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Appendix D

Staff Report

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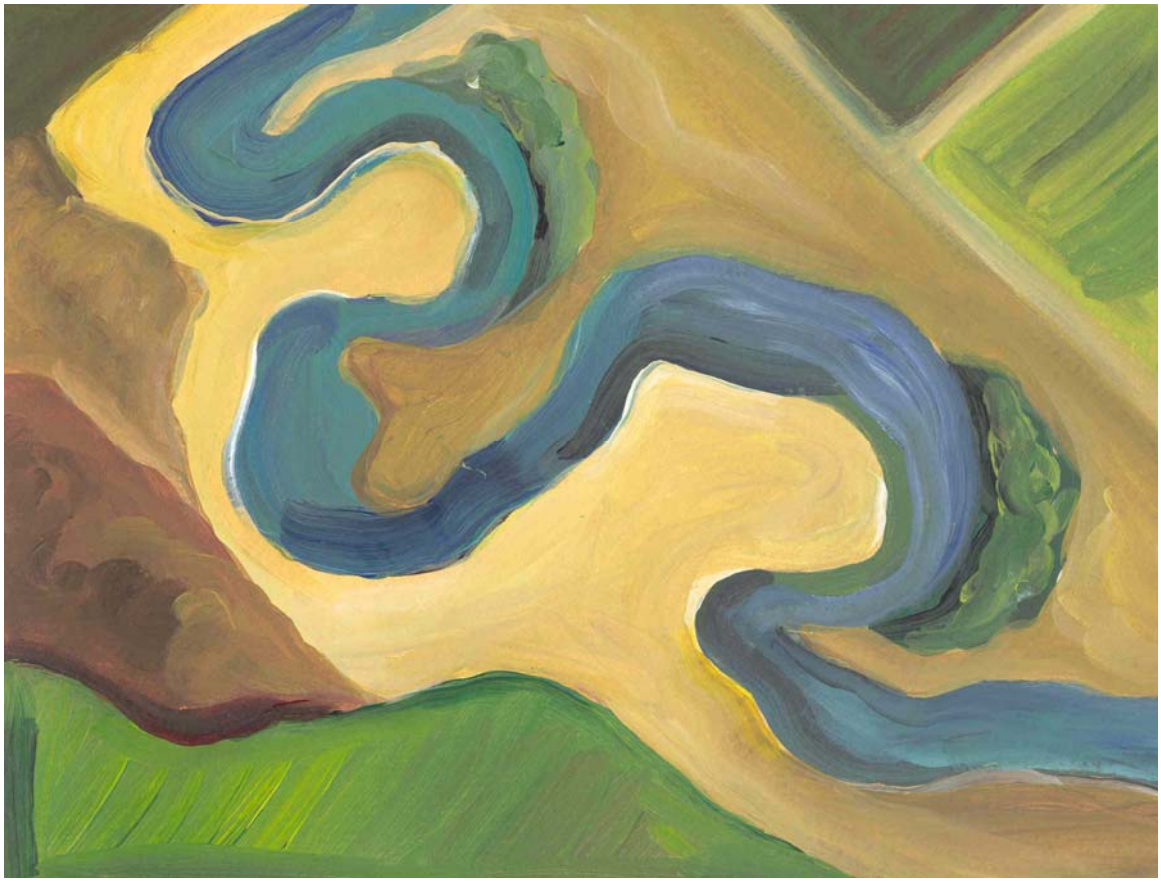
Sonoma Creek Watershed Sediment TMDL and Habitat Enhancement Plan



Staff Report

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December 3, 2008

California Regional Water Quality Control Board
San Francisco Bay Region

2008
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Chapter 1: Introduction

1.1 Overview

The primary goals of the *Sonoma Creek Watershed Sediment TMDL and Habitat Enhancement Plan* are to: a) attain water quality objectives for sediment, settleable material, and population and community ecology; and b) support a broader suite of actions, also needed to conserve steelhead and other native fish and wildlife populations.

Based on evidence of excessive erosion, and concerns regarding decline of native fishes, Sonoma Creek has been officially designated as impaired by sediment since 1996. Staff of the San Francisco Bay Regional Water Quality Control Board (Water Board) propose to address this impairment, and the larger goal of conservation of steelhead and other native fish populations, by amending the Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) to incorporate a Total Maximum Daily Load (TMDL) for sediment, and a Habitat Enhancement Plan. A key aspect of the Basin Plan amendment is its implementation plan, which in this case specifies both the required actions to achieve water quality objectives for sediment, and recommended actions to enhance other habitat attributes including baseflow, fish passage, and habitat complexity.

This Staff Report provides the scientific and technical bases for the project. As we explain below, our approach to developing a Basin Plan amendment will entail: 1) confirming the nature of impairment by identifying significant limiting factors for fish using a limiting factors analysis of the Sonoma Creek watershed; 2) evaluating sediment loads and sources; 3) establishing narrative and numeric targets needed to support fish in good condition; and 4) developing an implementation plan to reduce sediment discharges and enhance native fish habitat.

1.2 California Environmental Quality Act

This Staff Report provides the rationale and the technical basis for the required TMDL elements and associated implementation plan. This report meets the requirements of the California Environmental Quality Act (CEQA), including the preparation of a checklist for adopting Basin Plan amendments and serves in its entirety as a substitute CEQA environmental document. It was developed with consideration of stakeholder input including incorporation of the comments received on a Preliminary Project Report dated July 19, 2007 and has been updated with this information.

1.3 Project Definition and Objectives

Sonoma Creek is currently listed (in the 2006 version of the Clean Water Act Section 303(d) impaired waterbodies list) as impaired by sediment (as well as pathogens and nutrients). While the TMDL (allowable sediment load per unit time) applies to mainstem

Sonoma Creek, the water quality targets, allocations, and implementation plan apply throughout the watershed in order to assure attainment of the TMDL.

The proposed project is a Basin Plan amendment that would establish a sediment TMDL for Sonoma Creek and an implementation plan to achieve the TMDL and related habitat enhancement goals. The bases of the TMDL are numeric targets for streambed permeability, pool filling and substrate composition, selected to be protective of fishery beneficial uses. The TMDL assigns wasteload and load allocations to dischargers that, over time, will ensure that the targets are achieved.

The Project Objectives are to:

- Protect Beneficial Uses of cold water fish spawning and migration, and habitat for rate and endangered species, specifically steelhead trout
- Attain numeric targets to meet water quality standards
- Comply with CWQ requirements to adopt TMDLs for 303(d) listed water bodies
- Avoid imposing regulatory requirements that are more stringent than necessary to meet numeric targets and attain water quality standards
- Complete implementation of the TMDL in as short a time as is feasible

To achieve these project objectives, we have developed the Sonoma Creek Watershed Sediment TMDL and Habitat Enhancement Plan. The following paragraphs describe the rationale and objectives of the Sonoma Creek Watershed TMDL and Habitat Enhancement Plan.

Although reducing fine sediment supply and reducing discharges fromare necessary, actions in these areas alone are not sufficient to recover native fish and aquatic wildlife populations in the Sonoma Creek watershed. Therefore in addition to the sediment TMDL, we also have prepared a complimentary habitat enhancement plan. The Habitat Enhancement Plan provides an outline of the actions that may be needed to address other stressors to fish and aquatic wildlife populations[1], including: a) habitat complexity; b) migration barriers; c) lack of woody debris; d) stressful water temperatures; and e) low baseflows during the springtime and the dry season. Habitat enhancement actions will also greatly facilitate attainment of water quality targets in a faster timeframe, and in a manner that provides much greater ecological benefit than sediment control actions alone.

[1] In general, the habitat enhancement plan provides an outline of actions identified in the Limiting Factors Analysis as priority restoration measures (in addition to sediment-related measures addressed through regulatory actions identified in the implementation plan for the TMDL). The Limiting Factors Analysis (SEC et al, 2006) and other information relevant to conservation and recovery of native fish and aquatic wildlife species within the watershed (USFWS, 1998) should be reviewed to gain a detailed and specific understanding of restoration priorities. Our intent by including the habitat enhancement plan is to provide a formal recognition by Water Board staff of our intent to support watershed stakeholders and agency partners in their efforts to achieve these restoration priorities.

The goals of the Sonoma Creek Watershed Sediment TMDL and Habitat Enhancement Plan are to:

- Conserve the steelhead trout population
- Restore water quality to meet water quality standards, including attaining beneficial uses
- Enhance the overall health of the native fish community
- Protect and enhance habitat for native aquatic species
- Enhance the aesthetic and recreational values of the river and its tributaries

To achieve these goals, stakeholders in the watershed must work to:

- Reduce sediment loads, and fine sediment[2] in particular, to Sonoma Creek and its tributaries
- Attain and maintain suitable gravel quality in freshwater reaches of Sonoma Creek and its tributaries
- Reduce and prevent channel incision
- Reduce erosion and sedimentation
- Repair large sources of sediment supply (e.g., landslides)
- Enhance channel complexity (e.g., by adding and encouraging retention of large woody debris)

1.4 TMDL Process

The Sonoma Creek Watershed Sediment TMDL defines the allowable amount of sediment that can be discharged into Sonoma Creek while ensuring attainment of water quality standards. This TMDL is expressed as a mass per unit time, as well as a percentage of the natural background sediment delivery rate to Sonoma Creek. To ensure attainment of water quality standards, we include a water-body specific cleanup or restoration plan that targets the pollutant causing impairment (in this case, sediment).

The Clean Water Act requires California to adopt and enforce water quality standards to protect San Francisco Bay. The Water Quality Control Plan for the San Francisco Bay Region (Basin Plan) delineates those standards, which include beneficial uses of waters in the Region, numeric and narrative water quality objectives to protect those uses, and provisions to enhance and protect existing water quality (antidegradation). Section 303(d) of the Clean Water Act requires states to compile a list of "impaired" water

[2] In this report, unless otherwise noted, we use the term fine sediment to refer primarily to sand and fine gravel (e.g., ≤ 10 mm in diameter) deposited in or on the streambed in fish bearing reaches of gravel- or cobble-bedded channels. High concentrations of fine sediment in the streambed are associated with: a) poor rates of survival of salmonid eggs from spawning-to-emergence; b) diminished growth and survival of juvenile salmonids during the dry season; and/or c) low rates of survival of juvenile steelhead during the wet season.

bodies that do not meet water quality standards and to establish a TMDL for the pollutant that causes impairment. Sonoma Creek has been officially designated as impaired by sediment since 1996. The proposed TMDL and implementation plan are designed to resolve sediment impairment in Sonoma Creek and its tributaries.

The TMDL process includes compiling and considering available data and information, conducting appropriate analyses relevant to defining the impairment problem, identifying sources, and allocating responsibility for actions to resolve the impairment.

In addition, the scientific basis of the Basin Plan amendment is subjected to external scientific peer review. This step is required under §57004 of the Health and Safety Code, which specifies that an external review is required for work products that serve as the basis for a rule, "…establishing a regulatory level, standard, or other requirements for the protection of public health or the environment." The scientific basis of the Sonoma Creek Watershed Sediment TMDL, as presented in the Staff Report, was evaluated by two peer reviewers, Dr. Peter Goodwin, and Dr. Susan M. Bolton, who concluded that the scientific basis of the proposed Basin Plan amendment is based on sound scientific knowledge, methods, and practices.

1.5 Report Organization

This Staff Report presents the supporting documentation for a proposed Basin Plan amendment that establishes a Total Maximum Daily Load (TMDL) and Implementation Plan for sediment, and Habitat Enhancement Plan designed to protect beneficial uses of Sonoma Creek. It is organized into chapters that reflect background information, the key elements of the TMDL process, and regulatory analyses required to adopt the amendment.

Chapter 1 introduces the project and discusses CEQA, the TMDL process, organizational layout of the Staff Report, and provides an overview of key elements and goals of the Sonoma Creek Sediment TMDL and Habitat Enhancement Plan.

Chapter 2 presents the physical setting, climate, hydrology, and geology of the Sonoma Creek watershed, and Beneficial Uses, as defined in the Basin Plan, supported by the watershed.

Chapter 3 presents the problem statement that the project is based on and defines the project, habitat conditions, and why it is necessary, its objectives, and describes current fish habitat conditions that may be adversely affecting fish populations.

Chapter 4 provides a discussion of the water quality standards that are applicable to Sonoma Creek and its tributaries.

Chapter 5 presents the derivation of the numeric targets and desired conditions for the watershed.

Chapter 6 presents our understanding of the sources of loading of sediment to Sonoma Creek and its tributaries. Sources and loading are identified as those attributable to natural background and those caused by human activities in the watershed.

Chapter 7 presents the linkage analysis which describes the relationship between sediment sources and the proposed targets, establishes the TMDL, sets allocations, including estimates of the percent reduction from each source's current contribution to the total sediment load. Chapter 7 additionally presents a margin of safety that accounts for any lack of knowledge about the relationship between the pollutant loads and desired receiving water quality.

Chapter 8 presents the Implementation Plan which includes actions and requirements deemed necessary to resolve the sediment impairment, support beneficial uses, and restore a sustainable fishery. It specifies monitoring activities to demonstrate attainment of numeric targets. It also presents an adaptive implementation strategy to review implementation progress and to evaluate any new information generated, which may lead to improved implementation actions, and refinement of the TMDL, the numeric targets or the allocations in the future.

Chapter 9 presents a brief summary of the external scientific peer review, the results of CEQA analyses including an environmental impact assessment, an evaluation of alternatives to the proposed Basin Plan amendment, economic considerations, cost estimates, and discussion on potential source of funding.

Lastly, the References section, lists all the information sources cited and relied upon in preparation of this report.

Chapter 2: Watershed Description

The Sonoma Creek watershed, in California's Coast Range north of San Pablo Bay (Figure 1), covers an area of approximately 166 square miles (430 km^2). The watershed ranges in elevation from sea level to the peak of Bald Mountain (2,739 ft.). It lies in a valley bounded by Sonoma Mountain to the west and the Mayacamas Mountains to the east. The mainstem of Sonoma Creek flows in a southeasterly direction from headwaters on Sugarloaf Ridge through Sonoma Valley before discharging to San Pablo Bay. Numerous tributaries enter the main stem from the mountains that rise on both sides of the valley (SEC et al., 2004). Figure 1a shows the tributaries and their respective drainage areas. The Sonoma Creek watershed includes about 465 miles of streams mapped by the USGS (SEC et al., 2004).

Average rainfall ranges from approximately 23 inches in the lower portions of Sonoma Valley to more than 50 inches on the highest slopes of Sonoma Mountain and the Mayacamas. Most of the rain falls from November through April, with heaviest rainfall occurring from December through February. This rainfall regime results in two distinct seasons in the watershed. During the winter wet season, streamflow and pollutant loading are dominated by precipitation –driven surface runoff. In contrast, groundwater inflow or runoff from human activities dominates streamflow during the dry summer months.

The watershed supports the following Beneficial Uses, as defined in the Basin Plan: cold freshwater habitat (COLD), warm freshwater habitat (WARM), water contact recreation (REC-1), noncontact water recreation (REC-2), fish migration(MIGR), preservation of rare and endangered species (RARE), fish spawning (SPWN), and wildlife habitat (WILD). It provides habitat for several native species of concern, including steelhead trout (*Oncorhynchus mykiss*), Chinook salmon (*Oncorhynchus tshawytscha*), and California freshwater shrimp (*Syncaris pacifica*).

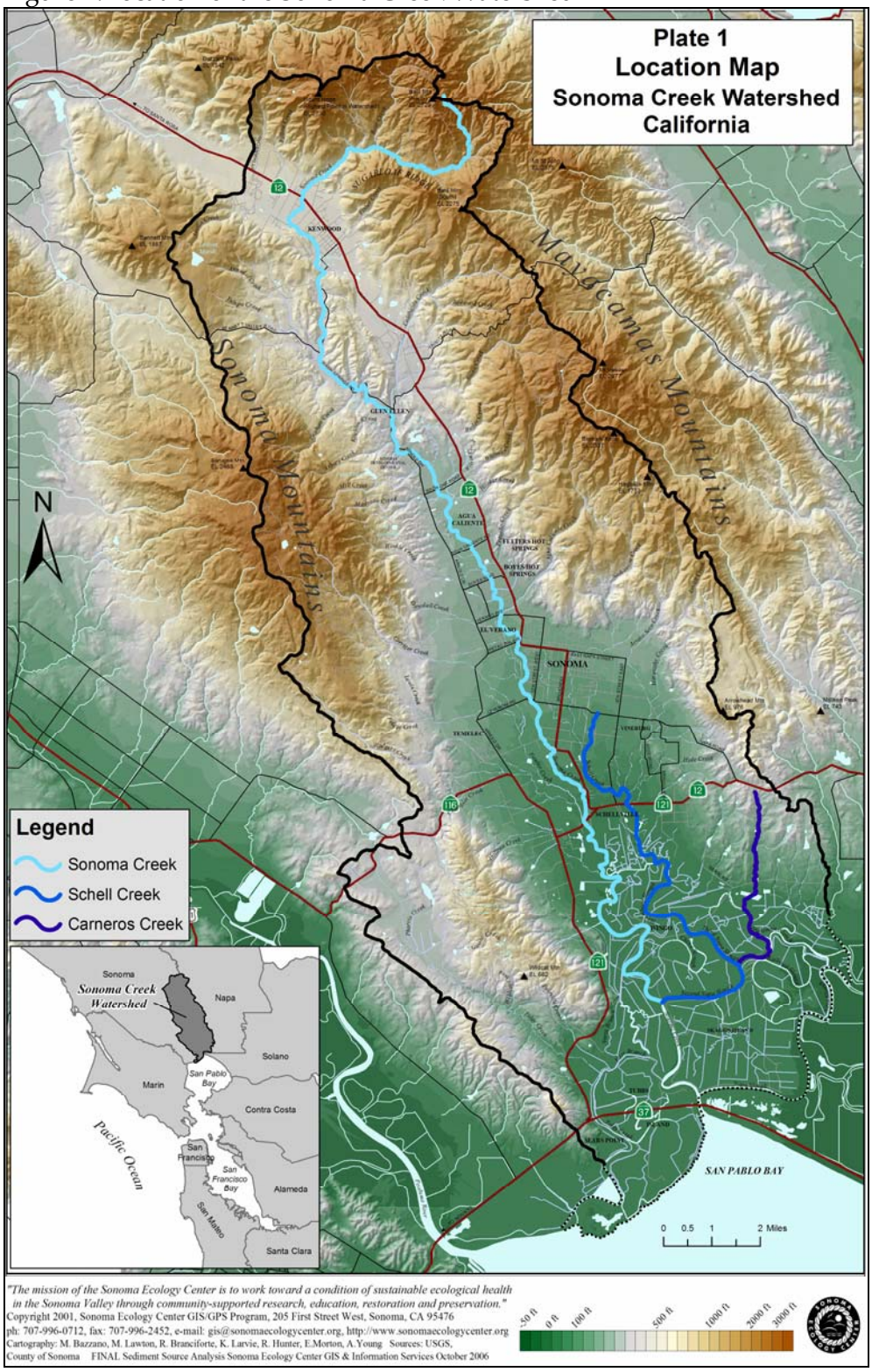
Major land cover types in the watershed are forest (approximately 30 percent), grassland/rangeland (20 percent), agriculture (30 percent—a large portion of this in vineyards), and wetlands and sparsely vegetated land (5 percent). Developed land (residential, industrial, or commercial) accounts for approximately 15 percent of the watershed (ABAG, 2000).

Compared to other San Francisco Bay Area streams, the watershed is relatively free of concrete channelization, major flood control projects, and water supply structures (dams). However, historical ditching and draining of the valley floor (see discussion in source analysis that follows) has fundamentally altered the routing of peak flows and sediment in lower Sonoma Creek, with consequent and significant increases in sediment delivery, flooding and degradation of aquatic habitat quality. Early maps and accounts describe a large 400-acre marsh complex known as the Kenwood Marsh. The Kenwood Marsh stored winter rain and runoff, and released the water over many months, reducing downstream flooding and increasing summer flows in Sonoma Creek. Freshwater wetland loss is estimated to be greater than 95 percent in the watershed.

Along with reducing aquatic habitat, draining of the freshwater wetlands has increased peak flows (SFEI and Sonoma Ecology Center, 2008).

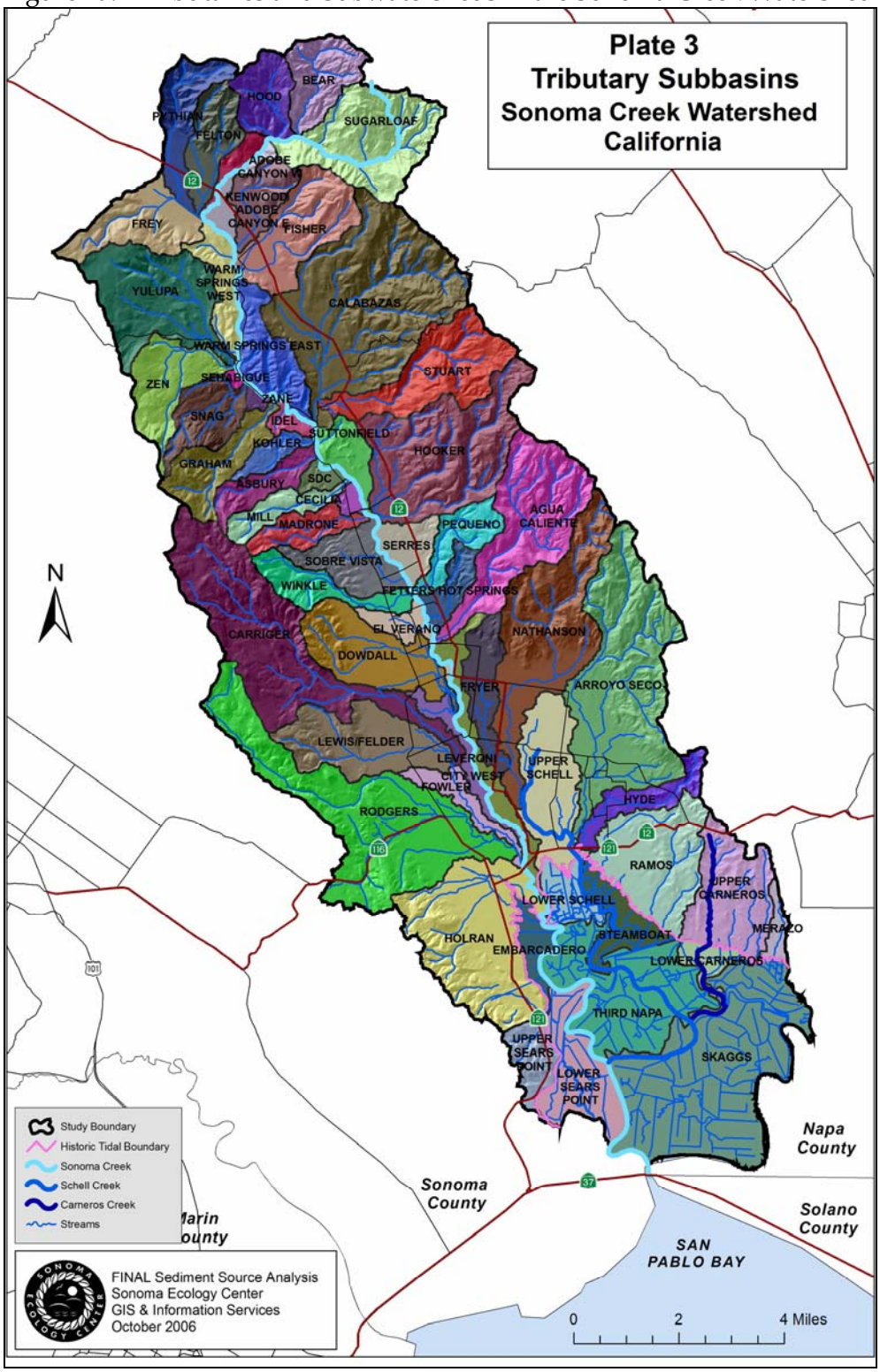
Sonoma Creek is also listed as impaired by nutrients and pathogens. It is likely that actions implemented to reduce sediment loading and enhance habitat will also reduce nutrients and pathogens, and help Sonoma Creek in supporting many of its designated Beneficial Uses.

Figure 1.Location of the Sonoma Creek Watershed



Source: Sonoma Ecology Center el al, 2006

Figure 1a. Tributaries and Subwatersheds in the Sonoma Creek Watershed



Source: Sonoma Ecology Center et al, 2006

California Regional Water Quality Control Board
San Francisco Bay Region

Napa River Sediment TMDL and Habitat Enhancement Plan

Staff Report

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September 2009

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Cover Photo: Napa River near St. Helena
Photo by: Stillwater Sciences, Inc.

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We thank the staff of the Napa County Resource Conservation District and Napa County Office of the US Natural Resources Conservation Service for sharing results of their recent and ongoing investigations of sediment, water quality, and fisheries in the watershed, and for allowing us to review historical aerial photographs and channel cross-sections of the Napa River in their collection.

We also express our thanks to all of the landowners who provided us with permission for access for this study. A clearer and more representative picture of the watershed was produced as a result of your assistance and involvement.

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CHAPTER 1: INTRODUCTION

Key Points

- Section 303(d) of the Clean Water Act requires states to compile a list of "impaired" water bodies that do not meet water quality standards.
- In 1990, the Water Board listed Napa River as impaired by sedimentation based on evidence of widespread erosion, and concerns regarding adverse impacts to fish.
- This report contains Water Board staff analyses and findings pertaining to sediment impairment in the Napa River.

We prepared this report to provide an opportunity for interested parties to comment on the scientific basis for the TMDL, and to provide a framework for discussion of implementation actions that may be needed to resolve sediment impairment and enhance steelhead and salmon populations within Napa River watershed. We expect the proposed regulatory policy to be improved as a result of the knowledge and involvement of the stakeholders of the Napa River watershed.

1.1 Background

In 1967, the California Legislature established the State Water Resources Control Board (State Board), and the nine Regional Water Quality Control Boards (Regional Boards) to regulate and protect water resources for the use and enjoyment of the people of the state. The State Board administers water rights, water pollution control, and water quality functions as part of the California Environmental Protection Agency. The State Board provides guidance to the Regional Boards, which conduct regulatory planning, permitting, and enforcement activities to protect water resources from pollution. Water pollution control regulatory authorities of the State Board and the Regional Boards are shared and derived from the state Porter-Cologne Act and federal Clean Water Act. The California Regional Water Quality Control Board, San Francisco Bay Region (Water Board) regulates surface and groundwater quality throughout the Bay Area including Napa River and its tributaries. By law, the Water Board is required to develop, adopt, and implement a Water Quality Control Plan (Basin Plan) for the San Francisco Bay region. The Basin Plan specifies and describes:

- Designated beneficial uses of water
- Water quality objectives, which are parameters that can be evaluated to determine whether the designated beneficial uses are protected
- Implementation plans and policies to protect water quality

Designated beneficial uses of water for the Napa River include the following:

- Water supply (agricultural, municipal, and domestic)
- Recreation (fishing, swimming, boating, etc.)
- Navigation
- Fish migration and spawning
- Cold and warm freshwater habitats
- Wildlife habitat
- Preservation of rare and endangered species

Beneficial uses adversely affected by excess sediment in the Napa River are recreation (i.e., fishing), cold freshwater habitat, fish spawning, and preservation of rare and endangered species.

As designated in the federal Clean Water Act, the State Board and the Regional Boards share several water pollution control responsibilities, including establishment of ambient water quality standards. Ambient water quality standards include beneficial use protection and water quality objectives (described above), and an anti-degradation policy. The anti-degradation policy requires that where water quality is better than needed to protect beneficial uses, that such superior water quality be maintained. Furthermore, Section 303(d) of the Clean Water Act also requires biennial assessments to determine whether ambient water quality standards are being achieved in individual water bodies throughout the United States.

In 1990, based on evidence of widespread erosion and concern regarding adverse impacts to fish habitat, the Water Board listed the Napa River as impaired by sedimentation. The primary impetus for listing was a concern regarding substantial decline since the 1940s in abundance and distribution of steelhead and salmon in the Napa River and its tributaries. As a result of the sediment impairment listing, the Water Board is required to prepare a total maximum daily load (TMDL). A TMDL involves development of a pollutant budget and a control plan to restore the health of a polluted water body. Key components of a TMDL include the following:

- Problem statement
- (Pollutant) Source analysis
- Numeric targets (e.g., specification of water quality parameter[s] that can be measured to evaluate attainment of water quality standards)
- Linkage analysis (between pollutant sources and numeric targets)
- Pollutant load allocations
- Implementation plan (to attain and maintain water quality standards)
- Monitoring plan (to evaluate progress in achieving pollutant allocations and numeric targets)

To improve understanding of the significance of sediment pollution relative to other factors that may be limiting steelhead and salmon populations, the Water Board partnered with the State Coastal Conservancy to fund the *Napa River Basin Limiting Factors Analysis* (Stillwater

Sciences and Dietrich, 2002). The limiting factors analysis documented two adverse impacts of erosion and sedimentation on salmon and steelhead habitat:

- Low permeability values indicating a high concentration of fine sediment in the streambed
- Channel incision in mainstem Napa River

Channel incision, which occurs in Napa River and lower reaches of its tributaries, has greatly reduced the quantity and quality of spawning and rearing habitat for salmon, and appears to be a key factor limiting Chinook salmon reproductive success and smolt survival under current conditions (Stillwater Sciences and Dietrich, 2002). High concentrations of fine sediment deposited in the streambed at potential spawning and rearing sites for salmon and/or steelhead in Napa River and its tributaries causes high rates of egg and larval mortality during incubation, and also degrade the quality of juvenile rearing habitat for steelhead and salmon. Increases in the amount of fine sediment deposited in the streambed are contributing to the decline of what appears to be a very small run of steelhead. Other factors including poor flow persistence during the spring and dry season and poor habitat access appear to be even more important controls on steelhead productivity and survival in the Napa River watershed at present (Stillwater Sciences, 2002). We conclude that progress towards resolution of all factors limiting steelhead productivity and survival in the Napa River watershed is needed to conserve and recover steelhead populations. Therefore, we recommend actions to reduce sediment supply, and protect or enhance baseflow, stream temperature, habitat complexity, and fish passage as elements of the implementation plan that is presented in Chapter 6.

1.2 Document Organization

***Chapter 1. Introduction*.** Provides background regarding the responsibilities of the Water Board, the TMDL program, and the problems of sediment and other limiting factors. The introduction also describes the purpose of the draft technical report, and outlines subsequent steps in the TMDL process.

Chapter 2. Problem Statement. Describes the relationships between the identified pollutant (sediment), applicable water quality objectives and beneficial uses, and current water quality conditions in Napa River and it is tributaries. The problem statement also describes factors limiting steelhead run-size in the Napa River watershed.

Chapter 3. Sediment Source Analysis. Presents the approach, methods, and results of the sediment source analysis

***Chapter 4. Numeric Targets*.** Presents the rationale to support proposed water quality parameters and numeric targets, and their relation to the attainment of applicable water quality standards

Chapter 5. Linkage Analysis and Allocations. Describes hypothesized linkages between sediment loads and habitat conditions, and therefore provides the rationale for estimating the assimilative capacity for sediment in the Napa River. Allocations are amounts of sediment allocated to each source category, including a margin of safety to account for uncertainty in estimating loads and assimilative capacity, and allowance for future growth.

***Chapter 6. Implementation Plan*.** Discusses actions needed to attain water quality standards for sediment and to protect and/or enhance other stream habitat conditions and includes a monitoring plan.

Chapter 7. Regulatory Analysis. Contains legally required analyses of potential environmental impacts and costs that may be associated with the adoption of the proposed Basin Plan amendment.

Office of Governor
Edmund G. Brown Jr.
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Vineyard Program for Vineyard Facilities in the Napa River and Sonoma Creek Watersheds

You can receive Vineyard Waiver program updates via email! Subscribe online: Electronic Subscription List

Draft Vineyard Waiver

The conditional waiver of Waste Discharge Requirements for Vineyards is withdrawn.

Due to the comments received and current staff resource limitations, the Board will not proceed with the draft Conditional Waiver for Vineyards in the Napa River and Sonoma Creek watersheds and associated Mitigated Negative Declaration. Board staff intend on moving forward with preparation of general waste discharge requirements for vineyard discharges and an associated environmental document under the California Environmental Quality Act in the near future. We will update you on these developments.

Documents associated with the draft Vineyard Waiver and Mitigated Negative Declaration dated November 16, 2012

- List of Commenting Parties (with links to comment letters)
- Second Revised Public Notice
- Link to Disclosure Forms
- First Revised Public Notice
- Original Public Notice
- Draft Conditional Waiver of Waste Discharge Requirements
- Initial Study and Proposed Mitigated Negative Declaration
- Fact Sheet and FAQ
- Presentation from the Sustainable Vineyard Practices, Replating Strategies & Economics Seminar (Power Point)

Public Workshop and CEQA Scoping Meeting

Water Board staff held a publicly-noticed workshop and CEQA Scoping Meeting for the Vineyard Waiver on April 14, 2011, at the Napa Main Library Community Meeting Room. During the workshop session, staff described the background, purpose, main elements, and proposed conditions of the Vineyard Waiver. The proposed conditions would require vineyard owners and/or operators to:

5th AVENUE STORMWATER PUMP STATION UPGRADE

CITY OF REDWOOD CITY, CALIFORNIA

FLOOD MITIGATION PROJECT

BENEFIT-COST ANALYSIS REPORT

Kenneth A. Goettel
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1732 Arena Drive
Davis, CA 95618
(530) 750-0440

October 16, 2011

Cover Photo: 1983 Flood

EXECUTIVE SUMMARY

Redwood City's 5th Avenue Pump Station is a critical facility which pumps stormwater from the 5th Avenue drainage basin to the Bay Front Canal. The 5th Avenue drainage basin, the smallest of the Redwood City drainage basins, lies at the lowest point in the entire drainage area and subsequently experiences the greatest flooding and resulting property damage (Redwood City Public Works Department, Flood Strategy Report, 2000).

The 5th Avenue Pump Station serves the Friendly Acres neighborhood in Redwood City and parts of adjacent neighborhoods. The Friendly Acres neighborhood is predominantly a residential neighborhood with low to moderate income residents. The housing inventory is predominantly small single family one story homes, with some multi-family apartments and several small industrial and commercial buildings.

The Friendly Acres neighborhood has a 60 year history of repetitive flood events, since 1951 when the 5th Avenue Pump Station was put in service with 38 significant flood events from 1951 through 2011. 38 flood events in 60 years corresponds to significant flooding about every 1.6 years on average. All of these events involved substantial street flooding with road closures. 13 of the 38 flood events were larger events that also included flood damage to homes. The 1983 flood, the flood of record, was approximately a 100-year event.

This compilation of historical flood events does <u>not</u> include minor nuisance flooding events. The lowest elevation areas within the Friendly Acres neighborhood typically experience flooding events two or three times per year. Many, but not all, of these extremely frequent flood events are limited to shallow flooding in streets and yards. Such floods may have minor costs, including debris removal, but these minor flood events are <u>not</u> included in the benefit-cost analysis. Rather, the benefit-cost analysis includes only the larger flood events with road closures and/or property damage.

The predominant cause of flooding in the Friendly Acres neighborhood is the inadequate pumping capacity of the 5th Avenue Pump Station, which as a maximum pumping capacity of only 30 cubic feet per second (cfs). The proposed mitigation project is to upgrade the pump station's capacity to 270 cfs which is adequate to handle the 100-year inflows.

The benefit-cost analysis for this project was completed using the FEMA Version 4.5.5 Damage-Frequency Benefit-Cost software.

The benefit-cost analysis considers only two categories of damages and losses: 1) the economic losses attributable to road closures, using the FEMA standard value

per vehicle hour of delay or detour time and 2) building damages, contents damages and displacement costs calculated using FEMA standard depth-damage functions.

The total project engineering cost estimate is $4,083,355; this estimate is for a mid-2013 start of construction. The summary cost estimate is shown below; the detailed cost estimate with unit costs and quantities is attached to e-Grants and also included in Appendix 1 of this report.

Construction[1]	$3,432,935
Design & Admin (10% of Construction)	$ 350,000
Environmental Compliance/Permitting[2]	$ 145,500
Additional Easement Procurement[3]	$ 154,920
Project Total	$4,083,355

[1] Construction Estimate based on detailed breakdown attached.

[2] Environmental Compliance/Permitting based on estimated cost to comply with the California Environmental Quality Act (CEQA), and possible permit application to the Corps of Engineers, San Francisco Bay Regional Water Quality Control Board (RWQCB), and the San Francisco Bay Conservation and Development Commission (BCDC). The estimate breakdown is as follows:

CEQA Compliance	$75,000
Corps Permit	$36,000
RWQCB Permit	$17,250
BCDC Permit	$17,250

[3] Easement Procurement estimate based on additional easement need of about 5,164 square foot (sf) at $30 per sf. Unit price per sf is based on the attached map showing the average land value per sf from the County's assessor's data for the area.

The detailed engineering cost estimate with unit costs and quantities and the assessor's data documenting land costs for the easement procurement are attached to e-Grants. This supporting documentation is also included in Appendix 1 at the end of this report

Benefit-cost results are:

Benefits	**$7,577,742**
Costs	**$4,083,355**
Benefit-Cost Ratio	**1.86**

These benefit-cost analysis results indicate that the project is cost-effective with a benefit-cost ratio of 1.86.

The data inputs for this benefit-cost analysis are conservative and well documented throughout. Furthermore, in several regards, this benefit-cost analysis is a lower-bound type analysis.

The following potential flood damages (benefits when avoided by the proposed mitigation project) were not considered in this benefit-cost analysis:

- Any damages or losses in the very frequent, 2 or 3 times per year, small floods which don't result in road closures. Although generally small there are undoubtedly some costs for cleanup and the potential for damages to landscaping, other property outside of the home, and damages to garages at very low elevations. The potential for such damages in exacerbated by speeding drivers who create wakes while driving down flooded streets.
- Emergency management costs, including City of Redwood Police and Public Works staff time to install and monitor barricades during street closures, debris cleanup after events, and flood event management costs.
- Damages to vehicles, outbuildings, garages, and equipment outside of homes.
- Disruption time and costs for owners of flooded homes to cleanup, make repairs, replace damaged goods and so on.

Including these additional categories of damages in the BCA would result in a higher BCR. These categories of damages were not included in the present BCA because credible data to estimate these damages were not available and the BCR was already 1.860 without considering these categories.

Footnote:

During a site visit to the Friendly Acres neighborhood on September 29, 2011 to survey the building inventory in the flood prone area, a young teenage boy approached me and asked why I was taking pictures of houses on his street.

I told him that I was a consultant working for the City of Redwood City and helping with a project to reduce flooding in Friendly Acres.

His eloquent, colloquial response affirms the importance and priority for mitigating the highly repetitive flooding in this neighborhood:

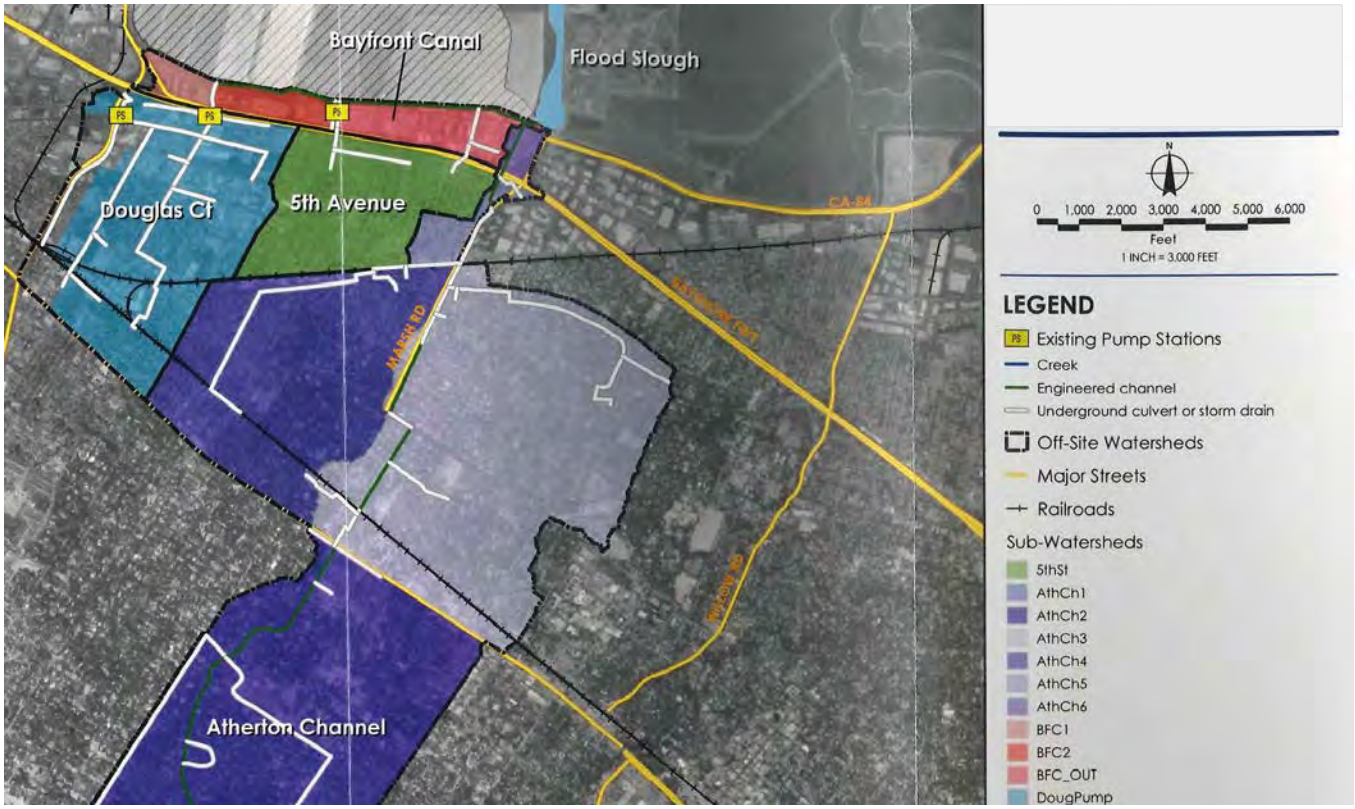
> **"Hey man, you gotta fix it. It floods here all the time."**

1.0 FLOOD DATA AND ANALYSIS

1.1 5th Avenue Drainage Basin

For reference, the boundaries of the 5th Avenue drainage basin are shown below in Figures 1 and 2.

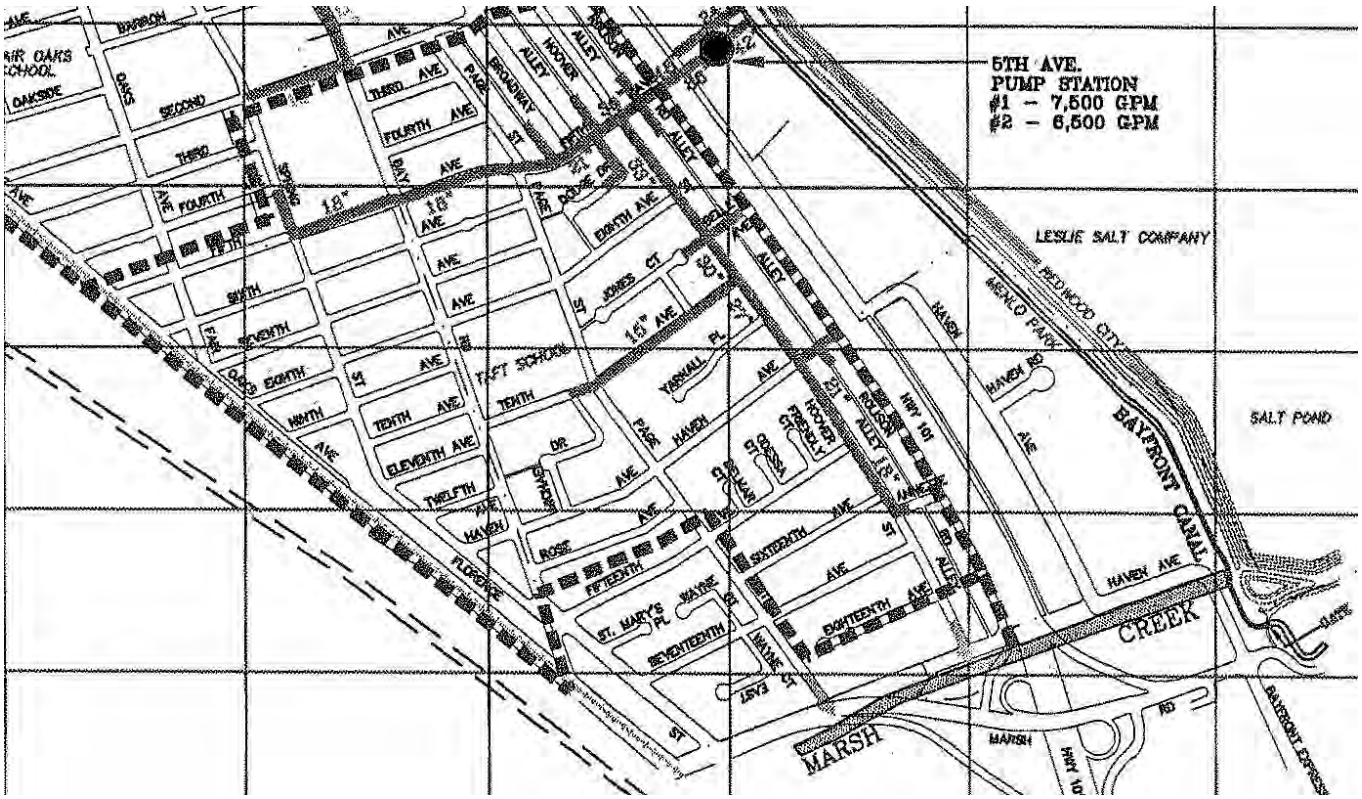
Figure 1
5th Avenue Drainage Basin – Overview



The location of the 5th Avenue Pump Station is shown in the above figure, near the Bayfront Canal, above the 5th Avenue drainage basin.

The boundaries of the the 5th Avenue drainage basin, along with a street map are shown in more detail on the following figure.

Figure 2
5th Avenue Drainage Basin – Boundaries with Streets



The 5th Avenue drainage basin extends from the northern boundary at Second Avenue to the southern boundary near Marsh Road. Drainage flow within the basin is by gravity flow from the north and south to 5th Avenue, which is at the lowest elevation within the basin. Flow along the 5th Avenue collection mains is by gravity to the 5th Avenue Pump Station which pumps water into the Bay Front Canal which in turn drains through sloughs into San Francisco Bay.

The eastern boundary of the drainage basin is defined by Highway 101 which is at considerably higher elevation than the surrounding ground. Highway 101 acts as a flood berm and isolates the 5th Avenue drainage basin from tidal effects which are important east of Highway 101.

The western boundary is defined by the raised railroad embankment and the topography of local streets in the southwest corner of the basin.

The lowest elevation areas within the 5th Avenue drainage basin, with the highest frequency and severity of flooding, are located between 2nd Avenue and 8th Avenue, between Highway 101 and Broadway. This portion of the Friendly Acres neighborhood, in the northeast corner of the drainage basin, is the area which will benefit the most from the proposed flood mitigation project.

1.2 FEMA Flood Insurance Study

The current FEMA Flood Insurance Study (FIS) for Redwood City is dated November 18, 1981. The current FEMA Flood Insurance Rate Map (FIRM) for the Friendly Acres neighborhood is Panel 12 of 16 with an effective date of May 17, 1982. Thus, the FIS and FIRM are both approximately 30 years old.

The FIRM Map shows the Friendly Acres neighborhood as being in Zone B, probably because the drainage area is less than one square mile: the 5th Avenue drainage basin as an area of only 0.44 square miles. Because the area is mapped as Zone B, there are no quantitative flood hazard data included in the FIS.

The FEMA FIS/FIRM data are not useful for the present BCA, because no quantitative flood hazard data are included in the FEMA FIS or FIRM.

1.3 Flood History Data

The flood history for the Friendly Acres neighborhood extends back to the 1940s or earlier. However, the 5th Avenue Pump Station began operation in 1951. Thus, the relevant period of record begins in 1951.

Historical flood events for Friendly Acres are compiled in Table 1 on the following page. These data are predominantly from the engineering reports and the Redwood City Public Works department referenced in Table 1, with supplemental data from the Friendly Acres Neighborhood Association. The Neighborhood Association has been actively involved in flood issues since the flood of record in 1983, which was approximately a 100-year event.

The historical flood data in Table 1 show 38 flood events in the 60 years from 1951 to 2011 which corresponds to an average return period for floods of 1.58 years; all of these events included significant street flooding with road closures. For the present benefit-cost analysis, we round the return period for street flooding up to 1.6 years.

The historic flood data also include 13 larger flood events which including flood damage to homes in Friendly Acres. 13 flood events in 60 years corresponds to an average return period for building damages of 4.62 years. For the present benefit-cost analysis, we round the return period for building damages up to 5 years.

This compilation of historical flood events does <u>not</u> include minor nuisance flooding events. The lowest elevation areas within the Friendly Acres neighborhood typically experience flooding events two or three times per year (McGovern, 1986). These extremely frequent flood events are generally limited to shallow flooding in streets and yards. Such floods may have minor costs, including debris removal, but these minor flood events are <u>not</u> included in the benefit-cost analysis.

Table 1
Flood Events: 1951 to 2011

Event Number	Flood Event[1,2,3]	Street Flooding - Road Closures	Major Flood: Building Damages	Notes
1	January 1952	**X**		
2	December 1953	**X**		
3	December 1955	**X**	**X**	
4	December 1956[4]	**X**		
5	December 1956[4]	**X**		
6	March 1958	**X**		
7	April 1958	**X**	**X**	
8	February 1959	**X**		
9	February 1062	**X**		
10	January 1963	**X**	**X**	
11	October 1963	**X**		
12	November 1964	**X**		
13	December 1966	**X**		
14	January 1967	**X**	**X**	
15	January 1969	**X**	**X**	
16	January 1970	**X**		
17	October 1972	**X**	**X**	
18	January 1973	**X**	**X**	
19	March 1975	**X**		
20	February 1980	**X**		
21	January 1982	**X**	**X**	
22	November 1982	**X**		
23	**January 1983**	**X**	**X**	**Flood of Record[5]**
24	March 1983	**X**		
25	December 1983	**X**		
26	1984	**X**		
27	1985	**X**		
28	February 1986	**X**	**X**	
29	1989	**X**		
30	1992	**X**		
31	1995	**X**		
32	1996	**X**		
33	February 1988	**X**	**X**	
34	2003	**X**		
35	January 2006	**X**	**X**	
36	January 2010	**X**		
37	December 2010	**X**	**X**	
38	March 2011	**X**		

[1] Wilsey & Ham Engineering Report (1994) Redwood City Bay Front Canal Interim Report

[2] Redwood City Public Works Department (2000) Strategy to Address Flooding Problems in Friendly Acres/East Bayshore and Centennial

[3] Friendly Acres Neighborhood Association (2011) Communications from Bonnie Miller and Lauren Perritt

[4] Two separate flood events

5 Mofatt & Nichol Engineering Report (2009) Redwood Shores Levee System. This flood of record corresponds to, or is slightly larger than, the one-percent annual chance event.

1.4 2011 Hydrology and Hydraulics Report

The historical flood data discussed in the preceding section are supplemented by a recently completed rigorous hydraulic engineering and hydrology analysis of flooding in the Friendly Acres and East Bayshore neighborhoods in Redwood City.

WRECO, a consulting engineering firm specializing in hydraulic engineering and hydrology, stormwater management, water resources, flood control system design and related fields, conducted a study of the Bayfront Canal Improvement Project. This rigorous study included a combination of flood routing modeling and steady-state flood modeling using HEC-RAS for four scenarios.

The first two scenarios were flood modeling for: 1) the existing conditions of Redwood City's stormwater infrastructure in the Friendly Acres and East Bayshore areas, and 2) after the proposed upgrade of the 5th Avenue Pump Station. Scenarios 3 and 4 evaluated two alternative upgrades to the Bay Front Canal and tide gate. These scenarios modeled a 25-year rain storm event with two tide conditions: a 25-year tide and a MHHW tide. Tides are an important factor for Scenarios 3 and 4, but have no impact on Scenarios 1 and 2.

For the present analysis, of the proposed upgrade for the 5th Avenue Pump Station. only Scenarios 1 and 2 are relevant; that is, tidal conditions have no effects.

Tidal conditions have <u>no</u> impact on the results for these scenarios because with the tide gate closed, only extreme tides much larger than the 25-year event effect flood levels in either Friendly Acres or East Bayshore. For Friendly Acres, the high ground Highway 101 area further blocks any possible tidal events from reaching Friendly Acres.

Flood modeling results for the 25-year rain storm event for the area including the Friendly Acres neighborhood are shown in Figures 3 and 4 on the following pages. The following figures for the existing conditions and after the proposed upgrade of the 5th Avenue Pump Station are excerpts from Figures 25 and 27.

Before upgrade of the 5th Avenue Pump Station the peak flood water surface elevation is 9.1 feet (NAVD 1988) with a peak ponding storage volume of 42 acre-feet.

After upgrade of the 5th Avenue Pump Station, there is no flooding because the enhanced pumping capacity, along with the existing conveyance capacity of the pipe system, is adequate to handle the 25-year rain storm event without flooding.

The yellow rectangles in Figures 3 and 4 show the area within the 5th Avenue drainage basin and Friendly Acres neighborhood subject to the highest flood risk. In this view, North is approximately to the left.

In the left to right direction, the area extends from 2nd Avenue on the left to 8th Avenue on the right. In the top to bottom direction, the area extends from the alley between Rolison Road and Hoover Street on the top to Broadway (and the extension of the Broadway orientation east of 5th Avenue) on the right.

As illustrated in Figure 3, the rectangular area includes approximately 85% of the area subject to inundation in the 25 year flood event.

Figures 5 and 6 show a Google Earth view and a Google Maps view, respectively, to identify the building inventory and streets within this highest flood risk part of the Friendly Acres neighborhood. The hand-drawn rectangles on these figures correspond to those in Figures 3 and 4 above.

The rectangular flood-prone area shown on these figures is the area for which the benefits of the proposed flood mitigation project are calculated.

Figure 3
25-Year Flood Event - Friendly Acres and Vicinity: Existing Conditions

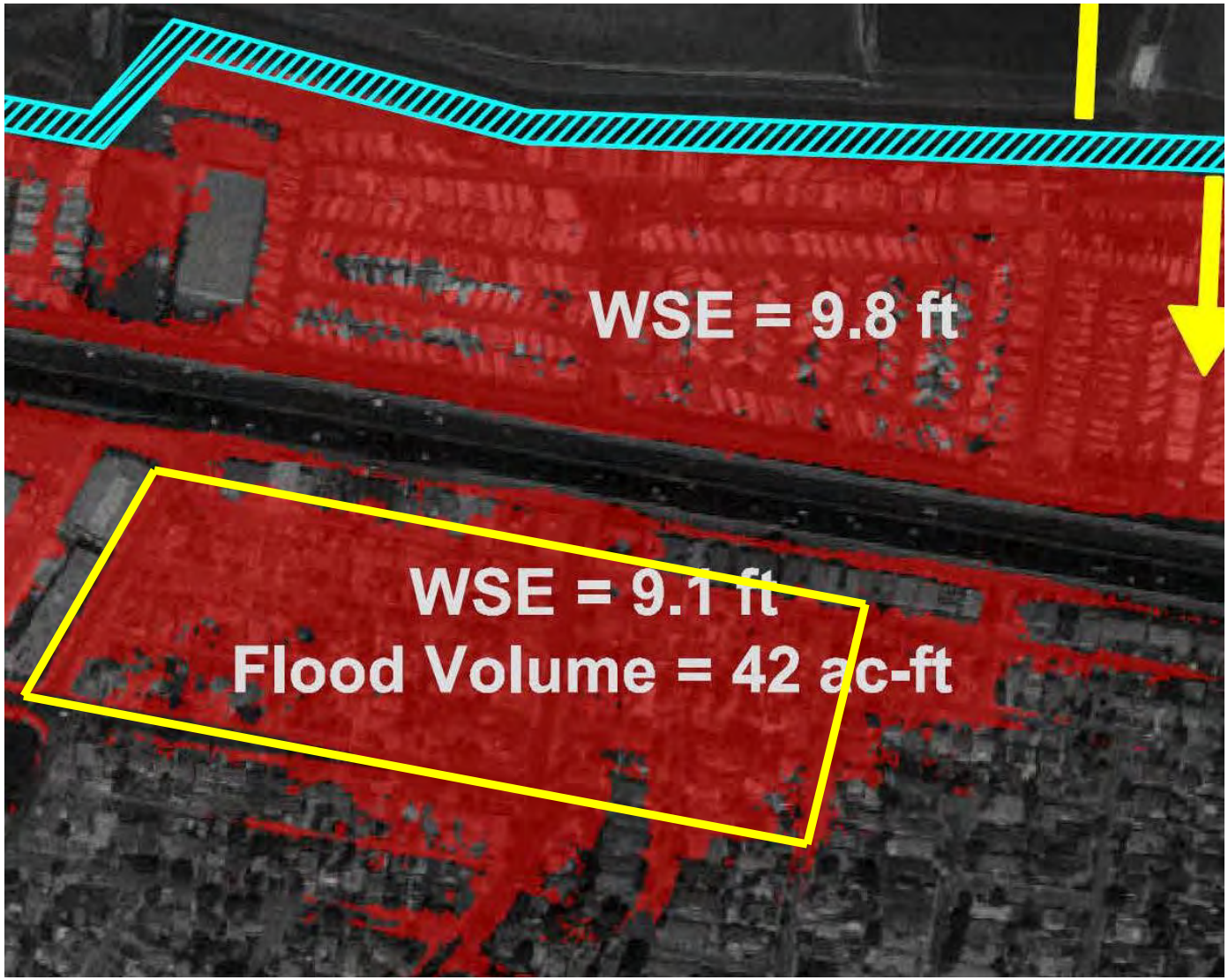


Figure 4
25-Year Flood Event - Friendly Acres and Vicinity: After Upgrade of the 5th Avenue Pump Station

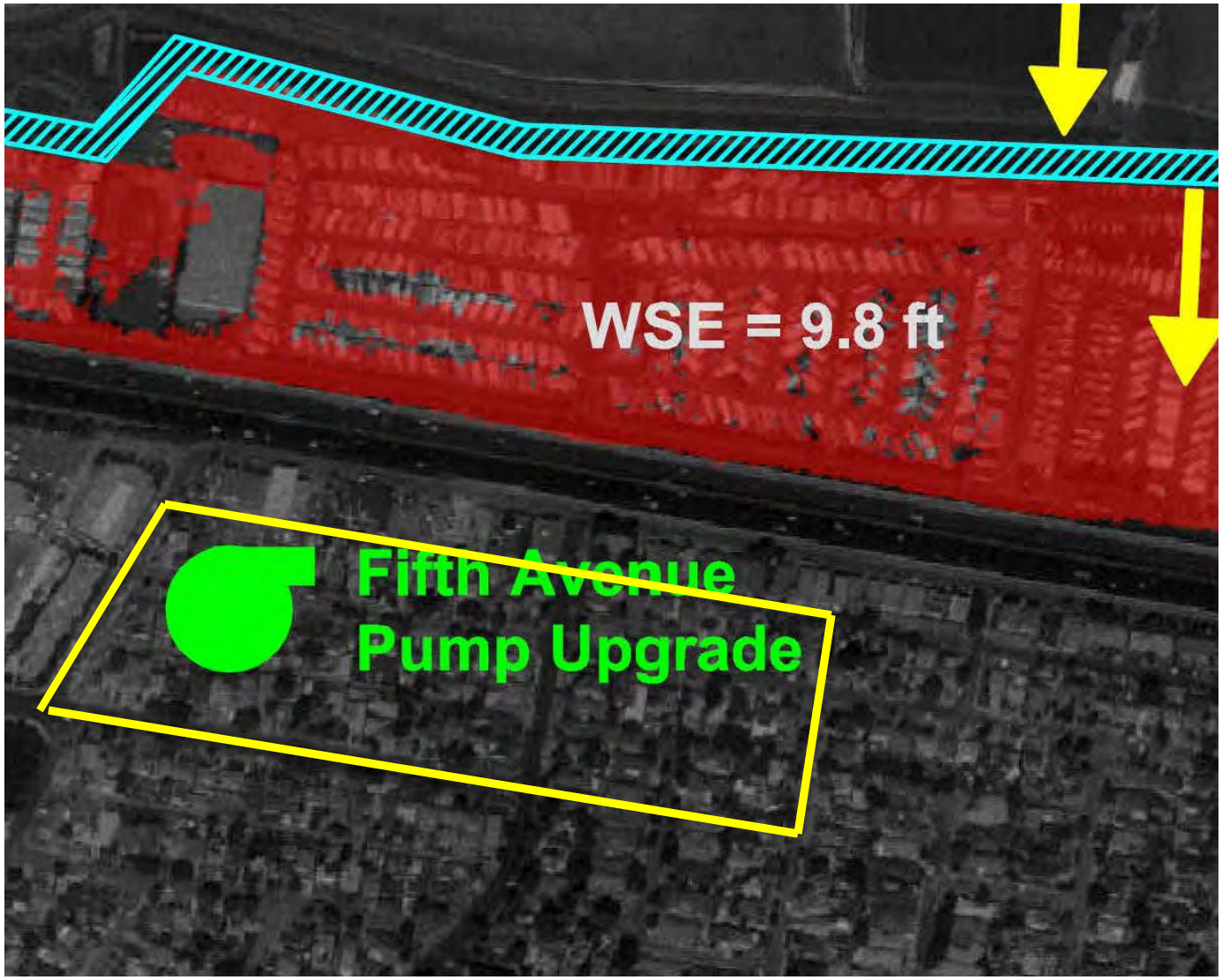


Figure 5
Google Earth View

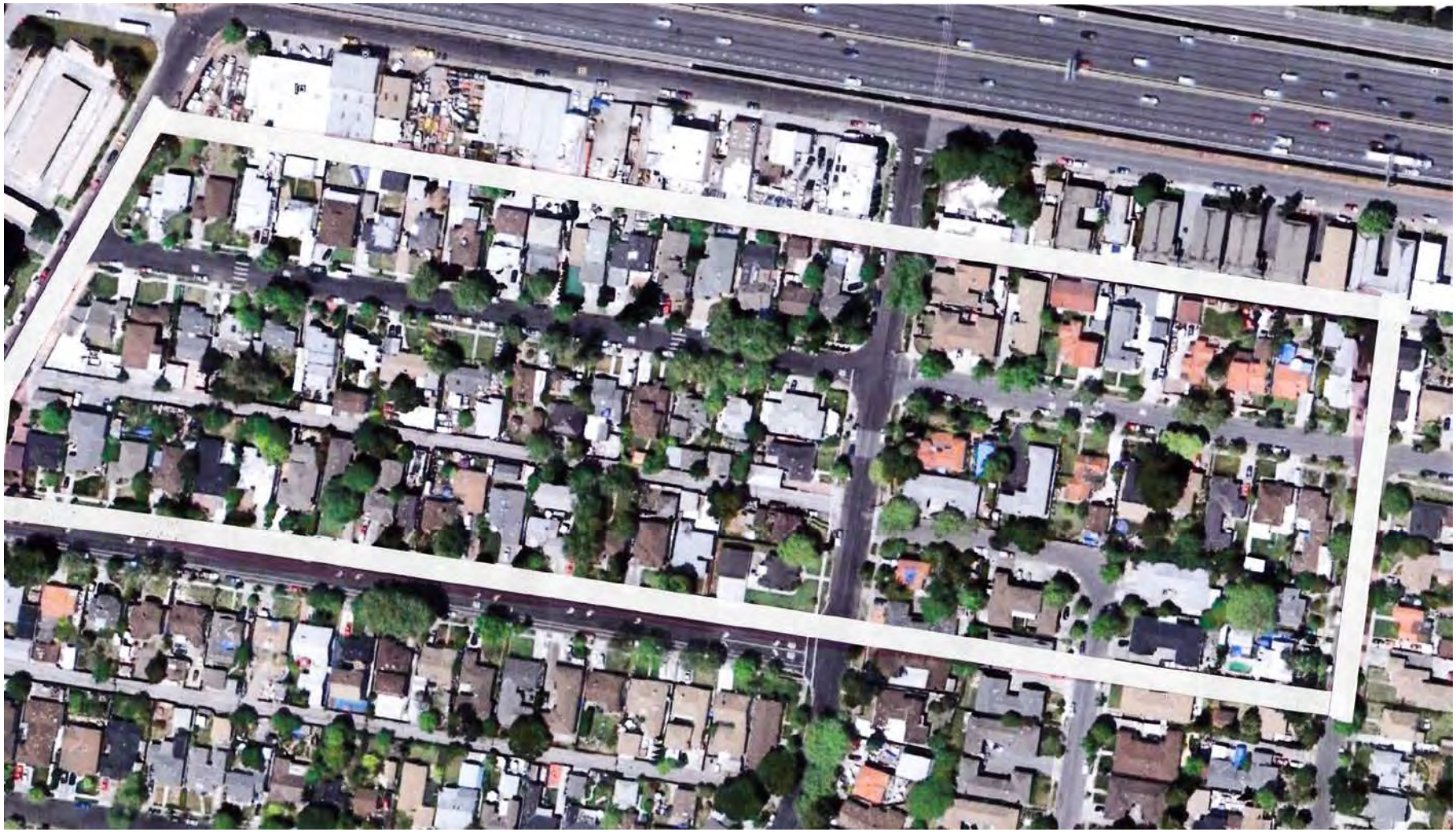
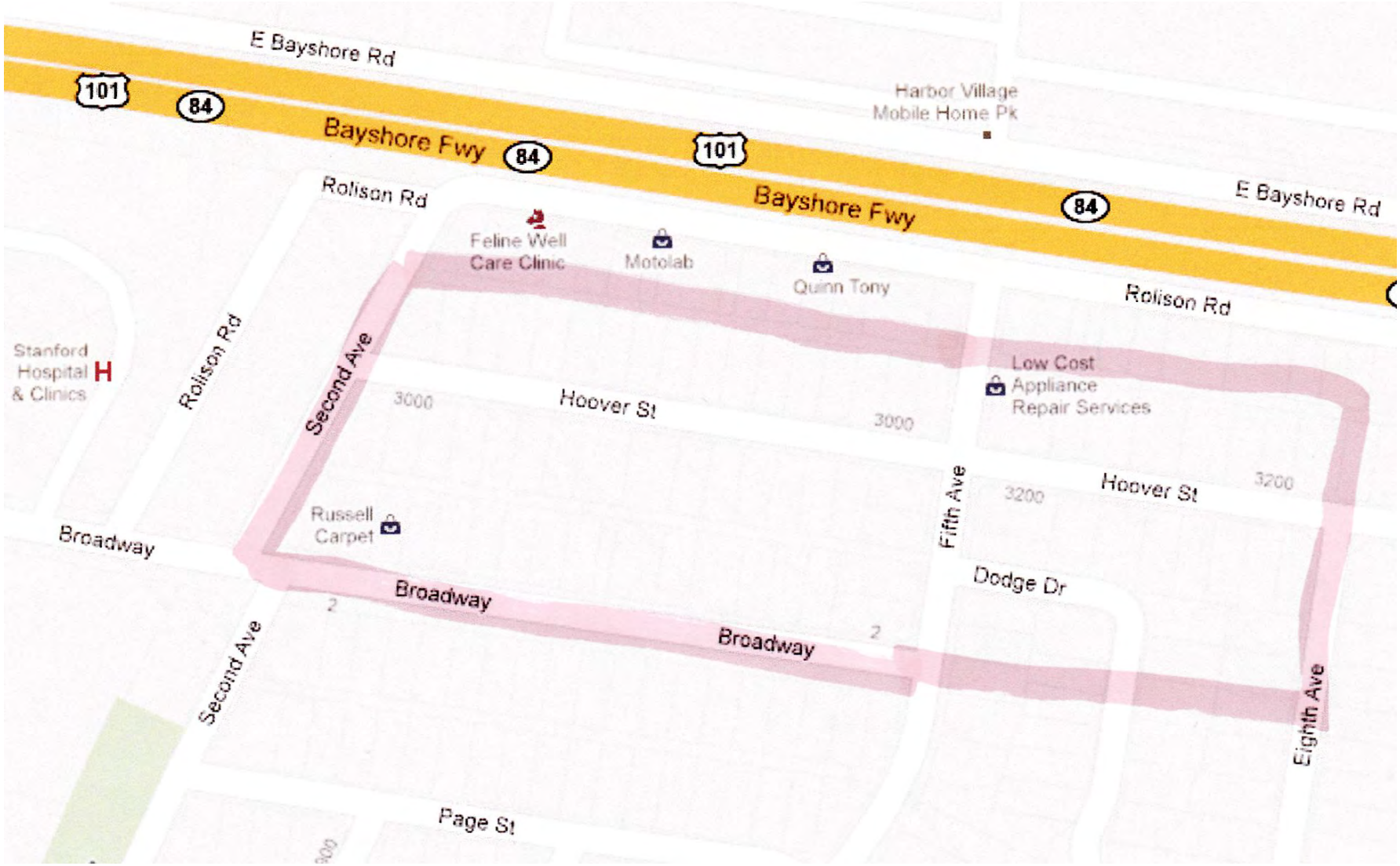


Figure 6
Google Maps View



1.5 Synopsis of Flood Events

1.5.1 Flood Elevation Data

For benefit-cost analysis, we consider four levels of flood events as summarized in Table 2.

Table 2
Flood Events for Benefit-Cost Analysis

Return Period (Years)	Street Closures	Damage to Homes	Maximum Flood Depth (Feet)[1]	Flood Elevation NAVD 1988 (feet)
1.6	YES	NO	1	8.0
5	YES	YES	1.5	8.5
25	YES	YES	2.1	9.1
100	YES	YES	3	10.0

[1] Maximum flood depth is depth of street flooding in the vicinity of 5th Avenue and Hoover Street. Flood depths in homes are always less and vary with the elevation and location of homes.

Flood depths for the 25-year flood event are as calculated from WRECO's 2011 hydraulic and hydrology modeling as discussed in the previous section. Flood depths of the other events are estimated conservatively from historical information, calibrated to the 25-year flood event.

For the 100-year flood event (1983), the maximum depth of street flooding in the vicinity of 5th Avenue and Hoover Street was stated to be over 3 feet (Friendly Acres Neighborhood Association Chair, Bonnie Miller, 2011 communication). For purposes of benefit-cost analysis this estimate was rounded down to 3 feet. The 0.9 foot increase in flood elevation is consistent with the NOAA rainfall data shown later in this section.

The 5-year and 1.6 year flood depth estimates of 1.5 feet and 1.0 feet, respectively, are towards the low end of estimates made by City of Redwood City staff and Friendly Acres Neighborhood Association members, from the many flood events experienced over the past 30+ years. As with the 100-year flood estimate noted above, these estimates of flood elevations are consistent with the NOAA rainfall data shown below.

Storm event inflows exceed the existing pumping capacity of the 5th Avenue Pump Station below the 2-year rain event. With increasing rainfall, flood levels rise significantly in proportion to the intensity and duration of rainfall events, because local topography concentrates ponding in the lowest elevation part of the 5th Avenue drainage basin as shown in Figure 3 in the previous section.

For reference, the NOAA rainfall data are shown below in Table 3.

Table 3
NOAA Precipitation Frequency Estimates

NOAA Atlas 14, Volume 6, Version 2
Location name: Redwood City, California, US*
Coordinates: 37.4900, -122.2103
Elevation: 10 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.117 (0.104-0.132)	0.144 (0.128-0.163)	0.180 (0.160-0.204)	0.210 (0.185-0.240)	0.252 (0.214-0.299)	0.285 (0.237-0.346)	0.319 (0.258-0.398)	0.355 (0.279-0.456)	0.404 (0.304-0.543)	0.443 (0.321-0.618)
10-min	0.168 (0.150-0.189)	0.206 (0.183-0.233)	0.257 (0.229-0.292)	0.300 (0.265-0.344)	0.361 (0.307-0.428)	0.408 (0.339-0.496)	0.457 (0.370-0.570)	0.509 (0.400-0.654)	0.580 (0.436-0.779)	0.635 (0.461-0.885)
15-min	0.203 (0.181-0.229)	0.249 (0.222-0.282)	0.311 (0.277-0.354)	0.363 (0.320-0.416)	0.436 (0.371-0.518)	0.494 (0.410-0.600)	0.553 (0.448-0.690)	0.615 (0.484-0.791)	0.701 (0.527-0.942)	0.768 (0.557-1.07)
30-min	0.281 (0.251-0.317)	0.345 (0.307-0.390)	0.431 (0.384-0.490)	0.503 (0.444-0.577)	0.604 (0.514-0.718)	0.684 (0.568-0.830)	0.766 (0.621-0.955)	0.852 (0.670-1.09)	0.971 (0.731-1.30)	1.06 (0.772-1.48)
60-min	0.396 (0.354-0.448)	0.487 (0.434-0.552)	0.609 (0.542-0.692)	0.711 (0.627-0.815)	0.853 (0.726-1.01)	0.966 (0.803-1.17)	1.08 (0.877-1.35)	1.20 (0.947-1.55)	1.37 (1.03-1.84)	1.50 (1.09-2.10)
2-hr	0.579 (0.517-0.655)	0.707 (0.630-0.800)	0.878 (0.781-0.998)	1.02 (0.900-1.17)	1.22 (1.04-1.45)	1.38 (1.15-1.67)	1.54 (1.25-1.92)	1.71 (1.34-2.20)	1.94 (1.46-2.61)	2.13 (1.54-2.96)
3-hr	0.729 (0.651-0.825)	0.890 (0.794-1.01)	1.11 (0.984-1.26)	1.29 (1.13-1.47)	1.54 (1.31-1.83)	1.74 (1.44-2.11)	1.94 (1.57-2.42)	2.15 (1.69-2.77)	2.45 (1.84-3.29)	2.68 (1.94-3.73)
6-hr	1.04 (0.926-1.17)	1.27 (1.14-1.44)	1.59 (1.41-1.81)	1.85 (1.64-2.13)	2.22 (1.89-2.64)	2.52 (2.09-3.06)	2.82 (2.28-3.51)	3.13 (2.46-4.02)	3.57 (2.69-4.79)	3.91 (2.84-5.45)
12-hr	1.35 (1.21-1.53)	1.69 (1.51-1.92)	2.15 (1.91-2.44)	2.53 (2.23-2.90)	3.06 (2.60-3.64)	3.48 (2.90-4.23)	3.92 (3.18-4.89)	4.38 (3.45-5.63)	5.02 (3.78-6.75)	5.53 (4.01-7.71)
24-hr	1.62 (1.47-1.82)	2.06 (1.87-2.31)	2.65 (2.40-2.98)	3.15 (2.83-3.57)	3.84 (3.36-4.48)	4.39 (3.77-5.21)	4.96 (4.17-6.01)	5.55 (4.56-6.91)	6.39 (5.06-8.24)	7.05 (5.42-9.37)

1.5.2 LIDAR Elevation Data

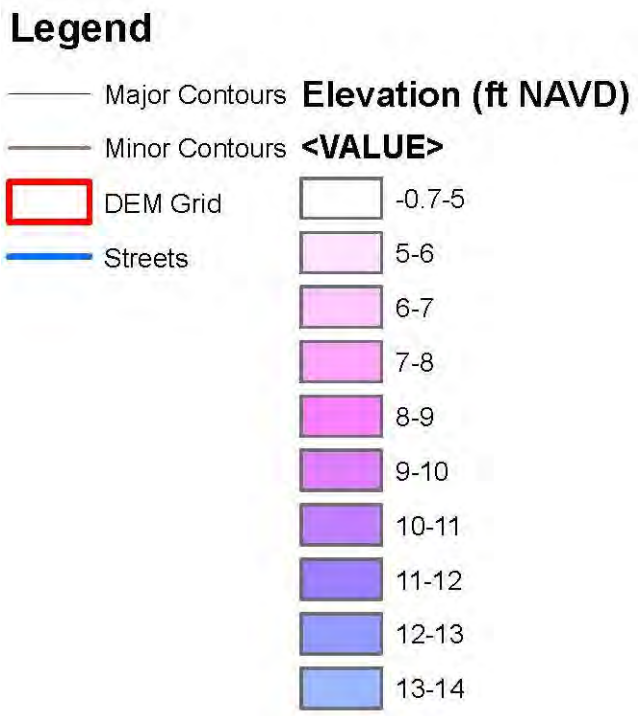
Street and grade elevations for the flood prone area of Friendly Acres neighborhood were determined primarily by high resolution LIDAR data, along with a limited number of surveyed elevation data points from City of Redwood City “block maps” for the water, wastewater, and stormwater systems.

An excerpt from the LIDAR contour maps for the flood prone area of the Friendly Acres neighborhood is shown in Figure 7.

Figure 7
LIDAR Elevation Contours (NAVD 1988)

The color key for the elevation contours is shown on the following page. For the flood prone area from 2nd Avenue to 8th Avenue (left to right in figure above) and from Rolison Road to Broadway Street (top to bottom in the figure above), at grade elevations range from a low 6 to 7 feet (lightest shading above) to above 10 feet (darker purple shading).

Figure 8
LIDAR Elevation Contours (NAVD 1988): Contour Color Key



2.0 MITIGATION PROJECT SCOPE AND COST ESTIMATE

2.1 Mitigation Project Scope

As noted previously, the predominant cause of the repetitive flooding in the Friendly Acres neighborhood is the inadequate pumping capacity of the 5th Avenue Pump Station. The pump station has a pumping capacity of only 30 cubic feet per second (CFS) which is inadequate to convey even the 2-year inflows.

Given this very limited capacity, the collection system backs up and causes flooding two or three times every year, with more severe flooding for larger events.

The proposed project is to upgrade the pumping capacity of the 5th Avenue Pump Station from 30 cfs to 260 cfs. The upgraded pumping capacity will be adequate to handle the 100 year inflows.

The pump station upgrade is designed for to handle 100-year flows, but the effectiveness of the project in completely eliminating future flood damages will be initially limited to 30-year flood events. The 30-year limit is the current collection and conveyance capacity of the storm water drainage system in this part of the Friendly Acres neighborhood. However, in larger flood events, the pump station upgrade will significantly reduce flood levels, but not completely eliminate ponding. In the future, as the collection and conveyance system is improved, the effectiveness of the upgraded pump station will rise.

For the present benefit-cost analysis, documented in Section 3.0, the pump station upgrade is considered to avoid flood damages up to the 30-year flood event, with reduced damages for larger flood events.

2.2 Mitigation Project Engineering Cost Estimate

The mitigation project cost estimate is $4,083,355 as shown in the summary in Table 4 on the following page.

The detailed engineering cost estimate with unit costs and quantities and the assessor's data documenting land costs for the easement procurement are attached to e-Grants. This supporting documentation is also included in Appendix 1 at the end of this report.

Table 5
Engineering Cost Estimate Summary

Construction[1]	$3,432,935
Design & Admin (10% of Construction)	$ 350,000
Environmental Compliance/Permitting[2]	$ 145,500
Additional Easement Procurement[3]	$ 154,920
Project Total	$4,083,355

[1] Construction Estimate based on detailed breakdown attached.

[2] Environmental Compliance/Permitting based on estimated cost to comply with the California Environmental Quality Act (CEQA), and possible permit application to the Corps of Engineers, San Francisco Bay Regional Water Quality Control Board (RWQCB), and the San Francisco Bay Conservation and Development Commission (BCDC). The estimate breakdown is as follows:

CEQA Compliance	$75,000
Corps Permit	$36,000
RWQCB Permit	$17,250
BCDC Permit	$17,250

[3] Easement Procurement estimate based on additional easement need of about 5,164 square foot (sf) at $30 per sf. Unit price per sf based on the attached map showing the average land value per sf from the County's assessor's data for the area.

The detailed engineering cost estimate with unit costs and quantities and the assessor's data documenting land costs for the easement procurement are attached to e-Grants. This supporting documentation is also included in Appendix 1 at the end of this report

3.0 BENEFIT-COST ANALYSIS INPUT DATA

3.1 Building Inventory Data

The flood-prone area as shown previously in Figure 3 from the WRECO hydraulic engineering and hydrology modeling, contains 128 homes.

Building inventory data for each of these 128 homes, along with photos and damage calculations using FEMA Standard Depth-Damage Functions from the Version 4.5.5 Flood BCA Software Module, are shown in full detail in the following file, which is attached to e-Grants:

Redwood City Inventory-BCA Data.xlsx

Building inventory data were obtained from the Assessor's Database, which includes:

- Address,
- Use (single family, multifamily, commercial, industrial),
- Building footprint (square feet),
- Number of stories, and
- Other data.

Building replacement values (BRV) per square foot were obtained from the latest edition of the BNi Building News Homebuilder's Costbook 2012:

- Medium costs for "Average" (contractor grade) homes were used,
- For homes below 1,500 square feet, BRV per square foot was assumed to be the same as for 1,500 square foot homes. This is a conservative , lower-bound estimate since unit costs increase for smaller homes.
- For homes above 3,000 square feet, BRV per square foot was estimated to be 10% lower than for a 3,000 square foot home. This is a conservative, lower bound type estimate because larger homes are typically more high-end with higher costs per square foot.
- BRVs include a geographic cost modifier of 1.26, which is the value for San Jose, the nearest city listed. Costs Redwood City are very similar to those in San Jose or San Francisco (cost modifier of 1.29).

For reference, scans of the relevant pages from the BNi Costbook are shown in Appendix2 and the end of this report. These data for "average" one-story and two-story homes, the lowest price category in the BNi Costbook.

For each of the 128 homes, the BRVs/SF were extracted from the BNi costs/SF in the Excel file referenced above, using the HLOOKUP Excel function, from the BNi cost tables on the Data Lookup Tables worksheet in the Excel file.

The building inventory Excel file, referenced above, also contains a Google Earth – Street View thumbnail photo of each of the 128 homes. These photos are active links to the Google Earth database which includes a larger format, wider view photo of each house.

3.2 First Floor Elevation Data

First floor elevations for the 128 homes in the flood-prone area were estimated from the high- resolution LIDAR elevation data and evaluation of each individual home via the following procedure:

1. Street and at-grade elevations were determined for each parcel from the high-resolution data LIDAR data shown previously in Figure 3, with additional elevation checks from surveyed elevations on the City of Redwood City block maps which map the City's water, wastewater and stormwater systems on a block by block, parcel by parcel basis.

2. A site visit was made in September 2011 to visually inspect each of the 128 homes. The topography of this neighborhood is flat with homes only minimal elevation rise for drainage between homes' footprint and the adjacent sidewalk/curbs. The estimated elevation difference between the street crest elevation and the sidewalk adjacent to porch steps ranged from only about 6" for a few homes to less than 18" for the highest elevation homes. For the vast majority of the 128 homes this elevation difference was estimated to be 10" to 12". For purposes of the present benefit cost analysis, this elevation difference was assumed to be 12". This estimate is higher than the median estimate and thus somewhat underestimates flood depths and damages in flood events. Thus, for benefit-cost analysis, this is a conservative, lower-bound type estimate.

3. The elevation difference between the sidewalk at the bottom of porch steps and the first floor door threshold was estimated from the number of steps and the average height per step. Step heights vary but were predominantly between 6" and 8". Most first floor thresholds were only an inch or two above the porch, but in a few cases the threshold was a full step above the porch. The elevation differences between the sidewalk at the bottom of the porch steps and the first floor was based on the number of steps (including one extra step is the door threshold was a step above the porch elevation). In a few cases, when step heights or the elevation of the threshold above the porch was irregular, the number of steps was estimated fractionally (e.g., 2.5 steps). For purposes of the present benefit-cost analysis, the average step height was assumed to be 8" which is somewhat higher than the median step height estimate. This estimate somewhat underestimates flood depths and damages in flood events and is thus a conservative lower-bound type estimate for the BCA.

4. The number of steps to the first floor for each home was determined from the Google Earth – Street View Photos, which are shown for each home in the previously referenced file which is attached to e-Grants:

   Redwood City Inventory-BCA Data.xlsx

   For homes where the thumbnail photos did not clearly show the number of steps, the number of steps was determined from the full Google Earth – Street View photos, which show wider views (and sometimes different views) than the thumbnail photo. For homes where none of the Google Earth photos showed the number of steps, the numbers of steps were determined visually during the September 2011 site visit.

5. The first floor elevation for each of the 128 homes, determined per the systematic procedure summarized above, is shown in the Excel file referenced above. These data are shown in columns P and S to V. Identical building elevation data are shown on the 5-Year Flood, 25-Year Flood and 100-Year Flood pages; the elevation data on these pages differ only with respect to the flood elevations and thus in the depth of water in each home for the various flood events. Column labels are as follows

   a. The first floor height above grade is the elevation difference between the sidewalk at the bottom of the porch steps and the first floor elevation.
   b. The first floor height above reference is the above height plus 12", reflected the average elevation difference discussed in paragraph 2 above.
   c. The reference elevation is the street crest elevation determined from the LIDAR elevation data.
   d. The first floor elevation (NAVD 1988) is shown in Column S.

Flood elevation data for the four levels considered in the BCA (1.6-, 5-, 25- and 100-year) were determined as summarized previously in Section 1.5.1 and as shown in Table 2. Flood depths are constant over the flooded area, which is a ponding area with negligible water surface slope over the few block area.

Flood depths of each of the four floods were determined for each of the 128 homes by the difference between the first floor elevation and the flood depth.

An excerpt from the detailed data tables for each of the 128 homes for the 5-year, 25-year and 100-year flood events is shown in the following figure (25-year flood event).

The full data set is shown in: **Redwood City Inventory-BCA Data.xlsx** which is attached in the e-Grants application.

Figure 9
Sample Excerpt From Redwood City Inventory-BCA Data.xlsx

APN	LAND USE	UNITS	YEAR BUILT	STORIES	BLDG FOOT PRINT (SF)	Number	Street	PHOTO	Building Replacement Value/SF	Building Replacement Value	First Floor Elevation NAVD 1988 (feet)
055022200	Multi Family	0	1952	1	2,249	26	BROADWAY		$213.41	$479,951	8.60
055023160	Single Family	1	1946	1	1,576	33	BROADWAY		$222.30	$350,348	11.00
055022210	Single Family	1	1936	1	593	34	BROADWAY		$222.30	$131,825	11.00
055022220	Single Family	1	1949	1	1,403	38	BROADWAY		$222.30	$311,889	11.67
055023150	Multi Family	2	1960	1	2,457	41	BROADWAY		$212.30	$521,615	11.00
055023140	Multi Family	2	1948	1	2,956	49	BROADWAY		$201.66	$596,116	11.00

3.3 Depth-Damage Functions

FEMA standard depth-damage functions for the relationships between flood depth (relative to the first floor) and building damages, contents damages and displacement costs were used in the BCA calculations.

The FEMA depth-damage function for building damages expresses damage a percentage of building replacement value (BRV). BRV was calculated as the product of BRV/SF from the BNi cost tables and the building size. The assessor's database for Redwood City contains only the square footage of the building footprint. For the one-story homes (110 of the 128 homes), the footprint and the building square footage are identical. For two-story homes (18 of 128 homes), the footprint square footage represents only the area of the first floor.

Because the two-story square foot data include only the first floor, the FEMA depth-damage functions for one-story without basement homes was used for all 128 homes. None of the 128 homes have basements. For reference, these FEMA depth-damage functions from the Version 4.5.5 BCA Software Flood Module are shown below in Table 5.

Table 5
FEMA Depth-Damage Functions: One-Story Home Without Basement

FEMA Standard Depth Damage Relationships (USACE Generic)				
1-Story Residence Without Basement				
Flood Depth Relative to First Floor (feet)	Building Damage Percent	Contents Damage Percent	Displacement Time (days)	Displacement Time (months)
-10.00	0.00%	0.00%	0	0
-2.00	0.00%	0.00%	0	0
-1.00	2.50%	2.40%	0	0
0.00	13.40%	8.10%	0	0
1.00	23.30%	13.30%	45	1.5
2.00	32.10%	17.90%	90	3.0
3.00	40.10%	22.00%	135	4.5
4.00	47.10%	25.70%	180	6.0
5.00	53.20%	28.80%	225	7.5
6.00	58.60%	31.50%	270	9.0

Note: the -10.00 feet flood depth was added to the above table to facilitate the automated lookup in the Excel table using the VLOOKUP function. This entry is necessary to enable the VLOOKUP function to automatically return zero damages for flood depths below -2.00 feet.

The FEMA Standard Depth-Damage Relationship (USACE generic) expresses contents damage as a percentage of BRV (that is, the FEMA standard value of contents is set at 100%).

Displacement costs were calculated using the FEMA standard value of $1.44 per square foot per month as per the FEMA Version 4.5.5 BCA Software Flood Module.

3.4 Building Damages Before and After Mitigation

3.4.1 Before Mitigation

Building damages before mitigation are calculated for each of the 128 homes individually, using the methods described in full detail in the above section. The totals for each flood event for three categories of damages and losses: building damages, contents damages and displacement costs are entered into the FEMA Version 4.5.5 Damage Frequency Assessment (DFA) software module, along with traffic count and road closure data that are discussed later in Section 3.5.

Calculated building damages and losses before mitigation, which were calculated using FEMA Standard Depth-Damage Functions as described above in Section 3.3, are shown below in Table 6.

Table 6
Building Damages and Losses: Before Mitigation

Damage or Loss Category	Flood Event			
	1.6 Year	5 Year	25 Year	100 Year
Building Damage	$0	$542,849	$1,572,315	$3,690,686
Contents Damage	$0	$400,697	$1,063,591	$2,349,879
Displacement Costs	$0	$0	$4,858	$62,048
Total	$0	$943,546	$2,640,764	$6,102,612

The calculated damages and losses shown in Table 7 are as calculated shown in: **Redwood City Inventory-BCA Data.xlsx** which is attached in the e-Grants application. These results are shown in Row 133 of the worksheets for the 5-Year, 25-Year and 100-Year flood events.

The calculated numbers of homes with flood damages are 21, 59, and 100 for the 5-year, 25-year and 100-year flood events, respectively.

3.4.2 After Mitigation

As discussed previously, in Section 2.1, the proposed upgrade to the 5th Avenue Pump Station will provide sufficient capacity to handle 100-year inflows. However, the achievable level of flood protection is governed by the combination of the pump station capacity and the collection/conveyance capacity of the stormwater system. The collection/conveyance capacity of the stormwater system limits the achievable level of complete protection against flooding to a 30-year event.

In flood events greater than a 30-year event, the depth of flooding will be substantially reduced but there will still be some level of street flooding. Maximum flood depths for the four levels of floods considered were shown and discussed previously in Section 1.5.1. Summary maximum flood depths in the flood prone area, Table 2 in Section 1.5.1, are repeated below in Table 7.

Table 7
Flood Events for Benefit-Cost Analysis

Return Period (Years)	Street Closures	Damage to Homes	Maximum Flood Depth (Feet)[1]	Flood Elevation NAVD 1988 (feet)
1.6	YES	NO	1	8.0
5	YES	YES	1.5	8.5
25	YES	YES	2.1	9.1
100	YES	YES	3	10.0

[1] Maximum flood depth is depth of street flooding in the vicinity of 5th Avenue and Hoover Street. Flood depths in homes are always less and vary with the elevation and location of homes.

From the flood elevation data in Table 8 above, the achievable 30-year flood protection means that flood elevations will be reduced more than the before-mitigation flood depth of 2.1 feet (25-year event shown above). That is, no street flooding is expected except for floods above the 30-year event.

This level of protection corresponds to reducing flood depths by >2.1 feet. The 100-year flood depth before mitigation is only 0.9 feet more than the 25-year flood depth. This analysis suggests that after-mitigation flood depths will be less than 0.9 feet up to the 100-year event. This level of street flooding is below the flood depth at which building damages will occur. Thus, this analysis suggests that the proposed mitigation project may completely eliminate building damages up to the 100-year event. That is, that after mitigation flood events greater than the 30-year event will be limited to street flooding only, up to at least the 100-year event.

More conservatively, in the spirit of a lower-bound type benefit-cost analysis, the maximum flood depth for a "100-year" flood event or any other flood event may vary depending on the combination of duration and intensity of a given rainfall event. For

example, a 6-hour 100-year rainfall event with 2.82” of rain (See: Table 3) might have a higher maximum flood depth than a 12-hour 100-year rainfall event with 3.92” of rain. Given this inherent variability in the duration-intensity of rainfall events, we do not assume that building damages after mitigation will always be zero, although this seems likely.

Rather, we make the more conservative estimate that building damages after mitigation won’t be more than the 5-year damages before mitigation. Given the above analysis, this data input likely overestimates the building damages after mitigation and thus underestimates the benefits (and BCR) of the proposed mitigation project.

Estimated building damages after mitigation are shown in Table 8.

Table 8
Building Damages and Losses: After Mitigation

Damage or Loss Category	Flood Event			
	1.6 Year	5 Year	25 Year	100 Year
Building Damage	$0	$0	$0	$542,849
Contents Damage	$0	$0	$0	$400,697
Displacement Costs	$0	$0	$0	$0
Total	$0	$0	$0	$943,546

3.5 Road Closures

As discussed previously, the highly repetitive flooding in the most flood-prone part of the Friendly Acres neighborhood results in frequent road closures. As shown in Table 8, road closures occur in all significant flooding events starting with the 1.6 year flood event.

As noted previously, some level of flooding typically occurs 2 or 3 times per year in Friendly Acres. Some road closures or disruption of traffic flow from standing water may also occur in these extremely frequent events. However, for benefit-cost analysis, we consider no damages, losses or road closures for these extremely frequent events.

The most recent available traffic count data for the main thoroughfare streets in the flood project area of Friendly Acres are shown in Table 9.

Table 9
Traffic Count Data from City of Redwood City

2nd Ave east of Broadway		2,296
2nd Ave west of Broadway		2,920
5th Avenue east of Broadway		3,485
5th Avenue west of Broadway		6,770
Rolison Rd south of 5th		3,628
Rolinson Rd north of 5th		2,280
Broadway between 2nd & Fifth		5,265
	Total	**26,644**

For calculation of the economic impacts of the delay/detour time associated with road closures, we use the FEMA standard value of $38.15 per vehicle hour of delay/detour, as built into the Version 4.5.5 DFA BCA software.

Road closures in the flood-prone area have occurred dozens of times over the past 60 years. The typical closure times for flood events of varying severity are shown below the Table 10. These “best estimates” are based on historical experience in Redwood City. Actual closure times may be longer, taking into account the necessity to remove barricades, generally at several locations on each major street and complete any necessary debris removal.

Table 10
Typical Road Closure Durations

Event	Closure Time (Days)
1.6 Year Flood	0.2
5 Year Flood	0.3
25-Year Flood	0.5
100-Year Flood	1
Friendly Acres Typical Delay/Detour Time (hours)	0.25

The typical delay/detour time for closures of all of the major thoroughfares in the flood prone part of Friendly Acres is estimated very conservatively at 15 minutes (0.25 hours). Redwood City is a dense, highly urbanized community with high levels of traffic congestion. The thoroughfares within this area feed adjacent thoroughfares which in turn feed major arteries which connect to Highway 101, immediately south of the Friendly Acre neighborhood. Given the confusion and congestion, especially under severe winter rainstorm conditions, an average delay time of only 15 minutes is a conservative lower bound type data input.

4.0 BENEFIT-COST RESULTS

Benefit-cost analysis for the 5th Avenue Pump Station Upgrade was conducted using the FEMA Version 4.5.5 BCA Software Module.

The data inputs for the benefit-cost analysis are as documented in Section 3.0 above.

The benefit-cost analysis also used the following FEMA Standard Values:

- Discount Rate: 7%. This is the OMB-mandated discount rate for all FEMA BCAs.
- Project Useful Life: 50 years. This is the FEMA Standard Value for pump stations, as stated Appendix D, Project Useful Life Summary in the FEMA BCA Reference Guide, June 2009.

The total mitigation project cost for benefit-cost analysis is the engineering cost estimate shown in Table 4: $4,083,355. The detailed engineering cost estimate with unit costs and quantities is included in Appendix 1.

Benefit-cost results are as shown in Table 11.

Table 11
Benefit-Cost Results

Benefits	**$7,577,742**
Costs	**$4,083,355**
Benefit-Cost Ratio	**1.86**

The above benefit-cost analysis results indicate that the project is cost-effective with a benefit-cost ratio of 1.860.

The data inputs for this benefit-cost analysis are conservative and well documented throughout.

Furthermore, in several regards, this benefit-cost analysis is a lower-bound type analysis. The following potential flood damages (benefits when avoided by the proposed mitigation project) were <u>not</u> considered in this benefit-cost analysis:

- Any damages or losses in the very frequent, 2 or 3 times per year, small floods which don't result in road closures. Although generally small there are undoubtedly some costs for cleanup and the potential for damages to landscaping, other property outside of the home, and damages to garages at very low elevations. The potential for such damages in exacerbated by speeding drivers who create wakes while driving down flooded streets.

- Emergency management costs, including City of Redwood Police and Public Works staff time to install and monitor barricades during street closures, debris cleanup after events, and flood event management costs.
- Damages to vehicles, outbuildings, garages, and equipment outside of homes.
- Disruption time and costs for owners of flooded homes to cleanup, make repairs, replace damaged goods and so on.

Including these additional categories of damages in the BCA would result in a higher BCR. These categories of damages were not included in the present BCA because credible data to estimate these damages were not available and the BCR was already 1.604 without considering these categories.

REFERENCES

McGovern, Janet (1986). Residents ask City County for Better Drainage System, Times Tribune, February 26, 1986.

Moffat & Nichols Engineering Report (2009), Redwood Shores Levee System.

Redwood City Public Works Department (2000), Strategy to Address Flooding Problems in Friendly Acres/East Bayshore and Centennial Neighborhoods, 44p.

Wilsey & Ham Engineering Report (1994), Redwood City Bay Front Canal Interim Report.

WRECO (2011). Hydrology and Hydraulics Report. Bayfront Canal Improvement Project, City of Redwood City, California (September 2011).

APPENDIX 1

Engineering Cost Estimate for Construction

and Land Value Map for Easement Costs

FIFTH AVENUE PUMP STATION
ENGINEER ESTIMATE

Item No.	EST. Qty.	Unit	Description of Item	Unit Price	Item Cost
1	1	LS	Mobilization and Traffic Control, Overhead (Not to Exceed 5%)	170,000	170,000
2	1	LS	Demolition, Clearing, AC And Equipment Removal, Grubbing	70,000	70,000
3	1	LS	Shoring / Dewatering / Storm Drain Bypass	180,000	180,000
4	1	LS	Pump Station, Pipeline, Structures Excavation, Foundation Preparation and Material, & Backfill	175,000	175,000
5	1	LS	Pump Station Concrete, Reinforcement & Misc. Metal	550,000	550,000
6	2	EA	Flygt PL – 7101 - 590 240 HP Pump	85,000	170,000
7	2	EA	Flygt PL – 7101 – 590 170 HP Pump	75,000	150,000
8	4	EA	48" Dia. Pump Steel Column with Base Plate, Anchoring Bracket and Anti-Swirl Plate	85,800	343,200
9	2	EA	48" x 48" Pump Elbow	14,000	28,000
10	2	EA	48" x 42" Pump Elbow	13,500	27,000
11	2	EA	48" Flexible Coupling	6,500	13,000
12	2	EA	42" Flexible Coupling	6,300	12,600
13	2	EA	48" Steel Pipe Connector	5,500	11,000
14	2	EA	42" Steel Pipe connector	5,200	10,400
15	4	EA	10" Air / Vacuum Valve	2,500	10,000
16	4	EA	3" Air Release Valve	600	2,400
17	1	EA	Flygt 3152/620 14 HP Sump Pump	28,000	28,000
18	2	EA	2" Dia. 25' long Galv. Steel Schedule 40 Sump pump Guide Bar	800	1,600
19	4	EA	24" Dia. Air/Vacuum Cover (H-20)	1,000	4,000
20	4	EA	6' x 6' Pump Maintenance Hatch (H-20)	8,500	34,000
21	1	EA	4' x 2' 6" Sump Pump Access Hatch (H- 20)	3,500	3,500
22	1	EA	5' - 6" x 3' - 6" Debris Removal Hatch (H-20)	5,500	5,500
23	1	EA	4' x 8' Pump Station Access Hatch (H-20)	8,500	8,500
24	4	EA	Grating With Counter Balance Assembly (H-20)	5,500	22,000
25	4	EA	Counter Balance Metal Cover (H-20)	650	2,600
26	1	EA	3' x 3" Approach Channel Access Hatch (H-20)	2,750	2,750
27	10	EA	Safety Handrail Stand Base	125	1,250
28	10	EA	Safety Handrail Stand with Safety Chain	300	3,000
29	3	EA	Pump Station Access Hatch Safety Rail w/Chain	350	1,050
30	1	EA	4' x 2' – 6" Sump Pump Cover	2,250	2,250
31	1	EA	4' – 8" x 3' – 6" Debris Bin Cover	3,500	3,500
32	1	EA	3' x3' Sump Hatch	1,500	1,500
33	2	EA	4" Floor Drain	200	400
34	35	LF	Pump Station Handrail	125	4,375
35	1	EA	Metal Trash Rack Assembly	8,500	8,500
36	1	EA	Trash Bin and Safety Cage	3,000	3,000

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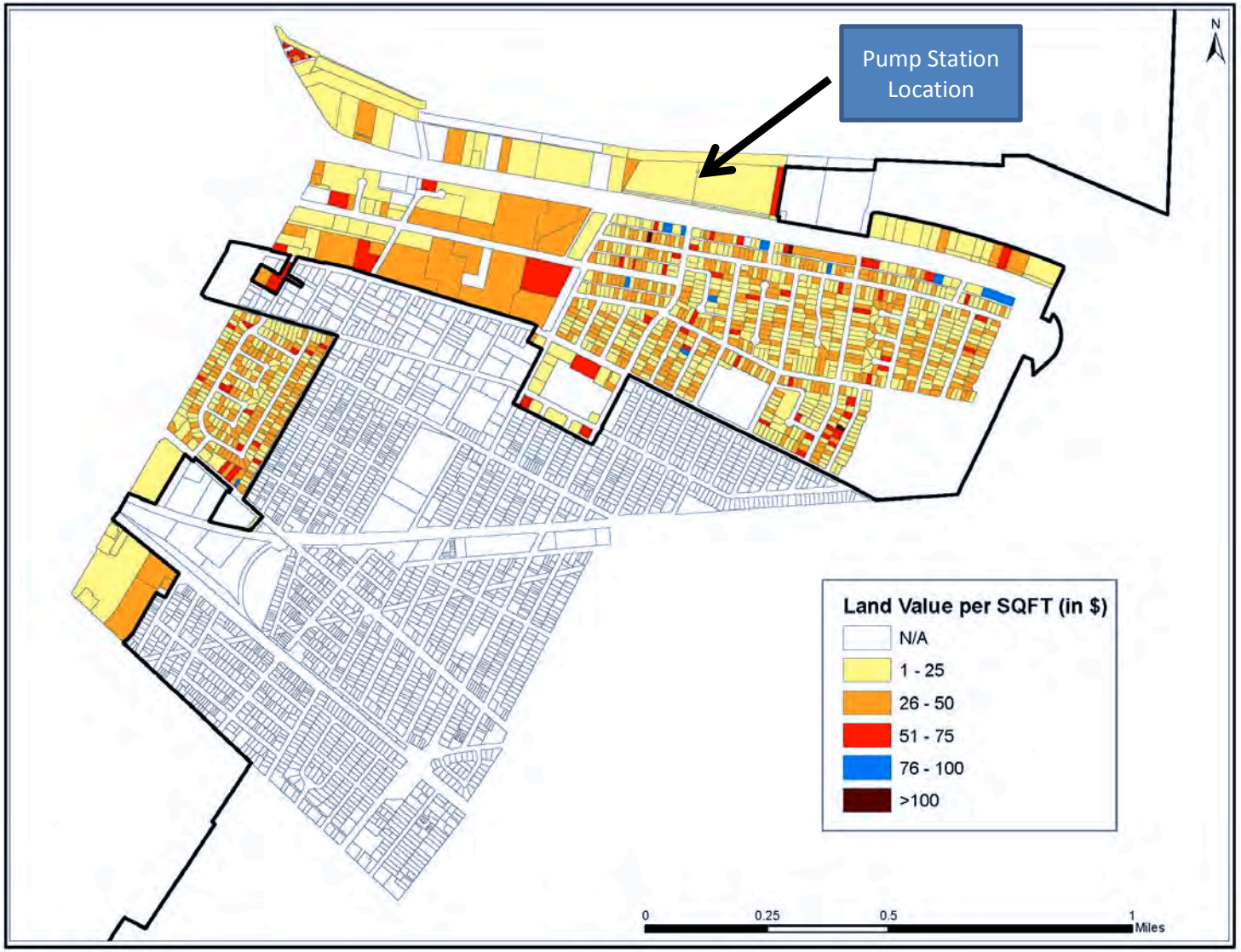
FIFTH AVENUE PUMP STATION
ENGINEER ESTIMATE

37	1	LS	Stairway and Handrail	6,500	6,500
38	1	LS	Metal Ladder with Safety Post – 21 LF	1,650	1,650
39	1	LS	Metal Ladder with Safety Post – 13 LF	1,450	1,450
40	142	LF	15" PVC Vent Pipe Including Fitting	45	6,390
41	40	LF	66" Class VI RCP	520	20,800
42	140	LF	48" Class VI RCP	420	58,800
43	140	LF	42" Class VI RCP	400	56,000
44	180	LF	10" DI Sump Pump Discharge Pipe Including Fittings and SS Clamps	60	10,800
45	51	LF	Discharge Structure Sheet Pile	820	41,820
46	1	LS	Discharge Structure Concrete and Reinforcement, Misc. Metal in place	160,000	160,000
47	54	LF	Discharge Structure Chain Link Fence	45	2,430
48	2	EA	48" Flanged Tideflex Check Valve	27,500	55,000
49	2	EA	42" Flanged Tideflex Check Valve	23,000	46,000
50	2	EA	10" Tideflex Check Valve	2,400	4,800
51	1	LS	Storm Drain Junction Box Structure in place	95,000	95,000
52	1	LS	Remove Existing 66" Bulkhead and Connect to New Junction Box Structure with 66" RCP	15,000	15,000
53	3	EA	SD Manhole	3,000	9,000
54	2	EA	SD Catch Basin	2,500	5,000
55	112	LF	24" SD Pipeline	120	13,440
56	226	LF	12" SD Pipeline	80	18,080
57	260	TON	Asphalt Concrete	85	22,100
58	1	LS	Striping	2,500	2,500
59	1	EA	Centrifugal Filtered Roof Supply Fan	6,500	6,500
60	1	LS	Concrete Block Building	60,000	60,000
61	1	LS	Painting	17,500	17,500
62	1	EA	500 KW Diesel Engine Emergency Generator	92,500	92,500
63	1	LS	Electrical Work	475,000	475,000
64	1	LS	Telemetry and Control System	65,000	65,000
			TOTAL BASE BID ITEMS 1 THROUGH 64		**$ 3,432,935**

Assesor's Data on Land Values for Estimating Easement Cost for the 5th Avenue Pump Station Upgrade



APPENDIX 2

BNi Building News Homebuilder's Costbook 2012

Building Replacement Cost Data

ONE STORY AVERAGE

LOW

SQUARE FOOTAGE	1500	1750	2000	2250	2500	2750	3000
COSTS							
FRAME	73.78	72.30	70.83	70.46	68.69	66.93	66.23
INTERIORS	70.57	69.16	67.75	67.39	65.70	64.02	63.35
OVERHEAD & PROFIT	16.04	15.72	15.40	15.32	14.93	14.55	14.40
TOTAL	**$160.39**	**$157.18**	**$153.97**	**$153.17**	**$149.32**	**$145.50**	**$143.98**

MEDIUM

SQUARE FOOTAGE	1500	1750	2000	2250	2500	2750	3000
COSTS							
FRAME	81.16	79.53	77.91	77.50	75.56	73.62	72.85
INTERIORS	77.63	76.07	74.52	74.13	72.27	70.42	69.69
OVERHEAD & PROFIT	17.64	17.29	16.94	16.85	16.43	16.01	15.84
TOTAL	**$176.43**	**$172.90**	**$169.37**	**$168.49**	**$164.25**	**$160.05**	**$158.38**

HIGH

SQUARE FOOTAGE	1500	1750	2000	2250	2500	2750	3000
COSTS							
FRAME	84.84	83.15	81.45	81.03	78.99	76.97	76.17
INTERIORS	81.16	79.53	77.91	77.50	75.56	73.62	72.85
OVERHEAD & PROFIT	18.44	18.08	17.71	17.61	17.17	16.73	16.56
TOTAL	**$184.45**	**$180.76**	**$177.07**	**$176.15**	**$171.72**	**$167.33**	**$165.58**

TWO STORY AVERAGE

LOW

SQUARE FOOTAGE	1500	1750	2000	2250	2500	2750	3000
COSTS							
FRAME	63.18	61.91	60.65	60.33	58.82	57.31	56.71
INTERIORS	60.43	59.22	58.01	57.71	56.26	54.82	54.25
OVERHEAD & PROFIT	13.73	13.46	13.18	13.12	12.79	12.46	12.33
TOTAL	**$137.34**	**$134.59**	**$131.85**	**$131.16**	**$127.86**	**$124.59**	**$123.29**

MEDIUM

SQUARE FOOTAGE	1500	1750	2000	2250	2500	2750	3000
COSTS							
FRAME	69.49	68.10	66.71	66.37	64.70	63.04	62.38
INTERIORS	66.47	65.14	56.81	63.48	61.89	60.30	59.67
OVERHEAD & PROFIT	15.11	14.81	14.50	14.43	14.06	13.71	13.56
TOTAL	**$151.07**	**$148.05**	**$145.03**	**$144.28**	**$140.65**	**$137.05**	**$135.62**

HIGH

SQUARE FOOTAGE	1500	1750	2000	2250	2500	2750	3000
COSTS							
FRAME	72.65	71.20	69.75	69.38	67.64	65.91	65.22
INTERIORS	69.49	68.10	66.71	66.37	64.70	63.04	62.38
OVERHEAD & PROFIT	15.79	15.48	15.16	15.08	14.70	14.33	14.18
TOTAL	**$157.94**	**$154.78**	**$151.62**	**$150.83**	**$147.04**	**$143.28**	**$141.78**

GEOGRAPHIC COST MODIFIERS		01025
State	Metropolitan Area	Multiplier
AK	ANCHORAGE	132
AL	ANNISTON	81
	AUBURN	82
	BIRMINGHAM	82
	DECATUR	84
	DOTHAN	83
	FLORENCE	84
	GADSDEN	82
	HUNTSVILLE	84
	MOBILE	86
	MONTGOMERY	81
	OPELIKA	82
	TUSCALOOSA	81
AR	FAYETTEVILLE	79
	FORT SMITH	79
	JONESBORO	78
	LITTLE ROCK	82
	NORTH LITTLE ROCK	82
	PINE BLUFF	80
	ROGERS	79
	SPRINGDALE	79
	TEXARKANA	79
AZ	FLAGSTAFF	94
	MESA	94
	PHOENIX	95
	TUCSON	93
	YUMA	94
CA	BAKERSFIELD	116
	CHICO	118
	FAIRFIELD	120
	FRESNO	118
	LODI	117
	LONG BEACH	119
	LOS ANGELES	119
	MERCED	118
	MODESTO	114
	NAPA	120
	OAKLAND	124
	ORANGE COUNTY	118
	PARADISE	114
	PORTERVILLE	116
	REDDING	114
	RIVERSIDE	116
	SACRAMENTO	118
	SALINAS	120
	SAN BERNARDINO	116
	SAN DIEGO	117
	SAN FRANCISCO	129

GEOGRAPHIC COST MODIFIERS		01025
State	Metropolitan Area	Multiplier
CA	SAN JOSE	126
	SAN LUIS OBISPO	113
	SANTA BARBARA	116
	SANTA CRUZ	120
	SANTA ROSA	121
	STOCKTON	117
	TULARE	118
	VALLEJO	120
	VENTURA	116
	VISALIA	118
	WATSONVILLE	118
	YOLO	118
	YUBA CITY	118
CO	BOULDER	103
	COLORADO SPRINGS	100
	DENVER	101
	FORT COLLINS	110
	GRAND JUNCTION	99
	GREELEY	108
	LONGMONT	103
	LOVELAND	110
	PUEBLO	105
CT	BRIDGEPORT	113
	DANBURY	113
	HARTFORD	112
	MERIDEN	113
	NEW HAVEN	113
	NEW LONDON	110
	NORWALK	117
	NORWICH	110
	STAMFORD	117
	WATERBURY	112
DC	WASHINGTON	105
DE	DOVER	105
	NEWARK	106
	WILMINGTON	106
FL	BOCA RATON	80
	BRADENTON	80
	CAPE CORAL	78
	CLEARWATER	81
	DAYTONA BEACH	75
	FORT LAUDERDALE	83
	FORT MYERS	78
	FORT PIERCE	81
	FORT WALTON BEACH	76
	GAINESVILLE	80
	JACKSONVILLE	78
	LAKELAND	78

Residential Losses from Urban Water Shortages in California

Prepared for

California Urban Water Agencies
455 Capitol Mall, Suite 705
Sacramento, CA, 95814

By

Berkeley Economic Consulting, Inc.
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July 7, 2010

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Residential Losses from Urban Water Shortages in California

Executive Summary

California's water system is susceptible to periodic and potentially prolonged periods of water supply disruption due to natural variations in precipitation and runoff. Recent environmental protections in the Delta and the possibility that climate change may alter future precipitation levels both over regions and over time increase the risk that California water providers are at times unable to meet their target levels of water delivery. Combined with projections for continued population growth in the State, this confluence of forces makes it increasingly important to model the economic implications of periodic disruptions in water supply.

This report measures the economic losses to residential customers of California Urban Water Agencies (CUWA) that arise from different magnitude reductions in annual water deliveries. The analysis considers consumer willingness to pay to avoid a water supply disruption of a given size based on regional estimates of residential demand conditions facing water purveyors within CUWA member agencies. Economic losses are calculated and presented as a range between a lower bound value of consumer surplus loss, which is the additional premium consumers are willing to pay above the prevailing water rate for water units displaced during a shortage, and an upper bound value of total consumer willingness to pay, which includes the water rate that would actually be paid for the displaced water units absent a shortage. Actual economic losses in each region, which would fall somewhere between these extremes, can be calculated as consumer willingness to pay to avoid a water supply interruption (the upper bound value) net of any cost savings incurred at the agency level from reduced delivery levels during the period of interruption.

The foundation for calculating consumer willingness to pay to avoid a supply disruption is based on regional estimates of the price elasticity of demand facing water retailers within each CUWA member agency. The estimated residential demand model controls for several pertinent factors apart from water rates that affect water consumption levels. These factors include average household income, average lot size, average daily summer temperature, average annual precipitation level, and the current extent to which best-management practices (BMPs) are employed for water conservation in each region, as well as time trends. Controlling for these factors is essential, as the empirical results indicate that: (*i*) households with higher income levels are willing to pay a greater amount to avoid a supply disruption than households with lower income levels; (*ii*) households with larger lot sizes have a lower willingness to pay than households with smaller lot sizes due to a greater share of water allocated to lower-valued uses in outdoor irrigation; and (*iii*) households in regions that extensively employ BMPs are willing to pay a greater amount to avoid a water supply disruption. This last result is important because it provides empirical evidence of demand hardening: Given previous

conservation gains from adopting BMPs in a region, achieving further reductions in water use through conservation efforts becomes more difficult.

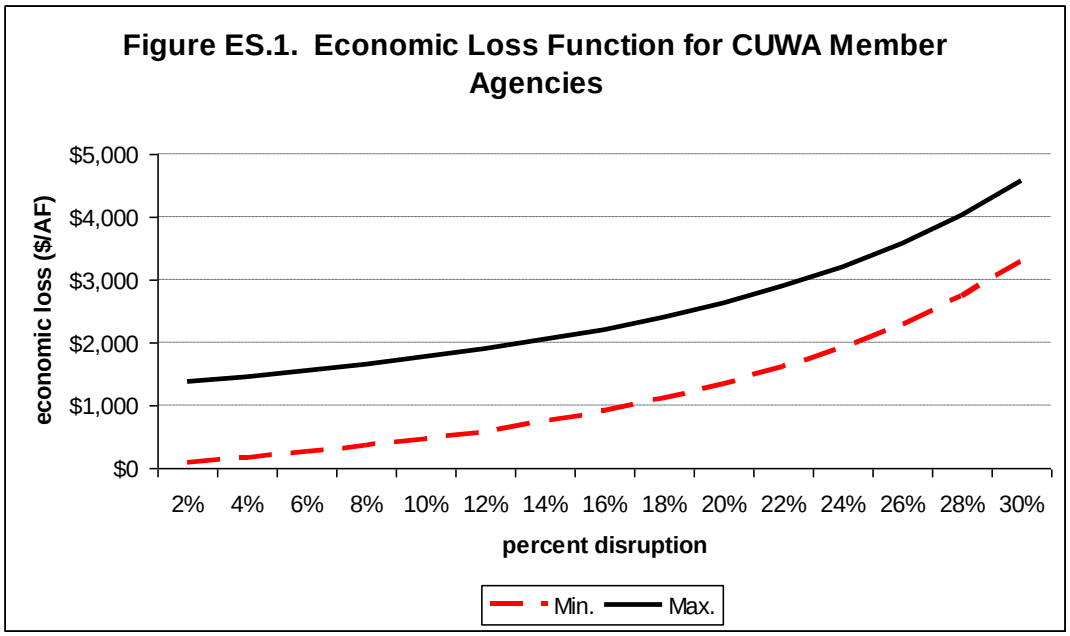
The combined economic loss across CUWA member agencies is summarized in Table ES.1 for an annual supply disruption of 10%, 20%, and 30%. For the total loss calculation, annual losses are expressed for the case in which the decline in municipal and industrial deliveries is mediated through the residential sector of each region. For a 10% annual reduction in water deliveries among CUWA member agencies, the total economic loss is in the range between $222 million ($458/AF) and $858 million ($1,765/AF); for a 20% annual reduction in water deliveries, the total economic loss is in the range between $1.3 billion ($1,324/AF) and $2.6 billion ($2,632/AF); and for a 30% annual reduction in water deliveries, the total economic loss is in the range between $4.8 billion ($3,267/AF) and $6.7 billion ($4,574/AF).

Table ES.1. Economic Losses from a Cumulative 10%, 20%, and 30% Supply Disruption for CUWA Member Agencies

Scenario	10% disruption	20% disruption	30% disruption
Lower Bound			
Total Loss (million $s)	$222.33	$1,287.19	$4,763.84
Average Loss ($/AF)	$458	$1,324	$3,267
Upper Bound			
Total Loss (million $s)	$857.68	$2,557.88	$6,668.89
Average Loss ($/AF)	$1,765	$2,632	$4,574

Economic losses on a per unit basis ($/AF) increase considerably for larger magnitudes of supply disruption. The reason is that less costly methods of water conservation are adopted by households before turning to more costly methods of water conservation. Thus, consumer willingness to pay to avoid a supply disruption rises at an increasing rate with the magnitude of the water shortage as more valuable end-uses of water are displaced at larger disruption levels than at smaller disruption levels.

Figure ES.1 shows the trend in economic losses ($/AF) across CUWA members for increasing magnitudes of the water shortage. The dashed line represents the lower bound of losses represented by the loss of consumer surplus and the solid line represents the upper bound of losses represented by total consumer willingness to pay to avoid a water service disruption.



There is considerable variation in economic losses across individual CUWA member agencies. CUWA member agencies differ widely in socioeconomic factors such as average household income levels, adoption of conservation BMPs, and prevailing water rates, each of which has an important bearing on the willingness to pay of consumers to avoid a water shortage. For a 10% supply disruption, the standard deviation of economic losses across members is $406/AF at the lower boundary and $807/AF at the upper boundary of losses. For a 20% supply disruption, the standard deviation of economic losses across members is $1,353/AF at the lower boundary and $1,710/AF at the upper boundary of losses. For a 30% supply disruption, the standard deviation of economic losses across members is $3,895/AF at the lower boundary and $4,216/AF at the upper boundary of losses.

Variability in economic losses across members in response to a water supply disruption is driven by two features: (i) differences in water rates; and (ii) differences in the elasticity of residential water demand. Average economic losses from a water shortage rise at a faster pace with the magnitude of the disruption in regions in which residential demand conditions are less elastic, for instance in regions that have extensively adopted best-management practices for conservation prior to undergoing a water shortage. Agencies that have intensively implemented BMPs are less able to facilitate further water conservation relative to agencies that have not as actively exploited the conservation potential of households, and accordingly, consumer willingness to pay to avoid a supply disruption rises more rapidly in the magnitude of the water supply disruption in these regions.

October 30, 2008

Final
Program Environmental Impact Report
Volume 4 of 8

For the
San Francisco Public Utilities Commission's
WATER SYSTEM IMPROVEMENT PROGRAM

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6 Mitigation Measures

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Mitigation Measures

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6.1 Introduction

This chapter presents mitigation measures for impacts associated with implementation of the proposed program as identified in Chapters 4 and 5 of this PEIR. Chapter 4 identifies impacts that would be associated with construction and operation of WSIP facility improvement projects, while Chapter 5 identifies impacts that would result from the proposed water supply and system operations. In these chapters, the level of significance is indicated for each impact; these determinations are one of the following: N/A (not applicable), B (Beneficial, no mitigation required), LS (Less than Significant, no mitigation required), PSM/SM (Potentially Significant/Significant, can be mitigated to less than significant), LSM (Less than Significant, since it would be mitigated with program-level mitigation measures) PSU/SU (Potentially Significant Unavoidable/Significant and Unavoidable, where mitigation would not necessarily reduce the impact to less than significant). The significance determinations are based on the potential effects of the proposed program as they relate to the significance criteria listed in Chapters 4 and 5, with consideration of how SFPUC construction measures and regulatory requirements may reduce the severity of the effect. Mitigation measures are then identified for all impacts determined to be PSM as well as for impacts determined to be PSU or SU, to the extent that any feasible mitigation would be available. The detailed descriptions of all mitigation measures are included in this chapter.

Section 6.2 of this chapter presents the SFPUC construction measures that will be applied to all WSIP facility improvement projects; Section 6.3 describes the mitigation measures to minimize facilities-related impacts; and Section 6.4 describes the mitigation measures to minimize water supply and system operations impacts. All mitigation measures are numbered to correspond to impact numbers presented in Chapters 4 and 5; in some cases where the same measure would mitigate more than one impact, the measure number corresponds to the first impact identified. In a few cases, implementation of the mitigation measures in and of themselves could result in additional environmental effects, and therefore, Section 6.5 includes a general description of impacts of those mitigation measures. Section 6.6 presents summary tables of all impacts and mitigation measures, showing which measures apply to which impact.

For the facilities-related mitigations, Section 6.3 presents the detailed text of the mitigation measures by environmental topic for all PSM/SM and PSU/SU impacts identified in the Chapter 4 analysis. The summary tables in Section 6.6 list all impacts analyzed in Chapter 4 and provides the mitigation information as applicable to each facility improvement project, including the impact statement, the significance determination, applicable SFPUC construction measure, PEIR mitigation measure, and regulations that reduce the severity of the impact. For some projects, an identified impact would not apply (N/A). For some projects, the impact would be LS with implementation of applicable SFPUC construction measures, though in a few cases, the identified impact would be LS without implementation of the SFPUC construction measures. For impacts determined to be PSM/SM, the mitigation measures described in Section 6.3 must be implemented to reduce potentially significant impacts to a less-than-significant level. For impacts determined to be PSU or SU, implementation of mitigation measures would still be required, but it has been determined that these measures would not reduce the identified impact to a less-than-

significant level.[1] Section 6.3 identifies the appropriate program-level mitigation measures in general terms, referred to as "Program Measures," that would apply to impacts identified for individual facilities improvement projects. Section 6.3 also presents "Collective Measures" and "Cumulative Measures," which would reduce collective and cumulative impacts, respectively, and would apply to the WSIP by region or as a whole.

For the water supply/system operations mitigations, Section 6.4 presents the detailed text of the mitigation measures by watershed/groundwater basin for all PSM/SM and PSU/SU impacts identified in the Chapter 5 analysis. The summary tables in Section 6.6 list all impacts analyzed in Chapter 5 together with the significance determinations and the mitigation measures for PSM, PSU, and SU impacts. Similar to the facilities impact analysis, for impacts determined to be PSM, the mitigation measures described in Section 6.4 must be implemented to reduce potentially significant impacts to a less-than-significant level. For impacts determined to be PSU and SU, implementation of mitigation measures would still be required, but it has been determined that these measures would not reduce the identified impact to a less-than-significant level.[2] Section 6.4 identifies water supply/system operations mitigation measures which apply to the WSIP as a whole and are referred to as "System Measures."

CEQA Section 15126.4 states that an EIR shall distinguish between the mitigation measures which are proposed by project sponsor to be included in the project and the measures that are identified in the EIR as proposed by the lead agency. At this time, the SFPUC intends to incorporate all mitigation measures presented in this PEIR into the implementation of the WSIP, if approved, and therefore all measures are considered to be proposed by the project sponsor except in the following cases:

- If any of the project-level EIRs completed on WSIP facility improvement projects finds a different impact determination and deems a PEIR mitigation measures unnecessary
- If any of the project-level EIRs determines that a project-specific mitigation measure would be more appropriate than a PEIR mitigation measure once the impact is more fully analyzed with additional project-level details

In the above cases, the SFPUC may not need to provide mitigation due to less-than-significant impact findings, or may chose to implement alternative mitigation measures identified in the project-level EIRs.

1 In some cases, a mitigation measure may reduce an impact but because there is no definitive threshold, a less-than-significant determination cannot be made.

2 *Ibid*.

6.2 SFPUC Construction Measures

The following SFPUC standard construction measures apply to all proposed WSIP facility improvement projects. The SFPUC standard construction measures are aimed at minimizing disruptions to surrounding neighborhoods, resources, and land uses during any SFPUC construction, maintenance, or repair activity or project that requires CEQA review. As required by the SFPUC, each project must include the SFPUC standard construction measures in the construction contract or project implementation procedures, as appropriate.

Some of the SFPUC standard construction measures may not be appropriate for certain kinds of projects, but each of the measures must be addressed, either by explaining why the measure is not applicable to the particular site, undertaking the activities listed, or undertaking further investigation and developing a more detailed work plan to address the issue.

1. *Neighborhood Notice*: The SFPUC will provide reasonable advance notification to the businesses, owners and residents of adjacent areas potentially affected by the Water System Improvement Program (WSIP) projects about the nature, extent and duration of construction activities. Interim updates should be provided to such neighbors to inform them of the status of the construction.

   Where schools would be affected, the SFPUC will coordinate with school facility managers to schedule construction for time periods with the least impact on school activities and facilities to ensure student safety and to minimize disruption to educational and recreational uses of the school property.

2. *Seismic and Geotechnical Studies*: Projects will incorporate review of existing information and, if necessary, new engineering investigations to provide relevant geotechnical information about the particular site and project, including a characterization of the soils at the site, and the potential for subsidence and other ground failure. Construction will address any recommendations by such geotechnical reports to ensure seismic stability and reliability of the proposed project. All SFPUC projects must be designed for seismic reliability and minimum potential water loss and property damage. All components of the water system improvement program must be designed to continue water service during a major earthquake.

3. *On-Site Air and Water Quality Measures during Construction*: All construction contractors must take measures to minimize fugitive dust and dirt emissions resulting from the construction, and implement measures to minimize any construction effects on local air and water quality, including a local storm drain system or watercourse. These measures could include preparation of a Stormwater Pollution Prevention Plan (SWPPP), if required by the California Regional Water Quality Control Board. At a minimum, construction contractors should undertake the following measures, as applicable, to minimize any adverse effects:

   - Erosion and sedimentation controls tailored to the site and project
   - Dust control plan
   - Placement of straw rolls around each of the nearby stormwater inlets;
   - Preservation of existing vegetation;
   - Installation of silt fences;

- Use of wind erosion control (e.g. – geotextile or plastic covers on stockpiled soil);
- Sweeping of nearby streets at least once a day; and/or;
- Stabilization of site ingress/egress locations to minimize erosion.
- Spraying the disturbed areas of the site, or any stockpiled soil, with water to minimize fugitive dust emissions.

4. *Groundwater*: If groundwater is encountered during any excavation activities, the construction contractor shall prepare a dewatering plan so that water is discharged to the stormwater system in compliance with the local standards and discharge permit requirements.

5. *Traffic*: Each contractor shall prepare a traffic control plan which will minimize the impacts on traffic and on-street parking on any streets affected by construction of the proposed project. As appropriate, SFPUC or the contractor will consult with local traffic and transit agencies.

6. *Noise*: The contractor will comply with local noise ordinances regulating construction noise to the extent feasible, and will undertake efforts to minimize any noise disruption to nearby neighbors and sensitive receptors during construction.

7. *Hazardous Materials*: Appropriate measures will be implemented to characterize and dispose of hazardous materials should they be encountered during excavation and construction. Contract specifications will mandate full compliance will all applicable local, state and federal regulations related to the identification, transportation and disposal of hazardous materials/soils. As necessary, a spill prevention and countermeasure plan will be prepared.

   A qualified environmental professional will conduct any necessary site assessment. The site assessment would include a regulatory database review to identify permitted hazardous materials and environmental cases in the vicinity of each project no more than three months before construction, and a review of appropriate standard information sources to determine the potential for soil or groundwater contamination to occur. Follow-up sampling would be conducted as necessary to characterize soil and groundwater quality prior to construction and, if needed, site investigations or remedial activities would e performed in accordance with applicable laws. The environmental professional would prepare a report documenting the activities performed, summarize the results and make recommendations for appropriate handling of any contaminated materials during construction. A contingency plan would also be prepared identifying measures to be taken should unanticipated contamination be identified during construction. Construction contractors will conduct asbestos and lead abatement in accordance with established regulations.

8. *Biological Resources*: As an initial matter, SFPUC project managers will screen the project site and area to determine whether biological resources may be affected by construction activities. In the event further investigation is necessary, the SFPUC will comply with all requirements for investigation, analysis and protection of biological resources. A qualified biologist must conduct any required biological screening survey. The biologist will review standard information sources to determine special status species with the potential to occur on the project site. The biologist would carry out a site survey by walking or driving over the project site, as appropriate, to note the general resources and whether any habitat for special-status species is present. The biologist would then document the survey with a brief letter report or memo, setting forth the date of the visit, whether habitat for special-status

species is present, providing a map or description showing where sensitive areas exist within the site, and identifying any appropriate avoidance measures.

9. *Cultural Resources*: As an initial matter, SFPUC project managers will screen the project site and area to determine whether cultural resources, including archaeological and other historical resources, may be affected by construction activities. In the event further investigation is necessary, the SFPUC will comply with all requirements for investigation, analysis and protection of cultural resources.

   CEQA considers paleontological resources to be "cultural resources." Any screening for cultural resources would include screening for archaeological, paleontological and historic resources. For projects requiring excavation, deep grading, well drilling or tunneling into geologic material at sites identified as having high potential for encountering paleontological resources, a state-registered professional geologist or qualified professional paleontologist will conduct a site-specific evaluation of the paleontological sensitivity. The assessment will include a report of findings for the SFPUC.

   A qualified archaeologist, historian or paleontologist will conduct all cultural resources survey and screening work. Screening surveys for cultural resources would include a cultural resources records search to be conducted at the appropriate office member of the California Historical Resources Information System. A field survey will be conducted if determined necessary after the cultural resources records search. Any impacts on identified cultural resources will be avoided to the extent feasible.

   Any initial historic resource screening will identify historic resources on the project site as well as adjacent to the project site.

   It is possible that project work may affect accidentally discovered buried or submerged cultural resources. Any contractor must distribute the Planning Department archaeological resource “ALERT” sheet to any person involved in soil-disturbing activities. If there is any indication of an archaeological or a paleontological resource during the soils disturbing activity of the project, the contractor shall immediately suspend any soils disturbing activities in the area and notify the SFPUC of such discovery. The SFPUC will then work with the Planning Department’s Environmental Review Officer to determine what additional measures should be implemented, based on reports from a qualified archaeological or paleontological consultant.

10. *Project Site*: The SFPUC will conduct construction activities on SFPUC-owned lands to the extent feasible and minimize the need for use of non-SFPUC-owned land during construction. In cases where construction easement or staging areas are needed on non-SFPUC land, the SFPUC will restore these areas to their prior condition so that the owner may return them to their prior use, unless otherwise arranged with the property owner. The site will be maintained to be clean and orderly. Construction staging areas will be sited away from public view where possible. Nighttime lighting will be directed away from residential areas.

    Upon project completion, the construction contractor will return the SFPUC project site to its general condition before construction, including re-grading of the site and re-vegetation of disturbed areas.

6.3 Mitigation Measures to Minimize Facilities Impacts

This section presents all mitigation measures for PSM/SM and PSU/SU impacts described in Chapter 4. Mitigation measures for impacts identified in Sections 4.2 through 4.15 are presented under the respective environmental resource topic, such as Land Use or Biological Resources. Mitigation measures for collective and cumulative impacts (Sections 4.16 and 4.17) are also presented under the appropriate environmental resource topic, rather than under a separate heading, so that similar measures are grouped together. As stated above, all mitigation measures are numbered to correspond to the same impact numbers, although in some cases, the same measure would mitigate more than one impact and the numbering corresponds to the first impact identified and cross-referenced so that measures are not duplicated.

6.3.1 Plans and Policies

None applicable.

6.3.2 Land Use and Visual Resources

Program Measures

Facility Siting Studies

Measure 4.3-2: It is the policy of the SFPUC to construct and operate its facilities on SFPUC-owned lands to the extent feasible. When use of SFPUC-owned land is not feasible, and where additional permanent easement or land acquisition is required, the SFPUC will conduct project-specific facility siting studies and implement these studies' recommendations to avoid or minimize impacts on existing land uses to the maximum extent feasible. Siting studies will identify and evaluate alternative site locations, access roads, building configurations and facility operations to minimize or avoid land use impacts. The studies will also consider existing and planned land uses on and adjacent to proposed facility sites and rights-of-way on non-SFPUC-owned land. To the extent feasible, the SFPUC will implement the recommendations in the siting studies.

Architectural Design

Measure 4.3-4a: The design of permanent new, above-ground facilities will consider the existing visual character of the site and surrounding area, including the visibility of facilities and related structures from scenic highways and scenic roads. Structures will be designed to incorporate building features and design elements that are compatible with the surroundings.

Landscaping Plans

Measure 4.3-4b: The SFPUC will prepare and implement landscaping plans to restore project sites to their pre-construction condition such that short-term construction disturbance does not result in long-term visual impacts. To retain the existing visual character of the site and surrounding area, disturbed areas will be recontoured and revegetated and recontoured to pre-construction condition. Landscape vegetation will include noninvasive, and where possible, native grasses, shrubs, and trees similar to existing landscaping. The SFPUC will monitor landscape plantings annually for five years

after project completion to ensure that sufficient ground coverage has developed and will implement additional measures, such as replanting or modifying irrigation systems, as determined necessary.

Landscape Screens

Measure 4.3-4c: In addition to revegetation of disturbed areas, the landscaping plans will include new plantings and landscape berms to screen views of new structures and equipment from scenic roads to the extent possible, provided that such landscaping does not affect security of SFPUC facilities.

Minimize Tree Removal

Measure 4.3-4d: The SFPUC will minimize or avoid the removal of existing trees that currently screen existing and proposed sites of WSIP facilities by modifying the proposed alignments of new temporary and permanent roads to the extent feasible. The SFPUC will consult with a qualified arborist regarding the minimum buffer zones required to prevent root damage to remaining trees and to provide the SFPUC with any necessary maintenance requirements for remaining trees. Also, the arborist will develop and assist the SFPUC in implementing an appropriate landscaping plan (see Measure 4.3-4b, above), including tree replacement, that is compatible with project operation and maintenance.

Reduce Lighting Effects

Measure 4.3-5: To the extent possible, all permanent exterior lighting will incorporate cutoff shields and non-glare fixture design. All permanent exterior lighting will be directed onsite and downward. In addition, new lighting will be oriented to ensure that no light source is directly visible from neighboring residential areas and will be installed with motion-sensor activation. In addition, highly reflective building materials and/or finishes will not be used in the designs for proposed structures, including fencing and light poles. Vegetation selected for landscaping will be selected, placed and maintained to minimize offsite light and glare in surrounding areas as part of the landscaping plans described in Measure 4.3-4b.

Collective Measures

Construction Coordination at Irvington Portal

Measure 4.16-1a: If construction schedules of multiple WSIP projects occurring at and near Irvington Portal coincide or overlap, the SFPUC will coordinate with construction contractor(s) and neighbors to minimize disturbance of residents in the adjacent neighborhood to the extent practicable. Such coordination will need to balance the duration of construction with the magnitude of construction-related impacts on the same sensitive receptors.

6.3.3 Geology, Soils and Seismicity

Program Measures

Quantified Landslide Analysis

Measure 4.4-1: If the screening analysis conducted in accordance with SFPUC Construction Measure #2 identifies any landslide hazards, affected WSIP facilities will, to the extent feasible, be located away from known landslides, very steep hillsides, debris-flow source areas, the mouths of steep sidehill drainages, and the mouths of canyons that drain steep terrain. However, where these landslide hazard areas cannot be avoided, a more quantified analysis (including a site-specific geologic investigation and a slope stability analysis to determine the potential for landsliding) should be performed as part of the geotechnical investigation. Recommendations identified in the site-specific geotechnical report regarding the potential for landsliding, including appropriate construction measures, will be incorporated into the project designs to minimize the potential for damage to project facilities.

Subsidence Monitoring Program

Measure 4.4-4: As part of the project-specific CEQA review for the New Irvington Tunnel (SV-4) and BDPL Reliability Upgrade (BD-1), the SFPUC will analyze the potential for ground subsidence to occur during tunneling, and will identify project-specific trigger levels that would require corrective action should subsidence occur. As determined to be necessary, the tunnel contractor will implement a subsidence monitoring program during tunneling to detect subsidence, including measurements of groundwater levels, surface and subsurface settlement, ground movement and displacement, and movement in existing infrastructure as needed. The SFPUC will implement corrective actions, such as increased tunnel support, if measured displacement reaches the specified trigger levels.

Characterize Extent of Expansive and Corrosive Soil

Measure 4.4-9: If the screening analysis conducted in accordance with SFPUC Construction Measure #2 identifies a potential for expansive or corrosive soils, the site-specific geotechnical investigation will include a characterization of the presence and extent of expansive and corrosive soil at the project facility site. The results and recommendations of the investigation will be incorporated into the final project design.

6.3.4 Surface Water Hydrology and Water Quality

Program Measures

Site-Specific Groundwater Analysis and Identified Measures

Measure 4.5-2: As part of the project-specific CEQA review for the New Irvington Tunnel project (SV-4), the SFPUC will inventory springs and wells in the area of the planned tunnel and conduct a project-specific analysis of the potential for tunnel dewatering to stop or decrease spring flow, lower groundwater levels in nearby wells, or to otherwise cause adverse effects on groundwater resources and beneficial uses of the groundwater. If a significant impact is identified, then measures such as altering groundwater withdrawal

rates and/or providing an alternate water supply for affected users will be implemented to ensure that groundwater resources or beneficial uses are not adversely affected.

Flood Flow Protection Measures

Measure 4.5-4a: In construction contract specifications, the SFPUC will require the contractor(s) to include, in their erosion control measures or SWPPP prepared for the project, a measure prohibiting the stockpiling of soil, storage of hazardous materials, and stockpiling of construction materials in flood zones, where practical. Where construction would occur in large flood zones, making it impractical to implement this requirement, the erosion control measures or SWPPP will include measures for protecting stockpiled soil, sources of hazardous materials, and stockpiled construction materials from exposure to flood waters.

Site-Specific Flooding Analysis and Identified Measures

Measure 4.5-4b: As part of the project-specific CEQA review for the Alameda Creek Fishery (SV-1) and New Irvington Tunnel (SV-4) projects, the SFPUC will conduct a site-specific analysis of the potential for flooding as a result of project implementation. If a dam or concrete weir is installed in Alameda Creek under the Alameda Creek Fishery project, the analysis will include, at a minimum, the stream flow data and planned design and operation of the dam or weir to prevent flooding impacts. For the New Irvington Tunnel project, the analysis will include design measures needed to ensure that upstream water levels are not affected, bridge abutments are protected from damage due to flood flows and would not adversely redirect flood flows, and that bridge pilings are protected from scour.

Stormwater Treatment and Groundwater Monitoring

Measure 4.5-5: If treated stormwater is used to augment Lake Merced water levels, the project-level CEQA analysis for the Local Groundwater Projects (SF-2) will include measures to ensure that use of stormwater does not promote eutrophication of the lake and provisions for implementing these measures. The project-level CEQA analysis will also evaluate the potential for groundwater quality degradation due to the use of treated stormwater to augment lake levels. If necessary, the SFPUC will implement a groundwater monitoring program in the vicinity of Lake Merced to monitor for degradation of groundwater quality. Monitoring will include water quality sampling for total coliform bacteria, total nitrogen, nitrate, nitrite, total organic carbon, parameters for which drinking water quality criteria have been established, and any other potential pollutants of concern. The project-level CEQA documentation will identify corrective actions that would be implemented should groundwater quality degradation be identified, such as additional treatment of water used to augment water levels in Lake Merced.

Appropriate Source Control and Site Design Measures

Measure 4.5-6: For projects located in areas not covered by a municipal stormwater permit and disturbing less than one acre of land during construction, the SFPUC will implement appropriate source control and site design measures that 1) minimize the stormwater flow rate and quantity to prevent off-site erosion and flooding; and 2) minimize stormwater pollutant discharges to the maximum extent possible. These measures will ensure compliance with applicable water quality criteria and goals and protect the beneficial uses of the receiving water.

6.3.5 Biological Resources

Program Measures

Wetlands Assessment

Measure 4.6-1a: As part of project-specific CEQA review, a qualified wetland scientist will review project plans, airphotos, and topographic maps and conduct a site visit to determine whether wetlands are present and could be affected by the project. If the review shows that wetlands could be affected, the wetland scientist will perform a formal wetland delineation and develop mitigation as per Measure 4.6-1b, below.

Compensation for Wetlands and Other Biological Resources

Measure 4.6-1b: If the wetland delineation indicates that the WSIP project will affect jurisdictional wetlands or aquatic resources, then, in accordance with state and federal permit requirements, the SFPUC will avoid and minimize direct and indirect impacts such as erosion and sedimentation, alteration of hydrology, and degradation of water quality. As a first priority, the SFPUC will implement (1) avoidance measures. For unavoidable impacts, the SFPUC will implement (2) minimization of unavoidable impacts, (3) restoration procedures, and (4) compensatory creation or enhancement to ensure no net loss of wetland extent or function.

In addition to wetlands, the SFPUC will compensate for sensitive riparian and upland habitats and habitats which support key special-status species or other species of concern lost as a result of WSIP project construction and operation. Similar habitat will be identified, protected, restored, enhanced, created and managed off-site[3] to ensure no net loss of habitat extent or function. For each WSIP project, a qualified biologist will quantify the magnitude and extent of impacts to wetlands, sensitive habitats, and key special-status species and other species of concern, and the SFPUC will develop and implement restoration and/or compensation plans that meet the appropriate regulatory requirements and permit conditions with respect to restoration and/or compensation ratios. Compensation ratios typically range from a minimum of 1:1 for common habitats to 2:1 or higher for rare and sensitive habitats. If individual project requirements of the RWQCB, CDFG, or USFWS differ somewhat from these ratios, they are still intended to achieve the same purpose of full restoration and/or compensation, to mitigate project impacts to less-than-significant levels, and to ensure no net reduction in the populations of any species listed as threatened or endangered by the state or federal resource agencies.

The SFPUC will obtain required permits for each project and comply with applicable environmental regulations addressing sensitive habitats and species. Compensatory lands, including those restored or enhanced as well as those acquired or designated as protected as part of program or project mitigation, will be established in perpetuity with a commitment that such lands will not be used for any purpose that conflicts with the primary purpose of maintaining intact wildlife and plant habitat.

[3] Off-site means the compensatory action is located other than within the project construction footprint, but could be on lands already under SFPUC ownership. Measure 4.6-2 addresses compensatory actions to be taken within the construction footprint.

One alternative for implementing off-site habitat compensation is the Habitat Reserve Program (HRP) currently being developed by the SFPUC. The purpose of the HRP is to provide a comprehensive, coordinated approach to mitigation and related regulatory compliance for WSIP projects. This related SFPUC project is described further in Chapter 3.0, Section 3.11. Under the proposed HRP, the SFPUC would proceed as soon as possible with securing (through designation, management agreement, conservation easement, or acquisition of fee title) and improving lands to be used for habitat compensation so that mitigation is underway before or concurrent with habitat loss related to WSIP project activities, further ensuring no net loss of resources. CEQA environmental

review for the proposed HRP will commence in 2007 and is targeted for implementation as soon as possible thereafter. Once the HRP is approved and implemented, the SFPUC will use this as one vehicle or method for implementing the mitigation requirements for individual WSIP projects. Otherwise, where appropriate and necessary, the SFPUC will develop and implement appropriate habitat compensation mitigation for individual WSIP projects.

Habitat Restoration/Tree Replacement

Measure 4.6-2: If the biological screening survey identifies sensitive habitats or heritage trees, the following measures, as modified and applied to WSIP projects, will be implemented:

- Temporarily-impacted sensitive habitats (natural communities identified as sensitive by CDFG, and USFWS-designated critical habitat) would be restored to their pre-project condition.

- If specific trees to be removed are designated as heritage trees (or similar local designation), then SFPUC will replace the trees, consistent with requirements in local ordinances. If such heritage trees occur near extensive areas of sensitive habitats, locally collected, native species will be used as replacement trees where possible.

- Where possible, the loss of sensitive habitats will be minimized by coordinating WSIP projects to make repeated use of staging/construction areas and access roads. For example, tunnel spoils could be considered for borrow material for other projects.

Protection Measures During Construction for Key Special-Status Species and Other Species of Concern

Measure 4.6-3a: The following general practice measures, as modified and applied to the WSIP projects, will be implemented if the initial biological screening survey (SFPUC Construction Measure #8) indicates the potential for the presence of key special-status species and other species of concern:

- Preconstruction surveys for key special-status species and other species of concern will be conducted by a qualified biologist to verify their presence or absence. Surveys will occur during the portion of the species' life cycle when the species is most likely to be identified within the appropriate habitat. Key special-status species and other species of concern will be avoided during construction when possible.

- A worker awareness program (environmental education) will be developed and implemented to inform project workers of their responsibilities in regards to sensitive biological resources.

- An environmental inspector will be appointed to serve as a contact for issues that may arise concerning implementation of mitigation measures, and to document and report on adherence to these measures during construction.

- Loss of habitat will be minimized through the following measures: (1) the number and size of access routes and staging areas and the total area of the project activity

will be limited to the minimum necessary to achieve the project goal; (2) the introduction or spread of invasive non-native plant species and plant pathogens will be avoided or minimized by developing and implementing a weed control plan; and (3) all areas temporarily disturbed by construction will be revegetated to pre-project or native conditions, as specified in project-specific revegetation plans.

Standard Mitigation Measures for Specific Plants and Animals

Measure 4.6-3b: Table 6.1 identifies the key special-status species mitigation measures that the program analysis indicates would apply to each WSIP project. Measures listed in **Table 6.2** (listed by species) are generic measures and will be modified to fit site-specific conditions and applied to each WSIP project wherever special-status species could be affected by the projects. Surveys required under Measure 4.6-3a will refine the list of species that could be affected by a project. Table 6.1 is intended as the minimum necessary actions. In addition to adopting the generic measures, as more site-specific information is available, project-specific CEQA analysis may identify additional measures for key special-status species and additional measures for other species.

Pipeline and Water Treatment Plant Treated Water Discharge Restrictions

Measure 4.6-4: Planned discharges of regional system water from the WSIP pipelines and water treatment plants (such as crossover facilities) to creeks, rivers or other natural water bodies will be designed to minimize impacts to riparian and aquatic resources to the extent feasible. This will include dechlorination and/or pH adjustment facilities and energy dissipation structures that avoid or reduce bank erosion. In addition, the facilities should include design features to avoid or minimize temperature effects on aquatic resources; or alternatively, whenever possible, planned discharges should be scheduled to occur in the winter, when stream flows are high and temperatures low in the receiving waters to avoid or minimize temperature effects.

Collective Measures

Bioregional Habitat Restoration Measures

Measure 4.16-4a: Bioregional effects (those beyond the level of individual plants or animals and impacts not readily associated with any particular project) could result from the collective construction of WSIP facilities and the cumulative effects of implementing WSIP projects along with other proposed projects. Combined collective and cumulative bioregional effects that will need to be addressed as part of future mitigation efforts include the following:

- Compound impacts on functional units of habitat as WSIP projects simplify vegetation structure and increase “edge” (the boundary between two different habitats);
- Increased habitat impacts due to the spread of weedy, non-native plant species;
- Genetic diversity impacts on small populations that become reduced and isolated by development;

TABLE 6.1 (SEE MEASURE 4.6-3b)
MITIGATION MEASURES FOR KEY SPECIAL-STATUS SPECIES

No.	Project Name Notes: 1. This table is for guidance only and is not intended as a complete list of mitigations for all projects, which must be assessed individually at the project-specific level. 2. Standard measure B.4 (general surveys for raptors and protection of raptor nests) apply to all projects.	Suites of Key Special-Status Species						Individual Special-Status Species								
		Vernal Pool Invertebrates	Vernal Pool Plants	Riparian and Reservoir Species	Native Grassland Species	Salt Marsh Species	Fishes	Large-Flowered Fiddleneck	Foothill yellow-legged frog	California Red-Legged Frog	California Tiger Salamander	San Francisco Garter Snake	Alameda Whipsnake	Swainson's Hawk	Western Burrowing Owl	San Joaquin Kit Fox
SJ-1	Advanced Disinfection	I.2								RA.1	RA.2			B.1	B.2, B.3	M.2
SJ-2	Lawrence Livermore Supply Improvements	I.2						P.3		RA.1	RA.2			B.1	B.2, B.3	M.2
SJ-3	San Joaquin Pipeline System	I.2	P.1	I.1, P.2, B.5, M.3			F.1			RA.1	RA.2			B.1	B.2, B.3	M.2
SJ-4	Rehabilitation of Existing San Joaquin Pipelines	I.2	P.1	I.1, P.2, B.5, M.3			F.1			RA.1	RA.2			B.1	B.2, B.3	M.2
SJ-5	Tesla Portal Disinfection Station	I.2								RA.1	RA.2			B.1	B.2, B.3	M.2
SV-1	Alameda Creek Fishery Enhancement			B.5			F.1		RA.1	RA.1	RA.2		RA.4		B.2, B.3	
SV-2	Calaveras Dam Replacement			B.5	I.3		F.1		RA.1	RA.1	RA.2		RA.4		B.2, B.3	
SV-3	Additional 40-mgd Treated Water Supply			B.5					RA.1	RA.1	RA.2		RA.4		B.2, B.3	
SV-4	New Irvington Tunnel			B.5			F.1		RA.1	RA.1	RA.2		RA.4		B.2, B.3	
SV-5	SVWTP – New Treated Water Reservoirs			B.5			F.1		RA.1	RA.1	RA.2		RA.4		B.2, B.3	
SV-6	San Antonio Backup Pipeline			B.5			F.1		RA.1	RA.1	RA.2		RA.4		B.2, B.3	
BD-1	Bay Division Pipeline Reliability Upgrade	I.2				B.6, B.7, M.1	F.1			RA.1	RA.2		RA.4		B.2, B.3	
BD-2	BDPL Nos. 3 and 4 Crossovers	I.2					F.1			RA.1	RA.2				B.2, B.3	
BD-3	Seismic Upgrade of BDPL Nos. 3 and 4 at Hayward Fault									RA.1	RA.2				B.2, B.3	

TABLE 6-1 (SEE MEASURE 4.6-3b) (Continued)
MITIGATION MEASURES FOR KEY SPECIAL-STATUS SPECIES

No.	Project Name **Notes:** **1. This table is for guidance only and is not intended as a complete list of mitigations for all projects, which must be assessed individually at the project-specific level.** **2. Standard measure B.4 (general surveys for raptors and protection of raptor nests) apply to all projects.**	Suites of Key Special-Status Species						Individual Special-Status Species								
		Vernal Pool Invertebrates	Vernal Pool Plants	Riparian and Reservoir Species	Native Grassland Species	Salt Marsh Species	Fishes	Large-Flowered Fiddleneck	Foothill yellow-legged frog	California Red-Legged Frog	California Tiger Salamander	San Francisco Garter Snake	Alameda Whipsnake	Swainson's Hawk	Western Burrowing Owl	San Joaquin Kit Fox
PN-1	Baden and San Pedro Valve Lots Improvements									RA.1	RA.2	RA.3				
PN-2	Crystal Springs/San Andreas Transmission Upgrade			B.5						RA.1	RA.2	RA.3				
PN-3	HTWTP Long-Term Improvements															
PN-4	Lower Crystal Springs Dam Improvements			B.5	I.3, P.4		F.1			RA.1	RA.2	RA.3				
PN-5	Pulgas Balancing Reservoir Rehabilitation									RA.1	RA.2	RA.3				
SF-1	San Andreas Pipeline No. 3 Installation															
SF-2	Groundwater Projects				P.4, I.3					RA.1		RA.3				
SF-3	Recycled Water Projects				P.4, I.3					RA.1		RA.3				

Note: Project-specific CEQA documents would review recent special-status species lists relevant to the habitats present.

All codes are defined in Table 6-2.

Vernal pool invertebrates:
- Vernal pool fairy shrimp
- Conservancy fairy shrimp
- Vernal pool tadpole shrimp

Vernal pool species:
- Succulent owl's-clover
- Hoover's spurge
- Colusa grass
- San Joaquin Valley Orcutt grass
- Hairy Orcutt grass
- Greene's tuctoria

Salt marsh species:
- Western snowy plover
- California clapper rail
- California black rail
- Salt marsh harvest mouse

Riparian and Reservoir species:
- Least Bell's vireo
- Valley elderberry longhorn beetle
- Riparian woodrat
- Delta button-celery
- Bald eagle

Fishes:
- Green sturgeon (San Joaquin Valley only)
- Chinook salmon
- Central Valley DPS steelhead
- Central California Coast DPS steelhead
- Rainbow trout (Alameda watershed)

Native grassland species:
- Bay checkerspot butterfly
- Callippe silverspot butterfly
- Fountain thistle (Peninsula)
- Marin dwarf flax (Peninsula)
- San Mateo woolly sunflower (Peninsula)

TABLE 6-2 (MEASURE 4.6-3b)
STANDARD PROGRAMMATIC BIOLOGICAL RESOURCES MITIGATION MEASURES

Biological Resource Species and Status	Standard Mitigation Measures for Specific Plants and Animals
Invertebrates	
Valley Elderberry Longhorn Beetle (FT/--)	**I.1:** A biological monitor will accompany tree/brush clearing crews. The monitor will flag all elderberry shrubs in the tree clearing zone and be present during tree clearing operations in the vicinity of flagged shrubs to ensure that elderberry shrubs are not cut. If avoidance is not feasible, habitat impacts will be mitigated in accordance with the Programmatic Biological Opinion (PBO) for Valley elderberry longhorn beetle, issued by the USFWS Sacramento Field Office in 1996.
Vernal Pool Crustaceans Vernal pool fairy shrimp (FT/--) Conservancy fairy shrimp (FE/--) Vernal pool tadpole shrimp (FE/--)	**I.2:** Suitable habitat for vernal pool invertebrates will be avoided. If infeasible, impacts will be mitigated in accordance with the PBO for vernal pool invertebrates, issued by the USFWS Sacramento Field Office in 1995. Surveys may be conducted, with USFWS approval, to establish whether or not listed invertebrates are present.
Bay Checkerspot Butterfly (FT/--), Callippe Silverspot Butterfly (FE/--)	**I.3:** Suitable habitat for Bay checkerspot and Callippe silverspot butterflies will be avoided
Fishes	
Central Valley fall- and late-fall run DPSChinook salmon (FC/--) Central Valley DPS steelhead (FT/--) Green sturgeon Southern District DPS (FT/--) Central Coast DPS Steelhead (FT/--) Rainbow trout (--/--)	**F1:** For construction activity in anadromous fish-bearing streams, a biological monitor with appropriate permits will be present during all construction activities to relocate fish as necessary.
Reptiles and Amphibians	
California Red-Legged Frog (FT/CSC) Foothill yellow-legged frog (--/CSC)	**RA.1:** A PBO for construction impacts on red-legged frog was prepared by the USFWS (Federal Register, 1999). The general mitigation measures, above, and the measures listed below, are taken largely from the PBO and may be modified by a project-specific BO. The foothill yellow-legged frog has no legal protection under FESA; however, all potential FYLF habitat is also considered potential habitat for CRLF and these protection measures would be applied in any case. • The name and credentials of a biologist qualified to act as a construction monitor will be submitted to the USFWS for approval at least 15 days prior to commencement of work. • The USFWS-approved biologist will survey the site two weeks prior to the onset of work activities and immediately prior to commencing work. If frog adults, tadpoles, or eggs are found, the approved biologist will contact the USFWS to determine whether relocating any life stages is appropriate. • If worksites require dewatering, the intakes will be screened with a maximum mesh size of 5 millimeters. • The USFWS-approved biologist will remove and destroy from within the project area any individuals of non-native species, such as bullfrogs, crayfish, and centrarchid fishes, to the maximum extent possible.

TABLE 6-2 (MEASURE 4.6-3b) (Continued)
STANDARD PROGRAMMATIC BIOLOGICAL RESOURCES MITIGATION MEASURES

Biological Resource Species and Status	Standard Mitigation Measures for Specific Plants and Animals
Reptiles and Amphibians (cont.)	
California Tiger Salamander (FT/CSC)	**RA.2:** In addition to measures described for California red-legged frog, which would serve to protect California tiger salamander, the following measures will minimize adverse effects to California tiger salamander. • A preconstruction survey will be conducted at each site to identify suitable burrow aestivation areas. Aestivation habitat will be defined as the presence of two or more small mammal burrows greater than 1 inch in diameter within a 10-foot-diameter area and within 10 feet of proposed construction sites (i.e., the presence of a single isolated gopher hole would not be considered habitat). As feasible within the context of the work area, aestivation areas will be temporarily fenced and avoided. • At locations where aestivation burrows are identified and cannot be avoided, aestivation burrows will be excavated by hand prior to construction and individual animals moved to natural burrows or artificial burrows constructed of PVC pipe within 0.25 mile of the construction site. • To ensure compliance with these measures and minimize California tiger salamander take, a qualified biological monitor will be present during all construction operations at locations with suitable aestivation burrows. Construction sites where potential habitat has been identified will be surveyed by a qualified biologist for California tiger salamander. Surveys would be appropriately timed with respect to salamander activity and proposed construction activities. • Surveys would include drift fences and pitfall traps within construction sites to identify and relocate animals. Following removal of individuals, construction areas will be fenced with temporary silt fencing.
San Francisco Garter Snake (FE/CE/CP)	**RA.3:** San Francisco garter snake is a California fully protected species, and incidental taking must be avoided. Therefore, in addition to measures RA.1 and RA.2, above, for construction activities in occupied habitat the work area will be fenced with frog- and snake-proof mesh fence, or 4- x 8-foot plywood panels joined lengthwise, with escape funnels to allow egress, but not access, by San Francisco garter snake.
Alameda Whipsnake (FT/CT)	**RA.4:** Construction-related impacts on individual Alameda whipsnakes will be minimized and/or avoided through the development and implementation of an Alameda whipsnake protection and monitoring plan, to be approved by the USFWS during informal consultation under FESA. Protective measures outlined in RA.1 will apply to all areas of known or potential habitat for Alameda whipsnake. In addition, it will include: • Sites within Alameda whipsnake habitat will be hand-cleared, or a qualified biologist will do surveys and relocate the snake immediately prior to equipment clearing. • Activities that could harm or harass Alameda whipsnake will be avoided or minimized. • Upland habitats used by Alameda whipsnake will be restored as feasible, and lost habitat will be compensated according to an agreed-upon ratio.
Birds	
Swainson's Hawk (FSC/CT)	**B.1:** To avoid disrupting nesting Swainson's hawks, construction activities at known nesting locations will occur prior to the nesting season (March 1 through September 15). Alternatively, if construction activities take place during the nesting season, a qualified biologist will conduct a preconstruction survey no more than two weeks before the start of construction and report whether or not there are nesting Swainson's hawks within 1,320 feet of any project (access permitting). If there are nesting Swainson's hawks within the 1,320-foot buffer areas, construction will be delayed until the CDFG has been consulted to determine suitable avoidance measures. A potential avoidance measure may include delaying all construction activity within 1,320 feet of an active Swainson's hawk nest until the adult and/or juvenile hawks are no longer using the nest as the center of their activity.

TABLE 6-2 (MEASURE 4.6-3b) (Continued)
STANDARD PROGRAMMATIC BIOLOGICAL RESOURCES MITIGATION MEASURES

Biological Resource Species and Status	Standard Mitigation Measures for Specific Plants and Animals
Birds (cont.)	
Western Burrowing Owl (FSC/CSC)	**B.2:** No more than two weeks before construction, a survey for burrows and burrowing owls will be conducted by a qualified biologist within 500 feet of the project (access permitting). The survey will conform to the protocol described by the California Burrowing Owl Consortium (1995), which includes up to four surveys on different dates if there are suitable burrows present. **B.3:** If occupied owl burrows are found within the survey area, a determination will be made by a qualified biologist, in consultation with the CDFG, as to whether or not work will affect the occupied burrows or disrupt reproductive behavior. If it is determined that construction will not affect occupied burrows or disrupt breeding behavior, construction will proceed without any restriction or mitigation measures. If it is determined that construction will affect occupied burrows during August through February, the subject owls will be passively relocated from the occupied burrow(s) using one-way doors. There will be at least two unoccupied burrows suitable for burrowing owls within 300 feet of the occupied burrow before one-way doors are installed. Artificial burrows will be in place at least one-week before one-way doors are installed on occupied burrows. One-way doors will be in place for a minimum of 48 hours before burrows are excavated. If it is determined that construction will physically affect occupied burrows or disrupt reproductive behavior during the nesting season (March through July), then avoidance is the only mitigation available. Construction will be delayed within 300 feet of occupied burrows until it is determined that the subject owls are not nesting or until a qualified biologist determines that juvenile owls are self-sufficient or are no longer using the natal burrow as their primary source of shelter.
Raptors including bald eagle (FD/CE/CFP)	**B.4: Raptor nests:** • In consultation with CDFG and USFWS trees with unoccupied raptor nests (stick nests or cavities) may only be removed prior to March 1, or following the nesting season. • A survey to identify active nests will be conducted by a qualified biologist no more than two weeks before the start of construction at project sites from February 1 through July 30. • Construction activities within 0.5 mile of an active bald eagle nest may not occur between February 1 and July 31. • Active raptor nests located within 500 feet of the project will be mapped, to the extent allowed by access. • If an active raptor nest is found within 500 feet of the project, a determination will be made by a qualified biologist, in consultation with the CDFG, as to whether or not construction work will affect the active nest or disrupt reproductive behavior. • If it is determined that construction will not affect an active nest or disrupt breeding behavior, construction will proceed without any restriction or mitigation measure. • If it is determined that construction will affect an active raptor nest or disrupt reproductive behavior, then avoidance is the only mitigation available. Construction will be delayed within 300 feet of such a nest until a qualified biologist determines that the subject raptors are not nesting or until any juvenile raptors are no longer using the nest as their primary day and night roost.
Least Bell's vireo (FE/CE)	**B.5:** Protection for least Bell's vireos depend principally on seasonal avoidance of habitat during the nesting season and protection of suitable habitat. To avoid working during the active breeding season, construction activities in suitable habitat (dense willows [*Salix* sp.], mulefat [*Baccharis glutinosa*], or California wild rose [*Rosa californica*] may not proceed until July 15 unless approved by the USFWS and CDFG, as appropriate.
California Black Rail (FE/CE), California Clapper Rail (FSC/CT/CFP)	**B.6:** When working within 100 feet of salt or brackish marshland (e.g., the BDPL Reliability Upgrade, BD-1), presume presence for either species during the period from February 1 to August 31, and schedule construction to begin no earlier than September 1 and end no later than January 31.

TABLE 6-2 (MEASURE 4.6-3b) (Continued)
STANDARD PROGRAMMATIC BIOLOGICAL RESOURCES MITIGATION MEASURES

Biological Resource Species and Status	Standard Mitigation Measures for Specific Plants and Animals
Birds (cont.)	
Western Snowy Plover (FT/CSC)	**B.7:** When project activities are in or adjacent to suitable habitat (e.g., portions of the BDPL Reliability Upgrade, BD-1) no earlier than September 1 and no later than January 31, no measures are necessary; however, between March 15 and August 31 the following will be observed: • A qualified biologist will conduct preconstruction surveys two weeks and one week before the start of work. If western snowy plovers or their nests are not observed, then the project activity may proceed; or • If a western snowy plover is observed within a 50-foot perimeter of the location of the construction activity two weeks or one week before, a qualified biologist will observe the activities of the bird(s) to determine if nesting behavior is exhibited. If either nesting behavior or a nest is observed within a 50-foot perimeter of the location of the activity, then the activity will be delayed until either nesting is abandoned or completed.
Mammals	
Salt Marsh Harvest Mouse (FE/CE/CFP)	**M.1:** When project activities are in or adjacent to suitable habitat (e.g., portions of the BDPL Reliability Upgrade, BD-1), vehicles will be confined to existing roads where possible, and disturbed areas will be revegetated with brackish marsh species. Crews will use matting, pontoon boards, or other comparable methods whenever feasible to minimize impacts on vegetation. The placement of mats will be verified by a qualified biologist before their placement to minimize habitat impacts. Crews will work exclusively from mat boards and boardwalks to minimize the trampling of vegetation. A qualified biologist will be available during the course of the maintenance work. In situations where habitat is to be permanently disturbed, project-specific take avoidance measures (such as fencing and trapping to exclude salt marsh harvest mouse) will be developed, since the mouse is a California fully protected species, and incidental taking must be avoided.
San Joaquin Kit Fox (FE/CT)	**M.2:** The following reasonable and prudent measures will be followed to avoid direct or indirect project-related disturbances and impacts on San Joaquin kit fox. Prior to the commencement of construction activities, a qualified biologist will survey for potential kit fox dens within the area to be disturbed and will photograph, mark, and map the dens. Disturbance of all known San Joaquin kit fox dens will be avoided. Limited destruction of potential dens may be allowed, provided the following procedures are implemented: • Potential dens occurring within the construction area will be monitored for three days with tracking medium or an infrared beam camera to determine current usage. If no kit fox activity is observed during this period, the den would be destroyed immediately to preclude subsequent use. If kit fox activity is observed, the den will be considered a known den. • Project-related vehicles will observe a 20-mph speed limit in habitat areas except as posted on county roads and state and federal highways. Off-road traffic outside the designated project area will be prohibited. • To prevent accidental entrapment of kit fox or other animals during construction, all excavated or deep-walled holes or trenches greater than 2 feet will be covered at the end of each workday by plywood or similar materials, or provided with escape routes constructed of earth fill or wooden planks. Before such holes are filled they will be thoroughly inspected for trapped animals. • Kit foxes are attracted to den-like structures such as pipes and may enter stored pipe and become trapped or injured. All construction pipes, culverts, or similar structures with a diameter of 4 inches or greater that are stored at construction sites for one or more overnight periods will be thoroughly inspected for kit foxes before the pipe is subsequently buried, capped, or otherwise used or moved in any way.

TABLE 6-2 (MEASURE 4.6-3b) (Continued)
STANDARD PROGRAMMATIC BIOLOGICAL RESOURCES MITIGATION MEASURES

Biological Resource Species and Status	Standard Mitigation Measures for Specific Plants and Animals
Mammals (cont.)	
Riparian Woodrat (FE/CSC)	**M.3:** If construction will involve surface disturbance or vegetation removal in riparian habitat in the San Joaquin Region, a biologist will carry out a preconstruction survey to determine the presence or any signs of riparian woodrat, such as stick nests. Such areas will be avoided if feasible. If avoidance is not feasible, a protection and monitoring plan will be developed and approved by the USFWS during formal consultation under FESA.
Plants	
Vernal Pool Plants Succulent Owl's-Clover ((FE/CE) Hoover's Spurge (FT/--) Colusa Grass (FT/CE) San Joaquin Valley Orcutt grass (FT/CE) Greene's Tuctoria (FE/CR) Hairy Orcutt Grass (FE/CE)	**P.1:** The avoidance measures for vernal pool crustaceans will also apply to vernal pool special-status plants. Surveys to ascertain presence are highly recommended, and if first-year surveys occur during unusually low rainfall conditions, a second year of surveys, if possible, will help to establish whether avoidance measures are needed.
Riparian Plants Delta button-celery (FSC/CE)	**P.2:** The state endangered Delta button-celery occurs on clay soils on the sparsely vegetated margins of seasonally flooded floodplains and swales. Periodic flooding maintains the species' habitat through sustenance of seasonal wetlands and reduction of competition due to scouring. If a population of this species is located in an area proposed for construction, the preferred action is to avoid it if possible. The CDFG might allow salvage and restoration of the site, since this is a species that depends on ongoing disturbance to maintain its habitat. However, such strategies generally involve several years of treatment and post-treatment monitoring, so the simplest approach is to avoid impacts if possible.
Large-Flowered Fiddleneck (FE/CE)	**P.3:** Surveys for large-flowered fiddleneck will be carried out at an appropriate time of year for projects located within the known range of the species (Corral Hollow and hills immediately to the west). Any populations found will be avoided. An approved biological monitor will be present during all surface clearing activities.
San Mateo Woolly Sunflower (FE/CE), Marin Western Flax (FT/CT) Fountain thistle (FE/CE)	**P.4:** Surveys for San Mateo woolly sunflower, fountain thistle and Marin western flax will be carried out at an appropriate time of year for projects located within the known range of the species. Any populations found will be avoided. An approved biological monitor will be present during all construction activities. A plan will be developed to protect populations located along Crystal Springs and Polhemus Roads where project-related construction vehicle traffic will occur. Where populations cannot be avoided, salvage of plants or seed will be implemented, along with a program to compensate for losses.

Status Codes: FE-Federal Endangered; FT-Federal Threatened; FC-Federal Candidate; FSC-Federal Species of Concern. FD-Federal Delisted; CE-California Endangered; CT-California Threatened; CR-California Rare; CFP-California Fully Protected

- Impacts on wildlife movement due to habitat fragmentation;
- Suppression of natural disturbance regimes (e.g., fire, flood) as projects are constructed, operated, and maintained; and
- Reduced population recovery opportunities from stochastic events (e.g., random events such as disease).

When implementing habitat compensation mitigation required for individual WSIP facility projects, the SFPUC shall do so in a manner that addresses the above bioregional effects and includes the following conservation principles:

- The parcels are either contiguous with other areas of relatively undisturbed habitat or are themselves large enough to support most of the species associated with the habitat;
- The distribution of mitigation lands will allow movement of plants and animals between them or from them to habitats otherwise conserved (e.g. as described in The Wilderness Society, 2001); and
- Implementation of habitat compensation mitigation for individual WSIP facility projects will be combined and implemented through a coordinated program with other mitigation efforts, such as through the Habitat Reserve Program (HRP), and shall meet these standards:
    - Long-term management of these lands stipulates maintaining natural disturbance regimes (e.g., through prescribed burning);
    - Long-term control actions for non-native species are applied; and
    - Contingencies are considered which address sharing biological materials and information with other conservation land stewards.[4] This might include restoring suitable sites with plants brought from another protected area once a weed infestation has been brought under control, or animal relocation if done strictly for the purpose of genetic diversity or recovery, and with the approval of the regulatory agencies.

Coordination of Construction Staging and Access

Measure 4.16-4b: When construction schedules for WSIP projects affecting the same areas overlap, the SFPUC will coordinate construction contractor(s) to the extent practicable to minimize surface disturbance associated with access roads, laydown areas, and staging areas.

[4] For example, the California Department of Parks and Recreation (CDPR), East Bay Regional Parks District (EBRPD), and the Midpeninsula Regional Open Space District (MROSD).

6.3.6 Cultural Resources

Program Measures

Suspend Construction Work if Paleontological Resource is Identified

Measure 4.7-1: This mitigation measure builds on SFPUC Construction Measure # 9 for cultural resources, which requires that construction work will be suspended immediately if there is any indication of a paleontological resource. When a paleontological resource (fossilized invertebrate, vertebrate, plant or micro-fossil) is discovered at any of the project sites, an appointed representative of the SFPUC will notify a qualified paleontologist, who will document the discovery as needed, evaluate the potential resource, and assess the significance of the find under the criteria set forth in Section 15064.5 of the CEQA Guidelines. When a fossil is found during construction, excavations within 50 feet of the find will be temporarily halted or diverted until the discovery is examined by a qualified paleontologist, in accordance with Society of Vertebrate Paleontology standards (SVP 1995, 1996). The paleontologist will notify the SFPUC to determine procedures to be followed before construction is allowed to resume at the location of the find. If the SFPUC determines that avoidance is not feasible, the paleontologist will prepare an excavation plan for mitigating the effects of the project.

Archaeological Testing, Monitoring, and Treatment of Human Remains

Measure 4.7-2a: SPFUC Construction Measure #9 for cultural resources requires that a pre-construction screening be conducted by a qualified archaeologist. Based on the results of this screening, the Environmental Review Officer (ERO) shall determine if implementation of an archaeological testing or archaeological monitoring program or both is the appropriate strategy for avoidance of potential adverse effects to significant archaeological resource. For those projects that require a federal permit and compliance with the NHPA, Section 106, the ERO will review the SHPO-approved requirements in the permit conditions and consider protective approaches that limit undue duplication of efforts.

Archaeological Testing Program. The archaeological consultant shall prepare and submit to the ERO for review and approval an archaeological testing plan (ATP). The archaeological testing program shall be conducted in accordance with the approved ATP. The ATP shall identify the property types of the expected archaeological resource(s) that potentially could be adversely affected by the proposed project, the testing method to be used, and the locations recommended for testing. The purpose of the archaeological testing program will be to determine to the extent possible the presence or absence of any expected archaeological resources and to identify and to preliminarily evaluate the integrity and significance of the resource.

At the completion of the archaeological testing program, the archaeological consultant shall submit a written report of the findings to the ERO. If based on the archaeological testing program the archaeological consultant finds that significant archaeological resources may be present, the ERO in consultation with the archaeological consultant shall determine if additional measures are warranted. Additional measures that may be undertaken include additional archaeological testing, archaeological monitoring, preparation of an archaeological research design and treatment plan, or an archaeological data recovery program.

Archaeological Monitoring Program. The archaeological consultant shall prepare and submit to the ERO for review and approval an archaeological monitoring plan (AMP). The archaeological monitoring program shall be conducted in accordance with the approved AMP. The AMP shall specify what project activities in areas sensitive for buried resources shall be archaeologically monitored. Project activities that may require monitoring may include the installation of pipelines and crossover facilities and certain soils-altering activities such as grading and access road construction associated with construction or improvement of water storage facilities. The archaeological monitoring program shall include the following:

- All project contractors shall be advised to be on the alert for evidence of the presence of the expected resource(s), of how to identify the evidence of the expected resource(s), and of the appropriate protocol in the event of apparent discovery of an archaeological resource;

- The archaeological monitor(s) shall be present on the project site according to a schedule agreed upon by the archaeological consultant and the ERO until the ERO has, in consultation with project archaeological consultant, determined that project construction activities are unlikely to have effects on significant archaeological deposits;

- The archaeological monitor shall record and be authorized to collect soil samples and artifactual/ecofactual material as warranted for analysis;

- If an intact archaeological deposit is encountered, all soils-disturbing activities within the area specified in the AMP of the deposit shall cease. The archaeological monitor shall be empowered to temporarily redirect demolition/excavation/pile driving/construction activities and equipment until the deposit is evaluated. The archaeological consultant shall immediately notify the ERO of the encountered archaeological deposit. The archaeological consultant shall make a reasonable effort to assess the identity, integrity, and significance of the encountered archaeological deposit, and present the findings of this assessment to the ERO.

Whether or not significant archaeological resources are encountered, the archaeological consultant shall submit a written report of the findings of the monitoring program to the ERO.

Additional Requirements: the following requirements, as applicable, are requisite in implementation of either an archaeological testing or monitoring program.

Archaeological Data Recovery Program. The archaeological data recovery program shall be conducted in accord with an archaeological data recovery plan (ADRP). The archaeological consultant, project sponsor, and ERO shall meet and consult on the scope of the ADRP prior to preparation of a draft ADRP. The archaeological consultant shall submit a draft ADRP to the ERO. The ADRP shall identify how the proposed data recovery program will preserve the significant information the archaeological resource is expected to contain. That is, the ADRP will identify what scientific/historical research questions are applicable to the expected resource, what data classes the resource is expected to possess, and how the expected data classes would address the applicable research questions. Data recovery, in general, should be limited to the portions of the historical property that could

be adversely affected by the proposed project. Destructive data recovery methods shall not be applied to portions of the archaeological resources if nondestructive methods are practical.

The scope of the ADRP shall include the following elements:

- *Field Methods and Procedures*. Descriptions of proposed field strategies, procedures, and operations.
- *Cataloguing and Laboratory Analysis*. Description of selected cataloguing system and artifact analysis procedures.
- *Discard and Deaccession Policy*. Description of and rationale for field and post-field discard and deaccession policies.
- *Interpretive Program*. Consideration of an on-site/off-site public interpretive program during the course of the archaeological data recovery program.
- *Security Measures*. Recommended security measures to protect the archaeological resource from vandalism, looting, and non-intentionally damaging activities.
- *Final Report*. Description of proposed report format and distribution of results.
- *Curation*. Description of the procedures and recommendations for the curation of any recovered data having potential research value, identification of appropriate curation facilities, and a summary of the accession policies of the curation facilities.

Human Remains and Associated or Unassociated Funerary Objects. The treatment of human remains and of associated or unassociated funerary objects discovered during any soils disturbing activity shall comply with applicable State laws. This shall include immediate notification of the coroner of the county within which the project is located and in the event of the coroner's determination that the human remains are Native American remains, notification of the California State Native American Heritage Commission (NAHC) who shall appoint a Most Likely Descendant (MLD) (Pub. Res. Code Sec. 5097.98). The archaeological consultant, project sponsor, and MLD shall make all reasonable efforts to develop an agreement for the treatment of, with appropriate dignity, human remains and associated or unassociated funerary objects (CEQA Guidelines. Sec. 15064.5(d)). The agreement should take into consideration the appropriate excavation, removal, recordation, analysis, custodianship, curation, and final disposition of the human remains and associated or unassociated funerary objects. State law allows 24 hours to reach agreement on these matters. If the MLDs do not agree on the reburial method, the Project will follow Section 5097.98(b) of the California Public resources code which states, "the landowner or his or her authorized representative shall reinter the human remains and items associated with Native American burials with appropriate dignity on the property in a location not subject to further subsurface disturbance."

Final Archaeological Resources Report. The archaeological consultant shall submit a Draft Final Archaeological Resources Report (FARR) to the ERO that evaluates the historical significance of any discovered archaeological resource and describes the archaeological and historical research methods employed in the archaeological testing/monitoring/data

recovery program(s) undertaken. Information that may put at risk any archaeological resource shall be provided in a separate removable insert within the final report. Once approved by the ERO, copies of the FARR shall be distributed as follows: the relevant California Historical Resources Information System Information Center shall receive one (1) copy and the ERO shall receive a copy of the transmittal of the FARR to the Information Center. The Major Environmental Analysis division of the Planning Department (MEA) shall receive three copies of the FARR along with copies of any formal site recordation forms (CA DPR 523 series) and/or documentation for evaluation under National Register of Historic Places/California Register of Historical Resources criteria. The SFPUC shall receive copies of the FARR as requested in number. In instances of high public interest in or the high interpretive value of the resource, the ERO may require a different final report content, format, and distribution than that presented above.

Accidental Discovery Measures

Measure 4.7-2b: SFPUC Construction Measure # 9 for cultural resources requires that construction activities be suspended immediately if there is any indication of an archaeological resource.

To avoid any potential adverse effect from the proposed project on accidentally discovered buried or submerged historical resources as defined in CEQA Guidelines Section 15064.5(a)(c), the project sponsor shall distribute the Planning Department archaeological resource “ALERT” sheet to the project prime contractor; to any project subcontractor (including demolition, excavation, grading, foundation, pile driving, etc. firms); or utilities firm involved in soil disturbing activities within the project site. Prior to any soil disturbing activities being undertaken, each contractor is responsible for ensuring that the “ALERT” sheet is circulated to all field personnel including, machine operators, field crew, pile drivers, supervisory personnel, etc. The project sponsor shall provide the Environmental Review Officer (ERO) with a signed affidavit from the responsible parties (prime contractor, subcontractor(s), and utilities firm) to the ERO confirming that all field personnel have received copies of the “ALERT” sheet.

If the ERO determines that an archaeological resource may be present within the project site, the project sponsor shall retain the services of a qualified archaeological consultant. The archaeological consultant shall advise the ERO as to whether the discovery is an archaeological resource, retains sufficient integrity, and is of potential scientific/historical/cultural significance. If an archaeological resource is present, the archaeological consultant shall identify and evaluate the archaeological resource. The archaeological consultant shall make a recommendation as to what action, if any, is warranted. Based on this information, the ERO may require, if warranted, specific additional measures to be implemented by the project sponsor.

Measures might include: preservation in situ of the archaeological resource; an archaeological monitoring program; or an archaeological testing program. If an archaeological monitoring program or archaeological testing program is required, it shall be consistent with the MEA guidelines for such programs. The ERO may also require that the project sponsor immediately implement a site security program if the archaeological resource is at risk from vandalism, looting, or other damaging actions.

The project archaeological consultant shall submit a Final Archaeological Resources Report (FARR) to the ERO that evaluates the historical significance of any discovered archaeological resource and describing the archaeological and historical research methods employed in the archaeological monitoring/data recovery program(s) undertaken. Information that may put at risk any archaeological resource shall be provided in a separate removable insert within the final report. Once approved by the ERO, copies of the FARR shall be distributed as follows: the relevant California Historical Resources Information System Information Center shall receive one (1) copy and the ERO shall receive a copy of the transmittal of the FARR to the Information Center. The MEA shall receive three copies of the FARR along with copies of any formal site recordation forms (CA DPR 523 series) and/or documentation for nomination to the National Register of Historic Places/California Register of Historical Resources. The SFPUC shall receive copies of the FARR as requested in number. In instances of high public interest in or the high interpretive value of the resource, the ERO may require a different final report content, format, and distribution than that presented above.

Protection of Historic Districts

Measure 4.7-3: The city's water system facilities affected by WSIP facility projects will be assessed by a qualified historian for their potential contribution to an historic district, following the guidelines identified under Impact 4.7-3. To qualify as an historic district, each resource within that potential district would need to be reliant upon the other resources within the district to be historically significant. Impacts on one resource within the potential district may or may not affect the others, and this conclusion would determine the ultimate significance of the impact.

If an historic district would be affected by one or more proposed WSIP facility projects, the SFPUC, in consultation with the ERO, will develop mitigation measures for effects with attention to the potential district as a whole, with utmost effort made to maintain the district's function, appearance, cohesive site organization, and ability to convey historic significance. Appropriate measures may also include but not be limited to: refinement of facility sites to minimize effects on district appearance and site organization as well as visual screening efforts to reduce the impact of adding new facilities or otherwise modifying the landscape.

Should an historic district be identified at the project level, it should be recorded as such, using the four National/California Register criteria of significance to explain its historical importance as a cohesive group of resources. The district should be documented by completing the State of California Department of Parks and Recreation 523 forms, using a 523D (District) form as an umbrella record to unify the 523A (Primary Record) and 523B (Building, Structure, Object) forms completed for each individual resource within the potential district, and submitting them to SHPO.

Alternatives Identification and Resource Relocation

Measure 4.7-4a: If a project proposes to demolish or remove a historical resource, including individual historic resources and/or historic districts, the SFPUC will attempt to identify feasible project alternatives that eliminate or reduce the need for demolition or removal to the greatest extent possible. The SFPUC will pursue and implement these project alternatives to the extent feasible, consistent with the goals and objectives of the WSIP.

Relocation of a resource will always be preferable to demolition, although relocation might not mitigate impacts to a less-than-significant level. If preservation of the affected historical resource at the current site is determined to be infeasible, the structure shall, if feasible, be stabilized and relocated to other nearby sites appropriate to their historic setting and general environment. This may not be possible in some cases, like in the replacement of Calaveras Dam (if it were identified as a historical resource for the purposes of CEQA). After relocation, the resource shall be treated according to preservation, rehabilitation, or restoration standards, as appropriate, that follow the Secretary of the Interior's *Standards*. This will ensure that the building, structure, object, site, or district retains historic integrity and its historic significance (Measure 4.7-4c). If the affected historical resource can neither be preserved at its current site nor moved to an alternative site and is to be demolished, the SFPUC shall consult with local historical societies and governmental agencies regarding salvage of materials from the affected historical resource for public information or reuse in other locations. Demolition may proceed only after any significant historic features or materials have been identified, preserved (as feasible), and their removal completed.

Representative features such as aqueduct/pipe sections, valves subject to replacement, decorative elements, or plaques/inscriptions from buildings or other portions of structures demolished as a part of the WSIP projects could be preserved and displayed. Most of these types of structures are of sufficient size that they would form "monumental" commemorative structures. For example, an original pipeline valve replaced by modern equipment might be mounted and displayed on publicly accessible SFPUC property with informative placards. Such displays, if located in other jurisdictions, might be subject to those jurisdiction's requirements related to public art, safety, and liability considerations.

Historical Resources Documentation

Measure 4.7-4b: Documentation of a historical resource, including resources identified as contributors to a historic district or as individually significant, prior to demolition or removal is a standard mitigation measure. Such documentation is often tied to meeting the documentation standards of the Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER). The publication *Recording Historic Structures: Historic American Buildings Survey/Historic American Engineering Record* (Burns, 1989) provides four levels of documentation corresponding to the level of importance of the historic resource to be documented. For the purpose of this PEIR, the standards for photography in Documentation Levels III and IV have been modified to allow for the use of digital photographs instead of large-format negatives.

Documentation Level I:

1. Drawings: a full set of measured drawings depicting existing or historic conditions.
2. Photographs: photographs with large-format negatives of exterior and interior views; photocopies with large-format negatives of select existing drawings or historic views where available. Photographs would follow the HABS/HAER Photographic Specifications.
3. Written data: history and description.

Documentation Level II:

1. Drawings: select existing drawings, where available, should be photographed with large-format negatives or photographically reproduced on Mylar.

2. Photographs: photographs with large-format negatives of exterior and interior views, or historic views, where available. Photographs would follow the HABS/HAER Photographic Specifications.
3. Written data: history and description.

Documentation Level III:

1. Drawings: sketch plan.

2. Photographs: digital photographs of exterior and interior views.
3. Written data: architectural data form.

Documentation Level IV:

1. Drawings: sketch plan.
2. Photographs: digital photographs of exterior and interior views.
3. HABS/HAER inventory cards.

Digital photography will follow the standards in the National Register of Historic Places and National Historic Landmarks Survey, Photo Policy Expansion, March 2005 (Table VV). Digital image files would be burned to archival-quality disks, such as the eFilm Archival Gold CD-R or DVD-R; or MAM-A Mitsui Gold Archive CD-R or DVD-R.

The SFPUC will prepare, or retain a consultant to prepare, documentation of historical resources prior to any construction work associated with demolition or removal. The appropriate level of documentation will be selected by a qualified professional who meets the standards for history, architectural history, and/or architecture (as appropriate) set forth by the Secretary of the Interior (*Secretary of the Interior's Professional Qualification Standards*, 36 CFR 61) in consultation with a preservation specialist assigned by the San Francisco Planning Department and the local jurisdiction if deemed appropriate by the Planning Department. In addition to the four levels of documentation listed above, salvage and/or interpretive display may also be required if determined appropriate. The professional in history, architectural history and/or architecture (as appropriate) will prepare the documentation and submit it for review and approval by the Planning Department's preservation specialist. One set of the documentation will be archived at each of the following repositories: San Francisco Planning Department, SFPUC, the History Room of the San Francisco Public Library and the Water Resources Center Archive at the University of California Berkeley. Additional dissemination of documentation to local historical societies or historic preservation organizations may be appropriate. The San Francisco Planning Department will identify additional appropriate recipients of historical documentation during the project-level analysis.

Secretary of the Interior's Standards for Treatment of Historic Properties

Measure 4.7-4c: Compliance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties* would reduce potential impacts associated with the alteration or modification of a historical resource (including historic districts and individually eligible resources) to a less-than-significant level. (In accordance with CEQA Section 15064.5(b)(3), a project that follows the *Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings* or the *Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings* is generally considered to have impacts of a less-than-significant level.)

The SFPUC will prepare materials describing and depicting the proposed project, including but not limited to plans, drawings, and photographs of existing conditions (digital, following the standards in Measure 4.7-4a as well as proposed project plans, drawings, specifications, and description). Prepared materials will be submitted to the San Francisco

Planning Department. The Planning Department will review the proposed project, for compliance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties*.

If a project is determined to be inconsistent with the *Secretary of the Interior's Standards for the Treatment of Historic Properties*, the SFPUC will pursue and implement redesign of the project to the extent feasible, consistent with the goals and objectives of the WSIP, such that consistency with the standards is achieved.

Historic Resources Survey and Redesign

Measure 4.7-4d: The SFPUC will undertake a historic resources survey within a designated area of potential effect that encompasses the proposed project to identify and evaluate potential historical resources, including districts, which may exist within or partially within the project's study area or area of potential effect. The survey will be conducted by a qualified professional who meets the *Secretary of the Interior's Professional Qualification Standards* for architectural history, history, or architecture (36 CFR 61).

If a survey identifies one or more historical resources in the projects' study area, or area of potential effect (i.e. historically significant resources), the qualified professional will then assess the impact the project may have on those historical resources. If the project will cause a substantial adverse change to a historical resource, the SFPUC will prepare materials describing and depicting the proposed project, including but not limited to plans, drawings, and photographs of existing conditions (digital, following the standards in Measure 4.7-1a) as well proposed project plans, drawings, specifications, and description. Prepared materials will be submitted to the San Francisco Planning Department. The San Francisco Planning Department will assign a preservation specialist to review the proposed project, for compliance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties.*

If a project is determined to be inconsistent with the *Secretary of the Interior's Standards for the Treatment of Historic Properties*, the SFPUC will pursue and implement redesign of the project to the extent feasible, consistent with the goals and objectives of the WSIP, such that consistency with the standards is achieved.

Historic Resources Protection Plan

Measure 4.7-4e: A qualified historian will prepare a plan that specifies procedures for protecting historical resources and a monitoring method to be employed by the contractor while working near these resources. At a minimum, the plan will address the operation of construction equipment near adjacent historical resources, storage of construction materials away from adjacent resources, and education/training of construction workers about the significance of the historical resources.

Preconstruction Surveys and Vibration Monitoring

Measure 4.7-4f: If vibration-related impacts could impact historical resources, one or more geotechnical investigations by a California-licensed geotechnical engineer will be included as part of the proposed project. The SFPUC and its contractors will follow the recommendations of the final geotechnical reports regarding any excavation and

construction for the project. The SFPUC will ensure that the construction contractor conducts a preconstruction survey of existing conditions and monitors the adjacent buildings for damage during construction, if recommended by the geotechnical engineer. Any preconstruction surveys and construction monitoring would include the services of a professional meeting the *Secretary of the Interior's Professional Qualification Standards* for architecture.

6.3.7 Traffic, Transportation, and Circulation

Program Measures

Traffic Control Plan Measures

Measure 4.8-1a: SFPUC Construction Measure #5 for traffic requires each contractor to prepare a traffic control plan to minimize traffic and on-street parking impacts on any streets affected by construction of the proposed program. SFPUC and construction contactor(s) will prepare and implement a traffic control plan, and coordinate with Caltrans and local jurisdictions, as appropriate, for affected roadways and intersections. Each project may require the implementation of different measures, depending on the project's site-specific construction details, the characteristics of the transportation network, and daily and peak hour vehicle, pedestrian and bicycle volumes. As applicable, elements of the traffic control plan could include, but are not necessarily limited to, the following:

- Circulation and detour plans will be developed to minimize impacts on local street circulation. Flaggers and/or signage will be used to guide vehicles through and/or around the construction zone.
- Truck routes designated by cities and counties will be identified in the traffic control plan. Haul routes that minimize truck traffic on local roadways and residential streets will be utilized to the extent possible.
- Sufficient staging areas will be provided for trucks accessing construction zones to minimize disruption of access to adjacent land uses, particularly at entries to onsite pipeline construction within residential neighborhoods.
- Access to driveways and private roads will be maintained by using steel trench plates. If access must be restricted for brief periods, property owners will be notified in advance.
- Construction vehicle movement will be controlled and monitored through the enforcement of standard construction specifications by onsite inspectors.
- Along major arterials, truck trips will be scheduled outside of the peak morning and evening commute hours to the extent possible.
- Lane closures will be limited during peak hours to the extent possible. Outside of allowed working hours or when work is not in progress, roads will be restored to normal operations, with all trenches covered with steel plates.

- Where possible, pipeline construction work in roadways will be limited to a width that, at a minimum, maintains alternate one-way traffic flow past the construction zone. Parking may be prohibited if necessary to facilitate construction activities or traffic movement. If the work zone width will not allow a 10-foot-wide paved travel lane, then the road will be closed to through-traffic (except emergency vehicles), and detour signing on alternative access roads will be used.

- Pedestrian and bicycle access and circulation will be maintained during project construction where safe to do so. If construction activities encroach on a bicycle lane, warning signs will be posted that indicate bicycles and vehicles are sharing the lane.

- Detours will be included for bicycles and pedestrians in all areas potentially affected by project construction.

- All equipment and materials will be stored in designated contractor staging areas on or adjacent to the worksite, in such a manner to minimize obstruction of traffic.

- Locations will be identified for parking by construction workers, either within the construction zone or, if necessary, at a nearby location with transport provided between the parking location and the worksite.

- Roadside safety protocols will be implemented. Advance "Road Work Ahead" warning signs and speed control (including signs informing drivers of state-legislated double fines for speed infractions in a construction zone) will be provided to achieve required speed reductions for safe traffic flow through the work zone.

- Construction will be coordinated with facility owners or administrators of sensitive land uses such as police and fire stations (including all fire protection agencies), transit stations, hospitals, and schools. Facility owners or operators will be notified in advance of the timing, location, and duration of construction activities and the locations of detours and lane closures.

- Construction will be coordinated with local transit service providers, including temporary relocation of bus routes or bus stops in work zones as necessary.

- Roadway right-of-ways will be repaired or restored to their original conditions or better upon completion of construction.

- To the extent applicable, the traffic control plan will conform to the *California Manual on Uniform Traffic Control Devices for Streets and Highways: Part 6 Temporary Traffic Control* and *Caltrans' 2006 Standard Plans*.

Coordination of Individual Traffic Control Plans

Measure 4.8-1b: To the extent that the adopted SFPUC Construction Measure #5 does not contain such provisions already, or the provisions are not required for a project as a result of local encroachment or right-of-way permit conditions, the contract specifications for individual contracts within a single WSIP project will include the following:

- In the event that more than one construction contract is issued for work along existing or new pipelines, and where construction could occur within and/or across

multiple streets in the same vicinity, the SFPUC and construction contractor(s) will coordinate the traffic control plans in order to mitigate the impact of traffic disruption. The coordinated plan will include measures that address overlapping construction schedules and activities, truck arrivals and departures, lane closures and detours, and the adequacy of on-street staging requirements.

Accommodation of Displaced Public Parking Supply for Recreational Visitors

Measure 4.8-4: Due to the potential displacement of designated parking areas where limited parking is available for adjacent public uses, traffic control plans prepared as part of SFPUC Construction Measure #5 and Measure 4.8-1a will include an additional measure to accommodate any anticipated visitor parking demand that would be displaced by proposed projects at public recreational facilities.

Collective Measures

SFPUC WSIP Projects Construction Coordinator

Measure 4.16-6a: Due to the potential for overlapping project activities and construction vehicles to affect travel within and across the five regions, the SFPUC will identify a qualified construction coordinator responsible for coordinating the project-specific traffic control plans developed as part of Measure 4.8-1a, and for developing a public information campaign (e.g., internet website, radio and newspaper updates) to inform the public of construction activities, detour routes, and alternate routes. Throughout the seven-year construction schedule for the WSIP projects, the SFPUC construction coordinator will work with local and regional agencies to pursue additional traffic mitigation measures to minimize local and regional traffic impacts and will incorporate these measures into the project-specific traffic control plans, as appropriate.

Combined San Joaquin Traffic Control Plan

Measure 4.16-6b: Due to the potential for overlapping project schedules in the San Joaquin Region near Tesla Portal, the SFPUC will develop [or the SFPUC's construction contractor(s) will be required to develop] a San Joaquin Traffic Control Plan that coordinates the project-specific traffic control plans developed as part of Measure 4.8-1a and identifies additional measures to minimize the combined impacts of multiple WSIP project construction traffic on I-580, Chrisman Road, and Vernalis Road. As applicable, these measures will be developed consistent with the standards of San Joaquin County, Stanislaus County, and Caltrans and could include:

- Additional traffic control devices, such as traffic signals at key intersections providing access to local roadways and land uses
- Additional traffic control personnel at key locations to facilitate vehicular traffic flow during peak periods of truck activity
- Adjustments in truck arrival and departure schedules for the various facilities (e.g., staggering departures)

Combined Sunol Valley Traffic Control Plan

Measure 4.16-6c: Due to the potential for overlapping project schedules in the Sunol Valley Region as well as for construction traffic to use Calaveras Road as an access route to all projects sites, the SFPUC or its construction contractor(s) will develop a Sunol Valley Traffic Control Plan that coordinates the project-specific traffic control plans developed as part of Measure 4.8-1a and identifies additional measures to minimize the impacts of construction traffic on Calaveras Road and I-680. As applicable, these measures will be developed consistent with the standards of Alameda County and Caltrans and could include:

- Additional traffic control devices, such as traffic signals at key intersections providing access to local roadways and land uses. Traffic signals could facilitate access onto Calaveras Road at intersections and also allow for gaps in truck traffic flow to facilitate access from driveways along Calaveras Road.
- Additional traffic control personnel at key locations to facilitate vehicular traffic flow during peak periods of truck activity.
- Adjustments in truck arrival and departure schedules for the various facilities (e.g., staggering departures).
- Public information regarding periods when construction traffic on Calaveras Road would be greatest.
- Working with Caltrans to determine if warning signs, such as a “Slow Trucks” sign (California Code W51), would be appropriate to inform drivers that slow-moving trucks may interfere with the flow of traffic on I-680.

Cumulative Measures

SFPUC WSIP Projects Construction Coordinator – Other Agencies

Measure 4.17-6: As required in Measure 4.8-1, contractors will be required to submit traffic control plans to the SFPUC, and in Measure 4.16-6a, the SFPUC will be required to identify a WSIP construction coordinator who will be responsible for coordinating the project-specific traffic control plans. The SFPUC WSIP construction coordinator will also consider the effects of any traffic generated by SFPUC maintenance activities and other SFPUC projects (as listed in Tables 4.17-1 through 4.17-6). The SFPUC WSIP construction coordinator will also coordinate with Caltrans, other county agencies, and local jurisdictions responsible for reviewing and/or approving the construction of other identified private and public development projects (as listed in Tables 4.17-1 through 4.17-6) so as to minimize traffic impacts on local access roads, particularly local streets where sensitive receptors (e.g., schools, residences, or hospitals) are located.

6.3.8 Air Quality

Program Measures

SJVAPCD Dust Control Measures

Measure 4.9-1a: In the San Joaquin Region, the SJVAPCD has determined that compliance with the following Regulation VIII (Fugitive PM_{10} Prohibitions) and Regulation IX (Mobile and Indirect Sources, Rule 9510, where applicable) control measures would mitigate PM_{10} impacts to a less-than-significant level. The SFPUC will include these measures, where applicable, in contract specifications:

SJVAPCD Basic Control Measures (applies to all construction sites)

- All disturbed areas, including storage piles, that are not being actively utilized for construction purposes, shall be effectively stabilized of dust emissions using water, chemical stabilizer/suppressant, covered with a tarp or other suitable cover, or vegetative ground cover.
- All onsite unpaved roads and offsite unpaved access roads shall be effectively stabilized of dust emissions using water or chemical stabilizer/suppressant.
- All land clearing, grubbing, scraping, excavation, land leveling, grading, cut and fill, and demolition activities shall be effectively controlled of fugitive dust emissions utilizing application of water or by presoaking.
- When materials are transported offsite, all material shall be covered, or effectively wetted to limit visible dust emissions, and at least 6 inches of freeboard space from the top of the container shall be maintained.
- All operations shall limit or expeditiously remove the accumulation of mud or dirt from adjacent public streets at the end of each workday. The use of dry rotary brushes is expressly prohibited except where preceded or accompanied by sufficient wetting to limit the visible dust emissions. Use of blower devices is expressly forbidden.
- Following the addition of materials to, or the removal of materials from, the surface of outdoor storage piles, said piles shall be effectively stabilized of fugitive dust emissions utilizing sufficient water or chemical stabilizer/suppressant.
- Within urban areas, trackout shall be immediately removed when it extends 50 or more feet from the site and at the end of each workday.
- Any site with 150 or more vehicle trips per day shall prevent carryout and trackout.

SJVAPCD Enhanced Control Measures (also applies when required to mitigate significant PM_{10} impacts)

- Traffic speeds on unpaved roads shall be limited to 15 mph.
- Sandbags or other erosion control measures shall be installed to prevent silt runoff to public roadways from sites with a slope greater than 1 percent.

SJVAPCD Additional Control Measures (also applies to construction sites that are large in area, located near sensitive receptors, or which for any other reason warrant additional emissions reductions)

- Wheel washers shall be installed for all exiting trucks, or all trucks and equipment leaving the site shall be washed off.
- Wind breaks shall be installed at windward side(s) of construction areas.
- Excavation and grading activity shall be suspended when winds exceed 20 mph and, regardless of windspeed, an owner/operator must comply with Regulation VIII's 20 percent opacity limitation.
- The area subject to excavation, grading, and other construction activity at any one time shall be limited.

SJVAPCD Rule 9510, Indirect Source Review, Section 6.1, Construction Equipment Emissions (applies to any project subject to discretionary approval by a public agency that ultimately results in the construction of a new building, facility, or structure or reconstruction of a building, facility, or structure for the purpose of increasing capacity or activity and also involving 9,000 square feet of space).

- 6.1.1: The exhaust emissions for construction equipment greater than fifty (50) horsepower used or associated with the development project shall be reduced by the following amounts from the statewide average as estimated by the ARB:
  - 6.1.1.1: 20% of the total NO_x emissions, and
  - 6.1.1.2: 45% of the total PM_{10} exhaust emissions.
- 6.1.2: An applicant may reduce construction emissions on-site by using less-polluting construction equipment, which can be achieved by utilizing add-on controls cleaner fuels, or newer lower emitting equipment.
- 6.3: The requirements listed in Section 6.1 above can be met through any combination of on-site emission reduction measures or off-site fees.

SJVAPCD Exhaust Control Measures

Measure 4.9-1b: To limit exhaust emissions within the San Joaquin Region, the SJVAPCD specifies the following exhaust controls for heavy-duty equipment (scrapers, graders, trenchers, earthmovers, etc.). The SFPUC will include these measures, where applicable, in contract specifications:

- Alternative-fueled or catalyst-equipped diesel construction equipment shall be used.
- Idling time (e.g., 10-minute maximum) shall be minimized.
- The hours of operation of heavy-duty equipment and/or the amount of equipment in use shall be limited.

- Fossil-fueled equipment shall be replaced with electrically driven equivalents (provided they are not run via a portable generator set).
- Construction shall be curtailed during periods of high ambient pollutant concentrations; this may include ceasing construction activity during the peak hour of vehicular traffic on adjacent roadways.
- Activity management (e.g., rescheduling activities to reduce short-term impacts) shall be implemented.

BAAQMD Dust Control Measures

Measure 4.9-1c: In the Sunol Valley, Bay Division, Peninsula, and San Francisco Regions, the BAAQMD has determined that implementation of the following control measures would mitigate PM_{10} impacts to a less-than-significant level. The SFPUC will include these measures, where applicable, in contract specifications:

BAAQMD Basic Control Measures (applies to all construction sites)

- All active construction areas shall be watered at least twice daily.
- All trucks hauling soil, sand, and other loose debris shall be covered *or* all trucks shall be required to maintain at least 2 feet of freeboard on public roads.
- All unpaved access roads, parking areas, and staging areas at construction sites shall either be paved, watered three times daily, or nontoxic soil stabilizers shall be applied.
- All paved access roads, parking areas, and staging areas at construction sites shall be swept daily (with water sweepers).
- If visible soil material is carried onto adjacent public streets, adjacent streets shall be swept daily (with water sweepers).

BAAQMD Enhanced Control Measures (also applies to sites over four acres)

- All inactive construction areas (previously graded areas inactive for 10 days or more) shall be hydroseeded or nontoxic soil stabilizers shall be applied.
- Exposed stockpiles (dirt, sand, etc.) shall be enclosed, covered, and watered, or nontoxic soil binders shall be applied.
- As feasible, traffic speeds on unpaved roads shall be limited to 15 mph.
- Sandbags or other erosion control measures shall be installed to prevent silt runoff to public roadways.
- Disturbed areas shall be replanted as quickly as possible.

BAAQMD Optional Control Measures (also applies to construction sites that are large in area, located near sensitive receptors, or which for any other reason warrant additional emissions reductions)

- Wheel washers shall be installed for all exiting trucks, or all trucks and equipment leaving the site shall be washed off.
- Wind-breaks or trees/vegetative wind-breaks shall be installed at windward side(s) of construction areas.
- Excavation and grading activity shall be suspended when winds exceed 25 mph.
- The area subject to excavation, grading, and other construction activity at any one time shall be limited.

BAAQMD Exhaust Control Measures

Measure 4.9-1d: To limit exhaust emissions within the Sunol Valley, Bay Division, Peninsula, and San Francisco Regions, the SFPUC will implement the following exhaust controls, where applicable:

- Grid power will be used instead of diesel generators at all construction sites where it is feasible to connect to grid power. While it may not be practical to connect to grid power for pipeline projects (since construction sites keep moving along the alignments), grid power shall be used for projects with fixed locations, such as tunnel entry and exit shafts/portals.
- All WSIP contracts specifications shall include Sections 2480 and 2485, Title 13, California Code of Regulations, which limit the idling of all diesel-fueled commercial vehicles (weighing over 10,000 pounds, both California- or non-California-based trucks) to 30 seconds at a school or five minutes at any location. In addition, the use of diesel auxiliary power systems and main engines shall be limited to five minutes when within 100 feet of homes or schools while the driver is resting.
- All WSIP contracts specifications shall include Section 93115, Title 17, California Code of Regulations, Airborne Toxic Control Measure for Stationary Compression Ignition Engines, which specifies fuel and fuel additive requirements; emission standards for operation of any stationary, diesel-fueled, compression-ignition engines; and operation restrictions within 500 feet of school grounds when school is in session.
- A schedule of low-emissions tune-ups shall be developed and such tune-ups shall be performed on all equipment, particularly for haul and delivery trucks. A log of required tune-ups shall be maintained and a copy of the log shall be submitted to the SFPUC on a monthly basis for review.
- Low-sulfur fuels shall be used in all stationary and mobile equipment.

Health Risk Screening or Use of Soot Filters

Measure 4.9-2a: If truck volumes associated with a particular project along a particular haul route exceed 40,000 truck trips over the entire construction period, a health risk screening will be completed. If a potentially significant impact is indicated, a site-specific

health risk assessment (HRA) will be completed for the project. Any subsequent project-level analysis will consider DPM emission rates at the time of construction since emission rates are expected to decline in the future. Based on the site-specific HRA, a mitigation program will be developed implementing one or more the following methods of reducing DPM emission or exposure to a less-than-significant level:

- Modify haul routes to reduce exposure.
- Require use of biodiesel fuel, which reduces DPM emissions.
- Require new construction equipment to be utilized. Newer construction equipment is far cleaner than old equipment.
- Require that the vehicle fleet include trucks with soot filters (particulate traps) within the equipment fleet.
- Temporarily vacate affected receptors.
- Any other effective means of reducing DPM emissions or exposure.

Vacate SFPUC Land Managers' Residences in Sunol Valley

Measure 4.9-2b: The two SFPUC Land Managers' residences in the Sunol Valley will be vacated during construction of the Calaveras Dam (SV-2) or Treated Water Reservoirs (SV-5) projects. Alternatively, a health risk screening could be completed to determine health risks at these residences from either of these two projects. If a potentially significant impact is indicated, a health risk assessment will be completed, and measures will be implemented, as set forth in Measure 4.9-2a.

Tunnel Gas Odor Control

Measure 4.9-3: For any projects that would require a tunnel ventilation system, if hydrogen sulfide gas or any other odorous gases (including diesel exhaust) are encountered during tunnel excavation and become a nuisance odor problem (i.e., odor complaints are received), water scrubbers will be added to the ventilation system and appropriate chemicals will be added to remove the nuisance odors.

Collective Measures

Dust and Exhaust Control Measures for All WSIP Projects

Measure 4.16-7a: Measures 4.9-1a through 4.9-1d requires specific projects to implement dust and exhaust control measures. To address collective construction-related air quality impacts, these measures will be required for all WSIP projects as applicable and required by SJVAPCD and BAAQMD.

Health Risk Screening or Use of Soot Filters for All Projects in the San Joaquin and Sunol Valley Regions

Measure 4.16-7b: Measure 4.9-2a requires specific projects to either conduct a health risk assessment or use soot filters to reduce DPM emissions associated with haul trucks. To address collective DPM impacts, this measure will be required for all WSIP projects in the

San Joaquin and Sunol Valley Regions. This measure would only apply in the Sunol Valley Region if, under Measure 4.9-2b, the SFPUC elects not to vacate the two SFPUC Land Managers' residences in the Sunol Valley. If this requirement is applied to the New Irvington Tunnel project (SV-4), it shall be applied to both the Sunol Valley and Fremont tunnel portals, taking into account truck traffic from other WSIP projects in the vicinity of both portals.

Vacate SFPUC Land Managers' Residences for All Projects in the Sunol Valley Region

Measure 4.16-7c: Measure 4.9-2b requires the two SFPUC Land Managers' residences in the Sunol Valley to be vacated during construction of the Calaveras Dam (SV-2) and Treated Water Reservoirs (SV-5) projects. Alternatively, a health risk screening could be completed to determine health risks at these residences. If a potentially significant impact is indicated, a health risk assessment will be completed. To address collective DPM impacts, this measure will be required for all WSIP projects in the Sunol Valley Region.

6.3.9 Noise and Vibration

Program Measures

Noise Controls

Measure 4.10-1a: SFPUC Construction Measure #6 for noise requires compliance with local noise ordinances to the extent feasible. Many of these ordinances restrict hours when construction can occur, but do not specify noise limits for construction noise. For most projects, the SFPUC will conduct construction activities during the daytime hours to the extent feasible. However, if nighttime construction cannot be avoided, noise generated by these activities will be required to comply with applicable noise ordinance nighttime limits or not exceed 50-dBA sleep interference criterion (with windows open at night) to the extent feasible.

To ensure that construction noise impacts are mitigated to a less-than-significant level, all WSIP projects located within 500 feet of any noise-sensitive receptors (e.g., residences, schools, childcare centers, churches, hospitals, and nursing homes) will be required to implement appropriate noise controls to reduce daytime construction noise levels to meet the 70-dBA daytime speech interference criterion to the extent feasible. For nighttime construction, all WSIP projects located within 3,000 feet of any noise-sensitive receptors will be required to implement appropriate noise controls to maintain noise levels at or below any applicable ordinance nighttime noise limits or the 50-dBA nighttime sleep interference criterion to the extent feasible. Such controls could include any of the following, as appropriate:

- Best available noise control techniques (including mufflers, intake silencers, ducts, engine enclosures, and acoustically attenuating shields or shrouds) will be used for all equipment and trucks in order to minimize construction noise impacts. If feasible, construction equipment noise will not exceed the mitigated noise levels listed in **Table 4.10-4** (see measure below for limits on impact equipment).

- If impact equipment (e.g., jack hammers, pavement breakers, and rock drills) is used during project construction, hydraulically or electric-powered equipment will be used wherever feasible to avoid the noise associated with compressed-air exhaust from pneumatically powered tools. However, where use of pneumatically powered tools is unavoidable, an exhaust muffler on the compressed-air exhaust will be used (a

- muffler can lower noise levels from the exhaust by up to about 10 dBA). External jackets on the tools themselves will be used, where feasible, which could achieve a reduction of 5 dBA. Quieter procedures, such as drilling rather than impact equipment, will be used whenever feasible.

- Pile holes will be pre-drilled wherever feasible to reduce potential noise and vibration impacts. Where feasible, sonic or vibratory pile drivers will be used instead of impact pile drivers (sonic pile drivers are only effective in some soils).

- Pile driving activities shall be prohibited during the evening and nighttime hours (7 p.m. to 7 a.m.).

- Operation of equipment requiring use of back-up beepers will be avoided near sensitive receptors to the extent feasible during nighttime hours (10 p.m. to 7 a.m.).

- Stationary noise sources will be located as far from sensitive receptors as feasible. If they must be located near receptors, adequate muffling (with enclosures where feasible and appropriate) will be used to ensure local noise ordinance limits are met to the extent feasible. Enclosure opening or venting will face away from sensitive receptors. If any stationary equipment (e.g., ventilation fans, generators, dewatering pumps) is operated beyond the time limits specified by the pertinent noise ordinance, this equipment will conform to the affected jurisdiction's pertinent day and night noise limits to the extent feasible.

- Material stockpiles as well as maintenance/equipment staging and parking areas will be located as far as feasible from residential and school receptors.

- Wherever feasible, pipeline alignments will be located at least 100 feet away from sensitive receptors.

- Where pipeline construction zones are within 100 feet of school classrooms or childcare facilities, pipeline construction activities (or at least the noisier phases of construction) will be scheduled on weekend or school vacation days to the extent feasible, avoiding weekday hours when schools are in session. If construction must occur when school is in session, interior noise levels in classrooms will not exceed 60 dBA if possible to avoid speech interference problems, which would allow for a maximum exterior noise level of 70 to 80 dBA, depending on whether windows are open or closed.

- Given the long duration of construction activities at tunnel shafts/portals and proposed nighttime activities, tunnel-related construction activities will be designed to comply with nighttime noise limits specified in local noise ordinances. Measures that could be implemented to comply with these limits include: using quiet ventilation fans (pure tone components of fan noise will be considered), using line power instead of generators, erection of temporary sound barriers, restricting heavy equipment operation during the nighttime hours, using nonmetallic containers in the muck removal system to prevent clanging/banging noises, limiting controlled detonations in the tunnel shaft/portal vicinities to the daytime hours, retrofitting windows/doors of affected homes, and/or prohibiting use of backup alarms on equipment during the nighttime hours.

- Where controlled detonation activities will occur, surrounding cities and residents should be notified of the blasting schedule, indicating the time range when blasting could occur (hours and duration).

- Proposed jack-and-bore pits will be located as far from sensitive receptors as technically feasible. If ventilation fans, dewatering pumps, or generators are required as part of this type of pipeline crossing, such equipment will comply with daytime and nighttime noise limits specified in pertinent noise ordinances to the extent feasible (also see Measure 4.9-1d in Section 4.9, Air Quality, for additional restrictions on generator operation).

- Wherever necessary, temporary or permanent noise barriers will be erected to maintain construction noise levels at or below the 70-dBA daytime speech interference criterion and the 50-dBA nighttime sleep interference criterion.

- A designated project liaison will be responsible for responding to noise complaints during the construction phases. The name and phone number of the liaison will be conspicuously posted at construction areas and on all advanced notifications. This person will take steps to resolve complaints, including periodic noise monitoring, if necessary. Results of noise monitoring will be presented at regular project meetings with the project contractor, and the liaison will coordinate with the contractor to modify any construction activities that generated excessive noise levels to the extent feasible.

- A reporting program will be required for each project that documents complaints received, actions taken to resolve problems, and effectiveness of these actions.

Vacate SFPUC Caretaker's Residence at Tesla Portal

Measure 4.10-1b: The SFPUC caretaker's residence at Tesla Portal will be vacated during construction of the Advanced Disinfection (SJ-1) and Tesla Portal Disinfection (SJ-5) projects as well as those portions of the SJPL System (SJ-3) and SJPL Rehabilitation (SJ-4) projects located at Tesla Portal.

Limit Hourly Truck Volumes

Measure 4.10-2a: In addition to SFPUC Construction Measure #6 for noise, which requires compliance with local noise ordinances to the extent feasible, haul and delivery truck routes for all WSIP projects will avoid local residential streets and will follow local designated truck routes to the extent feasible. Total project-related haul and delivery truck volumes on any particular haul truck route will be limited to 80 trucks per hour.

Restrict Truck Operations

Measure 4.10-2b: Haul and delivery trucks will be prohibited from operating within 200 feet of any residential uses during the nighttime hours (10 p.m. to 7 a.m.). If there are receptors, but they are beyond 200 feet from the haul route, limited truck operations will be allowed during the more sensitive nighttime hours, but noise generated by these operations cannot exceed the 50-dBA sleep interference criterion at the closest receptors. If trucks must operate during these hours and residential uses are located within 200 feet of the haul route, deliveries will be made to staging areas outside residential areas, then transferred to the construction site during daytime hours (7 a.m. to 7 p.m.).

Vacate SFPUC Land Manager's Residence

Measure 4.10-2c: To minimize nighttime noise impacts, the SFPUC Land Manager's residence adjacent to Alameda East Portal will be vacated during off-site truck operations associated with the New Irvington Tunnel project (SV-4), if truck operations occur during the nighttime hours (10 p.m. to 7 a.m.) and are estimated to exceed the 50-dBA sleep interference criterion at this residence.

Vibration Controls to Prevent Cosmetic or Structural Damage

Measure 4.10-3a: To prevent cosmetic or structural damage to adjacent or nearby structures, the SFPUC will incorporate restrictions into all contract specifications (primarily for sheetpile driving, pile driving, or tunnel construction activities), whereby surface vibration will be limited to 0.2 in/sec PPV for continuous vibration (e.g., vibratory equipment and impact pile drivers) and 0.5 in/sec PPV for controlled detonations at the closest receptors to ensure that cosmetic or structural damage does not occur.

Limit Vibration Levels at or Below Vibration Perception Threshold

Measure 4.10-3b: For nighttime construction activities, the SFPUC will maintain vibration levels at or below the vibration perception threshold (0.012 in/sec PPV) at adjacent properties (or in accordance with local ordinances) to the extent feasible. If vibration complaints are received during facility construction, operational adjustments will be made (e.g., restricting use of equipment causing vibration disturbance during the nighttime hours or slowing the pace of its operation), as necessary, to reduce vibration annoyance effects.

Limit Tunnel-Related Detonation to Daylight Hours

Measure 4.10-3c: The SFPUC will limit controlled detonation associated with tunnel construction to the daylight hours, Monday through Saturday.

Collective Measures

Limiting Hourly Truck Volumes and Restricting Truck Operations on Haul Routes for Multiple WSIP Projects

Measure 4.16-8a: Measures 4.10-2a and 4.10-2b outline restrictions and guidelines for daytime and nighttime truck operations on local roadways. To address collective truck-related noise impacts, these measures will be applied to total haul and delivery truck volumes on any particular haul truck route that are attributable to all WSIP projects, including the Tesla Portal, Irvington Portal, Lower Crystal Springs Dam vicinities as well as haul routes in San Francisco Region. Therefore, total truck volumes from all WSIP projects on a particular route will not exceed 80 trucks per hour (so as not to exceed the 70-dBA speech interference criterion during the daytime hours) and will be restricted near sensitive receptors (to meet the 50-dBA sleep interference criterion) during the nighttime hours.

Vacate Land Manager's Residence for All Projects in Sunol Valley Region

Measure 4.16-8b: Measure 4.10-2c requires the SFPUC Land Manager's residence adjacent to Alameda East Portal to be vacated during construction truck operations associated with the New Irvington Tunnel project (SV-4). To address collective noise

impacts, this residence will be vacated during construction truck operations associated with all WSIP projects in this region, if collective daytime truck volumes exceed the 70-dBA speech interference criterion (7 a.m. to 10 p.m.) or nighttime truck volumes exceed the 50-dBA sleep interference criterion (10 p.m. to 7 a.m.).

Cumulative Measures

Coordination of Truck Traffic on Local Streets

Measure 4.17-8: The SFPUC WSIP construction coordinator designated in Measure 4.17-6 will also be responsible for coordinating truck traffic generated on these same streets by SFPUC maintenance activities and other SFPUC projects (as listed in Tables 4.17-1 through 4.17-6) so that SFPUC-related truck noise increases are maintained at or below threshold levels specified in Measures 4.10-2a and 4.10-2b to the extent feasible (80 trucks per hour along a haul/delivery route and restricted nighttime truck operations).

6.3.10 Public Services and Utilities

Program Measures

Notify Neighbors of Potential Utility Service Disruption

Mitigation 4.11-1a: As part of the neighborhood notice, the SFPUC will notify residents and businesses in project area of potential utility service disruption two to four days in advance of construction.

Locate Utility Lines Prior to Excavation

Measure 4.11-1b: Prior to excavation, the SFPUC or its contractors will locate overhead and underground utility lines, such as natural gas, electricity, sewer, telephone, fuel, and water lines, that may be encountered during excavation work prior to opening an excavation.

Confirmation of Utility Line Information

Measure 4.11-1c: The SFPUC or its contractors will find the exact location of underground utilities by safe and acceptable means. Information regarding the size, color, and location of existing utilities must be confirmed before construction activities commence.

Safeguard Employees from Potential Accidents Related to Underground Utilities

Measure 4.11-1d: While any excavation is open, the SFPUC or its contractors will protect, support, or remove underground utilities as necessary to safeguard employees.

Notify Local Fire Departments

Measure 4.11-1e: The SFPUC or its contractors will notify local fire departments any time damage to a gas utility results in a leak or suspected leak, or whenever damage to any utility results in a threat to public safety.

Emergency Response Plan

Mitigation 4.11-f: The SFPUC will develop an emergency response plan in the event of a leak or explosion prior to commencing construction activities.

Prompt Reconnection of Utilities

Measure 4.11-2g: The SFPUC or its contractors will promptly reconnect any disconnected utility lines.

Coordinate Final Construction Plans with Affected Utilities

Measure 4.11-1h: The SFPUC or its contractors will coordinate final construction plans and specifications with affected utilities.

Waste Reduction Measures

Measure 4.11-2: The following requirements will be incorporated into contract specifications for each WSIP project:

The contractor(s) will obtain any necessary waste management permits prior to construction and will comply with conditions of approval attached to project implementation. As part of the waste management permit process, the contractor(s) will submit a solid waste recycling plan to the affected agencies. Elements of the plan will likely include, but are not necessarily limited to, the following:

- Identification of the types of debris that will be generated by the project and identify how all waste streams will be handled.
- Actions to reuse or recycle construction debris and clean excavated soil to the extent possible.
- Actions to divert at least 50% of inert solids (asphalt, brick, concrete, dirt, fines, rock, sand, soil, and stone) from disposal in a landfill.

6.3.11 Recreational Resources

Program Measures

Coordination with Golf Course/Recreational Facility Managers

Measure 4.12-1: Where golf courses or other recreational facilities would be directly affected by pipeline construction, the SFPUC will coordinate with facility managers to minimize adverse impacts on golfers and other recreational users.

Appropriate Siting of Proposed Facilities

Measure 4.12-2: The SFPUC will locate WSIP project facilities on park and recreation properties in consultation with park planning staff to minimize the direct loss of recreation and play space and to minimize any inconvenience to park, playground, or golf course users associated with the installation of non-recreational facilities within recreational areas.

6.3.12 Agricultural Resources

Program Measures

Supplemental Noticing and Soil Stockpiling

Measure 4.13-1a: For the San Joaquin Pipeline projects (SJPL System, SJ-3, and SJPL Rehabilitation, SJ-4), as part of the SFPUC Construction Measure #1 for neighborhood notice, advanced notification will include the name and number of an SFPUC staff person who can be contacted to discuss special needs and to work out accommodations to minimize temporary disruption to agricultural activities. The SFPUC will stockpile and replace topsoil in mapped areas of Prime and Unique Farmland and Farmland of Statewide Importance that would be temporarily disturbed by pipeline construction, unless other actions are required under specific agreements with individual land owners. (The SFPUC typically holds easements for work on its projects, but prior owners may have residual rights to use the rights-of-way for agricultural purposes. The SFPUC will work with farmers under the terms of these agreements.)

Avoidance or Soil Stockpiling

Measure 4.13-1b: The SFPUC will minimize any potential impacts on agricultural lands in the Sunol Valley by avoiding these resources wherever possible. Where this is not possible, topsoil along the pipeline right-of-way will be stockpiled, replaced, and hydroseeded to prevent erosion, unless other actions are required as a result of contracts affecting use of the property or under specific agreements with individual land owners.

Siting Facilities to Avoid Prime Farmland

Measure 4.13-2: The SFPUC will avoid areas identified as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance in the siting of facilities for the 40-mgd Treated Water project (SV-3), Treated Water Reservoirs project (SV-5), and ancillary power supply facilities for the SJPL System project (SJ-3). If avoidance is not feasible, the SFPUC will adopt a permanent set-aside for an equivalent acreage of similarly-valued farmland in the area.

6.3.13 Hazards

Program Measures

Site Health and Safety Plan

Measure 4.14-1a: For all projects requiring excavation where the site assessment conducted in accordance with SFPUC Construction Measure #7 indicates the potential to encounter hazardous materials in the soil or groundwater, the contractor will prepare a site health and safety plan identifying the chemicals present, potential health and safety hazards, monitoring to be performed during site activities, soils-handling methods required to minimize the potential for exposure to harmful levels of any chemicals identified in the soil, appropriate personnel protective equipment, and emergency response procedures.

Materials Disposal Plan

Measure 4.14-1b: For all projects requiring excavation where the site assessment conducted in accordance with SFPUC Construction Measure #7 indicates the potential to encounter hazardous materials in the soil, the contractor will prepare a materials disposal plan that specifies the disposal method and approved disposal site for the soil and will provide written documentation that the disposal site will accept the waste.

Coordination with Property Owners and Regulatory Agencies

Measure 4.14-1c: Based on regulatory agency file reviews conducted in accordance with SFPUC Construction Measure #7, the SFPUC will assess the potential to encounter unacceptable levels of hazardous materials at known environmental cases, for construction activities to cause groundwater plume migration or interfere with ongoing remediations at known environmental cases, and for increased water levels in reservoirs or lakes to inundate known environmental cases. Should the review indicate that the project could encounter unacceptable levels of hazardous materials or interfere with a remediation, the SFPUC will contact the site owner (or responsible SFPUC department for the Peninsula Sportsmen's Club and Pacific Rod and Gun Club) and responsible regulatory agency to determine appropriate construction modifications or remediation necessary to avoid adverse effects during construction and operation of the project. Construction modifications will be designed to reduce groundwater plume migration or interference with the remediation; alternatively, modifications will be made to the remediation activities during construction to reduce interference with remediation activities to avoid encountering unacceptable levels of hazardous materials. The SFPUC will implement the requirements of the responsible regulatory agency.

Health Risk Screening and Airborne Asbestos Monitoring Plan

Measure 4.14-2: For tunneling projects where soil or rock containing naturally occurring asbestos has been identified, the SFPUC will conduct a health risk screening assessment to identify acceptable levels of asbestos in tunnel emissions based on site conditions and proximity to receptors. Prior to operation of the tunnel exhaust system, the contractor will be required to prepare an airborne asbestos monitoring plan for approval by the BAAQMD. The plan will specify the identified asbestos criterion, monitoring that will be conducted to identify asbestos concentrations in tunnel emissions, sampling methods, analytical methods, and corrective actions that will be taken if the asbestos criterion is exceeded. Additional dust filtration will be added to the tunnel exhaust system if the criterion is exceeded.

Hazardous Building Materials Surveys and Abatement

Measure 4.14-5: For all WSIP projects involving demolition or renovation of existing facilities, the SFPUC will retain a registered environmental assessor or a registered engineer to perform a hazardous building materials survey for each structure prior to demolition or renovation activities. If any friable asbestos-containing materials, lead-containing materials, or hazardous components of building materials are identified, adequate abatement practices, such as containment and/or removal, will be implemented prior to demolition or renovation. Any PCB-containing equipment or fluorescent lights containing mercury vapors will also be removed and disposed of properly.

6.3.14 Energy Resources

Program Measures

Incorporation of Energy Efficiency Measures

Measure 4.15-2: Consistent with the Energy Action Plan II priorities for reducing energy usage, the SFPUC will ensure that energy efficient equipment is used in all WSIP projects. A repair and maintenance plan will also be prepared for each facility to minimize power use. The potential for use of renewable energy resources (such as solar power) at facility sites will be evaluated during project-specific design.

6.4 Mitigation Measures to Minimize Water Supply and System Operations Impacts

This section presents all mitigation measures for impacts described in Chapter 5. Mitigation measures for impacts identified in Sections 5.3 through 5.6 are presented under the respective geographic area (i.e., watershed or groundwater basin). In some cases, a mitigation measure would mitigate more than one impact, and the mitigation measure numbering corresponds to the first impact identified. Impact and mitigation summary tables for Section 5.3, Tuolumne River Watershed and Downstream Waterbodies; Section 5.4, Alameda Creek Watershed Streams and Reservoirs; Section 5.5, San Francisco Peninsula Streams and Reservoirs; and Section 5.6, Westside Groundwater Basin, are presented in Section 6.6.

6.4.1 Plans and Policies

System Measures

None required.

6.4.2 Tuolumne River System and Downstream Water Bodies

Stream Flow and Reservoir Water Levels

System Measures

None required.

Geomorphology

System Measures

None required.

Surface Water Quality

System Measures

None required.

Surface Water Supplies

System Measures

None required.

Groundwater

System Measures

None required.

Fisheries

System Measures

Overview of Measures 5.3.6-4a, 5.3.6-4b, and 5.3.7-6

The SFPUC will attempt to implement Measure 5.3.6-4a as described below, which could mitigate both Impacts 5.3.6-4 and 5.3.7-6 to a less than significant level. Measure 5.3.6-4a involves some uncertainty because its implementation depends on the SFPUC negotiating and reaching agreement with MID/TID and possibly other water agencies. If Measure 5.3.6-4a proves to be infeasible, the SFPUC will implement Measure 5.3.6-4b to lessen fisheries impacts and Measure 5.3.7-6 to lessen impacts on riparian vegetation.

Avoidance of Flow Changes by Reducing Demand for Don Pedro Reservoir Water

Measure 5.3.6-4a: The SFPUC will pursue a water transfer arrangement with MID/TID and/or other water agencies such that the water acquired is developed through actions that result in reduction of demand on Don Pedro Reservoir as a result of conservation, improved delivery efficiency, inter-agency transfer of conserved water, or use of an alternative supply such as groundwater. The TID and MID would deliver less water from Don Pedro Reservoir. The consequent increase in water storage in Don Pedro Reservoir would offset the reduction in inflow to Don Pedro Reservoir attributable to the WSIP. The release pattern from La Grange Dam would be the same or similar to the existing condition thus lessening or eliminating Impacts 5.3.6-4 and 5.3.7-6. The actions necessary to reduce demand for Don Pedro Reservoir water may themselves have environmental effects. See Section 6.5 for a review of potential environmental effects associated with the expected actions of this mitigation measure. Further environmental review would be undertaken prior to approving a specific water transfer agreement.

Fishery Habitat Enhancement

Measure 5.3.6-4b: If Measure 5.3.6-4a is not implemented, then the SFPUC will mitigate potential fishery effects on the lower Tuolumne River by implementing (or funding) one of

the following two habitat enhancement actions that are designed to sustain fishery resources under the river's flow regime, which are consistent with the Habitat Restoration Plan for the Lower Tuolumne River Corridor: gravel augmentation/habitat enhancement to provide salmonid spawning and rearing habitat, or isolating or filling a captured former gravel quarry pit along the river that provides habitat for salmonid predators.

The gravel augmentation/habitat enhancement project will be implemented to increase salmonid spawning success and to improve the survival of rearing salmonids in the reach of the river downstream of La Grange Dam. Spawning success will be improved by the addition of suitable gravel to the stream channel. Other habitat features will be created to provide cover for juvenile salmonids and to increase the availability of substrate for macroinvertebrates that would be used as food by rearing juvenile salmon and steelhead. The gravel augmentation/habitat enhancement project will involve the planning, design, permitting, purchase, placement, and monitoring of suitable gravel and associated habitat enhancements at three riffle locations within the spawning reach between Basso Bridge and La Grange Dam. The three locations will meet the criteria for suitable habitat as described in the Habitat Restoration Plan for the Lower Tuolumne River Corridor. The gravel will preferentially be rounded river rock of native origin that would be sized and pre-washed before placement into the river. The gravel augmentation/habitat enhancement project will also involve the addition of large woody debris and boulders to create increased habitat complexity and diversity at each of the three enhancement sites. After construction of the gravel augmentation/habitat enhancement project, it will be surveyed to establish its baseline condition. A survey of the three sites will be made at a minimum of five-year intervals by a qualified fisheries biologist. The fisheries biologist will determine whether the three sites continue to meet established criteria for salmonid spawning and rearing habitat. If the sites do not meet the criteria, as part of its long-term operations, the SFPUC will make the improvements necessary to return it to the baseline conditions.

As an alternative to the gravel augmentation project, the SFPUC will remove from the lower river channel one of the former gravel quarry pits that has been "captured" by the river and acts as predator zones for fish such as largemouth and striped bass to prey on rearing and emigrating juvenile salmonids. Removal could be accomplished by filling the pit or installing a levee berm around the pit to isolate it permanently from the river channel. The SFPUC could implement this action directly or fund implementation by another entity involved in river restoration.

The performance standard for gravel pit removal would be an established permanent reduction in area of salmonid predator habitat. The SFPUC will monitor the pit removal project at five-year intervals. If floods have eroded the fil1 or damaged the levees in a manner that restores salmonid predator habitat, the SFPUC will make the necessary repairs. The SFPUC will continue periodic monitoring and repair as part of long-term system operations.

Terrestrial Biological Resources

System Measures

Controlled Releases to Recharge Groundwater in Streamside Meadows and Other Alluvial Deposits

Measure 5.3.7-2: To mitigate for potential WSIP effects on meadow resources along the Tuolumne River below Hetch Hetchy Reservoir, the SFPUC will manage releases from

Hetch Hetchy Reservoir during the spring to recharge groundwater in the riverside meadows in the Poopenaut Valley and streamside alluvial deposits. The goal of the release pattern will be to approximate conditions characteristic of most Sierra meadows, which are mainly wetlands or semi-wetlands supporting a cover of both emergent wetlands plants and upland vegetation (Ratliff, 1982), and which depend on precipitation and upslope flows to recharge the upper soil layers with water (Ratliff, 1985). The performance standard to be achieved by this measure is no net loss of the extent, diversity, and condition of the existing meadow and wetland vegetation types in the Poopenaut Valley.

The SFPUC will manage reservoir releases for this purpose by releasing the expected available volume of water in the reservoir in a pattern that provides flows of a magnitude that inundate the meadows and streamside alluvial deposits for as long as possible. For example, rather than making releases at a constant rate each day (e.g., releasing 1,000 cfs

for seven days), the SFPUC could release the same volume of water but with varying cfs rates, creating flow pulses to meet the objective.

As part of this measure the SFPUC will gather baseline data regarding the extent, species composition and condition of the existing meadow vegetation within the Poopenaut Valley. Some of these environmental baseline data may be available as a result of current study efforts in the Poopenaut Valley[5]. As needed, the SFPUC will augment this information by carrying out vegetation composition surveys in the meadow before implementing the WSIP and at 5 year intervals after WSIP implementation to assess the efficacy of mitigation releases in maintaining or improving the percentage cover of meadow species as described by Ratliff (1985). The basic methodology for baseline vegetation survey and subsequent mitigation monitoring will be generally accepted quantitative vegetation sampling methods to permit statistical comparison of vegetation composition over time, as well as mapping the meadow vegetation in the Poopenaut Valley. The SFPUC will retain the services of a qualified biologist to assist in shaping the releases from Hetch Hetchy Reservoir in consideration of baseline and future meadow vegetation data. If a significant decline in the extent or diversity of native meadow vegetation occurs, releases will be modified as needed to achieve the mitigating effect of sustaining the existing meadow communities.

Avoidance of Flow Changes by Reducing Demand for Don Pedro Reservoir Water

See **Measure 5.3.6-4a** in the Fisheries section, above. This measure also addresses impact 5.3.7-6 Impacts on biological resources along the Tuolumne River below La Grange. The SFPUC will attempt to implement Measure 5.3.6-4a as described above, which could mitigate both Impacts 5.3.6-4 and 5.3.7-6 to a less than significant level. Measure 5.3.6-4a involves some uncertainty because its implementation depends on the SFPUC negotiating and reaching agreement with MID/TID and possibly other water agencies. If Measure 5.3.6-4a proves to be infeasible, the SFPUC will implement Measure 5.3.6-4b to lessen fisheries impacts and Measure 5.3.7-6 to lessen impacts on riparian vegetation.

Lower Tuolumne River Riparian Habitat Enhancement

Measure 5.3.7-6: To mitigate the WSIP effects on riparian vegetation, the SFPUC will both protect and enhance one mile of riparian vegetation along the contemporary floodplain of the lower Tuolumne River. This will include funding the acquisition of fee title to or a conservation easement over riparian land totaling one mile (consisting of one or multiple sites) in order to permanently protect that land, and also funding riparian enhancement and on-going vegetation management to maintain the enhanced riparian values in perpetuity along one mile of river. The enhancement and management may be carried out along one river mile either on the land acquired by the SFPUC as described above or on land already under the permanent management of a public agency or conservation organization.

The SFPUC will implement this measure consistent with the Habitat Restoration Plan for the Lower Tuolumne River Corridor (McBain and Trush, 2000) and in coordination with the Tuolumne River Technical Advisory Committee. The SFPUC will also strive to

5 In 2006 the SFPUC, National Park Service (and USFWS) began a collaborative study effort in the Poopenaut Valley. The effort has led to geomorphology test releases in May 2006, fieldwork in the channel in 2006 and 2007 to examine sediment transport and deposition relationships with flow. Two transects with ten recording piezometers have been installed across the meadow to measure groundwater recharge and drainage patterns. Supplementary stream staff gages have been installed to allow manual readings during high flows. Surveys have been done of the meadow to define the topography and the location and elevation of the piezometers. Infiltration of water from the stream to the meadow soils will be monitored during high flows to develop a better understanding of groundwater dynamics in the meadow so that reservoir operations, flow pulses, and minimum streamflow releases can be managed to improve meadow conditions within the constraints of water supply and facility limitations.

implement these projects in partnership with those groups currently working to restore riparian floodplains on the lower Tuolumne River.

The SFPUC may implement riparian enhancement in accordance with site locations and plans already developed as part of the Habitat Restoration Plan for the Lower Tuolumne River Corridor or on other appropriate sites along the river. For sites that haven't already had plans developed, a riparian enhancement plan will be prepared for each. The plan shall include, but not be limited to, the following:

- Clearly stated objectives and goals consistent with the Habitat Restoration Plan for the Lower Tuolumne River Corridor (McBain and Trush, 2000).
- Location, size, and type of mitigation actions proposed.
- Documentation of performance and monitoring standards.
- Performance and monitoring standards shall indicate success criteria to be met within 5 years for vegetation, removal of exotic species, etc. Adaptive management standards shall include contingency measures that shall outline clear steps to be taken if and when it is determined, through monitoring or other means, that the enhancement or restoration techniques are not meeting success criteria.
- Documentation of the necessary long-term management and maintenance requirements, and provisions for sufficient funding.

Recreational and Visual Resources

System Measures

None required.

Energy Resources

System Measures

None required.

6.4.3 Alameda Creek Watershed Streams and Reservoirs

Stream Flow and Reservoir Water Levels

System Measures

Diversion Tunnel Operation

Measure 5.4.1-2: The SFPUC will establish and implement written operational criteria for the Alameda Creek Diversion Dam that directs that the diversion dam and tunnel shall be operated to pass flows down Alameda Creek when diversion of those flows is not required to maintain desired levels in Calaveras Reservoir in order to provide the maximum possible days of winter and spring flows in Alameda Creek below the diversion dam.

This measure reinforces the way the SFPUC generally operates the diversion tunnel now: that diversion gates are closed in the spring once desired Calaveras Reservoir storage have been reached. However, at times additional flows have been diverted from Alameda Creek after reservoir storage levels have been achieved such that the "excess" water has subsequently been released from the reservoir to maintain the appropriate water level. This measure would formalize Alameda Creek diversion procedures to maintain flows in Alameda Creek to the extent they are not needed to achieve required reservoir storage. This measure would reduce the flow reduction impact but not to a level that is less than significant.

Geomorphology

System Measures

None required.

Surface Water Quality

System Measures

None required.

Groundwater

System Measures

None required.

Fisheries

System Measures

Minimum Flows for Resident Trout on Alameda Creek

Measure 5.4.5-3a: The SFPUC shall develop and carry out as part of the implementation of the Calaveras Dam Replacement (SV-2) project, an operational plan to implement minimum bypass flows when precipitation generates runoff into the creek below the diversion dam to the Calaveras Creek confluence from December 1 through April 30 to support spawning and egg incubation for resident trout as well as breeding habitat for other native stream-dependent amphibians. This is the period when winter precipitation typically would produce flows for spawning and egg incubation and breeding habitat for other native stream-dependent species. The operational plan will identify the specific minimum flow requirements to support resident trout spawning and egg incubation, and a detailed monitoring plan to survey and document trout spawning and egg incubation and any diversion facility modifications that are needed to implement the minimum stream flows. This measure will be implemented in conjunction with the proposed bypass flows at the diversion dam to meet the 1997 CDFG MOU flow requirements.

Minimum flow requirements to support resident trout spawning and egg incubation vary depending on stream reach conditions. Although site-specific studies are needed to determine an appropriate minimum flow requirement for each specific creek reach, based on the general size and characteristics of the Alameda Creek channel immediately downstream of the diversion structure it has been suggested that a minimum flow on the

order of 10 cfs may be needed to support trout spawning and egg incubation. The SFPUC's Natural Resources Division will complete the site-specific studies needed to determine the appropriate minimum stream flow for this reach of the creek; studies may show that the minimum flow requirement is more or less than 10 cfs. This minimum flow requirement would be met when precipitation would naturally generate runoff in the creek (below the diversion dam) under unimpaired conditions between December 1 and April 30. When precipitation generates runoff in the creek, the SFPUC shall provide for bypass of flow up to the required minimum flow amount. The operational plan will allow for adapting minimum flow amounts to support resident trout spawning and egg incubation and other native stream-dependent species based on the monitoring results and best available scientific information.

The monitoring plan will be provided to appropriate resource agencies for review and comment and will subsequently be implemented by the SFPUC's Natural Resources Division staff. Monitoring results shall be provided to the resource agencies as requested. Monitoring shall occur for a minimum of five years and a maximum of ten years following completion of the Calaveras Dam Replacement project. At the completion of the monitoring period the SFPUC shall produce a draft comprehensive report describing the methods, data collected, and results used to assess the performance of the minimum streamflow in providing suitable habitat for resident trout spawning and egg incubation.

The Alameda Creek Fisheries Restoration Workgroup is currently overseeing collaborative studies to better characterize the flow-habitat relationships for trout spawning within Alameda Creek, and the SFPUC is providing staff and funding to support this effort. Information from these studies will also be used in developing the specific range of minimum stream flows needed to support suitable habitat within the reach below the diversion dam to the Calaveras Creek confluence.

This measure addresses two areas of impact to the resident trout fishery in Alameda Creek below the diversion dam. First, it addresses the decrease in flow below the diversion dam that would occur under the WSIP as a result of re-instituting flow diversions to Calaveras Reservoir once the dam is replaced (WSIP Project SV-2) and current DSOD storage capacity restrictions are removed. Second, it addresses the loss of fish from the lower creek system that would result from fish entrainment through the unscreened diversion tunnel to Calaveras Reservoir. Providing for minimum stream flows in Alameda Creek below the diversion dam, as required by the mitigation measure, would support resident trout spawning and egg incubation and it is expected that this measure would be sufficient to sustain the trout population in this reach of the creek. This would fully address/mitigate for both areas of WSIP impact to the resident trout fishery below the diversion dam. If monitoring indicates that this measure is adequate to sustain the resident trout population below the diversion dam, then no additional mitigation action would be required. If monitoring indicates that this measure does not sustain the resident trout fishery in this reach, then the SFPUC shall either modify the minimum stream flow to enhance downstream habitat conditions to fully meet the mitigation requirement or also implement Measure 5.4.5-3b Diversion Restrictions or Fish Screens.

Alameda Diversion Dam Diversion Restrictions or Fish Screens

Measure 5.4.5-3b: If, after 10 years of monitoring results for Measure 5.4.5-3a, Minimum Flows for Resident Trout in Alameda Creek, indicate that the measure does not sustain the resident trout population in Alameda Creek below the diversion dam, then the SFPUC shall also implement additional measures as follows: either implement seasonal restrictions on Alameda Creek diversions to Calaveras Reservoir to protect the downstream resident trout fishery during the critical spawning period (December 1 through April 30) or install and operate a fish passage barrier to "screen" the diversion facility (screening could consist of a behavioral barrier, such as electrical or sound barrier that deters fish, or a physical barrier – such as a screen facility).

SFPUC shall consult with the appropriate resource agencies, including CDFG, to first review the monitoring results for Measure 5.4.5-3a and determine the need for any further mitigation actions. If needed, SFPUC will consult with the appropriate resource agencies to develop appropriate seasonal restrictions on diversions. This could involve establishing a set annual time period for diversion restrictions or annual monitoring of fishery conditions that would then trigger implementation of diversion restrictions.

Alternatively, the SFPUC will implement a fish passage barrier if determined to be feasible. During the 10-year monitoring and evaluation period for Measure 5.4.5-3a, the SFPUC will evaluate the feasibility of installing and operating a fish passage barrier. The feasibility study will include an engineering evaluation of the existing site and diversion structure, access for construction and power supplies to the site, the application of various alternative designs, and identification of a preferred design if determined to be feasible. If it is determined that a fish passage barrier is needed to protect resident trout at the diversion structure then engineering design will be completed and be sufficiently detailed to allow permitting and completion of construction within a period of 24 months after the date that the additional mitigation is determined to be required.

Terrestrial Biological Resources

System Measures

Compensation for Impacts on Terrestrial Biological Resources

Measure 5.4.6-1: This measure mitigates for water supply and systemwide operation effects on resources within the Alameda Creek watershed. These impacts would occur primarily through operation of the Calaveras Dam Replacement project (SV-2).

The SFPUC will compensate for sensitive wetland, riparian and upland habitats and habitats which support key special-status species or other species of concern lost as a result of WSIP system operation. Similar habitat will be identified, protected, restored, enhanced, created and managed off-site[6] to ensure no net loss of habitat extent or function. A qualified biologist will quantify the magnitude and extent of impacts to wetlands, sensitive habitats, and key special-status species and other species of concern, and the SFPUC will develop and implement mitigation and compensation plans that meet the appropriate regulatory requirements and permit conditions with respect to compensation ratios, other

6 Off-site means the compensatory action is located other than within the project construction footprint, but could be on lands already under SFPUC ownership. Measure 4.6-2 addresses compensatory actions to be taken within the construction footprint.

conservation measures and management requirements to mitigate project impacts to less than significant levels.

The SFPUC will obtain required permits and comply with applicable environmental regulations addressing sensitive habitats and species. Compensatory lands—including those restored or enhanced as well as those acquired or designated as protected as part of program mitigation--will be established in perpetuity with a commitment that such lands will not be used for any purpose that conflicts with the primary purpose of maintaining intact wildlife and plant habitat.

One alternative for implementing such habitat compensation is the Habitat Reserve Program (HRP) currently being developed by the SFPUC. The purpose of the HRP is to provide a comprehensive, coordinated approach to mitigation and related regulatory compliance for WSIP projects and operations. This related SFPUC project is described further in Chapter 3.0, Section 3.12.3. Under the proposed HRP, the SFPUC would proceed as soon as possible with identifying, securing (through designation, management agreement, conservation easement, or acquisition of fee title) and improving lands to be used for habitat compensation so that mitigation is underway concurrent with habitat loss related to WSIP program activities, further ensuring no net loss of resources. The proposed HRP is scheduled for CEQA environmental review in 2007 and is targeted for implementation as soon as possible thereafter. Once the HRP is approved and implemented, the SFPUC will use this as one vehicle or method for implementing the mitigation requirements for individual WSIP projects. Otherwise, where appropriate and necessary, the SFPUC will develop and implement appropriate habitat compensation mitigation for individual WSIP projects and their associated operational impacts.

Operational Procedures for Calaveras Dam Releases

Measure 5.4.6-3: During project-level CEQA review on the Calaveras Dam Replacement project (SV-2), the SFPUC will develop operational procedures for managing planned releases from Calaveras Dam to minimize habitat impacts on amphibians, their egg masses, and tadpoles. The goal of such releases, apart from benefits to fish, is to mimic a more natural pattern of hydrology regime as much as possible. The procedures will specify the minimum amount and frequency of planned releases and the rate of the increase and decrease of any individual release event. One of the specific goals of such releases would be to reduce the risk of mortality to breeding amphibians. Such operational procedures will be developed prior to completion of construction of the Calaveras Dam Replacement project. In addition, instream flow releases required under CDFG agreement with SFPUC (see Table 5.4.1-9) would begin upon completion of construction.

Recreational and Visual Resources

System Measures

None required.

6.4.4 San Francisco Peninsula Streams and Reservoirs

Stream Flow and Reservoir Water Levels

System Measures

None identified.

Geomorphology

System Measures

None required.

Surface Water Quality

System Measures

Low-head Pumping Station at Pilarcitos Reservoir

Measure 5.5.3-2a: The SFPUC shall install a permanent low-head pumping station at Pilarcitos Reservoir which would enable the SFPUC to access and use an additional 350 acre-feet of water from Pilarcitos Reservoir. In years when the WSIP would cause releases from Pilarcitos Reservoir to Pilarcitos Creek to be reduced to reservoir inflow earlier in the summer than under the existing condition (about 25 percent of years in the hydrologic record), the SFPUC will use the pumping station to augment flow in Pilarcitos Creek with water from the reservoir. The pumping station will draw water from the cool pool of water below the thermocline during times when the reservoir is stratified. The pumping station outlet will be designed to ensure that water discharged to the creek is adequately aerated.

Aeration System at Pilarcitos Reservoir

Measure 5.5.3-2b: The SFPUC shall install a permanent aeration system at Pilarcitos Reservoir. The SFPUC will operate the aeration system as necessary to avoid anoxic conditions and maintain good water quality conditions at the reservoir.

Groundwater

System Measures

None required.

Fisheries

System Measures

Create New Spawning Habitat Above Crystal Springs Reservoir

Measure 5.5.5-1: The SFPUC will survey the extent and quality of fish spawning habitat that could potentially be lost due to inundation and, if feasible, create new spawning habitat at a higher elevations. The specifics of this mitigation measure will be determined as part of project-level CEQA review for the Lower Crystal Springs Dam Improvements project (PN-4).

Establish Flow Criteria, Monitor and Augment Flow

Measure 5.5.5-5: The SFPUC shall develop a monitoring and operations plan for Stone Dam to ensure WSIP-related flow reductions downstream of Stone Dam do not impair steelhead passage and spawning during the winter months of normal and wetter hydrologic years. This operational plan will provide for minimum stream flows to support existing adult steelhead passage and spawning downstream of Stone Dam, in the reach between Stone Dam and the confluence with the tributary at Albert Canyon, approximately 3.5 miles downstream. Downstream of Albert Canyon, WSIP flow reductions are unlikely to cause a significant impact to steelhead migration and spawning due to contributing flows from numerous downstream tributaries being sufficient to maintain adult upstream passage and spawning conditions within the creek. Monitoring and implementation of the operational plan will occur when precipitation generates runoff into Pilarcitos Creek below Stone Dam from December 1 through April 30 of normal and wetter years. This monitoring and operations plan will be established within five years of the approval of the PEIR.

Specific instream flows needed to support anadromous steelhead downstream of Stone Dam have not yet been identified. Suitable instream flows for steelhead passage on Pilarcitos Creek may be defined as providing a water depth of at least 0.6 feet over 25 percent of the total wetted channel cross-sectional area with 10 percent being contiguous. In cooperation with CDFG and NMFS, the SFPUC will identify up to five critical riffles, downstream of Stone Dam and upstream of Albert Canyon that may cause a passage impediment/barrier to steelhead migration at reduced flows as defined by the water depth criterion above. Such habitat types will be selected for survey because they represent the shallowest habitat type and thus would most likely represent low flow passage barriers under WSIP-related reduced flow scenarios. This monitoring plan will survey and document the critical riffles identified to determine physical conditions (e.g., depth, velocity, and top width of the channel) present at various flow levels. The SFPUC will measure the stage-discharge relationship at each of the five critical riffles and identify the minimum stream flow that meets the steelhead passage criterion at the most restrictive of the five riffle locations.

The SFPUC will calibrate and validate the flow measurements made at the existing flow monitoring gage (USGS Gage 11162620) located immediately downstream of Stone Dam. The SFPUC will then develop a statistical relationship between the flow measurements at the existing gage and the flow at the most restrictive critical riffle downstream of Stone Dam to establish minimum average daily flows necessary to meet steelhead passage criterion. The SFPUC will monitor average daily flows at the stream flow gage during the period from December 1 through April 30 each year. If average daily flow, as measured at the gage, indicates that the minimum stream flow at the downstream critical riffle is not met, the SFPUC will release bypass flows from Stone Dam at a rate sufficient to meet the minimum stream flow for steelhead passage at a release rate up to, but not exceeding, the average daily inflow into Pilarcitos Reservoir as determined by SFPUC operators.

The SFPUC's Natural Resources Division will complete the site-specific studies needed to determine the appropriate minimum stream flow for the most restrictive critical riffle identified during monitoring. This minimum flow criterion will be met when WSIP diversions occur between December 1 and April 30 of normal and wetter hydrologic years. The operational plan will allow for adapting minimum flow amounts to support steelhead migration based on the monitoring results and best available scientific information.

Monitoring and flow management will be continued for a minimum period of five years and a maximum period of ten years, at which time the SFPUC will prepare a technical report describing results of the stream flow monitoring, identifying whether or not operation of Stone Dam reduced passage flows below the minimum criteria, and identifying, if needed, an appropriate bypass flow for future operations at Stone Dam (a minimum flow below which water could not be diverted to storage between December and April 30). The technical report will be provided to CDFG and NMFS.

Terrestrial Biological Resources

System Measures

Habitat Monitoring and Compensation

Measure 5.5.3-2c The SFPUC shall compensate for reduced productivity and diversity of San Francisco garter snake (SFGS) and California red-legged frog (CRLF) wetland habitat which could occur as a result of greater variability, extent and duration in drawdowns at Pilarcitos Reservoir as a result of implementation of Revised Measure 5.5.3-2a (Low-head Pumping Station at Pilarcitos Reservoir). To offset the potential loss of habitat quality, the SFPUC will develop an adaptive management plan for managing and maintaining freshwater marsh and other wetlands around the periphery of Pilarcitos Reservoir. This adaptive management plan would include pre- implementation monitoring and post-implementation monitoring for up to 10 years to ensure that habitat is sustained at Pilarcitos Reservoir, to achieve no net loss of habitat and value for SFGS and CRLF habitat and document changes (if any) in extent or quality of the habitat attributable to operation of the low-head pumping station.

In the event that habitat is reduced, one alternative for implementing such habitat compensation is the Habitat Reserve Program (HRP) currently being developed by the SFPUC. The purpose of the HRP is to provide a comprehensive, coordinated approach to mitigation and related regulatory compliance for WSIP projects and operations. The HRP is described further in the PEIR, Chapter 3.0, Section 3.12.3. Under the proposed HRP, the SFPUC would proceed as soon as possible with identifying, securing (through designation, management agreement, conservation easement, or acquisition of fee title) and improving lands to be used for habitat compensation so that mitigation is underway concurrent with habitat loss related to WSIP program activities, further ensuring no net loss of resources. The proposed HRP is undergoing CEQA environmental review in 2008 and 2009 and is targeted for implementation as soon as possible thereafter. Once the HRP is approved and implemented, the SFPUC will use this as one vehicle or method for implementing the mitigation requirements for WSIP-related activities. Otherwise, where appropriate and necessary, the SFPUC will develop and implement appropriate habitat compensation mitigation for WSIP system operational effects on Pilarcitos Reservoir, independent of the HRP.

Adaptive Management of Freshwater Marsh and Wetlands at Upper and Lower Crystal Springs Reservoirs

Measure 5.5.6-1a: To offset the loss of wetlands, a qualified professional will develop an adaptive management plan for managing and maintaining freshwater marsh and other wetlands around the periphery of Upper Crystal Springs, and Lower Crystal Springs Reservoirs. This adaptive management plan may include the following:

- Gradually raise the reservoir elevations at appropriate times of year to maintain continuous freshwater marsh and riparian habitat along the shorelines to reduce potentially adverse effects to San Francisco garter snakes and California red-legged frogs.

- Identify feasible measures to help to moderate the effects of reservoir drawdown, increase the extent of reservoir margins with the potential to support freshwater

marsh vegetation, and investigate the effectiveness for the management and control of predatory aquatic species such as largemouth bass and bullfrogs.

- Perform monitoring and review to ensure that habitat is sustained at Upper and Lower Crystal Springs Reservoirs and elsewhere, as appropriate, to achieve no net loss of habitat and value for freshwater marsh, wetlands, and special-status species.

- Observe all appropriate protective measures to avoid "take" of San Francisco garter snake. In the event that the mitigation measures above cannot be followed, the SFPUC will prepare a sensitive species relocation plan, which would be approved by both the CDFG and USFWS. Such a plan would detail how underground refugia would be excavated, identify suitable relocation areas, etc.

Compensation for Impacts on Terrestrial Biological Resources

Measure 5.5.6-1b: This measure mitigates for water supply and systemwide operation effects on resources within the Peninsula watershed. These impacts would occur primarily through operation of the Upper and Lower Crystal Springs Reservoir facilitated by the Crystal Springs Dam Improvements project (PN-9).

The SFPUC will compensate for sensitive wetland, riparian and upland habitats and habitats which support key special-status species or other species of concern lost as a result of WSIP system operation. Similar habitat will be identified, protected, restored, enhanced, created and managed off-site[7] to ensure no net loss of habitat extent or function. Similarly, in the event of the loss of large, mature oaks and oak woodland, creation and/or restoration of oak woodland elsewhere will be implemented to compensate for the loss of these common upland habitats. A qualified biologist will quantify the magnitude and extent of impacts to wetlands, sensitive habitats, other upland habitats, and key special-status species and other species of concern, and the SFPUC will develop and implement mitigation and compensation plans that meet the appropriate regulatory requirements and permit

[7] Off-site means the compensatory action is located other than within the project construction footprint, but could be on lands already under SFPUC ownership. Measure 4.6-2 addresses compensatory actions to be taken within the construction footprint.

conditions with respect to compensation ratios, other conservation measures and management requirements to mitigate project impacts to less than significant levels.

The SFPUC will obtain required permits and comply with applicable environmental regulations addressing sensitive habitats and species. Compensatory lands—including those restored or enhanced as well as those acquired or designated as protected as part of program mitigation--will be established in perpetuity with a commitment that such lands will not be used for any purpose that conflicts with the primary purpose of maintaining intact wildlife and plant habitat.

One alternative for implementing such habitat compensation is a Habitat Reserve Program (HRP) currently being developed by the SFPUC. The purpose of the HRP is to provide a comprehensive, coordinated approach to mitigation and related regulatory compliance for WSIP projects and operations. This related SFPUC project is described further in Chapter 3.0, Section 3.11. Under the proposed HRP, the SFPUC would proceed as soon as possible with identifying, securing (through designation, management agreement, conservation easement, or acquisition of fee title) and improving lands to be used for habitat compensation so that mitigation is underway concurrent with habitat loss related to WSIP program activities, further ensuring no net loss of resources. The proposed HRP is scheduled for CEQA environmental review in 2007 and targeted for implementation as soon as possible thereafter. Once the HRP is approved and implemented, the SFPUC will use this as one vehicle or method for implementing the mitigation requirements for individual WSIP projects. Otherwise, where appropriate and necessary, the SFPUC will develop and implement appropriate habitat compensation mitigation for individual WSIP projects and operational effects.

Compensation for Serpentine Seep-Related Special Status Plants

Measure 5.5.6-1c: The SFPUC will develop and implement a plan to protect, create, and restore habitat for plant species adapted to serpentine seeps, particularly fountain thistle, around Upper and Lower Crystal Springs Reservoirs. The plan will also include control of pampas grass and any other invasive plant species within the serpentine seep habitat.

Recreational and Visual Resources

System Measures

None required.

6.4.5 Westside Groundwater Basin Resources

System Measures

Groundwater Monitoring to Determine Basin Safe Yield

Measure 5.6-1: The SFPUC will continue ongoing studies, including the existing groundwater and lake level monitoring programs, to determine the safe yield of the North Westside Groundwater Basin in order to avoid overdraft and associated effects including adverse effects on surface water features and seawater intrusion. Using this data, the SFPUC will develop and implement a plan identifying appropriate pumping patterns to avoid overdraft and the undesirable effects associated with overdraft. The plan will

establish both a regular (average annual) and an intermittent (dry year or emergency) yield as well as a strategy for modifying pumping patterns such that the pumping levels can be sustained as an ongoing reliable water supply without depletion of groundwater storage or degradation of water quality.

Implementation of a Lake Level Management Plan

Measure 5.6-2: The SFPUC will develop and implement a lake level management plan identifying strategies for altering pumping patterns or lake augmentation to maintain Lake Merced water levels within the desired long-term range should monitoring conducted under Measure 5.6-1 indicate the potential for adverse effects on lake levels due to groundwater pumping. The SFPUC will coordinate the implementation of this measure with Measure 5.6-1.

Drinking Water Source Assessments for Groundwater Wells

Measure 5.6-5: As required by the California Department of Health Services and incorporated as part of the WSIP, the SFPUC will prepare drinking water source assessments for groundwater wells constructed under the Local and Regional Groundwater Projects (SF-2) and will update these assessments every five years. If the assessment indicates no potential for contamination, then no mitigation is required. However, for wells that are considered vulnerable to contamination on the basis of the drinking water source assessment, the SFPUC will develop and implement a source water protection program specifying actions and a program to be implemented to prevent contamination of the drinking water source.

The source water protection program could include nonregulatory components such as watershed restoration, stormwater monitoring, groundwater monitoring, and public education to protect drinking water quality. Land use planning, permitting, and possibly more restrictive regulatory methods may also be implemented by the local municipality where a threat to drinking water quality is indicated, and management of potential sources of microbiological or direct chemical contamination to eliminate or reduce the risk of contamination of the water supply may be considered. The SFPUC will encourage public participation in the development of the program and will update the program every five years along with the drinking water source assessments.

6.4.6 Cumulative Projects and Impacts Related to WSIP Water Supply and System Operations

System Measures

None required.

6.5 Impacts of Mitigation Measures

CEQA Section 15126.4 states that "if a mitigation measure would cause one or more significant effect in addition to those that would be caused by the project as proposed, the effects of the mitigation measure shall be discussed but in less detail than the significant effects of the project as proposed." This section identifies which mitigation measures described in Sections 6.3 and 6.4 above may result in significant effects independent of the identified WSIP impacts, and describes the general nature of those effects. This discussion includes the following categories of mitigation measures:

- Measures that would involve designated long-term use of lands for mitigation purposes. This includes mitigation measures requiring habitat compensation through creation, restoration, and enhancement of habitat as well as permanent set-aside for farmlands
- Measures that would involve construction or operation in sensitive habitats
- Measures that would affect SFPUC regional system water supply sources, potentially reducing overall supply available for customers. This includes mitigation measures requiring increased streamflow releases from storage reservoirs, reduced diversions to storage reservoirs, or reduced groundwater pumping.
- Measures that would involve water transfers from other agencies, with potential to affect other water sources and associated resources or other water users.

Prior to implementation of these types of measures, project-level CEQA review would be conducted as necessary to identify if and what impacts would be associated with these measures in and of themselves. Even though the objective of these measures is to reduce environmental impacts, additional mitigation actions may be necessary during the construction and/or operation of these measures depending on the specific design and location. However, the mitigation measures described in this section and the associated CEQA review are not integral to the approval and adoption of the overall WSIP as a comprehensive program and policy. In some cases, CEQA review of these measures may be incorporated as part of the subsequent project-level environmental review of individual facility improvement projects, while in other cases, as described above for those measures, the measures are optional approaches to avoiding or reducing significant impacts and the SFPUC may elect to implement the alternative approach such that CEQA review would be superfluous.

6.5.1 Measures that Designate Land for Mitigation Purposes

Depending on the actual design of the measure, the following PEIR mitigation measures could be in this category: Measure 4.6-1b (Compensation for Wetlands and Other Biological Resources); Measure 4.13-2 (Siting Facilities to Avoid Prime Farmland); Measure 4.16-4a (Bioregional Habitat Restoration Measures); Measure 5.3.7-6 (Lower Tuolumne River Riparian Habitat Enhancement); Measure 5.4.6-1 (Compensation for Impacts on Terrestrial Biological Resources); Measure 5.5.6-1b (Compensation for Impacts on Terrestrial Biological Resources); and Measure 5.5.6-1c (Compensation for Serpentine Seep-Related Special Status Plants). In

general, the types of potential impacts associated with long-term designation of lands for mitigation purposes include:

- *Land use*: change existing character of the land; result in short-term disruption to nearby land uses during construction; and displace existing land uses (similar to Impacts 4.3-1 and 4.3-2, which could be mitigated through siting measures similar to Measure 4.3-2). In particular, habitat compensation could affect existing agricultural uses (similar to Impact 4.13-2, which could be mitigated through measures similar to Measure 4.13-2, avoidance of Prime Farmland)

- *Biological resources*: convert existing habitat types to other types, although habitat compensation would be expected to result in long-term benefit to biological resources; result in short-term disruption to existing biological resources during construction (similar to Impact 4.6-2, which could be mitigated through habitat protection/restoration measures similar to Measure 4.6-2, including construction timing restrictions to avoid impacts on sensitive species)

- *Geology*: change the topography or physical features of a site (which could be mitigated through standard engineering and design measures to avoid substantial changes to unique geologic or physical features)

- *Water quality and hydrology*: alter drainage patterns due to changes in grading and vegetation; result in erosion and sedimentation during construction (similar to Impacts 4.5-1 and 4.5-6, which could be mitigated through standard construction measures for erosion and sedimentation control as well as through compliance with water quality regulations)

- *Traffic, air quality, noise*: temporary construction impacts related to increased truck traffic on local streets, increased dust, and construction noise (similar to Impacts 4.8-1, 4.8-2, 4.8-3, 4.9-1, 4.9-2, 4.10-1 and 4.10-2, which could be mitigated through standard construction measures, compliance with air quality regulations, and traffic, dust and noise control measures similar to Measures 4.8-1a, 4.9-1a, 4.9-1b, 4.9-1c, 4.9-1c, 4.9-1d, 4.10-1a, 4.10-2a, and 4.10-2b)

- *Agricultural resources*: convert prime farmland to non-agricultural uses (similar to Impact 4.13-2, which could be mitigated through measures similar to Measure 4.13-2, avoidance with Prime Farmland); conflict with existing zoning for agricultural uses

As indicated above, standard mitigation approaches are available, and implementation of those measures as well as any applicable water quality or biological resource permit conditions could reduce these impacts to less than significant.

6.5.2 Measures that Involve Sensitive Habitats or Cultural Resources

Depending on the actual design of the measure, the following PEIR mitigation measures could be in this category: Measure 5.3.6-4b (Fishery Habitat Enhancement Projects); Measure 5.3.7-6 (Lower Tuolumne River Riparian Habitat Enhancement); Measure 5.4.5-3a (Minimum Flows for Resident Trout on Alameda Creek, which would requiring modifying the Alameda Creek Diversion Dam to allow bypass flows); Measure 5.4.5-3b (Alameda Diversion Dam Diversion Restrictions or Fish Screens, but only the fish passage barrier or screening option); and

Measure 5.5.5-1 (Create New Spawning Habitat Above Crystal Springs Reservoir). In general, the types of potential impacts associated with measures that involve construction or operation in sensitive habitats include:

- *Biological resources*: convert existing habitat types to other types, although habitat compensation would be expected to result in long-term benefit to biological resources; result in short-term disruption to existing biological resources during construction (similar to Impacts 4.6-1 and 4.6-2, which could be mitigated through habitat protection/restoration measures similar to Measures 4.6-1a, 4.6-1b, and 4.6-2, including construction timing restrictions to avoid impacts on sensitive species)

- *Cultural resources*: alteration of existing structures with potential historic significance such as the Alameda Creek Diversion Dam (similar to Impact 4.7-4 which could be mitigated through historic protection and documentation measures similar to Measures 4.7-4a, 4.7-4b, 4.7-4c, 4.7-4d, and 4.7-4e) or the accidental discovery of cultural resources (similar to Impacts 4.7-1 and 4.7-2, which could be mitigated through paleontological and archaeological measures similar to Measures 4.7-1, 4.7-2a, and 4.7-2b)

- *Geology*: change the topography or physical features of a site (which could be mitigated through standard engineering and design measures to avoid substantial changes to unique geologic or physical features)

- *Water quality and hydrology*: alter drainage patterns due to changes in grading and vegetation; result in erosion and sedimentation during construction; place structures within a 100-year flood hazard area (similar to Impacts 4.5-1 and 4.5-6, which could be mitigated through standard construction measures for erosion and sedimentation control and implementation of water quality and flood protection measures required under applicable permit conditions)

- *Traffic, air quality, noise*: temporary construction impacts related to increased truck traffic on local streets, increased dust, and construction noise (similar to Impacts 4.8-1, 4.8-2, 4.8-3, 4.9-1, 4.9-2, 4.10-1 and 4.10-2, which could be mitigated through standard construction measures, compliance with air quality regulations, and traffic, dust and noise control measures similar to Measures 4.8-1a, 4.9-1a, 4.9-1b, 4.9-1c, 4.9-1c, 4.9-1d, 4.10-1a, 4.10-2a, and 4.10-2b)

As indicated above, standard mitigation approaches are available, and implementation of those measures as well as any applicable water quality or biological resource permit conditions could reduce these impacts to less than significant.

6.5.3 Measures that Affect SFPUC Supply Sources

The following PEIR mitigation measures would be in this category: Measure 5.4.5-3a (Minimum Flows for Resident Trout on Alameda Creek); Measure 5.4.6-3 (Operational Procedures for Calaveras Dam Releases); Measure 5.5.3-2 (Revised Operations Plan for Pilarcitos Watershed Facilities); Measure 5.6-1 (Groundwater Monitoring to Determine Basin Safe Yield); and Measure 5.6-2 (Implementation of Lake Level Management Plan). These measures could have the effect of reducing available local water supply sources needed to meet customer demands and to achieve WSIP goals, objectives, and levels of service. Measures 5.4.5-3a and 5.4.6-3 could reduce storage in Calaveras Reservoir; Measure 5.5.3-2 would limit use of Pilarcitos watershed

supplies to current levels and, in turn, may require additional supply from other regional system sources; and Measure 5.6-1 could result in reduced levels of groundwater pumping from the North Westside Groundwater Basin. Depending on the magnitude of these measures, the SFPUC may need to increase use of other water supply sources in order to serve the 300 mgd average annual customer purchase requests in 2030 and to meet the water supply level of service performance objectives of the WSIP.

One possibility could be increased use of water supplies from Hetch Hetchy Reservoir, resulting in potential impacts on the Tuolumne River similar to those discussed in Chapter 5 and Chapter 8 (under Variant 1, All Tuolumne). Other possible alternative water sources and their potential impacts are discussed in Chapters 8 and 9. These include potable water from desalination, increased levels of conservation and water recycling, or other water sources. However, at this time, the timing as well as the magnitude of the potential effects of these measures are unknown, and the actual impact on other SFPUC supply sources could be less than significant if the change is within the typical inter-annual variation of SFPUC customer water deliveries. Other intervening factors, such as results of groundwater monitoring under Measure 5.6-1 or the planned Habitat Conservation Plan for fish in Alameda Creek, could reduce the estimated severity of the potential impacts and obviate or override the need for these measures.

6.5.4 Measures that Affect Other Water Sources

The following PEIR mitigation measure would be in this category: Measure 5.3.6-4a (Avoidance of Flow Changes by Reducing Demand for Don Pedro Reservoir Water). At this time, it is unknown what sources of water or water users could be affected by a water transfer arrangement with TID, MID, or other agency or agencies that involves use only of conserved water. Supplemental water could be made available as a result of:

- Water use efficiency and conservation for agricultural, residential and commercial users
- Land use changes, either agricultural to urban, or more water intensive (e.g., pasture) to less intensive (e.g., orchard)
- Conjunctive use of groundwater
- Recycled water
- Tiered water pricing
- Land fallowing of agricultural lands.

In general, the types of potential environmental impacts associated with water transfers from these types of sources include:

- *Land use*: reduced agricultural activity (similar or related to Impact 4.3-2 which could be mitigated through siting measures similar to Measure 4.3-2)
- *Biological resources*: indirect effects on aquatic and/or terrestrial biological resources due to possible reductions in irrigation/drainage system return flows, reductions in discharges

of treated wastewater, changes in land use from more water intensive uses to less water intensive uses, or lowered groundwater tables (similar to Impacts 4.6-1, 4.6-2, 4.6-3, and 4.6-4 which could be mitigated through habitat protection/restoration measures similar to Measures 4.6-1a, 4.6-1b, 4.6-2, 4.6-3a, 4.6-3b, and 4.6-4)

- *Water quality and hydrology*: reduced groundwater recharge due to agricultural water conservation practices such as lining irrigation canals or conversion to drip irrigation, or land use changes (similar to Impact 4.5-2 which could be mitigated through groundwater protection measures similar to Measure 4.5-2)

- *Agricultural resources*: reduced agricultural activity due to farming; potential conversion of idle agricultural land to other uses (similar to Impact 4.13-2, which could be mitigated through measures similar to Measure 4.13-2, avoidance of Prime Farmland)

- *Noise*: increased noise from use of pumps for conjunctive-use groundwater program (similar to Impact 4.10-4, which could be mitigated through standard construction measures for noise controls)

- *Energy*: increased use of energy for conjunctive-use groundwater or recycled water programs (similar to Impact 4.15-2 for the Groundwater Projects, SF-2) and Recycled Water Projects, SF-3, which could be mitigated through energy efficiency measures similar to Measure 4.15-2)

- *Air Quality*: increased particulate emissions from on-farm efficiency measures like land leveling (which could be mitigated through standard dust control measures similar to those listed in Measure 4.9-1a)

As indicated above, standard mitigation approaches are available, and implementation of those measures as well as any applicable water quality or biological resource permit conditions could reduce these impacts to less than significant.

6.6 Summary Tables of All Impacts and Mitigation Measures

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FINAL

Feasibility Study for Developing an Alternative Water Supply for Golf Course Irrigation

22 December 2010

Prepared for

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Section 1: Purpose and Background

1.1 Purpose

This report presents the results of a conceptual-level feasibility analysis for developing an alternative water supply for golf course irrigation at Menlo Country Club (Menlo CC). Three water supply alternatives were evaluated for the study, including:

1. Local groundwater from onsite or offsite wells;
2. Recycled water from the City of Redwood City (Redwood City) system; and
3. Recycled water from a new onsite satellite treatment facility.

The objective of the study is to identify which of these alternatives are most feasible, and what the appropriate next steps would be to move forward with one or more potentially feasible alternatives. The study participants include Menlo CC and the San Francisco Public Utility Commission (SFPUC).

1.2 Background

The use of potable water for irrigation at Menlo CC has become increasingly expensive. The cost is approaching $350,000 annually and is projected to increase further in the coming years. In addition to cost increases, the level of reliability during droughts could become an issue, as the Menlo CC may be subject to irrigation water rationing or reductions during certain drought conditions.

Currently, Menlo CC receives water from two retail providers. Domestic water is supplied from CalWater, and irrigation water is supplied by the SFPUC. Historically, the SFPUC met the majority of its water demands through the Regional Water System[1]. In 2008, the SFPUC adopted the Phased Water System Improvement Program Variant (Phased WSIP Variant). The Phased WSIP Variant requires that the SFPUC limit surface water sales from the Regional Water System watersheds to an average of 265 million gallons per day (MGD) to meet the combined demands of San Francisco (retail) and other (wholesale) SFPUC customers through 2018. Based on that decision, the SFPUC agreed to limit supplies from the Regional Water System watersheds to serve retail customers, including Menlo CC, to a total of 81 MGD through 2018.

To diversify the water supply portfolio and meet the needs of the Phased WSIP Variant, the SFPUC is developing new local water supplies. The SFPUC's diversification efforts include water conservation, groundwater and recycled water to appropriately meet customers' needs. In

[1] The entire SFPUC water system, including all facilities serving the SFPUC wholesale and retail customers, except for the retail customers in San Francisco. The SFPUC Regional Water System consists of a complex network of facilities covering a geographic range of about 160 miles, from Hetch Hetchy Reservoir in the Sierra Nevada on the east to San Francisco on the west. The regional water system crosses seven counties—Tuolumne, Stanislaus, San Joaquin, Alameda, Santa Clara, San Mateo, and San Francisco. The regional water system includes over 280 miles of pipelines, over 60 miles of tunnels, 11 reservoirs, 5 pump stations, and 2 water treatment plants

recent years, the SFPUC has helped develop projects that reduce potable water demands for non-potable applications, such as irrigation.

Redwood City is the water and recycled water purveyor within its city limits. Menlo CC is located adjacent to the Redwood City boundary within the City of Woodside. Redwood City recently completed its $72.4M Phase 1 Recycled Water Project that includes treatment, storage, pumping and pipeline facilities serving a variety of customer sites. Recycled water is used primarily for landscape and turf irrigation at night at these sites, although some commercial and industrial uses occur during the day.

Recycled water is produced at the South Bayside System Authority (SBSA) Wastewater Treatment Facility in the Redwood Shores area. SBSA produces Disinfected Tertiary Recycled Water suitable for "unrestricted use" under Title 22 of the California Code of Regulations (CCR). This is the highest classification of recycled water under this regulation, and it may be used for golf course irrigation and for storage in onsite impoundments at golf courses with unrestricted public access.

SBSA is a Joint Powers Authority (JPA) between the Redwood City, Belmont, San Carlos and West Bay Sanitary District. Redwood City was the lead agency in developing and implementing a recycled water project, and paid for all of the treatment, storage, pumping, and pipeline facilities and customer site retrofits. The Final Environmental Impact Report for a city-wide Recycled Water Project includes serving up to 3,238 acre-feet per year (af/yr) (2.9 MGD), Average Annual Demand[2], to existing and future Redwood City customers.

SBSA and Redwood City have a separate agreement for the Phase 1 Recycled Water Project. Under the terms of this agreement, SBSA operates the tertiary treatment and disinfection facilities and is responsible for providing recycled water that meets Title 22 regulatory requirements for unrestricted use at the point where recycled water flows over the weir from the chlorine contact tank into the storage facility. Redwood City owns and operates the storage and pumping facilities that are located on SBSA's site, and a recycled water distribution system consisting of over 40,000 linear feet (lf) of pipelines constructed in city streets. Redwood City currently is serving recycled water to customers in the Redwood Shores area and the Seaport Industrial area, located on the east side of Highway 101 along the San Francisco Bay. The pipelines from SBSA's site, through the Redwood Shores area to Highway 101 and along Highway 101 to the Seaport Industrial area, have been oversized in anticipation of a future system expansion to serve customers in the central areas of Redwood City on the west side of Highway 101 and/or to deliver recycled water to neighboring communities as part of a possible regional system. Additional details of the Redwood City Recycled Water Project are included in Section 4.1. Figure 1 illustrates the existing Redwood City Recycled Water Project.

[2] Throughout this Study, Average Annual Demand is listed in acre-feet per year (af/yr), with the equivalent in million gallons per day (MGD) listed in parenthesis. The Average Annual Demand listed in MGD is the amount of recycled water used annually, averaged over 365 days, and should not be confused with peak project capacity.

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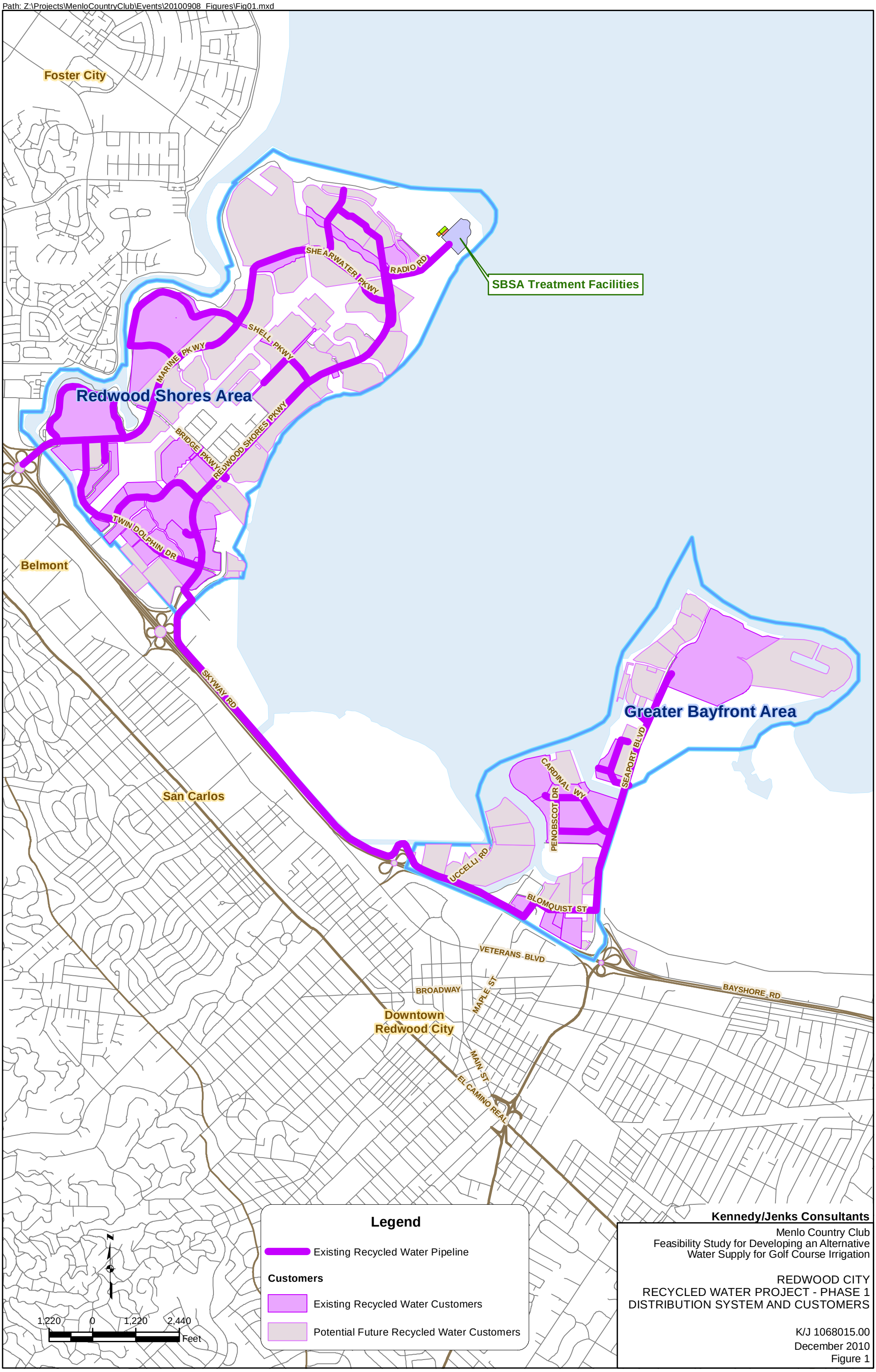


Section 2: Irrigation Demand

This section summarizes the methodologies used to establish the average and peak irrigation demands at Menlo CC.

2.1 Methodology

2.1.1 Data Collection and Review

The consultant team met with the Golf Course Superintendent, Scott Lewis, to discuss the current irrigation strategy and to obtain water meter records, local ETo data, and soil test reports. Menlo CC maintains billing records of water usage and operates its own weather station that records evapotranspiration (ETo) rates. This information is used by the operating staff to set watering schedules for the golf course. According to Menlo CC, irrigation demands are not expected to change significantly in the future, even if the golf course is improved (for example, relocating Hole #12) or completely redeveloped. Therefore, the historical water use is considered a good estimate for this conceptual level feasibility analysis. The potential impact of climate change is not considered.

Menlo CC provided 23 years of monthly water bills from 1987 to 2009, which were reviewed and analyzed to determine the following water use patterns:

- Long-term average annual use,
- Long-term average monthly use, and
- Annual and monthly use in wet and dry weather years.

These use patterns are illustrated on bar charts provided in Appendix A.

2.1.2 Irrigation Demand Estimates

Average and peak irrigation demands were developed using two methodologies. First, site-specific meter and ETo data were reviewed and this information was compared to a theoretical approach using general site information:

1. Meter Record Methodology: Meter data and ETo data from the onsite weather station were used to estimate irrigation demands.
2. Theoretical ETo Methodology: Theoretical irrigation demands were estimated using the estimated irrigated area at Menlo CC, average monthly ETo data obtained from the California Irrigation Management Information System (CIMIS), and precipitation data obtained from the Western Regional Climate Center.

The following demands were developed using the two methods and are summarized in Table 1.

a. **Average Annual Demand (AAD)** –Annual irrigation demand during a year with average climate conditions is typically measured in units of acre-feet per year (af/yr) and/or millions of gallons per day (MGD). To the SFPUC, the AAD represents the potential water supply benefit of converting Menlo CC from the potable supply to an alternative water supply.

b. **Average Month Demand (AMD)** – Average monthly irrigation demand over the months when irrigation occurs

c. **Average Day Demand (ADD)** – Average demand for all the days of the irrigating months

d. **Peak Month Demand (PMD)** – Peak monthly irrigation demand during a year with dry climate conditions.

e. **Peak Month, Average Day Demand (PMAD)** – Average daily demand during the peak month.

f. **Peak Day Demand (PDD)** – Largest demand that would need to be provided for irrigation over any 24-hour period. The PDD is used to size two facility components in this evaluation: the daily supply capacity of the alternative water source under consideration and the onsite storage requirement. Onsite storage volume depends on the timing, delivery rate and operations of the alternative source and on the delivery capacity of the onsite irrigation system. Refer to Sections 4.6 and 4.7 for further discussion of how Peak Day Demand impacts facilities sizing.

g. **Peak Hour Demand (PHD)** – Instantaneous maximum demand on the irrigation system during the peak day. The PHD, typically expressed in gallons per minute (gpm), is used to establish the size of the onsite irrigation pumping and pipeline facilities.

   Irrigation at Menlo CC typically occurs during a 5-hour period from 11:00 pm to 4:00 am, and the onsite irrigation pumps typically operate at 1,100 to 1,200 gpm. However, the irrigation pumps can deliver up to 1,400 gpm to meet peak demands. On peak demand days, the irrigation window is extended to ensure adequate irrigation water is delivered. For this evaluation it is assumed that onsite irrigation pumps would be sized to match the existing system and that current operating practices would continue in the future.

   Therefore, a 1,400 gpm peak hour demand is used to size irrigation pipelines and pump facilities, as discussed further in Sections 4.6 and 4.7.

Table 1: Comparison of Demand Estimating Methodologies

	Meter Record Methodology	**Theoretical ETo Methodology[(a)]**
Average Annual Demand (AAD)	long-term average of annual irrigation demands using 23 years of meter data from Menlo CC	The following formula is used to estimate AAD: *Theoretical Demand (af/yr) = Replacement ETo) x (Irrigated Area) x (ETo Factor)* *Where: Replacement ETo = 30 inches/year* *Irrigated Area = 100 acres (provided by Menlo CC)* *ETo Factor = 1.0 for an average-climate year*
Average Month Demand (AMD)	AMD = AAD ÷ number of months of irrigation per year Menlo CC irrigation records indicate that irrigation occurs for 8 months, from March through October	AMD = AAD ÷ number of months of irrigation per year ETo data presented in Appendix B indicates that irrigation occurs for 7 months, from April through October.
Average Day Demand (ADD)	ADD = AAD x (365 ÷ # of days of irrigation) Menlo CC's meter data indicates that irrigation occurs from March through October, for 245 days per year.	ADD = AAD x (365 ÷ # of days of irrigation) ETo data presented in Appendix B indicates that irrigation occurs from April through October, for 214 days per year.

	Meter Record Methodology	Theoretical ETo Methodology[a]
Peak Month Demand (PMD)	Bay Area climate conditions and Menlo CC's meter data were analyzed with the following results: i. The year 2007 was chosen for analysis as the most recent year with notably dry climate conditions in the Bay Area. Precipitation in the Redwood City/Woodside area was less than 50% of the long-term average. The annual irrigation demand at Menlo CC in 2007 was among the highest of the past 23 years. ii. The peak irrigating month at Menlo CC in 2007 occurred in June, and is chosen as the basis for the peak month demand.	Estimated based on the relationship between the average and peak month demands of an average precipitation year. PMD = AMD x (Peak Month ETo ÷ Average Month ETo) Using the data provided in Appendix B: Peak Month ETo ÷ Average Month ETo = 1.3
Peak Month, Average Day Demand (PMAD)	PMAD = PMD ÷ 30 days per month	PMAD = PMD ÷ 30 days per month
Peak Day Demand (PDD)	Based on the peak month of the dry year noted above (June 2007). The PDD is calculated in three steps: i. Estimate the average daily demand during the peak month. This is Peak Month Average Day (PMAD). PMAD = PMD/30 days. ii. Estimate the ratio of peak daily demand to average daily demand in June using daily ETo data provided by Menlo CC. This ratio is 1.5. iii. PDD demand is calculated as PDD = PMAD x 1.5.	Estimated based on the peaking relationship between the average and peak month demand for a year of average precipitation and a dry year, respectively. PDD = ADD x (Dry-Year Peak Month ETo ÷ Average-Year Average Month ETo) Using the data provided in Appendix B, Dry-Year Peak Month ETo ÷ Average-Year Average Month ETo = 1.3. Note that average demand is significantly higher during the dry year, but the peak demand remains relatively constant for average and dry years using this methodology.
Peak Hour Demand (PHD)	Assumes that irrigation pumps would be sized to match the existing system and that current operating practices would continue in the future.	Assumes that irrigation pumps would be sized to match the existing system and that current operating practices would continue in the future.

(a) ETo and Precipitation Data are Provided in Appendix B.

2.2 Demand Summary

The two demand estimating methodologies resulted in significantly different average and peak demands. This is due to the nature of the data upon which each methodology is based, as explained below:

- For Average Annual Demand, the two methodologies use different base data. The Meter Record Methodology takes into consideration the actual metered use for landscape irrigation over a 23 year period. The Theoretical ETo Methodology is based on a rough estimate of irrigated area, as provided by Menlo CC staff, and assumes 100% turf irrigation. A detailed site assessment to determine different types of landscape coverage or efficiencies of specific irrigation devices would be necessary to develop a more accurate Theoretical ETo demand estimate, but was not within the scope of work for this study. Therefore, it is assumed that the 23-year average used in the Meter Record Methodology provides a more accurate estimate of Average Annual Demand for Menlo CC irrigation demands than the Theoretical ETo Methodology.

- For peak demands, the two methodologies use different base data, resulting in different peaking factors. The Meter Record Methodology uses the historical meter data to determine the peak month demand and uses onsite ETo data to determine the daily peaking factor. The Theoretical ETo Methodology uses historical ETo and precipitation data to estimate the peaking factors.

- For Peak Day Demand, the Meter Record Methodology incorporates the Menlo CC irrigation strategy, in which irrigation rates are adjusted daily based on the previous day's replacement ETo rate. Therefore, the Peak Day Demand is impacted by the variation in daily ETo rates. The Peak Day Demand developed in the Theoretical ETo Methodology is more appropriate for a site that sets the irrigation system to operate on a consistent schedule from day to day. Therefore, the Theoretical ETo Methodology is not expected to provide a good indication of Peak Day Demand for Menlo CC. Facilities sizing in Sections 4.6 and 4.7 is based on the Meter Record Methodology.

The meter record information is the most accurate demand information available and is used for facilities sizing herein. The Peak Day Demand of approximately 0.72 MGD falls within the demand range (0.5 MGD – 1 MGD) that has been observed for other 18-hole championship courses in the Bay Area. Regional golf courses are trending towards reduced irrigation in response to rising water costs and compliance with Senate Bill 7 requirements for the state to conserve 20% of its water supply by the year 2020. In order to respond to these challenges, golf course operators are employing a variety of measures, including using ETo based irrigation, reducing irrigation in rough areas, downsizing fairways, and improving onsite irrigation system efficiency via newer sprinkler technologies, all of which reduce the amount of water required for irrigation. Menlo CC implemented an ETo based irrigation system in 1986, which has allowed the irrigation system to adjust to irrigation demands on a daily basis. Menlo CC staff does not anticipate a reduction in irrigation demands in the future.

Table 2: Summary of Irrigation Demands

Type	Demand: Meter Record Methodology	Demand: Theoretical ETo Methodology
Average Annual Demand	207 af/yr / 0.18 MGD[(a)]	250 af/yr / 0.22 MGD[(a)]
Average Month Demand	24.9 af/mo / 8.1 MG/mo	35.7 af/mo / 11.6 MG/mo
Average Day Demand	0.27 MGD	0.36 MGD
Peak Month Demand	43.8 af/mo / 14.3 MG/mo	46.3 af/mo / 15.1 MG/mo
Peak Month, Average Day Demand	0.48 MGD	0.50 MGD
Peak Day Demand	0.72 MGD	0.51 MGD
Peak Hour Demand	1,400 gpm	1,400 gpm

(a) The Average Annual Demand in MGD is the amount of recycled water used annually, averaged over 365 days.

Section 3: Groundwater Supply Potential

The potential use of groundwater as an alternative water supply for golf course irrigation at Menlo CC was considered by Kennedy/Jenks in consultation with Todd Engineers. Todd Engineers is a nationally recognized hydrogeology firm, and they have specific, recent experience with similar local groundwater evaluations for Menlo Park, Sharon Heights Golf and Country Club, and Redwood City. These studies are used as a basis to evaluate the potential for developing onsite and offsite wells. Groundwater is considered an alternative of interest because using groundwater for irrigation could potentially be less costly than extending recycled water service to the site from Redwood City or by using an onsite satellite treatment approach. The onsite groundwater supply alternative was considered using two scenarios:

1. Scenario 1 would establish an onsite or offsite well (or wells) that could reliably supply the peak day demand of 0.72 MGD over a 24-hour period. An appropriately sized onsite storage facility would provide the operational storage required to meet the peak hour demand. A new irrigation pump station would pump groundwater from storage into the existing irrigation system.

2. Scenario 2 would involve establishing an onsite or offsite well (or wells) that could reliably supply the peak hour demand of 1,400 gpm directly from the wellhead(s) to the irrigation system, without requiring a new storage facility or irrigation pump station.

For both scenarios, a provision for standby connection to the existing potable system would be recommended to maintain reliability for ongoing operations and maintenance of the wells.

3.1 Methodology

The potential to develop groundwater resources onsite at Menlo CC was assessed through the use of recent evaluations and hydrogeological studies relevant to the area. Alluvial deposits are of most interest to this study since they comprise the water-bearing deposits in the area.

3.1.1 Onsite Groundwater Well

Todd Engineers evaluated the potential for using an onsite groundwater well as an alternative water supply for Menlo CC. The evaluation of the onsite groundwater potential for Menlo CC is provided in a Memorandum by Todd Engineers, dated 22 September 2010, which is included in Appendix C. The evaluation is summarized in the following paragraphs.

In 2003, Todd Engineers conducted a feasibility study assessing the potential to develop groundwater resources for Redwood City (included as an Attachment in Appendix C). Although Menlo CC lies just outside of Redwood City, the conclusions and analysis of that study are useful in conducting this assessment. The Redwood City study concluded that the area has marginal potential as a groundwater resource, and that a properly sited and designed well might be expected to produce a flowrate on the order of 200 gpm. Due to the variation in the thickness of the alluvium that comprises the water bearing formations in the area, it was concluded that the greatest opportunities for developing groundwater were either in south Redwood City near

the border with Atherton or near San Francisco Bay. Menlo CC is outside the area where a reliable groundwater source could be developed.

While the Whiskey Hill Formation (bedrock) beneath the site might potentially contain zones with adequate porosity and/or fractures to produce water, it is doubtful that a bedrock well or wells would produce the quantities of water needed for golf course irrigation. There are no available data on production from bedrock wells in the area, but a well would be expensive to drill, would likely need to be relatively deep, and its production capability would be uncertain.

Further evidence of the lack of reliability of local groundwater resources was provided by a nearby pilot well in 2006/2007. Redwood City was interested in serving Red Morton Park with groundwater by constructing a bedrock well. This park is located approximately one mile north of Menlo CC and at a similar location and elevation with respect to the subsurface geologic formation. The pilot well failed to produce groundwater (less than 1 gpm) and the concept of using groundwater to irrigate the park was abandoned.

3.1.2 Offsite Groundwater

Irrigation at Sharon Heights

A study was performed in 2009 to evaluate the feasibility of developing an alternative irrigation water supply for Sharon Heights Golf & Country Club (Sharon Heights). Sharon Heights is located approximately two miles southwest of Menlo CC and at a higher elevation. Several water supply alternatives were considered, including a groundwater supply. Possible well sites under consideration included Nealon Park, Hillview School, and areas west of I-280. The most promising groundwater alternative was to partner with the City of Menlo Park to develop a new well at Nealon Park, which is located approximately three miles east of Menlo CC. This new well would be used to serve both the City of Menlo Park and Sharon Heights with irrigation water.

The results of the Nealon Park evaluation indicate that a 600-foot deep, 12-inch diameter well might produce between 450 and 625 gpm. No excess well capacity is expected to exist. A site-specific exploration (boring and/or a test well) was recommended to confirm factors such as the potential yield and groundwater quality.

The conceptual groundwater project included constructing a well at Nealon Park, a new pipeline from Nealon Park to Sharon Heights, and a storage tank at Sharon Heights. The facilities would serve Sharon Heights, Nealon Park, and other parks and schools along the pipeline alignment. The study estimated the facilities capital costs to be approximately $3.7 million, including the well, pipelines, and storage facility.

Alternative Water Supply for Menlo Park and East Palo Alto

In 2006, a study was performed to evaluate alternative water supplies for the City of Menlo Park and the City of East Palo Alto, both of which are 100% reliant on the SFPUC Regional Water System for potable supply. As part of this study, an evaluation was performed to determine the potential for using groundwater as an alternative supply in the event of long-duration outages of Hetch Hetchy aqueducts due to a significant seismic event. The use of groundwater as a continuous, long-term supply was not investigated.

Current groundwater use in the area is approximately 1,100 af/yr, and it is used primarily for irrigation, although some municipal and industrial uses are served by the Palo Alto Park Mutual Water Company and the O'Connor Tract Cooperative Water Company. The groundwater quality is acceptable for potable uses but has higher concentrations of hardness, total dissolved solids, iron, manganese, and chlorides when compared to potable water from the SFPUC Regional System.

The evaluation concluded that emergency groundwater resources could likely be developed in the Menlo Park/East Palo Alto area. Properly sited wells might be capable of producing between 300 and 1,800 gpm, but site-specific studies would be necessary to determine final well siting and production capacity. The study concluded that groundwater could be a viable alternative supply source during longer-duration outages and droughts, and that careful monitoring and management at a regional level would be required to prevent saltwater intrusion and subsidence from occurring. The reliability of using groundwater over the long-term would require further evaluation. The study estimated that the capital cost to construct a 500 foot deep, 12-inch diameter well and related facilities capable of producing 1,000 gpm is approximately $4 million.

Areas West of Menlo CC

Alluvial deposits, which comprise the water-bearing formations, form a wedge that thins to the west near the bedrock hills and thickens to the east towards the Bay. Areas west of Menlo CC, near Highway 280, are underlain by bedrock with little to no alluvial deposits and are farther from water-bearing strata. Therefore, the hilly areas west of Menlo CC are not likely to produce adequate quantities of water for irrigation.

3.2 Groundwater Summary

The results of the groundwater feasibility analysis indicate that the Menlo CC is positioned over the Whiskey Hill Formation, which does not possess the hydrogeologic attributes required to provide a reliable onsite irrigation supply under either of the two groundwater scenarios. The recent failure of Redwood City's well development project at nearby Red Morton Park further supports this conclusion.

The proposed Sharon Heights/City of Menlo Park well at Nealon Park would appear to have sufficient capacity to serve Menlo CC only under Scenario 1, which uses storage. However, the current planning for this project shows that the supply is fully committed to Menlo Park and Sharon Heights uses, and no excess capacity exists. Therefore, importing groundwater from Nealon Park is not a feasible supply alternative.

Developing a reliable long-term groundwater supply for Menlo CC from wells in the Menlo Park/East Palo Alto area might be possible under Scenarios 1 and 2. However, there is inadequate information available to assess this alternative under this study. Additional hydrogeologic evaluations and siting analysis would be required to determine the long-term reliability of the supply, well locations, pipeline alignments, and estimated costs for this alternative. Menlo CC and SFPUC would likely need to partner with the City of Menlo Park and/or the City of East Palo Alto to move forward with such a feasibility analysis.

Section 4: Recycled Water Supply Potential: Connection to Redwood City's Recycled Water System

The potential to use Redwood City's recycled water as an alternative source of supply is explored in this section. This alternative involves serving Menlo CC via connection to Redwood City's existing Phase 1 Recycled Water Project.

4.1 Redwood City Recycled Water Program Background

The "Water Recycling Feasibility Study for Redwood City" (August 2002, Kennedy/Jenks) evaluated several project alternatives and recommended moving forward with a project that supplies 1,955 af/yr (1.75 MGD), average annual demand. During the project approval process, community opposition developed against a potential "mandatory use" policy and against the use of recycled water where children play. In 2003/2004, Redwood City convened the Community Task Force on Recycled Water as a means to address the community's concerns and to build support for a project that was agreeable to all parties. The Community Task Force provided recommendations to the City Council which were accepted, and a decision was made to proceed with implementation of a project titled "Alternative TF". Alternative TF removed parks and schools from the customer base, converted some play fields from grass to synthetic turf, made the use of recycled water voluntary for existing Redwood City customers, and implemented aggressive water conservation measures to achieve additional potable water savings. Alternative TF, depicted in Figure 2, serves up to 1,722 af/yr (1.54 MGD), Average Annual Demand, of recycled water to customers primarily on the east side of Highway 101, with a few customers on the west side of Highway 101. Redwood City has taken a phased approach to implementation of the recycled water system and has focused on construction of a Phase 1, which is limited to serving customers on the eastern side of Highway 101.

4.2 Existing Redwood City Recycled Water Facilities

Redwood City recently completed its $72.4M Phase 1 Recycled Water Project. The project includes treatment, storage and pumping facilities at the South Bayside System Authorities Wastewater Treatment Plant, distribution pipelines in City streets and the Highway 101 bike path, and customer site retrofits at the point of use. The facilities are further described as follows:

- Treatment Facilities – Tertiary treatment and disinfection of the recycled water is provided to create the recycled water supply at South Bayside System Authorities (SBSA) Wastewater Treatment Plant, which is located in the Redwood Shores area east of Highway 101. These facilities were designed and permitted to produce up to 12.96 MGD (9,000 gpm) of Disinfected Tertiary Recycled Water suitable for unrestricted use under the California Code of Regulations (CCR), Title 22. This classification of water may be used for golf course irrigation and storage in onsite impoundments, where there is unrestricted public access.

- Storage Facilities – Two 2.1 million gallon storage tanks at SBSA provide a total recycled water storage capacity of 4.2 MG. These partially buried, cast-in-place concrete structures provide the operational storage needed to manage diurnal variations in supply and demand. The peak system demand occur primary at night when the system serves its irrigation customers.

- Pumping Facilities – The Distribution Pump Station (DPS) is also located at SBSA, adjacent to the storage tanks, and it is currently being upgraded to a capacity of 13,100 gpm at 73 psi. The DPS provides the peak hour demand for the entire Phase 1 System. Typical system operating pressures are approximately 65 psi. Although the pump station can provide a higher discharge pressure, the system is operated at lower pressure, as part of Redwood City's voluntary "Delta 10 Operating Strategy." Under this operating strategy, the recycled water system pressure is maintained 10 psi lower than the pressure in the adjacent potable water system, providing enhanced cross-connection protection. This operating strategy is voluntary, so Redwood City could increase the system pressure in the future should it become a desirable option.

- Distribution Pipelines – Over 40,000 lf of new recycled water pipelines, ranging from 8 to 36-inches in diameter, have been constructed within Redwood City streets and along Highway 101 right-of-way (ROW) in the Caltrans bike path. The pipelines deliver recycled water to irrigation, commercial and industrial customers in the Redwood Shores and the Seaport Industrial areas on the east side of Highway 101.

The institutional arrangement between Redwood City and SBSA is detailed in the "Agreement for the Production and Delivery of Recycled Water Between the South Bayside System Authority and Redwood City" (August 2004). Under the agreement, SBSA owns, operates and maintains the treatment facilities[3] and agrees to deliver up to 9,000 gpm of recycled water to Redwood City. Redwood City owns, operates and maintains the storage, pumping and distribution facilities.

Recycled water use is increasing as new customers apply for service and are connected to the Phase 1 system. Approximately 475 af (0.42 MGD) of recycled water will be served to customers in 2010. Redwood City is currently evaluating the potential to serve Homeowners Associations (HOAs) in the Redwood Shores area and is developing retrofit plans for 15 HOA sites. Additionally, twelve sites are also considering using recycled water for non-irrigation applications uses such as toilet flushing, cooling tower makeup, dust control, washdown and concrete batching. By the end of 2012, it is anticipated that 835 af (0.75 MGD) will be delivered to Phase 1 customers. The HOA's will use water for irrigation at night; commercial and industrial customers will use recycled water primarily for non-irrigation uses during the day. Table 3 summarizes the existing and anticipated future annual demands on the Phase 1 system through the end of the year 2012.

[3]The disinfection system is owned by Redwood City but operated and maintained by SBSA.

Table 3: Phase 1 Recycled Water System Annual Demands

	Demand[(a)]
Existing Customers in 2010[(b)]	475 af/yr / 0.42 MGD
Future Customers by 2012[(c)]	360 af/yr / 0.32 MGD
Total Demand	**835 af/yr / 0.75 MGD**

(a) The Average Annual Demand in MGD is the amount of recycled water used annually, averaged over 365 days.
(b) Existing customer demand is based on recycled water meter records as of October 2010 and assumes that demands in November and December will be similar to demands in January and February.
(c) Anticipated future demands include irrigation of HOAs and non-irrigation uses within the Phase 1 area and these demands are based on water meter records.

4.3 Available System Capacity for Expansion Opportunities

The 2002 Feasibility Study provided a conceptual plan for a city-wide recycled water project (see Figure 3). However, this study has not been updated to reflect the impacts of the Community Task Force recommendations or the final design of the Phase 1 System. Because of turf replacement programs and a decision to not serve public spaces where children play, the customer base and pipeline alignments shown in Figure 3 may change. The Phase 1 facilities were designed with provisions for future expansion to Redwood City customers west of Highway 101 and possibly to other SBSA participants (Belmont and San Carlos) or other regional partners under the certain conditions:

- Redwood City Customers – The Phase 1 facilities were designed for flexibility to serve an Average Annual Demand of 3,238 af/yr (2.9 MGD), which is based on a detailed city-wide market assessment of potential customers[4]. A hydraulic model was used to approximate day and night conditions in the distribution system. The Phase 1 distribution pipelines were upsized from the DPS at SBSA to the Highway 101 corridor to accommodate these potential future demands. The market assessment and facilities sizing for the Phase 1 System included the demands for Menlo Country Club and Woodside High School. These sites, although outside Redwood City, were included because they are located along Redwood City's boundary in the vicinity of other Redwood City customers.

- Other SBSA Participants (Belmont and San Carlos) – provisions for serving other SBSA participants was also incorporated into the design of the Phase 1 System, using a conceptual level market assessment of the potential customer demands in Belmont and San Carlos (apparent viable demand of 300 to 500 af/yr) and hydraulic modeling of the system. The service concept for these two areas included using available off-peak system capacity during the day to convey recycled water from SBSA outside the Redwood City limits, to terminal storage facilities located within Belmont and San Carlos. These two cities would be responsible for constructing new pipelines from the Phase 1

[4] The recycled water market assessment used Redwood City water meter records to estimate demands for each potential recycled water customer. Where meter records were not available, theoretical irrigation demands were developed using ETo data and irrigated areas. The market assessment was performed as part of the Water Recycling Feasibility Study for Redwood City (2002, Kennedy/Jenks).

System to their jurisdiction, as well as for constructing storage and pumping facilities to serve their customers.

- Other Potential Regional Partners – Serving other potential regional partners was explored, including southern portions of Foster City that are near Redwood City. A concept level market assessment of Foster City estimated that up to 2,000 af/yr of irrigation demand could exist. The use of available daytime capacity to convey water outside the City was recognized, as noted above, providing some level of future flexibility for serving other regional partners.

Additional detailed information about Redwood City's Recycled water system can be found on its website: http://www.redwoodcity.org/publicworks/water/recycling/index.html

4.4 Water Quality

Recycled water from Redwood City's system is treated at SBSA to the highest standards delineated in Title 22 of the California Code of Regulations for Disinfected Tertiary Recycled Water, which meets the requirements for unrestricted use, including golf course irrigation and for storage in onsite impoundments. Local courses currently irrigating with recycled water quality comparable to Redwood City's supply includes the Lake Merced Golf Club, the Olympic Club, the San Francisco Golf Club, and the Palo Alto Golf Course.

Understanding turf grass management issues is important to use recycled water successfully for golf course irrigation because recycled water contains higher levels of Total Dissolved Solids (TDS) than the potable water. This is particularly important for irrigating tees and greens where the grass is cut shorter, has greater foot traffic, and is more susceptible to salt- or heat-induced stress. Tee and green construction, and onsite soil permeability conditions are also important to review and understand, to both manage turf appearance and prevent runoff.

Turf grass construction has evolved and improved over the years. The golf course greens at Menlo CC are a mixture of three different types of construction:

Type of Construction:	**Green:**
Original Construction (early 1900's)	2, 10, 14, 15, 18, Pitch Green, Upper Putting Green
Renovated1969	4, 5, 7, 8, 9, 11, 12, 16, 17
Renovated 1998 (USGA Spec)	1, 3, 6, 13

The newest greens that meet USGA specifications should be relatively unaffected by the application of recycled water. The older greens, however, may have permeability issues and require some management. Turf health would need to be monitored and assessed during initial operations and appropriate irrigation and management measures identified to ensure good turf and playing conditions are maintained.

The water quality differences between potable and recycled water supply are commonly managed by adapting irrigation management practices, if necessary. Periodic heavy irrigation (flushing) can be used to leach salts from the root-zone of turfgrass. Application of gypsum to less permeable areas, or introducing it into the onsite supply (as is done at Daly City) can also be used to help maintain adequate permeability and drainage. The Menlo CC site retrofit design

could include flexibility for adding gypsum to the irrigation water at the onsite pump station. Alternatively, manual application of gypsum could be performed seasonally in conjunction with plugging, reseeding, and other turf management activities.

If Menlo CC moves forward with converting to recycled water for irrigation, a more detailed site analysis should be performed in order to determine specific management strategies that would be necessary. This evaluation should be performed by a landscape/irrigation specialist with direct experience with soil, recycled water and turf/plant interactions. Section 6.2 provides additional recommendations for further study.

Table 4 provides a summary of key water quality data for both Redwood City's recycled water and Menlo CC's current supply, potable water from the SFPUC. The parameters of acceptable values for landscape irrigation and the resulting degree of restriction for use that may be required are provided in the Water Quality Matrix for Landscape Irrigation in Appendix D. Appendix D also provides a more detailed list of water quality data for SBSA recycled water and SFPUC potable water.

Table 4: Redwood City Recycled Water Quality Summary

Water Quality Parameter	SBSA Recycled Water	SFPUC Potable Supply
Total Dissolved Solids (TDS), mg/L	660 – 690	15 – 170
Electrical Conductivity, µS/cm	1500 – 1600	30 – 309
Sodium Absorption Ratio (SAR)	4.8 – 5.4	NA
Nitrogen (total N = ammonia + nitrite + nitrate), mg/L	28 – 35	< 0.4
Sodium, mg/L	203 - 204	<3 – 9
Chloride, mg/L	270 – 300	<3 – 10
Boron, µg/L	330 – 515	<100 – 102

4.5 Regulatory Requirements

In the State of California, recycled water requirements are administered by the California State Water Resource Control Board (SWRCB), individual Regional Water Quality Control Boards (RWQCBs), and the Department of Public Health (DPH). State requirements for the production, discharge, distribution, and use of recycled water are contained in the CCR, which includes Title 22 and Title 17, and in the California Health and Safety Code and Water Code. Applicable excerpts from Title 22, Title 17, the Water Code, and the Health and Safety Code are included in "The Purple Book", which provides a single source of guidelines and requirements for recycled water production, distribution, and use in California.

Recycled Water Permit

The Redwood City recycled water project operates under General Order 96-011 and is permitted for all applicable Title 22 approved uses. The permitting agency is the San Francisco Bay RWQCB. Irrigation with recycled water at Menlo CC would be covered under Redwood City's existing permit and must be in compliance with the requirements of the permit.

Engineering Report

Title 22 requires an Engineering Report for each recycled water project. The Engineering Report should include a description of the design of the proposed reclamation system and clearly indicate the means for compliance with regulations. Redwood City issued an Engineering Report for its recycled water system in 2004, which was subsequently approved by DPH. As a customer of Redwood City, Menlo CC would be covered under the existing Engineering Report. However, Redwood City may need to make some revisions to the Engineering Report to account for the expansion of its service area and customer base beyond that described by Alternative TF.

Site Supervisor Training

Title 22 requires that each recycled water customer designate a Site Supervisor to operate and maintain their recycled water system. The Site Supervisor should be familiar with both the recycled water and potable water systems on site. The Site Supervisor should be knowledgeable in the safe use of recycled water and should be familiar with Redwood City's Cross Connection Prevention Program. Site Supervisor training is a pre-requisite to a customer receiving recycled water. Redwood City historically has offered periodic Site Supervisor training at no cost to customers.

NPDES Permit

The National Pollutant Discharge Elimination System (NPDES) Permit Program, as authorized by the Clean Water Act, controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. It is the responsibility of the California Water Boards to preserve and enhance the quality of the State's waters through the development of water quality control plans and the issuance of waste discharge requirements (WDRs). WDRs for discharges to surface waters also serve as NPDES permits. Recycled water is considered a pollutant if it is discharged off the site where it is being used. Therefore, to avoid the need for a NPDES permit, the onsite recycled water facilities (irrigation system, storage facility, etc.) should be designed to ensure no runoff from the site occurs.

CEQA

The California Environmental Quality Act (CEQA) is a statute that requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. Redwood City adopted a Mitigated Negative Declaration (MND) in July 2003 for the Redwood City Recycled Water Project as depicted in Figure 3. An environmental consultant should review any new recycled water storage facilities and the pipeline alignment to serve Menlo CC to determine if they are within the scope of Redwood City's CEQA documentation. Additionally, because Menlo CC is not within Redwood City's Recycled Water Service Area, as defined in the MND, a separate environmental review may be required to proceed with this project. The CEQA documentation for any new facilities associated with delivering recycled water to Menlo CC should be performed in one document and would include a public review element. The documentation also needs to include any necessary agreements between Menlo CC, Redwood City, SFPUC, and possibly others. The CEQA review should be performed by the agency with the most responsibility for the new recycled water facilities.

Cross-Connection Prevention and Retrofit Design

The focus of CCR Title 17 is the protection of drinking (potable) water supplies through the control of cross-connections with potential contaminants, including non-potable water supplies such as recycled water. Title 17 specifies the minimum backflow protection on the potable water system to ensure that any potential for contamination to the potable water supply is avoided. In conjunction with local health agencies, DPH reviews and approves final onsite (customer) system plans for cross-connection control in accordance with Title 17, and inspects each system prior to operation.

Backflow protection requirements that would apply to Menlo CC are as follows:

- An air-gap separation is required on "Premises where the public water system is used to supplement the recycled water supply."
- A reduced pressure principle backflow prevention device is required on "Premises where recycled water is used and there is no interconnection with the potable water system."
- It is required that all new recycled water pipes installed above or below the ground are colored purple, are distinctively wrapped with purple tape, or have the appropriate purple markings. Meeting one of these three options would comply with the requirements of the Health and Safety Code. Note that existing onsite irrigation pipe that is part of the current irrigation system, does not have to be dug up or identified as recycled water piping. However, above-ground equipment like valves, valve boxes, and quick-couplers must be marked as part of the recycled water system.

The retrofit design must also conform to CCR Title 22 guidelines, Redwood City's Recycled Water Use Guidelines, AWWA California-Nevada Section's *Guidelines for the On-site Retrofit of Facilities Using Disinfected Tertiary Recycled Water*, AWWA *Guidelines for Distribution of Nonpotable Water*, and A*ppendix J of the Uniform Plumbing Code* as applicable. A detailed description of retrofit design requirements is also provided in Chapter 5 of the "Operations Plan for the City of Redwood City and the South Bayside System Authority."

4.6 Conceptual Facilities Requirements

For purposes of this initial feasibility analysis the following base case alternative would be sized to serve only Menlo CC's requirements. Considerations for an expanded project that could serve other customers are addressed separately in Section 6.2.3 of this report.

4.6.1 System Connection Point

Connection to Redwood City's existing recycled water pipeline system could be made to the 24-inch diameter pipeline in Maple Street, between the San Mateo County Women's Correction Center and the Redwood City Police Facility, as indicated on Figure 4.

4.6.2 Distribution Pipeline

A new distribution pipeline could be considered along a conceptual alignment as illustrated on Figure 4. This alignment was discussed between Kennedy/Jenks (Craig Lichty) and Redwood City Engineering (Phong Du) in March 2010 as a potentially feasible alignment. This new pipeline would be 16 inches in diameter and approximately 20,000 feet (approx 3.8 miles) long. The pipeline is sized to deliver the Peak Day Demand (0.72 MG as developed in Section 2.1) to new onsite storage over a 12-hour time period during the day, in order to use available off-peak system capacity in the existing pumping and distribution system. The flow rate in the pipeline would be 1,000 gpm under these assumptions. Because this alignment is within a developed urban area with significant traffic, construction might require trenchless techniques or night work to pass through major intersections and minimize traffic disruption.

The general alignment is as follows:

- Cross under Highway 101 via an existing utility tunnel
- West of the freeway, continue south along Walnut Street to Marshall Street.
- West on Marshall Street to Main Street.
- South on Main Street to Woodside Road
- South on Woodside Road to the Menlo Country Club driveway
- Onsite piping is approximately 200 feet from Woodside Road to the tank

The actual pipeline alignment may vary somewhat based on Redwood City input on construction issues and opportunities to connect additional Redwood City customers. Specific considerations for this pipeline alignment include:

- Special crossing requirements would likely be needed at the Main Street/El Camino Real intersection. This could be done either by trenchless construction (jack-and-bore, etc.) or night construction.

- Special crossing requirements may also be necessary at the Alameda De Las Pulgas/Woodside Road intersection.

The pipelines alignment crosses major SFPUC pipelines at two locations as indicated on Figure 4. The crossing of Bay Division Pipelines #1 and #2 is on Woodside Road, near Union Cemetery (Cypress Street). The crossing of Bay Division Pipelines #3 and #4 is on Woodside Road near Woodside High School. Title 22 establishes the criteria for separation requirements between potable and non-potable pipes to protect potable water supplies. Typically a non-potable pipeline must cross below a potable water pipeline. However, DPH has allowed exceptions to these criteria under certain conditions, with prior review and approval. Preliminary discussions with SFPUC staff (e-mail with Lawrence Soe on August 27, 2010) suggest that the SFPUC typically follows DPH standards for pipeline crossings. However, SFPUC may consider allowing a recycled water pipeline to cross over their large-diameter potable water pipelines using open-cut construction, if the crossing met their specific requirements and a waiver of standard separation requirements is obtained from DPH.

4.6.3 Pumping

Redwood City's Distribution Pump Station (DPS) would pump recycled water from SBSA to Menlo CC to fill a new onsite storage facility (discussed in Section 4.6.4). Pumping rates are assumed to be the Peak Day Demand of 0.72 MGD (as developed in Section 2.1) over a 12-hour time period. Delivery hours are assumed to be from 8 am to 8 pm, to avoid Redwood City's peak nighttime irrigation demand period and to take advantage of available system capacity during the day. It is estimated that the available daytime system capacity following the DPS expansion this winter will be approximately 8,000 gpm or more, but this would need to be verified with Redwood City Public Works Services operating staff. The Menlo CC delivery rate of 1,000 gpm is small in comparison to the available pumping capacity.

4.6.4 Storage

The storage facility would be situated so the high water level is set at the shutoff head/hydraulic grade line of the Distribution Pump Station to properly integrate with the existing recycled water distribution system. The Distribution Pump Station currently operates with a discharge pressure of 65 psi, which is equivalent to a Hydraulic Grade Line of 150 feet in elevation. Menlo CC is in the midst of planning major renovations for the golf course that would change the layout and topography of the site. Because these renovations are indefinite, this analysis uses existing site conditions.

- The Hydraulic Grade Line of 150 feet establishes the approximate high water surface in the storage facility. This elevation and the facility configuration (buried or above ground) sets the range of elevations at which the pad or foundation for the facility should be located. (Should Redwood City change its "Delta 10 Operating Strategy" and increase the system pressure up to 73 psi, this elevation would increase to 168 feet, accordingly.)

- It is recommended that the minimum operating storage volume be equal to one day of the peak day irrigation demand (0.72 MGD as developed in Section 2.1). Considering the preliminary nature of this feasibility analysis, and to account for additional volume associated with inlet piping, irrigation pump head requirements, and storage overflow configurations, a 1 MG storage tank is assumed at this time.

- It is also recommended that a standby potable connection (10-inch diameter or larger, to match existing connection size) from the SFPUC system be provided through an air gap connection at the storage facility. This would provide additional operating flexibility in the event the recycled water system experienced an operational problem requiring temporary shutdown of facilities. The backup potable connection can be smaller than Redwood City's supply pipeline because there is less head loss for the shorter length of onsite piping and because it is assumed that the storage facility can be filled continuously from the backup potable supply rather than the 12-hour limit assumed for the Redwood City supply pipeline.

- The facility is assumed to be above-ground, welded steel construction with 12-foot high walls and be 120 feet in diameter. Above-grade steel is a less expensive option than buried concrete construction but is more visible. An overflow would typically be located

approximately 1 to 2 feet above the high water level. Therefore, the elevation of the tank pad might be located at an elevation of approximately 140 feet.

- Topographic maps of Menlo CC indicate that the maintenance area near the club entrance is relatively flat and ranges in elevation from 133 to 150 feet with an empty flat area next to the tennis courts. Therefore, it might be feasible to consider siting a storage facility near the tennis courts. Although this location creates some visual disturbance for the tennis courts, it minimizes visual impacts for much of the country club, minimizes disruption during construction, and simplifies access for construction and maintenance. Additionally, the low tank height (12-foot side wall) would allow for vegetative screening of the tank.

- As planning proceeds for golf course renovations, Menlo CC should continue to take into account possible storage facility locations. Specific siting of the storage facility would depend upon such factors as elevation and grade and if Menlo CC would prefer the facility to be located above- or below-grade. If Menlo CC preferred a below-grade facility, the ground surface elevation of the site would be at least 155 feet. The surface elevations at Menlo CC range from approximately 95 feet near Alameda de las Pulgas to approximately 250 feet above the driving range and the 18th hole (see Figures 5 and 6). Therefore, it is likely feasible that a below-grade storage facility could be constructed without a requirement for fill. A site specific geotechnical evaluation would need to be performed to confirm foundation requirements and the presence of rock that could significantly increase costs of below grade construction.

- The overflow from the storage facility must be configured as to not result in the release of recycled water off site (i.e., it cannot discharge to a storm drain) so as not to violate National Pollution Discharge Elimination System (NPDES) requirements. The storage facility siting should take this requirement into consideration. The overflow could likely be directed to a sanitary sewer to avoid a discharge to the environment. However, an evaluation must be performed to determine where the connection would be made and confirm that adequate capacity exists to handle the flow that might occur if a pump were left on and the tank spilled.

Above-grade welded steel and below-grade concrete construction each have advantages and disadvantages. Welded steel tends to be less expensive and more easily constructed with less site work. However, above-grade construction may be less aesthetically pleasing at a site like Menlo CC and limits the availability of appropriate locations. Below-grade concrete construction is more expensive and requires more invasive site work. However, tank siting becomes somewhat more flexible when the tank is buried because aesthetics are less of an issue. Additional points to consider when siting the tank are access for tank construction and maintenance and site slope/grade.

4.6.5 Onsite Pumping and Retrofit

A new onsite irrigation pump station is assumed to be required to meet the needs of Menlo CC and could be co-located with the new storage facility. Currently, the onsite irrigation pumps boost pressure up to 80 to 100 psi to serve the golf course, and pressure regulators are used where required to control high pressure. This analysis assumes that the future system would be designed to match closely the existing system. Alternatively, it may be possible to utilize the

existing irrigation pump station by relocating it or by installing a pipeline from the new storage facility to the existing pump stations. The suction head requirements and pump curves for the existing pump station would need to be evaluated for this alternate to be considered. A detailed evaluation of the retrofit of onsite piping and pumping facilities is not included in this initial analysis.

Appropriate site retrofit would ensure the irrigation system meets applicable regulatory requirements. Irrigation run-off control, overspray guidelines, signage requirements, and backflow prevention and cross-connection control would be evaluated as part of site retrofit. Recycled water equipment and materials should be approved for use in a pressurized recycled water system and converted or installed according to DPH approved plans. Since the golf course is a public facility with unrestricted access areas, the retrofit plans should also include locations for the advisory signage.

Retrofit plans should include new points of separation from the existing potable system and identify modifications to the existing onsite irrigation system to bring it into conformance with State standards for recycled water. Additionally, the retrofit plans should highlight locations for potable line capping, new connections to the recycled water system, necessary provisions for cross-connection control, backflow prevention and separation, and location of signage to comply with State and County Departments of Public Health. The onsite system at Menlo CC would be tested for cross-connection prevention in accordance with DPH requirements before the recycled water system is put into operation.

4.7 Conceptual Facilities Sizing and Cost Summary

The existing hydraulic model (WATERCAD) for the Redwood City recycled water system was used to incorporate demands and facilities to serve Menlo CC. The analysis indicates that serving recycled water to Menlo CC from the existing Redwood City system is feasible.

Table 5 provides a summary of the conceptual facilities sizing analysis. These facilities are illustrated on Figures 4 and 5. Table 6 provides the conceptual-level cost estimate for completing the project, including capital facilities, related professional services, and a 30% planning-level contingency.

Table 5: Summary of Conceptual Facilities Sizing (Menlo CC Only)

Description	Basis	
New Storage Facility (above-ground)[(a)]	Peak Day Demand + Additional Volume for Overflow & Pump Head	1,000,000 gallons (720,000 gallons, Min. Operating Volume)
Standby Potable Connection	Existing Connection; Storage Located by Maintenance Yard	2,300 lineal feet 10 inch diameter
New Offsite Pipelines	Peak Day Demand Delivered over a 12-hour Period	20,000 lineal feet 16 inch diameter
2- Special Crossings by Jack & Bore Method	Previous Redwood City Pipeline Projects	400 lineal feet 36 inch casing

Description	Basis	
New Onsite Pipelines	Storage Located by Maintenance Yard	600 lineal feet 16 inch diameter
New Irrigation Pumping Facility	Matches Existing Facility	1,200 - 1,400 gpm (variable) @ 100 psi discharge pressure

(a) The total storage volume is sized to accommodate the minimum operating volume with additional freeboard to accommodate the overflow line (1-2 feet) and to provide adequate pump head at low water levels (1-2 feet).

Table 6: Summary of Conceptual Facilities Costs (Menlo CC Only)[a]

Description	Cost
New Storage Facility (above-ground)[b]	$ 1,250,000
Standby Potable Connection	$ 200,000
New Offsite Pipelines	$ 4,000,000
Special Crossings by Jack & Bore	$ 450,000
New Onsite Pipeline	$ 75,000
New Irrigation Pumping Facility	$ 200,000
Subtotal Facilities	**$ 6,175,000**
Legal, Engineering, CM & Administration @ 20%	$ 1,250,000
Conceptual-level Contingency @ 30%	$ 1,850,000
TOTAL CONCEPTUAL COST ESTIMATE	**$ 9,275,000**

(a) This summary of costs is a comprehensive estimate of costs at a concept level of development. It assumes the existing irrigation system continues to operate as it currently does and assumes installation of an above-ground storage facility near the entrance of Menlo CC. Any onsite irrigation system upgrades would be additional cost and are not included. The controls system for the Redwood City Recycled Water system would likely need to be modified and may be an additional cost.

(b) The cost for underground storage would vary depending on the location chosen and type of facility selected, but is expected to range from $1.50 to $2.00 per gallon and may incur additional costs for construction access. Its location would also impact the length of onsite and standby potable connection pipelines.

There are potential partnership opportunities to explore between Menlo CC, the SFPUC, and Redwood City that possibly could reduce costs to Menlo CC. Redwood City is exploring various ways to expand its recycled water system to serve new customers. The existing distribution system has significant excess daytime transmission capacity available to convey recycled water to Menlo CC and other users. Delivering recycled water to Menlo CC during the daytime would allow Redwood City to increase use of its recycled water system with very little impact to existing customers. Additionally, a new storage facility located at Menlo CC may provide operating benefits to the overall Redwood City recycled water distribution system, by attenuating pressure losses during peak demand periods.

The SFPUC is seeking to develop alternative water supplies (conservation, groundwater and recycled water) to diversify its water supplies and reduce demands on its Regional Water System. Menlo CC is a retail customer of the SFPUC whose irrigation demands are currently met with potable water from the Regional Water System. Replacing irrigation supply with a different and appropriate water supply would be a beneficial potable offset for the SFPUC.

REDWOOD CITY RECYCLED WATER PROJECT

Kennedy/Jenks Consultants
Engineers & Scientists

Redwood City California Founded 1867

SITE	CUSTOMER
A01a	Electronic Arts
A01b	Speiker Properties
A02	Paragon Center
A03	Macromedia
A04	Instill Corp
A05	RealNames (Speiker Properties)
A06	Provident Central Credit Union
A07	ERI Dolphin
A08	Harris Farnon
B01	Oracle Corporation
B02	The Shores Business Center
B03	Emery Worldwide/Paragon Point
B04	Marina Park Center
B05	Dolphin Unit 2
B06a	Bowsprit Dr, Pennant Ct Island
B06b	Port Park
B07	Co-op Housing
B08	Shore Breeze HOA
B09	Hotel Sofitel
B10	Executive Guild (Westshore Office Park)
B11	San Mateo County Office of Education
B12	Dolphin Park
C01	Starboard Park
C02	Portside Park
C03	Pelican Cove HOA
C04	Shorebird Solar HOA
C05	Shorebird Island HOA
C06	Beacon Shores HOA #1 & #2
C07	Islands (Marlin Ct)
C08	Seabridge Community Association
C09	Harbor Colony
C10	Marlin Subdivision Units #1 & #6
C11	Lighthouse Cove HOA
C12	Marlin Park
C13	Shorebird Park
C14	Davit Lane Parcel
D01	Redwood Shores Apts
D02	Harborside Apts
D03	Regatta HOA
D04	Stratford Bay HOA #1 & #2
D05	Manors HOA
D06	Ventana Del Mar HOA #1 & #2
D07	Lakeshore Townhomes #1 & #2
D08	Laguna Pointe HOA
D09	Harbor Court HOA
D10	The Shores HOA
D11	Sandpiper School/Park
D12	Shannon Park

SITE	CUSTOMER
E01	Adecco (Slam Dunk Networks)
E02	Pacific Athletic Club (Western)
E03	Market Place
E04	Hastings HOA
E05a	Cringle Dr Park
E05b	Teredo Dr Island
E06	Sunrise HOA #1
E07	Sandpiper Lagoon HOA #1
E08	Sandpiper Lagoon HOA #2
E09	Bridgeport HOA
E10	Governor's Bay HOA
E11	Mariner Park
E12	Fire Station #20
E13	Marlin Subdivision Units #2 & #2a
F01	Hampton HOA
F02	Pescadero Apts
F03	The Pointe
F04	Cove HOA
F05	Seacrest HOA
F06	Gossamer Hollow HOA
F07	Gossamer Cove HOA
F08	Gossamer Village HOA #1 & #2
F09	Gossamer Isle HOA
F10	Dogs Park
F11	PG & E Easement
G01	Indian Creek Garden Apts
G02	Peninsula Landing HOA
G03a	IPASS/Westport Office Complex
G03b	Neptune Dr. Park
G04	Oracle Corporation
G05	Boardwalk HOA
ST01	Twin Dolphin Dr
ST02	Marine Pkwy
ST03a	Redwood Shores Pkwy
ST03b	Radio Road
ST04	Bridge Pkwy
ST05	Shell Pkwy
ST06	Shearwater Pkwy
ST07	Oracle Pkwy
ST08	Davit Ln to Cul-de-sac
T01	South Bayside Systems Authority

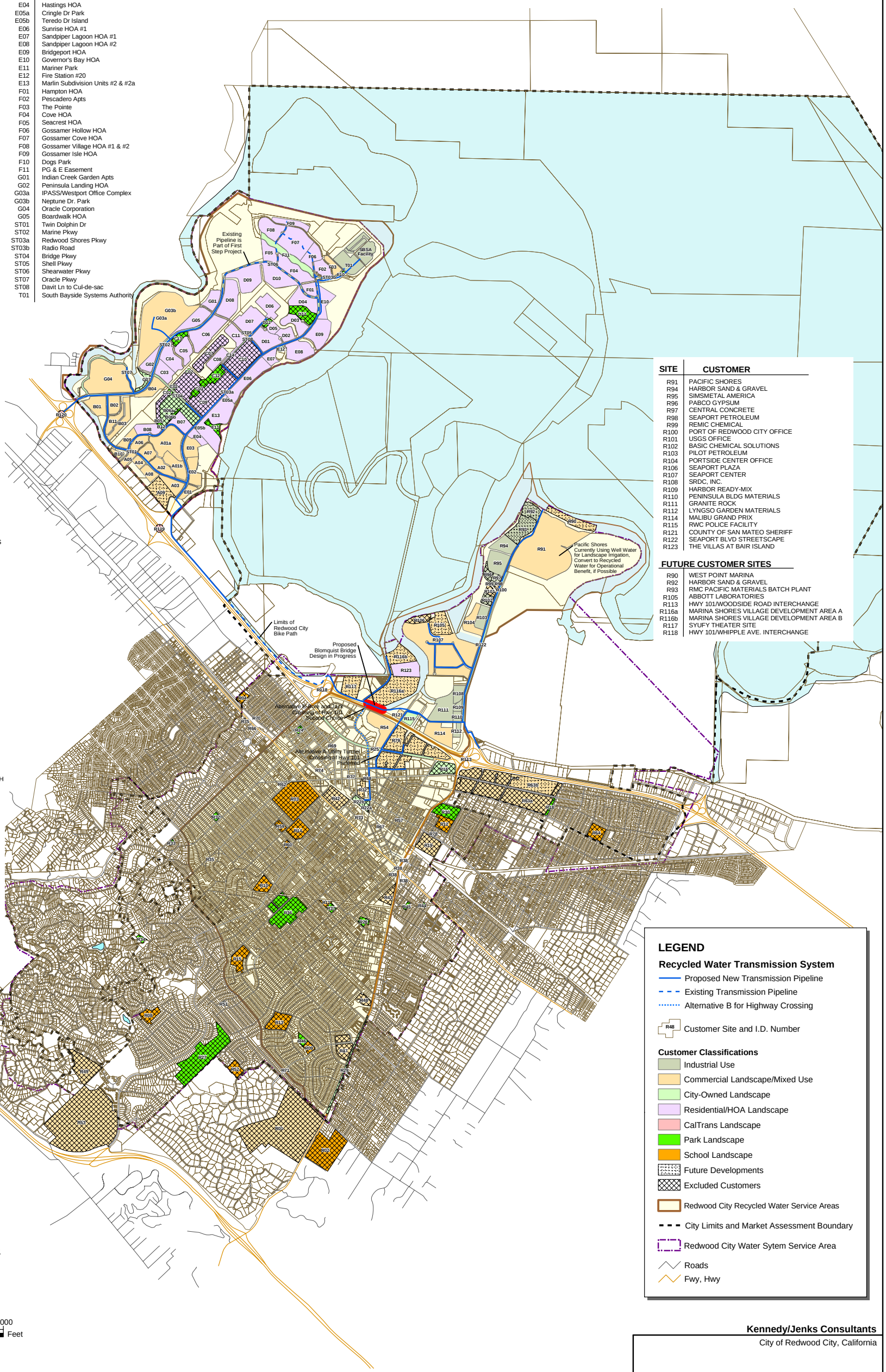
FUTURE CUSTOMER SITES

A09	Vacant Parcel
G07	Redwood Shores Branch Library
R119	Hwy 101/RedwoodShores Pkwy Interchange
R120	Hwy 101/Marine World Pkwy Interchange

SITE	CUSTOMER
R01	MENLO COUNTRY CLUB
R02	WOODSIDE HIGH SCHOOL
R03	SEQUOIA HIGH SCHOOL
R04	REDWOOD HIGH SCHOOL
R08	ROY CLOUD ELEMENTARY SCHOOL
R09	HENRY FORD ELEMENTARY SCHOOL
R10	JOHN GILL ELEMENTARY SCHOOL
R11	HAWES ELEMENTARY SCHOOL
R12	HOOVER ELEMENTARY SCHOOL
R13	KENNEDY MIDDLE SCHOOL
R14	McKINLEY ELEMENTARY SCHOOL
R15	ROOSEVELT ELEMENTARY SCHOOL
R16	CITY OF REDWOOD CITY PUBLIC WORKS
R18	ANDREW SPINAS PARK
R19	PRICE CLUB ISLANDS
R20	EL CAMINO REAL MEDIANS
R22a	LIBRARY
R22b	CITY HALL
R24	MEZES PARK
R25	VETERANS BLVD MEDIAN
R26	PALM PARK
R27	STULSAFT PARK
R29	WOODSIDE ROAD MEDIAN
R30	HOOVER PARK
R32	STAFFORD PARK
R33	DOVE BEEGER CITY PARK
R34	GEORGE GARRET PARK
R35	DUNCAN PARK
R36	RED MORTON PARK
R37	HAWES PARK
R38	WOODSIDE/EL CAMINO INTERCHANGE
R42	SEQUOIA STATION SHOPPING CENTER
R43	UNION CEMETERY
R44	LINDEN PARK
R45	FLEISHMAN PARK
R46	MADDUX PARK
R47	WOODSIDE PLAZA SHOPPING CENTER
R48	ST. PIUS SCHOOL
R49	EMERALD HILLS GOLF COURSE
R51	WESTWOOD PARK
R52	ADELANTE SCHOOL
R53	CANADA COLLEGE
R54	MERVYN'S SHOPPING PLAZA
R57	JARDIN DE NINOS PARK
R59	OUR LADY OF MT. CARMEL SCHOOL
R60	REDEEMER LUTHERAN SCHOOL/CHURCH
R62	UNITED METHODIST CHURCH
R63a	MIDPOINT TECHNOLOGY
R63b	MIDPOINT TECHNOLOGY (FUTURE)
R64	TAFT ELEMENTARY SCHOOL
R66	CAR WASH
R67	CITY LANDSCAPE ISLAND
R68	CITY PLANTERS
R69	STREET TREES
R70	CITY STREET TREES
R71	CITY LANDSCAPED ISLAND
R73	FRANKLIN HOUSING (APARTMENTS)

FUTURE CUSTOMER SITES

R72	DOWNTOWN AREA PLAN
R74	500 ARGUELLO STREET
R75	150 El CAMINO REAL
R76	885 WOODSIDE ROAD
R77	2170 BROADWAY (Downtown Cinema)
R78	2233 MIDDLEFIELD ROAD (Opfer Building)
R79	KAISER MASTER PLAN



SITE	CUSTOMER
R91	PACIFIC SHORES
R94	HARBOR SAND & GRAVEL
R95	SIMSMETAL AMERICA
R96	PABCO GYPSUM
R97	CENTRAL CONCRETE
R98	SEAPORT PETROLEUM
R99	REMIC CHEMICAL
R100	PORT OF REDWOOD CITY OFFICE
R101	USGS OFFICE
R102	BASIC CHEMICAL SOLUTIONS
R103	PILOT PETROLEUM
R104	PORTSIDE CENTER OFFICE
R106	SEAPORT PLAZA
R107	SEAPORT CENTER
R108	SRDC, INC.
R109	HARBOR READY-MIX
R110	PENINSULA BLDG MATERIALS
R111	GRANITE ROCK
R112	LYNGSO GARDEN MATERIALS
R114	MALIBU GRAND PRIX
R115	RWC POLICE FACILITY
R121	COUNTY OF SAN MATEO SHERIFF
R122	SEAPORT BLVD STREETSCAPE
R123	THE VILLAS AT BAIR ISLAND

FUTURE CUSTOMER SITES

R90	WEST POINT MARINA
R92	HARBOR SAND & GRAVEL
R93	RMC PACIFIC MATERIALS BATCH PLANT
R105	ABBOTT LABORATORIES
R113	HWY 101/WOODSIDE ROAD INTERCHANGE
R116a	MARINA SHORES VILLAGE DEVELOPMENT AREA A
R116b	MARINA SHORES VILLAGE DEVELOPMENT AREA B
R117	SYUFY THEATER SITE
R118	HWY 101/WHIPPLE AVE. INTERCHANGE

LEGEND

Recycled Water Transmission System

- Proposed New Transmission Pipeline
- Existing Transmission Pipeline
- Alternative B for Highway Crossing
- Customer Site and I.D. Number

Customer Classifications

- Industrial Use
- Commercial Landscape/Mixed Use
- City-Owned Landscape
- Residential/HOA Landscape
- CalTrans Landscape
- Park Landscape
- School Landscape
- Future Developments
- Excluded Customers
- Redwood City Recycled Water Service Areas
- City Limits and Market Assessment Boundary
- Redwood City Water Sytem Service Area
- Roads
- Fwy, Hwy

N W E S

0 2,000 4,000 Feet

Source:
Redwood City Planning Division
GIS Basemap

Kennedy/Jenks Consultants
City of Redwood City, California

ALTERNATIVE TF
RECYCLED WATER PROJECT

Project No: 040501.00
June 2004
Plate 1

FIGURE 2: Menlo Country Club Feasibility Study for Developing an Alternative Water Supply for Golf Course Irrigation

Kennedy/Jenks Consultants
Engineers & Scientists

REDWOOD CITY RECYCLED WATER SYSTEM
Redwood City, California

Redwood City California Founded 1867

SITE	CUSTOMER
A01	Electronics Art
A02	Paragon Center
A03	Macromedia
A04	Instill Corp
A05	RealNames (Speiker Properties)
A06	Provident Central Credit Union
A07	ERI Dolphin
A08	Harris Farnon
B01	Oracle Corporation
B02	The Shores Business Center
B03	Emery Worldwide (Oracle)
B04	Marina Park Center
B05	Dolphin Unit 2
B06	Dolphin Unit 1
B07	Co-op Housing
B08	Shore Breeze HOA
B09	Hotel Sofitel
B10	Executive Guild (Westshore Office Park)
B11	San Mateo County Office of Education
B12	Dolphine Park
C01	Starboard Park
C02	Park (Starboard Dr & Bark Dr)
C03	Pelican Cove HOA
C04	Shorebird Solar HOA
C05	Shorebird Island HOA
C06	Beacon Shores HOA #1 & #2
C07	Islands (Marlin Ct)
C08	Seabridge Community Association
C09	Harbor Colony
C10	Marlin Subdivision Unit #1 & #6
C11	Lighthouse Cove HOA
C12	Marlin Park
C13	Park
C14	Davit Lane Parcel
D01	Redwood Shores Apts
D02	Harborside Apts
D03	Regatta HOA
D04	Stratford Bay HOA #1 & #2
D05	Manors HOA
D06	Ventana Del Mar HOA #1 & #2
D07	Lakeshore Townhomes #1 & #2
D08	Laguna Pointe HOA
D09	Harbor Court HOA
D10	The Shores HOA
D11	Sandpiper School/Park
D12	Shannon Park

FUTURE CUSTOMER SITES

A09	Vacant Parcel

SITE	CUSTOMER
E01	Adecco (Slam Dunk Networks)
E02	Pacific Atletic Club (Western)
E03	Market Place
E04	Hastings HOA
E05	Cringle Dr Park
E06	Sunrise HOA #1
E07	Sandpiper Lagoon HOA #1
E08	Sandpiper Lagoon HOA #2
E09	Bridgeport HOA
E10	Governor's Bay HOA
E11	Mariner Park
E12	Fire Station #20
F01	Hampton HOA
F02	Pescadero Apts
F03	The Pointe
F04	Cove HOA
F05	Seacrest HOA
F06	Gossamer Hollow HOA
F07	Gossamer Cove HOA
F08	Gossamer Village HOA #1 & #2
F09	Gossamer Isle HOA
F10	Dogs Park
F11	P G & E Easement
G01	Indian Creek Garden Apts
G02	Peninsula Landing HOA
G03	IPASS
G04	Oracle Corporation
G05	Boardwalk HOA
G06	Belmont Sports Complex
R119	Holley Street Interchange
R120	Ralston Street Interchange
ST01	Twin Dolphin Dr
ST02	Marine Pkwy
ST03	Redwood Shores Pkwy
ST04	Bridge Pkwy
ST05	Shell Pkwy
ST06	Shearwater Pkwy
ST07	Oracle Pkwy
ST08	Davit Ln to Cul-de-sac

SITE	CUSTOMER
R01	MENLO COUNTRY CLUB
R02	WOODSIDE HIGH SCHOOL
R03	SEQUOIA HIGH SCHOOL
R04	REDWOOD HIGH SCHOOL
R08	ROY CLOUD ELEMENTARY SCHOOL
R09	HENRY FORD ELEMENTARY SCHOOL
R10	JOHN GILL ELEMENTARY SCHOOL
R11	HAWES ELEMENTARY SCHOOL
R12	HOOVER ELEMENTARY SCHOOL
R13	KENNEDY MIDDLE SCHOOL
R14	McKINLEY ELEMENTARY SCHOOL
R15	ROOSEVELT ELEMENTARY SCHOOL
R16	CITY OF REDWOOD CITY PUBLIC WORKS
R18	ANDREW SPINAS PARK
R19	PRICE CLUB ISLANDS
R20	EL CAMINO REAL MEDIANS
R22	LIBRARY
R24	MEZES PARK
R25	VETERANS ROAD MEDIAN
R26	PALM PARK
R27	STULSAFT PARK
R29	WOODSIDE ROAD MEDIAN
R30	HOOVER PARK
R32	STAFFORD PARK
R33	DOVE BEEGER CITY PARK
R34	GEORGE GARRET PARK
R35	DUNCAN PARK
R36	RED MORTON PARK
R37	HAWES PARK
R38	WOODSIDE/EL CAMINO INTERCHANGE
R42	SEQUOIA STATION SHOPPING CENTER
R43	UNION CEMETERY
R44	LINDEN PARK
R45	FLEISHMAN PARK
R46	MADDUX PARK
R47	WOODSIDE PLAZA SHOPPING CENTER
R48	ST. PIUS SCHOOL
R49	EMERALD HILLS GOLF COURSE
R51	WESTWOOD PARK
R52	ADELANTE SCHOOL
R53	CANADA COLLEGE
R54	MERVYN'S SHOPPING PLAZA
R55	KAISER
R57	JARDIN DE NINOS PARK
R59	OUR LADY OF MT. CARMEL SCHOOL
R60	REDEEMER LUTHERAN SCHOOL/CHURCH
R62	UNITED METHODIST CHURCH
R63	MIDPOINT TECHNOLOGY
R64	TAFT ELEMENTARY SCHOOL
R66	CAR WASH
R68	CITY PLANTERS
R69	STREET TREES
R70	CITY STREET TREES
R71	CITY LANDSCAPED ISLAND

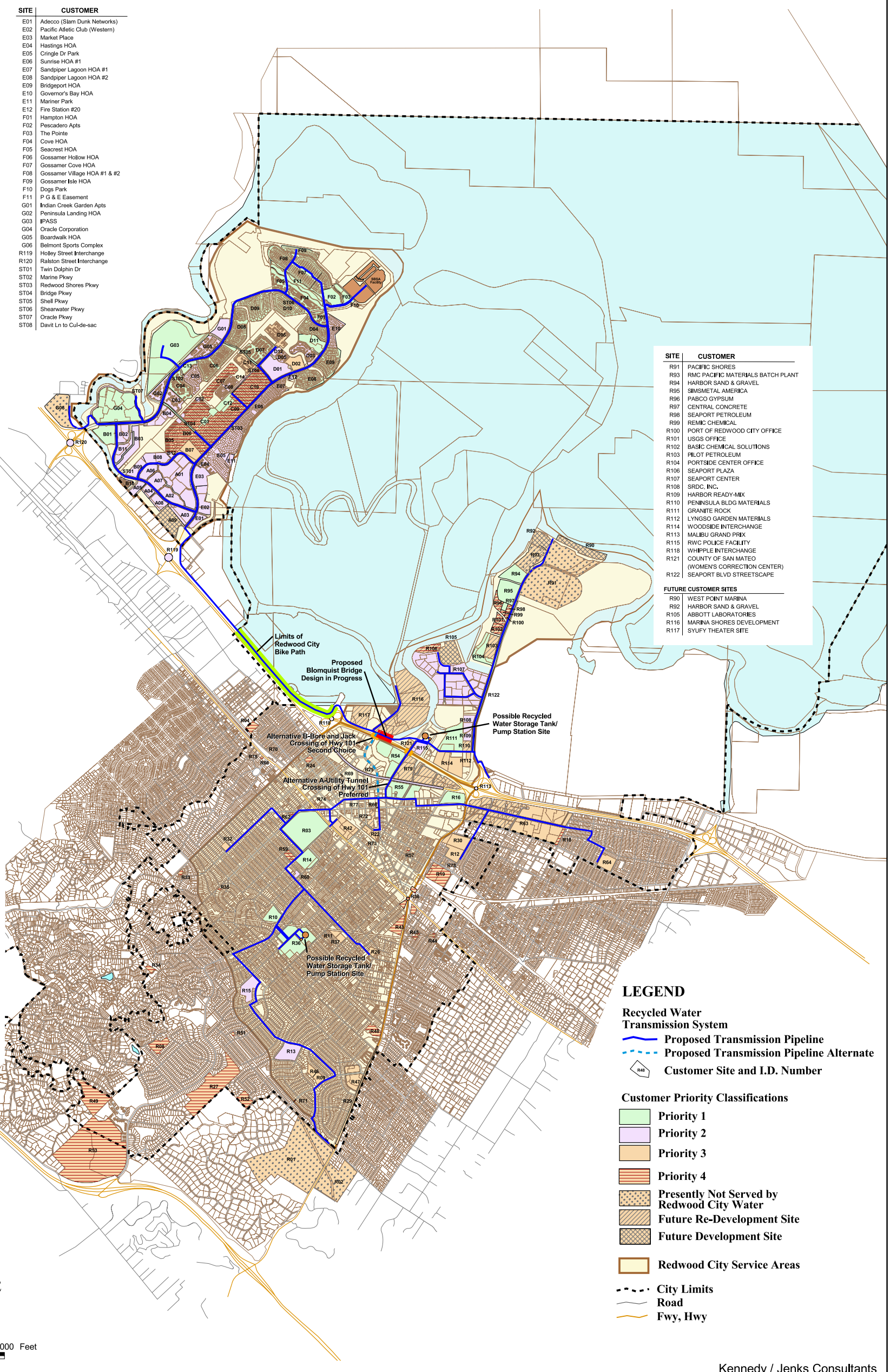
FUTURE CUSTOMER SITES

R72	DOWNTOWN AREA PLAN
R73	FRANKLIN HOUSING (APARTMENTS)
R74	500 ARGUELLO STREET
R75	150 El CAMINO REAL
R76	885 WOODSIDE ROAD
R77	2170 BROADWAY (Downtown Cinema)
R78	2233 MIDDLEFIELD ROAD (Opfer Building)
R79	KAISER MASTER PLAN

SITE	CUSTOMER
R91	PACIFIC SHORES
R93	RMC PACIFIC MATERIALS BATCH PLANT
R94	HARBOR SAND & GRAVEL
R95	SIMSMETAL AMERICA
R96	PABCO GYPSUM
R97	CENTRAL CONCRETE
R98	SEAPORT PETROLEUM
R99	REMIC CHEMICAL
R100	PORT OF REDWOOD CITY OFFICE
R101	USGS OFFICE
R102	BASIC CHEMICAL SOLUTIONS
R103	PILOT PETROLEUM
R104	PORTSIDE CENTER OFFICE
R106	SEAPORT PLAZA
R107	SEAPORT CENTER
R108	SRDC, INC.
R109	HARBOR READY-MIX
R110	PENINSULA BLDG MATERIALS
R111	GRANITE ROCK
R112	LYNGSO GARDEN MATERIALS
R114	WOODSIDE INTERCHANGE
R113	MALIBU GRAND PRIX
R115	RWC POLICE FACILITY
R118	WHIPPLE INTERCHANGE
R121	COUNTY OF SAN MATEO (WOMEN'S CORRECTION CENTER)
R122	SEAPORT BLVD STREETSCAPE

FUTURE CUSTOMER SITES

R90	WEST POINT MARINA
R92	HARBOR SAND & GRAVEL
R105	ABBOTT LABORATORIES
R116	MARINA SHORES DEVELOPMENT
R117	SYUFY THEATER SITE



LEGEND

Recycled Water Transmission System
- Proposed Transmission Pipeline
- Proposed Transmission Pipeline Alternate
- Customer Site and I.D. Number

Customer Priority Classifications
- Priority 1
- Priority 2
- Priority 3
- Priority 4
- Presently Not Served by Redwood City Water
- Future Re-Development Site
- Future Development Site
- Redwood City Service Areas
- City Limits
- Road
- Fwy, Hwy

Source: Redwood City Redevelopment & Planning Division GIS Basemap

Kennedy / Jenks Consultants

Water Recycling Feasibility Study for Redwood City

FINAL REPORT
POTENTIAL CUSTOMERS AND DISTRIBUTION SYSTEM COMPONENTS

Project No.: 020506.03
August 7, 2002

Plate 1

FILE REFERENCE: N:\2002\020506.03\PRV\CIB\KJ_Projects\02_0715_draft\02_0715_v01.apr
LAYOUT: fig_D_Plate_1
DATE: July 30, 2002 7:39 AM

FIGURE 3: Menlo Country Club Feasibility Study for Developing an Alternative Water Supply for Golf Course Irrigation

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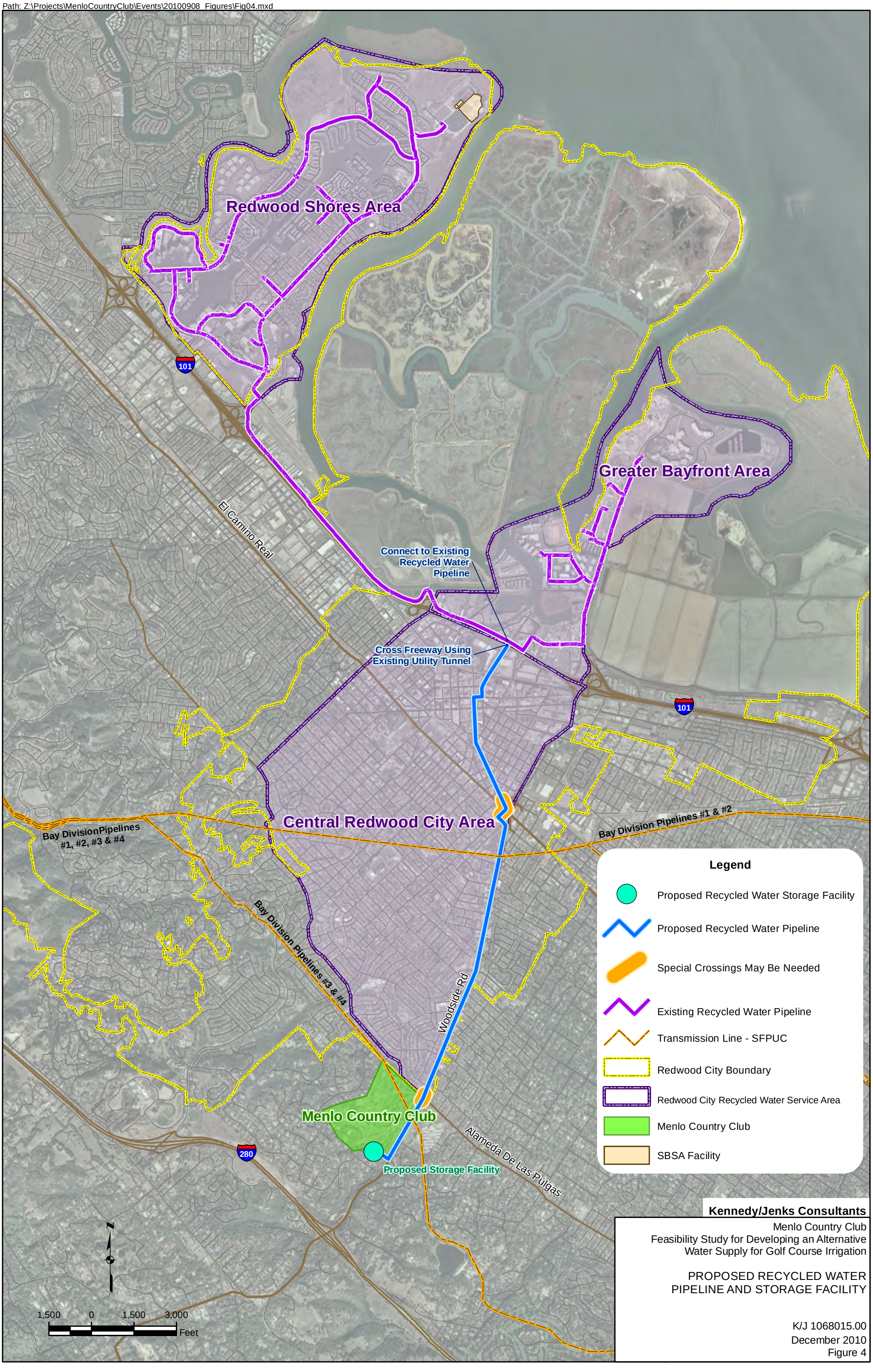

Kennedy/Jenks Consultants

Menlo Country Club
Feasibility Study for Developing an Alternative Water Supply for Golf Course Irrigation

PROPOSED RECYCLED WATER PIPELINE AND STORAGE FACILITY

K/J 1068015.00
December 2010
Figure 4

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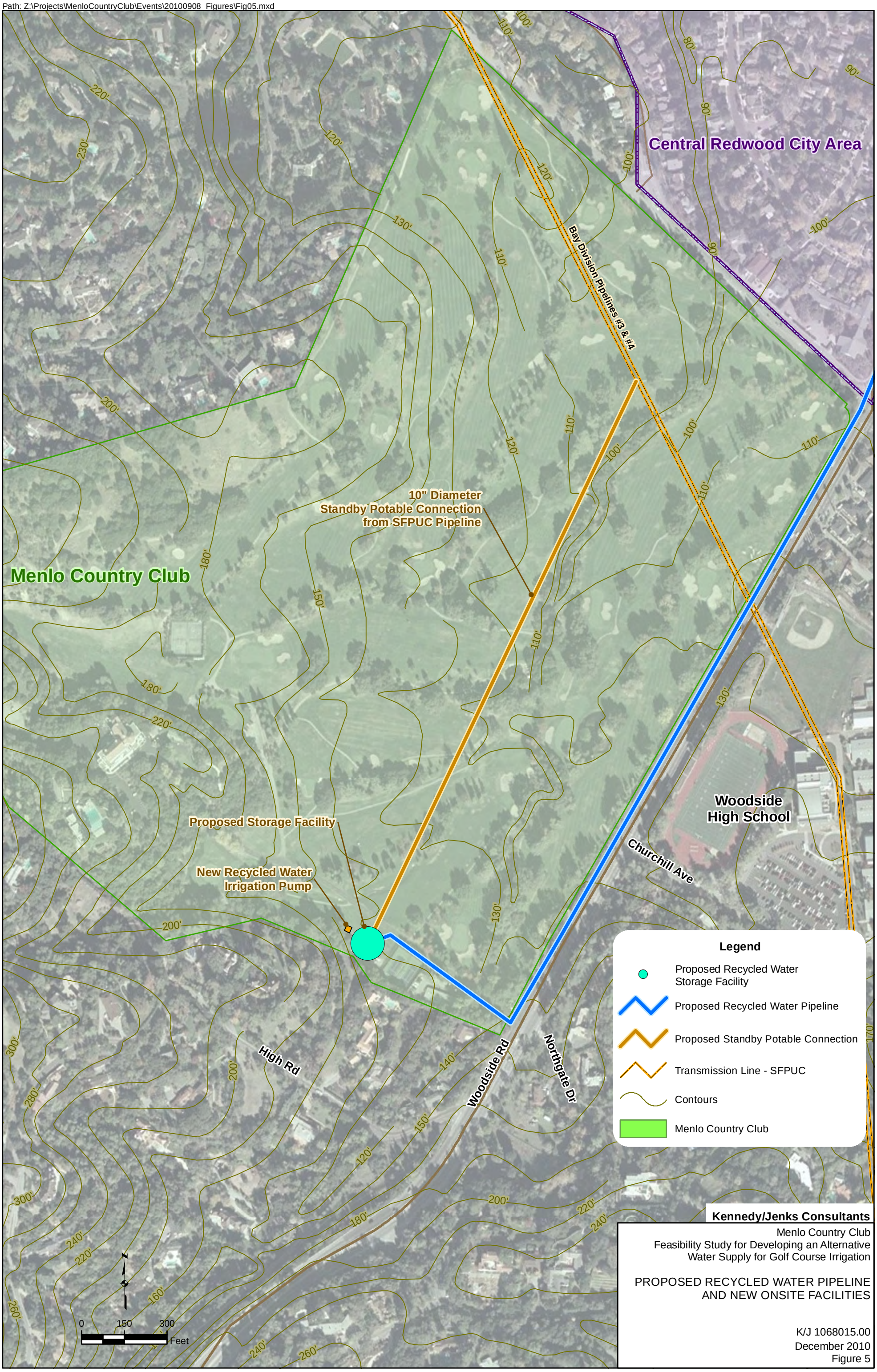


BLUE 70.9/127 MEN	WHITE 69.4/125 MEN	GREEN 67.6/121 MEN	STROKE HOLES	PAR					HOLE			PAR	STROKE HOLES	GREEN 72.6/126 WOMEN
394	355	319	12	4					1			4	12	319
410	392	392	6	4					2			5	4	400
376	364	348	8	4					3			4	8	348
183	173	145	16	3					4			3	16	145
519	498	467	2	5					5			5	2	467
330	320	306	14	4					6			4	14	306
379	370	352	10	4					7			4	10	352
175	165	134	18	3					8			3	18	134
379	373	359	4	4					9			4	6	359
3145	3010	2822		35					OUT			36		2830
361	342	327	9	4					10			4	9	327
388	372	324	11	4					11			4	11	324
524	510	481	3	5					12			5	1	481
201	187	171	13	3					13			3	15	171
429	405	405	1	4					14			5	3	411
319	293	259	15	4					15			4	13	259
160	154	130	17	3					16			3	17	130
400	385	340	5	4					17			4	7	340
393	384	368	7	4					18			4	5	368
3175	3032	2805		35					IN			36		2811
6320	6042	5627		70					TOTAL			72		5641
HANDICAP												HANDICAP		
NET SCORE												NET SCORE		

FIGURE 6: Menlo Country Club Feasibility Study for Developing an Alternative Water Supply for Golf Course Irrigation

Section 5: Recycled Water Supply Potential: Onsite Satellite Treatment System

The concept of using decentralized treatment systems to serve recycled water to customers has been considered for many years, and a cursory assessment of this alternative is provided.

5.1 Facilities General Description

Satellite facilities are typically more expensive and complex to implement and operate than centralized treatment schemes. However, satellite treatment facilities can be viable in the following situations:

- where there are complex water and wastewater issues that need to be addressed, or
- when the costs of using more conventional approaches are high in comparison or are technically infeasible.

For example, consider a case in which a new non-potable water supply was desired, and the costs of connecting to either local groundwater resources or existing recycled water systems was much higher than the cost of constructing new satellite treatment facilities. To justify satellite treatment, a life-cycle cost evaluation of capital and operating costs and avoided implementation costs could be performed to determine if a reasonable payback period existed as compared to the conventional options. Avoided implementation costs include regulatory permitting, compliance with the California Environmental Quality Act, institutional agreements, land purchases and ROW acquisition, and operations. If the conceptual capital costs for constructing new satellite treatment facilities are not significantly lower than the costs for providing local groundwater or connecting to an existing recycled water system, the satellite treatment option becomes undesirable from cost, implementation, schedule and operating perspectives.

A conceptual-level schematic of a typical satellite system is included as Appendix E. A conceptual-level Capital Cost Curve for satellite treatment is included in Appendix F[5]. The cost curve has been adjusted to reflect 2010 pricing for this study, using the Engineering News Record construction cost index.

5.2 Facilities Overview

The satellite treatment option includes both offsite and onsite facilities. See Appendix E for a conceptual facilities schematic.

[5] Satellite treatment facilities conceptual level cost estimate is based on a 2003 study by the North Bay Watershed Association for a facility in Novato, CA. The 2003 costs have been adjusted to 2010 dollars using the Engineering News Record Construction Cost Index.

5.2.1 Offsite Facilities

Offsite facilities include the connection to the wastewater source, a pump to deliver wastewater to the onsite facilities, and a waste return line. Each of these is described in the following paragraphs.

- **Connection to Existing Wastewater Source** - For this evaluation, the wastewater source would be a larger diameter wastewater interceptor with a diurnal flow pattern that would be sufficient both for providing relatively consistent flow to the treatment facilities throughout the day and for maintaining adequate sewer flows to avoid solids deposition or odors in the sewer system. Flows in sewer systems vary significantly throughout the day. In typical residential based communities, the daily flow pattern begins with an early morning peak followed by a drop off during the day and a smaller evening peak, followed by a significant drop off through the night and early morning hours. In order to size the treatment facilities efficiently from both cost and operations perspective, it is important to find a location in the sewer system where flows throughout the day are greater than the peak day demand. It is also desirable to find a location in the sewer system where there is excess flow available, so the scalped flow to satellite treatment facilities can be diverted in a way that does not pull in excessive grit and solids from the bottom of the sewer or foam, grease and scum from the surface. Meeting these requirements avoids a need to upsize the treatment and pumping capacity (above the peak day demand) and avoids operating the treatment facilities when there is little or no inflow into the unit processes.

  Prior experience indicates that sewers with 5 to 10 times the peak day recycled water demand are a good starting point for a conceptual-level evaluation. Therefore, a sewer system location with average daily flow of between 3.5 and 7 MGD would be required to provide high quality scalping and coarse screening of the wastewater prior to pumping it to the treatment facility. Preliminary investigation indicates that the sewer lines in Woodside Road and Alameda de las Pulgas near Menlo CC do not appear to offer adequate flows to support a satellite recycled water treatment facility for Menlo CC. Further investigation would be required to determine the nearest sewer pipe that could provide an adequate source of wastewater for a 0.72 MGD satellite treatment facility.

- **Wastewater Pump Station** – A wastewater pump station and electrical service would be necessary at the connection to the wastewater system to pump wastewater through a force main to the satellite treatment facility. These remote facilities can be expensive and institutionally complex to site, obtain ROW and real property agreements, permit, operate and maintain.

- **Waste Activated Sludge (WAS) Return Line** – The treatment facilities would generate WAS and solids that are typically expensive to treat and dispose of onsite and therefore are returned to the sewer system. Because the volume of WAS is relatively small and the timing of its release can be managed, the connection point to the sewer does not require the same amount of tributary flow as does the source of wastewater for the treatment facilities.

5.2.2 Onsite Facilities

Onsite facilities include treatment equipment and ancillary equipment.

- **Treatment Facility**: Onsite facilities are primarily comprised of a small wastewater treatment facility. The most common technology that is used to meet Title 22 requirements for unrestricted use for recycled water is a membrane bio-reactor for physical and biological treatment, followed by ultraviolet light for disinfection. These systems are compact and can be housed in many types of structures, but they must be completely enclosed in residential areas to control blower noise and contain and treat odors that would develop (particularly from fine screenings).

- **Ancillary Facilities**: Ancillary onsite facilities include a fine screen and screenings handling approach (high odor generation), chemical storage and handling equipment, large blowers for the treatment process and odor control system, and associated electrical and control systems, including instrumentation required for real-time water quality monitoring for regulatory compliance requirements.

5.2.3 Preliminary Facilities Costs

Satellite treatment facilities at a small scale (under 2 MGD) have high unit costs compared to larger facilities (see curve in Appendix F), as would be the case for Menlo CC, which has an estimated Peak Day Demand of 0.72 MGD. The estimated conceptual cost for a satellite treatment option at Menlo CC is estimated to be $13M, as indicated on the cost curve in Appendix F (a facility size of 0.72 MGD at $18M per MGD).

A recent example of a similarly sized satellite project was a 0.2 MGD facility, expandable to 0.5 MGD, designed for the Presidio of San Francisco. The treatment site was located approximately 1,500 feet away from of a large diameter wastewater interceptor with adequate source flows. For comparison purposes, the planning, environmental compliance and permitting related costs for the Presidio Project were approximately $500,000 and required about 18 months to complete. There were many contentious community issues that needed to be resolved during the planning process, primarily related to odor, noise and chemical delivery/storage with adjacent land uses. Preliminary and Final Design costs were approximately $1M over a 9 month design period, and the facilities construction cost estimate for 0.2 MGD capacity (expandable to 0.5 MGD in the future) is currently estimated to be over $10M. The total project cost is $11.5M, not including ongoing operations contracts, reporting and O&M costs. The project did not include any offsite considerations for ROW and site acquisition. The Presidio is proceeding with this facility because it is a requirement of their Redevelopment EIR and because it would reduce their costs both for offsite wastewater treatment and disposal and for purchasing potable water. The return on investment for this project is about 15 years or more.

A satellite project for Menlo CC would cost more than the Presidio project, because it is approximately 50% larger in size and the closest source of adequate wastewater appears to be almost 2 miles away near the El Camino Real Corridor. Siting the buried wastewater pump station in this area would also be challenging, costly, and likely would require detailed

institutional arrangements to obtain the rights to the wastewater flow and to site the facilities on offsite private or public property.

5.3 Summary

Based on the preliminary analysis, a satellite treatment project at Menlo CC is estimated to have a capital cost of $13M or more and is considered a complex option to implement due to the following issues:

- Offsite and onsite facilities siting requirements and ROW acquisition
- Institutional and regulatory complexities
- Potential for onsite and offsite odor issues
- Overall facilities cost
- CEQA compliance requirements
- Operations and maintenance services procurement and costs

Section 6: Conclusion and Recommendations

6.1 Conclusion

Three alternative sources for golf course irrigation were investigated for Menlo CC:

1. Groundwater from local wells;
2. Recycled water from the Redwood City system; and
3. Recycled water from a new onsite satellite treatment facility.

The most feasible alternative water supply to consider further is the use of recycled water from Redwood City. The other alternatives do not appear to be as desirable; adequate and reliable groundwater resources are not currently available, and onsite satellite treatment is significantly more expensive and complex to implement. In addition, there are potential partnership opportunities to explore between Menlo CC, the SFPUC, and Redwood City that possibly could reduce the cost of providing service to Menlo CC for the following reasons:

- Redwood City is exploring various ways to expand its recycled water system to serve new customers. The existing distribution system has significant excess daytime transmission capacity available to convey recycled water to Menlo CC and other users.
- Constructing a new storage facility at Menlo CC may provide operating benefits to the overall Redwood City recycled water distribution system, by potentially attenuating system pressure losses during peak demand periods. There may be an opportunity to upsize the new offsite pipelines to Menlo CC and the new onsite storage facility at Menlo CC to provide additional benefits to Redwood City (pressure stabilization and capacity). Additional opportunities may include cost sharing on a capacity basis, or other equitable arrangement.
- The SFPUC is seeking to develop alternative water supplies (conservation, groundwater and recycled water) to diversify its water supplies and reduce demands on its Regional Water System. Menlo CC is a retail customer of the SFPUC whose irrigation demands are currently met with potable water from the Regional Water System. Replacing irrigation supply with a different and appropriate water supply would be a beneficial potable offset for the SFPUC.

6.2 Recommendations

The following paragraphs outline possible next steps for Menlo CC, the SFPUC, and other potential partners to consider:

6.2.1 Site-Specific Water Quality/Soil/Turf Evaluation

A site specific evaluation is suggested to confirm the acceptability of using Redwood City's recycled water for irrigation. This evaluation should be performed by a landscape irrigation specialist with experience in evaluating soil, recycled water and turf/plant interactions. Based upon feedback from existing Redwood City irrigation customers and the successful use of recycled water at many other local golf courses, it expected that Redwood City's recycled water would be appropriate for Menlo CC's irrigation needs. However, it is important to confirm this assumption and obtain the consensus and buy-in from operating staff and Menlo CC's Board of Directors. The cost for performing such an evaluation might range from $5,000 to $10,000 and could be completed in about 4 to 6 weeks. It might also be beneficial for Menlo CC's operations staff to speak with the Northern California Golf Association's Environmental and Water Resources personnel and/or operating personnel at other courses about their experiences using recycled water for golf course irrigation.

6.2.2 Financial Evaluation

Using the conceptual level cost estimate for connecting to the Redwood City recycled water system, the payback period for the Menlo CC Only scenario should be determined. This evaluation should include the proposed SFPUC rate increases and Redwood City's recycled water rates to determine the return on an investment in new facilities to serve the irrigation needs of Menlo CC. The potential cost impacts of droughts (both duration and intensity) or other operating conditions that could limit Menlo CC's ability to obtain potable water supply and/or increase potable water costs should be included. This evaluation is likely to cost $5,000 to $7,000 if performed by a consultant.

6.2.3 Alternatives Analysis

Menlo CC and the SFPUC should meet with Redwood City[6] representatives to discuss the merits of expanding its recycled water project in connection with one or more of the following options, including:

1. Phase 2 Project Feasibility – Includes expanding the existing Phase 1 recycled water project to serve only new Redwood City customers on the west side of Highway 101. This would represent Redwood City's "base case" alternative for a stand-alone project. Planning is currently underway by Redwood City staff and commitments for service are being explored with several customers. Understanding Redwood City's base case in conjunction with the Menlo CC base case presented in this study would provide a foundation for exploring the advantages and disadvantages of other alternatives.

2. Phase 2+ Project Feasibility – Builds on Phase 2 and includes new Redwood City and non-Redwood City customers between the proposed system connection and Menlo CC. Phase 2+ includes an extension of the Phase 2 project, in order to serve other non-Redwood City customers in the vicinity of Menlo CC, such as Woodside High

[6] SBSA should be consulted if the demands of any project alternative change the existing agreement for facilities and operations, cost sharing, or if recycled water demands exceed the contributions of Redwood City to SBSA. This is not expected to be an issue for the Menlo CC base case, but should be evaluated as part of a follow-up study or alternatives analysis.

School. Increasing the size of Redwood City's new recycled water distribution pipelines and the new onsite storage facility at Menlo CC to accommodate additional customers likely would help stabilize system pressures and improve overall system reliability. Additionally, this would allow Redwood City to deliver more recycled water, thereby increasing the cost effectiveness of the recycled water facilities and further reducing potable water demands on the SFPUC Regional Water System. An assessment of Redwood City's existing CEQA documentation should also be performed to assess the requirements and timeline for supplemental CEQA work that would likely be required to implement this alternative (changed facilities siting, alignments, and project area). Because non-Redwood City customers would be served under this alternative, institutional agreements likely would be necessary to lay out the terms and conditions for use of Redwood City's recycled water.

3. Regional Program – Builds on the Phase 2+ alternative and includes other major potential customers in the vicinity of Menlo CC, such as the Sharon Heights Golf Course, Canada College, and the Stanford Linear Accelerator. The next steps for evaluating this alternative include the following:

    a. Confirming recycled water demands for each potential customer,

    b. Determining the interest of each potential customer in using recycled water,

    c. Evaluating if the capacity and existing facilities of the Redwood City recycled water system can accommodate the demands,

    d. Developing a conceptual level facilities plan and cost for serving the new customers, and

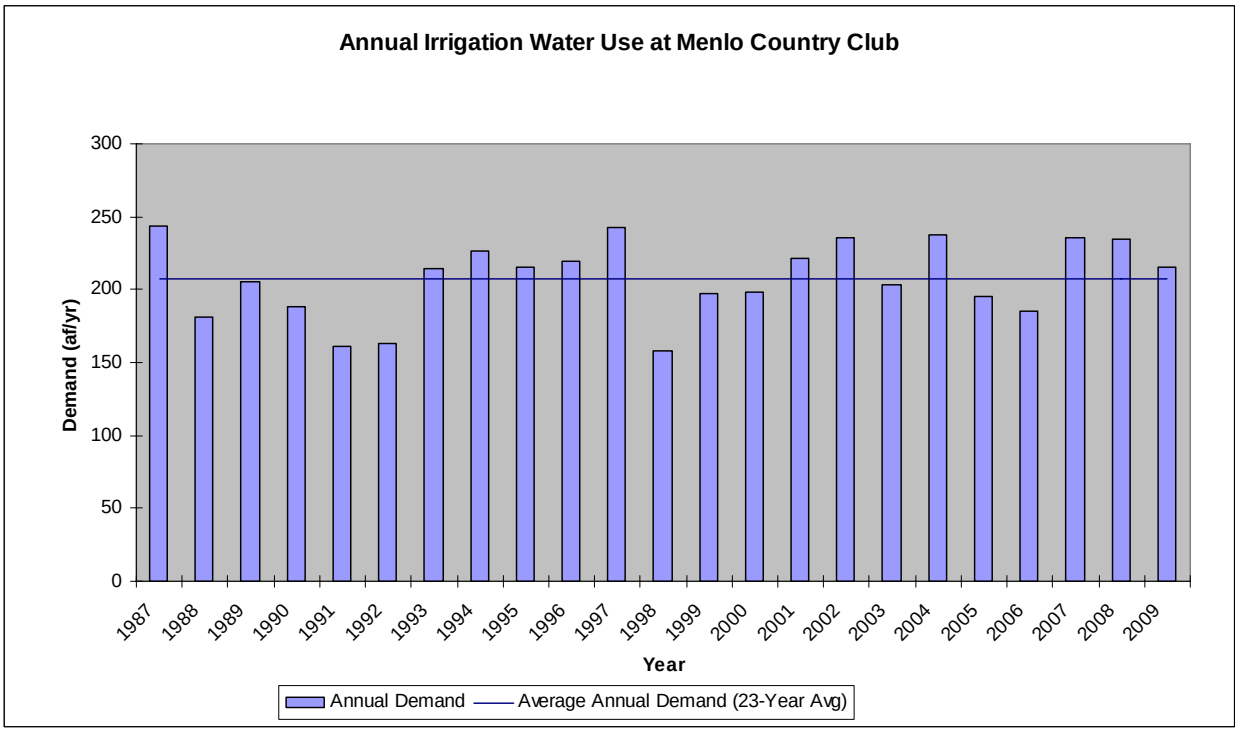
    e. Determining the required CEQA requirements and any institutional arrangements that would be necessary to implement the alternative.

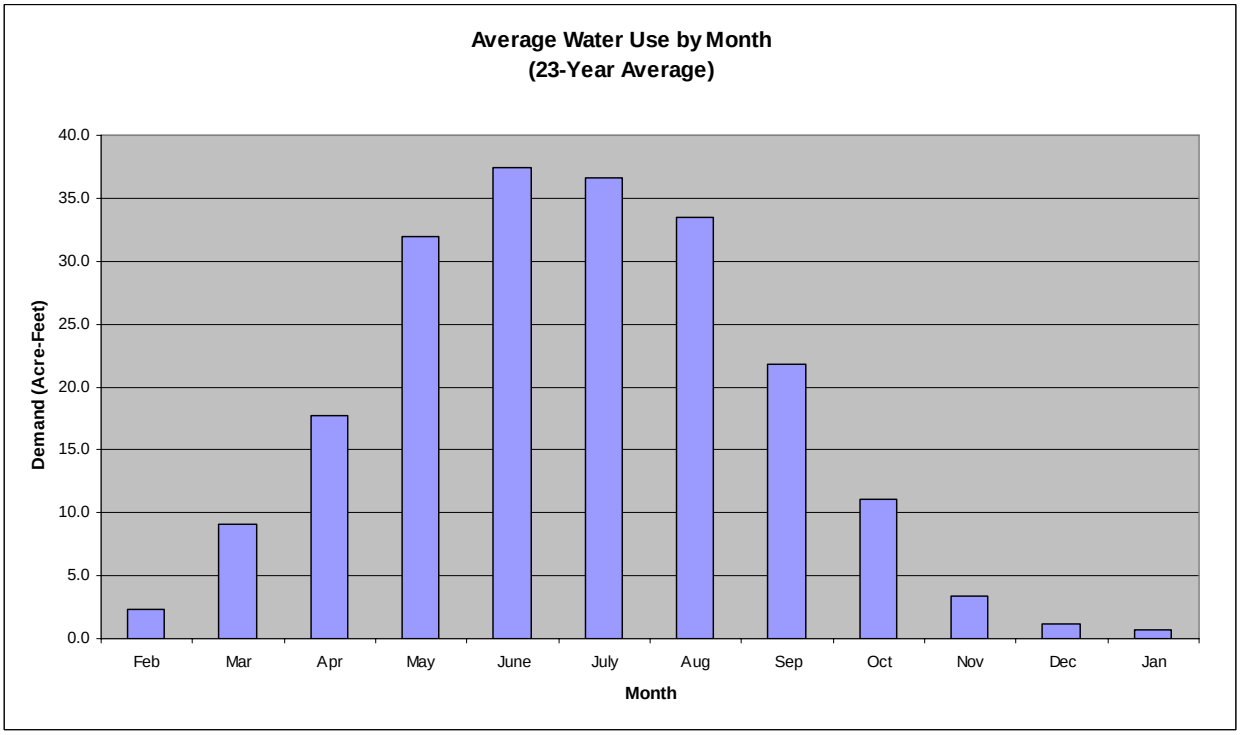
Similar expansion opportunities could be considered and evaluated with other SBSA partner agencies (City of Belmont, San Carlos, etc.) or non-SBSA partners like Foster City. The Regional Program alternative could include several sub-alternatives that would identify and evaluate the advantages and disadvantages affiliated with serving different customers.

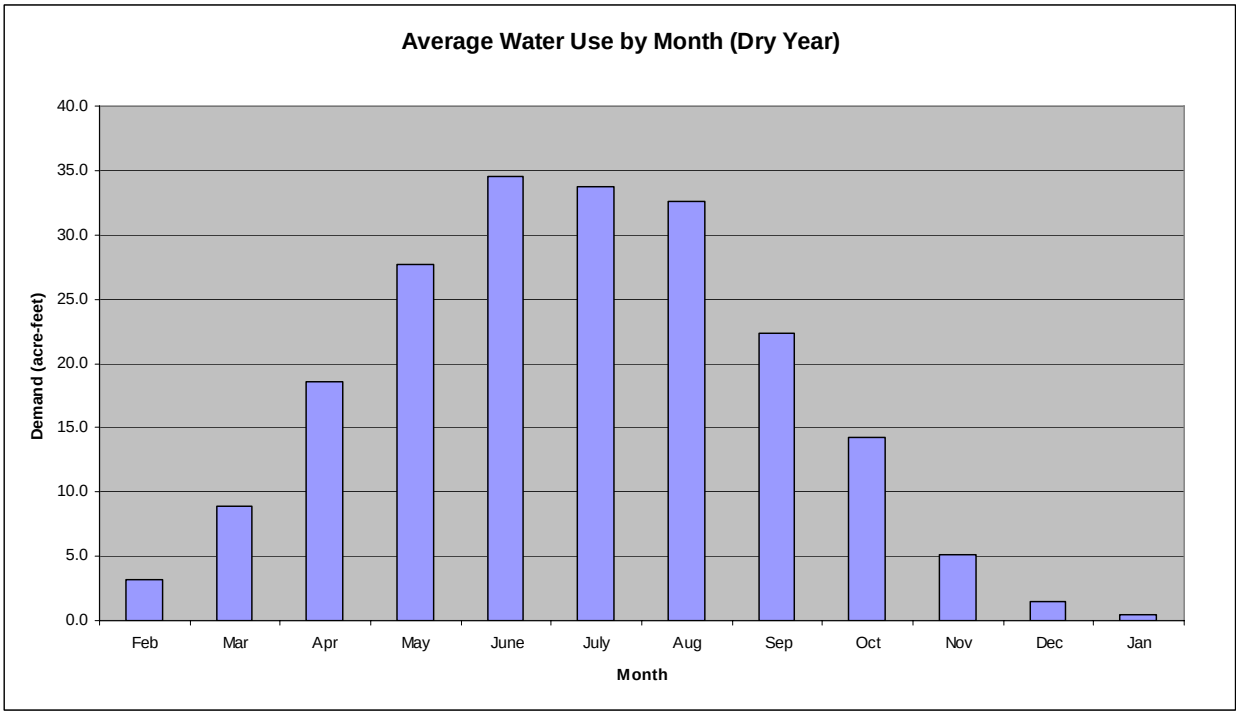
Understanding the additional investments needed to implement any of these alternatives and integrating the desire to preserve future flexibility would likely be important factors for Redwood City to evaluate before any decisions about a Phase 2 project can be made.

Information from this analysis would be useful to support discussions between Menlo CC, SFPUC and Redwood City about potential partnering opportunities for a recycled water project. In addition, an evaluation of potential funding avenues that might be enhanced by a project partnership could be explored.

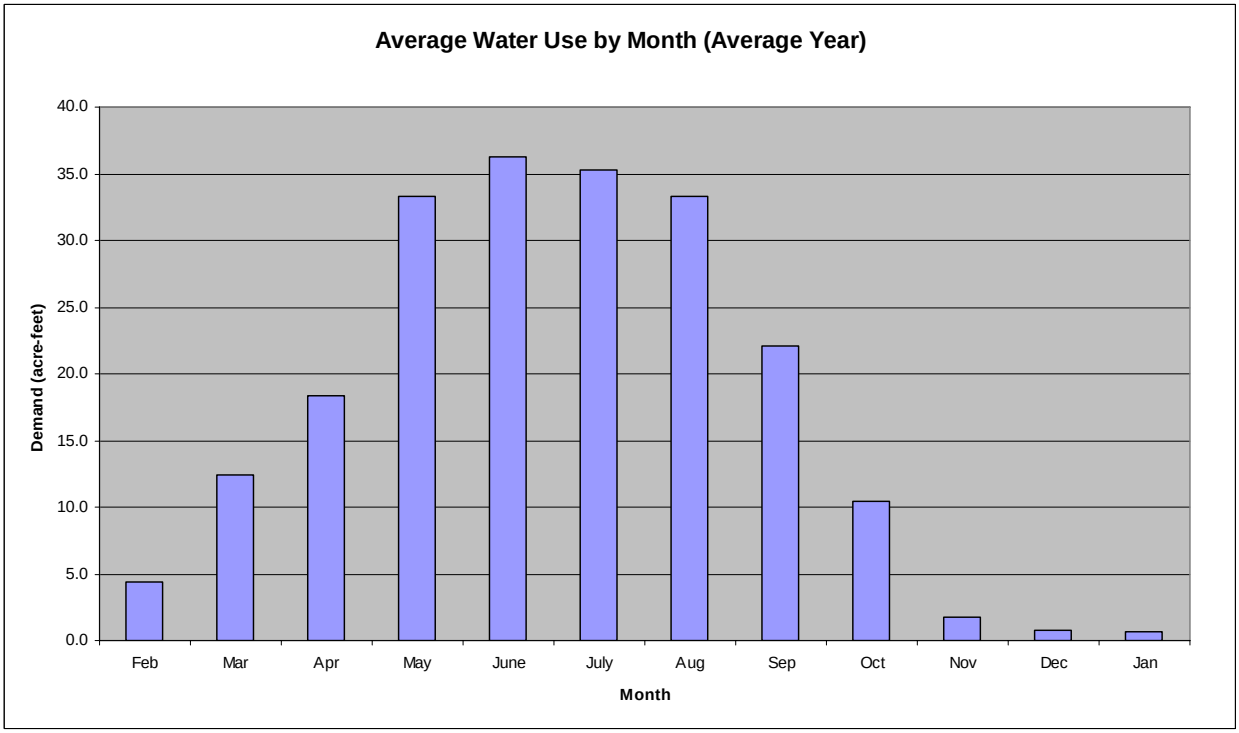
Appendix A: Menlo CC Irrigation Water Demand Patterns


Annual Irrigation Water Use at Menlo Country Club
Demand (af/yr)
300
250
200
150
100
50
0
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Year
Annual Demand
Average Annual Demand (23-Year Avg)

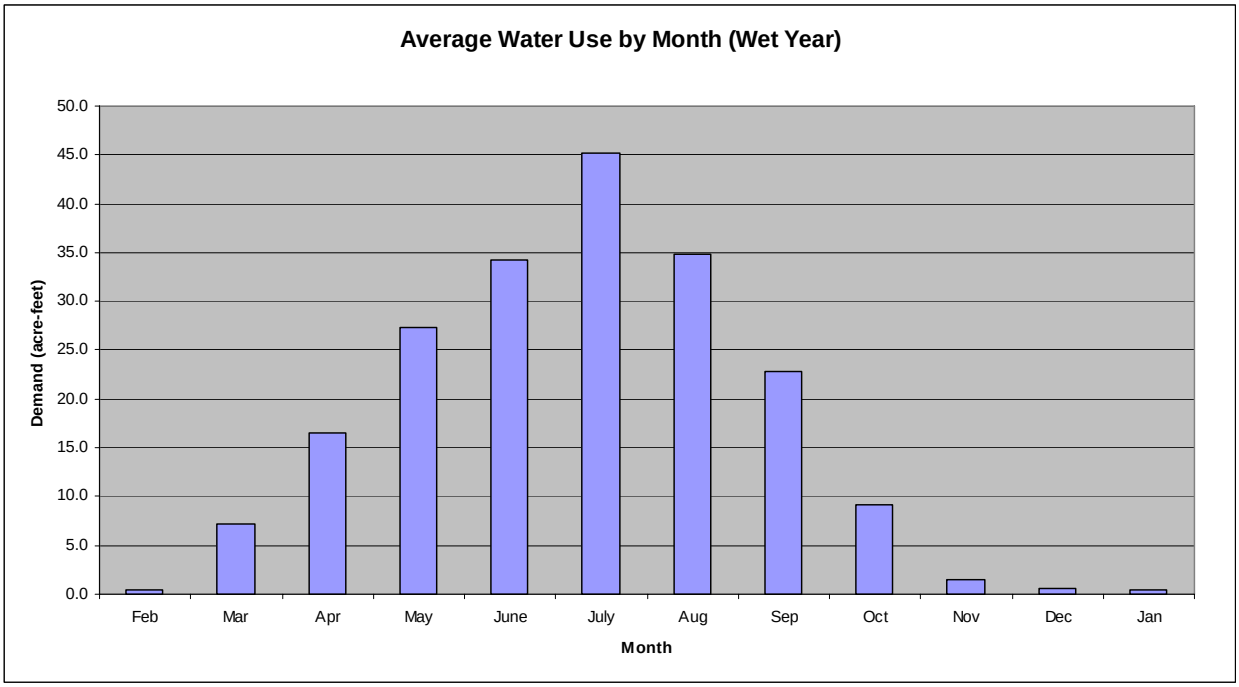

Average Water Use by Month
(23-Year Average)
Demand (Acre-Feet)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Feb
Mar
Apr
May
June
July
Aug
Sep
Oct
Nov
Dec
Jan
Month



Dry Years (precipitation is less than 75% of average): 1988, 1989, 1990, 2007



Average Precipitation Years: 1992, 1997, 2001



Wet Years (precipitation is more than 125% of average rainfall):1995, 1996, 1998

Appendix B: Evapotranspiration and Precipitation Data and Estimated Irrigation Demands for Menlo CC

Evapotranspiration and Precipitation and Estimated Irrigation Demands for Menlo CC

Month	Average Precipitation[a] (inches)	Average Reference ETo[b] (inches)	Average-Year Irrigation Demand[c] (inches)	Dry-Year Irrigation Demand[d] (inches)	Theoretical Irrigation Demands[e] (acre-feet)	Average Irrigation Demands[f] (acre-feet)
January	5.95	1.86	0	0	0	0.7
February	5.66	2.24	0	0	0	2.3
March	4.47	3.72	0	0	0	9.1
April	1.75	4.8	3.05	4.8	25.4	17.7
May	0.68	5.27	4.59	5.27	38.3	31.9
June	0.14	5.7	5.56	5.7	46.3	37.5
July	0.03	5.58	5.55	5.58	46.3	36.6
August	0.13	5.27	5.14	5.27	42.8	33.4
September	0.25	4.2	3.95	4.2	32.9	21.9
October	1.29	3.41	2.12	3.41	17.7	11.1
November	3.76	2.4	0	0	0	3.4
December	5.44	1.86	0	0	0	1.1
Total	**29.55**	**46.31**	**29.96**	**34.23**	**250**	**207**
Average			**4.28**			
Peak			**5.56**	**5.7**		

(a) Source: Western Regional Climate Center, Woodside Fire Station 1
(b) Source: California Irrigation Management Information System (CIMIS) ETo Zone Map, Zone 3.
(c) Irrigation demand = ETo - Precipitation; irrigation demand = 0 in months when precipitation exceeds ETo.
(d) The estimation of dry-year irrigation demand assumes that precipitation during irrigating months is zero and ETo rates remain at historical average
(e) Theoretical irrigation demand = *(Replacement ETo) x (Irrigated Area) x (ETo Factor)*. Irrigated area is assumed to be 100 acres based on information provided by Menlo CC staff. It should be noted that site specific information on landscape type was not factored into this estimation.
(f) Irrigation demands are a 23-year average based on meter records provided by Menlo CC staff.
(g) It should be noted that the Theoretical ETo Methodology indicates no irrigation demand November through March. However, meter records indicate that Menlo CC irrigates year-round. Some irrigation occurs November through February, but it is a relatively small demand, representing less than 4% of the total annual demand. For the purposes of estimating peak demands under the Meter Record Methodology, it is assumed that irrigation months are March through October. For the purposes of estimating peak demands under the Theoretical ETo Methodology, it is assumed that irrigation months are April through October.

City of Redwood City
Redwood City, California

Feasibility of Supplemental Groundwater Resources Development

Redwood City, California

March 2003

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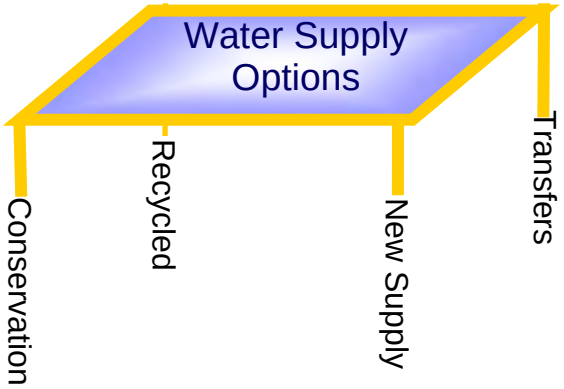
1 Introduction

The City of Redwood City (City) currently obtains 100 percent of its water supply from the City of San Francisco Water Department through its Hetch Hetchy Aqueduct water allocation. The City currently exceeds its supply assurance level by about 1,100 acre-feet per year (AFY). The capacity of this existing water supply to meet future demand is limited and drought conditions could reduce the City's allocation in the future. The City is considering four of the most viable options to reduce current demands on the Hetch Hetchy supply, to comply with the supply assurance level, and to provide supply for future growth. These four options are:

1. Negotiating water transfers from other agencies that use the Hetch Hetchy regional system
2. Negotiating a new source of potable water supply via the regional system ("wheeling")
3. Implementing water conservation measures
4. Implementing a water recycling program for landscape irrigation and industrial uses

Redwood City Water Supply Options



To further explore the use of recycled water, the City completed the *Water Recycling Feasibility Study for the Redwood Shores Area* (Kennedy/Jenks, January 22, 2002) and the *Water Recycling Study for Redwood City* (Kennedy/Jenks, August 7, 2002). The latter of the two feasibility studies recommended implementing a 1,955 AFY recycled water system in conjunction with water conservation programs to reduce existing demands on the San Francisco Hetch Hetchy regional water system to be within the City's contractual supply assurance and to provide a source of future water supply for potential new developments within the City. The City Council subsequently made a policy decision that "Redwood City will not make the use of recycled water mandatory to existing residences or homeowners' associations". This decision required that the recycled water project be modified to account for the loss of planned irrigation

customers, and the refined project (Alternative E) was presented in a Technical Memorandum (Kennedy/Jenks, February 21, 2003).

Recent public discussions about the recommended recycled water project have resulted in the City wanting to re-explore and confirm information related to other possible “new water supply” options. One possibility for new supply could be local groundwater sources. Historically, groundwater has not been a source of supply for the City because of water quality, reliability, and long-term production capacity concerns. Local groundwater does exist, and this memorandum provides a preliminary feasibility level evaluation of the potential groundwater supply, groundwater quality and cost considerations associated with possibly developing groundwater resources in Redwood City that could be comparable to the proposed recycled water project under Alternative E.

The study area encompasses the area within the City limits (Figure 1). For this study, existing data were compiled and evaluated. Study results are summarized and conclusions are presented regarding the feasibility of developing local groundwater resources to supplement water supply.

2 Geology

Regionally, Redwood City is located in the Coast Range Physiographic Province. The region is characterized by northwest-trending faults, mountain ranges, and valley depressions. Movement along the San Andreas, Hayward, and Calaveras faults and down warping of the area in between the fault zones has formed the depression whose axis is along the San Francisco Bay (DWR, August 1967).

Redwood City is located in the South Bay Drainage Unit, which is characterized by a broad alluvial valley sloping toward the San Francisco Bay and flanked on the east and west by alluvial fans deposited at the foot of the Diablo Range in the East Bay and the Santa Cruz Mountains in the west (DWR, August 1967). Surface streams have flowed out from the elevated areas to the east and west of the San Francisco Bay area and deposited debris as alluvial fans and flood plains. These alluvial deposits comprise the major aquifers of the region.

The near surface geologic materials beneath the City can be divided into three areas. The area in the northeast part of the City near the San Francisco Bay (Bay) is underlain by unconsolidated Bay Muds and Artificial Fill (see Figure 2). Review of water well logs indicates that the thickness of the Bay Muds in the vicinity of Redwood City is from 15 to 100 feet. In the area southwest of Highway 101, the central area of the City is underlain by fine- to coarse-grained unconsolidated alluvial deposits. On the southwestern edge of the City near Highway 280, the City is underlain by bedrock units comprised predominantly of the Butano and Franciscan Formations (SEEHRL, December 1987).

The alluvial deposits form a wedge that thins near the bedrock hills and thickens toward the Bay. Review of water well logs indicates the thickness of the alluvial deposits in the vicinity of the City range from zero where bedrock crops out to approximately 500 feet near the Bay. Alluvial deposits underlie the Bay Muds and Artificial Fill. Bedrock units are the underlying basement complex beneath the alluvial deposits.

Alluvial deposits are of most interest to this study since they comprise the water-bearing deposits in the study area. Alluvial deposits tend to be more fine-grained near the Bay and more coarse-grained near the bedrock units and along stream channels. The percentage of coarse-grained sediments in the study area is relatively less than in

surrounding areas to the south and north along the Peninsula. This is because local streams are small, drain relatively small watersheds, and thus have less capacity for transporting significant volumes of coarse-grained sediment (Fio and Leighton, 1995). Relatively coarse-grained deposits are found on the southeast edge of the City near Atherton associated with San Francisquito Creek (Fio and Leighton, 1995). San Francisquito Creek has a large watershed (40 square miles) and as a result alluvial deposits associated with the creek are permeable and the alluvial deposition area of the creek is large (DWR, August 1967).

3 Hydrogeology

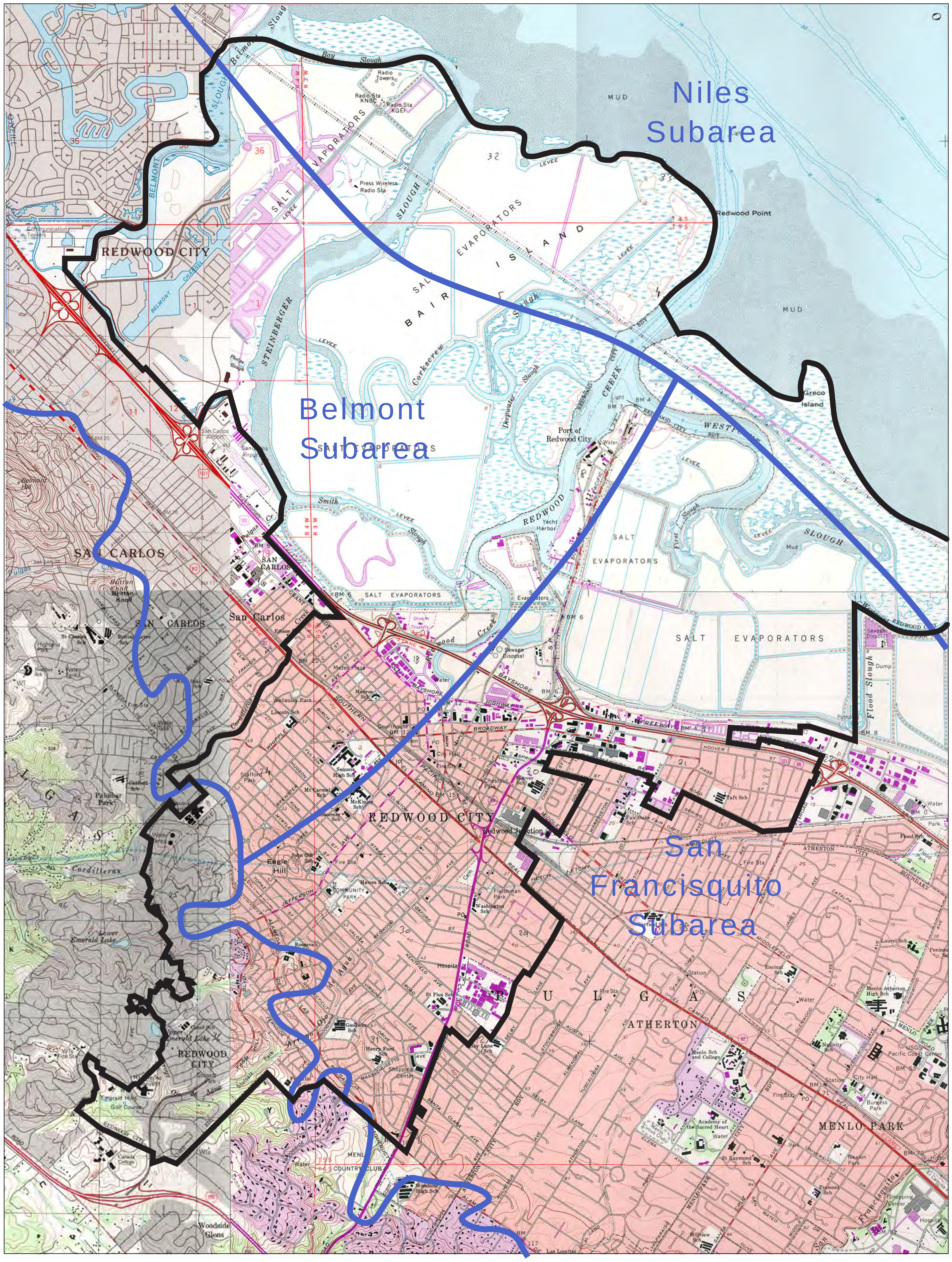
Redwood City is located in the south San Mateo Bay Plain Groundwater Basin, which is part of the Santa Clara Valley Groundwater Basin (DWR, August 1967; SEEHRL, December 1987). Numerous aquifers make up the water-bearing units of the Santa Clara Valley Groundwater Basin. The aquifers are composed of unconsolidated permeable alluvial deposits separated by lower permeability units that act as aquitards or barriers to groundwater flow. The bedrock formations in the southwest of the study area are considered non-water-bearing, except for local small water supplies (SEEHRL, December 1987).

The Department of Water Resources (DWR, August 1967) has defined three hydrogeologic subareas in the Redwood City area, which are based on the sources of the alluvial deposits found in each. These subareas include the San Francisquito Subarea, the Belmont Subarea, and the Niles Subarea (Figure 1).

The City is underlain by the San Francisquito Subarea south of Brewster Avenue. The San Francisquito Subarea is the most important groundwater producing area on the Peninsula and for many years during the early half of the twentieth century supplied the municipal needs of Stanford University and the City of Palo Alto. The water-bearing sands and gravels of the San Francisquito Subarea are discontinuous and cannot be correlated into distinct aquifers across the area. The thickness of water-bearing sediments in the San Francisquito Subarea range from more than 1,000 feet south of Palo Alto thinning to approximately 500 at the northern end of the subarea beneath Redwood City (Fio and Leighton, 1995; DWR well logs). These alluvial deposits form a wedge; thin near the base of the Santa Cruz Mountains and thickening toward the Bay. Groundwater in the San Francisquito Subarea is recharged by infiltration along San Francisquito Creek, infiltration from Lake Lagunita, deep percolation and sub-surface inflow. Groundwater discharge is to wells and through the shallow aquifer to the Niles Subarea to the east.

The City is underlain by the Belmont Subarea from just south of Brewster Avenue. to the northern City border. Relative to the San Francisquito Subarea, the alluvial deposits become thinner and more fine-grained with distance north along the Peninsula. Groundwater recharge in the subarea is mainly by infiltration along small streams draining the adjacent uplands. Groundwater may discharge to the Niles subarea to the east (DWR, August 1967).

The City is underlain by the Niles Subarea near the Bay margin. The Niles Subarea includes the Niles Cone, which is the large alluvial fan formed by Alameda Creek in the East Bay that extends westward beneath the San Francisco Bay to the Redwood City bay front area (DWR, August 1967). With increasing distance westward from the City of Niles in the East Bay, the water-bearing units within this subarea thin and become more fine-grained. Recharge to the aquifers in this subarea occurs at its eastern edge in the



Legend

Study Area

Groundwater Subarea

N

0 2000

Scale in Feet

January 2003	Figure 1 Study Area and Groundwater Subareas
TODD ENGINEERS Emeryville, California	

DESCRIPTION OF MAP UNITS

Qyf — YOUNGER (INNER) ALLUVIAL FAN DEPOSITS (Holocene)—Unconsolidated fine- to coarse-grained sand, silt, and gravel, coarser grained at heads of fans and in narrow canyons

Qyfo — YOUNGER (OUTER) ALLUVIAL FAN DEPOSITS (Holocene)—Unconsolidated fine sand, silt, and clayey silt

Qb — BASIN DEPOSITS (Holocene)—Unconsolidated, locally organic, plastic silt and silty clay

Qcl — COLLUVIUM (Holocene)—Loose to firm, friable, unsorted sand, silt, clay, gravel, rock debris, and organic material in varying proportions

Qs — SAND DUNE AND BEACH DEPOSITS (Holocene)—Predominantly loose, medium- to coarse-grained, well-sorted sand but also includes pebbles, cobbles, and silt. Thickness usually less than 6 m but in places may exceed 30 m

Qm — BAY MUD (Holocene)—Blue-gray, dark-gray, or black unconsolidated silty clay and clay containing abundant organic matter, with interspersed lenses and layers of sand, peat, gravel, and shell fragments. Mud varies in thickness from zero, at landward edge, to as much as 40 m near north County line

Qal — ALLUVIUM (Holocene)—Unconsolidated gravel, sand, silt, and clay along streams. Less than a few meters thick in most places

Qaf — ARTIFICIAL FILL (Holocene)—Loose to very well consolidated gravel, sand, silt, clay, rock fragments, organic matter, and manmade debris in various combinations. Thickness is variable and may exceed 30 m in places

Qof — COARSE-GRAINED OLDER ALLUVIAL FAN AND STREAM TERRACE DEPOSITS (Pleistocene)—Poorly consolidated gravel, sand, and silt, coarser grained at heads of old fans and in narrow canyons

Qob — FINE-GRAINED OLDER BASIN AND ALLUVIAL FAN DEPOSITS (Pleistocene)—Moderately consolidated, plastic, organic clay and silty clay with irregular stringers of coarse-grained sand

Qmt — MARINE TERRACE DEPOSITS (Pleistocene)—Poorly consolidated and poorly indurated well- to poorly-sorted sand and gravel. Thickness variable but probably less than 30 m

Qc — COLMA FORMATION (Pleistocene)—Yellowish-gray and gray to yellowish-orange and red-brown, friable to loose, fine- to medium-grained arkosic sand with subordinate amounts of gravel, silt, and clay. Total thickness unknown but may be as great as 60 m

QTs — SANTA CLARA FORMATION (lower Pleistocene and upper Pliocene)—Gray to red-brown poorly indurated conglomerate, sandstone, and mudstone in irregular and lenticular beds. Conglomerate consists mainly of subangular to subrounded cobbles in a sandy matrix but locally includes pebbles and boulders. Cobbles and pebbles are mainly chert, greenstone, and graywacke with some schist, serpentine, and limestone. On Coal Mine Ridge, south of Portola Valley, conglomerate contains boulders of an older conglomerate as long as a meter. Gray to buff claystone and siltstone beds on Coal Mine Ridge contain carbonized wood fragments as large as 60 cm in diameter. Included in Santa Clara Formation are similar coarse-grained clastic deposits near Burlingame. Sarna-Wojcicki (1976, p. 27) found a tuff bed in Santa Clara Formation near Woodside, and correlated it with a similar tuff in Merced Formation. Thickness of Santa Clara Formation is variable but reaches a maximum of about 500 m along Coal Mine Ridge

Tb? — BUTANO(?) SANDSTONE (middle and lower Eocene)—Light-gray to buff coarse-grained feldspathic sandstone, with light-gray to buff silty claystone, glauconitic sandstone, and tuffaceous siltstone. sandstone beds constitute about 30 percent of map unit. Tuffaceous and silty claystone beds are expansive. Locally sandstone beds are well cemented with calcite. At apparent base of section on north side of Jasper Ridge, just east of Searsville Lake, a thin, greenstone-pebble conglomerate is present in contact with underlying serpentine; at apparent base on south side of Jasper Ridge approximately 60 m of cobble conglomerate is present. In places within this map unit sandstone and claystone beds are chaotically disturbed. Butano(?) Sandstone is as much as 900 m thick

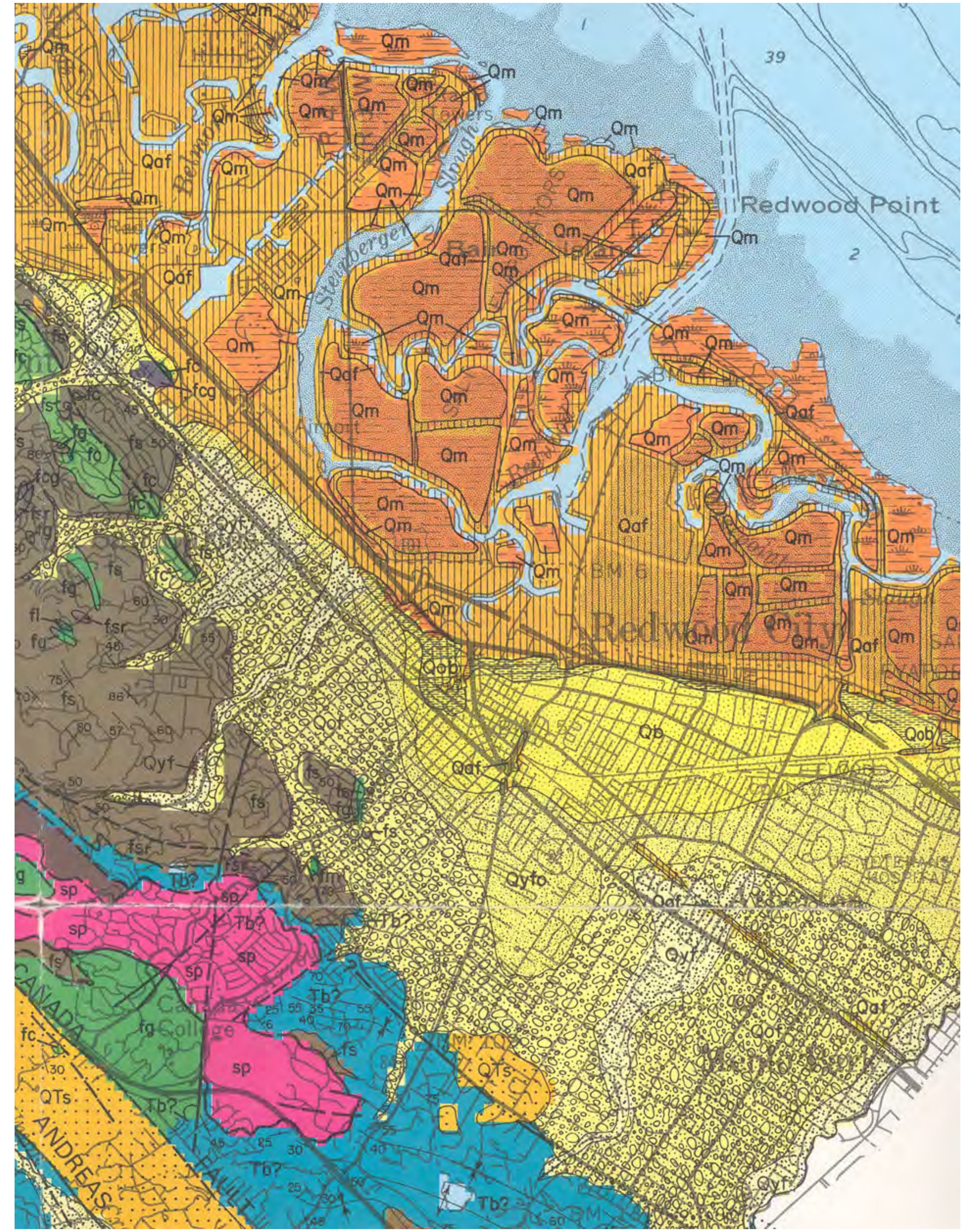
fs — SANDSTONE—Greenish-gray to buff colored fine- to coarse-grained sandstone (graywacke), with interbedded siltstone and shale. Siltstone and shale interbeds constitute less than 20 percent of unit, but in places form sequences as much as several tens of meters thick. In many places shearing has obscured bedding relations, and rock in which shale has been sheared to gouge constitutes about 10 percent of unit. Gouge is concentrated in zones that are commonly less than 30 m wide but in places may be as much as 150 m wide. Total thickness of unit is unknown but is probably at least many hundreds of meters

fg — GREENSTONE—Dark-green to red altered basaltic rocks, including flows, pillow lavas, breccias, tuff breccias, tuffs, and minor related intrusive rocks, in unknown proportions. Unit includes some Franciscan chert and limestone bodies that are too small to show on map. Greenstone occurs in lenticular bodies varying in thickness from a few meters to many hundreds of meters

fc — CHERT—White, green, red, and orange chert, in places interbedded with reddish-brown shale. Chert and shale commonly are rhythmically banded in thin layers, but chert also occurs in very thick layers. In San Carlos chert has been altered along faults to tan- to buff-colored clay. Chert and shale occurs in lenticular bodies as much as 75 m thick; chert bodies commonly are associated with Franciscan greenstone

fsr — SHEARED ROCK—Predominantly graywacke, siltstone, and shale, substantial portions of which have been sheared, but includes hard blocks of all other Franciscan rock types. Total thickness of unit is unknown but is probably at least several tens of meters

sp — SERPENTINITE (Cretaceous and (or) Jurassic)—Greenish-gray to bluish-green sheared serpentinite, enclosing variably abundant blocks of unsheared rock. Blocks are commonly less than 3 m in diameter but range in size from several centimeters to several meters; they consist of greenish-black serpentine, schist, rodingite, ultramafic rock, and silica-carbonate rock, nearly all of which are too small to be shown on map



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Scale in Miles

Source: Brabb, E.E. and Pampeyan,E.H., 1983, Geologic Map of San Mateo County.

January 2003	Figure 2 Geology of Redwood City Area
TODD ENGINEERS Emeryville, California	

East Bay. Multiple laterally continuous aquifers have been defined in the Niles Subarea. The lateral continuity of Niles Subarea aquifers beneath the Bay was demonstrated through geologic profiling along the length of the Dumbarton Bridge and through pumping tests that showed drawdown in wells in the middle and on the east side of the Bay when a well on the west side of the Bay was pumped (DWR, August 1967).

Because of the discontinuous nature of the water-bearing units in the San Francisquito and Belmont Subareas, groundwater levels vary from well to well and groundwater may be confined, semi-confined, or unconfined depending on the location of the well and depth of the screened interval. Depths to groundwater in the Niles Subarea vary from about 5 to 50 feet below the ground surface and occur under confined conditions. A review of driller's logs in the study area indicates depths to groundwater from 3 to 155 feet below ground surface (bgs) with an average of 34 feet bgs. It should be noted that the well logs represent wells drilled at various times from the 1920s to 2001, in different subareas, and at different depths. Generally groundwater flow in the study area is from the southwest uplands area to the northeast toward the Bay.

Probable well yields in the study area have been estimated as varying from 1 to 100 gallons per minute (gpm) within the alluvial deposits (Webster, 1972). Generally, this range of well yields is thought to be adequate for single family domestic use, but inadequate to marginal for light industrial use (Webster, 1972). Most of the wells drilled in the study area are small diameter (less than 8 inches) domestic and irrigation wells, with a few larger diameter (10 to 30 inch) industrial wells. It should be noted that the limited number of wells in the study area and the lack of long-term formal pumping test data limit the ability to reliably predict well yields. The pumping rates listed on drillers' well logs compiled for the study area indicated minimum, maximum, mean, and median well yields of 0 gpm, 450 gpm, 70 gpm, and 28 gpm, respectively.

Storage capacity is an estimate of the maximum volume of groundwater stored in the aquifer. Storage capacity can be estimated based on the specific yield of the sediments in the aquifer and the thickness and areal extent of saturated permeable sediments. Simply, specific yield is a measure of the volume of water that an aquifer releases by gravity. Thus, a gravel aquifer has a higher specific yield than a clay formation. Groundwater storage in the area east of the bedrock uplands, south of Ralston Avenue, north of Atherton Avenue and west of the Bay front is estimated at approximately 800,000 acre-feet (AF). This estimate assumes an area of 27 square miles, an average alluvial thickness of 275 feet, an average depth to groundwater of 30 feet, and an average specific yield of 20 percent.

It should be noted that the total volume of subsurface storage is not available for pumping because of the potential for of subsidence and salt water intrusion. Historically, land subsidence and compaction of the aquitards occurred in areas south of the study area when groundwater levels were drawn down approximately 50 feet below sea level (Fio and Leighton, 1995). Additionally, pumping to levels below sea level has the potential to reverse the natural groundwater flow direction and induce salt water intrusion from the Bay and shallow water-bearing units with poor quality water. Thus the usable volume of groundwater is much less than 800,000 AF.

A more relevant indicator of the recoverable groundwater resource is the amount of groundwater that is recharged to the water-bearing units beneath the City on an annual basis. The data are not available to support a detailed evaluation of the water balance, including inflows, outflows, and change in storage. However, a number of assumptions can be made to calculate a reasonable range of values for groundwater recharge (see

Table 1). For this estimate, it was assumed that percolation of rainfall and return flows from landscape irrigation are the major sources of recharge. Other sources of inflow (stream percolation, subsurface groundwater inflow, and leaking water and sewer lines) were assumed to be small. Based on the assumptions in Table 1, the annual groundwater recharge in the vicinity of Redwood City is estimated between a low of 1,700 AFY and a high of 2,800 AFY.

Table 1

Estimate of Annual Groundwater Recharge Redwood City Area

Precipitation				
Watershed Area[1]	Annual Rainfall	Rainfall on Watershed Area	Rainfall Percolation to Groundwater	
			5% - low	10% - high
(acres)	(feet)	(AFY)	(AFY)	(AFY)
12,000	1.5	18,000	**900**	**1,800**
Imported Water				
Annual Importation	40% Used for Irrigation low	50% Used for Irrigation high	Irrigation Percolation to Groundwater	
			15%	15%
(AFY)	(AFY)	(AFY)	(AFY)	(AFY)
13,000	5,200	6,500	**780**	**975**
		Total	**1,680**	**2,775**

[1] The watershed was measured as the area between the drainage divide on the southwest, Stockbridge Ave. on the south, San Carlos Ave. on the north, and Highway 101 on the west.

AFY - acre-feet per year

4 Wells and Production

In the first half of the 20th century, water supplies in the Redwood City and surrounding Bay area were provided primarily by groundwater. In the second half of the century, substantial quantities of surface water were imported to supply the rapidly growing urban population of the area. A large number of wells used for residential irrigation still exist in the Atherton City area (Fio and Leighton, 1995; SEEHRL, December 1987).

Groundwater production wells have been installed by some nearby water purveyors such as the California Water Service Company and the City of Palo Alto. The City of Palo Alto wells are not currently pumping and are used as an emergency backup in case of drought or imported supply interruption. The California Water Service Company wells were used in the past but have all been abandoned.

Water well drillers reports for the Redwood City area and the areas immediately surrounding the City were collected from the Department of Water Resources (DWR) and inventoried to provide an indication of the characteristics of the aquifer beneath the Redwood City area. Just over 100 supply well logs (irrigation, domestic, and industrial)

were available. Monitoring, test and cathodic protection well logs were also collected. Many of the wells were older and likely have been abandoned or destroyed.

Sixty-one wells have been constructed in the area since 1970 and it is assumed that these wells are still active. Almost all of the wells are relatively small diameter wells used for domestic supply or irrigation. Thirty-eight of the wells are located in the City of Atherton.

Transmissivity is an indication of the productivity of the aquifer. Transmissivity can be estimated by performing a constant rate, long-term pumping test. A number of irrigation wells have been drilled recently in the Pacific Shores Center area (Geoconsultants, Inc., May 17, 1991; Bohley/Maley Associates, December 16, 1993; Maggiora Bros. Drilling, Inc., October 16, 2001). These wells have larger diameter casings and more extensive pumping tests and water quality testing than most other wells in the study area. Four long-term pumping tests were conducted for Pacific Shores. During these tests the wells were pumped at rates between 40 and 250 gpm yielding a range of transmissivities from approximately 100 to 6,000 gallons per day per foot (gpd/ft) (Bohley/Maley Associates, December 16, 1993). Currently, three irrigation wells are operated in the Pacific Shores area and produce about 55 AFY (Bohley, March 5, 2003).

While a constant rate, long-term pumping test is the best method of determining transmissivity, it can also be calculated empirically based on the initial pumping rate of the well and the observed drawdown. These initial measurements are often recorded on driller's well logs. Review of the driller's well logs collected in the Redwood City area from the DWR indicates a range in the empirically calculated transmissivity from 22 to 60,000 gpd/ft with an average of 6,332 gpd/ft. If an aquifer has a transmissivity of less than 1,000 gpd/ft, it can supply only enough water for domestic wells or other low-yield uses. When transmissivity is 10,000 gpd/ft or more, well yields can be adequate for industrial and municipal purposes (Driscoll, 1986).

Empirical transmissivity results indicate that development of a municipal supply may be possible; however, the initial pumping rates and drawdowns recorded on driller's logs are not highly reliable and tend to overestimate well yields. Limited actual long-term pumping test data indicate transmissivities that are marginal for municipal supply.

5 Groundwater Quality

Limited data are available on natural groundwater quality beneath the City. It appears that water quality varies by the strata from which the samples were obtained (SEEHRL, December 1987). General mineral and physical testing was available for nine wells in the study area. The water quality results for these wells are presented in Attachment A.

Elevated levels of nitrate can make groundwater unsuitable for drinking water supplies due to health concerns. Thus a primary maximum contaminant level (MCL) has been established for nitrate (45 mg/L). Sources of nitrate include septic systems, leaking sewer lines, and fertilizer application. Two wells with levels of nitrate above the primary MCL were identified north of San Francisquito Creek and just south of the study area (Leighton and Fio, 1995). Nitrate concentrations in two well samples within the study area were below the MCL (Attachment A).

Elevated levels of other parameters such as total dissolved solids (TDS), hardness, iron, manganese, and chloride make groundwater undesirable for potable use for aesthetic rather than health reasons. Aesthetic concerns include problems with soap lathering,

taste, odor, and plumbing/clothing staining. Accordingly, these parameters are evaluated with reference to secondary MCLs or other criteria.

TDS is a measure of the general dissolved mineral content of groundwater. The recommended secondary MCL for TDS in drinking water is 500 milligrams per liter (mg/L). Elevated TDS and chloride can be an indication of salt water intrusion. Because of the proximity of the San Francisco Bay to Redwood City, there is potential for salt water intrusion into the groundwater beneath the City. Shallow water-bearing zones near San Francisco Bay have levels of TDS above 500 mg/l. In addition, elevated TDS and chloride has been identified in an area north of San Francisquito Creek and south of the study area. TDS was above 500 mg/l in three of three wells sampled in the study area. Specific conductance, which is related to TDS, was above 900 micromhos per centimeter in five of eight wells sampled in the study area. Chloride was above 250 mg/l in two of eight samples collected in the study area (Attachment A).

Water quality analyses available in the study area indicate hard (121 to 180 mg/l) to very hard (>180 mg/l) water in six of seven samples analyzed (Attachment A). Generally, hard water prevents soap from lathering and causes encrustation on surfaces when the water is heated.

Iron exceeded the secondary MCL of 0.3 mg/l in three of five samples collected in the study area and manganese exceeded the secondary MCL of 0.05 mg/l in six of six samples (Attachment A).

Water quality analyses performed for irrigation wells in the Pacific Shores area showed water that meets Title 22 requirements for potable supplies. However, iron, manganese, chloride, TDS, turbidity, and color exceeded secondary MCLs in individual wells.

Elevated levels of some constituents including sodium and boron make groundwater unsuitable for irrigation uses. Elevated sodium levels in groundwater used for irrigation can cause deflocculation of clays and damage to soil structure (Hem, 1989). Elevated levels of sodium have been reported in some wells near San Francisquito Creek (Fio and Leighton, 1995). Limited analyses available in the study area indicate acceptable boron levels for irrigation use.

Because Redwood City is intensively developed with residential neighborhoods and commercial and industrial sites, groundwater resources are vulnerable to releases of contaminants associated with these land uses. A large number of possible contaminating activities exist in the city and range from leaking underground storage tanks to overuse of fertilizers and pesticides in residential areas. A total of 183 leaking underground storage tank sites have been identified in the City (SWRCB, 2003). Not all leaking underground tanks impact groundwater. However, 65 of the 183 sites have an “open” status, meaning that the extent of contamination has not been characterized or fully contained and/or remediated. Most of the contamination sites are located in areas of commercial and industrial development along the Highway 101 and El Camino Real corridors. A review of monitoring well logs compiled for the study area showed 30 sites where monitoring wells had been installed indicating the potential for groundwater contamination at these sites. All of the monitoring well logs available from the DWR in the study area are less than 30 feet deep. This indicates that contamination may be limited to shallower water-bearing zones with deeper zones protected by intervening aquitards. However, the extent of anthropogenic contamination in deeper water-bearing zones has not been characterized as part this study. A thorough review of regulatory files would be necessary to characterize contamination sites as part of the process for siting a new well.

6 Supplemental Wells

This section summarizes our evaluation of the feasibility of supplemental wells to augment Redwood City's water supply.

6.1 Expected Yields

Supplemental wells could be installed by the City for local irrigation and/or to augment existing water supplies in case of emergency or drought. However, yields from wells in the vicinity of Redwood City can be expected to be low ranging from 10 to less than 500 gpm. This range of well yield has historically been considered inadequate to marginal for irrigation and municipal use. However, as water resources in California have become more stressed with ever increasing demand, what constitutes an acceptable yield has declined. Based on the existing data, a properly sited and designed, large diameter water well could potentially yield 200 gallons per minute (gpm) on a sustained basis. One well producing 200 gpm on a continuous basis, allowing for 30 days of down time and annual maintenance, would produce approximately 300 AFY.

At this time, the groundwater resources in the Redwood City area are not widely utilized with the exception of the Atherton area; therefore, existing groundwater extraction is minimal. Thus, although the annual groundwater recharge is not great, there is not currently a large demand on the resource. As discussed in Section 3 above, a preliminary estimate of annual groundwater recharge in the Redwood City area ranges from 1,700 to 2,800 AFY. The City could install supplemental wells to capture some portion of this annual recharge without mining the groundwater resource. It is estimated that a supplemental drilling program with wells distributed across the City might produce between 500 and 1,000 AFY.

6.2 Expected Water Quality

Based on the limited water quality data available, supplemental wells can be expected to have acceptable water quality for irrigation or potable uses. However, the water is hard with some wells exhibiting levels of TDS, iron, manganese, and chloride that are objectionable for aesthetic reasons. Therefore, groundwater would likely require blending and treatment prior to use for potable supplies.

The Department of Health Services (DHS) requires that any new municipal drinking water supply well have a drinking water source assessment and protection (DWSAP) program completed prior to issuing an operation permit. A DWSAP program will define the capture zone of the well as well as all of the potentially contaminating activities that exist within that capture zone. Ideally, the DWSAP would identify any contamination site that could potentially impact the water quality in the supply well. As discussed in Section 5 above, a number of contaminant releases have occurred in the City and many have impacted shallow groundwater supplies. These contamination sites would need to be assessed further as part of the process of siting a new well. In general, it is preferable to site wells away from commercial/industrial areas where most contaminant releases occur.

6.3 Locations

Based on the available data, it appears that supply wells located on the south side of the City in the San Francisquito Subarea and wells located near the Bay in the Niles Subarea are more likely to produce groundwater yields in the hundreds of gallons per minute range. In addition, groundwater wells located near stream channels are more

likely to penetrate more coarse-grained alluvial deposits than wells located at the midpoints between stream channels and nearer to the Bay.

Water supply wells located near San Francisco Bay will be more susceptible to salt water intrusion from the Bay. Accordingly, operation of wells near the Bay would require regular monitoring to ensure that poor quality water from the Bay is not being pulled landward. As a general rule water supply wells located away from commercial and industrial areas are less susceptible to water quality degradation from the accidental release of contaminants due to leaks and spills in the near surface.

6.4 Costs

Due to the limited amount of data that exist in the study area, it would be prudent to conduct an exploration drilling program prior to drilling a production well. An exploration program would include drilling of one or more borings to the bedrock interface (~500 feet), geophysical logging in the open borehole to characterize the permeable units and other aquifer parameters, converting the boring to a test well, constructing the test well with an 8-inch diameter casing, developing the test well, collecting and analyzing groundwater quality samples, conducting a pumping test to determine aquifer transmissivity, and preparing a report. The cost of an exploration program, including engineering costs would be approximately $100,000 per test well.

Based on positive results of the exploration program, a production well could be designed and installed. The cost to design and install a 12-inch diameter, 500-foot deep production well is approximately $225,000 per well.

Significant additional costs may be associated with permitting, land acquisition, treatment, power, pumps, and piping. Assuming that each well would require purchase of a 50-foot by 100-foot lot, a soundproof building enclosure matching adjacent development appearance, power service, pumping equipment, motor, motor control center, standby power generator, disinfection treatment system, mechanical piping and controls, planning, engineering, CEQA and administrative costs, an individual well for potable water could cost from $1M to $2M to construct, without additional treatment for iron and manganese. A well for onsite irrigation would be less expensive but would still provide an in-lieu water supply.

7 Conclusions

Our hydrogeologic review indicates that while the aquifers under the Redwood City area are considered marginal as sources of municipal supplies, these water-bearing zones are adequate to provide small amounts of supplemental water. There is available groundwater storage and recharge to provide a supplemental source of water. Currently, use of groundwater in the area is minimal so there is little competition for the resource. Existing data indicate that the expected yield from a properly sited and designed production well in the area would likely be less than 500 gpm and probably would be on the order of 200 gpm. The estimated annual recharge to groundwater in the Redwood City area is between 1,700 and 2,800 AFY. With a network of properly sited and designed well, the City might feasibly recover between 500 and 1,000 AFY of supplemental water.

Groundwater quality is acceptable for potable and/or irrigation uses; however, to address aesthetic concerns, groundwater treatment and blending would be required for potable use. The existence of contamination sites would need to be evaluated and considered in the well siting process.

Groundwater resources could be developed for local irrigation applications, replacing imported water and/or for standby emergency potable use in case of drought or imported water interruption. Groundwater use for irrigation of local parks and open spaces would require less infrastructure since treatment and connection to the municipal supply would not be required. Development of supplemental groundwater for standby and emergency potable uses would involve considerable greater costs for CEQA approval, hook-up to the distribution system, groundwater treatment and transmission.

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Attachment A

Groundwater Quality Data - Redwood City Area

Constituent	Units	Drinking Water Standard	Bayport Center #1 Apr-91	Bayport Center #1 May-91	Pacific Shores #1 Sep-93	Pacific Shores #2 Oct-93	Pacific Shores #3 Nov-93	Pacific Portland Cement #5 Jul-43	Pacific Portland Cement #7 Jul-43	Pacific Portland Cement #8 Jul-43	5S/3W-20P1m Feb-51
aluminum	mg/L	1	**16**	-	0.53	0.14	-	-	-	-	-
arsenic	mg/L	0.05	0.014	-	-	-	-	-	-	-	-
barium	mg/L	1	0.3	-	0.23	0.18	-	-	-	-	-
bicarbonate alkalinity	mg/L		260	-	290	300	-	-	-	-	264
boron	mg/L		0.29	-	-	-	0.29	-	-	-	-
cadmium	mg/L	0.005	<0.001	-	<0.01	<0.01	-	-	-	-	-
calcium	mg/L		21	-	31	23	-	-	-	-	58
carbonate alkalinity	mg/L		<2.0	-	<2.0	<2.0	-	-	-	-	0
chloride	mg/L	250	110	-	12	**260**	140	**356**	144	166	184
chromium	mg/L	0.05	0.034	-	<0.01	<0.01	-	-	-	-	-
color	color units	15	15	-	**60**	<5.0	-	-	-	-	-
copper	mg/L	1.3	0.05	-	<0.01	<0.01	-	-	-	-	-
fluoride	mg/L	2	0.2	-	-	-	-	-	-	-	-
hardness	mg/L		160	-	170	160	-	170	120	190	300
hydroxide alkalinity	mg/L		<0.1	-	<0.1	<0.1	-	-	-	-	-
iron	mg/L	0.3	**25**	0.17	**0.95**	0.27	-	-	-	-	**1.1**
lead	mg/L	0.015	0.0079	-	<0.005	<0.005	0.029	-	-	-	-
magnesium	mg/L		25	-	21	17	-	-	-	-	38
manganese	mg/L	0.05	**0.46**	**0.08**	**0.19**	**0.11**	**0.097**	-	-	-	**0.26**
mercury	mg/L	0.002	<0.0002	-	-	-	-	-	-	-	-
nitrate as NO_3	mg/L	45	<1.0	-	-	-	<0.1	-	-	-	6
odor	threshold units	3	<1.0	-	<1.0	<1.0	-	-	-	-	-
pH	pH units	>6.5 <8.5	8.3	-	7.5	7.8	-	7.6	7.6	7.6	8.0
potassium	mg/L		19	-	7.1	2.7	-	-	-	-	-
selenium	mg/L	0.05	<0.005	-	-	-	-	-	-	-	-
silver	mg/L	0.1	<0.001	-	<0.01	<0.01	-	-	-	-	-
sodium	mg/L		140	-	160	180	-	-	-	-	-
specific conductance	umhos/cm	900	900	-	**940**	860	890	**1,750**	**962**	**974**	**1,040**
sulfate	mg/L	250	23	-	2	250	-	-	-	-	49
surfactants	mg/L	0.5	<0.02	-	<0.025	<0.025	-	-	-	-	-
total dissolved solids	mg/L	500	**660**	-	**540**	**560**	-	-	-	-	-
turbidity	NTU	5	**450**	-	**25**	3.5	-	-	-	-	-
zinc	mg/L	5	0.023	-	0.2	0.096	-	-	-	-	-
total coliform			-	-	-	-	absent	-	-	-	-

Appendix D: Water Quality Data

D.1 Water Quality Matrix for Landscape Irrigation

D.2 Redwood City Recycled Water Quality Monitoring

D.3 City of San Francisco Water Quality Data for Year 2009

Table 2 – Water Quality Matrix for Landscape Irrigation

SALINITY, PERMEABILITY, TOXICITY & NITROGEN

PARAMETER OF POTENTIAL CONCERN			Units	Degree of Restriction of Use[1]			Comments (Reference Next Page)	SBSA RECYCLED WATER	HETCH HETCHY POTABLE WATER
				None	Slight to Moderate	Severe		RANGE	RANGE
SALINITY (Total Salt Content)	Electrical Conductivity (Ecw)		dS/m	<0.7	0.7 - 3.0	>3.0	See Salinity Comments next page	1.5 - 1.6	0.009 - 0.34
	Total Dissolved Solids (TDS)		mg/l	<450	450 - 2000	>2000		710 - 800	15 - 170
PERMEABILITY	Sodium Absorption Ratio (SAR) =	6 -- 12	with an Ecw =	>1.9	1.9 - 0.5	<0.5	See Permeability Comments next page	SAR = 7.2 - 7.3 Ecw = 1.53 - 1.56	NA NA
NITROGEN (Total N)			mg-N/l	<5	5 -- 30	>30	See Nitrogen Comments next page	~23 (ammonia + nitrite + nitrate as nitrogen)	<0.4
TOXICITY	Ion Toxicity								
	Sodium (Na)						See Ion Toxicity Comments next page		
	Surface Irrigation		SAR	<3	3 -- 9	>9		7.23 - 7.31	NA
	Spray Irrigation		mg/l	<70	>70			203 - 204	<3 - 9
	Chloride (Cl)								
	Surface Irrigation		mg/l	<140	140 - 350	>350		300	<3 - 10
	Spray Irrigation		mg/l	<100	>100			300	<3 - 10
	Boron (B)		mg/l	<0.7	0.7 - 3.0	>3.0		0.515	
	Trace Metal Toxicity								
	Trace Metals		Recommended Maximum Concentration (mg/l)[1]				See Trace Metals Toxicity Comments next page		
	Aluminum		5.0					0.00012 - 0.00013	<0.050 - 0.088
	Copper		0.20					<0.00002	<0.001 - 0.034
	Iron		5.0					0.00009 - 0.0001	<0.1 - 0.28
	Lead		5.0					0.00048 - 0.0024	<0.002 - 0.028

[1]Adapted from Ayers and Westcott & Irrigation with Reclaimed Municipal Wastewater A Guidance Manual, 1984

University of California Extension Leaflet 2995 Water Quality - Its Effects on Ornamental Plants

Data from the National Urban Agriculture Council on Marin Municipal Water District's Recycled Water Demonstration Garden 1995 - 2002.

Table 2 – Water Quality Matrix for Landscape Irrigation (Comments)

Salinity Comments:
Concerns - Salinity (salt content) is measured in terms of Ecw and/or TDS. If high levels of salt build up in surface soils, they can retard plant growth due to effects of ion toxicity and also reduced soil permeability which keeps water from percolating to the plant roots.

Remarks - The salinity level of SBSA recycled water could have a 'slight' degree of restriction on use. The data from the references, SBSA pilot project, and area demonstration gardens indicates that SBSA recycled water will not present a salinity problem for turf and the vast majority of ornamentals. Additional treatment for salt reduction is not required on a continuous basis; however, standby connection to potable water is available for blending or leeching salt from soils if needed in the future. A water management protocol for avoiding or replacing salt sensitive plants, at the customers' preference, is recommended.

Permeability Comments:
Concerns - Soil permeability is commonly expressed in terms of SAR -- a ratio of the concentrations of sodium, calcium, and magnesium -- in conjunction with a specific salinity (Ecw) value. As SAR increases and Ecw decreases in any water source, soil permeability is impacted, which in turn causes reduction of soil aeration and water infiltration and percolation.

Remarks - The SAR and Ecw values indicate that SBSA recycled water could have a 'slight' degree of restriction of use. The use of SBSA recycled water will not present a significant problem associated with soil permeability. There are well-established methods for managing soil permeability that are typically performed for any landscape such as surface cultivation, sod plugging and the use of mulch to prevent soil compaction. Gypsum can also be added to the water or soil to further enhance permeability in the soil. Concepts for managing soil permeability should be included in a water management protocol for customers.

Nitrogen Comments:
Concerns - Nitrogen in recycled water is beneficial in landscape management because it is a essential plant nutrient and reduces the need for fertilizer. However, excessive nitrogen concentration can increase the incidence of heat stress, particularly in hot climates during the summer when temperatures and irrigation volumes are at seasonal highs. Total Nitrogen (N) is composed of nitrate, nitrite and ammonia species. SBSA recycled water averages nitrate at 2.3 mg-N/l and ammonia at 21 mg-N/l.

Remarks - SBSA recycled water may have a 'slight' to moderate' degree of restriction of use in terms of its nitrogen content. The temperate climate at Redwood City helps to buffer potential heat stress as compared to the Central Valley of California where recycled water is used successfully for irrigation. It is anticipated that fertilization amounts and frequency will need to be reduced to prevent heat stress in the summer, and this should be provided as a water management protocol for customers.

Ion Toxicity Comments:
Concerns - Ion toxicity can occur when specific ions accumulate to toxic concentration levels in the leaves during transpiration or from overhead irrigation. Primary constituents of concern are sodium, chloride, and boron. Ion toxicity can cause foliar damage at leaf edges, leaf drop, and in severe cases long-term plant dieback.

Remarks - According to the guidelines, SBSA recycled water would have a "slight to moderate" degree of restriction of use for both spray and surface irrigation due to relatively elevated levels of sodium and chloride. Boron appears to be within the ranges where an ion toxicity problem will not occur. If sodium and chloride concentrations can be maintained close to their current levels, and proper water management practices are employed on landscape sites, ion problems can be avoided for the vast majority of plant species. It is recommended that plant lists and plant monitoring be performed for sensitive species, and that water quality monitoring of these ions be performed. Ion toxicity can be addressed by blending with potable water to reduce ion concentrations, if required.

Trace Metals Toxicity Comments:
Concern - Some heavy metals accumulate in the environment and are toxic to plants and animals. Aluminum can cause nonproductivity in acid soils, but soils at pH 5.5 to 8.0 will precipitate the ion and eliminate toxicity; copper can be toxic to a number of plants a at 0.1 mg/L in nutrient solution; iron can contribute to soil acidification and loss of essential phosphorous and molybdenum; and lead can inhibit plant cell growth at very high concentrations.

Remarks - SBSA recycled water was tested for aluminum, copper, lead, and iron. The concentrations of these metals were well below the maximum allowable concentrations and no problems related to Trace Metal Toxicity are anticipated.

Redwood City Recycled Water
Water Quality Monitoring

	Sample Date	12/22/2009	4/15/2010	7/21/2010
INORGANIC	Units			
Aluminum (total)	mg/L	0.25	0.14	0.19
Ammonia (total, as N)	mg/L	32	30	35
Antimony (total)	mg/L	0.0012	0.0011	0.0013
Arsenic (total)	mg/L	< 0.0050	0.00071	0.001
Barium (total)	mg/L	0.0076	0.0074	0.004
Bicarbonate (as HCO3)	mg/L	260	310	280
Boron (total)	micro g/L	< 500	330	330
Cadmium (total)	mg/L	< 0.00010	< 0.00011	< 0.00012
Calcium (total)	mg/L	28	35	28
Chloride	mg/L	290	270	300
Chromium (total)	mg/L	0.00084	0.00063	< 0.00050
Cobalt (total)	micro g/L	0.59	0.82	0.68
Copper (total)	mg/L	0.012	0.028	0.14
Fluoride	mg/L	0.90	0.81	0.82
Iron (total)	mg/L	0.12	0.084	0.14
Lead (total)	mg/L	0.00045	0.0021	0.00068
Magnesium (total)	mg/L	26	31	27
Manganese (total)	mg/L	0.12	0.14	0.13
Mercury (total)	mg/L	< 0.0010	< 0.0011	< 0.0012
Nickel (total)	mg/L	0.0051	0.0046	0.0053
Nitrate (as N)	mg/L	0.27	0.37	0.22
Nitrite (as N)	mg/L	2.3	< 0.20	< 0.21
o-Phosphate (as PO4)	mg/L	7.6	5.4	7.5
Phosphate (computed)	mg/L	7.6	5.4	7.5
Potassium (total)	mg/L	18	14	16
Selenium (total)	mg/L	0.0027	0.0034	0.0021
Silicon (dissolved, as SiO2)	mg/L	9.8	15	11
Silver (total)	mg/L	< 0.00010	< 0.00011	< 0.00012
Sodium (total)	mg/L	160	160	170
Sulfate	mg/L	59	65	55
Tin (total)	mg/L	< 0.050	< 0.051	< 0.052
Zinc (total)	mg/L	0.031	0.023	0.032

Redwood City Recycled Water
Water Quality Monitoring

		Sample Date	12/22/2009	4/15/2010	7/21/2010
ORGANIC					
1,1,1-Trichloroethane	mg/L		< 0.00050	< 0.00050	< 0.00050
1,1,2,2-Tetrachloroethane	mg/L		< 0.00050	< 0.00050	< 0.00050
1,1,2-Trichloroethane	mg/L		< 0.00050	< 0.00050	< 0.00050
1,1-Dichloroethane	mg/L		< 0.00050	< 0.00050	< 0.00050
1,1-Dichloroethylene	mg/L		< 0.00050	< 0.00050	< 0.00050
1,2-Dichlorobenzene	mg/L		< 0.00050	< 0.00050	< 0.00050
1,2-Dichloroethane	mg/L		< 0.00050	< 0.00050	< 0.00050
1,2-Dichloropropane	mg/L		< 0.00050	< 0.00050	< 0.00050
1,3-Dichlorobenzene	micro g/L		< 0.50	< 0.50	< 0.50
1,3-Dichloropropene	mg/L		< 0.00050	< 0.00050	< 0.00050
1,4-Dichlorobenzene	mg/L		< 0.00050	< 0.00050	< 0.00050
Acetone	micro g/L		< 5.0	8.4	< 5.0
Anionic Surfactants (MBAS)	mg/L		0.099	0.095	0.052
Benzene	mg/L		< 0.00030	< 0.00031	< 0.00032
Bromodichloromethane	micro g/L		2.7	4.4	2.5
Bromoform	micro g/L		< 0.50	3	0.54
Carbon tetrachloride	mg/L		< 0.00050	< 0.00050	< 0.00050
Chloroethane	micro g/L		< 0.50	< 0.50	< 0.50
Chloroform	micro g/L		3.0	5.2	4.2
Chloromethane	micro g/L		< 0.50	< 0.50	< 0.50
cis-1,2-Dichloroethylene	mg/L		< 0.00050	< 0.00050	< 0.00050
cis-1,3-Dichloropropene	micro g/L		< 0.50	< 0.50	< 0.50
Dibromochloromethane	micro g/L		1.2	3.8	1.3
Dichloromethane	mg/L		< 0.00050	0.0026	< 0.00050
Ethylbenzene	mg/L		< 0.00050	< 0.00050	< 0.00050
Ethylene dibromide	mg/L		< 0.00050	< 0.00050	< 0.00050
m- + p- Xylene	micro g/L		< 0.50	< 0.50	< 0.50
Methyl bromide	micro g/L		< 0.50	< 0.50	< 0.50
Methyl ethyl ketone	micro g/L		< 1.0	< 1.0	< 1.0
Methyl isobutyl ketone	micro g/L		< 1.0	< 1.0	< 1.0
Monochlorobenzene	mg/L		< 0.00050	< 0.00050	< 0.00050
o-Xylene	micro g/L		< 0.50	< 0.50	< 0.50
Styrene	mg/L		< 0.00050	< 0.00050	< 0.00050
Tetrachloroethylene	mg/L		< 0.00050	< 0.00050	< 0.00050
Toluene	mg/L		< 0.00030	0.00034	0.0004
Total Kjeldahl Nitrogen / TKN	mg/L		32	28	36
Total Nitrogen	mg/L		35	28	37
Total Xylenes	mg/L		< 0.00050	< 0.00050	< 0.00050
trans-1,2-Dichloroethylene	mg/L		< 0.00050	< 0.00050	< 0.00050
trans-1,3-Dichloropropene	micro g/L		< 0.50	< 0.50	< 0.50
Trichloroethylene	mg/L		< 0.00050	< 0.00050	< 0.00050
Vinyl chloride	mg/L		< 0.00050	< 0.00050	< 0.00050

Redwood City Recycled Water
Water Quality Monitoring

		Sample Date	12/22/2009	4/15/2010	7/21/2010
PHYSICAL					
Alkalinity (bicarbonate, as CaCO3)	mg/L		220	260	230
Alkalinity (carbonate, as CaCO3)	mg/L		< 5.0	< 5.0	< 5.0
Alkalinity (hydroxide, as CaCO3)	mg/L		< 5.0	< 5.0	< 5.0
Alkalinity (total, as CaCO3)	mg/L		220	260	230
BOD-5	mg/L		> 11	6	7.3
Color	CU		20	11	12
Conductivity	micro mho/cm		1,600	1600	1500
Hardness (total, as CaCO3)	mg/L		180	214	183
pH			7.35	7.5	7.44
Sodium Absorption Ratio			5.18	4.82	5.44
Suspended Solids	mg/L		2.2	2.6	2.4
Total dissolved solids / TDS	mg/L		690	690	660

City of San Francisco Water Quality Data for Year 2009

The table below lists drinking water contaminants detected in 2009. Contaminants below detection limits are not shown. In addition to the contaminants' names, applicable drinking water standards or regulatory action levels, ideal goals for public health, and levels detected in water, the table also includes the information about typical contaminant sources and footnotes explaining the findings. The State allows the SFPUC to monitor for some contaminants less than once per year because their concentrations do not change frequently. The SFPUC received from the State a monitoring waiver for some contaminants that were absent in the water.

DETECTED CONTAMINANTS	UNIT	MCL	PHG OR (MCLG)	RANGE OR LEVEL FOUND	AVERAGE OR [MAX]	MAJOR SOURCES IN DRINKING WATER
TURBIDITY [1]						
For Unfiltered Hetch Hetchy Water	NTU	5	N/A	0.27 - 0.52 [2]	[3.87] [3]	Soil runoff
For Filtered Water from Sunol Valley Water Treatment Plant (SVWTP)	NTU	1 [4]	N/A	-	[0.26]	Soil runoff
	-	min 95% of samples ≤0.3 NTU [4]	N/A	100%	-	Soil runoff
For Filtered Water from Harry Tracy Water Treatment Plant (HTWTP)	NTU	1 [4]	N/A	-	[0.18]	Soil runoff
	-	min 95% of samples ≤0.3 NTU [4]	N/A	100%	-	Soil runoff
DISINFECTION BYPRODUCTS AND PRECURSOR						
Total Trihalomethanes	ppb	80	N/A	13 - 50	[34] [5]	Byproduct of drinking water chlorination
Haloacetic Acids	ppb	60	N/A	7 - 32	[22] [5]	Byproduct of drinking water chlorination
Total Organic Carbon [6]	ppm	TT	N/A	2.3 - 3.2	2.7	Various natural and man-made sources
MICROBIOLOGICAL						
Total Coliform	-	NoP ≤5.0% of monthly samples	(0)	-	[0.3%]	Naturally present in the environment
Giardia lamblia	cyst/L	TT	(0)	0.01 - 0.05	[0.05]	Naturally present in the environment
INORGANIC CHEMICALS						
Fluoride (source water) [7]	ppm	2.0	1	<0.1 - 0.8	0.3 [8]	Erosion of natural deposits
Chloramine (as chlorine)	ppm	MRDL = 4.0	MRDLG = 4	0.02 - 2.5	[1.8] [5]	Drinking water disinfectant added for treatment
CONSTITUENTS WITH SECONDARY STANDARDS	**UNIT**	**SMCL**	**PHG**	**RANGE**	**AVERAGE**	**TYPICAL SOURCES OF CONTAMINANT**
Aluminium	ppb	200	N/A	<50 - 51	<50	Erosion of natural deposits
Chloride	ppm	500	N/A	4 - 14.6	9.5	Runoff / leaching from natural deposits
Color	unit	15	N/A	<5 - 9	<5	Naturally-occurring organic materials
Specific Conductance	µS/cm	1600	N/A	30 - 309	170	Substances that form ions when in water
Sulfate	ppm	500	N/A	1.1 - 35.6	16.6	Runoff / leaching from natural deposits
Total Dissolved Solids	ppm	1000	N/A	22 - 168	92	Runoff / leaching from natural deposits
Turbidity	NTU	5	N/A	0.08 - 0.33	0.16	Soil runoff
LEAD AND COPPER [9]	**UNIT**	**AL**	**PHG**	**RANGE**	**90TH PERCENTILE**	**MAJOR SOURCES IN DRINKING WATER**
Copper	ppb	1300	300	12 - 152	66	Corrosion of household plumbing systems
Lead	ppb	15	0.2	<1 - 16.6	6.9	Corrosion of household plumbing systems

OTHER WATER QUALITY PARAMETERS	UNIT	ORL	RANGE	AVERAGE
Alkalinity (as $CaCO_3$)	ppm	N/A	8 - 102	50
Boron	ppb	N/A	<100 - 102	<100
Bromide	ppb	N/A	<10 - 16	<10
Calcium (as Ca)	ppm	N/A	2 - 26	12
Chlorate [10]	ppb	(800) NL	56 - 511	258
Hardness (as $CaCO_3$)	ppm	N/A	12 - 108	55
Magnesium	ppm	N/A	0.2 - 8.8	4.5
pH	-	N/A	8.7 - 8.8	8.7
Potassium	ppm	N/A	0.24 - 1.5	0.9
Silica	ppm	N/A	4.8 - 7.5	5.9
Sodium	ppm	N/A	3 - 23	14

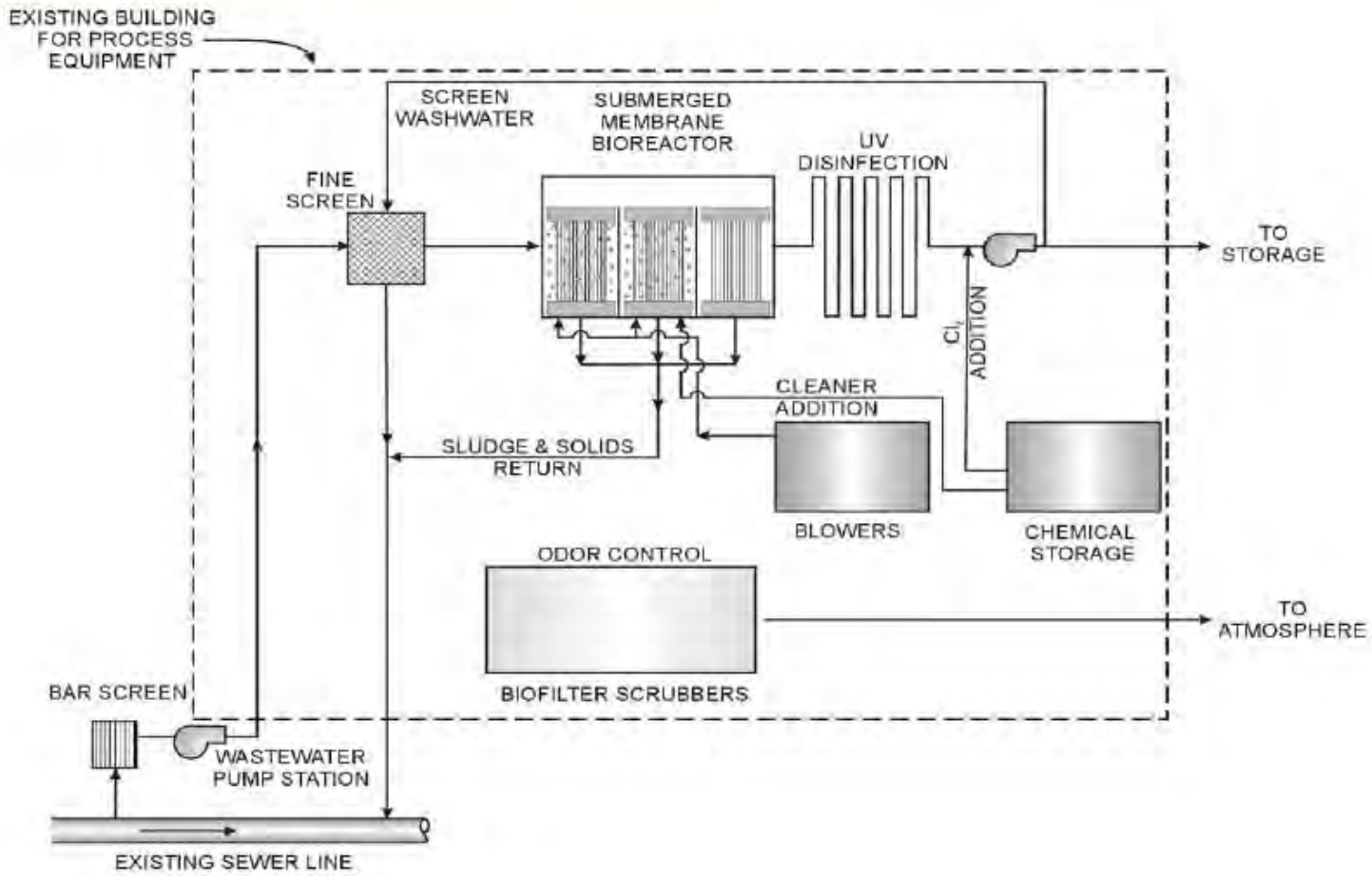
KEY:

< / ≤ = less than / less than or equal to
AL = Action Level
Max = Maximum
Min = Minimum
N/A = Not Available
ND = Non-detect
NL = Notification Level
NoP = Number of Coliform-Positive Samples
NTU = Nephelometric Turbidity Unit
ORL = Other Regulatory Level
ppb = part per billion
ppm = part per million
µS/cm = microSiemens / centimeter

NOTES: (1) Turbidity is a water clarity indicator; it also indicates the effectiveness of the filtration plants; **(2)** Turbidity is measured every four hours. These are monthly average turbidity values; **(3)** This is the highest turbidity of the unfiltered water served to customers in 2009. The highest single turbidity measurement of the unfiltered water in 2009 was 10 NTU but the turbid water was pumped away to San Antonio Reservoir without serving customers. The startup of San Joaquin Pipelines caused elevated turbidities as a result of sediment resuspension in the pipelines; **(4)** There is no MCL for turbidity. The limits are based on the TT requirements in the State drinking water regulations; **(5)** This is the highest quarterly running annual average value; **(6)** Total organic carbon is a precursor for disinfection byproduct formation. The TT requirement applies to the filtered water from the SVWTP only; **(7)** The SFPUC adds fluoride to the naturally occurring level to help prevent dental caries in consumers. The CDPH requires our fluoride levels in the treated water to be maintained within a range of 0.8 ppm - 1.5 ppm. In 2009, the range and average of our fluoride levels were 0.7 ppm - 1.3 ppm and 1.0 ppm, respectively; **(8)** The naturally occurring fluoride levels in the Hetchy Hetchy and SVWTP raw water are ND and 0.2 ppm, respectively. The HTWTP raw water has elevated fluoride levels due to the continued supply of the fluoridated Hetch Hetchy & SVWTP treated water into Lower Crystal Springs Reservoir, which supplies water via San Andreas Reservoir to the HTWTP for treatment; **(9)** The most recent Lead and Copper Rule monitoring was in August 2009. One of the 59 water samples collected at consumer taps had lead concentration above the Action Level; **(10)** There was no chlorate detected in the raw water sources. The detected chlorate in treated water is a byproduct of the degradation of sodium hypochlorite, the primary disinfectant used by SFPUC for water disinfection. **Note:** The blend of different water sources has been variable and has resulted in varying water quality parameters due to system improvements and operational constraints. Additional water quality data may be obtained by calling the SFPUC Water Quality Division toll free number at **(877) 737-8297**.

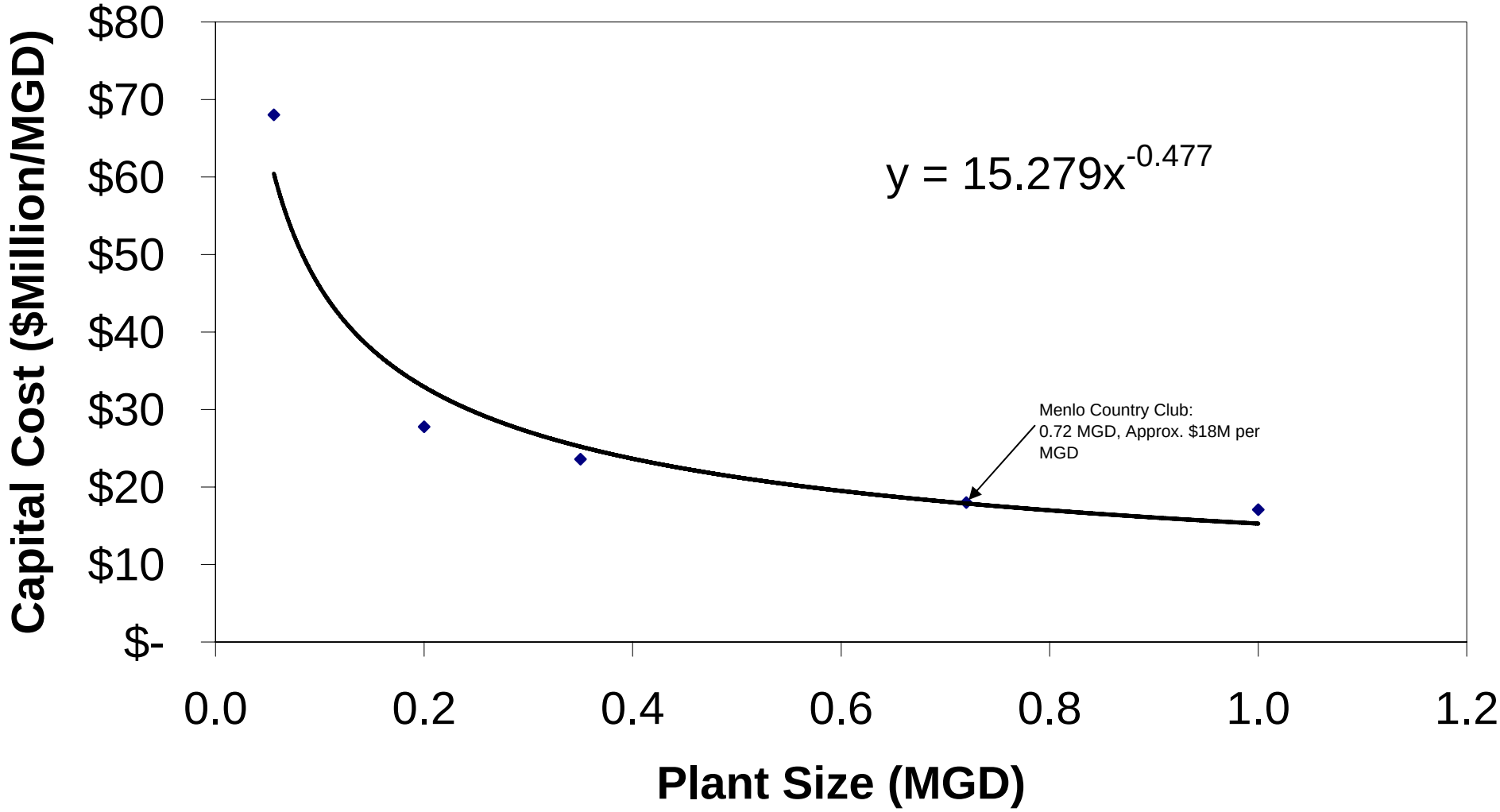
Appendix E: Conceptual-Level Schematic of a Typical Satellite Treatment System

Treatment System Schematic



Appendix F: Conceptual-Level Capital Cost Curve for Satellite Treatment (2010 dollars)

Capital Cost for Satellite Treatment (Adjusted to October 2010 Dollars[1])



(1) Based on a 2003 study by the North Bay Watershed Association for a facility in Novato, CA. The 2003 costs have been adjusted to 2010 dollars using the Engineering News Record Construction Cost Index [Aug 2003 = 7,801; Oct 2010 = 10,111]

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UPDATE ON THE CONCEPTUALIZATION OF THE LAKE-AQUIFER SYSTEM

WESTSIDE GROUND-WATER BASIN

SAN FRANCISCO AND SAN MATEO COUNTIES

Exploratory Drilling and Well Construction

Conceptual Model Components

Lake Merced Water Additions In-Lieu Recharge Demonstration

Aquifer Testing

prepared for
San Francisco Public Utilities Commission

Luhdorff and Scalmanini
Consulting Engineers
Woodland, California

April 2004

Hypothesis: Seawater intrusion into the deep aquifer system directly west of Daly City pumping is impeded by geologic structural features, including dipping and folded beds and an interpreted outcropping in the ocean that extends as far as 25 miles offshore.

The conceptualization of impedance to seawater intrusion from the ocean into Daly City has been advanced through a close examination of offshore topography and geology, and stratigraphic relationships in the Merced Uplands area. The results support the hypothesis that water supply wells in the Daly City area do not have a direct connection to the Pacific Ocean. The controlling factors are the presence of the Serra Fault, deformation of beds in the sea cliffs along the coast, and a shallow sea shelf that extends about 25 miles offshore. This combination of factors is a refinement of the previous conceptualization which identified steeply dipping beds and possibly offshore topography as primary conceptual model components.

In addition to the above, seawater intrusion is not currently occurring west of Daly City as evident from water levels in monitoring wells recently constructed within three different depth horizons at Thornton Beach that are above sea level.

Hypothesis: Seawater intrusion north of Lake Merced is constrained by the lack of a gradient for onshore flow and also by projections of offshore structural features.

A network of multiple completion, dedicated monitoring wells was installed along the coast in the Sunset district to extend Pacific coastal monitoring from the San Francisco Zoo to Golden Gate Park. Initial ground-water level readings west and north of Lake Merced indicate that ground-water levels are higher than sea level at the time the wells were installed in late 2003 to early 2004.

Hypothesis: There is no direct pathway (i.e., through geologic strata) for seawater intrusion to occur from the San Francisco Bay into the San Bruno portion of the Westside Basin.

Monitoring in two privately owned monitoring wells near the San Francisco Bay in the area east of San Bruno's municipal well field during the in-lieu demonstration and aquifer testing indicates some hydraulic connection in the ground-water system between these two areas. This observation points to a need for possible follow-up geologic investigation to determine whether there may be a connection between the Bay and the San Bruno well field.

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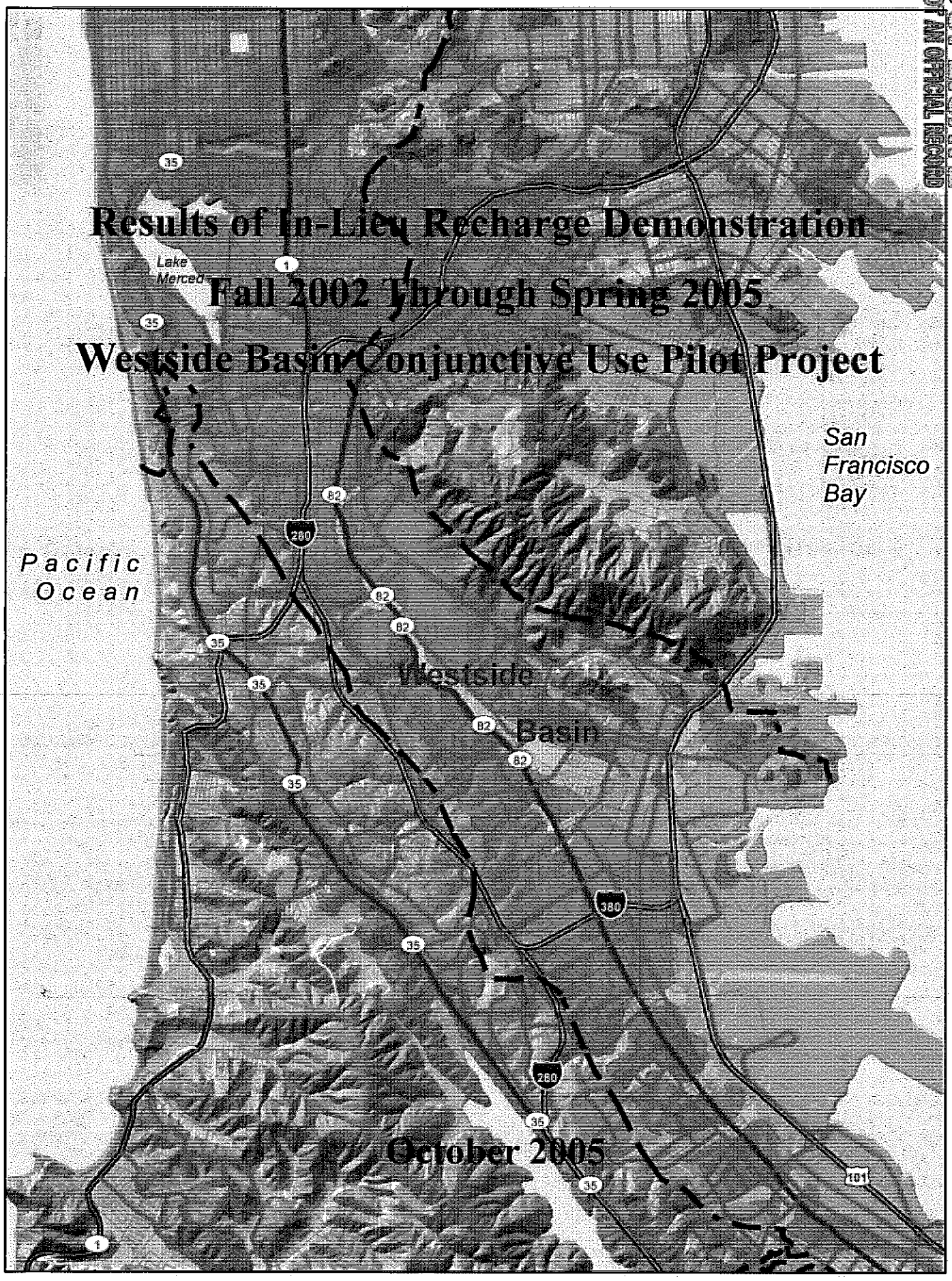
Results of In-Lieu Recharge Demonstration

Fall 2002 Through Spring 2005

Westside Basin Conjunctive Use Pilot Project



October 2005

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Results of In-Lieu Recharge Demonstration Fall 2002 Through Spring 2005

Westside Basin Conjunctive Use Pilot Project

SFPUC
WATER
HETCH HETCHY
WATER & POWER
CLEAN WATER

San Francisco
Public Utilities Commission

Luhdorff and Scalmanini
Consulting Engineers

October 2005

File No. 05-6-063

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Results of In-Lieu Recharge Demonstration
Fall 2002 Through Spring 2005
Westside Basin Conjunctive Use Pilot Project

Executive Summary

Results from an In-Lieu Recharge Demonstration in the Westside Basin indicate that in-lieu recharge of the groundwater basin can successfully be accomplished by reducing pumping, using supplemental water to replace the reduced pumping, and allowing ongoing recharge to accumulate in the basin. From the Fall of 2002 through the Spring of 2005, California Water Service Company and the Cities of San Bruno and Daly City participated in a pilot project to study the effects of the recharge component of a conjunctive use program in which these entities reduced groundwater pumping and purchased supplemental surface water from the SFPUC. The cooperation of these entities in the demonstration program allowed a study of the resultant increase in groundwater storage, as reflected by a rise in groundwater levels, and the corresponding decline when the wells were pumped again.

The pilot project was intended to assess the recharge component of a potentially permanent program with the following objectives:

- Increase groundwater levels in the Westside Basin,
- Reduce the potential for seawater intrusion,
- Develop increased SFPUC system supplemental dry year and emergency supply from the overall surface and groundwater system, and
- Potentially improve conditions at Lake Merced.

As a result of varying reductions in pumping through the southern Westside Basin, the total increase in storage for the southern Westside Basin during the in-lieu recharge period was approximately 13,000 acre feet (af), of which approximately 6,300 af was in the Daly City area, 3,600 af in the South San Francisco area, and 3,000 af in the San Bruno area.

IRWMP Round 2 Implementa | Adobe Acrobat 9 Pro: Using | Adobe Acrobat X Pro * Using | Bids On Line | IRWMP R2 - SF Groundwate
www.sfwater.org/bids/projectDetail.aspx?prj_id=309

Regional Groundwater Storage and Recovery (WSIP)

A Water Savings Account for Protection Against Drought

The proposed Regional Groundwater Storage and Recovery (GSR) project is part of our Water System Improvement Program (WSIP) and would benefit over 2.6 million people and businesses in the Bay Area by providing a local supply of water for use in times of drought. By storing water in wet years, when water supply is sufficient, this project builds a water savings account that can be tapped during dry years or in emergency situations such as an earthquake. The project is needed to meet our dry year water supply needs. Without the project, we cannot fulfill its dry year water supply needs for its residents and would need to increase mandatory rationing above currently projected levels.

A Regional Approach to Drought Protection

Project Information

CONSTRUCTION START	May 2014
CONSTRUCTION FINISH	February 2016
COST	$88 Million
PROJECT PHASE	Design

Additional Information

The information shown reflects the current forecast information published in the latest WSIP Quarterly Report.

- Hydrogeologic Conditions in the Westside Basin - 2005
- USGS: Geohydrology, Water Quality, and Estimation of Ground-Water Recharge
- North Westside Basin Groundwater Management Plan, Final Draft
- South Westside Basin Groundwater Management Plan, Final
- South Westside Basin Groundwater Management Plan, Appendix
- Regional Groundwater - Frequently Asked Questions

Luhdorff and Scalmani....pdf | Executive Summary - ....pdf | GSR NOP.pdf | Exec Summary - Final ....pdf | Pages from South_We....pdf | Show all downloads...

The GSR project is a partnership between SFPUC and three San Mateo County agencies: the California Water Services Company (serving South San Francisco and Colma), the City of Daly City and the City of San Bruno. ***"Every drop of water stored by this project helps our region during times of drought".*** The project would balance the use of both groundwater and surface water to increase dry-year water supplies. During years of normal or heavy rainfall, the project would provide additional surface water to the partner agencies in San Mateo County in order to reduce the amount of groundwater pumped from the South Westside Groundwater Basin. Over time, the reduced pumping would result in a water savings account of up to 60,500 acre-feet of water — a volume equivalent to that of Crystal Springs Reservoir. The water would be stored underground in the South Westside Groundwater Basin aquifer in San Mateo County.

To extract the stored groundwater, 16 recovery wells, well stations, pumps and piping would be installed as part of the GSR project. The wells could extract the stored groundwater at a rate of up to 7.2 million gallons per day which would serve up to 24,000 households. The project is designed to protect against drought, and will provide enough of a water savings account to provide protection through a multi-year dry spell lasting up to seven and a half years. The water quality from this stored supply would meet California Department of Public Health requirements for drinking water supplies.

The proposed project would include installation of up to 16 new recovery well facilities in northern San Mateo County

- Regional Groundwater Fact Sheet November 2012
- Regional Groundwater Fact Sheet – Spanish – November 2012
- Regional Groundwater Fact Sheet – Chinese – November 2012
- Update on the Conceptualization of the Lake-Aquifer System, Westside Groundwater Basin, Report
- Results of In-Lieu Recharge Demonstration Fall 2002 through Spring 2005, Final Report
- Notice of Preparation
- Glossary
- Useful Links

Need More Information? Contact

Amy Sinclair
Phone: (415) 551-4659
Email: asinclair@sfwater.org

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

2008

Bicycle Facility Program

Grant Application Package
for Fiscal Year 2008/2009

Bay Area Air Quality Management District
939 Ellis Street, San Francisco, CA 94109
April 2008

Funding for the Bicycle Facility Program is provided through the Bay Area Air Quality Management District's Transportation Fund for Clean Air

TABLE OF CONTENTS

This document describes the Bay Area Air Quality Management District's (Air District's) Bicycle Facility Program (BFP) and explains how to apply for a grant in the fiscal year (FY) 2008/09 funding cycle. This grant application package includes copies of the:

Page

- Bicycle Facility Program Summary 1
- Overview of the Funding Process 6
- Grant Application Instructions 8
- Bicycle Facility Program FY 2008/09 Grant Application Form 10
- Appendix A. Bicycle Facility Program Guidelines for Fiscal Year 2008/2009 16

An electronic version of this document and user modifiable copies of the grant application forms are available at:
http://www.baaqmd.gov/pln/grants_and_incentives/bfp/index.htm

REMINDER CHECKLIST

Grant Application Submittal Dates: The Air District will begin reviewing FY 2008/09 BFP grant applications at **4:00 PM** on **Monday, June 16, 2008** and on an ongoing basis while BFP funds are available.

- ❑ Review this grant application package, including the BFP Guidelines.
- ❑ Attend the joint TFCA Regional Fund / BFP grant application workshop at **9:30 AM on Friday, May 16, 2008 at the Air District's offices.** Attendance at the workshop is not required to apply for funds. Directions to the Air District are available at http://www.baaqmd.gov/dst/directions/index.htm.
- ❑ Grant applicants are encouraged to discuss their project and any questions they have with Air District staff prior to submitting a grant application.
- ❑ Complete the grant application form (Parts 1 through 4, plus 5A and/or 5B, as required by the project components).
- ❑ Submit all required attachments and documentation (Bike Plan, Budget, Photo's, etc.) clearly labeled with the grant application.
- ❑ Make sure the amount requested is greater then $10,000 and less than the maximum amount allowable.

BICYCLE FACILITY PROGRAM SUMMARY

BACKGROUND

The Bay Area Air Quality Management District (Air District) makes grants through the Bicycle Facility Program (BFP) to encourage bicycling as a strategy to reduce mobile source emissions in the Bay Area. The BFP has been developed as a separate grant program to provide a more streamlined mechanism for funding the implementation of new bicycle facilities in the region. By providing default funding amounts that are in line with past cost-effective projects, the BFP simplifies the grant application, funding, and monitoring processes.

The BFP is funded by the Transportation Fund for Clean Air (TFCA). TFCA revenues are generated through a $4 surcharge on motor vehicle registrations within the Air District's jurisdiction. The Air District's objectives for the TFCA program are to fund the most cost-effective projects that reduce motor vehicle emissions, and to support the implementation of the transportation control measures and mobile source measures in the *Bay Area 2005 Ozone Strategy.*

SCHEDULE

The Air District will initially review all grant applications received by **Monday, June 16, 2008**. If the BFP is oversubscribed, projects will be chosen, by lottery, from all eligible applications that were received by **4:00 PM** that day. Grant applicants will be notified, and invited to attend, if a selection lottery becomes necessary. While BFP funds remain available, grant applications will continue to be accepted on an ongoing basis until funds are exhausted or Air District staff begins preparing for the next funding cycle.

Schedule for FY 2008/09 BFP Fund Cycle

Friday, May 16, 2008	Joint BFP and TFCA Regional Fund workshop for grant applicants at 9:30 AM. The workshop is scheduled for two hours, with the BFP discussion immediately following the TFCA session.
Monday, June 16, 2008	**The Air District begins reviewing grant applications. Grant applications will be accepted on an ongoing basis while FY 2008/09 funding for the BFP remains.**
Ongoing – (beginning July 2008)	Grant applicants are notified of the status of their grant application within 30 days of receipt.
Ongoing – (beginning September 2008)	Proposed funding agreements and vouchers are issued within 60 days of a grant application being accepted for BFP funding.

WHO CAN APPLY

Any public agency sponsoring an eligible project within the jurisdiction of the Air District is eligible to apply for BFP grants. The Air District encompasses all of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, and Santa Clara Counties, and the southern parts of Solano and Sonoma Counties. Eligible public agencies include cities, counties, transit districts, school districts, and other special purpose agencies. Eligible grant recipients will be responsible for the implementation of the project and must have the authority and capability to complete the project.

Project sponsors may not be eligible for additional BFP funding if they have unresolved issues related to a project previously funded through the Air District as indicated in guidelines #6-10, including an:

- Outstanding unfulfilled monitoring and reporting obligation,
- Exclusion from future funding due to a failed fiscal or performance audit,
- Unsigned funding agreement from a previous year's grant cycle, or
- Existing project that is not being executed in a manner consistent with its implementation schedule.

AVAILABLE FUNDS

A total amount of $600,000 will be available for distribution via the BFP in FY 2008/09. The minimum BFP grant for a single project is $10,000 and the maximum grant is 35% of the total funds available (or $210,000 in FY 2008/09). The BFP grant amount plus matching funds must equal the total amount needed for the project.

PROJECT TYPES AND FUNDING AMOUNTS

During FY 2008/09 the Air District has approved maximum funding levels for the following project types, as listed in the table below. A single grant application may combine multiple project types, but must call out each component of the project. The grant amounts listed below are inclusive of all eligible project costs, and constitute the maximum funding available for each component. Project sponsors may request less funding if appropriate for their projects. Payments will only be made on the actual costs of the project.

Project Type / Project Component	Maximum Grant Amount
Bikeways	
Class I (Bicycle Path)	$115,000 per mile of path
Class II (Bicycle Lane) – Standard	$30,000 per mile of roadway
Class II (Bicycle Lane) – Continuous Construction	$85,000 per mile of roadway
Class III (Bicycle Route)	$15,000 per mile of route
Bicycle Parking Facilities	
Bicycle Locker(s) – Mechanical	$900 per locker
Bicycle Locker(s) – Electronic	$2,500 per locker
Bicycle Locker(s) – Retrofit Mechanical to Electronic	$650 per retrofit kit
Bicycle Rack(s)	$60 per bicycle accommodated
Secure Bicycle Parking	$130 per bicycle accommodated
Bicycle Rack(s) on Public Transportation Vehicles	$750 per rack

The Air District has determined that the above funding levels for each project type meet the TFCA cost-effectiveness criterion for the BFP ($90,000 of TFCA funds per ton of emissions reduced over the lifetime of a project). These grant amounts reflect historic funding levels for similar projects, adjusted based on information from previous projects and outside literature and performance reviews. The grant amounts are not necessarily intended to pay the full cost of project implementation. Applications that request additional amounts beyond those listed will not be considered.

Additional Information for Select Project Types:

A **Class I – Bicycle Path** provides a separated right of way for the exclusive use of bicycles and pedestrians, in which motorized vehicles are prohibited and crossings by pedestrians and automobiles are minimized.

A **Class II – Bicycle Lane** is a paved, on-road bikeway that separates bicyclists from vehicle traffic by a striped lane dedicated for one-way bicycle travel. The grant amounts listed are for two lanes installed on a roadway, to provide for bicycle travel in both directions; *a single bike lane (in one direction only) would qualify for one-half the stated amount.*

- **Class II – Standard** projects include projects that can be completed within the existing roadway width through restriping and realignment of existing lanes and parking spaces.
- **Class II – Continuous Construction** projects entail physical improvements (e.g., the purchase of right-of-ways, non-maintenance paving or the widening of a roadway, relocation of utilities) over the length of the segment.
- Grant amounts for **Continuous Construction** and **Standard Class II** facilities cannot be combined for the same roadway segment but can be applied to different segments along the same bikeway.

* If a roadway is already striped for wide shoulder and only needs signs, then the project will be considered Class II at Class III award amounts.

A **Class III – Bicycle Route** indicates a preferred route for bicycle travel that is shared with motor vehicles. It should follow roadways where traffic is relatively light and potential conflicts between bicycles and vehicles can be minimized. Bicycle routes must be indicated with signs. Street markings and traffic calming devices and barriers, which route vehicle traffic but allow bicycles to pass through, are also allowed as part of a Class III project.

A **Bicycle Rack** installed with TFCA funds should be anchored in place. Its capacity is determined based on the manufacturer's specifications and the location in which it will be installed. For example, a standard inverted "U" rack holds two bicycles (unless installed in a location where only one bicycle can access the rack).

Secure Bicycle Parking facilities provide a secure location for storing bicycles, such as in limited-access bicycle cages and bike stations. BFP funds can be used for the capital costs of bicycle parking, but <u>not</u> the operational costs.

ELIGIBILITY CRITERIA

An eligible project must meet the following criteria to be considered for funding:

- Result in a new bicycle facility, which is available for public use;
- Be included in an adopted countywide bicycle plan (as described in Guideline 15), Congestion Management Program (CMP), or the Metropolitan Transportation Commission's *Regional Bicycle Plan*. A written statement of intent from the responsible Congestion Management Agency to include the project in the next update of the CMP will also fulfill this requirement;
- Adhere to the applicable design standards in Chapter 1000 of the California Highway Design Manual;
- Reduce motor vehicle emissions through providing an alternative to vehicle trips made for utilitarian purposes (such as work/school commuting, shopping, etc.). In order to ensure that this criteria is met:
    - **Bikeways** must be within one-half mile of at least three major activity centers (as defined in the Grant Application Instructions below), or extend/provide gap closure in a system that already services major activity centers, and;
    - Each **bicycle parking** component must be located at a major activity center;
- Be ready for implementation. A project will only be considered for funding if it will commence (e.g., begin installation, award a construction contract, take delivery of the product, etc.) in calendar year 2009 or sooner; and be completed within two years of the funding agreement execution.
- Have the funding necessary to complete the project available so that the project meets the implementation and completion criteria. Any matching funds must be in place or reasonably secured.

ELIGIBLE PROJECT COSTS

BFP funds can cover the direct costs associated with carrying out the project, including:

- Salaries, wages, and benefits directly and solely related to implementation of the BFP project;
- Construction and/or installation costs;
- Contractor labor charges related to the BFP project; and
- Capital and materials costs, including project features such as signage, pavement markings (striping and stenciling), bicycle loop detectors and signals, and lighting.

The costs for design, engineering, installation, and preparation of required environmental review documents that directly support project implementation are eligible for BFP funding, although payment will not be made until a project is completed and in service.

Please note that to be eligible for reimbursement, all project costs must be:

- Identified in the grant application and outlined in the funding agreement or voucher,
- Incurred after the funding agreement's effective date or the voucher issue date, and
- Properly documented in the project invoice.

INELIGIBLE PROJECTS AND COSTS:

The BFP provides funding to construct new public facilities to encourage a transportation mode shift away from vehicle travel; as such, BFP funds may not be used to cover:

- Maintenance costs, repairs, or rehabilitation,
- Upgrades to existing bicycle facilities,
- Ongoing operations (e.g., staffing a bike station),
- Planning activities that are not directly related to BFP project implementation, or
- Indirect and administrative costs (e.g., completing the grant application, executing a funding agreement, accounting, reporting, record-keeping).

Projects that do not achieve additional emission reductions will not be considered for funding. This includes projects that duplicate existing Air District-funded projects or projects that are required by emission reduction regulations or other legally binding obligations. Such projects must demonstrate that they achieve emissions reductions beyond what is required in order to receive BFP funding.

Finally, payment requests will not be processed (see Guideline #10) if the:

- Funding agreement or voucher for the project has not been fully and properly executed,
- Costs were incurred before the effective date of the funding agreement or date the voucher was executed, or
- Project is no longer eligible for BFP funding (e.g., due to additional information becoming available to indicate that the project does not meet the eligibility requirements).

OVERVIEW OF THE FUNDING PROCESS

Air District staff will determine the projects to be funded primarily on **a first-come, first-served basis**, with completed grant applications reviewed in the order in which they are received. Once submitted, a grant application cannot be altered or revised without the consent of the Air District. However, air district staff may contact the project sponsor if clarifying information is needed. An application for grant funding will only be considered complete once all required information has been submitted.

Air District staff will notify applicants of the status of their grant application within 30 days of receipt. After an award has been made, staff will plan to generate either a funding agreement (for bikeway projects) or a purchasing voucher (for bicycle parking and public transit projects) within 60 days of acceptance of a project for funding.

- **Funding Agreements** (Bikeway Projects): Each grant recipient for bikeway projects shall enter into a binding agreement with the Air District outlining the terms, conditions, and reporting requirements of the grant. Only a fully-executed funding agreement (i.e., signed by both the Air District and the project sponsor) constitutes a final approval and obligation on the part of the Air District to fund a project. The project sponsor has two months to sign and return the funding agreement to the Air District.
- **Vouchers** (Bicycle Parking and Public Transit Projects) Grant awards for bicycle parking and public transit projects follow a more streamlined approach in which the Air District issues a voucher to the project sponsor which constitutes a promise of payment once the project has been completed.
- If a project combines both bikeways and other components, a funding agreement will be issued for the entire project.

All BFP grant recipients must expend the funds awarded within two years of the effective date of the funding agreement, or the date the voucher was issued, unless a longer period is requested in writing by the project sponsor and approved in advance by the Air District (see Guideline #14 for details).

Once a project is fully implemented, the project sponsor submits an invoice and documentation of the expenditure of funds and completion of the project. Air District staff will review the invoice and supporting materials and issue payment. In general, payment will be made in one invoice after the project has been completed and is in service.

Additional Requirements

- During the life of the project, the project sponsor must submit quarterly progress reports.
- Grant recipients are subject to audits of each project funded to ensure that the funds have been spent in accordance with regulatory requirements and the BFP guidelines.

- The Air District reserves the right to conduct studies of BFP funding facilities to gather usage, cost-effectiveness, and similar information.
- Projects funded through the BFP will display an Air District-approved logo acknowledging this funding.
- The Air District must be credited in any publicity/media material about the project.
- The project sponsor must meet the insurance requirements set forth in the funding agreement (bikeway projects only).
- The project sponsor must provide before and after photographs of the roadway/corridor on which a bicycle facility is installed (bikeway projects only).

AIR DISTRICT STAFF CONTACT

Grant applicants are encouraged to discuss their grant applications with Air District staff prior to submittal. The primary Air District contact person for the BFP is:

Avra Goldman
Grant Programs Section
agoldman@baaqmd.gov
415-749-5093

GRANT APPLICATION INSTRUCTIONS

All grant applicants must complete all parts of the FY 2008/09 BFP grant application form. The space provided on the form may be expanded to fully answer each question and additional documentation may be included, as needed.

Project Scope

The grant applicant has flexibility to determine what project types / components to include in one grant application. For example, a single project could include:

- Two segments of Class I Bicycle Paths connected by a Class II Bicycle Lane,
- Multiple bicycle parking facilities at different locations, or
- A combination of bikeways and parking facilities within that jurisdiction.

Each component of the project must be accounted for in the Budget Table (in Part 3 of the grant application) and described in the appropriate Project Information sections (Parts 5A and/or 5B).

Requirement for a Facility to Serve Activity Centers

Part 5 (A and B) of the grant application requires the project sponsor to identify activity centers serviced by the project. For the purpose of the BFP, major activity centers are locations that attract significant vehicle travel for utilitarian purposes, such as work/school commuting, shopping, organized recreation, etc. Examples of such destinations include, but are not limited to, transit stations, office complexes, educational institutions, shopping centers (e.g., a mall or other shopping complex) or recreation centers (e.g., municipal pool or gym).

- For a **bikeway** to be eligible for funding, it must serve at least three major activity centers. Part 5A of the grant application requests information on all centers within one-half mile of the bikeway.
    - Grant applicants must provide this information for each non-contiguous segment of bikeway being installed.
    - If a bikeway segment is an extension to, or closes a gap within, an existing bicycle network, the project can be funded if the new segment is within three contiguous bikeway miles of the requisite activity centers.
- For **bicycle parking project** components (Part 5B), information is required on the location in which the bicycle racks or lockers will be installed.

SUBMITTAL

The Air District will initially review all grant applications that have been received by **4:00 PM, on Monday, June 16, 2008.** Grant applications may be mailed or hand-delivered to the address below. E-mails and faxes will not be accepted. If the BFP is oversubscribed and a lottery is necessary, only grant applications received by **4:00 PM, on Monday, June 16, 2008** will be considered received on the first day, and thus eligible for the lottery.

Submit a printed and signed copy of each grant application to:

Damian Breen
Grant Programs Manager
Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109

BICYCLE FACILITY PROGRAM
FY 2008/09 GRANT APPLICATION FORM

Complete Parts 1 through 6 of this grant application form. For parts 5A and 5B, provide information on each separate component of your project. A Microsoft Word version of this form is available at www.baaqmd.gov/pln/grants_and_incentives/bfp/index.htm.

PART 1. SUMMARY INFORMATION

Project Title: _____

Total Project Cost: $ _____ (should equal BFP plus Matching Funds)

BFP Funding Requested: $ _____ Matching Funds Provided, if any $ _____

Tax ID number (needed for reimbursement if project is awarded a grant): _____

Agency/Project Sponsor: _____ Date of Submittal: _____

Primary Contact Person: _____ Job Title: _____

Phone #: (____)_____ Fax #: (___)_____ E-mail: _____

Mailing Address of Primary Contact:

Secondary Contact Person: _____ Job Title: _____

Phone #: (___)_____ Fax #: (__)_____ E-mail: _____

Individual authorized to enter into a formal agreement with the Air District:

I, _____(signature), authorize the submittal of this grant application and certify that all information is correct and accurately reflects the project scope, costs, timeline, and availability of funds, and that the Project Sponsor will complete the project as outlined.

Name: _____ Title: _____ Phone: ( )_____

Mailing Address (if different from above):

PART 2. PROJECT DESCRIPTION

Provide a concise description of the project (who, what, when, where, etc.). Be sure to name any partners and their role in implementing the project, and describe the implementation area for the project (i.e., specific neighborhood or corridor, city, county, etc.):

PART 3. PROJECT BUDGET

A. BFP Funding Request

List each project component proposed and the amount of BFP funds requested. Please identify each individual component separately (bikeway segment; rack and locker location; and/or type of public transportation vehicle).

Bikeway	Distance		Request per Mile (Guideline # 16)	Amount Requested per Item
Class I (Bicycle Path)				
•		miles	$	$
•		miles	$	$
Class II (Bicycle Lane) – Standard				
•		miles	$	$
•		miles	$	$
Class II (Bicycle Lane) – Cont. Construction				
•		miles	$	$
•		miles	$	$
Class III (Bicycle Route)				
•		miles	$	$
•		miles	$	$
Total #		**miles**	**Total**	**$**

Bicycle Parking	Bicycle Capacity		Request per Bicycle Capacity (Guideline #16)	Amount Requested
Bicycle Locker(s) – Electronic				
•		bicycles	$	$
•		bicycles	$	$
Bicycle Locker(s) – Mechanical				
•		bicycles	$	$
•		bicycles	$	$
Bicycle Lockers(s) – Retrofit				
•		bicycles	$	$
•		bicycles	$	$
Bicycle Rack(s)				
•		bicycles	$	$
•		bicycles	$	$
Secure Bicycle Parking				
•		bicycles	$	$
•		bicycles	$	$
Total #		**bicycles**	**Total**	**$**

Bicycle Rack(s) on Public Transportation Vehicles	Number of Racks		Request per Rack (Guideline #16)	Amount Requested per Item
•		racks	$	$
•		racks	$	$
Total #		**racks**	**Total**	**$**

B. <u>BFP Covered Project Expenses</u>

Include a detailed listing of the major costs that the BFP funding would be used cover (i.e., capital purchases, installation costs, personnel expenses). Only costs identified in this grant application will be eligible for reimbursement.

•
•
•
•
•
•
•
•

C. Matching Funds (should equal amount on cover page)

Projects eligible for BFP funding must have secured all funding necessary to complete the project. Please specify the amount and source of all matching funds and attach documentation. If pending, please provide an indication of how secure the funds are and how the project will be completed if the funds do not become available.

Source of Funds	Amount	Funding Status (secure, pending)	If pending, anticipated award date
Total Matching Funds			

PART 4. IMPLEMENTATION SCHEDULE

Provide a detailed implementation schedule for the proposed project. Include all key milestones, including planning and preliminary activities required for project completion (e.g., environmental review, land acquisition, easements, encroachment permits, etc.). Your implementation schedule must comply with all BFP project timing requirements (i.e., be ready to begin implementation 2008 or sooner and be completed within two years of the Funding Agreement execution).

Activity or Milestone	Completion Date
• Project Start Date	
•	
•	
•	
•	
• Project Completion Date	

PART 5A. PROJECT INFORMATION: BICYCLE PATHS, LANES, AND ROUTES

Please answer these questions for each noncontiguous segment of bikeway in this project.

1) Project Specifications

a) Type of Facility (select multiple classes if appropriate)

☐ Class I ☐ Class II ☐ Class III

b) Total length of the proposed facility:_____

c) Describe key design specifications & features:

2) Eligibility

a) Is the project contained in an adopted countywide bicycle plan, Congestion Management Program (CMP), or the Metropolitan Transportation Commission's Regional Bicycle Plan? ☐ YES ☐ NO Attach documentation.

b) Do all facilities comply with applicable Caltrans design standards (See Chapter 1000 in California Highway Design Manual)? ☐ YES ☐ NO If no, explain:

c) Are there at least three major activity centers within one-half mile of each contiguous section of bikeway? ☐ YES ☐ NO If no, does this project provide a gap closure in a system that already services major activity centers? Explain:

List those major activity centers and their distance from each bikeway (replicate table for each segment if project continues over multiple segments):

Activity Center	Distance to Bikeway	Daily Trip Volume (if available)

PART 5B. PROJECT INFORMATION: BICYCLE PARKING FACILITIES AND BICYCLE RACKS ON PUBLIC TRANSPORTATION VEHICLES

Include information on all locations and components in this project.

1) Project specifications

Describe type of lockers or racks to be purchased (including name of the vendor, if known) and expected lifespan of lockers/racks. Attach summary of specifications.

2) For Bicycle Parking Projects (only)

a) Describe location(s) where the proposed lockers/racks will be installed and how those sites were selected.

b) Describe the anticipated demand and why lockers/racks are needed at project site(s).

c) Describe how lockers will be assigned to cyclists.

PART 6. ATTACHMENTS & DOCUMENTATION CHECKLIST

Ensure that the following attachments are clearly labeled and included with the grant application:

- ❑ Documentation that each project component is contained in an adopted countywide bicycle plan, Congestion Management Program, or the Metropolitan Transportation Commission's *Regional Bicycle Plan* (send copies of the plan).
- ❑ Documentation that all matching funds have been secured and their source. Explain budget documents.
- ❑ Projects including bikeway components should attach "before" photographs of the corridor to house the funded bikeway.
- ❑ Bicycle parking and public transit projects should include a summary of the specifications of the racks to be installed.
- ❑ Maps (optional and not required, but helpful in visualizing the project).

Appendix A
BICYCLE FACILITY PROGRAM GUIDELINES FOR FISCAL YEAR 2008/2009

The following guidelines apply only to the **Bicycle Facility Program** (BFP). Each guideline applies to the project type(s) listed immediately following that guideline. "Bikeways" refers to Class-1 bicycle paths, Class-2 bicycle lanes, and Class-3 bicycle routes; "Racks/Lockers" refers to bicycle racks (including those on vehicles and vessels), bicycle lockers, and secure bicycle parking.

GENERAL

1. **Purpose:** The purpose of the BFP is to reduce emissions from mobile sources by contributing Air District funding for the implementation of bicycle facilities in the Bay Area, via streamlined processes that are cost-effective in both air-quality and administrative terms. (Bikeways; Racks/Lockers)

BASIC ELIGIBILITY

2. **Reduction of Emissions:** A project must result in the cost-effective reduction of motor vehicle emissions within the Air District's jurisdiction to be considered eligible for BFP funding. Projects that are subject to emission reduction regulations or other legally binding obligations must achieve surplus emission reductions to be considered for funding by the BFP. Surplus emission reductions are those that exceed the requirements of applicable regulations or other legally binding obligations at the time the Air District approves a grant award.

   Planning activities (e.g., feasibility studies) that are not directly related to the implementation of a specific project are not eligible for BFP funding (Bikeways; Racks/Lockers)

3. **Eligible Recipients:** Only public agencies located within the jurisdiction of the Air District are eligible for BFP grants. Eligible grant recipients must be responsible for the implementation of the project and have the authority and capability to complete the project. (Bikeways; Racks/Lockers)

4. **Minimum and Maximum Funding Amounts:** Only projects requesting $10,000 or more in BFP funds will be considered for funding. No single project may receive more than 35 percent (35%) of the funds available for the BFP in any given funding cycle. (Bikeways; Racks/Lockers)

5. **Readiness:** A project will be considered for BFP funding only if the project would commence in calendar year 2009 or sooner. For purposes of this policy, "commence" means to begin delivery of the service or product provided by the project, or to award a construction contract. (Bikeways; Racks/Lockers)

APPLICANT IN GOOD STANDING

6. **Monitoring and Reporting:** Project sponsors who have failed to fulfill monitoring and reporting requirements for any previously funded Transportation Fund for Clean Air (TFCA) Regional Fund, TFCA County Program Manager Fund, or BFP project will not be considered for new funding for the current funding cycle, and until such time as the unfulfilled obligations are met. (Bikeways; Racks/Lockers)

7. **Failed Audit:** Project sponsors who have failed either the fiscal audit or the performance audit for a prior TFCA-funded or BFP-funded project will be excluded from future funding for five (5) years, or for a different period of time determined by the Air District Air Pollution Control Officer (APCO). Existing TFCA and BFP funds already awarded to the project sponsor will not be released until all audit recommendations and remedies have been satisfactorily implemented. A failed fiscal audit means an uncorrected audit finding that confirms an ineligible expenditure of TFCA or BFP funds. A failed performance audit means that a project was not implemented as set forth in the project funding agreement. (Bikeways; Racks/Lockers)

8. **Signed Funding Agreement:** All grant recipients shall enter into a funding agreement with the Air District as a written, binding agreement to implement the approved project. Only a fully executed funding agreement (i.e., signed by both the Air District and the project sponsor) constitutes a final approval and obligation on the part of the Air District to fund a project. Project sponsors must sign a funding agreement within two months from the date it has been transmitted to them in order to remain eligible for the awarded BFP grant; the Air District may authorize extensions for just cause. Project applications will not be considered from project sponsors who were awarded TFCA or BFP grants in a previous year and have not signed a funding agreement with the Air District by the current application deadline. (Bikeways)

9. **Insurance:** Each project sponsor must maintain general liability insurance, and additional insurance as appropriate for specific projects, with coverage amounts specified in the respective funding agreements.

10. **Payments:** No payment requests associated with the implementation of a BFP project will be processed if: a) the funding agreement or voucher for the project has not been fully and properly executed, b) the costs in the payment request were incurred before the date that the funding agreement or voucher was executed, or c) the project is no longer eligible for BFP funding (e.g., due to additional information becoming available after initial Air District approval of the grant award). (Bikeways; Racks/Lockers)

11. **Implementation:** Project sponsors that have a signed funding agreement for a prior-year TFCA-funded or BFP-funded project, but have not yet implemented that project by the current application deadline will not be considered for funding for any new BFP project. The phrase "implemented that project" means that the project has moved beyond initial planning stages and the project is being implemented consistent with the implementation schedule specified in the project funding agreement. (Bikeways)

INELIGIBLE PROJECTS

12. **Duplication:** Grant applications for projects that duplicate existing Air District-funded projects and, therefore, do not achieve additional emission reductions will not be considered for funding. (Bikeways; Racks/Lockers)

USE OF BFP FUNDS

13. **Ineligible Costs:** Costs for maintenance, repairs, upgrades, rehabilitation, operations (e.g., for a bikestation), and developing grant applications for BFP funding are not eligible to be reimbursed with BFP funds. Administrative costs are not eligible for reimbursement with BFP funds. Administrative costs include costs

associated with entering into a funding agreement, accounting for BFP funds, and fulfilling reporting and record-keeping requirements specified in a BFP funding agreement or voucher. (Bikeways; Racks/Lockers)

14. **Deadline to Expend Funds:** Any project sponsor awarded a BFP grant for the implementation of a bikeway project must expend the funds awarded within two (2) years of the effective date of the funding agreement , unless a longer period is formally (i.e., in writing) requested by the project sponsor and approved in advance by the Air District. (Bikeways)

    Any project sponsor awarded a BFP grant for the implementation of a bicycle rack/locker project must expend the funds awarded according to the implementation schedule specified in the BFP grant documentation. (Racks/Lockers)

PROJECT-SPECIFIC REQUIREMENTS AND GUIDELINES

15. **Eligible Bicycle Facility Projects:**

    New bicycle facility projects that are included in an adopted countywide bicycle plan, Congestion Management Program (CMP), or the Metropolitan Transportation Commission's Regional Bicycle Plan are eligible to receive BFP funds. For purposes of this policy, a written statement of intent from the responsible Congestion Management Agency to include the project in the next update of the CMP may substitute for inclusion in the county's CMP. Eligible projects are limited to the following types of bicycle facilities for public use: a) new Class-1 bicycle paths; b) new Class-2 bicycle lanes; c) new Class-3 bicycle routes; d) bicycle racks, including bicycle racks on transit buses, trains, shuttle vehicles, and ferry vessels; e) secure bicycle parking; and e) bicycle lockers. All bicycle facility projects must, where applicable, be consistent with design standards published in Chapter 1000 of the California Highway Design Manual. Costs for design, engineering, installation, and preparation for required environmental review documents that directly support implementation of a project are eligible for BFP funding. (Bikeways; Racks/Lockers)

    Bikeway projects must reduce vehicle trips made for utilitarian purposes, such as work/school commuting. Bikeways must be within one-half mile of at least three major activity centers (e.g., transit stations, office complexes, schools), or provide a gap closure in a system that already services major activity centers. Infrastructure and gap closure projects (e.g., bridges over roadways) may apply for TFCA funding under the Smart Growth project type, as well as for BFP funding under Guideline #15. (Bikeways)

    Each bicycle rack and locker project must serve an activity center (e.g., transit station, office building, and school). (Racks/Lockers)

16. **Grant Amounts:** The Air District has determined that the project types and funding levels set forth below meet the TFCA cost-effectiveness (i.e., funding effectiveness) of $90,000 of BFP funds per ton ($/ton) of total reactive organic gases (ROG), oxides of nitrogen (NO_x), and weighted particulate matter less than 10 microns in diameter (PM_{10}) emissions reduced. The maximum grant amounts set forth below are not necessarily intended to pay the full cost of project implementation. (Bikeways; Racks/Lockers)

Project Type	Grant Amount
Class-1 Bicycle Path	$115,000 per mile of path
Class-2 Bicycle Lane – Continuous Construction	$85,000 per mile of roadway
Class-2 Bicycle Lane – Standard	$30,000 per mile of roadway
Class-3 Bicycle Route	$15,000 per mile of route
Bicycle Locker(s) – Electronic	$2,500 per locker
Bicycle Locker(s) – retrofit mechanical to electronic	$650 per retrofit kit
Mechanical	$900 per locker
Bicycle Rack(s)	$60 per bicycle accommodated
Bicycle Rack(s) on Vehicles	$750 per rack
Secure Bicycle Parking	$130 per bicycle accommodated

Class-2 Bicycle Lane grant amounts are for two lanes on a roadway; a single bike lane would qualify for only one-half the stated amount. A Class-2 Bicycle Lane – Continuous Construction project must entail physical improvements (e.g., non-maintenance paving or the widening of a roadway shoulder) continuously over the length of the segment. Class-2 Bicycle Lane – Standard projects include projects other than Continuous Construction, such as striping, marking and loop detectors. Grant amounts for Continuous Construction and Standard Class-2 Bicycle Lanes cannot be combined for the same segment. Secure bicycle parking includes bicycle cages and the capital costs of bicycle parking at bike stations. (Bikeways; Racks/Lockers)

Point Pinole Regional Shoreline

About The Park
History
Park Features
Park Activities
Park Hiking Video
Park Accessibility
To Reach The Park
Trail Map

Notice

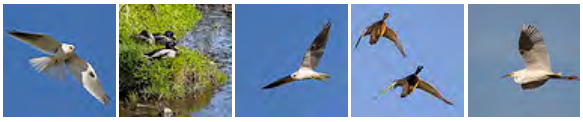
Beginning January 1, 2013, shuttle service will begin operating 7 days per week.
Shuttle van service will be available daily, including weekends and holidays.

About The Park

Please note: Atlas Bridge and Park Entrance Project - Beginning October 2010

The journey is as scenic as the destination at Point Pinole Regional Shoreline, a 2,315-acre parkland right next to densely populated Pinole, Richmond, and San Pablo. Trails lead through breezy meadows with wildflowers in season, through aromatic eucalyptus woods, or along bluffs and beaches on San Pablo Bay.

There are beautiful views of Mt. Tamalpais, the Marin shoreline, and San Pablo Bay with its sailboat and shipping traffic.
Watch movie clips.



Submit Your Photos to the EBRPD Photo Pool

History

Point Pinole opened to the public in 1973 after a long process of acquiring the property from Bethlehem Steel. Bethlehem had acquired the land in the early 1960s from Atlas Powder Co., one of several firms that had manufactured gunpowder and dynamite there for almost 100 years.

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Park Features

Point Pinole Regional Shoreline features over 100 species of bird due to a myriad of habitats within its 2,315 acres. Bird life can be found on sandy shores, marshland, eucalyptus groves, meadows, and in a fresh water pond while meandering along the park's twelve miles of trails. To see a list of common species in the park, download the Point Pinole bird list.

The eucalyptus woodlands, originally planted as a buffer against potential explosions, now shelter wildlife instead, such as deer, hawks, owls, Monarch butterfies, and many other species. Shorebirds wade at the beaches, and the salt marshes are home to song sparrows and harvest mice.

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Park Activities

Visitors can birdwatch, hike, ride their bicycles or horses, or take the park's shuttle bus for a mile and a half to reach Point Pinole's 1,250-foot fishing pier. There is a small fee to ride on the shuttle bus (see Shuttle Ride Fee under Park Info).

Although a State fishing license is required to fish along the 5.5-mile shoreline, none is needed to fish from the pier. Sturgeon is the big quarry there; striped bass, bay rays, leopard sharks, perch, kingfish, and flounders are among the other catches of the day.

Learn about San Francisco Bay Trail connections.

Group Camping

Point Pinole Group Campsite - May be reserved by calling 1-888-EBPARKS or 1-888-327-2757, press option 2, or by writing to EBRPD Reservations, 2950 Peralta Oaks Court, P.O. Box 5381, Oakland, CA 94605-0381. Reservations must be made at least 7 days in advance.

Park Info

Address
5551 Giant Highway
Richmond, CA 94806
Download Brochure

Phone Number
Toll Free: 888-EBPARKS (888-327-2757), option 3, extension 4551

Local Weather

Weather Forecast

Movie Clips

Maps
View Trail Map
Download PDF Map
Yahoo Map <

Panorama

Park/Gate Hours
Nov. - March
7 a.m. - 4 p.m.
April
7 a.m. - 5 p.m.
May - Sept.
7 a.m. - 7 p.m.
October
7 a.m. - 5 p.m.

Park Events
Click HERE for upcoming events

Parking Fee
Fees are collected when the Kiosk is attended on weekends and major holidays from April through October.
Car/Trailer: $3
Buses: $25/per bus.

Dog Fee and Limits
$2 per dog are collected when the Kiosk is attended on weekends and major holidays from April through October. Guide/service dogs free.
Limit: 3 dogs per person, No commercial dog walking trails are available.

Grazing Information
Grazing in the Parks

Shuttle Ride Service Schedule
Shuttle van service is available daily (holidays included).
Shuttle schedule:
Shuttle leaves from the parking lot at 7:30 a.m., 8:30 a.m., 9:30 a.m., 10:30 a.m., 11:30 a.m., 12:30 p.m., 1:30 p.m., and 2:30 p.m.
Shuttle leaves from the pier at 9:15 a.m., 10:15 a.m.,

Photos of the Pt. Pinole Group Campsite

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Park Hiking Video

♿Park Accessibility

There are wheelchair accessible restrooms and a paved shuttle trail in the park.

Trail Accessibility Reports

Bayview Trail: Download PDF format | Download Word format

Point Pinole Trail: Download PDF format | Download Word format

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To Reach The Park

From I-80 in Richmond, exit at the Richmond Parkway. From the Richmond Parkway, turn right onto Giant Highway and proceed to the park entrance.

Public Transit

Call 511 (TDD/TTY: 1-800-448-9790) or visit www.transit.511.org to confirm transit information.

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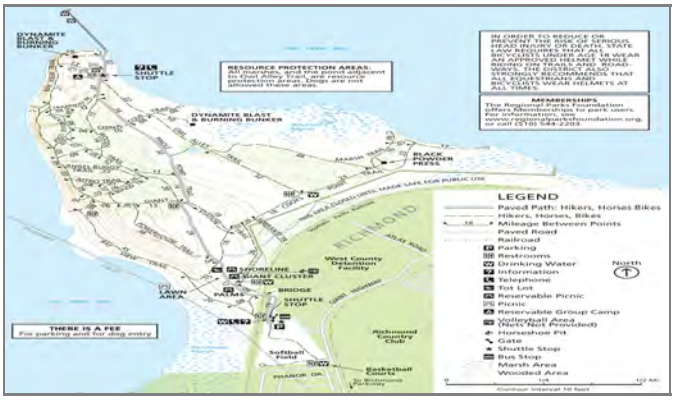
Trail Map

Click the map image below to see an enlarged version.



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Directions for navigating the enlarged map:

When the enlarged version of the map opens click on the 'Full Expand' icon in the lower right hand corner of the map to see the 'Actual Size' map.

11:15 a.m., 12:15 p.m., 1:15 p.m., 2:15 p.m., and 3:00 p.m.

Shuttle Ride Fee (Round Trip)
$1 age 12 and older; 50 cents age 6-11; children under 6, seniors 62+ or disabled ride free

Camping Reservations
Point Pinole Group Campsite - May be reserved by calling 1-888-EBPARKS or 1-888-327-2757, press option 2, or by writing to EBRPD Reservations, 2950 Peralta Oaks Court, P.O. Box 5381, Oakland, CA 94605-0381. Reservations must be made at least 7 days in advance.

Picnic Reservations
1-888-EBPARKS or 1-888-327-2757, press option 2

Emergency Number
911

EBRPD Headquarters
1-888-EBPARKS or 1-888-327-2757

Park Update

Grazing Update

Goats will be returning to Point Pinole beginning Monday, March 11, as part of the Regional Parks coastal prairie enhancement program, and will be here for about 60 days. Goats are an important tool in controlling European grasses and reducing the encroachment of coyote brush and other invasive species. Annual grazing favors deep rooted perennial native grasses, and reduces fuel loads and fire danger at the park.

Maps will be posted in the park with the general grazing areas shown. Dog owners must leash their dogs when approaching the electrified fencing which encloses the herd of 400 goats at each grazing location.

Seeing the goats happily chomping away on the grass is a positive experience for many urban dwellers, especially families with younger children, many of whom rarely get a chance to see animals in a natural setting. We hope you enjoy this opportunity to see these hard-working animals at work in our parks.

'Full Expand' icon >

When the 'Actual Size' map is viewable, you can 'Click-Hold and Drag' the mouse button (left on a PC) to reposition the map, as desired.

'Single-Click' on the 'Enlarged' or 'Actual Size' map to return to the park page.

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Movie Clips

You can also save movies to your computer in QuickTime format.

Download Movie Clip 1
(2.7 MB QuickTime Movie): Point Pinole History

Download Movie Clip 2
(6.5 MB QuickTime Movie): Point Pinole "Saved by Dynamite"

Download Movie Clip 3
(3 MB QuickTime Movie): Point Pinole Park Features

If you don't have QuickTime, you may download QuickTime here.

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East Bay Regional Park District
2950 Peralta Oaks Court, Oakland, California 94605
1-888-EBPARKS or 1-888-327-2757 (Deaf or Hearing Impaired TDD: 510-633-0460)
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A VISION FOR THE NORTH RICHMOND SHORELINE

NORTH RICHMOND SHORELINE OPEN SPACE ALLIANCE

2012 FESTIVAL
CALENDAR OF EVENTS
ACTION ALERT!
WE'RE IN THE NEWS!
GETTING TO THE SHORELINE
ECOSYSTEM - NORTH SHORELINE
COMMUNITY VISION
DONATE!
VOLUNTEER!
MAPS & PLANS
DOCUMENTS & REPORTS
HISTORY OF THE NORTH RICHMOND COMMUNITIES
HISTORY OF THE NORTH RICHMOND SHORELINE
ABOUT NRSOSA
LINKS
CONTACT US
HOME

A Community Vision for the North Richmond Shoreline Neighborhoods

The North Richmond Shoreline should be restored and protected to provide jobs, educational opportunities, a safe place to recreate, and a source of clean, healthy food.

A BEAUTIFUL PARK, HEALTHY NEIGHBORHOODS, A SCENIC PARKWAY
North Richmond Shoreline Area Neighborhood Housing & Economic Opportunity Zone

THE GOALS

Acquire land from willing sellers and convert it to parks and open space.
Connect the local communities to the shoreline with trails and overpasses at Wildcat Creek and Parchester Village.
Construct a nature center in Point Pinole Regional Shoreline overlooking the North Richmond Shoreline.
Restore oysters and eelgrass in the subtidal zone.
Create community gardens to provide a source of safe, healthy, local food.

PARCHESTER VILLAGE VIEW

ROADSIDE VIEW

SCENIC PROTECTION ZONE

PROTECT THE SHORELINE AND THE NEIGHBORHOODS

Development should benefit the residents, rather than displacing them

PLAN FOR THE EXISTING COMMUNITIES TO SURVIVE

Slow enough to hire locals for job training and to infill
in abandoned sites like this single family home in the Iron Triangle

800 ACRES OF POTENTIAL INFILL LOTS IN THE NEIGHBORHOODS

80% OF NEW JOBS COME FROM SMALL BUSINESSES

THE PROBLEM

FAST HOUSING AND OUTSIDE BUSINESSES

- North Richmond area communities' problems are exacerbated by large-scale development.
- In inclusionary housing only 5-15% of units are "low-income" in areas that are 100% low-income.
- $400,000-$700,000+ tract homes aimed at the middle-class are built rapidly, often profiting a single developer outside of Richmond.
- Families are displaced

THE SOLUTION

WORKING TOGETHER TO SUPPORT HEALTHY NEIGHBORHOODS

GREEN JOB DEVELOPMENT - ANNIE'S ANNUALS, A NORTH RICHMOND BUSINESS

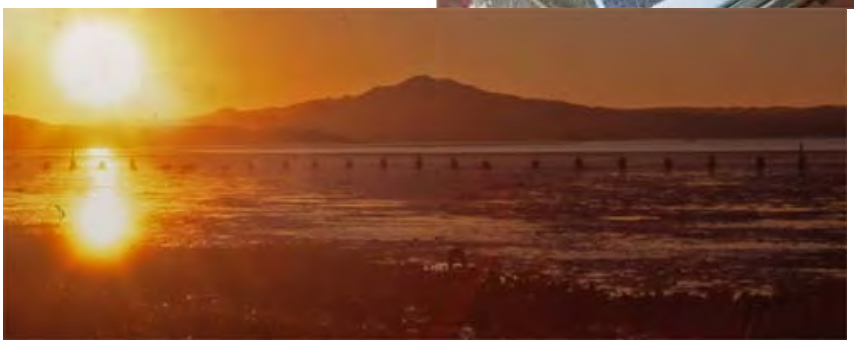
- Neighborhood-scale development allows for local builders, design, and ownership; Locally owned income cycles 7x within the community compared to 3x with outside ownership.
- Renovation and construction while preserving neighborhood character.
- Link and Enhance Existing Programs and Organizations including health, education, business, government, financing, public safety

A PILOT PLAN

LINK AND ENHANCE EXISTING PROGRAMS AND ORGANIZATIONS

Detailed expertise can be provided by sectors like these:

- Redevelopment policy
- Enterprise zones
- Incentive programs
- Permit/ One-stop shop
- Construction and business-training programs
- First-time home-buyers programs
- Family health services
- Drug and alcohol counseling
- Education
- Adjudicated youth and parolee programs
- Micro-loans
- Land trusts
- Community design clinic
- Community law clinic
- Neighborhood historic preservation
- Small business development programs
- Green job development programs
- Local businesses
- Elected officials
- Neighborhood centers and organizations
- Green Corridor
- Community Policing



Photos: R. Freeman Design: J Del Arroz, R. Freeman

SINCEREDESIGN.COM

Email: info@northrichmondshoreline.org

THE PLANNING CENTER DC&E

Draft Environmental Impact Report

Breuner Marsh Restoration and Public Access Project

for the East Bay Regional Park District

SCH # 2011072011

March 9, 2012

SCH # 2011072011

March 9, 2012

Draft Environmental Impact Report

Breuner Marsh Restoration and Public Access Project

for the East Bay Regional Park District

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THE PLANNING CENTER
DC&E

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1 INTRODUCTION

This Draft Environmental Impact Report (Draft EIR) has been prepared to assess the potential environmental consequences of the proposed Breuner Marsh Restoration and Public Access Project (also referred to as "the Proposed Project") at Point Pinole Regional Shoreline Park in Richmond, CA.

The Draft EIR identifies mitigation measures and alternatives that would avoid or reduce significant impacts. It is intended to inform decision makers, other agencies, and the public, of the Proposed Project.

This Draft EIR has been prepared in accordance with the California Environmental Quality Act (CEQA). The East Bay Regional Park District (EBRPD) is the lead agency for the Project.

A. Proposed Action

The Breuner Marsh Restoration and Public Access Project would involve the removal of the existing site structures, debris, and hazardous materials, and existing vegetation, and re-grading of much of the southern portion of the site. Existing wetland areas would be enhanced by excavating new channels to connect them to the Bay and allow tidal flooding. Material removed from wetland areas would be used to build upland areas with gentle slopes and broad transitional zone habitat. The transitional zone would become future tidal marsh as sea level rises in line with predictions. Restoration of the mouth of Rheem Creek by lowering the level of the north bank to allow tidal flooding of the lower reaches would be a highly desirable project component and is considered here as an optional component, subject to cost, permitting, and feasibility analysis.

Following mass grading, areas would be re-vegetated with appropriate native plants, and weeded and irrigated as necessary to ensure that the plants become established. Non-native predators would be trapped to allow native wildlife to gain ground and reestablish territory. These maintenance activities would gradually diminish in scope around the fourth year of the Proposed Project.

Two trails would be built across the project site to allow public access. The Main Trail, which would serve as a section of the San Francisco Bay Trail, would run from the parking lot located in the south of the site, across a new bridge over Rheem Creek, to the east of the existing paved trail, turn east and inland to near the property boundary, and run parallel to the railroad tracks north to connect with existing trails at Point Pinole. The Main Trail would be paved and would cross slough and wetland areas via a variety of bridges and boardwalk segments.

The Spit Trail would diverge from the Main Trail to connect to an existing spit. Although the Main Trail would be for bicycle and pedestrian access, the Spit Trail would be pedestrian-only. The westernmost part of the Spit Trail would remain unimproved. A picnic area and rest area would be built by the side of the Main Trail and interpretative signs would be located at intervals along both trails. Gates would separate the Spit Trail from the Main Trail and the improved portion from the unimproved portion of the Spit Trail.

B. Planning Process

1. Project Background

EBRPD acquired 218 acres in January 2011 from Don and Lonnie Carr and Bay Area Wetlands (BAW LLC) with the intent of preserving it for open space and public access and restoring the property to tidal marsh, seasonal wetlands, and associated coastal prairie and scrub. The Carrs and BAW LLC had owned the larger project area (together with the 20-acre enclave now known as the Carr property), since 1999 after purchasing it from the Breuner family. During that time, two unsuccessful development projects were advanced for the properties.

Of these newly purchased 218 acres (formerly the Breuner Property), 120 acres, plus approximately 30 acres of Giant Marsh, and a small section of trail at Point Pinole that would be regraded to allow disabled access, together form the 150-acre project area that is discussed in this EIR.

On May 4, 2010, EBRPD made the first public presentation of a restoration and public access project at a meeting of the EBRPD Board of Directors in Oakland. On January 20, 2011, a public workshop was held at Parchester Village Community Center to discuss project plans with the site neighbors and other interested parties. Additional public meetings followed as part of the EIR process (see below).

2. Consultation with Resource Agencies

As the Proposed Project will affect tidal wetland areas and sensitive wildlife habitat, consultation with the California Department of Fish and Game and U.S. Fish and Wildlife Service was initiated early in the process to define a project to protect and restore biological resources. As the Proposed Project could alter a federal flood control project – Rheem Creek – and also because some wetland areas would be filled, consultation was also initiated with the U.S. Army Corps of Engineers. Several major utilities such as petroleum pipelines, electricity transmission lines, and a sewer line, cross the site, and a railroad runs alongside. Consultation was therefore also undertaken with the owners of these utilities.

C. *Environmental Review Process*

1. Initial Study

An Initial Study checklist was completed for the Proposed Project on July 1, 2011. The Initial Study included a project description and an analysis of the following issues:

- Aesthetics
- Agriculture and Forest Resources
- Air Quality
- Biological Resources
- Cultural Resources
- Geology and Soils
- Greenhouse Gas Emissions
- Hazards and Hazardous Materials

- Hydrology and Water Quality
- Land Use and Planning
- Mineral Resources
- Noise
- Population and Housing
- Public Services
- Recreation
- Transportation/Traffic
- Utilities and Service Systems

The IS concluded that there could be potentially significant impacts in all issues except for:

- Agriculture and Forest Resources
- Mineral Resources
- Population and Housing
- Public Services

No impacts were found for these four issues.

Because there could be potentially significant impacts from the Proposed Project, an EIR was prepared to evaluate these issues in more detail.

2. Notice of Preparation

A Notice of Preparation (NOP) of an EIR was published on July 1, 2011. This noted that the IS was available on the EBRPD website and announced the date and venue for the public Scoping Meeting. The NOP described the environmental issues to be covered in the EIR and invited comments on the proposed EIR scope. The NOP was sent to the State Clearinghouse, as required under CEQA, and to over 800 interested parties. These included: government agencies with a responsibility or interest over the Proposed Project, non-governmental agencies (NGOs), adjacent property owners and residents, elected officials, and utility owners. EBRPD also posted links to the NOP on its website and encouraged other organizations to also post links.

3. Public Scoping Meeting

A public scoping meeting to describe the EIR process and to solicit comments on issues that should be covered in the EIR was held at Parchester Village Community Center, Richmond, on July 14, 2011.

4. Comments Received

Comments were received verbally at the Scoping Meeting and have been transcribed and are summarized for this EIR. Written comments received in the 30-day comment period following publication of the NOP, are included with the Scoping Meeting transcript in Appendix B of this Draft EIR.

5. Draft EIR Availability

A copy of this Draft EIR has been sent to the State Clearinghouse and to those who requested a copy by responding to the NOP. It is also available for downloading from the EBRPD website at www.ebparks.org. Copies are also available at the Main Branch of Richmond Public Library at 325 Civic Center Plaza, Richmond; and at the San Pablo Library at 2300 El Portal Dr # D, San Pablo; and the Parchester Village Community Center, 900 Williams Street, Richmond.

6. Draft EIR Comments

This Draft EIR was published on March 12, 2012, which marks the start of the 45-day comment period as required under CEQA. Written comments should be received no later than 5 p.m. on April 27, 2012 and should be sent to:

Brad Olson
East Bay Regional Parks District
2950 Peralta Oaks Court
PO Box 5381
Oakland, CA 94605
Comments can also be sent via email to bolson@ebparks.org.

Verbal comments can be made at the Public Hearing (see below).

Comments should focus on the environmental impacts and the adequacy of the EIR. Section 15151 of the State *CEQA Guidelines* defines the standards for EIR adequacy as follows:

> *An EIR should be prepared with a sufficient degree of analysis to provide decision makers with information which enables them to make a decision which intelligently takes account of environmental consequences. An evaluation of the environmental effects of a proposed project need not be exhaustive, but the sufficiency of an EIR is to be reviewed in the light of what is reasonably feasible. Disagreement among experts does not make an EIR inadequate, but the EIR would summarize the main points of disagreement among the experts. The courts have looked not for perfection; but for adequacy, completeness, and a good faith effort at full disclosure.*

7. Public Hearing

A Public Hearing on the Draft EIR where additional comments will be received will be held at:
Parchester Village Community Center,
900 Williams Street, Richmond, 94806
On Thursday, March 22, at 7 p.m.

8. Final EIR and Responses to Comments

All comments received within the comment period and pertaining to the environmental impacts and adequacy of the Draft EIR, will be responded to in writing. Comments on the project merits, or unsubstantiated comments, do not require a response. Responses, together with comment letters, emails, and a hearing transcript summary, will be included in the Final EIR, along with any necessary revisions to the contents of the Draft EIR.

9. Final EIR Approval and Project Approval

The Final EIR will be made publicly available in the same manner as the Draft EIR. The Final EIR will be presented to the EBRPD Board of Directors to certify the Final EIR, adopt findings, and approve the project.

The EBRPD meeting for EIR certification and project approval will be a public hearing where additional comments may be received.

D. Report Organization

This Draft EIR is organized into the following chapters:

- **Chapter 1, Introduction.** Chapter 1 provides background and an overview of this Draft EIR document.
- **Chapter 2, Report Summary.** Chapter 2 is a synopsis of the Project description, required permits, environmental impacts of the Proposed Project, alternatives, and CEQA conclusions.
- **Chapter 3, Project Description.** Chapter 3 describes the Proposed Project.
- **Chapter 4, Environmental Evaluation.** Chapter 4 evaluates the potential environmental impacts of the Proposed Project.
- **Chapter 5, Alternatives.** Chapter 5 considers the No Project Alternative and Additional Tidal Habitat Alternative, and identifies the "Environmentally Superior Alternative."
- **Chapter 6, CEQA-Required Assessment Conclusions.** Chapter 6 evaluates effects with regard to growth inducement, significant irreversible changes, and impacts found not to be significant.
- **Chapter 7, Report Preparers.** Identifies the preparers of the Draft EIR.
- **Appendices.** Include relevant background materials.

2 REPORT SUMMARY

This summary presents an overview of the analysis contained in this Draft EIR. The chapter summarizes the following: 1) the Project under review, 2) areas of controversy, 3) significant impacts and mitigation measures, 4) unavoidable significant impacts, and 5) alternatives to the Project. Additional detail on the proposed Project is provided in Chapter 3. Additional detail on the environmental impacts is provided in Chapter 4. Alternatives are described and evaluated in Chapter 5.

A. Project Under Review

1. Location and Setting

The 150-acre Breuner Marsh project area is the focus of the restoration and public access Project. It is located at Point Pinole, in the northwest part of the City of Richmond on the San Francisco Bay shoreline (see Figure 3-1). Breuner Marsh is bordered by Rheem Creek to the south and merges with Giant Marsh to the north. Approximately 120 acres of the recently purchased Breuner property, 30 acres of Giant Marsh and some additional upland areas of Point Pinole Peninsula, are the subject of the Proposed Project. Together they form an enlarged Point Pinole Regional Shoreline Park. This geographic context of the site is shown in more detail in Figure 3-2.

Union Pacific railroad tracks run along the eastern boundary of the property. East of the railroad tracks lies the residential community of Parchester Village. The Carr property, which is a separate parcel of 20 acres under private ownership, abuts the project area in the southeast corner. The shallow offshore area and two man-made spits within the boundaries of the Breuner property are owned by the State Lands Commission and are managed by EBRPD.

A Shell Oil petroleum pipeline, Pacific Gas & Electricity transmission lines, and a West County Sanitary District sanitary sewer force main cross parts of the project site on easements. Rheem Creek, a federal flood control channel, operated and maintained by the Contra Costa County Flood Control and

Water Conservation District, under agreement with the U.S. Army Corps of Engineers, runs along the southern site margin.

2. Project Characteristics

The Proposed Project would involve the removal of the existing site structures, debris, and hazardous materials, and existing non-native vegetation, and re-grading of much of the southern portion of the site. Existing wetland areas would be enhanced by excavating new channels to connect them to the Bay and allow tidal flooding. Material removed from wetland areas would be used to build upland areas with gentle slopes and to create broad transitional zone habitat. The transitional zone would become a future tidal marsh as sea level rises in line with predictions. Restoration of the mouth of Rheem Creek by lowering the level of the north bank to allow tidal flooding of the lower reaches would be a highly desirable project component. This remains an optional part of the Proposed Project, subject to cost and feasibility; however, it is evaluated in this EIR.

Following mass grading, areas would be re-vegetated with appropriate native plants, and weeded and irrigated as necessary to ensure that the plants become established. Non-native invasive *Spartina* (cordgrass) would be eradicated from existing tidal marsh areas before site grading. Predators, such as feral cats and red fox would be trapped to allow wildlife to gain ground and reestablish territory.

Two trails would be built across the project site to allow public access. The Main Trail, which would serve as a section of the Bay Trail, would run from the parking lot located in the south of the site, across a new bridge over Rheem Creek, to the east of the existing paved trail, run inland to the property boundary, and run parallel to the railroad tracks north to connect with existing trails. The Main Trail would be paved and would cross slough and wetland areas by a variety of bridges and boardwalk segments.

The Spit Trail would diverge from the Main Trail to connect to the existing fishing spit. Although the Main Trail would be for bicycle and pedestrian access, the Spit Trail would be pedestrian only. A picnic area and rest area

would be built by the side of the Main Trail and appropriate interpretative signs would be located at intervals along the trail.

3. Required Permits and Approvals

It is estimated that permits and/or approvals would be required from nine separate agencies. These are:

a. Federal Agencies

U.S. Fish and Wildlife Service – Consultation/Biological Opinion under Section 7 of Federal Endangered Species Act

U.S. Army Corps of Engineers – Permits for filling wetlands under Section 404 of the Clean Water Act; and Section 408 of the Rivers and Harbors Act for construction/restoration of Rheem Creek and bridge construction

U.S. Coast Guard – Bridge Construction

b. State Agencies

State Lands Commission – Public Trust Lands and Leases for construction of segment of Bay Trail in Giant Marsh

Department of Fish and Game – Section 1601 Streambed Alteration Agreement; and Section 2081 Agreement

c. County and Regional Agencies

San Francisco Bay Regional Water Quality Control Board (RWQCB) – Water Quality Certification under Section 401 of the Clean Water Act for wetland restoration

Bay Area Conservation and Development Commission (BCDC) – Permit for work in wetland areas and conformance with climate change policies

Contra Costa County Flood Control and Water Conservation District - Encroachment Permit for Rheem Creek bridge

d. Local Agencies

City of Richmond – Demolition, Grading, and Building Permits

In addition, small easements may be acquired from Shell Pipeline, Pacific Gas & Electric Company (PG&E), and Union Pacific Railroad in order to construct the Bay Trail along the chosen alignments.

B. Areas of Controversy

Public comments were received at the EIR scoping meeting held at Parchester Village Community Center on July 14, 2011. Issues raised that were pertinent to the scope of the EIR (and not to the project merits), and requests for information to be included in the EIR were as follows:

1. Hydrology/Flooding

- Flooding impacts on Parchester Village, the Carr property, pipelines, and sewer manholes.
- Effects of sea level rise on all resources.
- Inclusion of parcel map and watershed boundary map with all drainage shown.
- Quantification of runoff and impacts to existing drainage facilities and drainage problems in the downstream area.
- Flooding impacts from modification of Rheem Creek channel.

2. Hazards/Contamination

- Proximity of buried pipelines.
- Contamination on the Carr property and public availability of information.
- Lead contamination in the former Rheem Creek drainage.
- Possible migration of contaminated groundwater onto the project site.

3. Land Use

- Access to the Carr property, and utilities during and after construction.
- Inclusion of a wetland delineation for the project site.

- Possible conflicts with development of the Carr property that is zoned as office/flex.[1]
- Project impacts to the possibility of constructing a second bridge across the Creek for the Carr property.
- State Lands Jurisdiction over parts of the project site.

4. Recreation

- Access to Bay Trail after dark to allow commuting.
- Impacts to recreational resources (short-term and long-term).

5. Biological Resources

- Impacts to existing wetlands, wildlife habitat, and special-status species.
- Disturbance to birds during construction; bird populations on the transitional habitat.
- Sensitive species occurrence; invasive species; construction noise and wildlife impacts.
- Rules on off-leash dogs and potential dog and human intrusion into marsh habitat with impacts to wildlife.
- Long-term preservation and restoration of native habitat.
- Possible impacts to wildlife, particularly rafting birds, from water users in small boats.
- Areas of existing coastal prairie that will be lost.

6. Cultural Resources

- Shellmound occurrences and impacts.

7. Air Quality

- Dust and fumes from project construction.
- Air Quality impacts from removal of the contaminated soil.

8. Greenhouse Gases

- Greenhouse gas emissions from project construction and operation.

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[1] The City of Richmond has proposed to redesignate this land as Open Space as part of the pending General Plan update. However, this is currently in dispute.

C. Significant Impacts and Mitigation Measures

Significant Impacts and Mitigation Measures are summarized in Table 2-1.

D. Unavoidable Significant Impacts

Section 15126.2(b) of the CEQA Guidelines requires that an EIR identify any significant impacts that cannot be avoided, even with the implementation of feasible mitigation measures. No Significant and Unavoidable Impacts were found.

E. Alternatives to the Project

This CEQA review analyzes the following alternatives to the Proposed Project:

1. No Project Alternative

Under the No Project Alternative, the site would remain in its existing condition. There would continue to be no official public access, and signs and derelict fences would discourage, but not prevent, casual hikers, dogwalkers, birdwatchers, and fishers from using the site. The existing trail would provide a route as far as the debris mound east of the spit and to the spit itself. There would continue to be no through-route for bicycles on the Bay Trail from Richmond Parkway south of the site to Point Pinole.

The model airplane structures and runway would remain, although the BARCS lease, which will end in June 2012, would not be renewed. The debris mounds, contaminated soil, old fences, and scattered concrete blocks would remain. Through time, with sea level rise, the existing habitats close to the Bay would flood. Low marsh (cordgrass) would migrate to where high marsh (pickleweed) is found now. Tidal marsh habitat would replace today's transitional habitat and transitional habitat would be found in areas that are upland today. The man-made topographic features, such as the mounds that

were originally building pads, and some of the drainage ditches, would become scattered islands and canals as a result of sea level rise.

2. Additional Tidal Marsh Acreage Alternative

The public access component of the Additional Tidal Habitat Alternative would be the same as the Proposed Project. A Bay Trail route and a smaller pedestrian-only spur to the spit would still be provided in a site cleared of debris and contamination. However, the restoration component of the project would differ in that, west of the trail in the south of the site, the site would be excavated to a greater depth, with a steeper slope than the Project. Both the Project and Additional Tidal Habitat Alternative would require the removal of a small amount of contaminated soil, concrete, fill, and the import of some aggregate base for the parking area and trails. With these exceptions, there would be a zero balance of sediment, with no net import or export from the site for both the Additional Tidal Habitat Alternative and the Proposed Project.

Under the Additional Tidal Habitat Alternative there would be larger areas of tidally connected wetlands, instead of transitional habitat and uplands with seasonal wetlands. On project completion, there would therefore be a reduced area of transitional habitat and seasonal wetlands, but an increased area of tidal wetlands compared to the Proposed Project. With sea level rise, the area of tidal wetland would increase at the expense of some transition zone habitat. Although on project construction the Additional Tidal Habitat Alternative would have more acres of tidal marsh than the Proposed Project, the Proposed Project would add acres at a faster rate until eventually the Additional Tidal Marsh Habitat Alternative would have fewer acres of tidal marsh than the Proposed Project.

3. Environmentally Superior Alternative

In the long term, over the next century, the Proposed Project would prove to be the Environmentally Superior Alternative.

3 PROJECT DESCRIPTION

This chapter describes the proposed Breuner Marsh Restoration and Public Access Project that is analyzed in this Draft EIR.

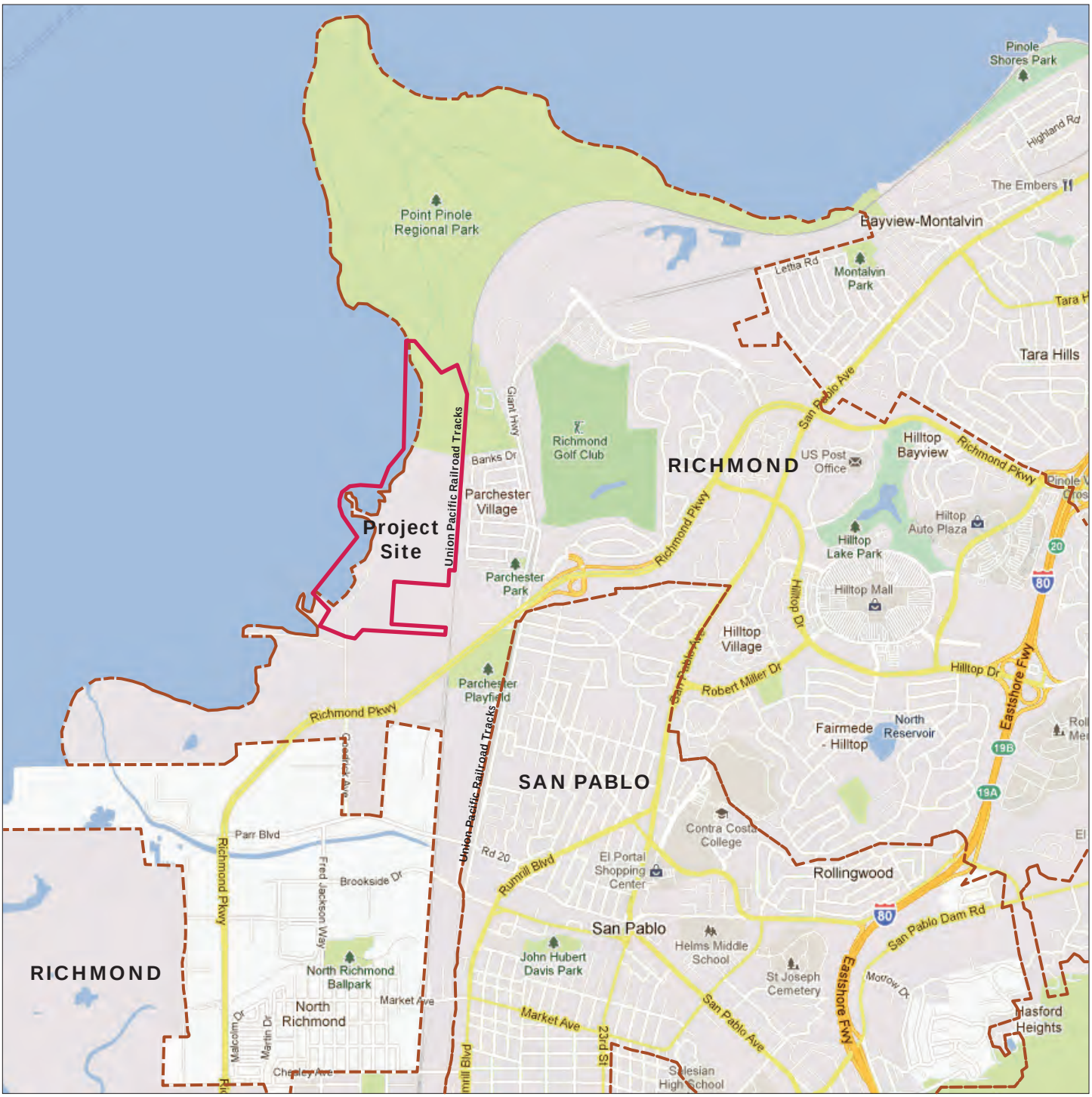
A. Location, Ownership, and Surrounding Land Uses

The 150-acre Breuner Marsh project area is the focus of the Restoration and Public Access Project (Proposed Project). It is located in the northwest part of the City of Richmond on the San Francisco Bay shoreline (see Figure 3-1). Breuner Marsh is bordered by Rheem Creek to the south and merges with Giant Marsh to the north, and is part of the East Bay Regional Park District (EBRPD) Point Pinole Regional Shoreline. Approximately 120 acres of the Breuner Marsh property, 30 acres of Giant Marsh and some additional upland areas of Point Pinole Peninsula, are the subject of the Proposed Project. The geographic context of the site is shown in more detail in Figure 3-2.

Union Pacific (UP) railroad tracks run along the eastern boundary of the property. The residential community of Parchester Village lies east of the railroad tracks. The Carr property, which is a separate parcel of 20 acres under private ownership, abuts the project area in the southeast corner. The shallow offshore area and two man-made spits within the boundaries of the Breuner property are owned by the State Lands Commission and are managed by EBRPD.

B. Site Access

Access to Breuner Marsh is provided via Goodrick Avenue from the Richmond Parkway. Goodrick Avenue crosses Rheem Creek on an existing concrete bridge. The closest BART station is Richmond, at the northern terminus of the Richmond line. Three AC Transit bus routes equipped with bike racks (71, 76, and 376) provide service to within 1.5 miles of the project site.



Source: Google, 2011.

FIGURE 3-1

PROJECT LOCATION AND ACCESS

Source: Google Earth, 2011.

FIGURE 3-2

SITE CONTEXT

C. Site History

The earliest maps of San Pablo Bay are from the 1850s and show the northern part of the project area was historically tidal marshland connected to Giant Marsh to the north.[1] Early aerial photographs[2] and a 1939 U.S. Department of Agriculture soil survey show that freshwater seasonal wetlands existed in the southwest corner and upland grasslands were found in the southeast corner.

The project area has a long history of use and disturbance, with automobile access to the site via Goodrick Avenue beginning around 1915. Prior to the late 1970s, when the Breuner family purchased 238 acres of the property; it was used primarily for cattle grazing. The Breuner family, owners of the Breuner Furniture store chain, purchased the property as two separate parcels in 1975 and 1979 and began the transformation of the land from agricultural to light industrial uses, including boat and automobile storage and repair, and warehousing. Several buildings, including residential buildings, can be seen on aerial photographs of the site from the 1970s to early 2000.

From the 1950s to 1980s, much of the northern tidal marsh was filled, bermed, blocked from tidal flooding, and partially drained. In the 1950s, a new channel for Rheem Creek which previously existed as a small tidal slough, was constructed by Southern Pacific Railroad, in part to drain areas to the east that were partially blocked by their elevated railroad embankment. The remains of this channel, which crosses the site from ESE to WNW, is still visible as a scar in the aerial photo, Figure 3-2, and is outlined on Figure 3-3. Fill was also placed along a narrow linear strip parallel to the Bay shore, possibly for construction of a runway, as the Breuner family intended to use the property as a small commercial airport. A review of historic aerial pho

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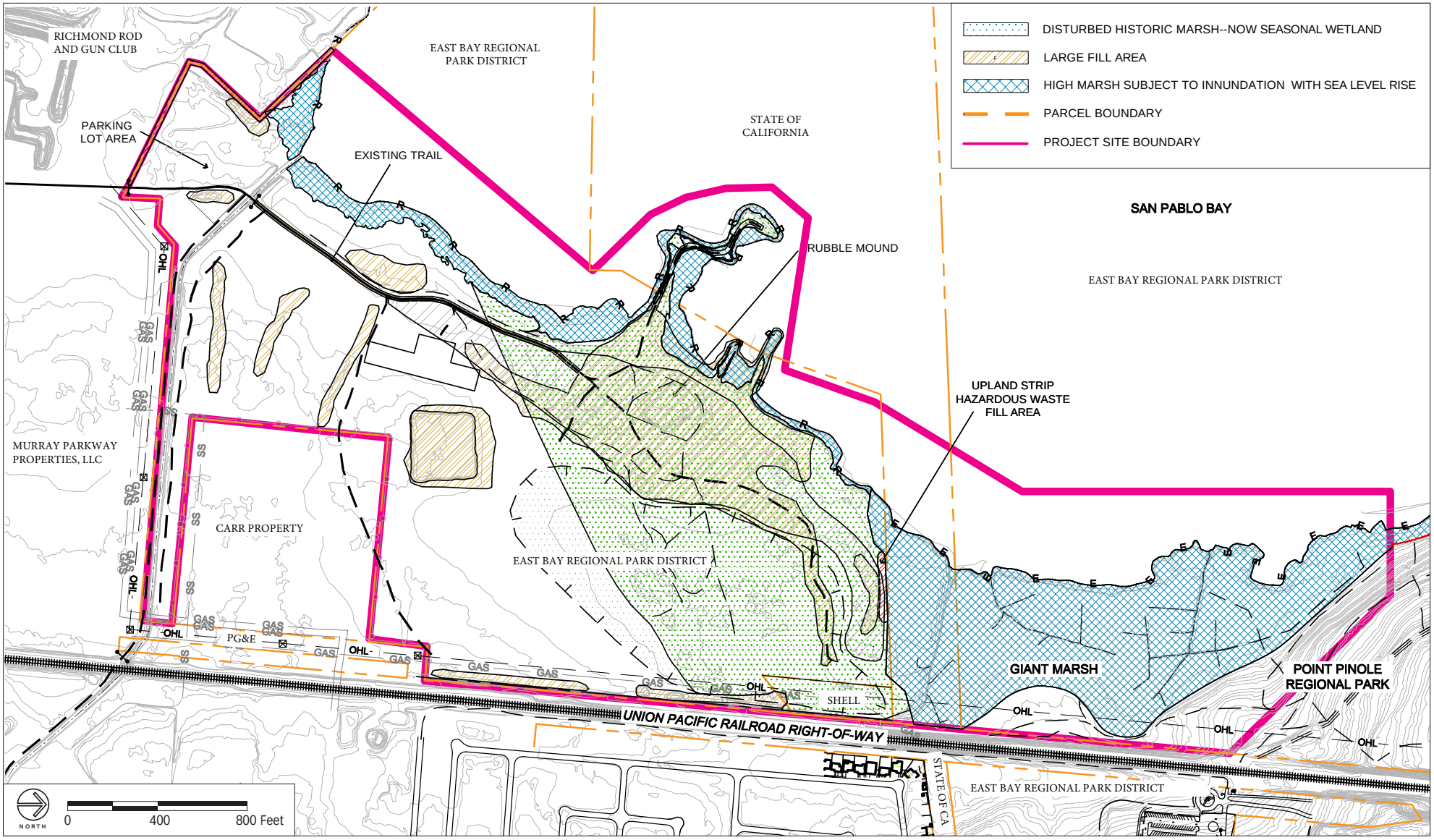
[1] Nichols and Wright, U.S. Geological Survey (USGS), 1971. *Historic Margins of Marshlands of the San Francisco Bay, California.*

[2] Environmental Data Resources, Inc.. Aerial Photo Decade Package for 3800 Goodrick Ave., Richmond, CA 94801. Includes photos from 1939, 1946, 1958, 1965, 1982, 1993, and 1998. October 30, 2006.



Source: Questa Engineering, 2011.

FIGURE 3-3

EXISTING CONDITIONS

tographs shows that from 1939 to the late 1990s, around two-thirds of the site was significantly disturbed by off-road vehicles, scraping and grading, and fill placement.

In the early 1960s, Rheem Creek was relocated again, this time to its current location south of the site, and channelized as a part of a US Army Corps of Engineers (Corps) Flood Control Project. Contra Costa County Flood Control and Water Conservation District now operates this flood control facility under an agreement with the Corps.

In 1999, Don and Lonnie Carr and Bay Area Wetlands LLC (BAW LLC) purchased the 238-acre property from the Breuner family. In 2000 all of the buildings, wrecked automobiles, and much of the rubble were removed from the property. The Carrs proposed a mixed commercial/office building and light industrial development (Technology Park) in 2002 that would have covered the eastern portions of the property. BAW LLC proposed a formal wetlands mitigation bank for the western portion of the property; however, the application and review and approval process was terminated by the City of Richmond in 2005 due to public controversy. In 2006, there was a proposal for a transit village on the property, but the application is no longer active.[3]

EBRPD acquired 218 acres in 2011 from BAW LLC with the intent of preserving it for open space and public access and restoring the property to tidal marsh, seasonal wetlands, and associated coastal prairie and scrub. All of the remaining buildings were removed by the Carrs, except the existing Model Airplane Facility, which is operated by the Bay Area Radio Control Society (BARCS) under an annual lease from EBRPD, and located near the center of the property. The southeast corner of the property (zoned Office/Industrial Flex), approximately 20 acres in size, was retained by the Carrs.

[3] Email from Bryan Grunwald representing Don Carr and Bay Area Wetlands, to Brad Olson, EBRPD, July 13, 2011.

D. Existing Conditions

The site is generally flat and bordered by Rheem Creek to the south, the railroad tracks on a low embankment to the east, and by the Point Pinole Peninsula, which rises to higher land to the north. There are a few trees and some mounds of fill and debris on the site as well. The model airplane facility has various structures including a runway, parking area, and storage and shade structures. Several pipelines and utilities cross the edges of the project site.

1. Existing Site Features

Photographs of the project site are presented in Figures 3-4 to 3-7 in this chapter, 4.1-4.9 in Section 4.1 Aesthetics, and 4.4-1 to 4.4-2 in Section 4.4 Cultural Resources.

a. Goodrick Avenue

Goodrick Avenue is used for access to the Rod and Gun Club and to the access easement on the south side of Rheem Creek. There is a locked, metal swing gate at the property line next to the Rod and Gun Club entrance where there is also space to park two to three cars at the side of the road (Figure 3-4a). The property line and access gate are approximately 540 feet south of the Rheem Creek bridge.

b. Rheem Creek Bridge

There is an existing concrete box culvert bridge over Rheem Creek, surrounded by chain link fencing (Figure 3-4b). The double box culvert structure has two approximately 5 feet by 7 feet openings, a total of 10 feet in width and 20 feet in length. Underneath, Rheem Creek has concrete embankments with curved walls. The structure dates from the 1960s.[4] It provides vehicle access to the site.

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[4] GANDA, 2011. *Cultural Resources Inventory and Evaluation for the Breuner Marsh Restoration and Public Access Project.*

3-4a. Site access gate on Goodrick Avenue

3-4b. Rheem Creek Bridge

3-4c. Rheem Creek Channel

3-4d. Rheem Creek Mouth

FIGURE 3-4

SITE PHOTOGRAPHS I

3-5a. BARCS model airplane facility

3-5b Debris and old fence

3-5c Concrete debris

3-5d Former pipeline footings

FIGURE 3-5

SITE PHOTOGRAPHS 2

3-6a. Train on UP railroad tracks

3-6b. Pylons and pipeline markers

FIGURE 3-6

SITE PHOTOGRAPHS 3

3-7a. Pipeline markers, railroad bridge and Richmond Parkway overpass

3-7b. Sewer manhole on Carr property

FIGURE 3-7

SITE PHOTOGRAPHS 4

c. Rheem Creek Channel

Rheem Creek runs in a straight channel, lined with boulders and bordered by grassy-covered banks a few feet high that extend to within 10 to 15 feet of the Creek mouth (Figure 3-4c and d). Although there are some flap gates in the Creek at the Carr property that might have served as outfall to the Creek, they are not connected to any storm drain system, nor do they appear to have been used for drainage.

d. Model Airplane Facility

The model airplane facility occupies an asphalted area with shade structures, a small office, a storage container, benches, and fences, and the runway near the south of the site (Figure 3-5a).

e. Concrete Pipeline Footings

Concrete pipeline footings run northeast-southwest (offshore) within San Pablo Bay from the former marina at the Rod and Gun Club.[5] The footings are two to three feet above the water line at low tide. The exposed concrete and wood posts make a prominent feature across the areas of shallow water (Figure 3-5d) and provide bird perches.

Four large concrete footings are found in the saltwater marsh at the south-western corner of the project site. These are approximately 8 feet tall by 5 feet wide and 10 feet long, and consist of rebar, steel beams, with pieces of wood board extending from the top. The pipeline footings were probably installed during the early 20th century. These are described in greater detail in Section 4.4, Cultural Resources.

f. Existing Trails

A decaying, paved trail extends from Goodrick Avenue to the model airplane facility and onwards to the spit and provides vehicle access (Figure 4.1-1). Trails from Point Pinole terminate at the southern edge of Point Pinole Peninsula with signs discouraging entry.

g. Constructed Wetlands

In the northern portion of the project site, just south of the area known as Giant Marsh, there is a 2-acre depression surrounded by berms. This wetland area was constructed in 2003 as a wetland mitigation site for impacts to wetlands incurred from developing a Target store.[6] Historically this area was tidal marsh that had been filled.

h. Railroad Channel

A channel enters the project site in the southeastern portion of the property from a culvert under the UP railroad berm opposite Morton Avenue in the Parchester Village neighborhood and runs along the base of the UP railroad berm near the eastern site boundary. The current alignment is man-made and leads to a constructed channel that passes through Giant Marsh to San Pablo Bay. Multiple smaller artificial channels are tributary to this channel where the feature turns away from the railroad and drains toward the Bay. However, historically, this was a natural drainage that crossed the project site to the northwest and drained into the historic tidal marshes.[7,8]

i. Areas of Fill

The depth of fill varies greatly over the site, from 1 to 2 feet to 12 feet or more, and is concentrated in the central-west part of the site. The total amount of fill on the site is estimated at 222,000 cubic yards. There are several larger mounds, some of which have elevated levels of soil contaminants

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[5] GANDA, 2011. *Cultural Resources Inventory and Evaluation for the Breuner Marsh Restoration and Public Access Project.*

[6] Declaration of Covenants and Restrictions, Grant of Options, and Memorandum of Contract for Transfer of Mitigation Rights, and Performance of Mitigation Services and Irrevocable Escrow Instructions. March 7, 2006.

[7] Environmental Data Resources, Inc. Aerial Photo Decade Package for 3800 Goodrick Ave., Richmond, CA 94801. Includes photos from 1939, 1946, 1958, 1965, 1982, 1993, and 1998. October 30, 2006.

[8] U.S. Geological Survey, 1947. Richmond quadrangle. 7.5-minute topographic map.

including petroleum hydrocarbons, arsenic, lead, and other heavy metals. One of these fill areas is shown on Figure 3-5b. They include:

- Mound with square outline immediately west of the model airplane runway that was probably intended as a building pad.
- Mound with semi-circular outline, east of the spit.
- Three elevated strips in the southern part of the site. Fill from the previous Rheem Creek channel composes the most northerly of these strips.

j. Shoreline Rubble and Debris

Concrete rubble makes up the fill in the western part of the site and is prominent along the shoreline (Figure 3-5c). There are also old tires, fence posts, and pieces of metal in the water. (As it is difficult to access these places without crossing and damaging wetland areas, most of the debris would remain.)

k. Spit

The rubble extends offshore in a duck-neck-shaped spit that allows access to the open water for fishing, wildlife viewing, and hiking. (The water is still only a few feet deep in these locations.)

l. Other General Debris

Miscellaneous debris including pieces of metal and old fence is found throughout the site.

m. Monitoring Wells

There are several monitoring wells on the site installed to measure potential migration of plumes of contaminated groundwater from the Whitco properties on the eastern side of the UP railroad corridor. EBRPD will contact the company that installed the wells and ask them to abandon them by removing the casing and plugging them with concrete.

n. Invasive Weeds

As shown on Figure 4.1-3, of the Aesthetics chapter, thickets and clumps of *Spartina* (cordgrass) can be found along most of the shoreline, but is thickest

in the south of the site and around the spit (Figure 4.1-5). The *Spartina* is a non-native species that has replaced native *Spartina* and is therefore described as invasive. There are several uplands weeds, notably *Lepidium latifolium*, that would also be removed.

2. Pipelines, Utility Corridors and Easements

Several existing utilities run along the eastern side of the project site, either just inside the property line, or within easements in the UP railroad corridor. These are shown on Figure 3-8.

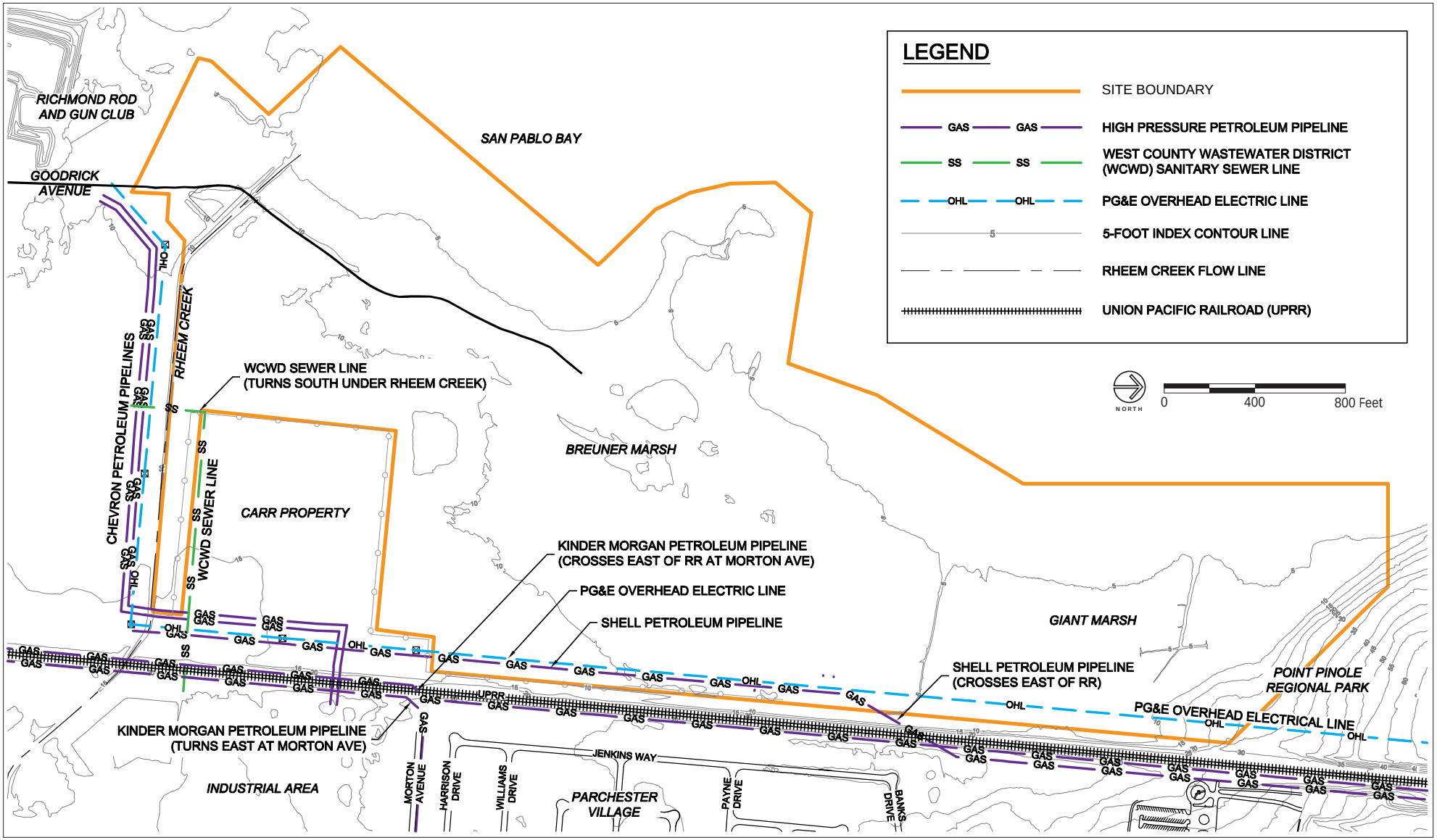
a. Union Pacific Railroad and Right-of-Way

The UP Railroad runs on a 10- to 15-foot-high embankment along the east side of the site (Figure 3-6a). The embankment has some low bushes and some marsh areas at the base and culverts, or pipes that run through it and allow drainage from Parchester Village. The railroad occupies a right-of-way that is approximately 100 feet wide. The Proposed Project would be built either just within, or just outside, this right-of-way, over Giant Marsh. The railroad crosses Rheem Creek on a trestle bridge supported by wooden piers and with wooden railing, a few feet from the southeast corner of the site (Figure 3-7a). Water flows relatively freely in the Creek under the bridge although trash collects in the Creek at the bridge.[9] A fiber optic cable and two Kinder Morgan high pressure gas pipelines (see below) run within the UP railroad right-of-way, generally buried within the railroad embankment fill.

b. Flood Control Easement and Rheem Creek Access Road

A gravel road runs parallel to Rheem Creek bank on the south side, just within the southern boundary of the project site. The road provides access to the Creek, sewer line, UP railroad bridge over the Creek, and to various pipelines and electricity transmission lines that traverse the area. The access road and Creek are within an easement on either side of the Creek, owned by Contra Costa County Flood Control and Water Conservation District (CCCFCWCD).

[9] Other than the bridge itself, there are no obvious constrictions to water flow in the Creek at this point such as flood control gates or flap gates.



Source: Questa Engineering, 2011.

FIGURE 3-8

UTILITY LINES

c. Carr Property Access Easement

A 60-foot-wide floating access easement is provided across the project site to the Carr property. While the Carr property remains undeveloped, access to the easement is allowed by EBRPD on the existing bridge, or through a shared use agreement, on the new bridge. If the Carr Property is developed, a new bridge would have to be built by the project applicant. Neither development of a road across the Carr Property easement nor a second bridge is part of the Proposed Project.

d. PG&E Electricity Transmission Lines and Easement

High-voltage (250-kW) Pacific Gas and Electric (PG&E) electricity lines run overhead on metal pylons from Goodrick Avenue parallel to and south of Rheem Creek and south of the property line and turn northwards through the Carr property (Figure 3-6b). PG&E owns some of the land south of the project site where these transmission lines are located.

The high voltage lines terminate next to the Carr property with a metal transmission tower and two wooden poles at a step-down station.[10] A lower voltage line (60 kV) on wooden poles connects from this location to run both north, parallel to the UP railroad lines, and across the UP railroad tracks.[11] North of the Carr property, through Giant Marsh, this lower voltage line is generally within the project site, but on a PG&E easement until it reaches the Point Pinole Peninsula.

This transmission line, and the petroleum pipelines (see below), place constraints on possible placement of fill in the project site. In addition, one of the transmission towers is located at the gentle bend in Rheem Creek, 400 feet south of the existing bridge, near where the new bridge would be sited.

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[10] An informal road runs from Goodrick Avenue at the end of the model airplane runway across the project site to this location. It is presumably used by PG&E to access its transmission towers. However, PG&E has no recorded access easement.

[11] PG&E has indicated to EBRPD that it plans on replacing some of these wooden poles in the near future.

e. Shell Petroleum Pipeline

A high pressure petroleum pipeline, owned by Shell Oil and/or it subsidiaries, runs along the eastern side of the site, approximately 100 feet inside the property line until the point where it bends north-northeast and crosses under the UP railroad tracks. The property line deflects westwards at the location of the bend in the pipe and Shell Oil (now) owns this area. In the south, the pipeline runs through the Carr Property and probably through the "leg" of the project site before continuing southwards.

f. Chevron High-Pressure Gas Pipelines

Two Chevron high pressure gas pipelines run parallel to Goodrick Avenue on the east side and turn east at a right angle to run south of the Rheem Creek access road, south of the project site boundary. The pipelines are marked by rectangular signs divided into red and white triangles and by some yellow-capped posts through the tall vegetation (Figure 3-7a). They then turn north to run just within the Breuner site (across the narrow southeastern "leg" of the project site), cross the Carr property, then bend at a right angle to run east under the UP railroad.

g. Kinder Morgan Gas Pipelines

Two high pressure gas pipelines owned by Kinder Morgan run along the railroad tracks inside the railroad right-of-way and railroad embankment. A 12-inch pipeline runs west of the tracks, crosses under the railroad at Morton Avenue and continues north along the eastern side of the tracks. Another 8-inch line runs east of the tracks and turns 90 degrees to run parallel to the north side of Morton Avenue.

h. Sewer Pipeline and Easement

A 34-inch sanitary sewer line owned by the West County Wastewater District (WCWD) crosses under Rheem Creek and runs north-south across the "leg" of the project site within a 10-foot-wide easement. It then bends at 90 degrees and runs east through the Carr property and under the railroad. It is probably buried at a depth of 10 to 15 feet. There are several vertical tubes on the Carr Property that connect to manholes and allow sewer access (Figure 3-7b).

i. Water line

A 1-inch water line runs from its point of connection at the East Bay Municipal Water District (EBMUD) along Richmond Parkway along Goodrick Avenue, where it terminates at the Rod & Gun Club. There is no known domestic water service to the project site, and if built as part of the Proposed Project, a new water line would have to be installed under Goodrick Avenue, beginning near the Richmond Parkway.

j. Unknown Utility Lines

There could be unknown, abandoned utility lines that connected to the abandoned buildings, now removed from the project site. These buildings included a residence and some shop buildings in the center of the property near to the rubble mound. It is possible that old utility lines could be uncovered during site grading.

3. Existing Site Use

The site is not currently open to the public, although there is unrestricted pedestrian access past the locked gate over Rheem Creek bridge, and on the paved track into the site. Some people cross the fenced railroad tracks from Parchester Village. A few local people walk dogs, fish, or ride bicycles or horses across the site. The model airplane field operated by BARCS receives some visitors who unlock the gate and drive their cars to the BARCS facility. There are some encampments by homeless people in the southeast corner of the Carr Property site under the clumps of willow trees and debris boxes.

E. Project Need and Purpose

The Proposed Project has been conceived with three goals in mind:

1. To restore a part of the San Pablo Bay shoreline to a healthy, biologically diverse community where native plant and wildlife species will flourish and can be protected for the foreseeable future;
2. To encourage public access into this attractive, and valuable stretch of the Bay shore; and

3. To facilitate pedestrian and bicycle passage around the Bay by filling a gap in the San Francisco Bay Trail.

The area is currently degraded by patches of construction debris, concrete blocks, old fences, and areas of artificial fill, some of it contaminated; its surface has been artificially modified by imported fill; and there are widespread invasive weeds providing poor-quality wildlife habitat.

Although degraded, the land is scenically attractive, and provides a large expanse of Bay margin open space close to urban Richmond. It is immediately south of the Point Pinole Peninsula. Public trail access through the site would close one of the major gaps in the San Francisco Bay Trail and allow transit on foot and bicycle from north Richmond and adjoining communities, to urban areas to the south.

The Proposed Project would remove much of the debris and other development remnants. Weeds would be cleared and the site re-shaped to resemble a more natural topography. Some areas would be lowered and channels dug to connect them to the Bay and to tidal action. Soil from the excavations would be used to create upland areas with gradual sloping sides that would be transitional habitats today, but would become new tidal marsh habitat with predicted sea level rise.

Amenities such as a parking lot, restrooms, picnic areas and signs would invite public access into this environment and extend the trail connections around the Bay margins.

1. Objectives

General Objectives

1. Balance habitat enhancement and public access in the context of a multipurpose, net-beneficial project.
2. Result in a mosaic of sustainable habitats that do not require future human intervention but which will evolve naturally with changing climate and sea level rise.

3. Create 30 acres of tidal marsh and seasonal wetland habitat that can serve as mitigation for the Castro Cove Trustees[12] and provide critical project funding.
4. Locate trails where they do not fragment or disrupt existing and planned habitats.

Public Access Objectives

5. Provide new recreational opportunities and complete a gap in the San Francisco Bay Trail.
6. Allow continued fishing access as long as shoreline conditions allow safe use.
7. Educate visitors about natural and cultural resources, with special focus on endangered species, global climate change, and the cultural history of the area.

Restoration Objectives

8. Increase the area of wetland habitats on the project site in the near term.
9. Improve the quality of wetland habitats, especially special-status species habitats.
10. Offset the trend of high marsh conversion to low marsh with rising sea level by providing or preserving transitional habitat that will later convert to high marsh.

[12] Castro Cove is part of the San Pablo Bay in Richmond, California. Investigation in the late 1990s uncovered chronic, long-term release of wastewater discharge into the Cove, primarily from the nearby Chevron refinery. A March 18, 2010 Consent Decree ordered Chevron refinery to pay a $2,850,000 settlement to a fund managed by the Castro Cove Trustees. According to the Consent Decree, funds may be awarded to natural resource restoration projects which will result in restoration, rehabilitation or replacement of San Pablo Bay habitats similar to the damaged Castro Cove habitat. To receive funding, projects must comply with all applicable laws, the 2010 Consent Decree, a Trustee-prepared Restoration Plan, and any relevant memoranda of understanding.

F. Proposed Project

The Proposed Project would involve the removal of existing site structures, debris, and a small amount of hazardous materials, clearing existing, mostly non-native, vegetation, and re-grading of much of the southern portion of the site. Existing wetland areas would be enhanced by excavating new channels to connect them to the Bay and allow tidal flooding. Seasonal wetlands that trap rainfall and local runoff would also be created and enhanced. A schematic site plan with habitat shown based on elevation, and with new public access features, is shown in Figure 3-9.[13] Excavated soil removed from wetland areas would be used to build upland areas with gentle slopes and broad transitional zone habitat. The transitional zone would become future tidal marsh as sea level rises in line with predictions.

The mouth of Rheem Creek would be restored by removing the north bank levee and lowering an area adjacent to the channel to allow overbank flood flows and tidal flooding. However, this remains an optional part of the Proposed Project, depending on cost, permitting, and feasibility.

Following mass grading, areas would be re-vegetated with appropriate native plants, and weeded and irrigated as necessary to ensure that the plants become established. The Proposed Project would establish native grasses and scrub within approximately 70 plus acres of uplands that will be disturbed by grading. EBRPD would perform weed abatement and reseed this native grass/scrub area for 5 years to promote the successful establishment of native vegetation within this area.

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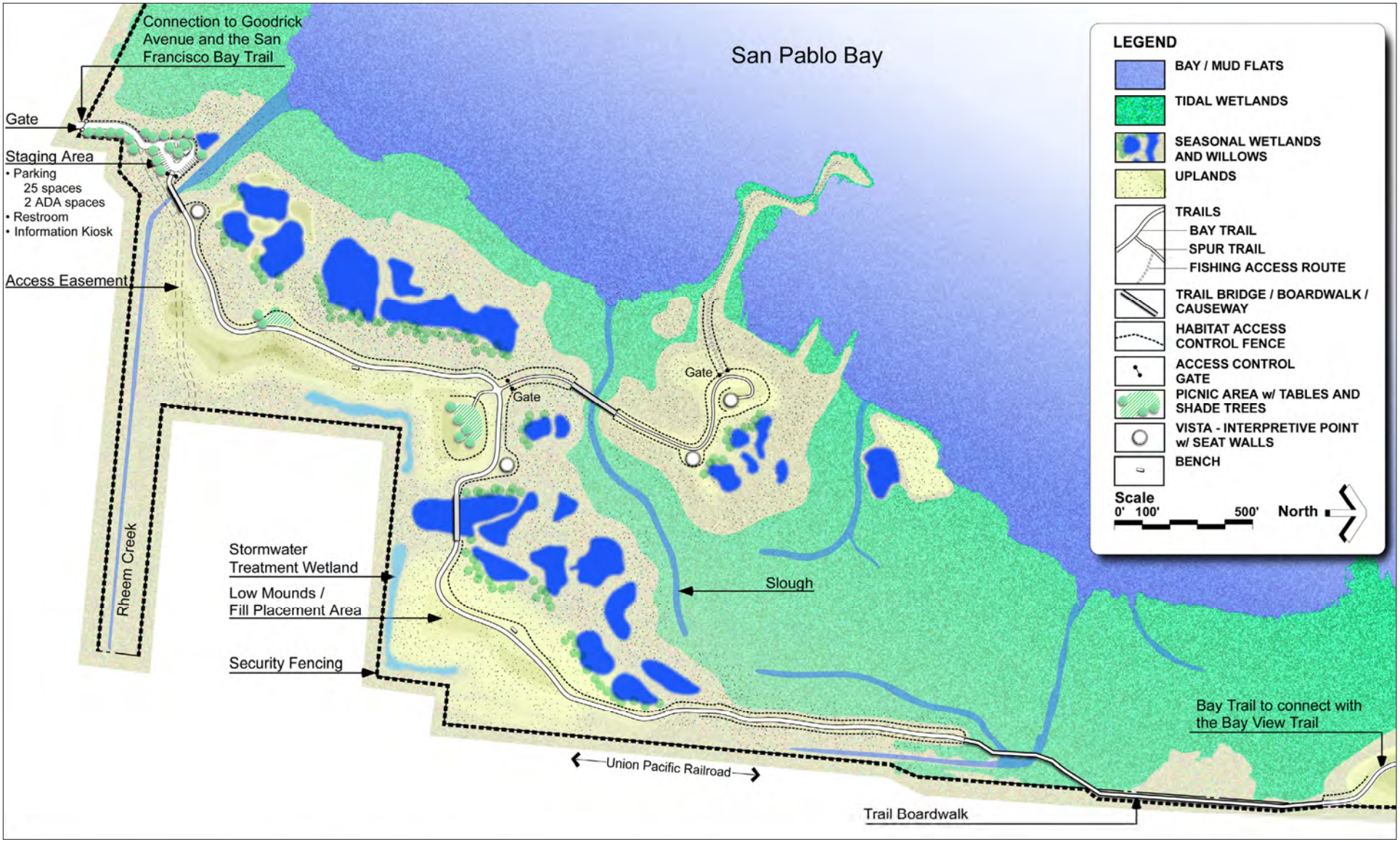
[13] The pictorial representation in Figure 3-9 is obtained by adding colors to intervals of the final site topography. It differs slightly from the schematic shown in the Notice of Preparation, in that it is based on a slightly modified grading plan and lacks the additional features (such as the riparian/screening plants and stormwater treatment wetland) that were added for illustrative purposes.



Source: East Bay Regional Park District, 2011.

FIGURE 3-9

SCHEMATIC DRAWING OF RESTORED PROJECT SITE

Non-native predators would be trapped to allow native wildlife to gain ground and reestablish territory. These maintenance activities would gradually diminish in scope from approximately the fourth year of the Project.

Two trails would be built across the project site to allow public access. The Main Trail, which would serve as a new section of the San Francisco Bay Trail, would run from the parking lot located in the south of the site, across a new bridge over Rheem Creek to the east of the existing paved trail, running inland to the property boundary and parallel to the railroad tracks north to connect with trails on the Point Pinole Peninsula. The Main Trail would be paved and would cross slough and wetland areas by a variety of bridges and boardwalk segments. It would be designed for bicycle and pedestrian use.

The pedestrian-only Spit Trail would diverge from the Main Trail to connect to the existing spit. There would be an improved, paved section of the Spit Trail from the Main Trail, as far as the waterfront, and then an unimproved section extending out to the Bay, accessible through a gate. A picnic area and rest area would be built at the junction of the Main Trail and Spit Trail and interpretative signs would be located at intervals along both trails.

The Proposed Project components are described in more detail below.

1. Demolition and Disposal

Several existing structures and facilities on the site would be demolished and the debris buried on-site or transported off-site for disposal. The structures to be demolished include:

- Goodrick Avenue Bridge at Rheem Creek – concrete box culvert bridge structure, wing walls, and abutments.
- Goodrick Avenue Extension through southwestern edge of property – road surface including asphalt and some existing aggregate base rock.
- Miscellaneous rubble, debris, and fencing – several long, narrow strips of concrete and asphalt rubble and debris, and some fencing along the perimeter.

- Model airplane area – shade structure, cargo storage containers, asphalt parking areas, and runway.

Most of the concrete from the demolition would be reused onsite as rubble for the base of fill areas. Asphalt-containing concrete, from the model airplane runway and from Goodrick Avenue, could be crushed onsite and be used as trail and parking lot base material if cost-effective. Demolition material that contains rebar, metal, asphalt, and concrete that cannot be recycled, would be removed to a landfill. The destination of the demolition material is not known at this time, but it would most likely go to the West County Landfill, located less than 2 miles from the Breuner property off Richmond Parkway.

2. Model Airplane Facility

The model airplane facility is operated through an annual lease from EBRPD. Model airplane use is considered incompatible with the proposed restoration and public access improvements. The BARCS lease will terminate in 2012 and, as part of the Proposed Project, the facility would be demolished and not be replaced.

3. Hazardous Materials

The site has been thoroughly investigated for the presence of hazardous materials and only a small amount of hazardous materials, associated with historic uses of the property, has been found. This consists of approximately 1,000 cubic yards of arsenic-contaminated soils that would be excavated, stockpiled, tested, removed from this area, and transported to a Class II Special Category waste disposal facility such as Altamont Pass Landfill near Livermore, in accordance with applicable regulatory standards.[14]

4. Ecological Restoration

Areas of existing habitat, habitat for restoration and enhancement, and habitat that will be created are summarized in Table 3-1. The habitats described

[14] As is common practice, it is likely the area would be over-excavated to ensure that all contaminated material is removed.

TABLE 3-1 **HABITAT ACREAGES BY ELEVATION FOR PROJECT AND EXISTING CONDITIONS**

Habitat	Existing Conditions (2011)[a]	Project (2014)[a]
Low Marsh, Cordgrass-Dominated	6.9	7.9
High Marsh, Pickleweed-Dominated	28.6	53.5
Transition Zone	27.4	22.3
Upland	94.8	73.7
Adjacent San Pablo Bay/Mudflat	47.8	48.1
Total[b]	**205.5**	**205.5**
Tidal Wetlands[c]	35.5	61.4
Seasonal Wetlands[c]	N/A	7.0

Notes: Giant Marsh acreage is not included. The table does not indicate the quality of the existing habitat.

[a] Existing Conditions habitat acreages and Proposed Project acreages are based on a generalized habitat-by-elevation analysis. Detailed habitat mapping of the site is presented in Section 4.3 Biological Resources. Source: WRA, 2011.

[b] The analysis area included the project boundary and adjacent mudflats and open water within San Pablo Bay.

[c] Acreages of tidal and seasonal wetlands are part of the total of 205.6 acres. Source: WRA, 2011.

in this table and elsewhere in this EIR are plant communities in zones that depend primarily upon the amount of tidal influence and their elevation with respect to sea level. The following terms are used:

- *Tidal sloughs* are fully connected tidal channels that contain water except at the very lowest tides. Their salinity fluctuates depending on the amount of rainwater flowing from the land. These tidal channels typically have mud bottoms and may be vegetated with cordgrass and pickleweed at the upper edges of the channel banks.

Tidal Marsh, or *Tidal Wetlands,* are the terms used for the entire zone between the lowest and highest tidal levels. In the area of the project site there is a height difference of 7.4 feet between the High Tide Line and the Mean Lower Low Water level. This zone is subdivided into low marsh and high marsh.

- *Low Marsh* is typically inundated twice per day with each high tide and often remains inundated during some portion of the daily low tides. The low marsh is dominated by cordgrass, (*Spartina* spp.). Low marsh provides critical habitat for clapper rails and other species of marsh birds.
- *High Marsh* is typically not inundated at low tide but is inundated during the higher of the daily high tides. The high marsh is dominated by pickleweed (*Sarcocornia* spp., formerly known as *Salicornia*) and other species such as salt grass and alkali heath. High marsh provides critical habitat for the salt marsh harvest mouse.
- *Transition Zone* refers to the area between high marsh and upland areas. Although above the zone of daily tidal inundation, portions of these areas are occasionally flooded by higher tides. This area is dominated bygumweed, salt grass, and coyote brush. It is important to the Proposed Project because it provides upland refugia for wildlife species such as the salt marsh harvest mouse and clapper rail. As sea level rises through time, it will become high marsh.
- *Uplands* are regarded as land above approximately 8 feet that are not submerged by the tide and dominated by grasses and other non-wetland species.
- *Seasonal Wetlands* are found in areas where standing water or saturated soils persist during the rainy season. Typically these areas will dry out during the summer. Seasonal wetlands are dominated by plant species that are adapted to tolerate extended periods of standing water and/or saturated soils. These species also have the ability to become dormant

during the summer when there is no fresh water in the wetlands. These areas receive their water from the rain, either directly or indirectly from runoff from higher areas or from groundwater when the soil is saturated and water ponds on the surface.[15]

- *Wetlands* are both tidal wetlands and seasonal wetlands. The U.S. Army Corps of Engineers has a precise definition for wetlands that can be considered "Waters of the State." More information on this definition is provided in Section 4.3, Biological Resources.

a. Vegetation Removal

Vegetation would be removed from the project site prior to regrading using a combination of motor-powered and hand-powered mowing and cutting machines. A biological monitor would inspect the area shortly before the area is cleared, to relocate wildlife. After the vegetation has been removed, exclusion fencing would be installed around cleared areas to prevent wildlife re-entry.[16]

b. Grading

A grading plan has been prepared for the Proposed Project that shows areas of the site that would be restored by removing imported fill and debris. Approximately 110,000 cubic yards of material occupying approximately 90 acres would be moved around on the site.Areas for restoration and creation would be cleared and grubbed of vegetation, and then excavated. Up to 2.5 feet of soil would be removed to create suitable elevations for tidal flooding and marsh restoration. Approximately 24 acres of saltmarsh would be creat-

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[15] Some of the seasonal wetlands occur in areas of historic tidal marsh that have been removed from regular tidal influence. Because of the high soil salinity, some of these areas also support plans that are salt tolerant.

[16] The area is listed by the *Invasive Spartina Project* as one that would benefit from its removal in order to promote clapper rail and other bird habitat. Its removal was described in a programmatic CEQA document that included the project site. Although some invasive *Spartina* would be eradicated from the existing tidal marsh areas prior to site regrading, complete removal from the project site is not part of the project as proposed.

ed. Three new tidal sloughs would also be excavated to facilitate tidal flooding of these areas. A further 4.7 acres of new seasonal wetlands would be created, 2.6 acres of seasonal wetlands would be enhanced and restored, and drainage swales would be constructed. Transition zone habitat would be created that, with expected sea level rise would become salt marsh in the future. The increase in tidal wetlands would be approximately 26 acres, and of seasonal wetlands 7.0 acres, making a total increase in wetlands of 33 acres.

Upland areas used for soil disposal would be created in the southeast and south-central portions of the site. These areas would be restricted in height to avoid blocking Bay views, and the proposed Bay Trail would be located along the low ridge line that would be created by the fill placement. The Proposed Project has been designed to balance cut-and-fill with about 105,500 cubic yards of total earthwork. Off-haul of rubble and unsuitable soil is estimated to total about 4,500 cubic yards.

c. Habitat Restoration

After vegetation removal and grading, areas to be restored would be seeded and planted with native wetland transition zone and upland plant materials. Areas of tidal marsh would mainly be left to natural marsh plant recolonization.

Soil conditions in the restoration areas would be tested to ensure that they are suitable for plant establishment. In some areas, soils may need to be prepared prior to planting by mechanically loosening the soil and, where needed, adding soil amendments. Small quantities of topsoil from areas with a good cover of native grassland plants may also be salvaged and stored for use as a topdressing and seedbank of native grass seed.

d. Irrigation

An irrigation system would be installed in some areas for summer and fall irrigation of plant materials to assist in native plant establishment. The irrigation would last for about three years with the precise duration, frequency, and amount of water used dependent upon annual precipitation and tempera-

tures. At an expected irrigation application rate of about 2 acre-feet[17] of water per acre per year, the 1 to 2 acres of restoration plantings that would be irrigated would use about 4 acre-feet of water per year. Irrigation water may either be brought to the site via lines from the existing main to the areas needing irrigation; lines from the existing main to the trailhead and then trucked to the areas needing irrigation; or trucked directly from the existing main to the areas needing irrigation. There are no plans to install a groundwater well at the site as the water below the site is considered too brackish for effective irrigation. After the plants are established, no more water would be required.

The restored areas would be monitored for success in achieving approved vegetative performance criteria for five years. These areas would be maintained, weeded and reseeded or replanted as necessary to meet required performance criteria.

5. Rheem Creek Restoration

As an optional part of the Proposed Project (but which will be analyzed here for CEQA purposes), dependent upon the economics, permit requirements, and funding availability, the lower 500 feet of Rheem Creek would be enhanced as part of the Proposed Project. This would involve lowering the north levee, or berm, by 2 to 3 feet, and grading the northern bank of the creek to support brackish marsh habitat within the channel.

6. Public Access Construction

Elements of the public access component of the Proposed Project are described below and in Table 3-2.

a. Goodrick Avenue Entrance and Parking Area

A 29,000-square-foot parking lot with 27 spaces, two of which would be reserved for disabled drivers, would be built at the site's southern entrance, in the place of the staging area. A gate would close the parking lot to vehicle use after the park is closed. There would be sufficient room in the parking area

[17] An acre-foot is the amount of water that would cover an acre of land to a depth of 1 foot.

to allow emergency vehicles to turn around. A 10-foot high, permanent prefabricated restroom with two vault toilets would be installed. It is possible that these would later be connected to a public water supply and converted to flush toilets. If that occurs, a drinking fountain could also be installed. A parking fee collection device may be included. An information panel kiosk may also be built close to the site entrance.

b. Rheem Creek Bridge

A new bridge would be built across Rheem Creek. This bridge would be a 16-foot-wide by 60-foot-long steel truss structure located about 500 feet upstream from the existing concrete box bridge structure. The new bridge would allow 3 feet of clearance over the 100-year flood water surface elevation of 12 feet (NAVD88 datum) for the bottom cord of the bridge.

c. Northern Site Access

Site access would be available as present, at Point Pinole at the northern end of the Bay Trail (see below) crossing the UP railroad tracks on Badger Bridge. Parking is available in the existing Point Pinole main parking lot and the smaller parking lot close to Parchester Village (see Section A Site Access).[18] The Proposed Project would not include a new crossing of the UP railroad tracks.[19] Such a crossing could be provided as part of a future project.

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[18] A new entrance at Atlas Road is currently planned slightly north of this as described in Section 4.0 Environmental Evaluation.

[19] A bridge connecting Parchester Village directly to the project site was not included in the Plan because of the very high cost of such a bridge compared to the cost of the project overall. In addition, EBRPD does not own the land east of the railroad tracks and substantial land would have to be acquired so that the slope of the bridge did not exceed the maximum 30:1 slope stipulated by the Americans with Disabilities Act. Any new crossing would also require approval by the California Public Utilities Commission and UP railroad, both of which are generally not in favor of new crossings. A tunnel under the tracks would be infeasible due to several reasons including safety due to the proximity of the petroleum pipeline and very high cost.

TABLE 3-2 **PUBLIC ACCESS CONSTRUCTION COMPONENTS**

Feature	Design Characteristics
Entrance	
Entrance Road	Length: ~250 feet from Richmond Rod & Gun Club gate to new parking lot (approximately 6,000 square feet) Area: 30,000 square feet, 0.7 acres Width: 24 feet Bordered by vegetated swales to protect water quality
Property line fence	6-foot-tall, chain link fence on eastern boundary adjacent to UP railroad. Other fences 4-foot high, wire mesh, barbed wire, or similar. At least 10 wire or pipe gates on boundary fencing.
Lockable gate to parking lot	Gate including "dragon's teeth" mechanism for one-way travel
Staging/Parking Area	
Area	Area: 21,270 square feet, 0.5 acres
Parking	25 unrestricted vehicle spaces 2 ADA van-accessible spaces Bus turnaround and parking Turnaround for emergency vehicles, 40 feet in length Onsite stormwater treatment features
Restroom	Prefabricated permanent vault toilet unit with two toilet stalls
Drinking fountain (possible component)	Water fountain
Use and regulatory signs	Standard EBRPD signs Bay Trail signs
Main Trail	
Main Trail Parking lot to Pt. Pinole 6,037 feet; Switchbacks at Pt. Pinole 1,931 feet; Total 7,968 feet (~1.5 miles)	At-grade trail length: 6,350 feet Width: 12 feet with two, 2-foot shoulders at grade Bridge length: 160 feet; width 16 feet between railings Boardwalk/causeway length: 1,350 feet; width 12 feet between railings Road surface: asphalt Bridge/boardwalk/causeway surface: concrete

Feature	Design Characteristics
Access control gates (2)	One between Main Trail and Spit Trail, and one between Spit Trail and end of the Spit
Habitat access control fencing	Continuous 4-foot black vinyl-clad chain-link, probably on wood posts along the west/Bay side of the Main Trail Livestock fencing, 48 inches high, wire with metal posts
Picnic areas	South Area: 3,790 square feet, 0.1 acre North Area: 11,590 square feet, 0.3 acre Picnic tables (An additional picnic area may be provided when site plans are developed.) Access control fencing: 4-foot fence on three sides Livestock fencing (recommended) Landscape plantings
Vista points/interpretive overlooks (4)	Interpretive panels at each site Standard EBRPD and Bay Trail signs
Spit Trail (improved)	
Overlook to gate 1,418 feet	At-grade trail length: 1,230 feet; width 6 to 8 feet Bridge length: 160 feet; width 8 feet between railings At grade trail surface: asphalt Bridge surface: concrete
Gate	Lockable
Habitat access control fencing	On both sides to spit, except in bridge and boardwalk areas, and around overlook
Vista points/interpretive overlooks (2)	Interpretive panel at each of the sites Benches and/or seat walls Standard EBRPD and Bay Trail signs
Water Access Trail (unimproved)	
Gate to spit 771 feet	Existing footpath: length 1,100 feet; width 3 feet
Gate	Lockable
Habitat access control fencing	None

Source: EBRPD, 2011.

d. San Francisco Bay Main Trail and Spit Trail

i. Main Trail

Approximately 1½ miles of paved multi-use trail would be built from the Goodrick Avenue Staging Area north to the existing trails at Point Pinole. Although the Main Trail would be an EBRPD trail built to EBRPD standards, it would serve as a segment of the San Francisco Bay Trail (Bay Trail) and fill in one of the current gaps in the trail system in this area.[20] (Please refer to Section 4.11, Recreation, for a description of the Bay Trail Plan.) The Main Trail, including all bridges and boardwalks would be accessible to small patrol and emergency response vehicles (pick-up truck rated) in addition to bicycles and pedestrians. One picnic area and additional benches would be provided along the Main Trail. Schematic drawings of the trail design are shown in Figures 3-10 through 3-13.

From the southern site entrance, the Main Trail route would run north, 300 to 400 feet inland from the existing trail route, and turn inland at the start of the Spit Trail (see below) to follow a route along the railroad, approximately 100 to 200 feet from the tracks. The northernmost section would cross the drainage ditch and run parallel to the tracks, at or near the base of the railroad embankment, on a boardwalk, until reaching the existing Bay View Trail at Point Pinole. The trail would be located just inside, or just outside, the UP railroad right-of-way. The southern termination of the Bay View trail would be altered by adding switchbacks to reduce the grade and ensure that it is ADA accessible.

ii. Spit Trail

The Spit Trail[21] would divide from the Main Trail, with an access control gate allowing access to pedestrians only, and run to an overlook point near the

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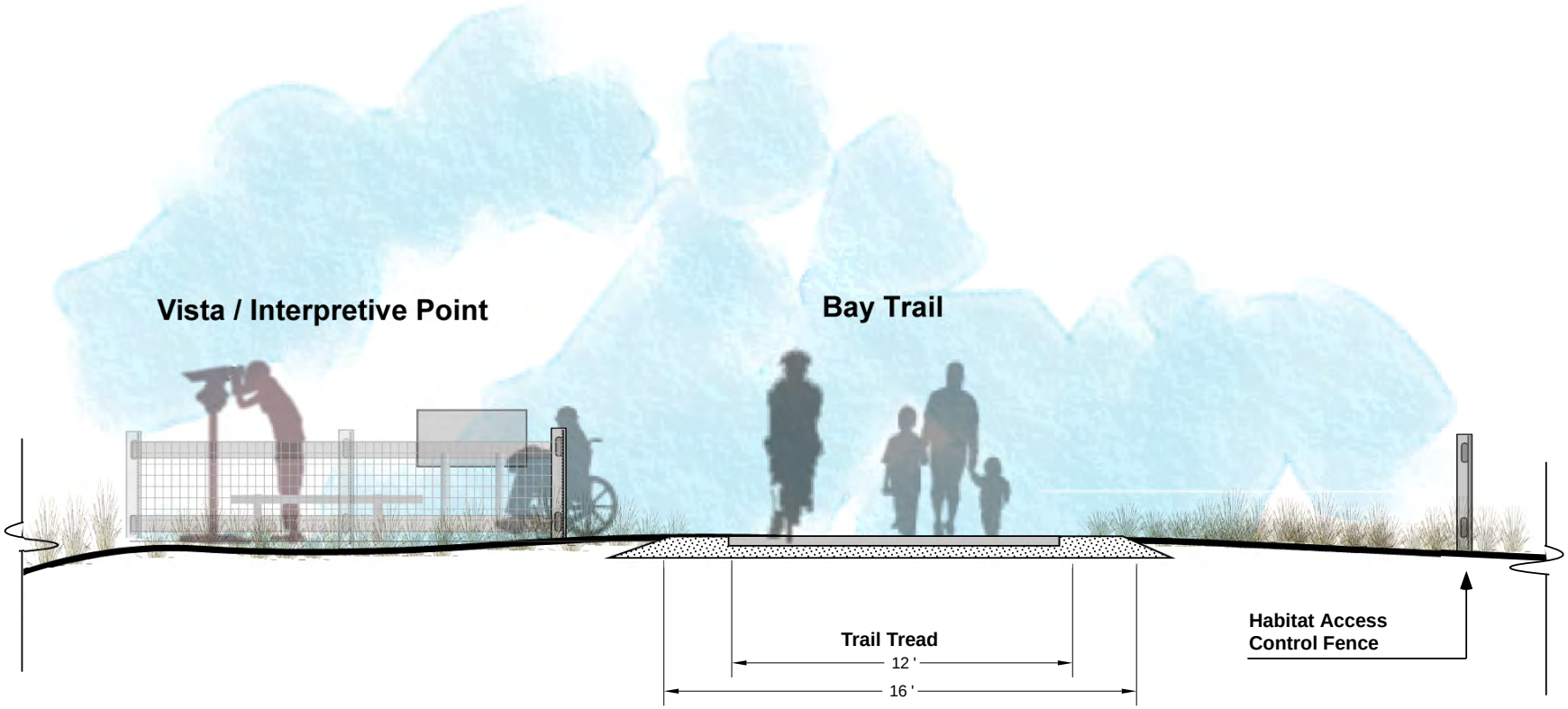
[20] There is no legal requirement that the new trail comply with Bay Trail standards, if those are different from EBRPD standards.

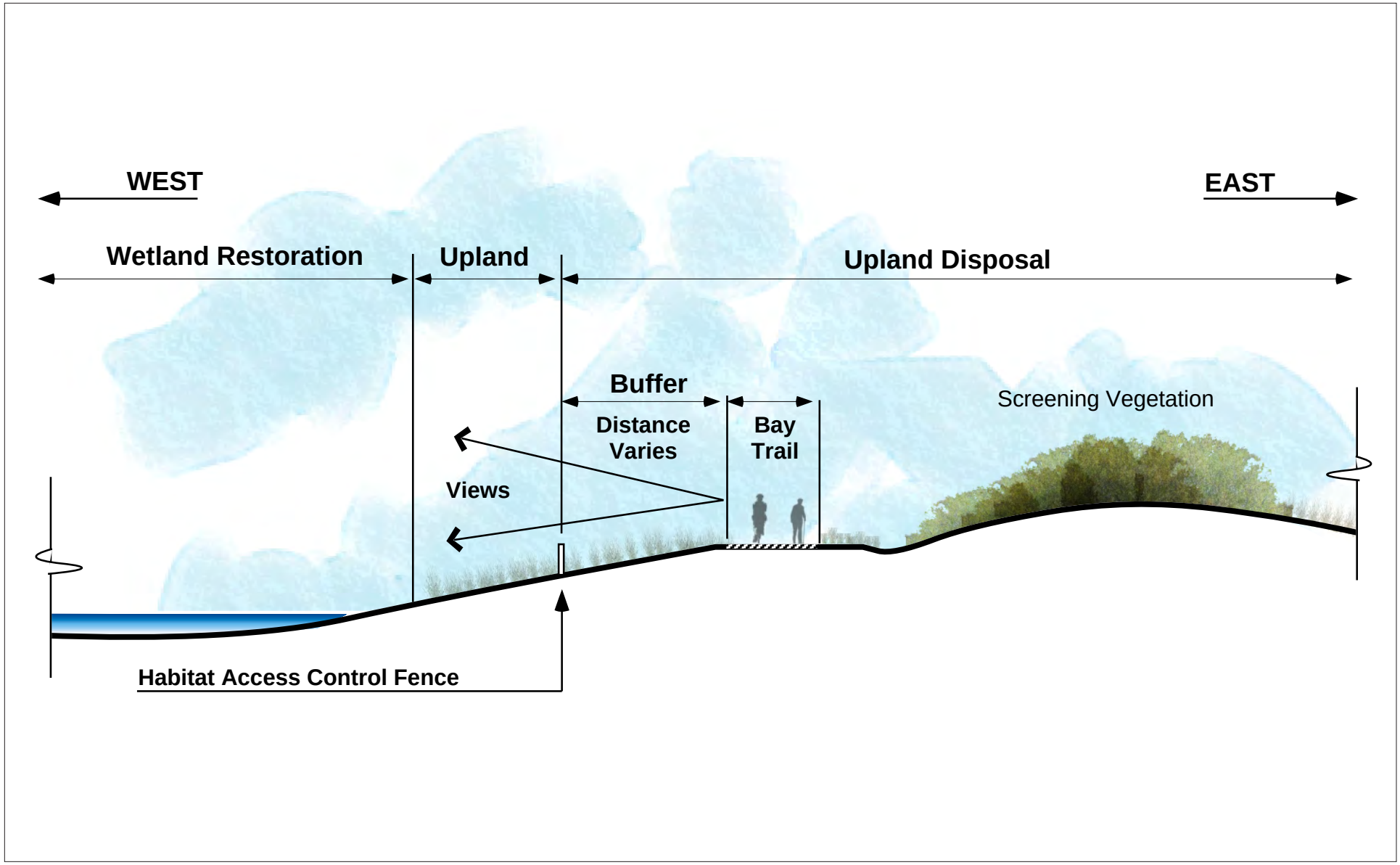
[21] This is referred to as a Spur Trail in the Bay Trail Plan. See more information in Section 4.11, Recreation.



Source: 2M Associates.

FIGURE 3-10

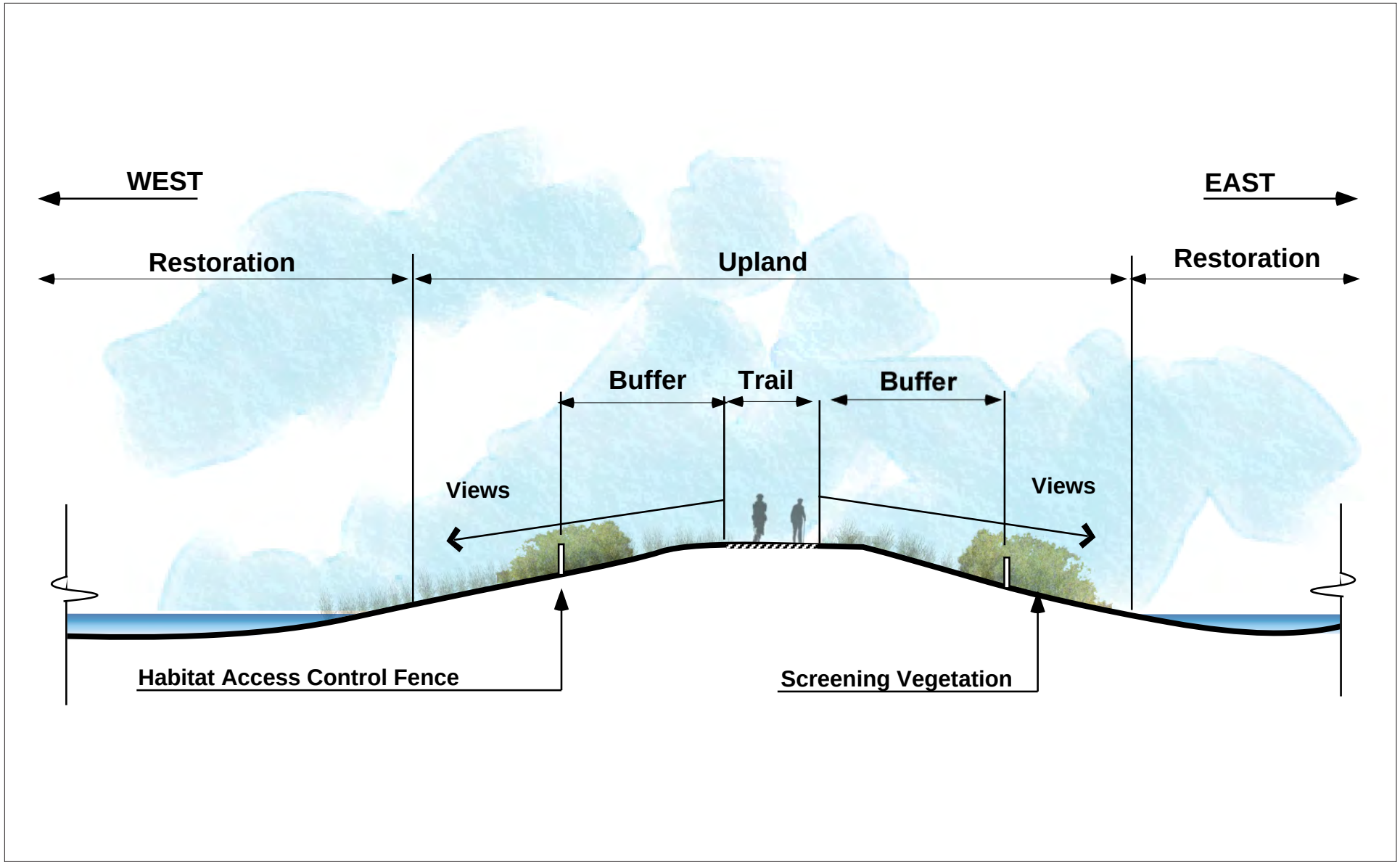
BAY TRAIL DESIGN



Source: 2M Associates.

FIGURE 3-11

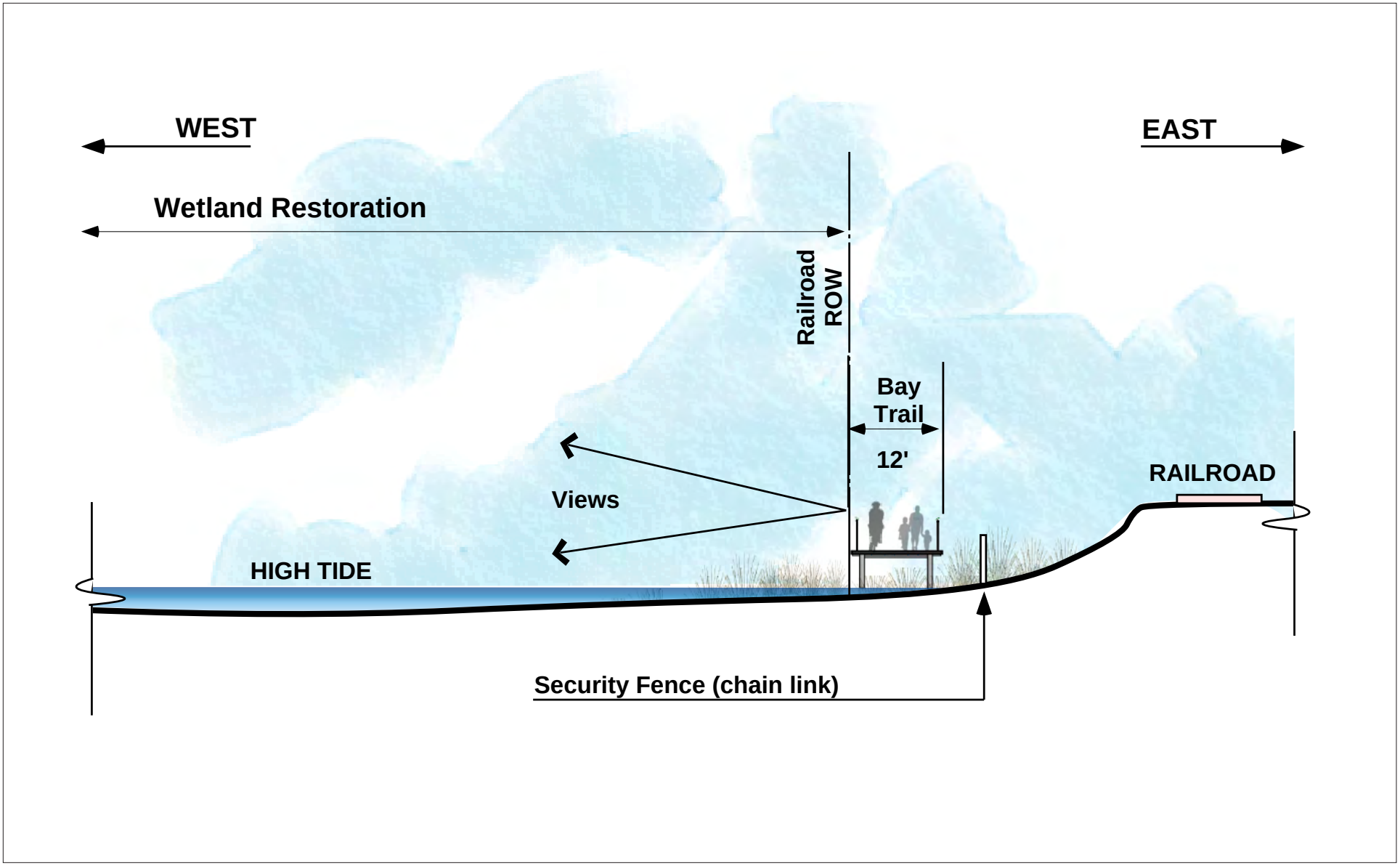
BAY TRAIL IN UPLAND FILL AREA



Source: 2M Associates.

FIGURE 3-12

BAY TRAIL ALONG UPLAND BERM



Source: 2M Associates.

FIGURE 3-13

BAY TRAIL ON BOARDWALK

open-water edge of the Giant Marsh.[22] The improved, 1,230-foot-long, north-south section of the trail would be 6 feet wide and probably be gravel-covered. Light weight all-terrain vehicles (ATVs) or golf-cart-sized maintenance vehicles could gain access to the Spit Trail through the gates. A lockable gate would be located between the improved section of the Spit Trail and an unimproved, 771-foot-long, 4-foot-wide section of trail out to the end of the spit. This water-access section of the trail is currently eroding and cannot be maintained. It could be closed to all users for safety at times of very high water, and permanently when sea level rise or trail failure necessitates.

e. Bridges and Boardwalks

A series of bicycle and pedestrian bridges and boardwalks will be installed as a part of the Proposed Project to traverse over creek and slough drainages and wetlands, including existing wetland areas and new wetlands and slough channels that will be created as a part of the restoration project. The bridges will be painted, pre-engineered steel truss structures with concrete decks, while the boardwalks will be concrete with painted steel handrails, designed to keep trail users on the trail and preclude access to the adjacent wetland areas. The bridges and boardwalks will likely rest on 12-inch to 18-inch diameter concrete piers or piles, depending on the design load and size of the structure, total span, and underlying soil conditions. The Main Trail will have a minimum design elevation of 12 feet (NAVD88 datum), while the bridges and boardwalks will be elevated such that the bottom cord or member of these structures will be at a minimum design elevation of 12 feet. Using a 2-foot-thick beam, plus an 8-inch thick deck, the bridges and boardwalks would have minimum deck surface elevations of approximately 15 feet.

The following is a listing of proposed bridges and boardwalks that would be constructed as a part of the Proposed Project:

[22] A bike rack could be located at the start of the Spit Trail.

i. Boardwalk over Southeast Wetland

The proposed Boardwalk crossing of the new wetland area in the southeast corner will be 12 feet wide by 160 feet long. The boardwalk will have a concrete deck and painted steel handrails, 54 inches high. Included in the 160-foot-long structure will be a 50-foot-long painted steel truss bridge structure spanning the flat bottomed center section of the wetlands.

ii. Bridge and Boardwalk to Spit

One proposed bridge and boardwalk would consist of a 200-foot-long section of bridge and boardwalk spanning the tidal slough near the overlook with access to the existing fishing access jetty, or spit. The 8-foot-wide boardwalk will have a concrete deck and painted steel handrails 42 to 48 inches high. An 8-foot-wide by 50-foot-long painted steel truss bridge will span the new tidal slough channel and adjacent pickleweed tidal marsh, centered on the channel.

iii. Giant Marsh Boardwalk to Pt. Pinole

The Giant Marsh boardwalk structure will be approximately 1,700-lineal-feet long and 12 feet wide. It will include a 300-foot-long elevated structure connecting to Point Pinole on the north, a 500-foot-long section with a 3- to 3½-foot-high concrete retaining wall on the west (Bay) side resting on existing upland soils, a 400-foot-long concrete boardwalk section to the south of this, and a 450-foot-long concrete boardwalk section connecting to the at-grade Bay Trail on the south.

f. Infrastructure Extension

There are several options for providing water for irrigation (i.e. infrastructure extension):

- **Lines from main to irrigated areas.** A 1½- or 2-inch water line may be extended from the existing main, located within Goodrick Avenue near the Richmond Parkway, to the proposed parking lot and staging area. Any irrigation lines into the site would run across the new Rheem Creek bridge and under the Trail, where they would be abandoned in place after the vegetation is established. They would probably be used to fill on-site

tanks, and hoses would run from the tanks to feed a gravity-driven drip and/or spray irrigation system.

- **Lines from main to trail head.** With this option, water would then need to be transported (e.g. via truck) from the trail head to areas needing irrigation.
- **No lines.** Water would be transported (e.g. via truck) from the existing Goodrick Avenue main to areas needing irrigation.

Extending water lines, either to irrigated areas or to just to the staging area, could also facilitate installation of a drinking fountain and restroom in the staging area. If the toilets are later converted to flush toilets, the sanitary sewer would need to be extended to the staging area with additional trenching along Goodrick Avenue. Electricity would also need to be provided for a sewer lift station.

g. Fencing, Open Space Buffers, and Signs

The public would be restricted from intruding into wetland habitats by fencing, railings, boardwalks, vegetative barriers, and open space buffers. They would also be prevented from entering the railroad right-of-way for security reasons.

A 6-foot-high chain-link security fence would be installed along the eastern edge of the property, where it abuts the UP railroad.[23] A 4-foot-high chain link fence would be placed on either side of the trail where it parallels the railroad ditch. Where the fences cross the buried pipelines, fence posts would be spaced at 10-foot intervals to allow for pipeline maintenance and/or replacement.

A 4-foot-high, vinyl-clad chain-link fence, or similar, would run along the west side of the Main Trail, both sides of the Spit Trail, and around the overlook except in the bridge and boardwalk areas, to prevent human intrusion

[23] In the northernmost parts through Giant Marsh, the fence may be at the foot of the railroad embankment east of the boardwalk, and may have a slightly different design, depending on the outcome of consultation with UP railroad.

into wetlands. Fencing would be designed with a gap of at least 6 to 8 inches at the base to allow wildlife movement underneath. The parking/staging area would be similarly fenced on the Bay (west) side and the central picnic area, where necessary to protect public safety and to prevent development of "social trails." Where feasible, the fencing would be set back from the edge of the trail to allow users to experience unobstructed views. Screening vegetation would be strategically planted along the trail system to provide a visual and sound buffer for wildlife in high value habitat, provide additional wildlife habitat, and help erosion control.

In wetland areas, sections of boardwalk and bridges would have railings to prevent public entry into sensitive wildlife areas. Signs would be posted at regular intervals on rails, fences, and posts, stating: "Resource Protection Area" with additional messages such as: "Keep Out," "Dogs on Leash," or "Stay on Trail."[24]

With the exception of bridges and boardwalks that cross wetland areas, an open space buffer would separate the trail from the tidal wetland area. Seasonal wetlands and extended drainage channels would present additional physical barriers to discourage human intrusion into sensitive areas.

7. Construction Phasing and Scheduling

The Proposed Project is scheduled to commence grading in the late Spring of 2013. Some tasks, such as demolition, removal of hazardous materials and inorganic debris, installation of fencing, and construction of a new bridge across Rheem Creek, could occur in Fall 2012. Some grading near tidal wetlands would probably continue into 2014 due to seasonal permit restrictions. In the Fall to Winter of 2014 seasonal wetland, transitional habitats, and upland areas would be planted and seeded with site native vegetation. Construction of additional bridges, trails, and boardwalk would follow in late Spring of 2015, followed by construction of lower Rheem Creek restoration, staging

[24] These are EBRPD signs E-37, E-38, and F-26. Other signs may also be applicable.

(parking) area, restrooms, picnic facilities, and other public access improvements in the Fall of 2015.

Assuming this schedule, seasonal wetlands would begin collecting precipitation in the Fall of 2013, portions of the tidal marsh would be subject to tidal inundation in late 2013, followed by the remainder in 2014, and restored portions of Rheem Creek would be inundated in the Fall of 2015. The construction schedule is directly dependent upon the availability of funding, processing time and conditions of permits, contractors' construction phasing, and site conditions (especially annual precipitation volume and duration).

8. Construction Equipment and Hours of Operation

A variety of bulldozers, backhoes, and scrapers would be needed for the mass grading phase of the Proposed Project and the precise type of equipment would vary according to the solidity of the substrate, and the availability of suitable construction equipment.[25] For example, larger earth-moving equipment could be used in the upland areas to grade faster and more efficiently. This equipment would also be used to create the seasonal wetlands because their construction depends on grading and on-site disposal of excavated fill materials. Construction in tidal and former tidal areas would be slower and would require smaller pieces of equipment on construction mats, and low-pressure tire or tracked vehicles to prevent vehicles from becoming stuck in the mud. For construction of the new Rheem Creek bridge, it is unlikely pile drivers would be required. Pile driving may be needed to build the Spit Bridge, depending on the sub-soil conditions.

Construction would take place between the hours of 7 a.m. to 7 p.m. weekdays. Some quieter activities such as planting, mowing, and irrigation (and not involving heavy construction equipment), may occur if necessary between 9 a.m. and 8 p.m. on weekends. To minimize the annoyance to Parchester Village residents, EBRPD would notify neighbors in Parchester

[25] Details of equipment anticipated as used in the modeling for air quality and greenhouse gas emissions are presented in Appendix E.

Village in advance of pile installation in the Giant Marsh area. These activities would be restricted to weekdays between 9 a.m. and 5 p.m.

9. Use Expectations and Visitor Use Projections

Users of the Breuner Marsh site are expected to be walkers, hikers, bicyclists, birdwatchers, and other wildlife observers out to enjoy the restored wetlands. There would also be small groups of casual picnickers. Some would visit both the north and south of the site in the same visit. School groups could arrive in buses to the Badger Bridge parking lot and walk south through Giant Marsh. Many of the project site visitors are expected to be Bay Trail users either emanating from entrances on the Point Pinole Peninsula, or biking through from points to the north or south. Some of the visitors may also be local residents who want to complete a short hike to the Point Pinole Peninsula and back (or vice versa).

There are several methods for estimating the number of future visitors. One method, which considers the likely number of bicycle users on a new 1½-mile off-street bicycle trail, estimates the number of visitors at 60 per day.[26] This method assumes that many of these users would start their trips at the (existing) Point Pinole facility; while others would be bike users coming from the south on the Bay Trail. When other gaps in the Bay Trail are filled, the number of users in this category is expected to increase and some would be bicycle commuters. More information on this is provided in Section 4.11, Recreation.

Another method, which considers the likely number of vehicle users given the amount of useable open space, estimates the number of visitors at 47 per day.[27] However, this methodology, when compared to actual park users at the existing Point Pinole park, overestimates vehicle users. A more realistic

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[26] Calculated using the Federal Highway Administration Benefit Cost Analysis of Bicycle Facilities online model, available at: http://www.bicyclinginfo.org/bikecost/index.cfm.

[27] Institute of Traffic Engineers (ITE), 2009. *Traffic Engineering Handbook*, 6th Edition.

average would be 24 vehicle users per day, or 9,000 to 10,000 per year is probably more realistic. More information on visitor use calculations is included in Section 4.12, Traffic and Transportation.

Use is expected to be highest on weekends, and seasonal, with twice as many users during spring and summer than in late fall and winter. In addition, there are likely to be some groups, although most would not be larger than 25 people.

10. Hours of Operation and Trail Rules

As with other facilities operated by the EBRPD, the site day-use facilities would be open from sunrise to sunset every day of the year, including holidays. However, the proposed staging area and/or trails may be closed periodically to protect public safety or to perform major maintenance activities, such as to repair storm damage or repave the trails. A locked gate would prevent vehicular access outside these times. A pipe gate on the south side of Rheem Creek would allow only approved maintenance and emergency response vehicles and easement holders on the main part of the project site. Although the park would be officially closed, the Bay Trail would be accessible to bicycles and pedestrians from 5 a.m. to 10 p.m., in line with EBRPD's hours for regional trails.[28] Dogs would be allowed on leash on the Main Trail only. No lighting would be provided in either the parking area or along the trail or overlook points. Trail rules, as listed on signs at park entry points, are listed in Appendix C.

11. Maintenance and Ongoing Management

a. Plant and Wildlife Maintenance and Control

As the plants are being established during the first three years, some maintenance work would be required. This would consist of irrigation and replacement, as necessary, weeding (primarily to remove non-native cordgrass and perennial pepperweed), and control of non-native predators by trapping (mainly red fox and feral cats), in addition to maintenance of fences, gates,

[28] There would be sufficient gaps for bikes between the bollards, even after the park is closed.

and signs. Maintenance would continue in Year 4 and beyond, but be considerably reduced in scale. It is expected that by the end of Year 10, it would no longer be necessary to maintain the native plants. Weed control would be performed periodically by park volunteers, Park District staff, and potentially by periodic grazing of uplands by cattle, goats or sheep.[29] Non-native predator control would be addressed through public education and periodic monitoring.

b. Site Management

The site is already part of Point Pinole Regional Shoreline Park and would be managed as part of ongoing operations. Site boundaries would be continually secured against trespassing by maintenance of fences and signs, and the site would be protected from vandalism, dumping, establishment of homeless encampments,[30] hunting, and fishing. Duck hunting from boats would presumably still occur in San Francisco Bay, but the hunters would not have access to the Bay from EBRPD property. All garbage, recycling, and composting will be kept in closed containers and latched or locked to prevent wildlife from using the waste as a food source. Contents would be collected regularly. Rangers would patrol regularly during park opening hours to provide security and to collect trash, litter, and debris.[31] There would be periodic shoreline clean-up events.

G. Avoidance and Minimization Measures

The following measures are incorporated into the project description to avoid and minimize possible environmental impacts. Additional measures have

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[29] Selection of the appropriate animal depends on management goals, available funding, and practicality in an area adjacent to urban development.

[30] Under EBRPD Ordinance 38, homeless encampments are not allowed.

[31] EBPRD rangers provide routine security. EBRPD Police would be required for enforcement and criminal investigation. It is possible that Richmond City police might be first to respond to a crime, but typically they would hand over management to EPRPD police upon their arrival. Almost all EBRPD police calls are for injuries, infractions or misdemeanors, usually referred by the park rangers.

been included in Chapter 4 as mitigation measures. Further measures may be added if required as terms and conditions of permits issued for the project. All these measures will be made a part of the project's construction documents and contractor work requirements.

1. During Construction

a. Biological Monitoring

A qualified biological monitor shall be present on-site during all work activities to inspect work areas and halt work if necessary. At the start of the project, vegetation shall be cleared from work areas with a walk-behind mower and hand tools, with the operator closely following the biological monitor who will inspect the area in advance and scare away or relocate any listed or protected species.

b. Contractor Education

Contractor employees shall be educated and trained to be aware of the wildlife and plants with which they are working and to take suitable precautions for the protection of wetlands and listed plant and animal species.

c. Exclusion Fencing

Exclusion fencing and other structures shall be installed to keep listed species out of cleared work areas. All work areas shall be inspected daily and any wildlife found to be present shall be relocated.

d. Seasonal Work Restrictions

Work in wetlands and listed species habitat shall only occur during the months of August through October. Work could occur from April to early December depending on weather conditions, and provided that all erosion control and stormwater management measures are in place and fully functional.

e. Use of Newer Construction Equipment[32]

The construction contractors shall use construction equipment rated by the United States Environmental Protection Agency as having Tier 3 or higher exhaust emission limits for equipment over 50 horsepower. Tier 3 engines between 50 and 750 horsepower are available for 2006 to 2008 model years. A list of construction equipment by type and model year shall be maintained by the construction contractor onsite. The construction contractor shall ensure that all construction equipment is properly serviced and maintained to the manufacturer's standards to reduce operational emissions. The construction contractor shall limit nonessential idling of construction equipment to no more than five consecutive minutes.

f. Limits on Number of Truck Trips per Day

The construction contractors shall limit offsite disposal hauling of hazardous materials and inorganic debris to the landfill to no more than 13 truck trips per day.

g. Drilled Piers/Piles

Pile driving shall not be used to install piers for the boardwalk segments over wetlands that are within 700 feet of the residences of Parchester Village. Instead a quieter method such as drilled, cast-in-place, auger-cast, torque-down, or helical piers or piles shall be used.

h. Pipeline Avoidance

Fill placement within a zone 10 feet on either side of a known pipeline location, or excavation within 25 feet, shall be avoided if possible. If field conditions dictate a reduced distance in certain locations, the absolute minimum distance for excavation would be 5 feet from any high risk utility pipeline.

[32] This is also included as Mitigation Measures in Section 4.2 Air Quality. However, its inclusion in the Project Description is assumed for the purpose of the greenhouse gas analysis.

No more than 1-foot of additional fill shall be placed on top of a pipeline. Existing markers shall be relocated as needed. [33]

i. Contaminated Soil

Soil excavated from the Upland Strip area investigated by Fugro West in the Phase I Environmental Site Assessment (ESA) and shown on Figure 4.7-1 in the Draft EIR, shall be excavated for offsite disposal and will be tested prior to off-haul to confirm the waste classification. Soil from the excavation margins shall also be tested to confirm that contaminated soil that exceeds regulatory levels has been removed.

Soil excavated from the Rubble Mound area investigated in the Phase I ESA, and shown on Draft EIR Figure 4.7-1, shall be only be reused onsite if placed in an upland setting, capped with clean soil, and placed above the groundwater table.

Soil from the Parking Lot area investigated in the Phase I ESA, and shown on Draft EIR Figure 4.7-1, shall not be used as wetland fill.

2. Post-Construction Restoration Monitoring and Management Actions

a. Habitat Mitigation and Monitoring Plan

A Habitat Mitigation and Monitoring Plan (Restoration Planting Plan), subject to review and approval by regulatory agencies having jurisdiction over the project, shall be prepared at the end of project construction. The Plan shall include detailed planting, irrigation, maintenance, and plant establishment monitoring instructions, specific vegetative performance criteria, scientific monitoring and reporting protocols and requirements, and a list of actions that will be taken for the management and control of non-native invasive plants, especially those that may be found in the tidal marsh areas.

[33] This measure is based on California DOT, 1999. *Policy on High and Low Risk Underground Facilities within Highway Rights-of-Way.*

b. Annual Monitoring Reports

Annual monitoring reports shall be prepared for five years and thereafter until the performance criteria have been shown to have been met.[34] The reports will be submitted to the regulatory agencies that have jurisdiction over the project. The annual reports will document:

- Results of monitoring activities.
- Remedial or management measures conducted to assist in meeting vegetative performance criteria.
- Recommendations for future actions, such as re-planting and re-seeding, and invasive plant control measures.

3. Adaptive Management Actions

The following management actions will also be employed:

- Use monitoring as a secondary management technique to help ameliorate the problem of pathways providing predator access routes.
- Predator control as a secondary management technique to help ameliorate the problem of pathways providing predator access routes.

H. Required Permits and Approvals

It is estimated that permits and/or approvals would be required from nine separate agencies. These are:

a. Federal Agencies

- U.S. Fish & Wildlife Service – Consultation/Biological Opinion under Section 7 of Federal Endangered Species Act
- U.S. Army Corps of Engineers – Permits for work in wetland areas under Section 404 of the Clean Water Act; and Section 408 of the

[34] Monitoring is only required for mitigation of impacts as defined by this Draft EIR. Additional monitoring may be carried out by EBRPD as considered useful.

Rivers and Harbors Act of 1899 (as amended in 1985) for bridge construction and restoration of lower Rheem Creek.

- U.S. Coast Guard – Bridge Construction

b. State Agencies

- State Lands Commission – Public Trust Lands and Leases for construction of the Bay Trail segment in Giant Marsh
- Department of Fish and Game – Section 1601 Streambed Alteration Agreement; and Section 2081 Agreement
- San Francisco Bay Regional Water Quality Control Board (RWQCB) – Water Quality Certification under Section 401 of the Clean Water Act for wetland restoration
- San Francisco Bay Conservation and Development Commission (BCDC) – Permit for work in wetland areas and conformance with climate change policies

c. County and Local Agencies

- Contra Costa County Flood Control and Water Conservation District - Encroachment Permit
- City of Richmond – Demolition, Grading, and Building Permits

In addition, easements would be acquired from Shell Pipeline, PG&E, and UP railroad in order to construct the Bay Trail along the chosen alignments.

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Final Environmental Impact Report

Breuner Marsh Restoration and Public Access Project

for the East Bay Regional Park District

SCH # 2011072011

June 12, 2012

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June 12, 2012

Final Environmental Impact Report

Breuner Marsh Restoration and Public Access Project

for the East Bay Regional Park District

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I INTRODUCTION

A. Purpose of the Environmental Impact Report

This document and the Draft Environmental Impact Report (EIR) together comprise the Final EIR for the Breuner Marsh Restoration and Public Access Project.

The Draft EIR described the Proposed Project, identified the environmental impacts associated with the Project, and identified mitigation measures that could reduce those impacts. The Draft EIR evaluated two alternatives to the Project: the No Project Alternative, and the Additional Tidal Habitat Alternative.

This document responds to comments received during the public review period on the Draft EIR and makes revisions to the Draft EIR, as necessary, in response to these comments. The revisions are limited to correcting errors, omissions, or misinterpretations.

This document, together with the Draft EIR, will be presented to the East Bay Regional Park District (EBRPD) Board of Directors at a public meeting to certify as a complete and adequate analysis of the environmental effects of the Project, under the California Environmental Quality Act (CEQA), prior to taking action to approve the Project. The EBRPD Board must consider the conclusions of the EIR and make findings regarding that information as part of any approval.

B. Environmental Review Process

1. Notice of Completion of Draft EIR and Review Period

A Notice of Completion of the Draft EIR (NOC) was filed with the Governor's Office of Planning and Research (OPR). The public review period began on March 12, 2012, and ended on April 27, 2012.

2. Draft EIR Availability for Public Review

The Draft EIR was made available for downloading from the EBRPD website at www.ebparks.org. Copies were also available at the Main Branch of Richmond Public Library at 325 Civic Center Plaza, Richmond; and at the San Pablo Library at 2300 El Portal Drive # D, San Pablo; and the Parchester Village Community Center, 900 Williams Street, Richmond.

The public was advised of the availability of the Draft EIR through posting on and off the site in the project vicinity, and through a Notice of Availability mailed to owners and occupants of property within 300 feet of the site, as required by law.

3. Agency Review

According to CEQA, lead agencies are required to consult with public agencies having jurisdiction over a proposed project, and to provide the general public with an opportunity to comment on the environmental impact analysis that is prepared for a project. Several federal, State, and local agencies were contacted by EBRPD or through the Governor's Office of Planning and Research and sent a copy of the Draft EIR summary and/or a compact disk with the entire Draft EIR.

4. Community Meeting on Draft EIR

A community meeting on the Draft EIR was held on Thursday, March 22, at 7 p.m. at Parchester Village Community Center in Richmond. Additional verbal comments were received and recorded for inclusion in the Draft EIR. Responses to questions were provided at the meeting. Responses to comments are included in Chapter 5 of this Final EIR.

5. Public Hearing on Final EIR, Certification, and Project Adoption

A Public Hearing will be held at an EBRPD Board meeting following publication of this Final EIR. Certification of the EIR and adoption of the project will be considered at that meeting. Comments that concern the project description and project merits will be addressed through the staff report that will be made available at least three days prior to that meeting.

Notice of the meeting will be sent to the same parties that were notified of the publication of the Draft EIR and any additional parties that request notification.

C. Document Organization

This document is organized into the following chapters:

- Chapter 1: Introduction. This chapter discusses the use and organization of this Final EIR.
- Chapter 2: Draft EIR Summary. This chapter is a summary of the findings of the Draft EIR including corrections to the text of the Draft EIR. Underline text represents language that has been added to the EIR; text with ~~strikethrough~~ has been deleted from the EIR.
- Chapter 3: Revisions to the Draft EIR. Additional corrections to the text and graphics of the Draft EIR are contained in this chapter. Underline text represents language that has been added to the EIR; text with ~~strikethrough~~ has been deleted from the EIR.
- Chapter 4: List of Commenters. Names of organizations and individuals who commented on the Draft EIR are included in this chapter.
- Chapter 5: Comments and Responses. This chapter contains a tabular listing of each comment and responses to them; master responses to commonly-made comments; reproductions of the letters received from organizations and individuals on the Draft EIR; and transcripts of the public hearing.

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2 REPORT SUMMARY

This summary presents an overview of the analysis contained in the Draft EIR as originally presented in the Chapter 2 of that document, with corrections incorporated. The corrections are included in Chapter 3 in underline and ~~strikethrough~~ text.

This summary presents an overview of the analysis contained in this Draft EIR. The chapter summarizes the following: 1) the Project under review, 2) areas of controversy, 3) significant impacts and mitigation measures, 4) unavoidable significant impacts, and 5) alternatives to the Project. Additional detail on the proposed Project is provided in Chapter 3. Additional detail on the environmental impacts is provided in Chapter 4. Alternatives are described and evaluated in Chapter 5.

A. Project Under Review

1. Location and Setting

The 150-acre Breuner Marsh project area is the focus of the restoration and public access Project. It is located at Point Pinole, in the northwest part of the City of Richmond on the San Francisco Bay shoreline (see Figure 3-1). Breuner Marsh is bordered by Rheem Creek to the south and merges with Giant Marsh to the north. Approximately 120 acres of the recently purchased Breuner property, 30 acres of Giant Marsh and some additional upland areas of Point Pinole Peninsula, are the subject of the Proposed Project. Together they form an enlarged Point Pinole Regional Shoreline Park. This geographic context of the site is shown in more detail in Figure 3-2.

Union Pacific railroad tracks run along the eastern boundary of the property. East of the railroad tracks lies the residential community of Parchester Village. The Carr property, which is a separate parcel of 20 acres under private ownership, abuts the project area in the southeast corner. The shallow offshore area and two man-made spits within the boundaries of the Breuner property are owned by the State Lands Commission and are managed by EBRPD.

A Shell Oil petroleum pipeline, Pacific Gas & Electricity transmission lines, and a West County Sanitary District sanitary sewer force main cross parts of the project site on easements. Rheem Creek, a federal flood control channel, operated and maintained by the Contra Costa County Flood Control and Water Conservation District, under agreement with the U.S. Army Corps of Engineers, runs along the southern site margin.

2. Project Characteristics

The Proposed Project would involve the removal of the existing site structures, debris, and hazardous materials, and existing non-native vegetation, and re-grading of much of the southern portion of the site. Existing wetland areas would be enhanced by excavating new channels to connect them to the Bay and allow tidal flooding. Material removed from wetland areas would be used to build upland areas with gentle slopes and to create broad transitional zone habitat. The transitional zone would become a future tidal marsh as sea level rises in line with predictions. ~~Restoration of the mouth of Rheem Creek by lowering the level of the north bank to allow tidal flooding of the lower reaches would be a highly desirable project component. This remains an optional part of the Proposed Project, subject to cost and feasibility; however, it is evaluated in this EIR.~~

Following mass grading, areas would be re-vegetated with appropriate native plants, and weeded and irrigated as necessary to ensure that the plants become established. Non-native invasive *Spartina* (cordgrass) would be eradicated from existing tidal marsh areas before site grading. Predators, such as feral cats and red fox would be trapped to allow wildlife to gain ground and reestablish territory.

Two trails would be built across the project site to allow public access. The Main Trail, which would serve as a section of the Bay Trail, would run from the parking lot located in the south of the site, across a new bridge over Rheem Creek, to the east of the existing paved trail, run inland to the property boundary, and run parallel to the railroad tracks north to connect

with existing trails. The Main Trail would be paved and would cross slough and wetland areas by a variety of bridges and boardwalk segments.

The Spit Trail would diverge from the Main Trail to connect to the existing fishing spit. Although the Main Trail would be for bicycle and pedestrian access, the Spit Trail would be pedestrian only. A picnic area and rest area would be built by the side of the Main Trail and appropriate interpretative signs would be located at intervals along the trail.

3. Required Permits and Approvals

It is estimated that permits and/or approvals would be required from nine separate agencies. These are:

a. Federal Agencies

U.S. Fish and Wildlife Service – Consultation/Biological Opinion under Section 7 of Federal Endangered Species Act

U.S. Army Corps of Engineers – Permits for filling wetlands under Section 404 of the Clean Water Act; and Section 408 of the Rivers and Harbors Act for construction/restoration of Rheem Creek and bridge construction

U.S. Coast Guard – Bridge Construction

b. State Agencies

State Lands Commission – Public Trust Lands and Leases for construction of segment of Bay Trail in Giant Marsh

Department of Fish and Game – Section 1601 Streambed Alteration Agreement; and Section 2081 Agreement

c. County and Regional Agencies

San Francisco Bay Regional Water Quality Control Board (RWQCB) – Water Quality Certification under Section 401 of the Clean Water Act for wetland restoration

Bay Area Conservation and Development Commission (BCDC) – Permit for work in wetland areas and conformance with climate change policies

Contra Costa County Flood Control and Water Conservation District - Encroachment Permit for Rheem Creek bridge

d. Local Agencies
City of Richmond – Demolition, Grading, and Building Permits

In addition, small easements may be acquired from Shell Pipeline, Pacific Gas & Electric Company (PG&E), and Union Pacific Railroad in order to construct the Bay Trail along the chosen alignments.

B. Areas of Controversy

Public comments were received at the EIR scoping meeting held at Parchester Village Community Center on July 14, 2011. Issues raised that were pertinent to the scope of the EIR (and not to the project merits), and requests for information to be included in the EIR were as follows:

1. Hydrology/Flooding

- Flooding impacts on Parchester Village, the Carr property, pipelines, and sewer manholes.
- Effects of sea level rise on all resources.
- Inclusion of parcel map and watershed boundary map with all drainage shown.
- Quantification of runoff and impacts to existing drainage facilities and drainage problems in the downstream area.
- Flooding impacts from modification of Rheem Creek channel.

2. Hazards/Contamination

- Proximity of buried pipelines.
- Contamination on the Carr property and public availability of information.
- Lead contamination in the former Rheem Creek drainage.
- Possible migration of contaminated groundwater onto the project site.

3. Land Use

- Access to the Carr property, and utilities during and after construction.
- Inclusion of a wetland delineation for the project site.
- Possible conflicts with development of the Carr property that is zoned as office/flex.[1]
- Project impacts to the possibility of constructing a second bridge across the Creek for the Carr property.
- State Lands Jurisdiction over parts of the project site.

4. Recreation

- Access to Bay Trail after dark to allow commuting.
- Impacts to recreational resources (short-term and long-term).

5. Biological Resources

- Impacts to existing wetlands, wildlife habitat, and special-status species.
- Disturbance to birds during construction; bird populations on the transitional habitat.
- Sensitive species occurrence; invasive species; construction noise and wildlife impacts.

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[1] The City of Richmond has ~~proposed to redesignate~~ redesignated this land as ~~Open Space~~ Low Intensity Business/Light Industrial as part of the ~~pending~~ General Plan update. ~~However, this is currently in dispute~~.

- Rules on off-leash dogs and potential dog and human intrusion into marsh habitat with impacts to wildlife.
- Long-term preservation and restoration of native habitat.
- Possible impacts to wildlife, particularly rafting birds, from water users in small boats.
- Areas of existing coastal prairie that will be lost.

6. Cultural Resources
- Shellmound occurrences and impacts.

7. Air Quality
- Dust and fumes from project construction.
- Air Quality impacts from removal of the contaminated soil.

8. Greenhouse Gases
- Greenhouse gas emissions from project construction and operation.

C. Significant Impacts and Mitigation Measures

Significant Impacts and Mitigation Measures are summarized in Table 2-1.

D. Unavoidable Significant Impacts

Section 15126.2(b) of the CEQA Guidelines requires that an EIR identify any significant impacts that cannot be avoided, even with the implementation of feasible mitigation measures. No Significant and Unavoidable Impacts were found.

E. Alternatives to the Project

This CEQA review analyzes the following alternatives to the Proposed Project:

1. No Project Alternative

Under the No Project Alternative, the site would remain in its existing condition. There would continue to be no official public access, and signs and derelict fences would discourage, but not prevent, casual hikers, dogwalkers, birdwatchers, and fishers from using the site. The existing trail would provide a route as far as the debris mound east of the spit and to the spit itself. There would continue to be no through-route for bicycles on the Bay Trail from Richmond Parkway south of the site to Point Pinole.

The model airplane structures and runway would remain, although the BARCS lease, which will end in June 2012, would not be renewed. The debris mounds, contaminated soil, old fences, and scattered concrete blocks would remain. Through time, with sea level rise, the existing habitats close to the Bay would flood. Low marsh (cordgrass) would migrate to where high marsh (pickleweed) is found now. Tidal marsh habitat would replace today's transitional habitat and transitional habitat would be found in areas that are upland today. The man-made topographic features, such as the mounds that were originally building pads, and some of the drainage ditches, would become scattered islands and canals as a result of sea level rise.

2. Additional Tidal Marsh Acreage Alternative

The public access component of the Additional Tidal Habitat Alternative would be the same as the Proposed Project. A Bay Trail route and a smaller pedestrian-only spur to the spit would still be provided in a site cleared of debris and contamination. However, the restoration component of the project would differ in that, west of the trail in the south of the site, the site would be excavated to a greater depth, with a steeper slope than the Project. Both the Project and Additional Tidal Habitat Alternative would require the removal of a small amount of contaminated soil, concrete, fill, and the import of some aggregate base for the parking area and trails. With these exceptions,

there would be a zero balance of sediment, with no net import or export from the site for both the Additional Tidal Habitat Alternative and the Proposed Project.

Under the Additional Tidal Habitat Alternative there would be larger areas of tidally connected wetlands, instead of transitional habitat and uplands with seasonal wetlands. On project completion, there would therefore be a reduced area of transitional habitat and seasonal wetlands, but an increased area of tidal wetlands compared to the Proposed Project. With sea level rise, the area of tidal wetland would increase at the expense of some transition zone habitat. Although on project construction the Additional Tidal Habitat Alternative would have more acres of tidal marsh than the Proposed Project, the Proposed Project would add acres at a faster rate until eventually the Additional Tidal Marsh Habitat Alternative would have fewer acres of tidal marsh than the Proposed Project.

3. Environmentally Superior Alternative

In the long term, over the next century, the Proposed Project would prove to be the Environmentally Superior Alternative.

United States Environmental Protection Agency

Office of Water (4601)

EPA 815-B-06-002
January 2006

INITIAL DISTRIBUTION SYSTEM EVALUATION GUIDANCE MANUAL

FOR THE FINAL STAGE 2 DISINFECTANTS AND DISINFECTION BYPRODUCTS RULE

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Note on the Initial Distribution System Evaluation Guidance Manual for the Final Stage 2 Disinfectants and Disinfection Byproducts Rule

Purpose:

The purpose of this guidance manual is solely to provide technical information for water systems and states to assist them in complying with the Initial Distribution System Evaluation (IDSE), a component of the Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR). This guidance is not a substitute for applicable legal requirements, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on any party, including EPA, states, or the regulated community. Interested parties are free to raise questions and objections to the guidance and the appropriateness of using it in a particular situation. Although this manual describes many methods for complying with IDSE requirements, the guidance presented here may not be appropriate for all situations, and alternative approaches may provide satisfactory performance. The mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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Acronyms

CBI	Confidential Business Information
CWS	Community water system
DBP	Disinfection byproduct
DBPR	Disinfectants and Disinfection Byproducts Rule
EPA	U.S. Environmental Protection Agency
EPS	Extended period simulation
FOIA	Freedom of Information Act
GIS	Geographic information system
GWUDI	Ground water under the direct influence of surface water
HAA	Haloacetic acid
HAA5	The sum of five HAA species
HPC	Heterotrophic plate count
ICR	Information Collection Rule
IDSE	Initial distribution system evaluation
IPMC	Information Processing and Management Center
LRAA	Locational running annual average
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
MCL	Maximum contaminant level
M-DBP	Microbial and disinfection byproduct
NOM	Natural organic matter
NPDWR	National Primary Drinking Water Regulation
NTNCWS	Nontransient noncommunity water system
PWS	Public water system
PWSID	Public water system identification number
SDWA	Safe Drinking Water Act
SSS	System-specific study
STEP	Simple Tools for Effective Performance
SUVA	Specific ultraviolet absorbance
SWTR	Surface Water Treatment Rule
TCR	Total Coliform Rule
THM	Trihalomethane
TOC	Total organic carbon
TNCWS	Transient noncommunity water system
TTHM	Total trihalomethanes
TTHMFP	Total trihalomethane formation potential
UV	Ultraviolet light
VSS	Very small system

Definitions

Aquifer: a geological formation composed of rock, gravel, sand, or other porous material that yields water to wells or springs.

Biodegradation: a biological process where HAA5s are broken down into smaller compounds by microbes.

Booster disinfection: the practice of adding disinfectant in the distribution system to maintain disinfectant residual concentration throughout the distribution system.

Combined distribution system: the interconnected distribution system consisting of the distribution systems of wholesale systems and of the consecutive systems that receive finished water. 40 CFR 141.2

Community water system: a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents. 40 CFR 141.2

Consecutive system: a public water system that receives some or all of its finished water from one or more wholesale systems. Delivery may be through a direct connection or through the distribution system of one or more consecutive systems. 40 CFR 141.2

Disinfectant: any oxidant, including but not limited to chlorine, chlorine dioxide, chloramines, and ozone added to water in any part of the treatment or distribution process, that is intended to kill or inactivate pathogenic microorganisms. 40 CFR 141.2

Disinfectant residual concentration: the concentration of disinfectant that is maintained in a distribution system. Disinfectant could be free chlorine (the sum of the concentrations of hypochlorous acid (HOCl) and hypochlorite (OCl^-)) or combined chlorine (chloramines). It is used in Surface Water Treatment Rule as a measure for determining CT.

Disinfection: a process which inactivates pathogenic organisms in water by chemical oxidants or equivalent agents. 40 CFR 141.2

Disinfection byproduct (DBP): compound formed from the reaction of a disinfectant with organic and inorganic compounds in the source or treated water during disinfection and distribution.

Dual Sample set: a set of two samples collected at the same time and same location, with one sample analyzed for TTHM and the other sample analyzed for HAA5. Dual sample sets are collected for the purpose of conducting an IDSE under subpart U and determining compliance with the TTHM and HAA5 MCLs under subpart V. 40 CFR 141.2

Entry Point: the point(s) where finished water first enters the distribution system from one or more sources. Samples taken at these points represent minimum residence time in the distribution system.

Finished Water: water that is introduced into the distribution system of a public water system and is intended for distribution and consumption without further treatment, except as treatment necessary to maintain water quality in the distribution system (e.g., booster disinfection, addition of corrosion control chemicals). 40 CFR 141.2

GAC10: granular activated carbon filter beds with an empty-bed contact time of 10 minutes based on average daily flow and a carbon reactivation frequency of every 180 days, except that the reactivation frequency for GAC10 used as a best available technology for compliance with subpart V MCLs under §141.64(b)(2) shall be 120 days. 40 CFR 141.2

GAC20: granular activated carbon filter beds with an empty-bed contact time of 20 minutes based on average daily flow and a carbon reactivation frequency of every 240 days. 40 CFR 141.2

Ground water system: public water systems that use ground water only or purchase ground water from other systems (40 CFR 141.2). For the purposes this guidance manual, ground water systems refers to the subset of systems that disinfect their water, or purchase disinfected ground water, even if they do not apply any additional treatment.

Ground water under the direct influence of surface water (GWUDI): any water beneath the surface of the ground with significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as *Giardia lamblia*, or *Cryptosporidium*, or significant and relative rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions. Direct influence must be determined for individual sources in accordance with criteria established by the State. The State determination of direct influence may be based on site-specific measurements of water quality and/or documentation of well construction characteristics and geology with field evaluation. 40 CFR 141.2

Haloacetic acid (HAA): one of the family of organic compounds named as a derivative of acetic acid, wherein one to three hydrogen atoms in the methyl group in acetic acid are each substituted by a halogen atom (namely, chlorine and bromine) in the molecular structure.

Haloacetic acids (five) (HAA5): the sum of the concentrations in milligrams per liter of the haloacetic acid compounds (monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid), rounded to two significant figures after addition. 40 CFR 141.2

Heterotrophic plate count (HPC): a procedure for estimating the number of heterotrophic bacteria in water, measured as the number of colony forming units per 100 mL.

Information Processing and Management Center (IPMC): a receiving, processing, and mailing facility with a web-based data management system that allows EPA and states to access, track, and respond to IDSE submissions.

Influence zone: the portions of the distribution system supplied with water from a particular source of supply.

Locational running annual average (LRAA): the average of sample results taken at a particular monitoring location during the previous four calendar quarters. 40 CFR 141.2

Maximum contaminant level (MCL): the maximum permissible level of a contaminant in water which is delivered to any user of a public water system. 40 CFR 141.2

Maximum contaminant level goal (MCLG): the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and which allows an adequate margin of safety. Maximum contaminant level goals are nonenforceable health goals. 40 CFR 141.2

Mixing Zone: an area in the distribution system where water flowing from two or more different sources blend.

Monitoring site: the location where samples are collected.

Non-community water system: a public water system that is not a community water system. A non-community water system is either a "transient non-community water system (TNCWS)" or a "non-transient non-community water system (NTNCWS) 40 CFR 141.2

Non-transient non-community water system (NTNCWS): a public water system that is not a community water system and that regularly serves at least 25 of the same persons over 6 months per year. 40 CFR 141.2

Population served: the retail number of people served by a water system. Systems typically work with their State to determine population served for compliance purposes. Note that IDSE and Stage 2 compliance monitoring requirements (e.g., number of samples and sampling frequency) are based on the population served by the water system. IDSE and Stage 2 compliance monitoring schedules, however, are based on the largest population served by systems in the combined distribution system. If you do not know the population of your system, ask your state.

Public water system (PWS): a system for the provision to the public of water for human consumption through pipes or, after August 5, 1998, other constructed conveyances, if such system has at least fifteen service connections or regularly serves an average of at least twenty-five individuals daily at least 60 days out of the year. Such term includes: any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system; and any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system. Such term does not include any "special irrigation district." A public water system is either a "community water system" or a "noncommunity water system. 40 CFR 141.2

Residence time: the time period lasting from when the water is treated to a particular point in the distribution system. Also referred to as water age.

Residual disinfection: also referred to as "secondary disinfection." The process whereby a disinfectant (typically Chlorine or Chloramines) is added to finished water in order to maintain a disinfection residual in the distribution system.

State: the agency of the State or Tribal government which has jurisdiction over public water systems. During any period when a State or Tribal government does not have primary enforcement responsibility pursuant to Section 1413 of the Safe Drinking Water Act, the term "State" means the Regional Administrator, U.S. Environmental Protection Agency. 40 CFR 141.2

Subpart H systems: public water systems using surface water or ground water under the direct influence of surface water as a source that are subject to the requirements of 40 CFR 141.2 (H). 40 CFR 141.2

Surface water: all water which is open to the atmosphere and subject to surface runoff. 40 CFR 141.2

Total chlorine residual: the sum of combined chlorine (chloramine) and free available chlorine residual.

Total trihalomethanes (TTHM): the sum of the concentration in milligrams per liter of the trihalomethane compounds (trichloromethane [chloroform], dibromochloromethane, bromodichloromethane, and tribromomethane [bromoform]), rounded to two significant figures. 40 CFR 141.2

Tracer study: a procedure for estimating hydraulic properties of the distribution system, such as residence time. Where more than one water source feeds the distribution system, tracer studies can be used to determine the zone of influence of each source.

Transient Non-Community Water System (TNCWS): a non-community water system that does not regularly serve at least 25 of the same persons over six months per year. 40 CFR 141.2

Trihalomethane (THM): one of the family of organic compounds named as derivatives of methane, wherein three of the four hydrogen atoms in methane are each substituted by a halogen atom in the molecular structure. 40 CFR 141.2

Water distribution system model: a computer program that can simulate the hydraulic, and in some cases, water quality behavior of water in a distribution system.

Wholesale system: a public water system that treats source water as necessary to produce finished water and then delivers some or all of that finished water to another public water system. Delivery may be through a direct connection or through the distribution system of one or more consecutive systems. 40 CFR 141.2

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1.0 Introduction

This chapter covers:

1.1 Getting Started (*Read this Section First*)
1.2 Overview of IDSE Options
1.3 IDSE Schedule
1.4 Early Implementation Process
1.5 Changes to IDSE Requirements Since the Proposed Stage 2 DBPR

The Administrator of the EPA signed the Stage 2 Disinfectants and Disinfection Byproducts Rule (DBPR) on December 15, 2005, and it was published in the Federal Register on January 4, 2006 (71 FR 388). This rule applies to all community and non-transient noncommunity water systems that provide disinfected water (other than water disinfected only by Ultraviolet [UV] light) to their customers. The rule has two primary sections. Subpart U is referred to as the Initial Distribution System Evaluation (IDSE) section. The requirements of this part of the rule are discussed in this manual. Subpart V, the Stage 2 Disinfection Byproducts Requirements, is referred to as Stage 2 Compliance Monitoring in this guidance manual. Stage 2 Compliance Monitoring Requirements are an extension of the Stage 1 DBPR. Note that systems that are exempt from the IDSE portion of the rule may not be exempt from the Stage 2 Compliance Monitoring section.

EPA developed this **Initial Distribution System Evaluation Guidance Manual** to help systems meet the IDSE requirements of the Stage 2 DBPR. System personnel should start by reading Section 1.1 to answer basic questions about the IDSE, select the appropriate guidance materials to meet IDSE requirements, and get instructions on how to use this manual.

1.1 Getting Started

Read this Section First

1.1.1 What is the IDSE? What is its purpose?

IDSEs are an important part of the Stage 2 DBPR. They are one-time studies conducted by water systems to identify distribution system locations with high concentrations of trihalomethanes (THMs) and haloacetic acids (HAAs). Water systems will use results from the IDSE, in conjunction with their Stage 1 DBPR compliance monitoring data, to select compliance monitoring locations for the Stage 2 DBPR.

1.1.2 Do I have to conduct an IDSE?

You are subject to the IDSE requirements of the Stage 2 DBPR if you meet the following criteria:

- You use a primary or residual disinfectant other than ultraviolet light (UV), or you are a consecutive system that delivers water that has been treated with a primary or residual disinfectant other than UV.

AND

- You are a community water system (CWS) of any size, or you are a non-transient non-community water system (NTNCWS) that serves $\geq$ 10,000 people.

IDSE requirements do not apply to NTNCWSs serving fewer than 10,000 people, although these systems have other requirements under the Stage 2 DBPR. Transient non-community water systems (TNCWSs) *are not* subject to any part of the Stage 2 DBPR.

There are **four options** systems can use to comply with the IDSE requirements of the Stage 2 DBPR:

- Qualify for a Very Small System (VSS) Waiver
- Meet 40/30 Certification requirements
- Conduct a System Specific Study (SSS) using existing monitoring results or a distribution system hydraulic model
- Conduct Standard Monitoring

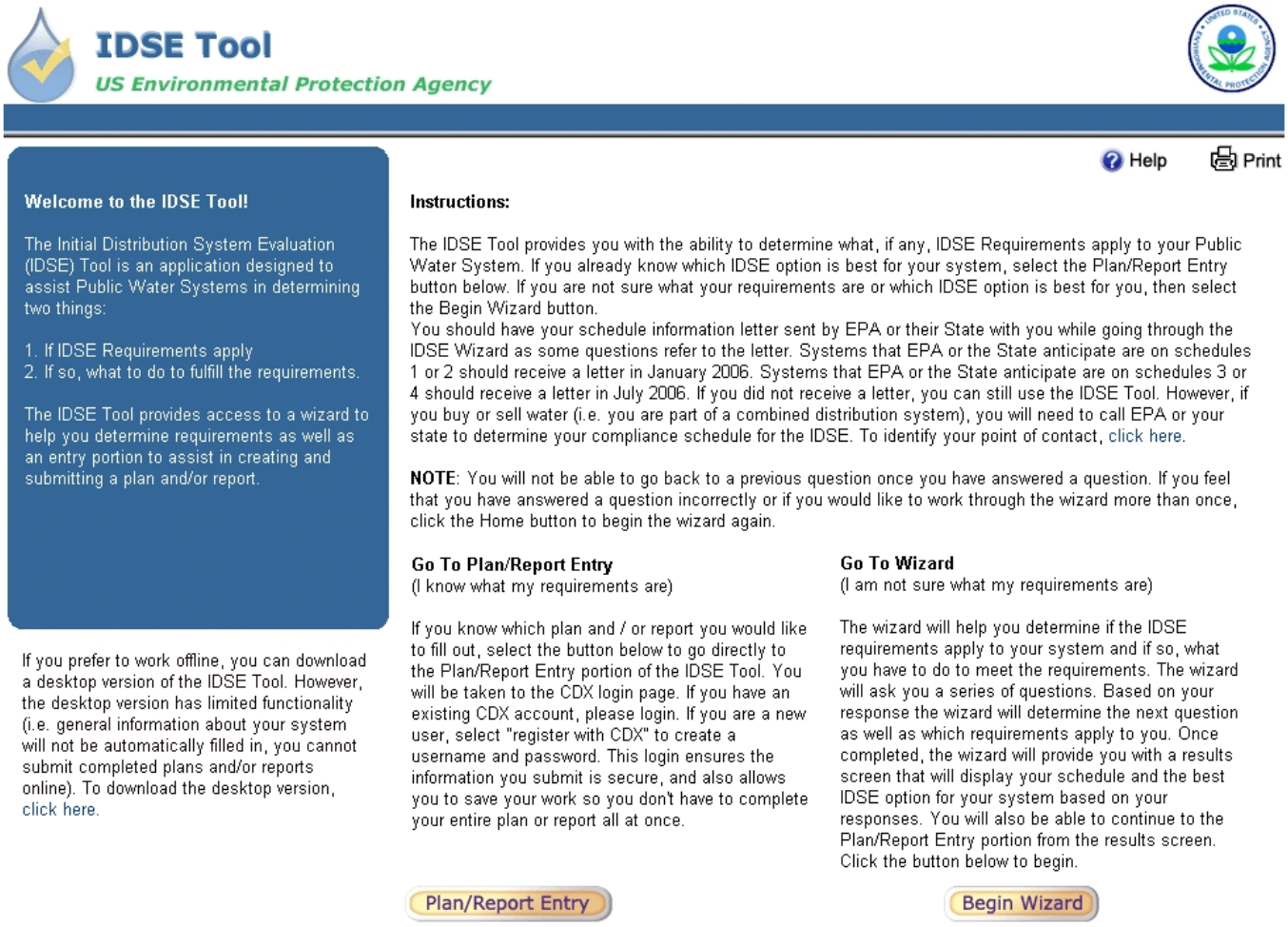
The four options are described briefly in Section 1.2 of this chapter, with further details provided in the remainder of this guidance manual.

1.1.3 What guidance materials are available for the IDSE?

EPA has developed two guidance manuals and an on-line tool to help you comply with the IDSE requirement. This manual is comprehensive and includes IDSE requirements and technical guidance for all system sizes and types and all IDSE options, designed for easy access to specific modules. The second manual, entitled the *Initial Distribution System Evaluation Guide for Systems Serving < 10,000 People*, is targeted to smaller systems and focuses on information they are most likely to use. It provides examples to help smaller systems as they proceed with satisfying IDSE requirements. It does not, however, discuss the IDSE SSS options.

EPA has also developed the **IDSE Tool,** available on-line at http://www.epa.gov/safewater/disinfection/stage2 and on CD. The IDSE tool walks systems through the entire IDSE process, and it can be used in place of the IDSE guidance manuals. It contains a **Wizard** you can use to determine your requirements and select the best IDSE option for your system. The tool then creates **Custom Forms** for your system size and type that can be submitted electronically for EPA or state review. See Section 1.4 for more information. Exhibit 1.1 shows the IDSE Tool home page.

Exhibit 1.1 IDSE Tool Home Page



IDSE Tool

US Environmental Protection Agency

Help Print

Welcome to the IDSE Tool!

The Initial Distribution System Evaluation (IDSE) Tool is an application designed to assist Public Water Systems in determining two things:

1. If IDSE Requirements apply
2. If so, what to do to fulfill the requirements.

The IDSE Tool provides access to a wizard to help you determine requirements as well as an entry portion to assist in creating and submitting a plan and/or report.

If you prefer to work offline, you can download a desktop version of the IDSE Tool. However, the desktop version has limited functionality (i.e. general information about your system will not be automatically filled in, you cannot submit completed plans and/or reports online). To download the desktop version, click here.

Instructions:

The IDSE Tool provides you with the ability to determine what, if any, IDSE Requirements apply to your Public Water System. If you already know which IDSE option is best for your system, select the Plan/Report Entry button below. If you are not sure what your requirements are or which IDSE option is best for you, then select the Begin Wizard button.
You should have your schedule information letter sent by EPA or their State with you while going through the IDSE Wizard as some questions refer to the letter. Systems that EPA or the State anticipate are on schedules 1 or 2 should receive a letter in January 2006. Systems that EPA or the State anticipate are on schedules 3 or 4 should receive a letter in July 2006. If you did not receive a letter, you can still use the IDSE Tool. However, if you buy or sell water (i.e. you are part of a combined distribution system), you will need to call EPA or your state to determine your compliance schedule for the IDSE. To identify your point of contact, click here.

NOTE: You will not be able to go back to a previous question once you have answered a question. If you feel that you have answered a question incorrectly or if you would like to work through the wizard more than once, click the Home button to begin the wizard again.

Go To Plan/Report Entry
(I know what my requirements are)

If you know which plan and / or report you would like to fill out, select the button below to go directly to the Plan/Report Entry portion of the IDSE Tool. You will be taken to the CDX login page. If you have an existing CDX account, please login. If you are a new user, select "register with CDX" to create a username and password. This login ensures the information you submit is secure, and also allows you to save your work so you don't have to complete your entire plan or report all at once.

Plan/Report Entry

Go To Wizard
(I am not sure what my requirements are)

The wizard will help you determine if the IDSE requirements apply to your system and if so, what you have to do to meet the requirements. The wizard will ask you a series of questions. Based on your response the wizard will determine the next question as well as which requirements apply to you. Once completed, the wizard will provide you with a results screen that will display your schedule and the best IDSE option for your system based on your responses. You will also be able to continue to the Plan/Report Entry portion from the results screen. Click the button below to begin.

Begin Wizard

The *IDSE Guidance Manual*, the *IDSE Guide for Systems Serving < 10,000 People*, and the IDSE Tool address only IDSE requirements and DO NOT cover other provisions of the Stage 2 DBPR. For additional guidance on implementing the Stage 2 DBPR, you can refer to the following EPA materials:

- *The Stage 2 DBPR Quick Reference Guide*
- *Stage 2 Disinfectant and Disinfection Byproducts Rule: Small Entity Compliance Guide – One of the Simple Tools for Effective Performance (STEP) Guide Series (draft version)*

EPA will be releasing draft versions of additional Stage 2 DBPR guidance manuals soon, including *The Consecutive Systems Guidance Manual*, *The Simultaneous Compliance Guidance Manual*, and *The Operational Evaluation Guidance Manual*. Your state may have additional, state-specific materials to assist you in complying with the Stage 2 DBPR.

1.1.4 How can I get copies of EPA guidance materials?

- You can download guidance manuals and fact sheets from EPA's Web site at http://www.epa.gov/safewater/disinfection/stage2.
- You can call the Safe Drinking Water Hotline at 1-800-426-4791
- You can call the National Service Center for Environmental Publications at 1-800-490-9198 or visit their Web site at http://www.epa.gov/ncepihom.

Also, you may wish to contact your state drinking water program office for additional guidance.

1.1.5 How do I use this guidance manual?

To help you find information quickly, EPA has designed this manual in a **modular format**. While Chapters 1 and 2 contain information for all systems, Chapters 3, 4, 5, 6 and 7 each contain comprehensive requirements for a specific IDSE option. Appendices are organized similarly. The first three appendices include general information for all systems. Appendix D addresses consecutive and wholesale system issues. Appendices E through H provide examples for specific IDSE options. Exhibit 1.2 shows which chapters and appendices you should use for the different IDSE options.

EPA recommends that once you have read the introductory materials in Chapter 1, you use the **flowchart in Chapter 2** to determine the best IDSE option for your system. Then you can go to the chapter and appendices addressing your IDSE option and skip the rest of the manual. If you are accessing this guidance manual electronically, you can download only those chapters and appendices that you need to build a custom manual for your system.

Remember that **the IDSE Tool does these steps for you**. The IDSE Tool Wizard asks questions about your system and, based on your answers, extracts the appropriate requirements summary sheet and guidance manual material.

IDSE Tool

Chapter 2 contains **requirements summary sheets** for each IDSE option and compliance schedule. These sheets contain compliance deadlines for IDSE submissions and other important information. EPA recommends that you make a copy of your requirements summary sheets (or if you are accessing the manual electronically, print them out) and keep them handy throughout the IDSE process.

Exhibit 1.2a IDSE Guidance Manual Chapters and Appendices

Chapters

1 Introduction

2 Determining Your IDSE Schedule and Option

3* Very Small System Waiver

4* 40/30 Certification

5* System Specific Study Using Existing Monitoring Results

6* System Specific Study Using a Distribution System Hydraulic Model

7* Standard Monitoring

Appendices

A Factors Affecting DBP Formation

B Stage 2 DBPR and LT2ESWTR Compliance Schedule

C TTHM and HAA5 Sampling Protocol

D Consecutive and Wholesale System Issues

E Example System Specific Study using Existing Monitoring Results for a Surface Water System Serving 40,000 People

F Example System Specific Study Using a Hydraulic Model for a Surface Water System Serving 55,000 People

G Complex Modeling Analysis Example for a System with Multiple Sources

H Example IDSE Standard Monitoring Plan and Report for a Surface Water System Serving 160,000 People

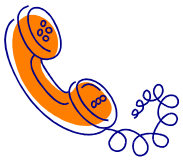
I Example IDSE Standard Monitoring Plan and Report for a Ground Water System Serving 200,000 People

* You need **one** of these Chapters for the IDSE

Exhibit 1.2b Building a Custom IDSE Guidance Manual for Your System

All Systems	Chapter 1 Chapter 2 Appendix A Appendix B
PLUS	
Systems qualifying for the VSS Waiver	Chapter 3
Systems qualifying for 40/30 Certification	Chapter 4
Systems conducting an SSS using existing monitoring results	Chapter 5 Appendix E
Systems conducting an SSS using a model	Chapter 6 Appendix C Appendix F Appendix G
Systems conducting standard monitoring	Chapter 7 Appendix C Appendix H Appendix I
PLUS	
Consecutive and wholesale systems only	Appendix D

1.1.6 Whom do I call with questions?



Because compliance activities begin soon after the Stage 2 DBPR is finalized, EPA and states will be working together to implement the IDSE. In some cases, EPA will be your main point of contact during the first phases of the IDSE. In other cases, your state will be your main point of contact.

To identify your point of contact for the IDSE, visit EPA's website at http://www.epa.gov/safewater/disinfection/stage2. The website contains a list of contact numbers for the IDSE by state. You can also call the EPA SDWA hotline at 1-800-426-4791 for this information. Refer to Section 1.4 of this chapter for more information on how the IDSE will be implemented.

1.2 Overview of IDSE Options

There are four options available to systems to meet IDSE requirements. Your option will depend on your technical resources, existing monitoring results, size, and preference. The four options are described briefly below, with further details provided in the remainder of this guidance manual.

- **Very Small System (VSS) Waiver**. Systems serving fewer than 500 people that have TTHM and HAA5 data automatically receive the VSS waiver unless they are notified by EPA or their state that they must conduct an IDSE. Systems receiving the VSS waiver have no further IDSE requirements.

- **40/30 Certification**. Systems can fulfill the IDSE requirements by certifying that all individual TTHM and HAA5 monitoring results for compliance with the Stage 1 DBPR are less than or equal to 0.040 mg/L for TTHM and 0.030 mg/L for HAA5 during a prescribed 2-year time period. In addition, the system must not have had any Stage 1 DBPR monitoring violations for TTHM and HAA5 during the same period. The system must submit the required 40/30 certification and, unless told otherwise by EPA or their state, they have no further requirements under the IDSE.

- **System Specific Study (SSS)**. Systems can meet IDSE requirements using existing monitoring results or a distribution system hydraulic model if their data or model meet certain minimum criteria. Systems conducting an SSS must prepare an SSS plan and IDSE report. Existing monitoring requirements were developed to be equivalent to standard monitoring.

- **Standard Monitoring**. Any system can choose to conduct standard monitoring, even if they receive a VSS, qualify for the 40/30 certification, or have enough data to conduct an SSS. Standard monitoring entails 1 year of distribution system monitoring at multiple locations (in addition to Stage 1 DBPR monitoring). The required sampling frequency and minimum number of sample locations depend on

population served and source water type. Systems conducting standard monitoring must prepare a standard monitoring plan and IDSE report.

1.3 IDSE Schedule

IDSE activities begin soon after the Stage 2 DBPR is finalized. Appendix B provides the overall schedule for the Stage 2 DBPR and Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) to show how the IDSE fits into the overall compliance schedule for both rules. Exhibit 1.3 shows a more detailed schedule for IDSE activities only. Note that the schedule is staggered by system size, and that the schedule for **consecutive and wholesale systems** is based on the population served by the largest system in the combined distribution system. Guidance for determining your schedule is in Chapter 2.

1.4 Early Implementation Process

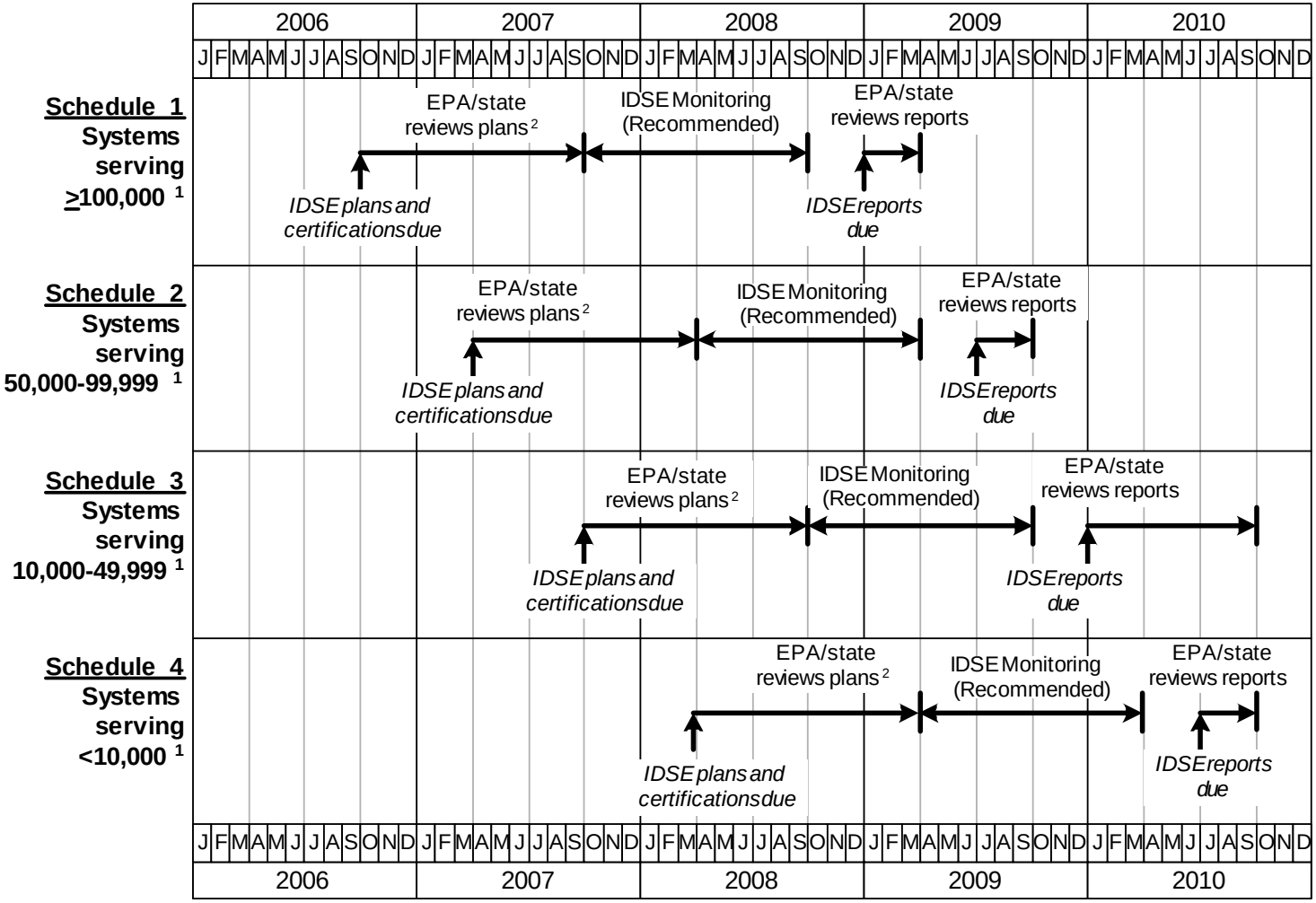
Because IDSE activities begin soon after the Stage 2 DBPR is finalized, EPA and states will be working together to implement the IDSE. To facilitate review and processing of IDSE submissions, EPA has created the **Information Processing and Management Center (IPMC)**. The IPMC is both a receiving facility and a web-based data management system that allows EPA and states to access, track, and respond to IDSE submissions.

The IPMC is password protected and accessible only by EPA and state drinking water representatives. IDSE submissions will not, however, be considered confidential business information (CBI) and are subject to the Freedom of Information Act (FOIA). ***Therefore, your IDSE submissions should not contain information that poses a security risk to your system.*** Chapters 5, 6, and 7 of this manual provide guidelines on the kinds of information you may want to exclude from your distribution system schematic for security reasons.

One advantage of the IPMC is that it provides a one-stop location for IDSE submissions. Regardless of whether EPA or your state is reviewing your IDSE materials, all submissions go to the same address. See Exhibit 1.4 on page 1-10 for ways in which you can submit IDSE materials to the IPMC. EPA and/or your state will review your IDSE plan and report. If they have concerns regarding your submission, they will work with you to resolve those issues during the one year review period.

If you have questions during the IDSE, you should visit EPA's website at http://www.epa.gov/safewater/disinfection/stage2 to determine the contact name and phone number for the IDSE for your state. You can also call the Safe Drinking Water Hotline at 1-800-426-4791 for this information.

Exhibit 1.3 Staggered Schedule for the IDSE



[1] For consecutive and wholesale systems, the schedule is based on the population served by the largest system in a combined distribution system.
[2] Communication with the system is included in the EPA/state review period.

Exhibit 1.4 Options for Submitting IDSE Material to EPA and States Through the IPMC [1]

Option 1	Option 2	Option 3
Use the **IDSE Tool** to submit completed certifications, plans and reports electronically	Mail paper copies of submissions to: STAGE 2 DBPR US EPA-IPMC P O Box 98 Dayton, OH 45401-0098	E-mail electronic submissions as attachments to: *stage2mdbp@epa.gov*

Notes:
1. You can use one of these three options to submit IDSE materials to the IPMC.

The IPMC accepts a variety of electronic formats:

- Adobe PDF file (*.pdf)
- Microsoft Word (*.doc)
- WordPerfect (*.wpd)
- Image files (*.gif, *.bmp, *.jpg, *.jpeg)
- Microsoft Excel (*.xls)
- Text file (*.txt)

1.5 Changes to IDSE Requirements Since the Proposed Stage 2 DBPR

Several changes have been made to the IDSE requirements since the publication of the proposed Stage 2 DBPR on August 18, 2003. Many of these changes are in response to public comment received on the proposed rule and are intended to facilitate implementation. These changes, which are discussed in more detail below, include:

- Change from plant-based to population-based monitoring for all systems
- Change in definition of consecutive systems
- Staggered IDSE schedule
- Changes to VSS waivers
- Change in 40/30 requirements
- Clarification to the IDSE SSS option
- Elimination of Stage 2A

Change from plant-based to population-based monitoring for all systems

The Stage 2 DBPR proposal included population-based monitoring requirements for consecutive systems that purchase all of their water. For all other systems, plant-based

monitoring requirements were proposed. The plant-based approach, consistent with Stage 1 DBPR compliance monitoring requirements, is grounded in the assumption that larger systems have more treatment plants and thus greater system complexity. While this is generally true, the plant-based approach created disproportionately burdensome monitoring requirements for some systems where the number of plants did not correlate with system size, such as larger systems with only a few very large plants or smaller systems with many disinfecting wells. Moreover, a plant-based approach can complicate monitoring of purchased water systems, particularly complex ones with multiple connections.

For these reasons, EPA has developed population-based compliance monitoring requirements for all systems for the final Stage 2 DBPR. EPA believes that the new population-based approach makes monitoring requirements simpler and more equitable for systems of the same size and type.

Change in definition of consecutive system

For the Stage 2 DBPR proposal, the definition for consecutive systems specified the minimum length of time (60 days) a system must receive water from a wholesale system to be considered a consecutive system. EPA received public comments on this definition. Several commenters expressed concerns with including a time period of water delivery that defined whether a system was a consecutive system or wholesale system. This change was also made due to the change to population based monitoring because it is no longer necessary to define consecutive system entry points as it was under plant based monitoring. EPA has dropped this requirement from the final rule and has provided some flexibility for states to determine which systems are part of a combined distribution system (without presenting a time criterion).

Staggered IDSE schedule

EPA has modified the proposed compliance schedule to stagger deadlines for CWSs and NTNCWSs serving 10,000 to 99,999 people to allow for a more evenly distributed workload and greater opportunity for EPA and state involvement. The final compliance schedule includes a formal review period for EPA and/or state review of IDSE plans and 40/30 certifications as well as IDSE reports. The staggered schedule also provides time for analytical laboratories to build up capacity as necessary to accommodate the sample analysis needs of systems. The new IDSE plan and IDSE report submission dates are shown in Exhibit 1.3. It is important to note that, as in the proposal, smaller systems may have to comply on an earlier schedule than indicated for their individual system size if they are part of a combined distribution system that includes a large system. This is discussed further in Chapter 2.

*Changes to VSS waiver*s

The final rule grants a waiver from the IDSE requirements to community water systems serving fewer than 500 people that have taken TTHM and HAA5 samples. This provision was changed from the proposal to reflect that most small systems have sampling locations that are representative of both high TTHM and high HAA5 because they have small and simple

distributions systems. In addition, many very small systems are ground water systems which typically have stable DBP levels (ground water systems tend to have lower DBP levels than surface water systems). EPA recognizes, however, that there may be some small systems with extended or complex distribution systems that should be studied further to determine new sampling locations. For this reason, EPA or a state can contact a very small system and require them to conduct an IDSE.

Change in 40/30 requirements

The reporting requirements for the 40/30 certification option have been reduced from the requirements in the proposed Stage 2 DBPR. In the proposal, systems qualifying for the 40/30 certification were required to submit all qualifying data and provide recommendations for Stage 2 compliance monitoring locations. The final rule requires systems to submit a certification that their data meets all the requirements of the 40/30 certification and to include their Stage 2 compliance monitoring recommendations in their Stage 2 compliance monitoring plan. These changes were made to reduce the reporting burden on systems that qualify for the 40/30 certification and to maintain consistency with monitoring plan requirements under the Stage 1 DBPR. This approach also gives systems more time to select appropriate monitoring sites for Stage 2 compliance monitoring. EPA or the state may request systems to submit the data, a distribution system schematic, and/or recommendations for Stage 2 compliance monitoring as part of the 40/30 certification.

Clarification to the IDSE SSS option

The final rule includes more specific requirements than the proposal regarding how systems can use distribution system hydraulic models and existing monitoring results for the IDSE SSS. This change was made to help systems better understand expectations under this provision and lessen the chances of an SSS plan not being approved. The new modeling requirements reflect that distribution system hydraulic models can appropriately identify monitoring locations by predicting water age in distribution systems if they meet certain minimum requirements. Existing monitoring results requirements are equivalent to Standard Monitoring requirements, except they apply to data already collected.

Elimination of Stage 2A

The Stage 2 DBPR proposal included a phased-in approach to calculating compliance with MCLs using a Locational Running Annual Average (LRAA), referred to as Stage 2A and Stage 2B which coincided with the IDSE period. EPA received public comments that found this confusing, and this provision is no longer in the final rule. What was referred to in the proposal as Stage 2B compliance monitoring is now referred to as Stage 2 Compliance Monitoring.

PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY. You may report some or all of this information on separate sheets (*use the same format*) instead of completing these pages.
SEE INSTRUCTIONS.

EPA I.D. NUMBER (*copy from Item 1 of Form 1*)
CAT0080033822

V. INTAKE AND EFFLUENT CHARACTERISTICS *(continued from page 3 of Form 2-C)*

OUTFALL NO.
E-003

PART A –You must provide the results of at least one analysis for every pollutant in this table. Complete one table for each outfall. See instructions for additional details.

1. POLLUTANT	2. EFFLUENT							3. UNITS (*specify if blank*)		4. INTAKE (*optional*)		
	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
a. Biochemical Oxygen Demand (*BOD*)	23.2	79.6			16.65	44.7	7	mg/L	kg/day			
b. Chemical Oxygen Demand (*COD*)												
c. Total Organic Carbon (*TOC*)	30.2	411.1			21.2	104.4	8	mg/L	kg/day			
d. Total Suspended Solids (*TSS*)	213	657.7			80.5	253.2	8	mg/L	kg/day			
e. Ammonia (*as N*)	1.6	12.5			0.98	4.08	8	mg/L	kg/day			
f. Flow	VALUE 8.496		VALUE 3.6		VALUE 1.26		8	MGD		VALUE		
g. Temperature (*winter*)	VALUE		VALUE		VALUE			°C		VALUE		
h. Temperature (*summer*)	VALUE		VALUE		VALUE			°C		VALUE		
i. pH	MINIMUM 6.90	MAXIMUM 7.36	MINIMUM 6.90	MAXIMUM 7.36				STANDARD UNITS				

PART B – Mark "X" in column 2-a for each pollutant you know or have reason to believe is present. Mark "X" in column 2-b for each pollutant you believe to be absent. If you mark column 2a for any pollutant which is limited either directly, or indirectly but expressly, in an effluent limitations guideline, you must provide the results of at least one analysis for that pollutant. For other pollutants for which you mark column 2a, you must provide quantitative data or an explanation of their presence in your discharge. Complete one table for each outfall. See the instructions for additional details and requirements.

1. POLLUTANT AND CAS NO. (*if available*)	2. MARK "X"		3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. BELIEVED PRESENT	b. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
			(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
a. Bromide (24959-67-9)														
b. Chlorine, Total Residual														
c. Color														
d. Fecal Coliform	X		20,000				1,894		8	cfu/100mL				
e. Fluoride (16984-48-8)														
f. Nitrate-Nitrite (*as N*)														

CONTINUE ON REVERSE

ITEM V-B CONTINUED FROM FRONT

1. POLLUTANT AND CAS NO. (*if available*)	2. MARK "X"		3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. BELIEVED PRESENT	b. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
			(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
g. Nitrogen, Total Organic (*as N*)														
h. Oil and Grease	X		14.8	<68.1			J8.4	24.0	8	mg/L	kg/day			
i. Phosphorus (as P), Total (7723-14-0)														
j. Radioactivity														
(1) Alpha, Total														
(2) Beta, Total														
(3) Radium, Total														
(4) Radium 226, Total														
k. Sulfate (*as* SO_4) (14808-79-8)														
l. Sulfide (*as S*)														
m. Sulfite (*as* SO_3) (14265-45-3)														
n. Surfactants														
o. Aluminum, Total (7429-90-5)														
p. Barium, Total (7440-39-3)														
q. Boron, Total (7440-42-8)														
r. Cobalt, Total (7440-48-4)														
s. Iron, Total (7439-89-6)														
t. Magnesium, Total (7439-95-4)														
u. Molybdenum, Total (7439-98-7)														
v. Manganese, Total (7439-96-5)														
w. Tin, Total (7440-31-5)														
x. Titanium, Total (7440-32-6)														

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EPA I.D. NUMBER (*copy from Item 1 of Form 1*)	OUTFALL NUMBER
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CONTINUED FROM PAGE 3 OF FORM 2-C

PART C - If you are a primary industry and this outfall contains process wastewater, refer to Table 2c-2 in the instructions to determine which of the GC/MS fractions you must test for. Mark "X" in column 2-a for all such GC/MS fractions that apply to your industry and for ALL toxic metals, cyanides, and total phenols. If you are not required to mark column 2-a (*secondary industries, nonprocess wastewater outfalls, and nonrequired GC/MS fractions*), mark "X" in column 2-b for each pollutant you know or have reason to believe is present. Mark "X" in column 2-c for each pollutant you believe is absent. If you mark column 2a for any pollutant, you must provide the results of at least one analysis for that pollutant. If you mark column 2b for any pollutant, you must provide the results of at least one analysis for that pollutant if you know or have reason to believe it will be discharged in concentrations of 10 ppb or greater. If you mark column 2b for acrolein, acrylonitrile, 2,4 dinitrophenol, or 2-methyl-4, 6 dinitrophenol, you must provide the results of at least one analysis for each of these pollutants which you know or have reason to believe that you discharge in concentrations of 100 ppb or greater. Otherwise, for pollutants for which you mark column 2b, you must either submit at least one analysis or briefly describe the reasons the pollutant is expected to be discharged. Note that there are 7 pages to this part; please review each carefully. Complete one table (*all 7 pages*) for each outfall. See instructions for additional details and requirements.

1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. TESTING REQUIRED	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
				(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
METALS, CYANIDE, AND TOTAL PHENOLS															
1M. Antimony, Total (7440-36-0)															
2M. Arsenic, Total (7440-38-2)	X	X		10.25	<0.068			<5.0	<.01218	8	µg/L	kg/day			
3M. Beryllium, Total (7440-41-7)															
4M. Cadmium, Total (7440-43-9)	X	X		42.01	0.135			<1.0	<.0034	8	µg/L	kg/day			
5M. Chromium, Total (7440-47-3)	X	X		18.73	0.060			J3.96	0.01803	8	µg/L	kg/day			
6M. Copper, Total (7440-50-8)	X	X		81.0	0.381			52.33	0.1858	8	µg/L	kg/day			
7M. Lead, Total (7439-92-1)	X	X		32.56	0.104			J7.8	0.03501	8	µg/L	kg/day			
8M. Mercury, Total (7439-97-6)	X	X		0.046	.000142			0.022	0.00006	8	µg/L	kg/day			
9M. Nickel, Total (7440-02-0)	X	X		24.338	0.113			J10.9	0.0502	8	µg/L	kg/day			
10M. Selenium, Total (7782-49-2)	X	X		2.74	0.025			<0.5	<.00141	8	µg/L	kg/day			
11M. Silver, Total (7440-22-4)	X	X		4.41	<0.014			<0.1	<.00033	8	µg/L	kg/day			
12M. Thallium, Total (7440-28-0)															
13M. Zinc, Total (7440-66-6)	X	X		704.75	2.137			180.7	0.877	8	µg/L	kg/day			
14M. Cyanide, Total (57-12-5)															
15M. Phenols, Total															
DIOXIN															
2,3,7,8-Tetra-chlorodibenzo-P-Dioxin (1764-01-6)				DESCRIBE RESULTS											

CONTINUE ON REVERSE

CONTINUED FROM THE FRONT

1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. TESTING REQUIRED	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
				(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
GC/MS FRACTION – VOLATILE COMPOUNDS															
1V. Accrolein (107-02-8)															
2V. Acrylonitrile (107-13-1)															
3V. Benzene (71-43-2)	X		X	<0.50	<0.002			<0.50	<.00152	4	µg/L	kg/day			
4V. Bis (*Chloro-methyl*) Ether (542-88-1)															
5V. Bromoform (75-25-2)															
6V. Carbon Tetrachloride (56-23-5)															
7V. Chlorobenzene (108-90-7)															
8V. Chlorodi-bromomethane (124-48-1)															
9V. Chloroethane (75-00-3)															
10V. 2-Chloro-ethylvinyl Ether (110-75-8)															
11V. Chloroform (67-66-3)															
12V. Dichloro-bromomethane (75-27-4)															
13V. Dichloro-difluoromethane (75-71-8)															
14V. 1,1-Dichloro-ethane (75-34-3)															
15V. 1,2-Dichloro-ethane (107-06-2)															
16V. 1,1-Dichloro-ethylene (75-35-4)															
17V. 1,2-Dichloro-propane (78-87-5)															
18V. 1,3-Dichloro-propylene (542-75-6)															
19V. Ethylbenzene (100-41-4)	X		X	<0.50	<0.002			<0.50	<.00152	4	µg/L	kg/day			
20V. Methyl Bromide (74-83-9)															
21V. Methyl Chloride (74-87-3)															

 CONTINUE ON PAGE V-5

CONTINUED FROM PAGE V-4

1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. TESTING REQUIRED	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
				(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
GC/MS FRACTION – VOLATILE COMPOUNDS (*continued*)															
22V. Methylene Chloride (75-09-2)															
23V. 1,1,2,2-Tetrachloroethane (79-34-5)															
24V. Tetrachloro-ethylene (127-18-4)															
25V. Toluene (108-88-3)	X	X		0.59	0.003			<0.57	<.00179	4	µg/L	kg/day			
26V. 1,2-Trans-Dichloroethylene (156-60-5)															
27V. 1,1,1-Trichloro-ethane (71-55-6)															
28V. 1,1,2-Trichloro-ethane (79-00-5)															
29V Trichloro-ethylene (79-01-6)															
30V. Trichloro-fluoromethane (75-69-4)															
31V. Vinyl Chloride (75-01-4)															
GC/MS FRACTION – ACID COMPOUNDS															
1A. 2-Chlorophenol (95-57-8)															
2A. 2,4-Dichloro-phenol (120-83-2)															
3A. 2,4-Dimethyl-phenol (105-67-9)															
4A. 4,6-Dinitro-O-Cresol (534-52-1)															
5A. 2,4-Dinitro-phenol (51-28-5)															
6A. 2-Nitrophenol (88-75-5)															
7A. 4-Nitrophenol (100-02-7)															
8A. P-Chloro-M-Cresol (59-50-7)															
9A. Pentachloro-phenol (87-86-5)															
10A. Phenol (108-95-2)															
11A. 2,4,6-Trichloro-phenol (88-05-2)															

 CONTINUE ON REVERSE

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1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. TESTING REQUIRED	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
				(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
GC/MS FRACTION – PESTICIDES (*continued*)															
17P. Heptachlor Epoxide (1024-57-3)															
18P. PCB-1242 (53469-21-9)	X		X	<0.5	<0.006			<0.47	<.00148	8	µg/L	kg/day			
19P. PCB-1254 (11097-69-1)	X		X	<0.5	<0.006			<0.47	<.00148	8	µg/L	kg/day			
20P. PCB-1221 (11104-28-2)	X		X	<0.5	<0.006			<0.47	<.00148	8	µg/L	kg/day			
21P. PCB-1232 (11141-16-5)	X		X	<0.5	<0.006			<0.47	<.00148	8	µg/L	kg/day			
22P. PCB-1248 (12672-29-6)	X		X	<0.5	<0.006			<0.47	<.00148	8	µg/L	kg/day			
23P. PCB-1260 (11096-82-5)	X		X	<0.5	<0.006			<0.47	<.00148	8	µg/L	kg/day			
24P. PCB-1016 (12674-11-2)	X		X	<0.5	<0.006			<0.47	<.00148	8	µg/L	kg/day			
25P. Toxaphene (8001-35-2)															

United States Environmental Protection Agency
Office of Water (4203) Washington, DC 20460
EPA-841-B-00-005 October 2000

LOW-IMPACT DEVELOPMENT CENTER

Low Impact Development (LID)

A Literature Review

EXECUTIVE SUMMARY

A literature review was conducted to determine the availability and reliability of data to assess the effectiveness of low impact development (LID) practices for controlling stormwater runoff volume and reducing pollutant loadings to receiving waters.

Background information concerning the uses, ownership and associated costs for LID measures was also compiled. In general LID measures are more cost effective and lower in maintenance than conventional, structural stormwater controls. Not all sites are suitable for LID. Considerations such as soil permeablility, depth of water table and slope must be considered, in addition to other factors. Further, the use of LID may not completely replace the need for conventional stormwater controls.

Maintenance issues can be more complicated than for conventional stormwater controls because the LID measures reside on private property. In most instances, homeowners agree to only the first year of maintenance. Homeowner associations could be a mechanism for providing long-term maintenance to these areas. Generally, bioretention facilities require replacement of dead or diseased vegetation, remulching as needed, and replacement of soils after 5–10 years. Grass swales require periodic mowing and removal of sediments. Maintenance of permeable pavements requires annual high-powered vacuuming of the area to remove sediments.

Several studies have been conducted to analyze the effectiveness of various LID practices based on hydrology and pollutant removal capabilities. Bioretention areas, grass swales, permeable pavements and vegetated roof tops were the most common practices studied. These techniques reduce the amount of Effective Impervious Area (EIA) in a watershed. EIA is the directly connected impervious area to the storm drain system and contributes to increased watershed volumes and runoff rates. There are documented case studies that conclusively link urbanization and increased watershed imperviousness to hydrologic impacts on streams. Existing reports and case studies provide strong evidence that urbanization negatively affects streams and results in water quality problems such as loss of habitat, increased temperatures, sedimentation and loss of fish populations (USEPA, 1997)

In general bioretention areas were found to be effective in reducing runoff volume and in treating the first flush (first ½ inch) of stormwater. Results from three different studies indicate that removal efficiencies were quite good for both metals and nutrients. Removal rates for metals were more consistent than for nutrients. Removal rates for metals ranged from 70–97% for lead, 43–97% for copper and 64–98% for zinc. Nutrient removal was more variable and ranged from 0–87% for phosphorus, 37–80% for Total Kjeldahl Nitrogen, <0–92% for ammonium and for nitrate <0–26%. Effluent volumes were lower than influent volumes. These studies were conducted by means of simulated rainfall events. Analysis of actual long-term rainfall events would produce more reliable data.

The effectiveness of grass swales was also quite good for both pollutant removal and runoff volume reduction. A study of three different sites in the United States reveal similar results despite the differences in location. In general, performance of swales is

dependant on not only channel length, but also longitudinal slope and the use of check dams to slow flows and allow for greater infiltration. Further, the removal of metals was found to be directly related to the removal rate of total suspended solids, and the removal rate of metals was greater than removal of nutrients.

Reduction of impervious surfaces can greatly reduce the volume of runoff generated by rainfall. Several methods can be employed to reduce total impervious surface area. Permeable pavements and vegetated rooftops are two methods to accomplish this goal. Vegetated rooftops have been used extensively in Germany for more than 25 years and results show up to 50% reduction in annual runoff in temperate climates. Many opportunities exist to retrofit these systems into older highly urbanized areas of the United States. The Philadelphia project case study provides an example of this practice.

Permeable pavements can also reduce impervious surfaces. However, they are more expensive to construct than traditional asphalt pavements. Costs of these systems may be off set by the reduction of traditional curb and gutter systems to convey stormwater. Benefits of these alternate pavement types include better infiltration, ground water recharge, reduction in runoff volume and treatment of stormwater for pollutants. The study conducted in Tampa, Florida outlines these benefits as well as the opportunity to retrofit permeable pavements into existing parking lots with little or no loss of parking space. Less than 20% of rainfall was converted to runoff when using permeable pavements. Study results from the University of Washington, compare several different treatments of varying permeablility. The study shows that the higher the amount of perviousness of the treatment, the greater the reduction of runoff volume and pollutant loadings.

The use of LID is relatively new and not widespread. Most of the available data are from Prince George's County, Maryland, which pioneered the use of LID. The data available for bioretention analysis were from single simulated storm events in actual bioretention facilities or from laboratory constructed and tested bioretention systems. The data for grass swales were for only a few storm events, collected over a short period of time. The only available data for a long-term study came from the Aquarium parking lot in Tampa, Florida and the Washington permeable pavement project. More long-term analysis is required to more accurately assess the effectiveness of LID and to determine long term trends.

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1 LOW IMPACT DEVELOPMENT

1.1 Introduction

Low impact development (LID) is a relatively new concept in stormwater management. LID techniques were pioneered by Prince George's County, Maryland, in the early 1990's, and several projects have been implemented within the state. Some LID principles are now being applied in other parts of the country, however, the use of LID is infrequent and opportunities are often not investigated. The purpose of this report is to conduct a literature review to determine existing information about the application of LID in new development and existing urbanized areas, including ownership, operation and maintenance issues. A related objective was to locate relevant studies of LID projects, which would provide evidence of the effectiveness of LID in retaining predevelopment hydrology and as a mechanism for pollutant removal for stormwater. The data from the studies were analyzed for usefulness and validity and the findings are summarized.

LID is a site design strategy with a goal of maintaining or replicating the pre-development hydrologic regime through the use of design techniques to create a functionally equivalent hydrologic landscape. Hydrologic functions of storage, infiltration, and ground water recharge, as well as the volume and frequency of discharges are maintained through the use of integrated and distributed micro-scale stormwater retention and detention areas, reduction of impervious surfaces, and the lengthening of flow paths and runoff time (Coffman, 2000). Other strategies include the preservation/protection of environmentally sensitive site features such as riparian buffers, wetlands, steep slopes, valuable (mature) trees, flood plains, woodlands and highly permeable soils.

LID principles are based on controlling stormwater at the source by the use of micro-scale controls that are distributed throughout the site. This is unlike conventional approaches that typically convey and manage runoff in large facilities located at the base of drainage areas. These multifunctional site designs incorporate alternative stormwater management practices such as functional landscape that act as stormwater facilities, flatter grades, depression storage and open drainage swales. This system of controls can reduce or eliminate the need for a centralized best management practice (BMP) facility for the control of stormwater runoff. Although traditional stormwater control measures have been documented to effectively remove pollutants, the natural hydrology is still negatively affected (inadequate base flow, thermal fluxes or flashy hydrology), which can have detrimental effects on ecosystems, even when water quality is not compromised (Coffman, 2000). LID practices offer an additional benefit in that they can be integrated into the infrastructure and are more cost effective and aesthetically pleasing than traditional, structural stormwater conveyance systems.

Conventional stormwater conveyance systems are designed to collect, convey and discharge runoff as efficiently as possible. The intent is to create a highly efficient drainage system, which will prevent on lot flooding, promote good drainage and quickly convey runoff to a BMP or stream. This runoff control system decreases groundwater

recharge, increases runoff volume and changes the timing, frequency and rate of discharge. These changes can cause flooding, water quality degradation, stream erosion and the need to construct end of pipe BMPs. Discharge rates using traditional BMPs may be set only to match the predevelopment peak rate for a specific design year. This approach only controls the rate of runoff allowing significant increases in runoff volume, frequency and duration of runoff from the predevelopment conditions and provides the mechanisms for further degradation of receiving waters (Figure 1).

LID has often been compared to other innovative practices, such as Conservation Design, which uses similar approaches in reducing the impacts of development, such as reduction of impervious surfaces and conservation of natural features. Although the goals of Conservation Design protect natural flow paths and existing vegetative features, stormwater is not treated directly at the source. Conservation Design protects large areas adjacent to the development site and stormwater is directed to these common areas.

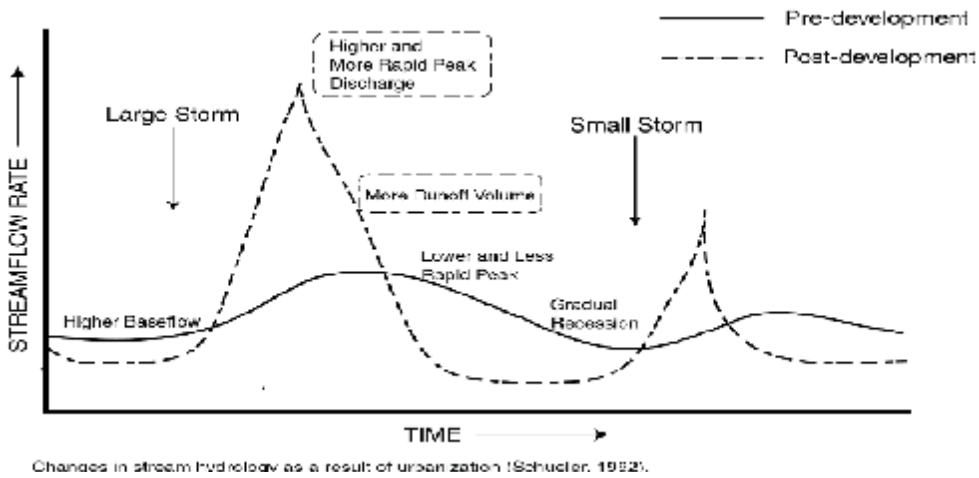

Figure 1: Changes in Stormwater Hydrology as a Result of Urbanization

Although this approach protects trees and does reduce runoff, there is still potentially a significant amount of connected impervious area and centralized stormwater facilities that may contribute to stream degradation through stormwater volume, frequency and thermal impacts. Therefore, the hydrologic and hydraulic impacts of this approach on receiving waters may still be significant, although the volume and flows will be less than without the conservation design. The stormwater control measures used in Conservation Design are off-site and therefore not the individual property owner's responsibility. However, maintenance is generally provided by the homeowners association and financed through association fees.

1.2 Benefits and Limitations

The use of LID practices offers both economical and environmental benefits. LID measures result in less disturbance of the development area, conservation of natural features and can be less cost intensive than traditional stormwater control mechanisms. Cost savings for control mechanisms are not only for construction, but also for long-term

maintenance and life cycle cost considerations. For example, an alternative LID stormwater control design for a new 270 unit apartment complex in Aberdeen, NC will save the developer approximately 72% or $175,000 of the stormwater construction costs. On this project, almost all of the subsurface collection systems associated with curb and gutter projects have been eliminated. Strategically located bioretention areas, compact weir outfalls, depressions, grass channels, wetland swales and specially designed storm water basins are some of the LID techniques used. These design features allow for longer flow paths, reduce the amount of polluted runoff and filter pollutants from stormwater runoff (Blue Land, Water and Infrastructure, 2000).

Today many states are facing the issue of urban sprawl, a form of development that consumes green space, promotes auto dependency and widens urban fringes, which puts pressure on environmentally sensitive areas. "Smart growth" strategies are designed to reconfigure development in a more eco-efficient and community oriented style. LID addresses many of the environmental practices that are essential to smart growth strategies including the conservation of open green space. LID does not address the subject of availability of public transportation.

LID provides many opportunities to retrofit existing highly urbanized areas with pollution controls, as well as address environmental issues in newly developed areas. LID techniques such as rooftop retention, permeable pavements, bioretention and disconnecting rooftop rain gutter spouts are valuable tools that can be used in urban areas. For example, stormwater flows can easily be directed into rain barrels, cisterns or across vegetated areas in high-density urban areas. Further, opportunities exist to implement bioretention systems in parking lots with little or no reduction in parking space. The use of vegetated rooftops and permeable pavements are 2 ways to reduce impervious surfaces in highly urbanized areas.

LID techniques can be applied to a range of lot sizes. The use of LID, however, may necessitate the use of structural BMPs in conjunction with LID techniques in order to achieve watershed objectives. The appropriateness of LID practices is dependent on site conditions, and is not based strictly on spatial limitations. Evaluation of soil permeability, slope and water table depth must be considered in order to effectively use LID practices. Another obstacle is that many communities have development rules that may restrict innovative practices that would reduce impervious cover. These "rules" refer to a mix of subdivision codes, zoning regulations, parking and street standards and other local ordinances that determine how development happens (Center for Watershed Protection, 1998). These rules are responsible for wide streets, expansive parking lots and large-lot subdivisions that reduce open space and natural features. These obstacles are often difficult to overcome.

Additionally, community perception of LID may prevent its implementation. Many homeowners want large-lots and wide streets and view reduction of these features as undesirable and even unsafe. Furthermore, many people believe that without conventional controls, such as curbs and gutters and end of pipe BMPs, they will be required to contend with basement flooding and subsurface structural damage.

2 LOW IMPACT DEVELOPMENT PRACTICES

LID measures provide a means to address both pollutant removal and the protection of predevelopment hydrological functions. Some basic LID principles include conservation of natural features, minimization of impervious surfaces, hydraulic disconnects, disbursement of runoff and phytoremediation. LID practices such as bioretention facilities or rain gardens, grass swales and channels, vegetated rooftops, rain barrels, cisterns, vegetated filter strips and permeable pavements perform both runoff volume reduction and pollutant filtering functions.

2.1 Bioretention

Bioretention systems are designed based on soil types, site conditions and land uses. A bioretention area can be composed of a mix of functional components, each performing different functions in the removal of pollutants and attenuation of stormwater runoff (Figure 2).

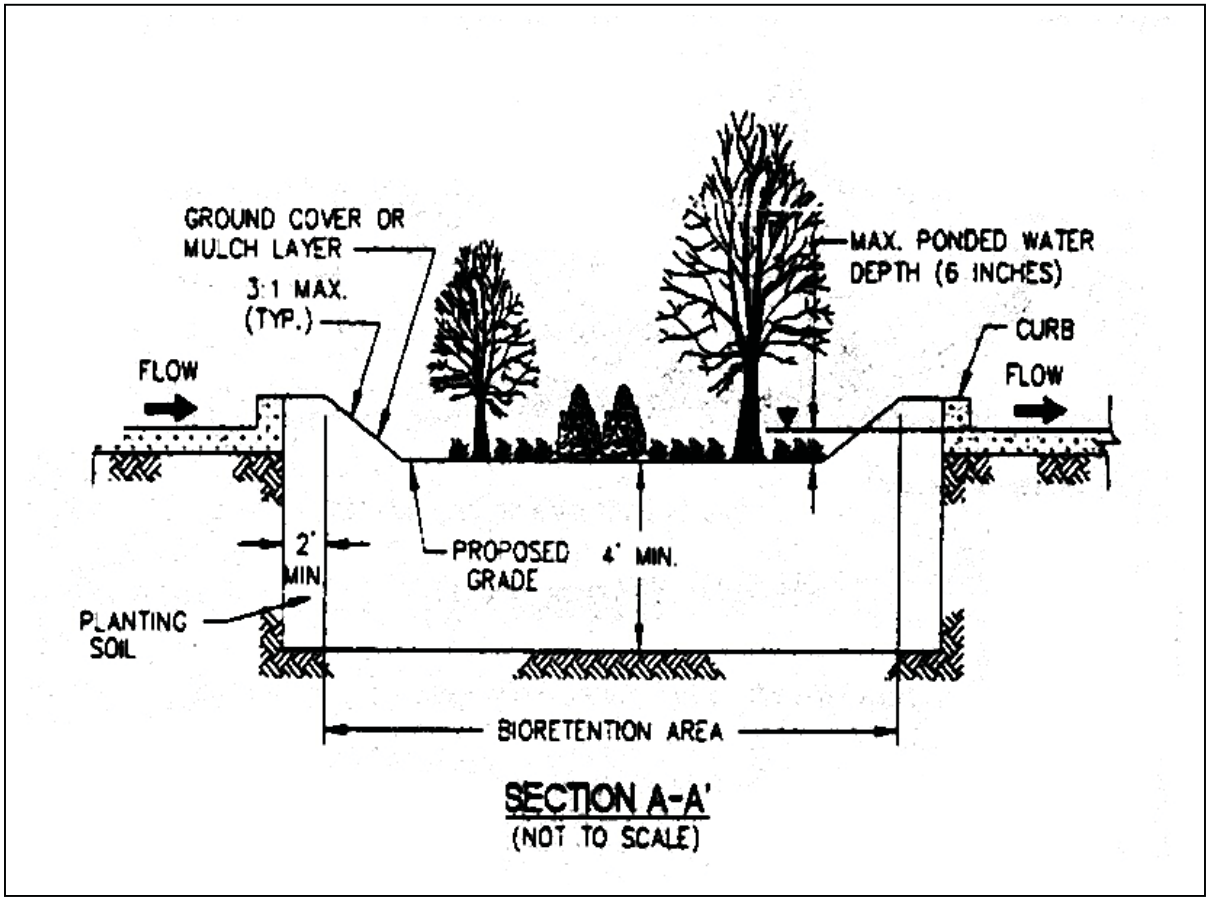

Figure 2: Typical Bioretention System (Prince George's County Department of Environmental Resources, 1993)

Six typical components found in bioretention cells:

- Grass buffer strips reduce runoff velocity and filter particulate matter.
- Sand bed provides aeration and drainage of the planting soil and assists in the flushing of pollutants from soil materials.
- Ponding area provides storage of excess runoff and facilitates the settling of particulates and evaporation of excess water.
- Organic layer performs the function of decomposition of organic material by providing a medium for biological growth (such as microorganisms) to degrade petroleum-based pollutants. It also filters pollutants and prevents soil erosion.
- Planting soil provides the area for stormwater storage and nutrient uptake by plants. The planting soils contain some clays which adsorb pollutants such as hydrocarbons, heavy metals and nutrients.
- Vegetation (plants) functions in the removal of water through evapotranspiration and pollutant removal through nutrient cycling.

Bioretention facilities are less cost intensive than traditional structural stormwater conveyance systems. Construction of a typical bioretention area in Prince George's County, Maryland is between $5,000 and $10,000 per acre drained, depending on soil type (Weinstein, 2000). Other sources estimate the costs for developing bioretention sites at between $3 and $15 per square foot of bioretention area. Design guidelines recommend that bioretention systems occupy 5-7% of the drainage basin. Additional savings can be realized in reduced construction costs for storm drainpipe. For example, bioretention practices reduced the amount of storm drain pipe at a Medical Office building in Prince George's County, Maryland from 800 to 230 feet, which resulted in a cost savings of $24,000 or 50% of the overall drainage cost for the site (Dept. of Env. Resources, 1993).

Components of the bioretention area should meet required guidelines in order to provide the most productive system possible. The mulch layer should be approximately 2-3 inches thick and replaced annually. Soil should be tested for several criteria before being used.

- pH range 5.5–6.5
- Organic matter 1.5–3.0%
- Magnesium (Mg) 35lbs/acre
- Phosphorus (P2O5) 100lbs/acre
- Potassium (K2O) 85lbs/acre
- Soluble salts < 500 ppm

Plant material should be obtained from certified nurseries that have been inspected by state or federal agencies (Dept. of Env. Resources, 1993). Native species should be used and selected according to their moisture regime, morphology, susceptibility to pests and diseases and tolerance to pollutants. Selection of plant species should be based on site conditions and ecological factors. A minimum of three species of trees and three species of shrubs should be selected to insure diversity, differing rates of transpiration and ensure a more constant rate of evapotransportation and nutrient and pollutant uptake throughout the growing season (Dept. of Env. Resources, 1993). Species that require regular maintenance should be avoided or restricted. Prince George's County recommends a warranty be established with the nursery as part of the plant installation, and should include care and 80% replacement of plants for the first year.

Table 1: Example Maintenance Schedule for Bioretention Areas (Prince George's County, Department of Environmental Resources, 1993)

Description	Method	Frequency	Time of Year
Soil			
Inspect and Repair Erosion	Visual	Monthly	Monthly
Organic Layer			
Remulch void areas	By Hand	As Needed	As Needed
Remove previous mulch layer before applying new layer (optional)	By Hand	Once a Year	Spring
Additional mulch added (optional)	By Hand	Once a Year	Spring
Plants			
Remove and replace all dead and diseased vegetation that cannot be treated	See Planting Specifications	Twice a Year	Mar 15–Apr 30 and Oct 1–Nov 30
Treat all diseased trees and shrubs	Mechanical or by Hand	N/A	Varies, depends on insect or disease infestation
Water of plant materials, at the end of the day for 14 consecutive days after planting	By Hand	Immediately after Completion of Projects	N/A
Replace stakes after one year	By Hand	Once a Year	Remove only in the Spring
Replace deficient stakes or wires	By Hand	N/A	As Needed

Annual maintenance is required for the overall success of bioretention systems. This includes maintenance of plant material, soil layer and the mulch layer. A maintenance schedule outlining methods, frequency and time of year for bioretention maintenance should be developed. Table 1 is a typical maintenance checklist. Plants will provide enhanced environmental benefit over time as root systems and leaf canopies increase in size and pollutant uptake and removal efficiencies. Soils, however, begin filtering pollutants immediately and can lose their ability to function in this capacity over time. Therefore, evaluation of soil fertility is important in maintaining an effective bioretention system. Substances in runoff such as nutrients and metals eventually disrupt normal soil

functions by lowering the cation exchange capacity (CEC) (Dept. of Env. Resources, 1993). CEC is the soil's ability to adsorb pollutant particles through ion attraction and will decrease over time. It is recommended that soils be tested annually and replaced when soil fertility is lost. Depending on environmental factors, this usually occurs within 5-10 years of construction. Replacement of soil can be accomplished in 1-2 days for approximately $1,000-$2,000 for a typical system which will drain one acre in the northeastern U.S. (Weinstein, 2000).

2.2 Grass Swales

Grass swales or channels are adaptable to a variety of site conditions, are flexible in design and layout, and are relatively inexpensive (USDOT, 1996). Generally open channel systems are most appropriate for smaller drainage areas with mildly sloping topography (Center for Watershed Protection, 1998). Their application is primarily along residential streets and highways. They function as a mechanism to reduce runoff velocity and as filtration/infiltration devices. Sedimentation is the primary pollutant removal mechanism, with additional secondary mechanisms of infiltration and adsorption. In general grass channels are most effective when the flow depth is minimized and detention time is maximized. The stability of the channel or overland flow is dependant on the erodibility of the soils in which the channel is constructed (USDOT, 1996). Decreasing the slope or providing dense cover will aid in both stability and pollutant removal effectiveness.

Engineered swales are less costly than installing curb and gutter/storm drain inlet and storm drain pipe systems. The cost for traditional structural conveyance systems ranges from $40–$50 per running foot. This is two to three times more expensive than an engineered grass swale (Center for Watershed Protection, 1998). Concerns that open channels are potential nuisance problems, present maintenance problems, or impact pavement stability can be alleviated by proper design. Periodic removal of sediments and mowing are the most significant maintenance requirements.

2.3 Vegetated Roof Covers

Vegetative roof covers or green roofs are an effective means of reducing urban stormwater runoff by reducing the percentage of impervious surfaces in urban areas. They are especially effective in older urban areas with chronic combined sewer overflow (CSO) problems, due to the high level of imperviousness. The green roof is a multilayered constructed material consisting of a vegetative layer, media, a geotextile layer and a synthetic drain layer. Vegetated roof covers in urban areas offer a variety of benefits, such as extending the life of roofs, reducing energy costs and conserving valuable land that would otherwise be required for stormwater runoff controls. Green roofs have been used extensively in Europe to accomplish these objectives. Many opportunities are available to apply this LID measure in older U.S. cities with stormwater infrastructures that have reached their capacities.

Green roofs are highly effective in reducing total runoff volume. Simple vegetated roof covers, with approximately 3 inches of substrate can reduce annual runoff by more than 50 percent in temperate climates (Miller, 2000). Research in Germany shows that the 3-inch design offers the highest benefit to cost ratio. Properly designed systems not only reduce runoff flows, but also can be added to existing rooftops without additional reinforcement or structural design requirements. The value of green roofs for reducing runoff is directly linked to the design rainfall event considered. Design should be developed for the storm events that most significantly contribute to CSOs, hydraulic overloads and runoff problems for a given area.

2.4 Permeable Pavements

The use of permeable pavements is an effective means of reducing the percent of imperviousness in a drainage basin. More than thirty different studies have documented that stream, lake and wetland quality is reduced sharply when impervious cover in an upstream watershed is greater than 10%. Porous pavements are best suited for low traffic areas, such as parking lots and sidewalks. The most successful installations of alternative pavements are found in coastal areas with sandy soils and flatter slopes (Center for Watershed Protection, 1998). Permeable pavements allow stormwater to infiltrate into underlying soils promoting pollutant treatment and recharge, as opposed to producing large volumes of rainfall runoff requiring conveyance and treatment. Costs for paving blocks and stones range from $2 to $4, whereas asphalt costs $0.50 to $1 (Center for Watershed Protection, 1998).

2.5 Other LID Strategies

Another strategy to minimize the impacts of development is the implementation of rain gutter disconnects. This practice involves redirecting rooftop runoff conveyed in rain gutters out of storm sewers, and into grass swales, bioretention systems and other functional landscape devices. Redirecting runoff from rooftops into functional landscape areas can significantly reduce runoff flow to surface waters and reduce the number of CSO events in urban areas. As long as the stormwater is transported well away from foundations, concerns of structural damage and basement flooding can be alleviated. As an alternative to redirection of stormwater to functional landscape, rain gutter flows can be directed into rain barrels or cisterns for later use in irrigating lawns and gardens. Disconnections of rain gutters can effectively be implemented on existing properties with little change to present site designs.

Many strategies exist to reduce the amount of impervious surface in development areas. Designing residential streets for the minimum required width needed to support traffic, on-street parking and emergency service vehicles, can reduce imperviousness. Other practices include shared driveways and parking lots, alternative pavements for overflow parking areas, center islands in cul-de-sacs, alternative street designs rather than traditional grid patterns and reduced setbacks and frontages for homes.

3 EVALUATION OF LID EFFECTIVENESS

3.1 Hydrological Measures

Enhancements in site drainage from traditional stormwater control measures, such as curbs and gutters that eliminate potential on-site flooding, often result in an increase in surface runoff. These alterations can cause an increase in volume, frequency and velocity of runoff flows, resulting in flooding, high erosion and a reduction in groundwater infiltration, as well as a reduction in water quality and habitat degradation. Four hydrological functions should be considered when investigating the effectiveness of LID practices. The runoff curve number (CN), time of concentration, retention and detention. LID techniques and the hydrological design and analysis components are represented in (Table 2).

Table 2: Low Impact Hydrologic Design and Analysis Components (Coffman, 2000)

	Low Impact Hydrologic Design and Analysis Components			
LID Practice	Lower Post-Development CN	Increase Tc	Retention	Detention
Flatten Slopes		X		
Increase Flow Path		X		
Increase Roughness		X		
Minimize Disturbances	X			
Flatten Slopes on Swale		X		X
Infiltration Swales	X		X	
Vegetative Filter Strips	X	X	X	
Disconnected Impervious Areas	X	X		
Reduce Curb and Gutter	X	X		
Rain Barrels		X	X	X
Rooftop Storage		X	X	X
Bioretention	X	X	X	
Revegetation	X	X	X	
Vegetation Presentation	X	X	X	

The runoff potential for a site is characterized by the runoff curve number or CN. One method of measuring hydrological function on a developed site is to compare the pre and post developed curve number. The CN method is used extensively in the analysis of environmental impact and design rainfall-runoff hydrology. The curve number measures a watershed or subwatershed's hydrological response and is determined based on soil type, land cover and amount of impervious surfaces (Hawkins 1998). A detailed evaluation of both proposed and existing land cover is the basis for determining the low-impact development CN, which is a calculation of the potential for runoff at a development site. One of the goals of LID is to design a system so that the post-developed CN is as close as possible to the predevelopment CN for the site. Limiting the percent of imperviousness is one technique to accomplishing this. The runoff coefficient, which can be derived from the CN, calculates the percent of rainfall converted to runoff.

The time of concentration (Tc) refers to the amount of time it takes for water to travel from the most distant point to the watershed outlet. By retaining predevelopment Tc, negative impacts associated with development can be reduced. Retention and detention of rainfall are the key components of increases in Tc. As the amount of impervious surface increases within a site, altering drainage paths, the contribution of total land area to excess rainfall increases, causing the time for stormwater to reach downstream outlets to decrease. This decrease in Tc reduces the pollutant removal capabilities of the site as well as resulting in an increase in the peak runoff rate. Maintaining Tc can be achieved by:

- Maintaining flow path lengths
- Increasing surface roughness
- Detaining flows
- Minimizing disturbances at the site
- Flattening grades in impact areas
- Disconnecting impervious surfaces
- Connecting pervious surfaces

3.2 Pollutant Removal Measures

Changes in site runoff characteristics can contribute to a reduction in water quality and degradation of aquatic and terrestrial habitats. LID practices provide a high level of water quality treatment controls due to runoff volume control of the "first flush" (first ½ inch) of runoff, which contains the highest pollutant loadings. Often LID practices control up to the first 2 inches of runoff and therefore treat a much greater volume of annual runoff (Coffman, 2000). By increasing the Tc and decreasing the flow velocity, LID practices result in a reduction in pollutant transport capacity and overall pollutant loading. Further, LID practices support pollution prevention by modifying human activities, which lower the introduction of pollutants into the environment.

LID practices such as bioretention facilities or rain gardens can be used as a mechanism for infiltration and pollutant removal, which is performed through physical and biological treatment processes occurring in the plant and soil complex. These processes include filtration, decomposition, ion exchange, adsorption and volatilization (Dept. of Env. Resources, 1993). Pollutant loadings are concentrated in the "first flush" of runoff from impervious surfaces and contain grease and oil, nutrients (nitrogen and phosphorous), sediments and heavy metals. Pollutant loadings and water quality impacts from development have been well documented in numerous studies. Concentrations of pollutants are appropriate to look at bio affects, but pollutant loads are better for assessing impacts to downstream habitats when cumulative effects are considered (Rushton, 1999). Studies should consider investigating both total metals and dissolved metals, when analyzing LID practice's effectiveness.

4 CASE STUDIES

The LID "functional landscape" is designed to mimic the predevelopment hydrological conditions through runoff volume control, peak runoff rate control, flow frequency/duration control and water quality control. Determining effectiveness of LID practices can be achieved by evaluating hydrological function and pollutant removal capabilities. Little investigation has been done to prove the actual effectiveness of LID in retaining predevelopment hydrology and preventing or reducing pollutant loadings caused by stormwater runoff on developed sites. LID is a relatively new concept in stormwater management and not widely implemented in all areas and climates in the United States. Limited research and analysis has been conducted on the various practices, due to this limited application.

The following case studies, though limited, represent the best examples of projects that use LID concepts for stormwater management. Both hydrologic and pollutant removal effectiveness are investigated. The most significant source for data is Prince George's County, Maryland where many of the LID practices were developed and first implemented. The Low-Impact Development Center, also located in Maryland, has done significant work in design and planning of LID sites. First year data from a two-year study of a Tampa, Florida, retrofit parking lot and an on-going permeable pavement project in Washington state provide the only long term analysis for the effectiveness of LID concepts (permeable pavements and swales) currently available.

From: Mark Heintz [mheintz@wildlandsinc.com]
Sent: Friday, October 12, 2012 10:40 AM
To: Mark Seedall
Subject: RE: Newark Site

Understood—thanks Mark.

Mark B. Heintz
COO and General Counsel
WILDLANDS
3855 Atherton Road - Rocklin, CA 95765
916-435-3555 Office - 916-435-3556 Fax

www.wildlandsinc.com

From: Mark Seedall [mailto:mseedall@ccwater.com]
Sent: Friday, October 12, 2012 8:51 AM
To: Mark Heintz; Kim Erickson
Subject: RE: Newark Site

Mark,

We are trying to limit our requirements to a 1:1 ratio. However, Bay Area RWQCB has been indicating that they want 2:1, plus 0.1:1 for temporary impacts.

CCWD impacts are only 1.23 acres permanent and are 6.5 acres temporary. Hence our needs are small, somewhere around 1.23 to 3.11 acres.

I am thinking that at the Newark site we might have to have 2:1 or 2.46 acres.

Management at CCWD is very uncomfortable with the cost of Bay Area credits and they are very uncomfortable with a ratio higher than 1:1 given the cost of the mitigation. They are also very uncomfortable with the location of the mitigation since it is very far from our service area.

I am not sure I know enough yet about the issues at Newark to even recommend it, other than we would be working with Wildlands who has in my opinion the resources to do the job.

A very good deal might would motivate us to work with Wildlands at the Newark site. I know that we would prefer to purchase bank credits given our small needs.

Mark A. Seedall
Principal Planner
Contra Costa Water District
P.O. Box H2O
Concord, CA 94524-2099

925 688-8119 office
925 688-8142 fax
mseedall@ccwater.com

From: Mark Heintz [mailto:mheintz@wildlandsinc.com]
Sent: Thursday, October 11, 2012 6:04 PM
To: Mark Seedall; Kim Erickson
Subject: RE: Newark Site

Thanks for following up Mark—I managed to sneak away on a vacation. I will discuss internally but that price is less than half of where the market is. What is the range of acres that you might need?

Mark B. Heintz
COO and General Counsel
WILDLANDS
3855 Atherton Road - Rocklin, CA 95765
916-435-3555 Office - 916-435-3556 Fax

www.wildlandsinc.com

From: Mark Seedall [mailto:mseedall@ccwater.com]
Sent: Thursday, October 11, 2012 5:26 PM
To: Mark Heintz; Kim Erickson
Subject: RE: Newark Site

Mark, Let me know if you have had a chance to think about this further.

Mark A. Seedall
Principal Planner
Contra Costa Water District
P.O. Box H2O
Concord, CA 94524-2099
925 688-8119 office
925 688-8142 fax
mseedall@ccwater.com

From: Mark Seedall
Sent: Monday, September 24, 2012 4:51 PM
To: 'Mark Heintz'; Kim Erickson
Subject: RE: Holland Tract

Mark,

The number I suggested will not be supported here at CCWD. There may be some interest if the price could be reduced to $320k per acre.

Mark A. Seedall
Principal Planner
Contra Costa Water District
P.O. Box H2O
Concord, CA 94524-2099
925 688-8119 office
925 688-8142 fax

mseedall@ccwater.com

From: Mark Heintz [mailto:mheintz@wildlandsinc.com]
Sent: Tuesday, September 18, 2012 2:19 PM
To: Mark Seedall; Kim Erickson
Subject: RE: Holland Tract

Sounds like the usual odds!

If you are willing to pursue the effort with us I think we can work with you on price.

Mark B. Heintz
COO and General Counsel
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916-435-3555 Office - 916-435-3556 Fax

www.wildlandsinc.com

From: Mark Seedall [mailto:mseedall@ccwater.com]
Sent: Tuesday, September 18, 2012 12:51 PM
To: Kim Erickson
Cc: Mark Heintz
Subject: RE: Holland Tract

Kim and Mark,

No idea if the USACE and or Bay Area RWQCB will agree with CCWD's use of Newark.

RWQCB is probably more difficult than the USACE.

No approvals, budget or management ok yet for mitigation.

Will consider working with you if you think you can sell the credits we need at $400k per acre.

We are stronger worker together.

Let me know what you think.

Mark A. Seedall
Principal Planner
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925 688-8142 fax
mseedall@ccwater.com

From: Kim Erickson [mailto:kerickson@wildlandsinc.com]
Sent: Friday, August 24, 2012 2:58 PM

To: Mark Seedall
Cc: Mark Heintz
Subject: RE: Holland Tract

Mark Seedall – I just spoke with Mark Heintz. We are ready to start the process (submit the wetland delineation and Prospectus) at Newark, but we are having challenges with the city and we anticipate challenges with the Corps and the Regional Board. Mark Heintz said that if you are interested in working with us similar to our relationships at Holland Tract and Liberty Island, he is interested in talking. But his estimate of the market at Newark is roughly $650,000 per credit and he could only go to roughly $500,000 per credit for CCWD at Newark if you were working closely with us.

My memory is that your Shortcut Project is resulting in impacts to 1.23 acres of seasonal wetlands just north of Concord.

If you think this approach is feasible, Mark Heintz is willing to talk.

Kim

Kim C. Erickson
(916) 435-3555 (office)
(916) 960-9738 (mobile)

From: Mark Seedall ~~[mailto:mseedall@ccwater.com]~~
Sent: Friday, August 24, 2012 2:36 PM
To: Kim Erickson
Subject: RE: Holland Tract

Is it really ready to go? If so that would be great.

Negatives...

Cost.
Distance.

Mark A. Seedall
Principal Planner
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mseedall@ccwater.com

From: Kim Erickson ~~[mailto:kerickson@wildlandsinc.com]~~
Sent: Friday, August 24, 2012 2:31 PM
To: Mark Seedall
Subject: RE: Holland Tract

What about Newark Slough? I think they would support that. We are (still) at the final stages of city approval to abandon an easement. If you supported the abandonment, it would get the project moving.

Banks located in Marin County:

Burdell Mitigation Bank

service area

Approved Credit Type:

Wetland Creation

Sponsor:

Burdell Tenancy in Common
Post Office Box 2039
Mill Valley, California 94942

Contact:

Anthony Georges
Telephone: 415-602-4151
email: **tonygeorges@burdellranch.com**

Banks located in San Benito County:

Pajaro Mitigation Bank

service area

Approved Credit Type:

Wetland Creation

Sponsor and Contact:

Mr. Mark Heintz
Wildlands, Inc.
3855 Atherton Road
Rocklin, California 95765

wildlands@wildlandsinc.com
www.wildlandsinc.com

Banks located in San Mateo County:

San Francisco Bay Wetland Mitigation Bank

service area

Approved Credit Type:

Tidal Wetland and Other Waters Creation.

Non-tidal/seasonal wetland and other waters within the service area may be eligible to use the Bank for mitigation on a case-by-case basis (i.e., for projects with impacts to non-tidal/seasonal wetlands or other waters that may have been historic tidal wetlands or other waters).

Sponsor and Contact :

Mr. Max A. Keech
Keech Properties, LLC
Telephone (650) 529-9500

Email: mkeech@keechproperties.com

Banks located in Solano County:

Elsie Gridley Mitigation Bank

service area

Approved Credit Type:

Wetland Creation

Sponsor and Contact:

Wetlands Resources, LLC

169 Magee Avenue
Mill Valley, CA 94941
and
3030 Bridgeway #107
Sausalito, CA 94965
Telephone: 415-289-0250
Fax: 415-289-0253

North Suisun Mitigation Bank

CTS service area
Vernal Pool Service Area

Approved Credit Type:

Vernal Pool Wetland Creation

Vernal Pool Wetland Preservation

California Tiger Salamander

Sponsor and Contact:

Julie Maddox
Wildlands, Inc.
3855 Atherton Road
Rocklin, CA 95765
Telephone: 916-435-3555
Fax: 916-435-3578
wildlands@wildlandsinc.com
www.wildlandsinc.com

Banks located in Sonoma County:

Carinalli-Todd Mitigation Bank

service area = **Santa Rosa Plain**

Approved Credit Types:

Wetland Creation

Wetland Preservation

California Tiger Salamander

Sponsor and Contact:

Kevin Carinalli
Carinalli Nature Preserve, LLC.
520 Mendocino Avenue, Suite 250
Santa Rosa, CA 95401
(707)-578-1302
kcar@sonic.net

Desmond Mitigation Bank

The Desmond Bank is established in order to primarily serve the central and southern parts of the **Santa Rosa Plain** from potentially as far north as Airport Boulevard (the northern edge of the "Central" geographic zone as per the Programmatic Consultation) in the north, south through Cotati. Depending on agency authorizations, the Desmond Bank may also potentially serve to mitigate minor impacts outside the Santa Rosa Plain, specifically (and as permitted project by project) in or near Sebastopol, Forestville, and/or other nearby vicinities, depending upon agency approvals for those independent projects.

service area

Approved Credit Types:

Wetland Creation

Wetland Preservation

Sponsor and Contact:

Christopher and Annie Desmond
4801 Llano Road
Sebastopol, CA 95472
Telephone: 707-824-9100
Fax: 707-824-9192

Hale Mitigation Bank

service area = **Santa Rosa Plain**

Pending Credits:

Wetland Creation

Wetland Preservation

California Tiger Salamander

Sponsor:

Ilan Silberstein

Contact:

Charlie Traboulsi
3289 Regional Parkway
Santa Rosa, CA 95403
Telephone: 707-577-0425
Cell: 707-494-0425
Fax: 707-573-1418

Hazel Mitigation Bank
(service area = **Santa Rosa Plain**)

Approved Credit Types:

Wetland Creation

California tiger salamander

Sponsor:

Harvey Rich
Hazel Mitigation Preserve, L.L.C.

Contact:

Harvey Rich
336 Bon Air Center, Box 232
Greenbrae, CA 94904
Telephone: (415) 472-1086
Fax: (415) 471-1147

Horn Avenue Mitigation Bank

The Horn Avenue Bank is established in order to primarily serve projects in the southern and central parts of the Santa Rosa Plain (Cotati to Airport Blvd.) as portrayed by the "Programmatic Consultation" between the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers. The Bank is targeted to serve the immediate geographic portion of the **Santa Rosa Plain** in which it occurs (southern third) plus the zone next closest, i.e. the Central portion.

service area

Approved Credit Types:

Wetland Creation

Sponsor:

Horn Avenue LLC

Contact:

Charlie Traboulsi
3289 Regional Parkway
Santa Rosa, CA 95403
Telephone: 707-577-0425
Cell: 707-494-0425
Fax: 707-573-1418

Laguna Valley Bank

The Laguna Valley Bank is established in order to serve the **Santa Rosa Plain** from potentially as far north as Windsor in the north, south to Cotati. Depending on agency authorizations, the Laguna Valley Bank may also potentially serve to mitigate minor impacts outside the Santa Rosa Plain, specifically (and as permitted project by project) in or near Sebastopol, Forestville, and/or other nearby vicinities, depending upon agency approvals for those independent projects. There are currently 27.5 acre credits available.

service area

Approved Credit Types:

Wetland Creation

Sponsor:

Lynda and Domenic Carinalli

Contact:

Lynda Carinalli
4905 Gravenstein Highway, South
Sebastopol, CA 95472
Telephone: 707-795-7052
Fax: 707-824-9432

From: Jeff Quimby
Sent: Friday, January 25, 2013 11:10 AM
To: Mark Seedall
Subject: Shortcut info

The flow meter measures flow at the end of the shortcut, so water going into the Martinez reservoir. I am adding other flows below to account for Foster Wheeler's use and TWSA deliveries through the 30/36" meters

Measured flow into Mrtz:	7,200 AF
Foster Wheeler:	1,100 AF
TWSA:	10,500 AF (30% of total TWSA demand)
Total:	18,800 AF

I think you said 20 TAF/yr which is a reasonable estimate.

In terms of water value, CCWD's current untreated water quantity charge is $1.7544 per thousand gallons , or $572/AF. We recover 90% of UW costs through the quantity charge, so $572/0.9 = $635/AF. Other charges include monthly service charges and demand charges.

Jeff Quimby | Principal Engineer
Contra Costa Water District
PO Box H2O
Concord, CA 94520
Ph:(925) 688-8310
Fax:(925) 688-8142
jquimby@ccwater.com

MEMORANDUM

To: John Kopchik, Contra Costa County

From: Teifion Rice-Evans and Catherine Meresak

Subject: East Contra Costa County HCP/ NCCP 2011 Mitigation Fee Update: Additional Information; EPS# 20149

Date: July 15, 2011

The Economics of Land Use

The 2011 Mitigation Fee Update (March 17, 2011) memorandum prepared by Economic & Planning Systems, Inc. (EPS) evaluated the latest available cost information to determine recommended refinements in the East Contra Costa County HCP/ NCCP Development Mitigation and Wetland Mitigation Fees. This technical analysis recommended:

(1) No change in the current 2011 development mitigation fees;
(2) Increase of between 5.3 percent and 32.4 percent in the wetland mitigation fees (excluding streams); and,
(3) Decrease of 22.7 percent in the per linear foot streams fee.

As documented in the 2011 Mitigation Fee Update memorandum, the recommended increases in the wetland fees were based on the Conservancy cost experience to date, restoration cost data from other projects in the region, and interviews with restoration specialists active in the East Bay and other Bay Area locations.

This memorandum describes new information available on two restorations projects, one Conservancy and one EBMUD. It also considers the relative effects of our recommendations on mitigation costs.

Additional Resotoration Cost Information

The recommended fee increases were based on estimates of per acre wetland restoration costs of between $114,000 and $122,500 per acre for wetlands, ponds, open water, and sloughs. The cost of riparian restoration was estimated at $68,000 per acre. These costs are conservative compared with the new project information described below:

Economic & Planning Systems, Inc.
2501 Ninth Street, Suite 200
Berkeley, CA 94710-2515
510 841 9190 tel
510 841 9208 fax

Berkeley
Sacramento
Denver

www.epsys.com

- **Upper Hess Creek**. The Upper Hess Creek project is a Conservancy project that involves the restoration of wetlands/ ponds and streams. Based on Conservancy cost information, the total restoration cost associated with wetlands/ ponds component of the project was about $900,000, including staff costs, with about 45 percent of the costs representing direct construction costs. The project restored a total of 2.59 acres of wetlands/ ponds at an average restoration cost of $345,000 per acre.

- **Pavon Creeks and Scow Canyon**. Pavon Creeks and Scow Canyon are two restoration projects undertaken by EBMUD. The two projects both involved the restoration of wetlands/ ponds and streams. Based on EBMUD cost information (provided collectively for both projects), the total restoration cost associated with wetlands/ ponds component of the projects was about $1.65 million, excluding staff costs, with about 55 percent associated with direct construction costs. The project restored a total of 2.19 acres of wetlands/ ponds at an average restoration cost of $755,000 per acre.

Changes in Average Developer Cost

The recommended adjustments in wetland impact fees will allow the Conservancy to appropriately cover the costs associated with its ongoing restoration efforts. While the proposed increases are significant on a percentage basis, the wetlands component of the overall plan costs are relatively modest, and the development fees rather than the wetland mitigation fees are by far the biggest fee component for most projects. To illustrate this reality, EPS calculated the overall HCP/NCCP mitigation fees (including development, wetland (non-stream), and stream) associated with all development to date under the HCP/ NCCP for three different fee scenarios: (1) 2006 fee schedule; (2) current 2011 fee schedule; and, (3) recommended 2011 fee schedule.

Table 1 shows these three fee schedules for the different habitat types/ zones. **Table 2** shows the total "fee-paying acres" between 2008 and the present. As shown, the equivalent of 120.3 acres of activities have paid HCP/ NCCP fees to date, including 119.4 acres paying development mitigation fees and 0.65 acres paying wetland mitigation fees. The acreages were adjusted to incorporate temporary impact fees (which pay a reduced per-acre fee) and multipliers associated with rural roads. In addition, about 177 linear feet of streams have paid the streams restoration fee. **Table 2** also shows the total fee payments associated with the three different fee scenarios. Particular points of note include:

- The large majority of developer payments to date (about 90 percent) have been associated with the development mitigation fee.

- The wetland mitigation fee increases have been balanced out by the reduced stream payments, meaning that overall developer cost burden to date would have been similar under the current 2011 and recommended 2011 fee structures.

The actual future levels of development will not precisely mimic the distributions between development, wetland, and stream fee payments. As a result, it remains important to tie each of these elements to their own particular cost characteristics. It is also possible, for example, that the additional costs in wetland mitigation fee payments will be more under the recommended 2011 fee schedule than savings from the reductions in the streams fee. Nevertheless, the relatively limited level of wetland impacts from all covered development activities will continue to mean that the aggregate effect of the wetlands fee increase will be proportionally modest.

Table 1
Comparison of Mitigation Fee Amounts at the Time of HCP/NCCP Approval with Current and Recommended Fees

Fee Type/ Category	2006 Original Fee per Acre (2006 dollars)	2011 Current [1] Fee per Acre (2011 dollars)	2011 Recommended Fee per Acre (2011 dollars)
Development Fees			
Zone I	$11,919	$10,662	$10,662
Zone II	$23,838	$21,324	$21,324
Zone III	$5,960	$5,332	$5,332
"Zone IV" [2]	$17,879	$15,993	$15,993
Wetland Mitigation Fee			
Riparian Woodland/ Scrub	$58,140	$64,570	$68,000
Perennial Wetland	$79,560	$88,359	$117,000
Seasonal Wetland	$172,380	$191,445	$245,000
Alkali Wetland	$163,200	$181,250	$228,000
Ponds	$86,700	$96,289	$117,000
Aquatic (Open Water)	$43,860	$48,711	$58,000
Slough/ Channel	$98,940	$109,883	$124,000
Streams 25 feet wide or less	$474 [3]	$526 [3]	$407 [3]
Streams Greater than 25 feet wide	$714 [3]	$793 [3]	$613 [3]

[1] Current fee levels reflect application of the annual, automatic adjustment process to the original fees.
[2] Zone IV applies to certain covered projects within Antioch, such as EBART. HCP/NCCP provides that fees in this area will be an average of the Zone I and Zone II fees.
[3] Per linear foot

Sources: East Contra Costa County Habitat Conservancy; Economic & Planning Systems, Inc.

Table 2
Comparison of Cumulative Mitigation Costs from all Projects Covered by the HCP/NCCP to Date*

Fee Type/ Category	Total Acres of Impact Under HCP/NCCP to Date[1]	2006 Original Fee (2006 dollars)	2011 Current Fee [2] (2011 dollars)	2011 Recommended Fee (2011 dollars)
Development Fees				
Zone I	58.70	$699,660	$625,882	$625,882
Zone II	53.00	$1,263,372	$1,130,150	$1,130,150
Zone III	0.13	$779	$697	$697
"Zone IV" [3]	7.55	$134,911	$120,685	$120,685
Subtotal	**119.38**	**$2,098,722**	**$1,877,413**	**$1,877,413**
Wetland Mitigation Fee				
Riparian Woodland/ Scrub	0.26	$15,144	$16,818	$17,712
Perennial Wetland	0.02	$1,448	$1,608	$2,129
Seasonal Wetland	0.29	$50,283	$55,844	$71,466
Alkali Wetland	0.00	$8	$9	$11
Ponds	0.00	$0	$0	$0
Aquatic (Open Water)	0.00	$0	$0	$0
Slough/ Channel	0.08	$7,849	$8,717	$9,837
Subtotal	**0.65**	**$74,732**	**$82,997**	**$101,156**
Streams 25 feet wide or less	133.05 [4]	$63,066 [4]	$70,041 [4]	$54,127 [4]
Streams Greater than 25 feet wide	43.98 [4]	$31,401 [4]	$34,874 [4]	$26,950 [4]
Subtotal	**177.03 [4]**	**$94,467 [4]**	**$104,915 [4]**	**$81,077 [4]**
Total [5]	**120.03**	**$2,267,921**	**$2,065,325**	**$2,059,646**

[1] Acreage totals reflect all acres paying permanent impact fees. Acres of temporary impacts, cell tower buffers, or rural roads which pay a modified per acre fee were included in the totals but prorated at the appropriate rate.
[2] Current fee levels reflect application of the annual, automatic adjustment process to the original fees.
[3] Zone IV applies to certain covered projects within Antioch, such as EBART. HCP/NCCP provides that fees in this area will be an average of the Zone I and Zone II fees.
[4] Measured in linear feet
[5] Total acreage does not include linear feet of stream.

***Note: This table illustrates the collective fee burden from all 21 projects covered under the HCP/NCCP between 2008 and 2011 assuming all projects paid fees at the Original, Current, and Recommended levels.**

Sources: East Contra Costa County Habitat Conservancy; Economic & Planning Systems, Inc.

East Contra Costa County HCP / NCCP Mitigation Fee Audit

Prepared For:

East Contra Costa County Habitat Conservancy

Prepared By:

Robert D. Spencer, Urban Economics

Hausrath Economics Group

AECOM

Willdan Financial Services

December 2012

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EXECUTIVE SUMMARY

The purpose of this report is to present the findings, conclusions, and recommendations of an audit of mitigation fees that partially fund the *East Contra Costa Habitat Conservation Plan and Natural Community Conservation Plan* (the Plan). The purpose of this audit is to fulfill the requirements of the periodic audit requirements of the Plan. The audit also provides the basis for the five-year review findings required by the Mitigation Fee Act (MFA).

Revenue sources to fund estimated Plan costs during the 30-year permit term include four types of mitigation fees:

- Development Fee
- Wetland Mitigation Fee
- Rural Infrastructure Fee
- Temporary Impact Fee.

Covered activities that cause permanent impacts pay the development fee or rural infrastructure fee depending on location (inside or outside the Urban Development Area or "UDA"). Covered activities that cause temporary impacts pay the temporary impact fee regardless of location. All projects that cause impacts on aquatic land cover types pay the wetland mitigation fee in addition to the applicable development or rural infrastructure fee. **Table E.1** summarizes how the four types of mitigation fees are applied to covered activities based on location and type of impact.

Table E.1: Application of Mitigation Fees To Covered Activities

	Location of Impact	
Type of Impact	**Inside UDA**	**Outside UDA**
Permanent	• Development fee • Wetland mitigation fee (if applicable)	• Rural infrastructure fee • Wetland mitigation fee (if applicable)
Temporary	• Temporary impact fee (plus temporary wetland mitigation fee if applicable)	

Note: "UDA" is the urban development area.

This audit recognizes that post-permit term costs are currently an unfunded liability of the Plan. All cost estimates presented in this audit would be higher if post-permit term costs were included. Mitigation fees would be higher if the Conservancy included post-permit term costs in the fee calculation.

For the development fee the results of the audit are compared to the fees in the original Plan and the current adopted fees in **Table E.2**. The development fee is also the basis for the rural infrastructure and temporary fees so the same trends would apply to those fees as well. The recommended development fee is one percent less than current levels based on the results of this audit. The recommended fee is 12 percent below the fee originally calculated in the Plan primarily because of a decrease in land acquisition costs associated with the decline in real estate prices in East Contra Costa County since 2006. The impact of lower land prices more than offset a 14 percent increase in the consumer price index over the same period affecting other Plan costs.

Table E.2: Development Fee Comparison

	Plan	Current Fee	Nexus Analysis Update[1]	Nexus Analysis Update Compared To:	
	2006	2012	2012	Plan 2006	Current 2012
Zone 1	11,919	10,584	10,526	(12%)	(1%)
Zone 2	23,838	21,169	21,052	(12%)	(1%)
Zone 3	5,960	5,293	5,263	(12%)	(1%)

Note: Fees exclude post-permit costs. Fees would be higher if these costs were included in the analysis.

[1] Represents fee for initial urban development area. Fee for maximum urban development area is lower.

Sources: Table 5.3.

For the wetland mitigation fee the results of the audit are compared to the fees in the original Plan and the current adopted fees in **Table E.3**. The wetland mitigation fee is also the basis for the wetland mitigation component of the temporary fee so the same trends would apply to the wetland component of that fees as well.

The habitat restoration/creation costs shown in Table 3.1 are significantly higher than the 2006 Plan estimates for all aquatic land cover types except streams. Construction unit costs increased between 21 percent and 89 percent for the seven wetland and pond land cover types, and decreased 30 percent for stream projects. The reason for these changes is that estimates developed for the Plan did not have the benefit of actual project cost experience in Eastern Contra Costa County gained since year 1. These costs may change significantly in the future based on future project experience.

Table E.3: Wetland Mitigation Fee Comparison

		Plan	Current Cities/ County[1]	Nexus Analysis Update	Nexus Analysis Update Compared To:	
		2006	2012	2012	Plan 2006	Current Cities/ County[1]
Riparian	per acre	$58,140	$66,462	$87,978	51%	32%
Perennial Wetland	per acre	79,560	90,948	129,261	62%	42%
Seasonal Wetland	per acre	172,380	197,053	299,636	74%	52%
Alkali Wetland	per acre	163,200	188,559	302,668	85%	61%
Aquatic (Open Water)	per acre	86,700	99,110	163,972	89%	65%
Aquatic (Open Water)	per acre	43,860	50,138	81,986	87%	64%
Slough / Channel	per acre	98,940	113,102	119,488	21%	6%
Streams (<=25 ft. wide)	per linear foot	474	542	334	(30%)	(38%)
Streams (>25 ft. wide)	per linear foot	714	816	501	(30%)	(39%)

[1] The "Cities/County" fee applies to most covered activities at this time, those subject to city or county implementing ordinances, and represents the fee updated for inflation in 2012. The ECCC Habitat Conservancy currently uses an updated fee schedule based on the results of an audit completed in 2011. The fee schedule only applies to participating special entities and others who apply directly by the Conservancy for permit coverage because the cities and the County did not adopt it.

Sources: Table 4.2.

The increase in the wetland cover fee for a covered activity is typically not as large as indicated by the results in Table E.3. Wetland mitigation fees are calculated based on the surface area of the aquatic land cover type affected regardless of the total acres of impact of the covered activity. Aquatic land covers are typically small areas so wetland mitigation fees are typically applied to a small portion of the total acres of impact.

An example of the overall effect of the updated fees calculated in this audit on mitigation fee revenues is shown in **Table E.**4. The table uses the actual impact data for the years 1-5 to illustrate how total fee revenues would have varied under three fee schedules: (1) the original Plan fees, (2) the current fee schedule, and (3) the fees recommended by this audit. The results in Table E.4 indicate that based on the fee levels recommended by this audit:

- Total mitigation fee revenues decline to levels below both the original Plan fees and the current fees.
- Both development fee and wetland mitigation fee revenues decline to levels below both the original Plan fees and the current fees.
- Wetland mitigation fee revenue declines because the decrease in the stream fee more than offsets the increase in fees on other aquatic land cover types.

Table E.4: Comparison of Mitigation Costs To Date (Years 0-5)

	Impact Years 1-5		Plan	Current Fee	Nexus Analysis Update
	2007-2012		2006	2012	2012
Non-Aquatic Fees					
Development Fee					
Zone 1	91	acres	$1,085,000	$963,000	$958,000
Zone 2	24	acres	572,000	508,000	505,000
Zone 3	3	acres	18,000	16,000	16,000
Rural Infrastructure Fee[1]	29	acres	691,000	614,000	611,000
Subtotal			$2,366,000	$2,101,000	$2,090,000
Wetland Mitigation Fee					
Riparian	0.30	acres	17,000	20,000	26,000
Perennial Wetland	0.03	acres	2,000	3,000	4,000
Seasonal Wetland	0.42	acres	72,000	83,000	126,000
Slough / Channel	0.07	acres	7,000	8,000	8,000
Streams (<=25 ft. wide)	348	linear ft.	165,000	189,000	116,000
Streams (>25 ft. wide)	173	linear ft.	124,000	141,000	87,000
Subtotal			$387,000	$444,000	$367,000
Total			$2,753,000	$2,545,000	$2,457,000

Note: Fees exclude post-permit costs. Fees would be higher if these costs were included in the analysis.

Note: Estimated fee revenues are similar to but do not equal actual revenues (see Appendix F) because of: (1) annual adjustments to fee levels, (2) adjustments to rural infrastructure fees for rural road impacts, and (3) adjustment to rural infrastructure fees for Antioch area impacts. Temporary fees are excluded.

[1] Based on zone 2 fee. Actual fee varies based on project location and impacts (see Chapter 6).

Sources: Tables 2.1, 4.2, 4.3, and 5.3.

4. WETLAND MITIGATION FEE

This chapter presents the updated wetland mitigation fee schedule and the reasonable relationship findings required by the MFA and explained in Chapter 1. Unless the applicant chooses to perform their own restoration or creation, the wetland mitigation fee is applied to covered activities that generate permanent impacts on aquatic land cover types whether inside or outside the UDA.[19] Wetland mitigation fees are calculated based on the surface area of the aquatic land cover type impacted, regardless of the size of the covered activity or the total amount of impacts. The wetland mitigation fee is therefore typically applied to small portion of the total impacts of a covered activity.

Updated Fee Schedule

The wetland mitigation fee is based on the unit costs (cost per acre or cost per linear foot for streams) presented in the prior chapter multiplied by a mitigation ratio established by the Plan. The mitigation ratio represents the restoration area needed to mitigate one acre (or one linear foot in the case of streams) of impact. Most mitigation ratios are one-to-one, that is one acre of impact requires one acre of wetland restoration/creation to mitigate impacts. Several land cover types require a higher or lower mitigation ratio to adjust for the relative ability of restoration projects to mitigate the types of impacts associated with a given land cover type. The updated wetland mitigation fees based on mitigation ratios by land cover type are shown in **Table 4.1**.

Consistent with the habitat restoration/creation cost estimates explained in Chapter 3, above, the wetland mitigation fee is only related to the one-time activity of restoration or creation of aquatic land cover types. The three other fees presented in the following two chapters of this report address the other Plan costs to mitigate the impacts of covered activities on aquatic land cover types. These other costs include, for example, acquisition of sites for wetland, pond, and stream restoration/creation, preservation of existing wetland, pond, and stream habitat and long-term management, maintenance, and monitoring of habitat restoration/creation sites.

[19] 2006 Plan, Chapter 9, pp. 9-23 to 9-24 and Table 9-5.

Table 4.1: Wetland Mitigation Fee Schedule

	Habitat Restoration / Creation Cost		Mitigation Ratio	Wetland Impact Fee	
Riparian	$ 87,978	per acre	1:1	$ 87,978	per acre
Perennial Wetland	129,261	per acre	1:1	129,261	per acre
Seasonal Wetland	149,818	per acre	2:1	299,636	per acre
Alkali Wetland	151,334	per acre	2:1	302,668	per acre
Pond	163,972	per acre	1:1	163,972	per acre
Aquatic (Open Water)	163,972	per acre	0.5:1	81,986	per acre
Slough / Channel	119,488	per acre	1:1	119,488	per acre
Streams (<=25 ft. wide)	334	per linear foot	1:1	334	per linear foot
Streams (>25 ft. wide)	501	per linear foot	1:1	501	per linear foot

Sources: 2006 Plan, Tables 5-16 and 5-17; Table 3.1.

Table 4.2 compares the updated wetland mitigation fee to the fee in the 2006 Plan, the adopted fees for year 1 in 2007, and the current fee. The current fee has two levels. The "Cities/County" level applies to covered activities subject to city or county implementing ordinances. The "Conservancy" level represents the results of an audit completed in 2011 but not adopted by the cities and the County and therefore only applies to participating special entities who apply directly by the Conservancy for permit coverage. Most covered activities are currently paying the "Cities/County" fee.

Estimated restoration costs and revenues associated with aquatic land cover impacts are shown in **Table 4.3**. The table multiplies the aquatic land cover acreage impacts from Table 2.4 by the update fee schedule in Table 4.1. The 30-year revenue estimates in the table are used in the development fee calculation presented in Chapter 5.

The reasons for the significant increase in fees on wetland and pond (non-stream) land cover types were explained in Chapter 3. These fees only apply to the actual surface area of wetland on the site of a covered activity and typically are significantly less than one acre. Of the 10 covered activities that paid a wetland mitigation fee in years 1-5, impacts subject to the fee were typically less than 0.20 acres and stream impacts were typically less than 50 linear feet (see Table A.1 in Appendix A).

Table 4.2: Wetland Mitigation Fee Comparison

		Plan	Initial Adopted	Current Cities/ County[1]	Current Conser-vancy[1]	Nexus Analysis Update	Nexus Analysis Update Compared To:		
		2006	2007	2012	2012	2012	Plan 2006	Current Cities/ County[1]	Current Conser-vancy[1]
Riparian	per acre	$58,140	$60,004	$66,462	$69,992	$87,978	51%	32%	26%
Perennial Wetland	per acre	79,560	82,111	90,948	120,428	129,261	62%	42%	7%
Seasonal Wetland	per acre	172,380	177,908	197,053	252,178	299,636	74%	52%	19%
Alkali Wetland	per acre	163,200	168,433	188,559	234,680	302,668	85%	61%	29%
Aquatic (Open Water)	per acre	86,700	89,480	99,110	120,428	163,972	89%	65%	36%
Aquatic (Open Water)	per acre	43,860	45,266	50,138	59,699	81,986	87%	64%	37%
Slough / Channel	per acre	98,940	102,113	113,102	127,633	119,488	21%	6%	(6%)
Streams (<=25 ft. wide)	per linear foot	474	489	542	419	334	(30%)	(38%)	(20%)
Streams (>25 ft. wide)	per linear foot	714	737	816	631	501	(30%)	(39%)	(21%)

Note: Fees and revenues exclude post-permit costs. Amounts would be higher if these costs were included in the analysis.

[1] The "Cities/County" fee applies to most covered activities at this time, those subject to city or county implementing ordinances, and represents the fee updated for inflation in 2012. The "Conservancy" fee represents the results of an audit completed in 2011. The fee schedule only applies to participating special entities and others who apply directly by the Conservancy for permit coverage because the cities and the County did not adopt it.

Sources: 2006 Plan, Table 9-5; , ECCC Habitat Conservancy, "Annual Adjustment of East Contra Costa County Habitat Conservation Plan / Natural Community Conservation Plan ("HCP/NCCP") Mitigation Fees" (table); Table 4.1.

Table 4.3: Wetland Mitigation Fee Revenue

	Wetland Mitigation Impact Fee		Estimated Wetland Mitigation Fee Revenue (Year 6-30) Initial UDA	Maximum UDA
Riparian	$87,978	per acre	$2,610,000	$3,050,000
Perennial Wetland	129,261	per acre	2,870,000	2,900,000
Seasonal Wetland	299,636	per acre	3,650,000	4,910,000
Alkali Wetland	302,668	per acre	2,540,000	2,810,000
Pond	163,972	per acre	1,150,000	1,310,000
Aquatic (Open Water)	81,986	per acre	980,000	980,000
Slough / Channel	119,488	per acre	8,590,000	8,590,000
Subtotal			$22,390,000	$24,550,000
Streams (<=25 ft. wide)	334	per linear foot	6,940,000	8,700,000
Streams (>25 ft. wide)	501	per linear foot	1,500,000	2,030,000
Total			$30,830,000	$35,280,000
			Estimated Wetland Mitigation Fee Revenue (Year 1-30) Initial UDA	**Maximum UDA**
Actual (Year 0-5)			$640,000	$640,000
Estimated (Year 6-30)			30,830,000	35,280,000
Total (Year 0-30)			$31,470,000	$35,920,000

Note: "UDA" is the urban development area.

Sources: Tables 2.4 and 4.1; Appendix F, Table F.1.

Mitigation Fee Act Findings

The following findings are required by the MFA and were presented in Chapter 1.

Purpose: Identify the purpose to which the fee is to be put.

The wetland mitigation fee is intended to pay the full cost of restoration or creation of aquatic land cover types, including design, implementation, post-construction monitoring, and remediation. The development fee described in

the next chapter will fund acquisition of the site for the restoration or creation and the management and monitoring after the wetland is fully functioning. Restoration of oak savanna is also required by the Plan, but the cost of this restoration is included in the development fee because it is not associated with jurisdictional wetlands and waters.

Impact: *Identify a reasonable relationship between the need for the fee and the type of development paying the fee.*

A reasonable relationship exists between the need for the wetland mitigation fee and covered activities that would pay the fee. Chapter 3 of the Plan explains the relationship between the 17 animal and 11 plant species covered under the Plan and aquatic land cover types (see Table 3-9 in Chapter 3 of the Plan). Chapter 4 of the Plan explains the impacts of covered activities on these animal and plant species, and more broadly on natural communities. The importance of aquatic land cover types is demonstrated by:

- The eight aquatic land cover types provide habitat for all 17 animal species covered under the Plan.
- Individual aquatic land cover types provide habitat for at least three and, in the case of seasonal wetlands, as many as 11 covered animal species.
- Vernal pools are an essential habitat for four covered species and 11 covered plants.

Benefit: *Identify a reasonable relationship between the use of fee revenues and the type of development paying the fee.*

A reasonable relationship exists between the use of wetland mitigation fee revenue and covered activities that would pay the fee. Chapter 5 of the Plan explains the conservation strategy and Chapter 9 explains the costs associated with implementing the strategy. The conservation strategy is designed to mitigate the impacts on species and natural communities within aquatic land cover types summarized in the finding, above.

Specific elements of the strategy from Chapter 5 of the Plan that relate to the restoration or creation of wetlands, ponds, and streams include:

- Conservation methods include:
  - Biological goals and objectives that include the restoration and creation of wetlands, ponds, and streams.
  - Mitigation of impacts on state and federal jurisdictional wetlands and waters.
- Conservation measures including:

2013 IRWMP

St. Helena Upper York Creek Dam Removal and Ecosystem Restoration Project

Selected Reference Materials

The “Original Location” references include:

Acronym Used Below	Full Citation
CDFG 1992	California Department of Fish and Game. 1992. Brian Hunter Letter to City of St. Helena, July 30, 1992.
CDFG 2005	California Department of Fish and Game. 2005. *Central Napa River Watershed Project, Salmonid Habitat Form and Function*. Prepared by Napa County Resource Conservation District.
Chiabai 2009	Chiabai, A., C. Travisi, H. Ding, et al. Economic Valuation of Forest Ecosystem Services' Methodology and Monetary Estimates. Fondazione Eni Enrico Mattei Working Paper No. 2009. 12.
Corps DPR 2006	U.S. Army Corps of Engineers (Corps). 2006. Draft Detailed Project Report: Upper York Creek Ecosystem Restoration Project, Napa County, California (DPR). U.S. Army Corps of Engineers, San Francisco District, South Pacific Division. December 15, 2006.
Costs Memo 2013	Prunuske Chatham, Inc. 2013. Memo to File: Upper York Creek Dam Annual No Project Alternative Costs. January 24, 2013.
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ECON 2009	ECONorthwest. 2009. The Economic Values of Rogue River Salmon. January 2009.
H&H 2007	City of St. Helena. 2007b. Lower York Creek Hydrologic and Hydraulic Assessment Summary Report. July 5, 2007.
IS/MND 2002	City of St. Helena. 2002. *Initial Study/Proposed Mitigated Negative Declaration For the York Creek Dam Removal and Stream Restoration Project, Napa County, California.*
Koehler 2012	Koehler, J., & Blank, P. (2012). *Napa River Steelhead and Salmon Monitoring Program: 2011-2012 Season.* Napa, California: Napa County Resource Conservation District.
Kondolf 1997	Kondolf, G. 1997. Hungry Water: Effects of Dams and Gravel Mining on River Channels. Environmental Management Vol. 21, No. 4, pp. 533–551
Nordhaus 2008	Nordhaus, W. 2008. A Question of Balance: Weighing the Options on Global Warming Policies. New Haven: Yale University Press.
Shaw 2008	Shaw, M., L. Pendleton, D. Cameron, et al. 2009. The Impact of Climate Change on California's Ecosystem Services. California Climate Change Center. CEC-500-2009-025-F.
Smith 2006	Smith, James E., Linda S. Heath, Kenneth E. Skog, Richard A. Birdsey. 2006. *Methods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the United States.* United States Department of Agriculture, Forest Service, Northeastern Research Station. General Technical Report NE-343. Appendix A, Table B21.
Stillwater 2002	Stillwater Sciences and William Dietrich. 2002. Napa River Basin Limiting Factors Analysis Final Technical Report. June 14, 2002
Woodward 2001	Woodward, W. and Y. Wui. 2001. "Economic Value of Wetland Services: A Meta-Analysis." Ecological Economics 37: 257-270.

Benefit/Background	Location in Application	Original Reference	Page Herein
Restore fish passage for steelhead:			
Restore anadromous fish passage, quantified as 1.7 miles of spawning and rearing habitat that can support 825-1,811 juvenile steelhead annually.	Monetized Benefit-Cost Questionnaire	DEIR p.1 DEIR p.75 Corps DPR Appendix L p.10 IS/MND 2002 p.2	7 11 14-15 40
York Creek is one of the most significant spawning and rearing streams for federally listed as threatened Central California Coast steelhead within the Napa Basin. Removing the reservoir will allow access to 1.7 miles of aquatic habitat. The upper reaches of York Creek offer high quality rearing and spawning habitat, and creating access to these areas will benefit the Napa River watershed steelhead population as a whole.	Monetized Benefit-Cost Questionnaire and Monitoring, Assessment, and Performance Measures	CDFG 2005	16-17
Restore sediment transport:			
Restore sediment delivery to lower York Creek and Napa River. Sediment accumulates in the reservoir at a rate of 1,000 to 5,000 cubic yards per year depending on the magnitude of winter storm events. UYCD traps all the coarse sediment delivered from the watershed upstream of the dam – 63% of the watershed's sediment source area. Removal of UYCD will allow sediment produced in the upper watershed to be transported through the lower reaches to the Napa River.	Monetized Benefit-Cost Questionnaire	DEIR p.1 DEIR p. 134 Stillwater 2002	7 13 18-19
Disruption of sediment transport by dams has been shown to have significant geomorphic, ecological, and economic impacts.	Economic Analysis Key Assumptions and Data Sources	Kondolf 1997	42-44
Dams intercept coarse sediment and, thereby, reduce delivery to downstream reaches, which can cause bed coarsening and channel incision.	Economic Analysis Key Assumptions and Data Sources	Stillwater 2002	18-19
Restore aquatic habitat:			
Restore 1.7 miles of aquatic habitat, including 0.30 acres of pool, 0.33 acres of flatwater, and 0.85 acres of riffle habitat. Restoration area measurements were taken from conceptual project plans.	Monetized Benefit-Cost Questionnaire	DEIR p.1 DEIR p.86 Corps DPR 2006 Sheet 5	7 12 41
Removal of Upper York Creek Dam will provide access to an additional 1.7 miles of fish spawning and rearing habitat for federally listed steelhead.	Monitoring, Assessment, and Performance Measures	DEIR p.1	7
The restored spawning and rearing habitat in upper York Creek has an estimated carrying capacity of 825-1,811 juvenile steelhead annually	Monitoring, Assessment, and Performance Measures	Corps DPR Appendix L p.10	14-15

Benefit/Background	Location in Application	Original Reference	Page Herein
Ocean survival rates of Napa River steelhead smolt are estimated to range between 15-25%	Monitoring, Assessment, and Performance Measures	Koehler 2012 p.12	45-46
Restore riparian habitat:			
Restore 2.0 acres of riparian habitat, quantified as 0.4 acres of streambank, 0.5 acres of terrace, and 1.1 acres of riparian zone. Restoration area measurements were taken from conceptual project plans.	Monetized Benefit-Cost Questionnaire	DEIR p.86 Corps DPR 2006 Sheet 5	12 41
Sequester carbon emissions:			
Sequester 280 metric tons CO_2 by 2100 that would not occur without project implementation due to on-going disturbance to trees during maintenance. Carbon sequestration was estimated using tables for Northwest, West Alder/Maple forests. Only live tree sequestration was included.	Monetized Benefit-Cost Questionnaire	Smith 2006	20-22
Estimates of potential carbon sequestration were developed using tables for Northwest, West Alder/Maple forests from Smith et. al. 2006.	Monitoring, Assessment, and Performance Measures	Smith 2006	20-22
The current social value of carbon sequestration in California is estimated at $13 per ton (Shaw, 2009), increasing at a real rate of 2.5% per year (Nordhaus, 2008).	Monitoring, Assessment, and Performance Measures	Shaw 2008 Nordhaus 2008	23-31 32-33
Eliminate risk of future spills to protect downstream habitat:			
Eliminate potential for future downstream habitat degradation and fish kills. Downstream release of fine sediments trapped behind Upper York Creek Dam pose significant risk to aquatic species.	Monetized Benefit-Cost Questionnaire and Monitoring, Assessment, and Performance Measures	DEIR p.4	9
Downstream release of fine sediments trapped behind Upper York Creek Dam pose significant risk to aquatic species. Prior to 1993 when annual maintenance and periodic dredging were begun, there were four recorded sediment releases (1965, 1973, 1975, 1992), resulting in significant downstream fish kills (Hunter 1992).	Monetized Benefit-Cost Questionnaire and Monitoring, Assessment, and Performance Measures	CDFG 1992 p.1	34-37
Eliminate annual costs of No Project Alternative:			
Eliminate annual costs ($145,783) for dam maintenance and annual NMFS assessment for blocking salmonid migration. Dam maintenance costs average $125,783 per year, plus $20,000 assessment from NMFS.	Monetized Benefit-Cost Questionnaire and Monitoring, Assessment, and Performance Measures	Costs Memo 2013	38

Benefit/Background	Location in Application	Original Reference	Page Herein
Related information:			
To avoid overestimating potential benefits and to account for inherent uncertainty in both the expected increase in the adult salmonid population and WTP estimates, a value of $2,000 per fish is used to value the restoration of fish spawning and rearing habitat above Upper York Creek Dam.	Monitoring, Assessment, and Performance Measures	ECON 2009	47-52
Economic values for restored riparian habitat vary widely and depend on many factors. At the very low end of the value range, Chiabai et al. (2009) report a value of $128/acre/yr for restored riparian.	Monitoring, Assessment, and Performance Measures	Chiabai 2009	53-55
Woodward & Wui (2001) report values between $218 and $2,256/acre/yr for freshwater wetland	Monitoring, Assessment, and Performance Measures	Woodward 2001	56-58

Prunuske Chatham, Inc
Design and Construction Cost Estimate
Summary Sheet
1/25/2013

Upper York Creek Dam Removal
Cost Estimate

Cost Element	Cost
Prime Contractor Labor	$1,354,472
Prime Contractor Equipment	$264,439
Prime Contractor Materials	$440,741
Subcontractors	$2,056,527
Construction Subtotal	**$4,116,179**
Design	$240,000
Permits	$50,000
Contractor Procurement	$10,000
Construction Mngmnt Special Inspection	$120,000
Design Permit CM Subtotal	**$420,000**
Total	**$4,536,179**

Notes

All spoils are accepted by Spring Mountain Vineyard (SMV), no spoils go to LYCD or to Clover Flat
SMV prepares stockpile site at no cost to project
SMV handles its own erosion control at stockpile
Stream flow at April 15 is 5cfs or less
Round trip to SMV is 0.5 hours
A 10 Wheel dump truck can enter and exit the site every 5 minutes for 9 hours per day for about 2.5 months
Project provides spoil pile management at SMV
Need to confirm feasibility of SMV accepting all soil (approximately 30,000 to 40,000 yards)
Landslide stabilization design is conceptual and assumed 22 ISAs 50'-100' deep
Channel bed design is conceptual
Channel Bed material is supplied 30% from on-site material and 70% trucked in from a quarry
Spring Mountain Road Repair has a WAG for budget, see subcontractor work sheet
Erosion control blanket installation assumes a maximum use of blanket
10 woody debris structures assumed, complexity of each structure assumed to be medium
There are no toxic waste materials

Napa River Basin
Limiting Factors Analysis

FINAL TECHNICAL REPORT

Prepared for

San Francisco Bay Water Quality Control Board
1515 Clay St, Suite 1400
Oakland, CA 94612

and

California State Coastal Conservancy
1330 Broadway Ave, Suite 1100
Oakland, CA 94612

Prepared by

Stillwater Sciences
2532 Durant Avenue
Berkeley, CA 94704

and

Professor William Dietrich
Department of Earth and Planetary Science
University of California, Berkeley 94720

14 June 2002

Stillwater Sciences

the incised current level of the mainstem Napa River. In some cases, smaller tributaries cutting across the valley floor have not fully adjusted to the lowered level of the mainstem and are elevated at their confluence with the mainstem, forming potential barriers to upstream fish migration referred to as "hanging tributaries."

Based on field reconnaissance of Napa River tributaries, we conclude that pools appear to be less frequent than would be expected under historical conditions, where large woody debris loading would have created obstructions and forced deep pools to form. Our field observations in several tributaries, particularly those on the west side, indicate that large woody debris loading (amount per length of channel) is much lower than would be typical of streams in unmanaged mixed evergreen forests. Although the history of wood removal from the Napa River and its tributaries is poorly known (there are some records of stream clearing projects in the 1960s and 1970s), large woody debris has likely been reduced by direct removal from many or most streams for a variety of reasons. The reduction in large woody debris loading has likely increased the mobility of spawning gravels and reduced the diversity of in-channel habitats in Napa River tributaries. Additionally, loss of large woody debris has likely reduced cover for juvenile steelhead rearing in tributaries. A channel lacking sufficient deep-water refugia would likely increase exposure of fish to higher temperatures and greater predation pressure by terrestrial predators such as birds, snakes, and mammals. Large woody debris may also be reduced because of increases in the magnitude and duration of peak flows capable of dislodging debris jams, possibly as a result of land use changes.

Several large dams were built between 1924 and 1959 on major eastside tributaries (Conn, Rector, Milliken, and Bell dams) and the northern headwaters of the Napa River (Kimball Dam). In addition, many smaller dams can be found throughout the basin. Many of these dams intercept coarse sediment supply, and thereby reduce delivery to downstream reaches, which can cause bed coarsening and channel incision (although incision may be limited by bedrock and bed coarsening).

6.2 Sediment-Related Impacts on Salmonid Habitat

We examined sediment-related impacts on salmonid habitat in the Napa River watershed by examining factors that are: (1) known to affect salmonid reproductive success directly, (2) targeted by proposed habitat rehabilitation efforts, and (3) cost-effective and efficient given the size of the study area. Sediment-related factors evaluated during Phase I included:

- Turbidity (which can affect salmonid feeding efficiency, growth, and survival);
- Spawning gravel permeability in the mainstem and the tributaries (which affects survival-to-emergence of steelhead and Chinook salmon eggs);
- Bed mobility in the mainstem (which also affects survival-to-emergence for steelhead and Chinook); and
- Filling of pools in the tributaries (which reduces the quality and quantity of juvenile rearing habitat).

6.2.1 Turbidity and Juvenile Feeding and Growth

High turbidity and suspended sediment concentrations can have detrimental effects on aquatic biota in river systems (e.g., Bisson and Bilby 1982, Berg and Northcote 1985, Newcombe and Jensen 1996). While very high turbidity levels may cause acute physiological stress and tissue damage to some aquatic organisms during peak flows, fish tend to survive high turbidity levels

2013 IRWMP

St. Helena Upper York Creek Dam Removal and Ecosystem Restoration Project

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Restore sediment transport:			
Restore sediment delivery to lower York Creek and Napa River. Sediment accumulates in the reservoir at a rate of 1,000 to 5,000 cubic yards per year depending on the magnitude of winter storm events. UYCD traps all the coarse sediment delivered from the watershed upstream of the dam – 63% of the watershed's sediment source area. Removal of UYCD will allow sediment produced in the upper watershed to be transported through the lower reaches to the Napa River.	Monetized Benefit-Cost Questionnaire	DEIR p.1 DEIR p. 134 Stillwater 2002	7 13 18-19
Disruption of sediment transport by dams has been shown to have significant geomorphic, ecological, and economic impacts.	Economic Analysis Key Assumptions and Data Sources	Kondolf 1997	42-44
Dams intercept coarse sediment and, thereby, reduce delivery to downstream reaches, which can cause bed coarsening and channel incision.	Economic Analysis Key Assumptions and Data Sources	Stillwater 2002	18-19
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Restore 1.7 miles of aquatic habitat, including 0.30 acres of pool, 0.33 acres of flatwater, and 0.85 acres of riffle habitat. Restoration area measurements were taken from conceptual project plans.	Monetized Benefit-Cost Questionnaire	DEIR p.1 DEIR p.86 Corps DPR 2006 Sheet 5	7 12 41
Removal of Upper York Creek Dam will provide access to an additional 1.7 miles of fish spawning and rearing habitat for federally listed steelhead.	Monitoring, Assessment, and Performance Measures	DEIR p.1	7
The restored spawning and rearing habitat in upper York Creek has an estimated carrying capacity of 825-1,811 juvenile steelhead annually	Monitoring, Assessment, and Performance Measures	Corps DPR Appendix L p.10	14-15

Benefit/Background	Location in Application	Original Reference	Page Herein
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Estimates of potential carbon sequestration were developed using tables for Northwest, West Alder/Maple forests from Smith et. al. 2006.	Monitoring, Assessment, and Performance Measures	Smith 2006	20-22
The current social value of carbon sequestration in California is estimated at $13 per ton (Shaw, 2009), increasing at a real rate of 2.5% per year (Nordhaus, 2008).	Monitoring, Assessment, and Performance Measures	Shaw 2008 Nordhaus 2008	23-31 32-33
Eliminate risk of future spills to protect downstream habitat:			
Eliminate potential for future downstream habitat degradation and fish kills. Downstream release of fine sediments trapped behind Upper York Creek Dam pose significant risk to aquatic species.	Monetized Benefit-Cost Questionnaire and Monitoring, Assessment, and Performance Measures	DEIR p.4	9
Downstream release of fine sediments trapped behind Upper York Creek Dam pose significant risk to aquatic species. Prior to 1993 when annual maintenance and periodic dredging were begun, there were four recorded sediment releases (1965, 1973, 1975, 1992), resulting in significant downstream fish kills (Hunter 1992).	Monetized Benefit-Cost Questionnaire and Monitoring, Assessment, and Performance Measures	CDFG 1992 p.1	34-37
Eliminate annual costs of No Project Alternative:			
Eliminate annual costs ($145,783) for dam maintenance and annual NMFS assessment for blocking salmonid migration. Dam maintenance costs average $125,783 per year, plus $20,000 assessment from NMFS.	Monetized Benefit-Cost Questionnaire and Monitoring, Assessment, and Performance Measures	Costs Memo 2013	38

Benefit/Background	Location in Application	Original Reference	Page Herein
Related information:			
To avoid overestimating potential benefits and to account for inherent uncertainty in both the expected increase in the adult salmonid population and WTP estimates, a value of $2,000 per fish is used to value the restoration of fish spawning and rearing habitat above Upper York Creek Dam.	Monitoring, Assessment, and Performance Measures	ECON 2009	47-52
Economic values for restored riparian habitat vary widely and depend on many factors. At the very low end of the value range, Chiabai et al. (2009) report a value of $128/acre/yr for restored riparian.	Monitoring, Assessment, and Performance Measures	Chiabai 2009	53-55
Woodward & Wui (2001) report values between $218 and $2,256/acre/yr for freshwater wetland	Monitoring, Assessment, and Performance Measures	Woodward 2001	56-58

Draft Environmental Impact Report
Upper York Creek
Ecosystem Restoration Project

Napa County, California

(State Clearinghouse No. 2006092096)

CEQA Lead Agency

City of St. Helena
1480 Main Street
St. Helena, CA 95474

Contact: Jonathon Goldman
Director of Public Works/City Engineer
707-968-2658

A Joint Project of the

City of St. Helena, Napa County, California
U.S. Army Corps of Engineers, San Francisco District, South Pacific Division

April 20, 2007

1 Proposed Action

1.1 Project Description and Objectives

The *Upper York Creek Ecosystem Restoration Project* is jointly sponsored by the City of St. Helena (City) and the U.S. Army Corps of Engineers (Corps). The project involves alteration or removal of the Upper St. Helena Dam and restoration of the former reservoir area into a natural creek channel and native riparian corridor. Project objectives include:

- **Improved fish passage and habitat connectivity.** The project will provide upstream passage to 1.7 miles of spawning and rearing habitat for steelhead *(Oncorhynchus mykiss)* and habitat connectivity for both anadromous and resident fish and other aquatic and riparian species.

- **Reduced future downstream habitat degradation and fish kills.** The project will prevent potentially detrimental sediment releases during summer low-flow conditions that have caused fish and aquatic organism kills in the past. It will provide a permanent solution to prevent short-term aquatic habitat impairment associated with possible dam breach/failure.

- **Habitat restoration.** The project will restore approximately 3 acres of degraded riparian and aquatic habitat within the existing upper dam and reservoir area. Restoration of natural sediment transport processes will occur through the project site, with potential habitat improvement occurring in downstream reaches of York Creek and the Napa River. Disturbed areas in the project site will be revegetated with a palette of multistory native plants. A diversity of habitats for aquatic, riparian, and terrestrial animals will be provided.

1.2 Project Location

The proposed project is located on the western edge of the Napa Valley near the City of St. Helena. The Napa River runs north to south on the east side of the City, and several of its tributaries flow through the City eastward from the hills of the Mayacmas Mountains. The primary project site is on York Creek, which is one of these tributaries. The proposed project will take place at the Upper York Creek Dam and Reservoir (Upper St. Helena Dam), which is located at 38º 30′ 48″ N, 122º 30′ 9″ W, in the SW ¼, Section 26, Range 6 West, Township 8 North, Mt. Diablo Base and Meridian of the USGS St. Helena Quadrangle, St. Helena, Napa County, California (Figure 1). The project area is zoned AW (Agriculture, Watershed or Open Space Lands).

The project area also includes 3 ancillary sites that are under consideration for reuse or disposal of materials removed during project activities: an adjacent private vineyard, Lower York Creek Reservoir (LYCR or lower reservoir), and Clover Flat landfill. Spring Mountain Vineyard (SMV) is accessed from 2805 Spring Mountain Road, which is located approximately 0.5 miles downhill and south of the upper reservoir; there is also an access road approximately 0.5 miles uphill. The lower reservoir is located less than 0.5 miles downhill on the east side of Spring Mountain Road. Clover Flat is located at 4380 Silverado Trail near Calistoga, 8.5 miles north of the main project site.

1.3 Characteristics of the Project Area

York Creek runs approximately 7.24 miles from its headwaters to its confluence with the Napa River (Corps 2006b). It descends steeply over the first portion of its range then flattens out as it crosses the floodplain of the Napa River. It drains a watershed of approximately 4.4 square miles (Watershed Information and Conservancy Center of Napa County). At the site of the upper reservoir, York Creek traverses a steep valley cut from serpentinite and sheared shale. Vegetation is a mixture of redwood forest, mixed evergreen forest, riparian woodland, foothill pine-oak woodland, freshwater wetland, non-native grassland, vineyards, and ruderal areas.

According to the Napa County Resource Conservation District (NCRCD), York Creek is one of the most significant spawning and rearing streams in the Napa River watershed for Central California Coast ESU steelhead, which are listed as threatened under the federal Endangered Species Act. It has been designated as critical habitat for steelhead by NOAA Fisheries Service. The Napa River watershed is considered one of the key anadromous fish streams within the San Francisco Bay (NCRCD 2005).

The Upper St. Helena Dam is a total barrier to fish passage. It is comprised of an earthen structure, 140 feet wide and 50 feet high. The outlet is a standpipe that collects water near the downstream edge of the reservoir and discharges it through a stone culvert in the bottom center of the dam. The reservoir behind the dam is full of sediment (approximately 28,000 cubic yards, essentially eliminating any water storage capacity) and is no longer used to provide water for the City's needs. The dam itself is made up of approximately 12,000 cubic yards of material. (Corp 2006a)

There are two spillways: the original on the south and a newer, functioning spillway between the reservoir and Spring Mountain Road that was built in 1933. The left wall of the newer spillway (looking downstream) provides structural support to the road, which connects St. Helena to Santa Rosa in Sonoma County.

The reuse site at Spring Mountain Vineyard is a fallow field adjacent to the upper reservoir that will be replanted with grape vines. Lower York Creek Reservoir currently has a storage capacity of approximately 156 acre-feet; it provides untreated water for a portion of the City's agricultural irrigation and construction water demands. The approved disposal facility being considered is Clover Flat landfill, which is located approximately 8.5 miles from the upper reservoir.

1.4 Project Background and History

York Creek was first dammed in 1871. The current dam was built upstream of the original reservoir in 1900 to extend the City's water delivery system to match its expanding development (Eastman 2003). In 1933, a new concrete overflow spillway was added along the eastern edge of the reservoir and dam immediately adjacent to Spring Mountain Road, the crest of the dam was raised 15 feet to its current height of 50 feet, the standpipe outlet was installed, and other incidental modifications were made.

On July 28, 1992, during routine maintenance of the reservoir outlet, there was an accidental sediment discharge downstream of the dam. This significant release resulted in a silt discharge within the streambed from the face of the dam to York Creek's confluence with the Napa River.

The depth of the silt varied from heavy deposits (up to 18 inches) just below the dam and continuing downstream for about 0.5 miles, gradually thinning until only a light covering of fine silt was deposited at the confluence with the Napa River. According to a CDFG letter dated July 30, 1992, this sediment release was the fourth since 1965. In each incidence, "dense anaerobic sediments, high in toxic hydrogen sulfide, were released from the dam and deposited in pools and riffle areas downstream, quickly suffocating and burying all fish and aquatic invertebrates within a mile or more of the dam."

After this discharge, CDFG filed a complaint with the Napa County District Attorney. In September of 1992, CDFG and the City concluded that the City should remove the existing earthen dam structure on York Creek. An agreement was signed obligating the City to remove the dam, stabilize silt, remove silt that had filtered downstream, and take certain precautions to preserve the stability and natural character of the area.

In October 1993, the City applied to the Corps Regulatory Branch for a federal Clean Water Act Section 404 permit to remove the dam. This application and a revised application in 1994 were determined to be incomplete. At the time of the initial 1993-1994 coordination with the Corps, steelhead in the central California coast Evolutionarily Significant Unit (CCC ESU) were not yet listed pursuant to the federal ESA, and the Corps was not obligated to initiate consultation with NOAA Fisheries Service.

On August 18, 1997, NOAA Fisheries Service listed CCC ESU steelhead as threatened with loss of habitat and threats to their current range. In August of 1998, the City sent a letter to Corps Regulatory Branch requesting that they reactivate the previous permit application for dam removal. This request was declined, citing lack of adequate information to evaluate impacts to the aquatic environment from the project.

In October 2000, a letter was sent from NOAA Fisheries Service law enforcement to the City Manager that provided clarification about the City's potential liabilities under the ESA if the Upper St. Helena Dam were to remain in place. On November 21, 2000, the City Attorney sent NOAA Fisheries Service, Corps Regulatory Branch, CDFG, and the Napa County District Attorney a letter explaining that it was the City Council's position that the Upper St. Helena Dam should at least be breached to allow fish passage and that "the downstream diversion structure should be modified so that it is not a barrier or impediment to the passage of steelhead [5]."

Representatives from NOAA Fisheries Service, the City, Department of Water Resources (DWR), CDFG, Corps Regulatory, Corps Civil Works, and the Napa County District Attorney's Office attended a meeting in early 2001 to discuss the project. DWR representatives stated their intention to assist the City by providing planning and permitting services for the project to modify the diversion structure and to remove the Upper St. Helena Dam. Because in-stream work and dewatering were necessary to correct the adverse effects on steelhead, NOAA Fisheries Service advised that the dam removal or modification project would require formal consultation under Section 7 of the federal ESA.

[5] The City removed the lower diversion in 2004. One-half mile of aquatic habitat was opened to the base of the Upper St. Helena Dam. The modifications involved removal of the concrete structure, creation of cascading steps with resting pools, bank stabilization, and revegetation with native species.

downstream migration of smolts, as well as local migration and dispersal of other aquatic species. In addition, the fish ladder is expected to clog with sediment and debris 4 to 7 times each winter, thereby further restricting steelhead passage (Corps 2006a).

The Fish Ladder Alternative allows for the removal of 37% of the sediment behind the dam and removal of 52% of the actual dam structure. The alternative offers limited sediment transport, which paradoxically improves when the ladder is allowed to fill up with debris. The Fish Ladder Alternative would have little impact on the existing support structures for Spring Mountain Road, and, therefore, no additional geotechnical stabilization measures would be required (Section 3.5, Geology, Soils, Landslides, and Seismic Activity).

Construction of the fish ladder would generate approximately 19,000 cubic yards of materials: 1,000 from downstream of the dam, 8,000 cubic yards of dam material, and 10,000 yards of sediment (Corps 2006a).

Upstream of the ladder, a stream channel would be reconstructed on top of approximately 12 feet of sediment with a gradient of 3% instead of the 5% gradient in both the Small Notch and Full Removal Alternatives. Slopes created by sediment removal would be planted with native trees and shrubs. The Fish Ladder Alternative would include 0.4 acres of bank zone, 0.9 acres of terrace zone, and 0.6 acres of riparian influenced slope for a total of 1.9 acres of restored habitat acreage (Corps 2006a). Not including the fish ladder itself, slightly less than 1.5 acres of steelhead spawning and rearing habitat would be opened.

2.2.5 Summary of Alternatives

Table 2. Comparison of Objectives Met in Relation to Each Alternative.

Alternative	Objectives				Constraint
	Improve aquatic passage	Provide natural sediment transport	Reduce future downstream fish kills and habitat degradation	Habitat restoration	Slope stability
No Project	No	No	No	No	No change
Small Notch	Yes. Equivalent to natural up- and downstream conditions	Yes	Eliminates threat of sediment spill	2.0 acres of restored riparian habitat and 1.7 miles of restored creek in historic channel	Requires reinforcement measures
Full Removal	Yes. Equivalent to natural up- and downstream conditions	Yes	Eliminates threat of sediment spill	2.2 acres of restored riparian habitat and 1.7 miles of restored creek in historic channel	Requires highest level of reinforcement measures

called rainbow trout. Unlike steelhead, rainbow trout are not protected under the federal Endangered Species Act.

Environmental requirements for steelhead vary by season and life stage. Optimal water temperatures for steelhead range from 10 to 15°C, with an upper lethal limit of 20°C. Rearing salmonids require a high level of dissolved oxygen, at least 80%, with a minimum temporary reduction no lower than 5.0 mg/l. Deposited and suspended sediment plays a significant role in their ability to successfully spawn and rear. Optimal upstream migration water velocities range from 40 to 90 cm/s and a minimum stream depth of 13 cm.

Population Estimates

> "Napa River steelhead populations have been greatly reduced from historical levels. It is estimated that the Napa River watershed supported a population of approximately 8,000 adult steelhead as recently as 100 years ago. The current steelhead population is unknown due to a lack of quantitative data. Recent basin wide surveys estimate the population to be between 200 and 1,000 adult steelhead (Stillwater Sciences, 2002; EcoTrust, 2001). NOAA Fisheries listed steelhead as a threatened species in Napa County in August 1997. Spawning adult steelhead are still documented each year by landowners and agencies, and most tributaries to the Napa River appear to be well seeded with juveniles (EcoTrust, 2001). Despite reduced populations, the Napa River watershed is considered one of the most significant anadromous fish streams within San Francisco Bay (Leidy et al., 2005) (RCD, 2005)." (Corps 2006b)

York Creek is known to support Central California Coast steelhead. Habitat surveys by NOAA Fisheries Service and CDFG, completed during the summers of 2000 and 2002, found abundant steelhead downstream of the dam and resident rainbow trout above the dam (Corps 2006b). Snorkel surveys conducted in the summer of 2004, by Napa County RCD, found moderate densities of juvenile steelhead and larger resident rainbow trout in most reaches (Corps 2006b). In summer 2005, as part of the York Creek Diversion Modification project, a 120-foot reach of stream channel was dewatered to facilitate construction. Sixty-four steelhead were captured within the work area and relocated (PCI 2004). In summer 2006, the Upper York Creek Reservoir was dewatered to facilitate routine maintenance and sediment removal above the dam. In a 500-foot reach of stream channel, 12 rainbow trout were captured and released upstream (PCI 2006b). There are no reports of stocking trout in York Creek by CDFG (Corps 2006b).

Based on habitat data collected as part of the Central Napa River Watershed Plan by Napa County RCD, York Creek has been identified as one of the "most significant spawning and rearing streams for steelhead within the Napa Basin" (NCRCD 2005). The upper reaches of the watershed, above the dam, "offer excellent spawning and rearing habitat, and creating access to these areas will greatly benefit the overall steelhead population" (NCRCD 2005). As a result of dam removal, approximately 1.7 miles (8,855 feet) of aquatic habitat could become available to CCC steelhead. Newly accessible steelhead habitat would include 0.30 acres of pool, 0.33 acres of flatwater, and 0.85 acres of riffle habitat, totaling 1.5 acres. This reach could potentially support between 825 and 1,810 juvenile steelhead annually, under current habitat conditions (Corps 2006b).

Lower York Creek Reservoir. In addition, non-native upland vegetation, including ruderal vegetation around Upper York Creek Reservoir, ruderal and non-native grassland around Lower York Creek Reservoir, and ruderal vegetation at Spring Mountain Vineyard, will be impacted during maintenance activities.

Mitigation BIO-NP12:
Adverse but less than significant impacts do not require mitigation; however, to avoid and/or reduce the potential for adverse impact to vegetation, the City of St. Helena shall implement protective measures:

- Vegetation removal will be minimized to the maximum extent practicable during all work activities. Grading limits will be clearly flagged to minimize disturbance from construction equipment.
- Upland native trees greater than 12 inches diameter at breast height that are removed as a result of maintenance dredging activities will be replaced at a minimum 1:1 ratio with equivalent native species. All propagules used for native plantings will be obtained from local nursery stock, if available.
- All disturbed areas will be revegetated with native plantings and/or a native seed mix as soon as practicable to minimize erosion and recruitment of invasive non-native plant species. Best Management Practices that avoid dispersal of invasive non-native plants will be used, including using only certified, weed-free materials dominated by native species for erosion control and revegetation.
- Any tree removal associated with maintenance dredging will comply with the City of St. Helena's Tree Ordinance.

Significance after Mitigation. Less than significant.

3.3.4 Preferred Alternative - Small Notch: Impacts and Mitigation Measures

The Small Notch Alternative is designed to restore the ecological connectivity between habitats upstream and downstream of the dam and provide for a natural sediment transport system. Central California Coast (CCC) steelhead migration would be restored to 100% effectiveness[19]. This alternative allows for the removal of 95% of sediment behind the dam reducing the threat of future sediment releases and removal of 72% of the actual dam material. A 23-foot wide natural stream channel would be restored, and 2.0 acres of streambank (0.4 acres), terrace (0.5 acres), and riparian zone (1.1 acres) would be revegetated. Approximately 1.7 miles (8,855 feet) of aquatic habitat would become available to CCC steelhead including 0.30 acres of pool, 0.33 acres of flatwater, and 0.85 acres of riffle habitat, totaling 1.5 acres. This reach could potentially support between 825 and 1,810 juvenile steelhead annually under current habitat conditions (Corps 2006a).

The existing spillway adjacent to Spring Mountain Road would remain intact and be filled with sediment from the project site. This provides the most geologically stable alternative that allows for the restoration of York Creek's natural hydrologic functions. Notching the dam would generate approximately 40,000 cubic yards of materials (Corps 2006a). Materials not utilized during ecosystem restoration will be reused or disposed of at LYCR, SMV, and/or Clover Flat Landfill. Materials deposited at LYCR would impact 0.22 acres of freshwater wetland habitat, 1.2 acres of open water habitat, and less than 0.1 acres of foothill pine-oak woodland, non-native

[19] 100% effectiveness means unobstructed fish passage upstream and downstream of the project site.

Geomorphology

York Creek is predominantly classified as a moderately entrenched, riffle dominated, relatively stable, gravel/cobble substrate channel (Figure 12) (NCRCD 2005). Channel features were measured in a reach upstream of UYCD, which represents natural stream conditions, to determine average channel width, as well as pool and riffle lengths (Corps 2006a, Appendix A citing Entrix 2002; PCI 2007a). Average pool and riffle lengths are 105 and 128 feet, respectively (Corps 2006a, Appendix A). PCI measured channel widths range 20-25 feet. In the lower reaches where the channel is not so constrained by the steep valley walls, the planform begins to meander, and a pool/riffle structure occurs (Figure 13). Through the City, York Creek maintains a fairly consistent width and depth except for one location adjacent to the Beringer Winery warehouse where a large gravel/cobble bar has formed and filled the channel (Figure 14).

Sediment Transport

The area above the dam represents 55% of the total watershed and 63% of the steep, sediment-source zone. The reservoir captures the entire coarse bedload and a portion of the suspended load produced in its 4.4 square mile drainage area – approximately 1,000-5,000 cubic yards of material annually depending on the rainfall and runoff patterns. An average hydrologic year with no unusual storm events delivers roughly 1,250 cubic yards of sediment to the reservoir. The winter of 2005/2006, an above-average year with the largest storm in recent history, deposited approximately 3,000 cubic yards of material behind the dam.

Throughout the watershed, the channel bed is composed of sediment ranging from sand to small boulders. The mean grain size is consistently very coarse gravel (32-64mm) to small cobble (64-128 mm), with low percentages of fines in the deposits (NCRCD 2005, PCI 2007a). Sediment deposited in the upper reservoir ranges from silt to small cobbles. Forty-one percent of the material by weight is made up of fine sediment (<2 mm) transported as wash and suspended load, while 30% is bedload composed of coarse gravel (16 mm) and larger particles.

Regulatory Environment

The upper watershed, including UYCD, is located within unincorporated Napa County. The lower reaches of York Creek are within the limits of City of St. Helena. The upper dam property, structure, and right-of-way were purchased by the City of St. Helena in 1922 (Corps 2006a). The City of St. Helena has the only pre-1914 appropriative rights to York Creek.

The City of St. Helena's Municipal Code Title 15, Chapter 15.52 Flood Damage Prevention provides for the establishment of areas of special flood hazard through scientific studies and mapping, as recommended by the City floodplain administrator. The floodplain administrator has the responsibility to manage activities that affect flooding and maintain the carrying capacity of channels within, or affecting properties within, City limits.

Detailed Project Report
Draft

Upper York Creek
Ecosystem Restoration Project
Napa County, California

U.S. Army Corps of Engineers, San Francisco District, South Pacific Division
City of St. Helena, Napa County, California

York Creek Steelhead Carrying Capacity Model - Napa County RCD (March, 2006)

Habitat survey data collected in 2003 by NCRCD were compiled for the reaches above York Creek dam to the end of anadromy at a bedrock falls. These data were used to calculate summary statistics for usable habitat area for juvenile steelhead rearing. Average widths and depths were calculated and assigned to each habitat unit for the reach to arrive at total available habitat. Steelhead densities calculated from electrofishing efforts by Stillwater Sciences (2005) were assigned to each habitat category to estimate potential carrying capacity. High and low density estimates represent the highest and lowest recorded value respectively. Moderate estimates are the average of the two.

HABITAT	Above Restored Area (sq ft)	Habitat+Restored Habitat (sq feet)	Acres
TOTAL POOL AREA (sq. ft.)	11,053	13153	0.30
TOTAL FLATWATER AREA (sq. ft.)	13,016	14297	0.33
TOTAL RIFFLE AREA (sq. ft.)	34,705	36994	0.58
	58,774	**64444**	**1.21**

FISH DENSITY (# of steelhead per square foot)			
	High	Moderate*	Low
Pool	0.053	0.0375	0.022
Flatwater	0.021	0.015	0.009
Riffle	0.022	0.0165	0.011

** Calculated values*

HABITAT	length (ft)	Habitat+Restored Habitat (feet)	Acres
TOTAL STREAM LENGTH (ft.)	8,030	8855	2

ESTIMATED CARRYING CAPACITY			
	HIGH	**MODERATE**	**LOW**
POOL	697	493	289
FLATWATER	300	214	129
RIFFLE	814	610	407
TOTAL STANDING CROP	**1,811**	**1,318**	**825**
STEELHEAD PER 100 ft.	**23**	**16**	**10**

CENTRAL NAPA RIVER WATERSHED PROJECT

SALMONID HABITAT FORM AND FUNCTION

October, 2005

FINAL REPORT

Prepared By

Napa County Resource Conservation District

For

California Department of Fish and Game

Contract # P9985160

SB271 Funded

Reach 5 had a canopy density of 97%, and Reach 6 had a canopy density of 97%). In general, revegetation projects are considered when canopy density is less than 80%. Reaches 1 and 2 would benefit from riparian planting and restoration in areas with sparse canopy and narrow buffers. Reach 2 has extensive areas of exotic vegetation that should be removed and replaced with native species.

The percentage of right and left bank covered with vegetation was high at 71% and 73%, respectively. In areas of stream bank erosion or where bank vegetation is sparse, planting native plant species, in conjunction with bank stabilization, is recommended. Bank vegetation was most sparse in Reach 1.

Overall, York Creek is one of the most significant spawning and rearing streams for steelhead within the Napa Basin. Reach 1 and 2 have been adversely affected by riparian encroachment, levee construction, road building, and channel modifications (i.e. straightening). Reaches 2, 3, and 4 are the only reaches currently accessible and suitable for steelhead spawning and rearing. These reaches contain high quality habitat and sustained flow. Reach 1 contains limited rearing habitat, primarily above Highway 29. The instream reservoir on York Creek is scheduled for removal in 2006-2008 by the US Army Corps of Engineers and the City of St. Helena. Removing the reservoir will allow access to over 1.5 miles of high quality steelhead habitat. The upper reaches of York Creek offer excellent rearing and spawning habitat, and creating access to these areas will greatly benefit the overall steelhead population.

A small diversion dam in Reach 3 that was identified in our 2003 habitat survey was removed by the City of St. Helena in 2004 and restored to allow fish passage. The site is a significant improvement to fish migration in York Creek.

A complete inventory of 35 potential restoration sites for York Creek has been compiled and prioritized in section 4 of this report.

Napa River Basin
Limiting Factors Analysis

FINAL TECHNICAL REPORT

Prepared for

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14 June 2002

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the incised current level of the mainstem Napa River. In some cases, smaller tributaries cutting across the valley floor have not fully adjusted to the lowered level of the mainstem and are elevated at their confluence with the mainstem, forming potential barriers to upstream fish migration referred to as "hanging tributaries."

Based on field reconnaissance of Napa River tributaries, we conclude that pools appear to be less frequent than would be expected under historical conditions, where large woody debris loading would have created obstructions and forced deep pools to form. Our field observations in several tributaries, particularly those on the west side, indicate that large woody debris loading (amount per length of channel) is much lower than would be typical of streams in unmanaged mixed evergreen forests. Although the history of wood removal from the Napa River and its tributaries is poorly known (there are some records of stream clearing projects in the 1960s and 1970s), large woody debris has likely been reduced by direct removal from many or most streams for a variety of reasons. The reduction in large woody debris loading has likely increased the mobility of spawning gravels and reduced the diversity of in-channel habitats in Napa River tributaries. Additionally, loss of large woody debris has likely reduced cover for juvenile steelhead rearing in tributaries. A channel lacking sufficient deep-water refugia would likely increase exposure of fish to higher temperatures and greater predation pressure by terrestrial predators such as birds, snakes, and mammals. Large woody debris may also be reduced because of increases in the magnitude and duration of peak flows capable of dislodging debris jams, possibly as a result of land use changes.

Several large dams were built between 1924 and 1959 on major eastside tributaries (Conn, Rector, Milliken, and Bell dams) and the northern headwaters of the Napa River (Kimball Dam). In addition, many smaller dams can be found throughout the basin. Many of these dams intercept coarse sediment supply, and thereby reduce delivery to downstream reaches, which can cause bed coarsening and channel incision (although incision may be limited by bedrock and bed coarsening).

6.2 Sediment-Related Impacts on Salmonid Habitat

We examined sediment-related impacts on salmonid habitat in the Napa River watershed by examining factors that are: (1) known to affect salmonid reproductive success directly, (2) targeted by proposed habitat rehabilitation efforts, and (3) cost-effective and efficient given the size of the study area. Sediment-related factors evaluated during Phase I included:

- Turbidity (which can affect salmonid feeding efficiency, growth, and survival);
- Spawning gravel permeability in the mainstem and the tributaries (which affects survival-to-emergence of steelhead and Chinook salmon eggs);
- Bed mobility in the mainstem (which also affects survival-to-emergence for steelhead and Chinook); and
- Filling of pools in the tributaries (which reduces the quality and quantity of juvenile rearing habitat).

6.2.1 Turbidity and Juvenile Feeding and Growth

High turbidity and suspended sediment concentrations can have detrimental effects on aquatic biota in river systems (e.g., Bisson and Bilby 1982, Berg and Northcote 1985, Newcombe and Jensen 1996). While very high turbidity levels may cause acute physiological stress and tissue damage to some aquatic organisms during peak flows, fish tend to survive high turbidity levels

United States
Department of
Agriculture

Forest Service

**Northeastern
Research Station**

General Technical
Report NE-343

Methods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the United States

James E. Smith
Linda S. Heath
Kenneth E. Skog
Richard A. Birdsey

Introduction

International agreements recognize forestry activities as one way to sequester carbon, and thus mitigate the increase of carbon dioxide in the atmosphere; this may slow possible climate change effects. The United States initiated a voluntary reporting program in the early 1990's (U.S. Dep. Energy 2005). A system for developing estimates of the quantity of carbon sequestered in forest stands and harvested wood products[1] throughout the United States is a vital part of the voluntary program. This system must be relatively easy to use, transparent, economical, and accurate. In this publication, we present methods and regional average tables that meet these criteria.

Carbon is sequestered in growing trees, principally as wood in the tree bole. However, accrual in forest ecosystems also depends on the accumulation of carbon in dead wood, litter, and soil organic matter. When wood is harvested and removed from the forest, not all of the carbon flows immediately to the atmosphere. In fact, the portion of harvested carbon sequestered in long-lasting wood products may not be released to the atmosphere for years or even decades. If carbon remaining in harvested wood products is not part of the accounting system, calculation of the change in carbon stock for the forest area that is harvested will incorrectly indicate that all the harvested carbon is released to the atmosphere immediately. Failing to account for carbon in wood products significantly overestimates emissions to the atmosphere in the year in which the harvest occurs.

We adopted the approach of Birdsey (1996), who developed tables of forest carbon stocks and carbon in harvested wood to provide basic information on average carbon change per area. The tables are commonly referred to as "look-up tables" because users can identify the appropriate table for their forest, and look up the average regional carbon values for that type of forest. We have updated the tables by using new inventory surveys, forest carbon and timber projection models, and a more precise definition of carbon pools. We also include additional forest types and background information for customizing the tables for a user's specific needs.

The look-up tables are categorized by region, forest type, previous land use, and, in some cases, productivity class and management intensity. Users must identify the categories for their forest, estimate the area of forestland, and, if needed, characterize the amount of wood harvested from the area in a way that is compatible with the format of the look-up tables. The average carbon estimates per area in the look-up tables must be multiplied by the area or, as appropriate, harvested volumes, to obtain estimates in total carbon stock or change in carbon stock.

The estimates in the look-up tables are called "average estimates," indicating that they should be used when it is impractical to use more resource-intensive methods to characterize forest carbon, that is, particularly when more specific information is not available. Because these tables represent averages over large areas, the actual carbon stocks and flows for specific forests, or projects, may differ. The look-up tables should not be used when conditions for a project or site differ greatly from the classifications specified for the tables. Some users may require an alternative to an "all-or-nothing" use of the tables because they may have some information and need to use the tables to supplement, or fill in gaps, in carbon stocks. Alternatively, users may require slight alterations to the tabular data provided. Therefore, we also include the underlying assumptions and appropriate citations so that the tables can be adjusted to data availability and information requirements of individual activities.

The focus of this document is to explain the methodology in a transparent way and present sets of look-up tables for quantifying forest carbon when site-specific information is limited. In the sections that follow, we introduce the tables and provide general guidance for their use. First, tables of forest ecosystem carbon are presented; these are followed by tables to calculate the disposition of carbon in harvested wood products. Additional information on methods and data sources

[1]Traditionally, the phrase "forest products" includes paper, but the phrase "wood products" does not. The literature for forest carbon has not recognized this distinction. Thus, we use the phase "wood products" to include all forest products including paper.

B21.— Regional estimates of timber volume and carbon stocks for alder-maple stands with afforestation of land in the Pacific Northwest, West

Age	Mean volume	Mean carbon density						
		Live tree	Standing dead tree	Under-story	Down dead wood	Forest floor	Soil organic	Total nonsoil
years	*m^3/hectare*	*tonnes carbon/hectare*						
0	0.0	0.0	0.0	4.7	0.0	0.0	86.4	4.7
5	0.0	8.0	0.8	4.7	0.8	1.8	86.7	16.1
15	49.5	31.0	3.1	3.7	2.9	4.4	88.9	45.2
25	229.7	99.4	9.9	2.8	9.4	6.2	92.8	127.8
35	380.8	153.8	15.4	2.5	14.6	7.6	97.6	193.9
45	513.7	200.8	20.1	2.4	19.0	8.6	102.4	250.9
55	633.3	242.5	22.2	2.3	23.0	9.4	106.7	299.4
65	742.1	280.1	23.9	2.2	26.5	10.1	109.9	342.8
75	842.1	314.4	25.3	2.2	29.8	10.7	112.2	382.4
85	934.5	346.0	26.6	2.1	32.8	11.1	113.6	418.6
95	1,020.3	375.2	27.7	2.1	35.5	11.5	114.5	452.0
105	1,100.3	402.2	28.7	2.0	38.1	11.9	114.9	483.0
115	1,175.0	427.4	29.6	2.1	40.5	12.2	115.1	511.8
125	1,244.9	450.9	30.4	2.3	42.7	12.4	115.2	538.7
years	*ft^3/acre*	*tonnes carbon/acre*						
0	0	0.0	0.0	1.9	0.0	0.0	35.0	1.9
5	0	3.2	0.3	1.9	0.3	0.7	35.1	6.5
15	708	12.6	1.3	1.5	1.2	1.8	36.0	18.3
25	3,282	40.2	4.0	1.1	3.8	2.5	37.6	51.7
35	5,442	62.3	6.2	1.0	5.9	3.1	39.5	78.5
45	7,342	81.3	8.1	1.0	7.7	3.5	41.5	101.5
55	9,050	98.1	9.0	0.9	9.3	3.8	43.2	121.1
65	10,605	113.3	9.7	0.9	10.7	4.1	44.5	138.7
75	12,034	127.2	10.3	0.9	12.1	4.3	45.4	154.7
85	13,355	140.0	10.8	0.9	13.3	4.5	46.0	169.4
95	14,582	151.8	11.2	0.8	14.4	4.7	46.3	182.9
105	15,725	162.8	11.6	0.8	15.4	4.8	46.5	195.4
115	16,792	173.0	12.0	0.9	16.4	4.9	46.6	207.1
125	17,791	182.5	12.3	0.9	17.3	5.0	46.6	218.0

The Impact of Climate Change on California's Ecosystem Services

A Paper From:
California Climate Change Center

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FINAL PAPER

DISCLAIMER

This paper was prepared as the result of work sponsored by the California Energy Commission (Energy Commission) and the California Environmental Protection Agency (Cal/EPA). It does not necessarily represent the views of the Energy Commission, Cal/EPA, their employees, or the State of California. The Energy Commission, Cal/EPA, the State of California, their employees, contractors, and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this paper; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This paper has not been approved or disapproved by the California Energy Commission or Cal/EPA, nor has the California Energy Commission or Cal/EPA passed upon the accuracy or adequacy of the information in this paper.

Arnold Schwarzenegger, *Governor*

August 2009
CEC-500-2009-025-F

dark orange is where fire is expected to consume more biomass than historical levels.

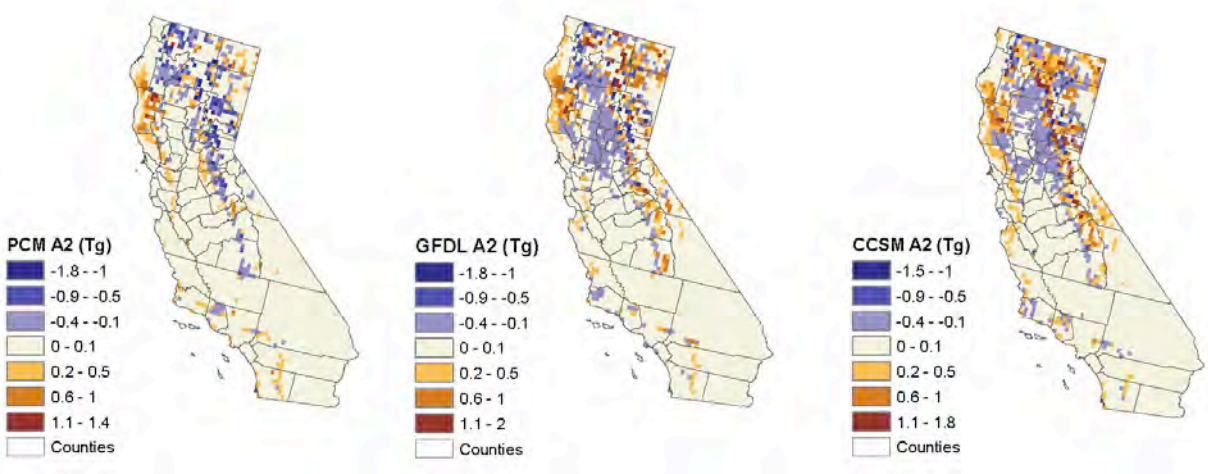

Figure 12. Net change in carbon in biomass consumed by fire by the end of the century (2070–2099 mean) under the high A2 scenario between the neutral climate future scenario and three AOGCMs (PCM1, GFDL, and CCSM3) simulated future climate conditions. Dark blue represents areas where historically fire consumed more than is projected by the end of the century on average and dark orange is where fire is expected to consume more biomass than historical levels.

Carbon Sequestration Valuation

The sequestration of carbon generates both market value, through constructed markets for carbon emissions, and a more comprehensive social value. The market value of carbon reflects the least-cost method for reducing carbon emissions in the atmosphere, as revealed by the market. The social value of carbon sequestration (also known as the social cost of carbon) reflects the global economic consequences of each ton of carbon released into the atmosphere.

To estimate the market and economic values of carbon over time we consider how much carbon will be stored in live trees above ground under the base future climate scenario and under each climate change scenario. We then estimate the value (in 2007 dollars) of the stock of carbon under each scenario and measure the change in value between the base future climate carbon stock and the stock estimated under each scenario.

For this study, we draw upon the literature to provide best estimates of the 2007 market price of carbon per metric ton to estimate the market value of carbon sequestered or released. In addition to estimates based on the market value of carbon, we use the literature to provide a review and best estimates of the societal value of a ton of carbon sequestered (or the costs of a ton of carbon released), recognizing that the value of carbon sequestered also will change over time, mostly as a function of the total stock of carbon in the atmosphere and the time of release or sequestration.

To estimate the value of carbon stored, we valued the costs of carbon emitted, assuming that if the carbon stock at time *t* decreases by one ton of carbon, that ton has (1) a market impact

because it will need to be offset in the carbon market,[2] and (2) an economic impact because it causes a marginal increase in damages associated with climate change.

Market Value of Carbon

We use information from the Chicago Climate Exchange (CCX, a voluntary climate exchange) and the European Union Emissions Trading System (EU ETS), a compliance-based system to estimate market values. To meet the goals of AB32 and reduce the impacts of atmospheric carbon on the global climate, The California Air Resources Board (CARB) has recommended a cap-and-trade program. Forest carbon offsets (aboveground live biomass in trees) are to be included in the program as a limited percentage of allowances. A cap-and-trade program will create a market for carbon and carbon sequestered by forests could be used to offset carbon generated by industry. The actual market value of forest carbon will depend on the development of this program and specific allowances made for forest carbon offsets. Generally, the market price is determined by the total amount of carbon that is permitted to be released into the atmosphere and the cost of meeting this cap through reductions in carbon emissions or the sequestration of carbon (for instance in natural vegetation.) From the perspective of the State of California, carbon sequestration is an important part of the technical portfolio the state must employ in order to meet the goals of AB32. Market price provides a rough estimate of the potential costs of meeting these goals and thus the gross economic value, in terms of cost savings or increases that would result due to changes in the natural ability of terrestrial ecosystems to sequester carbon. (Note, marine systems also play an important role in carbon sequestration, but we do not currently have good quantitative models for marine CO_2 sequestration.)

Currently, carbon trading occurs through a number of allowance-based markets and project-based transactions. The three main markets are the European Union Emissions Trading Scheme (EU ETS) and the New South Whales GHG Reduction Scheme, which are both regulated markets, and the CCX. For this study, we use 2007 annual volumes and transactions on the EU ETS and CCX markets to derive a low and high price for a metric ton of carbon. For each market, we derive the average annual price per metric ton of carbon (MTC) as follows:

$$\left(\frac{Total\ Value\ (M\$)}{Total\ Volume\ (MtCO_2e)} \right) 3.67$$

where 3.67 is the conversion factor from CO_2 to carbon.

The price derived from the EU ETS is $89.19/MTC and from CCX is $11.49/MTC (Capoor et al. 2008). The reason for the large difference in price between the CCX and the EU ETS markets is that the EU ETS is a regulated cap-and-trade market. In a regulated market, buyers have a higher certainty that what they are buying will maintain a value in the market. The CCX is a voluntary market with higher levels of uncertainty. Buyers speculate that the credits they

[2] The AB 32 (Assembly Bill 32 - California's Global Warming Solution Act of 2006) Climate Change Scoping Plan, approved by the Air Resources Board on December 11, 2008, recommends developing a cap and trade program that would link with other Western Climate Initiative partner programs to create a regional market by 2012. The plan recommends reduction measures of 5 MMTCO2e in the sustainable forest sector. It also recommends the use of offsets (include in the forest sector) and allowances from other systems be limited to 49 percent of the required reduction of emissions.

purchase will hold value should a cap-and-trade system be developed. Investors are looking for high potential returns on their investments given the risk they incur.

The CCX price could be considered a lower bound value (should forest offsets not be included in a regulated market). The EU ETS rate could be considered a more accurate estimate if forest carbon offsets are included in a statewide, regional, or national cap-and-trade system.[3]

Social Value of Carbon

The economic value of carbon sequestration can also be measured in terms of the social cost (or economic benefit from avoided damage) of damage avoided when carbon is removed from the atmosphere and climate change is slowed. The social cost of carbon (SCC) measures the full global cost today of emitting an incremental unit of carbon (in the form of CO_2) at some point of time in the future, and it includes the sum of the global cost of the damage it imposes the entire time it is in the atmosphere (Price et al. 2007; Pearce 2003). Damage is a function of the cumulated stock, so one extra unit released in the future is likely to have a higher associated damage than a unit emitted now (Pearce 2003). In theory, the SCC attempts to capture how much society could pay to avoid climate change and still be as well off as they would be in the absence of climate change. In other words, if society were aware of the full costs of climate change, the SCC is what they would be willing to pay now to avoid the future damage caused by incremental carbon emissions (Price et al. 2007). The SCC also represents the appropriate tax on CO_2 emissions that would result in the economically optimal reduction in CO_2 emissions (also known as the Pigouvian tax—a tax levied to correct the negative externalities of a market activity) (Tol 2007). The total social cost is the damage done by carbon emissions compared to a neutral climate future context in which the emissions do not increase. In our analysis, we assume that lost carbon sequestration is not offset by technological reductions in human-created sources of atmospheric carbon dioxide and thus lost carbon sequestration results in global economic cost.

The process for estimating SCC requires a model of atmospheric residence time and a means of discounting economic values back to the year of emissions (Yohe et al. 2007). The amount of damage done by each incremental unit of carbon in the atmosphere depends on the concentration of atmospheric carbon today and in the future. Therefore, the SCC should vary depending on which emissions trajectory the world experiences.

Currently, the peer-reviewed and gray literature provide over 200 different estimates of the marginal costs of climate change with varying levels of sophistication, including differing discount rates, different mechanisms for including discount rates and performing sensitivity analysis, varying estimates of total costs of climate change used, dynamic and static elements, differing assumptions about future climate change, and publication dates (the older the study, the less sophisticated it might be) (Tol 2007). Generally, a higher discount rate implies a lower estimate of the SCC and estimates in the peer reviewed literature tend to be lower than estimates in the gray literature and have fewer uncertainties (Tol 2007).

[3] Note that forest sector offsets are not included in the EU ETS compliance system, but this system still provides the best market estimate for forest sector carbon credits. Also note that the California AB 32 Climate Change Scoping Plan recommended inclusion of forest credits produced in-state, as well as out-of-state and internationally, although the rules for these mechanisms have yet to be created.

In 2005, Richard Tol published a meta-analysis of the marginal damage costs of CO_2 emissions. He reviewed 103 estimates from 28 public studies. Including only peer-reviewed studies and accounting for differences in the types of studies (discount rates, equity weighting, dependence on dynamic climate change scenarios and economic scenarios, and estimations of marginal or average damage costs), Tol determined the mean to be $43 ($54 in 2007 inflation adjusted dollars) per MTC with a standard deviation of $83 (Tol 2005). He found that studies with better methods yielded lower estimates with fewer uncertainties. He also discovered that much of the uncertainty was due to assumptions on the discount rate and around equity weights used to aggregate monetized impacts over countries.

In 2007, Tol presented an as yet unpublished update of his 2005 meta-analysis. With more data (211 estimates from the gray and published literature) and more advanced statistical analysis, Tol's results showed a downward trend in the estimates of the SCC but that uncertainty about the SCC is large (although many of the high estimates were not yet peer-reviewed and used unacceptably low discount rates). In Tol's 2007 analysis, with conservative assumptions, the mean for peer-reviewed estimates is $23/MTC. He states that there is a 1% probability that the SCC is greater than $78/MTC.

Watkiss and Downing (2008) provide further updates of Tol and summarize a number of values for the social cost of capital for carbon emissions in the UK. The authors report that in 2002, the UK Government recommended a marginal global SCC estimate of £70/MTC ($185/MTC in 2007 dollars), within a range of £35 to £140/MTC ($93 to $371/MTC in year 2007 dollars), with all three estimates increasing £1/MTC ($1.50/MTC) per year from the year 2000. Since 2002, the UK Government has used these values widely in regulatory impact assessment and for considering environmental taxes and charges (Watkiss et al. 2008). We conservatively examine a central value from Watkiss and Downing of $185/MTC (2007 dollars) noting that the authors expect significant increases over time. (The authors also provide estimates from the FUND and PAGE models, which are substantially higher than even the UK SCC estimates.)

Using the DICE-2007 model, William Nordhaus shows that the trajectory of optimal carbon prices (or carbon taxes) should rise to reflect the increasing damage caused by climate change and the need for increasingly tight constraints. In the model, the optimal price rises steadily over time, at between 2% and 3% per year in real terms, to reflect the rising damages from climate change. In this trajectory, Nordhaus' carbon price (adjusted to 2007 dollars) rises from $34/MTC to $113/MTC by 2050 and $251 per MTC in 2100. Ultimately, the carbon price will top out at the level at which the backstop technology becomes economically viable (Nordhaus 2008).

The DICE-2007 model is a globally aggregated model. The model incorporates simplified representations of the major analytical dimensions of climate change problems and is focused on analyzing the economic and environmental impacts of alternative policies (Nordhaus 2008). Like the other models, DICE-2007 does not provide for a complete understanding of the major components and has greater error the further into the future the projections move. It contains highly simplified representations of the major relationships relating emissions, concentrations, climate change, the costs of emissions reductions, and the impacts of climate change, and some of the tradeoffs—particularly between rich and poor regions—cannot be explored (Nordhaus 2008).

Realizing that no model is perfect, that each method for estimating the SCC or optimal carbon price provides different perspectives, and that there are complexities and uncertainties relating to how different variables are considered in the models, we use Nordhaus' carbon price trajectory to illustrate the potential costs (and benefits) to society that climate change can have as a result of changes in forest carbon stocks in California. (Note that as mentioned previously, social cost values have been discounted)

Predicting the Value of Future Carbon Sequestration

As the aboveground carbon storage varies, there is subsequent variation in total market value represented by losses or gains in natural carbon sequestration in the future (Table 2a). With the warmer and wetter climate (PCM1), the change in market value is positive, ranging from an average annual difference due to climate change of $19 million to $146 million/year for 2005–2035 under scenario B1 to as much as $1 billion to $7.9 billion annually by 2065–2090. The warm, wet PCM1 climate simulations consistently enhance carbon sequestration for all the periods considered and thus increase the service value, with highest change at the end of the century (2065–2099) under the low emissions scenario (B1). Conversely, under the high (A2) emissions scenario, climate projections by the hot, dry CCSM3 model cause an average annual loss of between $2.9 billion and $22.1 billion.

These estimates for changes in market values are in 2007 dollars with no discounting for present value. It is conceivable that in a market situation, real market prices will change—prices could increase if it becomes more expensive to reduce greenhouse gas emissions and, conversely, technological innovation could cause market prices to fall. Market prices will also vary depending on the types of policies implemented at the state and national level. Research economists from New Carbon Finance predict that if a cap-and-trade program is confined to domestic trading only, the carbon emissions market could be worth $1 trillion by 2020 (Environmental Leader 2008). Allowing trading with other countries like India or China, where emissions reduction measures are relatively inexpensive will yield lower prices and a cost savings to the U.S. economy (New Carbon Finance 2008).

Table 2a. Projected change in live aboveground carbon sequestered and the market value of these changes

2005–2034					
		Carbon		Change in value (2007$ million)	
Scenario	Model	Total (Tg)	% Change from Base	CCX $3.13/MTCO2e ($11.49/MTC)	EU ETS $24.30/MTCO2e ($89.20/MTC)
Base		*1,025*			
B1	PCM1	1,027	0%	$19	$146
	GFDL	997	-3%	-$325	-$2,524
	CCSM3	997	-3%	-$323	-$2,504
A2	PCM1	1,035	1%	$115	$891
	GFDL	1,024	0%	-$15	-$118
	CCSM3	992	-3%	-$380	-$2,950

2035–2064					
		Carbon		Change in value (2007$ million)	
Scenario	Model	Total (Tg)	% Change from Base	CCX $3.13/MTCO2e ($11.49/MTC)	EU ETS $24.30/MTCO2e ($89.20/MTC)
Base		*1,028*			
B1	PCM1	1,057	3%	$327	$2,541
	GFDL	987	-4%	-$475	-$3,685
	CCSM3	881	-14%	-$1,693	-$13,145
A2	PCM1	1,055	3%	$304	$2,357
	GFDL	968	-6%	-$690	-$5,355
	CCSM3	902	-12%	-$1,446	-$11,223

2070–2099					
		Carbon		Change in value (2007$ million)	
Scenario	Model	Total (Tg)	% Change from Base	CCX $3.13/MTCO2e ($11.49/MTC)	EU ETS $24.30/MTCO2e ($89.20/MTC)
Base		*952*			
B1	PCM1	1,041	9%	$1,021	$7,926
	GFDL	935	-2%	-$199	-$1,546
	CCSM3	820	-14%	-$1,516	-$11,769
A2	PCM1	1,023	7%	$815	$6,327
	GFDL	778	-18%	-$1,994	-$15,481
	CCSM3	704	-26%	-$2,850	-$22,129

Table 2b. Projected change in live aboveground carbon sequestered and the economic value including social cost of carbon of these changes

2005–2034						
		Carbon		Change in value (2007$ million)		
Scenario	Model	Total (Tg)	% Change from Base	Tol, 2007 Mean ($23/MTC)	DICE-2007 Optimal Price ($34/MTC)	Existing UK SCC ($185/MTC)
Base		*1,025*				
B1	PCM1	1,027	0%	$38	$56	$303
	GFDL	997	-3%	-$651	-$962	-$5,236
	CCSM3	997	-3%	-$646	-$955	-$5,194
A2	PCM1	1,035	1%	$230	$340	$1,847
	GFDL	1,024	0%	-$31	-$45	-$245
	CCSM3	992	-3%	-$761	-$1,125	-$6,119

2035–2064						
		Carbon		Change in value (2007$ million)		
Scenario	Model	Total (Tg)	% Change from Base	Tol, 2007 Mean ($23/MTC)	DICE-2007 Optimal Price ($113/MTC)	Existing UK SCC ($185/MTC)
Base		*1,028*				
B1	PCM1	1,057	3%	$655	$3,220	$5,271
	GFDL	987	-4%	-$950	-$4,669	-$7,644
	CCSM3	881	-14%	-$3,390	-$16,656	-$27,269
A2	PCM1	1,055	3%	$608	$2,987	$4,890
	GFDL	968	-6%	-$1,381	-$6,786	-$11,109
	CCSM3	902	-12%	-$2,894	-$14,220	-$23,281

2070–2099						
		Carbon		Change in value (2007$ million)		
Scenario	Model	Total (Tg)	% Change from Base	Tol, 2007 Mean ($23/MTC)	DICE-2007 Optimal Price ($251/MTC)	Existing UK SCC ($185/MTC)
Base		*952*				
B1	PCM1	1,041	9%	$2,044	$22,309	$16,443
	GFDL	935	-2%	-$399	-$4,350	-$3,207
	CCSM3	820	-14%	-$3,035	-$33,123	-$24,413
A2	PCM1	1,023	7%	$1,632	$17,807	$13,125
	GFDL	778	-18%	-$3,992	-$43,570	-$32,113
	CCSM3	704	-26%	-$5,707	-$62,281	-$45,904

The expected change in the social value of stored carbon (Table 2b) is similar to that found for the analysis of market values. The warm, wet PCM1 model consistently predicts a higher capacity to store carbon and thus the affect of climate change on natural carbon storage in

California would result in a net benefit to society of between of $38 million annually in the period 2005–2034 and as high as $22 billion annually by 2070. The hotter, drier models, however, project a sharp negative difference in carbon storage capacity in natural areas leading to social costs of -$646 million to -$5.2 billion annually for the period 2005–2034 (under scenario B1 using the CCSM3 model of climate change) to as high as -$62 billion annually by the period 2070–2099, under scenario A2 using the Nordhaus' DICE-2007 model predictions.

Conclusion: Carbon Sequestration

The current voluntary carbon markets that incorporate natural system sequestration focus largely on the aboveground biomass in a forest system and so, for this study, we focused our valuation on aboveground biomass in forested systems. Sequestration of aboveground biomass decreases with all model-emissions scenario combination except the most optimistic, and the declines are more pronounced in the second and third time periods of this study. There are two main reasons why the model projects a decline in biomass: (1) loss of conifer forests due to drought stress, which might be mitigated to some extent by a CO_2 "fertilization effect" that may enhance carbon capture as CO_2 concentrations increase but more importantly should increase water use efficiency—that is, maintaining carbon uptake under a moderate level of drought stress; (2) fire losses will be significant as temperatures rise and humidity drops. When all carbon stocks (i.e., aboveground and belowground live biomass, aboveground and belowground organic carbon) are included in the analysis—not just the aboveground biomass carbon stocks included in the existing voluntary carbon market—the picture changes slightly. Net change in total carbon stocks increases under the warmer, wetter future (PCM1) for both the low and high emissions scenarios (Appendix B). In contrast, we see decreased carbon storage under both emissions scenarios using the hot, dry models (GFDL, CCSM3), largely driven by a combination of decreases in aboveground and belowground organic carbon (Appendix B). In the model-emissions scenarios with carbon loss, fires burn the vegetation and carbon losses are emitted as gases and drought conditions reduce production and carbon capture, resulting in total carbon loss. For California to take advantage of the potential for carbon storage in natural systems stocks in the future, greenhouse gas emissions must be curbed to a B1 scenario that would reduce both drought-stress conditions for natural and commercial vegetation (forests, agriculture, forage) and fire danger.

The results of our carbon projections indicate that forests and other sources of natural carbon storage are critically important assets that need to be considered, employed, and protected if we are going to work to stem the increase in global atmospheric concentration of carbon dioxide. The majority of the model-emissions scenarios find that climate change will lead to a loss of the natural ability of California's forests to store carbon by the end of the century. The result will be annual losses of potentially hundreds of millions and possibly billions of dollars in carbon sequestration capacity—a cost that will be borne by carbon emitters, automobile drivers, factories, homeowners, and others—and will be reflected in future markets for carbon. Similarly, this loss of carbon sequestering capability will result in global economic impacts if the loss of carbon is not offset by other reductions in carbon emissions.

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A Question of Balance

Weighing the Options on Global Warming Policies

William Nordhaus

Yale University Press New Haven & London

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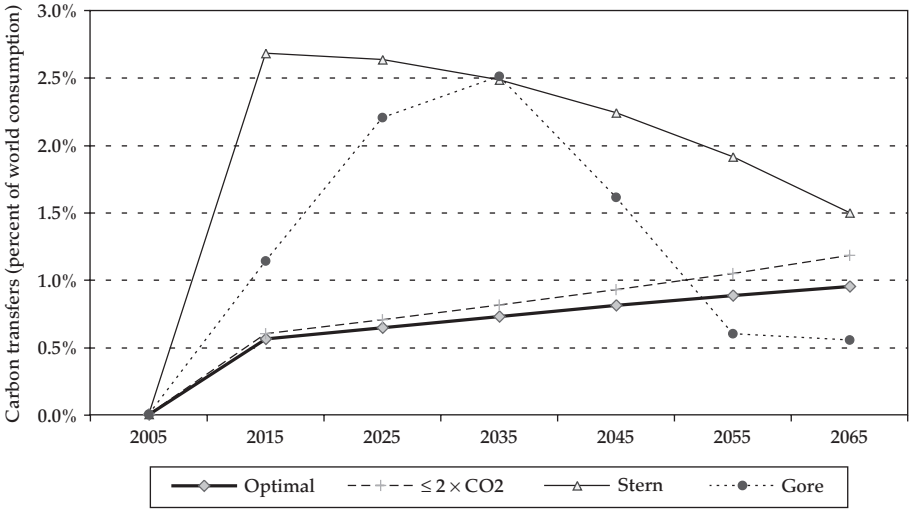


Figure 5-11. Carbon revenue transfers as a percentage of world consumption. The total transfers from consumers to producers and taxpayers due to carbon restrictions. These would apply whether the restrictions were imposed by cap-and-trade measures or by carbon taxes. The transfers are carbon prices times carbon use, while the denominator of the fraction is world consumption expenditures.

July 30, 1992

Mr. Marty Oldford
Director of Public Works
City of St Helena

Dear Mr. Oldford:

Removal of Dam, York Creek

As a result of the unfortunate incident involving the draining of your reservoir and collected silt into York Creek on July 28, 1992, we have reviewed our files and found that this was not the first such episode; similar incidents occurred in 1965, 1973, and again in 1975. In each and every instance dense, anaerobic sediments, high in toxic hydrogen sulfide, were released from the dam and deposited in pools and riffle areas downstream, quickly suffocating and burying all fish and aquatic invertebrates within a mile or more of the dam.

Following the third episode in 1975, we suggested to the City that, since the reservoir was no longer a part of the City's water supply, its continued existence created not only an unnecessary barrier to fish migration, but a continuing liability to the City for on-going maintenance; and fines, damages, and cleanup costs, should a discharge occur in the future. We suggested that removal of the dam and impoundment might be the most expedient means to avoid such periodic disasters in the future.

It would seem that the economic liability to the City from the existence of this unnecessary structure would far outweigh any peripheral benefits the City might enjoy from its existence. Therefore, we again encourage the City to consider complete removal of this structure and impounded sediments as an integral part of cleanup operations mandated by the latest episode.

If you have any questions, or wish to pursue this option, please contact Warden Jack Edwards at (707) 944-5500 for details.

Sincerely,

Brian Hunter
Regional Manager
Region 3

MER/dcf

CALIFORNIA DEPARTMENT OF FISH AND GAME
P.O.BOX 47
YOUNTVILLE, CA. 94599

INVESTIGATION REPORT: SILT RELEASE INTO YORK CREEK, NAPA COUNTY.

DATE OF OCCURANCE: JULY 28, 1992

LOCATION OF OCCURANCE: UPPER RESERVOIR, YORK CREEK, TRIBUTARY TO NAPA RIVER.

CAUSE OF RELEASE: SUSPECTED MALFUNCTION OF OLD VALVE AND OR FAILURE OF CRIBBING AROUND VALVE STRUCTURE.

PROPERTY OWNER: CITY OF ST. HELENA

VIOLATION: FISH AND GAME CODE SECTION 5650 (F)...POLLUTION OF STATE WATERS.

SYNOPSIS: ON THE ABOVE DATE, A REPORT WAS RECEIVED BY THE ? CALISTOGA POLICE DEPARTMENT THAT THE DAM ON YORK CREEK HAD FAILED, AND THAT A LARGE AMOUNT OF SILT HAD FLOWED DOWN STREAM AND INTO THE NAPA RIVER. A RESPONSE TO THE CALL WAS MADE AND CONFIRMED THAT A FAILURE OF SOME TYPE HAD OCCURED BUT THAT THE DAM HAD NOT FAILED.

AN INSPECTION OF THE STREAMBED FROM THE DAM DOWNSTREAM TO THE NAPA RIVER DISCLOSED THAT SILT HAD BEEN DEPOSITED WITHIN THE STREAM BED FROM THE FACE OF THE DAM TO A POINT WHERE THE NAPA RIVER JOINS THE STREAM. THE EXTENT OF THE SILT DEPOSITS VARY FROM A RATHER HEAVY DEPOSIT JUST BELOW THE DAM AND CONTINUING DOWNSTREAM FOR ABOUT ONE HALF MILE AND THEN GRADUALLY THINNING UNTIL THERE IS A LIGHT COVERING OF FINE SILT AT THE NAPA RIVER.
THE TOTAL DISTANCE BEING ABOUT 2 1/2 TO 3 MILES LONG.

WITHIN THE "ZONE", THERE IS TOTAL LOSS OF AQUTIC LIFE. THE ORGANISMS WHICH FORMERLY SURVIVED HAD BEEN SMOTHERED BY THE SILT AS IT WAS DEPOSITED ON THE STREAM BOTTOM. A NUMBER OF SMALL DEAD FISH AND FROGS ALONG WITH INSECTS WERE NOTED LITTERING THE DEPOSITS OF SILT.

DUE TO THE LARGE VOLUME OF SILT REMAINING BEHIND THE DAM AND THAT WHICH FLOWED DOWNSTREAM. AND THE FACT THAT THE EXACT CAUSE OF THE FAILURE MAY NOT BE KNOWN FOR QUITE SOME TIME. AN URGENCY OCCURED IN PROCEEDING WITH A PLAN OF ACTION WHICH WOULD BOTH SATISFY THE REQUIREMENTS OF FISH AND GAME SECTION 5650 AND THE CITY OF ST HELENA'S DESIRE IN PREVENTING FURTHER DAMAGE TO THE STREAM.

IT WAS FOUND THAT THERE HAD BEEN SEVERAL PREVIOUS EVENTS RELATING TO THE RESERVOIR DURING THE PAST TWENTY SEVEN YEARS. AND THAT AT LEAST ON ONE OCCASION, THE NAPA COUNTY DISTRICT ATTORNEY'S OFFICE, WAS INVOLVED WITH BOTH THE DEPARMENT OF FISH AND GAME AND THE CITY OF ST HELENA OVER PROBLEMS WITH THE DAM.

ABOUT 1975, THE CITY WORKED ON THE VALVE STRUCTURE AND BUILT A CRIB STRUCTURE TO PREVENT DAMAGE TO THAT VALVE. SINCE THEN, AS FAR AS CAN BE DETERMINED, LITTLE OR NO WORK HAS BEEN DONE TO THE RESERVOIR. SILTATION HAS CONTINUED ON A YEAR TO YEAR BASIS, CAUSING A BUILD UP WITHIN THE RESERVOIR TO A POINT WHERE THE SILT IS NEARLY UP TO THE LEVEL OF THE V NOTCH WHICH WAS CUT INTO THE SPILLWAY THE PURPOSE OF WHICH WAS TO CAUSE A LOWER WATER LEVEL BEHIND THE DAM. THUS REDUCING THE CHANCE OF A MAJOR MALFUNCTION OF THE DAM ITSELF. ALSO, BY REDUCING THE HEIGHT OF THE DAM, THE STATE DIVISION OF DAMS WOULD NO LONGER HAVE JURISDICTION BECAUSE IT WOULD BE UNDER A HEIGHT OF TWENTY FIVE FEET.

SHORTLY AFTER THE ABOVE INCIDENT, (1992), THE DEPARTMENT OF FISH AND GAME WROTE A LETTER TO THE CITY OF ST HELENA SUGGESTING THAT BECAUSE OF A HISTORY OF PROBLEMS RELATING TO YORK CREEK AND THE FACT THAT THIS RESERVOIR NO LONGER SERVES AS A VIABLE WATER SOURCE; THAT THE CITY MAY WISH TO CONSIDER IT'S REMOVAL. THE LIABILITY IN THIS CASE APPEARS TO BE SUBSTANTIAL BECAUSE OF THE PRIOR HISTORY AND THE RECENT EVENT. ADDITIONALY, SECTION 5937 OF THE FISH AND GAME CODE NOW REQUIRES A FISH LADDER IN ANY STRUCTURE WHICH BLOCKS A STREAM.

AS OF SEPTEMBER 18, 1992 THE CITY OF ST HELENA, IN ITS ATTEMPT TO LOCATE THE ELUSIVE VALVE, HAS BEEN UNSUCCESSFUL. THE REASON IS THAT THERE WAS SUCH A BUILDUP OF SILT AROUND THE BASE OF THE DAM THAT THE DEPTH OF THE VALVE MAY HAVE BEEN DEEPER THAN ORIGINALY THOUGHT.

Jack M. Edwards
Fish & Game Warden
10-14-92

STATE OF CALIFORNIA
DEPARTMENT OF FISH AND GAME

REGION 3

[X] INVESTIGATION [ ] ARREST [ ] POLLUTION OTHER: _____ CITATION NUMBER: _____

DATE OF INCIDENT	TIME	DAY OF WEEK	LOCATION
July 28, 1992			Spring Mt. Rd. St Helena Napa County

	SUSPECT(S) FIRST, MIDDLE, LAST	DOB	LIC/ID #	ADDRESS
S-1	City of St Helena			
S-2				
S-3				
S-4				

OFFENSE(S) LIST SECTION NUMBERS AND CODE: T-14 CCR OR F&G CODE OR PENAL CODE AND DESCRIPTION

COUNT 1	5650 - Siltation of State Waters
COUNT 2	
COUNT 3	
COUNT 4	

WITNESS INFORMATION

	FIRST, MIDDLE, LAST	ADDRESS	TELEPHONE
W-1	Jack M. Edwards	P.O. Box 47 Yountville, CA 94599	707-944-5512
W-2			

EVIDENCE SEIZED (DETAILED DESCRIPTION)

See Report - Numerous Photographs -

SYNOPSIS

See Attached Report

REPORTING EMPLOYEE Jack M. Edwards TITLE: Fish + Game Warden BADGE NO. 147

DATE OF REPORT 10-14-92 PHONE (707) 944-5512 BUSINESS ADDRESS P.O. Box 47 Yountville CA 94599

Jack M. Edwards
SIGNATURE OF REPORTING EMPLOYEE

H. L. St. Clair
SIGNATURE OF REVIEWING OFFICER

WLP-6A (Rev. 4-89)

PRUNUSKE CHATHAM, INC.

M E M O

Date: January 24, 2013

To: File

From: Dylan Loudon

Subject: Upper York Creek Dam Annual No Project Alternative Costs

---

Annual maintenance costs for the No Project Alternative were calculated using the City of St. Helena's SHEA Salary Schedule, FY 2011-2012 Step C pay rates. The costs were marked up 30% from the salary schedule to compensate for payroll and other costs. It is estimated that 3 days of site inspection by a Public Works Supervisor and 3 days cleaning out accumulated debris by a 2-person labor crew and one supervisor are required. In addition, an average of 3,500 cubic yards of sediment would need to be removed annually from upstream of the dam. An industry standard of $35/cubic yard was used.

Units	Personnel	Activity	Total
3 person day	Public Works Supervisor	Inspect dam site	$1,000.31
3 person day	Public Works Supervisor	Oversee clean out accumulated debris	1,000.31
6 person day	Laborers	Clean out accumulated debris	1,282.78
3,500 cy		Offhaul accumulated sediment to landfill	122,500.00
			$125,783.40

Further, as long as the dam continues to block salmonid migration, the City pays an annual $20,000 assessment to NMFS. Total on-going, annual costs for the No Project Alternative are:

Maintenance:	$125,783.40
NMFS assessment:	20,000.00
	$145,783.40

400 MORRIS STREET, SUITE G · SEBASTOPOL CA 95472 · 707 824-4600 · FAX 707 824-6854

DRAFT

INITIAL STUDY / PROPOSED MITIGATED NEGATIVE DECLARATION FOR THE YORK CREEK DAM REMOVAL AND STREAM RESTORATION PROJECT, NAPA COUNTY, CALIFORNIA

July 2002

Lead Agency:
The City of St. Helena

PROJECT SUMMARY

York Creek Dam Removal and Stream Restoration Project

Part 1. Introduction

The purpose of this initial study/environmental assessment (IS/EA) is to determine whether the proposed project would result in any potentially significant impacts to the environment and, if so, to incorporate mitigation measures to reduce or eliminate potentially significant effects to a less-than-significant level. This IS/EA has been prepared pursuant to the California Environmental Quality Act (CEQA) and the National Environmental Policy Act.

Environmental Setting

The York Creek watershed originates from the California Coast Ranges on the western side of the Napa Valley watershed at an elevation of approximately 1,800 feet (550 m) (Figure 1). The York Creek watershed is about 5 square miles (13 km^3). The creek flows in an easterly direction through a narrow canyon before joining the Napa River northeast of St. Helena at an elevation of approximately 225 feet (69 m). The City of St. Helena maintains the only pre-1914 appropriative water rights for York Creek. Approximately 2.5 miles (4.0 km) upstream from the mouth of York Creek, a concrete masonry diversion structure diverts water from York Creek to the St. Helena Lower Reservoir. The Lower Reservoir, located on an unnamed tributary to York Creek, supplies water for irrigation and other municipal uses and has a capacity of approximately 200 acre-feet. St. Helena Upper Dam (York Creek Dam) and Reservoir (Upper Reservoir) on York Creek are located approximately 0.5 miles (0.8 km) upstream of the diversion structure in York Creek Canyon (Figure 2). York Creek Dam and Upper Reservoir are no longer used for water supply. Other landowners adjacent to York Creek have riparian rights to water in York Creek and divert water via pumps placed in the stream.

Land use in the York Creek watershed consists of forested open-space, agriculture (primarily viticulture), and residential. Vineyards have been developed throughout the watershed, but particularly on the valley floor near the confluence of York Creek and the Napa River where two large wineries, Beringer and Krug, are located. Residential areas within the city limits of St. Helena occur primarily between Highway 12 (River Mile 1.0 of York Creek) and approximately River Mile 1.75 of York Creek. Stevenson Junior High School is located south of the intersection between York Creek and Highway 12.

Spring Mountain Road is a two-lane county road that runs adjacent to York Creek for nearly 2.5 miles and crosses the creek via three bridges. Several culverts carry water from unnamed tributaries that run under Spring Mountain Road and into York Creek. Three of the culverts empty into Upper Reservoir.

Purpose and Need of the Project

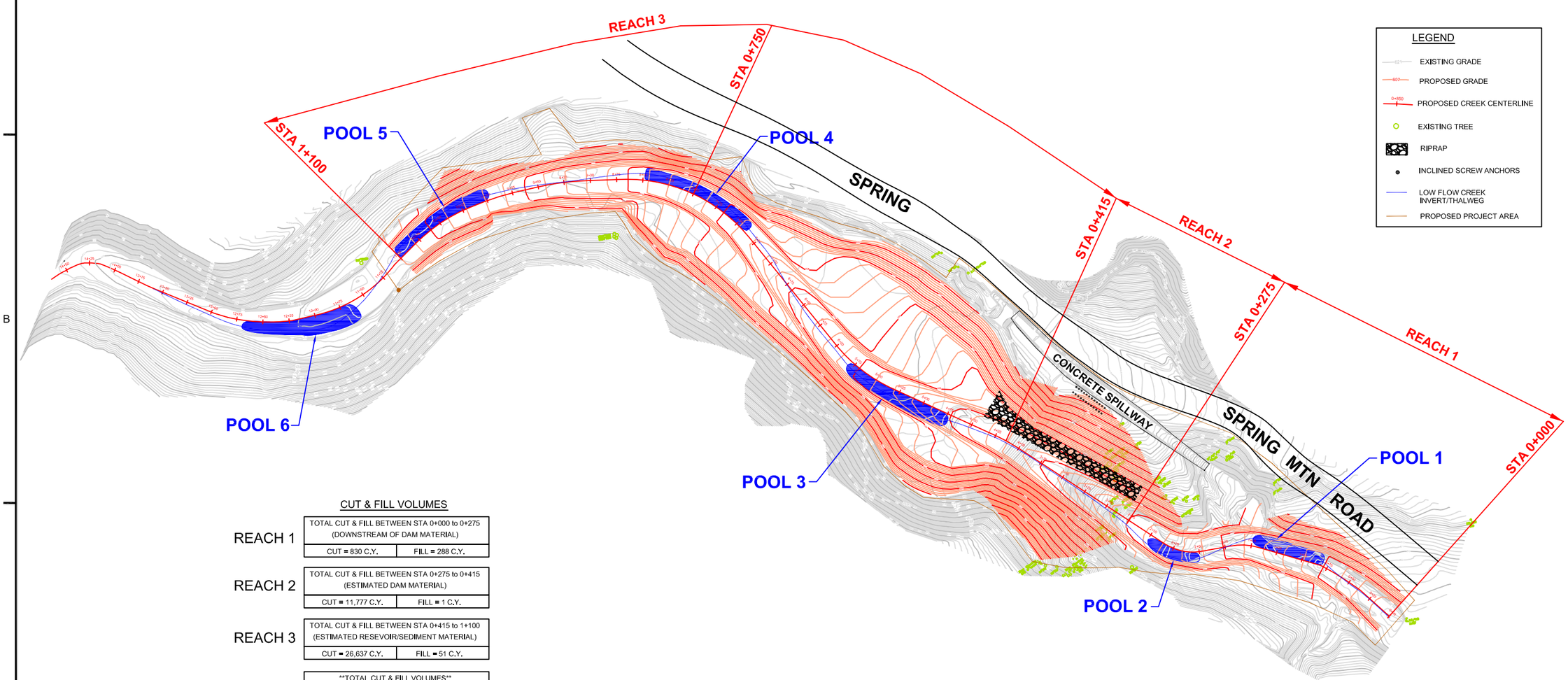
York Creek Dam and the Diversion Structure on York Creek have been identified as significant obstacles to passage for federally listed steelhead (*Oncorhynchus mykiss*) in the threatened Central California Coast (CCC) Evolutionary Significant Unit. The channel of York Creek that is impacted by the current diversion configuration is known to provide spawning and rearing habitat for CCC steelhead. The National Marine Fisheries Service (NMFS) has recognized that the diversion (1) is an impediment to steelhead passage, (2) has a screen that does not meet NMFS or Department of Fish and Game (DFG) criteria, and (3) likely is operated in a manner that results "in entrainment related mortality (take) of steelhead" (NMFS 2000b). York Creek Dam is a complete barrier to upstream fish migration.

In addition, since the City has owned York Creek Dam, there have been four documented silt discharges from the dam into York Creek that have caused kills of fish and other aquatic organisms. The most recent silt discharge occurred in July 1992 during routine maintenance of the reservoir outlet structure. After the 1992 discharge, DFG filed a complaint with the Napa County District Attorneys Office. In 1993, DFG and the Napa County District Attorney's Office obtained an injunction in State Superior Court ordering the City to remove York Creek Dam. As a result of the legal action, the City agreed to a settlement in 1993 that mandated the removal of York Dam. Recently, the Superior Court of Napa County dismissed the injunction against the City. Since 1993, the City has not used Upper Reservoir as a water source, but the reservoir has been periodically dredged. Approximately 9,500 yd^3 of sediment have re-deposited in the reservoir since the 1993 dredging following several years of above average rainfall. York Creek meanders widely and braids as it flows through the sediment in Upper Reservoir and forms shallow pools in some areas. The flow through Upper Reservoir went subsurface during the driest period of 2001 and most likely goes subsurface during most years.

Through implementation of the proposed project there is an opportunity to remove both York Creek Dam and the diversion structure thereby improving fish passage in York Creek. The proposed project will further provide improved fish passage by raising the streambed elevation below the diversion with boulder weirs to reduce the

ALTERNATIVE 2B : STA 0+000 to 1+100 - Grade 5.09%

SCALE: 1" = 50'



CUT & FILL VOLUMES

REACH 1	TOTAL CUT & FILL BETWEEN STA 0+000 to 0+275 (DOWNSTREAM OF DAM MATERIAL)	
	CUT = 830 C.Y.	FILL = 288 C.Y.
REACH 2	TOTAL CUT & FILL BETWEEN STA 0+275 to 0+415 (ESTIMATED DAM MATERIAL)	
	CUT = 11,777 C.Y.	FILL = 1 C.Y.
REACH 3	TOTAL CUT & FILL BETWEEN STA 0+415 to 1+100 (ESTIMATED RESEVOIR/SEDIMENT MATERIAL)	
	CUT = 26,637 C.Y.	FILL = 51 C.Y.
TOTAL	**TOTAL CUT & FILL VOLUMES** (ESTIMATED USING INROADS SOFTWARE)	
	CUT = 39,244 C.Y.	FILL = 340 C.Y.

US Army Corps of Engineers
San Francisco District
333 Market Street
San Francisco, CA 94105

Mark	Description	Date	Appr.

DESIGNED BY: LR/CG
DRAWN BY: GG
CHECKED BY:
DATE: 5/27/05
SHEET NO. 7 of 26
DRAWING NO. 1
PREPARED UNDER THE DIRECTION OF PHILIP T. FEIR LT. COLONEL, C.E., DISTRICT ENGINEER
SUBMITTED: Chief, Civil Design Section
APPROVAL RECOMMENDED: Chief, Engineering Branch
APPROVED: Chief, Engineering & Technical Services Division

FEASIBILITY

NAPA COUNTY CALIFORNIA
UPPER YORK CREEK-DAM REMOVAL PROJECT
ALTERNATIVE 2B
PROPOSED GRADING PLAN

Sheet reference number
5

PROFILE

Hungry Water: Effects of Dams and Gravel Mining on River Channels

G. MATHIAS KONDOLF
Department of Landscape Architecture and Environmental Planning
University of California
Berkeley, California 94720, USA
www.ced.berkeley.edu/~kondolf/

ABSTRACT / Rivers transport sediment from eroding uplands to depositional areas near sea level. If the continuity of sediment transport is interrupted by dams or removal of sediment from the channel by gravel mining, the flow may become sediment-starved (hungry water) and prone to erode the channel bed and banks, producing channel incision (downcutting), coarsening of bed material, and loss of spawning gravels for salmon and trout (as smaller gravels are transported without replacement from upstream). Gravel is artificially added to the River Rhine to prevent further incision and to many other rivers in attempts to restore spawning habitat. It is possible to pass incoming sediment through some small reservoirs, thereby maintaining the continuity of sediment transport through the system. Damming and mining have reduced sediment delivery from rivers to many coastal areas, leading to accelerated beach erosion. Sand and gravel are mined for construction aggregate from river channel and floodplains. In-channel mining commonly causes incision, which may propagate up- and downstream of the mine, undermining bridges, inducing channel instability, and lowering alluvial water tables. Floodplain gravel pits have the potential to become wildlife habitat upon reclamation, but may be captured by the active channel and thereby become instream pits. Management of sand and gravel in rivers must be done on a regional basis, restoring the continuity of sediment transport where possible and encouraging alternatives to river-derived aggregate sources.

As waters flow from high elevation to sea level, their potential energy is converted to other forms as they sculpt the landscape, developing complex channel networks and a variety of associated habitats. Rivers accomplish their geomorphic work using excess energy above that required to simply move water from one point on the landscape to another. In natural channels, the excess energy of rivers is dissipated in many ways: in turbulence at steps in the river profile, in the frictional resistance of cobbles and boulders, vegetation along the bank, in bends, in irregularities of the channel bed and banks, and in sediment transport (Figure 1). The transport of sand- and gravel-sized sediment is particularly important in determining channel form, and a reduction in the supply of these sediments may induce channel changes. The supply of sand and gravel may be the result of many factors, including changes in land use, vegetation, climate, and tectonic activity. This paper is concerned specifically with the response of river channels to a reduction in the supply of these sediments by dams and gravel mining.

Sediment is transported mostly as suspended load: clay, silt, and sand held aloft in the water column by turbulence, in contrast to bedload: sand, gravel, cobbles, and boulders transported by rolling, sliding, and bouncing along the bed (Leopold and others 1964). Bedload ranges from a few percent of total load in lowland rivers to perhaps 15% in mountain rivers (Collins and Dunne 1990), to over 60% in some arid catchments (Schick and Lekach 1993). Although a relatively small part of the total sediment load, the arrangement of bedload sediments constitutes the architecture of sand- and gravel-bed channels. Moreover, gravel and cobbles have tremendous ecological importance, as habitat for benthic macroinvertebrates and as spawning habitat for salmon and trout (Kondolf and Wolman 1993).

The rate of sediment transport typically increases as a power function of flow; that is, a doubling of flow typically produces more than a doubling in sediment transport (Richards 1982), and most sediment transport occurs during floods.

KEY WORDS: Dams; Aquatic habitat; Sediment transport; Erosion; Sedimentation; Gravel mining

Continuity of Sediment Transport in River Systems

Viewed over a long term, runoff erodes the land surface, and the river network carries the erosional products from each basin. The rates of denudation, or lowering of the land by erosion, range widely. The Appalachian Mountains of North America are being denuded about 0.01 mm/yr (Leopold and others 1964), the central Sierra Nevada of California about 0.1

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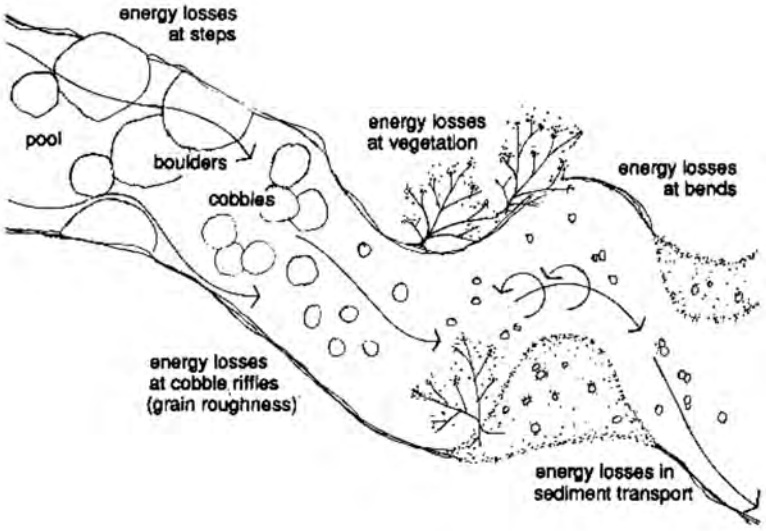

Figure 1. Diagram of energy dissipation in river channels.

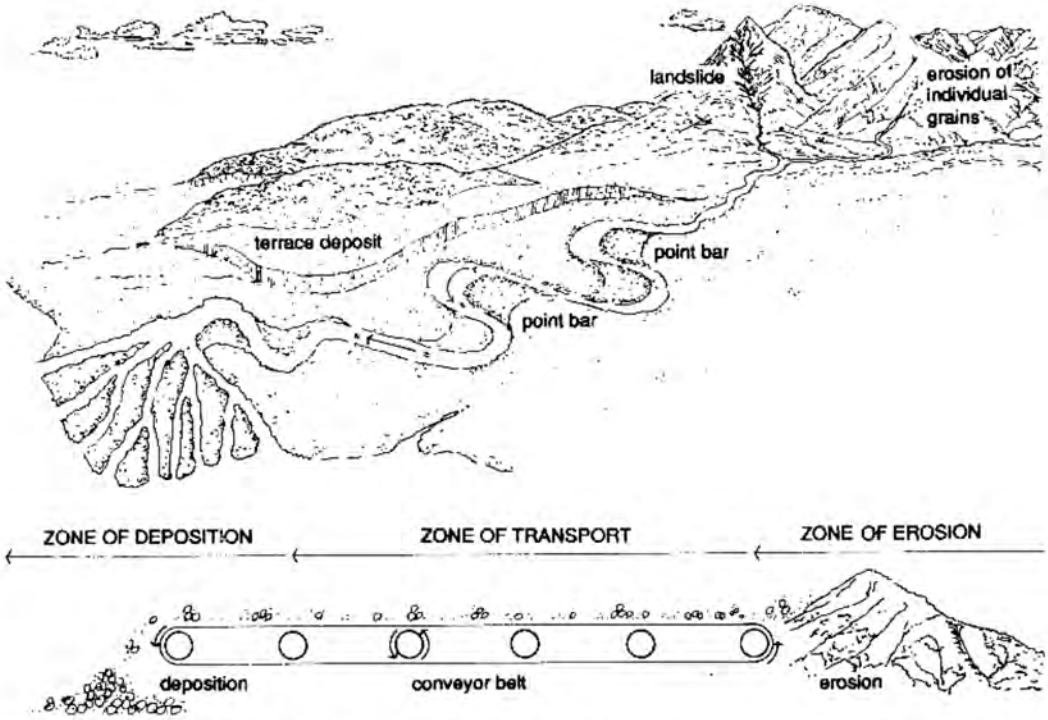

Figure 2. Zones of erosion, transport, and deposition, and the river channel as conveyor belt for sediment. (Reprinted from Kondolf 1994, with kind permission of Elsevier Science-NL.)

mm/yr (Kondolf and Matthews 1993), the Southern Alps of New Zealand about 11 mm/yr (Griffiths and McSaveney 1983), and the southern Central Range of Taiwan over 20 mm/yr (Hwang 1994). The idealized watershed can be divided into three zones: that of erosion or sediment production (steep, rapidly eroding headwaters), transport (through which sediment is moved more or less without net gain or loss), and deposition (Schumm 1977) (Figure 2). The river channel in the transport reach can be viewed as a conveyor belt, which transports the erosional products downstream to the ultimate depositional sites below sea level. The size of sediment typically changes along the length of the river system from gravel, cobbles, and boulders in steep upper reaches to sands and silts in low-gradient downstream reaches, reflecting diminution in size by

weathering and abrasion, as well as sorting of sizes by flowing water.

Transport of sediment through the catchment and along the length of the river system is continuous. Increased erosion in the upper reaches of the catchment can affect the river environment many miles downstream (and for years or decades) as the increased sediment loads propagate downstream through the river network. On Redwood Creek in Redwood National Park, California, the world's tallest trees are threatened with bank erosion caused by channel aggradation (building up of sediment in the channel), which in turn was caused by clear-cutting of timber on steep slopes in the upper part of the catchment (Madej and Ozaki 1996, Janda 1978).

Along the river channel conveyor belt, channel forms (such as gravel bars) may appear stable, but the grains of which they are composed may be replaced annually or biannually by new sediment from upstream. Similarly, the sediments that make up the river floodplain (the valley flat adjacent to the channel) are typically mobile on a time scale of decades or centuries. The floodplain acts as a storage reservoir for sediments transported in the channel, alternately storing sediments by deposition and releasing sediment to the channel by bank erosion. For example, the Carmel River, California, is flanked by flat surfaces (terraces) that step up from the river. The lowest terrace is the channel of sand and gravel deposited by the 1911 flood, but the surface now stands about 4 m above the present, incised channel (Kondolf and Curry 1986). By 1960, the terrace had been subdivided for low-density housing, despite the recent origin of the land and the potential for future shifts in channel position.

A river channel and floodplain are dynamic features that constitute a single hydrologic and geomorphic unit characterized by frequent transfers of water and sediment between the two components. The failure to appreciate the integral connection between floodplain and channel underlies many environmental problems in river management today.

Effects of Dams

Dams and diversions are constructed and operated for a wide variety of purposes including residential, commercial, and agricultural water supply; flood and/ or debris control; and hydropower production. Regardless of their purpose, all dams trap sediment to some degree and most alter the flood peaks and seasonal distribution of flows, thereby profoundly changing the character and functioning of rivers. By changing flow regime and sediment load, dams can produce adjustments in alluvial channels, the nature of which depends upon the characteristics of the original and altered flow regimes and sediment loads.

Dams disrupt the longitudinal continuity of the river system and interrupt the action of the conveyor belt of sediment transport. Upstream of the dam, all bedload sediment and all or part of the suspended load (depending upon the reservoir capacity relative to inflow) (Brune 1953) is deposited in the quiet water of the reservoir (reducing reservoir capacity) and upstream of the reservoir in reaches influenced by backwater. Downstream, water released from the dam possesses the energy to move sediment, but has little or no sediment load. This clear water released from the dam is often referred to as hungry water, because the excess energy is typically expended on erosion of the channel bed and banks for some years following dam construction, resulting in incision (downcutting of the bed) and coarsening of the bed material until equilibrium is reached and the material cannot be moved by the flows. Reservoirs also may reduce flood peaks downstream, potentially reducing the effects of hungry water, inducing channel shrinking, or allowing fine sediments to accumulate in the bed.

Channel Incision

Incision below dams is most pronounced in rivers with fine-grained bed materials and where impacts on flood peaks are relatively minor (Williams and Wolman 1984). The magnitude of incision depends upon the reservoir operation, channel characteristics, bed material size, and the sequence of flood events following dam closure. For example, the easily eroded sand bed channel of the Colorado River below Davis Dam, Arizona, has incised up to 6 m, despite substantial reductions in peak flows (Williams and Wolman 1984). In contrast, the Mokelumne River below Camanche Dam in California has experienced such a dramatic reduction in flood regime (and consequent reduction in sediment transport capacity) that no incision has been documented and gravels are reported to have become compacted and immobile (FERC 1993).

Reduction in bedload sediment supply can induce a change in channel pattern, as occurred on Stony Creek, a tributary to the Sacramento River 200 km north of San Francisco. Since the closure of Black Butte Dam in 1963, the formerly braided channel has adopted a single-thread meandering pattern, incised, and migrated laterally, eroding enough bedload sediment to compensate for about 20% of the bedload now trapped by Black Butte Dam on an annual average basis (Kondolf and Swanson 1993).

NAPA RIVER STEELHEAD AND SALMON MONITORING PROGRAM

2011-2012 SEASON

ADULT STEELHEAD IN MILLIKEN CREEK (MARCH 9, 2012)

SEPTEMBER, 2012

NAPA COUNTY RESOURCE CONSERVATION DISTRICT
1303 JEFFERSON ST. SUITE 500B
NAPA, CALIFORNIA 94559
WWW.NAPARCD.ORG

JONATHAN KOEHLER
SENIOR BIOLOGIST
(707) 252 – 4188 x 109
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PAUL BLANK
SENIOR HYDROLOGIST
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Steelhead smolt length (measured as fork length) during the past four years of sampling has averaged 187mm (7.4 inches). The median steelhead smolt size was 179mm (7.0 inches) in 2012. It appears that the size and range of steelhead smolts has varied little during the past four years (Figure 9), despite significant variability in environmental conditions including rainfall amounts and timing as well as seasonal flow patterns. Several studies have found a strong correlation between steelhead smolt size and ocean survival rates, with larger smolts having greater odds of returning as adults (Bond et al 2008, Ward and Slaney1988, Ward et al 1989). Given their large size, we would expect Napa River steelhead smolts to have relatively high ocean survival rates, perhaps 15-25% based on literature.

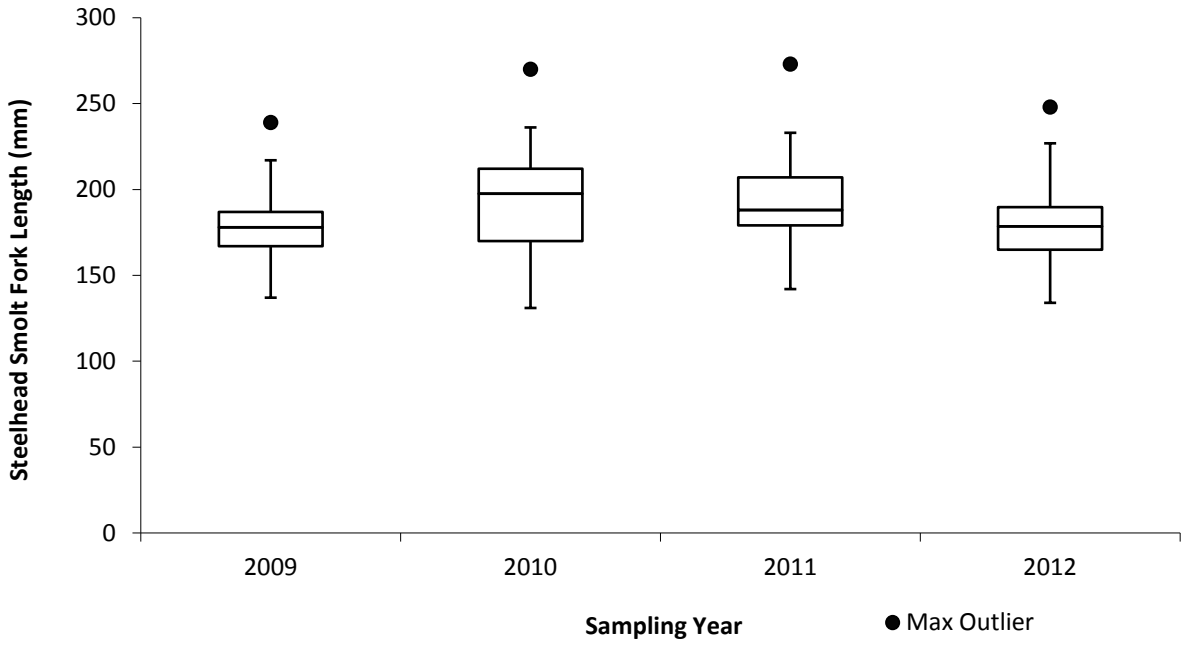

Figure 9. Box plot of steelhead smolt length from the Napa River rotary screw trap 2009-2012. Note: The bottom and top of each box are the 25th and 75th percentiles respectively. The line near the middle of each box is the median, and the vertical lines (whiskers) represent the lowest and highest values within 1.5 times the inter-quartile range. The maximum outlier values represent the largest individual measurement for each year.

Steelhead smolts were collected consistently throughout the 2012 season with the highest numbers captured during the third week in April. As observed in previous years, the highest steelhead catches corresponded with elevated flows following storms (Figure 10). Chinook salmon smolts were collected more regularly toward the end of the season with a peak around early May (Figure 11).

The Economic Value of Rogue River Salmon

Commissioned by the
Save the Wild Rogue Campaign,
with funding support from the Giles & Elise Mead Foundation

January 2009

ECONorthwest
ECONOMICS • FINANCE • PLANNING

wilderness experience offered by the Wild Rogue, the per fish and total willingness to pay (WTP) shown in Table 8 are likely low for that section of the river.

Table 8: Estimated Annual WTP by Sport Anglers for Rogue River Salmon, 2007 Dollars

Species	Catch Location	Estimated 2007 Catch	WTP Per Fish	Estimated Total WTP	Upper Bound WTP
Coho	Ocean	6,488	$64	$412,696	$412,696
	River	1,200	$157	$188,732	$363,404
Chinook	Ocean	5,355	$64	$340,600	$340,600
	River	15,988	$232	$3,711,003	$10,946,101
Steelhead	Ocean	1,040	$126	$131,130	$160,447
	River	4,165	$299	$1,246,599	$3,789,289
Total Sport Fishing		34,236		$6,030,759	$16,012,535

Source: ECONorthwest analysis of results from studies presented in Table 7 and data from Oregon Department of Fish and Wildlife (http://www.dfw.state.or.us/resources/fishing/sportcatch.asp)

3. NON-USE VALUE OF ROGUE RIVER SALMON

Even those who do not consume salmon or steelhead may benefit from their existence. In fact, the non-use value of an environmental resource is often far greater than it's commercial or sport value. Non-use value can take several different forms: option value, which is the value of saving a good for use at another time; bequest value, the value of saving a good for future generations; altruistic value, the value of saving a good for others to use now; and existence value, the value of saving a good for the sake of its existence[21]. Surveys indicate that, in aggregate, residents of the Pacific Northwest and California place a much higher non-use value on salmon than they do use value. Only a relatively small proportion of West Coast residents participate in fishing for salmon and steelhead. Thus there are many fewer households over which to aggregate total value. For example, based on information from the *2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: Oregon*, 455,000 Oregonians age 16 or older participated in fishing in 2006, out of a 16+ population of 2,894,050. This represents only 16% of Oregon's 16 and older population[22]. Comparatively, based on household survey results, a much larger percentage of Oregonians (and Americans in general) value Northwest salmon even though they likely will never participate in salmon fishing or even view a wild salmon (see Loomis, 1999, Pate and Loomis 1997, Loomis 1996).

[21] Schuhmann, P.W. and K.A. Schwabe. 2002. "Fundamentals of Economic Principles and Wildlife Management." In L. Clark, J. Hone, J.A. Shivik, R.A. Watkins, K.C. VerCauteren, and J.K. Yoder, eds., *Human Conflicts with Wildlife: Economic Considerations. Proceedings of the Third NWRC Special Symposium*. Fort Collins, CO: National Wildlife Research Center from http://www.aphis.usda.gov/ws/nwrc/symposia/economics/.

[22] U.S. Department of Interior, Fish & Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. *2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: Oregon.*

Loomis (1999) estimated the marginal non-use value of salmon and steelhead on the Lower Snake River to residents of Oregon, Washington, and California[23]. The results of the analysis indicate that, as one would expect, the marginal value (i.e., the value of the next additional salmon) goes down as the total population of salmon goes up. At very low populations, (e.g. fewer than 5,000 total fish) the marginal value of an additional fish is more than $1.0 million. This immense per-fish value embodies the scarcity associated with a small fish population and society's desire to preserve the species for current and future generations.

Based on the results of the survey analysis and through the incorporation of information from other surveys, Loomis (1999) developed a *marginal WTP benefit function*, which provides estimates of the marginal value of a fish based on the size of the underlying population. He then demonstrates that as the underlying population increases, the marginal value that society places on increasing the population by one fish decreases. For example, based on a salmon population of 500,000, the marginal value of one additional fish is $1,595. However, the marginal value of a second additional fish (e.g., the marginal value based on a salmon population of 500,001) is only $1,539.

Loomis (1999) developed the marginal WTP benefit function based on analysis of society's WTP to increase the salmon populations on the lower Snake River. Based on comments from one or more reviewers of his analysis, he contends that the benefit function may in fact be representative of the entire Pacific Northwest salmon population. What this means is that, though there are many distinct populations of salmon throughout the Pacific Northwest, many Northwest and California residents do not differentiate between salmon of various populations. Society's concern is for the overall welfare of salmon populations throughout the Northwest. Thus, the value that society places on the marginal fish returning to spawn in any one Northwest river is a function of the aggregate count of all salmon returning to spawn in all Northwest rivers. The result of embracing the assumption that society views all Northwest salmon as members of one Northwest-wide population, is that society's WTP for the marginal salmon of any actual (biological) population will be lower than if society viewed each biological population separately.

To estimate the society's non-use WTP for Rogue River salmon and the value society places on the entire population of Rogue River salmon we embrace the all-Northwest assumption regarding the WTP benefit function for Rogue River salmon. In doing so, we acknowledge that our estimates of the non-use or existence value represents a lower bound estimate of the actual non-use value society places on Rogue River salmon. That is, although we are unsure of society's actual non-use WTP for Rogue River salmon, we are confident

[23] Loomis reviewed and augmented survey data from three other studies which asked households in the Pacific Northwest and California how much they were willing to pay for a specified increase in the number of either salmon or salmon and steelhead on a given river as a result of dam removal. None of the fish in these studies were endangered which is an important consideration when relating the results of these studies to other rivers since individuals will likely place greater existence value on an endangered species than on a non-endangered species.

that it is no lower than and may be much higher than the estimated value based on the WTP benefit function developed by Loomis (1999).

Table 9 shows the estimated marginal and average values of Rogue River salmon, as well as the total value of the Rogue River fishery based on various assumptions about the entire population of Northwest salmon. To our knowledge, "official" estimates of the aggregate population of Northwest salmon are not available.[24] However, based on escapement counts[25] for the Columbia River system from the Pacific Fishery Management Council (PFMC), we estimate the 10-year average annual salmon escapement for the Northwest to be approximately 830,000 fish.[26] Based on this estimate of the Northwest salmon population, we estimate society's annual marginal non-use WTP for a Rogue River salmon to be $1,008, the average WTP to be $1,824, and the total annual non-use WTP of the entire Rogue River salmon fishery to be just over $1.5 billion.

At first glance, these numbers appear to be very large. However, consider that these estimates are aggregated across the entire population of Oregon, Washington, and California—more than 46 million people in 2007. The per-person value of the entire Rogue River salmon fishery is $32.37 per year. Another perspective from which to view the annual value of the fishery is to compare it to the economic output of the 3-state region. Based on Bureau of Economic Analysis data (BEA), the combined gross state product of the three states was $2.28 trillion. The estimated annual value of the Rogue River fishery represents a mere 0.07% of the total annual output for 2007.

[24] We define "aggregate population" as the 10-year average salmon escapement summed across all Northwest river systems.

[25] Escapement is the annual count of salmon and steelhead returning to their spawning ground or hatchery.

[26] The PFMC 2007 report can be found at: http://www.pcouncil.org/salmon/salsafe.html.

Table 9: Annual Non-Use Value of Rogue River Salmon, 2007 Dollars*

Assumed Northwest Salmon Population	Marginal Value of a Rogue River Salmon	Average Value of a Rogue River Salmon	Total Value of Rogue River Salmon Population
500,000	$1,595	$4,892	$2,446,138,182
750,000	$1,112	$2,217	$1,662,959,665
828,282	**$1,008**	**$1,824**	**$1,514,072,103**
1,000,000	$822	$1,266	$1,266,345,698
1,250,000	$793	$821	$1,026,859,060
1,500,000	$525	$576	$863,315,110

Source: ECONorthwest analysis of results from Loomis, J. 1999. *Recreation and Passive Use Values From Removing the Dams on the Lower Snake River to Increase Salmon*. Agricultural Enterprises, Inc. for the Department of the Army Corps of Engineers; data from the Pacific Fishery Management Council (http://www.pcouncil.org/salmon/salsafe.html) and data from Oregon Department of Fish and Wildlife (http://www.dfw.state.or.us/resources/fishing/sportcatch.asp).

* Consistent with the results of the WTP salmon question in the 1996 through 2006 Oregon Population Surveys, we assume no inflationary growth in the WTP between 1996 (the data year of the Loomis 1999 study) and 2007.

Table 9 also provides estimates of the value of Rogue River salmon based on alternative assumptions regarding the size of the entire Northwest salmon population. The declining values associated with increasing salmon populations shown in Table 9 are consistent with economic principles of diminishing marginal value. Under an assumption of relative scarcity (e.g. a total average annual escapement of 500,000 salmon across all Northwest rivers), the marginal value of Rogue River salmon is greater. And under the alternative assumption of relative abundance (e.g. 1.5 million salmon), the marginal value of Rogue River salmon is less. Stated another way, as local, regional, and oceanic conditions worsen for Northwest salmon, the value of the next Rogue River salmon increases.

While the results of Loomis' study provide insight into the values society place on salmon in general, it is important to realize that all salmon populations in the Northwest may not be valued the same. A 2005 report by Goodstein and Matson[27] summarized and augmented research by Layton, Brown, and Plummer in 1999 on people's willingness to pay for specific salmon restoration projects. Goodstein and Matson (2007) used these data to find the perceived economic benefit of restoring salmon populations or, alternatively, of avoiding further declines in salmon populations and they extended the data collected from Washington and Oregon households to households nationwide by assuming that residents outside of Oregon and Washington, on average, placed a value on salmon restoration equal to half that of Oregon and Washington residents. This is a conservative assumption according to other studies on the value of Pacific Northwest salmon for residents outside of the Northwest region. Table 10 summarizes their findings.

[27] Goodstein, E. and L. Matson. 2007. "Climate Change in the Pacific Northwest: Valuing Snowpack Loss for Agriculture and Salmon." In J.D. Erickson and J.M. Gowdy, eds., *Frontiers in Ecological Economic Theory and Applications*. Northampton, MA: Edward Elgar.

Table 10: The Economic Benefits of Restoring Salmon Populations and of Preventing Further Declines in Salmon Populations

The economic benefits to residents of Oregon and Washington of restoring salmon populations:	
Columbia River Salmon	$2,890 per fish
Washington Coastal Chum Salmon	$872 per fish
Oregon Coastal Coho Salmon	$872 per fish
Rogue River Coastal Coho Salmon	$872 per fish
Puget Sound Chinook Salmon	$872 per fish
The economic benefit per year, to residents of Oregon and Washington, of preventing further declines in wild-salmon populations:	
Preventing a one-third decline in populations	$359 million - $3.6 billion
Preventing a two-thirds decline in populations	$718 million - $7.2 billion
The economic benefit per year, to residents of the U.S., of preventing further declines in wild-salmon populations:	
Preventing a one-third decline in populations	$5.4 billion - $54 billion
Preventing a two-thirds decline in populations	$10.9 billion - $109 billion

Source: ECONorthwest with data from Goodstein, E. and L. Matson. 2007. "Climate Change in the Pacific Northwest: Valuing Snowpack Loss for Agriculture and Salmon." In J.D. Erickson and J.M. Gowdy eds., *Frontiers in Ecological Economic Theory and Application*. Northampton, MA: Edward Elgar.

One of the disadvantages of the reports of non-use value viewed thus far is that they take data only from one point in time and do not allow us to observe how residents' willingness to pay for salmon recovery changes with changes in the economy and social structure. To observe trends in Oregonians' willingness to pay for salmon habitat restoration and improved water quality, we look at the Biennial Oregon Population Survey, conducted by the Oregon Office of Economic Analysis and the Oregon Progress Board. The survey provides data from as far back as 1996 and asks Oregon residents, how much per month they are willing to pay for water quality and habitat improvement efforts to help improve salmon runs in Oregon.

In 2006, the survey results showed, on average, that each Oregonian household was willing to pay $4.42 per month in 2008 dollars. Extending that value over the course of a year and multiplying the result by 1,333,723 Oregon households, indicates that Oregonians alone are willing to pay a total of $75,958,977 per year to improve salmon runs. Figure 2 shows the average annual amount Oregonians stated they are willing to pay for water quality and salmon habitat improvements based on the results of the Oregon Population Survey. The willingness to pay remains fairly constant (in nominal dollars) throughout the years for which data are available indicating that Oregonians are willing to make a long-term commitment to protecting and improving salmon habitat. It also indicates that Oregonians have a

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Economic Valuation of Forest Ecosystem Services: Methodology and Monetary Estimates

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Abstract

By using ad hoc value transfer protocols, this paper offers a methodological contribution and provides accurate per hectare estimates of the economic value of some selected ecosystem services for all forest biomes in the world, identified following the Millennium Ecosystem Assessment taxonomy MEA. The research also estimates potential total economic losses from policy inaction in year 2050. Final results show that total losses are significant. The total figure is €78 billion, the greatest losses coming from North America and Mexico, followed by Africa, Russia and some Asiatic countries. Most of this loss is attributable to provisioning services and carbon sequestration, while only a minor part is due to loss of cultural services. In terms of biomes the greatest losses are from boreal and warm mixed forests, followed by tropical forests. These results may be surprising to some who argue that it is the loss of tropical forests, particularly the Amazon, that is the most significant. A detailed analysis, shows, however, that this is not the case. The best estimates point to greater losses in areas where use and non-use values are highest, which includes North America.

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ANALYSIS

The economic value of wetland services: a meta-analysis

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Abstract

The number of studies quantify the value of wetlands and the services provided by these ecosystems is rapidly expanding. The time is ripe for an assessment of what has been learned from this literature. Using results from 39 studies, we evaluate the relative value of different wetland services, the sources of bias in wetland valuation and the returns to scale exhibited in wetland values. While some general trends are beginning to emerge, the prediction of a wetland's value based on previous studies remains highly uncertain and the need for site-specific valuation efforts remains large. © 2001 Elsevier Science B.V. All rights reserved.

1. Introduction

The valuation of wetlands' ecological services is a relatively recent phenomenon. Historically, wetlands were viewed as a waste of valuable land that could only be 'improved' through drainage and destruction of the wetland (Mitsch and Gosselink, 1986). Today, while there is now widespread recognition that wetlands provide valuable ecological services, there remain substantial debates over whether particular areas are in their highest economic use as wetlands, and to what extent public and private resources should be used for their protection and restoration. Hence, there is a growing need to quantify the value of wetland services.

The services provided by wetlands include habitat for species, protection against floods, water purification, amenities and recreational opportunities. Because these services typically have no market price, a measure of their values can only be obtained through non-market valuation techniques. Many wetland valuation studies have been conducted and the range of the estimates is remarkable. A recent review by Heimlich et al. (1998) lists 33 studies over the last 26 years with per acre values ranging from US$0.06 to US$22050. Even within the same study looking at a single ecosystem function, Batie and Wilson (1978) find values per acre that differ by two orders of magnitude from one site to another.

The purpose of this paper is to assess whether any systematic trends can be distilled from the

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Table 2
Estimated models of the wetland valuation function[a] (log of value per acre dependent variable, standard errors in parentheses)

Variable	Mean	A	B	C
Intercept		7.945[b]	6.641[b]	7.872[b]
		(1.07)	(1.31)	(1.74)
Year	14.908	−0.052	−0.004	0.016
		(0.03)	(0.04)	(0.04)
Ln acres	9.281	−0.168[c]		−0.286[b]
		(0.10)		(0.11)
Coastal	0.431	−0.523		−0.117
		(0.71)		(0.68)
Flood	0.138	−0.358		0.678
		(1.03)		(0.77)
Quality	0.200	1.494[c]		0.737
		(0.78)		(0.75)
Quantity	0.062	0.514		−0.452
		(1.60)		(1.54)
Rec. Fish	0.354	0.395		0.582
		(0.55)		(0.56)
Com. Fish	0.277	0.669		1.360
		(0.79)		(1.01)
Birdhunt	0.400	−1.311[b]		−1.055[b]
		(0.49)		(0.52)
Birdwatch	0.277	1.704[b]		1.804[b]
		(0.52)		(0.59)
Amenity	0.154	−3.352[b]		−4.303[b]
		(0.93)		(0.95)
Habitat	0.308	0.577		0.427
		(0.56)		(0.59)
Storm	0.031	0.310		0.173
		(2.37)		(1.66)
Publish	0.769		−0.669	−0.154
			(0.72)	(0.71)
Data0	0.246		0.302	0.000
			(0.56)	(0.60)
Theory0	0.215		−1.020	−1.045
			(0.84)	(0.84)
Metric0	0.123		−4.030[b]	−3.186[b]
			(1.21)	(1.22)
PS	0.277	−2.416[b]	−2.034[b]	−3.140[b]
		(0.83)	(0.72)	(0.86)
HP	0.031		0.441	5.043[b]
			(1.02)	(1.12)
NFI	0.246		−0.724	0.273
			(0.82)	(0.90)
RC	0.277		1.376	2.232[b]
			(0.86)	(0.89)
TC	0.108		−1.196[c]	−0.341
			(0.64)	(1.05)
n	65	65	65	65
R^2		0.373	0.364	0.582

[a] Standard errors were calculated using White's (1980) correction for heteroskedasticity. All results were obtained using Shazam version 8.0 (White, 1997).

[b] Significantly different from zero at the 5% level.

[c] Significantly different from zero at the 10% level.

means of the variables the log of the wetland value predicted for a high-quality unpublished study is 5.68 with a standard error around the prediction (σ_p) of 0.61. If it is assumed that the study is published, however, σ_p falls to only 46% of the original value. For studies that are weak in the areas of theory or econometrics, σ_p increases by 1.9 or 2.1-fold, respectively. On the other hand, the impact of study's data being of poor quality is slight, leading to a 4% decline in σ_p.[7] Study quality is important not so much because it might bias results, but because high quality studies lead to a much more precise basis for prediction.

There is some evidence that the method used has a statistically significant effect on the value obtained. As in Fig. 2, in model B we find that CV tends to dominate other methods as the signs on their coefficients are either negative or statistically insignificant. However, when variables indicating the wetland services are introduced in model C, the dominance of CV disappears and the sign on HP and RC methods becomes significantly positive. Hence, relative to these methods, CV studies tend to find a lower value per acre and we cannot conclude that this method is biased relative to the TC or NFI method.[8]

6.3. Do wetlands values exhibit returns to scale?

The coefficient on LnAcres is consistently negative and statistically significant across the models reported in Table 2, indicating significant decreasing returns to scale. However, because of the double-log functional form, the scale effect is extremely small for large wetlands. From Eq. (1), the marginal effect of an increase in the size of a wetland is

$$\partial y/\partial x_a = a_a x_a^{(a_a - 1)} e^{(a_0 + a_s \cdot x_s + a_m \cdot x_m + a_0 \cdot x_0)}$$

[7] The predicted values and standard errors around the predictor were calculated following Goldberger (1991, p.175).

[8] The coefficient on the HP method should be interpreted with extra caution since it reflects only two studies in the data set that used this method.

While a negative value for a_a means that an increase in the size of a wetland pushes down the value per acre, this effect diminishes rapidly as wetland size increases. Using the coefficient from model C, a 1% increase in area leads to a 2.9% fall in value for a ten-acre wetland. This effect declines geometrically, and for a wetland of 1000 acres the elasticity is only −0.029. This confirms what we see in Fig. 4 where wetland area appears to have little impact on value per acre.

6.4. How do wetland services affect wetland value?

The final and central question that we seek to answer is how wetland services influence wetland value. The coefficients on the wetland service variables are estimates of the extent to which the presence of each service changes the value per acre. A very small coefficient on the habitat variable, for example, does not mean that this service has no value, but that the value of wetlands that provide this service are very close to the average value for all wetlands.

Most of the wetland service variables are not statistically significant. In models A and C, only the coefficient on the birdwatch variable is significant and greater than zero while those on the birdhunt and amenity variables are significant and less than zero. Hence, the data indicate that a wetland that provides bird watching opportunities is more valuable than the average wetland, while those that offer bird hunting or amenity services are less valuable.

As one would expect, based on the explanatory variables in the model, only very imprecise predictions of wetland values are possible. Using the estimates from model C, Table 3 presents the predicted values per acre for each possible single-service wetland and 90% confidence intervals around those estimates.[9] Some strong conclusions can be drawn from the results. Looking not only at the mean, but at the upper and lower bounds of the confidence interval, bird watching and commercial fishing services are among the highest three valued services while amenity services are the least valued among all wetland services. The confidence intervals are extraordinary, spanning thousands of dollars. Clearly it would be highly speculative to use of a single point from this distribution in a benefits transfer exercise.

Table 3
Predicted values per acre of single-service wetlands[a]

Service	$E[\ln y]$	90% confidence interval around $\hat{y}$ (1990 US$'s per acre)		
		Lower	Mean	Upper
Flood	5.97	89	393	1747
Quality	6.03	126	417	1378
Quantity	4.84	6	127	2571
Rec.fish	5.88	95	357	1342
Com.fish	6.66	108	778	5618
Birdhunt	4.24	25	70	197
Birdwatch	7.10	528	1212	2782
Amenity	0.99	1	3	14
Habitat	5.72	95	306	981
Storm	5.47	11	237	5142

[a] The results presented in Table 3 are obtained from model C. The predicted values are obtained at the means of year and acre variables. Except for the variables indicating the respective services, all other binary variables are set to zero so that the prediction reflects a high-quality CV study estimating consumer surplus.

7. Conclusions

We have seen that wetland valuation studies are remarkably diverse in terms of the values obtained, the wetlands evaluated, and the characteristics of the studies. Our goal in this study was to isolate the sources of the variability in the wetland value.

There is some evidence that the method employed affects the value obtained. Relative to the HP or RC methods, using the CV method tends to yield a lower estimated value while there is no statistically significant difference between the CV and the TC or NFI methods. While it is perhaps comforting that the method that is used does not appear to be a primary determinant of value, the unimportance of study quality is not so reassur-

[9] We emphasize that the values in Table 3 do not represent marginal values and cannot be summed to obtain the value of multiple function wetlands.

July 30, 1992

Mr. Marty Oldford
Director of Public Works
City of St Helena

Dear Mr. Oldford:

Removal of Dam, York Creek

As a result of the unfortunate incident involving the draining of your reservoir and collected silt into York Creek on July 28, 1992, we have reviewed our files and found that this was not the first such episode; similar incidents occurred in 1965, 1973, and again in 1975. In each and every instance dense, anaerobic sediments, high in toxic hydrogen sulfide, were released from the dam and deposited in pools and riffle areas downstream, quickly suffocating and burying all fish and aquatic invertebrates within a mile or more of the dam.

Following the third episode in 1975, we suggested to the City that, since the reservoir was no longer a part of the City's water supply, its continued existence created not only an unnecessary barrier to fish migration, but a continuing liability to the City for on-going maintenance; and fines, damages, and cleanup costs, should a discharge occur in the future. We suggested that removal of the dam and impoundment might be the most expedient means to avoid such periodic disasters in the future.

It would seem that the economic liability to the City from the existence of this unnecessary structure would far outweigh any peripheral benefits the City might enjoy from its existence. Therefore, we again encourage the City to consider complete removal of this structure and impounded sediments as an integral part of cleanup operations mandated by the latest episode.

If you have any questions, or wish to pursue this option, please contact Warden Jack Edwards at (707) 944-5500 for details.

Sincerely,

Brian Hunter
Regional Manager
Region 3

MER/dcf

CALIFORNIA DEPARTMENT OF FISH AND GAME
P.O.BOX 47
YOUNTVILLE, CA. 94599

INVESTIGATION REPORT: SILT RELEASE INTO YORK CREEK, NAPA COUNTY.

DATE OF OCCURANCE: JULY 28, 1992

LOCATION OF OCCURANCE: UPPER RESERVOIR, YORK CREEK, TRIBUTARY TO NAPA RIVER.

CAUSE OF RELEASE: SUSPECTED MALFUNCTION OF OLD VALVE AND OR FAILURE OF CRIBBING AROUND VALVE STRUCTURE.

PROPERTY OWNER: CITY OF ST. HELENA

VIOLATION: FISH AND GAME CODE SECTION 5650 (F)...POLLUTION OF STATE WATERS.

SYNOPSIS: ON THE ABOVE DATE, A REPORT WAS RECEIVED BY THE ? CALISTOGA POLICE DEPARTMENT THAT THE DAM ON YORK CREEK HAD FAILED, AND THAT A LARGE AMOUNT OF SILT HAD FLOWED DOWN STREAM AND INTO THE NAPA RIVER. A RESPONSE TO THE CALL WAS MADE AND CONFIRMED THAT A FAILURE OF SOME TYPE HAD OCCURED BUT THAT THE DAM HAD NOT FAILED.

AN INSPECTION OF THE STREAMBED FROM THE DAM DOWNSTREAM TO THE NAPA RIVER DISCLOSED THAT SILT HAD BEEN DEPOSITED WITHIN THE STREAM BED FROM THE FACE OF THE DAM TO A POINT WHERE THE NAPA RIVER JOINS THE STREAM. THE EXTENT OF THE SILT DEPOSITS VARY FROM A RATHER HEAVY DEPOSIT JUST BELOW THE DAM AND CONTINUING DOWNSTREAM FOR ABOUT ONE HALF MILE AND THEN GRADUALLY THINNING UNTIL THERE IS A LIGHT COVERING OF FINE SILT AT THE NAPA RIVER.
THE TOTAL DISTANCE BEING ABOUT 2 1/2 TO 3 MILES LONG.

WITHIN THE "ZONE", THERE IS TOTAL LOSS OF AQUTIC LIFE. THE ORGANISMS WHICH FORMERLY SURVIVED HAD BEEN SMOTHERED BY THE SILT AS IT WAS DEPOSITED ON THE STREAM BOTTOM. A NUMBER OF SMALL DEAD FISH AND FROGS ALONG WITH INSECTS WERE NOTED LITTERING THE DEPOSITS OF SILT.

DUE TO THE LARGE VOLUME OF SILT REMAINING BEHIND THE DAM AND THAT WHICH FLOWED DOWNSTREAM. AND THE FACT THAT THE EXACT CAUSE OF THE FAILURE MAY NOT BE KNOWN FOR QUITE SOME TIME. AN URGENCY OCCURED IN PROCEEDING WITH A PLAN OF ACTION WHICH WOULD BOTH SATISFY THE REQUIREMENTS OF FISH AND GAME SECTION 5650 AND THE CITY OF ST HELENA'S DESIRE IN PREVENTING FURTHER DAMAGE TO THE STREAM.

IT WAS FOUND THAT THERE HAD BEEN SEVERAL PREVIOUS EVENTS RELATING TO THE RESERVOIR DURING THE PAST TWENTY SEVEN YEARS. AND THAT AT LEAST ON ONE OCCASION, THE NAPA COUNTY DISTRICT ATTORNEY'S OFFICE, WAS INVOLVED WITH BOTH THE DEPARMENT OF FISH AND GAME AND THE CITY OF ST HELENA OVER PROBLEMS WITH THE DAM.

ABOUT 1975, THE CITY WORKED ON THE VALVE STRUCTURE AND BUILT A CRIB STRUCTURE TO PREVENT DAMAGE TO THAT VALVE. SINCE THEN, AS FAR AS CAN BE DETERMINED, LITTLE OR NO WORK HAS BEEN DONE TO THE RESERVOIR. SILTATION HAS CONTINUED ON A YEAR TO YEAR BASIS, CAUSING A BUILD UP WITHIN THE RESERVOIR TO A POINT WHERE THE SILT IS NEARLY UP TO THE LEVEL OF THE V NOTCH WHICH WAS CUT INTO THE SPILLWAY THE PURPOSE OF WHICH WAS TO CAUSE A LOWER WATER LEVEL BEHIND THE DAM. THUS REDUCING THE CHANCE OF A MAJOR MALFUNCTION OF THE DAM ITSELF. ALSO, BY REDUCING THE HEIGHT OF THE DAM, THE STATE DIVISION OF DAMS WOULD NO LONGER HAVE JURISDICTION BECAUSE IT WOULD BE UNDER A HEIGHT OF TWENTY FIVE FEET.

SHORTLY AFTER THE ABOVE INCIDENT, (1992), THE DEPARTMENT OF FISH AND GAME WROTE A LETTER TO THE CITY OF ST HELENA SUGGESTING THAT BECAUSE OF A HISTORY OF PROBLEMS RELATING TO YORK CREEK AND THE FACT THAT THIS RESERVOIR NO LONGER SERVES AS A VIABLE WATER SOURCE; THAT THE CITY MAY WISH TO CONSIDER IT'S REMOVAL. THE LIABILITY IN THIS CASE APPEARS TO BE SUBSTANTIAL BECAUSE OF THE PRIOR HISTORY AND THE RECENT EVENT. ADDITIONALY, SECTION 5937 OF THE FISH AND GAME CODE NOW REQUIRES A FISH LADDER IN ANY STRUCTURE WHICH BLOCKS A STREAM.

AS OF SEPTEMBER 18, 1992 THE CITY OF ST HELENA, IN ITS ATTEMPT TO LOCATE THE ELUSIVE VALVE, HAS BEEN UNSUCCESSFUL. THE REASON IS THAT THERE WAS SUCH A BUILDUP OF SILT AROUND THE BASE OF THE DAM THAT THE DEPTH OF THE VALVE MAY HAVE BEEN DEEPER THAN ORIGINALY THOUGHT.

Jack M. Edwards
Fish & Game Warden
10-14-92

STATE OF CALIFORNIA
DEPARTMENT OF FISH AND GAME

REGION 3

[X] INVESTIGATION [ ] ARREST [ ] POLLUTION OTHER: _____ CITATION NUMBER: _____

DATE OF INCIDENT	TIME	DAY OF WEEK	LOCATION
July 28, 1992			Spring Mt. Rd. St Helena Napa County

	SUSPECT(S) FIRST, MIDDLE, LAST	DOB	LIC/ID #	ADDRESS
S-1	City of St Helena			
S-2				
S-3				
S-4				

OFFENSE(S) LIST SECTION NUMBERS AND CODE: T-14 CCR OR F&G CODE OR PENAL CODE AND DESCRIPTION

COUNT 1	5650 - Siltation of State Waters
COUNT 2	
COUNT 3	
COUNT 4	

WITNESS INFORMATION

	FIRST, MIDDLE, LAST	ADDRESS	TELEPHONE
W-1	Jack M. Edwards	P.O. Box 47 Yountville, CA 94599	707-944-5512
W-2			

EVIDENCE SEIZED (DETAILED DESCRIPTION)

See Report - Numerous Photographs -

SYNOPSIS

See Attached Report

REPORTING EMPLOYEE Jack M. Edwards TITLE: Fish + Game Warden BADGE NO. 147

DATE OF REPORT 10-14-92 PHONE (707) 944-5512 BUSINESS ADDRESS P.O. Box 47 Yountville CA 94599

Jack M. Edwards
SIGNATURE OF REPORTING EMPLOYEE

H. L. St. Clair
SIGNATURE OF REVIEWING OFFICER

WLP-6A (Rev. 4-89)

CENTRAL NAPA RIVER WATERSHED PROJECT

SALMONID HABITAT FORM AND FUNCTION

October, 2005

FINAL REPORT

Prepared By

Napa County Resource Conservation District

For

California Department of Fish and Game

Contract # P9985160

SB271 Funded

Reach 5 had a canopy density of 97%, and Reach 6 had a canopy density of 97%). In general, revegetation projects are considered when canopy density is less than 80%. Reaches 1 and 2 would benefit from riparian planting and restoration in areas with sparse canopy and narrow buffers. Reach 2 has extensive areas of exotic vegetation that should be removed and replaced with native species.

The percentage of right and left bank covered with vegetation was high at 71% and 73%, respectively. In areas of stream bank erosion or where bank vegetation is sparse, planting native plant species, in conjunction with bank stabilization, is recommended. Bank vegetation was most sparse in Reach 1.

Overall, York Creek is one of the most significant spawning and rearing streams for steelhead within the Napa Basin. Reach 1 and 2 have been adversely affected by riparian encroachment, levee construction, road building, and channel modifications (i.e. straightening). Reaches 2, 3, and 4 are the only reaches currently accessible and suitable for steelhead spawning and rearing. These reaches contain high quality habitat and sustained flow. Reach 1 contains limited rearing habitat, primarily above Highway 29. The instream reservoir on York Creek is scheduled for removal in 2006-2008 by the US Army Corps of Engineers and the City of St. Helena. Removing the reservoir will allow access to over 1.5 miles of high quality steelhead habitat. The upper reaches of York Creek offer excellent rearing and spawning habitat, and creating access to these areas will greatly benefit the overall steelhead population.

A small diversion dam in Reach 3 that was identified in our 2003 habitat survey was removed by the City of St. Helena in 2004 and restored to allow fish passage. The site is a significant improvement to fish migration in York Creek.

A complete inventory of 35 potential restoration sites for York Creek has been compiled and prioritized in section 4 of this report.

DRAFT

INITIAL STUDY / PROPOSED MITIGATED NEGATIVE DECLARATION FOR THE YORK CREEK DAM REMOVAL AND STREAM RESTORATION PROJECT, NAPA COUNTY, CALIFORNIA

July 2002

Lead Agency:
The City of St. Helena

PROJECT SUMMARY

York Creek Dam Removal and Stream Restoration Project

Part 1. Introduction

The purpose of this initial study/environmental assessment (IS/EA) is to determine whether the proposed project would result in any potentially significant impacts to the environment and, if so, to incorporate mitigation measures to reduce or eliminate potentially significant effects to a less-than-significant level. This IS/EA has been prepared pursuant to the California Environmental Quality Act (CEQA) and the National Environmental Policy Act.

Environmental Setting

The York Creek watershed originates from the California Coast Ranges on the western side of the Napa Valley watershed at an elevation of approximately 1,800 feet (550 m) (Figure 1). The York Creek watershed is about 5 square miles (13 km^3). The creek flows in an easterly direction through a narrow canyon before joining the Napa River northeast of St. Helena at an elevation of approximately 225 feet (69 m). The City of St. Helena maintains the only pre-1914 appropriative water rights for York Creek. Approximately 2.5 miles (4.0 km) upstream from the mouth of York Creek, a concrete masonry diversion structure diverts water from York Creek to the St. Helena Lower Reservoir. The Lower Reservoir, located on an unnamed tributary to York Creek, supplies water for irrigation and other municipal uses and has a capacity of approximately 200 acre-feet. St. Helena Upper Dam (York Creek Dam) and Reservoir (Upper Reservoir) on York Creek are located approximately 0.5 miles (0.8 km) upstream of the diversion structure in York Creek Canyon (Figure 2). York Creek Dam and Upper Reservoir are no longer used for water supply. Other landowners adjacent to York Creek have riparian rights to water in York Creek and divert water via pumps placed in the stream.

Land use in the York Creek watershed consists of forested open-space, agriculture (primarily viticulture), and residential. Vineyards have been developed throughout the watershed, but particularly on the valley floor near the confluence of York Creek and the Napa River where two large wineries, Beringer and Krug, are located. Residential areas within the city limits of St. Helena occur primarily between Highway 12 (River Mile 1.0 of York Creek) and approximately River Mile 1.75 of York Creek. Stevenson Junior High School is located south of the intersection between York Creek and Highway 12.

Spring Mountain Road is a two-lane county road that runs adjacent to York Creek for nearly 2.5 miles and crosses the creek via three bridges. Several culverts carry water from unnamed tributaries that run under Spring Mountain Road and into York Creek. Three of the culverts empty into Upper Reservoir.

Purpose and Need of the Project

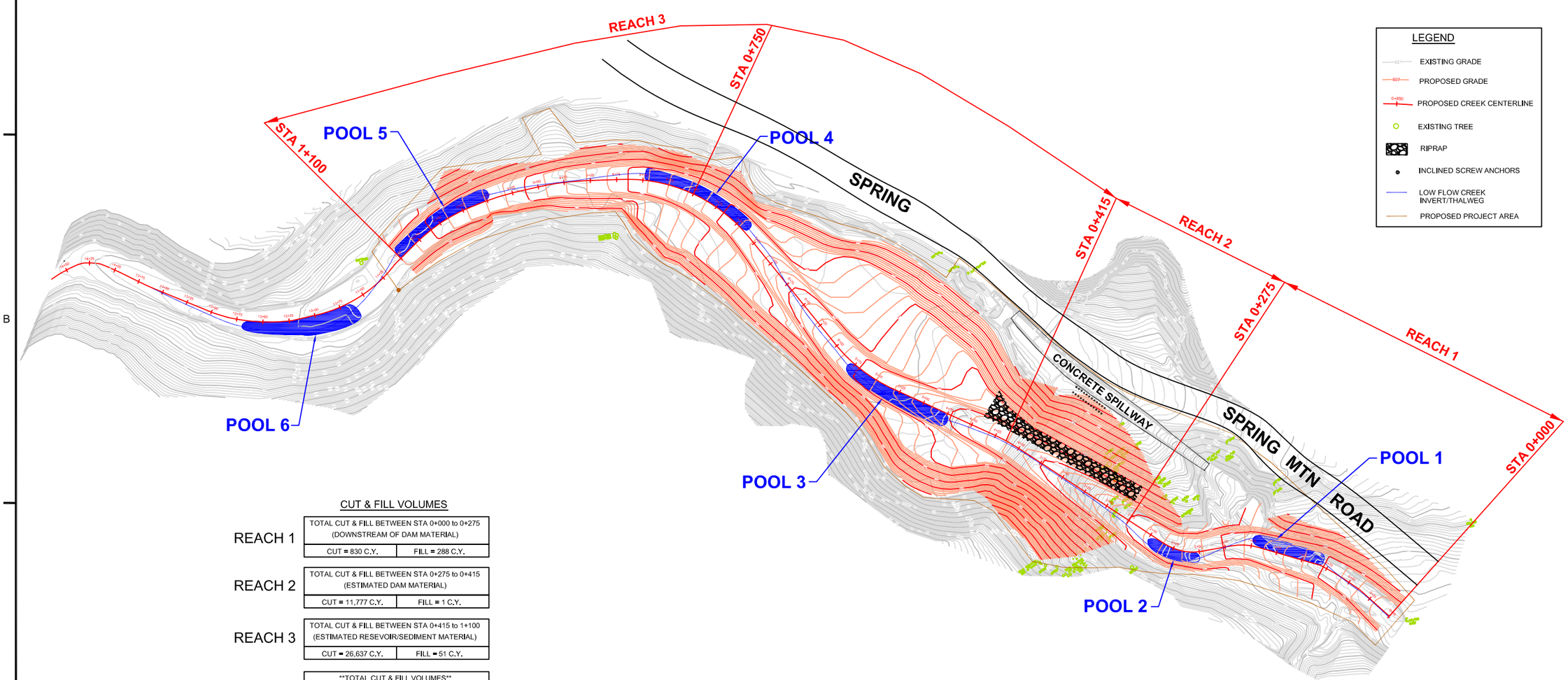
York Creek Dam and the Diversion Structure on York Creek have been identified as significant obstacles to passage for federally listed steelhead (*Oncorhynchus mykiss*) in the threatened Central California Coast (CCC) Evolutionary Significant Unit. The channel of York Creek that is impacted by the current diversion configuration is known to provide spawning and rearing habitat for CCC steelhead. The National Marine Fisheries Service (NMFS) has recognized that the diversion (1) is an impediment to steelhead passage, (2) has a screen that does not meet NMFS or Department of Fish and Game (DFG) criteria, and (3) likely is operated in a manner that results "in entrainment related mortality (take) of steelhead" (NMFS 2000b). York Creek Dam is a complete barrier to upstream fish migration.

In addition, since the City has owned York Creek Dam, there have been four documented silt discharges from the dam into York Creek that have caused kills of fish and other aquatic organisms. The most recent silt discharge occurred in July 1992 during routine maintenance of the reservoir outlet structure. After the 1992 discharge, DFG filed a complaint with the Napa County District Attorneys Office. In 1993, DFG and the Napa County District Attorney's Office obtained an injunction in State Superior Court ordering the City to remove York Creek Dam. As a result of the legal action, the City agreed to a settlement in 1993 that mandated the removal of York Dam. Recently, the Superior Court of Napa County dismissed the injunction against the City. Since 1993, the City has not used Upper Reservoir as a water source, but the reservoir has been periodically dredged. Approximately 9,500 yd^3 of sediment have re-deposited in the reservoir since the 1993 dredging following several years of above average rainfall. York Creek meanders widely and braids as it flows through the sediment in Upper Reservoir and forms shallow pools in some areas. The flow through Upper Reservoir went subsurface during the driest period of 2001 and most likely goes subsurface during most years.

Through implementation of the proposed project there is an opportunity to remove both York Creek Dam and the diversion structure thereby improving fish passage in York Creek. The proposed project will further provide improved fish passage by raising the streambed elevation below the diversion with boulder weirs to reduce the

ALTERNATIVE 2B : STA 0+000 to 1+100 - Grade 5.09%

SCALE: 1" = 50'



CUT & FILL VOLUMES

REACH 1	TOTAL CUT & FILL BETWEEN STA 0+000 to 0+275 (DOWNSTREAM OF DAM MATERIAL)	
	CUT = 830 C.Y.	FILL = 288 C.Y.
REACH 2	TOTAL CUT & FILL BETWEEN STA 0+275 to 0+415 (ESTIMATED DAM MATERIAL)	
	CUT = 11,777 C.Y.	FILL = 1 C.Y.
REACH 3	TOTAL CUT & FILL BETWEEN STA 0+415 to 1+100 (ESTIMATED RESEVOIR/SEDIMENT MATERIAL)	
	CUT = 26,637 C.Y.	FILL = 51 C.Y.
TOTAL	**TOTAL CUT & FILL VOLUMES** (ESTIMATED USING INROADS SOFTWARE)	
	CUT = 39,244 C.Y.	FILL = 340 C.Y.

US Army Corps of Engineers
San Francisco District
333 Market Street
San Francisco, CA 94105

Mark	Description	Date	Appr.

DESIGNED BY: LR/CG
DRAWN BY: GG
CHECKED BY:
DATE: 5/27/05
SHEET NO. 7 of 26
DRAWING NO. 1
PREPARED UNDER THE DIRECTION OF PHILIP T. FEIR LT. COLONEL, C.E., DISTRICT ENGINEER
SUBMITTED: Chief, Civil Design Section
APPROVAL RECOMMENDED: Chief, Engineering Branch
APPROVED: Chief, Engineering & Technical Services Division

FEASIBILITY

NAPA COUNTY CALIFORNIA
UPPER YORK CREEK-DAM REMOVAL PROJECT
ALTERNATIVE 2B
PROPOSED GRADING PLAN

Sheet reference number
5

PRUNUSKE CHATHAM, INC.

M E M O

Date: January 24, 2013

To: File

From: Dylan Loudon

Subject: Upper York Creek Dam Annual No Project Alternative Costs

---

Annual maintenance costs for the No Project Alternative were calculated using the City of St. Helena's SHEA Salary Schedule, FY 2011-2012 Step C pay rates. The costs were marked up 30% from the salary schedule to compensate for payroll and other costs. It is estimated that 3 days of site inspection by a Public Works Supervisor and 3 days cleaning out accumulated debris by a 2-person labor crew and one supervisor are required. In addition, an average of 3,500 cubic yards of sediment would need to be removed annually from upstream of the dam. An industry standard of $35/cubic yard was used.

Units	Personnel	Activity	Total
3 person day	Public Works Supervisor	Inspect dam site	$1,000.31
3 person day	Public Works Supervisor	Oversee clean out accumulated debris	1,000.31
6 person day	Laborers	Clean out accumulated debris	1,282.78
3,500 cy		Offhaul accumulated sediment to landfill	122,500.00
			$125,783.40

Further, as long as the dam continues to block salmonid migration, the City pays an annual $20,000 assessment to NMFS. Total on-going, annual costs for the No Project Alternative are:

Maintenance:	$125,783.40
NMFS assessment:	20,000.00
	$145,783.40

400 MORRIS STREET, SUITE G · SEBASTOPOL CA 95472 · 707 824-4600 · FAX 707 824-6854

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United States
Department of
Agriculture

Forest Service

**Northeastern
Research Station**

General Technical
Report NE-343

Methods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the United States

James E. Smith
Linda S. Heath
Kenneth E. Skog
Richard A. Birdsey

Introduction

International agreements recognize forestry activities as one way to sequester carbon, and thus mitigate the increase of carbon dioxide in the atmosphere; this may slow possible climate change effects. The United States initiated a voluntary reporting program in the early 1990's (U.S. Dep. Energy 2005). A system for developing estimates of the quantity of carbon sequestered in forest stands and harvested wood products[1] throughout the United States is a vital part of the voluntary program. This system must be relatively easy to use, transparent, economical, and accurate. In this publication, we present methods and regional average tables that meet these criteria.

Carbon is sequestered in growing trees, principally as wood in the tree bole. However, accrual in forest ecosystems also depends on the accumulation of carbon in dead wood, litter, and soil organic matter. When wood is harvested and removed from the forest, not all of the carbon flows immediately to the atmosphere. In fact, the portion of harvested carbon sequestered in long-lasting wood products may not be released to the atmosphere for years or even decades. If carbon remaining in harvested wood products is not part of the accounting system, calculation of the change in carbon stock for the forest area that is harvested will incorrectly indicate that all the harvested carbon is released to the atmosphere immediately. Failing to account for carbon in wood products significantly overestimates emissions to the atmosphere in the year in which the harvest occurs.

We adopted the approach of Birdsey (1996), who developed tables of forest carbon stocks and carbon in harvested wood to provide basic information on average carbon change per area. The tables are commonly referred to as "look-up tables" because users can identify the appropriate table for their forest, and look up the average regional carbon values for that type of forest. We have updated the tables by using new inventory surveys, forest carbon and timber projection models, and a more precise definition of carbon pools. We also include additional forest types and background information for customizing the tables for a user's specific needs.

The look-up tables are categorized by region, forest type, previous land use, and, in some cases, productivity class and management intensity. Users must identify the categories for their forest, estimate the area of forestland, and, if needed, characterize the amount of wood harvested from the area in a way that is compatible with the format of the look-up tables. The average carbon estimates per area in the look-up tables must be multiplied by the area or, as appropriate, harvested volumes, to obtain estimates in total carbon stock or change in carbon stock.

The estimates in the look-up tables are called "average estimates," indicating that they should be used when it is impractical to use more resource-intensive methods to characterize forest carbon, that is, particularly when more specific information is not available. Because these tables represent averages over large areas, the actual carbon stocks and flows for specific forests, or projects, may differ. The look-up tables should not be used when conditions for a project or site differ greatly from the classifications specified for the tables. Some users may require an alternative to an "all-or-nothing" use of the tables because they may have some information and need to use the tables to supplement, or fill in gaps, in carbon stocks. Alternatively, users may require slight alterations to the tabular data provided. Therefore, we also include the underlying assumptions and appropriate citations so that the tables can be adjusted to data availability and information requirements of individual activities.

The focus of this document is to explain the methodology in a transparent way and present sets of look-up tables for quantifying forest carbon when site-specific information is limited. In the sections that follow, we introduce the tables and provide general guidance for their use. First, tables of forest ecosystem carbon are presented; these are followed by tables to calculate the disposition of carbon in harvested wood products. Additional information on methods and data sources

[1]Traditionally, the phrase "forest products" includes paper, but the phrase "wood products" does not. The literature for forest carbon has not recognized this distinction. Thus, we use the phase "wood products" to include all forest products including paper.

B21.— Regional estimates of timber volume and carbon stocks for alder-maple stands with afforestation of land in the Pacific Northwest, West

Age	Mean volume	Mean carbon density						
		Live tree	Standing dead tree	Under-story	Down dead wood	Forest floor	Soil organic	Total nonsoil
years	*m^3/hectare*	*tonnes carbon/hectare*						
0	0.0	0.0	0.0	4.7	0.0	0.0	86.4	4.7
5	0.0	8.0	0.8	4.7	0.8	1.8	86.7	16.1
15	49.5	31.0	3.1	3.7	2.9	4.4	88.9	45.2
25	229.7	99.4	9.9	2.8	9.4	6.2	92.8	127.8
35	380.8	153.8	15.4	2.5	14.6	7.6	97.6	193.9
45	513.7	200.8	20.1	2.4	19.0	8.6	102.4	250.9
55	633.3	242.5	22.2	2.3	23.0	9.4	106.7	299.4
65	742.1	280.1	23.9	2.2	26.5	10.1	109.9	342.8
75	842.1	314.4	25.3	2.2	29.8	10.7	112.2	382.4
85	934.5	346.0	26.6	2.1	32.8	11.1	113.6	418.6
95	1,020.3	375.2	27.7	2.1	35.5	11.5	114.5	452.0
105	1,100.3	402.2	28.7	2.0	38.1	11.9	114.9	483.0
115	1,175.0	427.4	29.6	2.1	40.5	12.2	115.1	511.8
125	1,244.9	450.9	30.4	2.3	42.7	12.4	115.2	538.7
years	*ft^3/acre*	*tonnes carbon/acre*						
0	0	0.0	0.0	1.9	0.0	0.0	35.0	1.9
5	0	3.2	0.3	1.9	0.3	0.7	35.1	6.5
15	708	12.6	1.3	1.5	1.2	1.8	36.0	18.3
25	3,282	40.2	4.0	1.1	3.8	2.5	37.6	51.7
35	5,442	62.3	6.2	1.0	5.9	3.1	39.5	78.5
45	7,342	81.3	8.1	1.0	7.7	3.5	41.5	101.5
55	9,050	98.1	9.0	0.9	9.3	3.8	43.2	121.1
65	10,605	113.3	9.7	0.9	10.7	4.1	44.5	138.7
75	12,034	127.2	10.3	0.9	12.1	4.3	45.4	154.7
85	13,355	140.0	10.8	0.9	13.3	4.5	46.0	169.4
95	14,582	151.8	11.2	0.8	14.4	4.7	46.3	182.9
105	15,725	162.8	11.6	0.8	15.4	4.8	46.5	195.4
115	16,792	173.0	12.0	0.9	16.4	4.9	46.6	207.1
125	17,791	182.5	12.3	0.9	17.3	5.0	46.6	218.0

Urbanization affects stream ecosystem function by altering hydrology, chemistry, and biotic richness.

Chadwick MA, Dobberfuhl DR, Benke AC, Huryn AD, Suberkropp K, Thiele JE.

Source

Department of Biological Sciences, University of Alabama, Tuscaloosa 35487, USA.
chadwick@bama.ua.edu

Abstract

Catchment urbanization can alter physical, chemical, and biological attributes of stream ecosystems. In particular, changes in land use may affect the dynamics of organic matter decomposition, a measure of ecosystem function. We examined leaf-litter decomposition in 18 tributaries of the St. Johns River, Florida, USA. Land use in all 18 catchments ranged from 0% to 93% urban which translated to 0% to 66% total impervious area (TIA). Using a litter-bag technique, we measured mass loss, fungal biomass, and macroinvertebrate biomass for two leaf species (red maple [Acer rubrum] and sweetgum [Liquidambar styraciflua]). Rates of litter mass loss, which ranged from 0.01 to 0.05 per day for red maple and 0.006 to 0.018 per day for sweetgum, increased with impervious catchment area to levels of approximately 30-40% TIA and then decreased as impervious catchment area exceeded 40% TIA. Fungal biomass was also highest in streams draining catchments with intermediate levels of TIA. Macroinvertebrate biomass ranged from 17 to 354 mg/bag for red maple and from 15 to 399 mg/bag for sweetgum. Snail biomass and snail and total invertebrate richness were strongly related to breakdown rates among streams regardless of leaf species. Land-use and physical, chemical, and biological variables were highly intercorrelated. Principal-components analysis was therefore used to reduce the variables into several orthogonal axes. Using stepwise regression, we found that flow regime, snail biomass, snail and total invertebrate richness, and metal and nutrient content (which varied in a nonlinear manner with impervious surface area) were likely factors affecting litter breakdown rates in these streams.

IMPERVIOUS SURFACE AREA AS A PREDICTOR OF THE EFFECTS OF URBANIZATION ON STREAM INSECT COMMUNITIES IN MAINE, U.S.A.

CHANDLER C. MORSE, ALEXANDER D. HURYN* and CHRISTOPHER CRONAN
Department of Biological Sciences, University of Maine, Orono, Maine, U.S.A.
(author for correspondence, e-mail: huryn@maine.maine.edu)*

(Received 23 January 2002; accepted 22 October 2002)

Abstract. The influence of urbanization on stream insect communities was determined by comparing physical, chemical, and biological characteristics of streams draining 20 catchments with varying levels of urban land-cover in Maine (U.S.A). Percent total impervious surface area (PTIA), which was used to quantify urban land-use, ranged from ∼1–31% among the study catchments. Taxonomic richness of stream insect communities showed an abrupt decline as PTIA increased above 6%. Streams draining catchments with PTIA < 6% had the highest levels of both total insect and EPT (Ephemeroptera + Plecoptera + Trichoptera) taxonomic richness. These streams contained insect communities with a total richness averaging 33 taxa in fall and 31 taxa in spring; EPT richness ranged from an average of 15 taxa in fall and 13 taxa in spring. In contrast, none of the streams draining catchments with 6–27% PTIA had a total richness > 18 taxa or an EPT richness > 6 taxa. Insect communities in streams with PTIA > 6% were characterized by the absence of pollution-intolerant taxa. The distribution of more pollution-tolerant taxa (e.g. *Acerpenna* (Ephemeroptera); *Paracapnia, Allocapnia* (Plecoptera); *Optioservus, Stenelmis* (Coleoptera); *Hydropsyche, Cheumatopsyche* (Trichoptera)), however, showed little relation to PTIA. In contrast to the apparent threshold relationship between PTIA and insect taxonomic richness, both habitat quality and water quality tended to decline as linear functions of PTIA. Our results indicate that, in Maine, an abrupt change in stream insect community structure occurs at a PTIA above a threshold of approximately 6% of total catchment area. The measurement of PTIA may provide a valuable tool for predicting thresholds for adverse effects of urbanization on the health of headwater streams in Maine.

Keywords: bioassessment, biomonitoring, urban land use, urban streams, stream insects

1. Introduction

Urban land-use covers at least 26 million hectares of the U.S.A. (Vesterby, 1994). This area is expected to increase rapidly within the next few decades, primarily due to the expansion of suburbs that surround centralized metropolitan areas (O'Hara, 1997). The expansion of suburbs – a process popularly known as 'urban sprawl' – results in the rapid conversion of agricultural and forested lands to urban land-use (Peiser, 1989).

Urban land-use is associated with physical, chemical and biological changes to stream ecosystems. Physical changes include channel widening and incision, and increased rates of erosion and sedimentation (Leopold, 1968; Hammer, 1972;

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TABLE I
Summary of studies of the effect of urbanization and PTIA on the stream insect communities

Source	State/ province	PTIA threshold	Invertebrate community response
Klein (1979)	MD	10%	Decreased diversity with urbanization
Benke *et al*. (1981)	GA	n.d.[a]	Decreased diversity with urbanization
Pratt *et al*. (1981)	MA	n.d.	Decreased diversity with urbanization; loss of sensitive taxa
Duda *et al*. (1982)	NC	n.d.	Decreased diversity and loss of sensitive taxa with urbanization; shift toward tolerant taxa (Chironomidae, Oligochaeta)
Whiting and Clifford (1983)	AB	n.d.	Increased density and decreased diversity with urbanization; loss of sensitive taxa; shift toward tolerant taxa (Tubificidae, Chironomidae)
Pedersen and Perkins (1986)	WA	n.d.	Decreased functional diversity with urbanization
Jones and Clark (1987)	VA	15–25%[b]	Decreased diversity with urbanization; increased relative abundance of tolerant taxa (Chironomidae)
Schueler and Galli (1992)[c]	MD	15%	Decreased diversity with urbanization
Garie and MacIntosh (1986)	NJ	n.d.	Decreased population density and decreased richness and loss of sensitive taxa with urbanization; shift in dominance toward tolerant taxa (Tubificidae, Chironomidae)
Shaver *et al*. (1995)	DE	8–15%	Decreased diversity with urbanization
Maxted (1996)	DE	10–15%	Loss of sensitive taxa with urbanization; shift toward tolerant taxa (Chironomidae)
May (1997)	WA	5–10%	Decreased multimetric scores with urbanization

[a] n.d. = No data.
[b] Conversion of measure of urban intensity by Jones and Clark (1987) to PTIA using Schueler (1994).
[c] From Schueler (1994).

Whipple *et al*., 1981; Arnold *et al*., 1982; Booth, 1990). These physical changes are related to alterations of the hydrologic regime (Hollis, 1975; Ragan *et al*., 1977; Booth, 1991). Chemical changes include elevated levels of organic compounds, suspended and dissolved solids, nutrients (nitrogen and phosphorus), and heavy metals (Porcella and Sorenson, 1980). Physical and chemical changes that occur as a stream catchment is urbanized are correlated with biological changes such as alterations in the community composition of stream insects (Table I).

Schueler (1994) synthesized the available information concerning the effects of urbanization on stream ecosystems and concluded that the percentage of the total impervious area (PTIA) within a stream's catchment may serve as a predictor of environmental degradation. He reported that stream health, as indicated by changes in water and habitat quality, hydrology, and biodiversity, degraded rapidly as PTIA increased to 10–20%, suggesting a possible threshold effect. Schueler (1992) had previously proposed three categories of environmental stress that appeared to be related to PTIA: stressed streams with 5–10% PTIA within their catchment, impacted streams with 11–25% PTIA, and degraded streams with 26–100% PTIA. His later review supported these categories and he suggested the need for further research in varying locations to assess the potential for using PTIA to predict the effects of future changes in land use on aquatic resources (Schueler, 1994).

In this article we attempt to answer two questions. First, is increasing urbanization, as indicated by PTIA, correlated with degradation of the physical, chemical, and biological characteristics of headwater streams in Maine? Second, do adverse impacts of urbanization on streams occur at a threshold of 10–20% PTIA as suggested by Schueler (1994)? We addressed these questions by comparing insect community structure and indices of habitat and water quality among headwater streams draining 20 catchments with PTIA levels ranging from ∼1 to 31% PTIA.

2. Methods

2.1. Catchment selection

The goal of the catchment selection process was to locate 20 catchments representing the range of urban land-cover occurring in southern and central Maine. Criteria for selection included stream width, depth, discharge, gradient, substrate, habitat structure, absence of obvious point sources of pollution, and geographical location. Streams were required to be perennial with cobble riffle habitat. Their channels were required to have an average width of ≤8 m, an average depth of ≤80 cm, and an overall gradient of ≤4.0%. To further reduce variability, catchments were selected in regional blocks that included at least one reference catchment and catchments with low, moderate, and high PTIA. Reference catchments are defined as those that are predominately forested and with <5% PTIA (Schueler, 1994). For the initial catchment selection, urban intensity was estimated from 1:24 000 scale United States Geological Survey (USGS) topographic maps, *The Maine Atlas and Gazetteer* (DeLorme, 1997), and field inspection.

Twenty catchments, from over 300 assessed, met the selection criteria. Regional blocks were selected in the vicinity of the cities of Bangor (44°45′N, 68°46′W; area ∼90 km^2, population ∼33 000 people), Anson/Madison (44°48′N, 69°53′W; ∼24 km^2 and ∼21 000 people), Augusta (44°18′N, 69°47′W; ∼143 km^2 and ∼21 000 people), and South Portland (43°38′N, 70°14′W; ∼31 km^2 and ∼23 000

5.3. Water quality

The relationship between stream water quality and urbanization shown in our study was similar to that between habitat quality and urbanization. Base-flow water quality declined as PTIA increased, but this decline was manifested as relatively small and incremental changes. For example, even in the worst case scenario, DO concentrations rarely dropped below the 5 mg L^{-1} threshold often used to indicate environmentally significant low DO concentrations (Roesner, 1982). Similarly, NO_3-N concentrations almost never attained levels that could be considered a significant environmental problem. Only Pushaw contained an average NO_3-N concentration >0.6 mg L^{-1}, the concentration identified by the USGS as the national background level in streams (USGS, 1999). The results of our study, like those of similar studies, indicate that minimal water quality degradation occurs with increasing urban intensity when samples are taken during baseflow (Benke *et al*., 1981; Garie and MacIntosh, 1986; Jones *et al*., 1996). Our results are consistent with those of May *et al*. (1997), who reported significant water quality problems occurred only for streams draining catchments with >45% PTIA, a level of urban intensity greater than those found within this study.

5.4. Habitat quality, water quality, and insect community structure

The fundamental relationship between habitat characteristics and stream insect community structure (Ward, 1992) suggests that the decline in habitat quality as PTIA increased was a factor determining the parallel decrease in insect taxonomic richness. It should be noted, however, that streams with unusually high or low values for the QHI (Airport I, Long Creek, Airport II, and Brewer) or SRISCI (Jones Brook, Airport II, and Brewer) did not have noticeably greater or lesser taxonomic richness of their insect communities.

Because of the occurrence of high densities of Chironomidae and *Hydropsyche* in the more urbanized catchments, it may be inferred that increased sedimentation contributed to the simplification of insect community structure as PTIA increased. This is because some taxa of the Chironomidae (Merritt and Cummins, 1996) and *Hydropsyche* (Runde and Hellenthak, 2000) are known to tolerate high levels of silt. Nevertheless, even the maximum TSS concentrations observed in this study were low compared with levels considered to be environmentally damaging (<10 mg L^{-1}; Marsh, 1991). Furthermore, results of the pebble count procedure also indicated that D_{10} particle size was not significantly related to PTIA which indicates that sedimentation was not a major environmental problem at the study sites.

Duda *et al*. (1982), Whiting and Clifford (1983), and Pratt *et al*. (1981) all suggested that degraded water quality resulting from runoff containing non-point source (NPS) pollution was the causative agent for the degradation of the insect communities in the urban streams they studied (Table I). In our study, specific con-

ductance showed a strong positive relationship with PTIA ($r^2 = 0.74$). This implies that increased levels of chronic NPS pollution, due to dissolved materials such as salt and heavy metals, enters streams in runoff from roads and parking lots as urban land-cover increases. Pitt *et al*. (1995) noted that the effects of urban runoff on biota are rarely from acute toxicity but rather from long-term chronic exposure. Chronic NPS pollution could contain contaminants responsible for the simplification of stream insect communities as PTIA increased. Yet, because streams with unusually high specific conductance (Brewer), TSS (Long Creek), or NO_3-N (Pushaw) did not have unusually low levels of taxonomic richness of their insect communities, the relationship between potential NPS and insect community structure remains unclear.

We emphasize that significant relationships between attributes of insect community and the various indices of habitat and water quality cannot be considered indicative of causation due to the correlative nature of this study. Each of these categories of variables may show parallel responses to the effects of increasing urban land-cover.

5.5. The PTIA threshold

In the context of this study, PTIA is probably best considered a cumulative indicator of the many influences of urbanization on stream ecosystems. This is reflected by the correlation between increasing PTIA and the degradation of stream habitat quality, water quality, and insect community structure (Table I). Rather than a continuous relationship between attributes of insect community structure and PTIA, however, the relationship appeared to be best described as a step function, with abrupt changes occurring at an apparent threshold of PTIA. This threshold effect is manifested by an abrupt change in the taxonomic richness of stream insect communities at a specific level of PTIA, followed by a relatively constant levels of richness as PTIA departs from this level (Klein, 1979; Schueler, 1994; Arnold and Gibbons, 1996; May *et al*., 1997). Previous studies reported threshold levels ranging from 5–25% PTIA (Table I). Our study supports the conclusions of these studies by showing an abrupt change in stream insect community structure at approximately 6% PTIA. Total taxa richness and EPT richness showed sudden decreases when catchment PTIA increased above 6% PTIA. Furthermore, no statistical difference was found in total or EPT richness as PTIA increased from 6 to 27%, indicating that once the 6% PTIA threshold was exceeded, there was little further change in insect community structure.

It is uncertain whether the difference in the range of apparent PTIA thresholds reported by different studies (5–25%, Table I) is ecologically significant because of potential differences in the accuracy of available PTIA conversion factors (Klein, 1979; Schueler, 1994; Arnold and Gibbons, 1996; May *et al*., 1997; Morse 2001). Nevertheless, a threshold response by insect community structure as catchment PTIA increases generally should be expected (Table I). Although there is little

information concerning processes underlying this phenomenon, we speculate that it may be related to the implementation of storm sewer systems as urbanization intensifies. This may result in an abrupt and radical change to the hydrological regime of an urbanizing catchment, which will have an important effect on insect community structure due to the fundamental relationship between discharge and habitat attributes (cf. Townsend *et al*., 1997; Walsh *et al*., 2001). Understanding relationships between the hydrological regime of urban streams and their biotic communities is critical to the restoration and management of these systems (Walsh *et al*., 2001). Measurement of PTIA was found to be a reliable quantitative index for predicting the response of stream ecosystems to urbanization in central and southern Maine. Given the sensitivity of stream communities to PTIA, resource managers within the northeastern United States should be encouraged to use PTIA based indicators to identify streams likely to be affected by urbanization.

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Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practice and Research

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ABSTRACT

Over the next century, climate change will dramatically alter natural resource management. Specifically, historical reference conditions may no longer serve as benchmarks for restoration, which may foster a "why bother?" attitude toward ecological restoration. We review the potential role for riparian restoration to prepare ecological systems for the threats posed by climate change. Riparian ecosystems are naturally resilient, provide linear habitat connectivity, link aquatic and terrestrial ecosystems, and create thermal refugia for wildlife: all characteristics that can contribute to ecological adaptation to climate change. Because riparian systems and the projected impacts of climate change are highly variable geographically, there is a pressing need to develop a place-based understanding of climate change threats to riparian ecosystems. Restoration practitioners should consider how they can modify practices to enhance the resilience of riparian ecosystems to climate change. Such modifications may include accelerating the restoration of private lands, participating in water management decisions, and putting the emerging field of restoration genetics into practice.

Keywords: California, climate change, genetics, hydrology, restoration, riparian

In recent decades, advances in the science and practice of restoring damaged riparian ecosystems have addressed the local and regional threats posed by habitat loss and non-native species invasions (Bernhardt et al. 2005). While ecological restoration has often emphasized a return to historical reference conditions, this target has been complicated in riparian systems, where flood control and water delivery often result in modifications of natural flows. Today, riparian restoration is further complicated by global climate change (Harris et al. 2006, Battin et al. 2007, Palmer et al. 2008). During the next century, global temperatures are projected to increase by 1.1 to 6.4°C (IPCC 2007a, 2007b). Riparian ecosystems will face increases in air and surface water temperatures, alterations in the magnitude and seasonality of precipitation and run-off, and shifts in reproductive phenology and distribution of plants and animals (Meyer et al. 1999, Barnett et al. 2005, Parmesan 2007, Palmer et al. 2008, Rosenzweig et al. 2008). In this context it is now clearer than ever that a return to historical reference conditions will no longer be the benchmark for restoration success (Choi et al. 2008, Seastedt et al. 2008).

Given the uncertainties about future conditions, climate change may cause people to ask "why bother with restoration?" This question has motivated us to reevaluate our work in the science and practice of riparian restoration. Society is becoming aware of the need for mitigation and adaptation to address the adverse impacts of anthropogenic climate change. Mitigation describes actions for reducing greenhouse gas concentrations, for example, by reducing emissions or developing sinks that remove these gasses from the atmosphere (IPCC 2007a). Adaptation refers to actions designed to reduce the vulnerability of natural and societal systems to the effects of climate change (IPCC 2007a). Even if mitigation efforts were to stop the increase in all greenhouse gas emissions, adaptation would remain important because greenhouse gases already in the atmosphere today will continue to cause the climate to change for decades (IPCC 2007b, Solomon et al. 2009).

Climate change adaptation strategies often propose activities that can enhance ecological resilience (Millar et al. 2007, Heller and Zavaleta 2008). Ecological resilience encompasses 1) the amount of disturbance a system can withstand before changing state; 2) the rate at which a system recovers after disturbance; and 3) the way in

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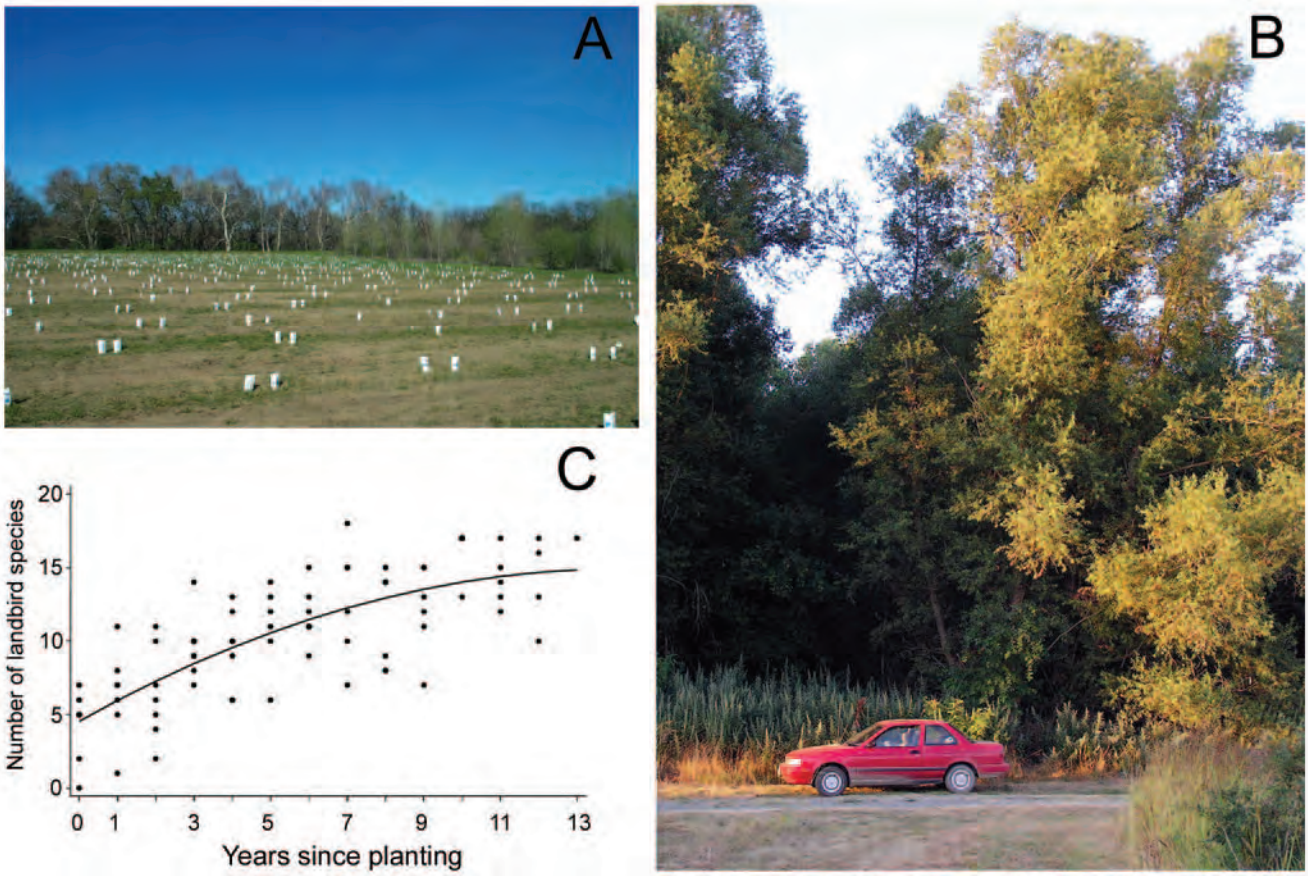

Figure 1. On the Sacramento River in California's Central Valley, horticulture-based restoration can transform open fields (A) to well-established riparian forest (B) in as little as 13 years. Over this same time, riparian wildlife communities, as measured by such metrics as bird species richness (C) can exhibit dramatic recoveries. Examples like this illustrate the inherent resilience of riparian ecosystems. Images reprinted with permission from Gardali et al. 2006 and Golet et al. 2008

which a system responds to gradual changes (Gunderson 2000, Scheffer et al. 2001). Specific recommendations for enhancing ecological resilience, however, are lacking (Heller and Zavaleta 2008).

Based on general ecological characteristics of riparian systems and our collective experience restoring these ecosystems in California, we suggest that healthy riparian ecosystems promote ecological resilience both within and beyond riparian zones. Here we address 1) how and why riparian restoration prepares ecosystems for climate change; 2) how riparian restoration can be enhanced to accommodate climate change; and 3) research needed to ensure that riparian restoration is robust to climate change.

How and Why Riparian Restoration Prepares Ecosystems for Climate Change

For forested ecosystems, Millar and others (2007) provide examples of management practices to enhance ecosystem resilience to climate change. These practices include enhancing habitat connectivity, promoting redundancy and buffers, reducing landscape synchrony (by maintaining a mix of successional stages), realigning disrupted conditions, expecting surprises, and identifying and protecting refugia (Millar et al. 2007). Similar recommendations have been made for a wide variety of habitats (Hansen et al. 2003). We use this general framework to review five specific reasons that riparian restoration can enhance ecosystem resilience to climate change.

Natural Resilience of Riparian Systems

Climate change is projected to lead to increased frequency and severity of extreme weather events, which will likely result in more frequent and severe floods as well as more intense droughts (Easterling et al. 2000). The rate at which ecological systems recover from disturbance will be an important consideration when designing restoration activities. Many riparian plants are adapted to hydrologic and geomorphic disturbances and tolerate both seasonal and annual variation in environmental conditions (Naiman and Decamps 1997). Thus, compared to plants in adjacent upland habitats, riparian species may be more resilient to the increased flooding or drought projected for many regions (Milly et al. 2002, Seager et al. 2007). Restoration programs that reestablish

appropriate hydrological processes, actively intervene with horticultural techniques to propagate and establish native vegetation where necessary, and manage for genetic diversity to facilitate evolutionary processes can build upon the natural resilience of riparian systems.

The natural resilience of riparian systems is exhibited in the response of riparian wildlife communities to habitat restoration along the Sacramento River in central California (Figure 1). Since European settlement, 95 percent of 324,000 ha of riparian habitat along this river was lost to logging, agriculture, urban development, and flood-control and power-generation projects (Katibah 1984). In 1988, the Sacramento River Project was launched to coordinate restoration efforts along a 161 km reach of the Sacramento River between the cities of Red Bluff and Colusa (Golet et al. 2008). A major component of this project was to restore sites previously in agriculture, mostly walnut (*Juglans regia*) and almond (*Prunus dulcis*) orchards, by planting local ecotypes of indigenous tree, shrub, and understory species (Alpert et al. 1999). In just ten years, these efforts restored a broad suite of faunal species including both special-status species and the larger native riparian animal community (Gardali et al. 2006, Golet et al. 2008). Consistent with the very high growth rates of floodplain trees, species associated with mature forest, including cavity-nesting birds and crevice-roosting bats, reoccupied restoration sites within a decade (Gardali et al. 2006, Golet et al. 2008).

Of course, there are limits to resilience. Severe human-induced disruptions to these regimes can interrupt important plant and animal population processes. Furthermore, disturbances that are too far out of any given system's natural range of variability (Richter et al. 1997) may lead to the proliferation of disturbance-adapted non-native invasive species (Zedler and Kercher 2004).

Enhancing Connectivity

Climate change, whether natural or anthropogenic, causes distributional shifts for many organisms. Prioritizing connectivity in landscape planning and reserve design is the most common recommendation for protecting biodiversity from climate change (Heller and Zavaleta 2008). Connectivity is also critical for preserving the ecological processes for evolutionary adaptations to climate change (Cowling and Pressey 2001).

Riverine habitats function as ecological corridors for a wide array of plants and animals (Naiman et al. 1993, Machtans et al. 1996, Hilty and Merenlender 2004). Rivers and riparian vegetation connect high-elevation montane areas to sea-level estuaries and oceans. Rivers flow across elevational gradients, linking ecological zones with different climates. Furthermore, tributaries within watersheds provide spatial redundancy that maintains metapopulation and metacommunity dynamics (Collinge et al. 2001). In addition, flowing water moves organic material and energy (Ahearn et al. 2006, Kondolf et al. 2006). Restoring riparian habitats and hydrological function recreates or increases connectivity between habitats and across elevational zones, thus providing avenues for species movements in response to climate change.

Promoting Linkages between Aquatic and Terrestrial Systems

Riparian zones link riverine and terrestrial systems and make each more ecologically diverse and productive (Naiman and Decamps 1997). Aquatically derived nutrients support luxuriant vegetation and diverse wildlife communities in adjacent upland areas (Merz and Moyle 2006, Uesugi and Murakami 2007). Emerging aquatic insects are prey for birds and bats foraging and breeding in riparian areas (Knopf et al. 1988, Grindal et al. 1999). Equally important are the resources and services that riparian areas convey from terrestrial to aquatic systems. The terrestrial component of riparian vegetation protects water quality by trapping sediment and filtering pollutants through physical and biological processes (National Research Council 2002), and furnishes aquatic food webs with detritus for aquatic invertebrates and terrestrial insect prey for fish (Wipfli 1997). Restoring riparian habitat will strengthen linkages between aquatic and terrestrial systems, making both more resilient and resistant to the stresses imposed by climate change.

In California, the importance of linkages between aquatic and terrestrial systems is exemplified by the Yolo Bypass, an engineered floodplain on the Sacramento River. When the Yolo Bypass floods, 24,000 ha of agricultural land, wetlands, and riparian and upland vegetation are covered with shallow water. The flooding provides important benefits to aquatic, wetland, and terrestrial taxa, including fish and birds (Sommer et al. 2001).

Expanding Thermal Refugia

Climate change is projected to result in higher air temperatures and, in turn, higher surface water temperatures (Battin et al. 2007, Nelson and Palmer 2007). Because riparian areas have higher water content than surrounding upland areas, they absorb heat and buffer organisms against extreme temperatures (Naiman et al. 2000). During previous periods of climate change, riparian areas served as refugia because they provided microclimates that protected plant biodiversity (Bakker 1984, Meave and Kellman 1994). Riparian vegetation can maintain cooler water temperatures by shading water from sunlight (Sridhar et al. 2004, Cassie 2006) and the infusion of cold groundwater into warmer surface waters creates and maintains pockets of cool water (Chu et al. 2008). Thus, riparian areas provide thermal refugia for animals with thermoregulatory limitations. For example, salmon are able to successfully migrate through high temperature river reaches, but

only when reaches contain pockets of cooler water (McCullough et al. 2001). Restoring vegetation and protecting groundwater resources will enhance thermal refugia that will be increasingly important as air temperature rises.

Hydrological Benefits

The projected effects of climate change on hydrologic regimes include increased frequency of extreme flooding events and altered seasonal patterns of precipitation and run-off (Milly et al. 2002, Barnett et al. 2005, Palmer et al. 2008). For example, in California's Central Valley, summer stream flows are projected to decline as annual snowpacks diminish and melt earlier in the spring (Hayhoe et al. 2004, Vicuna and Dracup 2007). Riparian vegetation can promote water infiltration (Brauman et al. 2007) and reduce losses to the ocean as more precipitation falls as rain. However, because riparian vegetation also removes water through evapotranspiration, the net effect of riparian vegetation on water flow is complex. More research on this topic is needed, especially comparing the effects of riparian vegetation on water flows to that of alternative land uses, such as orchards and row crops (Tabacchi et al. 2000).

Restoring riparian ecosystems may also reduce the impacts of extreme flood events. Levees, especially those nearest the river channel, may increase flood stage and flow velocity during floods (Gergel et al. 2002). Riparian restoration to reconnect the river channel with its floodplain by moving back or breaching levees can benefit ecosystem function and nonstructural flood control for urban or agricultural areas (Poff 2002, Golet et al. 2006). The engineered floodplains of the Yolo Bypass on the Sacramento River in California show how restoring ecologically important riparian processes can also provide flood protection for human populations (Sommer et al. 2001). By recharging groundwater and reducing flood damage, riparian restoration will strengthen ecosystem resistance against extreme floods and altered surface flows anticipated from climate change.

Restoration Strategies and Practices That Accommodate Climate Change

The challenges facing restoration practitioners are not trivial. To meet these challenges, restoration practitioners will need to remain flexible and creative. Novel conditions created by climate change will require that restoration proceeds within the framework of adaptive management, in which specific hypotheses are tested and monitoring is used to verify that desired outcomes are achieved (O'Donnell and Galat 2008). Here, we discuss how specific aspects of on-the-ground restoration activities might be modified to accommodate climate change and to build resilience.

Horticultural Restoration Strategies

Some horticultural restoration techniques can enhance riparian ecosystem resilience. Techniques under investigation include using ecological genetics to prepare for unexpected conditions (e.g., by deliberately increasing genetic variability) and also planting early seral colonizers adapted to flooding together with late seral species that may be less tolerant of flooding but grow better on drier sites.

Currently, plant materials for restoration are often collected locally, under the assumption that genetically controlled local adaptations are advantageous. When the climate is changing rapidly, planting only local genetic material may not be the most appropriate strategy (Rice and Emery 2003, Bower and Aitken 2008). Collecting seed from within a watershed but across a range of elevations may better facilitate evolutionary adaptation to climate change. Modifying horticultural practices to account for uncertainty is one approach to ensure that riparian restoration is robust to climate change. Planting species that are associated with both ends of the hydrologic spectrum may provide some insurance against unexpected future conditions. Incorporating strategies that address uncertainty into horticultural restoration has the potential to both increase the odds of short-term restoration success and provide long-term maintenance of critical evolutionary processes.

Emphasizing Restoration of Private Lands

Restoration of private lands will contribute to the connectivity, size, and quality of riparian areas at spatial scales appropriate to the challenges of climate change. Incentive programs for funding, technical assistance, and infrastructure can help private landowners to modify land-use practices and restore native vegetation for conservation (Norton 2000, Langpap 2006). In some cases, state and federal regulations for endangered species may restrict private-lands restoration without innovative incentives. Safe Harbor Agreements can allow landowners to restore habitat for endangered species without legal responsibility for impacts during restoration or to maintain the restored habitat indefinitely (Wilcove and Lee 2004). In California's Central Valley, the U.S. Fish and Wildlife Service and Audubon California have recently established a Safe Harbor Agreement for riparian and wetland restoration projects on private lands in Yolo County. This agreement allows incidental take of federally listed valley elderberry longhorn beetles (*Desmocerus californicus dimorphus*) and giant garter snakes (*Thamnophis gigas*) associated with restoration projects that enhance habitat for these species.

Such programs play an essential role in the restoration of riparian ecosystems. Future challenges include adequate funding, economic incentives for agricultural landowners to maintain their land as open space, creating holistic design criteria, and monitoring to ensure that private

lands restoration enhances ecosystem function and wildlife habitat quality.

Promoting Water and Watershed Management Policies

While planting riparian vegetation on public and private lands provides many benefits, riparian ecosystems will not fully function with insufficient water. Because climate change is projected to affect water resources for many urban and agricultural uses (Tanaka et al. 2006, Alcamo et al. 2007, Milly et al. 2008), the social and political pressures to modify riparian systems for water storage, transport, and extraction may increase. The ecological stresses of climate change on dammed rivers are projected to be greater than on undammed rivers (Palmer et al. 2008). If societies choose to respond to climate change by building taller levees, deeper wells, and larger dams, riparian ecosystems will be put at greater risk. Restoration practitioners and ecologists must engage with decisionmakers about water management. This engagement will need to include providing information on how changes in water use will influence the outcome of riparian restoration efforts.

Areas of extreme aridity will pose particular challenges, such as in California's Mojave Desert, where groundwater, forced to the surface by tectonic faulting zones, sustains arid riparian plant and animal communities. Urban water use may draw down groundwater below the roots of desert riparian vegetation. Groundwater resources for desert riparian ecosystems are already at risk, particularly at the California–Nevada border, where burgeoning human populations are draining groundwater resources (Bunn et al. 2007). To protect investments in riparian ecosystems, restoration ecologists and water users will need to collaborate to develop policies that ensure that these systems have adequate river flows and groundwater (Boulton and Hancock 2006).

Utility and benefits of water policy complementing riparian restoration are exemplified by work on the Cosumnes River in California. The ecological integrity of this system has been compromised by levees that disrupted hydrological connectivity and by groundwater overdraft resulting in reduced flows (Fleckenstein et al. 2004). This restoration project used engineered levee breaches to restore hydrological connectivity between the floodplain and river channel, which in turn increased aquatic primary production (Ahearn et al. 2006), juvenile salmon recruitment (Jeffres et al. 2008), and geomorphic heterogeneity necessary for riparian establishment and succession (Florsheim and Mount 2002, Trowbridge 2007). However, in order to restore hydrologic connectivity, reduction of upstream groundwater pumping and surface water augmentation is also necessary (Fleckenstein et al. 2004). In addition to providing ecologically important flows to the Cosumnes, this water management approach is also projected to recharge the regional aquifer tapped by two growing urban areas (Fleckenstein et al. 2004).

Riparian Research and Management Priorities for Climate Change

Research on riparian and hydrologic function spans multiple spatial scales, from the global impacts of climate change on hydrologic patterns to the evolutionary responses of plants and animals to changing climate conditions. We pose several specific research questions for restoring riparian ecosystems in a time of climate change.

How can historic hydrology inform future projections? Recent advances in computing technology allow for new, more robust analyses of the spatial and temporal dimensions of climate change, hydrology, and riparian ecology (Vicuna and Dracup 2007). These approaches use historic information to understand natural variability and the adequacy of climate models for projecting future hydrological conditions. From a nearly 100-year record of daily average flow from the Cosumnes River in California, for example, Booth and colleagues (2006) identified eight types of water-years based on the frequency, magnitude, and duration of hydrological events. This information provides useful historical context for future hydrological conditions.

On a broader scale, climate modeling can provide detailed information about the hydrologic consequences of climate change. Synthetic rainfall-runoff models can aid in understanding how changes in air temperatures influence evapotranspiration potential and surface water runoff. By combining spatial and temporal information, emerging methods will inform practitioners about potential future conditions to improve the planning, design, and implementation of restoration.

Effects of climate change on riparian systems will vary dramatically among river systems (Palmer et al. 2008); thus ecologists, climate modelers, and restoration practitioners need to anticipate consequences of climate change within the context of local ecosystems. This process will be similar to restoring ecosystems in areas where people have disrupted natural fire regimes—a one-size-fits-all solution is impractical. Instead, practitioners will need to draw upon local knowledge of ecosystems and guiding ecological principles to develop appropriate restoration strategies and prescriptions (Fulé 2008).

How can we enhance recruitment of wildlife populations into restored areas? To better respond to rapid environmental shifts accompanying climate change, research on methods to speed recruitment of wildlife into new habitat is needed. Two overarching questions arise: 1) what factors most strongly influence the distribution of a species? and 2) what characteristics promote viable populations in novel habitats? We will need research at the local, reach-level scale, as well as at watershed and multiwatershed

scales. At the reach level, experimental designs could be developed to determine planting prescriptions or vegetation management that produces desired vegetation composition and structure most rapidly. At the largest scales, research related to effective connectivity (both within the floodplain corridor and extending to upland habitats), landscape matrix, and land use patterns is needed. These small-to-large-scale studies can address the dynamic and unpredictable nature of riparian systems caused by hydrologic regimes and resulting in a dynamic network of seral stages or "mobile habitat mosaics" (Hughes et al. 2005). Research on behavioral mechanisms driving different species' dispersal choices may have an increasingly important role to play in the restoration of wildlife habitat. For example, the use of conspecific attraction—the tendency of individuals of a species to settle near one another—could facilitate the colonization of suitable habitat (reviewed in Ahlering and Faaborg 2006). Similarly, a better understanding of the dispersal and metapopulation dynamics of target species is essential for promoting restoration that improves landscape connectivity for wildlife (Bélisle and St. Clair 2001, Collinge et al. 2001).

How will the phenology of riparian plants and animals respond to climate change? Another ecological challenge of climate change is the loss of synchrony between reproductive phenology and resource availability or natural disturbances (Both and Visser 2001, Inouye 2008). Understanding the physiological tolerances and phenological responses of riparian plants and animals to changes in climate and hydrology will become increasingly important to restoration ecologists. For example, in California's Central Valley, Oregon ash (*Fraxinus latifolia*) typically breaks bud in mid-March in the northern Sacramento Valley, while on the lower San Joaquin River its buds break on the first of May. This six- to eight-week difference in phenology holds true for seedling germination from both areas as well. Phenological variation may be associated with genetic variation. In European riparian systems, black poplars (*Populus nigra*) show significant genetic variation among populations, even within catchments (Smulders et al. 2008). Understanding how genetic and environmental differences between the watersheds contribute to phenological variation will help in developing new strategies to restore riparian vegetation in a manner that is robust to climate change (Hufford and Mazer 2003).

Conclusion

Responding to climate change at the appropriate temporal and spatial scales will require that government agencies, private land owners, and nongovernmental organizations work together to improve water policy, land management, urban development, and many other diverse matters. Governments will be formative in climate change adaptation and the organization of management to transition from adaptation to recovery. However, the speed with which national governments respond to climate change may not match the need for ecological adaptation to climate change. For example, as recently as 2007, the U.S. Department of the Interior was not yet providing guidance to resource managers about how to respond to actual or forecasted climate changes (U.S. General Accountability Office 2007). In the absence of national leadership, smaller-scale governments and nongovernmental organizations may have a large role in guiding management that prepares riparian ecosystems for climate change.

The effects of climate change are already upon us, making it more important than ever for restoration practitioners and researchers to share information effectively and with diverse audiences. Information networks, such as the Global Restoration Network (www.globalrestorationnetwork.org) and the National River Restoration Science Synthesis (nrrss.nbii.gov), will be important to ensure that the most recent findings and best management practices are shared among those monitoring, managing, and restoring riparian ecosystems. The challenge includes efficiently converting information into knowledge (Roux et al. 2006). Sharing information about restoration and climate change with policymakers and the public is necessary. In an era of rapid environmental change, we need to inform people about the likely threats that climate change poses to ecosystems and society. It is also important to empower people with the knowledge that ecological restoration has the potential to reduce the severity of these threats.

Basic challenges confronting restoration practitioners today will remain important in the future. Invasions of non-native species, facilitated by climate change and movements by people, will continue to occur. Altered hydrological regimes may increase the risk that restoration strategies that worked in the past will fail in the future.

When medical resources are limited, doctors use triage to prioritize the treatment of patients based on the urgency for care and the likelihood that treatment will be successful. In a management context, Millar and colleagues (2007) suggested that such an approach to preparing ecosystems for climate change could be used "to sort management situations into categories according to urgency, sensitivity, and capacity of available resources to achieve desired goals." Given that many riparian systems are highly degraded from a long history of anthropogenic activities (Tockner and Stanford 2002, Zedler and Kercher 2005), we are now faced with a decision about whether to continue investing resources to treat these ecosystems. Functional riparian systems have tremendous potential to reduce the adverse effects of climate change by enhancing ecosystem resilience. To benefit from this capacity, we urgently

need riparian restoration and the science that guides it.

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Pathogens in Tomales Bay Watershed Total Maximum Daily Load (TMDL)

Staff Report

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California Regional Water Quality Control Board
San Francisco Bay Region

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DEFINITION OF ACRONYMS AND ABBREVIATIONS

ABAG:	Association of Bay Area Governments
APA:	Administrative Procedures Act
Basin Plan:	Water Quality Control Plan for the San Francisco Bay
BMP:	Best Management Practice
CAMMPR:	California Management Measures for Polluted Runoff Report
CWA:	Clean Water Act
CWC:	California Water Code
CZARA:	Coastal Zone Act Reauthorization Amendments
DFG:	California Department of Fish and Game
DHS:	California Department of Health Services
EFAP:	Equine Facilities Assistance Program
FC:	Fecal Coliform
FDA:	U.S. Food and Drug Administration
HEV:	Human Enteric Viruses
LA:	Load Allocation
LULC:	Land Use and Land Cover
MCSTOPPP:	Marin County Stormwater Pollution Prevention Program
MOS:	Margin of Safety
MPN:	Most Probable Number
MRCD:	Marin Resource Conservation District
MSD:	Marin Sanitation Device
MST:	Microbial Source Tracking
NRCS:	Natural Resources Conservation Service
NSSP:	National Shellfish Sanitation Program
OAL:	Office of Administrative Law
OSDS:	Onsite Sewage Disposal System
PRNS:	Point Reyes National Seashore
QAPP:	Quality Assurance Project Plan
RCD:	Resource Conservation District
REC I:	Water Contact Recreation Beneficial Use
REC II:	Non-contact Water Recreation Beneficial Use
SHEL:	Shellfish Harvesting Beneficial Use
SWAMP:	Surface Water Ambient Monitoring Program
TBAG:	Tomales Bay Agriculture Group
TBSTAC:	Tomales Bay Shellfish Technical Advisory Committee
TC:	Total Coliform
TMDL:	Total Maximum Daily Load
UCCE:	University of California Cooperative Extension
USEPA:	U.S. Environmental Protection Agency
WDRs:	Waste Discharge Requirements
WLA:	Waste Load Allocation
WMI:	Watershed Management Initiative
WQO:	Water Quality Objective
WQS:	Water Quality Standard

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1. INTRODUCTION

1.1 Overview

This staff report provides the technical background and basis for a proposed amendment to the *Water Quality Control Plan, San Francisco Bay Region* (Basin Plan) (SFBRWQCB, 1995). This staff report contains results of staff analyses of pathogen impairment and sources, recommended pathogen load reduction allocations, and a plan to implement the allocations. If adopted, the Basin Plan amendment would (1) establish a pathogen Total Maximum Daily Load (TMDL) in Tomales Bay Watershed pursuant to Section 303(d) of the Clean Water Act, and (2) establish an implementation strategy to achieve and support the TMDL. If adopted, portions of Basin Plan Chapter 4 (implementation plan) will be revised.

This report provides the scientific basis for the TMDL and associated implementation plan for the Tomales Bay Watershed. It discusses background conditions and current pathogen loads. It also describes how the TMDL ensures attainment of water quality objectives and protects beneficial uses of Tomales Bay Watershed.

1.2 Compliance with the California Environmental Quality Act (CEQA)

This staff report meets the requirements of the California Environmental Quality Act (CEQA) for adopting Basin Plan amendments. CEQA authorizes the California Resources Agency Secretary to exempt a state agency's regulatory program from preparing an Environmental Impact Report or Negative Declaration if certain conditions are met. The Resources Agency has certified the basin planning process to be "functionally equivalent" to the CEQA process. Therefore, this report is a functional equivalent document and fulfills CEQA environmental documentation requirements.

1.3 Next Steps

Staff of the San Francisco Bay Regional Water Quality Control Board (Water Board) have revised this Staff Report and the Basin Plan amendment based on the public comments received on April 20, 2005, and August 8, 2005. Staff will present the revised Basin Plan amendment to the Water Board for consideration and possible adoption (authorized under California Water Code §13240) on September 21, 2005. If adopted, the State Water Resources Control Board (State Board) will consider the Basin Plan amendment for adoption (authorized under California Water Code §13170), and if approved, the California Office of Administrative Law will review the amendment. If the Office of Administrative Law approves the amendment, the U.S. Environmental Protection Agency will consider this TMDL for final approval. Stakeholder comments and concerns will be considered at key milestones throughout the process.

2. BACKGROUND

2.1 Description of TMDL Process

The Tomales Bay estuary (the Bay) is a unique and highly valuable natural resource in the San Francisco Bay Regional Water Quality Control Board's jurisdiction. The State of California establishes and enforces water quality standards in order to protect the beneficial uses of water bodies. When states or local communities identify a water body that has failed to meet water quality standards, a TMDL must be developed to remedy the water quality problem(s). Tomales Bay and its tributaries have been identified as impaired for pathogens. The purpose of this TMDL is twofold: first, to assess the sources of pathogens that are causing water quality impairment in Tomales Bay and its tributaries, and second, to identify appropriate control measures that will lead to the attainment of the water quality standards set for the Bay and its tributaries. The proposed Tomales Bay Watershed TMDL applies to both Tomales Bay and its tributaries.

Section 303(d) of the Federal Clean Water Act (CWA) requires the California Regional Water Quality Control Board, San Francisco Bay Region (Water Board) to identify the Region's waters that do not comply with water quality standards (WQS); rank the impaired water bodies by taking into consideration the severity of pollution and the uses made of such waters; and establish TMDLs to ensure that impaired waters attain their beneficial uses. Lists of prioritized impaired water bodies, known as the "303(d) lists," must be submitted to the U.S. Environmental Protection Agency (U.S. EPA) every two years.

A TMDL expresses the total pollutant load a water body can receive and still meet water quality standards. The TMDL can be expressed as pollutant per unit time (load) or a pollutant concentration per unit time. In most cases, a TMDL establishes the allowable pollutant loading capacity and allocates a portion of that load to the various contributors in the watershed as wasteload (for point source discharge) and load (for nonpoint source) allocations. TMDLs must also account for natural background sources and provide a margin of safety (implicit or explicit). A TMDL can be expressed in terms of mass per unit time, toxicity, density, concentration, or other appropriate measures. For this pathogen TMDL we propose using a density-based (number of organisms per unit volume) measure of pathogen-indicator organisms.[1]

[1] The direct detection and measurement of pathogens in ambient waters is not practicable due to high cost, time, equipment, the need for highly skilled laboratory personnel, and other considerations. A class of non-pathogenic indicator organisms (bacteria) called fecal coliforms is therefore commonly used to indicate the presence and assess the magnitude of human fecal pathogenic microorganisms in the environment. Fecal coliforms live and reproduce in the intestinal tracts of all warm-blooded animals (including humans) and are abundantly found in the waste of all warm-blooded animals .The presence of fecal coliform in a water sample indicates the possible presence of pathogens that originate from feces. For more discussion, please refer to Section 3.1.

Tomales Bay and portions of its tributaries have also been identified as impaired for mercury, nutrients, and sediment. A TMDL will be developed for each of these pollutants. Many of the identified pathogen sources (i.e., equestrian facilities, on-site septic systems, dairy facilities, and ranchland activities) can also contribute to sediment and nutrient pollution. The goal of the implementation plan for pathogens is that it will lead to significant reductions in pathogens, nutrients, and sediment. Many of these identified source control actions may also be recommended or required for reduction of sediment and nutrients.

Section 303(d) of the CWA and section 130.0 et seq. of the 40 Code of Federal Regulations (CFR) specify the components and requirements of a TMDL plan. In general, a TMDL plan must:

1. **Develop a strategy to meet applicable Water Quality Standards**: A TMDL must include a plan for the specific waters and pollutants that must be addressed to ensure that applicable water quality standards are attained.

2. **Set quantifiable water quality goals or targets (numeric targets)**: A TMDL must establish specific goals and endpoints for the TMDL, which ensure attainment of applicable water quality standards.

3. **Analyze/account for all sources of pollutants (source assessment)**: A TMDL should describe all significant pollutant sources, including the magnitude and location of sources.

4. **Identify pollution reduction goals (pollutant load allocations)**: A TMDL plan includes pollutant reduction targets for all point and nonpoint sources of pollution. TMDLs, load allocations, and wasteload allocations indicate maximum pollutant loads allowed.

5. **Describe the linkage between water quality targets and pollutants of concern (linkage analysis)**: A TMDL must explain the relationship between the numeric targets and the pollutants of concern. That is, will the recommended pollutant load allocations lead to attainment of the target?

6. **Develop a margin of safety that considers uncertainties, seasonal variations, and critical conditions**: A TMDL must consider any uncertainties regarding the ability of the plan to meet water quality standards. The plan must consider these issues in its recommended pollution reduction goals.

7. **Include an appropriate level of public involvement in the TMDL process**: This is usually achieved by publishing a public notice of the TMDL, circulating the TMDL for public comment, and holding public meetings in local communities.

8. **Identify and implement alternative control measures to rectify impairment of the water body (implementation plan):** A TMDL must recommend specific

nonpoint source Best Management Practices (BMPs), point source controls, and other actions necessary to achieve the desired water quality endpoints.

9. **Include a monitoring and review plan:** A TMDL must include a plan to assess its implementation and effectiveness, and to provide for adjustment as needed.

In addition, the TMDL process involves the public in both the development and implementation stages of the TMDL, as public participation is key to a successful TMDL.

2.2 Regulatory Context

In the San Francisco Bay Region, the CWA is administered by the Water Board under its federally designated authority. The Water Board is one of nine regional water boards in California. The State Water Resources Control Board (State Water Board) establishes statewide policies and serves as the review and appeal body for the decisions of the regional water boards. The State Water Board is made up of five members appointed by the governor.

The San Francisco Bay Regional Water Quality Control Board (Water Board) consists of nine governor-appointed members who serve four-year terms. Scientific information is gathered and policy is developed for the Water Board by its civil service employees (staff). The Water Board has adopted a Water Quality Control Plan for the San Francisco Bay Region (Basin Plan) that contains a list of beneficial uses for waters in the Region and the standards and implementation measures necessary to protect those beneficial uses.

Some measures that go beyond the scope of the current Basin Plan must first be adopted by the Water Board, using a Basin Plan amendment process, before they are implemented. Such measures include the TMDL that is the subject of this report. The process involves presenting the proposed Basin Plan amendment to the Water Board in a publicly noticed hearing. The Water Board receives public comments and at least 45 days later staff presents responses to comments and relevant revisions to the proposed amendment. The Water Board then votes on adoption. If the amendment is adopted, it is sent to the State Water Board for approval. If the State Water Board approves the amendment, it is sent to the Office of Administrative Law (OAL) to determine whether the amendment is consistent with the California Administrative Procedures Act (APA). State TMDL adoption is complete after OAL approval and state transmittal of the TMDL to the U.S. EPA for approval.

2.3 Water Body Description

Tomales Bay is located in western Marin County, California, approximately 50 km northwest of San Francisco (Figure 1). The Bay has a surface area of approximately 28 square kilometers (11 square miles). The mouth of Tomales Bay is at the southern end

of Bodega Bay, and its body extends in a southeasterly direction along the line of the San Andreas Fault. The Bay is about 12 miles in length with an average width of less than one mile. Tomales Bay is characterized by relatively shallow water, with the average depth being less than 20 feet. Hydrographic studies conducted from 1966–1970 (TBSTAC, 2000) indicate that the currents in the Bay are primarily influenced by tidal cycles, not wind. They suggested that the Bay consists of three mixing regimes: 1) significant flushing in the lower Bay from the mouth to approximately Hog Island near the Walker Creek Delta, 2) sluggish mixing in the mid Bay (Pelican Point to Double Point), and 3) even less water exchange in the portion of the upper-Bay (south of Double Point). These studies were conducted in the summer and fall periods and therefore do not reflect the influence of increased inflow from runoff.

Figure 1

Tomales Bay, Marin County, California

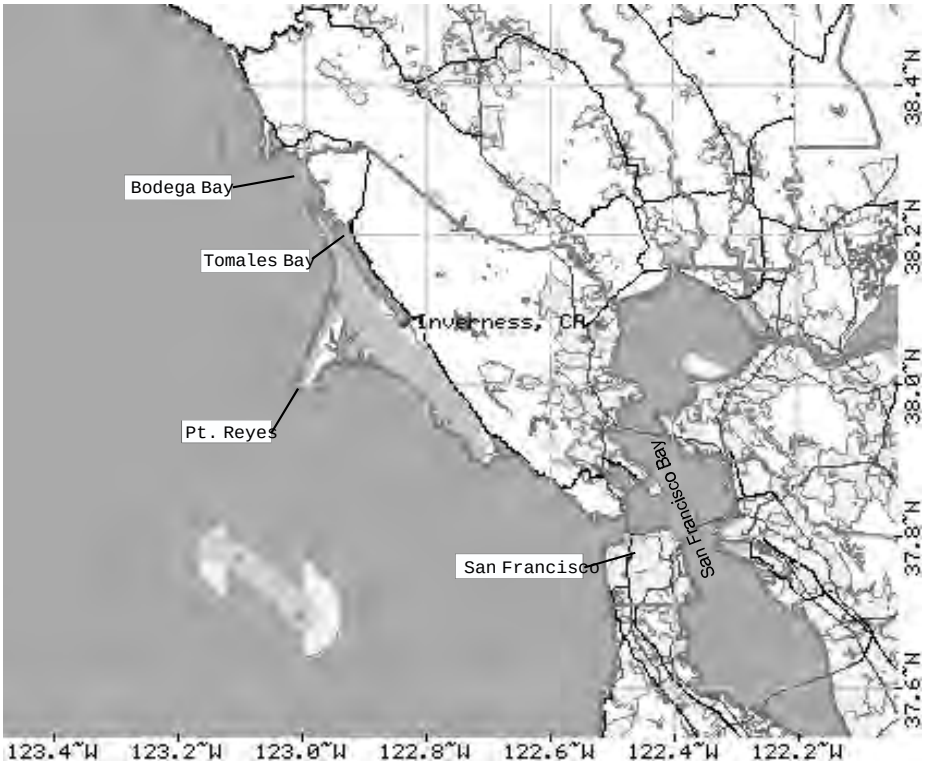


Figure 1. Location of Tomales Bay, Marin County, California (U.S. Census Tiger Map).

2.4 Watershed Description

The Tomales Bay Watershed climate is consistent with the Mediterranean climate of the Central Coast of California, receiving intense rain during the winter months (November through March). Eighty-five percent of the annual rain usually falls during this period.

Another 10% of the annual precipitation falls during October and April, with the remaining 5% during the other five months of the dry season. Average annual rainfall ranges from 26 inches per year in the northern and eastern part of the Watershed to 39 inches per year in the south (TBSTAC, 2000).

The watershed area for Tomales Bay is approximately 561 km^2 (216 square miles) with four major drainage areas: (1) Direct drainage from small tributaries along the west and east shores (73 km^2; 28 mi^2); (2) Lagunitas Creek (241 km^2; 93 mi^2) to the southeast; (3) Olema Creek (50 km^2; 19 mi^2), which flows into Lagunitas Creek close to the head of the Bay; and (4) Walker Creek (196 km^2; 76 mi^2) to the northeast (Table 1 and Figure 2) (TBSTAC, 2000).

The U.S. Geological Survey maintains stream gauges on both Walker and Lagunitas creeks. These gauges measure only a portion of the runoff from their respective watersheds, as well as any water released from catchment reservoirs (Table 2). It has been estimated that about two-thirds of the runoff into Tomales Bay comes through the Lagunitas-Olema Creek drainage even though this area only makes up about half of the Watershed (TBSTAC, 2000) (Tables 1 and 3). The Walker Creek drainage, which includes Chileno, Arroyo Sausal, Salmon, and Keyes creeks, makes up about 35% of the Tomales Bay Watershed area, but produces about 25% of the annual runoff into the Bay (TBSTAC, 2000). The remainder of the flows into the Bay (approximately 10%) comes from small tributaries that drain directly to the Bay, which make up 13% of the total Watershed area.

Table 1
Tomales Bay Watershed Area Estimates, Including Reservoirs

Subwatershed	**Area (KM^2)**	**Area (Percentage)**
Walker	196.35	35%
Lagunitas	241.72	43%
Olema	50.0	9%
Remainder	72.93	13%
Totals	**561**	**100%**

Source: TBSTAC, 2000.

Sediment runoff from the major creeks and tributaries into Tomales Bay may be as high as 48,600 tons/year. Approximately one-third of the sediment is carried into the Bay from the Walker/Keyes Creek drainage (TBSTAC, 2000).

Figure 2

Tomales Bay Watershed

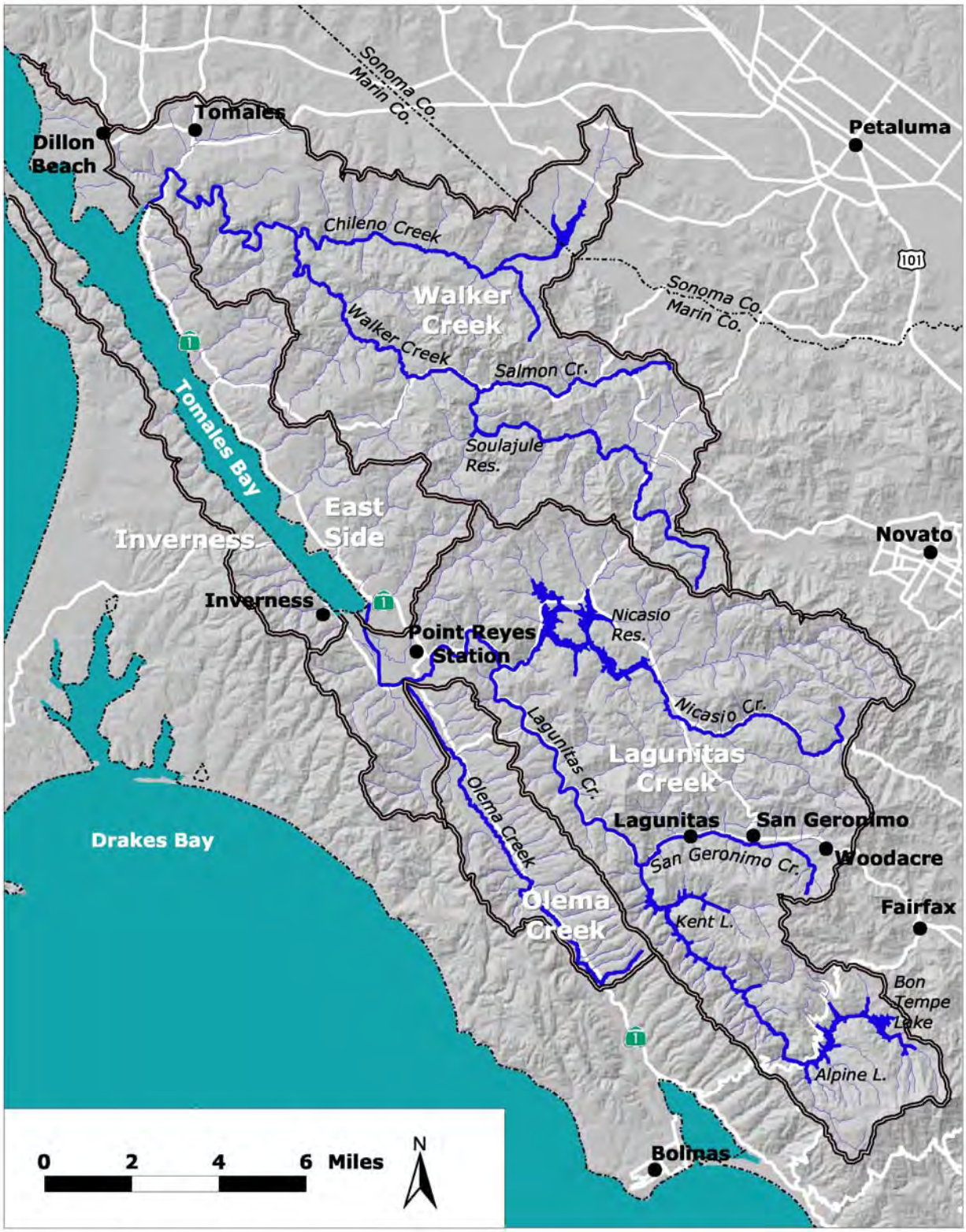


Table 2 **Area Estimates for the Gauged Portions of the Tomales Watershed***		
Watershed	**Area (KM^2)**	**Area (Percent)**
Walker (gauged portion)	78.54	14%
Lagunitas (gauged portion)	213.18	38%
Remainder (not gauged)	269.28	48%
Totals	**561**	**100%**
* Including release and spill from catchment reservoirs and unimpeded flow from the Watershed below the reservoirs. Source: TBSTAC, 2000.		

Table 3 **Estimates of Watershed Contributions to Runoff into Tomales Bay**	
Watershed	**Percentage of Total**
Walker	25%
Lagunitas	66%
Remainder	9%
TOTALS	**100%**
Source: TBSTAC, 2000.	

Marin Municipal Water District (MMWD) maintains five water catchment reservoirs in the Lagunitas Watershed (four on Lagunitas Creek and one on Nicasio Creek) with a total capacity of approximately 69,000 acre feet. MMWD also has a reservoir on a tributary to Walker Creek, with a capacity of 10,572 acre-feet.

2.5 Land and Water Uses

The Tomales Bay Watershed is used for recreational hiking, boating, camping, picnicking, clamming, fishing, and bird watching. The Bay also supports the commercial cultivation and harvesting of shellfish, including oysters, mussels, and clams. Herring and halibut are also harvested commercially from wild populations, and there is a sport fishery for halibut in the Bay.

The major land uses in the Watershed are livestock grazing, dairy farming, equestrian, low-density residential, and parklands. Beef, sheep, and dairy farms have been an important part of the local economy since the mid-1800s, although the number of dairies has been declining. However, since some dairies have switched to raising beef cattle and others have increased the size of their dairy herds, the current total number and type of animals in the Watershed is not known.

There are nine small towns within the Watershed, with limited commercial development and no industry. According to the 2000 census, the west side of Tomales Bay has a population of 1,421, with a total of 707 households. The east side of the Bay (Dillon

Beach, Tomales, Point Reyes Station, Lagunitas-Forest Knolls, San Geronimo, and Woodacre) has a population of 5,011, with 2,047 households. All of the towns are served by onsite sewage disposal system (OSDS) except the town of Tomales, which is served by a centralized wastewater treatment facility. Of the ten small permitted wastewater treatment facilities within the Watershed, only one facility accepts septage waste.

The Water Board prohibits direct discharge from treatment facilities into Tomales Bay or the creeks within the Watershed. A number of the wastewater treatment facilities have holding ponds and are permitted to discharge to irrigation fields during the dry season. A complete list and description of all small wastewater treatment facilities within the Tomales Bay Watershed is provided in Table 16 in Section 5.6.

2.6 Aquaculture

There was at least a minor fishery for native oysters (*Ostera lurida*) from Tomales Bay as early as 1859 (TBSTAC, 2000). Although eastern oysters (*Crassostrea virginica*) were initially transplanted to Tomales Bay near Millerton Station in 1875, these efforts were not successful due to the abundant production of the San Francisco Bay oyster grounds, which were closer to the major markets in San Francisco. Non-native oysters were again introduced into Tomales Bay around 1907 in response to increased pollution of San Francisco Bay and the resultant failure of its oyster industry. The Tomales Bay Oyster Company started operations near Hamlet, and the Consolidated Oyster Company began a short-lived operation at Blakes Landing.

The Tomales Bay Oyster Company was the first to introduce Pacific oysters (*Crassostrea gigas*) to Tomales Bay in 1929 following the earlier successful introduction of this species in the State of Washington. This species now constitutes the majority of oysters currently produced in Tomales Bay.

The vast majority of shellfish harvesting in Tomales Bay is from commercial shellfish growing areas. Currently seven certified active commercial shellfish harvesters and one certified wet storage facility operate in Tomales Bay, with a combined aquaculture lease area of 483 acres (Table 4 and Figures 3a, 3b, and 3c). All active commercial growers in Tomales Bay operate on the eastern shoreline under leases granted by the California Department of Fish and Game (DFG). An inactive grower, the Frank Spenger Company, used to operate on a Point Reyes National Seashore lease on the western shore.

Commercial shellfish production in Tomales Bay is primarily devoted to Pacific oysters (*Crassostrea gigas*) and bay mussels (*Mytilus edulis and M. galloprovincialis*). In addition, there is a small amount of commercial production of Eastern oyster (*Crassostrea virginica*), European oysters (*Ostrea edulis*), Kumomoto oysters (*Crassostrea gigas kumomoto*), and Manila clams (*Tapes semidecussata*). There is a fairly large amount of recreational harvesting for horseneck clams north of the Walker

Creek Delta during the spring and fall. There is also a small bed of cockles and clams used for recreational harvesting near Hamlet, just south of the Walker Creek Delta.

Table 4
Commercial Shellfish Growers and Wet Storage Operators in Tomales Bay

Company	Regulation Number	DFG Lease Number	Number of Acres	Products
Marin Oyster Company	00256	M-430-02 M-430-19	5 25	Pacific Oysters
Charles Friend Oyster Company	00256	M-430-04	87	Pacific Oysters
Cove Mussel Company	00311	M-430-06	10	Bay Mussels, Pacific Oysters
Hog Island Oyster Company, Inc.	00265 00364	M-430-10 M-430-11 M-430-15 M-430-12 Intake	5 5 98 25	Pacific Oysters, Manila Clams, Blue Mussels
Point Reyes Oyster Company	00416	M-430-13 M-430-14 M-430-17	25 5 62	Pacific Oysters, European Oysters, Kumomoto Oysters,
Tomales Bay Shellfish Farms, Inc.	00330	M-430-05	156	Pacific Oysters, Bay Mussels, Manila Clams, European Flat Oysters

Figure 3a.

Location of Commercial Shellfish Growing Area Leases and Prohibited Zones in Tomales Bay (Inner Bay)

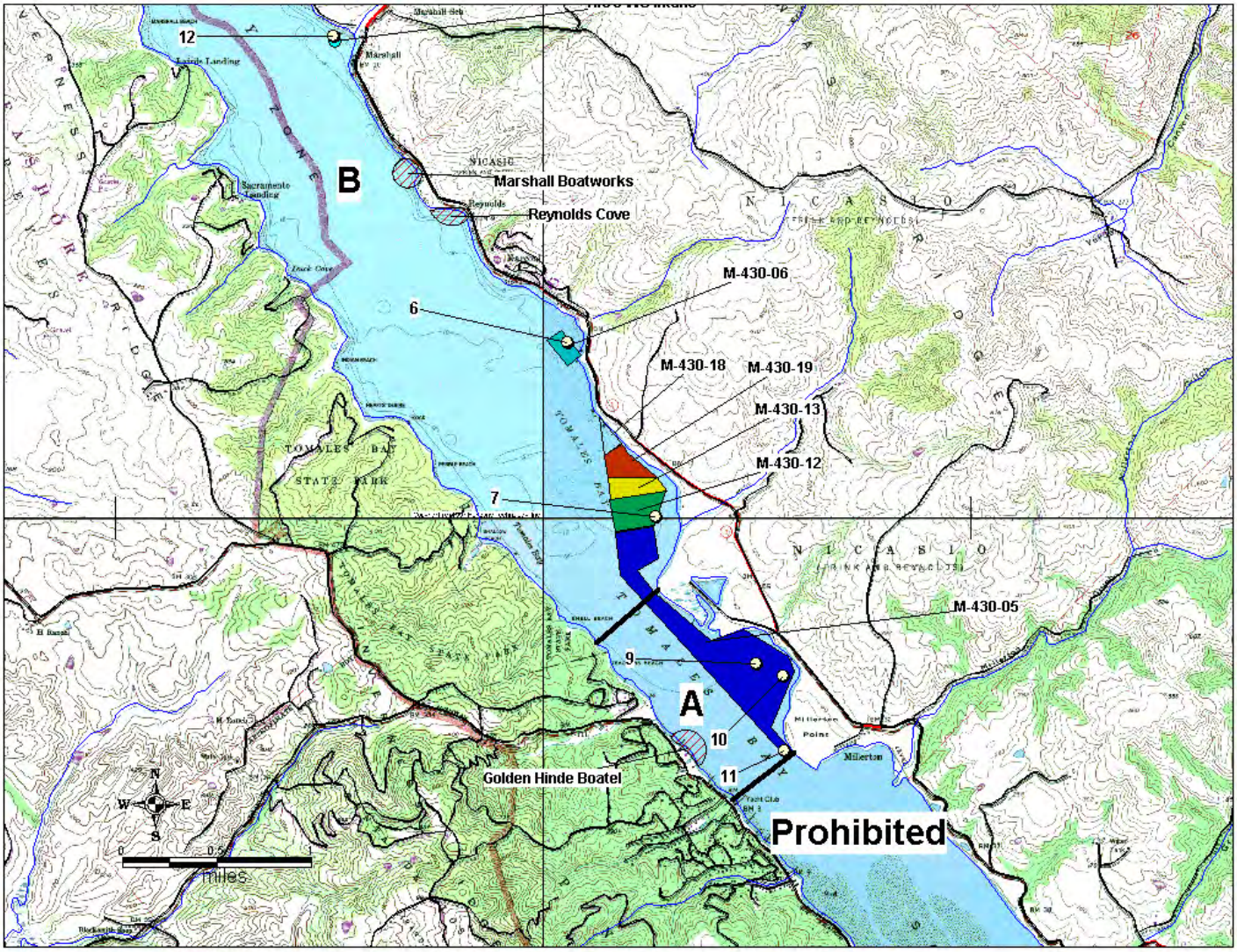


Figure 3b.

Locations of Commercial Shellfish Growing Area Leases and Prohibited Zones in Tomales Bay

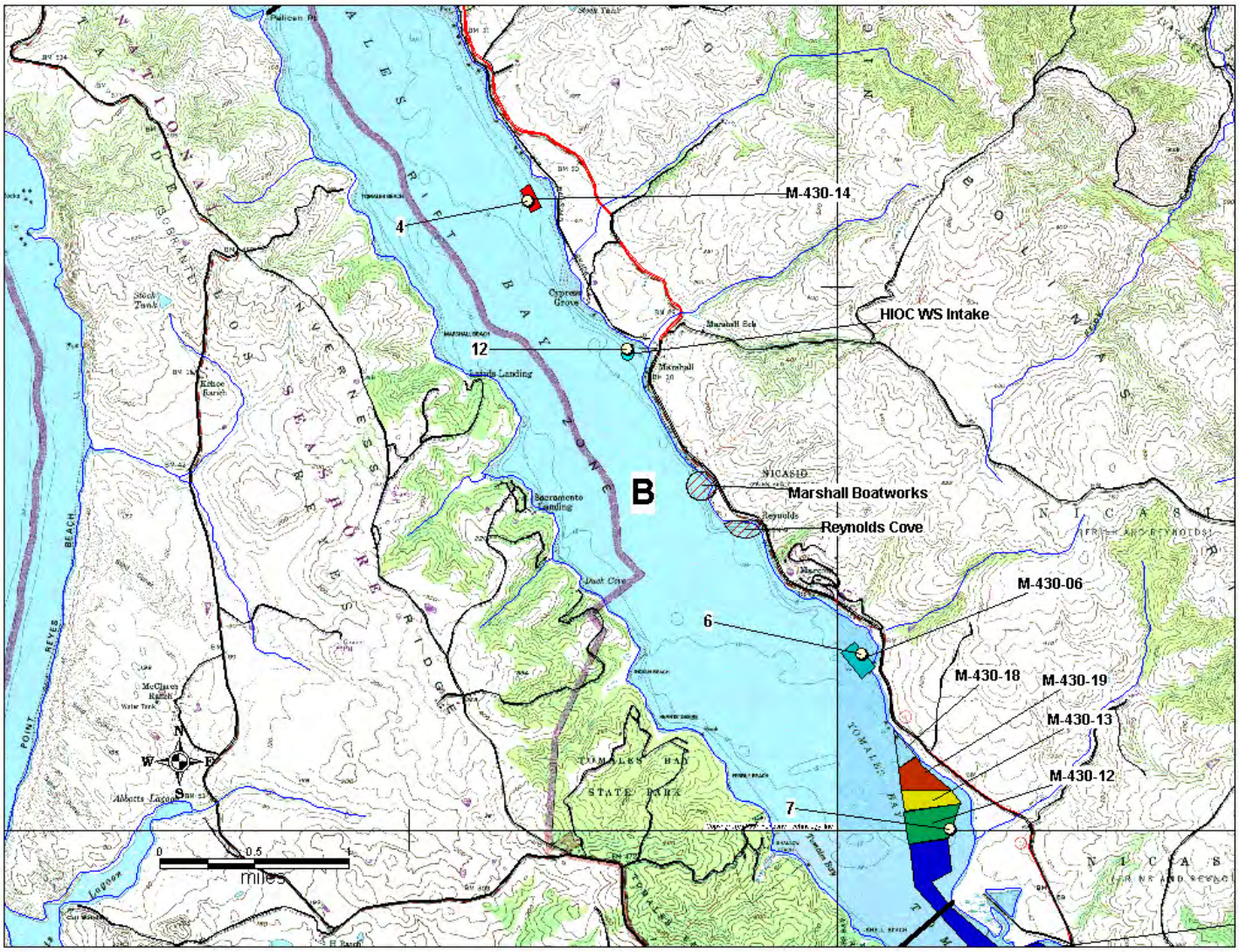
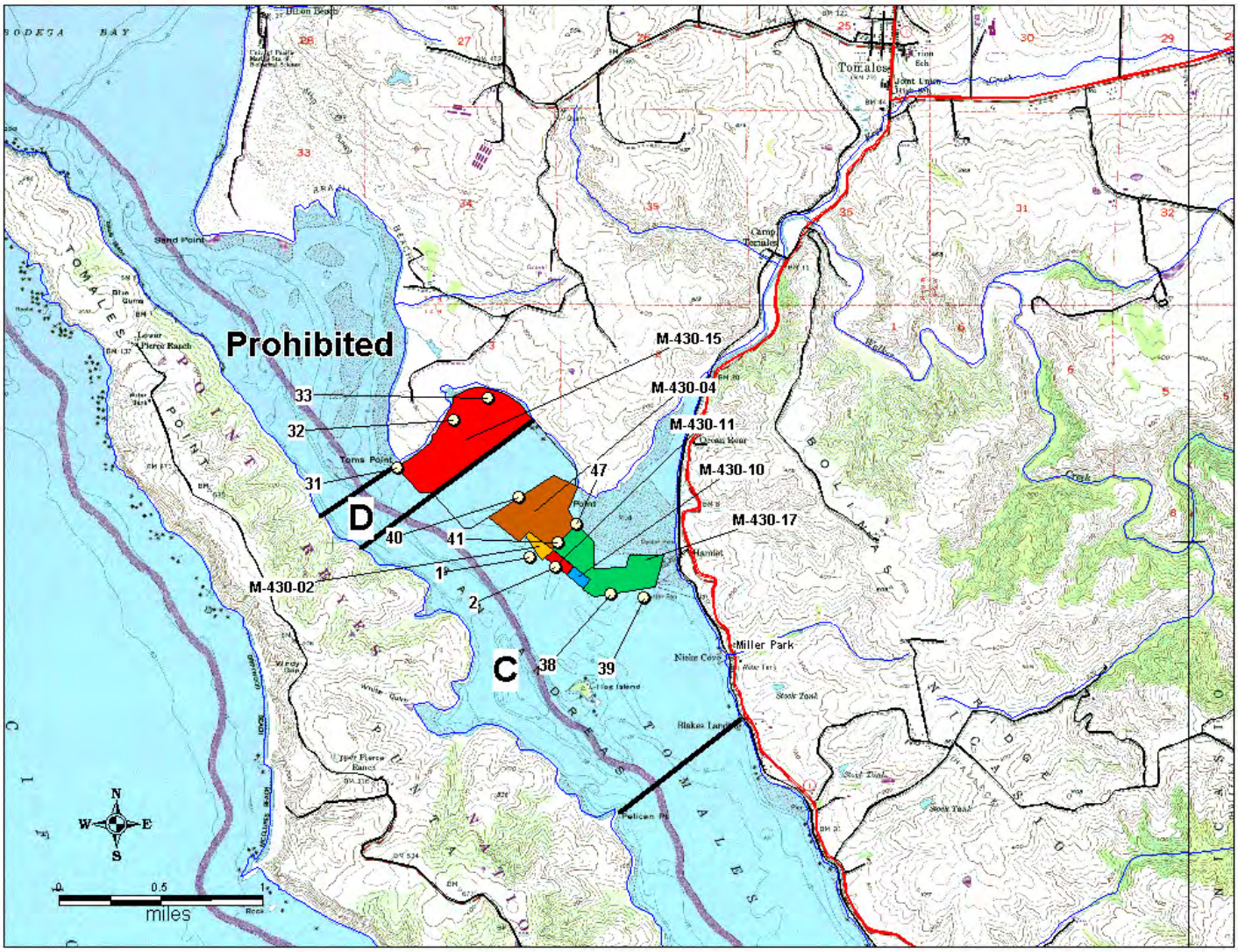


Figure 3c.

Location of Commercial Shellfish Growing Area Leases and Prohibited Zones in Tomales Bay



Source: *Draft Twelve-Year Sanitary Survey Report; Shellfish Growing Area Classification for Tomales Bay* (DHS, 2001).
* HIOC WS: Hog Island Oyster Company Wet Storage

2.7 Tomales Bay Hydrodynamics

Researchers at the University of California, Berkeley developed a three-dimensional hydrodynamic state-of-the-art numerical model of Tomales Bay to evaluate pollutant transport (Brennan and Stacey, 2005a). This model simulates the Bay as a network of over 800,000 cells, which exchange water according to the governing laws of physics,

including the effects of fresh and salt-water density differences. The model inputs include the tidal stage at the mouth of the bay and fresh water flow from the creeks discharging to the bay. Comparison between the model's predictions and direct field observations of currents and salinity show good agreement.

After constructing and validating the model, Brennan and Stacey investigated the transport of pathogens entering the Bay from fresh water creeks. Water entering the Bay was tagged with a tracer—a sort of virtual dye—unique to its source. This tracer then served to quantify how the flows of the Bay transport and dilute pathogens. The distribution of pathogens entering the Bay from Walker Creek was evaluated at the individual shellfish sampling areas located on the Walker Creek delta. The model quantified the temporal and spatial variability of pathogen concentrations in response to different tidal conditions and creek flow rates for a period corresponding to hydrologic conditions from the winter of 2003–04. The results indicate that at times minimal to no dilution of Walker Creek water occurs at a number of the shellfish growing beds. Similarly, at the south end of the Bay (i.e., inner Bay) there is little dilution of tributary flows.

PUBLIC REVIEW DRAFT

CITY OF OAKLAND MEASURE DD IMPLEMENTATION PROJECT ENVIRONMENTAL IMPACT REPORT

STATE CLEARINGHOUSE #2006122048

LSA

July 2007

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CITY OF OAKLAND MEASURE DD IMPLEMENTATION PROJECT ENVIRONMENTAL IMPACT REPORT

STATE CLEARINGHOUSE #2006122048

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July 2007

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Table II-1 *Continued*

Environmental Impacts	Level of Significance Without Mitigation	Mitigation Measures	Level of Significance With Mitigation
TRANS-3 (Group 1): For Existing Conditions Plus the Project, the average vehicle delay at the MacArthur Boulevard/Lakeshore Avenue intersection would increase by 13.8 seconds during the PM peak hour where the LOS is rated F without the project.	S	TRANS-3 (Group 1): The City shall make the following modifications at the MacArthur Boulevard/Lakeshore Avenue intersection to improve traffic operations: 1. Convert the combination left-through lane on eastbound MacArthur Boulevard to a through-only lane, resulting in one left-turn lane, two through lanes and one combination through-right turn lane; 2. Convert the center southbound lane on Lakeshore Avenue from a through movement to a combined through-left turning movement and provide split signal phasing for Lakeshore Avenue traffic movements; and 3. Optimize traffic signal timing. This mitigation measure would reduce the total intersection average vehicle delay by 39.3 seconds during the PM peak hour, and the intersection would operate at LOS E. After project mitigation, the intersection would operate at a total average vehicle delay that would be 25.5 seconds lower than the delay with no project and no mitigation.	LTS
TRANS-4 (Group 1): For Existing Conditions Plus the Project. the average vehicle delay at the 27th Street/Bay Place/Harrison Street intersection would increase by 4.6 seconds during the AM peak hour where the LOS is rated F without the project.	S	TRANS-4 (Group1): The City shall optimize the signal timing at the 27th Street/Bay Place/Harrison Street intersection to reduce the total intersection average vehicle delay by 49.9 seconds during the AM peak hour. Although with mitigation the intersection would remain at LOS F, it would operate at a total average vehicle delay that would be 45.3 seconds lower than the delay with no project and no mitigation.	LTS
TRANS-5 (Group 1): Under Cumulative Plus Project Conditions, the Santa Clara Avenue/Grand Avenue intersection would degrade to LOS F during the PM peak hour.	S	TRANS-5 (Group 1): Implementation of Mitigation Measure TRANS-1 would optimize the signal timing at the Santa Clara Avenue/Grand Avenue intersection and improve traffic operations to LOS E (73.9 seconds average delay) during the PM peak hour for the project under cumulative conditions. No other feasible mitigation measures were identified at this intersection as further improvements would entail widening of the roadway and require acquisition of right of way. Widening would also have adverse impact on the pedestrian environment at this heavily used intersection. After mitigation, the cumulative impact would remain significant and unavoidable.	SU

Table II-1 *Continued*

Environmental Impacts	Level of Significance Without Mitigation	Mitigation Measures	Level of Significance With Mitigation
TRANS-6 (Group 1): Under the Cumulative Plus Project Conditions, the MacArthur Boulevard/Grand Avenue intersection would degrade to LOS F during the PM peak hour.	S	TRANS-6 (Group 1): The City shall make the following modifications at the MacArthur Boulevard/Grand Avenue to improve traffic operations: 1. Convert the center southbound lane on Grand Avenue from a through movement to a combined through-left turning movement and provide split phasing for northbound and southbound Grand Avenue traffic movements; and 2. Optimize traffic signal timing for both AM and PM peak periods. The modifications at the MacArthur Boulevard/Grand Avenue intersection described above would reduce the delay from 120.2 seconds to 81.7 seconds under the Cumulative Plus Project Conditions, but the intersection would remain at LOS F during the PM peak hour. No other feasible mitigation measures were identified at this intersection as further improvements would entail widening of the roadway and require acquisition of right of way. Widening would also have adverse consequence for pedestrians. After mitigation, the cumulative impact of would remain significant and unavoidable.	SU
TRANS-7 (Group 1): Under the Cumulative Plus Project Conditions, the Lake Park Avenue/Lakeshore Avenue intersection would degrade to LOS F during the AM peak hour.	S	TRANS-7 (Group 1): The City shall implement Mitigation Measure TRANS-2 and make the following modifications at the Lake Park Avenue/Lakeshore Avenue intersection to improve traffic operations: 1. Add a left-turn lane from the freeway off-ramp on the westbound Lake Park Avenue approach to the intersection; and 2. Optimize traffic signal timing. The modification at the Lake Park Avenue/Lakeshore Avenue intersection described above would reduce the total intersection average vehicle delay by 115.3 seconds during the AM peak hour, although the intersection would operate at LOS E. After the project mitigation, the intersection would operate at a total average vehicle delay that would be 12.3 seconds lower than the delay under existing conditions with no project and no mitigation. Implementation of this mitigation measure would reduce the impact to a less-than-significant level. However, the City's ability to add the left-turn lane from the freeway ramp depends upon acquisition of right-of-way and an encroachment permit from Caltrans. Because the City cannot guarantee Caltrans' approval, the City is taking the conservative approach of considering this impact significant and unavoidable until sufficient right-of-way can be acquired and Caltrans approves an encroachment permit.	SU

Table II-1 *Continued*

Environmental Impacts	Level of Significance Without Mitigation	Mitigation Measures	Level of Significance With Mitigation
TRANS-8 (Group 1): Under the Cumulative Plus Project Conditions, the 10th Street/Oak Street intersection would degrade to LOS F during the AM peak hour.	S	TRANS-8 (Group 1): The City shall optimize the signal timing (modify the phase splits) at the 10th Street/Oak Street intersection to improve traffic operations. Implementation of the recommended mitigation would improve the intersection to LOS D during the AM peak hour.	LTS
TRANS-9 (Group 1): Under the Cumulative Plus Project Conditions, the 7th Street/Oak Street intersection would degrade to LOS F during the PM peak hour.	S	TRANS-9 (Group 1): The City shall optimize the signal timing (modify the phase splits) at the 7th Street/Oak Street intersection to improve traffic operations. Implementation of the recommended mitigation would improve the intersection to LOS D during the PM peak hour.	LTS
D. Air Quality			
There are no significant Air Quality impacts.			
E. Noise			
NOISE-1 (Group 1): Pile driving would generate noise levels that exceed the City's long-term construction noise standards.	LTS/S	The City's Standard and Uniformly Applied Conditions of Approval would reduce the impacts to less-than-significant levels. However, not all noise-reducing measures may be feasible in all cases and, if not, the impact would be significant and unavoidable.	SU
F. Biological Resources			
BIO-1 (Group 2): Construction of an observation structure at the 66th Avenue Gateway site may impact state or federally listed tidal marsh species.	S	BIO-1a (Group 2): Ground disturbance in the vicinity of Damon Marsh shall be conducted only when high tides are not at their winter or summer extremes, to reduce the likelihood that tidal marsh rails and SMHM will be present in the construction footprint. Ground disturbance shall be avoided during the highest tides of June–July and December–January (± one week each month).	LTS
		BIO-1b (Group 2): Prior to ground disturbance, a qualified biologist experienced with SMHM exclusion procedures shall prepare a site-specific SMHM avoidance plan. At a minimum, the plan shall include (1) the installation of silt fencing around the entire portion of the work area (that is within 100 feet from the edge of the marsh) to exclude SMHM from entering, (2) the clearing of all ground vegetation within the fenced area, and (3) the relocation to Damon Marsh of any SMHM found during the vegetation removal effort. Construction work shall start as soon as possible (and no longer than one week) after vegetation has been cleared. All exclusion measures and initial ground disturbance activities shall be monitored by a biologist, who has the necessary state and federal permits to handle and relocate SMHM.	

Table II-1 *Continued*

Environmental Impacts	Level of Significance Without Mitigation	Mitigation Measures	Level of Significance With Mitigation
BIO-1 *Continued*		BIO-1c (Group 2): To avoid potential disturbance to nesting tidal marsh rails, construction of the observation structure shall be conducted during the non-breeding season (September 1 through January 31), unless prior surveys indicate that marsh habitat within 100 feet of the construction footprint is not part of an active rail breeding territory. Such surveys must be conducted in accordance with a project-specific survey protocol prepared in accordance with the USFWS and CDFG guidelines.	
BIO-2 (Group 2): Construction of the pile-supported boardwalks along the Waterfront Trail may impact fisheries resources within the Oakland Inner Harbor.	S	BIO-2 (Group 2): To avoid adverse impacts to Pacific herring, federally listed salmonids (chinook salmon, coho salmon, and steelhead), and EFH, pile driving shall occur within the June 1 to November 30 work window in accordance with NMFS guidelines.[1] Any pile driving occurring outside this period will require informal or formal consultation with the NMFS (for listed salmonids and EFH) and CDFG (for Pacific herring) prior to the Corps' issuance of a Section 404 permit for impacts to waters of the U.S.	LTS
BIO-3 (Groups 1, 2, and 4): Construction of some components within the Lake Merritt and Lake Merritt Channel, Waterfront Trail, and City-wide Creeks groups may impact waters of the U.S. and State.	S	BIO-3a (Groups 1, 2, and 4): All Measure DD-funded activities within jurisdictional waters shall first obtain authorization from the appropriate agencies (Corps, Water Board, CDFG, and BCDC). At a minimum, each activity will likely require a Section 404 Corps permit and Section 401 water quality certification from the Water Board. Creek restoration activities may also require a CDFG Lake or Streambed Alteration Agreement, depending on site-specific conditions. Construction of the fixed pier boardwalks along the Waterfront Trail will require BCDC approval since it proposes construction over and filling of Bay waters (i.e., concrete piers).	LTS

[1] National Marine Fisheries Service (NMFS). San Francisco Bay Project Impact Evaluation System (PIES) website. <http://mapping.orr.noaa.gov/website/portal/pies/faqs.html> Accessed April 12, 2007.

Table II-1 *Continued*

Environmental Impacts	Level of Significance Without Mitigation	Mitigation Measures	Level of Significance With Mitigation
BIO-3 *Continued*		BIO-3b (Groups 1, 2, and 4): Impacts to jurisdictional wetlands shall be mitigated at a minimum replacement ratio of 1:1 (i.e., one acre created [and preserved] for every acre impacted). If feasible, replacement habitat shall be created/preserved in the same general area as the original impact. Off-site mitigation may be approved if the amount of required replacement habitat exceeds that which is available near a given impact site. A wetland mitigation and monitoring plan (MMP) shall be developed for each mitigation site, detailing the mitigation design, wetland planting design, adaptive management, maintenance and monitoring requirements, reporting requirements, and success criteria for the created wetland(s).	
BIO-4 (Group 1): The introduction of small boat traffic to the Lake Merritt Channel would result in increased disturbance levels to wintering migratory ducks and other waterbirds.	S	BIO-4 (Group 1): Small boat use of the Lake Merritt Channel shall be restricted to the non-wintering period of April–September, when waterbird abundance is low. During the closure period, booms shall be placed across the outlet to the Channel from Lake Merritt and at the 7th Street dam to prevent boat access and signs shall be posted indicating that the Channel is closed to recreational users. This would reduce the impact to a less-than-significant level.	LTS
G. Cultural Resources			
CULT-1 (Group 1): Project activities within the Lake Merritt and Lake Merritt Channel group may impact subsurface prehistoric archaeological materials that may qualify as historical resources under CEQA.	S	CULT-1 (Group 1): A qualified archaeologist who meets the Secretary of the Interior's Professional Qualifications Standards CFR 66, Appendix C, (48 FR 44738-9) and the certification requirements of the Register of Professional Archaeologists shall monitor initial project construction ground disturbing activities, such as trenching or excavating with a backhoe or bulldozer, in the 12th Street reconstruction area. The protocols for monitoring and data recovery outlined in the Archaeological Monitoring and Discovery Plan, 12th Street Reconstruction Project (AMDP)[1] shall be implemented. Monitoring shall continue as deemed necessary by the monitor based on the initial observations. If the monitor observes subsurface prehistoric archaeological materials during excavation, such as those associated with CA-ALA-5 or P-01-010694, the monitor shall ensure that appropriate actions are taken as described in the following paragraphs.	LTS

[1] William Self Associates, Inc., 2005:4-9. *Archaeological Monitoring and Discovery Plan, 12th Street Reconstruction Project*. William Self Associates, Inc., Orinda, California.

Table II-1 *Continued*

Environmental Impacts	Level of Significance Without Mitigation	Mitigation Measures	Level of Significance With Mitigation
CULT-1 *Continued*		In the event that archaeological materials are identified (e.g., obsidian, heat-affected rock, faunal bone, and midden), the archaeologist will immediately notify the Construction Manager, who will temporarily stop construction to permit an examination of the find. Should the monitoring archaeologist determine that the cultural object or feature is significant (i.e., appears eligible for listing in the California Register of Historical Resources), a determination will be made as to the areal extent of the find, and the time required to mitigate (i.e., record and remove or collect all or part of) the discovery. Once the archaeological monitor has made a determination as to the time required to mitigate the find, and has sufficient supporting information, the monitor will take the following steps: 1) record, but not remove materials if non-cultural or non-significant, and allow work to progress, or 2) record and remove the isolated or limited cultural materials and permit work to progress. If the above steps do not apply (i.e., in those instances where the cultural materials are significant and not isolated or spatially limited), then the Construction Manager shall be notified and recovery of the materials shall occur. Diagnostic artifacts, as well as those classes of artifacts for which an adequate sample has not yet been recovered, shall be collected and bagged following photographing and recording of provenience. Mapping of deposits would be coordinated using existing engineering survey controls, and elevation accuracy will be maintained during the excavation to permit provenience controls for artifact recording. All information needed, including soil color or type, elevation, location, photographs, and sketch maps will be gathered as quickly as conditions permit to allow resumption of construction activities. All recovered cultural materials shall be cleaned as appropriate, preserved if necessary, bagged, and tagged or marked so as to permit its identification in an acceptable record system, and in accordance with recognized professional standards. All recovered cultural material shall be analyzed sufficiently to permit identification in accordance with recognized professional standards and submitted to a curation facility, as appropriate. A Final Monitoring Report shall be prepared, describing the results of monitoring, data recovery, and analysis.	LTS

Table II-1 *Continued*

Environmental Impacts	Level of Significance Without Mitigation	Mitigation Measures	Level of Significance With Mitigation
CULT-2 (Group 4): Project activities associated with the City-wide Creeks group may impact historical resources.	S	CULT-2 (Group 4): A preconstruction cultural resources study by a qualified person shall be done for the City-wide Creeks project sites, unless the proposed activities at the site would involve minimal (or no) ground disturbance, such as weeding, hand planting, sign placement, or pruning. For this non-intrusive or minimally intrusive work no mitigation would be needed. For all other work, the preconstruction study will be used to determine whether cultural resource(s) will be adversely affected by project activities and will ensure that, if a cultural resource(s) is present within a City-wide Creek restoration site, impacts to this resource will be avoided or mitigated. The first phase of the study will assess the prehistoric and historical sensitivity for each City-wide Creeks restoration site (or group of sites) and will review project plans to assess the potential for project activities to impact cultural resources at a creek restoration site. The study will include a literature review and a records search at the Northwest Information Center, Rohnert Park, and a site visit to determine the likelihood of recorded or surface-exposed cultural resources at a creek restoration site. A brief letter report shall be prepared for the City that includes the results of the background research and, based on the results of the background research, a determination of whether additional study for cultural resources at a given location will be necessary. If no cultural resources that would be disturbed by the project activities are identified in this phase, the City's Standard Conditions of Approval, which address accidental discoveries, shall be implemented and would reduce the impact to a less-than-significant level. If cultural resources that could be disturbed by the project activities are tentatively identified, additional study, construction monitoring, and mitigation, as appropriate, shall be performed.	LTS

Table II-1 *Continued*

Environmental Impacts	Level of Significance Without Mitigation	Mitigation Measures	Level of Significance With Mitigation
CULT-2 *Continued*		If cultural resources that could be disturbed by the project activities are tentatively identified, a field survey shall be conducted to identify the cultural resources and an archaeological excavation shall be performed, as necessary, to determine whether archaeological deposits are present. The excavation phase may be conducted during the initial ground disturbing work at the site(s). If the excavation phase is conducted during the initial ground disturbing work, the monitoring protocols described in CULT-1 shall be followed. If no cultural resources are identified in this phase, the City's Standard Conditions of Approval, which address accidental discoveries, shall be implemented and would reduce the impact to a less-than-significant level. If cultural resources are identified, the cultural resources shall be preserved, mapped and otherwise documented as described in CULT-1. Implementation of these measures will reduce the impact to a less-than-significant level.	
H. Hydrology and Water Quality			
HYD-1 (Groups 1 – 4): Existing groundwater well(s), that may be encountered and/or damaged by proposed project activities, could act as conduits for migration of pollutants to the underlying groundwater aquifer.	S	HYD-1 (Groups 1 – 4): Any existing wells discovered during the implementation of Measure DD shall be either: 1) properly abandoned in compliance with the California Department of Water Resources California Well Standards and Alameda County Environmental Health Department requirements prior to final approval of the grading plan; or 2) inspected by a qualified professional to determine whether each well is properly sealed at the surface to prevent infiltration of water-borne contaminants into the well casing or surrounding gravel pack. The California Well Standards require an annular surface seal of at least 20 feet. If the wells are found not to comply with this requirement, the City shall retain a qualified well driller to install the required seal.	LTS
I. Geology, Soils and Seismicity			
There are no significant Geology, Soils and Seismicity impacts.			
J. Hazards and Hazardous Materials			
HAZ-1 (Group 1): The Reconstruction of 12th Street would temporarily close a designated emergency evacuation route. (S)	S	HAZ-1 (Group 1): In advance of construction, the City shall prepare detour plans for the emergency evacuation route along 12th Street in accordance with the City's Office of Emergency Services requirements. The plans shall be reviewed and approved by the Office of Emergency Services prior to the start of construction. The implementation of the plans during construction would ensure that alternative emergency evacuation routes are identified and available during project construction and would reduce the impact to a less-than-significant level.	LTS

Table II-1 *Continued*

Environmental Impacts	Level of Significance Without Mitigation	Mitigation Measures	Level of Significance With Mitigation
K. Public Services and Recreation			
There are no significant Public Services and Recreation impacts.			
L. Utilities and Infrastructure			
There are no significant Utilities and Infrastructure impacts.			
M. Aesthetics			
There are no significant Aesthetics impacts.			

- Restore Studio One; and
- Support the following objective for recreational facilities as set forth in the OSCAR Element:
  - Maintain park facilities so that their ability to meet recreational needs is optimized and to rehabilitate recreational facilities on a regular basis so that they remain useful, attractive, and safe.

City-wide Creeks Restoration, Preservation and Acquisition (Group 4)

- Acquire and restore creek habitat;
- Improve water quality within the City of Oakland;
- Restore Oakland's creeks and wetlands to a more natural state in order to enhance the beneficial uses of creeks and wetlands. These beneficial uses include native wildlife habitat creation, cleansing of stormwater runoff, slope stabilization, stormwater conveyance and storage, sediment transport and storage, recreation and educational opportunities and improvement of neighborhoods through community building and aesthetic improvements;
- Support the following objectives for creeks as set forth in the OSCAR Element:
  - Conserve open space along Oakland's creeks, restoring the creeks where feasible and enhancing creek access on public lands;
  - Minimize the adverse effects of urbanization on Oakland's groundwater, creeks, lakes, and near-shore waters;
  - Protect the ecology and promote the beneficial uses of Oakland's creeks, lakes, and near-shore waters; and
- Support the following objectives of the Oakland Creek Protection Ordinance:
  - Safeguard and preserve creeks and riparian corridors in a natural state;
  - Preserve and enhance creekside vegetation and wildlife;
  - Prevent activities that would contribute significantly to flooding, erosion or sedimentation, or that would destroy riparian areas or would inhibit their restoration;
  - Enhance recreational and beneficial uses of Creeks;
  - Control erosion and sedimentation;
  - Protect drainage facilities;
  - Protect the public health and safety, and public and private property; and
  - Protect and enhance the water quality of Oakland's watercourses, water bodies, and wetlands in a manner pursuant to and consistent with the federal Clean Water Act.

C. PROPOSED MEASURE DD IMPLEMENTATION COMPONENTS

Descriptions of the proposed components that comprise the four Measure DD implementation groups are provided in this section. The level of detail provided for each group and its proposed components varies based on current conditions surrounding each proposed project component and the level of

available detail. For example, some proposed components in the Lake Merritt and Lake Merritt Channel group and Waterfront Trail group are near or under construction, and as such, a detailed level of design information is available for their analysis and evaluation. In contrast, the proposed components within the North and East Oakland Recreational Facilities and City-wide Creeks groups are at widely varied stages of design. For example, the East Oakland Aquatic, Sports and Recreation Complex, one of the two recreational facilities identified in this group, is not yet fully funded and is still in an early stage of design while the other recreational component, Studio One Art Center, is already being renovated. Likewise, the City-wide Creeks group has proposed components at many levels of planning, design or construction, from completed project components to those that have not yet begun the design process. Table III-1 lists the components of Measure DD and their current stage of development.

As a result of the range in the level of detail currently available for the various proposed project components, the level of detail for the analysis of each component within this EIR also varies. Because fairly detailed information and plans are available for proposed components within the Lake Merritt and Lake Merritt Channel group and the Waterfront Trail group, these groups are evaluated at a project level. Proposed components within the Recreational Facilities and City-wide Creeks groups are analyzed at a program level. For the East Oakland Aquatic, Sports and Recreation Complex, the program-level analysis is appropriate because planning is still at a preliminary stage. For the City-wide Creeks group, acquisition and restoration is proposed to occur on many, small sites throughout Oakland that have not yet been specifically identified. Although each is unique, the types of activities required and their potential impacts would be similar and conducive to the application of performance standards that can be applied programmatically.

The following subsections describe the four Measure DD funded project groups and their associated components. Each proposed component is numbered for ease of reference.

1. Lake Merritt and Lake Merritt Channel Improvements (Group 1)

The major proposed components in the Lake Merritt and Lake Merritt Channel group are (beginning at the southern end of the Lake): the 12th Street Improvements (1a); Lake Merritt Channel (1b); Lakeshore Avenue, El Embarcadero, Pergola, and E. 18th Street Pier Improvements (1c); Lakeside Drive and Municipal Boathouse (1d); Snow Park/Lakeside-Harrison-20th Street Intersection (1e); Bellevue Avenue Redesign, Children's Fairyland, and the Sailboat House (1f). Additional proposed components include water quality improvements for the Lake and improvements of the Lake Merritt retaining walls (1g). The locations of these proposed components are shown in Figure III-1 and described in additional detail below. Given the level of detail known about these proposed components, they are analyzed within the EIR at a project level, as described above and within Chapter I, Introduction.

a. 12th Street Improvements (1a). Existing 12th Street is a 12-lane divided roadway that crosses the Lake Merritt Channel. Water passes under the roadway through a series of unnavigable culverts. Pedestrian and bicycle access between Lake Merritt Park and the Channel is only provided only through a tunnel. As part of the proposed Measure DD improvements, the 12th Street culvert at Lake Merritt Channel would be replaced with a 100-foot-wide open channel, spanned by bridges, to allow increased tidal flow into and out of Lake Merritt and greater public access to the Channel.

4. City-wide Creeks Restoration, Preservation and Acquisition (Group 4)

Oakland's watershed has fifteen main creeks with over thirty tributaries that comprise over 40 miles of open creeks. As part of Measure DD funded activities, the City would restore, preserve and/or acquire various targeted creek sites as shown in Figure I-3. The intent of the restoration is to improve water quality, hydrology and wildlife habitat to prevent floods, improve public accessibility and increase community stewardship. Specific activities may include creek bank stabilization, riparian habitat restoration, hydrology restoration, public education displays, erosion control, and introduction of native wildlife. Creeks specifically called out in Measure DD are Sausal Creek, Lion Creek, Palo Seco Creek, Cinderella Creek, Arroyo Viejo Creek, Shepherd Creek, Glen Echo Creek, Temescal Creek, Coliseum Slough, Horse Shoe Creek, San Leandro Creek, Peralta Creek, and Courtland Creek. All work would be accomplished in accordance with the City's "Creek Protection, Stormwater Management and Discharge Control Ordinance." The CEQA analysis for these proposed components of Measure DD implementation is at a program level as final selection of specific sites has not occurred.

a. Creek Restoration Activities. The proposed Measure DD funded creek restoration activities are intended to improve water quality and to enhance habitat for avian, fish, invertebrate, and insect populations through the creation of native plant communities, improved aquatic environments, and increased diversity of landscape types. Restoration would incorporate existing resources at creek sites to the extent feasible and would preserve and protect special-status species, if present. Existing habitat and vegetation to be preserved, including special-status plant species, would be identified by conducting site surveys before or during the design phase. The creeks on which restoration is contemplated include: Sausal Creek, Lion Creek, Palo Seco Creek, Cinderella Creek, Arroyo Viejo Creek, Shepherd Creek, Glen Echo Creek, Temescal Creek, Horse Shoe Creek, San Leandro Creek, Peralta Creek, Courtland Creek, and Coliseum Slough.

Restoration activities under Measure DD could include the following:

- Demolition of existing hardscape
- Demolition and construction of water diversion structures to and from bypass channels
- Realignment of existing utilities
- Grading, clearing and grubbing of existing landscaped areas
- Tree pruning and removal
- Control and removal of undesirable plant species
- Creek bed grading
- Creek realignment
- Removal of underground culverts and re-establishment of open creek channel
- Culvert/concrete channel alternations, repair and replacement
- Toe stabilization utilizing biotechnical engineering techniques and hard engineering solutions including but not limited to rip rap, boulder placement, root wads, gabions, and reinforced walls
- Slope stabilization utilizing biotechnical engineering techniques and hard engineering solutions including but not limited to brush layering, brush mattresses, fascines, crib walls, retaining walls, live stakes and plantings

- In-stream improvements including but not limited to riffles, check dams, pools, fish ladders, weirs, and dikes
- Planting and irrigation
- Access improvements including but not limited to pathways, bridges, stairs, boardwalks, ramps, overlooks, benches, tables, and fences
- Educational elements including but not limited to signage, outdoor seating areas, scopes, interpretive art, kiosks, and viewing platforms
- Reduction of vehicular and/or pedestrian access to some project areas
- Restoration to more stable hydrology
- Volunteer weed abatement, native planting propagation and plantings

b. Creek Property Preservation and Acquisition. The proposed Measure DD funded creek preservation and acquisition activities would enable the City and its partners to protect ecologically valuable lands in and around Oakland's waterways. Preservation of creek areas would improve water quality, create new open spaces and recreational opportunities, and protect special wildlife habitats and unique natural resources.

The principle tools that could be implemented with Measure DD funding include the following:

- City partnership with the private sector to protect creek property within proposed development plans,
- Conservation easements either obtained through purchase or donation, and
- Acquisition of Fee Simple Title either through purchase or donation.

c. Specific Creek Improvements. Specific creek restoration/acquisition activities that have been proposed under Measure DD are outlined in Table III-2.

D. DISCRETIONARY ACTIONS

The Measure DD Implementation Project would require discretionary actions that include but are not limited to: Design Review and Conditional Use Permits; Tree Removal Permits; Subdivision; Grading Permits; Land Acquisition & Condemnation; Creek Permits; and Encroachment Permits.

E. USE OF THIS EIR

A number of permits and approvals, including discretionary actions listed above, would be required for the project. As lead agency for Measure DD implementation, the City of Oakland would be responsible for the majority of the approvals required for implementation of the project. Other agencies may have some authority related to the project and its approvals. A non-exclusive list of the required permits and approvals that may be required by the City and other agencies is provided in Table III-3. This EIR is intended to be used for all discretionary approvals required by the City and other agencies in connection with the project. This includes funding decisions on grants, etc., which are not included on this list.

Table III-2: Proposed Creek Restoration and Preservation Components

Creek Area	Activity
Arroyo Viejo Creek Restoration at Knowland Park	Remove non-native vegetation, implement bank stabilization, restore native habitat, and install outdoor "classroom" patios with interpretative signage on watershed ecology
Sausal Creek Restoration, Dimond Park	Remove failing concrete spillway, repair eroding banks, create new trout habitat, possible daylighting a portion of creek in Dimond Park, and possible tree removals
Shepherd Creek at Shepherd Canyon Park	Stabilize creek banks, install bioengineering to address erosion, install berms to prevent flooding to field, create expanded wetland and native plant area, and expand footbridge
Claremont Creek Garber Park	Restore creek banks, revegetate with riparian plants, and create public access and recreational opportunities
Lion Creek at Lion Crossings Park	Create new creek/tidal channel with native riparian and wetland habitat areas
Peralta Creek, Butters Canyon	Develop and implement revegetation/restoration plan for lots previously acquired by Butters Land Trust and additional lots purchased and/or preserved via conservation easements by the City of Oakland
Glen Echo Creek at Oak Glen Park	Revegetation, bank stabilization, and increase flood detention capacity
Courtland Creek, Courtland Creek Park (between Brookdale and Fairfax Avenues)	Remove non-native vegetation, open up view of the creek, restore native plants, and implement bank stabilization
Temescal Creek Restoration at North Oakland Sports Field (SE of Hwy 13/24 interchange)	Riparian restoration at the City owned North Oakland Sports Field to enhance habitat function and educational opportunities
Horseshoe Creek Restoration/Leona Open Space (Between Redwood Rd. and Merritt College)	Remove a long concrete channel and implement restoration measures and trail improvements
Palo Seco Daylighting at Joaquin Miller Park	Daylight (remove from underground culvert) 1,000 feet of streambed, restore riparian habitat, retain existing picnic areas and provide bridges to link picnic areas to existing trails
Peralta Creek, Peralta Hacienda Park	Improve habitat and water quality along Peralta Creek in Peralta Hacienda Park, remove non-native plants and re-vegetate with riparian native plants
Coliseum Slough Restoration (between San Leandro Blvd and the Bay at the Oakland Coliseum)	Enhance habitat function, trail access to the Bay Trail, recreational facilities, and trash/debris removal at the mouth of Lion and Arroyo Viejo Creeks
Lion Creek at McCrea Memorial Park (casting ponds)	Restore channel and native habitat, improve connection between the park and the creek
Sausal Creek Restoration, Hawthorne School	Daylight creek to enhance water quality, restore native riparian vegetation, create a new creek open space behind Hawthorne School, and connect to Sanborn Park
Sausal Creek, 27th Street at Barry Place	Revegetate creek banks and install improvements to create a new public park
Sausal Creek, Beaconsfield Open Space	Daylight creek from deteriorating culvert, restore habitat, and address severe erosion
San Leandro Creek at Sobrante Park	Restore creek by removing concrete channel and layback the north creek bank to provide flow capacity, revegetate north bank and connect creek to Park and Washington Middle School through landscaping design
Seminary Creek at Rainbow Recreation Center	Remove concrete channel and restore creek meander and riparian vegetation
Glen Echo Creek Restoration at Mosswood Park	Daylight approximately 600 feet of creek and restore to natural condition
Lion Creek at Coliseum Gardens	Construct a creek and wetland adjacent to the existing concrete flood control channel in order to restore habitat

Source: City of Oakland, Public Works Agency, 2007.

- Policy OS-12.1: Incorporate a broad and varied range of tree species which is reflected on a City-maintained list of approved trees. Street tree selection should respond to the general environmental conditions at the planting site, including climate and micro-climate, soil types, topography, existing tree planting, maintenance of adequate distance between street trees and other features, the character of existing development, and the size and context of the tree planting area.
- Policy REC-2.3: Protect sensitive natural areas within parks, including creeks and woodlands, and integrate them into park design. Require new recreational facilities to respect existing park character, be compatible with the natural environment, and achieve a high standard of design quality.

The following policies from the LUTE of the General Plan are applicable to the proposed project:

- Policy W3.2: The function, design and appearance, and supplementary characteristics of all uses, activities, and facilities should enhance, and should not detract from or damage the quality of, the overall natural and built environment along the waterfront.
- Policy W3.3: Native plant communities, wildlife habitats, and sensitive habitats should be protected and enhanced.

The Oakland Estuary Plan contains the following policy relevant to biological resources:

- Policy OAK-1.1: Encourage the preservation and enhancement of wetland areas. The waterfront should be improved in a manner that maintains and enhances the ecological value of the area in general and the Lake Merritt Channel in particular. In some locations, tidelands function as tidal wetlands, providing marsh habitat for fish, migratory waterfowl, and other animals. Improvements should be encouraged that restore wetland and marsh habitat. Wetlands should be protected by such treatments as setting back trails from the shoreline, installing suitable buffer planting to prevent disruption nesting and resting areas, seasonal routing of pedestrians to avoid sensitive habitats, etc. As improvements and projects are considered, the City and Port should work with interested groups and organizations to ensure appropriate treatments along the shoreline, particularly along the channel on the eastern bank between I-880 and Embarcadero.

(12) City of Oakland Municipal Code. Title 12, Chapter 12.36 of the Oakland Municipal Code (OMC) requires that a permit be obtained prior to removing protected trees from either City or private property. Protected trees are defined as follows:

- Any coast live oak (*Quercus agrifolia*) larger than 4 inches diameter-at-breast height (dbh)
- Any tree that is larger than 9 inches dbh, except eucalyptus trees, or Monterey pines on City property and in development-related situations where more than five per acre are proposed to be removed.

(13) City of Oakland's Standard and Uniformly Applied Conditions of Approval. The City of Oakland's Standard and Uniformly Applied Conditions of Approval (Standard Conditions of Approval) that would apply to the proposed project are listed below. Implementation of these conditions would ensure minimization of a project's potential impacts to biological resources.

Condition 31: Tree Removal Permit on Creekside Properties. *Prior to issuance of a final inspection of the building permit.* Prior to removal of any tree located on the project site which is identified as a creekside property, the project applicant must secure the applicable creek protection permit, and abide by the conditions of that permit.

Condition 32: Tree Removal During Breeding Season. *Prior to issuance of a tree removal permit.* To the extent feasible, removal of the trees and other vegetation suitable for nesting of raptors shall not occur during the breeding season of March 15 through August 15. If tree removal must occur during the breeding season, all sites shall be surveyed by a qualified biologist to verify the presence or absence of nesting raptors or other birds. Pre-removal surveys shall be conducted within 15 days prior to the start of work from March 15 through May 31, and within 30 days prior to the start of work from June 1 through August 15. If the survey indicates the potential presence of nesting raptors or other birds, the biologist shall determine an appropriately sized buffer around the nest in which no work will be allowed until the young have successfully fledged. The size of the nest buffer will be determined by the biologist in consultation with the CDFG, and will be based to a large extent on the nesting species and its sensitivity to disturbance. In general, buffer sizes of 200 feet for raptors and 50 feet for other birds should suffice to prevent

disturbance to birds nesting in the urban environment, but these buffers may be increased or decreased, as appropriate, depending on the bird species and the level of disturbance anticipated near the nest.

Condition 33: Tree Removal Permit. *Prior to issuance of a demolition, grading, or building permit.* Prior to removal of any protected trees, per the Protected Tree Ordinance, located on the project site or in the public right-of-way adjacent to the project, the project applicant must secure a tree removal permit, and abide by the conditions of that permit.

Condition 34: Tree Replacement Plantings. *Prior to issuance of a final inspection of the building permit.* Replacement plantings shall be required for erosion control, groundwater replenishment, visual screening and wildlife habitat in accordance with the following criteria:

a) No tree replacement shall be required for the removal of nonnative species, for the removal of trees which is required for the benefit of remaining trees, or where insufficient planting area exists for a mature tree of the species being considered.

b) Replacement tree species shall consist of *Sequoia sempervirens* (Coast Redwood), *Quercus agrifolia* (Coast Live Oak), *Arbutus menziesii* (Madrone), *Aesculus californica* (California Buckeye) or *Umbellularia californica* (California Bay Laurel) or other tree species acceptable to the Tree Services Division.

c) Replacement trees shall be at least of 24-inch box size, unless a smaller size is recommended by the arborist, except that three 15-gallon-size trees may be substituted for each 24-inch box size tree where appropriate.

d) Minimum planting areas must be available on site as follows:

- For *Sequoia sempervirens*, three hundred fifteen square feet per tree;
- For all other species listed in #b above, seven hundred (700) square feet per tree.

e) In the event that replacement trees are required but cannot be planted due to site constraints, an in lieu fee as determined by the master fee schedule of the city may be substituted for required replacement plantings, with all such revenues applied toward tree planting in city parks, streets and medians.

f) Plantings shall be installed prior to the issuance of a final inspection of building permit, subject to seasonal constraints, and shall be maintained by the project applicant until established. The Tree Reviewer may require a landscape plan showing the replacement planting and the method of irrigation. Any replacement planting which fails to become established within one year of planting shall be replanted at the project applicant's expense.

Condition 35: Tree Protection During Construction. *Prior to issuance of a demolition, grading, or building permit.* Adequate protection shall be provided during the construction period for any trees which are to remain standing, including the following, plus any recommendations of an arborist:

a) Before the start of any clearing, excavation, construction or other work on the site, every protected tree deemed to be potentially endangered by said site work shall be securely fenced off at a distance from the base of the tree to be determined by the City Tree Reviewer. Such fences shall remain in place for duration of all such work. All trees to be removed shall be clearly marked. A scheme shall be established for the removal and disposal of logs, brush, earth and other debris which will avoid injury to any protected tree.

b) Where proposed development or other site work is to encroach upon the protected perimeter of any protected tree, special measures shall be incorporated to allow the roots to breathe and obtain water and nutrients. Any excavation, cutting, filing, or compaction of the existing ground surface within the protected perimeter shall be minimized. No change in existing ground level shall occur within a distance to be determined by the City Tree Reviewer from the base of any protected tree at any time. No burning or use of equipment with an open flame shall occur near or within the protected perimeter of any protected tree.

c) No storage or dumping of oil, gas, chemicals, or other substances that may be harmful to trees shall occur within the distance to be determined by the Tree Reviewer from the base of any protected trees, or any other location on the site from which such substances might enter the protected perimeter. No heavy construction equipment or construction materials shall be operated or stored within a distance from the base of any protected trees to be determined by the tree reviewer. Wires, ropes, or other devices shall not be attached to any protected tree, except as needed for support of the tree. No sign, other than a tag showing the botanical classification, shall be attached to any protected tree.

d) Periodically during construction, the leaves of protected trees shall be thoroughly sprayed with water to prevent buildup of dust and other pollution that would inhibit leaf transpiration.

e) If any damage to a protected tree should occur during or as a result of work on the site, the project applicant shall immediately notify the Public Works Agency of such damage. If, in the professional opinion of the Tree Reviewer, such tree cannot be preserved in a healthy state, the Tree Reviewer shall require replacement of any tree removed with another tree or trees on the same site deemed adequate by the Tree Reviewer to compensate for the loss of the tree that is removed.

f) All debris created as a result of any tree removal work shall be removed by the project applicant from the property within two weeks of debris creation, and such debris shall be properly disposed of by the project applicant in accordance with all applicable laws, ordinances, and regulations.

Condition 69: Creek Protection Plan. *Prior to and ongoing throughout demolition, grading, and/or construction activities.*

a) The approved creek protection plan shall be included in the project drawings submitted for a building permit (or other construction-related permit). The project applicant shall implement the creek protection plan to minimize potential impacts to the creek during and after construction of the project. The plan shall fully describe in plan and written form all erosion, sediment, stormwater, and construction management measures to be implemented on-site.

b) If the plan includes a stormwater system, all stormwater outfalls shall include energy dissipation that slows the velocity of the water at the point of outflow to maximize infiltration and minimize erosion. The project shall not result in a substantial increase in stormwater runoff volume or velocity to the creek or storm drains.

Condition 70: Regulatory Permits and Authorizations. *Prior to issuance of a demolition, grading, and/or building permit within vicinity of the creek.* Prior to construction within the vicinity of the creek, the project applicant shall obtain all necessary regulatory permits and authorizations from the U.S Army Corps of Engineers (Corps), Regional Water Quality Control Board (RWQCB), California Department of Fish and Game, and the City of Oakland, and shall comply with all conditions issued by applicable agencies. Required permit approvals and certifications shall include, but not be limited to the following:

a) U.S. Army Corps of Engineers (Corps): Section 404. Permit approval from the Corps shall be obtained for the placement of dredge or fill material in Waters of the U.S., if any, within the interior of the project site, pursuant to Section 404 of the federal Clean Water Act.

b) Regional Water Quality Control Board (RWQCB): Section 401 Water Quality Certification. Certification that the project will not violate state water quality standards is required before the Corps can issue a 404 permit, above.

c) California Department of Fish and Game (CDFG): Section 1602 Lake and Streambed Alteration Agreement. Work that will alter the bed or bank of a stream requires authorization from CDFG.

Condition 71: Creek Monitoring. *Prior to issuance of a demolition, grading, and/or building permit within vicinity of the creek.* A qualified geotechnical engineer and/or environmental consultant shall be retained and paid for by the project applicant to make site visits during all grading activities; and as a follow-up, submit to the Building Services Division a letter certifying that the erosion and sedimentation control measures set forth in the Creek Protection Permit submittal material have been instituted during the grading activities.

Condition 72: Creek Landscaping Plan. *Prior to issuance of a demolition, grading, and/or building permit within vicinity of the creek.* The project applicant shall develop a final detailed landscaping and irrigation plan for review and approval by the Planning and Zoning Division prepared by a licensed landscape architect or other qualified person. Such a plan shall include a planting schedule, detailing plant types and locations, and a system for temporary irrigation of plantings.

a) Plant and maintain only drought-tolerant plants on the site where appropriate as well as native and riparian plants in and adjacent to riparian corridors. Along the riparian corridor, native plants shall not be disturbed to the maximum extent feasible. Any areas disturbed along the riparian corridor shall be replanted with mature native riparian vegetation and be maintained to ensure survival.

b) All landscaping indicated on the approved landscape plan shall be installed prior to the issuance of a Final inspection of the building permit, unless bonded pursuant to the provisions of Section 17.124.50 of the Oakland Planning Code.

c) All landscaping areas shown on the approved plans shall be maintained in neat and safe conditions, and all plants shall be maintained in good growing condition and, whenever necessary replaced with new plant materials to ensure continued compliance with all applicable landscaping requirements. All paving or impervious surfaces shall occur only on approved areas.

Condition 73: Creek Dewatering and Aquatic Life. *Prior to the start of and ongoing throughout any in-water construction activity.*

a) If any dam or other artificial obstruction is constructed, maintained, or placed in operation within the stream channel, ensure that sufficient water is allowed to pass down channel at all times to maintain aquatic life (native fish, native amphibians, and western pond turtles) below the dam or other artificial obstruction.

b) The project applicant shall hire a biologist to relocate all native fish/native amphibians/western pond turtles within the work site, with all necessary State and Federal permits, prior to dewatering. Captured native fish/native amphibians/western pond turtles shall be moved to the nearest appropriate site on the stream channel downstream. The applicant shall first obtain a project-specific authorization from the CDFG and/or USFWS, as applicable, to relocate these animals. The biologist/contractor shall check daily for stranded aquatic life as the water level in the dewatering area drops. All reasonable efforts shall be made to capture and move all stranded aquatic life observed in the dewatered areas. Capture methods may include fish landing nets, dip nets, buckets, and by hand. Captured aquatic life shall be released immediately in the nearest appropriate downstream site. This condition does not allow the take or disturbance of any state- or federally listed species nor state-listed species of special concern, unless the applicant obtains a project-specific authorization from the CDFG and/or USFWS, as applicable.

2. Impacts and Mitigation Measures

This section discusses potential impacts to biological resources that could result from implementation of Measure DD. The section begins with the significance criteria, which establish the thresholds used to determine whether an impact is significant. The latter part of this section presents the impacts associated with Measure DD and identifies mitigation measures, as appropriate.

a. Criteria of Significance. Implementation of the proposed project components would have a significant impact on biological resources if they would:

1) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFG or USFWS;

2) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the CDFG or USFWS;

3) Have a substantial adverse effect on federally protected wetlands (as defined by Section 404 of the Clean Water Act) or state protected wetlands, through direct removal, filling, hydrological interruption, or other means;

4) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites;

5) Fundamentally conflict with any applicable habitat conservation plan or natural community conservation plan;

6) Fundamentally conflict with the City of Oakland Tree Preservation and Removal Ordinance (OMC Chapter 12.36) by removal of protected trees under certain circumstances. Factors to be

considered in determining significance include: the number, type, size, location and condition of (a) the protected trees to be removed and/or impacted by construction and (b) the protected trees to remain, with special consideration given to native trees.[33]

Protected trees include the following:

Coast live oak measuring 4 inches dbh or larger, and any other tree measuring 9 inches dbh or larger except eucalyptus and Monterey pine; however, Monterey pine trees on City property and in development-related situations where more than five Monterey pine trees per acre are proposed to be removed are considered to be protected trees; or

7) Fundamentally conflict with the City of Oakland Creek Protection Ordinance (OMC Chapter 13.16) intended to protect biological resources. Although there are no specific, numeric/quantitative criteria to assess impacts, factors to be considered in determining significance include whether there is substantial degradation of riparian and aquatic habitat through: (a) discharging a substantial amount of pollutants into a creek; (b) significantly modifying the natural flow of the water; (c) depositing substantial amounts of new material into a creek or causing substantial bank erosion or instability; or (d) adversely impacting the riparian corridor by significantly altering vegetation or wildlife habitat.

The level of impact to biological resources is discussed in the following section and summarized in Table IV.F-2. Many of the potential impacts will be reduced to a less-than-significant level through implementation of the City's Standard Conditions of Approval (see above), which are included as part of the project.

b. Impacts Applicable to All Project Groups. Several of the impacts to biological resources that may result from the implementation of Measure DD would essentially be the same for each or most of the four project groups. These impacts are defined below for each criterion of significance listed above. Where applicable, the City's specific Standard Conditions of Approval that will reduce potential impacts to a less-than-significant level are identified in the text after the discussion of the impact.

(1) Candidate, Sensitive, or Special-status Species. The only special-status species potentially occurring within all component groups is Cooper's hawk, a California Species of Special Concern. The numerous tall trees throughout the Measure DD Implementation Project area provide nesting habitat for a variety of native bird species, potentially including Cooper's hawk. In addition, some of the creek restoration sites in the upper Oakland watershed may contain suitable nest trees for sharp-shinned hawk. Both these species are California Species of Special Concern. Proposed tree removal within the Lake Merritt and the Lake Merritt Channel group area and potential tree removal within other group sites could directly impact nesting Cooper's and sharp-shinned hawks by removing trees that support active nests. Prolonged loud construction noise could also disturb nesting birds, resulting in nesting failure and/or nest abandonment.

[33] Oakland Planning Code section 17.158.280E2 states that "Development related" tree removal permits are exempt from CEQA if no single tree to be removed has a dbh of 36 inches or greater **and** the cumulative trunk area of all trees to be removed does not exceed 0.1 percent of the total lot area.

Table IV.F-2: Summary of Potential Impacts – Biological Resources

	Project Group[a]			
Would the Project:	**Group 1 Lake Merritt**	**Group 2 Waterfront Trail**	**Group 3 Recreational Facilities**	**Group 4 City-wide Creeks**
1. Adversely affect a candidate, sensitive or special-status species?	○	◉ BIO-1 BIO-2	○	○
2. Adversely affect riparian habitat of other sensitive natural community?	==	==	==	○
3. Adversely affect federally or state protected wetlands?	◉ BIO-3	◉ BIO-3	==	◉ BIO-3
4. Interfere with a migratory wildlife corridor or wildlife nursery site?	◉ BIO-4	○	○	○
5. Conflict with any applicable habitat conservation plan or natural community conservation plan?	==	==	==	==
6. Conflict with the City of Oakland Tree Preservation and Removal Ordinance?	○	○	○	○
7. Conflict with the City of Oakland Creek Protection Ordinance?	○	○	==	○

[a] The Lake Merritt and Waterfront Trail groups are analyzed at the project level. The Recreational Facilities and City-wide Creeks groups are analyzed at the program level. The level of impact and the proposed mitigation measure, if any, are identified as follows:

== No impact
○ Less-than-Significant or Less-than-Significant with Standard Conditions of Approval
◉ Reduced to Less-than-Significant after recommended mitigation
● Significant
NA Not Applicable
BIO-1, etc. identifies the mitigation measure, if any, that addresses the impact and reduces it to a level that is less than significant.

Source: LSA Associates, 2007

Implementation of the City's Standard Conditions of Approval (Condition 32) will reduce potential impacts to nesting Cooper's and sharp-shinned hawks to a less-than-significant level. The pre-construction survey shall be conducted within 15 days prior to the start of work from March 15 though May (since there is higher potential for birds to initiate nesting during this period), and within 30 days prior to the start of work from June through August 15.

(2) Riparian Habitat. No riparian habitat or other sensitive natural communities are present at the Lake Merritt and Lake Merritt Channel or Recreational Facilities groups. A small area of pickleweed wetland, considered a sensitive natural community by the CDFG, is present on the 66th Avenue Gateway site within the Waterfront Trail group, but will not be affected by any proposed project activities. Potential impacts to wildlife that may use this plant community are discussed in Section IV.F2c. The only project group that may result in direct impacts to riparian habitat or other sensitive natural communities is the City-wide Creeks group. This potential impact is discussed in Section IV.F2c.

(3) Wetlands. Waters of the U.S. and State are present on or adjacent to several components within the Lake Merritt and the Lake Merritt Channel, Waterfront Trail, and City-wide Creeks groups. Since no such features are present within the two components of the Recreational Facilities group, this potential impact is discussed in Section IV.F2c.

(4) Native Resident or Migratory Wildlife Movement, Wildlife Corridors, or Nursery Sites. Suitable nesting habitat for native bird species protected by the federal Migratory Bird Treaty Act (MBTA) and California Fish and Game Code is present within all of the project group areas. Additional impacts unique to the Lake Merritt Channel are discussed in Section IV.F2c.

Most existing vegetation and some un-vegetated areas within the project area have at least some potential to support breeding activities by native birds protected under the MBTA and California Fish and Game Code. Proposed removal of trees and other vegetation at Lake Merritt and the Lake Merritt Channel and potential vegetation removal for other project components (e.g., grading, clearing, and grubbing of existing landscaped areas at creek restoration sites) could directly impact nesting birds by removing vegetation that contains active nests. In addition, species that nest in un-vegetated areas (i.e., killdeer) may be vulnerable to construction activities (e.g., grading, site demolition, equipment traffic). Implementation of the City's Standard Conditions of Approval (Condition 32) will reduce potential impacts to nesting birds to a less-than-significant level.

(5) Regional Conservation Plans. The areas covered by the Measure DD Implementation Project are not currently subject to any adopted habitat conservation plans or natural community conservation plans.

(6) Protected Trees. Based on current plans, the Lake Merritt and Lake Merritt Channel group proposes to remove a number of protected trees. Protected trees might also be removed as part of the Waterfront Trail, Recreational Facilities, and City-wide Creeks groups. This impact is discussed in Section IV.F2c.

(7) Creek Protection Ordinance. Project components within the Lake Merritt and Lake Merritt Channel and City-wide Creeks groups are subject to the City's Creek Protection Ordinance. In addition, some creeks (e.g., Sausal Creek) discharge to the Oakland Harbor Channel within or adjacent to the Waterfront Trail group study area. No creeks are located on or adjacent to the site of the proposed Recreational Facilities group. This impact is discussed in Section IV.F2c.

c. Impacts and Mitigation Measures Unique to Specific Project Components. This section describes potential impacts that are unique to individual project components.

(1) Candidate, Sensitive, or Special-status Species. Potential site-specific impacts to special-status species are discussed below.

Western leatherwood and most beautiful jewel-flower, CNPS List 1B species, and Presidio clarkia, a State- and federally listed species as well as a CNPS List 1B species, are known to occur in the Oakland watershed, and suitable habitat (particularly mixed evergreen forest for western leatherwood, and serpentine for Presidio clarkia and most beautiful jewel-flower) may be present at some of the proposed creek restoration sites. Potential restoration activities that may impact these species include grading, clearing, and grubbing of landscaped areas, as well as tree pruning and removal. Surveys of

existing habitat and vegetation would be conducted during the design phase and would identify special-status plants that require protection during restoration activities and that would be incorporated into the restored site design. Other native species would be incorporated into the design to the extent feasible. Implementation of the City's Standard Conditions of Approval (Conditions 35, 70 and 72) will further ensure that any special-status plant species found at creek restoration sites will be fully protected during project activities, reducing any potential impacts to a less-than-significant level.

Pacific pond turtles, a California Species of Special Concern, are known to occur in the Oakland watershed and suitable habitat may be present at some of the creek restoration sites, depending on their level of disturbance. In-stream restoration activities (e.g., creek bed grading, creek realignment, in-stream improvements) may result in direct mortality of Pacific pond turtles if present. Implementation of the City's Standard Conditions of Approval (Condition 73) and approval of all relocation plans and involved biologists by the CDFG will reduce potential impacts to Pacific pond turtles to a less-than-significant level.

<u>Impact BIO-1 (Group 2)</u>: Construction of an observation structure at the 66th Avenue Gateway site may impact state or federally listed tidal marsh species. (S)

Suitable habitat for California black rail, California clapper rail, and salt marsh harvest mouse (SMHM) is present in Damon Marsh adjacent to the 66th Avenue Gateway site. Construction would not extend into existing marsh habitat. A fenced buffer of upland habitat at least 20 feet wide would be set up between marsh habitat and any nearby construction areas. Nevertheless, these species are known to use grasslands and other dense vegetation adjacent to marshes as escape cover during very high tides. As such, there is a small chance that they may occur within the construction footprint during very high tides, if present in Damon Marsh. In addition, construction noise could potentially disturb nesting tidal marsh rails since suitable habitat is present within 100 feet of the construction footprint.[34]

> <u>Mitigation Measure BIO-1a (Group 2)</u>: Ground disturbance in the vicinity of Damon Marsh shall be conducted only when high tides are not at their winter or summer extremes, to reduce the likelihood that tidal marsh rails and SMHM will be present in the construction footprint. Ground disturbance shall be avoided during the highest tides of June–July and December–January (± one week each month). (LTS)
>
> <u>Mitigation Measure BIO-1b (Group 2)</u>: Prior to ground disturbance, a qualified biologist experienced with SMHM exclusion procedures shall prepare a site-specific SMHM avoidance plan. At a minimum, the plan shall include (1) the installation of silt fencing around the entire portion of the work area (that is within 100 feet from the edge of the marsh) to exclude SMHM from entering, (2) the clearing of all ground vegetation within the fenced area, and (3) the relocation to Damon Marsh of any SMHM found during the vegetation removal effort. Construction work shall start as soon as possible (and no longer than one week) after vegetation has been cleared. All exclusion measures and initial ground

[34] This proposed project component has been designed and the City is currently requesting bids to construct it. Mitigation included in this environmental document has been incorporated into the bid documents.

disturbance activities shall be monitored by a biologist, who has the necessary state and federal permits to handle and relocate SMHM. (LTS)

Mitigation Measure BIO-1c (Group 2): To avoid potential disturbance to nesting tidal marsh rails, construction of the observation structure shall be conducted during the non-breeding season (September 1 through January 31), unless prior surveys indicate that marsh habitat within 100 feet of the construction footprint is not part of an active rail breeding territory. Such surveys must be conducted in accordance with a project-specific survey protocol prepared in accordance with the USFWS and CDFG guidelines. (LTS)

Impact BIO-2 (Group 2): Construction of the pile-supported boardwalks along the Waterfront Trail may impact fisheries resources within the Oakland Inner Harbor. (S)

Construction of the proposed boardwalks under the bridges at Park Street, Fruitvale Avenue, and High Street has the potential to impact fisheries resources within the Oakland Inner Harbor. Specifically, pile driving activities could directly impact Pacific herring and migrating salmonids, as well as other native San Francisco Bay fish species protected under the Magnuson-Stevens Act (i.e., Essential Fish Habitat [EFH]). Pile driving can generate intense underwater sound pressure waves that may injure and kill fish.[35]

Mitigation Measure BIO-2 (Group 2): To avoid adverse impacts to Pacific herring, federally listed salmonids (chinook salmon, coho salmon, and steelhead), and EFH, pile driving shall occur within the June 1 to November 30 work window in accordance with NMFS guidelines.[36] Any pile driving occurring outside this period will require informal or formal consultation with the NMFS (for listed salmonids and EFH) and CDFG (for Pacific herring) prior to the Corps' issuance of a Section 404 permit for impacts to waters of the U.S. (LTS)

(2) Riparian Habitat. Although the proposed creek restoration activities will ultimately result in improved and increased riparian habitat throughout the Oakland watershed, short-term impacts may include removal and/or pruning of existing native riparian trees and shrubs.

Due to the programmatic level at which the City-wide Creeks project group is being evaluated, the number of existing riparian trees and/or shrubs that would be removed is unknown. However, it is anticipated that removal of some riparian vegetation would be necessary at some sites to accommodate re-grading of creek channels, bank stabilization, to allow for re-vegetation with native vegetation and other activities. Implementation of the City's Standard Conditions of Approval (Conditions 34, 69, 70, and 72) will reduce potential impacts to riparian habitat to a less-than-significant level.

(3) Wetlands. Most components within the Lake Merritt and Lake Merritt Channel group (i.e., 12th Street Reconstruction, Lakeshore Avenue/El Embarcadero, E. 18th Street Pier Overlook,

[35] Hanson, J., M. Helvey, and R. Strach, editors. 2003. Non-fishing Impacts to Essential Fish Habitat and Recommended Conservation Measures. National Marine Fisheries Service, Alaska Region, Northwest Region, Southwest Region. August.

[36] National Marine Fisheries Service (NMFS). San Francisco Bay Project Impact Evaluation System (PIES) website. <http://mapping.orr.noaa.gov/website/portal/pies/faqs.html> Accessed April 12, 2007.

Municipal Boathouse) have already obtained the proper regulatory permits (e.g., Corps permit, Water Board water quality certification, CDFG Lake or Streambed Alteration Agreement) for actions within or adjacent to waters of the U.S. and State. Proposed activities within the Waterfront Trail and City-wide Creeks groups have yet to obtain permits for potential impacts to waters of the U.S. and State, or BCDC approval, since planning has not yet been completed for these groups.

Impact BIO-3 (Groups 1, 2, and 4): Construction of some components within the Lake Merritt and Lake Merritt Channel, Waterfront Trail, and City-wide Creeks groups may impact waters of the U.S. and State. (S)

The proposed fixed pier boardwalks at Park Street, Fruitvale Avenue, and High Street along the Waterfront Trail would involve the square-drilling or driving of concrete piers within waters of the Oakland Inner Harbor, which is under the jurisdiction of the Corps, Water Board, and BCDC as waters of the U.S. and State. In addition, proposed restoration activities within the Oakland watershed would likely result in temporary, short-term impacts to waters of the U.S. and State.

> Mitigation Measure BIO-3a (Groups 1, 2, and 4): All Measure DD-funded activities within jurisdictional waters shall first obtain authorization from the appropriate agencies (Corps, Water Board, CDFG, and BCDC). At a minimum, each activity will likely require a Section 404 Corps permit and Section 401 water quality certification from the Water Board. Creek restoration activities may also require a CDFG Lake or Streambed Alteration Agreement, depending on site-specific conditions. Construction of the fixed pier boardwalks along the Waterfront Trail will require BCDC approval since it proposes construction over and filling of Bay waters (i.e., concrete piers). (LTS)
>
> Mitigation Measure BIO-3b (Groups 1, 2, and 4): Impacts to jurisdictional wetlands shall be mitigated at a minimum replacement ratio of 1:1 (i.e., one acre created [and preserved] for every acre impacted). If feasible, replacement habitat shall be created/preserved in the same general area as the original impact. Off-site mitigation may be approved if the amount of required replacement habitat exceeds that which is available near a given impact site. A wetland mitigation and monitoring plan (MMP) shall be developed for each mitigation site, detailing the mitigation design, wetland planting design, adaptive management, maintenance and monitoring requirements, reporting requirements, and success criteria for the created wetland(s). (LTS)

(4) Native Resident or Migratory Wildlife Movement, Wildlife Corridors, or Nursery Sites. Several species of migratory waterbirds have been observed using the Lake Merritt Channel during the winter (approximately October through March), often in flocks of 40 to 70 birds (e.g., scaup, common goldeneye). A 2004 study of waterbird use and disturbance response within Berkeley's Aquatic Park found that disturbance sensitivity was positively related to flock size, with large flocks flushing more readily than smaller ones.[37] Although no such studies have been conducted at the Lake Merritt Channel, LSA observed a flock of approximately 50 common goldeneyes swimming away from a group of schoolchildren crossing the pedestrian bridge during the January 19 site visit, indicating sensitivity to disturbance. Human-caused disturbance negatively affects wintering ducks by causing the expenditure of energy (i.e., flying or moving away from the source of

[37] Avocet Research Associates. 2005. Aquatic Park, Berkeley, California: Waterbird Population and Disturbance Study, 2004. Prepared for the City of Berkeley, California. May 12. 41 pp.

disturbance) that would otherwise be used for behaviors necessary for survival, such as resting or feeding.[38] Repeated or periodic disturbance would cause a greater expenditure of energy and thus have a greater effect on wintering birds than singular events.

Both construction activities and future recreational use of the Channel have the potential to disturb wintering waterfowl. Although most construction would occur outside of the wintering period during April through September, some may be conducted during the period when waterbirds are most abundant (approximately October through March). Construction activities at the Lake Merritt Channel (e.g., grading, demolition of existing culverts, tree removal) during this time would disturb waterbirds by causing them to fly away from loud noises and/or workers and equipment. However, because construction would occur nearly daily, except weekends, for several months the birds would likely relocate to nearby areas on Lake Merritt or the Oakland Estuary during this time rather than returning to the disturbed area. This temporary displacement of birds to nearby suitable habitat areas would be a less-than-significant impact.

Impact BIO-4 (Group 1): The introduction of small boat traffic to the Lake Merritt Channel would result in increased disturbance levels to wintering migratory ducks and other waterbirds. (S)

As discussed above, wintering ducks are sensitive to a variety of human-caused disturbances, including both motorized and non-motorized boat traffic. Based on a review of several thousand scientific journal articles and books, Korschgen and Dahlgren[39] identified four categories of human disturbance to ducks. The second-most disruptive category was defined as over-water movement with little noise (sailing, wind surfing, rowing, and canoeing). If kayaks, rowboats, and other such vessels were allowed to use the Lake Merritt Channel during the wintering period (October–March), they would create a new source of disturbance to wintering ducks and other waterbirds in the channel. Because disturbance of waterbirds by recreational users could happen multiple times each day the birds are likely to experience frequent episodes of hazing. Many of the birds would likely relocate to nearby areas on Lake Merritt or the Oakland Estuary, rather than returning to Lake Merritt Channel, thus greatly reducing the average number of waterbirds using Lake Merritt Channel. In addition, the potential disturbance would continue for the life of the project. Therefore, this impact would be significant.

> Mitigation Measure BIO-4 (Group 1): Small boat use of the Lake Merritt Channel shall be restricted to the non-wintering period of April–September, when waterbird abundance is low. During the closure period, booms shall be placed across the outlet to the Channel from Lake Merritt and at the 7th Street dam to prevent boat access and signs shall be posted indicating that the Channel is closed to recreational users. This would reduce the impact to a less-than-significant level. (LTS)

(5) Regional Conservation Plans. The area covered by the Measure DD Implementation Project is not currently subject to any adopted habitat conservation plans or natural community conservation plans.

---

[38] Korschgen, C. E., and R. B. Dahlgren. 1992. Human disturbances of waterfowl: causes, effects, and management. Fish and Wildlife Leaflet 13.2.15.

[39] Op. Cit.

(6) Protected Trees. In order to create additional parkland along the south shore of Lake Merritt and make other improvements around the Lake, approximately 259 trees, including 129 protected trees, would be removed and 521 new trees and other landscaping would be installed to replace them. Approximately 510 existing trees would be retained. Overall, the trees would be replaced at about a 2:1 ratio, that is, two trees would be planted for each tree removed. Table IV.F-3 summarizes proposed tree removals and new plantings by project component within the Lake Merritt and Lake Merritt Channel project group. As part of the project design process the City engaged a certified arborist to evaluate the trees proposed for removal in this group. The arborist recommended preserving five trees by redesigning the project or by relocating some of the trees. The City has incorporated these recommendations into the project and the numbers in Table IV.F-3 reflect the preservation of these trees. The arborist's report is provided in Appendix I.

Table IV.F-3: Proposed Tree Removals for the Lake Merritt and Lake Merritt Channel Project Group

Project Component	Trees to be Retained[a]	Trees Proposed for Removal	Protected Trees Proposed for Removal	New Trees to be Planted	Ratio of Trees Planted to Trees Removed
Lakeside Drive/Municipal Boathouse	30	20	17	65	3.25
Lakeshore Avenue/El Embarcadero	90	24	6	135	5.4
12th Street Reconstruction	50	157	90	321	2.0
Lake Merritt Channel	340	58	16	0[b]	0
TOTAL	**510**	**259**	**129[c]**	**521**	**2.0**

[a] Numbers of trees are approximate. Totals include trees recommended for preservation or relocation by the certified arborist.
[b] No new trees would be planted along the Channel because the habitat type would be converted from landscaped urban parkland to wetlands and open water.
[c] Includes eight protected oak trees.
Source: HortScience, 2007.

The City of Oakland's Tree Preservation and Removal Ordinance (OMC Chapter 12.36) requires a permit for removal of protected trees. A permit is also required if work might damage or destroy protected trees. The project would comply with the Tree Preservation and Removal Ordinance and would obtain permits for the removal of any protected trees. In addition, the City considers other factors in determining significance for purposes of CEQA including: the number, type, size, location and condition of the protected trees to be removed and/or impacted by construction and the protected trees to remain, with special consideration given to native trees, as discussed below.

The majority of protected trees to be removed are located in the 12th Street reconstruction area. Although protected trees are present in this area many of the trees are in poor or fair condition (see Appendix I); are in the landscaped median strip for 12th Street that is accessible only via rarely used pedestrian underpasses; or are in small planting strips within the parking lot for the Kaiser Convention Center (see Figure III-3). Most of the trees are non-native ornamental species. When the project components around Lake Merritt are looked at as a whole, about twice as many trees are retained in the project area as would be removed and approximately two trees would be planted for each tree removed. The new trees in the 12th Street reconstruction area would be part of proposed landscaped areas that would have direct pedestrian access to Lake Merritt and surrounding civic

buildings. The four components of Group 1 (Lakeside Drive/Municipal Boathouse, Lakeshore Avenue/El Embarcadero, and Lake Merritt Channel) either retain more trees than they would remove and/or plant at least twice as many new trees as would be removed (Lakeside Drive/Municipal Boathouse, Lakeshore Avenue/El Embarcadero, and 12th Street Reconstruction). Eight trees to be removed are protected native oak trees.

The project would not fundamentally conflict with the City of Oakland's Tree Preservation and Removal Ordinance and would therefore be a less-than-significant impact for the following reasons: approximately twice as many trees would be retained as would be removed; removed trees would be replaced at a 2:1 ratio; the majority of trees to be removed are in poor or fair condition; and many are located in a parking lot or an inaccessible median strip. In addition, because trees are being replaced at a 2:1 ratio many benefits lost by the removal of trees, such as aesthetics, energy conservation, reductions in stormwater runoff, improvements in air quality, and capture of carbon dioxide (a greenhouse gas) would be compensated for in a few years because of the large number of new trees being planted. The impacts of removing trees and the benefits of planting new trees in the Lake Merritt and Lake Merritt Channel group were estimated quantitatively using a computer application developed by scientists at the United States Department of Agriculture (USDA) Forest Service's Pacific Southwest Research Station to assess populations of street trees.[40] The results of this study are provided in Appendix I. Because the City would comply with the Tree Preservation and Removal Ordinance, the Lake Merritt and Lake Merritt Channel project components would have a less-than-significant impact. To reach this conclusion, the City considered the number, type, size, location and condition of the protected trees to be removed and/or impacted by construction and the protected trees to remain, including native trees.

A small number of protected trees may require removal as part of the Waterfront Trail, Recreational Facilities, City-wide Creeks groups or other components of the Lake Merritt group (e.g., the Cleveland Cascade). The trees would be replaced in accordance with the City's Tree Protection Ordinance and Standard Conditions of Approval (Condition 32), which would reduce the impact to a less-than-significant level.

(7) Creek Protection Ordinance. Some proposed project components within the Lake Merritt and Lake Merritt Channel, City-wide Creeks and Waterfront Trail groups would be subject to the City's Creek Protection Ordinance. These project components would comply with the requirements of the Creek Protection Ordinance and would be constructed in accordance with a Creek Protection Permit issued by the City. Creek Protection Permits have already been obtained for the Lakeshore Avenue/El Embarcadero and East 18th Street Pier Overlook project components, for example.

Proposed project activities for creek sites range from manual activities such as hand planting, tree pruning or weed abatement, which would have no or minimal impacts, to activities that use heavy machinery such as creek bed or bank grading, culvert or concrete channel alterations, and creek realignment, as noted in Section III.C.4 of the Project Description. No mitigation is needed for manual activities with minimal impacts. For those activities that involve heavy machinery or equipment to excavate or move soil, to demolish structures, or to realign stream banks or waterways,

[40] USDA Forest Service. http://www.itreetools.org/street_trees/introduction_step1.shtm.

the City's Standard Conditions of Approval (Conditions 69 through 73) would ensure compliance with the Creek Protection Ordinance and reduce impacts to a less-than-significant level.

Creek Protection Permits will include requirements to minimize erosion and sedimentation in accordance with the Manual of Standards for Erosion and Sediment Control Measures, [41] as well as the mitigation measures described in Section IV.F.2.b, above (as applicable). In addition, Creek Protection Permits will require the preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP) and C3 requirements pursuant to Water Board requirements. With the incorporation of these requirements into project approvals, proposed project components would have a less-than-significant impact on City creeks or other areas subject to the Creek Protection Ordinance.

[41] Association of Bay Area Governments. 1995. *Manual of Standards for Erosion and Sediment Control Measures.* Second edition. Association of Bay Area Governments, Oakland, California. 422 pp.

PLANS FOR THE SAUSAL CREEK RESTORATION PROJECT IN DIMOND PARK

FUNDED BY MEASURE DD BOND FUNDS

CITY PROJECT NO. C244811

CALL BEFORE YOU DIG
UNDERGROUND SERVICE ALERT
800–227–2600

THE CONTRACTOR SHALL NOTIFY UNDERGROUND SERVICE ALERT AND THE CITY PUBLIC WORKS AGENCY AT LEAST 48 HOURS (2 WORKING DAYS) PRIOR TO BEGINNING ANY EXCAVATION IN THE VICINITY OF UNDERGROUND FACILITIES.

INDEX OF DRAWINGS

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4	C-1.2	CIVIL SURVEY UPSTREAM
5	L-1.1	DEMOLITION & TREE PROTECTION DOWNSTREAM
6	L-1.2	DEMOLITION & TREE PROTECTION UPSTREAM
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8	L-2.2	LAYOUT UPSTREAM
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40	RR-E3	ELECTRICAL ALTERNATE #1: SINGLE LINE DIAGRAM AND ELECTRICAL PLAN
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CLIENT:

CITY OF OAKLAND:
KRISTIN HATHAWAY, CSM,
WATERSHED PROGRAM SPECIALIST
CITY OF OAKLAND - PUBLIC WORKS AGENCY
250 FRANK OGAWA PLAZA, SUITE 4314
OAKLAND, CA 94612
(510) 238-7571

CONSULTANTS:

LANDSCAPE ARCHITECTURE AND ENGINEERING:
RESTORATION DESIGN GROUP, LLC
BOB BIRKELAND, ASLA
2612B EIGHTH STREET
BERKELEY, CA 94710
(510) 644-2798

GEOTECHNICAL:
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COREY T. DARE, P.E., G.E.
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OAKLAND, CA 94607
(510) 268-0461

STRUCTURAL ENGINEERING:
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(510) 922-9888

SITE SURVEY:
ALAMEDA COUNTY PUBLIC WORKS AGENCY
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HAYWARD, CA 94544
(510) 670-5480

RESTROOM AREA SURVEY:
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1721 BROADWAY, SUITE 201
OAKLAND, CA 94612
(510) 873-8866

RESTROOM ARCHITECTURE:
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LORNA DARE, LEED AP
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(510) 444-7959

RESTROOM STRUCTURAL ENGINEERING:
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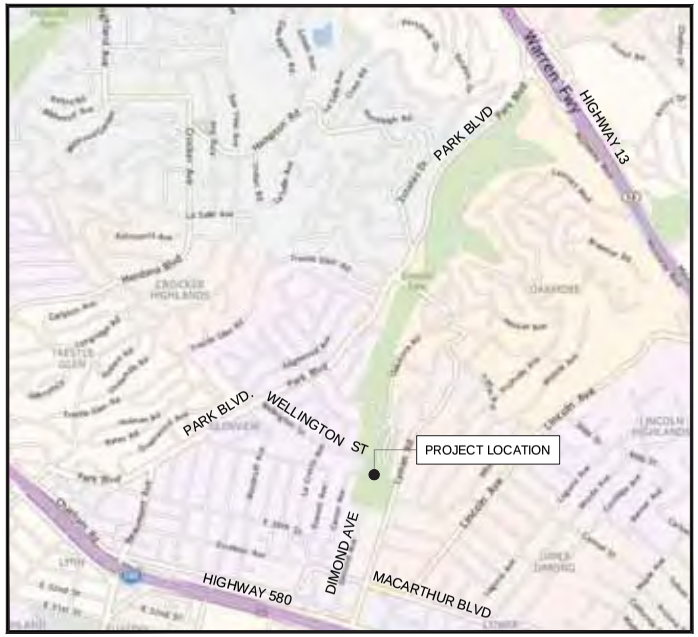
HOLLY RAZZANO / PARDEEP JHUTTI
1300 CLAY STREET, SUITE 900
OAKLAND, CA 94612
(510) 272-9040

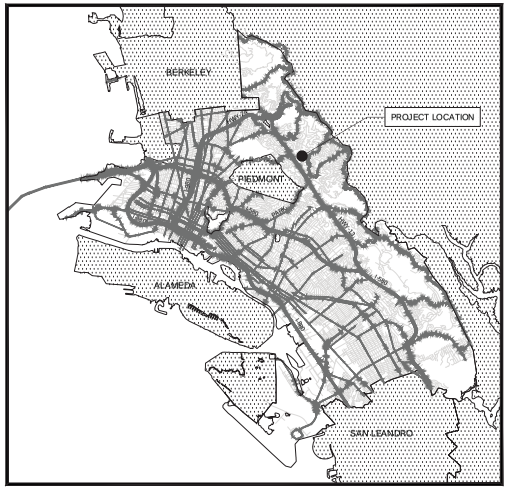
RESTROOM MECHANICAL ENGINEERING:
MCCRACKEN & WOODMAN, INC.
MARC WOODMAN
355 GRAND AVENUE
OAKLAND, CA 94610
(510) 763-4891

RESTROOM ELECTRICAL ENGINEERING:
ZEIGER ENGINEERS, INC.
RON ZEIGER
478 3RD STREET
OAKLAND, CA 94607
(510) 452-9391

LOCATION MAP



CITY OF OAKLAND MAP



MICHAEL NEARY, P.E.
ASSISTANT DIRECTOR, PWA
DEPARTMENT OF ENGINEERING AND CONSTRUCTION

No.	BY	DATE	REFERENCE

BB	CHECKER
BB / ES	DESIGNER
ES / JS / PR	DRAFTER

CITY OF OAKLAND
DEPARTMENT OF ENGINEERING AND CONSTRUCTION
250 FRANK H. OGAWA PLAZA
SUITE 4314
OAKLAND, CA 94612
(510) 238-7659
FAX (510) 238-7238

ENGINEERING AND RIGHT-OF-WAY DIVISION
DIVISION MANAGER

WATERSHED AND STORMWATER MANAGEMENT PROGRAM
WATERSHED PROGRAM SUPERVISOR

WATERSHED AND STORMWATER MANAGEMENT PROGRAM
PROJECT MANAGER

CITY ADMINISTRATOR'S OFFICE
CITY ADA COORDINATOR

PWA INFRASTRUCTURE AND OPERATIONS
ASSISTANT DIRECTOR

PWA FACILITIES & ENVIRONMENT
ASSISTANT DIRECTOR

OFFICE OF PARKS AND RECREATION
DIRECTOR

BID SET

NOT FOR CONSTRUCTION

PROJECT NO.
C244811

SCALE: NTS
DATE: SEPTEMBER 7, 2012

SHEET NO. T-1
1 OF 41

PROJECT NAME

DRAWING NAME: S:\Projects\Sausal Creek – Dimond Park\@ AutoCAD\Working Drawings\L5–Cover.dwg
PLOT DATE: 09–06–12
PLOTTED BY: Peter

GENERAL NOTES

1. THE CONTRACTOR AGREES THAT, IN ACCORDANCE WITH GENERALLY ACCEPTED CONSTRUCTION PRACTICES, THE CONTRACTOR WILL BE REQUIRED TO ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THE PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY. THIS REQUIREMENT SHALL BE MADE TO APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS. THE CONTRACTOR FURTHER AGREES TO DEFEND, INDEMNIFY, AND HOLD CITY AND ENGINEER HARMLESS FROM ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXEMPTING LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF THE CITY OF OAKLAND OR THE ENGINEER.
2. THE CONTRACTOR SHALL TAKE EFFECTIVE ACTION TO PREVENT THE FORMATION OF AN AIRBORNE DUST NUISANCE AND SHALL BE RESPONSIBLE FOR ANY DAMAGE RESULTING FROM FAILURE TO DO SO (SEE SPECIAL PROVISIONS SECTION 7–8).
3. THE CONTRACTOR SHALL PROVIDE ALL LIGHTS, SIGNS, BARRICADES, FLAGGERS OR OTHER DEVICES NECESSARY TO PROVIDE FOR SAFETY (SEE SPECIAL PROVISIONS SECTION 7–10.1.4).
4. CITY OF OAKLAND DOES NOT SPECIFY THE USE OR INSTALLATION OF ANY MATERIAL OR EQUIPMENT WHICH IS MADE FROM, OR WHICH CONTAINS ASBESTOS FOR USE IN THE CONSTRUCTION OF THESE IMPROVEMENTS. ANY PARTY INSTALLING OR USING SUCH MATERIALS OR EQUIPMENT SHALL BE SOLELY RESPONSIBLE FOR ALL INJURIES, DAMAGES, OR LIABILITIES OF ANY KIND, CAUSED BY THE USE OF SUCH MATERIALS OR EQUIPMENT. THE PROVISIONS OF THIS NOTE SHALL APPLY UNLESS THEY ARE EXPRESSLY WAIVED IN WRITING BY THE CITY.
5. THE CONTRACTOR SHALL MEET AND FOLLOW ALL REQUIREMENTS IN EFFECT AT THE TIME OF CONSTRUCTION AS STATED IN SPECIAL PROVISIONS SECTION 7–8.6 FOR WATER POLLUTION CONTROL.
6. DURING CONSTRUCTION, THE PUBLIC STREETS SHALL BE CLEANED AS OFTEN AS REQUIRED TO REMOVE ANY ACCUMULATION OF DEBRIS RESULTING FROM THIS CONSTRUCTION.
7. THE CONTRACTOR SHALL DESIGN, CONSTRUCT AND MAINTAIN ALL SAFETY DEVICES, INCLUDING SHORING, AND SHALL BE RESPONSIBLE FOR CONFORMANCE TO ALL LOCAL, STATE, AND FEDERAL SAFETY AND HEALTH STANDARD, LAWS AND REGULATIONS (SEE SPECIAL PROVISIONS SECTION 7–10.4).
8. THE CONTRACTOR SHALL PROVIDE THE PROJECT MANAGER WITH A REDLINED COPY OF "AS–BUILT" PLANS FOR PREPARATION OF RECORD DRAWINGS IN ACCORDANCE WITH THE SPECIFICATIONS. SEE SPECIFICATIONS FOR MORE AS–BUILT REQUIREMENTS (SEE SPECIAL PROVISIONS SECTION 9–4).
9. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO IMMEDIATELY NOTIFY THE ENGINEER UPON DISCOVERY OF ANY FIELD CONFLICTS (SEE SPECIAL PROVISIONS SECTION 5).
10. ANY DEVIATIONS OR CHANGES IN THESE PLANS SHALL BE MADE WITH THE APPROVAL OF THE PROJECT MANAGER.
11. SHOULD IT APPEAR THAT THE WORK TO BE DONE OR ANY MATTER RELATIVE THERETO IS NOT SUFFICIENTLY DETAILED OR EXPLAINED ON THESE PLANS, THE CONTRACTOR SHALL CONTACT THE PROJECT MANAGER.
12. DIMENSIONS SHALL TAKE PRECEDENCE OVER GENERAL NOTES AND TYPICAL DETAILS.
13. NOTES AND DETAILS ON SPECIFIC DETAIL DRAWINGS SHALL TAKE PRECEDENCE OVER GENERAL NOTES AND TYPICAL DETAILS.
14. WHERE THERE IS A DISCREPANCY BETWEEN THE WRITTEN DIMENSION AND SCALED DIMENSION, WRITTEN DIMENSIONS SHALL GOVERN.
15. ALL DISCREPANCIES BETWEEN THE INFORMATION SHOWN ON THE DRAWINGS AND THE ACTUAL FIELD CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE O.R.
16. THE LOCATION AND GENERAL ARRANGEMENT OF UTILITIES, STRUCTURES, AND APPURTENANCES WHERE SHOWN, ARE DIAGRAMMATIC AND SUBJECT TO VERIFICATION AND ADJUSTMENT IN THE FIELD.

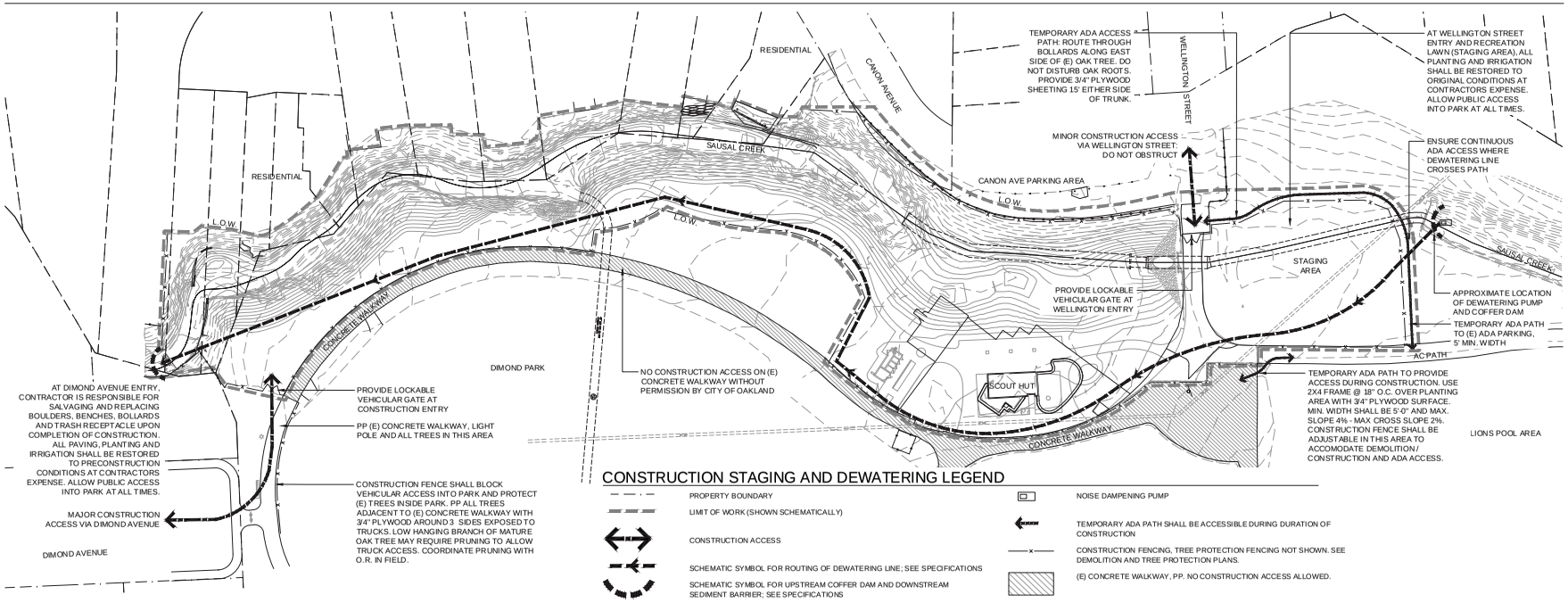
PROJECT NOTES

1. OWNER: CITY OF OAKLAND (CITY)
   PROJECT MANGER: KRISTIN HATHAWAY
   250 FRANK H. OGAWA PLAZA, STE 4314
   OAKLAND, CA 94602
   PHONE: (510) 238–7571
2. CITY & COUNTY: CITY OF OAKLAND
3. SANITARY SEWER: CITY OF OAKLAND
4. STORM DRAIN: CITY OF OAKLAND
5. WATER: EBMUD
6. GAS & ELECTRICAL: PG&E
7. TELEPHONE SERVICE: PACBELL/ATT
8. ALL APPLICABLE IMPROVEMENTS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE PROVISIONS OF THE CURRENT CITY OF OAKLAND ORDINANCE CODES, AND CITY OF OAKLAND STANDARD PLANS. ALL IMPROVEMENTS ARE SUBJECT TO INSPECTION AND APPROVAL BY THE CITY OF OAKLAND. THE CONTRACTOR SHALL CONTACT THE CITY AT LEAST TWO (2) WORKING DAYS PRIOR TO THE START OF ANY WORK TO ARRANGE FOR INSPECTION.
9. THE CONTRACTOR SHALL BE HELD RESPONSIBLE FOR ANY FIELD CHANGES MADE WITHOUT WRITTEN AUTHORIZATION FROM THE ENGINEER. ALL REVISIONS TO THESE PLANS MUST BE REVIEWED BY THE ENGINEER PRIOR TO CONSTRUCTION AND SHALL BE ACCURATELY SHOWN ON REVISED PLANS SIGNED BY THE ENGINEER.
10. PRIOR TO MOVING ANY MATERIAL TO OR FROM THE SITE, THE CONTRACTOR SHALL OBTAIN APPROVAL FOR HAUL ROUTE FROM THE ENGINEER.
11. ALL CONSTRUCTION ACTIVITIES ON THE PROJECT SITE SHALL BE LIMITED TO HOURS AND DAYS IN ACCORDANCE WITH SECTION 7–10.1.2 FOR RESTRICTED HOURS OF OPERATION AND STREETS, UNLESS ALTERNATIVE HOURS ARE APPROVED BY ENGINEER. CONSTRUCTION EQUIPMENT, INCLUDING COMPRESSORS, GENERATORS, AND MOBILE EQUIPMENT, SHALL BE FITTED WITH PROPERLY WORKING MUFFLERS.
12. ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE REQUIREMENTS AND RECOMMENDATIONS CONTAINED ON THE PLANS AND IN THE CONTRACT DOCUMENTS.

CREEK PROTECTION AND EROSION CONTROL NOTES

1. THE CONTRACTOR SHALL MEET AND FOLLOW ALL REQUIREMENTS IN EFFECT AT THE TIME OF CONSTRUCTION AS STATED IN SPECIAL PROVISIONS SECTION 7–8.6 FOR WATER POLLUTION CONTROL.
2. ALL GRADING WORK SHALL COMMENCE AFTER APRIL 15TH AND END BEFORE OCTOBER 15TH.
3. NO WORK SHALL BE CONDUCTED DURING WET WEATHER OR IF WATER IS PRESENT IN THE CREEK.
4. PRIOR TO ANY RAINSTORMS, ALL WORK AREAS, MATERIALS STOCK PILES, AND STAGING AREAS SHALL BE WINTERIZED TO PREVENT EROSION OR IMPAIRMENT OF WATER QUALITY.
5. BEST MANAGEMENT PRACTICES (BMP'S) FOR STORMWATER POLLUTION CONTROL HAVE BEEN DESIGNATED FOR THIS PROJECT AS FOLLOWS. SEE PROJECT SPECIFICATIONS AND SWPPP.
   - 5.1. STABILIZED CONSTRUCTION ENTRANCE, PER CALTRANS TC–1, TYPE 1
   - 5.2. PRESERVE AND PROTECT EXISTING VEGETATION, SEE DEMOLITION AND TREE PROTECTION PLAN
   - 5.3. SILT FENCE, SEE PROJECT SWPPP
   - 5.4. GRAVEL BAGS, SEE PROJECT SWPPP
   - 5.5. PERMANENT PLANTING, SEE REVEGETATION PLAN
   - 5.6. SOIL BIOENGINEERING, SEE REVEGETATION PLAN
   - 5.7. HYDROSEEDING, SEE REVEGETATION PLAN
   - 5.8. EROSION CONTROL FABRIC, SEE PLANS AND SPECIFICATIONS
   - 5.9. MULCHING, SEE PLANS AND SPECIFICATIONS
   - 5.6. INSPECTION AND CLEANING
   - 5.7. MATERIAL USE, DELIVERY AND STORAGE
   - 5.8. SPILL PREVENTION
   - 5.9. SOLID WASTE MANAGEMENT
   - 5.10. VEHICLE AND EQUIPMENT CLEANING, MAINTENANCE, FUELING

CONSTRUCTION STAGING AND DEWATERING DIAGRAM



CONSTRUCTION STAGING AND DEWATERING LEGEND

- PROPERTY BOUNDARY
- LIMIT OF WORK (SHOWN SCHEMATICALLY)
- CONSTRUCTION ACCESS
- SCHEMATIC SYMBOL FOR ROUTING OF DEWATERING LINE; SEE SPECIFICATIONS
- SCHEMATIC SYMBOL FOR UPSTREAM COFFER DAM AND DOWNSTREAM SEDIMENT BARRIER; SEE SPECIFICATIONS
- NOISE DAMPENING PUMP
- TEMPORARY ADA PATH SHALL BE ACCESSIBLE DURING DURATION OF CONSTRUCTION
- CONSTRUCTION FENCING, TREE PROTECTION FENCING NOT SHOWN. SEE DEMOLITION AND TREE PROTECTION PLANS.
- (E) CONCRETE WALKWAY, P.P. NO CONSTRUCTION ACCESS ALLOWED.

DATE	NO.	REVISIONS

DESIGN BY: BB / ES
DRAWN BY: JS / ES / PR
CHECKED BY: BB
SCALE: 1"=30'
DATE: SEPTEMBER 7, 2012

Restoration Design Group, LLC
2612 Eighth Street, Suite B
Berkeley, CA 94710
T 510.644.2798 F 510.644.2799
www.restorationdesigngroup.com

SAUSAL CREEK
RESTORATION PROJECT IN DIMOND PARK

BID SET

GENERAL NOTES, CONSTRUCTION STAGING AND DEWATERING PLAN

SHEET
T-2

SAUSAL CREEK: BID SET CONSTRUCTION DOCUMENTS - S:\PROJECTS\SAUSAL CREEK - DIMOND PARK\AUTOCAD\WORKING DRAWINGS\CONTROL\T-2

Survey Symbol Legend and Alpha Codes

NOTE: SYMBOLS ARE NTS

Category: Traffic

ARROW LEFT	TAL
ARROW RIGHT	TAR
ARROW STRAIGHT	TAS
ARROW STRAIGHT AND LEFT	TASL
ARROW STRAIGHT AND RIGHT	TASR
OTHER	TB
GUARDRAIL	TBG
K-RAIL	TBK
PED BARRICADE	TBP
WHEELBLOCK	TBW
DETECT/CONTROL PULLBOX	TCB
DETECT/CONTROL CABINET	TCC
DETECT/CONTROL HOLE (RND LID)	TCH
DETECTOR LOOP	TDL
GENERAL	TL
BROKEN	TLB
CROSSWALK	TLC
DOUBLE YELLOW	TLD
LIMIT	TLL
PARKING	TLP
REFLECTOR BOTS DOTS	TLR
WHITE LINE	TLW
YELLOW LINE	TLY
OTHER	TM
AHEAD	TMA
BUMP	TMB
HUMP	TMH
LEFT	TML
ONLY	TMO
PEDESTRIAN	TMP
RIGHT	TMR
RAILROAD XING	TMRR
STOP	TMS
SCHOOL	TMSC
TURN	TMT
XING	TMX
YIELD	TMY
POST/POLE MISC	TP
BOLLARD	TPB
DELINEATOR	TPD
ELECTROLIER	TPE
STREET LAMP	TPL
MILE POST	TPM
PARKING METER	TPP
TRAFFIC SIGNAL	TPS
XING SIGNAL/BUTTON POLE	TPX
SIGN OTHER	TS
SIGN ARROW	TSA
SIGN CONSTRUCTION (TEMP)	TSC
SIGN GUIDE (GREEN)	TSG
SIGN INFO (BLUE/RN)	TSI
SIGN SPEED LIMIT	TSL
SIGN NO PARKING	TSN
SIGN REGULATORY	TSR
SIGN STOP	TSS
SIGN STREET	TST
SIGN WARNING	TSW
SIGN YIELD	TSY

Category: Utilities

CATV OTHER	UC
CATV PULLBOX	UCB
CATV OVERHEAD	UCO
ELECTRIC OTHER	UE
ELECTRIC PULLBOX	UEB
ELECTRIC MANHOLE	UEH
ELECTRIC TOWER	UET
ELECTRIC VAULT	UEV
ELECTRIC OVERHEAD	UEO
ELECTRIC UNDERGROUND MARK	UEU
GAS OTHER	UG
STL/ANODE	UGE
GAS METER	UGM
GAS MARKING POST	UGP
GAS VALVE	UGV
GAS UNDERGROUND MARK	UGU
IRRIGATION OTHER	UI
IRRIGATION BOX	UIB
IRRIGATION BACKFLOW PREVENTER	UIF
SPRINKLER	UIS
IRRIGATION VALVE	UIV
IRRIGATION UNDERGROUND MARK	UIU
GUY WIRE	UJG
GUY POLE	UJGP
JOINT POLE	UJP
OVERHEAD	UJO
JOINT UNDERGROUND MARK	UJU
SEWER OTHER	US
SEWER CLEANOUT	USC
SEWER MANHOLE	USH
SEWER INVERT	USI
SEWER PIPE FL (VCP)	USP
SEWER UNDERGROUND MARK	USU
TELEPHONE OTHER	UT
TELEPHONE PULLBOX	UTB
TELEPHONE MANHOLE	UTH
TELEPHONE OVERHEAD	UTO
TELEPHONE POLE	UTP
TELEPHONE VAULT	UTV
TELEPHONE UNDERGROUND MARK	UTU
UNKNOWN	UU
UNKNOWN BOX	UUB
UNKNOWN HOLE	UUH
UNKNOWN VAULT	UUV
WATER OTHER	UW
AIRVALVE	UWA
WATER BLOWOFF	UWB
DRINKING FOUNTAIN	UWD
ETS	UWE
FAUCET/SPIGOT	UWF
WATER MANHOLE	UWH
WATER METER	UWM
WATER MARKING POST	UWP
WATER UNDERGROUND MARK	UWU
WATER VALVE	UWV
FIRE HYDRANT	UWY

Category: Survey

POINT FOUND:	
OTHER	SF
BOX W/TPN	SFBB
BENCHMARK	SFBM
CHISELED T	SFCT
CHISELED X	SFCX
MON DISK W/NIPPLE	SFDN
MON DISK W/PUNCH	SFDP
FLIGHT CROSS	SFFC
G1 PISTON	SFG1
DINNY AND TACK	SFDT
HUB AND TACK	SFHT
IRON BOLT	SFIB
IRON PIPE	SFIP
NAIL	SFN
NAIL AND SHINER	SFNS
PK NAIL	SFPN
PIPE AND TAG	SFPT
REBAR	SFRB
RAILROAD SPIKE	SFRR
STAKE AND TACK	SFST
SCRIBED X	SFSX
T-SPIKE	SFTS
TOBELL POINT	SFTB
MON WELL, DISK W/NIPPLE	SFWDN
MON WELL, DISK W/ PUNCH	SFWDP
MON WELL, PIN	SFWP
POINT SET:	
BENCHMARK	SSBM
CHISELED T	SSCT
CHISELED X	SSCX
MON DISK W/ NIPPLE	SSDN
MON DISK W/ PUNCH	SSDP
FLIGHT CROSS	SSFC
G1 PISTON	SSG1
DINNY AND TACK	SSDT
HUB AND TACK	SSHT
IRON BOLT	SSIB
IRON PIPE	SSIP
NAIL	SSN
NAIL AND SHINER	SSNS
PK NAIL	SSPN
PIPE AND TAG	SSPT
REBAR	SSRB
RAILROAD SPIKE	SSRR
STAKE AND TACK	SSST
SCRIBED X	SSSX
T-SPIKE	SSTS
MON WELL, DISK W/ NIPPLE	SSWDN
MON WELL, DISK W/ PUNCH	SSWDP
MON WELL, DISK W/ PIN	SSWP

Category: Drainage

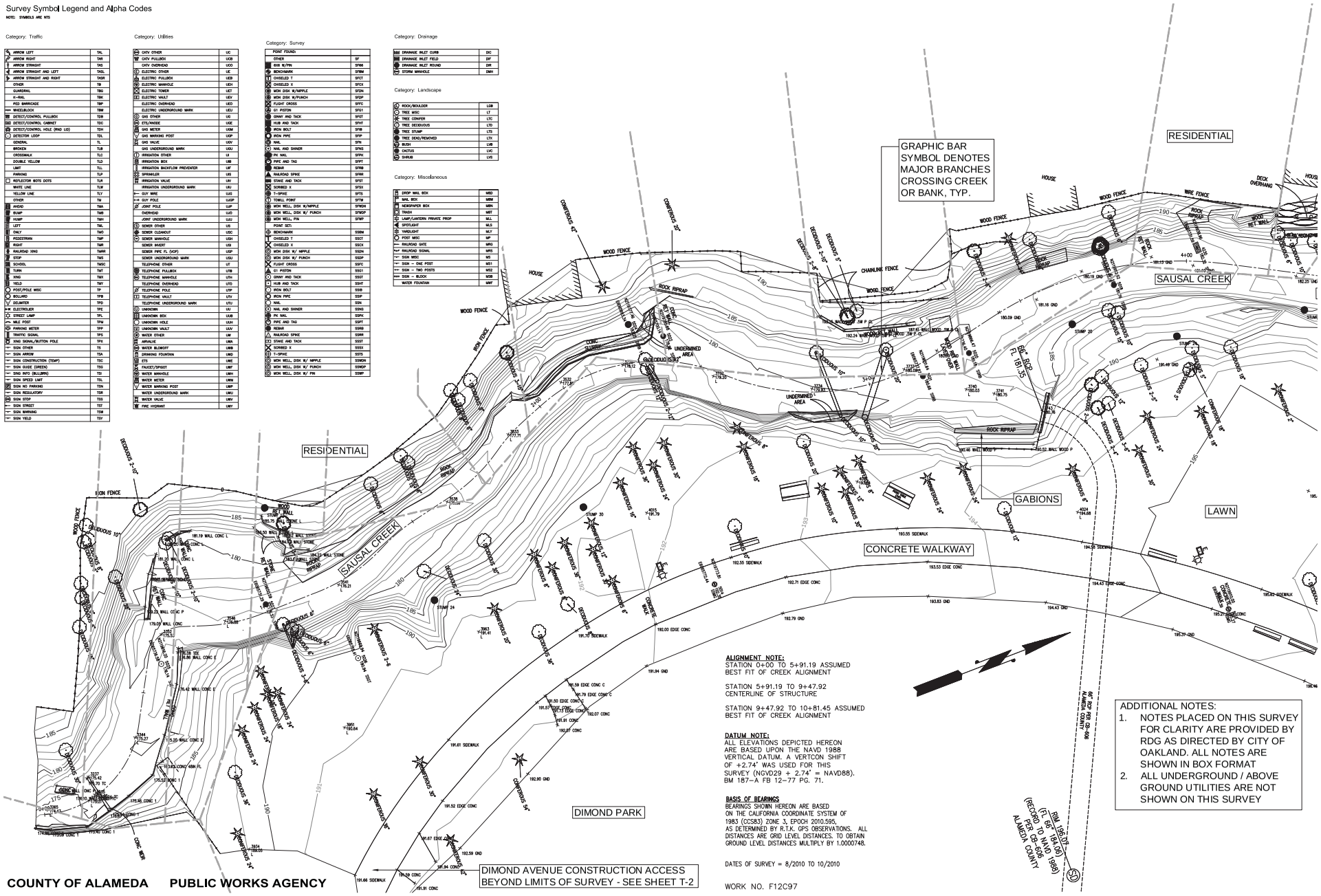
DRAINAGE INLET CURB	DIC
DRAINAGE INLET FIELD	DIF
DRAINAGE INLET ROUND	DIR
STORM MANHOLE	DMH

Category: Landscape

ROCK/BOULDER	LOB
TREE MISC	LT
TREE CONIFER	LTC
TREE DECIDUOUS	LTD
TREE STUMP	LTS
TREE DEAD/REMOVED	LTX
BUSH	LVB
CACTUS	LVC
SHRUB	LVS

Category: Miscellaneous

DROP MAIL BOX	MBD
MAIL BOX	MBM
NEWSPAPER BOX	MBN
TRASH	MBT
LAMP/LANTERN PRIVATE PROP	MLL
SPOTLIGHT	MLS
TAPELIGHT	MLT
POST MISC	MP
RAILROAD GATE	MRG
RAILROAD SIGNAL	MRS
SIGN MISC	MS
SIGN – ONE POST	MS1
SIGN – TWO POSTS	MS2
SIGN – BLOCK	MSB
WATER FOUNTAIN	MWF



COUNTY OF ALAMEDA PUBLIC WORKS AGENCY

DATE	NO.	REVISIONS

DESIGN BY
DRAWN BY
CHECKED BY
SCALE 1" = 10'
DATE 12-08-10

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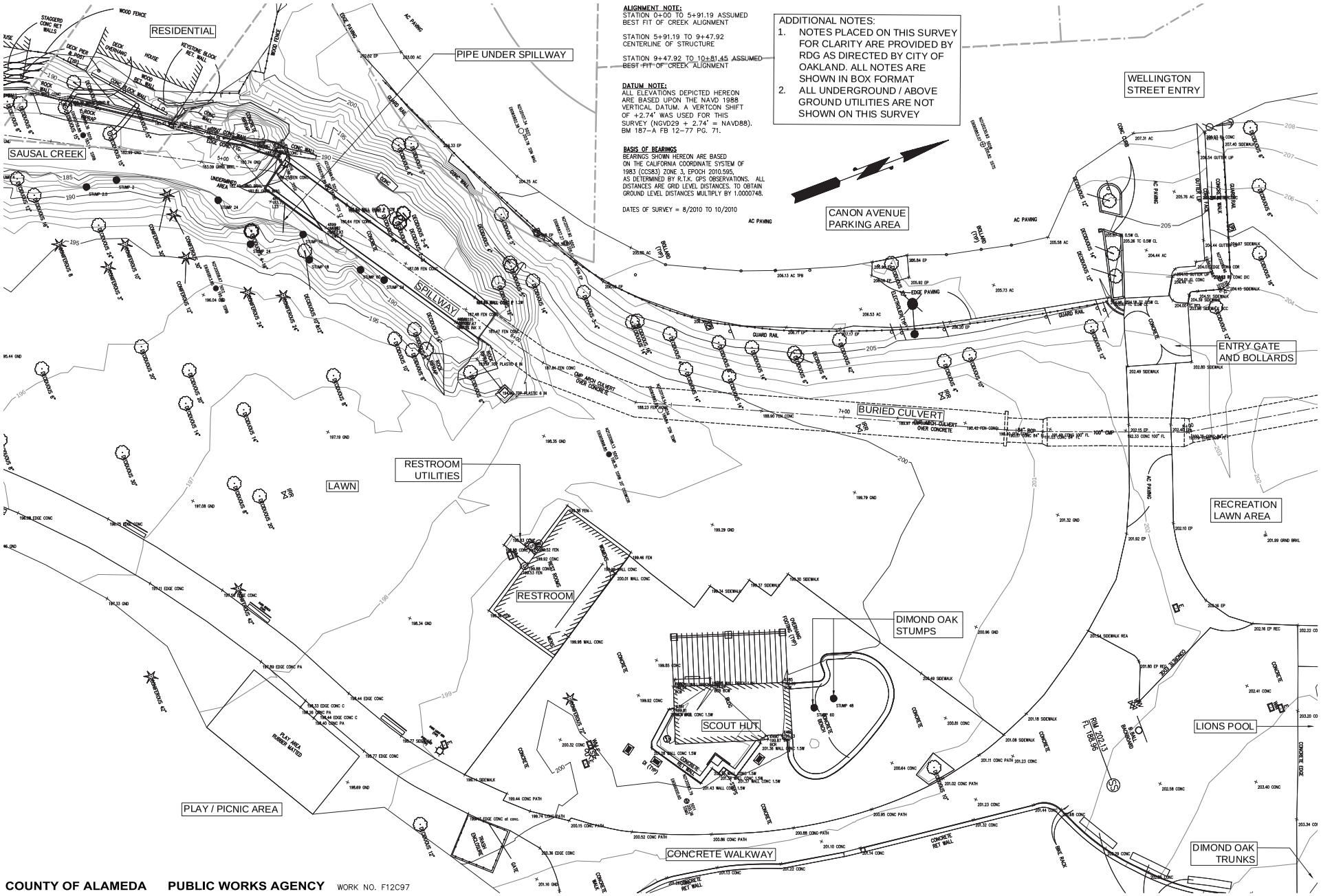
SAUSAL CREEK
RESTORATION PROJECT IN DIMOND PARK

BID SET

SURVEY DOWNSTREAM

SHEET C-1.1

SAUSAL CREEK: BID SET CONSTRUCTION DOCUMENTS - S:\PROJECTS\SAUSAL CREEK - DIMOND PARK\ AUTOCAD\WORKING DRAWINGS\L-SURVEY.DWG
PLOTTED ON: 9/6/2012



ALIGNMENT NOTE:
STATION 0+00 TO 5+91.19 ASSUMED BEST FIT OF CREEK ALIGNMENT

STATION 5+91.19 TO 9+47.92 CENTERLINE OF STRUCTURE

STATION 9+47.92 TO 10+81.45 ASSUMED BEST FIT OF CREEK ALIGNMENT

DATUM NOTE:
ALL ELEVATIONS DEPICTED HEREON ARE BASED UPON THE NAVD 1988 VERTICAL DATUM. A VERTCON SHIFT OF +2.74' WAS USED FOR THIS SURVEY (NGVD29 + 2.74' = NAVD88). BM 187–A FB 12–77 PG. 71.

BASIS OF BEARINGS
BEARINGS SHOWN HEREON ARE BASED ON THE CALIFORNIA COORDINATE SYSTEM OF 1983 (CCS83) ZONE 3, EPOCH 2010.595, AS DETERMINED BY R.T.K. GPS OBSERVATIONS. ALL DISTANCES ARE GRID LEVEL DISTANCES. TO OBTAIN GROUND LEVEL DISTANCES MULTIPLY BY 1.0000748.

DATES OF SURVEY = 8/2010 TO 10/2010

ADDITIONAL NOTES:
1. NOTES PLACED ON THIS SURVEY FOR CLARITY ARE PROVIDED BY RDG AS DIRECTED BY CITY OF OAKLAND. ALL NOTES ARE SHOWN IN BOX FORMAT
2. ALL UNDERGROUND / ABOVE GROUND UTILITIES ARE NOT SHOWN ON THIS SURVEY

COUNTY OF ALAMEDA **PUBLIC WORKS AGENCY** WORK NO. F12C97

DATE	NO.	REVISIONS

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DRAWN BY
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SCALE 1" = 10'
DATE 12-08-10

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SAUSAL CREEK
RESTORATION PROJECT IN DIMOND PARK

BID SET

SURVEY UPSTREAM

SHEET C-1.2

SAUSAL CREEK: BID SET CONSTRUCTION DOCUMENTS - S:\PROJECTS\SAUSAL CREEK - DIMOND PARK\ AUTOCAD\WORKING DRAWINGS\L-SURVEY.DWG
PLOTTED ON: 9/6/2012

DEMOLITION LEGEND

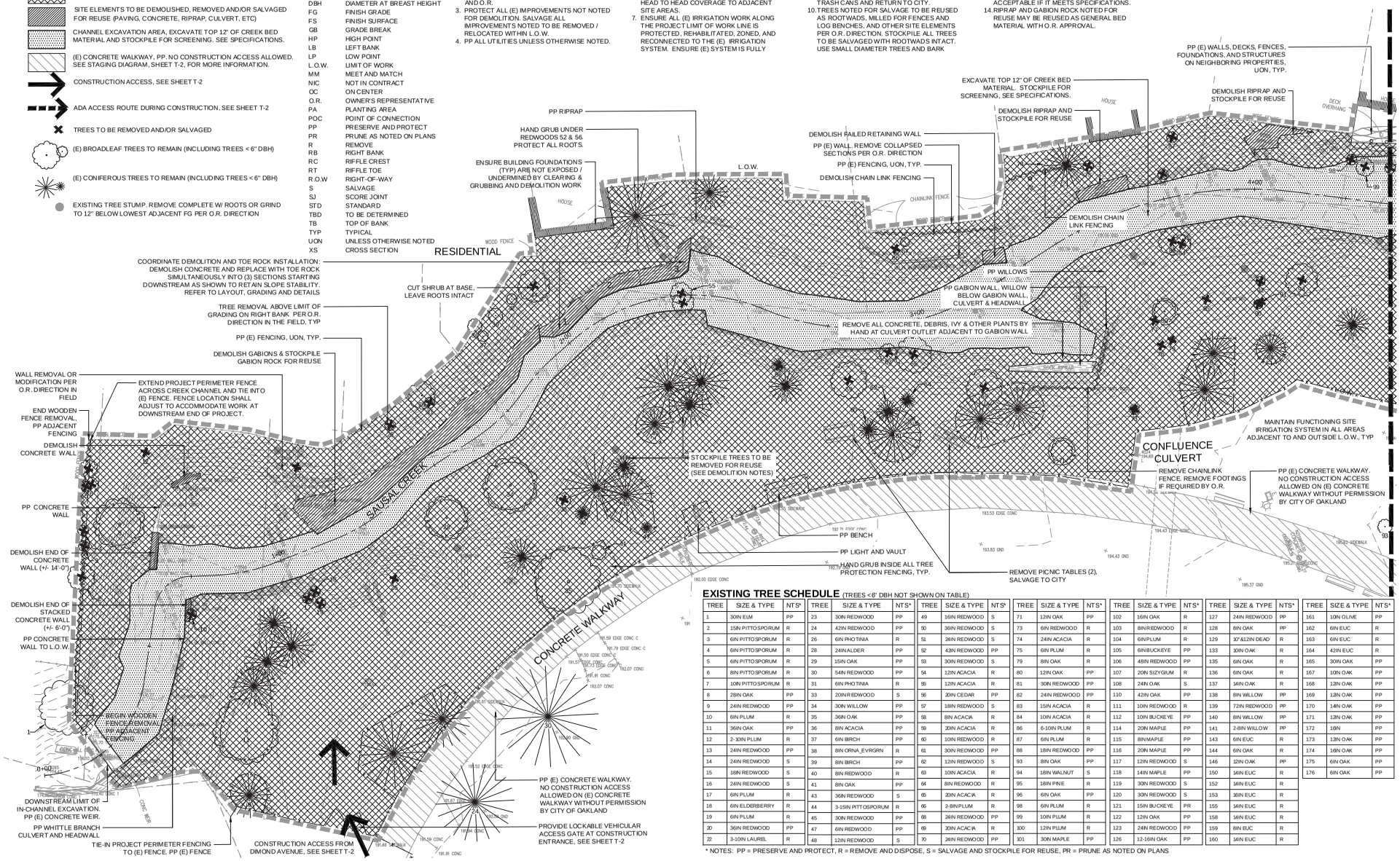
- PROPERTY BOUNDARY
- LIMIT OF WORK (SHOWN SCHEMATICALLY)
- PROJECT PERIMETER FENCE / TREE PROTECTION FENCE
- FENCING, GATES AND FOOTINGS TO BE REMOVED / SALVAGED FOR REUSE (SEE DEMOLITION NOTES)
- AREA TO BE CLEARED AND GRUBBED (SEE DEMOLITION NOTES).
- SITE ELEMENTS TO BE DEMOLISHED, REMOVED AND/OR SALVAGED FOR REUSE (PAVING, CONCRETE, RIPRAP, CULVERT, ETC)
- CHANNEL EXCAVATION AREA, EXCAVATE TOP 12" OF CREEK BED MATERIAL AND STOCKPILE FOR SCREENING. SEE SPECIFICATIONS.
- (E) CONCRETE WALKWAY, PP. NO CONSTRUCTION ACCESS ALLOWED. SEE STAGING DIAGRAM, SHEET T-2, FOR MORE INFORMATION.
- CONSTRUCTION ACCESS, SEE SHEET T-2
- ADA ACCESS ROUTE DURING CONSTRUCTION, SEE SHEET T-2
- TREES TO BE REMOVED AND/OR SALVAGED
- (E) BROADLEAF TREES TO REMAIN (INCLUDING TREES < 6" DBH)
- (E) CONIFEROUS TREES TO REMAIN (INCLUDING TREES < 6" DBH)
- EXISTING TREE STUMP. REMOVE COMPLETE W/ ROOTS OR GRIND TO 12" BELOW LOWEST ADJACENT FG PER O.R. DIRECTION

ABBREVIATIONS

AC	ASPHALT CONCRETE
BB	BOTTOM OF BANK
CLR	CLEAR
℄	CENTERLINE
DI	DRAIN INLET
EC	EDGE OF BANKFULL CHANNEL
(E)	EXISTING
EJ	EXPANSION JOINT
DBH	DIAMETER AT BREAST HEIGHT
FG	FINISH GRADE
FS	FINISH SURFACE
GB	GRADE BREAK
HP	HIGH POINT
LB	LEFT BANK
LP	LOW POINT
L.O.W.	LIMIT OF WORK
MM	MEET AND MATCH
NIC	NOT IN CONTRACT
OC	ON CENTER
O.R.	OWNER'S REPRESENTATIVE
PA	PLANTING AREA
POC	POINT OF CONNECTION
PP	PRESERVE AND PROTECT
PR	PRUNE AS NOTED ON PLANS
R	REMOVE
RB	RIGHT BANK
RC	RIFFLE CREST
RT	RIFFLE TOE
R.O.W	RIGHT-OF-WAY
S	SALVAGE
SJ	SCORE JOINT
STD	STANDARD
TBD	TO BE DETERMINED
TB	TOP OF BANK
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
XS	CROSS SECTION

DEMOLITION NOTES

1. SEE SPECIFICATIONS FOR PROJECT REQUIREMENTS & ADDITIONAL INFORMATION.
2. MAINTAIN PROJECT PERIMETER FENCE FOR THE DURATION OF CONSTRUCTION. CONTRACTOR MAY UTILIZE SECTIONS OF (E) SITE FENCING TO MEET THE REQUIREMENTS FOR PROJECT PERIMETER FENCE IF PERMISSION IS OBTAINED FROM ADJACENT RESIDENTIAL PROPERTY OWNERS, AGENCIES AND O.R.
3. PROTECT ALL (E) IMPROVEMENTS NOT NOTED FOR DEMOLITION. SALVAGE ALL IMPROVEMENTS NOTED TO BE REMOVED / RELOCATED WITHIN L.O.W.
4. PP ALL UTILITIES UNLESS OTHERWISE NOTED.
5. LEGALLY DISPOSE OF ALL MATERIAL CLEARED, GRUBBED, DEMOLISHED, OR SALVAGED BUT NOT UTILIZED FOR PROJECT OR ACCEPTED BY OWNER. STOCKPILE ALL MATERIALS NOTED ON PLANS FOR REUSE.
6. PP AND MODIFY AND ADJUST ALL (E) IRRIGATION NECESSARY FOR INSTALLATION OF SITE IMPROVEMENTS. ENSURE UNINTERRUPTED IRRIGATION SERVICE AND HEAD TO HEAD COVERAGE TO ADJACENT SITE AREAS.
7. ENSURE ALL (E) IRRIGATION WORK ALONG THE PROJECT LIMIT OF WORK LINE IS PROTECTED, REHABILITATED, ZONED, AND RECONNECTED TO THE (E) IRRIGATION SYSTEM. ENSURE (E) SYSTEM IS FULLY OPERATIONAL AND ALL (E) IRRIGATED LANDSCAPE AREAS ARE IRRIGATED WITH HEAD TO HEAD COVERAGE.
8. PROVIDE 4" LAYER OF MULCH AT ALL (E) TREES AND SHRUBS TO REMAIN WHICH ARE AFFECTED BY DEMOLITION. MULCH SHALL EXTEND 18" OUTSIDE THE DRIPLINE OF TREES OR SHRUBS.
9. SALVAGE ALL PARK BENCHES, TABLES & TRASH CANS AND RETURN TO CITY.
10. TREES NOTED FOR SALVAGE TO BE REUSED AS ROOTWADS, MILLED FOR FENCES AND LOG BENCHES, AND OTHER SITE ELEMENTS PER O.R. DIRECTION. STOCKPILE ALL TREES TO BE SALVAGED WITH ROOTWADS INTACT. USE SMALL DIAMETER TREES AND BARK REMOVED FROM LARGER DIAMETER TREES FOR BARK MULCH TO EXTENT FEASIBLE.
11. FOR CONSTRUCTION STAGING AND DEWATERING INFORMATION, SEE SHEET T-2
12. BASE ROCK WITHIN DEMOLITION LIMIT AREA MAY BE REUSED ON SITE IF SCREENED TO MEET SPECIFICATIONS FOR BASE ROCK.
13. CONCRETE RECYCLING / CRUSHING FOR REUSE AS BASE ROCK OR BACKFILL IS ACCEPTABLE IF IT MEETS SPECIFICATIONS.
14. RIPRAP AND GABION ROCK NOTED FOR REUSE MAY BE REUSED AS GENERAL BED MATERIAL WITH O.R. APPROVAL.



EXISTING TREE SCHEDULE (TREES <6" DBH NOT SHOWN ON TABLE)

TREE	SIZE & TYPE	NTS*
1	30IN ELM	PP
2	15IN PITTOSPORUM	R
3	6IN PITTOSPORUM	R
4	6IN PITTOSPORUM	R
5	6IN PITTOSPORUM	R
6	8IN PITTOSPORUM	R
7	10IN PITTOSPORUM	R
8	28IN OAK	PP
9	24IN REDWOOD	PP
10	6IN PLUM	R
11	36IN OAK	PP
12	2-10IN PLUM	R
13	24IN REDWOOD	PP
14	24IN REDWOOD	S
15	18IN REDWOOD	S
16	24IN REDWOOD	S
17	6IN PLUM	R
18	6IN ELDERBERRY	R
19	6IN PLUM	R
20	36IN REDWOOD	PP
22	3-10IN LAUREL	R

TREE	SIZE & TYPE	NTS*
23	30IN REDWOOD	PP
24	42IN REDWOOD	PP
26	6IN PHOTINIA	R
28	24IN ALDER	PP
29	15IN OAK	PP
30	54IN REDWOOD	PP
31	6IN PHOTINIA	R
33	20IN REDWOOD	S
34	30IN WILLOW	PP
35	36IN OAK	PP
36	8IN ACACIA	PP
37	6IN BIRCH	PP
38	8IN ORNA_EVRGRN	R
39	8IN BIRCH	PP
40	8IN REDWOOD	R
41	8IN OAK	PP
43	36IN REDWOOD	S
44	3-15IN PITTOSPORUM	R
45	30IN REDWOOD	PP
47	6IN REDWOOD	PP
48	12IN REDWOOD	S

TREE	SIZE & TYPE	NTS*
49	16IN REDWOOD	S
50	36IN REDWOOD	S
51	24IN REDWOOD	S
52	42IN REDWOOD	PP
53	30IN REDWOOD	S
54	12IN ACACIA	R
55	12IN ACACIA	R
56	20IN CEDAR	PP
57	18IN REDWOOD	S
58	8IN ACACIA	R
59	20IN ACACIA	R
60	10IN REDWOOD	R
61	30IN REDWOOD	PP
62	12IN REDWOOD	S
63	10IN ACACIA	R
64	8IN REDWOOD	R
65	20IN ACACIA	R
66	2-8IN PLUM	R
68	24IN REDWOOD	PP
69	20IN ACACIA	R
70	24IN REDWOOD	PP

TREE	SIZE & TYPE	NTS*
71	12IN OAK	PP
73	6IN REDWOOD	R
74	24IN ACACIA	R
75	6IN PLUM	R
79	8IN OAK	R
80	12IN OAK	PP
81	30IN REDWOOD	PP
82	24IN REDWOOD	PP
83	15IN ACACIA	R
84	10IN ACACIA	R
86	6-10IN PLUM	R
87	6IN PLUM	R
88	18IN REDWOOD	PP
93	8IN OAK	PP
94	18IN WALNUT	S
95	18IN PINE	R
96	6IN OAK	PP
98	6IN PLUM	R
99	10IN PLUM	R
100	12IN PLUM	R
101	30IN MAPLE	PP

TREE	SIZE & TYPE	NTS*
102	16IN OAK	R
103	8IN REDWOOD	R
104	6IN PLUM	R
105	6IN BUCKEYE	PP
106	48IN REDWOOD	PP
107	20IN SIZYGIUM	R
108	24IN OAK	S
110	42IN OAK	PP
111	10IN REDWOOD	R
112	10IN BUCKEYE	PP
114	20IN MAPLE	PP
115	8IN MAPLE	PP
116	20IN MAPLE	PP
117	12IN REDWOOD	S
118	14IN MAPLE	PP
119	30IN REDWOOD	S
120	30IN REDWOOD	S
121	15IN BUCKEYE	PR
122	12IN OAK	PP
123	24IN REDWOOD	PP
126	12-16IN OAK	PP

TREE	SIZE & TYPE	NTS*
127	24IN REDWOOD	PP
128	8IN OAK	PP
129	30"&12IN DEAD	R
133	30IN OAK	R
135	6IN OAK	R
136	6IN OAK	R
137	14IN OAK	R
138	8IN WILLOW	PP
139	72IN REDWOOD	PP
140	8IN WILLOW	PP
141	2-8IN WILLOW	PP
143	6IN EUC	R
144	6IN OAK	R
146	12IN OAK	PP
150	14IN EUC	R
152	14IN EUC	R
153	16IN EUC	R
155	14IN EUC	R
158	14IN EUC	R
159	8IN EUC	R
160	14IN EUC	R

TREE	SIZE & TYPE	NTS*
161	10IN OLIVE	PP
162	6IN EUC	R
163	6IN EUC	R
164	42IN EUC	R
165	30IN OAK	PP
167	10IN OAK	PP
168	12IN OAK	PP
169	12IN OAK	PP
170	14IN OAK	PP
171	12IN OAK	PP
172	16IN	PP
173	12IN OAK	PP
174	16IN OAK	PP
175	6IN OAK	PP
176	6IN OAK	PP

* NOTES: PP = PRESERVE AND PROTECT, R = REMOVE AND DISPOSE, S = SALVAGE AND STOCKPILE FOR REUSE, PR = PRUNE AS NOTED ON PLANS

DATE	NO.	REVISIONS

DESIGN BY: BB / ES
DRAWN BY: JS / ES / PR
CHECKED BY: BB
SCALE: 1" = 10'
DATE: SEPTEMBER 7, 2012

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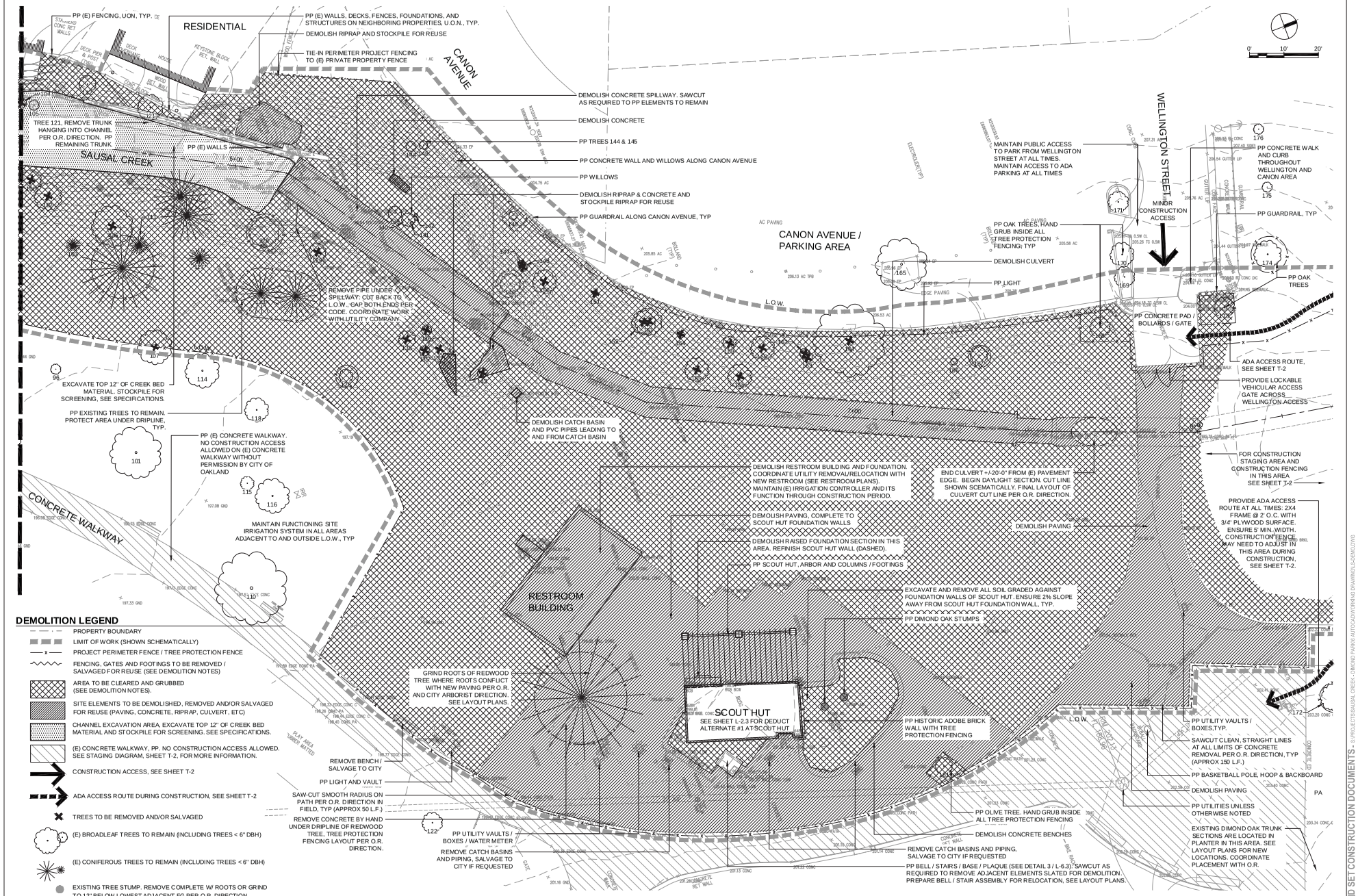
SAUSAL CREEK
RESTORATION PROJECT IN DIMOND PARK

BID SET

DEMOLITION & TREE PROTECTION DOWNSTREAM

SHEET
L-1.1

SAUSAL CREEK: BID SET CONSTRUCTION DOCUMENTS - S:\PROJECTS\SAUSAL CREEK - DIMOND PARK\AUTOCAD\WORKING DRAWINGS\L-SERIES.DWG
PLOTTED ON: 9/6/2012



DEMOLITION LEGEND

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DATE	NO.	REVISIONS

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CHECKED BY	BB
SCALE	1" = 10'
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SAUSAL CREEK

RESTORATION PROJECT IN DIMOND PARK

BID SET

DEMOLITION & TREE PROTECTION UPSTREAM

SHEET

L-1.2

SAUSAL CREEK: BID SET CONSTRUCTION DOCUMENTS - S:\PROJECTS\SAUSAL CREEK - DIMOND PARK\ AUTOCAD\WORKING DRAWINGS\L-2\DEMO.DWG

PLOTTED ON: 9/6/2012

ABBREVIATIONS

AC	ASPHALT CONCRETE
BB	BOTTOM OF BANK
CLR	CLEAR
℄	CENTERLINE
DI	DRAIN INLET
EC	EDGE OF BANKFULL CHANNEL
(E)	EXISTING
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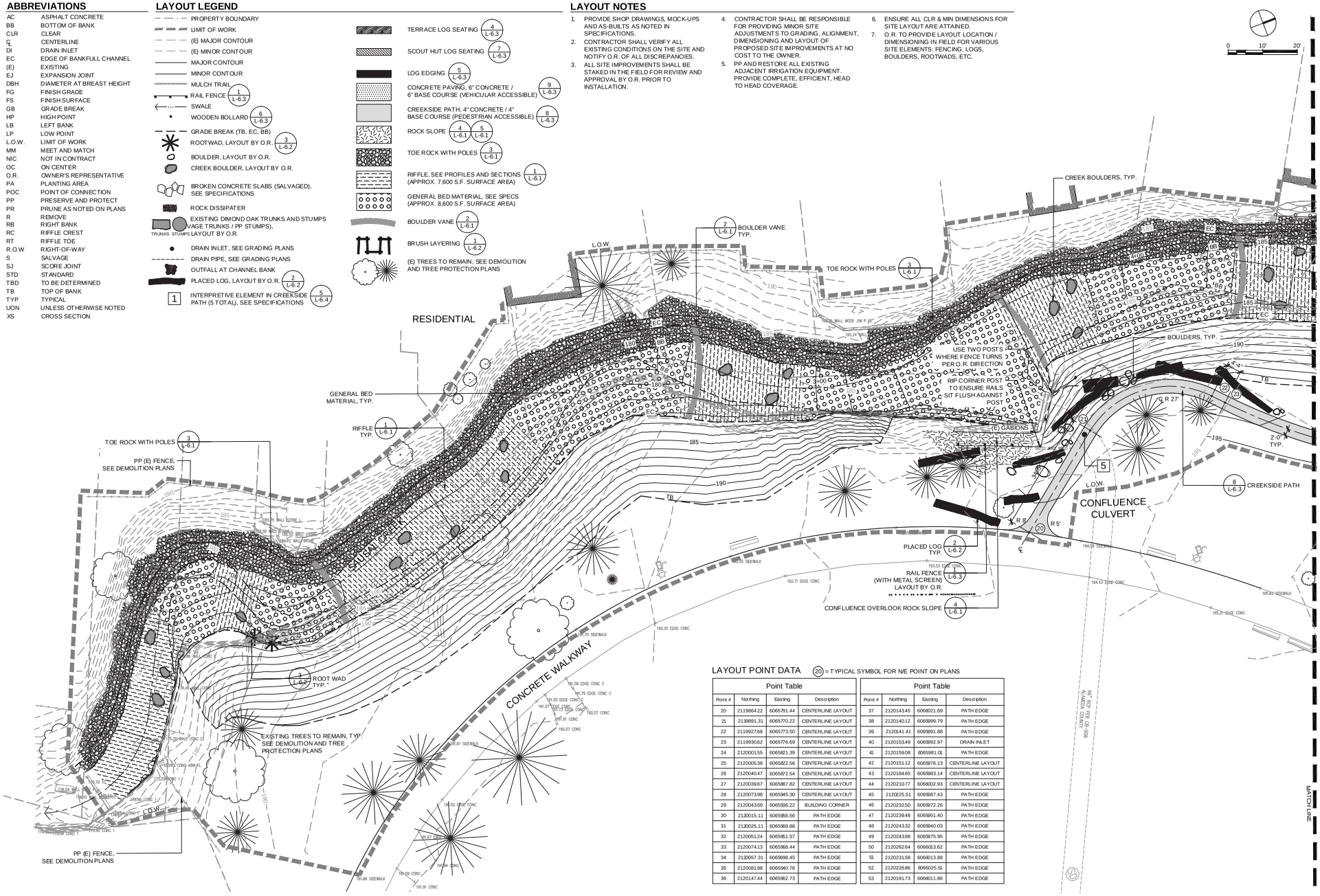
STD	STANDARD
TBD	TO BE DETERMINED
TB	TOP OF BANK
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
XS	CROSS SECTION

LAYOUT LEGEND

- PROPERTY BOUNDARY
- LIMIT OF WORK
- (E) MAJOR CONTOUR
- (E) MINOR CONTOUR
- MAJOR CONTOUR
- MINOR CONTOUR
- MULCH TRAIL
- RAIL FENCE (1 / L-6.3)
- SWALE
- WOODEN BOLLARD (6 / L-6.3)
- GRADE BREAK (TB, EC, BB)
- ROOTWAD, LAYOUT BY O.R. (3 / L-6.2)
- BOULDER, LAYOUT BY O.R.
- CREEK BOULDER, LAYOUT BY O.R.
- BROKEN CONCRETE SLABS (SALVAGED), SEE SPECIFICATIONS
- ROCK DISSIPATER
- EXISTING DIMOND OAK TRUNKS AND STUMPS (SALVAGE TRUNKS / PP STUMPS), LAYOUT BY O.R. (TRUNKS STUMPS)
- DRAIN INLET, SEE GRADING PLANS
- DRAIN PIPE, SEE GRADING PLANS
- OUTFALL AT CHANNEL BANK
- PLACED LOG, LAYOUT BY O.R. (2 / L-6.2)
- 1 INTERPRETIVE ELEMENT IN CREEKSIDE PATH (5 TOTAL), SEE SPECIFICATIONS (5 / L-6.4)
- TERRACE LOG SEATING (4 / L-6.3)
- SCOUT HUT LOG SEATING (7 / L-6.3)
- LOG EDGING (5 / L-6.3)
- CONCRETE PAVING, 6" CONCRETE / 6" BASE COURSE (VEHICULAR ACCESSIBLE) (9 / L-6.3)
- CREEKSIDE PATH, 4" CONCRETE / 4" BASE COURSE (PEDESTRIAN ACCESSIBLE) (8 / L-6.3)
- ROCK SLOPE (4 / L-6.1) (5 / L-6.1)
- TOE ROCK WITH POLES (3 / L-6.1)
- RIFFLE, SEE PROFILES AND SECTIONS (APPROX. 7,600 S.F. SURFACE AREA) (1 / L-6.1)
- GENERAL BED MATERIAL, SEE SPECS (APPROX. 8,600 S.F. SURFACE AREA)
- BOULDER VANE (2 / L-6.1)
- BRUSH LAYERING (1 / L-6.2)
- (E) TREES TO REMAIN, SEE DEMOLITION AND TREE PROTECTION PLANS

LAYOUT NOTES

1. PROVIDE SHOP DRAWINGS, MOCK-UPS AND AS-BUILTS AS NOTED IN SPECIFICATIONS.
2. CONTRACTOR SHALL VERIFY ALL EXISTING CONDITIONS ON THE SITE AND NOTIFY O.R. OF ALL DISCREPANCIES.
3. ALL SITE IMPROVEMENTS SHALL BE STAKED IN THE FIELD FOR REVIEW AND APPROVAL BY O.R. PRIOR TO INSTALLATION.
4. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING MINOR SITE ADJUSTMENTS TO GRADING, ALIGNMENT, DIMENSIONING AND LAYOUT OF PROPOSED SITE IMPROVEMENTS AT NO COST TO THE OWNER.
5. PP AND RESTORE ALL EXISTING ADJACENT IRRIGATION EQUIPMENT. PROVIDE COMPLETE, EFFICIENT, HEAD TO HEAD COVERAGE.
6. ENSURE ALL CLR & MIN DIMENSIONS FOR SITE LAYOUT ARE ATTAINED.
7. O.R. TO PROVIDE LAYOUT LOCATION / DIMENSIONING IN FIELD FOR VARIOUS SITE ELEMENTS: FENCING, LOGS, BOULDERS, ROOTWADS, ETC.



LAYOUT POINT DATA (20) = TYPICAL SYMBOL FOR N/E POINT ON PLANS

Point Table				Point Table			
Point #	Northing	Easting	Description	Point #	Northing	Easting	Description
20	2119864.22	6065791.44	CENTERLINE LAYOUT	37	2120143.45	6066021.69	PATH EDGE
21	2119891.31	6065770.22	CENTERLINE LAYOUT	38	2120140.12	6065999.79	PATH EDGE
22	2119927.68	6065773.50	CENTERLINE LAYOUT	39	2120141.41	6065991.88	PATH EDGE
23	2119930.62	6065776.69	CENTERLINE LAYOUT	40	2120153.49	6065992.97	DRAIN INLET
24	2120001.55	6065821.39	CENTERLINE LAYOUT	41	2120159.08	6065981.01	PATH EDGE
25	2120005.38	6065822.56	CENTERLINE LAYOUT	42	2120151.12	6065976.13	CENTERLINE LAYOUT
26	2120004.47	6065872.54	CENTERLINE LAYOUT	43	2120184.65	6065983.14	CENTERLINE LAYOUT
27	2120003.67	6065887.82	CENTERLINE LAYOUT	44	2120210.77	6066002.93	CENTERLINE LAYOUT
28	2120073.98	6065945.30	CENTERLINE LAYOUT	45	2120225.51	6065987.43	PATH EDGE
29	2120043.69	6065936.22	BUILDING CORNER	46	2120232.50	6065972.26	PATH EDGE
30	2120015.11	6065956.56	PATH EDGE	47	2120239.48	6065951.40	PATH EDGE
31	2120025.11	6065969.88	PATH EDGE	48	2120243.32	6065940.03	PATH EDGE
32	2120051.24	6065951.57	PATH EDGE	49	2120243.88	6065975.95	PATH EDGE
33	2120074.13	6065968.44	PATH EDGE	50	2120262.64	6066013.62	PATH EDGE
34	2120057.31	6065998.45	PATH EDGE	51	2120231.58	6066013.88	PATH EDGE
35	2120081.98	6065940.76	PATH EDGE	52	2120226.86	6066025.51	PATH EDGE
36	2120147.44	6065962.73	PATH EDGE	53	2120191.73	6066011.86	PATH EDGE

DATE	NO.	REVISIONS

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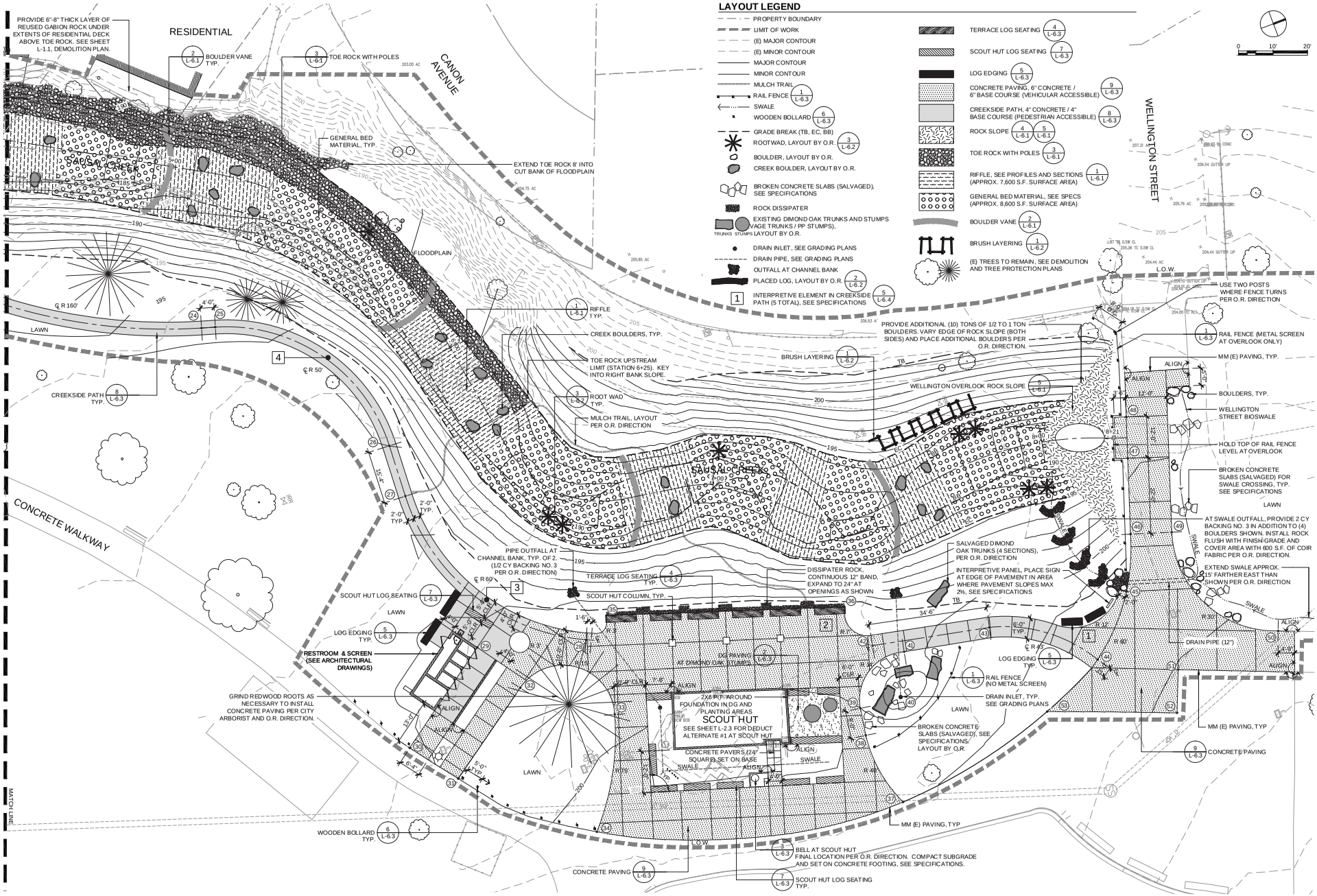
SAUSAL CREEK
RESTORATION PROJECT IN DIMOND PARK

BID SET

LAYOUT DOWNSTREAM

SHEET L-2.1

SAUSAL CREEK: BID SET CONSTRUCTION DOCUMENTS - S:\PROJECTS\SAUSAL CREEK - DIMOND PARK\ AUTOCAD\WORKING DRAWINGS\L-LAYOUT.DWG
PLOTTED ON: 9/6/2012



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SAUSAL CREEK

RESTORATION PROJECT IN DIMOND PARK

BID SET

LAYOUT UPSTREAM

SHEET L-2.2

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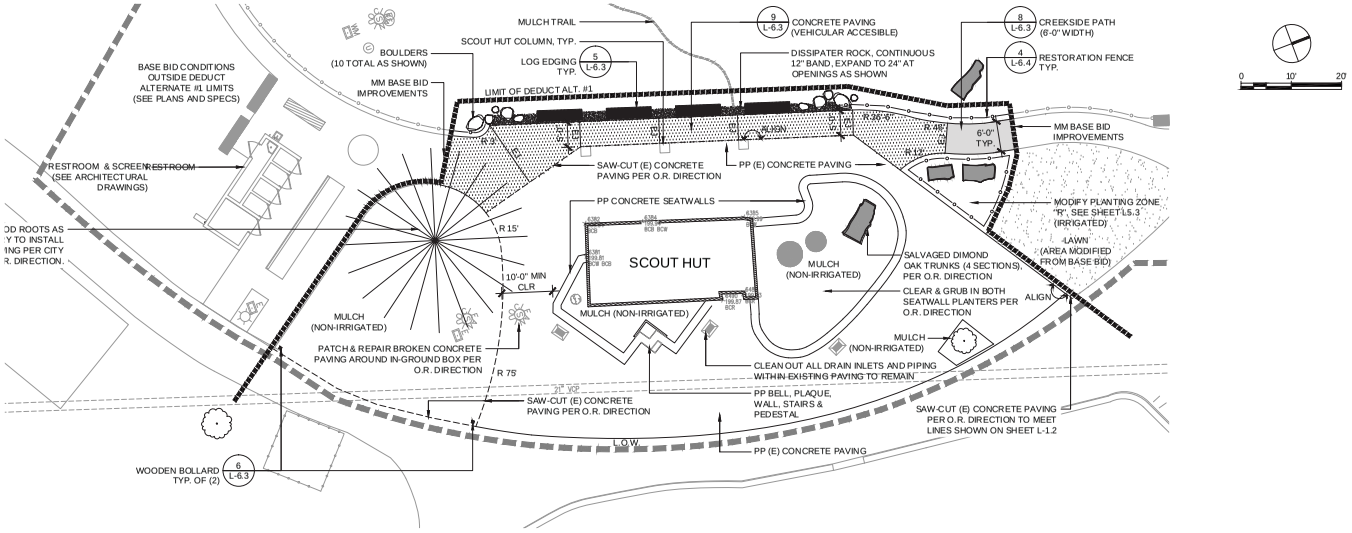
DEDUCT ALTERNATE #1 NOTES

1. CONTRACTOR TO COORDINATE DEDUCT ALTERNATE #1 WITH BASE BID PLANS AND SPECIFICATIONS. LIMIT OF WORK FOR DEDUCT ALTERNATE #1 IS AS SHOWN ON THIS DRAWING.
2. MODIFY DEMOLITION STRATEGY INSIDE LIMITS OF DEDUCT ALTERNATE #1: SAW-CUT AND REMOVE CONCRETE AS SHOWN ON SHEET L-2.3 AND PER O.R. DIRECTION. CONCRETE, AGGREGATE BASE, AND DEBRIS SHALL BE REMOVED FROM SITE AND DISPOSED OF LEGALLY. PRESERVE & PROTECT EXISTING CONCRETE AND SEATWALLS SHOWN TO REMAIN. CONTRACTOR SHALL PATCH ANY CONCRETE DAMAGED BY THE WORK TO (E) CONDITION OR BETTER, FINISH AND TONE TO MATCH (E). SEE DEMOLITION PLANS (L-1.1 AND L-1.2) AND RESTROOM UTILITY DEMOLITION PLANS (RR-C1.0).
3. CLEARING AND GRUBBING INSIDE LIMITS OF DEDUCT ALTERNATE #1 SHALL BE PER O.R. DIRECTION. CUT TO DARKSHED CONTRACTOR DIRECTION. INSTALL SOIL INSIDE SEATWALL PLANTERS IF REQUESTED BY O.R.
5. SEE SHEETS L-2.1 & L-2.2 FOR LEGEND.
6. NEW CONCRETE SHALL BE DOWELED INTO (E) CONCRETE WHERE POUR IS ADJACENT TO (E) CONCRETE TO REMAIN. DOWELS SHALL BE #5 REBAR, 24" LENGTH, SPACED AT 2'-0" O.C. CONTINUOUS ALONG ALL CUT EDGES AND DRILLED 12" MINIMUM INTO EXISTING CONCRETE & EPOXIED.
7. GRADING OF PLANTING AND PAVED AREAS INSIDE LIMITS OF DEDUCT ALTERNATE #1 SHALL BE PER O.R. DIRECTION. CONTRACTOR TO ENSURE THAT ALL AREAS HAVE POSITIVE DRAINAGE TOWARDS CREEK. FOR GRADING OUTSIDE THE LIMITS OF DEDUCT ALTERNATE #1, SEE PLANS AND SPECIFICATIONS.
8. CONTRACTOR SHALL CLEAN OUT EXISTING DRAIN INLETS AND DRAIN PIPE NETWORK AND LOCATE PIPES FOR O.R. INSPECTION. DURING CREEK GRADING, DRAIN PIPES SHALL BE 1/2 CUBIC YARD BACKING NO. 3 AT EACH PIPE OUTFALL PER O.R. DIRECTION. COORDINATE WITH DEMOLITION AND RESTROOM PLANS.
9. SCORE JOINT LAYOUT PER O.R. DIRECTION IN THE FIELD.
10. DELETE PLANTING ZONES "S" & "T" (SEE SHEET L-5.3). ZONE "R" PLANT COUNTS WILL BE REDUCED BY 50% TOTAL (EXCLUDING TREES). EXACT SPECIES COUNT PER O.R. DIRECTION. SEE SHEET L-5.1 FOR PLANT SCHEDULE.



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SAUSAL CREEK
RESTORATION PROJECT IN DIMOND PARK

BID SET

DEDUCT ALTERNATE #1 AT SCOUT HUT

SHEET
L-2.3

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ABBREVIATIONS

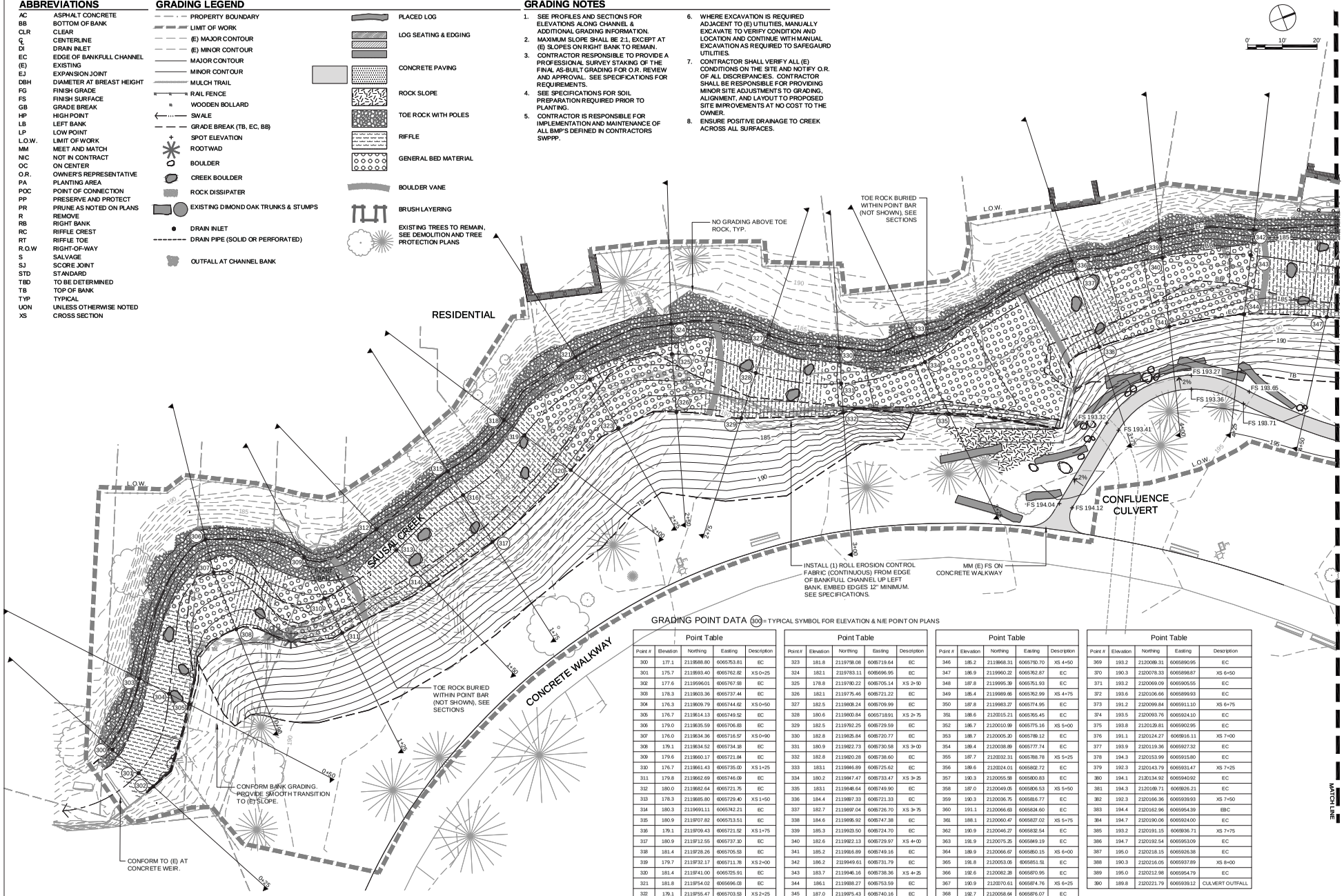
AC	ASPHALT CONCRETE
BB	BOTTOM OF BANK
CLR	CLEAR
℄	CENTERLINE
DI	DRAIN INLET
EC	EDGE OF BANKFULL CHANNEL
(E)	EXISTING
EJ	EXPANSION JOINT
DBH	DIAMETER AT BREAST HEIGHT
FG	FINISH GRADE
FS	FINISH SURFACE
GB	GRADE BREAK
HP	HIGH POINT
LB	LEFT BANK
LP	LOW POINT
L.O.W.	LIMIT OF WORK
MM	MEET AND MATCH
NIC	NOT IN CONTRACT
OC	ON CENTER
O.R.	OWNER'S REPRESENTATIVE
PA	PLANTING AREA
POC	POINT OF CONNECTION
PP	PRESERVE AND PROTECT
PR	PRUNE AS NOTED ON PLANS
R	REMOVE
RB	RIGHT BANK
RC	RIFFLE CREST
RT	RIFFLE TOE
R.O.W	RIGHT-OF-WAY
S	SALVAGE
SJ	SCORE JOINT
STD	STANDARD
TBD	TO BE DETERMINED
TB	TOP OF BANK
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
XS	CROSS SECTION

GRADING LEGEND

- PROPERTY BOUNDARY
- LIMIT OF WORK
- (E) MAJOR CONTOUR
- (E) MINOR CONTOUR
- MAJOR CONTOUR
- MINOR CONTOUR
- MULCH TRAIL
- RAIL FENCE
- WOODEN BOLLARD
- SWALE
- GRADE BREAK (TB, EC, BB)
- SPOT ELEVATION
- ROOTWAD
- BOULDER
- CREEK BOULDER
- ROCK DISSIPATER
- EXISTING DIMOND OAK TRUNKS & STUMPS
- DRAIN INLET
- DRAIN PIPE (SOLID OR PERFORATED)
- OUTFALL AT CHANNEL BANK
- PLACED LOG
- LOG SEATING & EDGING
- CONCRETE PAVING
- ROCK SLOPE
- TOE ROCK WITH POLES
- RIFFLE
- GENERAL BED MATERIAL
- BOULDER VANE
- BRUSH LAYERING
- EXISTING TREES TO REMAIN, SEE DEMOLITION AND TREE PROTECTION PLANS

GRADING NOTES

1. SEE PROFILES AND SECTIONS FOR ELEVATIONS ALONG CHANNEL & ADDITIONAL GRADING INFORMATION.
2. MAXIMUM SLOPE SHALL BE 2:1, EXCEPT AT (E) SLOPES ON RIGHT BANK TO REMAIN.
3. CONTRACTOR RESPONSIBLE TO PROVIDE A PROFESSIONAL SURVEY STAKING OF THE FINAL AS-BUILT GRADING FOR O.R. REVIEW AND APPROVAL. SEE SPECIFICATIONS FOR REQUIREMENTS.
4. SEE SPECIFICATIONS FOR SOIL PREPARATION REQUIRED PRIOR TO PLANTING.
5. CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTATION AND MAINTENANCE OF ALL BMP'S DEFINED IN CONTRACTORS SWPPP.
6. WHERE EXCAVATION IS REQUIRED ADJACENT TO (E) UTILITIES, MANUALLY EXCAVATE TO VERIFY CONDITION AND LOCATION AND CONTINUE WITH MANUAL EXCAVATION AS REQUIRED TO SAFEGAURD UTILITIES.
7. CONTRACTOR SHALL VERIFY ALL (E) CONDITIONS ON THE SITE AND NOTIFY O.R. OF ALL DISCREPANCIES. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING MINOR SITE ADJUSTMENTS TO GRADING, ALIGNMENT, AND LAYOUT TO PROPOSED SITE IMPROVEMENTS AT NO COST TO THE OWNER.
8. ENSURE POSITIVE DRAINAGE TO CREEK ACROSS ALL SURFACES.



GRADING POINT DATA (300) = TYPICAL SYMBOL FOR ELEVATION & N/E POINT ON PLANS

Point Table

Point #	Elevation	Northing	Easting	Description
300	177.1	2119588.80	6065753.81	EC
301	175.7	2119593.40	6065762.82	XS 0+25
302	177.6	2119596.01	6065767.98	EC
303	178.3	2119603.36	6065737.44	EC
304	176.3	2119609.79	6065744.62	XS 0+50
305	176.7	2119614.13	6065749.52	EC
306	179.0	2119635.59	6065706.83	EC
307	176.0	2119634.36	6065716.57	XS 0+90
308	179.1	2119634.52	6065734.38	EC
309	179.6	2119660.17	6065721.84	EC
310	176.7	2119661.43	6065735.00	XS 1+25
311	179.8	2119662.69	6065746.09	EC
312	180.0	2119682.64	6065721.75	EC
313	178.3	2119685.80	6065729.40	XS 1+50
314	180.3	2119691.11	6065742.21	EC
315	180.9	2119707.82	6065713.51	EC
316	179.1	2119709.43	6065721.52	XS 1+75
317	180.9	2119712.55	6065737.30	EC
318	181.4	2119728.26	6065705.59	EC
319	179.7	2119732.17	6065711.78	XS 2+00
320	181.4	2119741.00	6065725.91	EC
321	181.8	2119754.02	6065696.03	EC
322	179.1	2119755.47	6065703.53	XS 2+25

Point Table

Point #	Elevation	Northing	Easting	Description
323	181.8	2119758.08	6065719.64	EC
324	182.1	2119783.11	6065696.95	EC
325	178.8	2119780.22	6065705.14	XS 2+50
326	182.1	2119775.46	6065721.22	EC
327	182.5	2119808.24	6065709.99	EC
328	180.6	2119800.84	6065718.91	XS 2+75
329	182.5	2119792.25	6065729.59	EC
330	182.8	2119825.84	6065720.77	EC
331	180.9	2119822.73	6065730.58	XS 3+00
332	182.8	2119820.28	6065738.60	EC
333	183.1	2119846.89	6065725.62	EC
334	180.2	2119847.47	6065733.47	XS 3+25
335	183.1	2119848.64	6065749.90	EC
336	184.4	2119897.33	6065721.33	EC
337	182.7	2119897.04	6065726.70	XS 3+75
338	184.6	2119895.92	6065747.38	EC
339	185.3	2119923.50	6065724.70	EC
340	182.6	2119922.13	6065729.97	XS 4+00
341	185.2	2119916.89	6065749.16	EC
342	186.2	2119949.61	6065731.79	EC
343	183.7	2119946.16	6065738.36	XS 4+25
344	186.1	2119938.27	6065753.59	EC
345	187.0	2119975.43	6065740.16	EC

Point Table

Point #	Elevation	Northing	Easting	Description
346	185.2	2119968.31	6065750.70	XS 4+50
347	186.9	2119960.22	6065762.87	EC
348	187.8	2119995.39	6065751.93	EC
349	185.4	2119989.66	6065762.99	XS 4+75
350	187.8	2119983.27	6065774.95	EC
351	188.6	2120015.21	6065765.45	EC
352	186.7	2120010.99	6065775.16	XS 5+00
353	188.7	2120005.20	6065786.12	EC
354	189.4	2120038.89	6065777.74	EC
355	187.7	2120032.31	6065788.78	XS 5+25
356	189.6	2120024.01	6065802.72	EC
357	190.3	2120055.58	6065800.83	EC
358	187.0	2120049.05	6065806.53	XS 5+50
359	190.3	2120036.75	6065816.77	EC
360	191.1	2120066.63	6065824.60	EC
361	188.1	2120060.47	6065827.02	XS 5+75
362	190.9	2120046.27	6065832.54	EC
363	191.9	2120075.25	6065849.19	EC
364	188.9	2120066.67	6065850.15	XS 6+00
365	191.8	2120053.06	6065851.51	EC
366	192.6	2120082.28	6065870.95	EC
367	190.9	2120070.61	6065874.76	XS 6+25
368	192.7	2120058.64	6065876.07	EC

Point Table

Point #	Elevation	Northing	Easting	Description
369	193.2	2120089.31	6065890.95	EC
370	190.3	2120078.33	6065898.87	XS 6+50
371	193.2	2120069.09	6065905.55	EC
372	193.6	2120106.66	6065899.93	EC
373	191.2	2120099.84	6065911.10	XS 6+75
374	193.5	2120093.76	6065924.10	EC
375	193.8	2120129.81	6065902.95	EC
376	191.1	2120124.27	6065916.11	XS 7+00
377	193.9	2120119.36	6065927.32	EC
378	194.3	2120153.99	6065915.80	EC
379	192.3	2120143.79	6065931.47	XS 7+25
380	194.1	2120134.92	6065940.92	EC
381	194.3	2120169.71	6065926.21	EC
382	192.3	2120166.36	6065939.93	XS 7+50
383	194.4	2120162.96	6065954.39	EBC
384	194.7	2120190.06	6065924.00	EC
385	193.2	2120191.15	6065936.71	XS 7+75
386	194.7	2120192.54	6065953.09	EC
387	195.0	2120218.15	6065926.38	EC
388	190.3	2120216.05	6065937.89	XS 8+00
389	195.0	2120212.98	6065954.79	EC
390	189.8	2120221.79	6065939.12	CULVERT OUTFALL

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SAUSAL CREEK

RESTORATION PROJECT IN DIMOND PARK

BID SET

GRADING DOWNSTREAM

SHEET L-3.1

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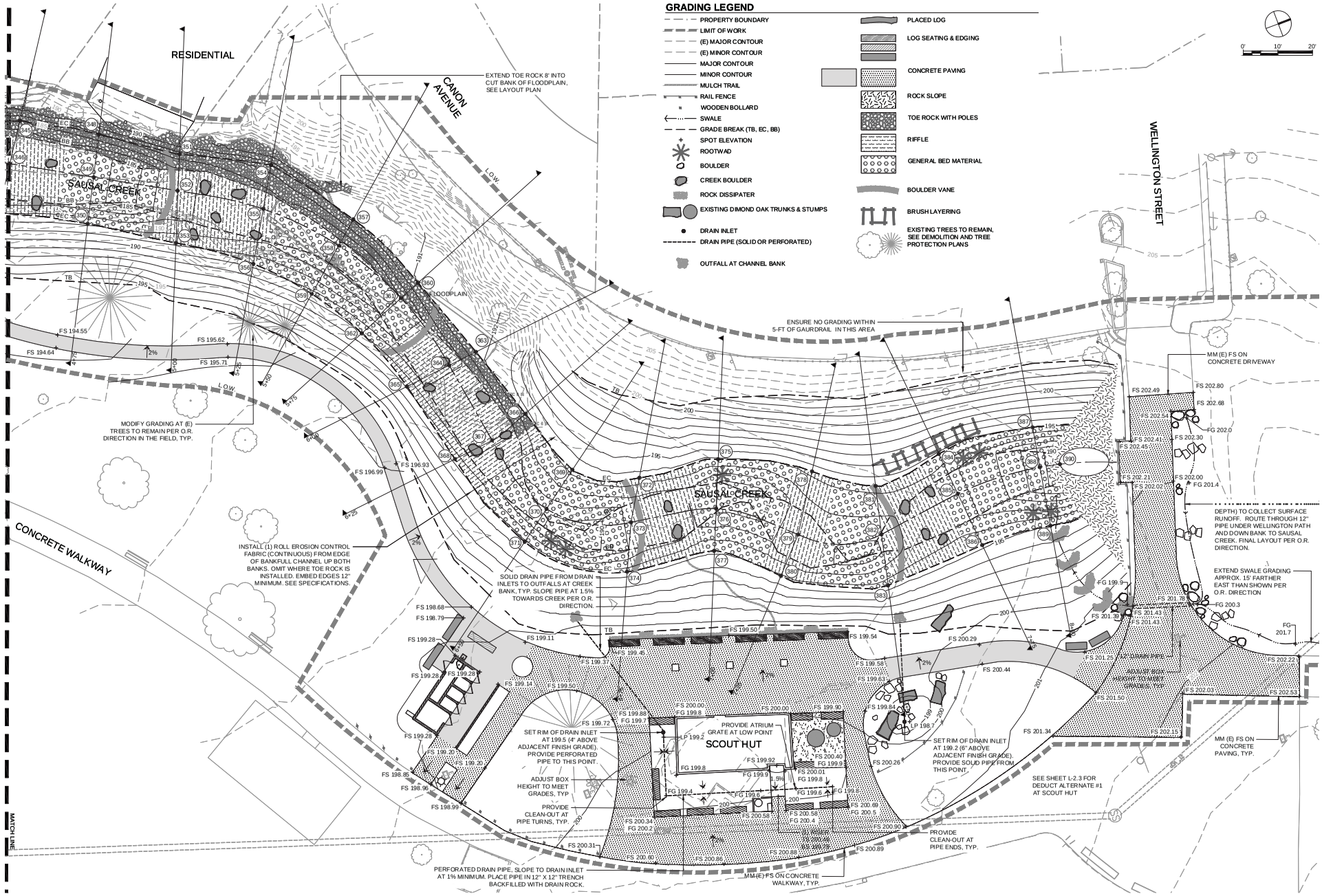

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SAUSAL CREEK

RESTORATION PROJECT IN DIMOND PARK

BID SET

GRADING UPSTREAM

SHEET

L-3.2

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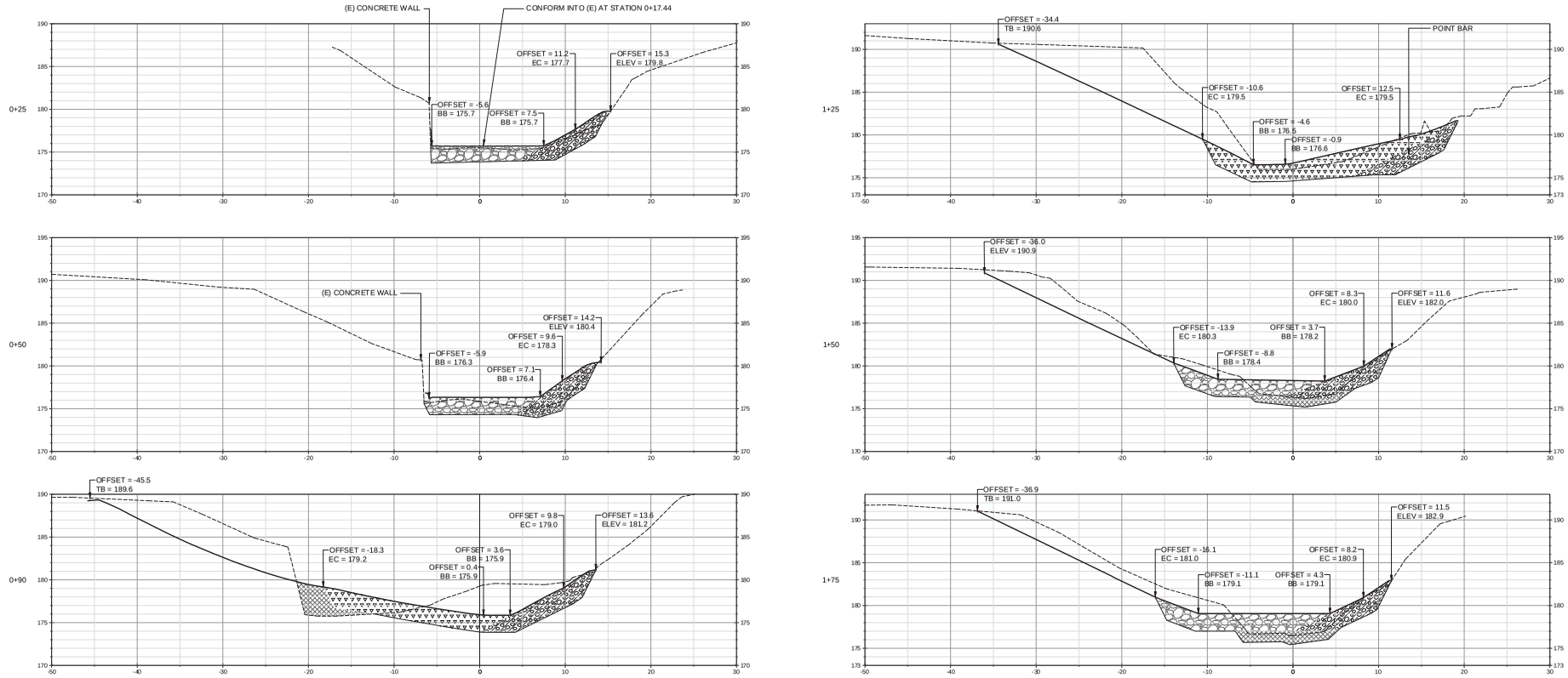
CROSS SECTIONS OF PROPOSED CHANNEL - STATIONS 0+25 TO 1+75

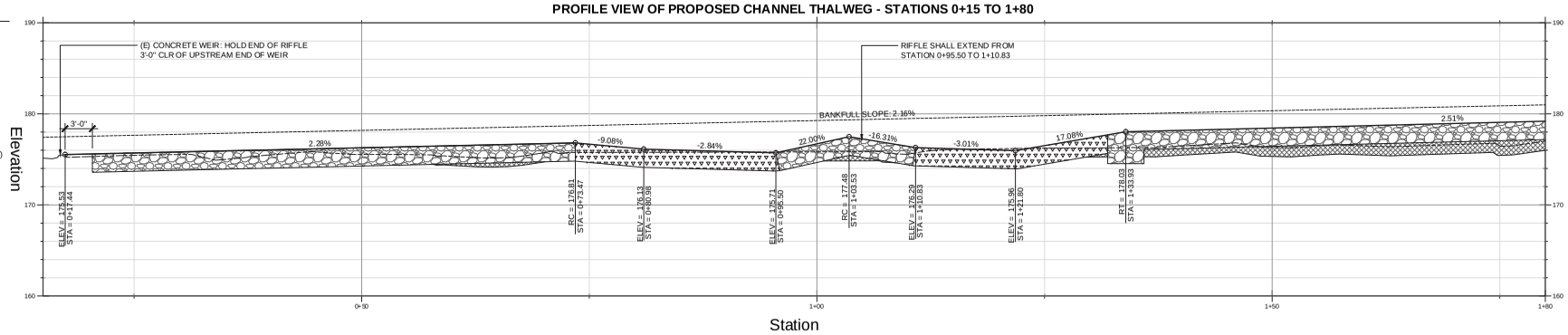
LOOKING DOWNSTREAM



LEGEND

- EXISTING SURFACE
- PROPOSED SURFACE
- EXCAVATION SURFACE
- BANKFULL ELEVATION (PROFILE ONLY)
- BRUSH LAYERING
- TOE ROCK (SECTION ONLY)
- GENERAL BED MATERIAL
- RIFFLE BED MATERIAL
- GENERAL FILL

PROFILE VIEW OF PROPOSED CHANNEL THALWEG - STATIONS 0+15 TO 1+80



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SAUSAL CREEK

RESTORATION PROJECT IN DIMOND PARK

BID SET

PROFILE AND SECTIONS
STATIONS 0+25 TO 1+75

SHEET
L-4.1

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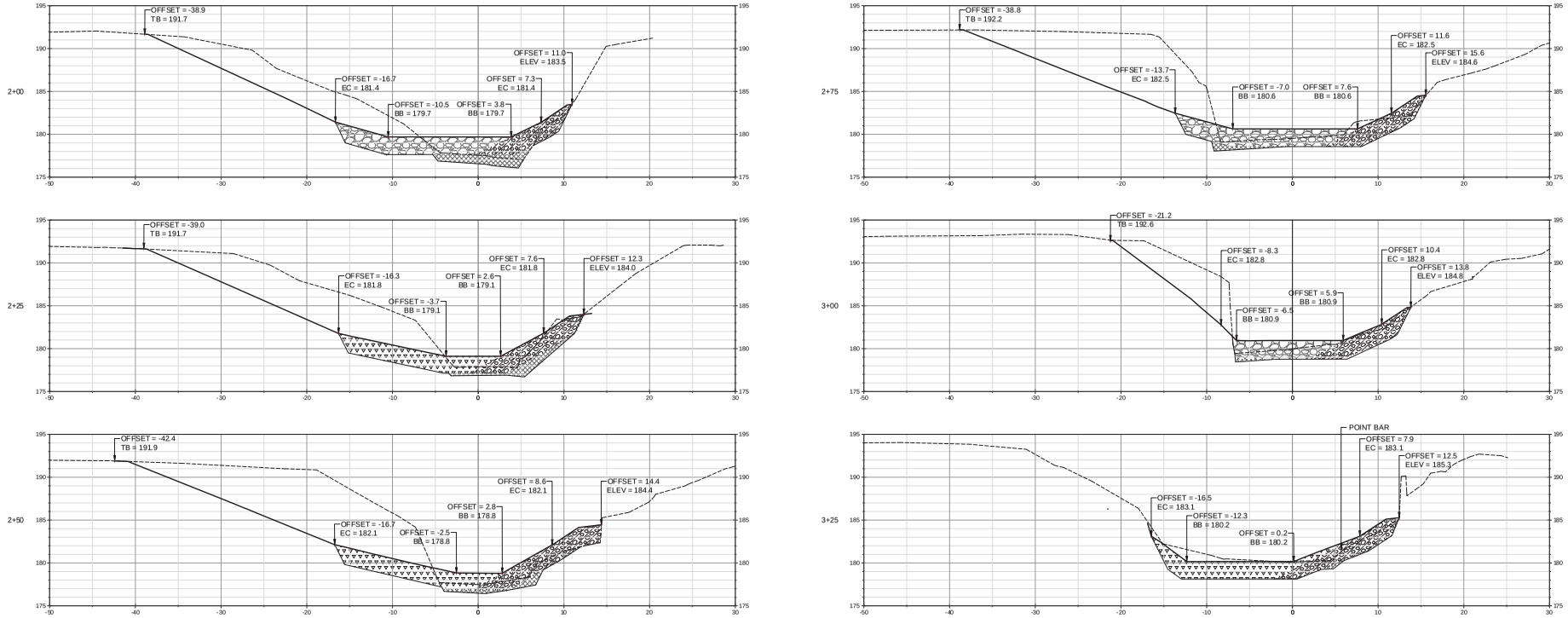
CROSS SECTIONS OF PROPOSED CHANNEL - STATION 2+00 TO 3+25

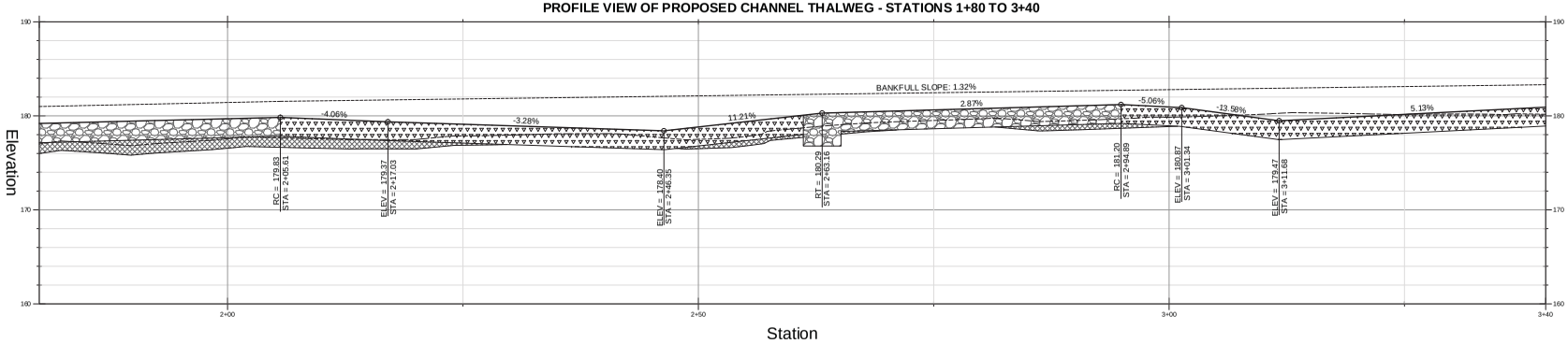
LOOKING DOWNSTREAM



LEGEND

- EXISTING SURFACE
- PROPOSED SURFACE
- EXCAVATION SURFACE
- BANKFULL ELEVATION (PROFILE ONLY)
- BRUSH LAYERING
- TOE ROCK (SECTION ONLY)
- GENERAL BED MATERIAL
- RIFFLE BED MATERIAL
- GENERAL FILL

PROFILE VIEW OF PROPOSED CHANNEL THALWEG - STATIONS 1+80 TO 3+40



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SAUSAL CREEK

RESTORATION PROJECT IN DIMOND PARK

BID SET

PROFILE AND SECTIONS STATIONS 2+00 TO 3+25

SHEET L-4.2

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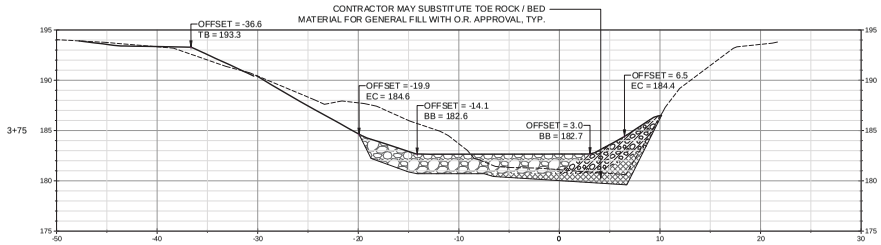
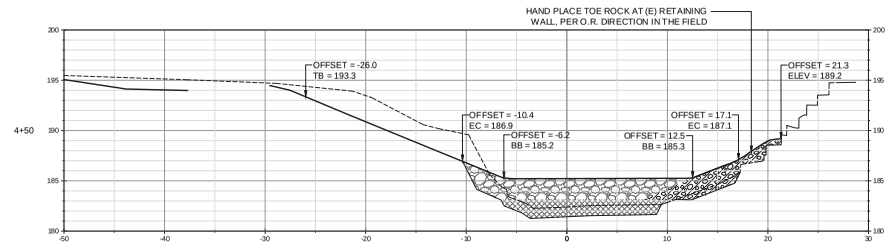
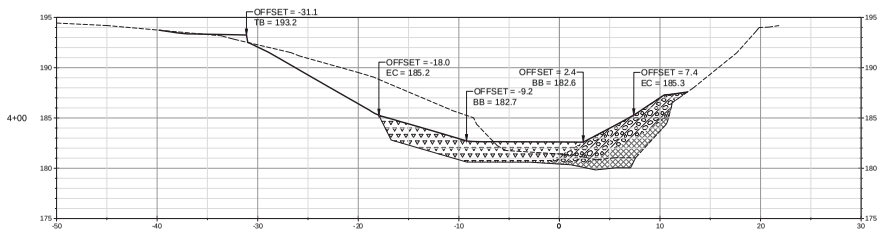
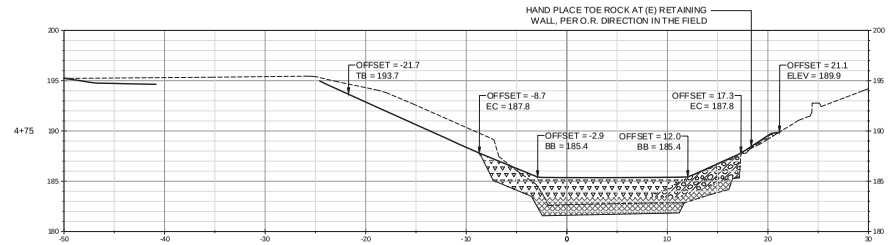
CROSS SECTIONS OF PROPOSED CHANNEL - STATIONS 3+75 TO 5+00

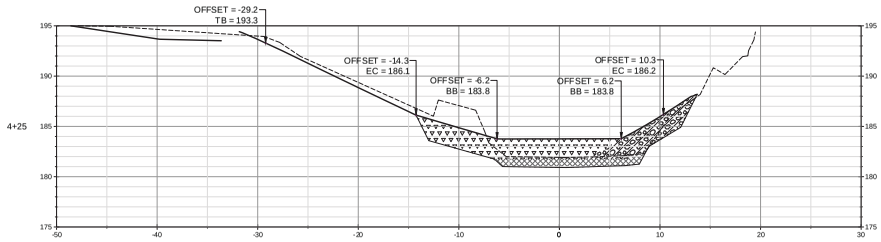
LOOKING DOWNSTREAM

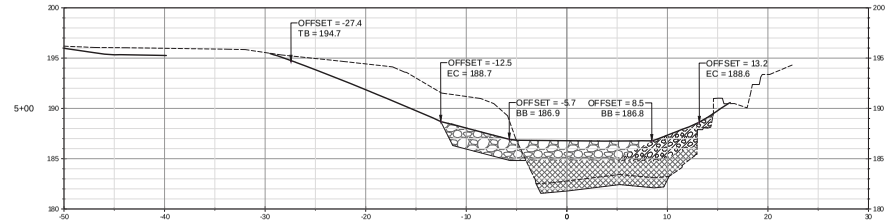








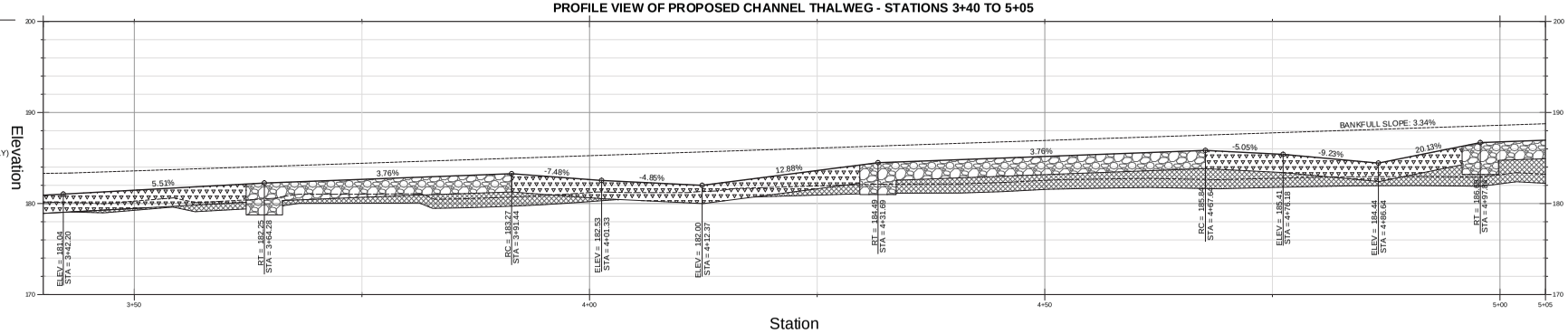




PROFILE VIEW OF PROPOSED CHANNEL THALWEG - STATIONS 3+40 TO 5+05

LEGEND

- EXISTING SURFACE
- PROPOSED SURFACE
- EXCAVATION SURFACE
- BANKFULL ELEVATION (PROFILE ONLY)
- BRUSH LAYERING
- TOE ROCK (SECTION ONLY)
- GENERAL BED MATERIAL
- RIFFLE BED MATERIAL
- GENERAL FILL



DATE	NO.	REVISIONS

DESIGN BY: BB / ES
DRAWN BY: JS / ES / PR
CHECKED BY: BB
SCALE: 1" = 5'
DATE: SEPTEMBER 7, 2012

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SAUSAL CREEK

RESTORATION PROJECT IN DIMOND PARK

BID SET

PROFILE AND SECTIONS STATIONS 3+75 TO 5+00

SHEET L-4.3

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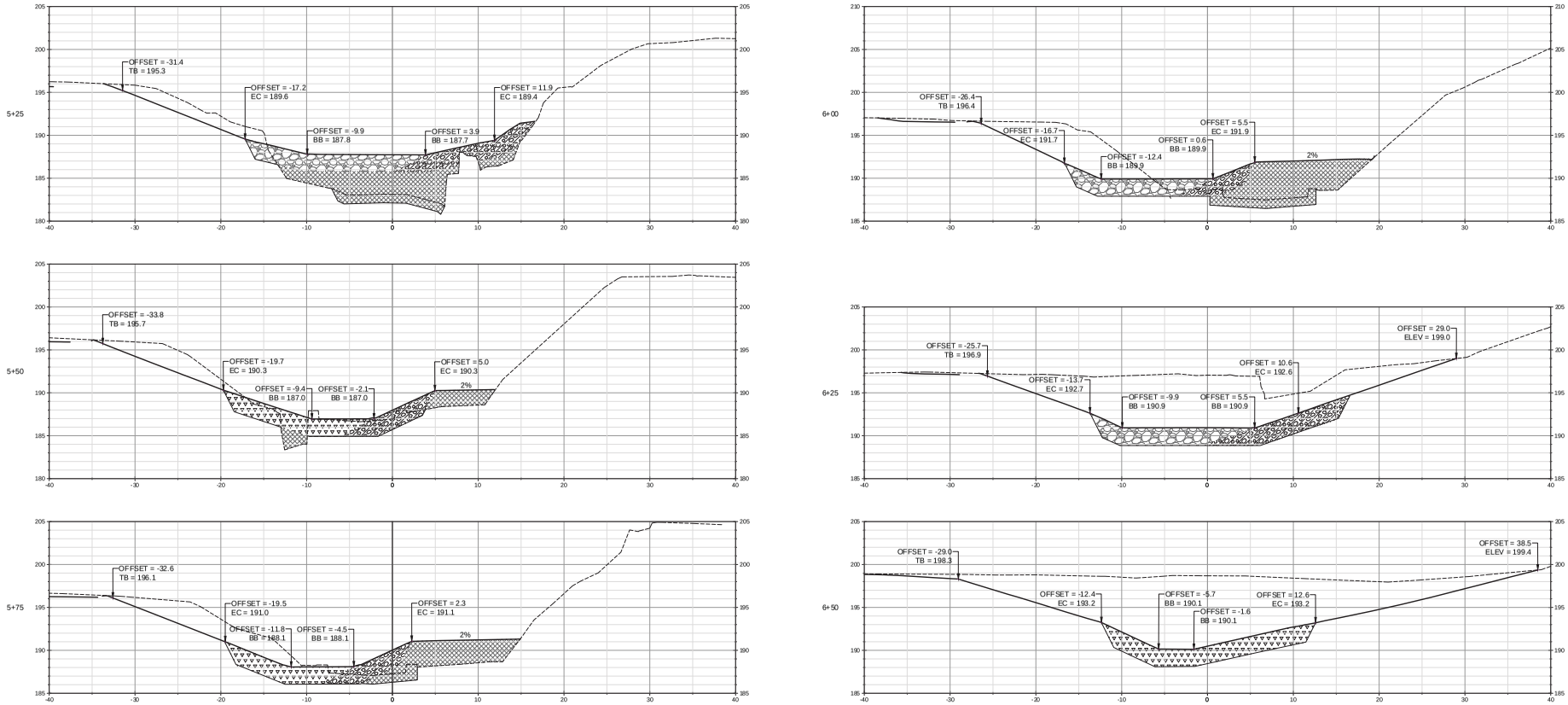
CROSS SECTIONS OF PROPOSED CHANNEL - STATIONS 5+25 TO 6+50

LOOKING DOWNSTREAM



LEGEND

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- PROPOSED SURFACE
- EXCAVATION SURFACE
- BANKFULL ELEVATION (PROFILE ONLY)
- BRUSH LAYERING
- TOE ROCK (SECTION ONLY)
- GENERAL BED MATERIAL
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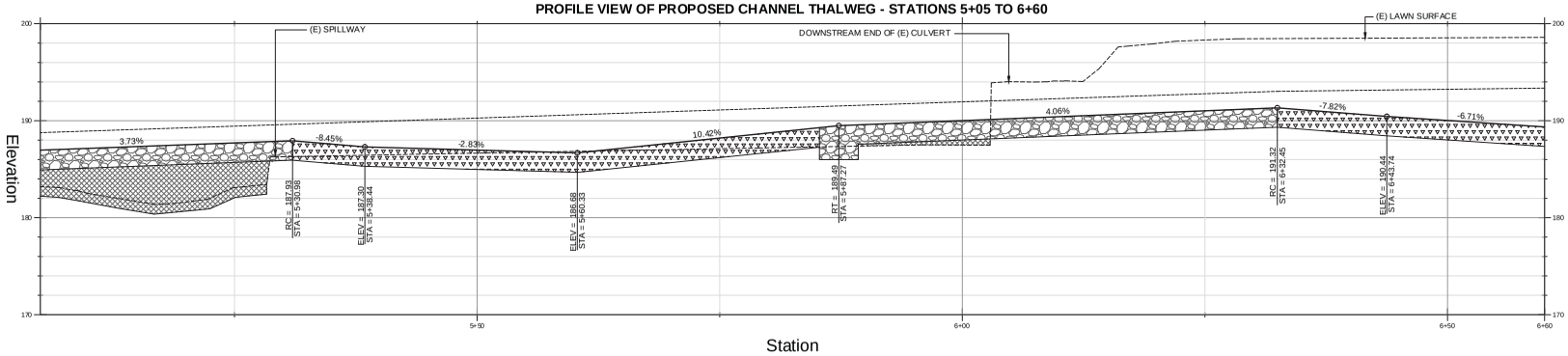
- GENERAL FILL

PROFILE VIEW OF PROPOSED CHANNEL THALWEG - STATIONS 5+05 TO 6+60



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SAUSAL CREEK

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PROFILE AND SECTIONS
STATIONS 5+25 TO 6+50

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L-4.4

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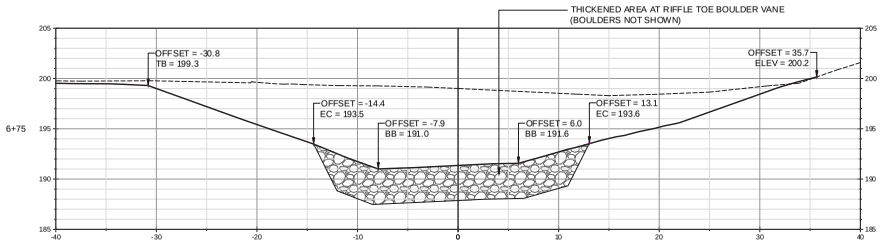
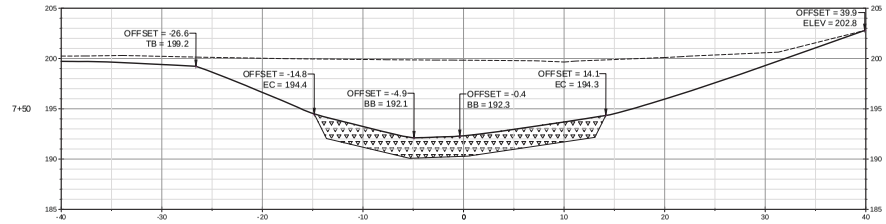
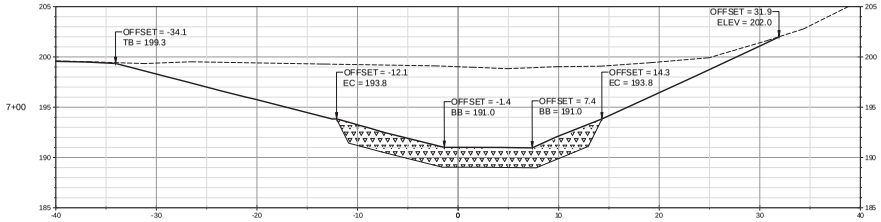
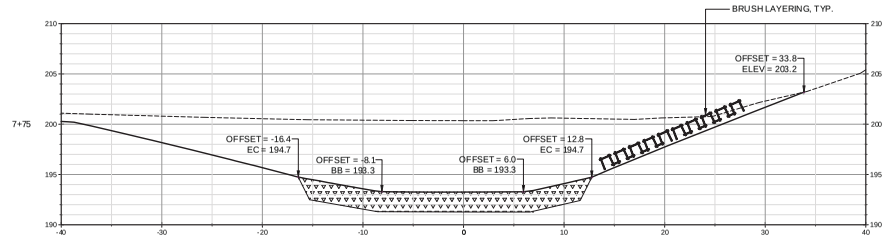
CROSS SECTIONS OF PROPOSED CHANNEL - STATIONS 6+75 TO 8+00

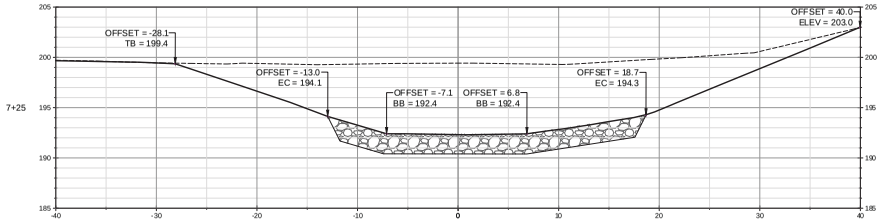
LOOKING DOWNSTREAM

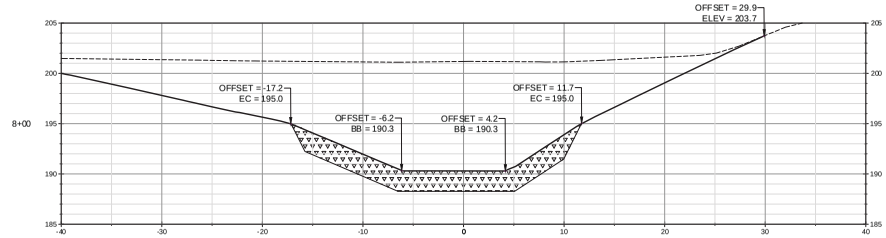








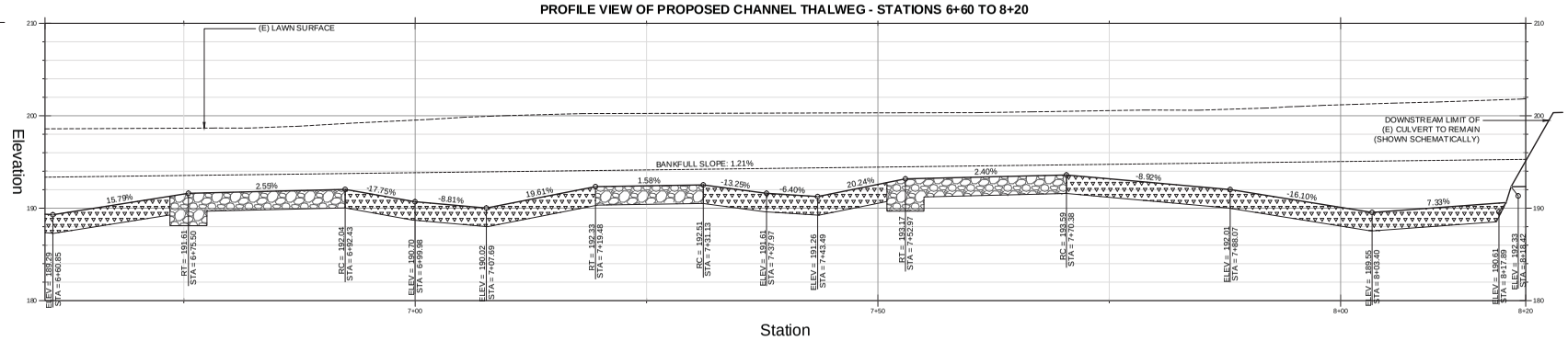




PROFILE VIEW OF PROPOSED CHANNEL THALWEG - STATIONS 6+60 TO 8+20

LEGEND

- EXISTING SURFACE
- PROPOSED SURFACE
- EXCAVATION SURFACE
- BANKFULL ELEVATION (PROFILE ONLY)
- BRUSH LAYERING
- TOE ROCK (SECTION ONLY)
- GENERAL BED MATERIAL
- RIFFLE BED MATERIAL
- GENERAL FILL



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SAUSAL CREEK

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BID SET

PROFILE AND SECTIONS STATIONS 6+75 TO 8+00

SHEET L-4.5

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PLOTTED ON: 9/6/2012

PLANT SCHEDULE

QUANTITY	SOURCE	BOTANICAL NAME & SYMBOL	COMMON NAME	SIZE	PLANT ZONE QUANTITIES																				
					A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
		TREES																						
12	CP	Acer macrophyllum (M15)	Big Leaf Maple	15 GALLON	2			1			1			2	1	4	1							
8	CP	Aesculus californica (B5)	California Buckeye	5 GALLON		1					1			3		1	2							
15	CP	Aesculus californica (B15)	California Buckeye	15 GALLON		1			1	1					3	3	3	2				1		
10	CP	Alnus rhombifolia (A5)	White Alder	5 GALLON	2			2				1		4	1									
12	CP	Alnus rhombifolia (A15)	White Alder	15 GALLON				1	4			2		1	1	1	2							
12	CP	Quercus agrifolia var. agrifolia (Q5)	Coast Live Oak	5 GALLON				4			1			5	1			1						
11	CP	Quercus agrifolia var. agrifolia (Q15)	Coast Live Oak	15 GALLON		2	1		2		1		2			2	1							
588	CP	Salix spp.*	Willow	LIVE POLE	29	54			46		52	7		109	90	81	112			8				
		SHRUBS																						
20	FOSC	Artemisia californica	California Sagebrush	D-40				1			2			2		10	5							
30	FOSC	Baccharis pilularis	Coyote Brush	D-40	3			5			6			6		10								
20	FOSC	Ceanothus oliganthus var. sorediatus	Jim Brush	1 GALLON	8		2	3			2			2		2	1							
195	CP	Cornus sericea ssp. sericea	Creek Dogwood	LIVE STAKE	10	18			16		18	2		37	16	27	38			13				
24	FOSC	Corylus cornuta var. californica	California Hazelnut	1 GALLON		4			4			4					5	3					4	
11	FOSC	Garrya elliptica	Coast Silk-Tassel	1 GALLON	2			2			2			1			2	1					1	
34	FOSC	Holodiscus discolor	Ocean Spray	1 GALLON	3	2	2	1	2	2	2	3	2		2		7	3					3	
10	FOSC	Lonicera involucrata	Twinberry Honeysuckle	1 GALLON	4	3			3															
75	FOSC	Mimulus aurantiacus	Sticky Monkey-Flower	D-16			10	10		5	10			10		15	5	4				1	5	
105	FOSC	Physocarpus capitatus	Ninebark	1 GALLON	10	10		10	10		10	10		5	15	15	5						5	
50	FOSC	Rhamnus californica ssp. californica	Coffeeberry	1 GALLON	6			6			7			5		20	5	1						
30	FOSC	Ribes californicum var. californicum	California Gooseberry	D-40		5			5			5	5		5		5							
55	FOSC	Ribes sanguineum var. glutinosum	Pink-Flowered Currant	1 GALLON		5	5		5	5		5	10				10	4					5	1
35	FOSC	Rosa californica	California Rose	D-40	4			4			4			3		10	5						5	
5	FOSC	Sambucus mexicana	Blue Elderberry	1 GALLON				1						1		2	1							
65	FOSC	Symphoricarpos albus var. laevigatus	Snowberry	1 GALLON		5	5		5	5		5			5		20						15	
		HERBACEOUS PERENNIALS																						
150	FOSC	Achillea millefolium	Yarrow	D-16			10			10		5	5		30	20	20	40				10		
10	FOSC	Aralia californica	Elk-clover	D-40	1			1			3													
105	FOSC	Artemisia douglasiana	Mugwort	D-40	3	4	8	6	6			10	10		20		20	4	8			1	5	
45	FOSC	Asarum caudatum	Wild Ginger	1 GALLON			4		4	4			4					6					20	3
25	FOSC	Carex barbarae	Santa Barbara Sedge	D-16	2	2		2	2		2	2		2	2	2	2						5	
25	FOSC	Carex obnupta	Slough Sedge	D-16	2	2		2	2		2	2		2	2	2	2						5	
140	FOSC	Epilobium canum ssp. canum	California Fuchsia	D-40			20	10		20	20			20		30	10	6				2		
270	FOSC	Festuca californica	California Fescue	D-16		30	30					30	30		30		75	18				7	20	
135	FOSC	Fragaria vesca	Woodland Strawberry	D-16		30	30					10						20				3	35	7
50	FOSC	Heracleum lanatum	Cow Parsnip	D-40		10	10		10			10					10							
125	FOSC	Iris douglasiana	Douglas Iris	D-40		5	5					20	20		20			20				6	25	4
35	FOSC	Juncus effusus var. pacificus	Pacific Rush	D-40	3	3		3	3		3	3		3	3	3	3						5	
70	FOSC	Juncus patens	Common Rush	D-40	2	2		2	2		2	3		3	3	3	3		25		20			
20	FOSC	Juncus xiphioides	Iris-Leaf Rush	D-40	2	2		2	2		2	2		2	2	2	2							
25	FOSC	Mimulus guttatus	Seep Monkey-Flower	D-16	2			3			4			6		6	4							
85	FOSC	Oxalis oregana	Redwood Sorrel	D-40			10		10	10			10					7					35	3
100	FOSC	Phacelia californica	California Phacelia	D-16		5	5	10	5	5	10	10	10	10	5		15	6				2		
20	FOSC	Rubus parviflorus	Thimbleberry	D-40		5	5		5								5							
400	FOSC	Rubus ursinus	California Blackberry	D-16	50	25		50	25		25	25		50		150								
40	FOSC	Satureja douglasii	Yerba Buena	D-40	5	5			5									6				2	15	2
100	FOSC	Scrophularia californica ssp. californica	California Bee Plant	D-16	5	5	5	5	15		10	10		5	10	10	15		5					
100	FOSC	Sisyrinchium bellum	Blue-Eyed Grass	D-16								10	20		20		20	25				5		
50	FOSC	Stachys ajugoides var. rigida	Hedge Nettle	D-16								10	10		10		10	7				2		1
75	FOSC	Tellima grandiflora	Fringecups	D-16					10			10	5		10			12					25	3
		VINES																						
8	CP	Aristolochia californica	Dutchman's Pipe	D-16														6						
5	CP	Ficus pumila 'Minima'	Creeping Fig	1 GALLON														5						
5	FOSC	Lonicera hispidula var. vacillans	California Honeysuckle	1 GALLON		2	1		1								1							
10	FOSC	Vitus California	California Grape	D-16																10				
3,655					160	247	168	147	210	67	202	216	143	299	307	431	452	213	38	31	20	42	238	24

* MIXTURE OF SALIX LAEVIGATA, SALIX LASIOLEPIS, SALIX SCOULERIANA
FOSC = Friends of Sausal Creek: FOSC Nursery will supply these plants. Contractor shall pick up plants and install.
CP = Contractor Provided: Contractor shall source plants and install.

REVEGETATION LEGEND

- PROPERTY BOUNDARY
- LIMIT OF WORK
- MAJOR COUNTOUR
- MINOR CONTOUR
- MULCH TRAIL, LAYOUT PER O.R. DIRECTION
- RAIL FENCE
- RESTORATION FENCE (4 / L-6.4)
- SWALE
- BOULDER
- ROCK DISSIPATER
- ROOTWAD
- BRUSH LAYERING (4 ROWS OF 15 L.F.)
- PLANTING ZONE A-T, BOUNDARY SHOWN SCHEMATICALLY, SEE PLANT SCHEDULE SHEET L-5.1
- LIVE CUTTINGS AT 3'-0" O.C. AVERAGE TRIANGULAR SPACING, LAYOUT PER O.R. DIRECTION 75% SALIX 25% CORNUS
- ROCK SLOPE
- TOE ROCK WITH POLES
- (N) LAWN, FOR TREATMENT OF EXISTING LAWN, SEE NOTES ON PLAN
- EXISTING TREES TO REMAIN
- NEW TREES, SEE REVEGETATION PLANS AND PLANT SCHEDULE FOR SPECIES. FINAL LAYOUT BY O.R.
- DIMOND OAK TRUNKS & STUMPS
- LOG EDGE OR SEATING

REVEGETATION NOTES

1. CONTAINER PLANTS SHALL BE RESTORATION GRADE NATIVE PLANTS. CULTIVARS OF NATIVE SPECIES WILL NOT BE ACCEPTED. COUNTY OF ORIGIN FOR EACH PLANT SHALL BE NOTED IN SUBMITTAL.
2. FINAL LAYOUT OF CONTAINER PLANTS TO BE APPROVED BY O.R. IN THE FIELD. CONTRACTOR TO PROVIDE MEANS OF MARKING PLANT LOCATIONS.
3. PLANTS SHALL BE PLANTED IN DRIFTS TO AVOID EQUAL SPACING, UNLESS OTHERWISE DIRECTED BY O.R.
4. INTERMIX SPECIFIED WILLOW SPECIES WITHIN WILLOW PLANTING AREAS, AS DIRECTED BY O.R.
5. SOIL BIOENGINEERING WILLOW PLANT MATERIAL FOR BRUSH LAYERING AND TOE ROCK POLE INSTALLATION ARE NOT INCLUDED IN PLANT QUANTITIES NOTED ABOVE.
6. ALL LAWN ZONES SHALL BE SEEDED. SEE SPECIFICATIONS FOR SEEDING INFORMATION.
7. SEE SPECIFICATIONS FOR SOIL PREPARATION REQUIREMENTS ALONG ENTIRE CREEK CORRIDOR.
8. PLANT ZONES NOTED AS SEEDED ON PLANS SHALL RECEIVE NATIVE SEED MIX PER THE SPECIFICATIONS. TOTAL AREA REPRESENTS NET SQUARE FOOTAGE; FINAL LAYOUT OF EDGE OF SEEDED AREAS ON LEFT BANK WILL MEANDER ABOVE AND BELOW TOP OF BANK PER O.R. DIRECTION. SEE SPECIFICATIONS FOR NATIVE SEED MIX AND OTHER REQUIREMENTS.
9. ALL AREAS NOT RECEIVING SEED MIX SHALL BE MULCHED PER THE SPECIFICATIONS.

ABBREVIATIONS

AC	ASPHALT CONCRETE
BB	BOTTOM OF BANK
CLR	CLEAR
℄	CENTERLINE
DI	DRAIN INLET
EC	EDGE OF BANKFULL CHANNEL
(E)	EXISTING
EJ	EXPANSION JOINT
DBH	DIAMETER AT BREAST HEIGHT
FG	FINISH GRADE
FS	FINISH SURFACE
GB	GRADE BREAK
HP	HIGH POINT
LB	LEFT BANK
LP	LOW POINT
L.O.W.	LIMIT OF WORK
MM	MEET AND MATCH
NIC	NOT IN CONTRACT
OC	ON CENTER
O.R.	OWNER'S REPRESENTATIVE
PA	PLANTING AREA
POC	POINT OF CONNECTION
PP	PRESERVE AND PROTECT
PR	PRUNE AS NOTED ON PLANS
R	REMOVE
RB	RIGHT BANK
RC	RIFFLE CREST
RT	RIFFLE TOE
R.O.W	RIGHT-OF-WAY
S	SALVAGE
SJ	SCORE JOINT
STD	STANDARD
TBD	TO BE DETERMINED
TB	TOP OF BANK
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
XS	CROSS SECTION

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REVEGETATION LEGEND

SHEET L-5.1

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REVEGETATION LEGEND

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- MINOR CONTOUR
- MULCH TRAIL, LAYOUT PER O.R. DIRECTION
- RAIL FENCE
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- DIMOND OAK TRUNKS & STUMPS
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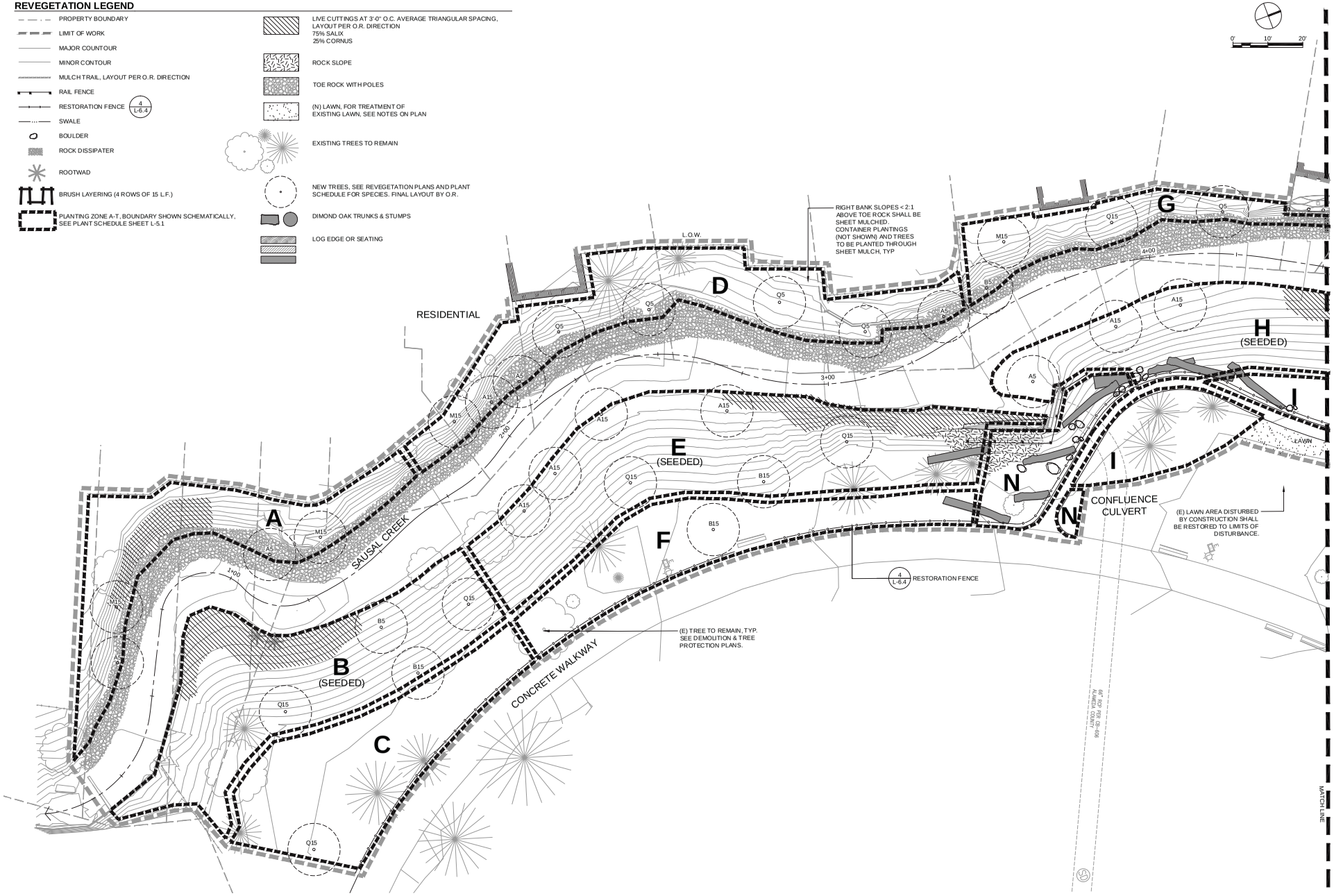

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SAUSAL CREEK
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REVEGETATION DOWNSTREAM

SHEET L-5.2

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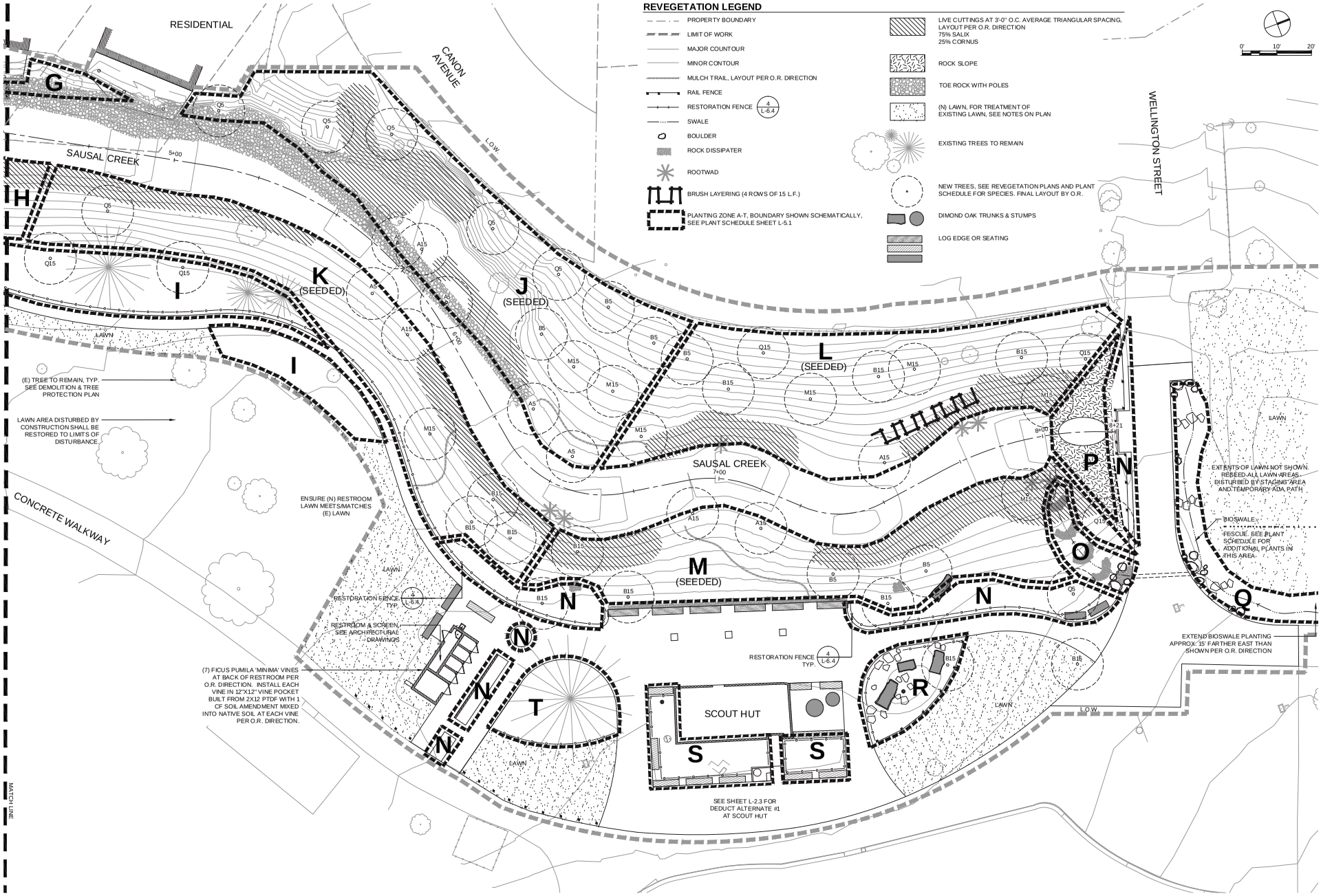

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REVEGETATION UPSTREAM

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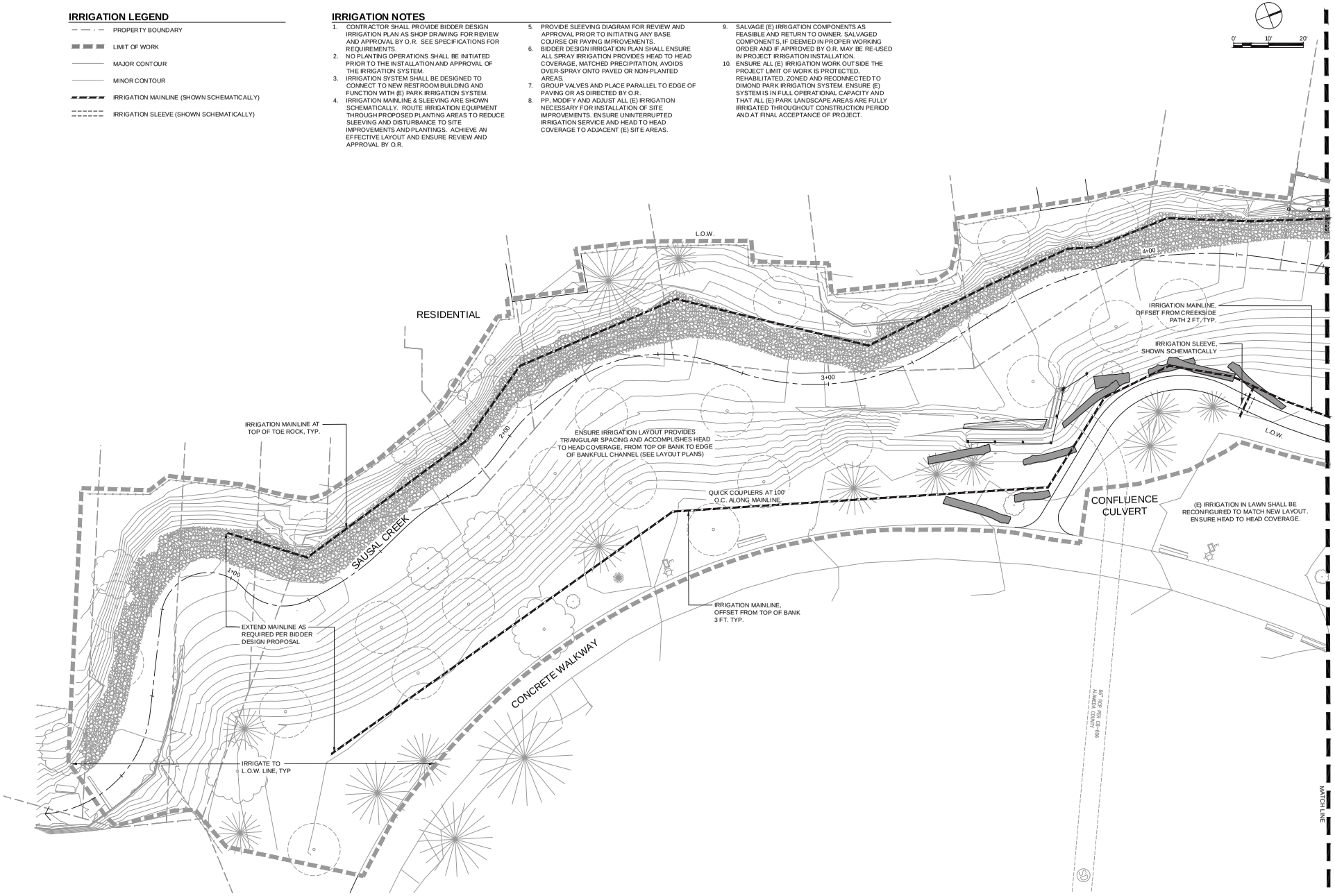
IRRIGATION LEGEND

- PROPERTY BOUNDARY
- LIMIT OF WORK
- MAJOR CONTOUR
- MINOR CONTOUR
- IRRIGATION MAINLINE (SHOWN SCHEMATICALLY)
- IRRIGATION SLEEVE (SHOWN SCHEMATICALLY)

IRRIGATION NOTES

1. CONTRACTOR SHALL PROVIDE BIDDER DESIGN IRRIGATION PLAN AS SHOP DRAWING FOR REVIEW AND APPROVAL BY O.R. SEE SPECIFICATIONS FOR REQUIREMENTS.
2. NO PLANTING OPERATIONS SHALL BE INITIATED PRIOR TO THE INSTALLATION AND APPROVAL OF THE IRRIGATION SYSTEM.
3. IRRIGATION SYSTEM SHALL BE DESIGNED TO CONNECT TO NEW RESTROOM BUILDING AND FUNCTION WITH (E) PARK IRRIGATION SYSTEM.
4. IRRIGATION MAINLINE & SLEEVING ARE SHOWN SCHEMATICALLY. ROUTE IRRIGATION EQUIPMENT THROUGH PROPOSED PLANTING AREAS TO REDUCE SLEEVING AND DISTURBANCE TO SITE IMPROVEMENTS AND PLANTINGS. ACHIEVE AN EFFECTIVE LAYOUT AND ENSURE REVIEW AND APPROVAL BY O.R.
5. PROVIDE SLEEVING DIAGRAM FOR REVIEW AND APPROVAL PRIOR TO INITIATING ANY BASE COURSE OR PAVING IMPROVEMENTS.
6. BIDDER DESIGN IRRIGATION PLAN SHALL ENSURE ALL SPRAY IRRIGATION PROVIDES HEAD TO HEAD COVERAGE, MATCHED PRECIPITATION, AVOIDS OVER-SPRAY ONTO PAVED OR NON-PLANTED AREAS.
7. GROUP VALVES AND PLACE PARALLEL TO EDGE OF PAVING OR AS DIRECTED BY O.R.
8. PP, MODIFY AND ADJUST ALL (E) IRRIGATION NECESSARY FOR INSTALLATION OF SITE IMPROVEMENTS. ENSURE UNINTERRUPTED IRRIGATION SERVICE AND HEAD TO HEAD COVERAGE TO ADJACENT (E) SITE AREAS.
9. SALVAGE (E) IRRIGATION COMPONENTS AS FEASIBLE AND RETURN TO OWNER. SALVAGED COMPONENTS, IF DEEMED IN PROPER WORKING ORDER AND IF APPROVED BY O.R. MAY BE RE-USED IN PROJECT IRRIGATION INSTALLATION.
10. ENSURE ALL (E) IRRIGATION WORK OUTSIDE THE PROJECT LIMIT OF WORK IS PROTECTED, REHABILITATED, ZONED AND RECONNECTED TO DIMOND PARK IRRIGATION SYSTEM. ENSURE (E) SYSTEM IS IN FULL OPERATIONAL CAPACITY AND THAT ALL (E) PARK LANDSCAPE AREAS ARE FULLY IRRIGATED THROUGHOUT CONSTRUCTION PERIOD AND AT FINAL ACCEPTANCE OF PROJECT.



DATE	NO.	REVISIONS

DESIGN BY: BB / ES
DRAWN BY: JS / ES / PR
CHECKED BY: BB
SCALE: 1"=10'
DATE: SEPTEMBER 7, 2012

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SAUSAL CREEK
RESTORATION PROJECT IN DIMOND PARK

BID SET

IRRIGATION DIAGRAM DOWNSTREAM

SHEET
L-5.4

SAUSAL CREEK: BID SET CONSTRUCTION DOCUMENTS - S:\PROJECTS\SAUSAL CREEK - DIMOND PARK\ AUTOCAD\WORKING DRAWINGS\L-5-PLANTING.DWG
PLOTTED ON: 9/6/2012

IRRIGATION NOTES

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4. IRRIGATION MAINLINE & SLEEVING ARE SHOWN SCHEMATICALLY. ROUTE IRRIGATION EQUIPMENT THROUGH PROPOSED PLANTING AREAS TO REDUCE SLEEVING AND DISTURBANCE TO SITE IMPROVEMENTS AND PLANTINGS. ACHIEVE AN EFFECTIVE LAYOUT AND ENSURE REVIEW AND APPROVAL BY O.R.
5. PROVIDE SLEEVING DIAGRAM FOR REVIEW AND APPROVAL PRIOR TO INITIATING ANY BASE COURSE OR PAVING IMPROVEMENTS.
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7. GROUP VALVES AND PLACE PARALLEL TO EDGE OF PAVING OR AS DIRECTED BY O.R.
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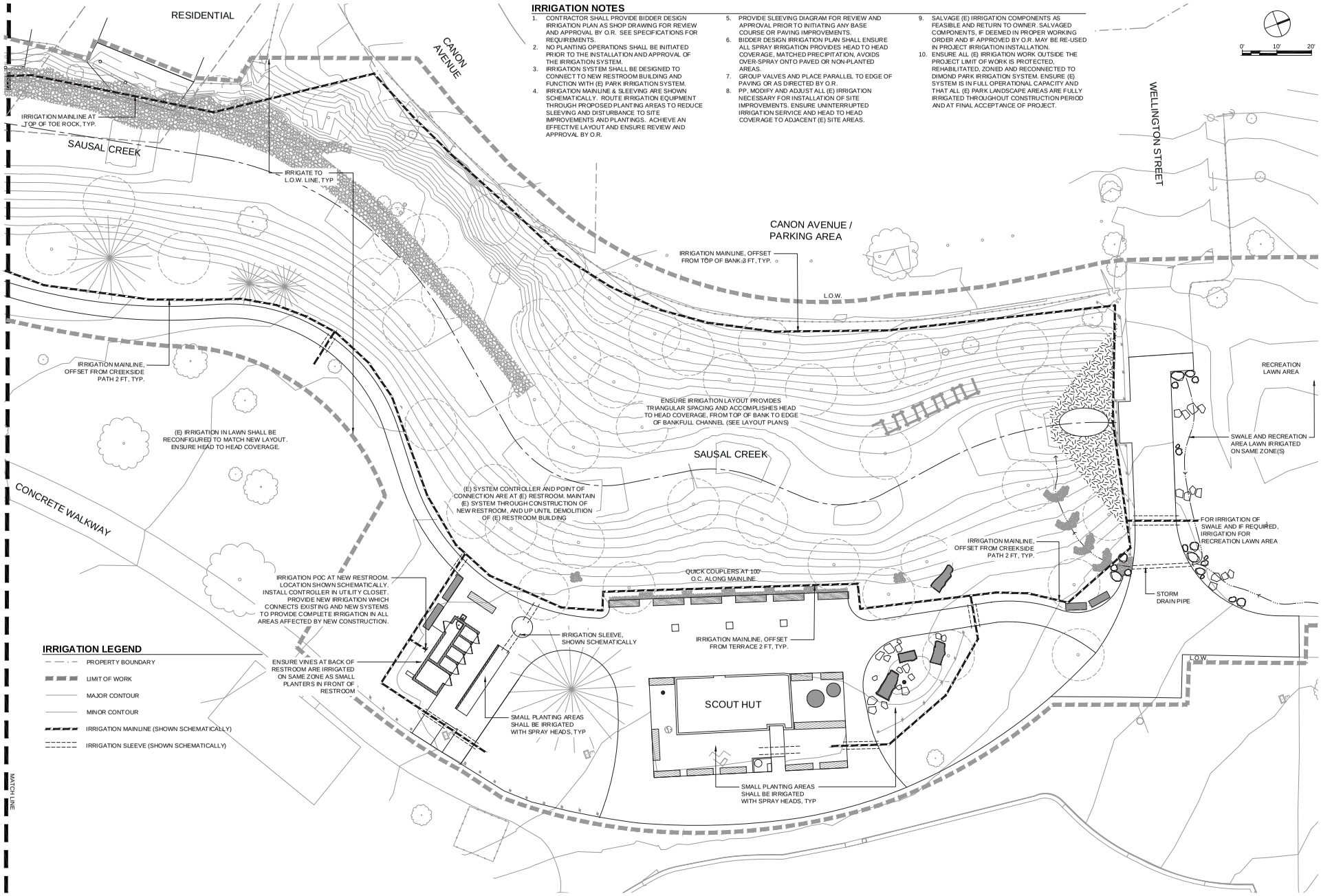

IRRIGATION LEGEND

- PROPERTY BOUNDARY
- LIMIT OF WORK
- MAJOR CONTOUR
- MINOR CONTOUR
- IRRIGATION MAINLINE (SHOWN SCHEMATICALLY)
- IRRIGATION SLEEVE (SHOWN SCHEMATICALLY)

DATE	NO.	REVISIONS

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SCALE: 1"=10'
DATE: SEPTEMBER 7, 2012

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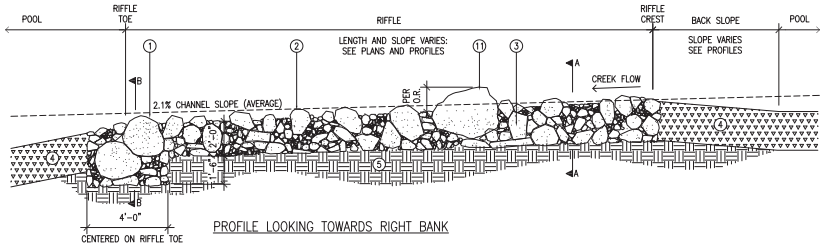
SAUSAL CREEK
RESTORATION PROJECT IN DIMOND PARK

BID SET

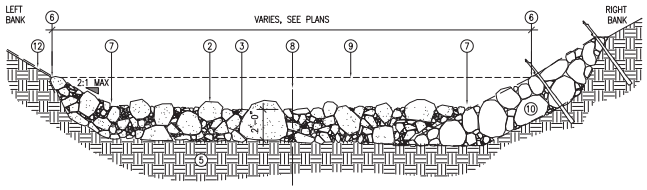
IRRIGATION DIAGRAM UPSTREAM

SHEET L-5.5

1. BOULDER VANE, SET DOWNSTREAM BOULDER BELOW UPSTREAM BOULDER AS SHOWN. (2/L-6.1)
2. PROVIDE ROUGHENED BED SURFACE WITH LARGER COBBLES PROTRUDING ABOVE RIFFLE SURFACE UP TO 6 INCHES PER O.R. DIRECTION
3. RIFFLE BED MATERIAL, 2'-0" DEPTH, SEE SPECIFICATIONS
4. GENERAL BED MATERIAL, SEE SPECIFICATIONS
5. SUBGRADE
6. EDGE OF BANKFULL CHANNEL
7. BOTTOM OF BANK
8. CHANNEL CENTERLINE
9. BANKFULL ELEVATION
10. TOE ROCK WITH POLES. SEE PLANS FOR LOCATIONS; WHERE NO TOE ROCK, EXTEND RIFFLE TO BANKFULL ELEVATION AS SHOWN ON LEFT BANK. (3/L-6.1)
11. CREEK BOULDER, INSTALL PER O.R DIRECTION. SEE LAYOUT PLANS FOR APPROXIMATE LOCATIONS.
12. FABRIC, EMBED 12" MINIMUM AT ALL EDGES



PROFILE LOOKING TOWARDS RIGHT BANK

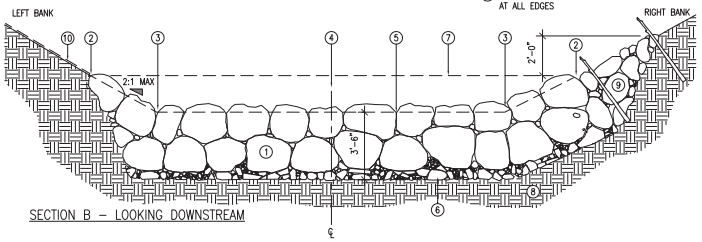


SECTION A – LOOKING DOWNSTREAM

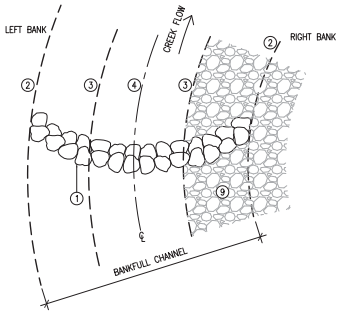
1 RIFFLE

SCALE: NTS

1. 1/2 TON BOULDERS. SET DOWNSTREAM BOULDER BELOW UPSTREAM BOULDER. ENSURE THREE POINTS OF CONTACT. EXTEND ACROSS ENTIRE BANKFULL CHANNEL.
2. EDGE OF BANKFULL CHANNEL
3. BOTTOM OF BANK
4. CHANNEL CENTERLINE
5. RIFFLE TOE ELEVATION NOTED IN PROFILES SHALL BE MET AT LOW POINT BETWEEN BOULDER NOTCHES, TYP. (1/L-6.1)
6. CHANNEL GRAVEL MIX, +/– 6" DEPTH, PLACE UNDER BOULDER VANE TO ENSURE RIFFLE TOE IS SET TO ELEVATIONS SHOWN ON PLANS.
7. BANKFULL ELEVATION
8. SUBGRADE
9. TOE ROCK, EXTEND 2' ABOVE EDGE OF BANKFULL CHANNEL. SEE PLANS FOR LOCATIONS; WHERE NO TOE ROCK, EXTEND BOULDER VANE TO BANKFULL ELEVATION AS SHOWN ON LEFT BANK. (3/L-6.1)
10. FABRIC, EMBED 12" MINIMUM AT ALL EDGES



SECTION B – LOOKING DOWNSTREAM



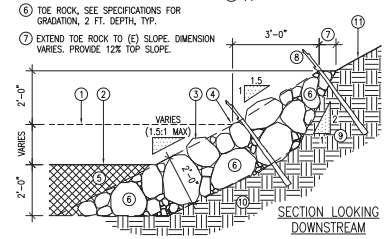
PLAN VIEW

2 BOULDER VANE

SCALE: NTS

1. BANKFULL ELEVATION
2. CHANNEL INVERT
3. TOE ROCK SURFACE SHALL BE UNEVEN; LARGER ROCKS PROTRUDE UP TO 6" BEYOND SURFACE
4. EDGE OF BANKFULL CHANNEL
5. RIFFLE BED OR GENERAL BED MATERIAL, SEE SECTIONS AND SPECIFICATIONS
6. TOE ROCK, SEE SPECIFICATIONS FOR GRADATION, 2 FT. DEPTH, TYP.
7. EXTEND TOE ROCK TO (E) SLOPE. DIMENSION VARIES. PROVIDE 12% TOP SLOPE.
8. WILLOW POLE, (2) COURSES OF POLES AT 3' O.C. AVERAGE HORIZONTAL SPACING. PLACE LOWER POLE COURSE DURING FIRST LIFT OF TOE ROCK INSTALLATION.
9. WHERE (E) CONDITIONS REQUIRE EXCAVATION TO RECIEVE IMPROVEMENTS, CUT SLOPE AT 1:2 MAX ANGLE AS SHOWN
10. SUBGRADE
11. (E) SLOPE ON RIGHT BANK

NOTE: SEE REVEGETATION PLANS FOR TREE LOCATIONS IN TOE ROCK. INSTALL PER O.R. DIRECTION.

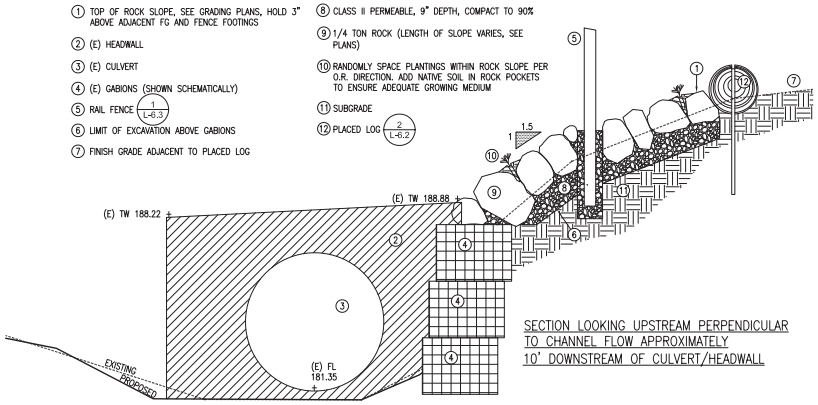


SECTION LOOKING DOWNSTREAM

3 TOE ROCK WITH POLES

SCALE: NTS

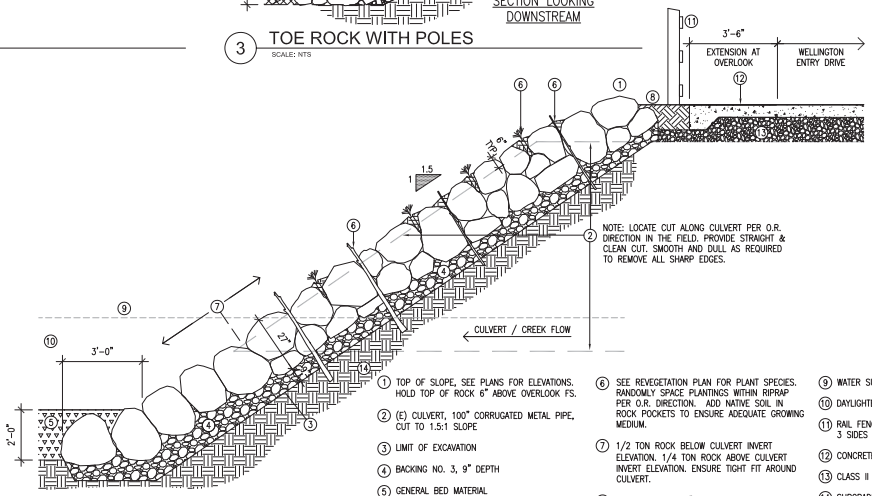
1. TOP OF ROCK SLOPE, SEE GRADING PLANS, HOLD 3" ABOVE ADJACENT FG AND FENCE FOOTINGS
2. (E) HEADWALL
3. (E) CULVERT
4. (E) GABIONS (SHOWN SCHEMATICALLY)
5. RAIL FENCE (1/L-6.3)
6. LIMIT OF EXCAVATION ABOVE GABIONS
7. FINISH GRADE ADJACENT TO PLACED LOG
8. CLASS II PERMEABLE, 9" DEPTH, COMPACT TO 90%
9. 1/4 TON ROCK (LENGTH OF SLOPE VARIES, SEE PLANS)
10. RANDOMLY SPACE PLANTINGS WITHIN ROCK SLOPE PER O.R. DIRECTION. ADD NATIVE SOIL IN ROCK POCKETS TO ENSURE ADEQUATE GROWING MEDIUM
11. SUBGRADE
12. PLACED LOG (2/L-6.2)



SECTION LOOKING UPSTREAM PERPENDICULAR TO CHANNEL FLOW APPROXIMATELY 10' DOWNSTREAM OF CULVERT/HEADWALL

4 CONFLUENCE OVERLOOK ROCK SLOPE

SCALE: NTS



NOTE: LOCATE CUT ALONG CULVERT PER O.R. DIRECTION IN THE FIELD. PROVIDE STRAIGHT & CLEAN CUT. SMOOTH AND DULL AS REQUIRED TO REMOVE ALL SHARP EDGES.

SECTION LOOKING TOWARDS RIGHT BANK

1. TOP OF SLOPE, SEE PLANS FOR ELEVATIONS. HOLD TOP OF ROCK 6" ABOVE OVERLOOK FS.
2. (E) CULVERT, 100" CORRUGATED METAL PIPE, CUT TO 1.5:1 SLOPE
3. LIMIT OF EXCAVATION
4. BACKING NO. 3, 9" DEPTH
5. GENERAL BED MATERIAL
6. SEE REVEGETATION PLAN FOR PLANT SPECIES. RANDOMLY SPACE PLANTINGS WITHIN RIPRAP PER O.R. DIRECTION. ADD NATIVE SOIL IN ROCK POCKETS TO ENSURE ADEQUATE GROWING MEDIUM.
7. 1/2 TON ROCK BELOW CULVERT INVERT ELEVATION. 1/4 TON ROCK ABOVE CULVERT INVERT ELEVATION. ENSURE TIGHT FIT AROUND CULVERT.
8. PLANTING SOIL, 12" DEPTH, BETWEEN CONCRETE PAVING AND ROCK
9. WATER SURFACE @ BASE FLOW
10. DAYLIGHTED CREEK CHANNEL
11. RAIL FENCE WITH MESH INFILL ON 3 SIDES OF OVERLOOK (1/L-6.3)
12. CONCRETE PAVING WITH THICKENED EDGE (9/L-6.3)
13. CLASS II PERMEABLE, COMPACT TO 95%
14. SUBGRADE

5 WELLINGTON OVERLOOK ROCK SLOPE

SCALE: NTS

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SCALE:
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SAUSAL CREEK

RESTORATION PROJECT IN DIMOND PARK

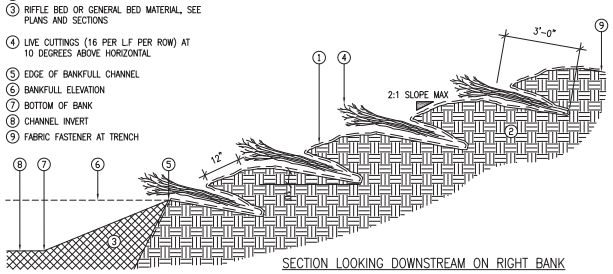
BID SET

DETAILS

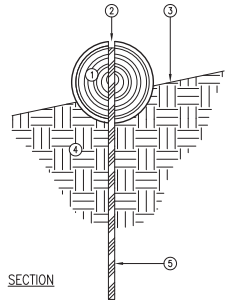
SHEET L-6.1

SAUSAL CREEK: BID SET CONSTRUCTION DOCUMENTS - S:\PROJECTS\SAUSAL CREEK\DIMOND PARK\AUTOCAD\WORKING DRAWINGS\DETAILS.DWG
PLOTTED: ON 9/6/2012

1. FABRIC, EMBED 12" MINIMUM AT ALL EDGES
2. GENERAL FILL
3. RIFFLE BED OR GENERAL BED MATERIAL, SEE PLANS AND SECTIONS
4. LIVE CUTTINGS (16 PER L.F PER ROW) AT 10 DEGREES ABOVE HORIZONTAL
5. EDGE OF BANKFULL CHANNEL
6. BANKFULL ELEVATION
7. BOTTOM OF BANK
8. CHANNEL INVERT
9. FABRIC FASTENER AT TRENCH



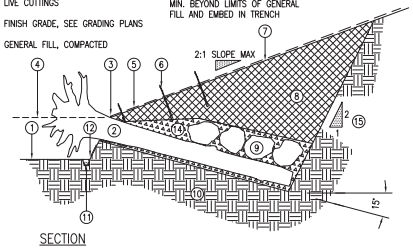
1 BRUSH LAYERING
SCALE: NTS

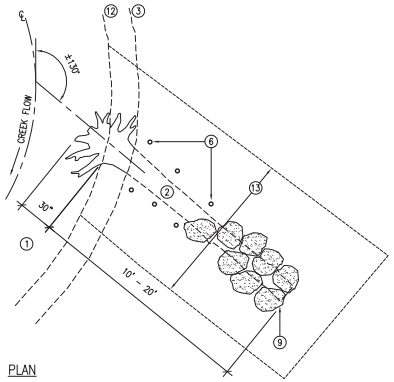


1. PLACED LOG, 18" TO 24" DIAMETER, 10' TO 20' LENGTH. LOG SELECTION PER O.R. BURY 1/3 DIAMETER. SEE PLAN FOR LOCATIONS.
2. PRE-DRILL 1-1/2" DIAMETER HOLE THROUGH CENTER OF LOG. SPACE HOLES AT ±3'-0" O.C. (THREE HOLES MIN. PER LOG). START DRILL HOLES 12" FROM END OF LOG, TYP.
3. FINISH GRADE, SEE GRADING PLANS
4. SUBGRADE
5. 1-1/2" DIAMETER GALVANIZED STEEL PIPE DRIVEN TO REFUSAL (6'-0" MINIMUM OVERALL LENGTH). DRIVE TOP OF PIPE 2" BELOW SURFACE OF LOG, TYP.

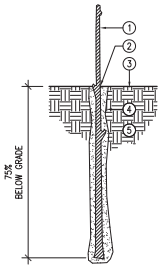
2 PLACED LOG
SCALE: NTS

1. CHANNEL INVERT
2. ROOTWAD, EXTEND 30" INTO ACTIVE CHANNEL
3. EDGE OF BANKFULL CHANNEL (EC)
4. BANKFULL ELEVATION
5. FABRIC, EMBED 12" MINIMUM IN TRENCH AT ALL EDGES.
6. LIVE CUTTINGS
7. FINISH GRADE, SEE GRADING PLANS
8. GENERAL FILL, COMPACTED
9. 1/4 TON RIPRAP – PROVIDE 2 TONS TOTAL COVERAGE PER TRUNK. HOLD HIGHEST ROCK 12" BELOW FINISH GRADE.
10. SUBGRADE
11. FABRIC TRENCH
12. BOTTOM OF BANK (BB)
13. FABRIC LIMITS, EXTEND FABRIC 12" MIN. BEYOND LIMITS OF GENERAL FILL AND EMBED IN TRENCH
14. ANGULAR ROCK BACKFILL 3" DEPTH UNDER ROOTWAD, PLACE AROUND ROOTWAD TO FILL VOIDS. INSTALL BOULDERS, FILL AROUND VOIDS IN BOULDERS TO THE LEVEL NECESSARY TO OBTAIN COMPACTABLE SURFACE.
15. WHERE (E) CONDITIONS REQUIRE EXCAVATION TO RECEIVE IMPROVEMENTS, CUT SLOPE AT 1:2 MAX ANGLE AS SHOWN





3 ROOT WAD
SCALE: NTS



1. LIVE CUTTING (POLE OR STAKE) – SEE SPECIFICATIONS FOR LENGTH AND SIZE
2. DRILL PILOT HOLE 1" DIAMETER LARGER THAN LIVE CUTTING DIAMETER
3. FINISH GRADE
4. NATIVE SOIL, VOID OF AIR POCKETS, SEE SPECIFICATIONS
5. SUBGRADE

NOTE: SET ALL LIVE CUTTINGS PERPENDICULAR TO SLOPE. INSTALL WITH IRREGULAR SPACING (NATURALISTIC) PER O.R. DIRECTION. SEE PLANS FOR APPROXIMATE SPACING.

4 LIVE CUTTINGS
SCALE: NTS

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SAUSAL CREEK
RESTORATION PROJECT IN DIMOND PARK

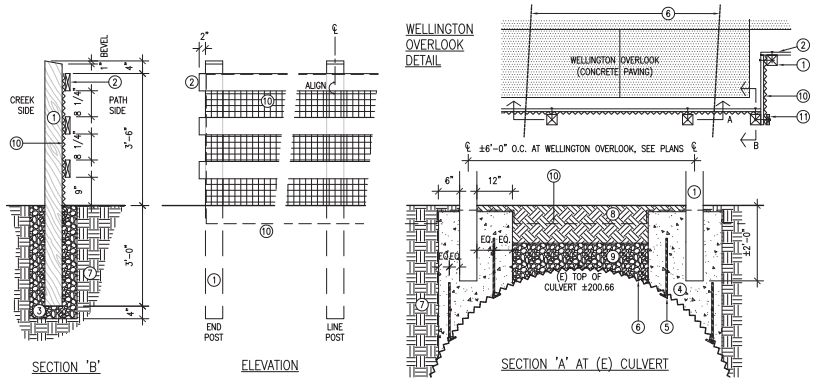
BID SET

DETAILS

SHEET
L-6.2

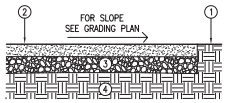
SAUSAL CREEK: BID SET CONSTRUCTION DOCUMENTS - S:\PROJECTS\SAUSAL CREEK - DIMOND PARK\0 AUTOCAD\WORKING DRAWINGS\DETAILS.DWG
PLOTTED ON: 9/6/2012

1. WOOD POST, 6X6, 8'-0" O.C. MAX. (AS SHOWN ON PLANS), LAYOUT BY O.R.
2. WOOD RAILS, 2X6, (3) CONTINUOUS, BUTT JOINTS AT ℄ OF POSTS. WRAP AROUND POST AT CORNERS AND EXTEND 2" PAST END POSTS. PRE-DRILL HOLES AND ATTACH W/ GALVANIZED LAG SCREWS.
3. BASE COURSE POST FOOTING, 15" DIAMETER, COMPACT TO 95% (TYPICAL, UON).
4. (2) CONCRETE FOOTINGS ABOVE CULVERT, FINISH SURFACE 2" BELOW ADJACENT PAVEMENT (SLOPE TO DRAIN). NOTCH METAL MESH TO CLEAR CONCRETE FOOTINGS
5. #6 REBAR PIN, 24" MIN. LENGTH WITH 6" BENT END (90°) INSIDE CULVERT (4 PER FOOTING). WELD 6" BEND TO TOP OF INSIDE OF CULVERT TO SECURE IN PLACE.
6. (E) CULVERT (LOCATION SHOWN SCHEMATICALLY)
7. SUBGRADE
8. NATIVE SOIL BACKFILL, 12" DEPTH, PER DETAIL 5, L-6.1
9. CLASS II PERMEABLE ABOVE TOP OF CULVERT, COMPACT TO 95%.
10. GUARDRAIL METAL SCREEN, SANDWICHED BETWEEN RAILS AND POSTS AT CONFLUENCE AND WELLINGTON OVERLOOKS (±80 L.F.), SEE SPECIFICATIONS. FINAL LAYOUT / EXTENTS OF SCREEN PER O.R. DIRECTION. JOINTS BETWEEN SCREEN SECTIONS SHALL ONLY FALL ON ℄ OF POSTS AND ENDS OF SCREEN SHALL BE COMPLETE WITH VERTICAL MESH BAR AT ENDS. EXTEND SCREEN TO OUTSIDE EDGE OF POST, TYP. EMBED SCREEN INTO GROUND ±6". GRIND ALL CUT SCREEN ENDS SMOOTH. ATTACH SCREEN TO BACK OF RAILS, 2X EA. RAIL.
11. 2X6, VERTICAL, TO SANDWICH GUARDRAIL METAL SCREEN TO POST AT OUTSIDE ENDS (WOOD TO MATCH RAILS). ATTACH W/ GALVANIZED LAG SCREWS TO MATCH RAILS. OMIT WHERE NO METAL SCREEN IS USED.



1 RAIL FENCE
SCALE: NTS

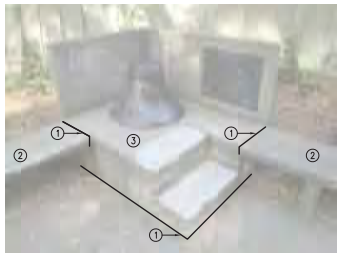
1. ADJACENT FINISH GRADE FLUSH TO DG PAVING
2. DECOMPOSED GRANITE, 3" DEPTH, SEE SPECIFICATIONS
3. CLASS II PERMEABLE, 4" DEPTH
4. COMPACTED SUBGRADE



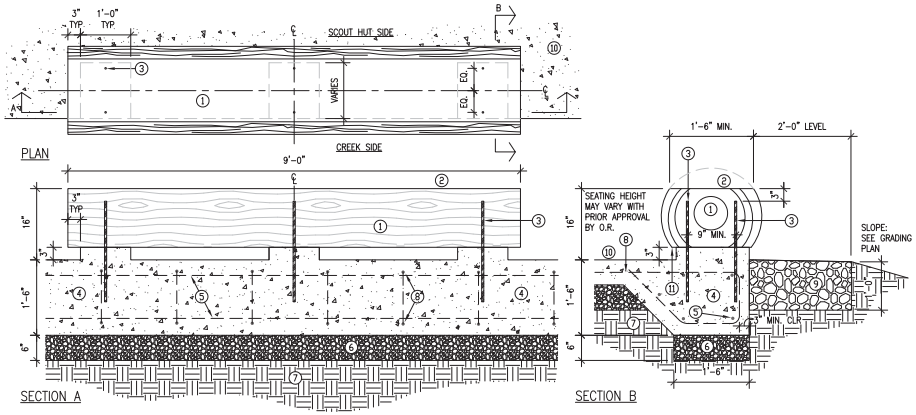
2 DG PAVING
SCALE: NTS

1. SAWCUT AS SHOWN
2. DEMOLISH ADJACENT SEATWALLS
3. PRESERVE/PROTECT BELL, STAIRS, BASE, WALLS AND PLAQUE. SEE PLANS AND SPECIFICATIONS FOR RELOCATION. PROTECT DURING CONSTRUCTION PER SPECIFICATIONS.

NOTE: SEE SHEET L-2.3 FOR DEDUCT ALTERNATE #1

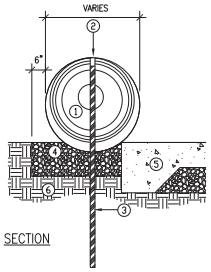


3 BELL AT SCOUT HUT
SCALE: NTS



1. SALVAGED LOG, SEE L-1.1, EXISTING TREE SCHEDULE. LOG SELECTION AND FINAL SEATING HEIGHT PER O.R. DIRECTION.
2. CUT TOP FACE OF LOG TO PROVIDE A LEVEL SURFACE. SAND SMOOTH FOR SEATING AND EASE EDGES. FINISH PER SPECIFICATIONS.
3. DRILL 3/4" DIAMETER HOLES FOR REBAR PINS INTO UNDERSIDE OF LOG ONLY. EPOXY SET EACH PIN INTO LOG. PINS SHALL BE #5 REBAR CUT TO 24" LENGTH AND HOT DIP GALVANIZED.
4. CONCRETE FOOTING (OVERSIZE THICKENED EDGE), CAST #5 REBAR PINS INTO FOOTING AND TIE TO SLAB REBAR. EXTEND FOOTING ACROSS ENTIRE TERRACE EDGE.
5. (5) #4 REBAR, CONTINUOUS
6. BASE COURSE, 6" DEPTH
7. COMPACTED SUBGRADE
8. EXTEND CONCRETE PAVING SLAB REBAR (#4 AT 18" O.C.) INTO FOOTING AND WRAP ALL FIVE BARS.
9. ROCK DISSIPATER, SEE SPECIFICATIONS
10. CONCRETE PAVING (9 / L-6.3)
11. OVERHANG LOG, BOTH SIDES OF FOOTING PER O.R. DIRECTION (3" MAX). TOP OF LOG FOOTING VARIES TO HOLD SPECIFIC LOG SIZE/SHAPE PER O.R. DIRECTION.

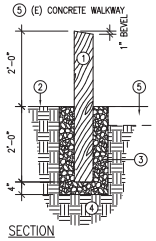
4 TERRACE LOG SEATING
SCALE: NTS



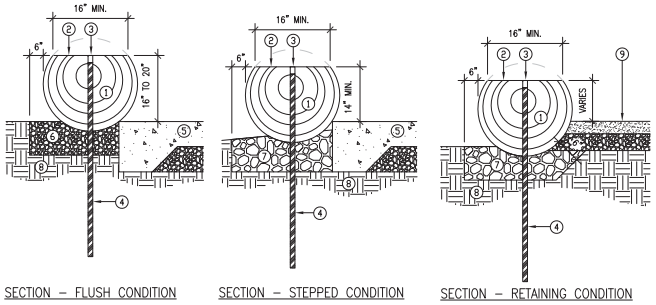
1. SALVAGED LOG, SEE L-1.1, EXISTING TREE SCHEDULE. LENGTH PER PLANS. LOG SELECTION PER O.R. DIRECTION.
2. CORE DRILL FOR PIPE AND FILL WITH REDWOOD CORED PLUG. INSTALL FINAL PLUG, 3" LONG. GLUE, THEN CUT PLUG FLUSH AND SAND SMOOTH.
3. 1 1/2" DIAMETER GALVANIZED PIPE DRIVEN TO REFUSAL (6'-0" MIN. OVERALL LENGTH). DRIVE TOP 3" BELOW TOP OF LOG SURFACE. (3) PIPE STAKES PER 6' LOG, (4) PIPE STAKES PER 8' LOG.
4. BASE COURSE, 8" DEPTH, EMBED LOG 4" MINIMUM.
5. CONCRETE PAVING (9 / L-6.3)
6. COMPACTED SUBGRADE

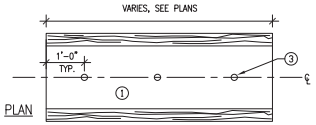
5 LOG EDGING
SCALE: NTS

1. 6X6 WOOD POST, ALL EDGES EASED
2. FINISH GRADE
3. BASE COURSE FOOTING, 15" DIAMETER, 95% COMPACTION
4. SUBGRADE
5. (E) CONCRETE WALKWAY



6 WOODEN BOLLARD
SCALE: NTS

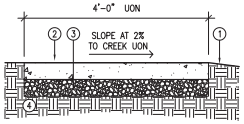




1. SALVAGED LOG, SEE L-1.1, EXISTING TREE SCHEDULE. LENGTH PER PLANS. LOG SELECTION AND SEATING HEIGHT PER O.R. DIRECTION.
2. CUT TOP FACE OF LOG IF REQUESTED BY O.R. TO PROVIDE LEVEL SURFACE PER O.R. DIRECTION. SAND SMOOTH FOR SEATING AND EASE EDGES. FINISH PER SPECIFICATIONS.
3. CORE DRILL FOR PIPE AND FILL WITH REDWOOD CORED PLUG. INSTALL FINAL PLUG, 3" LONG. GLUE, THEN CUT PLUG FLUSH AND SAND SMOOTH.
4. 1 1/2" DIAMETER GALVANIZED PIPE DRIVEN TO REFUSAL (6'-0" MINIMUM OVERALL LENGTH). DRIVE TOP 3" BELOW TOP OF LOG SURFACE. (3) PIPE STAKES PER 6' LOG, (4) PIPE STAKES PER 8–9' LOG, (5) PIPE STAKES PER 10'+ LOG.
5. CONCRETE PAVING (9 / L-6.3)
6. BASE COURSE (8" DEPTH) OR DG PAVING, EMBED LOG MIN. 4"
7. NO. 3 BACKING, 8" DEPTH, UNDER LOG FOR STEPPED OR RETAINING CONDITION, EMBED LOG MIN. 4"
8. COMPACTED SUBGRADE
9. DG PAVING (2 / L-6.3)

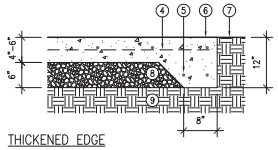
7 SCOUT HUT LOG SEATING
SCALE: NTS

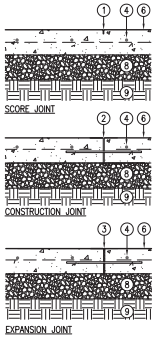
1. ADJACENT FG FLUSH TO CONCRETE FS. ENSURE POSITIVE DRAINAGE
2. CONCRETE, 4" DEPTH (9 / L-6.3)
3. BASE COURSE, 4" DEPTH
4. COMPACTED SUBGRADE



8 CREEKSIDE PATH
SCALE: NTS

1. SCORE JOINT, 1" DEEP, 3/16" TO 1/4" WIDE, 1/8" RADIUS PER PLANS, CITY STANDARDS, OR O.R. DIRECTION
2. CONSTRUCTION JOINT WITH 18" LONG, 5/8" DIAMETER SMOOTH, GALVANIZED STEEL DOWEL AT MID-DEPTH OF SLAB.
3. PRE-MOLDED EXPANSION JOINT FILLER WITH JOINT SEALANT TO PROTECT FILLER. 3/8" WIDTH WITH 18" LONG, 5/8" DIAMETER SMOOTH GALVANIZED STEEL DOWEL, 36" O.C. AT MID-DEPTH OF SLAB.
4. #4 REBAR @ 18" O.C. BOTH WAYS AT CENTER OF CONCRETE SLAB. PLACE BAR 3" FROM EDGES AND EACH SIDE OF FORMED JOINTS
5. (2) #4 REBAR @ BOTTOM OF THICKENED EDGE. PLACE 3" CLEAR FROM EDGES.
6. CONCRETE PAVING. INSTALL THICKENED EDGE AT PERIMETER. DIRECTIONAL BROOM FINISH, 90 DEGREES TO LINE OF TRAVEL PER O.R. DIRECTION. 6" DEPTH AT ALL CONCRETE EXCEPT CREEKSIDE PATH AND WHERE NOTED ON PLANS.
7. FINISH GRADE OR FINISH SURFACE FLUSH WITH CONCRETE PAVING FINISH SURFACE
8. BASE COURSE, 6" DEPTH
9. COMPACTED SUBGRADE





9 CONCRETE PAVING
SCALE: NTS

DATE	NO.	REVISIONS

DESIGNED BY: BB / ES
DRAWN BY: JS / ES / PR
CHECKED BY: BB
SCALE:
DATE: SEPTEMBER 7, 2012

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SAUSAL CREEK
RESTORATION PROJECT IN DIMOND PARK

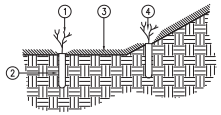
BID SET

DETAILS

SHEET
L-6.3

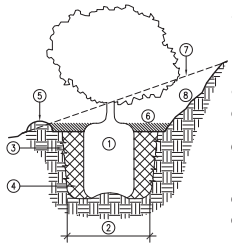
SAUSAL CREEK: BID SET CONSTRUCTION DOCUMENTS - S:\PROJECTS\SAUSAL CREEK - DIMOND PARK\AUTOCAD\WORKING DRAWINGS\L-DETAILS.DWG
PLOTTED ON: 9/6/2012

1. PLANT GROWN IN RESTORATION CONTAINER (SMALLER THAN 1 GALLON)
2. PLANTING PIT, EQUAL DIAMETER TO CONTAINER. USE DIBBLE OR HAND SPADE. SET CROWN ABOVE FINISH GRADE. PINCH NATIVE SOIL TIGHT AGAINST ROOTS.
3. MULCH / SEEDING, SEE PLANS AND SPECIFICATIONS. KEEP MULCH CLEAR OF CROWN.
4. SLOPED CONDITION – SET PLANT PLUMB

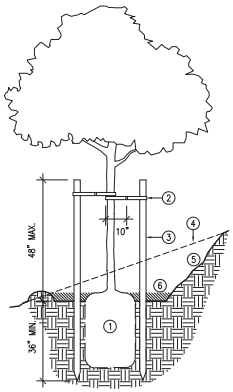


1 SMALL CONTAINER
SCALE: NTS

1. TREE OR SHRUB ROOTBALL (1 GALLON OR LARGER). SET CROWN 1–2" ABOVE FINISHED GRADE
2. PIT DIAMETER, TWO TIMES THE ROOTBALL DIAMETER. EXCAVATE PIT 2" SHALLOWER THAN CONTAINER, DEEPER BEYOND ROOTBALL. PLACE ROOTBALL ON CENTER MOUND AS SHOWN.
3. FRACTURE & SCARIFY EDGE OF PIT
4. NATIVE SOIL, HAND COMPACT IN 6" LIFTS
5. WATERING BASIN – DOWN SLOPE EDGE IN SLOPED CONDITION, COMPLETE PERIMETER IN LEVEL CONDITION
6. MULCH
7. ORIGINAL GRADE – SLOPED CONDITION
8. FINISHED GRADE



2 LARGE CONTAINER
SCALE: NTS

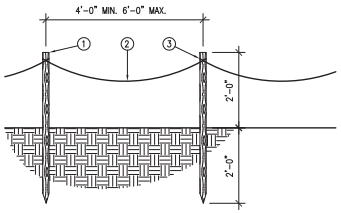


1. LARGE CONTAINER TREE (5 GALLON OR LARGER)
2. PROVIDE (2) ARBORTIE TREE TIES W/ 10" WIDE LOOPS AROUND TRUNK. SECURE ARBORTIES 4" MIN FROM TOP OF STAKES. DIRECTION AND APPROVAL OF INSTALLATION BY O.R.
3. TREE STAKES, SET VERTICAL OUTSIDE ROOTBALL. KEEP TOP OF STAKES 6" MIN CLEAR OF LIMBS.
4. ORIGINAL GRADE – SLOPED CONDITION
5. FINISH GRADE – SLOPED CONDITION
6. MULCH

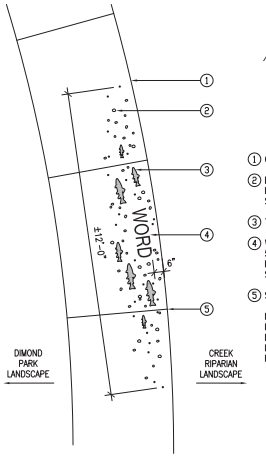
3 TREE STAKING
SCALE: NTS

1. WOOD POST, 2" DIAMETER
2. LIGHT BROWN NATURAL FIBER MANILA ROPE. 1/2" DIAMETER, TENSILE STRENGTH 1,200 LBS.
3. TIE CLOVE HITCH AT EACH POST, 2" BELOW TOP OF POST

NOTE: HOLD POSTS 12" OFF EDGE OF PAVING UON IN FIELD BY O.R.



4 RESTORATION FENCE
SCALE: NTS



1. CREEKSIDE PATH
2. ELEMENTS EMBEDDED INTO CONCRETE, SEE SPECIFICATIONS
3. TROUT ICON, EMBOSSED
4. WORD ICON, EMBOSSED, 5 STATIONS, SEE PLANS FOR LOCATIONS. SEE SPECIFICATIONS.
5. SCORE JOINT

NOTE:
ICONS AND EMBEDDED ELEMENTS SHALL BE LAID OUT BY O.R. IN FIELD, TYP.

5 INTERPRETIVE ELEMENT IN CREEKSIDE PATH
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DATE	NO.	REVISIONS

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DRAWN BY: JS / ES / PR
CHECKED BY: BB
SCALE:
DATE: SEPTEMBER 7, 2012

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SAUSAL CREEK
RESTORATION PROJECT IN DIMOND PARK

BID SET

DETAILS

SHEET
L-6.4

SAUSAL CREEK: BID SET CONSTRUCTION DOCUMENTS - S:\PROJECTS\SAUSAL CREEK - DIMOND PARK\CAD\WORKING DRAWINGS\DETAILS.DWG
PLOTTED ON: 9/6/2012

TYPE OF BUILDING[2] OR OCCUPANCY	WATER CLOSETS[14] (FIXTURES PER PERSON)	URINALS[5, 10] (FIXTURES PER PERSON)	LAVATORIES (FIXTURES PER PERSON)	BATHTUBS OR SHOWERS (FIXTURES PER PERSON)	DRINKING FOUNTAINS[3, 13, 17] (FIXTURES PER PERSON)
Hospitals Individual room Ward room	 1 per room 1 per 8 patients		1 per room 1 per 10 patients	1 per room 1 per 20 patients	1 per 150[12]
Industrial[6] warehouses, workshops, foundries, and similar establishments – for employee use	Male Female 1: 1-10 1: 1-10 2: 11-25 2: 11-25 3: 26-50 3: 26-50 4: 51-75 4: 51-75 5: 76-100 5: 76-100 Over 100, add 1 fixture for each additional 30 persons.		Up to 100, 1 per 10 persons Over 100, 1 per 15 persons[7, 8]	1 shower for each 15 persons exposed to excessive heat or to skin contamination with poisonous, infectious, or irritating material	1 per 150[12]
Institutional – other than hospitals or penal institutions (on each occupied floor)	Male Female 1 per 25 1 per 20	Male 0: 1-9 1: 10-50 Add one fixture for each additional 50 males.	Male Female 1 per 10 1 per 10	1 per 8	1 per 150[12]
Institutional – other than hospitals or penal institutions (on each occupied floor) – for employee use	Male Female 1: 1-15 1: 1-15 2: 16-35 3: 16-35 3: 36-55 4: 36-55 Over 55, add 1 fixture for each additional 40 persons.	Male 0: 1-9 1: 10-50 Add one fixture for each additional 50 males.	Male Female 1 per 40 1 per 40	1 per 8	1 per 150[12]
Office or public buildings	Male Female 1: 1-100 3: 1-50 2: 101-200 4: 51-100 3: 201-400 8: 101-200 11: 201-400 Over 400, add one fixture for each additional 500 males and 1 for each additional 150 females.	Male 1: 1-100 2: 101-200 3: 201-400 4: 401-600 Over 600, add 1 fixture for each additional 300 males.	Male Female 1: 1-200 1: 1-200 2: 201-400 2: 201-400 3: 401-750 3: 401-750 Over 750, add one fixture for each additional 500 persons.		1 per 150[12]
Office or public buildings – for employee use	Male Female 1: 1-15 1: 1-15 2: 16-35 3: 16-35 3: 36-55 4: 36-55 Over 55, add 1 fixture for each additional 40 persons.	Male 0: 1-9 1: 10-50 Add one fixture for each additional 50 males.	Male Female 1 per 40 1 per 40		
Penal institutions – for employee use	Male Female 1: 1-15 1: 1-15 2: 16-35 3: 16-35 3: 36-55 4: 36-55 Over 55, add 1 fixture for each additional 40 persons.	Male 0: 1-9 1: 10-50 Add one fixture for each additional 50 males.	Male Female 1 per 40 1 per 40		1 per 150[12]
Penal institutions – for prison use Cell Exercise room *Exercise Area*	 1 per cell 1 per exercise room *1 per 20*	Male 1 per exercise room	1 per cell 1 per exercise room *1 per 20*	*1 per 16*	1 per cell block floor 1 per exercise room *Access to drinking fountain*
Agriculture Buildings *Milking Barns* *Meat and Poultry Inspection Bldgs*	*At least 1* *Male Female* *1: 1-15 1: 1-15* *2: 16-35 2: 16-35* *3: 36-55 3: 36-55* *4: 56-80 4: 56-80* *1 for each additional 30 persons in excess of 80*		*At least 1*		
Schools of Cosmetology	*Male Female* **At least 1 *At least 2* **Per installation*		*At least 1*		
Cosmetological Establishments	**At least 1 *At least 1* **Per installation*				

East Bay Municipal Utility District

Water Conservation Market Penetration Study

FINAL REPORT

March 2002

Prepared by:

WRE Water Resources Engineering, Inc.

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San Francisco, California 94105

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Table 4-2: Incidence of Appliances/Fixtures in Single-Family Homes

Appliances/Fixtures	Percent of Homes with at Least One Appliance/Fixture
Toilets with design flush volumes of 1.6 gallons per flush (gpf)	37
Toilets with design flush volumes of 3.5 gpf	25
Toilets with design flush volumes of 5-plus gpf	20
Toilets with unknown design volume	36
Toilets with measured flush volumes of 1.6 gallons or less	32
Toilets with measured flush volumes between 1.61 and 3.5 gallons	74
Toilets with measured flush volumes over 3.5 gallons	20
Toilets where flush volumes could not be measured	4
Toilets with conservation devices	20
Toilets with leaks	4
Showerheads with flow rates 2.5 gallons per minute (gpm) or less	76
Showerheads with flow rates between 2.51 and 5.0 gpm	35
Showerheads with flow rates over 5 gpm	3
Showerheads with shutoff button	16
Showerheads with leaks	34
Bathtubs	95
Bathtubs with Jacuzzi/spa	4
Faucets with flow rates of 2 gpm or less	82
Faucets with flow rates between 2.01 and 2.99 gpm	52
Faucets with flow rates between 3 and 3.99 gpm	30
Faucets with flow rates of 4 gpm or more	29
Faucets with aerators	94
Leaky faucets	7
Dishwashers	63
Dishwashers with efficiency setting	54
Clothes washers	89
High-efficiency clothes washers	11
Recirculating hot water	4
Refrigerators with built-in water dispensers	26
Refrigerators with built-in ice-makers	41
Water softener	0.5
Point-source water heaters	8
Water purification units	17
Evaporative coolers	2
Pressure regulators	14
Swimming pool	10
Outdoor spa/Jacuzzi	12
Fountains/ponds	7
Gray water system	1
Well water	2

The base number of toilets was calculated by starting with the known number of accounts in the year 2000 and working back to 1991. The number of toilets per single-family home and multi-family housing unit were assumed to be the same in 1991 as they were in 1994.

The figures used to calculate the total rate of replacement for toilets in the single-family sector are presented in Table 7-3. A substantial number of ULFTs were determined to be in place at the end of 1991, based on data from this study. The 2001 database was queried for the number of ultra-low flush toilets with manufacture date before 1991, and toilets with unknown rating, measured flush volumes of 1.6 gpf or lower, and no inserts; 5.8% of the toilets in place in 1991 met these specifications.

Table 7-3: Figures Used to Calculate Total Rate of Replacement for Single-Family Toilets

Year	Number of Single-Family Accounts	Number of Toilets per Account	Total Toilets	Percent of Ultra-Low Flush Toilets	Number of Ultra-Low Flush Toilets	Number of Toilets Rated at 3.5 gpf and Higher
1991	266,618	2.0	533,236	5.8	30,928	502,308
1994	273,312	2.0	546,624	10.0	54,662	491,962
2001	289,593	2.1	608,145	34.0	206,769	401,376

The assumed number of accounts and toilets per account yield a total of 533,236 single-family toilets in place at the end of 1991. Almost 6% of these toilets (30,928/533,236) are ULFTs. The other 502,308 toilets represent the total non-ULFTs available for replacement.

The number of ULFTs increased to 206,769 by 2001. This number includes the initial 30,928 toilets increased by the replacement of 100,932 (502,308-401,376) non-ULFTs and the installation of 74,909 (608,145-533,236) new toilets.

Based on the assumptions outlined above, about one hundred thousand of the roughly half a million single-family non-ULFTs have been replaced since the end of 1991, or about 20%. The average annual rate of replacement was under one percent for the three years between 1991 and the baseline study, and went up to 2.08% for the period between 1991 and 2001.

The replacement rates calculated above are affected by the transition to mandatory ULFTs. Calculations assume that all new toilets installed after 1991 were ultra-low flush fixtures. Data from the 2001 survey, however, indicate otherwise: 27% of toilets installed in houses built after 1991 were rated at 3.5 gpf (all of these non-ULFTs were installed in houses built between 1992 and 1994). This represents 20,225 toilets (0.27x[608,145-533,236]) that were initially added to the ranks of non-ULFTs and increase the number of replacements. The replacement of 121,157 (100,932+20,225) toilets between 1991 and 2001 represents an average annual replacement rate of 2.5%.

The replacement rate for single-family toilets was verified by querying the 2001 database as to the percentage of ULFTs installed in houses built before 1992, all of which are likely to represent replacement

Water Savings from Ultra-Low Flush Toilet Installations: 4.64 mgd

Water savings were calculated using data from the 2001 surveys and other sources. The following assumptions were made:

- Installing ultra-low flush toilets in place of toilets with a higher rated flush volume will generate savings equivalent to the difference in the mean flush volumes.
- A person flushes a toilet on the average 5.05 times a day (*Residential End Uses of Water*, AWWA Research Foundation, Page xxvii).
- There are on the average 3 occupants per single-family account (Appendix I of this report).
- There are on the average 2.1 toilets per single-family home (Table 4-3 of this report).
- The number of occupants per apartment unit is estimated at 2.25; this assumes 1.3 million people in the District's service area and approximately 429,000 of them in 190,700 apartment units.
- The average number of toilets per multi-family housing unit is 1.2 (Table 5-3 of this report).
- There are an estimated 608,145 single-family toilets in the District's service area in 2001 (Table 7-3 of this report).
- There are an estimated 173,963 multi-family toilets in apartment buildings with five or more units in the District's service area in 2001 (Table 7-4 of this report).

Table 7-12: Potential Water Savings from Toilet Replacement

	Type of Toilet Replaced with ULFT			
	Single-Family 3.5 gpf	Single-Family > 3.5 gpf	Multi-Family 3.5 gpf	Multi-Family > 3.5 gpf
(1) Mean ULFT Flush Volume in Sector (gpf)	1.83	1.83	1.94	1.94
(2) Mean Toilet Flush Volume (gpf)	2.80	3.32	2.94	3.42
(3) Avg. Water Savings in Gallons per Flush (2)-(1)	0.97	1.49	1.00	1.48
(4) Avg. Number of People per Dwelling	3.0	3.0	2.25	2.25
(5) Avg. Number of Flushes per Person per Day	5.05	5.05	5.05	5.05
(6) Total Flushes per Dwelling per Day (4)x(5)	15.15	15.15	11.36	11.36
(7) Number of Toilets per Dwelling	2.1	2.1	1.2	1.2
(8) Total Flushes per Toilet per Day (6)/(7)	7.2	7.2	9.5	9.5
(9) Total Water Savings in Gallons per Toilet per Day (3)x(8)	**7.0**	**10.7**	**9.5**	**14.0**
(10) Total Number of Toilets in Sector in Year 2001	608,145	608,145	173,963	173,963
(11) Percent of Replaceable Toilets (Figure 7-3)	38.4	27.6	41.8	21.2
(12) Total Number of Replaceable Toilets (10)x(11)	233,528	167,848	72,717	36,880
(13) Total Water Savings in MGD (9)x(12)	**1.63**	**1.80**	**0.69**	**0.52**

- 53 percent of washers or 11,444 (21,593 x 0.53) machines are in common area laundries. Eighty-six percent of them or 9,842 washers are assumed to be of standard efficiency and available for replacement.
- Properties with common area laundries have on the average 2.6 washers per property (Table 5-10 shows 611 common area washers in 233 properties).
- Multi-family properties in the District's service area have on the average 21.3 apartment units and 2.25 people per unit, equivalent to about 48 tenants per property.
- Water use in common area laundries is estimated at 0.1 cycles per person per day, from *Multi-Residential High Efficiency Clothes Washer Pilot Project* in Metropolitan Toronto (Canada Mortgage & Housing Corporation, 2001).
- Water savings per washer cycle are estimated at 14.8 gallons, based on the Canadian study cited above.
- Multi-family residents with in-unit washers use 3.9 times more water to do their laundry on site than their counterparts in buildings with common area laundries (according to *A National Study of Laundry-Water Use in Multi-Housing*, National Research Center, Inc., Boulder, Colorado, 2001). This is equivalent to 0.39 (0.1 x 3.9) cycles per person per day.

Water savings from the replacement of in-unit washers with high efficiency appliances were calculated as follows:

In-Unit Washer Water Savings=
0.39 cycles per person per day x
2.25 persons x
14.8 gallons per cycle x
10,149 washers=
0.13 mgd

Water savings from the replacement of standard efficiency common area washers with high efficiency appliances were calculated as follows:

Laundry Washer Water Savings=
(0.1 cycles per person per day x
48 persons per property x
14.8 gallons per cycle /
2.6 washers per property) x
9,842 washers =
0.27 mgd

The potential water savings from replacing all standard efficiency washers, therefore, is 3.6 mgd (3.2 from the single-family sector and 0.4 from multi-family properties).

Water Savings from Improved Irrigation Efficiency

Survey data do not provide water consumption numbers that would allow the quantification of potential water savings. The surveys do provide valuable information on the breakdown of landscapable and irrigated areas and the use of various types of irrigation systems.

Outdoor water use is prevalent on the east side of the District area only. The comparison of summer to winter water use (see Appendix B) shows that residents east of the hills average from 20% to 390% percent outdoor water use in summer months (ratios

BMP 5: WATER USE BY URINALS

Jacqueline Martin and James Heaney
Conserve Florida Water Clearinghouse
Dept. of Environmental Engineering Sciences
University of Florida
March 26, 2008

INTRODUCTION

Urinals are found in men's bathrooms of the commercial, industrial, and institutional (CII) sectors of society. If men's restrooms account for a significant portion of a facility's water budget and the urinals are older, a urinal retrofit may provide significant water savings for the facility. The types of urinals and their water use characteristics are described in this report. Information on the expected prevalence of these urinals is also presented along with information on urinal retrofit programs.

TYPES OF URINALS

Conventional urinals, installed before 1994, use 1.5 to 5.0 gallons per flush (gpf) (Vickers 2001). Conventional urinals will be assumed to use 2.5 gpf.

Ultra low flush (ULF) urinals use 1.0 gpf or less. This maximum water use standard for new buildings was mandated by the United States Energy Policy Act of 1992 and went into effect on January 1, 1994. Water use per flush by urinal fixtures is certified by the American National Standards Institute (ANSI), but flush performance testing protocols for urinals are still in development (Koeller 2007). ULF urinals will be assumed to use 1.0 gpf.

High-efficiency urinals (HEU) flush with 0.5 gpf or less (Koeller 2007). The mechanism for flushing, the flushometer valve, is the same as for conventional and ULF urinals, but requires a higher pressure and higher velocity for the supply water and a smaller orifice in the diaphragm of the flush valve. HEU's will be assumed to use 0.5 gpf.

Non-water urinals are similar in appearance to others, but require neither water nor a valve. They use a dry drainage system as shown in Figure 1. The first component on figure 1 is the sealant liquid, the second is where the sediment collects to be passed, and the third is where the waste passes into the drain. Since urine is about 96% liquid, no additional water is needed to wash it down the drain (Bristow 2004). Instead, these fixtures have a cartridge that houses a sealant liquid which is less dense than water. Urine sinks below the sealant liquid and the weight of the liquid pushes the waste into the drainage pipe. When the sealant becomes depleted, the cartridge does not work effectively and may result in an unpleasant odor. For proper maintenance, excess amounts of water should not be poured through the cartridge. The drain

San Mateo County, California

People QuickFacts	San Mateo County	California
Population, 2012 estimate	NA	38,041,430
Population, 2011 estimate	727,209	37,683,933
Population, 2010 (April 1) estimates base	718,451	37,253,956
Population, percent change, April 1, 2010 to July 1, 2012	NA	2.1%
Population, percent change, April 1, 2010 to July 1, 2011	1.2%	1.2%
Population, 2010	718,451	37,253,956
Persons under 5 years, percent, 2011	6.4%	6.7%
Persons under 18 years, percent, 2011	22.1%	24.6%
Persons 65 years and over, percent, 2011	13.6%	11.7%
Female persons, percent, 2011	50.8%	50.3%
White persons, percent, 2011 (a)	64.4%	74.0%
Black persons, percent, 2011 (a)	3.2%	6.6%
American Indian and Alaska Native persons, percent, 2011 (a)	0.9%	1.7%
Asian persons, percent, 2011 (a)	25.8%	13.6%
Native Hawaiian and Other Pacific Islander persons, percent, 2011 (a)	1.6%	0.5%
Persons reporting two or more races, percent, 2011	4.1%	3.6%
Persons of Hispanic or Latino Origin, percent, 2011 (b)	25.6%	38.1%
White persons not Hispanic, percent, 2011	41.9%	39.7%
Living in same house 1 year & over, percent, 2007-2011	87.1%	84.2%
Foreign born persons, percent, 2007-2011	34.1%	27.2%
Language other than English spoken at home, percent age 5+, 2007-2011	44.9%	43.2%
High school graduate or higher, percent of persons age 25+, 2007-2011	88.4%	80.8%
Bachelor's degree or higher, percent of persons age 25+, 2007-2011	43.9%	30.2%
Veterans, 2007-2011	34,680	1,997,566
Mean travel time to work (minutes), workers age 16+, 2007-2011	24.9	27.0
Housing units, 2011	271,333	13,720,462
Homeownership rate, 2007-2011	60.1%	56.7%
Housing units in multi-unit structures, percent, 2007-2011	32.6%	30.8%
Median value of owner-occupied housing units, 2007-2011	$763,100	$421,600
Households, 2007-2011	256,423	12,433,172
Persons per household, 2007-2011	2.74	2.91
Per capita money income in the past 12 months (2011 dollars), 2007-2011	$45,346	$29,634
Median household income, 2007-2011	$87,633	$61,632
Persons below poverty level, percent, 2007-2011	7.0%	14.4%

Business QuickFacts	San Mateo County	California
Private nonfarm establishments, 2010	19,669	849,875[1]
Private nonfarm employment, 2010	328,353	12,536,402[1]
Private nonfarm employment, percent change, 2000-2010	-11.9	-2.7[1]
Nonemployer establishments, 2010	59,988	2,814,409
Total number of firms, 2007	74,604	3,425,510
Black-owned firms, percent, 2007	1.6%	4.0%
American Indian- and Alaska Native-owned firms, percent, 2007	0.9%	1.3%
Asian-owned firms, percent, 2007	18.6%	14.9%
Native Hawaiian and Other Pacific Islander-owned firms, percent, 2007	0.5%	0.3%
Hispanic-owned firms, percent, 2007	11.7%	16.5%
Women-owned firms, percent, 2007	29.9%	30.3%
Manufacturers shipments, 2007 ($1000)	17,918,237	491,372,092
Merchant wholesaler sales, 2007 ($1000)	12,607,786	598,456,486
Retail sales, 2007 ($1000)	10,198,837	455,032,270
Retail sales per capita, 2007	$14,625	$12,561
Accommodation and food services sales, 2007 ($1000)	2,107,180	80,852,787
Building permits, 2011	751	45,471

Geography QuickFacts	San Mateo County	California
Land area in square miles, 2010	448.41	155,779.22
Persons per square mile, 2010	1,602.2	239.1
FIPS Code	081	06
Metropolitan or Micropolitan Statistical Area	San Francisco-Oakland-Fremont, CA Metro Area	

1: Includes data not distributed by county.

(a) Includes persons reporting only one race.
(b) Hispanics may be of any race, so also are included in applicable race categories.

D: Suppressed to avoid disclosure of confidential information
F: Fewer than 100 firms
FN: Footnote on this item for this area in place of data
NA: Not available
S: Suppressed; does not meet publication standards
X: Not applicable
Z: Value greater than zero but less than half unit of measure shown

Source U.S. Census Bureau: State and County QuickFacts. Data derived from Population Estimates, American Community Survey, Census of Population and Housing, State and County Housing Unit Estimates, County Business Patterns, Nonemployer Statistics, Economic Census, Survey of Business Owners, Building Permits, Consolidated Federal Funds Report
Last Revised: Thursday, 10-Jan-2013 15:07:36 EST

DRAFT

CAPRI CREEK FLOOD TERRACE HYDROLOGIC ANALYSIS REPORT

Maria Drive to N. McDowell Boulevard

Petaluma, CA

November, 2011

Report by: Tom Hammond

Review by: Pam Tuft

Capri Creek Flood Terrace Hydrologic Analysis Report

Reach: from Maria Drive to N McDowell Boulevard

Existing Conditions

Capri Creek, once inside the City limits, is a linear trapezoidal earthen channel that runs through a series of subdivisions collecting the runoff and discharging to the Petaluma River. The reach studied in this report is from Maria Drive to N McDowell Boulevard (See appendix 1 for site and location maps). It is approximately five feet wide at the bottom, varies from 4 to 5 feet deep at the lowest bank, varies from 40 to 60 feet width at the top of bank and is 1400 feet long. Average slope along the channel bottom is 0.5%. The channel is mostly filled with vegetation for the full depth and has 6-12 inch rock lining the bottom. At the top of the reach two elliptical 34"x54" concrete culverts discharge into the channel and at downstream the end two 55" circular concrete culverts collect through a course bar screen and discharge under the road 230 feet to the next reach. See appendix 2 for photos.

Access for regular maintenance uses a road located out of the floodway to remove brush that accumulates at the bar screen. A storm water model was designed and is maintained for the City by WEST Consultants, Inc. (WEST) and all hydrologic data was provided by them for this study. The calculations, report, HEC-RAS model, preliminary design and engineer's estimate were all done by City staff.

Out of bank flow has historically occurred at the lower end of the reach and flows due South into the adjacent street, Sunrise Parkway, and onto private property. Data from WEST and models run showed that a 10 year storm event will breach the banks and cause water to flow into the street then back into the stormdrain. The modeled out-of-bank flows calculated to be 253 cubic feet per second (cfs) and 41cfs for 100-year and 10-year storms, respectively. Total estimated flow in the creek is 500cfs and 288cfs for 100 and 10-year storm events.

Proposed Improved Conditions

One of the main purposes of this study is to reduce out of bank flow along this section of Capri Creek without adversely impacting other reaches. Creation of a flood terrace will reduce the peak flow, bring the hydrograph peak down by spreading it over a longer period of time, and retain more storm flows within the modified channel. Maximizing the flood terrace storage volume, to reduce out-of-bank volume, and the potential of flooding of private property, is the desired result. An important consideration to keep in mind is that this creek discharges to the Petaluma River and by changing the flow and hydrograph of this reach, the resultant design must avoid negatively impacting the peak hydrograph along the River. Coordination with WEST Consultants and the XP-SWMM model will be necessary for a feasible design to be achieved and before any final design preparations.

Another purpose of this project is the opportunity to enhance the creek frontage for both adjacent residents who enjoy the line and the wildlife that inhabits it. The reaches upstream of the project site are good examples of what the City would like to see for this reach in its function, aesthetic, and habitat.

Quick analysis proved matching the 100 year flood flow out-of-bank volume and the potential storage volume at the site is not feasible. The water volume would require an 11 foot deep section be excavated from the entire area designated for the flood terrace. Instead a combined flood terrace and creek enhancement design, similar to the reach upstream, was determined more feasible. Recognizing these multi-use benefits, cross sections were developed along with a HEC-RAS model to optimize storage capacity along with usability for the residents, and wildlife habitat enhancement.

Model

A HEC-RAS model was developed using the peak hydrograph data from WEST Consultants (See appendix 5 for the data) and the flood terrace preliminary design utilizing lands within Sunrise Park. The park was surveyed and cross sections developed from the data. This was then used to determine how much of a reduction in out-of-bank flow could be achieved with the extra storage volume. See appendix 3.

Calculations

Using the flood terrace boundary and a max flow rate of 250cfs, assuming headwall improvements at the discharge end of the reach, the volume of water to be stored was 16.6ac-ft. The area designated for the flood terrace was 1.27 ac. The depth of the basin required to store this water would need to be 13ft. The average depth of the creek is 6 feet deep. With an improved entrance structure for the downstream culvert the max flow through should raise to 300cfs. See appendix 3.

Results

Using the HEC-RAS model, data from WEST Consultants, and some calculations on static structures the amount of water that was able to be detained was from 6 to 12 acre feet depending on the improvements made. This leaves 10 to 4.6 acre feet that would flow out of bank in a 100 year storm event. This would result in a reduction of 6.6 to 12 acre feet of water that currently floods private property.

Improvements that decreased out of bank flows were:

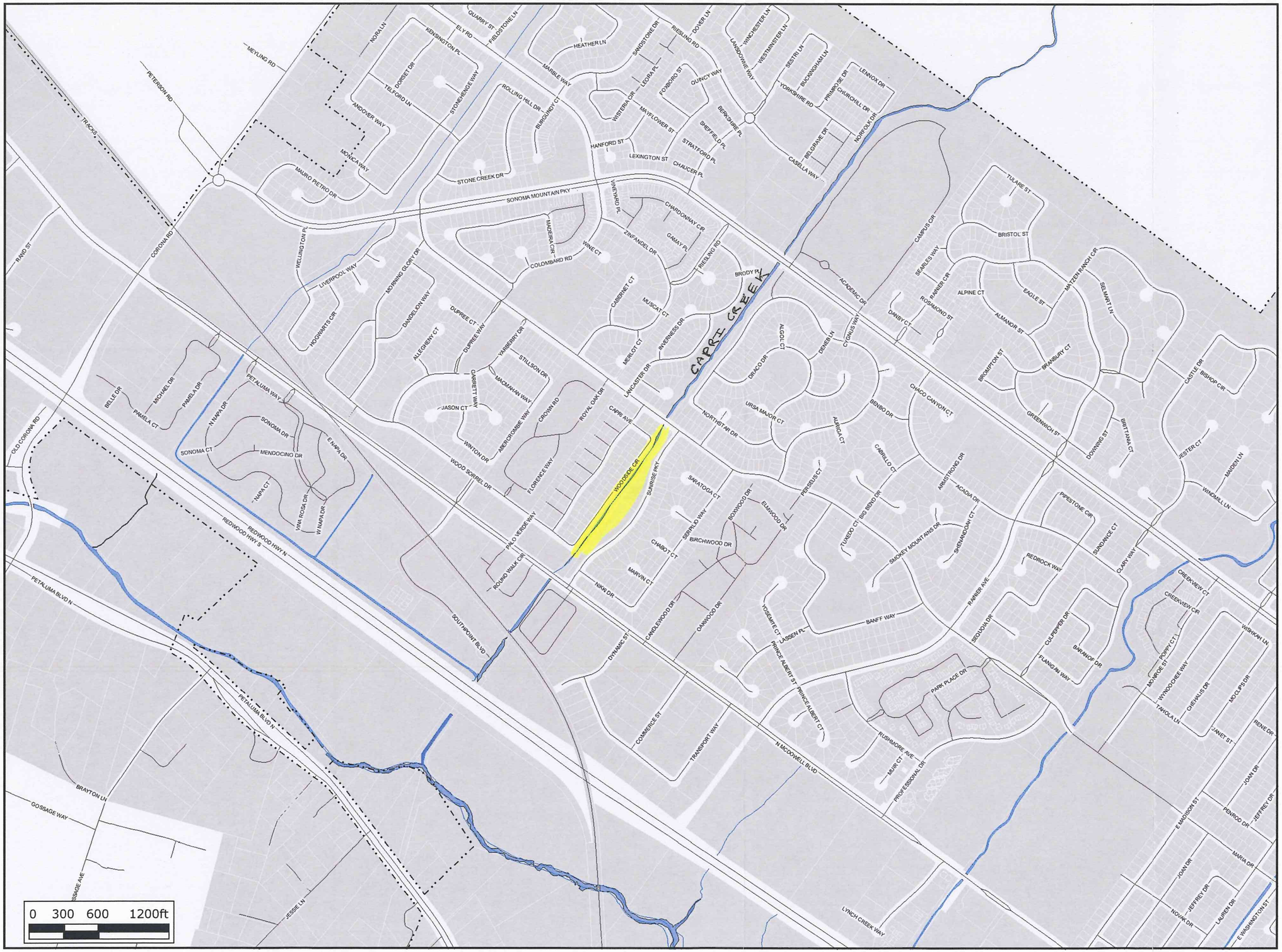
1. Inlet structure for the downstream culvert to achieve 300cfs flow through while also being able to use it as a bar screen for brush removal maintenance.
2. Modifying the downstream culvert for a shallower slope and deeper entrance.
3. A trapezoidal terrace section, 95 feet at the widest section, at the natural slope with a 2 percent slope back to the centerline of the creek at the section.
4. A widened basin at the lower section of the reach.

An Engineers estimate with all the improvements is in Appendix 4.

Appendix 1

Location Map and Site Map

Powered By GeoSmart



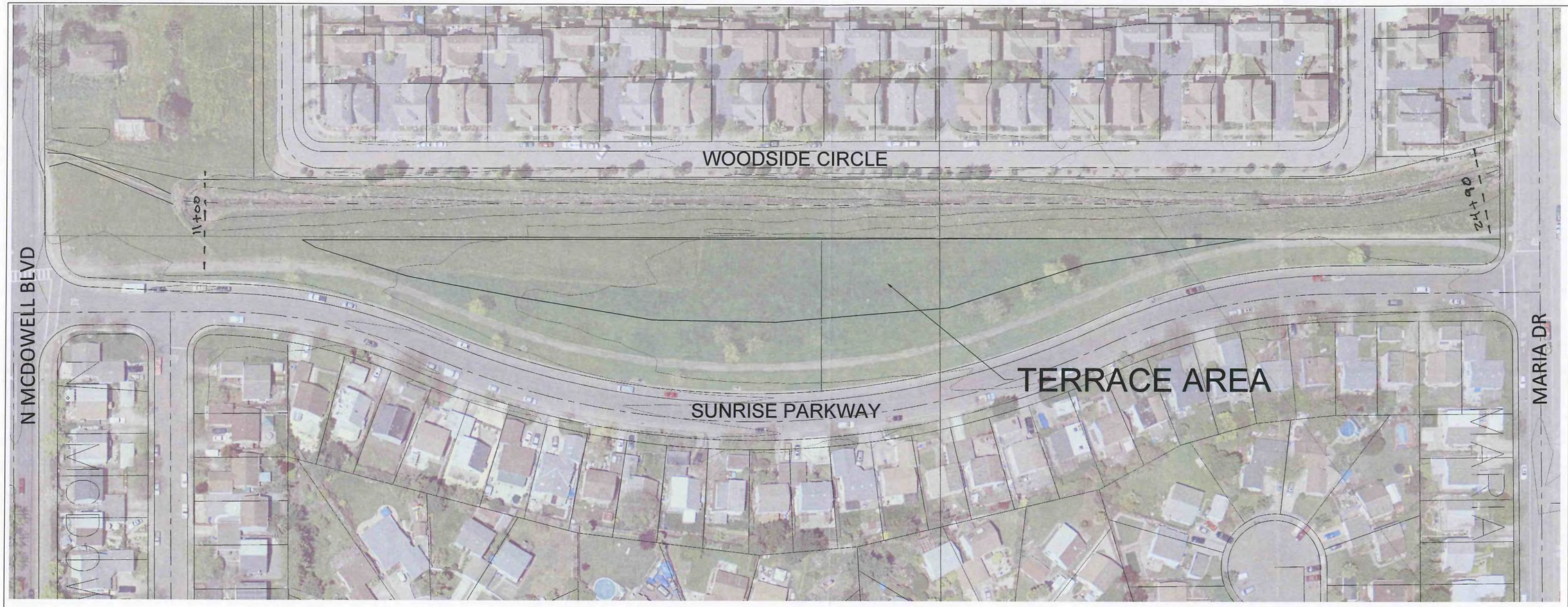
Site Map
Capri Creek

City of Petaluma
California

- City Limit
- Minor Waterways
- Major Waterways
- Parcels
- Street Names
- Parcels background - hide

GIS Division

DISCLAIMER:
These maps or plans were compiled and digitized via electronic means utilizing many source documents. It is intended to be representative of certain physical, legal and geometric features within the City of Petaluma, CA and its environs. The existence or location of facilities must be field verified and this document does not imply or guarantee neither adequate capacity nor the availability of service. The City of Petaluma assumes no responsibility regarding the accuracy of the information represented herein for legal documentation, representations of actual construction or for any other purpose for which this map was not intended



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GRAPHIC SCALE IN FEET

No scale

DATE: NOV/2011
DESIGNED BY: TCH
DRAWN BY: TCH
CHECKED BY:

CITY OF PETALUMA
WATER RESOURCES AND CONSERVATION
202 N. MCDOWELL BLVD, PETALUMA, CA, 94954
PH. 707-778-4546 FAX. 707-778-4508

WR&C

SUNRISE PARK EXHIBIT

SUNRISE PARK, PETALUMA
EXHIBIT

SHEET
C1
1 OF 1

Appendix 2

Photos- Wet and Dry Conditions

Outlet (right side of picture) and out-of-bank flow path across trail to Sunrise Parkway

Storm flow outlet and bar screen (to catch debris)

Upstream discharge at Maria Drive

Slight bend facing downstream

Continuing downstream.

Inlet from adjacent subdivision around 1403 Woodside Circle.

Proposed river terrace excavation area.

Outlet illustrating bar screen and blockage by debris from upstream areas.

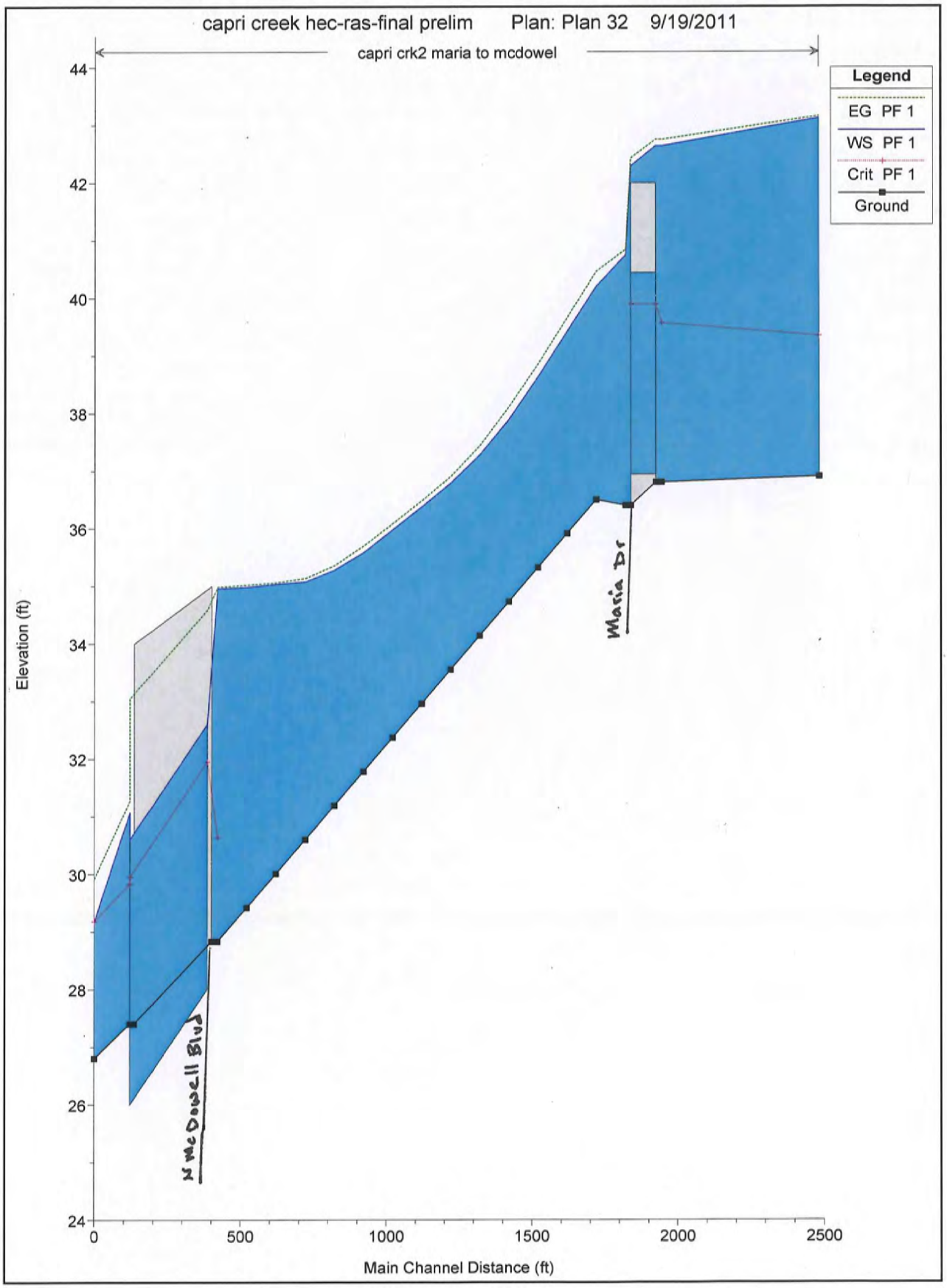
Maintenance access from N. McDowell Blvd. (looking upstream, East) Sunrise Parkway on right, Woodside Circle on left

Appendix 3

HEC-RAS Model Output

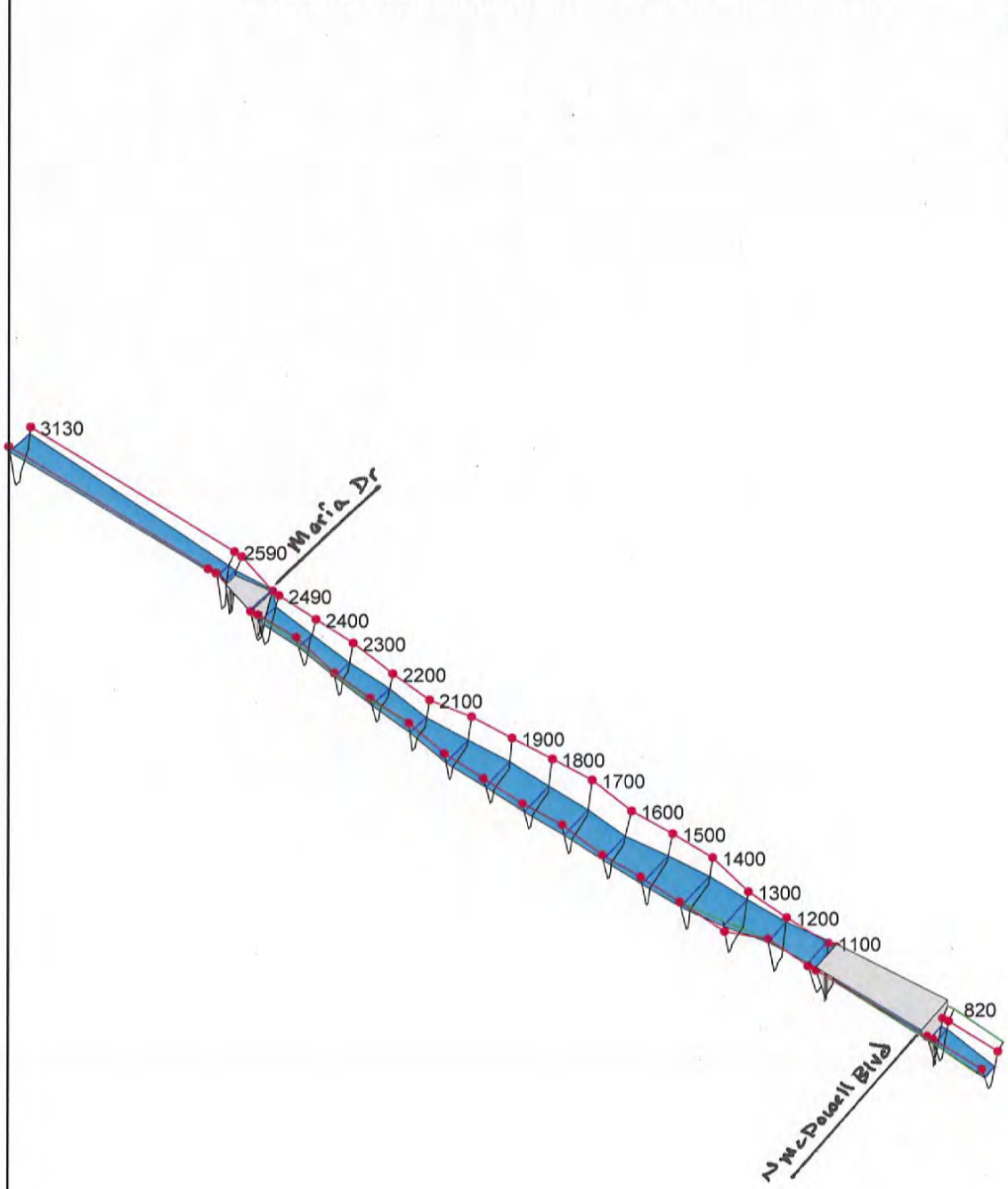
HEC-RAS Plan: Plan 30 River: capri crk2 Reach: maria to mcdowel Profile: PF 1 10 Year Flow

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
maria to mcdowel	3130	PF 1	350.00	36.90	43.12	39.34	43.15	0.000413	1.44	242.46	63.92	0.13
maria to mcdowel	2590	PF 1	350.00	36.80	42.64	39.56	42.75	0.001651	2.66	131.57	37.72	0.25
maria to mcdowel	2550		Culvert									
maria to mcdowel	2490	PF 1	350.00	36.40	40.74		40.84	0.002028	2.50	140.23	54.14	0.27
maria to mcdowel	2400	PF 1	350.00	36.50	40.20		40.46	0.008002	4.12	84.97	43.27	0.52
maria to mcdowel	2300	PF 1	350.00	35.91	39.42		39.66	0.007956	3.95	88.71	47.98	0.51
maria to mcdowel	2200	PF 1	375.00	35.32	38.63		38.85	0.008087	3.78	99.34	58.49	0.51
maria to mcdowel	2100	PF 1	375.00	34.73	37.89		38.11	0.006795	3.72	100.85	52.95	0.47
maria to mcdowel	2000	PF 1	375.00	34.14	37.28		37.43	0.006365	3.14	119.42	77.70	0.45
maria to mcdowel	1900	PF 1	375.00	33.55	36.79		36.90	0.004369	2.70	138.67	85.13	0.37
maria to mcdowel	1800	PF 1	375.00	32.96	36.37		36.48	0.004022	2.61	143.45	87.16	0.36
maria to mcdowel	1700	PF 1	375.00	32.37	35.98		36.08	0.003862	2.60	144.28	85.69	0.35
maria to mcdowel	1600	PF 1	375.00	31.78	35.58		35.69	0.003951	2.71	138.62	78.80	0.36
maria to mcdowel	1500	PF 1	375.00	31.19	35.27		35.35	0.002774	2.27	165.42	94.03	0.30
maria to mcdowel	1400	PF 1	375.00	30.60	35.08		35.13	0.001699	1.90	197.88	101.82	0.24
maria to mcdowel	1300	PF 1	375.00	30.01	35.03		35.06	0.000348	1.27	296.54	87.55	0.12
maria to mcdowel	1200	PF 1	375.00	29.42	34.98		35.02	0.000465	1.52	247.09	66.34	0.14
maria to mcdowel	1100	PF 1	375.00	28.83	34.96	30.63	34.98	0.000241	1.18	317.07	75.00	0.10
maria to mcdowel	970		Culvert									
maria to mcdowel	820	PF 1	375.00	27.40	31.07	29.83	31.26	0.005222	3.56	105.46	48.84	0.43
maria to mcdowel	700	PF 1	375.00	26.80	29.18	29.18	29.92	0.033128	6.91	54.28	37.22	1.01


capri creek hec-ras-final prelim Plan: Plan 32 9/19/2011
capri crk2 maria to mcdowel
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
Main Channel Distance (ft)
N McDowell Blvd
Maria Dr
44
42
40
38
36
34
32
30
28
26
24
0
500
1000
1500
2000
2500

10 Year Flow

capri creek hec-ras-final prelim Plan: Plan 32 9/19/2011



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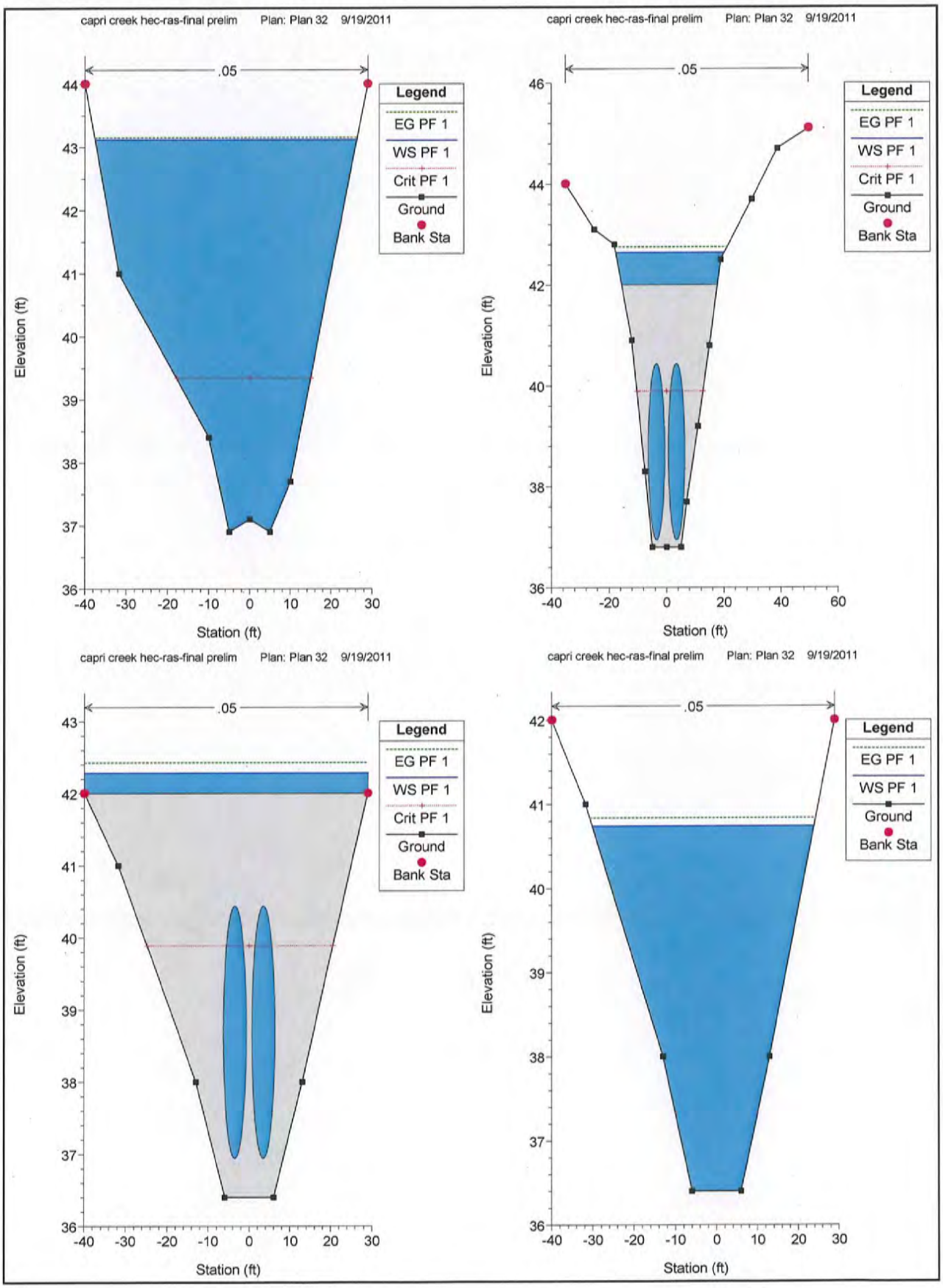
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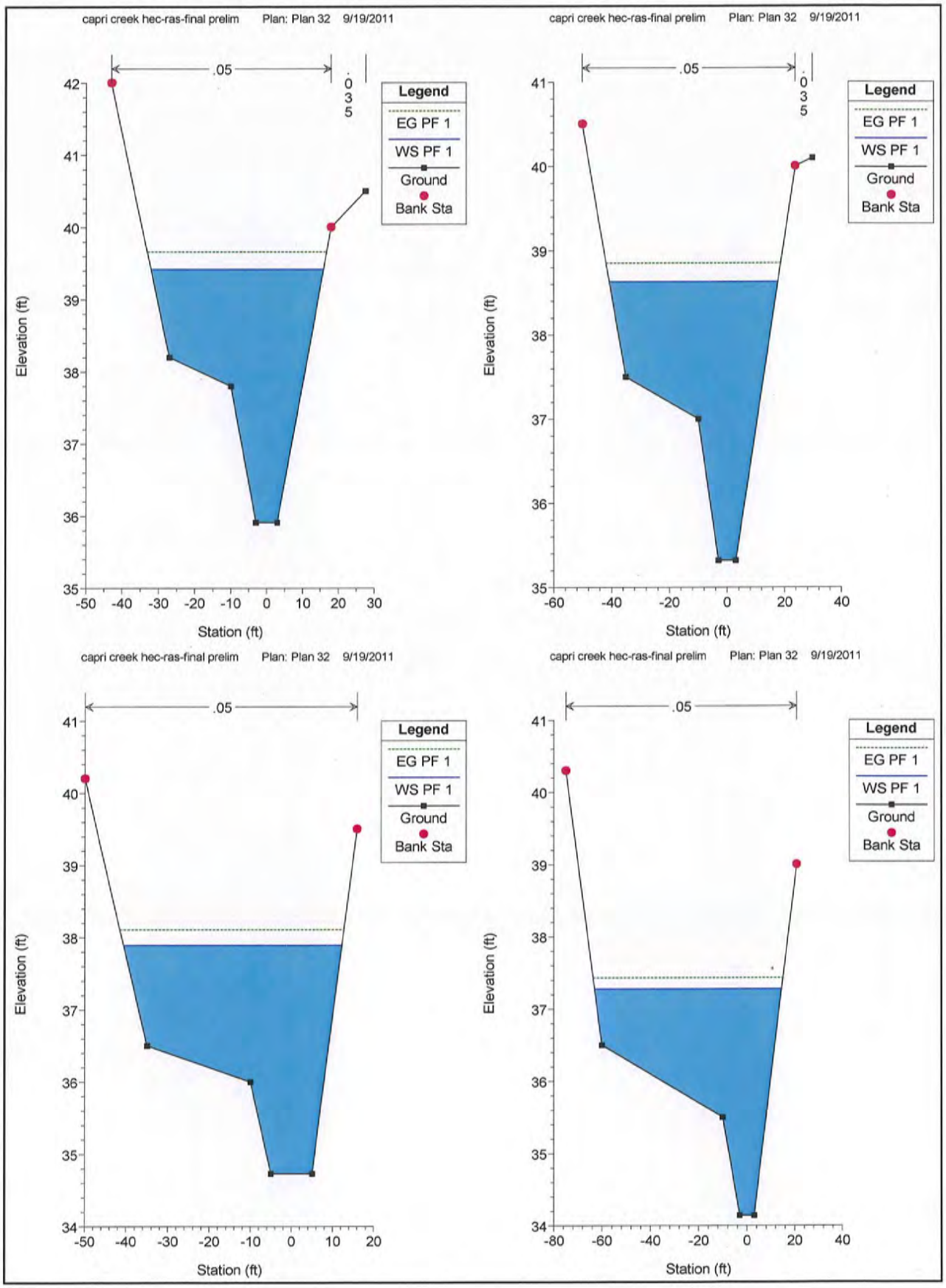
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capri creek hec-ras-final prelim Plan: Plan 32 9/19/2011
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EG PF 1
WS PF 1
Ground
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capri creek hec-ras-final prelim Plan: Plan 32 9/19/2011
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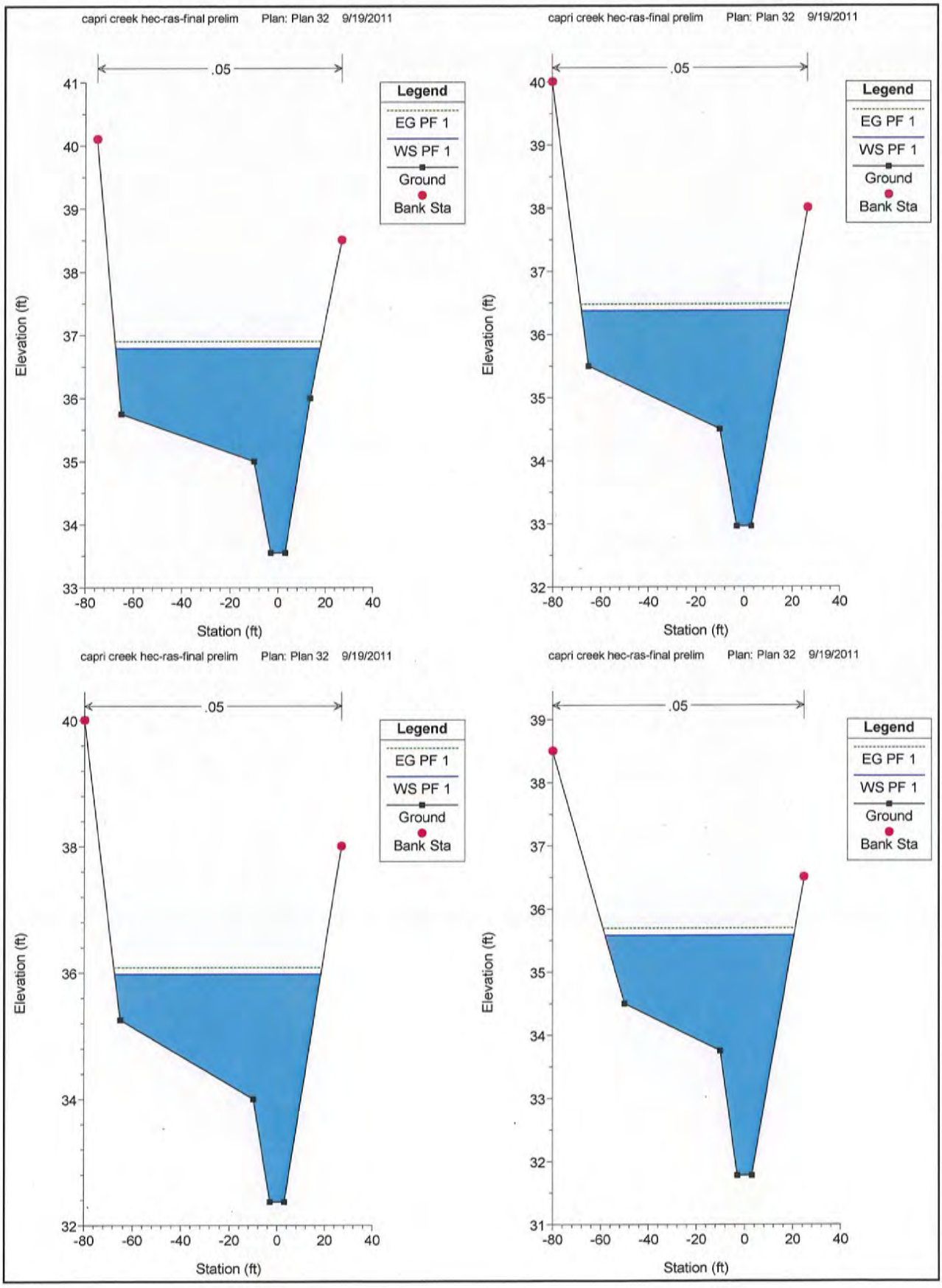
Elevation (ft)
Station (ft)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Elevation (ft)
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capri creek hec-ras-final prelim Plan: Plan 32 9/19/2011
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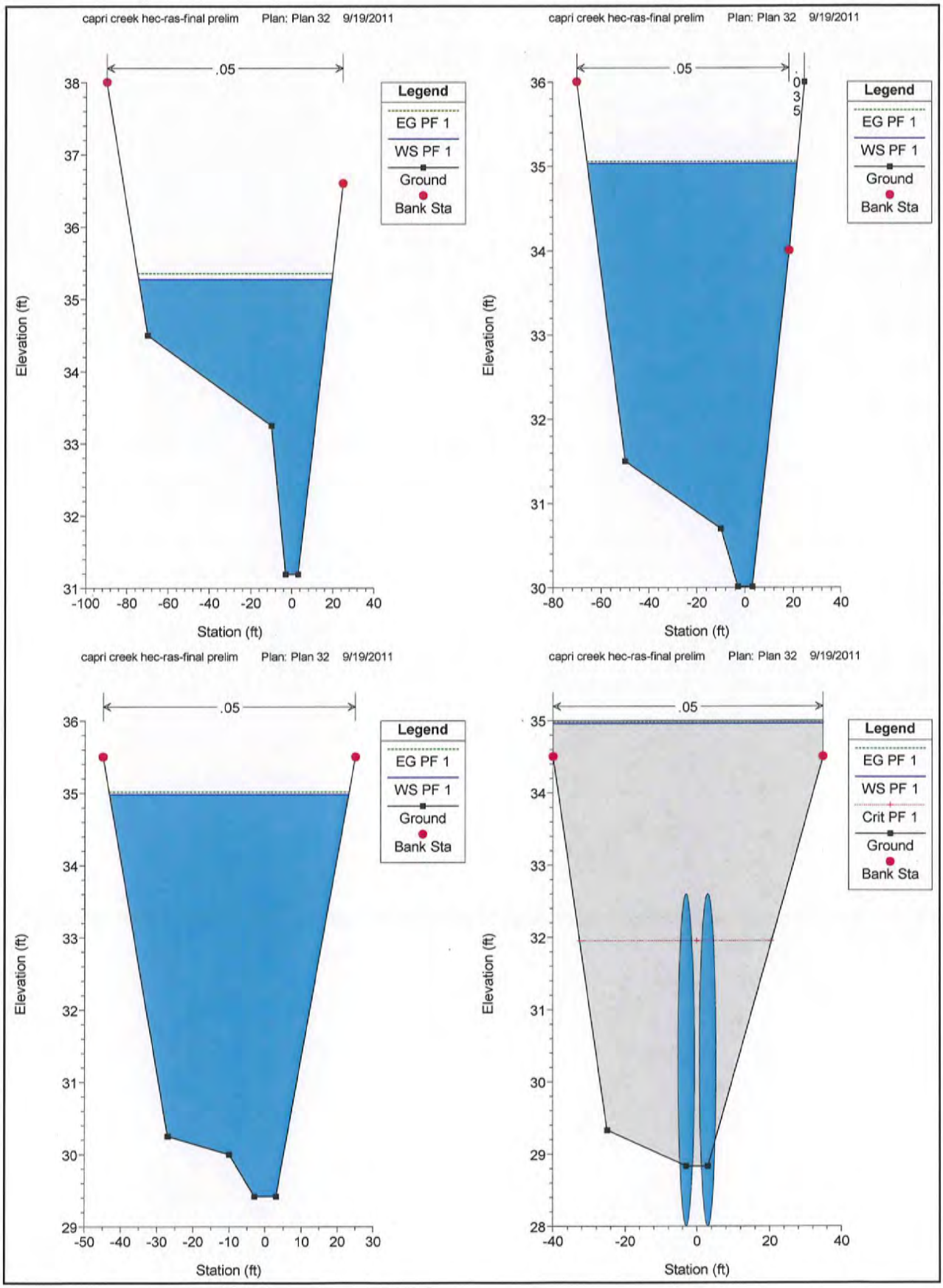
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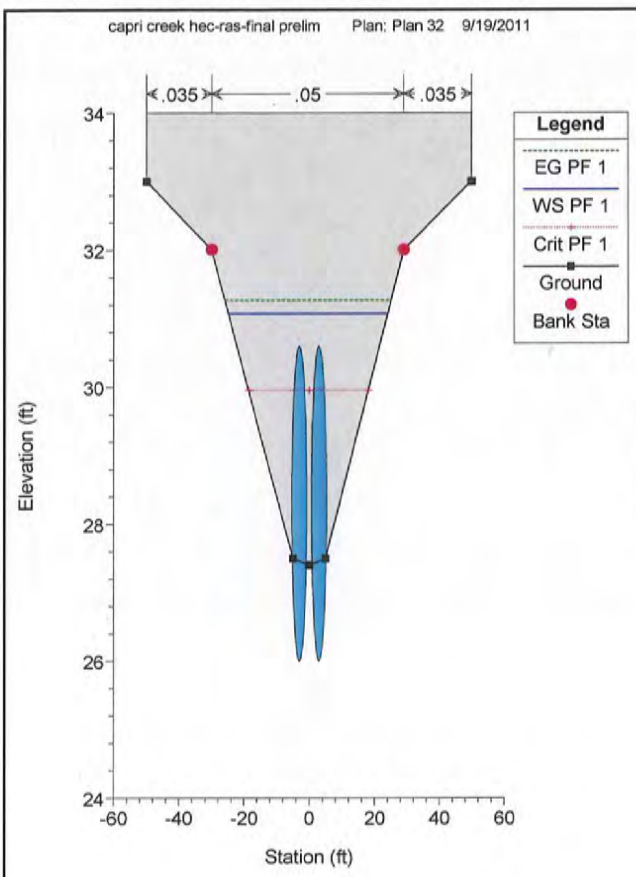
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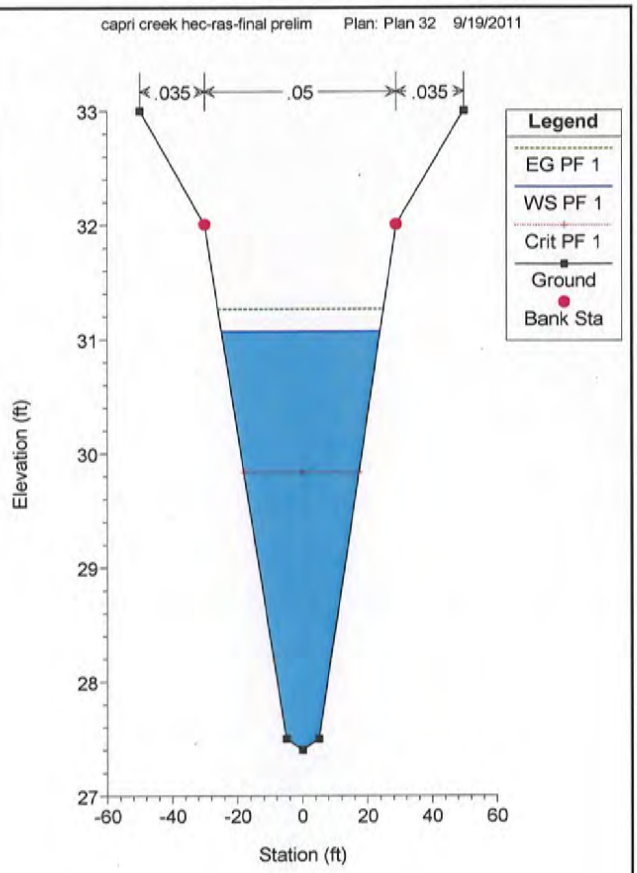
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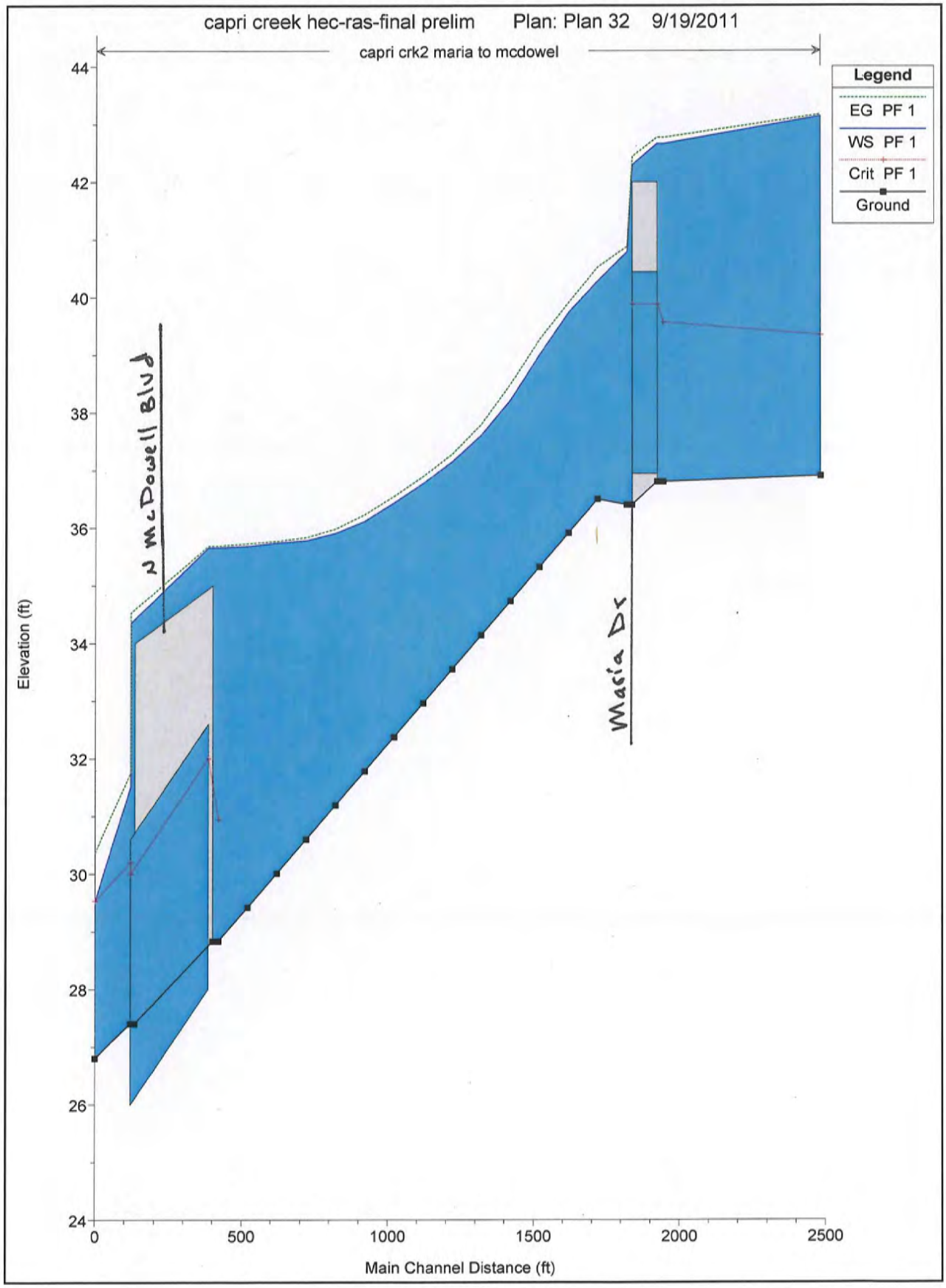
HEC-RAS Plan: Plan 30 River: capri crk2 Reach: maria to mcdowel Profile: PF 1 100 Year Flow

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
maria to mcdowel	3130	PF 1	350.00	36.90	43.13	39.34	43.16	0.000408	1.44	243.46	64.01	0.13
maria to mcdowel	2590	PF 1	350.00	36.80	42.66	39.56	42.77	0.001632	2.64	132.38	37.99	0.25
maria to mcdowel	2550		Culvert									
maria to mcdowel	2490	PF 1	350.00	36.40	40.78		40.87	0.001947	2.46	142.38	54.55	0.27
maria to mcdowel	2400	PF 1	350.00	36.50	40.28		40.52	0.007179	3.95	88.53	44.20	0.49
maria to mcdowel	2300	PF 1	350.00	35.91	39.74		39.91	0.004930	3.35	104.56	50.52	0.41
maria to mcdowel	2200	PF 1	500.00	35.32	39.00		39.27	0.007851	4.10	121.98	62.05	0.52
maria to mcdowel	2100	PF 1	500.00	34.73	38.22		38.50	0.007462	4.22	118.39	55.01	0.51
maria to mcdowel	2000	PF 1	500.00	34.14	37.61		37.79	0.006106	3.43	145.61	80.24	0.45
maria to mcdowel	1900	PF 1	500.00	33.55	37.15		37.28	0.004129	2.94	169.84	87.90	0.37
maria to mcdowel	1800	PF 1	500.00	32.96	36.77		36.89	0.003608	2.80	178.76	90.38	0.35
maria to mcdowel	1700	PF 1	500.00	32.37	36.43		36.55	0.003214	2.72	184.07	89.07	0.33
maria to mcdowel	1600	PF 1	500.00	31.78	36.12		36.23	0.003111	2.74	182.74	85.33	0.33
maria to mcdowel	1500	PF 1	500.00	31.19	35.91		35.98	0.001873	2.20	226.96	100.23	0.26
maria to mcdowel	1400	PF 1	500.00	30.60	35.78		35.83	0.001140	1.84	271.67	108.15	0.20
maria to mcdowel	1300	PF 1	500.00	30.01	35.74		35.77	0.000346	1.40	360.21	92.98	0.12
maria to mcdowel	1200	PF 1	500.00	29.42	35.68		35.73	0.000495	1.69	295.17	70.00	0.15
maria to mcdowel	1100	PF 1	500.00	28.83	35.66	30.94	35.69	0.000264	1.35	369.51	75.00	0.11
maria to mcdowel	970		Culvert									
maria to mcdowel	820	PF 1	500.00	27.40	31.51	30.19	31.75	0.005496	3.90	128.17	53.67	0.44
maria to mcdowel	700	PF 1	500.00	26.80	29.53	29.53	30.37	0.031907	7.34	68.10	41.42	1.01



100 Year Flow

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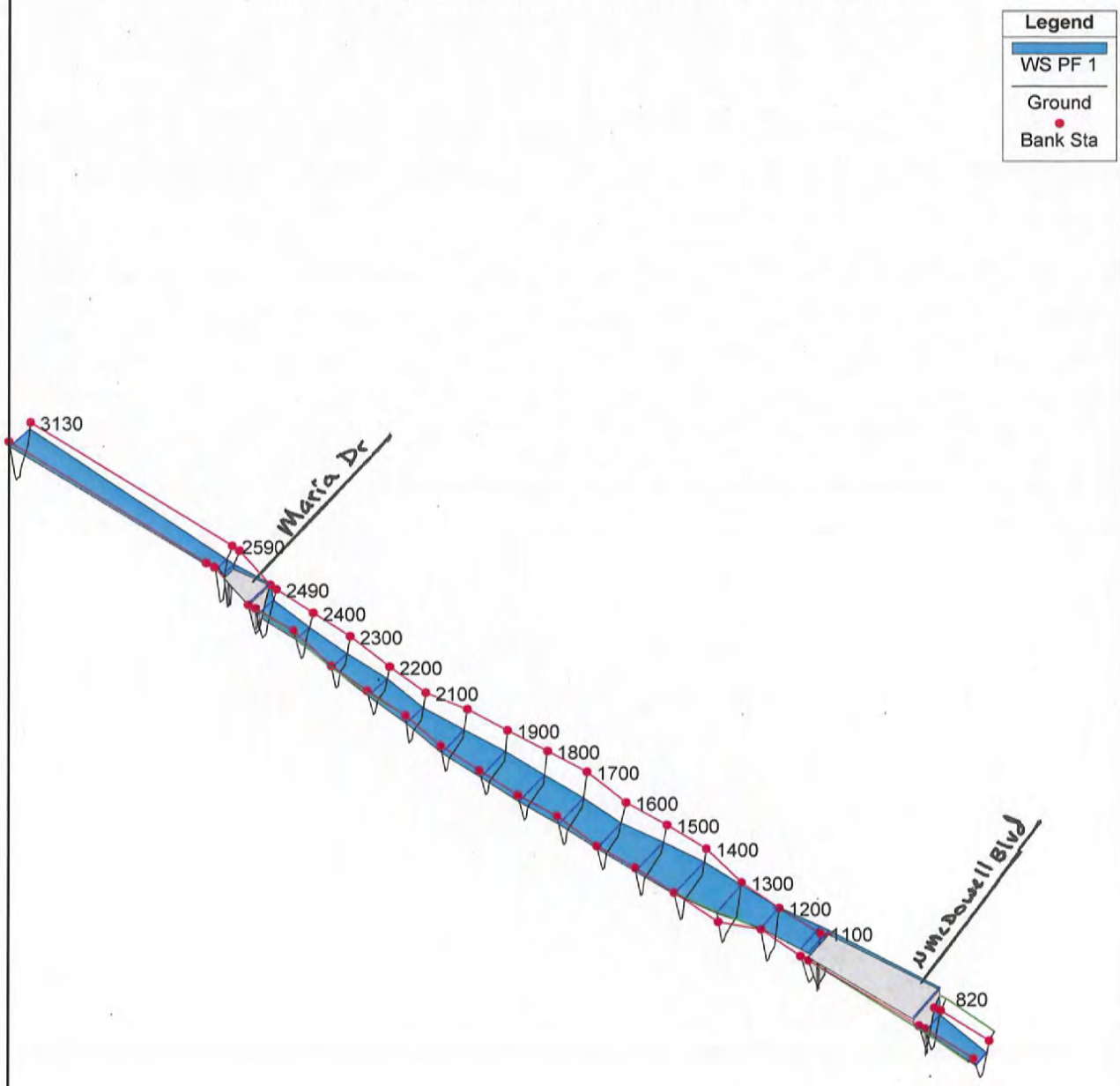

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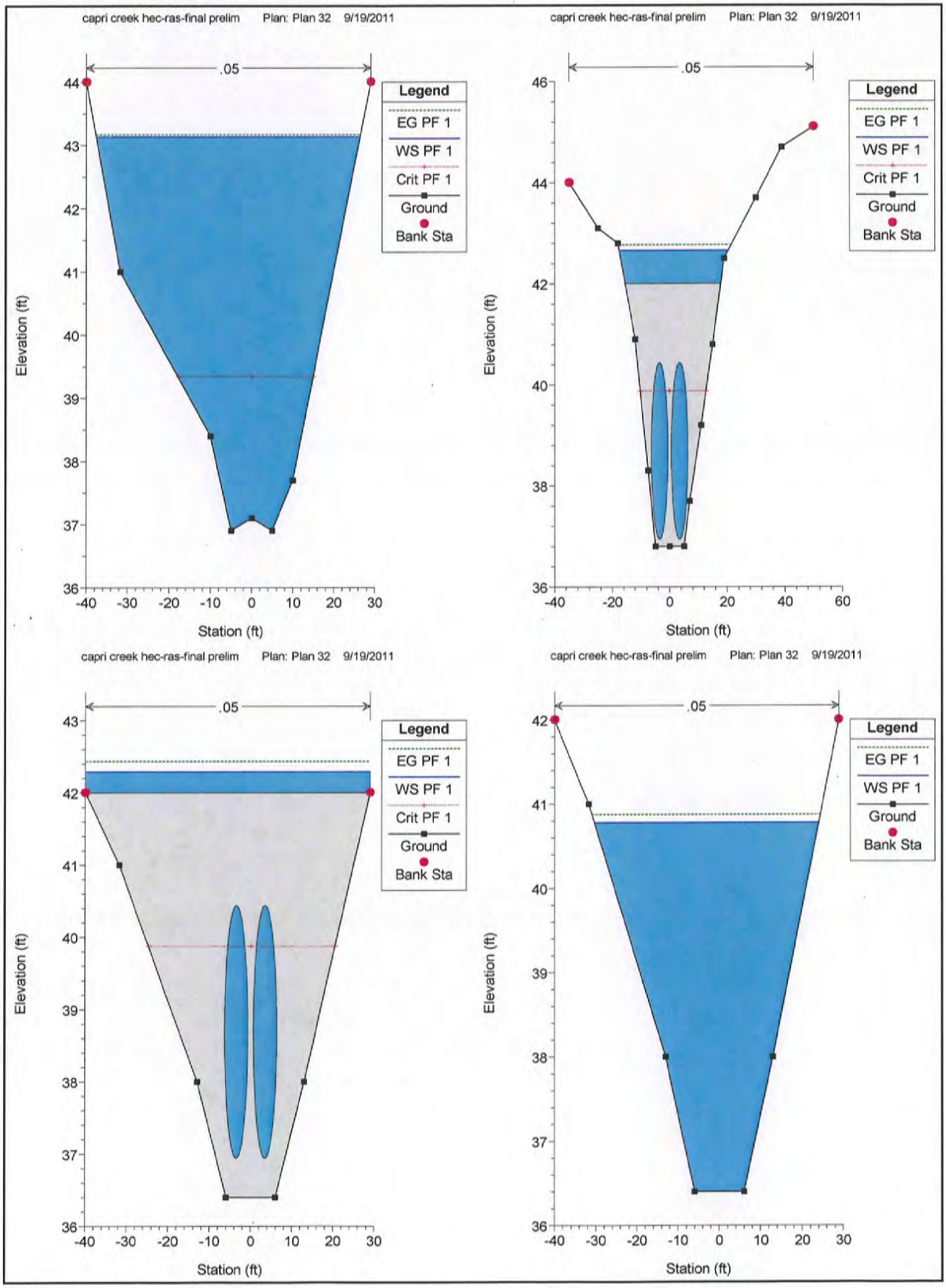
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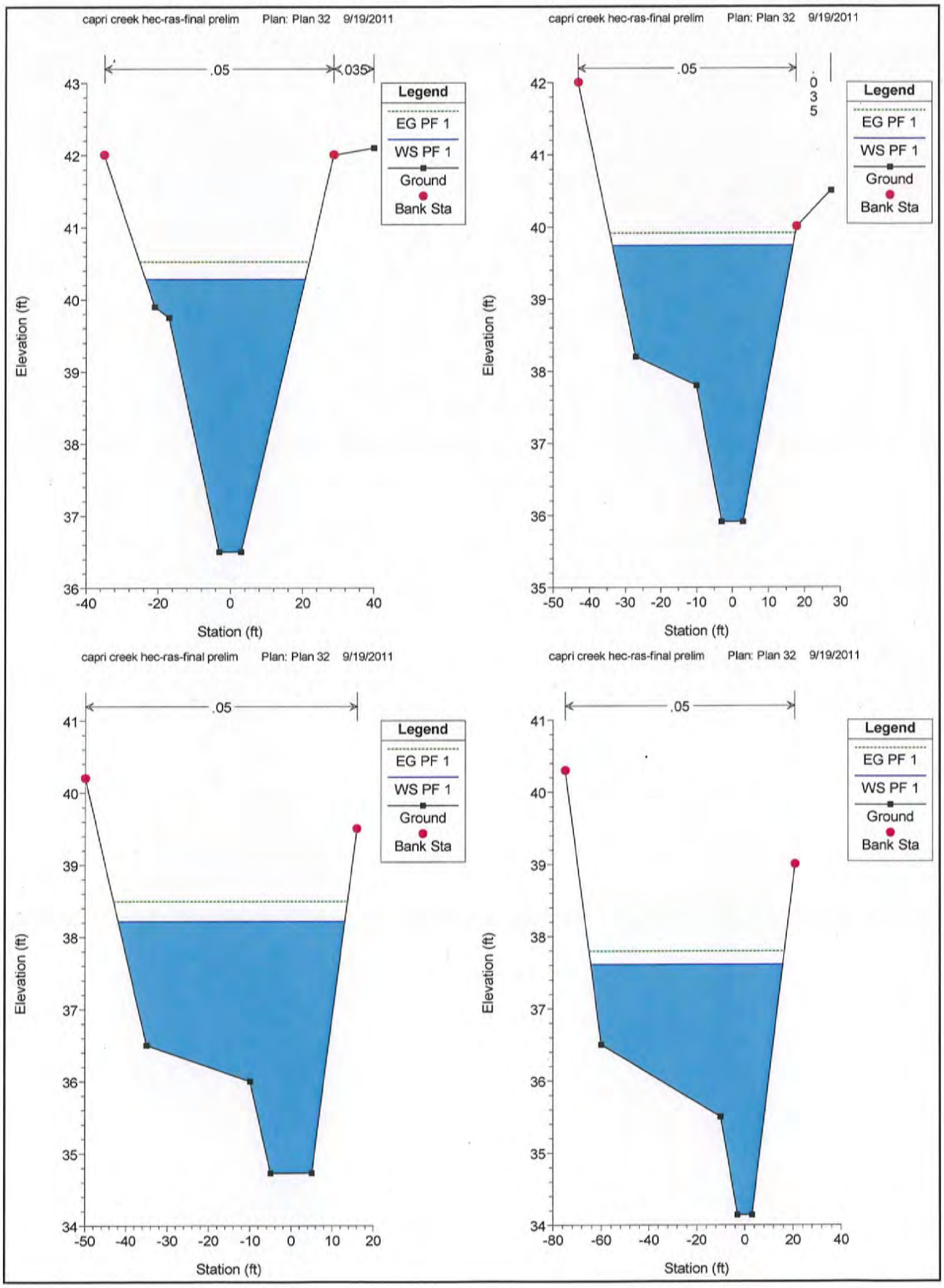
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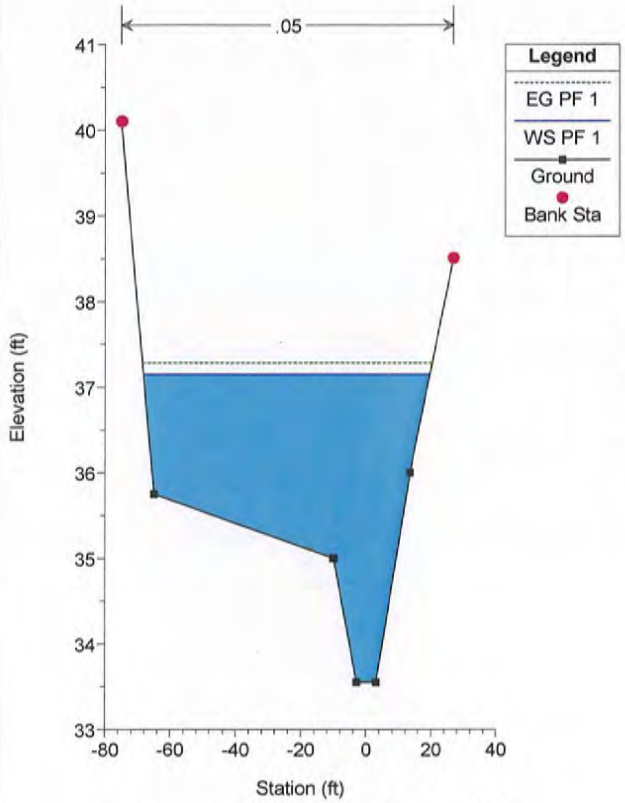

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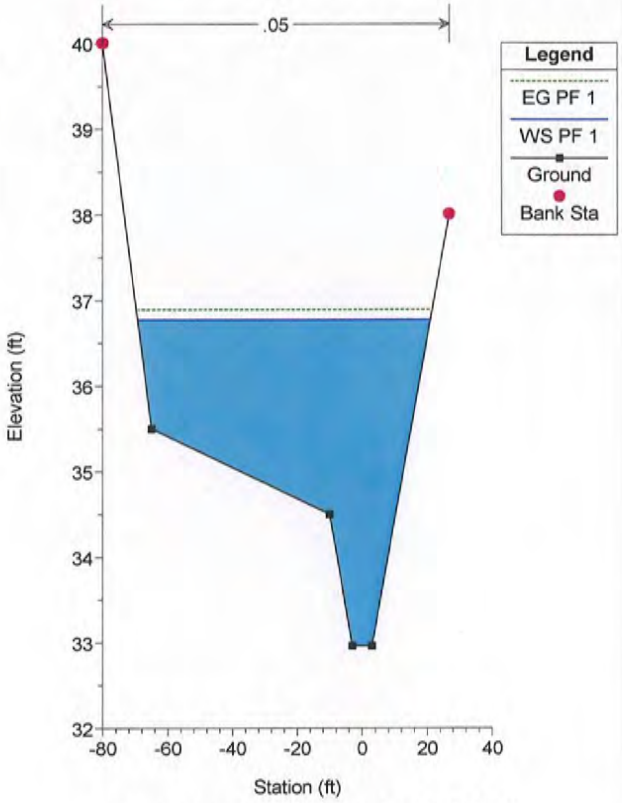

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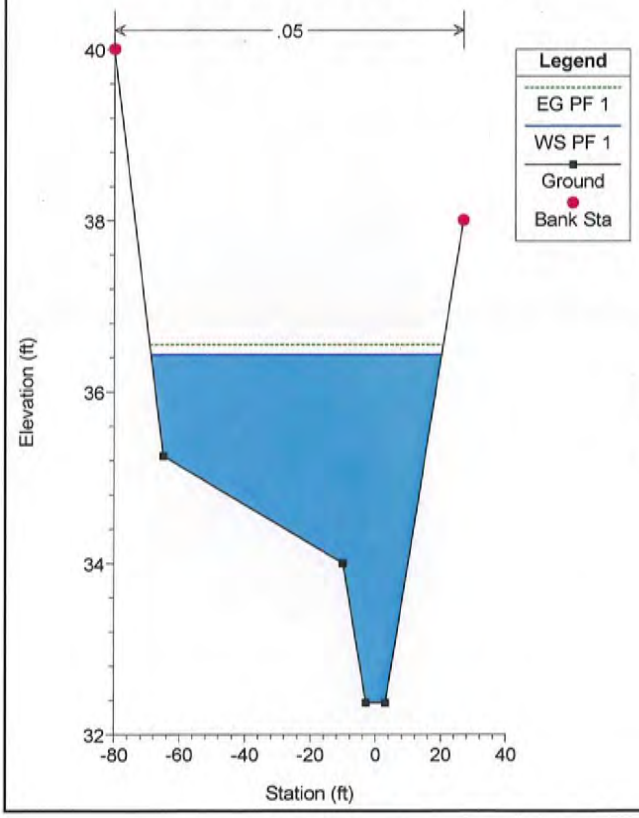

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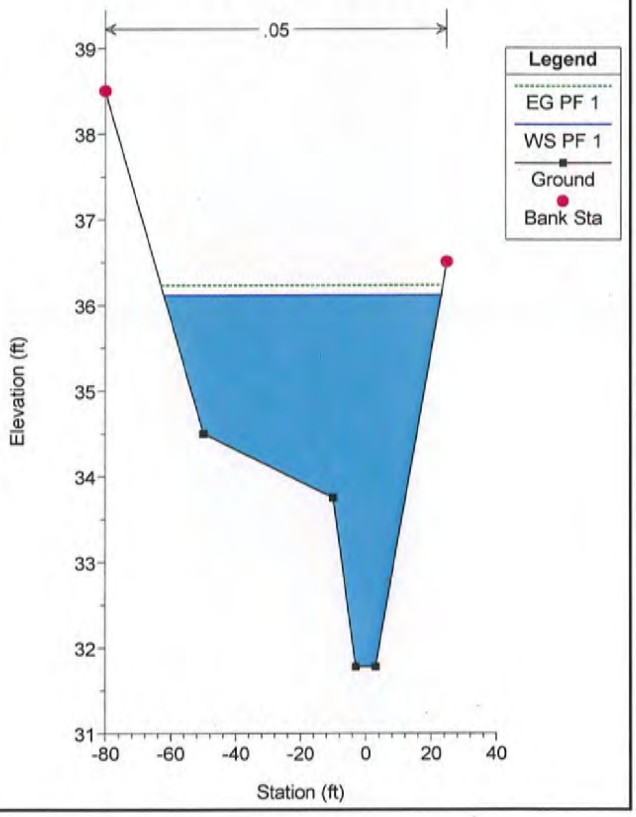

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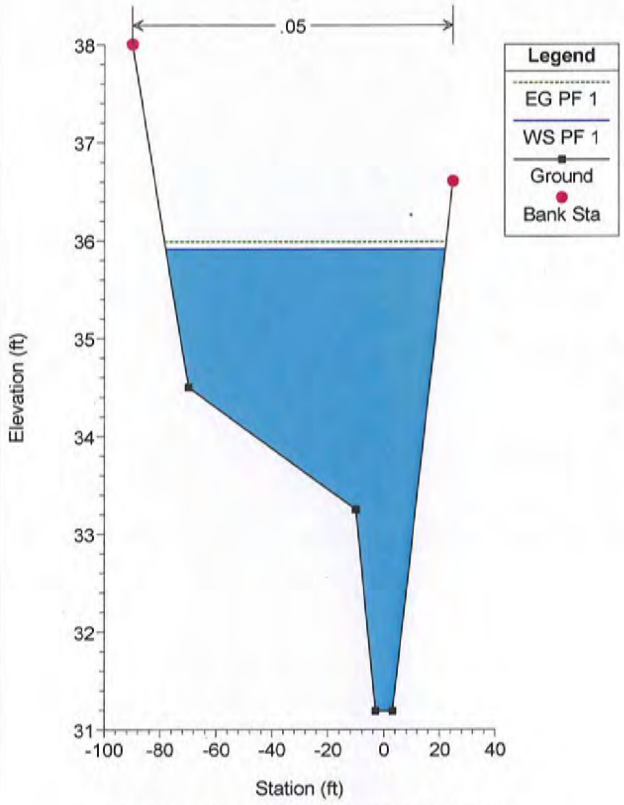

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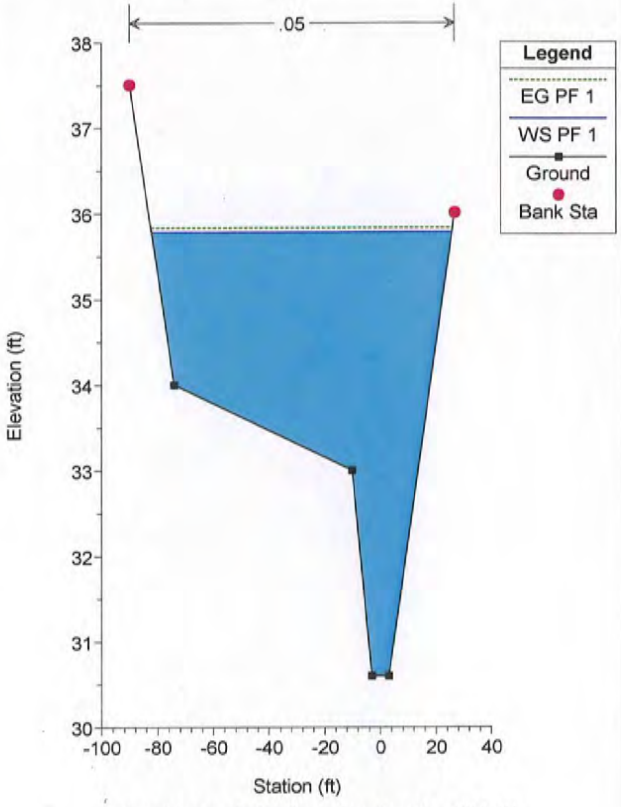

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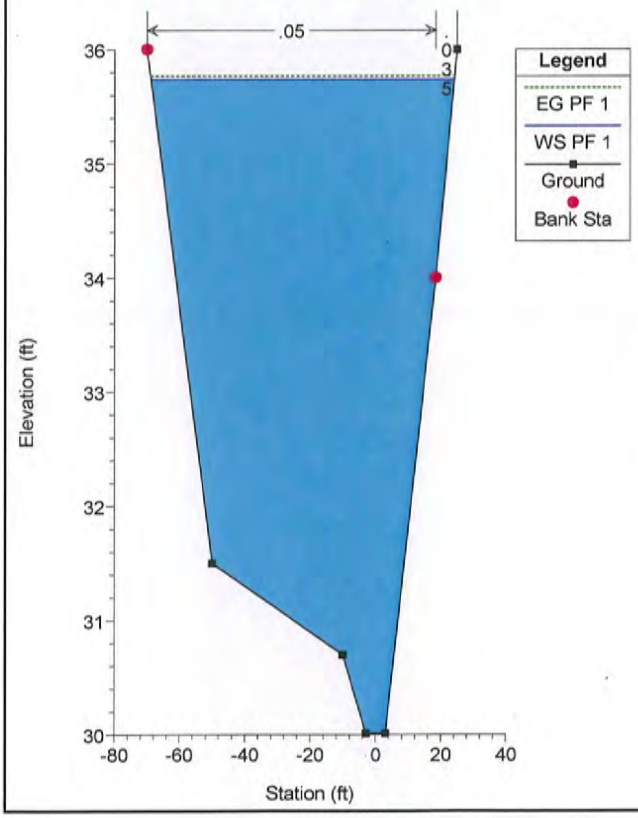

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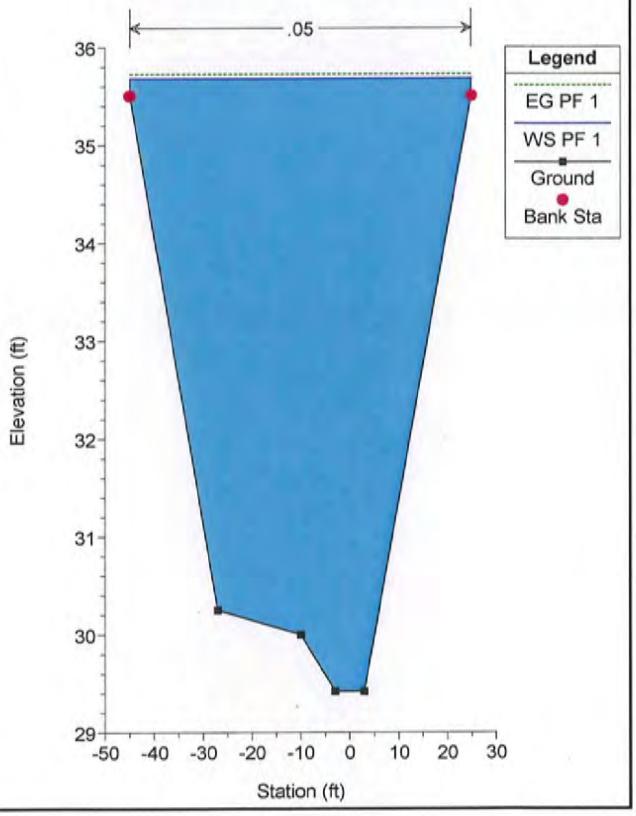

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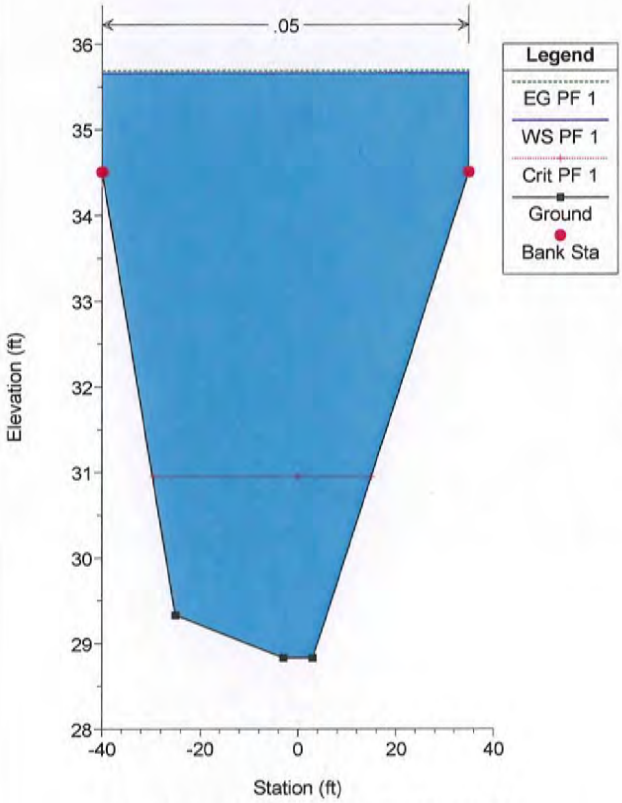

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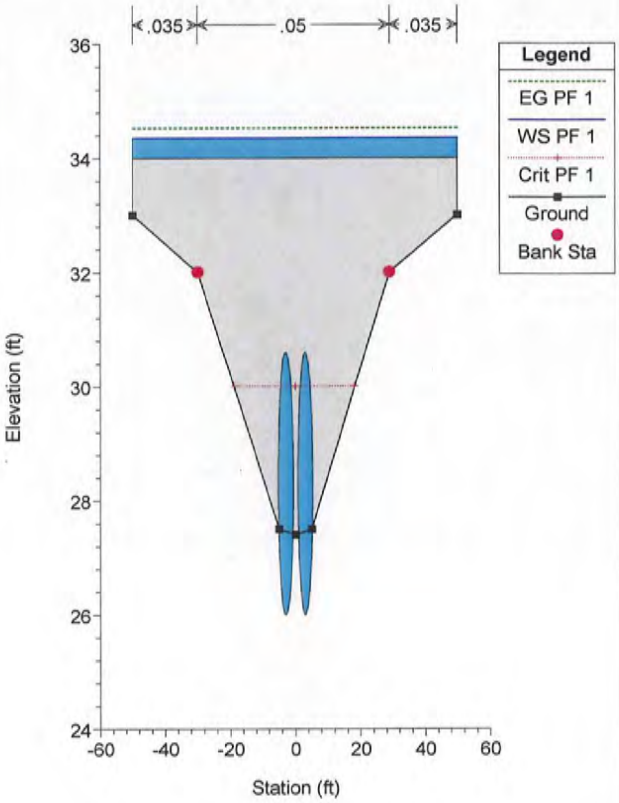

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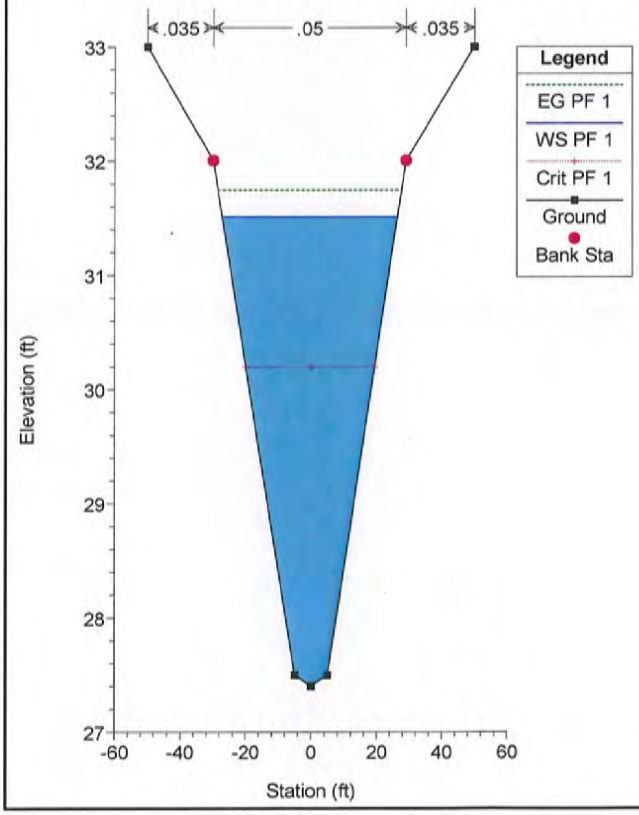

Appendix 4

Preliminary Engineer's Estimate

Preliminary
Engineer's Estimate
for
CAPRI CREEK FLOOD TERRACE

Description	Unit	Quantity	Unit Price	Cost
Design and Analysis				
City Staff	HR	350	$ 85.00	$ 29,750
Engineering Survey CM	LS	1	$ 74,625.00	$ 74,625
Agency Coordination	LS	4	$10,000.00	$ 40,000
Community Outreach	LS	1	$7,500.00	$ 7,500
Construction				
Off Haul	YD	10600	$8.00	$ 84,800
Grading	YD	10600	$25.00	$ 265,000
Planting	SF	150000	$0.20	$ 30,000
Concrete	YD	10	$120.00	$ 1,200
Berms	LF	550	$10.00	$ 5,500
Erosion Prevention	SF	150000	$0.40	$ 60,000
Irrigation	LS	1	$2,500.00	$ 2,500
Traffic Control	Day	60	$600.00	$ 36,000
SWPPP	LS	1	$10,000.00	$ 10,000
Outlet structure Re-Build	EA	1	$2,500.00	$ 2,500
Mobilization	LS	1	$49,750.00	$ 49,750

Subtotal (rounded to nearest whole num)	$	699,125
20% Contingency	$	139,825
Total	**$**	**838,950**

Date: 3/5/2012 march
Estimated by: TCH

Sonoma County General Plan 2020

INTRODUCTION

Sonoma County Permits and Resource Management Department
2550 Ventura Avenue
Santa Rosa, CA 95403

Adopted by Resolution No. 08-0808
of the Sonoma County Board of Supervisors
September 23, 2008

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INTRODUCTION

1. AUTHORITY AND PURPOSE

1.1 AUTHORITY FOR THE GENERAL PLAN

Statutory authority for a general plan is expressed in Title 7, Division 1 of the Government Code of the State of California. Article 5, Section 65300 et seq. requires the County to adopt a comprehensive general plan to guide its future physical development. The plan may recognize local conditions in a format that is appropriate for the local agency. Although the General Plan must address a number of different subjects and elements, the County may choose the degree of specificity and level of detail that is appropriate for its circumstances.

1.2 REQUIRED AND OPTIONAL ELEMENTS

The General Plan must contain a statement of development policies, including diagrams or maps and text, setting forth objectives, principles, standards, and plan proposals. Seven mandatory elements are Land Use, Circulation, Housing, Conservation, Open Space, Noise, and Safety.

A number of optional elements are allowed. This General Plan includes four optional elements: Agricultural Resources, Air Transportation, Water Resources, and Public Facilities and Services.

1.3 PURPOSE OF THE PLAN

Sonoma County General Plan 2020 (GP 2020) is a revision of the previous General Plan which was adopted in 1989, and supersedes and replaces that document. This plan carries forward the major goals and policy framework of the 1989 Plan, and retains the overall format. The primary purpose of the revised plan was to conduct a policy review which focused upon specific issues that were of paramount importance to the community.

The broad purpose of GP 2020 is to express policies which will guide decisions on future growth, development, and conservation of resources through 2020 in a manner consistent with the goals and quality of life desired by the county's residents. Under State law many actions on private land development, such as Specific Plans, Area Plans, zonings, subdivisions, public agency projects and other decisions must be consistent with the General Plan. The Goals, Objectives, and Policies set forth in the plan will be applied in a manner to insure their constitutionality.

Footnote: *Mitigating Policy

2. REGIONAL CONTEXT

2.1 THE REGIONAL SETTING

Sonoma County, the most northerly of the nine counties in the San Francisco Bay Region, is located along the Pacific coastline about forty miles north of San Francisco and the Golden Gate Bridge. The County is just over 1500 square miles, making it the largest of the nine Bay Area counties.

Sonoma County is bordered by the Pacific Ocean on the west, Marin County and San Pablo Bay to the south, Solano, Napa and Lake Counties to the east, and Mendocino County to the north. Because of the geographic configuration and topography of the North Bay area, transportation linkages to adjacent counties are limited to a few routes. The U.S. Highway 101 Freeway is the major north/south route, connecting the County to San Francisco and Marin to the south and to Mendocino on the north.

2.2 THE COUNTY SETTING

Sonoma County's 1500 square miles include a diverse mosaic of landforms, environments, and human settlements. The broad, flat Santa Rosa Plain, which lies between the Sonoma Mountains on the east and low coastal hills on the west, contains the cities of Santa Rosa, Rohnert Park, and Cotati. The sparsely settled western margin of the county, along the Pacific coastline, includes the redwood and mixed conifer forests of the Mendocino Highlands in the north and rolling oak studded hills, dairylands, and coastal prairies in the south. The Mayacamas Range forms the eastern boundary of the county. Along with the Sonoma Mountain range, it encloses the Sonoma Valley or "Valley of the Moon," a scenic valley which extends from near Santa Rosa southeastward to the City of Sonoma and the marshlands of San Pablo Bay. In the north, the Mayacamas Range and Mendocino Highlands enclose the farming regions of Alexander and Dry Creek Valleys. In the far northeast, the remote interior of the Mayacamas Range contains the Geysers geothermal steam field.

2.3 INTERGOVERNMENTAL PLANNING COORDINATION

Sonoma County has a particular interest in coordination of land use, infrastructure, and environmental protection with other local, state, federal, and tribal governmental jurisdictions within the County. GP 2020 is generally compatible with the plans of the nine cities, and with plans or policies established by other governmental agencies. Areas for future expansion of the cities were coordinated with the various cities and with the Local Agency Formation Commission, which is responsible for setting city boundaries and spheres of influence. Although GP 2020 does not regulate development within the cities, it is applicable to lands within their spheres of influence. In some instances, the policies of the plan establish larger "areas of interest" for cities, in order to provide for their review and comment on proposed County actions.

Footnote: *Mitigating Policy

Sonoma County also acknowledges both the presence of federally recognized tribal governments within Sonoma County and the need for communication and coordination with federal and tribal governments, where development of tribal and non-tribal land is proposed and where tribes seek to acquire new trust land.

GP 2020 also considers the policies and concerns of adjacent counties and regional agencies, such as the Association of Bay Area Governments, the Metropolitan Transportation Commission, the San Francisco Bay Conservation and Development Commission, the Bay Area Air Quality Management District, the Northern Sonoma County Air Pollution Control District, the Bay Area Water Quality Control Board, the North Coast Regional Water Quality Control Board, the Sonoma County Water Agency, and others. The text of the various elements notes those situations where these agencies have particular responsibilities that affect the physical development of the County and approval of permits.

3. ORGANIZATION AND OVERVIEW OF THE PLAN

3.1 THE PLAN FORMAT

GP 2020 consists of 10 elements:

- Land Use Element
- Housing Element
- Agricultural Resources Element
- Open Space and Resource Conservation Element
- Water Resources Element
- Public Safety Element
- Circulation and Transit Element
- Air Transportation Element
- Public Facilities and Services Element
- Noise Element

3.2 THE PLAN ELEMENTS

Land Use

In addition to the nine general goals and policies, the Land Use Element describes where the different kinds of uses for land may be established in the unincorporated areas of Sonoma County. The Land Use Element includes a set of nine planning area land use maps which establish the use and density of properties throughout the unincorporated area. Sections of the element also express policies which are specific to each planning area.

Footnote: *Mitigating Policy

Housing

Future housing production needed to accommodate projected growth is evaluated, along with policies and programs to:

- Encourage development of housing for very low, low, and moderate income households
- Meet the special shelter needs of specific population groups
- Maintain and improve the quality of housing
- Encourage production of diverse types of housing.

Agricultural Resources

Detailed guidelines and policies which apply to lands designated in one of the three agricultural land use categories are stated in this element. Policies address marketing of agricultural products, stabilization of agricultural use at the edge of urban areas, limitations on intrusion of residential uses, the location of agricultural services and visitor serving uses, provision of farmworker housing, the streamlining of permit procedures for agricultural uses, and recognition of the aquaculture and horse industries as agricultural endeavors.

Open Space and Resource Conservation

This element, in conjunction with the Water Resources and Agricultural Resources Elements, expresses the full range of goals, objectives, and policies for the preservation of open space, the protection of natural resources, and the provision of outdoor recreation opportunities. It designates various portions of the County in several open space classifications, such as Community Separators, Scenic Landscape Units, Scenic Corridors, Riparian Corridors, and Biotic Habitat Areas. Policies address natural resources such as soils, forests and timber, biotic resources, geothermal, mineral, and energy resources, and air quality. Policies are also established regarding parks, trails, and bikeways. Archaeological, cultural, and historical resources are also addressed.

Water Resources

This element was added for the first time in recognition of the importance of water to the environment, economic stability, agricultural protection, and the overall quality of life of the citizens of Sonoma County. Policies address subjects such as surface and groundwater, water conservation and re-use, public water systems, and water quality.

Public Safety

Special limitations and procedures for review of development projects located in areas subject to natural hazards are included in this element. Safety hazards addressed include seismic and other geologic hazards, flooding, and susceptibility to wildland fires. Hazardous materials are

Footnote: *Mitigating Policy

also included in this element.

Circulation and Transit

The plans for the county's future highway and transit systems are expressed, with particular emphasis on the Highway 101 corridor. GP 2020 emphasizes an increased role for transit in serving commute trips and the importance of measures which will allocate existing highway capacity more efficiently during peak travel periods.

Air Transportation

This element expresses policies related to the public use airports in the county, including compatibility of land uses in adjacent areas. It focuses on the Sonoma County Airport and expresses policies related to the types and amounts of aviation activities to be accommodated and facilities needed to serve them.

Public Facilities and Services

The various public services that may affect the future development of land are emphasized, including water, sewer, parks, education, fire protection, and others. New to this element are policies related to youth, family, and senior services.

Noise

This element evaluates existing and projected future noise conditions related to highways, airports, and other sources and expresses policies and standards to assure noise compatibility in future land development.

General Plan Environmental Impact Report

Prior to adoption of GP 2020, the Board certified the GP 2020 Final Environmental Impact Report that identified the impacts of GP 2020 and the policies that contribute to mitigation of these impacts. For informational purposes, each GP 2020 policy that was cited in the FEIR as a mitigating policy is identified with an asterisk (*) after the policy. In addition, a table is included at the end of GP 2020, entitled “Mitigating Policies of GP 2020". This table identifies the applicable Policies and their relevant impact sections.

4. CITIZEN PARTICIPATION IN PLAN PREPARATION AND FUTURE UPDATES

The County encourages a high degree of public awareness of planning and development issues and participation by interested citizens in the preparation and consideration of plan policies. Preparation of GP 2020 was assisted by a citizen’s advisory committee, appointed by the Board

Footnote: *Mitigating Policy

of Supervisors, responsible for reviewing and making recommendations on all issues and related policies that were included in the update. In effect, the committee directly participated in the drafting of the goals, objectives, and policies to be submitted for consideration by the Planning Commission and Board of Supervisors. During all phases of policy development, local residents, businesses, property owners, and interest groups were encouraged to express their views about planning issues and policies proposed for incorporation into GP 2020. Members of the Citizens' Advisory Committee are identified in Section 6, Acknowledgments.

Footnote: *Mitigating Policy

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Footnote: *Mitigating Policy

6. ACKNOWLEDGMENTS

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Footnote: *Mitigating Policy