more widespread in Muir Woods in the past (see Vegetation Maps in Figures 16 and 17).

### ***Invasive Species***

A total of 86 non-native plants are formally listed as present or probably present within Muir Woods on the official park species list (IRMA 2005) and park staff are aware of at least 125 non-native species within Muir Woods. Invasive plants within the project area include panic veldt grass (*Ehrharta erecta*) and French broom (*Genista monspessulana*) (IRMA 2005, NPS 2016). Panic veldt grass is of particular concern for spread during construction projects due to its rapid life cycle and presence within the Action Area. Volunteer and staff removal efforts have reduced the presence of invasive plants within Muir Woods (NPS 2016c), and treatment would occur prior to any construction to minimize the amount of invasive plant propagules in the project area. Large source populations of panic veldt grass occur at the upper end of the project area, so BMPs must be followed to minimize invasive plant introduction into new areas.

### ***Plant Pathogens***

Plant pathogens within the genus *Phytophthora* are known to occur within Muir Woods. The pathogen *Phytophthora ramorum* causes the plant disease Sudden Oak Death (SOD) and is known to occur within Muir Woods. The pathogen results in SOD in tanoak and several oak species, and reproduces in the foliage of other species including California bay laurel, Douglas-fir, and redwood. California bay laurel appears to be a major reservoir of *P. ramorum* inoculum. Of the known hosts of *P. ramorum*, tanoak is the most susceptible to SOD. Spores of *P. ramorum* can be found in soil and water in addition to on plant material. SOD has caused extensive tanoak mortality as well as some coast live oak mortality within Muir Woods and is present within the project area.

Soil-born species of *Phytophthora* have been identified in both GGNRA nurseries and in the wild. Soil-born *Phytophthora* species are common in nursery and agricultural settings and some species, such as *P. cinnamomi*, have the potential to cause extensive plant mortality in wildland settings. NPS is working to



limit the spread of these plant pathogens through improved sanitation practices in the park nurseries, during project implementation, and by staff.

## **Environmental Consequences**

### ***Impacts of Alternative 1***

Under the No Action Alternative 1, impacts on special-status or locally rare plants would not occur.

### ***Impacts of Alternative 2***

Project-related disturbance would impact native vegetation. This impact would be reduced through revegetation of disturbed areas. Implementation of BMPs and mitigation measures would reduce impacts to existing native vegetation including tree roots. Limited impacts on rare plants are anticipated because protective measures would be implemented.

The presence of construction crews and heavy equipment could potentially spread non-native invasive plant species in the Monument. BMPs would be implemented to limit the spread of invasive plant species by construction equipment, minimizing this risk. NPS Vegetation staff would treat invasive plants prior to construction in order to minimize invasive plant propagules within the site that could be spread to new areas.

## **Cumulative Impacts**

Actions when added to the no-action or proposed action activities that could have cumulative effects on vegetation in the analysis area includes temporary construction activities with parking area improvements and additions, lift station improvement, stormwater infrastructure improvements, roadside parking closures, Muir Woods Road rehabilitation, bridge replacements or additions, trail reroutes and improvements, and stream habitat restoration. Most of these activities would cause a minimal loss of vegetation and not affect rare plants because they have occurred or would occur on or near developed areas where vegetation has been previously disturbed and no rare plant habitat is present.

The no-action alternative would cause fewer short-term impacts, but the increasingly frequent failure and repair of water and sewer line would disturb small areas of vegetation adding to the long-term cumulative impacts of the other projects. Best Management Practices for controlling invasive plants and protection vegetation would be applied during all construction activities to minimize impacts on vegetation and rare plants. Disturbed areas, including construction sites, closed road shoulder parking areas, abandoned trail segments, and areas affected by the proposed action or no-action alternative would be regraded and replanted at each site resulting in long-term beneficial impacts on vegetation.

## **Visitor Use, Experience, and Safety**

### **Methodology and Assumptions**

The analysis of visitor use, experience and safety was based on reviewing the visitation demand forecast to determine future visitation to the monument and the resulting potential increase in traffic that would need to be accommodated. The analysis considered the following elements:

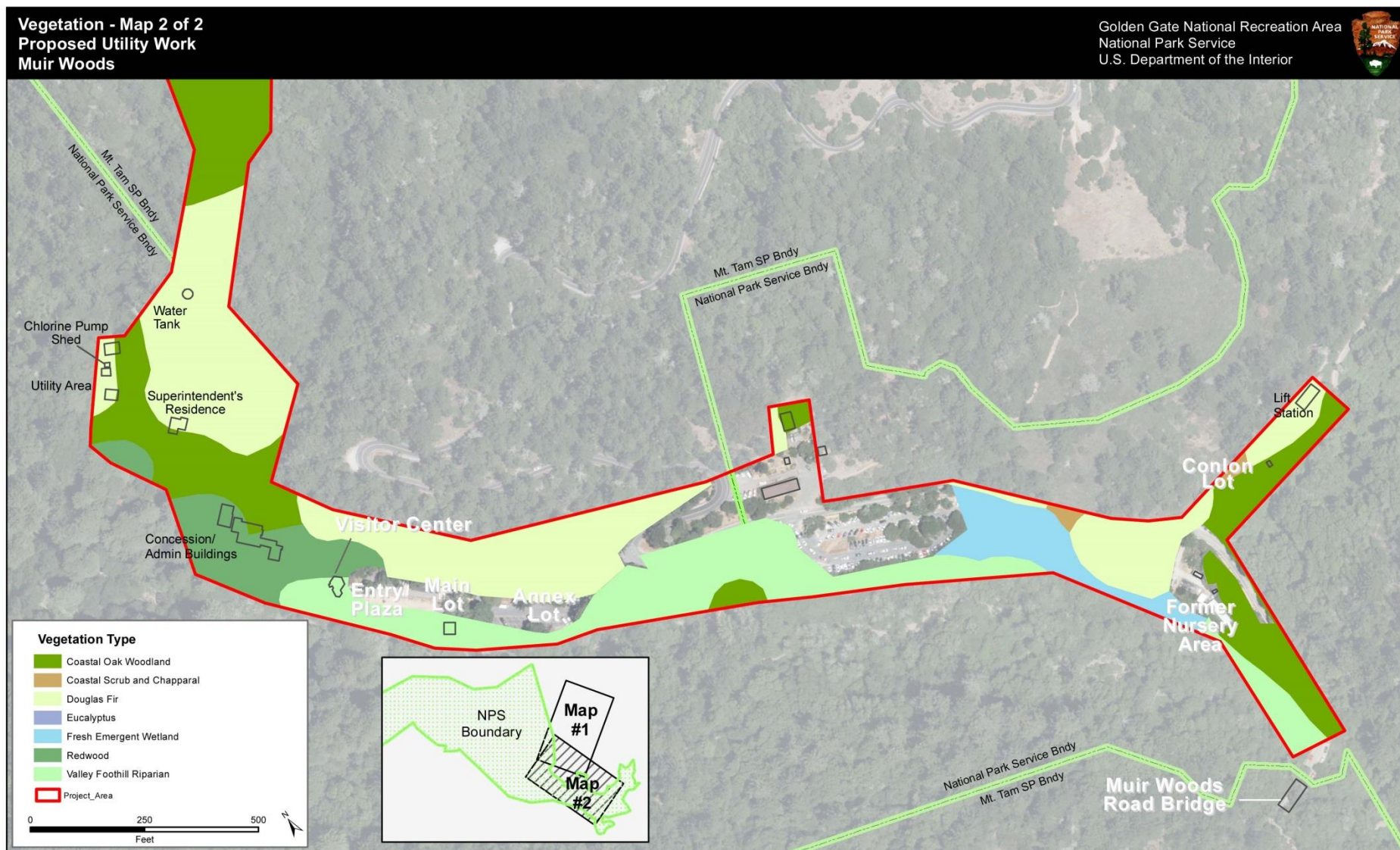
- implementing measures to ensure visitors do not experience crowded conditions
- evaluating the visitor arrival, entrance, and departure experience at the monument

FIGURE 16. VEGETATION MAP 1 OF 2





FIGURE 17. VEGETATION MAP 2 OF 2



- addressing wayfinding to assist visitors in finding parking lots and navigating the trail system
- evaluating amenities available to visitors
- evaluating the availability and location of accessible compliant parking spaces
- assessing the availability of interpretive and educational opportunities that prepare visitors for their experience at the monument
- evaluating emergency access and circulation to ensure emergency personnel can quickly access facilities at the monument

Each of these elements are evaluated under the two alternatives. Visitor safety covering vehicle to vehicle and vehicle to pedestrian conflicts are covered in the “Transportation” section.

### **Affected Environment**

Current visitor experience and visitor safety conditions at the monument have played a key role in the purpose of, and need for, action, and are a result of visitation levels and arrival rates that exceed the monument’s user capacity.

### **Environmental Consequences**

#### ***Impacts of Alternative 1***

Alternative 1 would have no impacts to visitor use, experience and safety.

#### ***Impacts of Alternative 2***

Alternative 2 would result in temporary short term impacts on the visitor experience associated with sights and sounds of construction activities. Visitors may also experience some temporary traffic delays or limited access to parking and trails during periods of construction in the Entry Plaza, Main Lot, Annex Lot, and Muir Woods Road. Each of these locations is expected to be affected for periods of between 1-3 weeks. The impacts during these periods would be reduced through scheduling and traffic control measures to avoid impacts to the greatest extent possible. Emergency access would be maintained at all times. Visitor access adjacent to active construction sites would be supported by installation of construction fencing and signage.

### **Cumulative Impacts**

Actions when added to the no-action or proposed action activities that could have cumulative effects on visitor experience and safety in the analysis area includes temporary construction activities associated with parking area improvements and additions, lift station replacement, stormwater infrastructure improvements, roadside parking closures, Muir Woods Road rehabilitation, bridge replacements or additions, trail reroutes and improvements, and stream habitat restoration. The temporary sights and sounds of construction activities would cause short-term intrusions on the visitor experience. Visitors may also experience some temporary traffic delays or limited access to parking and trails during construction periods. Construction for the various projects would be phased and limited to low visitor use periods to the extent feasible to help minimize these short-term impacts. The no-action alternative would cause less short-term impacts, but construction related to the increasingly frequent failure and repair of water and sewer line could add to the short-term cumulative impacts of the other projects.



Upon completion of the proposed action and the other projects, the upgraded sewer and water system and the new lift station would eliminate the risk of sewage contamination or loss of drinking water due to failure of an aging system. Plus the improved drainage features, road, parking areas, bridges, and trails that would ensure safe and enjoyable driving or walking conditions resulting in overall long-term beneficial cumulative impacts on the visitor experience and safety. The no-action alternative would not add long-term cumulative impacts.

## Transportation and Parking

### Affected Environment

High visitation rates and limited parking and road capacity have adversely impacted transportation to and within Muir Woods resulting in traffic congestion, illegal parking, and unsafe conditions for pedestrians. During peak visitation times, traffic can back up along Muir Woods Road, Panoramic Highway, Highway 1, and onto Highway 101. To address this, in 2015, shoulder parking areas on upper and lower Muir Woods Road were fenced off to prevent parking and an additional parking lot was added at lower Conlon Avenue. The upcoming implementation of a reservation system and the Sustainable Access Project would alter visitation rates, parking availability, and transportation options in the monument.

Trails: Multiple trails are located within the project area that provide access to the Entry Plaza and the monument. The Redwood Creek Trail, Dipsea Trail, and Deer Park Fire Road all provide pedestrian access from shoulder parking along Muir Woods Road into the monument. Redwood Creek Trail also extends between the Main Lot and the Annex Lot. Nearby public lands, including Mount Tamalpais State Park, provide trail access directly into the monument. However, because few visitors are aware of these alternate and historic access opportunities and because wayfinding signage is currently inadequate, most visitors walk directly through parking lots or along the side of Muir Woods Road before arriving at the Entry Plaza (NPS 2012c, 2014a). Dipsea Trail, which traverses the project area, drops steeply down a stairway to Muir Woods Road across from the Annex Lot. Trail users must cross Muir Woods Road and the Annex Lot to continue along the trail to cross the wooden plank at Redwood Creek, which is often removed in the winter and spring because it washes away during high flows.

Muir Woods Road: Muir Woods Road provides the primary access to the monument. The road is between 24 and 30 feet wide and has a striped centerline to indicate no passing is allowed. The posted speed limit has a county-designated speed varying between 25 and 35 miles per hour (25 miles per hour within the entire monument area). The National Park Service works cooperatively with the County Sheriff and California Department of Parks and Recreation with enforcement on Muir Woods Road. Marin County owns and maintains the roadway (NPS 2012d).

Travel modes into Muir Woods include pedestrian, bicycle, transit, and privately owned vehicle. Pedestrians can access the monument via trails outside of the monument's boundaries. However, bicycles, transit, and privately owned vehicles provide the majority of transportation into and out of the monument.

Parking: Parking is provided in four off-street lots and informally permitted along Muir Woods Road. The off-street lots are the Entry Plaza (with 9 spaces for visitors with disabilities and 2 spaces for privately owned vehicles), the Main Lot (43 spaces), the Annex Lot (114 spaces), and the Conlon Lot (49

spaces). Shoulder parking is allowed along the westbound side of Muir Woods Road beginning east of the Conlon Lot. Up to 31 shoulder parking spaces exist between the Conlon Lot and Muir Woods Road Bridge. On the Mount Tamalpais State Park side of Redwood Creek, informal shoulder parking occurs on both sides of Muir Woods Road.

## **Environmental Consequences**

### ***Impacts of Alternative 1***

None

### ***Impacts of Alternative 2***

Parking would be impacted to install the sewer through the main lot and annex lot. Conlon Parking lot or a portion of it would be used a permanent staging area. Accessible parking would remain available throughout the project with only minor impacts. In the Main parking lot only the entrance side of the lot would be closed and traffic would be able to access the accessible parking and the parking on exit side of the lot. In the Annex lot only the western half of the parking lot would be impacted and traffic would be able to enter and exit from the southern entry/exit gate. Traffic would be impacted while the sewer line is installed in Muir Woods Road from the Main lot to the Annex Lot. There would be one-lane traffic control during this portion of the work.

## **Cumulative Impacts**

Phase 1 of the reservation system removed some shoulder parking from Muir Woods Road, thus limiting the number of visitors who can arrive by privately owned vehicle. The reservation system would also limit the number of vehicles parking at the monument and reduce the number of vehicles entering and exiting the monument at one time. As a result, fewer vehicles would be driving to the monument and fewer drivers would be searching for parking, especially during peak times, resulting in reduced traffic congestion and improved safety along Muir Woods Road where shoulder parking is removed. The reduction of available privately owned vehicle parking is also forecasted to result in increased bus and shuttle use as the modal split shifts to alternative transportation modes. Therefore, implementation of the reservation system would have long-term, beneficial impacts on transportation.

The Muir Woods Road Bridge Replacement Project would replace an existing structure and improve the roadway alignment by removing an “S” curve or reverse curve where drivers must transition from a right roadway curve directly into a left roadway curve without the road straightening out to provide a safe transition between the curves. This geometric improvement would improve vehicle safety; therefore, the project would result in short-term, adverse impacts on transportation during the construction period and long-term, beneficial impacts on transportation once it is complete.

The Muir Woods Road Rehabilitation Project would resurface portions of Muir Woods Road and address the poor condition of the road where the pavement contains cracks, the shoulder has disappeared, and lane striping has faded or disappeared. A newly resurfaced pavement would improve vehicle safety; therefore, the project would result in short-term, adverse impacts on transportation during the construction period and long-term, beneficial impacts on transportation once the project is complete.

The Muir Woods Lift Station Rehabilitation Project would install pipe connecting the two lift stations in the Nursery and Conlon Lots. During construction, impacts on transportation would be short term and

adverse, potentially causing traffic congestion and safety issues, but these issues would be minimized because the project would be coordinated with Marin County and the Muir Woods Road Rehabilitation Project.

Impacts from cumulative projects would result in short-term, adverse and long-term, beneficial impacts. When the adverse impacts of alternative 1 are combined with the beneficial effects of cumulative actions to transportation, an overall long-term, adverse cumulative impact on transportation is expected from the remaining pedestrian and parking safety issues.

Under the No Action Alternative, pedestrian and parking safety issues would remain because parking lot circulation, shoulder parking between Muir Woods Road Bridge and Conlon Lot, shoulder parking south of Muir Woods Road Bridge, and parking lot driveway access to Muir Woods Road would remain unchanged, resulting in long-term adverse impacts.

Cumulative impacts on transportation would be limited, short term, and adverse during the construction period for the cumulative projects as well as long term and beneficial from resurfacing the pavement, replacing an old bridge, prohibiting shoulder parking, and implementing the reservation system. The impacts of the cumulative actions are beneficial; however, alternative 1 would contribute adverse impacts and would not address vehicle and pedestrian safety concerns. The contribution of alternative 1 to the cumulative impacts would be substantial because the vehicle and pedestrian safety in the parking lots would not be improved, resulting in an overall adverse cumulative impact.

Alternative 2 would result in short-term, adverse and long-term, beneficial impacts on transportation. Implementation of mitigation and safety measures in potentially problematic locations as noted in chapter 2 would further minimize most of the impacts to provide overall long-term benefits. When the impacts of alternative 2 are combined with the effects of cumulative actions, an overall long-term, beneficial cumulative impact on transportation is expected.

Many of the safety issues would be addressed through reducing the number of driveways crossing pedestrian trails and posting signs to warn drivers of approaching pedestrian crossings. Shoulder parking north of the Muir Woods Road Bridge would remain in place and continue to create unsafe vehicle conditions from potential U-turns to access the parking spaces and unsafe pedestrian conditions for visitors to walk between their vehicles to the opposite side of the roadway to access the trail to the monument.

There would be limited, short-term, adverse cumulative impacts on transportation during the construction period of the cumulative projects as well as greater long-term beneficial impacts from resurfacing the pavement, replacing an old bridge, prohibiting shoulder parking, and implementing the reservation system. The impacts of the cumulative actions would be beneficial and, combined with the impacts from Alternative 2, would continue to be beneficial, especially addressing vehicle and pedestrian safety in the parking lots. A few safety issues would remain, specifically shoulder parking; however, the contribution of Alternative 2 to the cumulative impacts would result in an overall beneficial cumulative impact.

## Chapter IV

# Consultation and Coordination

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A combination of public involvement and agency consultation, including internal scoping, has helped guide the NPS in developing this Muir Woods Water and Wastewater Rehabilitation Project Environmental Assessment.

### **Public Involvement**

Public scoping for this environmental assessment began with a public notice issued on February 24, 2017. The document contained information on the project and was posted on the NPS Planning, Environment, and Public Comment (PEPC) website. The public comment period closed on March 17, 2014.

The environmental assessment would be open for formal public and agency review for 28 days. Interested individuals, agencies, and organizations would be notified of its availability. The document would be available for public review on the NPS Planning, Environment, and Public Comment website at <https://parkplanning.nps.gov/projectHome.cfm?projectId=64419>, and hard copies would be available at the monument, GGRNA headquarters at Fort Mason, San Francisco, and local public libraries.

### **Agency Consultation**

The National Park Service has initiated consultation with appropriate agencies during the preparation of this environmental assessment. The consultation is discussed in more detail below. Copies of correspondence between the National Park Service and other agencies, and responses from the agencies, if applicable, would be provided in the decision document.

### **Section 7 of the Endangered Species Act**

Section 7 of the Endangered Species Act requires federal agencies to consult with the US Fish and Wildlife Service regarding the potential for proposed actions to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. As described in the “Threatened or Endangered Species” section of chapter 3, federally listed species and designated critical habitat occur in the vicinity of the project area. As a result, the National Park Service has sought concurrence from both the US Fish and Wildlife Service and the National Marine Fisheries Service on the determination that the project may affect, but is not likely to adversely affect, federally listed species.

### **Section 106 of the National Historic Preservation Act**

Section 106 of the National Historic Preservation Act requires federal agencies to take into account the impacts of their undertakings on historic properties. This environmental assessment evaluates impacts on cultural resources according to NPS *Management Policies 2006*. Compliance with Section 106 of the National Historic Preservation Act is being carried out separately but concurrently with the NEPA compliance process.



## References

- American Association of State Highway and Transportation Officials (AASHTO). 2011. *Policy on Geometric Design of Highways and Streets*. American Association of State Highway and Transportation Officials, Washington DC. 2011.
- Anderson, J. K., B. Pryor, and C. Pilkington 2015. *Preliminary Assessment of relocating the lower portion of the Conlon/Camino del Cañon Tributary within the Golden Gate National Recreation Area, Marin County, CA*. Technical Memorandum. Northern Hydrology and Engineering. Prepared for National Park Service, Golden Gate National Recreation Area.
- Anderson, J. K., B. Pryor, C. Pilkington, and C. Penny 2016. *“Redwood Creek Pedestrian Bridge Hydrologic and Hydraulic Assessment within the Muir Woods National Monument, Marin County, California.”* Technical Memorandum. Northern Hydrology and Engineering. Prepared for National Park Service, Golden Gate National Recreation Area. August 1.
- Armour, C. L. 1991. *Guidance for Evaluating and Recommending Temperature Regimes to Protect Fish*. US Department of the Interior, Fish and Wildlife Service.
- Bay Area Stormwater Management Agencies Association (BASMAA). 2014. *Post-Construction Manual: Design Guidance for Stormwater Treatment and Control for Projects in Marin, Sonoma, Napa, and Solano Counties*.  
<http://www.marincounty.org/~media/files/departments/pw/mcstoppp/development/basmaa-postconstruction-manual.pdf?la=en>.
- Behar, S. 1997. *Testing the Waters: Chemical and Physical Vital Signs of a River*. Montpelier, VT: River Watch Network. SBN-0-782-3492-3. (not seen, as cited in Wallitner 2016).
- California Department of Fish and Game (CDFG). 2004. *Recovery Strategy for California Coho Salmon*. Report to the California Fish and Game Commission. February 2004. 594 pp.
- California Department of Fish and Wildlife (CDFW). 2015. *Recovery Strategy for California Coho Salmon Progress Report 2004-2012*. A Report Prepared for the California Fish and Game Commission. 296 pp.
- Coopridge, M. 2004. San Francisco Area Network Preliminary Water Quality Status Report.
- Council on Environmental Quality (CEQ). 2016. *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews*. Executive Office of the President,

- Council on Environmental Quality, Washington DC. August 1.  
<https://www.whitehouse.gov/administration/eop/ceq/initiatives/nepa/ghg-guidance>.
- Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. US Department of the Interior, Fish and Wildlife Service, Washington, DC. Pp.131.
- Department of Defense, Department of Housing and Urban Development, General Services Administration, and US Postal Service (DoD, HUD, GSA, and USPS). 2015. Architectural Barriers Act (ABA) Standards (2015). <https://www.access-board.gov/attachments/article/1029/ABASTandards.pdf>.
- Ellis, T..2016. *Monitoring NSO Owls on Federal Lands in Marin County, California*. Prepared for the National Park Service, Inventory and Monitoring Program.
- Environmental Science Associates (ESA). 2014. *Redwood Creek – Channel Migration and Vulnerability Study*. Prepared for Golden Gate National Parks Conservancy. May 2014.
- Evans Mack, D., W. P. Ritchie, S. K. Nelson, E. KuoP a g e | 80-Harrison, P. Harrison, and T. E. Hamer. 2003. *Methods for surveying marbled murrelets in forests: a revised protocol for land management and research*. Pacific Seabird Group. Accessed October 10, 2016.  
[https://www.pacificseabirdgroup.org/publications/PSG\\_TechPub2\\_MAMU\\_ISP.pdf](https://www.pacificseabirdgroup.org/publications/PSG_TechPub2_MAMU_ISP.pdf).
- Federal Emergency Management Agency (FEMA). 2009. *Flood Insurance Rate Map Number 06041C0465D for Marin County, California and Incorporated Areas.* May 4, 2009. Accessed May 22, 2016. <https://msc.fema.gov/portal/search>.
- Fong, D. 2002. *Summer 1995 Stream Habitat and Benthic Macroinvertebrate Inventory, Redwood Creek, Marin County, California*. Prepared for the National Park Service, Golden Gate National Recreation Area, Division of Natural Resource Management and Science, San Francisco, CA. (not seen, as cited in NPS 2014a).
- Forman, R. T. T., and L. E. Alexander. 1998. *Roads and Their Major Ecological Effects*. Annual Review of Ecology and Systematics 29:207–231.
- Gavette, P. 2016. *Archeological Survey for the Muir Woods Parking Entrance Extension Planning, Muir Woods National Monument, California*.
- Georgakakos, A., P. Fleming, M. Dettinger, C. Peters-Lidard, T. C. Richmond, K. Reckhow, K. White, and D. Yates. 2014. *Water Resources*. In Climate Change Impacts in the United States: The Third National Climate Assessment, edited by J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe. U.S. Global Change Research Program 69-112.  
<http://nca2014.globalchange.gov/report/sectors/water>.

- Gerow, K., N. C. Kline, D. E. Swann, and M. Pokorny. 2010. *Estimating Annual Vertebrate Mortality on Roads at Saguaro National Park, Arizona*. Human-Wildlife Interactions 4:283–292.
- Kelly, E. G., E. D. Forsman, and R. G. Anthony. 2003. *Are BAROs Displacing Spotted Owls?*. The Condor 105:45–53.
- Kimball, L. C., and G. M. Kondolf. 2002. *Analysis of Channel Geomorphology and Habitat Forming Processes for Feasibility Assessment of Rip-rap Removal, Muir Woods National Monument, Mill Valley, California*. Prepared for the National Park Service. May 2002.
- Madej, M. A. 2010. *Analysis of trends in climate, streamflow, and stream temperature in north coastal California*. Bull Creek near Weott USGS Humboldt. 1961:72–8.
- Marin Transit. 2015. *2015 Muir Woods Shuttle Evaluation Report*.
2016. Muir Woods Shuttle Schedule. Accessed May 16, 2016.  
<http://www.marintransit.org/routes/66.html>.
- McBride, J. and D. Jacobs. 1978. *The History of the Vegetation at Muir Woods National Monument*. Prepared for the National Park Service, San Francisco, California.
- Wiederholm, T. 1984. *Response of aquatic insects to environmental pollution*. Pages 508–557. In: V. Resh and D. Rosenberg (eds). *The ecology of aquatic insects*. Praeger Publishers. New York, NY.
- Everest, F. Wh., R. L. Beschta, J. C. Scrivener, K. V. Koski, J. R. Sedell, and C. J. Cederholm. 1987. *Fine sediment and salmonid production: a paradox*. Pages 98–141. In: E. O. Salo and T. W. Cundy (eds.). *Streamside management: forestry and fishery interactions*. Contribution No. 57; Univ. of Washington, Seattle.
- National Marine Fisheries Service (NMFS). 2012. *Final Recovery Plan for Central California Coast Coho Salmon (Oncorhynchus kisutch) Evolutionarily Significant Unit*. National Marine Fisheries Service, Southwest Region, Santa Rosa, California.
- National Marine Fisheries Service (NMFS). 2016. *5-Year Review: Summary and Evaluation of Central California Coho Salmon*. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, West Coast Region. April 2016. 48 pp.
- National Parks Conservation Association (NPCA). 2009. *Muir Woods National Monument State of the Parks Natural Resources Assessment*. Report Prepared for the National Parks Conservation Association Center for State of the Parks.
- Muir Woods National Monument: A Resource Assessment. 2011. *State of the Parks*. 36 pp.  
<https://www.nps.gov/muwo/learn/management/upload/State-of-the-Parks-MUWO-by-NPCA.pdf>.

- National Park Service, US Department of the Interior (NPS). No Date. *Plan your Visit*. Webpage. Accessed May 16, 2016.  
<https://www.nps.gov/muwo/planyourvisit/upload/Parking-v-2-2.pdf>.
1995. *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*. Prepared by Kay D. Weeks and Anne E. Gimmer for the US Department of the Interior, National Park Service, Cultural Resources Stewardships and Partnerships, Heritage Preservation Services, Washington DC.
1999. *Fort Baker Plan Final Environmental Impact Statement*. Golden Gate National Recreation, Area Marin County, California. October 1999.
2000. *Director's Order 47: Soundscape Preservation and Noise Management*. NPS Office of Policy.
2001. *Director's Order 12 Handbook*.  
<http://planning.nps.gov/document/do12handbook1.pdf>.
2002. *Director's Order 77-1: Wetland Protection*. NPS Office of Policy.
2003. *Director's Order 77-2: Floodplain Management*. NPS Office of Policy.
2005. *Fire Management Plan Final Environmental Impact Statement*. Golden Gate National Recreation Area. November 2005.
2006. *Management Policies 2006*. Accessed October 2015. <http://www.nps.gov/policy/mp2006.pdf>.
2009. *General Management Planning Dynamic Sourcebook*. Version 2.2, December 2009. NPS-DOI. Accessed May 23, 2016.  
[http://parkplanning.nps.gov/files/GMPSourcebook/GMPSourcebook\\_Dec2009ver2.2.pdf](http://parkplanning.nps.gov/files/GMPSourcebook/GMPSourcebook_Dec2009ver2.2.pdf).
- 2011a. *Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision-Making*. Washington, DC.
- 2011c. *Redwood Creek Watershed Assessment*. Prepared by Stillwater Sciences and Horizon Water and Environment, LLC. August 2011.  
<http://www.nps.gov/goga/learn/management/redwood-creek-watershed-assessment.htm4/>.
- 2012a. *Climate Change Action Plan 2012–2014*. National Park Service. November 2012.  
[http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjhxOnqp4rPAhWBdiYKHUuyDt8QFggeMAA&url=http%3A%2F%2Fwww.nature.nps.gov%2Fclimatechange%2Fdocs%2FNPS\\_CCActionPlan.pdf&usg=AFQjCNHG36Lq2qCMwhgCnFmARRXY9QNbA](http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjhxOnqp4rPAhWBdiYKHUuyDt8QFggeMAA&url=http%3A%2F%2Fwww.nature.nps.gov%2Fclimatechange%2Fdocs%2FNPS_CCActionPlan.pdf&usg=AFQjCNHG36Lq2qCMwhgCnFmARRXY9QNbA).



- 2012b. *Technical Memorandum #4: Visitor Experience*. Muir Woods National Monument Transportation and Access Planning. June 2012.
- 2012c. *Technical Memorandum #1: Muir Woods Transportation and Access Planning*. Muir Woods National Monument Transportation and Access Planning.
- 2012d. *Technical Memorandum #3: Transportation*. Muir Woods National Monument Transportation and Access Planning. June 2012.
- 2013a. *Vegetation Resource Surveys in Muir Woods National Monument Parking Alternatives Project. Results of Vegetation Mapping, Floristic Surveys, and Focused Rare Plant Species Surveys*.
- 2013b. *Personal Communication between Robert Steers and Steven Culver, National Park Service*.
- 2014a. *Golden Gate National Recreation Area and Muir Woods National Monument Final General Management Plan / Environmental Impact Statement*.  
<https://parkplanning.nps.gov/document.cfm?parkID=303&projectID=15075&documentID=58777>.
- 2014b. *User Capacity Ranges to Support Transportation and Visitor Experience Planning, Muir Woods National Monument*.
- 2015a. *National Park Service NEPA Handbook*.  
<http://www.nps.gov/applications/npspolicy/DOrders.cfm>.
- 2015b. *Muir Woods National Monument Reservation System Environmental Assessment*. Accessed October 2015.  
<http://parkplanning.nps.gov/documentsList.cfm?projectID=48272>.
- 2015c. *Finding of No Significant Impact, Muir Woods National Monument Reservation System*. Accessed September 2016.
- 2015d. *Memorandum of Understanding between National Park Service and County of Marin, Signed June 30, 2015*.
- 2016a. *Personal communication between Lee Terzis, National Park Service, Denver Service Center, and Derrick Rosenbach, Louis Berger, concerning dismissal of Indian Trust Resources and Indian Sacred Sites*. October 19.
- 2016b. *Personal communication between Brian Aviles, Golden Gate National Recreation Area, and Derrick Rosenbach, Louis Berger, on the placement of restrooms at Muir Woods National Monument*. June 28.
- 2016c. *Muir Woods Hiking Trails*. Accessed May 16, 2016.  
<https://www.nps.gov/muwo/planyourvisit/hiking-trails.htm>.

- 2016d. *Personal communication between Darren Brown and Steve Culver on vehicle traffic at Muir Woods National Monument*. September 21.
- 2016e. *2016–2017 Commercial Carrier CUA Application Package*. Accessed September 28, 2016.
- 2016f. *Vascular Plants at Muir Woods National Monument*. NPSpecies Report. Accessed June 6, 2016. <https://irma.nps.gov/NPSpecies/Search/SpeciesList>.
- 2016g. *Freshwater Quality Monitoring in the San Francisco Bay Area Network 2011-2012 Biennial Report*. Natural Resource technical Report NPS/SFAN/MRTR—2013/801. October 2013. [http://www.sfnps.org/download\\_product/4478/0](http://www.sfnps.org/download_product/4478/0).
- 2016h. *Biological Assessment for the Sustainable Access Project at Muir Woods National Monument*.
- 2016i. *Request for concurrence from the California State Historic Preservation Officer regarding the adequacy of the Area of Potential Effects for Muir Woods National Monument*.
- National Park Service and Marin County. 2007. *Wetland and Creek Restoration at Big Lagoon, Muir Beach, Marin County, Final Environmental Impact Statement/Environmental Impact Report*. Report SCHB #2004042143.
- Nature Conservancy, The. 2009. *Climate Wizard for California, Change in Annual Temperature by the 2080s*. <http://www.climatewizard.org/>.
- Nearing, M. A., F. F. Pruski, and M. R. O’Neal. 2004. *Expected Climate Change Impacts on Soil Erosion Rates: A review*. Journal of Soil and Water Conservation 59(1):43–50. Accessed on May 27, 2016. [http://animalagclimatechange.org/wp-content/uploads/Expected\\_climate\\_change\\_impacts\\_on\\_soil\\_erosion1.pdf](http://animalagclimatechange.org/wp-content/uploads/Expected_climate_change_impacts_on_soil_erosion1.pdf).
- Roche, L., L. Kromschroeder, E. Atwill, R. Dahlgren, and K. Tate. 2013. *Water Quality Conditions Associated with Cattle Grazing and Recreation on National Forest Lands*. PLoS ONE 8(6): E68127. DOI:10.1371/journal.pone.0068127. (not seen, as cited in Wallitner 2016).
- Ryan, A. 2016. *Delineation of Wetlands and “other Waters” at Redwood Creek and Vicinity, Muir Woods National Monument, Golden Gate National Recreation Area*. National Park Service, Marin County, CA. February 2016.
- San Francisco Bay Region Water Quality Control Board (San Francisco RWQCB). 2013. *San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan)*. June 29, 2013. [http://www.waterboards.ca.gov/sanfranciscobay/water\\_issues/programs/planningtmdls/basinplan/web/docs/BP\\_all\\_chapters.pdf](http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/basinplan/web/docs/BP_all_chapters.pdf).

- Trombulak, S. C., and C. A. Frissell. 2000. *Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities*. Conservation Biology 14:18–30.
- US Department of Agriculture, Natural Resources Conservation Service (USDA, NRCS). 2016. *Web Soil Survey*. Accessed May, 26, 2016. <http://websoilsurvey.nrcs.usda.gov/>
- US Department of Agriculture, Soil Conservation Service, (USDA, SCS). 1985. *Soil Survey of Marin County, California*. Accessed May, 26, 2016. [http://www.nrcs.usda.gov/Internet/FSE\\_MANUSCRIPTS/california/marinCA1985/marinCA1985.pdf](http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/california/marinCA1985/marinCA1985.pdf).
- US Environmental Protection Agency (USEPA). 1998. *Environmental Justice Guidance*.
2000. *Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregion III*. EPA 822-B-00-016. <http://www2.epa.gov/nutrient-policy-data/ecoregional-nutrient-criteria-documents-rivers-and-streams>.
2008. *Green Parking Lot Resource Guide*.  
<https://nepis.epa.gov/Exe/ZyNET.exe/P100D97A.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2006+Thru+2010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C06thru10%5CTxt%5C00000031%5CP100D97A.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL>.
- US Fish and Wildlife Service (USFWS). 1997. *Recovery Plan for the Threatened MM (Brachyramphus marmoratus) in Washington, Oregon, and California*. Portland, OR: US Fish and Wildlife Service.
2009. *National Wetlands Inventory Website*. Washington, D.C: US. Department of the Interior, Fish and Wildlife Service. Accessed May 27, 2016. <http://www.fws.gov/wetlands/>.
2011. *Revised Recovery Plan for the NSO Owl (Strix occidentalis caurina)*. Portland, OR: US Fish and Wildlife Service.
2012. *Report on MM Recovery Implementation Team Meeting and Stakeholder Workshop*.
2016. *Species Profile for steelhead (Oncorhynchus (=salmo) mykiss)*. Environmental Conservation Online System (ECOS). Accessed May 2016. [http://ecos.fws.gov/tess\\_public/profile/speciesProfile.action?spcode=E08D](http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=E08D).

US Geological Survey (USGS). 2016. *National Water Information System Data for USGS Station 11460151, Redwood Creek*. Accessed May 24, 2016.  
[http://waterdata.usgs.gov/nwis/inventory/?site\\_no=11460151&agency\\_cd=USGS](http://waterdata.usgs.gov/nwis/inventory/?site_no=11460151&agency_cd=USGS).

Wallitner, K. 2016. *Freshwater Quality Monitoring in the San Francisco Bay Area: 2013-2014 Biennial Report*. Natural Resource Report NPS/SFAN/NRR—2016/1188. National Park Service, Fort Collins, CO.

Walsh, J., D. Wuebbles, K. Hayhoe, J. Kossin, K. Kunkel, G. Stephens, P. Thorne, R. Vose, M. Wehner, J. Willis, D. Anderson, S. Doney, R. Feely, P. Hennon, V. Kharin, T. Knutson, F. Landerer, T. Lenton, J. Kennedy, and R. Somerville. 2014. *Our Changing Climate*. In *Climate Change Impacts in the United States: The Third National Climate Assessment*, edited by J. M. Melillo, Terese (T. C.) Richmond, and G. W. Yohe. U.S. Global Change Research Program 19-67. Accessed May 27, 2016.  
<http://nca2014.globalchange.gov/report/our-changing-climate/introduction>.

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