PHOENIX LAKE IRWM RETROFIT

ATTACHMENT 3 - WORK PLAN – UPDATE JULY 2012

1.0 Introduction

1.1 Goals and Objectives

The Phoenix Lake IRWM Retrofit is an important component of the greater Ross Valley Watershed Flood Reduction Program. The Program goal is to substantially reduce the flood hazard in Ross Valley. Program objectives integrate restoration of creek ecological function and other public riparian resource enhancements with the primary objective of flood protection. Specific objectives of the Program include providing a 100-year level flood protection throughout Ross Valley; improve riparian and aquatic habitat, particularly to aid in the recovery of special-status anadromous salmonids; and, enhance access and public enjoyment of the creek.

Funding for Program projects and activities will partially derive from a drainage fee that was approved by voters of Ross Valley (Marin County Flood Control and Water Conservation District, Flood Zone 9; **FZ9**) in 2007 following the disastrous flood of December 31, 2005 (an approximate 100-year flood). The drainage fee will generate about $40 million between 2007 and 2027. Additional sources of funding, such as grants, will be needed to implement all Program projects and activities.

The guiding planning document for the Program is the Ross Valley Flood Reduction and Creek Management Capital Improvement Plan Study (Stetson Engineers, et al, May, 2011).[1] The Capital Improvement Plan Study identifies five flood detention basins for capturing and attenuating flood flows and over 180 in-channel improvements aimed at increasing flood conveyance capacity while simultaneously improving the ecological function of Corte Madera Creek and its tributaries (see Figure 1). These detention basins and in-channel capacity improvements work together to provide 100-year flood protection to homes and businesses in flood-prone Ross Valley.

Phoenix Lake, an existing water supply reservoir owned and operated by Marin Municipal Water District (**MMWD**), is the keystone of the Program owing to its sizable attenuation capacity and substantial effect in reducing flood flows. Originally built in 1906 on Ross Creek (a tributary to Corte Madera Creek) for municipal water supply, the 100-year old Phoenix Lake Dam may require major retrofit in order to function as a duel-purpose water supply-flood detention basin. The earthen embankment dam needs

[1] Document can be viewed and downloaded from the website, http://www.marinwatersheds.org/.

structural strengthening to improve seismic stability[2]; the spillway crest needs to be raised six feet for added water supply and flood attenuation capacity; the intake/outlet works of the low-level drain pipeline need modification to enable rapid lake drawdown in advance of a forecasted flood; and the lake water transfer piping system needs modification to enable more flexible utilization of the added water supply.

Concomitant with the above-described retrofit of the dam are other physical and operational improvements that are needed to better utilize this valuable, multi-purpose public asset in ways that are compatible, and even synergistic, with flood damage reduction and water supply functions. Installation of two lake circulation devices aims to improve lake water quality by reducing algal growth in the epilimnion and improving lake clarity, and increasing dissolved oxygen concentrations and reducing iron and manganese and other metals concentrations in the hypolimnion. Instream flow release of cooler water withdrawn from the lake hypolimnion by way of the modified intake of the low-level outlet aims to improve downstream water quality and aquatic habitat for target anadromous salmonids and other cold freshwater fish. If required by regulatory authorities, creek aquatic habitat will be further improved by the aeration of the low-level outlet discharge and reduction or elimination of seepage through the dam of water potentially containing low dissolved oxygen, iron and manganese through installation of a liner and grout curtain along the dam. Improvements to trails aim to improve public access and enjoyment of the lake and reduce erosion in tributaries and sediment delivery to the lake. The Capital Improvement Plan Study provides engineering analysis, preliminary designs, and costs for several of the component projects of the Phoenix Lake IRWM Retrofit.

FZ9 intends to implement an economical configuration of the Phoenix Lake IRWM Retrofit that complies with regulatory permit requirements. Although a significant body of technical work has been completed as described further in this workplan, FZ9 recognizes that the Retrofit is still in the early stages of development: Design is at the concept (30%) design stage, environmental review under NEPA and CEQA has not been initiated and regulatory agencies have not been consulted. In light of the uncertainties that may come about through the environmental review and permitting process, certain elements have been incorporated into the Retrofit to comply with potential mitigation requirements. These include the dam seismic upgrade, low-level outlet discharge aeration system, dam liner/grout curtain, and other mitigation measures. Based on the outcome of the environmental review and permitting process, FZ9, in consultation with MMWD, will decide on which of these elements to implement, if any.

[2] Preliminary geotechnical analysis (Miller Pacific, 2011) using strength properties from historical borings through the dam suggest that the seismic stability of the dam may be satisfactory. This workplan includes exploratory drilling and testing of new boreholes and further geotechnical analysis. Based on the findings, the need for structural strengthening will be re-evaluated and determined in consultation with DSOD.

FIGURE 1

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ROSS VALLEY WATERSHED PROGRAM: CAPITAL IMPROVEMENT PLAN FOR FLOOD REDUCTION AND CREEK MANAGEMENT

geomorph

STETSON ENGINEERS INC.

LOMA ALTA DETENTION BASIN

LEFTY GOMEZ DETENTION BASIN

FAIRFAX CREEK IMPROVEMENTS

SLEEPY HOLLOW CREEK IMPROVEMENTS

MEMORIAL PARK DETENTION BASIN

RED HILL PARK DETENTION BASIN

SAN ANSELMO CREEK IMPROVEMENTS

RECOMMENDED IMPROVEMENTS

UPSTREAM END OF CONCRETE CHANNEL (STA:369+70)

USGS GAUGE @ ROSS

US ARMY CORPS OF ENGINEERS PROJECT

UPSTREAM END OF EARTHEN CHANNEL (STA:319+00)

PHOENIX LAKE DETENTION BASIN

MODEL DOWNSTREAM BOUNDARY STA:166+00

GALLINAS CREEK WATERSHED

SAN RAFAEL WATERSHED

TOMALES BAY LAGUNITAS CREEK WATERSHED

FAIRFAX

SAN ANSELMO

RED HILL

BALD HILL

ROSS

KENTFIELD

GREENBRAE

LARKSPUR

SAN QUENTIN

SAN FRANCISCO BAY

Marin General Hospital

Iron Spring Cr.
Fairfax Cr.
Bothin Cr.
Ascade Cr.
Blue Ridge Cr.
Spring Cr.
Curry Camp Cr.
SAN ANSELMO CR.
Deer Park Cr.
Wood Lane Cr.
Phoenix Cr.
Fish Gulch Cr.
Eldridge Cr.
Tucker Cr.
Bill Williams Cr.
East Peak Cr.
Sleepy Hollow Cr.
Sorich Cr.
Ross Cr.
Kuss Cr.
Murphy Cr.
McAllister Cr.
Tamalpais Cr
King Montain Cr.
Low Canal Cr.
Larkspur Cr
CORTE MADERA CR.

Sir Francis Drake Blvd
Center Blvd
Forest Ave
Francis Ave
Central St
Red Hill Rd.
4th St
2nd St
3rd St
Bolinas Rd
Fairfax Bolinas Rd
Cascade Dr
Cascade Fire Rd
Broadway
Butterfield Rd
Olema Rd
Arroyo Ave
San Francisco Blvd
San Anselmo Ave
Elm Ave
Scenic Ave
Kensington Rd
Sunnyside Ave
Bolinas Ave
El Camino Bueno
Laurel Grove Ave
Upper Ridge Rd
Lagunitas Rd
Rose Dorman Rd
Doubles Rd
Shafer Grade Rd
Fish Gulch Fire Rd
Southern Marin Line Fire Rd
Goodhill Rd
Woodland Rd
Wolfe Grade
Bon Air Rd
La Cuesta Dr
Ellen Dr
Highway 101
Magnolia Ave
Meadowood Dr
Greenbrae Boardwalk
W Hwy 580
E Hwy 580

LEGEND

- CREEK
- HIGHWAY / MAJOR ROAD
- WATERSHED BOUNDARY
- CREEK IMPROVEMENT AREA
- DETENTION BASIN
- US ARMY CORPS OF ENGINEERS PROJECT
- SEDIMENTATION AND CHANNEL CAPACITY MANAGEMENT ZONE

SCALE (Feet)
0 1250 2500 5000

SCALE (Miles)
0 0.25 0.5 1

N
W E
S

F:\DATA\2292\AutoCAD\ImprovementsApplication_General Map.dwg

1.2 Purpose and Need

There is a need to reduce the frequency and severity of flooding in Ross Valley for the protection of property and public safety. The current capacity of Corte Madera Creek (below Phoenix Lake and the Ross Creek confluence) is about 3,600 cubic feet per second (cfs), which corresponds to about the 17-percent-annual-chance flood (i.e., 6-year recurrence flood). Several times in recent history Corte Madera Creek has flooded Ross Valley with varying degrees of severity. Prior to establishment in 1951 of the USGS streamflow gaging station on Corte Madera Creek in Ross, flooding was reported in calendar years 1914, 1925, 1937, and 1942. Since 1951 flood flows have been recorded in calendar years 1951, 1955, 1958, 1967, 1969, 1970, 1982, 1983, 1986, 1994 , and 2005. Of these, the two most severe floods occurred in 1982 and 2005, with peak discharges of approximately 7,200 cfs and 6,800 cfs; the annual-chances of which were approximately 0.6-percent and 1-percent, respectively. Historical flooding has caused extensive property damage and economic hardship to residents, businesses, and local governments, and has threatened the lives of those living in the floodplain, with at least one recorded death occurring in the 1955 flood and at least one rescue by Urban Search and Rescue personnel during the 2005 flood.

In accordance with its Congressional authorization for flood control along the lower reach of Corte Madera Creek, the Army Corps of Engineers has plans to increase creek conveyance capacity below the Ross Creek confluence to about 5,400 cfs (about the 4-percent-annual-chance or 25-year recurrence flood). Although this is clearly a major improvement, the Ross Valley community desires a higher level of protection. In order to increase the effectiveness of the Corps' design and achieve the desired 1-percent-annual-chance level of flood protection (i.e., 100-year recurrence flood protection), the 100-year flood discharge at the Ross Creek confluence needs to be reduced by 1,400 cfs, from 6,800 cfs down to 5,400 cfs. This reduction is achievable through detention basins, and retrofit of Phoenix Lake, the largest of the five basins, is critical because it can reduce the 100-year flood discharge by about 650 cfs, or nearly half of the total amount needed.

The Phoenix Lake IRWM Retrofit includes seismic upgrade of the dam to enable storage of floodwater to a the higher water level; stabilization of two landslides along the northern side of the lake to prevent rapid deposition into the lake due to slope failure during flood storage; modification of the intake/outlet works of the low-level drain pipeline to enable rapid lake drawdown in advance of a forecasted flood to provide additional storage and floodwater attenuation; and, excavation of the lake bottom to provide an adequate minimum pool when the lake is fully drawn down for fish and other aquatic wildlife and to prevent entrainment and discharge of sediment. Without the Phoenix Lake IRWM Retrofit, the lower reach of Corte Madera Creek will be limited to about the 4-percent-annual chance level of flood protection. Public safety and property downstream of the Ross Creek confluence in the communities of Ross, Kentfield, Larkspur and Greenbrae will remain at an unacceptable high risk of flooding.

There is a need to restore the ecological health and function of Corte Madera Creek and its tributaries. The creek provides important habitat for threatened and endangered species and is considered an "anchor stream" in the NMFS recovery plans for coho salmon and steelhead trout. Although overall ecosystem functions of the creek are still essentially intact, the freshwater aquatic and creek riparian habitats have been reduced and degraded by human activities and the ongoing presence of development. By the late 1800s, cattle grazing, deforestation, and dredging for navigation began directly modifying creek corridors and increasing the severity of rainfall and sediment-laden runoff. Railroad prisms, bridges, and other permanent infrastructure were installed flanking and spanning the creeks, often creating grade breaks or otherwise altering the creek bed making it difficult for native fish to pass through. In the 1900s, encroachment by urban development gradually filled in along the edges of the creek corridors eliminating portions of the riparian canopy and natural creek bank vegetation and encouraging invasion by non-native vegetation. With construction of Phoenix Lake in 1906, baseflow water temperatures in Ross Creek and farther downstream were warmed as historical seepage of cool groundwater into upper Ross Creek was replaced by spillway overflow from the warmer (and lighter) upper layer of the newly formed lake. Furthermore, water that seeps through or beneath the dam potentially has low dissolved oxygen and contains concentrations of iron and manganese. All of these factors have contributed at various levels to today's sub-optimal aquatic and riparian habitat conditions below Phoenix Lake. The Phoenix Lake IRWM Retrofit includes installation of a liner and grout curtain along the upstream face of the dam, modification of the intake/outlet works of the low-level drain pipeline, and an aeration system at the pipeline outlet. These modifications will reduced or eliminate seepage through the dam of water containing low dissolved oxygen and iron and manganese, enable instream flow release of cooler, oxygenated water from the lake hypolimnion, and thereby improve downstream water quality and aquatic habitat for target anadromous salmonids and other coldwater species. Without the Phoenix Lake IRWM Retrofit, recovery of target anadromous salmonids and other species will continue to be challenged by sub-optimal riparian and aquatic habitat conditions.

There is a need to provide more reliability and flexibility to MMWD's water supply. MMWD reliable water supply is less than the current water demand. If Marin County experiences another drought similar to that of 1976–77, water supplies may be inadequate to meet current demands. MMWD has begun to implement an aggressive water conservation program, investing $3.3 million in 2008–09 to support a wide range of conservation program activities. In combination with implementation of the California Plumbing Code, these activities are projected to save enough water to meet the needs of the projected future MMWD customers until 2025. Increasing its local supply would provide MMWD with much needed water supply reliability and flexibility, particularly during droughts. The Phoenix Lake IRWM Retrofit will restore the spillway crest to its pre-1985 elevation 180 ft, thereby increasing the storage capacity of the lake by about 120 acre-feet. This added capacity would increase average long-term yield of the lake by about 107 acre-feet per year for supply to the MMWD system. The added supply could potentially replace the need for more costly imported supplies from the Sonoma County Water Agency’s Russian River delivery system.

There is a need to improve the water quality of Phoenix Lake. The lake is afflicted with floating algae blooms, particularly during summertime, and low dissolved oxygen in the lake hypolimnion reduces available cold freshwater habitat in the lake and creates a potential for dissolution of sediment-bound metals (e.g., iron and manganese). Algae blooms can contribute to taste and odor problems in drinking water. These water quality problems can impair the beneficial uses of the lake, particularly for drinking water supply. To address these water quality issues, Phoenix Lake IRWM Retrofit includes installation of an epilimnetic circulation device and a hypolimnetic circulation device. The eplimnetic circulation device aims to reduce the growth of floating algae, thereby improving the water quality, lake clarity, and reducing treatment costs during the summertime when lake supply is most needed. The hypolimnetic circulation device aims to oxygenate the hypolimnion and prevent dissolution of sediment-bound metals. Without the Phoenix Lake IRWM Retrofit, MMWD will continue to explore other, more costly, options to achieve its water supply reliability and flexibility goals.

Finally, there is a need to enhance opportunities for public enjoyment of the lake. Phoenix Lake and its associated trails and watershed land provide fishing, hiking, mountain biking, and other enjoyment opportunities to the public. Phoenix Lake is one of the most heavily used recreational areas in the MMWD Watershed. Improvements to these trails are needed to keep up with the growing demand and maintain adequate access and safe conditions. Reduction in lake sedimentation is also needed. Comparison of the original lake bathymetric contours with recent contours surveyed in 2009 indicates that the lake has lost about 100 acre-feet to sedimentation, or about 25% of its original storage capacity, since 1906. Much of the sediment comes from erosion along creeks that are tributary to the lake. The Phoenix Lake IRWM Retrofit will implement necessary improvements to roads and trails, as well as culverts where these features cross over tributary drainages. These improvements will aim to enhance public access, safety, and reduce erosion and the delivery of sediment to lake. Without the Phoenix Lake IRWM Retrofit, lake sedimentation will continue at historical rates and opportunities for public enjoyment of the lake will remain at current levels.

1.3 Project List [and Elements]

The Phoenix Lake IRWM Retrofit consists of five projects; Flood Damage Reduction Project, Water Supply Project, Water Quality Project, Ecosystem Restoration Project, and Recreation and Public Access Project. All five projects are located at Phoenix Lake or in the immediate vicinity (see Figure 3a). Each project has one or more physical elements, which is a new facility or improvement to an existing lake facility. The tables below provide a list of the five component Projects comprising the Retrofit and an overview of the Projects. All Projects have been assessed and evaluated and are currently at the Concept (30%) Design stage. No environmental review or permitting work has been completed.

Phoenix Lake IRWM Retrofit Project List	
Component Projects	**Project Elements**
Flood Damage Reduction Project	• Dam Seismic Upgrade • Dam Face Erosion Protection and Crest Raising • Low-Level Drain Pipe Intake • Lake Bottom Excavation
Water Supply Project	• Spillway Crest Gate • Phoenix Lake to Bon Tempe Lake Transfer Piping
Water Quality Project	• Epilimnetic Circulation Device • Hypolimnetic Circulation Device
Ecosystem Restoration Project	• Low-Level Drain Pipe Intake Control Valve • Seepage Reduction Liner and Grout Curtain • Low-Level Outlet Discharge Aeration System
Recreation and Public Access Project	• Bill Williams Creek Arch Culvert Replacement • Phoenix Lake Watershed Trail Improvements • Visitor Use Facility Upgrades • Road-Related Sediment Reduction Improvements

Phoenix Lake IRWM Retrofit Overview			
Component Projects	**Project Elements**	**Abstract**	**Status**
Flood Damage Reduction Project	Dam Seismic Upgrade	Stabilization of the dam, including construction of a compacted earthen buttress fill and drain on the downstream face and rows of reinforced concrete displacement piles along the dam crest and upstream face.	At Concept (30%) Design stage: Geotechnical studies have been completed based on existing data; initial informal consultation with DSOD has been completed; concept designs and costs have been completed. Further geotechnical investigation, including exploratory drilling, is needed. Final design to be performed based on results of further geotechnical investigation and consultation with DSOD.
	Dam Face Erosion Protection and Crest Raising	Placement of a 3 ft thick rip-rap facing on the upstream face to prevent sloughing during rapid drawdown; placement of 2 ft thick compacted fill over the dam crest to provide added freeboard; stabilization of two landslides to prevent further failure and rapid deposition of sediment into lake during flood detention operations.	
	Low-Level Drain Pipe Intake	Installation of two new low level intakes, at el. 140 ft and el. 160 ft, on the low-level drain pipe to enable rapid drawdown and water level control for flood detention and cool water release to Ross Creek.	At Concept (30%) Design stage Hydraulic studies analyzing reservoir flood routing and new intake hydraulics have been completed; lake water quality studies confirming cool water pool have been completed.
	Lake Bottom Excavation	Excavation of about 30,000 cubic yards of deposited sediment to restore dead pool for aquatic wildlife refugia and reducing sediment in discharge during full lake drawdown.	At Concept (30%) Design stage Lake bathymetric survey has been completed establishing current lake bottom topography and historical sedimentation.

Water Supply Project	Spillway Crest Gate	Installation of a 6-ft high pneumatic spillway gate to add 120 acre-feet of storage capacity for flood attenuation (wet season) and water supply (dry season).	At Concept (30%) Design stage Hydraulic studies analyzing reservoir flood routing, potential water supply yield (preliminary), and engineering feasibility have been completed.
	Phoenix Lake to Bon Tempe Lake Transfer Piping	Modifications to delivery system from Phoenix Lake to enable pumping to Bon Tempe Lake thereby providing flexibility and new opportunities to use Phoenix Lake water in the MMWD system.	At Concept (30%) Design stage Engineering design study analyzing needed piping system modifications and engineering feasibility has been completed.
Water Quality Project	Epilimnetic Circulation Device	Installation of a self contained solar-powered device that circulates water in the lake epilimnion to reduce algae and improve lake clarity.	At Concept (30%) Design stage Preliminary layout of devices has been completed showing one epilimnetic device and one hypolimnetic device.
	Hypolimnetic Circulation Device	Installation of a self contained solar-powered device that circulates water in the lake hypolimnion to add oxygen and thereby reduce iron and manganese and enlarge the pool suitable for coldwater fish.	
Ecosystem Restoration Project	Low-Level Drain Pipe Intake Control Valve	Installation of small sliding gates on the new low level intakes at el. 140 ft and 160 ft to enable precise control and blending of cool water release to Ross Creek for aquatic habitat restoration.	At Concept (30%) Design stage Lake water quality studies confirming available in-lake cool water pool and benefits of release on Ross Creek water temperatures have been completed.
	Seepage Reduction Liner and Grout Curtain	Installation of a synthetic liner along the downstream side of the dam and a grout curtain along the downstream toe into bedrock.	At Concept (30%) Design stage Preliminary water quality testing of Ross Creek suggesting benefits of Fe/Mn reduction have been completed. Further testing to confirm that seepage is a significant source of the Fe/Mn is needed. Geotechnical concepts for seepage

			reduction have been developed. Further geotechnical investigation, including exploratory drilling, is needed. Final design to be performed based on results of further geotechnical investigation and consultation with DSOD and Regional Board.
	Low-Level Outlet Discharge Aeration System	Installation of a concrete aeration chamber adjacent to the existing outlet box to increase oxygen and reduce dissolved iron and manganese.	At Concept (30%) Design stage Preliminary water quality testing of Ross Creek suggesting benefits of Fe/Mn reduction have been completed. Further testing is needed to confirm Fe/Mn concentrations in outlet discharge. Final design to be performed based on results of further water quality testing and consultation with the Regional Board.
Recreation and Public Access Project	Bill Williams Creek Arch Culvert Replacement		At Concept (30%) Design stage Watershed assessments identifying source sites contributing sediment to streams and lake and describing restoration/remediation plans for the sites has been completed.
	Phoenix Lake Watershed Trail Improvements		
	Visitor Use Facility Upgrades		
	Road-Related Sediment Reduction Improvements		

1.3.1 Flood Damage Reduction Project

The goal of the Flood Damage Reduction Project is to enable Phoenix Lake to function as a flood detention basin. The objective of flood detention operations is to attenuate flows produced in the upper Ross Creek watershed sufficiently to reduce the peak discharge to lower Ross Creek, and hence lower Corte Madera Creek, during the 1-percent-chance-annual flood (or 100-year flood) by about 650 cfs[3]. In order to achieve this objective, Phoenix Lake needs to provide about 460 acre-feet of flood storage capacity for floodwater attenuation, including surcharge storage above the spillway crest. To provide this storage capacity, flood detention operations call for rapid drawdown of the lake level to elevation 140 ft ahead of a forecasted heavy storm event and storage of floodwaters up to elevation 180 ft, plus surcharge storage.

These flood detention operations require improvements and modifications to the dam, spillway, reservoir and inlet/outlet works. The earthen embankment dam needs structural strengthening to improve seismic stability at the higher water level, elevation 180 ft; the intake of the inlet/outlet works of the low-level drain pipeline needs modification to enable rapid lake drawdown in advance of a forecasted flood; and, the lake bottom needs to be excavated to provide an adequate minimum pool for fish and other aquatic wildlife and to prevent entrainment and discharge of sediment when the lake is fully drawn down to el. 140 ft.[4]

The Flood Damage Reduction Project has four elements that address the four above-described needs: (1) dam seismic upgrade element, (2) dam face erosion protection and dam crest raising element, (3) low-level drain pipeline intake element, and (4) lake bottom excavation element. Section 3.1 provides details on these elements, including the underlying need and rationale, design, and costs.

The dam seismic upgrade element consists of a compacted earthen buttress and drain on the downstream face of the dam and three rows of reinforced concrete displacement piles along both the dam crest and the upstream face of the dam.

The dam face erosion protection and dam crest raising element consists of 3 ft thick of rip-rap facing on the upstream face of the dam and 2 ft of compacted fill over the entire dam crest, which spans 350 ft in length and 22 ft in width. This element also includes stabilization of two landslides that are evident along the northern side of the lake. These landslides require stabilization to prevent deposition of large amounts of sediment into

[3] Phoenix Lake can also reduce peak flows for smaller floods. The amounts of peak flow reduction at the Ross streamflow gage for the 50-year, 25-year, 10-year, and 5-year floods are estimated to be approximately 600 cfs, 510 cfs, 370 cfs, and 270 cfs, respectively.

[4] In addition, the spillway crest, currently at el. 174 ft, needs to be raised six feet to el. 180 ft for the added storage and attenuation capacity. However, the added storage and attenuation capacity is an *enhancement* to the flood reduction project; while it is *essential* to the water supply project. For this reason, the element of raising the spillway crest is included in the water supply project and, accordingly, is described in section 1.3.2 below.

the lake during flood detention operations. Stabilization requires retaining wall and drilled pier and grade beam stabilization structures.

The low-level drain pipeline intake modification element consists of installation of a two-level, motor-controlled, gated intake structure connected to the existing low-level intake structure and extending along the side of the lake opposite the dam. The existing low-level drain pipeline intake was installed in the late 1960s**.** The intake has a 20-inch manually-operated hydraulic slide gate**.** It was designed to enable slow, gradual draining of the lake in the unlikely or rare case that draining was needed. It was not designed for frequent opening and closing and rapid lake drawdown that is required for flood detention operations. Further, there is concern that frequent operation of the gate for flood detention would be difficult, given its manual operation, and would place significant stress on the plate and open/close mechanism which could result in damage or failure of the slide gate mechanism. The modified two-level gated intake will be designed for frequent operations and will enable rapid drawdown of the lake ahead of a forecasted heavy storm and maintenance of the lake water surface at the el. 160 ft (referred to as "step 1 drawdown") or el. 140 ft level (referred to as "step 2 drawdown"). The gate will be electric motor-controlled. A diesel-powered electric-generator facility is included in this element to ensure a reliable source of power in case there is a disruption in the regional electrical power distribution system.

The lake bottom excavation element consists of excavating the lake bottom in the vicinity of the low-level drain pipeline intake. The existing low-level drain pipeline intake is set at approximately el. 133 ft. Examination of the 2009 bathymetric survey of the lake bottom reveals that much of the dead pool below el. 140 ft has been filled with sediment. The area of excavation will cover about 2.5 acres and the volume of excavated sediment will be about 30,000 cubic yards. The excavation will aim to recover much of the original dead pool volume of the lake. The recovered dead pool will provide adequate refugia for fish and other aquatic wildlife and prevent entrainment and discharge of sediment through the low-level drain pipe when the lake is drawn down to el. 140 ft.

1.3.2 Water Supply Project

The goal of the Water Supply Project is to increase the yield of Phoenix Lake and thereby provide more reliability and flexibility to MMWD's water supply. The Phoenix Lake IRWM Retrofit will restore the spillway crest to its pre-1985 elevation 180 ft, thereby increasing the storage capacity of the lake by 120 acre-ft. The added storage capacity could potentially increase the long-term average lake yield by up to 107 acre-ft per year and up to 50 acre-ft per year during shortage years for supply to the MMWD system. Accordingly, water supply operations require operating the lake at el. 180 ft for extended periods, particularly during the dry season.

Water supply operations require modification of the spillway. The spillway crest needs to be raised to its pre-1985 elevation, 180 ft. In addition, modifications to the piping system from Phoenix Lake to Bon Tempe Lake will be needed to create separate potable and lake water transfer systems for more flexible utilization of the increased yield of

Phoenix Lake water. Accordingly, the Water Supply Project has two elements: (1) spillway gate; and (2) Phoenix Lake to Bon Tempe Lake transfer piping. Section 3.2 provides details on these elements, including the underlying need and rationale, design, and cost.

The spillway gate element consists of installing a gate within the 14-ft wide by 6 ft high "notch" of the existing concrete spillway. The spillway gate will be an Obermeyer or similar type of pneumatically-operated spillway gate which can be raised and lowered over a range of levels. Obermeyer gates operate by inflating/deflating "bladders" placed beneath spillway panels. The spillway gate will raise the spillway crest by six feet and thereby enable capture and active storage of up to an additional 120 acre-feet of runoff from the MMWD watershed. The added active storage capacity could potentially increase the long term average annual yield of the lake by as much as 107 acre-feet per year and during shortage years by about 50 acre-feet per year for municipal supply to MMWD. Further hydrologic analysis is needed to confirm these estimates of increased yield using a longer period of historical record that includes extended shortage periods.

1.3.3 Water Quality Project

The goal of the Water Quality Project is to improve the quality of water in Phoenix Lake for municipal water supply and public recreation. The lake experiences floating algae blooms, particularly during summertime. This reduces water clarity and the overall aesthetic appeal of the lake to fishermen and other recreationalists who visit the lake. Algae also affect the filtration process and increase MMWD's treatment costs at its Bon Tempe Water Treatment Plant. Low dissolved oxygen in the lake hypolimnion creates a potential for dissolution of sediment-bound metals. The algae and low dissolved oxygen can lead to taste and odor problems in the treated drinking water.

The Water Quality Project has two elements that address the water quality issues in the lake: (1) epilimnetic circulation device and (2) hypolimnetic circulation device. Section 3.3 provides details on these two elements, including the underlying need and rationale, design, and cost. The two circulation devices will be SolarBee© or similar type of self-contained, independently solar powered, and automated devices. The devices will be supplied, delivered to the site, and installed by the manufacturer.

The epilmnetic circulation device is designed to reduce the growth of floating algae and thereby improve water quality, lake clarity, and reduce treatment costs, particularly during the summertime when lake supply is most needed. The hypolimnetic circulation device aims to oxygenate the hypolimnion and prevent dissolution of sediment-bound metals which can contribute to taste and odor problems in drinking water. Higher oxygen concentrations in the hypolimnion will enlarge the pool in the lake that is suitable for coldwater fish, including trout. This is expected to improve the lake's trout fishery.

1.3.4 Ecosystem Restoration Project

The goal of the Ecosystem Restoration Project is to improve aquatic habitat conditions below the dam in Ross Creek and lower Corte Madera Creek by cooling water temperatures and also reducing concentrations of soluble iron and manganese in these creeks during the dry season if/as required by regulatory permitting authorities. Cooling of water temperatures requires augmenting the design of the Flood Damage Reduction Project's low-level drain pipeline intake to allow precise control and blending of low flow release from the 140 ft and 160 ft level intakes.

The Ecosystem Restoration Project has three elements that address this need: (1) low-flow control gates at the elevation 140 ft and 160 ft level intakes; (2) an aeration system at the low-level outlet; and, (3) a seepage reduction system consisting of a synthetic liner embedded into the downstream side of the dam and a grout curtain along the downstream toe extending into bedrock to reduce or eliminate seepage through/beneath the dam and uncontrolled discharge of water containing low dissolved oxygen, high iron and manganese to Ross Creek. Section 3.4 provides details on these elements, including the underlying need and rationale, design, and cost.

The low-level drain pipe intake/low-flow control gate element consists of installing additional gates at the elevation 140 ft. and 160 ft. level intakes. These gates will be small sliding gates which can be adjusted over a range of levels to allow for precise control of low flow releases to Ross Creek over a range of low, summer base flows, preliminarily estimated to be 1 to 5 cfs. The gates will allow precise mixing of water from the 140 ft and 160 ft lake levels to efficiently utilize the pool of cool water in the hypolimnion in achieving the target blended water temperature in the discharge water. The gates will be electric motor-controlled. Release flow will be measured at the outlet of the low-level drain pipe where it overflows from a concrete vault below the dam. Water level and water temperature sensors will be placed in the bottom of the vault and a v-notch weir will be cut into one of the vault sides for measurement of outflow. A water level vs. discharge rating curve will be developed for the v-notch weir and a recorder installed nearby to enable continuous measurement and recording of low-flow discharges and temperatures.

The aeration system element consists of installing a concrete aeration vault adjoining the existing vault at the low-level pipe outlet. Overflow from the outlet vault will enter the aeration vault where the water will be aerated by air diffusers place just above the vault bottom. The diffusers will be fed by air produced and conveyed by pipeline from an air compressor located at the rubber dam equipment house. Aerated water will overflow from the aeration vault and flow into a discharge channel leading to Ross Creek. The aeration process will increase oxygen concentrations and reduce soluble iron and manganese concentrations.

The seepage reduction system consists of a synthetic liner embedded into the downstream side of the dam. A grout curtain would be installed along the downstream toe of the dam and extend into bedrock. The liner and grout curtain will reduce seepage through and

beneath the dam and thereby reduce loading of soluble iron and manganese into Ross Creek.

Instream flow release of cooler water from the lake hypolimnion containing reduced concentrations of soluble iron and manganese will improve downstream water quality and aquatic habitat for target anadromous salmonids and other coldwater species.

1.3.5 Recreation and Public Access Project

The goal of the Recreation and Public Access Project is to enhance public access, safety, and reduce erosion and the delivery of sediment to Phoenix Lake. This requires improvements to roads and trails, as well as culverts where these features cross over tributary drainages of Phoenix Lake.

The Recreation and Public Access Project has four elements that address public access, safety, and reduce erosion and the delivery of sediment to Phoenix Lake: (1) Bill Williams Creek arch culvert replacement; (2) Phoenix Lake Watershed trail improvements; (3) visitor use facility upgrades; and, (4) road-related sediment reduction improvements. Section 3.5 provides details on these elements, including the underlying need and rationale, design, and cost.

The Bill Williams Creek culvert replacement will prevent further erosion from occurring at the site, ensure that emergency and visitor access is maintained on Bill Williams Road, and re-establish fish passage in Bill Williams Creek. Phoenix Lake Watershed trail improvements to the trail network around Phoenix Lake will prevent ongoing chronic erosion from occurring on the trail surfaces, reduce sedimentation to Phoenix Lake and its tributaries, and improve visitor access and safety. Upgrading visitor use facilities will provide benches, bathrooms, and educational kiosks that will enhance the visitor experience, add a public outreach, stewardship, and educational component, and reduce user impacts to the Phoenix Lake watershed. Finally, road-related sediment reduction projects will significantly reduce the amount of erosion and sediment generation taking place in the watershed. This will provide safe and sustainable access for visitor use, watershed maintenance and emergency access vehicles, improve water quality and aquatic habitats in Phoenix Lake and its tributaries, and reduce sedimentation and maintain lake storage capacity for flood attenuation and water supply.

1.4 Integrated Elements of Projects

The component projects comprising the Phoenix Lake IRWM Retrofit work synergistically to enhance function and add value to each other. For example, the spillway gate element of the Water Supply Project increases the yield of Phoenix Lake while simultaneously enhancing the function and adding value to the Flood Damage Reduction Project by increasing the lake's ability to store floodwater and attenuate peak flood flows. Similarly, the low-level drain pipe intake modification element of the Flood Damage Reduction project enables drawdown and maintenance of lake level at el. 140 ft while simultaneously enhancing the Ecosystem Restoration Project by enabling withdrawal of cool water from the lake hypolimnion for release to Ross Creek. There are numerous similar examples of multiple project synergies. The table below explains how each element provides a benefit to its primary project (in red) as well as enhanced function and added value to other projects (in black).

Element	Project					
	Flood Damage Reduction	Water Supply	Water Quality	Ecosystem Restoration	Recreation /Public Access	Explanation
Dam Seismic Upgrade	X	X			X	Enables storage to a higher water level (el. 180 ft) for peak flow attenuation and flood reduction; enhances water supply by enabling increased storage and lake yield; adds to lake's recreational value by expanding lake area thereby improving the aesthetic appeal, and enlarging the lake coldwater habitat volume thereby improving the trout fishery.
Dam Face Erosion Protection and Raising	X	X				Enables rapid drawdown by preventing sloughing of dam face (erosion protection) and enables storage to a higher water level (el. 180 ft; raising) for peak flow attenuation and flood reduction; enhances water supply by providing necessary freeboard for storage to a higher water level (raising) thereby increasing lake yield.
Low-Level Drain Pipe Intake	X		X	X		Enables lake drawdown by discharge through low-level drain pipeline and lake level control for flood reduction; enhances ecosystem restoration and improves downstream water quality by enabling withdrawal of deep, cool water for downstream release thereby improving fresh coldwater beneficial use.
Low-Level Drain Pipe Intake Control Gates (140 ft and 160 ft lake levels)			X	X		Enables precise control and blending from the 140 ft and 160 ft level intakes and low-flow discharge through the low-level drain pipeline for cool water instream flow release during dry season; enhances downstream water quality by improving fresh coldwater beneficial use.
Spillway Gate	X	X			X	Enables storage to a higher water level (el. 180 ft) for increased storage and lake yield; enhances flood damage reduction by enabling increased storage for peak flow attenuation and flood reduction; adds to lake's recreational value by expanding lake area thereby improving the aesthetic appeal, and enlarging the lake coldwater habitat volume thereby improving the trout fishery.
Lake Bottom Excavation	X	X				Enables lake drawdown by providing adequate dead pool storage during flood detention drawdown; enhances water supply by providing adequate dead pool storage during water supply drawdown.
Epilimnetic Circulation Device		X	X	X	X	Improves lake water quality/clarity by reduce floating algae; enhances water supply by improving lake water quality for drinking water use; enhances ecosystem restoration and public recreation by reducing invasive aquatic vegetation and adding to lake's aesthetic appeal.
Hypolimnetic Circulation Device		X	X	X	X	Improves lake water quality by increasing dissolved oxygen and reducing dissolution of anaerobic chemicals in the lake hypolimnion water quality; enhances water supply by improving lake water quality for drinking water use; enhances ecosystem restoration by increasing dissolved oxygen in low-level outlet instream releases; enhances public recreation by increasing dissolved oxygen in the hypolimnion and enlarging the lake's suitable coldwater habitat volume thereby improving the trout fishery.
Dam Face Liner/Grout Curtain			X	X		Reduces or eliminates seepage through/beneath the dam and the discharge of water containing low dissolved oxygen and high soluble iron (Fe) and manganese (Mn); enhances downstream water quality by improving fresh coldwater beneficial use..
Discharge Aeration Device			X	X		Increases dissolved oxygen and reduces soluble Fe and Mn; enhances downstream water quality by improving fresh coldwater beneficial use..
Public Parking, Road, Trail Improvements	X	X	X		X	Improves public recreation and access by enhancing trail safety; improves lake water quality and maintains lake storage capacity for flood damage reduction (flood attenuation capacity) and water supply by reducing erosion and sediment delivery/sedimentation in the lake.

X (red) denotes primary project benefit; X (black) denotes enhanced function and added value and other secondary project benefit.

1.5 Regional Map

Figures 2a and 2b are regional maps showing the location of the Phoenix Lake IRWM Retrofit, major drainages, water bodies, and flood infrastructure, and relevant active faults. The location of the Retrofit relative to the State Plan of Flood Control (SPFC) is also shown.

1.6 Project Specifics

The tables in sections 1.3 and 1.4 above describe the various component projects comprising the Phoenix Lake IRWM Retrofit. The Retrofit's function and relation to the greater Ross Valley Flood Protection and Watershed Program is explained in Section 1.9 below.

The Phoenix Lake IRWM Retrofit is not a part of the SPFC as shown in Figure 2b, which shows the location of the Phoenix Lake IRWM Retrofit in relation to the SPFC. The figure shows that the Retrofit and the SPFC are located more than 50 miles apart in different hydrologic regions and otherwise not related.

1.7 Completed Work and Existing Data and Studies

Completed work, i.e., work that has been completed or is expected to be completed prior to grant award, will be limited to the data that has been collected and the studies, designs, and cost estimates that have already been completed. Completed work that is related to the five projects is tabulated and described in Sections 3.1 through 3.5. No further work will be completed prior to grant award.

1.8 Project Map

Figure 3a is a local map of Phoenix Lake and the immediate vicinity showing the locations of all projects and project elements comprising the Phoenix Lake IRWM Retrofit. Figure 3b shows the monitoring system that will be used to evaluate the performance of the projects.

FIGURE 2a

J:\jn2367\Regionalmap.mxd

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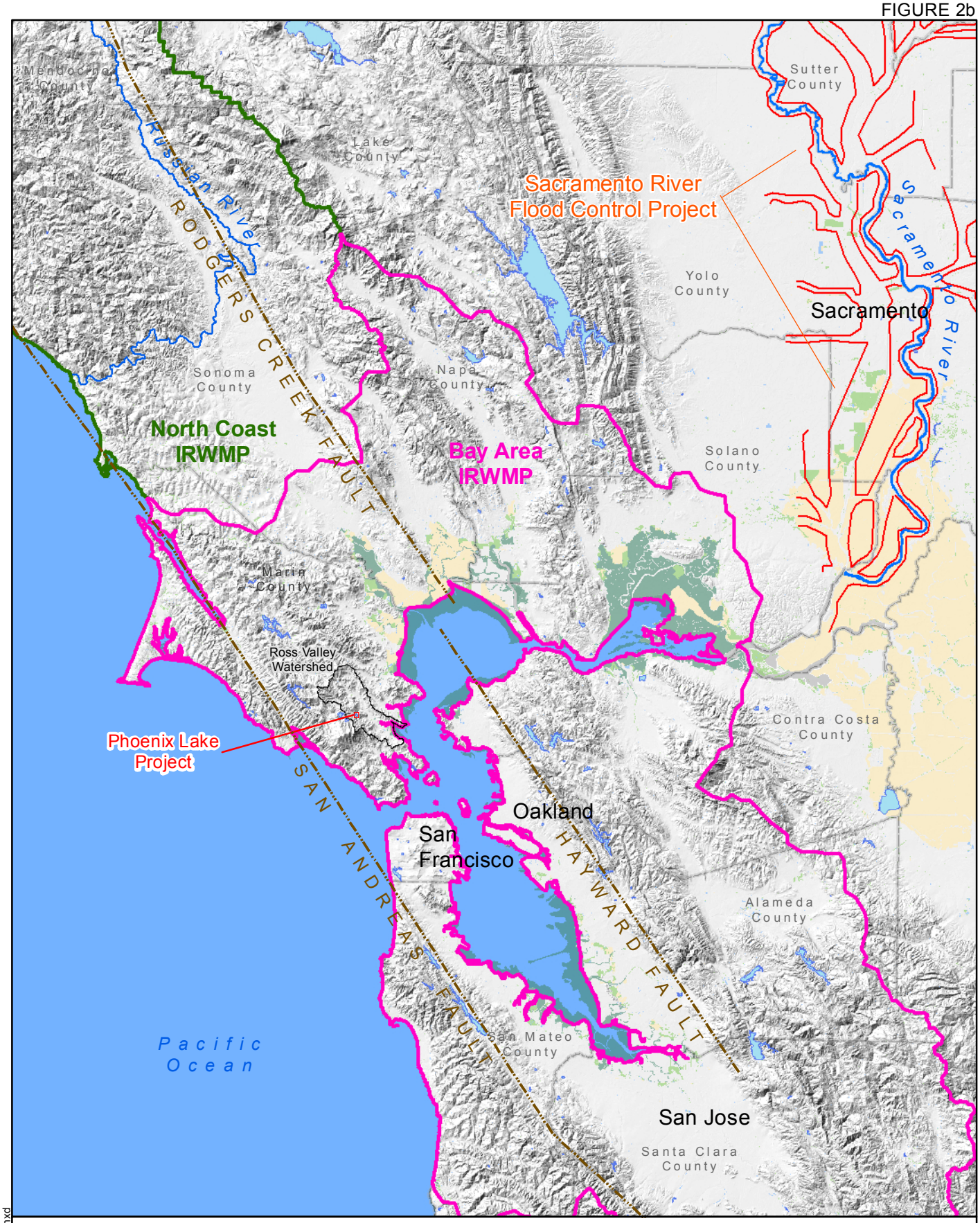
REGIONAL MAP SHOWING
THE LOCATION OF THE PHOENIX LAKE IRWM RETROFIT,
MAJOR WATER BODIES, AND THE ARMY CORPS
FLOOD CONTROL CHANNEL

N

0 0.5 1 Miles

FIGURE 2b



J:\jn2367\Regionalmap2.mxd

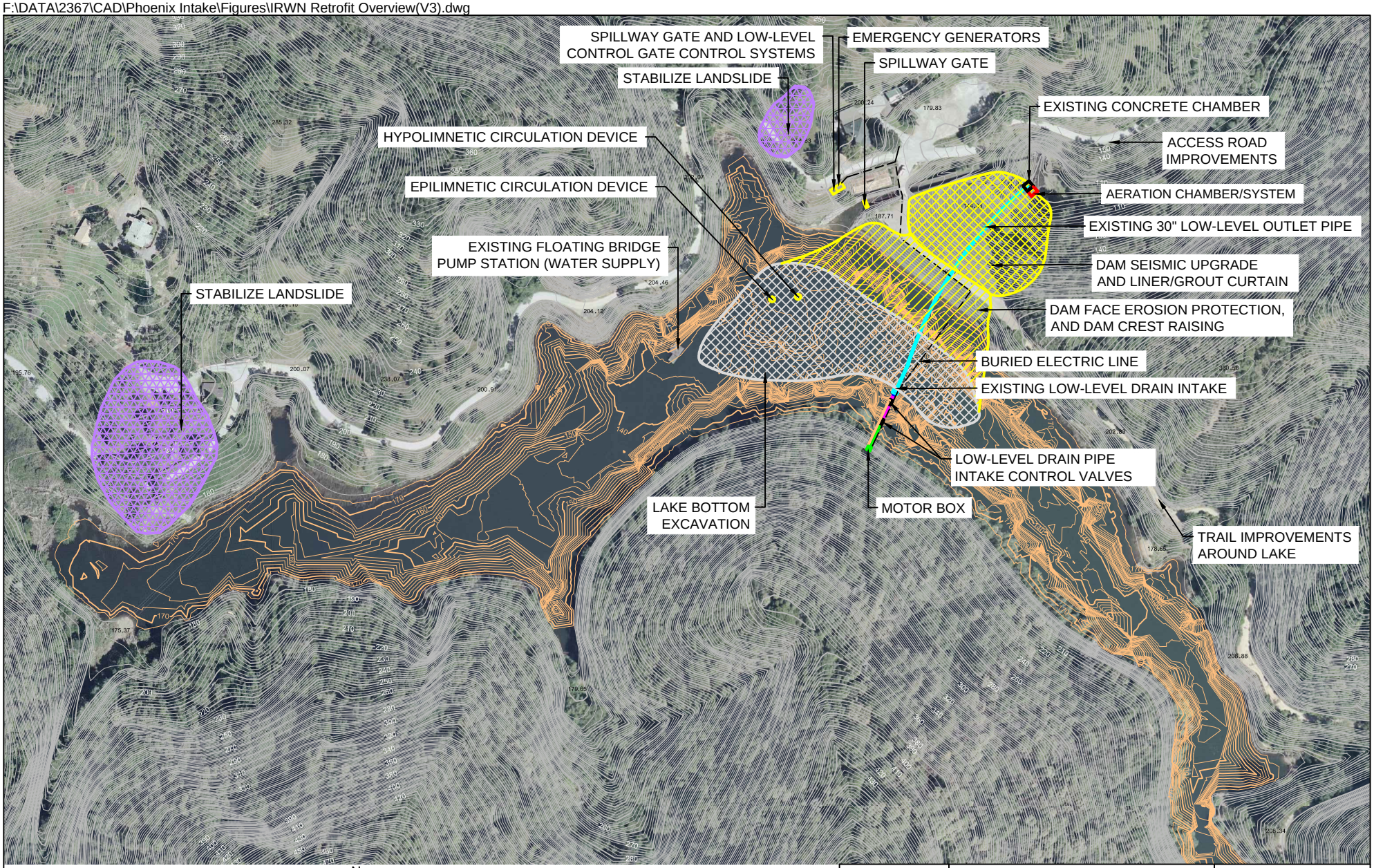
STETSON ENGINEERS INC.

REGIONAL MAP SHOWING THE LOCATION OF THE PHOENIX LAKE IRWM RETROFIT, BAY AREA IRWMP BOUNDARY, RELEVANT ACTIVE FAULTS, AND THE LOCATION OF THE RETROFIT RELATIVE TO THE SPFC

N

0 5 10 Miles

F:\DATA\2367\CAD\Phoenix Intake\Figures\IRWN Retrofit Overview(V3).dwg



LEGEND

- CONTOUR LINES (2 FOOT INTERVAL)
- BATHYMETRIC CONTOUR LINES (2 FOOT INTERVAL)
- 179.16 SPOT ELEVATION

N / W / E / S

SCALE (FEET)

0 125 250

Notes:

1. This drawing is in California State Plane NAD 83, zone 3 and vertical datum NGVD 29.
2. Bathymetry data points source is XYZ file data received from Environmental Data Solutions in November 2009.
3. 2' Interval Contourlines and Spot Elevations are based on the 2004 aerial survey contour data received from Marin County.

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DATE: JUNE 19, 2012 | JN: 2367

PHOENIX LAKE IRWM RETROFIT FACILITY LAYOUT

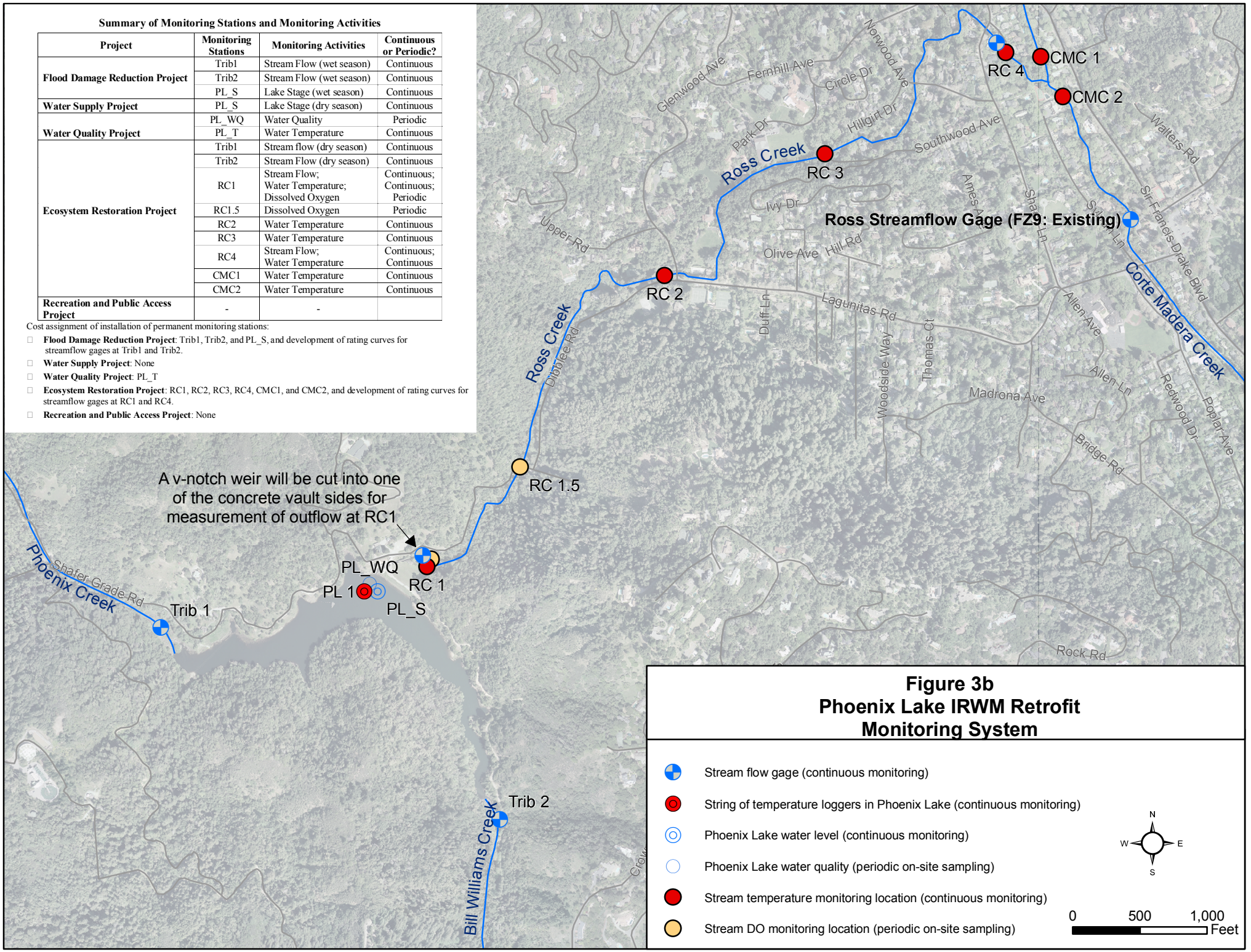
FIGURE 3a

Summary of Monitoring Stations and Monitoring Activities

Project	Monitoring Stations	Monitoring Activities	Continuous or Periodic?
Flood Damage Reduction Project	Trib1	Stream Flow (wet season)	Continuous
	Trib2	Stream Flow (wet season)	Continuous
	PL_S	Lake Stage (wet season)	Continuous
Water Supply Project	PL_S	Lake Stage (dry season)	Continuous
Water Quality Project	PL_WQ	Water Quality	Periodic
	PL_T	Water Temperature	Continuous
Ecosystem Restoration Project	Trib1	Stream flow (dry season)	Continuous
	Trib2	Stream Flow (dry season)	Continuous
	RC1	Stream Flow; Water Temperature; Dissolved Oxygen	Continuous; Continuous; Periodic
	RC1.5	Dissolved Oxygen	Periodic
	RC2	Water Temperature	Continuous
	RC3	Water Temperature	Continuous
	RC4	Stream Flow; Water Temperature	Continuous; Continuous
	CMC1	Water Temperature	Continuous
	CMC2	Water Temperature	Continuous
Recreation and Public Access Project	-	-	

Cost assignment of installation of permanent monitoring stations:

- **Flood Damage Reduction Project**: Trib1, Trib2, and PL_S, and development of rating curves for streamflow gages at Trib1 and Trib2.
- **Water Supply Project**: None
- **Water Quality Project**: PL_T
- **Ecosystem Restoration Project**: RC1, RC2, RC3, RC4, CMC1, and CMC2, and development of rating curves for streamflow gages at RC1 and RC4.
- **Recreation and Public Access Project**: None



1.9 Project Timing and Phasing

Although it is considered the keystone of the greater Ross Valley Watershed Flood Reduction Program, the Phoenix Lake IRWM Retrofit is geographically and physically isolated, so it can be implemented and operated as a stand-alone project with independent utility, function, and benefits. Acting alone, the Retrofit can substantially reduce flooding in Ross, Kentfield, Greenbrae, and Larkspur; improve water supply reliability and water quality of the MMWD system; deliver cooler instream flows to Ross Creek and lower Corte Madera Creek and thereby improve downstream aquatic and riparian habitat during the dry season; improve lake water quality; reduce growth of lake algae; reduce lake sedimentation; and, enhance overall public access and enjoyment of the lake.

However, it should be pointed out that the benefits of the Retrofit will be enhanced, synergistically, through completion of the Army Corps of Engineers' project farther downstream in Corte Madera Creek. The Army Corps project's completion date is unknown at this time but is likely to occur in the 2014-2017 timeframe. The Army Corps project is planned to include, at a minimum, removal of an existing timber bulkhead/fish ladder, which historically has acted as an impediment to fish passage and migration, and other in-channel improvements aimed at increasing the capacity of Corte Madera Creek to 5,400 cfs. These improvements will enhance fish passage and allow migrating Coho and steelhead better access into Ross Creek below Phoenix Lake. Working in concert, projects identified in the Ross Valley Watershed Flood Reduction Program, including the keystone Phoenix Lake IRWM Retrofit, and the Army Corps project can provide a 100-year level of flood protection to Ross Valley and substantially restore the ecological function of Corte Madera Creek and its tributaries.

The Phoenix Lake IRWM Retrofit will be implemented as a stand-alone project. Due to the synergies between its component projects, all of the component projects will be implemented in concert, including environmental review and regulatory permitting, design, and construction. Attachment 5, Schedule, provides details on timing of implementation. Once construction of the Retrofit is completed, Phoenix Lake will be operated for flood damage reduction, water supply, water quality, ecosystem restoration, and public recreation in a coordinated fashion. A Coordinated Operations Plan (COP), establishing the rules and criteria for operating the lake in a manner that achieves the lake's new multi-use benefits, will be developed that is mutually acceptable for MMWD and Flood Zone 9 (FZ9). Monitoring, assessment, and performance measurements will also be conducted in a coordinated fashion as well.

1.10 Relationship of the Phoenix Lake IRWM Retrofit to the Adopted Bay Area IRWMP

The Phoenix Lake IRWM Retrofit advances many of the goals and objectives of the adopted Bay Area IRWMP. The table below, which is derived from the adopted Bay Area IRWMP, identifies specific goals and objectives advanced by the five component Projects comprising the Retrofit.

Goals and Objectives of the Bay Area IRWMP Advanced by the Phoenix Lake IRWM Retrofit						
		Flood Reduction	Water Supply	Water Quality	Ecosystem Restoration	Public Recreation
Regional Goal	**Objectives**					
A. Contribute to the promotion of economic, social,and environmental sustainability	**Contribute to:**					
	1. Avoiding, minimizing, and mitigating net impacts to environment	x	x	x	x	x
	2. Maintaining and promoting economic and environmental sustainability through sound water resources management practices	x	x	x	x	x
	3. Maximizing external support and partnerships	x	x	x	x	x
	4. Maximizing ability to get outside funding	x	x	x	x	x
	5. Maximizing economies of scale and governmental efficiencies	x	x	x	x	x
	6. Providing trails and recreation opportunities					x
	7. Protecting cultural resources	x				
	8. Increasing community outreach and education for watershed health					x
	9. Maximizing community involvement and stewardship					x
	10.Reducing energy use and/or use renewable resources where appropriate		x	x	x	
	11.Minimizing solid waste generation/maximize reuse			x		
	12.Engaging public agencies, businesses, and the public in stormwater pollution prevention and watershed management, including decision -making					
	13.Achieving community awareness of local flood risks, including potential risks in areas protected by existing projects					
	14.Considering and addressing disproportionate community impacts					
	15.Balancing needs for all beneficial uses of water	x	x	x	x	x
	16.Securing funds to implement solutions	x	x	x	x	x
B. Contribute to improved supply reliability	**Contribute to:**					
	1. Meeting future and dry year demands		x	x		
	2. Maximizing water use efficiency		x	x	x	
	3. Minimizing vulnerability of infrastructure to catastrophes and security breaches	x				
	4. Maximizing control within the Bay Area region					
	5. Preserving highest quality supplies for highest use		x	x	x	
	6. Protecting against overdraft		x	x		
	7. Providing for groundwater recharge while maintaining groundwater resources					
	8. Increasing opportunities for recycled water use consistent with health and safety					
	9. Maintaining a diverse portfolio of water supplies to maximize flexibility		x	x		
	10.Securing funds to implement solutions	x	x	x	x	x
C. Contribute to the protection and improvement of	**Contribute to:**					
	1. Protecting, restoring, and rehabilitating natural watershed processes					x
	2. Controlling excessive erosion and managing sedimentation	x				x
	3. Maintaining or improving in-stream flow conditions		x		x	x
	4. Improving floodplain connectivity					

hydrologic function	5. Preserving land perviousness and infiltration capacity					
	6. Securing funds to implement solutions	x	x	x	x	x
D. Contribute to the protection and improvement of the quality of water resources	**Contribute to:**					
	1. Minimizing point and non-point source pollution					x
	2. Reducing salinity-related problems					
	3. Reducing mass loading of pollutants to surface waters		x		x	
	4. Minimizing taste and odor problems			x		
	5. Preserving natural stream buffers and floodplains to improve filtration of point and non-point source pollutants					
	6. Maintaining health of whole watershed, upland vegetation and land cover to reduce runoff quantity and improve runoff quality					x
	7. Protecting surface and groundwater resources from pollution and degradation			x		x
	8. Anticipating emerging contaminants					
	9. Eliminating non-stormwater pollutant discharges to storm drains					
	10.Reducing pollutants in runoff to the maximum extent practicable					x
	11.Periodically evaluating beneficial uses					
	12.Continuously improving stormwater pollution prevention methods					
	13.Securing funds to implement solutions	x	x	x	x	x
E. Contribute to the protection of public health, safety, and property	**Contribute to:**					
	1. Providing clean, safe, reliable drinking water		x	x		
	2. Minimizing variability for treatment		x	x		
	3. Advancing technology through feasibility studies/demonstrations			x		
	4. Meeting promulgated and expected drinking water quality standards					
	5. Managing floodplains to reduce flood damages to homes, businesses, schools, and transportation					
	6. Minimizing health impacts associated with polluted waterways					
	7. Achieving effective floodplain management by encouraging wise use and management of flood-prone areas					
	8. Maintaining performance of flood protection and stormwater facilities	x				
	9. Partnering with municipalities to prepare mitigation action plans that reduce flood risks to the community					
	10.Coordinating resources and mutual aid between agencies to enhance agency effectiveness	x	x	x	x	x
	11.Securing funds to implement solutions	x	x	x	x	x
F. Contribute to the creation, protection, enhancement, and maintenance of environmental resources and habitats	**Contribute to:**					
	1. Providing net benefits to environment	x	x	x	x	x
	2. Conserving and restoring habitat for species protection		x	x	x	
	3. Acquiring, protecting and/or restoring wetlands, streams, and riparian areas				x	
	4. Enhancing wildlife populations and biodiversity (species richness)			x	x	x
	5. Providing lifecycle support (shelter, reproduction, feeding)			x	x	
	6. Protecting and recovering fisheries (natural habitat and harvesting)			x	x	
	7. Protecting wildlife movement/wildlife corridors				x	
	8. Managing pests and invasive species			x		
	9. Recovering at-risk native and special status species			x	x	
	10.Improving structural complexity (riparian and channel)					
	11.Designing and constructing natural flood protection and stormwater facilities					
	12.Securing funds to implement solutions	x	x	x	x	x

1.11 Data Management and Deliverables

As part of the Bay Area IRWMP implementation, data will be collected to support assessment of the performance of Phoenix Lake IRWM Retrofit, as well as in meeting the regional goals and objectives identified in the Bay Area IRWMP. Details on the monitoring program, including the data that will be collected under the Phoenix Lake IRWM Retrofit, are described in Attachment 6, Monitoring, Assessment, and Performance Measures. To facilitate the data management and deliverables, FZ9 will assign a database coordinator to oversee the collection, storage, and dissemination of data and to ensure that the data management and deliverables are consistent with the Bay Area IRWMP standards.

Data collection will be ensured to be comparable with the statewide data collection programs, such as the Surface Water Ambient Monitoring Program (SWAMP). Upon completion of the performance assessment, the collected data, along with its associated quality assurance/quality control information, will be provided to the State in a format that can be easily integrated into statewide data collection and tracking programs. As appropriate, the collected data will be contributed to the following statewide data programs:

- California Environmental Resources Evaluation System (CERES), an information system developed by the California Resources Agency to facilitate access to natural resource data; and,
- California Environmental Data Exchange Network (CEDEN), a website developed by the State for coordinated data sharing.

2.0 Tasks

This chapter describes tasks that will be performed to implement the five component projects comprising the Phoenix Lake IRWM Retrofit. These tasks are consistent with those used in Attachment 4, Budget, and Attachment 5, Schedule.

As the biggest (by far) of the five component Projects, the Flood Damage Reduction Project tasks are described first. Some of the task descriptions are the same across all projects. So, for sake of brevity, these tasks are described just once in the Flood Damage Reduction Project, and the sameness is noted in the task descriptions of other projects. Although these task descriptions are the same, the level of effort and cost will differ across the five component projects and will be split approximately according to each project's pro-rata construction cost, as reflected in Attachment 4, Budget.

Given that the five component Projects comprising the Phoenix Lake IRWM Retrofit are linked geographically, functionally and institutionally (i.e., between FZ9 and MMWD) as one project, it is anticipated that the approach to environmental review will be a combined environmental document (e.g., Environmental Impact Report/Environmental Impact Statement (EIR/EIS) or Initial Study/Environmental Assessment (IS/EA)). This combined environmental document will analyze the environmental impacts and provide mitigation measures for the whole Phoenix Lake IRWM Retrofit. The level of effort and cost for Task 6, Environmental Documentation, will be split according to each project's pro-rata construction cost, as reflected in Attachment 4, Budget.

All activities of the Retrofit will be located on property owned by MMWD and augment facilities operated by MMWD. There will be a need for land purchases, easements, or other form of right-of-way acquisition.

It is anticipated that the work will be primarily performed using contractors under several contracts, with administration and oversight performed by FZ9 and MMWD. The contract work is summarized in the table below.

Summary of Contractors for Phoenix Lake IRWM Retrofit			
Pre-Construction	Geotechnical Pre-Design Report	Flood Damage Reduction Project	Geotechnical engineering consultant-contractor
	Design	Flood Damage Reduction Project, Ecosystem Restoration Project	Engineering consultant-contractor
	Combined CEQA/NEPA Documentation	All Projects	Environmental consultant-contractor
	Permitting	All Projects	Environmental consultant-contractor
	Environmental Compliance Workplan	All Projects	Environmental consultant-contractor
	Long term hydrologic analysis of reoperation of Phoenix Lake for flood detention and water supply	Flood Damage Reduction Project, Water Supply Project	Engineering consultant-contractor
	Probable Maximum Flood (PMF) Analysis	Flood Damage Reduction Project	Engineering consultant-contractor
	Coordinated Operations Plan	Flood Damage Reduction Project, Water Supply Project	Engineering consultant-contractor
	Design	Water Supply Project – Spillway gate	Engineering consultant-contractor
	Design	Water Supply Project – Phoenix Lake to Bon Tempe Lake transfer piping	Engineering consultant-contractor
	Baseline Water Quality Report for Phoenix Lake	Water Quality Project	Hydrographer consultant-contractor
	Design	Water Quality Project	Engineering consultant-contractor
	Baseline Water Quality Report for Ross Creek/Corte Madera Creek	Ecosystem Restoration Project	Hydrographer consultant-contractor
	Instream Flow Study for Ross Creek and Corte Madera Creek	Ecosystem Restoration Project	Fishery consultant-contractor
	Design	Recreation and Public Access Project – Trails Improvements	Engineering/erosion control consultant-contractor
	Design	Recreation and Public Access Project – Visitor Use Facilities	Engineering consultant-contractor
Construction	Construct	Flood Damage Reduction Project, Ecosystem Restoration Project	Construction contractor
	Construct	Water Supply Project – Spillway gate	Engineering construction contractor
	Construct	Ecosystem Restoration Project – Aeration system	Engineering construction contractor
	Construct	Water Supply Project – Phoenix Lake to Bon Tempe Lake transfer piping	Engineering construction contractor
	Furnish and Install Circulation Devices	Water Quality Project	Vendor-contractor
	Construct	Recreation and Public Access Project – Trails Improvements	Construction contractor
	Construct	Recreation and Public Access Project – Visitor Use Facilities	Construction contractor
	Furnish and install streamflow gages, lake level gage, water level sensor at outlet vault; develop discharge rating curves; furnish and install water temperature sensors	Flood Damage Reduction Project, Water Supply Project, Ecosystem Restoration Project	Hydrographer consultant-vendor

2.1 Flood Damage Reduction Project Tasks

2.1.1 Task 1: Administration

This task consists of administration of all Flood Damage Reduction Project-related activities that will be performed by FZ9, FZ9 contractors, and FZ9's partner agency, MMWD. Activities will primarily include, but will not be limited to, planning and design work and construction and testing work. FZ9 will be the lead agency under CEQA and will be the contracting agency on all work performed by contractors. MMWD, as owner of the Phoenix Lake property and facilities, will participate in all activities in a "review-and-comment" and "inspect-and-approve" capacity.

Administration will cover work performed by FZ9 and MMWD that is incidental but directly related to the above-described Project-related activities. Administration will also involve Grant Agreement-related administrative work.

Administration will also cover preparation of a Memorandum of Agreement (MOA) between FZ9 and MMWD concerning cost sharing and joint operation of Phoenix Lake for flood control, water supply, ecosystem restoration, and recreation. It is anticipated that the Coordinated Operations Plan (see section 2.2.4 below) for Phoenix Lake will be incorporated into the MOA. Preparation of the MOA will involve FZ9 and MMWD engineering, management, and legal staff.

Deliverables: Submission of invoices and other deliverables as required; Memorandum of Agreement[5]

2.1.2 Task 2: Labor Compliance Program

This task consists of providing the required information to the newly instituted Compliance Monitoring Unit (CMU) of the California Department of Industrial Relations (DIR) Division of Labor Standards Enforcement (DLSE). Implementation will involve FZ9 preparing and inserting provisions in all contracts requiring contractors to comply with the requirements of the CMU. Details on the specific role of FZ9 in the CMU will be provided by the DLSE.

Deliverable: Submission of required information to DLSE CMU.

2.1.3 Task 3: Reporting

This task consists of preparing quarterly, annual, and final progress reports for the whole Phoenix Lake IRWM Retrofit.[6] The progress reports will describe all grant-funded

[5] Since the MOA primarily addresses joint use of Phoenix Lake for flood control and water supply, it has been included under both the Flood Damage Reduction Project and the Water Supply Project. The cost to prepare the MOA has been split 50/50 between these two projects, as reflected in Attachment 4, Budget.
[6] The cost for reporting has been split across all five component projects comprising the Retrofit according to each project's pro-rata construction cost, as reflected in Attachment 4, Budget.

activities, expenditures vs. budget, and other information for the reporting period as specified in the Grant Agreement. As detailed in Attachment 5, Schedule, the Project is planned to occur over a 55 month period, from September 1, 2012 to March 31, 2017. Accordingly, it is anticipated that that 17 quarterly reports, 4 annual reports, and one final progress report will be prepared.

Deliverable: Submission of quarterly, annual, and final reports as specified in the Grant Agreement.

2.1.4 Task 4: Assessment and Evaluation

Completed work on the Flood Damage Reduction Project is summarized in Section 3.1. The completed work includes a Project Assessment and Evaluation Memorandum, Concept (30%) Design Memorandum, and prior hydrologic, hydraulic, and geotechnical studies. The completed hydrologic and hydraulic studies substantially established the feasibility and viability of these aspects of the Project; however, further assessment and evaluation work is needed in hydrology and hydraulics to verify that the spillway can pass the Probable Maximum Flood (PMF) with adequate residual freeboard as required by DSOD (i.e., the dam crest must be 1.5 ft above the lake water surface at PMF peak). PMF is based on the Probable Maximum Precipitation (PMP) event. In 1998, the National Weather Service published Hydrometeorological Report (HMR) No. 58 which superseded the previous HMR (upon which the PMF for Phoenix Lake is now based). It is anticipated that DSOD will require updating the PMF analysis for Phoenix Lake using the methods documented in the most recent HMR No. 58. . Further assessment and evaluation work is also needed in geotechnical engineering to verify the feasibility and viability of the geotechnical aspect of the Project. In particular, additional field data is needed on the engineering properties of the soil and rock that comprise the dam and to characterize the two landslides on the northern side of the lake that require stabilization (refer to Miller Pacific, May 2010; p. 10). This field data will support further assessment and evaluation of seismic upgrade and other geotechnical aspects of this Project, as well as provide the geotechnical information needed for final design.

Further assessment and evaluation work in geotechnical engineering will have three main elements: (1) consultation with DWR/DSOD to determine the project-specific field exploratory drilling, testing and geotechnical engineering analyses that will be required; (2) perform the required field exploratory drilling and testing; and (3) perform the required geotechnical engineering analyses.

For purposes of this grant application, it is anticipated that the required field exploratory drilling and testing work will include six (6) borings in the dam and two (2) borings in the two landslides and laboratory testing of the boring materials, including moisture density, strength (TXCU/pp), PI, and grain size. It is anticipated that the required geotechnical engineering analyses will include more refined (i.e., more refined than the previously completed analyses) stability and deformation analyses based on the new field data. All work, including field data, testing, and analyses, findings, and conclusions

verifying feasibility and viability of the geotechnical aspect of the Project will be documented in a Geotechnical Pre-Design Report.

A Coordinated Operations Plan (COP), establishing the rules and criteria for operating the lake in a manner that achieves the lake's new multi-use benefits will be developed that is mutually acceptable to MMWD and FZ9. Details on the COP are provided in section 2.2.4 below.[7]

It is anticipated that this work will be performed by civil and geotechnical engineering consultant-contractor (PMF analysis) and geotechnical engineering consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment services.

Deliverables: Probable Maximum Flood Analysis Report; Geotechnical Pre-Design Report; Coordinated Operations Plan

2.1.5 Task 5: Final Design

For purposes of this grant application and based on information in Section 3.1, the Flood Damage Reduction Project is currently at the Concept (30%) design stage. Further work will be needed to complete Final Design. This further work is divided into two groups based on the four elements of the Project as described in more detail in Section 3.1: (1) Low-Level Drain Pipe Intake, which will require civil, structural, mechanical, and electrical design, and (2) Dam Seismic Upgrade, Dam Face Erosion Protection and Dam Crest Raising, Lake Bottom Excavation, which will require geotechnical design.

Design plans for these two engineering groups will be prepared at three stages, based on the design stage definitions given in the Proposal Solicitation Package (PSP) for Stormwater Flood Management grants (2010, Round 1), p. 33, for review, comment, and approval by FZ9 and MMWD: 60% design, 90% (Pre-final) design, and 100% (Final) design. The 100% (Final) design will include the design package and contract that will be advertised for award for construction. It is anticipated that a single design package and contract, combining all four elements of the Flood Damage Reduction Project, will be advertised and awarded for construction to a single contractor. The design package and contract will also include Ecosystem Restoration Project elements relating to dam modifications and intake modifications since these would logically be designed and constructed in conjunction with the Flood Damage Reduction Project.[8] It is anticipated that the design work will be performed by an engineering consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment and approval of all designs.

Deliverables: 60% design, 90% (Pre-final) design, and 100% (Final) design package

[7] Since the COP primarily addresses joint use of Phoenix Lake for flood control and water supply, the cost for the COP has been split 50/50 between these two projects, as reflected in Attachment 4, Budget.

[8] The cost for the Ecosystem Restoration Project design and construction has allocated to that project, as reflected in Attachment 4, Budget.

2.1.6 Task 6: Environmental Documentation

The Phoenix Lake IRWM Retrofit will be subject to environmental review under the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). It is anticipated FZ9 and the U.S. Army Corps of Engineers will be the lead agencies under CEQA and NEPA, respectively. Given that the five component Projects comprising the Phoenix Lake IRWM Retrofit are linked geographically, functionally and institutionally (i.e., between FZ9 and MMWD) as one project, it is anticipated that the approach to environmental review will be a combined Environmental Impact Report/Environmental Impact Statement (EIR/EIS) or Initial Study/Environmental Assessment (IS/EA). This combined environmental document will analyze the environmental impacts and provides mitigation measures for the whole Phoenix Lake IRWM Retrofit, including the Flood Damage Reduction Project and the other four component Projects.

It is anticipated that environmental review will proceed concurrently with regulatory permitting (see section 2.1.7 below). This approach offers flexibility and expands opportunities for mitigating impacts associated with individual Projects and Project elements. Conceivably, impacts in one location within the geographic footprint of the Retrofit can be mitigated elsewhere in the geographic footprint. It can also streamline and reduce the overall costs (e.g., special studies) associated with the environmental review and permitting processes.

It is anticipated that this work will be performed by an environmental consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment.

Deliverables: Approved and adopted combined CEQA/NEPA documentation

2.1.7 Task 7: Permitting

The Flood Damage Reduction Project will be subject to the regulatory permitting authority of several federal and state agencies. The table below identifies the permits that are expected to be required.

Approvals and Permits Required for the Phoenix Lake IRWM Retrofit

Agency	Trigger	Approval	Submittal
US Army Corps of Engineers (USACE)	Discharge of fill within ordinary high water mark in creek, lake, or adjacent wetlands	Section 404/10 Permit (Nationwide Permit or an Individual Permit)	Application
National Marine Fisheries Service (NOAA Fisheries) US Fish and Wildlife Service	Effects on federally listed threatened or endangered species	Biological Opinion through a Section 7 Consultation with USACE	Biological Assessment

San Francisco Bay Regional Water Quality Control Board (RWQCB)	Section 404 Permit through USACE	Section 401 Water Quality Certification through Section 404 Permit with USACE	Application
California Department of Fish and Game (DFG)	Work in waters of the State Effects on federally listed threatened or endangered species	Lake and Streambed Alteration Agreement	CEQA document
State Historic Preservation Officer (SHPO)	Effects on cultural or archeological resources	SHPO review and concurrence of inventory/evaluation report	CEQA/NEPA document
Department of Water Resources/Division of Safety of Dams (DSOD)	Modification of dam, spillway, or low-level drain pipe	Approval of Plans and Specifications for modification	Application
Marin County	Construction, earthwork, work in a watercourse	Grading Permit, Building Permit, Watercourse Permit	Application; CEQA document

It is anticipated that environmental regulatory permitting will proceed concurrently with environmental review. This approach offers flexibility and expands opportunities for mitigating impacts associated with individual Projects and Project elements. Conceivably, impacts in one location within the geographic footprint of the Retrofit can be mitigated elsewhere in the geographic footprint. It can also streamline and reduce the overall costs (e.g., special studies) of the environmental review and permitting processes.

It is anticipated that DSOD permitting will proceed concurrently with Final (100%) Design (see section 2.1.5 above).

It is anticipated that special technical studies will be required to support the applications identified in the table above, including delineations of waters of the U.S. and State; vegetation surveys at affected areas; biological surveys for special-status species; and an instream flow study of aquatic habitat in Ross Creek. These studies will be used to support both the environmental review and permitting processes.

It is anticipated that permitting work in connection with the applications to DSOD and Marin County will be performed by an engineering consultant-contractor and the remaining environmental regulatory permitting work will be performed by environmental consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment.

Deliverables: Permit applications for Army Corps 404, Regional Board 401 Certification, and Fish and Game Stream/Lake Alteration, including requisite supporting technical studies; application for DSOD approval of plans and specifications; application to Marin County for grading/building/watercourse permit

2.1.8 Task 8: Construction Contracting

This task covers activities associated with construction contracting, including advertisement for bids; answering questions from contractors and preparing addendums to the design package during the bidding period; pre-bid contractors meeting; evaluation of bids; and award of contract. FZ9 will carry out the advertisement and award of contract work, and will be assisted by an engineering consultant-contractor in the other work.

Deliverables: Bid advertisement; written answers to questions during bidding; addendums to contract, if/as needed; meeting notes from pre-bid meeting with contractors; documented evaluation of bids and recommendation for award.

2.1.9 Task 9: Construction

As indicated above in section 2.1.5, it is anticipated that a single design package and contract, combining all four elements of the Flood Damage Reduction Project (Low-Level Drain Pipe Intake, Dam Seismic Upgrade, Dam Face Erosion Protection and Dam Crest Raising, Lake Bottom Excavation), will be advertised and awarded for construction. Construction is divided into three categories: mobilization and site preparation; project construction; and performance testing and demobilization.

Following construction, further work will be performed on the monitoring system. It is anticipated that this work will be performed by a consulting hydrographer-contractor.

2.1.9.1 Mobilization and Site Preparation

This category of work includes several items as described in the table below.

Mobilization and Site Preparation Work	
Staging area	Establish the on-site work staging area and support facilities (e.g., water tank, electric power)
Stockpile area	Establish stockpile area for temporary storage of excavated material
Mobilization	Mobilize equipment to the site
Erosion Control	Set up erosion control
Access roads	Trim and grade existing access road leading to the staging area; create new access road(s) to the reservoir bottom, as needed
Dewatering and water management	Gravity drain the lake using existing low-level drain pipe; dewater the remaining dead pool using temporary pumps; construct cofferdam(s) to collect tributary and groundwater inflow and maintain dewatered condition during construction using temporary pumps; install sediment controls and discharge pipeline to Ross Creek using Baker Tanks to treat water prior to discharge as required.
Wildlife protection	Set up exclusionary fencing as required by the ECW (see section 2.1.10 below)
Wildlife relocation	Collect fish and other aquatic wildlife from lake after gravity draining and temporarily store and/or relocate

2.1.9.2 Project Construction

This category of work includes several items as described in the table below.

Project Construction Work	
Excavate Lake Bottom	Excavate lake bottom
Grout curtain*	Install grout curtain along downstream toe of dam into bedrock
Liner*	Embed synthetic liner into downstream side of dam
Filter Fabric	Stabilize and place filter fabric on upstream dam face
Rip-rap facing	Placed 3 ft thick rip-rap on upstream dam face
Piles	Construct auger cast displacement piles in upstream face; 18-in dia, 60-ft deep, 6 rows at 10 ft o.c.
Excavate and stockpile	Excavate and stockpile material downstream face
Drainage blanket	Place and install drainage blanket on downstream dam face
Buttress fill	Place compacted buttress fill, using lake bottom material, on downstream dam face
Stabilize landslides	Construct retaining wall using soldier pile and timber lagging; install drilled pier and grade beam structure; finish site grading and install erosion control
Construct Intake	Install intakes on low-level drain pipe at el. 140 ft and 160 ft
Mechanical	Install slide gates and motor controls on intakes
Emergency Generators	Construct housing for emergency generators; install emergency generators and appurtances
Electrical	Install power lines; hook-up motor-controlled slide gates to power supply sources
Monitoring	Install gages at lake tributaries (2) and lake level gage (1)

* Ecosystem Restoration project element, but indicated here because installation will occur with other dam modification work.

2.1.9.3 Performance Testing and Demobilization

This category of work includes several items as tabulated below relating to the construction contract.

Performance Testing and Demobilization Work (Construction Contract)	
Performance testing	Test performance of mechanical and electrical systems, including emergency generators, motor-controlled gates, and monitoring components
Demobilization	Demobilize equipment and remove support facilities and temporary hookups from the site
Site restoration	Finish grade disturbed areas; hydroseed and install erosion control; plant other vegetation in disturbed areas as needed
Dewatering and water management	Gravity drain the lake using existing low-level drain pipe; dewater the dead pool using temporary pumps; construct cofferdam(s) to collect tributary and groundwater inflow and maintain dewatered condition during construction using temporary pumps; install sediment controls and discharge pipeline to Ross Creek using Baker Tanks to treat water prior to discharge, if/as needed.
Wildlife Replacement	Collect temporarily stored fish and other aquatic wildlife and replace into lake; supplement with planting of additional hatchery trout

2.1.9.4 Monitoring System Work

This category of work includes several items as described in the table below relating to the monitoring system.

Post-Construction Monitoring System Work	
Monitoring	Develop creek water level vs. discharge rating curves for gages (2) at the creek tributaries to lake
Monitoring	Install temporary flow measurement device at low-level outlet pipe; perform lake drawdown tests to assess lake drawdown capability and rate and to develop lake water level vs. discharge relationship for the new intakes (2)

2.1.10 Task 10: Environmental Compliance, Mitigation, Enhancement

It is anticipated that an outcome of environmental review under CEQA and NEPA and regulatory permitting will be various environmental compliance, mitigation, and enhancement measures that will be required pre-, during, and post-construction. Since the environment review has not been initiated, it is impossible at this time to predict exactly what measures will be required but, for purposes of this grant application, the following measures are anticipated.

Environmental Compliance, Mitigation and Enhancement	
Environmental Compliance Workplan	Preparation of a written Environmental Compliance Workplan (ECW) for the Phoenix Lake IRWD Retrofit[9] which will identify special-status species and other sensitive biological resources occurring in the Project area; describe pre-construction biological surveys and avoidance measures (e.g., exclusionary fencing); describe construction avoidance measures (e.g., construction season, exclusionary fencing) and monitoring; prepare a stormwater pollution prevention plan (SWPPP) that describes pre- , during-, and post-construction water quality protection measures and monitoring; describe post-construction restoration and mitigation measures; and describe post-construction mitigation monitoring
Pre-construction biological surveys	Perform pre-construction biological surveys as required in the ECW.
Construction monitoring	Perform continuous, on-site monitoring by an on-site resident biologist during all phases of construction activities to ensure compliance with the ECW; perform stormwater quality monitoring as called for in the SWPPP.
Post-construction restoration and mitigation (in addition to normal construction site restoration required by construction contractor)	Re-create five (5) acres of lake-fringe wetland habitat.
Initial post-construction monitoring (initial verification monitoring only – not long term)	Perform initial post-construction monitoring to verify and document initial installation of restoration and mitigation as required in the ECW.

[9] It is anticipated that the ECW will cover the whole Phoenix Lake IRWM Retrofit. The cost for the ECW has been split according to each project's pro-rata construction cost, as reflected in Attachment 4, Budget.

It is anticipated that this work will be performed by environmental consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment.

Deliverables: Environmental Compliance Workplan Report; SWPPP; pre-construction biological survey report; construction monitoring reports; initial post-construction monitoring (initial verification) report.

2.1.11 Task 11: Construction Administration

This task covers activities associated with administering and managing construction of the Project. Specifically this task includes collecting, reviewing, and filing all documentation, bonding, and certifications required from the contractor before work can begin; holding a pre-construction meeting with the contractor; field-inspecting the work of the contractor, including review of required materials certifications and earthwork testing; review of contractors submittals, including shop drawings; preparation of change orders; review of contractors progress invoices and recommendations for payment of progress invoices; inspection of performance testing; review of contractors final invoice and recommendation for payment.

FZ9 will carry out collecting, reviewing, and filing all documentation, insurance and bonding, and certifications as required from the contractor; and payment of invoices. FZ9 anticipates that the other work described above will be performed by an engineering consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also perform review-and-comment and inspection-and-approval functions during construction.

Deliverables: Meeting notes on pre-construction meeting; field-inspection reports; documented materials certifications and earthwork testing results; review/approved shop drawings, if/as needed; change orders, if/as needed; documented review and recommendations for progress and final payments to contractors.

2.2 Water Supply Project Tasks

The Water Supply Project has two elements, spillway gate and Phoenix Lake to Bon Tempe Lake transfer piping. Although the descriptions of some of the tasks that follow are similar to the Flood Damage Reduction Project, the level of effort to complete the tasks as well as the cost, as reflected in Attachment 4, Budget, will be substantially less.

As indicated in section 2.2.5 below, FZ9 anticipates awarding a single, separate contract to an engineering construction contractor to furnish and install the spillway gate.

2.2.1 Task 1: Administration

Same as Task 1 in Flood Damage Reduction Project (see section 2.1.1 above).

Deliverables: Submission of invoices and other deliverables as required; Memorandum of Agreement[10]

2.2.2 Task 2: Labor Compliance Program

Same as Task 2 in Flood Damage Reduction Project (see section 2.1.2 above).

Deliverable: Submission of required information to DLSE CMU.

2.2.3 Task 3: Reporting

Same as Task 3 in Flood Damage Reduction Project (see section 2.1.3 above).[11]

Deliverable: Submission of quarterly, annual, and final reports as specified in the Grant Agreement.

2.2.4 Task 4: Assessment and Evaluation

Completed work on the Water Supply Project is summarized in Section 3.2. The completed work includes a Project Assessment and Evaluation Memorandum, Concept (30%) Design Memorandum, and prior hydrologic studies. The Concept (30%) Design Memorandum has adequately verified the engineering feasibility and viability of the spillway gate and the Phoenix Lake to Bon Tempe Lake transfer piping; therefore, no further engineering assessment and evaluation work is needed. However, further hydrologic assessment and evaluation is needed.

One of the completed hydrologic studies was a long-term hydrologic analysis of re-operation of Phoenix Lake for flood detention and water supply. The purpose of the analysis was to assess and evaluate the long term yield of the Water Supply Project if Phoenix Lake is operated for both flood detention and water supply. The analysis was based on the best available hydrologic data covering the period 1986 to 2010. Unfortunately, there were years in this period with missing data (1989-1992 and 1996) which included some shortage years. In order to more thoroughly assess and evaluate the long term yield of the Water Supply Project, further long-term hydrologic analysis covering shortage years is needed. One approach is to synthesis the data that are missing for 1989-1992 and 1996. Another approach is to extend the period of analysis further back it time to cover the 1976-77 drought years if the data are available. Whatever approach(s) is taken, the Phoenix Lake operations model previously developed will be used again for this further analysis.

[10] Since the MOA primarily addresses joint use of Phoenix Lake for flood control and water supply, it has been included under both the Flood Damage Reduction Project and the Water Supply Project. The cost to prepare the MOA has been split 50/50 between these two projects, as reflected in Attachment 4, Budget.
[11] The cost for reporting has been split across all five component projects comprising the Retrofit according to each project's pro-rata construction cost, as reflected in Attachment 4, Budget.

A Coordinated Operations Plan (COP) will be developed that is mutually acceptable to MMWD and FZ9, establishing the rules and criteria for operating the lake in a manner that achieves the lake's new multi-use benefits. The operating rules and criteria will govern lake levels, withdrawals for water supply, and operation of the spillway gate. The COP will also describe instream flow releases for ecosystem restoration in Ross Creek below the dam and lake levels for public recreational uses of the lake. The Phoenix Lake operations model and findings of the instream flow study of Ross Creek and lower Corte Madera Creek (see section 2.4.7) will be used in developing the COP. It is anticipated that the COP will be incorporated into the MOA (see section 2.1.1 above).[12]

It is anticipated that the above-described work will be performed by an engineering consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment services.

Deliverables: Report on Long-Term Hydrologic Analysis of Re-operation of Phoenix Lake for Flood Detention and Water Supply; Coordinated Operations Plan

2.2.5 Task 5: Final Design

For purposes of this grant application and based on information in Section 3.2, the Water Supply Project is currently at the Concept (30%) design stage. Further work will be needed to complete Final Design of the spillway gate installation and the Phoenix Lake to Bon Tempe Lake transfer piping. This further work will require civil, structural, mechanical, and electrical design.

Design plans for the spillway gate installation and the transfer piping will be prepared at three stages, based on the design stage definitions given in the Proposal Solicitation Package (PSP) for Stormwater Flood Management grants (2010, Round 1), p. 33, for review, comment, and approval by FZ9 and MMWD: 60% design, 90% (Pre-final) design, and 100% (Final) design. The 100% (Final) design will include the design package and contract that will be advertised for award for construction. It is anticipated that separate two design packages and contracts will be advertised and awarded to two separate contractors for construction of the spillway gate and transfer piping.

It is anticipated that the design work will be performed by an engineering consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment and approval of all designs.

Deliverables: 60% design, 90% (Pre-final) design, and 100% (Final) design package, two of each.

2.2.6 Task 6: Environmental Documentation

[12] Since the COP primarily addresses joint use of Phoenix Lake for flood control and water supply, it has been included under both the Flood Damage Reduction Project and the Water Supply Project. The cost to prepare the COP has been split 50/50 between these two projects, as reflected in Attachment 4, Budget.

Same as Task 6 in Flood Damage Reduction Project (see section 2.1.6 above).

Deliverables: Approved and adopted combined CEQA/NEPA documentation[13]

2.2.7 Task 7: Permitting

The Water Supply Project will be subject to the regulatory permitting authority of state and local agencies. The table below identifies the permits that are expected to be required.

Approvals and Permits Required for the Phoenix Lake IRWM Retrofit

Agency	Trigger	Approval	Submittal
Department of Water Resources/Division of Safety of Dams (DSOD)	Modification of dam, spillway, or low-level drain pipe	Approval of Plans and Specifications for modification	Application
Marin County	Construction	Building Permit	Application; CEQA document

It is anticipated that the above-described permitting will proceed concurrently with Final (100%) Design (see section 2.2.5 above).

It is anticipated that the above-described permitting work will be performed by an engineering consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment and approval of applications.

Deliverables: Applications for DSOD approval of plans and specifications for spillway gate; application to Marin County for building permit

2.2.8 Task 8: Construction Contracting

Same as Task 8 in Flood Damage Reduction Project (see section 2.1.8 above).

Deliverables: Bid advertisement; written answers to questions during bidding; addendums to contract, if/as needed; meeting notes from pre-bid meeting with contractors; documented evaluation of bids and recommendation for award.

[13] Since it is anticipated that the approach to environmental review will be a combined CEQA/NEPA document covering the whole Phoenix Lake IRWM Retrofit, Task 6, Environmental Documentation is the same for all five component projects of the Retrofit. The cost for Task 6 has been split according to each projects pro-rata construction cost, as reflected in Attachment 4, Budget.

2.2.9 Task 9: Construction

As indicated above in section 2.2.5, it is anticipated that two separate design packages and contracts will be advertised and awarded to two separate contractors for construction of the spillway gate and transfer piping. Construction is divided into three categories: mobilization and site preparation; project construction; and performance testing and demobilization.

2.2.9.1 Mobilization and Site Preparation

This category of work includes several items as described in the table below.

Mobilization and Site Preparation Work	
Staging area	Establish the on-site work staging area and support facilities (e.g., electric power)
Mobilization	Mobilize equipment to the site
Wildlife protection	Set up exclusionary fencing as required by the ECW

2.2.9.2 Project Construction

This category of work includes several items as described in the table below.

Project Construction Work	
Mechanical	Furnish and install spillway gate
Equipment House	Construct housing for spillway gate inflation blower and controls
Electrical (spillway gate)	Install power lines; hook-up spillway gate controls to power supply sources

2.2.9.3 Performance Testing and Demobilization

This category of work includes several items as tabulated below relating to the construction contract.

Performance Testing and Demobilization Work (Construction Contracts)	
Performance testing	Test operations of spillway gate and electrical systems, including spillway gate control and monitoring components
Performance testing	Test operations of the transfer piping
Demobilization	Demobilize equipment and remove support facilities and temporary hookups from the site
Site restoration	Clean-up site as needed

2.2.9.4 Monitoring System Work

No post-construction monitoring system work is anticipated.

2.2.10 Task 10: Environmental Compliance, Mitigation, Enhancement

Since the Water Supply Project footprint will be limited to the existing concrete spillway and upland staging and equipment house areas, no environmental compliance, mitigation, or enhancement is anticipated.

2.2.11 Task 11: Construction Administration

Same as Task 11 in Flood Damage Reduction Project (see section 2.1.11 above).

Deliverables: Meeting notes on pre-construction meeting; field-inspection reports; documented materials certifications and earthwork testing results; review/approved shop drawings, if/as needed; change orders, if/as needed; documented review and recommendations for progress and final payments to contractors.

2.3 Water Quality Project Tasks

The Water Quality Project has only two elements; epilimnetic circulation device and hypolimnetic circulation device. Although the descriptions of some of the tasks that follow are similar to the Flood Damage Reduction Project, the level of effort to complete the tasks as well as the cost, as reflected in Attachment 4, Budget, will be substantially less.

As indicated in section 2.3.5 below, FZ9 anticipates awarding a single, separate contract to an equipment vendor to furnish and install the two circulation devices in the lake.

2.3.1 Task 1: Administration

This task consists of administration of all Water Quality Project-related activities that will be performed by FZ9, FZ9 contractors, and FZ9's partner agency, MMWD. Activities will primarily include, but will not be limited to, planning and design work and construction and testing work. FZ9 will be the lead agency under CEQA and will be the contracting agency on all work performed by contractors. MMWD, as owner of the Phoenix Lake property and existing facilities, will participate in all activities in a "review-and-comment" and "inspect-and-approve" capacity.

Administration will cover work performed by FZ9 and MMWD that is incidental but directly related to the above-described Project-related activities. Administration will also involve Grant Agreement-related administrative work.

Deliverables: Submission of invoices and other deliverables as required

2.3.2 Task 2: Labor Compliance Program

Same as Task 2 in Flood Damage Reduction Project (see section 2.1.2 above).

Deliverable: Submission of required information to DLSE CMU.

2.3.3 Task 3: Reporting

Same as Task 3 in Flood Damage Reduction Project (see section 2.1.3 above).[14]

Deliverable: Submission of quarterly, annual, and final reports as specified in the Grant Agreement.

2.3.4 Task 4: Assessment and Evaluation

Completed work on the Water Quality Project is summarized in Section 3.3. The completed work includes a Project Assessment and Evaluation Memorandum and Concept (30%) Design Memorandum. The Concept (30%) Design Memorandum has adequately verified the engineering feasibility and viability of the two circulation devices; therefore, no further engineering assessment and evaluation work is needed. However, further assessment and evaluation of baseline (existing, or pre-construction) water quality conditions in the lake is needed.

Further assessment and evaluation of existing water quality conditions will include pre-construction water quality monitoring summarized in the table below.

Monitoring Plan for Baseline (Existing) Conditions

	Description
What	• Water quality (Secchi depth and vertical profiles of Chlorophyll-*a*, dissolved oxygen, and iron and manganese) • Water temperature (vertical profiles of water temperature)
Why	• Provide data to establish baseline conditions for evaluating project performance
When	• Monthly sampling of water quality in the months from April through October: o *Pre-construction* • Continuous monitoring of water temperature in the months from April through October: o *Pre-construction*
Where	• Near the dam and near the proposed circulation devices
Who	• FZ9 contractor

[14] The cost for reporting has been split across all five component projects comprising the Retrofit according to each project's pro-rata construction cost, as reflected in Attachment 4, Budget.

It is anticipated that this work will be performed by a hydrographer-consultant contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment services.

Deliverables: Report on Baseline Water Quality Conditions in Phoenix Lake

2.3.5 Task 5: Final Design

For purposes of this grant application and based on information in Section 3.3, the Water Quality Project is currently at the Concept (30%) design stage. Further work will be needed to complete the installations of the circulation devices, including final determination of the depth settings of the devices and design of the tethering systems. The contract to furnish and install the devices will require the contractor to review the Baseline Water Quality Report for the lake to determine the depth of settings and provide shop drawings showing the installations of the circulation devices.

Final Design work for the Water Quality Project will be limited to preparation of the specification package and contract that will be advertised for award for furnishing and installing the two devices. It is anticipated that a single specification package and contract will be advertised and awarded to a single equipment vendor-contractor.

It is anticipated that preparation of the specification package and contract will be performed by an engineering consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment and approval of all specifications.

2.3.6 Task 6: Environmental Documentation

Same as Task 6 in Flood Damage Reduction Project (see section 2.1.6 above).

Deliverables: Approved and adopted combined CEQA/NEPA documentation[15]

2.3.7 Task 7: Permitting

It is not anticipated that the Water Quality Project will be subject to regulatory permitting authority. Therefore, no work is anticipated under this task.

2.3.8 Task 8: Construction Contracting

Same as Task 8 in Flood Damage Reduction Project (see section 2.1.8 above).

[15] Since it is anticipated that the approach to environmental review will be a combined CEQA/NEPA document covering the whole Phoenix Lake IRWM Retrofit, Task 6, Environmental Documentation is the same for all five component projects of the Retrofit. The cost for Task 6 has been split according to each projects pro-rata construction cost, as reflected in Attachment 4, Budget.

Deliverables: Bid advertisement; written answers to questions during bidding; addendums to contract, if/as needed; meeting notes from pre-bid meeting with contractors; documented evaluation of bids and recommendation for award.

2.3.9 Task 9: Construction

As indicated above in section 2.3.5, it is anticipated that a single specification package and contract to furnish and install the two circulation devices will be advertised and awarded for construction. Construction is divided into two categories: project construction and performance testing.

2.3.9.1 Mobilization and Site Preparation

There is no work planned for this category.

2.3.9.2 Project Construction

This category of work includes two items as described in the table below.

Project Construction Work	
Mechanical	Furnish and install two circulation devices in the lake
Tethering System	Furnish and install tethering systems for two circulation devices

2.3.9.3 Performance Testing and Demobilization

This category of work includes one item as tabulated below relating to the construction contract.

Performance Testing and Demobilization Work (Construction Contract)	
Performance testing	Test operation of the two circulation devices

2.3.9.4 Monitoring System Work

No post-construction monitoring system work is anticipated.

2.3.10 Task 10: Environmental Compliance, Mitigation, Enhancement

No environmental compliance, mitigation, or enhancement is anticipated for this project.

2.3.11 Task 11: Construction Administration

Same as Task 11 in Flood Damage Reduction Project (see section 2.1.11 above).

Deliverables: Meeting notes on pre-construction meeting; field-inspection reports; review/approved shop drawings, if/as needed; change orders, if/as needed;

documented review and recommendations for progress and final payments to vendor-contractor.

2.4 Ecosystem Restoration Project Tasks

The Ecosystem Restoration Project has three elements; (1) low-level drain pipe intake low-flow control gates at both the 140 ft and 160 ft intakes; (2) seepage reduction synthetic liner and grout curtain; and (3) aeration device at the low-level outlet discharge. Although the descriptions of some of the tasks that follow are similar to the Flood Damage Reduction Project, the level of effort to complete the tasks as well as the cost, as reflected in Attachment 4, Budget, updated July 2012, will be substantially less.

As indicated in section 2.4.5 below, FZ9 anticipates incorporating the low-flow control gates, the dam face liner and the aeration device in the Final (100%) design package and contract that is award for Flood Damage Reduction Project. The low-flow control gates will be physically attached to and made part of the new intake at elevations 140 ft and 160 ft; similarly, the aeration system will be connected with the existing outlet vault; and the liner and grout curtain will installed at the same time as other dam modifications that will be constructed as part of the Flood Damage Reduction Project. It is logical to have all these features installed at the same time and by the same contractor responsible for the Flood Damage Reduction Project work. Nonetheless, these activities and the associated costs are allocated to the Ecosystem Restoration Projects, as indicated in Attachment 4, Budget, updated July 2012.

2.4.1 Task 1: Administration

Same as Task 1 in the Water Quality Project (see section 2.3.1 above).

Deliverables: Submission of invoices and other deliverables as required

2.4.2 Task 2: Labor Compliance Program

Same as Task 2 in Flood Damage Reduction Project (see section 2.1.2 above).

Deliverable: Submission of required information to DLSE CMU.

2.4.3 Task 3: Reporting

Same as Task 3 in Flood Damage Reduction Project (see section 2.1.3 above).[16]

Deliverable: Submission of quarterly, annual, and final reports as specified in the Grant Agreement.

[16] The cost for reporting has been split across all five component projects comprising the Retrofit according to each project's pro-rata construction cost, as reflected in Attachment 4, Budget.

2.4.4 Task 4: Assessment and Evaluation

Completed work on the Ecosystem Restoration Project is summarized in Section 3.4. The completed work includes a Project Assessment and Evaluation Memorandum and Concept (30%) Design Memorandum. The Concept (30%) Design Memorandum has adequately verified the engineering feasibility and viability of the low-flow control gates; therefore, no further engineering assessment and evaluation work is needed. However, further assessment and evaluation is needed of baseline (existing, or pre-construction) water quality conditions below Phoenix Lake in Ross Creek and Corte Madera Creek. This will aid in identifying the important sources of concentrations of low dissolved oxygen and high iron and manganese.

Further assessment and evaluation of existing conditions will include pre-construction monitoring summarized in the table below.

Monitoring Plan for Baseline (Existing) Conditions

	Description
What	• Water temperature • Water quality (dissolved oxygen, iron and manganese) • Hydrology (stream flow)
Why	• Provide data to establish baseline conditions for evaluation of project performance
When	• Continuous monitoring of water temperature for the period of April through October: o *Pre-construction* • Monthly sampling of dissolved oxygen, iron and manganese in the months of April through October: o *Pre-construction* • Continuous stream flow for the period of April through October: o *Pre-construction*
Where	• Four water temperature locations along Ross Creek and two water temperature locations in Corte Madera Creek with one above the Ross Creek confluence and another below the confluence • Two dissolved oxygen, iron and manganese locations in Ross Creek; one immediately below Phoenix lake dam and another 1,500 ft below the dam • Two stream flow locations in Ross Creek; one immediately below Phoenix Lake dam and another at the mouth of Ross Creek • The same two stream flow locations as the Flood Damage Reduction Project to measure lake inflows in the dry season
Who	• FZ9 contractor

It is anticipated that this work will be performed by a hydrographer-consultant contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment services.

Deliverables: Report on Baseline Water Quality Conditions below Phoenix Lake in Ross Creek and Corte Madera Creek

2.4.5 Task 5: Final Design

For purposes of this grant application and based on information in Section 3.4, the Ecosystem Restoration Project is currently at the Concept (30%) design stage. Further work will be needed to complete Final Design of the synthetic liner/grout curtain, low-flow control gates installation, and low-level outlet discharge aeration system. This further work will require civil, mechanical, and electrical design.

It is anticipated that the design of low-flow control gates, the aeration device, and the synthetic liner/grout curtain will be incorporated into the overall design of the low-level drain pipe intake modifications and dam seismic upgrade, which are part of the Flood Damage Reduction Project. As such, these features will be included in the Final (100%) design package and contract that is awarded for the Flood Damage Reduction Project. Nonetheless, the design of these features as described in this section and the associated costs are allocated to the Ecosystem Restoration Projects, as indicated in Attachment 4, Budget, updated in July 2012. Design will be informed by the results of the Baseline Water Quality Report and will comply with water quality requirements, if any, as set forth in regulatory permits.

Design plans for the low-flow control gates, the aeration device, and the synthetic liner/grout curtain will be included in the design submittals for the Flood Damage Reduction Project at three stages, based on the design stage definitions given in the Proposal Solicitation Package (PSP) for Stormwater Flood Management grants (2010, Round 1), p. 33, for review, comment, and approval by FZ9 and MMWD: 60% design, 90% (Pre-final) design, and 100% (Final) design.

It is anticipated that the design work will be performed by an engineering consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment and approval of all designs.

Deliverables: 60% design, 90% (Pre-final) design, and 100% (Final) design package

2.4.6 Task 6: Environmental Documentation

Same as Task 6 in Flood Damage Reduction Project (see section 2.1.6 above).

Deliverables: Approved and adopted combined CEQA/NEPA documentation[17]

[17] Since it is anticipated that the approach to environmental review will be a combined CEQA/NEPA document covering the whole Phoenix Lake IRWM Retrofit, Task 6, Environmental Documentation is the

2.4.7 Task 7: Permitting

The Ecosystem Restoration Project will be subject to the regulatory permitting authority of state and local agencies. The table below identifies the permits that are expected to be required.

Approvals and Permits Required for the Ecosystem Restoration Project

Agency	Trigger	Approval	Submittal
National Marine Fisheries Service (NOAA Fisheries) US Fish and Wildlife Service	Effects on federally listed threatened or endangered species	Biological Opinion through a Section 7 Consultation with USACE	Biological Assessment
San Francisco Bay Regional Water Quality Control Board (RWQCB)	Section 404 Permit through USACE	Section 401 Water Quality Certification through Section 404 Permit with USACE	Application
California Department of Fish and Game (DFG)	Effects on federally listed threatened or endangered species	Lake and Streambed Alteration Agreement	CEQA document
Department of Water Resources/Division of Safety of Dams (DSOD)	Modification of dam, spillway, or low-level drain pipe	Approval of Plans and Specifications for modification	Application
Marin County	Construction	Building Permit	Application; CEQA document

It is anticipated that environmental regulatory permitting for the Ecosystem Restoration Project will be integrated with the permitting for the Flood Damage Reduction Project. It is anticipated that an instream flow study of aquatic habitat in Ross Creek and lower Corte Madera Creek will be needed to support preparation of the Biological Assessment and Section 7 Consultation process. This study will be used to support both the environmental review and permitting processes for the two projects.

It is anticipated that DSOD permitting will proceed concurrently with Final (100%) Design (see section 2.4.5 above).

It is anticipated that work in connection with the applications to DSOD and Marin County will be performed by an engineering consultant-contractor and the remaining environmental regulatory permitting work will be performed by environmental

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same for all five component projects of the Retrofit. The cost for Task 6 has been split according to each projects pro-rata construction cost, as reflected in Attachment 4, Budget.

consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment on all applications and approval of applications to DSOD and Marin County.

Deliverables: Biological Assessment; Permit applications for Regional Board 401 Certification, and Fish and Game Stream/Lake Alteration, including requisite supporting instream flow study; application for DSOD approval of plans and specifications; application to Marin County for building permit

2.4.8 Task 8: Construction Contracting

Same as Task 8 in Flood Damage Reduction Project (see section 2.1.8 above).

Deliverables: Bid advertisement; written answers to questions during bidding; addendums to contract, if/as needed; meeting notes from pre-bid meeting with contractors; documented evaluation of bids and recommendation for award.

2.4.9 Task 9: Construction

As indicated above in section 2.4.5, FZ9 anticipates incorporating the design of the low-flow control gates and the synthetic liner/grout curtain into the overall design of the low-level drain pipe intake modifications and dam seismic upgrade, which are part of the Flood Damage Reduction Project. As such, these features will be included in the Final (100%) design package and contract that is awarded for the Flood Damage Reduction Project. Nonetheless, the construction of these features is described in this section and the associated costs are allocated to the Ecosystem Restoration Projects, as indicated in Attachment 4, Budget – Updated July 2012 version. The design of the aeration system will be included in a separate design package. The construction will be done under a separate construction contract.
Construction is divided into two categories: project construction and performance testing.

2.4.9.1 Mobilization and Site Preparation

There is no work in this category

2.4.9.2 Project Construction

This category of work includes several items as described in the table below.

Project Construction Work	
Mechanical	Furnish and install low-flow slide gates at the 140 ft and 160 ft level intakes; Furnish and install aeration system at low-level outlet discharge vault
Civil	Install synthetic liner and grout curtain
Electrical	Furnish and hook-up motor-control for two low-flow slide gates to power supply sources
Monitoring	Furnish and install stream flow gages at lake tributaries (2) and lake level gage (1); water level sensor (1), temperature sensor (1), and dissolved oxygen sensor (1) at low-level outlet discharge vault; streamflow gage at mouth of Ross Creek(1); temperature sensors along Ross Creek (4) and Corte Madera Creek (2)

2.4.9.3 Performance Testing and Demobilization

This category of work includes several items as tabulated below relating to the construction contract.

Performance Testing and Demobilization Work (Construction Contract)	
Performance testing	Test operation of low-flow control gates and monitoring components
Performance testing	Test operation of aeration system

2.4.9.4 Monitoring System Work

This category of work includes several items as described in the table below relating to the monitoring system.

Post-Construction Monitoring System Work	
Monitoring	Develop creek water level vs. discharge rating curves for streamflow gages (3); develop water level vs. discharge rating curve at low-level outlet discharge vault (1)

2.4.10 Task 10: Environmental Compliance, Mitigation, Enhancement

No environmental compliance, mitigation, or enhancement associated with the low-flow control gate is anticipated.

2.4.11 Task 11: Construction Administration

FZ9 anticipates incorporating the design of low-flow control gates and synthetic liner/grout curtain into the overall design of the low-level drain pipe intake modifications and dam seismic upgrade which are part of the Flood Damage Reduction Project. As such, these features will be included in the Final (100%) design package and contract that is awarded for Flood Damage Reduction Project. Nonetheless, construction

administration of these features is described in this section and the associated costs are allocated to the Ecosystem Restoration Projects, as indicated in Attachment 4, Budget. Construction of the aeration system will be done under a separate construction contract.

This task covers activities associated with administering and managing construction of the Project. Specifically this task includes collecting, reviewing, and filing all documentation, bonding, and certifications required from the contractor before work can begin; holding a pre-construction meeting with the contractor; field-inspecting the work of the contractor, including review of required materials certifications and earthwork testing; review of contractors submittals, including shop drawings; preparation of change orders; review of contractors progress invoices and recommendations for payment of progress invoices; inspection of performance testing; review of contractors final invoice and recommendation for payment.

FZ9 will carry out collecting, reviewing, and filing all documentation, insurance and bonding, and certifications as required from the contractor; and payment of invoices. FZ9 anticipates that the other work described above will be performed by an engineering consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also perform review-and-comment and inspection-and-approval functions during construction.

Deliverables: Meeting notes on pre-construction meeting; field-inspection reports; documented materials certifications and earthwork testing results; review/approved shop drawings, if/as needed; change orders, if/as needed; documented review and recommendations for progress and final payments to contractors.

2.5 Recreation and Public Access Project Tasks

2.5.1 Task 1: Administration

Same as Task 1 in the Water Quality Project (see section 2.3.1 above).

Deliverables: Submission of invoices and other deliverables as required

2.5.2 Task 2: Labor Compliance Program

Same as Task 2 in Flood Damage Reduction Project (see section 2.1.2 above).

Deliverable: Submission of required information to DLSE CMU.

2.5.3 Task 3: Reporting

Same as Flood Damage Reduction Project (see section 2.1.3 above).[18]

[18] The cost for reporting has been split across all five component projects comprising the Retrofit according to each project's pro-rata construction cost, as reflected in Attachment 4, Budget.

Deliverable: Submission of quarterly, annual, and final reports as specified in the Grant Agreement.

2.5.4 Task 4: Assessment and Evaluation

Completed work on the Recreation and Public Access Project is summarized in Section 3.5. The completed work includes a Project Assessment and Evaluation Memorandum, Concept (30%) Design Memorandum, and the following two prior watershed studies:

- Summary Report, Road and Trail Inventory and Assessment, Erosion Prevention Implementation Plan, Mt. Tamalpais Watershed, Marin Municipal Water District, Marin County, California, Pacific Watershed Associates. 2003

- Mount Tamalpais Road and Trail Management Plan. Marin Municipal Water District. 2005. http://marinwater.org/controller?action=menuclick&id=249. Last accessed 04/08/2011.

The completed work has adequately assessed and evaluated the Recreation and Public Access Project and verified its feasibility and viability; therefore, no further assessment and evaluation work is needed.

2.5.5 Task 5: Final Design

For purposes of this grant application and based on information in Section 3.5, the Recreation and Public Access Project is currently at the Concept (30%) design stage. Further work will be needed to complete Final Design. This further work is divided into two groups based on the four elements of the Project as described in more detail in Section 3.5: (1) Bill Williams Creek Culvert Replacement; Phoenix Lake Watershed Trail Improvements; and Road-Related Sediment Reduction Projects, which will require civil, geotechnical, and erosion-control design, and (2) Visitor Use Facility Upgrades, which will require civil design.

Design plans for these two engineering groups will be prepared at three stages, based on the design stage definitions given in the Proposal Solicitation Package (PSP) for Stormwater Flood Management grants (2010, Round 1), p. 33, for review, comment, and approval by FZ9 and MMWD: 60% design, 90% (Pre-final) design, and 100% (Final) design. The 100% (Final) design will include the design package and contract that will be advertised for award for construction. It is anticipated that two separate design packages and contracts, corresponding to the two groups of elements described above, will be advertised and awarded for construction to two contractors. FZ9 anticipates that the design work for the road and trail elements will be performed by an engineering/erosion control consultant-contractor and the design work for the visitor use element will be performed by an engineering consultant-contractor with review and

oversight by FZ9 staff/ MMWD staff will also provide review-and-comment and approval of all designs.

Deliverables: 60% design, 90% (Pre-final) design, and 100% (Final) design package, two of each.

2.5.6 Task 6: Environmental Documentation

Same as Task 6 in Flood Damage Reduction Project (see section 2.1.6 above).

Deliverables: Approved and adopted combined CEQA/NEPA documentation

2.5.7 Task 7: Permitting

The Recreation and Public Access Project will be subject to the regulatory permitting authority of several federal and state agencies. The table below identifies the permits that are expected to be required.

Approvals and Permits Required for the Phoenix Lake IRWM Retrofit

Agency	Trigger	Approval	Submittal
US Army Corps of Engineers (USACE)	Discharge of fill within ordinary high water mark in creek, lake, or adjacent wetlands	Section 404/10 Permit (Nationwide Permit or an Individual Permit)	Application
National Marine Fisheries Service (NOAA Fisheries) US Fish and Wildlife Service	Effects on federally listed threatened or endangered species	Biological Opinion(s) through a Section 7 Consultation with USACE	Biological Assessment(s)
San Francisco Bay Regional Water Quality Control Board (RWQCB)	Section 404 Permit through USACE	Section 401 Water Quality Certification through Section 404 Permit with USACE	Application
California Department of Fish and Game (DFG)	Discharge of fill within waters of the State Effects on federally listed threatened or endangered species	Lake and Streambed Alteration Agreement	CEQA document
State Historic Preservation Officer (SHPO)		SHPO review and concurrence of inventory/evaluation report	CEQA/NEPA document
Marin County	Construction, earthwork, work in creeks	Grading Permit, Building Permit, Watercourse Permit	Application(s); CEQA document

It is anticipated that environmental regulatory permitting will proceed concurrently with environmental review. This approach offers flexibility and expands opportunities for mitigating impacts associated with individual Projects and Project elements. Conceivably, impacts in one location within the geographic footprint of the Retrofit can be mitigated elsewhere in the geographic footprint. It can also streamline and reduce the overall costs (e.g., special studies) of the environmental review and permitting processes.

It is anticipated that special technical studies will be required to support the applications identified in the table above, including delineations of waters of the U.S. and State; vegetation surveys at affected areas; and biological surveys for special-status species. These studies will be used to support both the environmental review and permitting processes.

FZ9 anticipates that work in connection with the application to Marin County will be performed by an engineering consultant-contractor, and the remaining work will be performed by environmental consultant-contractor with review and oversight by FZ9 staff. MMWD staff will also provide review-and-comment and approval of all work.

Deliverables: Permit applications for Army Corps 404, Regional Board 401 Certification, and Fish and Game Stream/Lake Alteration, including requisite supporting technical studies; applications to Marin County for grading/building permit and watercourse permit

2.5.8 Task 8: Construction Contracting

Same as Task 8 in Flood Damage Reduction Project (see section 2.1.8 above).

Deliverables: Bid advertisement; written answers to questions during bidding; addendums to contract, if/as needed; meeting notes from pre-bid meeting with contractors; documented evaluation of bids and recommendation for award.

2.5.9 Task 9: Construction

As indicated above in section 2.5.5, it is anticipated that two separate design packages and contracts, corresponding to the two groups of elements of the Recreation and Public Access Project ((1) Bill Williams Creek Culvert Replacement; Phoenix Lake Watershed Trail Improvements; and Road-Related Sediment Reduction Projects, and (2) Visitor Use Facility Upgrades), will be advertised and awarded for construction. Construction is divided into three categories: mobilization and site preparation; project construction; and demobilization.

2.5.9.1 Mobilization and Site Preparation

This category of work includes several items as described in the table below.

Mobilization and Site Preparation Work	
Staging area	Establish the on-site work staging area and support facilities (e.g., water tank, electric power)
Stockpile area	Establish stockpile area for temporary storage of excavated material, building materials
Mobilization	Mobilize equipment to the site
Wildlife protection	Set up exclusionary fencing as required by the ECW (see section 2.5.10 below)

2.5.9.2 Project Construction

This category of work includes several items as described in the table below.

Project Construction Work	
Trails	Construct trail improvements
Road Improvements	Construct road improvements
Culverts	Furnish and install arch and pipe culverts
Erosion protection	Install erosion protection
Facilities (Visitor Use Facilities contract only)	Furnish and install kiosks, benches, and restrooms

2.5.9.3 Performance Testing and Demobilization

This category of work includes several items as tabulated below relating to the construction contract.

Performance Testing and Demobilization Work (Construction Contract)	
Demobilization	Demobilize equipment and remove support facilities and temporary hookups from the site
Site restoration	Finish grade disturbed areas; hydroseed and install erosion control; plant other vegetation in disturbed areas as needed

2.5.9.4 Monitoring System Work

No work is anticipated in this category

2.5.10 Task 10: Environmental Compliance, Mitigation, Enhancement

It is anticipated that an outcome of environmental review under CEQA and NEPA and regulatory permitting will be various environmental compliance, mitigation, and enhancement measures that will be required during and post-construction. Since the environmental review has not been initiated, it is impossible at this time to predict exactly what measures will be required but, for purposes of this grant application, the following measures are anticipated.

Environmental Compliance, Mitigation and Enhancement	
Environmental Compliance Workplan	Preparation of an written Environmental Compliance Workplan (ECW)[19] which will identify special-status species and other sensitive biological resources occurring in the Project area; describe pre-construction biological surveys and avoidance measures (e.g., exclusionary fencing); describe construction avoidance measures (e.g., construction season, exclusionary fencing) and monitoring; describe water quality monitoring; describe post-construction restoration and mitigation measures; and describe post-construction mitigation monitoring
Pre-construction biological surveys	Perform pre-construction biological surveys as required in the ECW
Construction monitoring	Perform continuous, on-site monitoring by an on-site resident biologist during all phases of construction activities to ensure compliance with the ECW
Post-construction monitoring (initial verification monitoring only – not long term)	Perform post-construction initial monitoring to verify and document initial installation of restoration and mitigation as required in the ECW

Deliverables: Environmental Compliance Workplan Report; pre-construction biological survey report; construction monitoring report; post-construction monitoring (initial verification) report.

2.5.11 Task 11: Construction Administration

Same as Task 11 in Flood Damage Reduction Project (see section 2.1.11 above).

Deliverables: Meeting notes on pre-construction meeting; field-inspection reports; documented materials certifications and earthwork testing results; review/approved shop drawings, if/as needed; change orders, if/as needed; documented review and recommendations for progress and final payments to contractors.

[19] It is anticipated that the ECW will cover the whole Phoenix Lake IRWM Retrofit, as described in section 2.1.10. The cost for the ECW has been split according to each project's pro-rata construction cost, as reflected in Attachment 4, Budget.

3.0 Supporting Documents to Attachment 3

3.1 Flood Damage Reduction Project

3.1.1 Project Assessment and Evaluation Memorandum

3.1.2 Project Concept (30%) Design and Cost Memorandum

- Dam Seismic Upgrade
- Dam Face Erosion Protection and Raising
- Low-Level Drain Pipeline Intake
- Lake Bottom Excavation

3.1.3 Appendices

Appendix 1: HEC-HMS Hydrologic Modeling Analysis of Phoenix Lake in Peak Flow Reduction

Appendix 2: Preliminary Coordinated Operations Plan for Phoenix Lake

Appendix 3: Phoenix Lake Spillway Hydraulic Evaluation

Appendix 4: Geotechnical Evaluations (3) of Phoenix Lake Dam

3.2 Water Supply Project

3.2.1 Project Assessment and Evaluation Memorandum

3.2.2 Project Concept (30%) Design and Cost Memorandum

- Spillway Gate
- Phoenix Lake to Bon Tempe Lake Transfer Piping

3.2.3 Appendices

Appendix 5: Long-Term Hydrologic Analysis of Re-operating Phoenix Lake for Flood Detention and Water Supply

3.3 Water Quality Project

3.3.1 Project Assessment and Evaluation Memorandum

3.3.2 Project Concept (30%) Design and Cost Memorandum

- Epilimnetic Circulation Device
- Hypolimnetic Circulation Device

3.3.3 Appendices

Appendix 6: Phoenix Lake Water Quality Issues and Solutions

Appendix 7: SolarBee's Proposal for Phoenix Lake

3.4 Ecosystem Restoration Project

3.4.1 Project Assessment and Evaluation Memorandum

3.4.2 Project Concept (30%) Design Memorandum

- Low-level Drain Pipeline Intake Control Valve

3.4.3 Appendices

Appendix 8: Ross Creek Water Temperature Issues and Solutions

Appendix 9: Ross Creek Water Temperature Monitoring Report (Friends of Corte Madera Creek Watershed, 2008)

Appendix 10: Ross Creek Iron and Manganese Report (Friends of Corte Madera Creek Watershed, 2011)

3.5 Recreation and Public Access Project

3.5.1 Project Assessment and Evaluation Memorandum

3.5.2 Project Concept (30%) Design Memorandum

- Public Use Facility, Road, and Trail Improvements

3.1 Flood Damage Reduction Project

3.1.1 Project Assessment and Evaluation Memorandum

Project Name:
Flood Damage Reduction Project

Project Element(s):
Dam Seismic Upgrade; Dam Face Erosion Protection and Dam Crest Raising; Low-Level Drain Pipeline Intake; Lake Bottom Excavation; Monitoring System

Project Purpose and Need:
There is a need to reduce the frequency and severity of flooding in Ross Valley for the protection of property and public safety. The current capacity of Corte Madera Creek (below Phoenix Lake and the Ross Creek confluence) is about 3,600 cfs, which corresponds to about the 17 percent-annual-chance flood (i.e., 6-year flood).

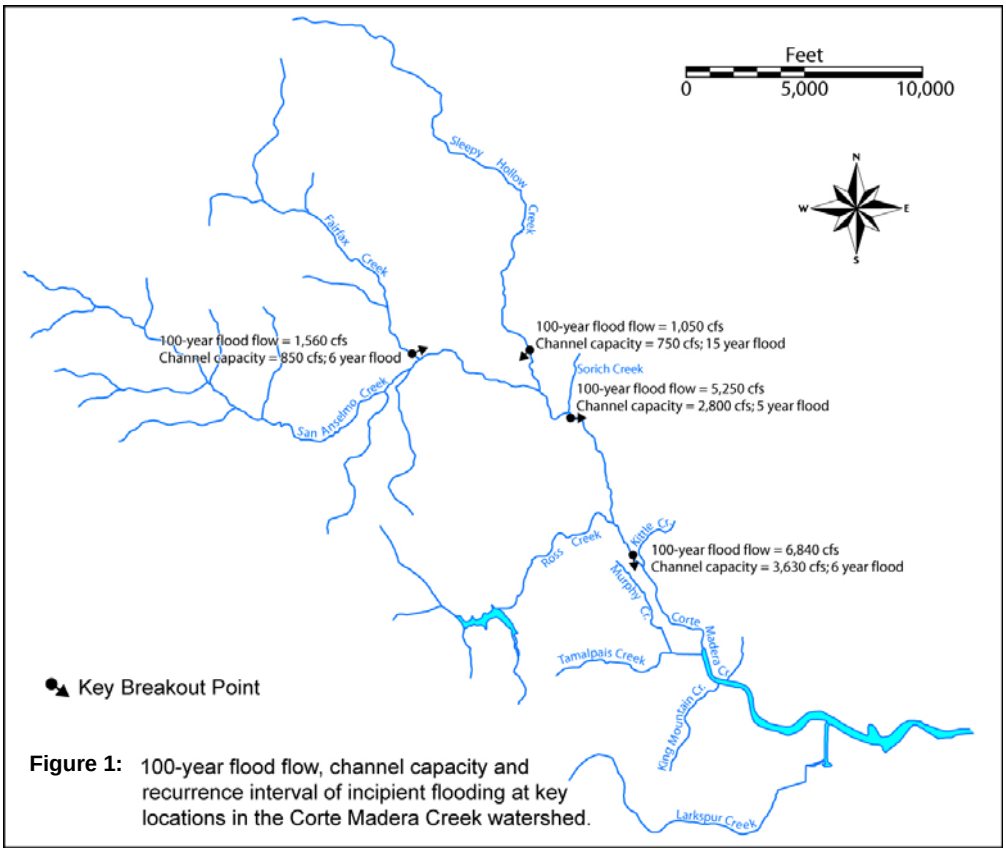

Figure 1: 100-year flood flow, channel capacity and recurrence interval of incipient flooding at key locations in the Corte Madera Creek watershed.

Several times in recent history the Ross Valley has been flooded by overflow from Corte Madera Creek with varying degrees of severity. Prior to establishment in 1951 of the USGS streamflow gaging station on Corte Madera Creek in Ross, flooding was reported in calendar years 1914, 1925, 1937, and 1942. Since the Corte Madera Creek streamflow gage in Ross has been in operation, flood flows have been recorded in calendar years 1951, 1955, 1958, 1967, 1969, 1970, 1982, 1983, 1986, 1994 , and 2005. Of these, the

two most severe floods occurred in 1982 and 2005, with peak discharges of approximately 7,200 cfs and 6,800 cfs; the percent-annual-chances of which were approximately 0.6 percent and 1 percent, respectively. Historical flooding has caused extensive property damage and economic hardship to residents, businesses, and local governments, and has threatened the lives of those living in the floodplain, with at least one recorded death occurring in the 1955 flood and at least one rescue of a stranded motorist reported by the Ross Valley Fire Department during the 2005 flood.

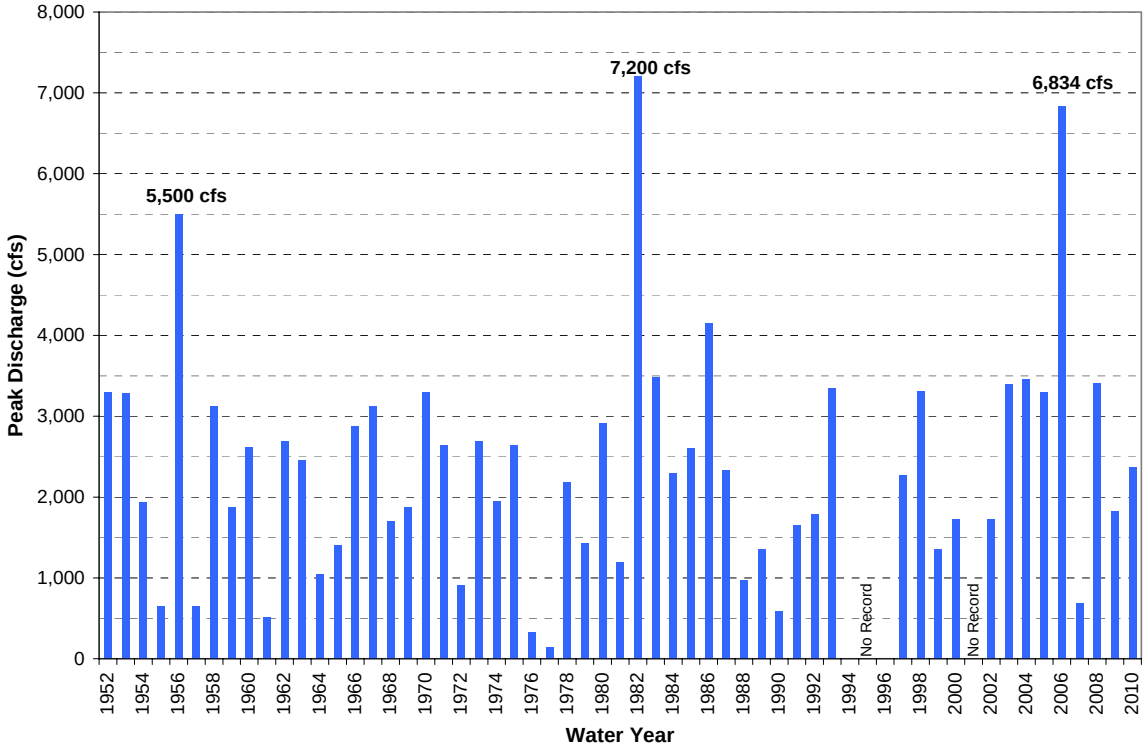

Figure 2 Historical Annual Peak Discharges Recorded at the Flood Zone 9 Streamflow Gage in Ross, Corte Madera Creek

In accordance with its Congressional authorization, the Army Corps of Engineers has plans to increase creek conveyance capacity below the Ross Creek confluence to about 5,400 cfs, or about the 4 percent-annual-chance flood (i.e., 25-year flood). This is considered a major improvement but the Ross Valley community desires a further reduction in the flood hazard. In order to increase the effectiveness of the Corps' design and achieve a more appropriate 1 percent-annual-chance level of flood protection (i.e., 100-year flood protection), the 100-year flood discharge at the Ross Creek confluence needs to be reduced by 1,400 cfs, from 6,800 cfs down to 5,400 cfs. This reduction is achievable through detention basins, and retrofit of Phoenix Lake is key since this basin could reduce the 100-year flood discharge by about 650 cfs, or nearly half of the total amount needed. Without the Phoenix Lake IRWM Retrofit, public safety and property downstream of the Ross Creek confluence in the communities of Ross, Kentfield, Larkspur and Greenbrae would remain at-risk of flooding.

Summary of Completed Work, Existing Data and Studies:

	Description	Reference	Purpose
Completed Work	Concept (30%) designs of all facility elements of the Flood Damage Reduction Project	Project Concept (30%) Design Memorandum	• Investigate the engineering feasibility of the flood damage reduction project. • Design project layout; size project facilities/components • Provide design information for estimating construction costs.
Existing Data	1) Hydrologic Data	Stetson in-house database; Marin County website; USGS database; DSOD Inspection Report	• Observed rainfall runoff data were used to develop and calibrate the HEC-HMS hydrologic model for the entire Corte Madera Creek watershed. • Observed annual peak discharge data the streamflow gage in Ross were used to develop flood frequency curve. • The DSOD-developed 30,000-year flood hydrograph for Phoenix Lake was used to evaluate the spillway hydraulic capacity. • Surveyed bathymetric data of Phoenix Lake were used to develop an elevation-storage curve for use in HEC-HMS hydrologic routing.
	2) Hydraulic Data	Stetson in-house database; Marin County website	• Observed stage-discharge data were used to update the rating curve of the Ross streamflow gage in Corte Madera Creek. • Surveyed channel geometry and bridge/culvert geometry data were used to develop the in-channel MIKE 11 hydraulic model. • Surveyed topographic data of the Ross Valley floodplain were used to develop the floodplain MIKE 21 hydraulic model. • Surveyed high water marks data for the 1982 and 2005 floods were used to calibrate the MIKE FLOOD hydraulic model.
	3) Geotechnical Data	Miller Pacific database	• Historical earthquakes data were used to demonstrate that the project is located within the seismic active region. • Historical subsurface exploration data were used to understand the soil type and geotechnical conditions of the earthen dam.
Existing Studies	1) HEC-HMS Hydrologic Modeling Analysis of Phoenix Lake in Peak Flow Reduction	Appendix 1	• To identify the best physical and operational modification alternatives for flood detention at Phoenix Lake. • To evaluate the alternatives' effectiveness at reducing peak flows.
	2) Preliminary Coordinated Operations Plan for Phoenix Lake	Appendix 2	• To provide an operations plan for Phoenix Lake to achieve flood detention during the wet season, water supply during the dry season, and other beneficial uses.
	3) Phoenix Lake Spillway Hydraulic Evaluation	Appendix 3	• To analyze the peak water surface in the lake during the 30,000-year design flood through reservoir routing to determine whether there is an adequate residual freeboard. • To compute the peak water surface profile along the spillway and chute during the 30,000-year design flood to determine whether the spillway has an adequate capacity.
	4) Geotechnical Evaluations (3) of Phoenix Lake Dam and Reservoir	Appendix 4	• To evaluate the seismic conditions of the dam, demonstrate the need for seismic retrofit, and provide engineering methods for seismic retrofit. • To investigate the geotechnical feasibility of operating the lake at a higher water level (el. 180 ft). • To evaluate slope stability and identify the need for dam face erosion protection under rapid drawdown. • To evaluate mitigation options for dam seepage reduction.

Finding(s):

1) HEC-HMS hydrologic modeling analysis of Phoenix Lake peak flow reduction (see Appendix 1) indicated that drawing the lake level down ahead of a forecasted storm to el.140 ft (NGVD29), in concert with installing a 6-foot high inflatable/deflatable rubber dam across the spillway, would provide sufficient storage space in the lake to detain floodwaters and effectively reduce 100-year peak flows (by about 650 cfs from 6,840 cfs to 6,190 cfs at the Ross streamflow gage) along Ross Creek and Corte Madera Creek, including key breakout points in Ross.
2) Analysis of routing winter baseflows through the Phoenix Dam with the existing 30-inch low-level outlet open (see Appendix 1, Section 4.0) indicated that it would take about 23 hours for the 30" low-level outlet to drain the lake from the spillway crest level (174 ft) down to elevation 160 ft, and an additional 24 hours from elevation 160 ft down to elevation 140 ft. In order to achieve rapid drain-down for evacuating the lake under winter baseflow conditions within 24 hours of impending heavy storm, a two-step drawdown procedure was developed (see Appendix 2). The first step is initial drawdown of the lake (from elevation 174 ft down to elevation 160 ft) and the second step is final drawdown of the lake (from elevation 160 ft down to elevation 140 ft). Accordingly, the existing low-level outlet structure (a 30" pipe with an intake elevation at 130 ft NGVD29) will be modified to have two level gates, one at elevation 140 ft and the other at elevation 160 ft.
3) The Phoenix Lake spillway hydraulic evaluation (see Appendix 3) indicated that the spillway has adequate capacity to pass the routed 30,000-year peak discharge. However, in order for the Phoenix Lake Flood Damage Reduction Project to meet the DSOD minimum requirement of 1.5 ft residual freeboard, the existing Phoenix Lake dam (el. 189 ft) needs to be raised by at least 1.1 ft.
4) The geotechnical evaluation (see Appendix 4) indicated that:
    - The proposed use of Phoenix Lake dam and reservoir as a flood detention basin is feasible. However, localized, shallow instability is likely during rapid drawdown. Erosion protection is needed for the identified areas where are potentially unstable during rapid drawdown.
    - Deformation of the dam will likely occur during strong seismic shaking. Seismic retrofit of the dam may be needed.
    - Exploratory drilling and lab testing of the existing earthen embankment dam are needed to determine strength properties, verify the need for seismic retrofit, and, if verified, develop design parameters for the retrofit.

3.1.2 Project Concept (30%) Design Memorandum

Project Name:
Flood Damage Reduction Project

Project Element(s):
Dam Seismic Upgrade; Dam Face Erosion Protection and Dam Crest Raising; Low-Level Drain Pipeline Intake; Lake Bottom Excavation; Monitoring System

Design Objective:
The goal of the Flood Damage Reduction Project is to enable Phoenix Lake to function as a flood detention basin. The objective of flood detention operations is to attenuate flows produced in the upper Ross Creek watershed sufficiently to reduce the peak discharge to lower Ross Creek, and hence lower Corte Madera Creek, during the 1-percent-chance-annual flood by about 650 cfs. In order to achieve this objective, Phoenix Lake needs to provide about 470 acre-feet of flood storage capacity for floodwater attenuation. Accordingly, flood detention operations call for rapid drawdown of the lake level, in a two-step process, first to elevation 160 ft if/when observed watershed saturation conditions and then to elevation 140 ft ahead of a forecasted heavy storm event, and storage of floodwaters up to elevation 180 ft.

Design Criteria and Other Design Considerations:
Meeting the design objective requires improvements and modifications to the dam, spillway, reservoir and inlet/outlet works. The earthen embankment dam needs structural strengthening to improve seismic stability at the higher water level, elevation 180 ft; the dam face needs to be stabilized to enable rapid drawdown by preventing sloughing of the dam face (erosion protection) and enables storage to a higher water level (el. 180 ft; raising) for peak flow attenuation and flood reduction; the intake/outlet works of the low-level drain pipeline need modification to enable rapid lake drawdown in advance of a forecasted flood; and, the lake bottom needs to be excavated to provide adequate minimum pool for fish and other aquatic wildlife and to prevent entrainment and discharge of sediment when the lake is drawn down to el. 140 ft.

Design Description:
The designed improvements include 1) constructing seismic retrofit of the dam; 2) stabilizing the dam embankment and raising the dam crest by at least 1.1 ft; 3) modifying the existing low-level outlet structure (a 30" pipe with an intake elevation at 130 ft NGVD29) to have two water level-control gates, one at elevation 140 ft and the other at elevation 160 ft; 4) creating about 20 acre-ft of additional (minimum) storage below elevation 140 ft by excavating the lake bottom near the existing low-level intake; 5) installing emergency generators; and 6) installing monitoring, flood warning, and control systems.

List of Design Drawing(s):
- Figure 1: Project Layout
- Figure 2: Plan View of the Low-Level Drain Pipe Intake

- Figure 3: Profile View of the Low-Level Drain Pipe Intake
- Figure 4: Cross Section of the New Inlet Structure
- Figure 5: Lake Bottom Excavation

Engineers Cost Estimate:

Total Construction Cost = $8,890,000

Flood Damage Reduction Project - Construction Cost Estimation

Item	Description	Quantity	Unit	Unit Price	Total Cost
General Requirements:					**$ 530,000**
01	Mobilization	1	LS	$ 200,000	$ 200,000
02	Access Road Improvements	1	LS	$ 100,000	$ 100,000
03	Clearing and Grubbing	1	LS	$ 30,000	$ 30,000
04	Temporary Construction Facilities:				
04.1	Dewatering / Coffer Dam / Pumping	1	LS	$ 100,000	$ 100,000
04.2	Wildlife Relocation	1	LS	$ 100,000	$ 100,000
Dam Seismic Upgrade:					**$ 3,005,000**
05	Seismic Retrofit of Dam	1	LS	$ 3,005,000	$ 3,005,000
Dam Face Erosion Protection and Crest Raising:					**$ 3,044,000**
06	Dam Face Erosion Protection and Crest Raising	1	LS	$ 2,394,000	$ 2,394,000
07	Landslide Stabilization Elsewhere	1	LS	$ 650,000	$ 650,000
Low-Level Drain Pipe Intake:					**$ 698,000**
08	Inlet/Outlet Works Modification:				
08.1	Earthworks	1,000	CY	$ 80	$ 80,000
08.2	Rip-Rap Slope Protection	600	Ton	$ 140	$ 84,000
08.3	Concrete (Gate Structures)	15	CY	$ 2,200	$ 33,000
08.4	Concrete (Slab)	40	CY	$ 1,000	$ 40,000
08.5	36" Steel Pipe	100	LF	$ 330	$ 33,000
08.6	6" Air Release Pipe	100	LF	$ 20	$ 2,000
08.7	Pipe Connection	1	LS	$ 5,000	$ 5,000
08.8	36" Sluice Gates	2	Each	$ 20,000	$ 40,000
08.9	Trash Racks	2	Each	$ 10,000	$ 20,000
08.10	Outlet Modification	1	LS	$ 32,000	$ 32,000
09	Concrete (Control Station)	5	CY	$ 1,800	$ 9,000
10	Hydraulic Control System	1	LS	$ 50,000	$ 50,000
11	Emergency Generators for the Gates Control System	1	LS	$ 250,000	$ 250,000
12	Revegetation	1	LS	$ 20,000	$ 20,000
Lake Bottom Excavation:					**$ 1,562,500**
13	Lake Bottom Excavation	31,250	CY	$ 50	$ 1,562,500
Monitoring System:					**$ 50,000**
14	Monitoring System	1	LS	$ 50,000	$ 50,000
				Total Construction	**$ 8,890,000**

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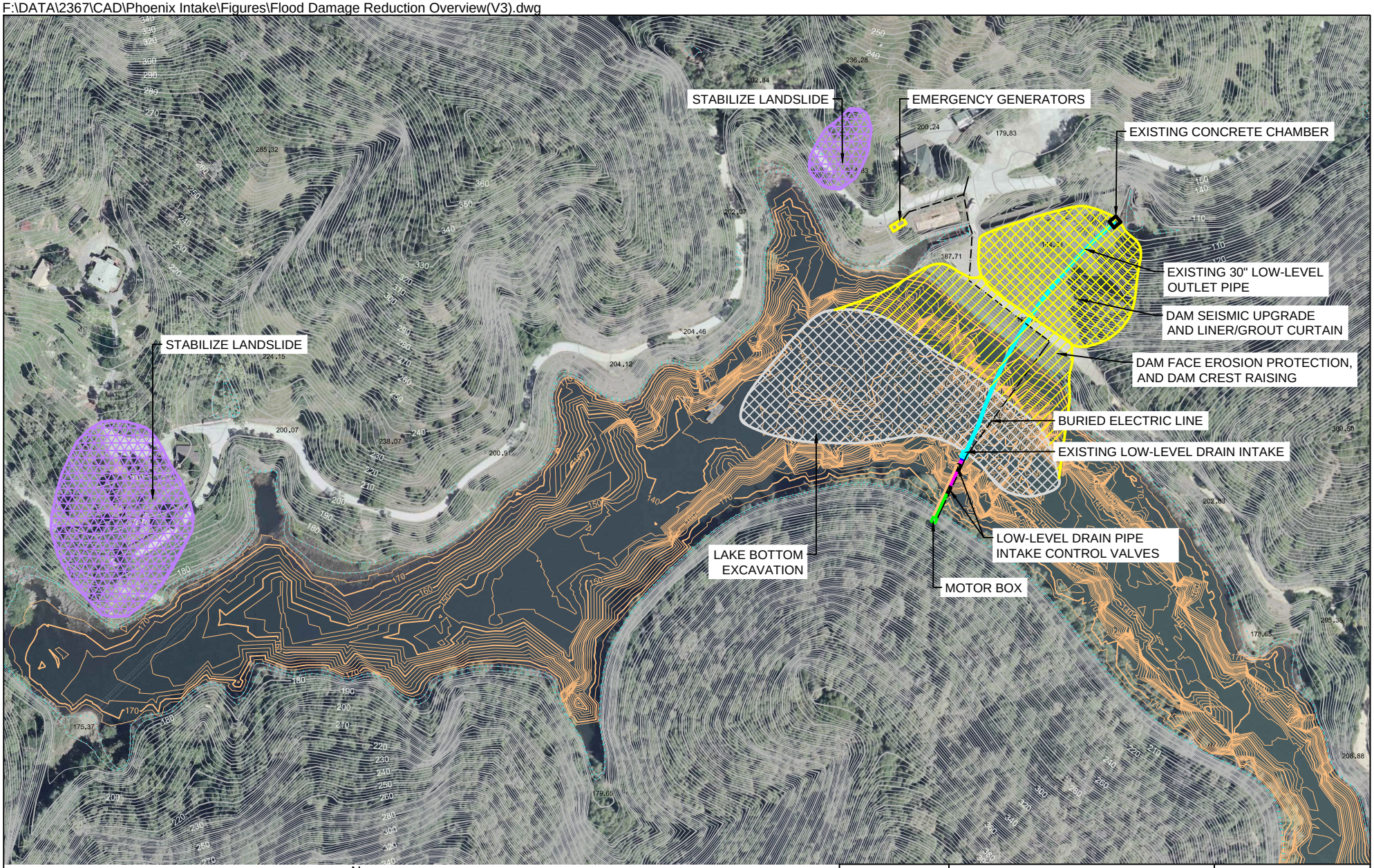

LEGEND

- CONTOUR LINES (2 FOOT INTERVAL)
- BATHYMETRIC CONTOUR LINES (2 FOOT INTERVAL)
- 179.16 SPOT ELEVATION

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Notes:

1. This drawing is in California State Plane NAD 83, zone 3 and vertical datum NGVD 29.
2. Bathymetry data points source is XYZ file data received from Environmental Data Solutions in November 2009.
3. 2' Interval Contourlines and Spot Elevations are based on the 2004 aerial survey contour data received from Marin County.

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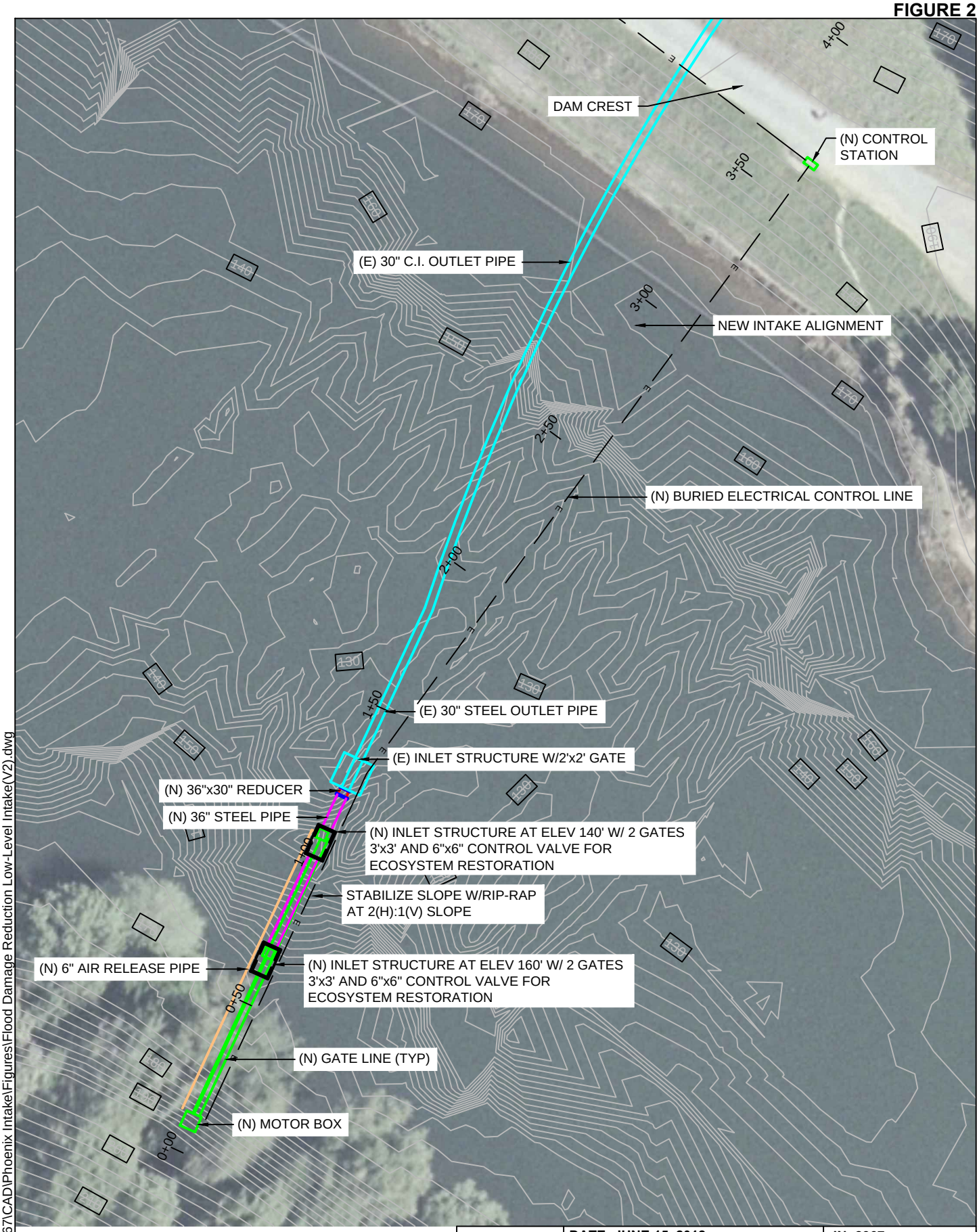
FLOOD DAMAGE REDUCTION PHOENIX LAKE

FIGURE 1

FIGURE 2



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FOOD DAMAGE REDUCTION
LOW-LEVEL DRAIN PIPE INTAKE - PLAN VIEW

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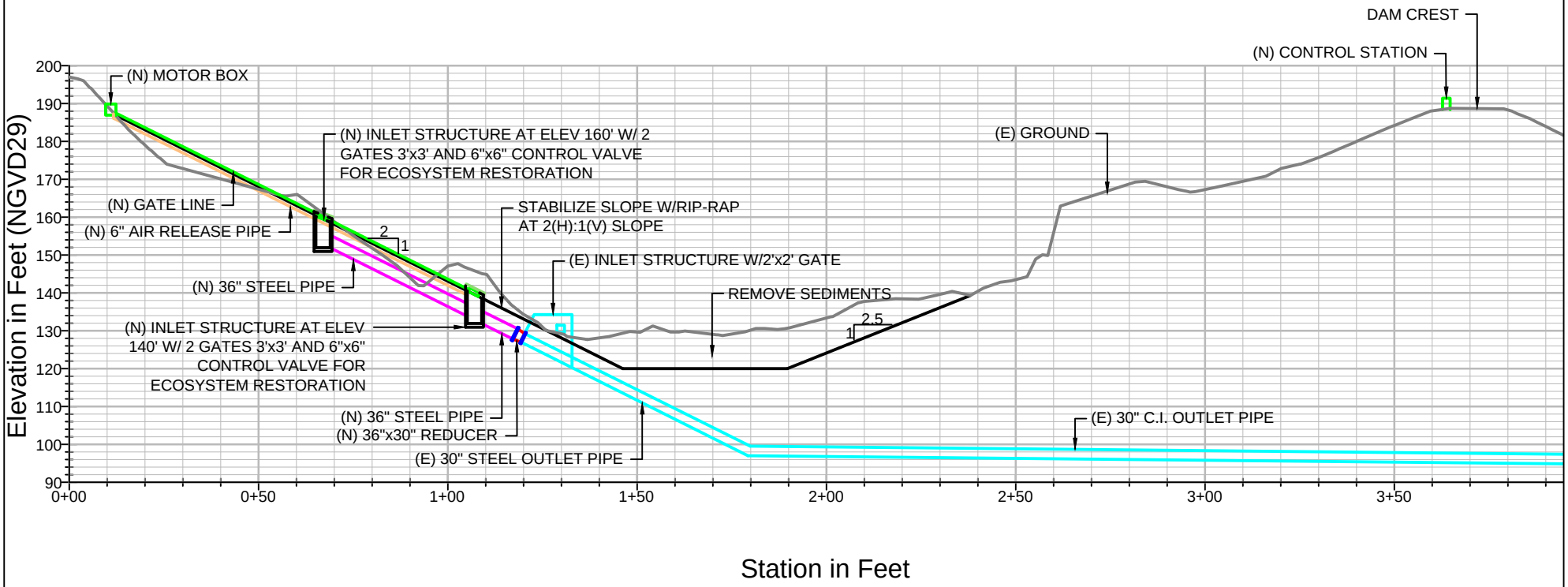
Profile View of New Inkake Alignment



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FOOD DAMAGE REDUCTION
LOW-LEVEL DRAIN PIPE
INTAKE - PROFILE

FIGURE 3

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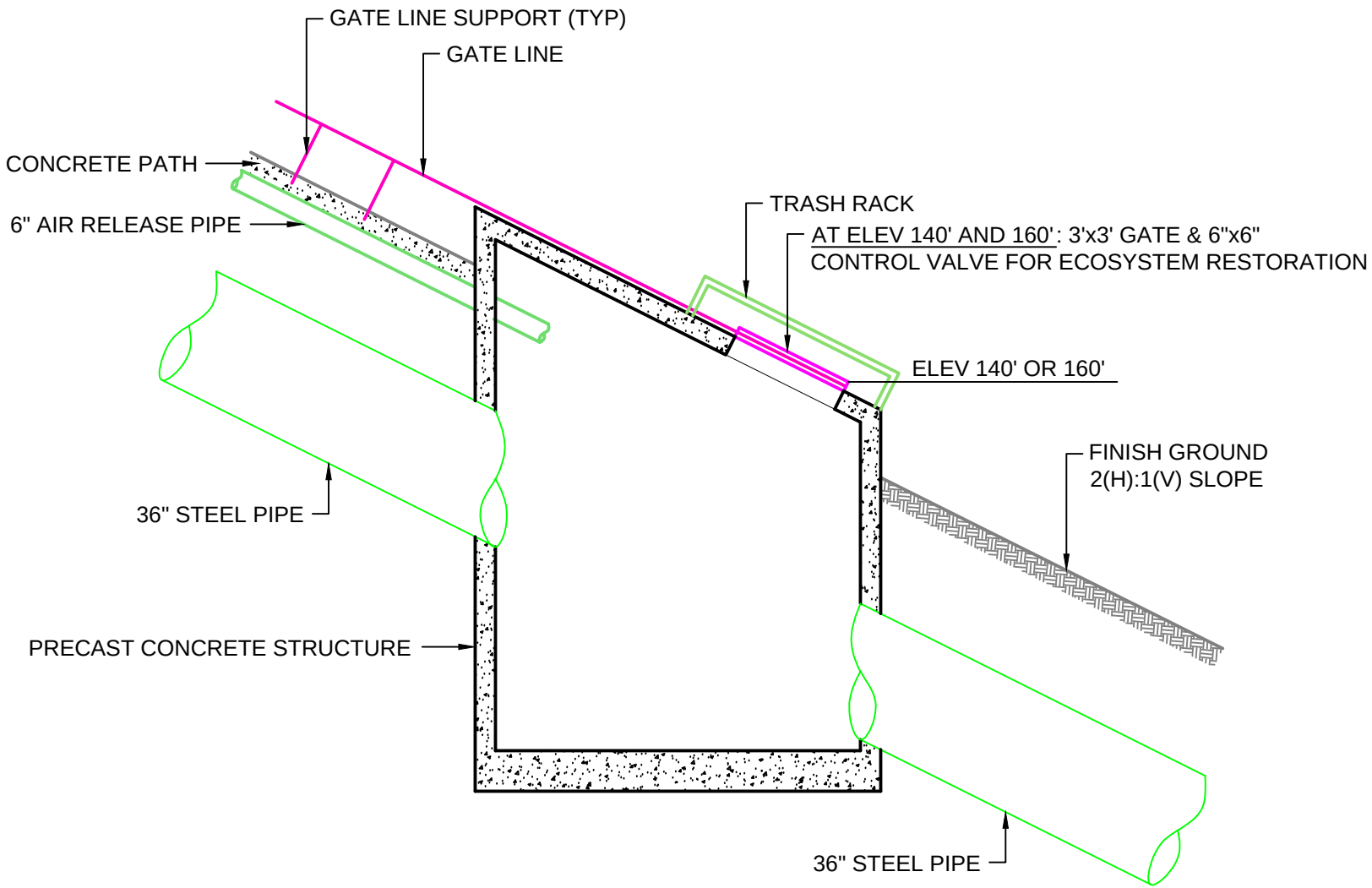

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FLOOD DAMAGE REDUCTION
NEW INLET STRUCTURE
TYPICAL SECTION

FIGURE 4

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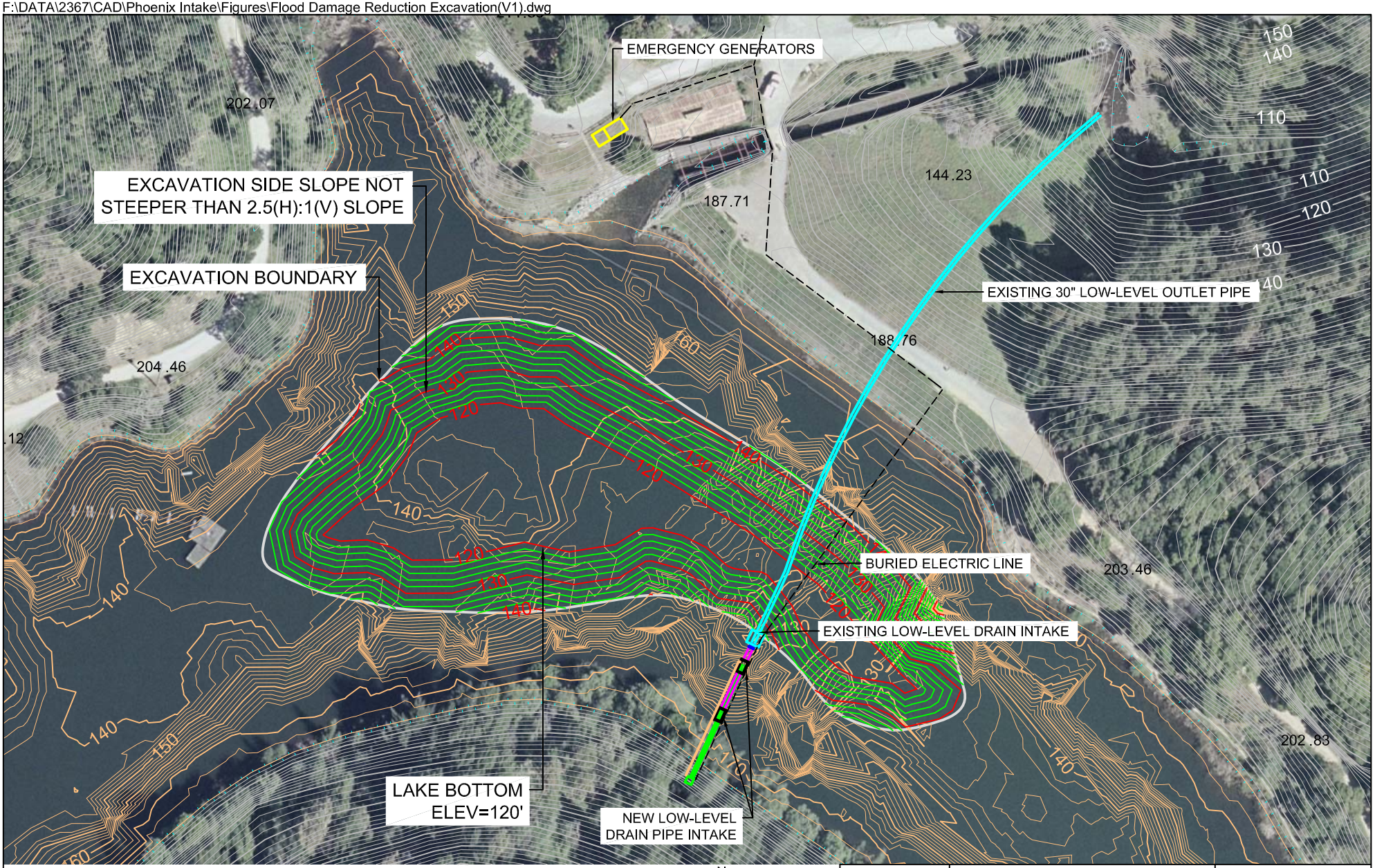

LEGEND

- CONTOUR LINES (2 FOOT INTERVAL)
- BATHYMETRIC CONTOUR LINES (2 FOOT INTERVAL)
- CONTOUR LINES AFTER EXCAVATION (2 FOOT INTERVAL)
- 179.16 SPOT ELEVATION

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FLOOD DAMAGE REDUCTION
LAKE BOTTOM EXCAVATION

FIGURE 5

3.2 Water Supply Project

3.2.1 Project Assessment and Evaluation Memorandum

Project Name:
Water Supply Project

Project Element(s):
Spillway Gate; Phoenix Lake to Bon Tempe Lake Water Transfer Piping

Project Purpose and Need:

There is a need to provide more reliability and flexibility to MMWD's water supply. The Water Supply Project will restore the spillway crest to its pre-1985 elevation 180 ft, thereby increasing the storage capacity of the lake by about 120 acre-ft. The added storage capacity could potentially increase the long-term average lake yield by up to 107 acre-ft per year and up to 50 acre-ft per year during shortage years for supply to the MMWD system.

Currently water from Phoenix Lake is pumped to the Bon Tempe Water Treatment Plant. In order for MMWD to more flexibly utilize the increased yield of Phoenix Lake water, it is necessary to install a new piping system from Phoenix Lake to Bon Tempe Lake to create completely separate potable and lake water transfer systems.

Summary of Completed Work, Existing Data and Studies:

	Description	Reference	Purpose
Completed Work	Concept (30%) designs of all facility elements of the Water Supply project	Project Concept (30%) Design Memorandum	• Investigate the engineering feasibility of the water supply project. • Design project layout; size project facilities/components. • Provide design information for estimating construction costs.
Existing Data	1) Water Demand and Supply Data and Historical Water Use Data of Phoenix Lake	MMWD website	• Water demand and supply data demonstrate that additional water supply is needed. • Historical water use data of Phoenix Lake demonstrate that the lake is an important water supply in the summer season of dry years, particularly during shortages.
	2) Lake Bathymetry Data	Stetson in-house database	• Surveyed bathymetric data of Phoenix Lake were used to analyze storage curve and volume reduction due to historical sedimentation.
Existing Studies	1) MMWD Desalination Project EIR; MMWD Urban Water Management Plan	MMWD website	• To demonstrate the need of additional water supply.
	2) Long-Term Hydrologic Analysis of Re-operating Phoenix Lake for Flood Detention and Water Supply	Appendix 5	• To analyze and verify whether natural inflow to the lake during the spring refilling period is sufficient to refill the lake for dry season water supply in case wet season drawdown for flood detention.

Finding(s):

5) Additional water supply is needed for MMWD to meet the water demand (see Appendix 5). For a variety of reasons, the current MMWD reliable water supply is about 3,300 AFY less than current water demand[20]. According to data presented in the *Urban Water Management Plan* (MMWD 2006a, updated 2007), if water demand in the MMWD service area increases as projected and if no new water supply is provided, this water supply deficit will increase to 6,700 AFY by the year 2025. As noted above, if Marin County experiences another drought similar to that of 1976–77, water supplies would be inadequate to meet current demands. In the first year of such a drought (known as the drought of record – the basis for MMWD's assessment of the supply that it can reliably provide to its customers), customers would be requested to reduce consumption by 10 percent. In the second year of a drought, MMWD would only be able to provide approximately 45 percent of demand, requiring 55 percent rationing of water. This rationing level would have catastrophic impacts on MMWD customers.

6) The long-term hydrologic analysis of re-operating Phoenix Lake for flood detention and water supply (see Appendix 5) indicated that, in most years, inflow into Phoenix Lake during the spring would be sufficient to refill the lake from the wet season flood operations drawdown level, el. 160 ft, to the raised spillway crest, el. 180 ft. In very dry years, complete refill may not occur. However, under the Preliminary Coordinated Operations Plan for Phoenix Lake (see Appendix 2), the initial drawdown will not happen during very dry years when the water supply of Phoenix Lake is needed most.

[20] Shortage year water supply availability, rather than long term average annual water supply availability, is the basis that MMWD uses to evaluate the reliability of its water supplies and determine whether there is any imbalance (or deficit) between supply and demand.

3.2.2 Project Concept (30%) Design Memorandum

Project Name:
Water Supply Project

Project Element(s):
Spillway Gate; Phoenix Lake to Bon Tempe Lake Water Transfer Piping

Design Objective:
The objective of the Water Supply Project is to increase the yield of Phoenix Lake and thereby provide more reliability and flexibility to MMWD's water supply. The Water Supply Project will restore the spillway crest to its pre-1985 elevation 180 ft, thereby increasing the storage capacity of the lake by 120 acre-ft. The added storage capacity could potentially increase the long-term average lake yield by up to 107 acre-ft per year and up to 50 acre-ft per year during shortage years for supply to the MMWD system. Accordingly, water supply operations require operating the lake at el. 180 ft for extended periods, particularly during the dry season.

Design Criteria and Other Design Considerations:
Water supply operations require modification the spillway. The spillway crest needs to be raised from current elevation 174 ft to its pre-1985 elevation, 180 ft. Accordingly, the Water Supply Project has just one element that addresses this single need: (1) pneumatic spillway gate.

Design Description:
The spillway gate element consists of installing a gate within the 14-ft wide by 6-ft high "notch" of the existing concrete spillway. The spillway gate will be an Obermeyer or similar type of pneumatically-operated spillway gate which can be raised and lowered over a range of levels. Obermeyer gates operate by inflating/deflating "bladders" placed beneath spillway panels. The spillway gate will raise the spillway crest by six feet and thereby enable capture and active storage of up to an additional 120 acre-feet of runoff from the MMWD watershed. The added active storage capacity will increase the long term average annual yield of the lake by 107 acre-feet per year and during shortage years by about 50 acre-feet per year for municipal supply to MMWD. In addition, a new piping system from Phoenix Lake to Bon Tempe Lake will be installed to create completely separate potable and lake water transfer systems to more flexibly utilize the increased yield of Phoenix Lake water (the attached MMWD Memorandum dated March 17, 2011).

Design Drawing(s):
- Figure 1: Project Layout
- Figure 2: Spillway Gate Detail

Engineers Cost Estimate:

Total Construction Cost = $262,000

Water Supply Project - Construction Cost Estimation

Item	Description	Quantity	Unit	Unit Price	Total Cost
General Requirements:					**$ 20,000**
01	Mobilization	1	LS	$ 15,000	$ 15,000
02	Clearing and Grubbing	1	LS	$ 5,000	$ 5,000
Spillway Gate:					**$ 160,000**
03	Obermeyer Spillway Gate (14' wide × 6' high)	1	LS	$ 60,000	$ 60,000
04	Spillway Gate Installation	1	LS	$ 50,000	$ 50,000
05	Spillway Gate Control System	1	LS	$ 20,000	$ 20,000
06	Control System Building	1	LS	$ 30,000	$ 30,000
Phoenix Lake to Bon Tempe Lake Transfer Piping:					**$ 82,000**
07	Move Floating Barge Pump Station	400	FT	$ 100	$ 40,000
08	Material, Labor, and Fabrication	1	LS	$ 37,000	$ 37,000
09	Flow Meter	1	LS	$5,000	$ 5,000
				Total Construction	**$ 262,000**

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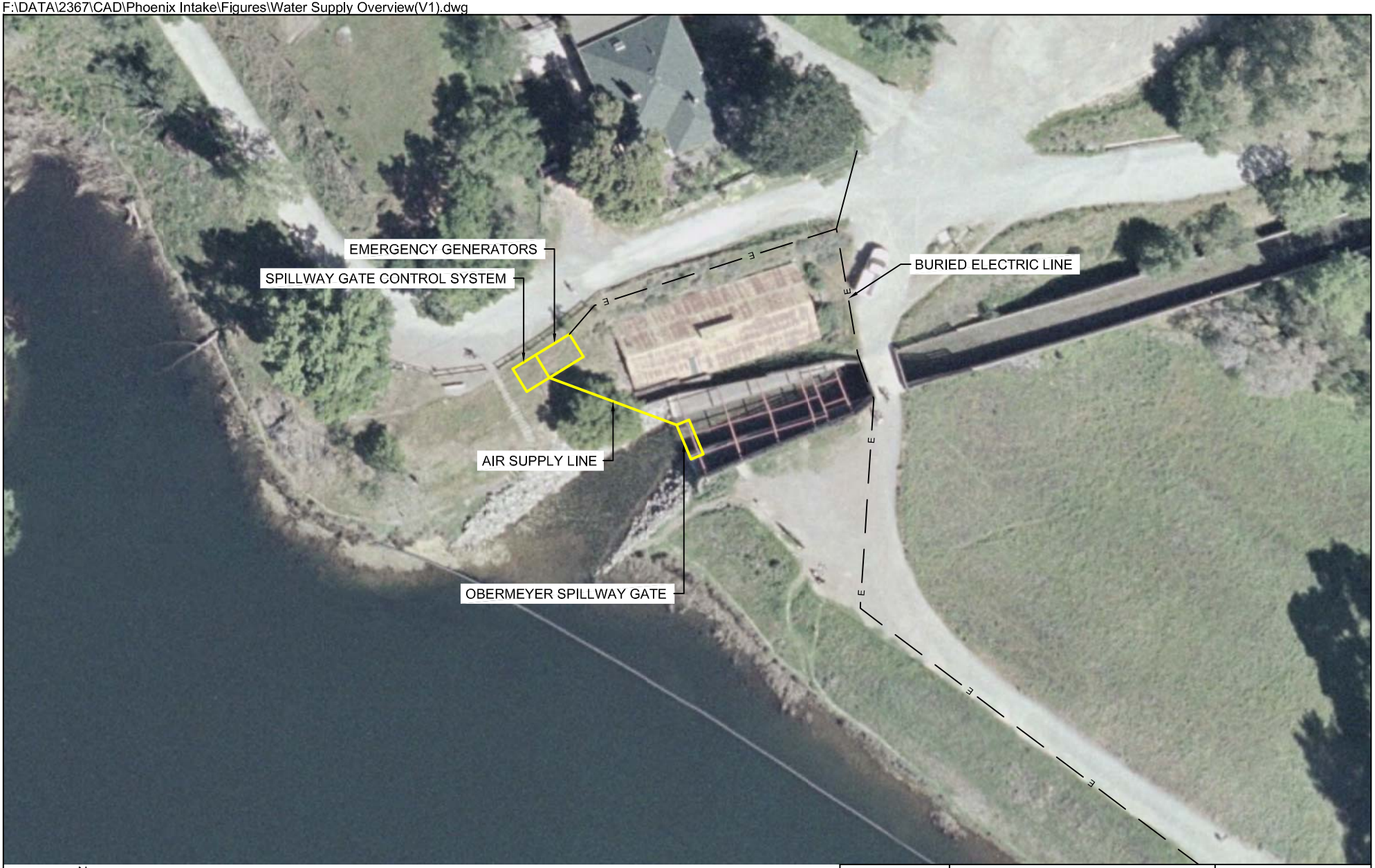

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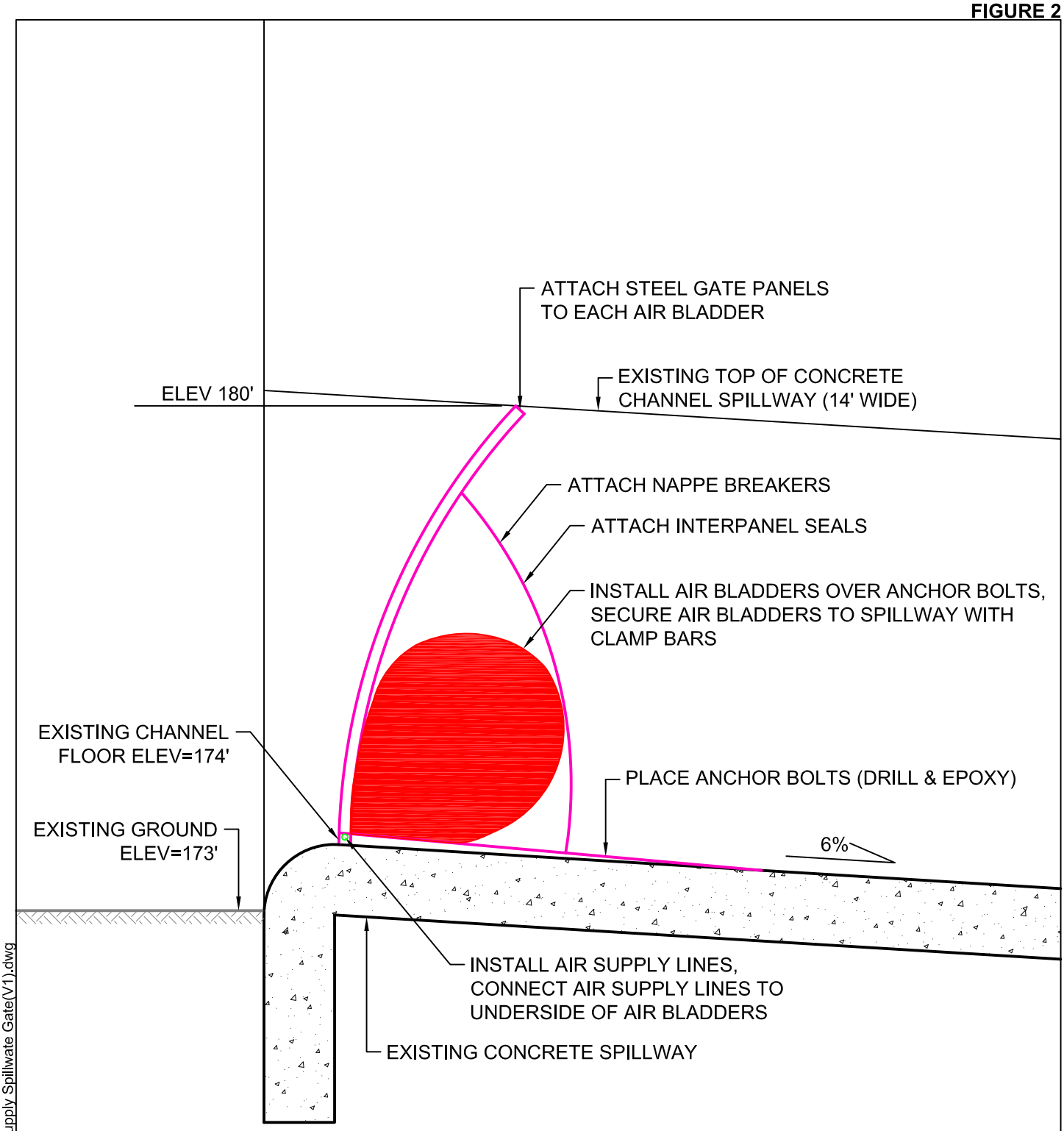
DATE: MARCH 23, 2011

JN: 2367

WATER SUPPLY
PHOENIX LAKE

FIGURE 1

FIGURE 2



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DATE: MARCH 24, 2011 | JN: 2367

WATER SUPPLY SPILLWAY GATE DETAIL

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3.3 Water Quality Project

3.3.1 Project Assessment and Evaluation Memorandum

Project Name:
Water Quality Project

Project Element(s):
Epilimnetic Circulation Device; Hypolimnetic Circulation Device; Monitoring System

Project Purpose and Need:

There is a need to improve the water quality of Phoenix Lake. The lake is afflicted with floating algae blooms, particularly during summertime, which can reduce lake clarity and contribute to taste and odor problems. Low dissolved oxygen in the lake hypolimnion reduces suitable cold freshwater habitat and creates a potential for dissolution of sediment-bound metals. These water quality problems can impair the beneficial uses of the lake. To address these water quality issues, Phoenix Lake IRWM Retrofit includes installation of a "Solar Bee ©" epilimnetic circulation device and a hypolimnetic circulation device or similar type of circulation devices. The eplimnetic circulation device aims to reduce the growth of floating algae, thereby improving the water quality, lake clarity, and reducing treatment costs during the summertime when lake supply is most needed for drinking water supply. The hypolimnetic circulation device aims to oxygenate the hypolimnion and prevent dissolution of sediment-bound metals.

Summary of Completed Work, Existing Data and Studies:

	Description	Reference	Purpose
Completed Work	Concept (30%) designs of all facility elements of the Water Quality Project	Project Concept (30%) Design Memorandum	• Investigate the engineering feasibility of the water quality project. • Design project layout; size project facilities/components. • Provide design information for estimating construction costs.
Existing Data	Lake Water Quality Data	Stetson in-house database	• Observed lake water quality data (algae, dissolved oxygen, and water temperature) were used to identify water quality issues of the lake. • Observed thermal structure data were used to determine the feasibility and deployment of epilimnetic and hypolimnetic circulation devices.
	Lake Bathymetry Data	Stetson in-house database	• Surveyed bathymetric data of Phoenix Lake were used to provide information (volume, area, depth) for the deployment of epilimnetic and hypolimnetic circulation devices.
Existing Studies	1) Water Temperature/ Water Quality Issues in Phoenix Lake and Recommended Solutions for Improving Water Quality and Cold Freshwater Habitat	Appendix 6	• To identify water quality issues in Phoenix Lake and recommend solutions.
	2) Evaluation of Applying SolarBee Circulation Devices in Phoenix Lake	Appendix 7	• To evaluate the feasibility of applying SolarBee circulation devices in Phoenix Lake

Finding(s):

1) Phoenix Lake has a strong stratification during summertime with low dissolved oxygen in the hypolimnion. The euphotic zone (i.e., epilimnion) of Phoenix Lake is about 15-20 ft in depth.

2) The lake is afflicted with floating algae blooms, particularly during summertime.

3) It is feasible to improve the lake water quality by deploying two Solarbee© circulation devices, one in the epilimnion to prevent algae blooms and another in the hypolimnion to increase dissolved oxygen.

3.3.2 Project Concept (30%) Design Memorandum

Project Name:
Water Quality Project

Project Element(s):
Epilimnetic Circulation Device; Hypolimnetic Circulation Device; Monitoring System

Design Objective:
The objective of the Water Quality Project is to improve the quality of water in Phoenix Lake for municipal water supply and public recreation. The lake experiences floating algae blooms, particularly during summertime. This reduces water clarity and the overall aesthetic appeal of the lake to fishermen and other recreationalists who visit the lake. Algae also affect the filtration process and increase MMWD's treatment costs at its Bon Tempe Treatment Plant. Algae, particularly blue-green algae, can create taste and odor problems in the treated drinking water. Low dissolved oxygen in the lake hypolimnion creates a potential for dissolution of sediment-bound metals.

Design Criteria and Other Design Considerations:
Design of the Water Quality Project needs to meet the following requirements:

- Prevent algae blooms in the epilimnion;
- Increase dissolved oxygen in the hypolimnion; and,
- Have little effects on the lake's thermal structure (i.e., stratification).

Design Description:
The Water Quality Project has two elements that address the water quality issues in the lake: (1) epilimnetic circulation device and (2) hypolimnetic circulation device. The two circulation devices are self-contained, independently powered by solar power, and automated. The two devices will be carefully designed so that little effects on the lake's thermal structure will be created. The devices will be furnished and installed by the manufacturer.

The eplimnetic circulation device is designed to reduce the growth of floating algae and thereby improve water quality, lake clarity, and reduce treatment costs, particularly during the summertime when lake supply is most needed. The hypolimnetic circulation device aims to oxygenate the hypolimnion and prevent dissolution of sediment-bound metals. Higher oxygen concentrations in the hypolimnion will enlarge the pool in the lake that is suitable for coldwater fish, including trout. This is expected to improve the lake's trout fishery.

Design Drawing(s):

- Figure 1: Project Layout
- Figure 2: Typical Tethering System

Engineers Cost Estimate:
Total Construction Cost = $123,000

Water Quality Project - Construction Cost Estimation

Item	Description	Quantity	Unit	Unit Price	Total Cost
General Requirements:					**$ 5,000**
01	Mobilization	1	LS	$ 5,000	$ 5,000
Epilimnetic Circulation Device:					**$ 53,000**
02	SB10000 v18 with 10 Feet of Hose	1	LS	$ 45,000	$ 45,000
03	Factory Delivery, Installation and Startup	1	LS	$ 8,000	$ 8,000
Hypolimnetic Circulation Device:					**$ 55,000**
04	SB7500 v18 with 50 Feet of Hose	1	LS	$ 47,000	$ 47,000
05	Factory Delivery, Installation and Startup	1	LS	$ 8,000	$ 8,000
Monitoring System:					**$ 10,000**
06	Monitoring System	1	LS	$ 10,000	$ 10,000
				Total Construction	**$ 123,000**

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DATE: MARCH 23, 2011

JN: 2367

WATER QUALITY
PHOENIX LAKE

FIGURE 1

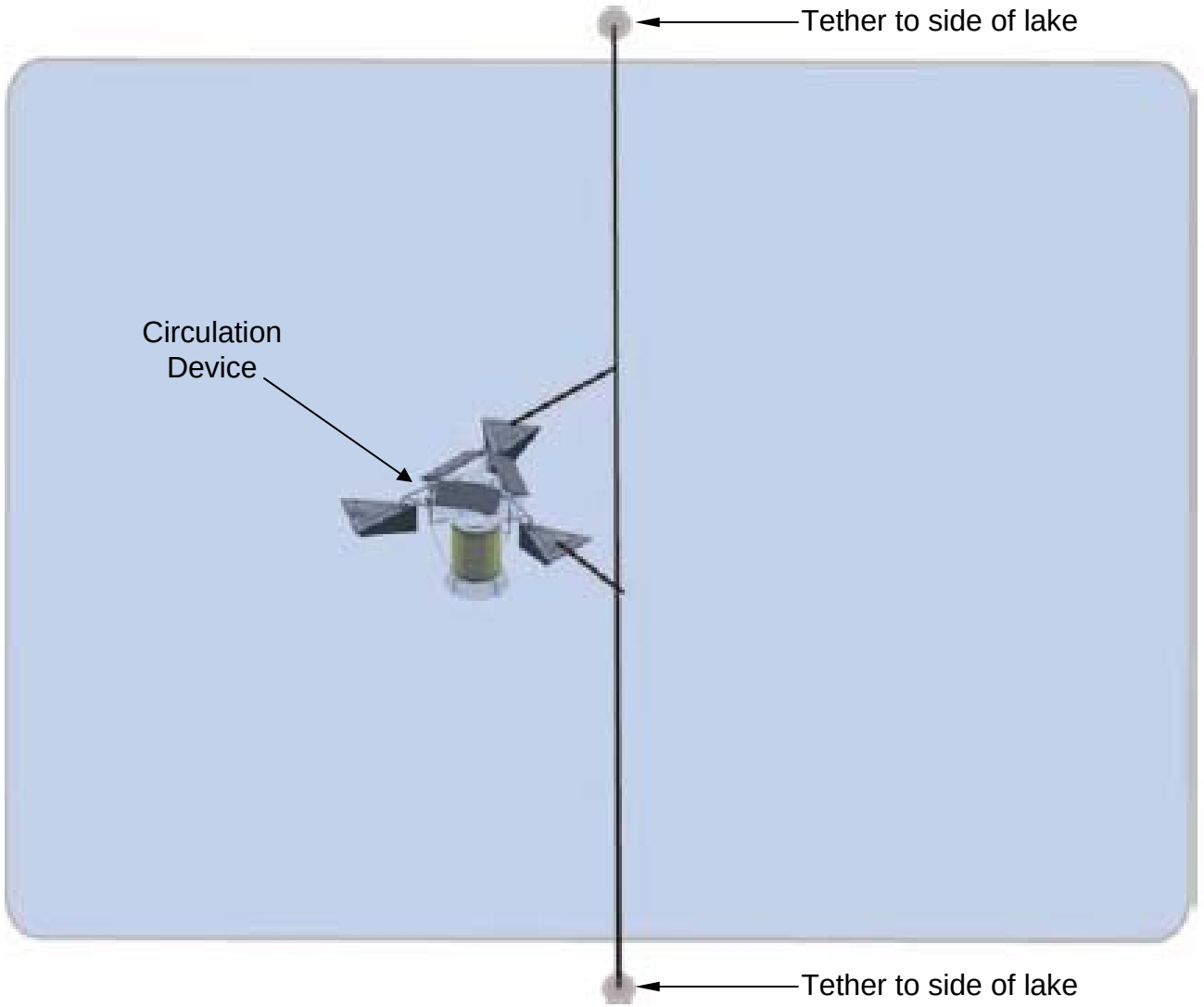

Figure 2 Installation of Circulation Device in Phoenix Lake Through Typical Tethering System

3.4 Ecosystem Restoration Project

3.4.1 Project Assessment and Evaluation Memorandum

Project Name:
Ecosystem Restoration Project

Project Element(s):
Low-Level Drain Pipe Intake Control Valve; Discharge Water Quality Improvements; Monitoring System

Project Purpose and Need:

There is a need to restore the ecological health and function of Corte Madera Creek and its tributaries. The creek provides important habitat for threatened and endangered species and is considered an "anchor stream" in the NMFS recovery plans for coho salmon and steelhead trout. Although overall ecosystem functions of the creek are still essentially intact, the freshwater aquatic and creek riparian habitats have been reduced and degraded by human activities and the ongoing presence of development. By the late 1800s, cattle grazing, deforestation, and dredging for navigation began directly modifying creek corridors and increasing the severity of rainfall and sediment-laden runoff. Railroad prisms, bridges, and other permanent infrastructure were installed flanking and spanning the creeks, often creating grade breaks or otherwise altering the creek bed making it difficult for native fish to pass through. In the 1900s, encroachment by urban development gradually filled in along the edges of the creek corridors eliminating portions of the riparian canopy and natural creek bank vegetation and encouraging invasion by non-native vegetation. With construction of Phoenix Lake in 1906, baseflow water temperatures in Ross Creek and farther downstream were warmed as historical seepage of cool groundwater into upper tributaries above Ross Creek was replaced by spillway overflow from the warmer (and lighter) upper layer of the newly formed Phoenix Lake. In addition, concentrations of iron and manganese that are unsuitable for fish have been detected in discharge from the Phoenix Lake low-level outlet pipe in Ross Creek just downstream of the dam. All of these factors have contributed to today's sub-optimal aquatic and riparian habitat conditions below Phoenix Lake.

The Phoenix Lake IRWM Retrofit includes modification of the intake/outlet works of the low-level drain pipeline. This modification will enable instream flow release of cooler water from the lake hypolimnion and improve downstream water quality and aquatic habitat for target salmonids and other coldwater species. It also includes a liner and grout curtain on the downstream side of the dam to reduce or eliminate seepage through/beneath the dam. In conjunction with an aeration device (bubbler) installed at the low-level drain discharge vault, these features will reduce iron and manganese concentrations in discharge to Ross Creek and function to improve discharge water quality thereby improving downstream aquatic habitat. Without the Phoenix Lake

IRWM Retrofit, recovery of target salmonids and other species will continue to be challenged by sub-optimal riparian and aquatic habitat conditions.

Summary of Completed Work, Existing Data and Studies:

	Description	Reference	Purpose
Completed Work	Concept (30%) designs of all facility elements of the Ecosystem Restoration Project	Project Concept (30%) Design Memorandum	• Investigate the engineering feasibility of the water quality project. • Design project layout; size project facilities/components. • Provide design information for estimating construction costs.
Existing Data	Ross Creek Water Temperature and Dissolved Oxygen Data	Stetson in-house database	• Observed stream water temperature and dissolved oxygen data were used to identify water quality issues of the creek.
Existing Studies	1) Water Temperature/ Water Quality Issues in Ross Creek below the Dam and Recommended Solutions for Improving Water Quality and Cold Freshwater Habitat	Appendix 8	• To identify water quality issues in Ross Creek and recommend solutions.
	2) Water Temperature Report by Friends of Corte Madera Creek Watershed	Appendix 9	• Assess water temperature in Ross Creek below the dam and the influence of Phoenix Lake on stream temperature.
	3) Iron and Manganese Report by Friends of Corte Madera Creek Watershed	Appendix 10	• Assess iron and manganese concentrations in Phoenix Lake outlet pipe discharge and in Ross Creek below the dam.

Finding(s):

1. The water temperatures in Ross Creek below the dam and farther downstream in Corte Madera Creek could be improved to better support steelhead habitat if the water is released from the hypolimnion of Phoenix Lake, instead of from the spillway overflow.
2. Water released from the hypolimnion of Phoenix Lake may have a low dissolved oxygen concentration and high concentrations of soluble iron and manganese. Dissolved oxygen concentration could be increased and soluble iron and manganese concentrations could be reduced through installation of an aeration device at the outlet vault. Further water quality improvement will occur after aeration as natural aeration and biological process occurs in the rocky streambed.

3.4.2 Project Concept (30%) Design Memorandum

Project Name:
Ecosystem Restoration Project

Project Element(s):
Low-Level Drain Pipe Intake Control Valves; Discharge Water Quality Improvements; Monitoring System

Design Objective:
The objective of the Ecosystem Restoration Project is to improve aquatic habitat conditions below the dam in Ross Creek and lower Corte Madera Creek by cooling water temperatures and reducing concentrations of soluble iron and manganese in these creeks during the dry season.

Design Criteria and Other Design Considerations:
The Ecosystem Restoration Project has three elements: (1) low-level drain pipe intake low-flow control gates; (2) aeration of water at the outlet discharge vault; and (3) seepage control through installation of a liner and grout curtain along the upstream face of the dam. Cooling of water temperatures requires augmenting the design of the Flood Damage Reduction Project's low-level drain pipeline intake to allow precisely controlled blending of a low flow release from the 140 ft and 160 ft level intakes. Aeration of water at the discharge requires installation of an aeration vault adjacent to the existing low-level outlet discharge vault. Seepage control requires installation of a synthetic liner on the downstream side of the dam and a grout along the downstream toe extending down into bedrock.

Design Description:
The low-level drain pipe intake low-flow control gate element consists of installing additional gates on the 140 ft. and 160 ft. level intakes. The gates will be a small sliding gates (6") which can be adjusted over a range of levels to allow for precise control and blending of low flow releases (from the 140 ft and 160 ft intakes) to Ross Creek over a range of low, summer baseflows; preliminarily estimated to be 1 to 5 cfs. The gates will be electric motor controlled. Release flow will be measured at the outlet of the low-level drain pipe where it overflows from a concrete vault. Water level sensor and water temperature sensors will be place in the bottom of the vault and a v-notch weir will be cut into one of the vault sides. A water level discharge rating curve will be developed and a recorder installed nearby to enable continuous measurement and recording of low-flow discharges and temperatures. Water will be blended to optimize downstream temperatures while preserving the thermal structure of the lake. Instream flow release of cooler water from the lake hypolimnion (140 ft intake) blended with water from a higher level (160 ft intake) will improve downstream water quality and aquatic habitat for target salmonids and other coldwater species.

The aeration system element consists of a concrete aeration vault installed adjoining the existing vault at the low-level pipe outlet. Overflow from the outlet vault will enter the

aeration vault where the water will aerated by air diffusers placed just above the vault bottom. The diffusers will be fed by air produced and conveyed by pipeline from an air compressor located at the rubber dam equipment house. Aerated water will overflow from the aeration vault and flow into a discharge channel leading to Ross Creek. The aeration process will reduce concentrations of soluble iron and manganese and thereby improve downstream water quality and aquatic habitat for target salmonids and other coldwater species.

The seepage reduction system consists of a synthetic liner embedded into the downstream side of the dam. A grout curtain would be installed along the downstream toe of the dam extending down into bedrock. The liner and grout curtain will reduce seepage through and beneath the dam. The seepage reduction system will function to reduce or eliminate uncontrolled discharge of water containing low dissolved oxygen and high concentrations of iron and manganese and thereby improve downstream water quality and aquatic habitat for target salmonids and other coldwater species.

Design Drawing(s):

- Figure 1: Project Layout
- Figure 2: Low-Level Drain Pipe Control Valve
- Figure 3a: Plan View of Aeration Chamber/ System
- Figure 3b: Cross Section of Aeration Chamber/ System

Engineers Cost Estimate:

Total Construction Cost = $1,872,000

Ecosystem Restoration Project - Construction Cost Estimation

Item	Description	Quantity	Unit	Unit Price	Total Cost
General Requirements:					**$ 47,000**
01	Mobilization	1	LS	$ 42,000	$ 42,000
02	Clearing and Grubbing	1	LS	$ 5,000	$ 5,000
Low-Level Drain Pipe Intake Control Valve:					**$ 14,000**
03	6" Gate	2	Each	$ 2,000	$ 4,000
04	Hydraulic Control System	1	LS	$ 10,000	$ 10,000
Liner/Grout Curtain:					**$ 1,585,500**
05	Construct Grout Curtain Under Dam Foundation	12,500	LF	$ 80	$ 1,000,000
06	Place and Install Drainage Blanket	5,180	CY	$ 100	$ 518,000
07	Install Synthetic Liners	45,000	FT^2	$ 1.5	$ 67,500
Aeration Chamber/System:					**$ 120,000**
08	Aeration Chamber/System	1	LS	$ 120,000	$ 120,000
Monitoring System:					**$ 105,000**
09	Monitoring System	1	LS	$ 100,000	$ 100,000
10	V-notch Weir Cut Into One of the Concrete Vault Sides	1	LS	$ 5,000	$ 5,000
				Total Construction	**$ 1,872,000**

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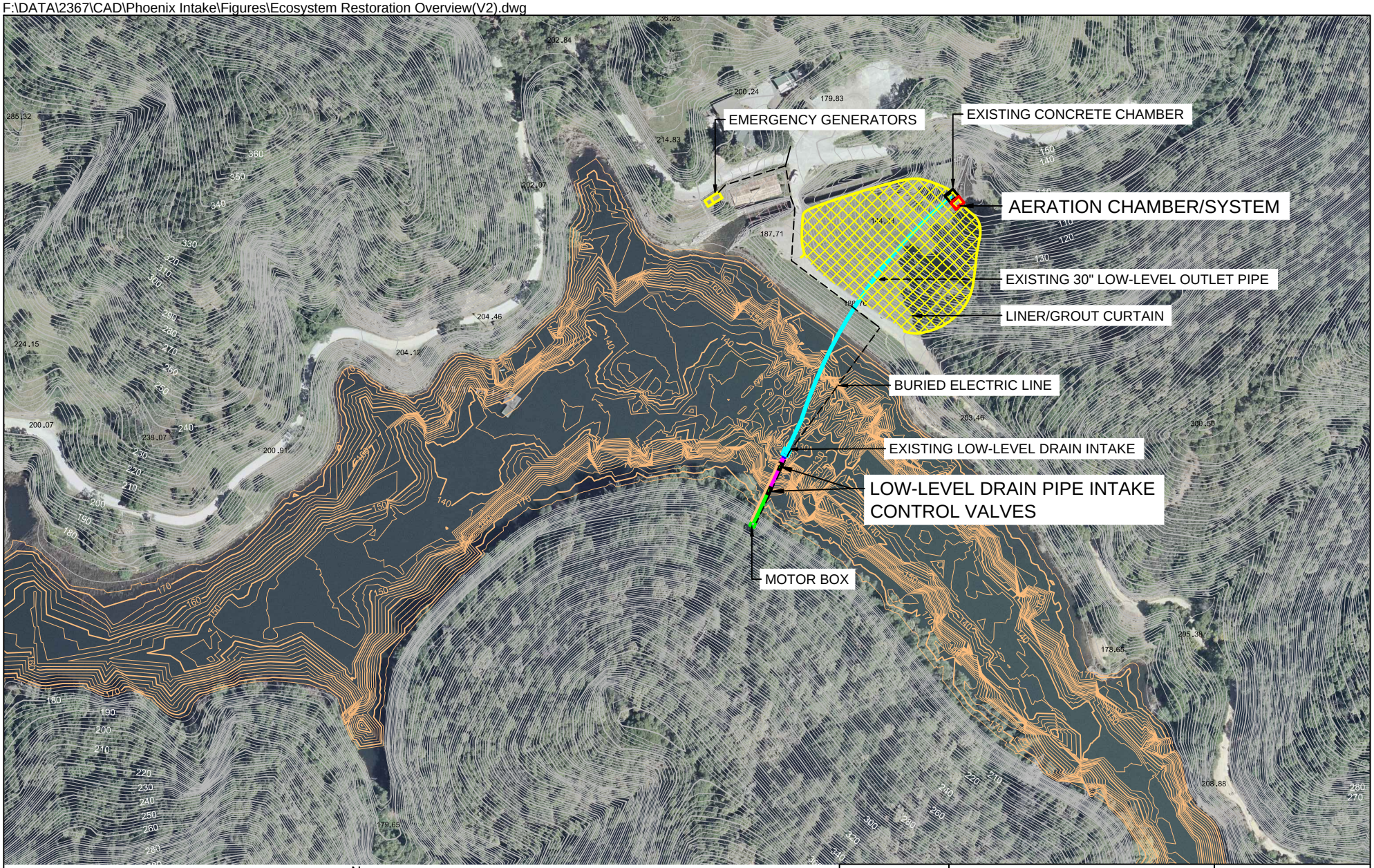

LEGEND

- CONTOUR LINES (2 FOOT INTERVAL)
- BATHYMETRIC CONTOUR LINES (2 FOOT INTERVAL)
- 179.16 SPOT ELEVATION

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Notes:

1. This drawing is in California State Plane NAD 83, zone 3 and vertical datum NGVD 29.
2. Bathymetry data points source is XYZ file data received from Environmental Data Solutions in November 2009.
3. 2' Interval Contourlines and Spot Elevations are based on the 2004 aerial survey contour data received from Marin County.

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ECOSYSTEM RESTORATION PHOENIX LAKE

FIGURE 1

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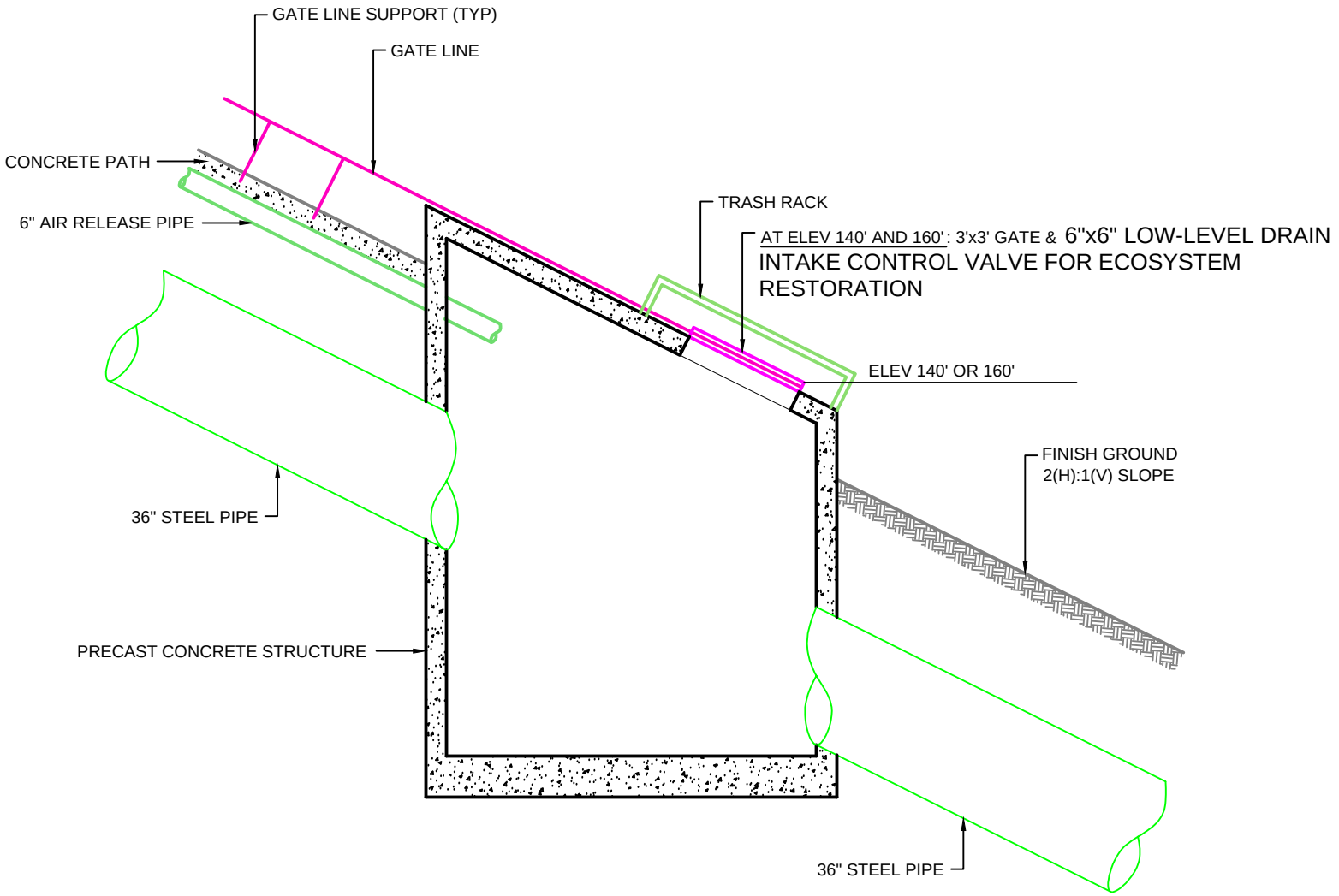

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ECOSYSTEM RESTORATION LOW-LEVEL DRAIN INTAKE CONTROL VALVE

FIGURE 2

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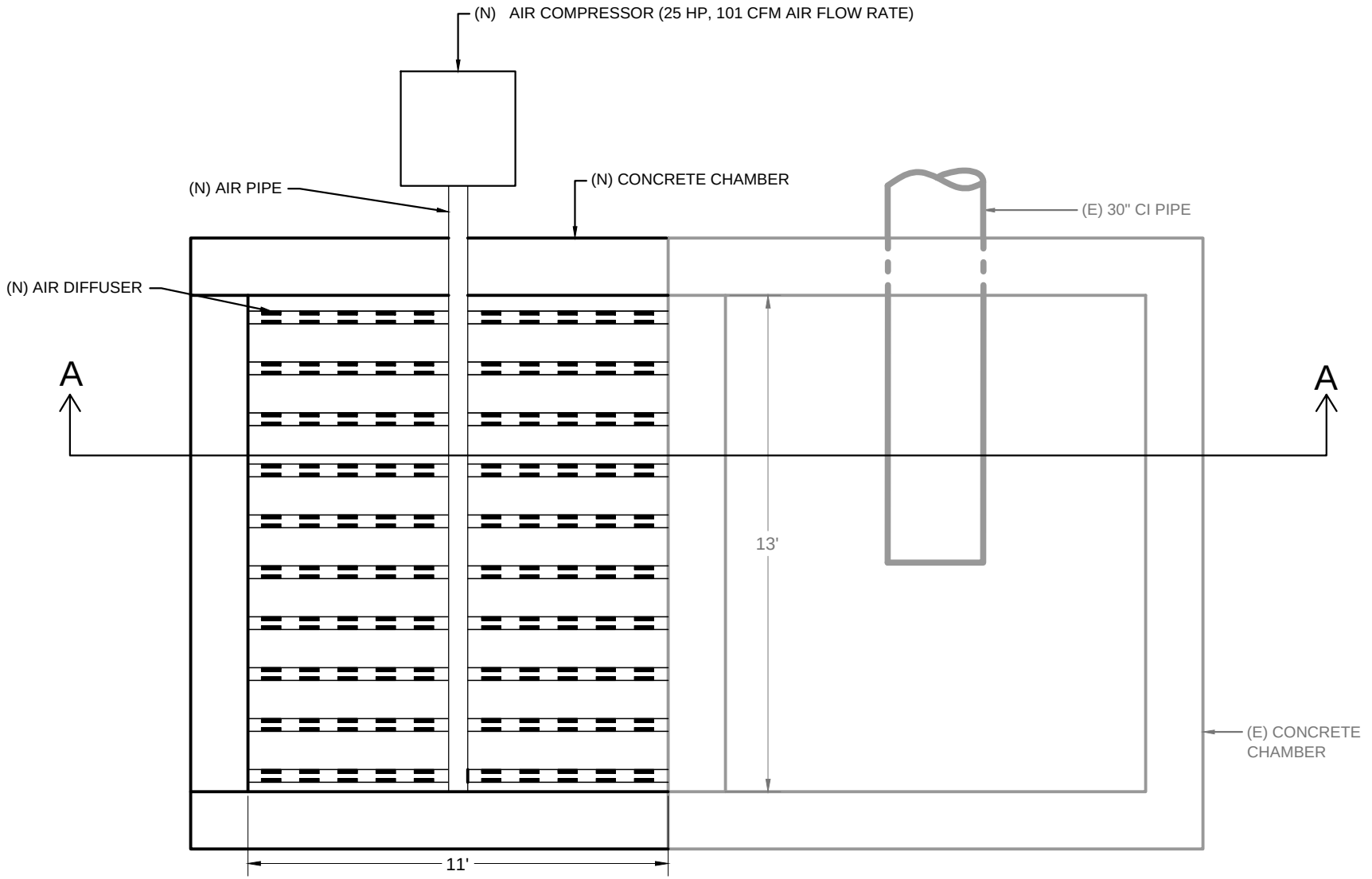

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AERATION CHAMBER/ SYSTEM (PLAN VIEW)

FIGURE 3a

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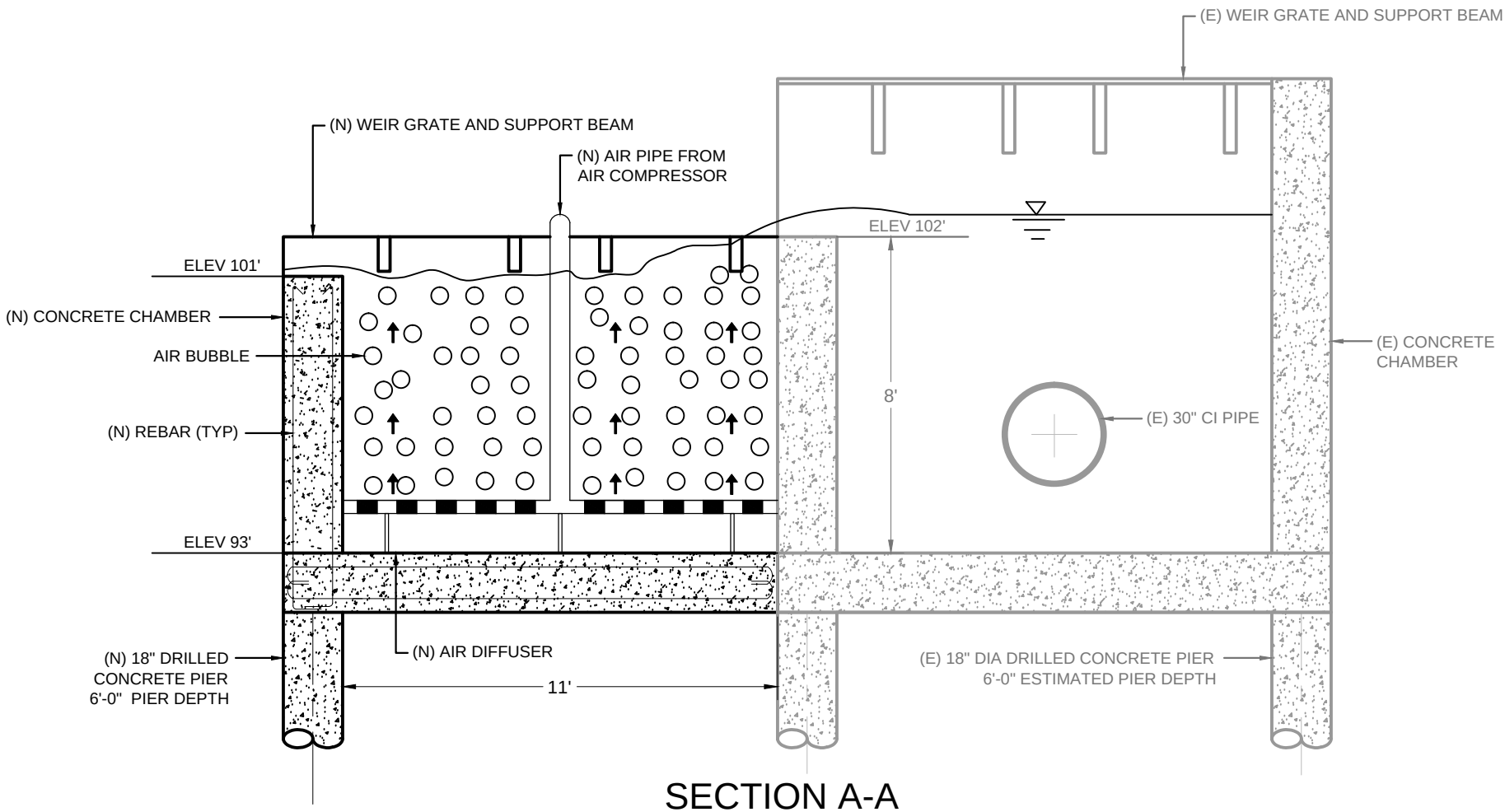

SECTION A-A

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AERATION CHAMBER/SYSTEM (CROSS SECTION)

FIGURE 3b

3.5 Recreation and Public Access Project

3.5.1 Project Assessment and Evaluation Memorandum

Project Name:
Recreation and Public Access Project

Project Element(s):
Bill Williams Creek Culvert Replacement; Phoenix Lake Watershed Trail Improvements; Visitor Use Facility Upgrades; Road-Related Sediment Reduction Projects

Project Purpose and Need:

There is a need to enhance opportunities for public enjoyment of the lake. Phoenix Lake and its associated trails and watershed land provide fishing, hiking, mountain biking, and other enjoyment opportunities to the public. MMWD records show that Phoenix Lake is one of its most heavily used recreational areas in the MMWD Watershed. Improvements to these trails are needed to keep up with the growing demand and maintain adequate access and safe conditions. Reduction in lake sedimentation is also needed. Comparison of the original lake bathymetric contours with recent contours surveyed in 2009 indicates that the lake has lost about 100 acre-feet to sedimentation, or about 25% of its original storage capacity, since 1906. The Phoenix Lake IRWM Retrofit will implement necessary improvements to roads and trails, as well as culverts where these features cross over tributary drainages of Phoenix Lake. These improvements will aim to enhance public access, safety, and reduce erosion and the delivery of sediment to lake. Without the Phoenix Lake IRWM Retrofit, lake sedimentation will continue at historical rates and opportunities for public enjoyment of the lake will remain at current levels.

1) Bill Williams Creek Arch Culvert Replacement - Bill Williams Creek is a major class 1 tributary to Ross Creek upstream of Phoenix Lake Dam. The Bill Williams Creek Arch Culvert Project will remove a fish passage barrier on this class 1 stream, prevent future erosion and sediment delivery at a failing stream crossing, and improve emergency and public access by replacing a non-functioning culverted stream crossing with a multi-plate arch culvert.

Currently, a non-functioning, 80% plugged, double-culvert crossing on Bill Williams Road prohibits the migration of fish and other aquatic species in Bill Williams Creek. A 2003 assessment of this stream crossing found that due to its extremely diminished capacity, it had a high likelihood to fail catastrophically during a large magnitude storm event. It was estimated that such a failure would deliver approximately 485 cubic yards of sediment to Bill Williams Creek.

By removing and replacing the current crossing with a multi-plate arch culvert designed to pass the 100 year flood, the possibility of future erosion and sediment delivery at the site will be addressed, emergency and visitor access will be improved, and fish and other aquatic species will be able to pass freely up and downstream.

2) **Phoenix Lake Watershed Trail Improvements** - The Marin Municipal Water District (MMWD) recognizes several miles of trails in the Phoenix Lake watershed for public use and enjoyment. Many of these trails date to the 1930's and are in need of restoration to reduce erosion, improve public safety, and lessen trail impacts on the natural environment. Approximately 4.11 miles of trails in the watershed have been identified by MMWD as requiring attention. Work along these reaches of trail include improving drainage to reduce erosion, trail re-routing to avoid problem and/or sensitive habitat areas, constructing or rebuilding minor structures, such as crib walls, puncheons, and bridges, and installing trail signage to improve user safety and enjoyment.

3) **Visitor Use Facility Upgrades** - The Phoenix Lake area provides multiple recreational benefits to the citizens of Marin County and the Bay Area, including hiking, cycling, horseback riding, bird watching, and fishing. However, the infrastructure to support visitor use in the immediate area surrounding Phoenix Lake is in need of upgrading to meet the growing population of visitors that enjoy the watershed. The purpose of the Phoenix Lake Public Use Facility Upgrades is to provide visitors with clean bathrooms, park benches, and information kiosks to enhance the user experience. This project is needed to lessen the impacts on the surrounding environment, and to educate the public of the importance to respect the watershed while at the same time enjoying its recreational opportunities.

4) **Road-Related Sediment Reduction Projects** – MMWD manages tens of miles of unpaved service and fire protection roads in the Phoenix Lake watershed. These roads are necessary for carrying out maintenance and repairs to the MMWD's water supply infrastructure, providing emergency access for fire, law enforcement and medical personnel, and providing the public with hiking, biking and other recreational opportunities. While unpaved road networks provide multiple benefits, if they are not properly constructed and maintained, they can lead to increased erosion and sediment delivery to streams and lakes, aquatic and terrestrial habitat degradation, and user safety concerns. Storm proofing roads is a proven method used to address all of these potential issues and is widely used by the US Forest Service, National Park Service, California State Parks, the California Department of Fish and Game, and other large public and private land managing agencies to minimize the impact of roads on the environment and improve watershed function.

   Storm proofing includes upgrade and decommissioning treatments, as well as site specific and contributing road length treatments. Site specific treatments focus on treating the point of sediment generation and delivery, such as replacing a currently undersized stream crossing culvert to prevent stream crossing failure, or removing unstable fill along the outer edge of a road that may potentially catastrophically erode into a stream. Contributing road length treatments focus on reducing chronic sediment generation and delivery from the road surfaces. The target of theses treatments is to produce the smallest flow length possible for any road-borne runoff. By reducing the runoff length through upgrade treatments like road outsloping, installing ditch relief

culverts and rolling dips, and through decommissioning treatments, such as total recontouring, installing crossroad drains, and in-place outsloping, surface runoff generated on, or intercepted by the road is quickly conveyed from the road prism to the natural hillslope. These treatments are designed to create the smallest drainage area and produce the shortest contact time of surface runoff with the road, thus limiting the amount of potential hydraulic energy that can be generated at each road drainage structure, and producing the least hydrologic impact to the watershed. Through such treatments, sediment generation is minimized, and the delivery of surface flows and entrained sediments transported from the road to identified sediment delivery sites is effectively reduced.

An assessment of Bill Williams Road and Filter Plant/Lower Eldridge Grade Road revealed that 23 identified sediment delivery sites would deliver over 5,300 cubic yards of sediment to Phoenix Lake and its tributaries. Sediment reduction through storm proofing techniques are needed on these roads to reduce erosion, protect terrestrial and aquatic habitats, ensure that access is maintained and that conditions are safe for public use and enjoyment.

Summary of Completed Work, Existing Data and Studies:

	Description	Reference	Purpose
Completed Work	Assessment, conceptual (30%) design and project planning for trail improvements, road related sediment reduction, and visitor use facilities	Project Concept (30%) Design Memorandum	• Assess road and trail-related environmental degradation • Evaluate erosion and sedimentation impacts from roads and trails • Design project layout and size project facilities/components • Provide design information for estimating construction costs to improve roads and trails, and provide visitor use facilities
Existing Data	GIS and tabular databases of sediment delivery sites	Stetson in-house database	• Provide comprehensive data of every road and trail related sediment delivery site in the Phoenix Lake watershed
Existing Studies	• Summary Report, Road and Trail Inventory and Assessment, Erosion Prevention Implementation Plan, Mt. Tamalpais Watershed, Marin Municipal Water District, Marin County, California, Pacific Watershed Associates. 2003 • Mount Tamalpais Road and Trail Management Plan. Marin Municipal Water District. 2005. http://marinwater.org/controller?action=menuclick&id=249. Last accessed 04/08/2011.	MMWD Website	• To identify, quantify, and provide restoration implementation planning to address surface water quality pollution stemming from road and trail-related erosion and sediment delivery.

Finding(s):

The Phoenix Lake watershed provides visitors with multiple recreational opportunities; however the current road and trail network and visitor use facilities are in need of repair and modification to ensure that recreation impacts do not negatively affect the surrounding environment. The Bill Williams Creek culvert replacement will prevent further erosion from occurring at the site, ensure that emergency and visitor access is maintained on Bill Williams Road, and re-establish fish passage in Bill Williams Creek. Improvements to the trail network around Phoenix Lake will prevent ongoing chronic erosion from occurring on the trail surfaces, reduce sedimentation to Phoenix Lake and its tributaries, and improve visitor access and safety. Upgrading visitor use facilities will provide benches, bathrooms, and educational kiosks that will enhance the visitor experience, add an educational component, and reduce user impacts to the Phoenix Lake watershed. Finally, road-related sediment reduction projects will significantly reduce the amount of erosion and sediment generation taking place in the watershed. This will provide safe and sustainable access for visitor use, watershed maintenance and emergency access vehicles, improve water quality and aquatic habitats in Phoenix Lake and its tributaries, and reduce sedimentation and maintain lake storage capacity (flood attenuation capacity) for flood damage reduction.

3.5.2 Project Concept (30%) Design Memorandum

Project Name:
Recreation and Public Access Project

Project Element(s):
Bill Williams Creek Culvert Replacement; Phoenix Lake Watershed Trail Improvements; Visitor Use Facility Upgrades; Road-Related Sediment Reduction Projects

Design Objective:
The goal of the Recreation and Public Access Project is to improve public access and recreational opportunities, while at the same time lessening user impacts on the natural environment and improving watershed function. Phoenix Lake and its associated trails and watershed land provide fishing, hiking, mountain biking, and other enjoyment opportunities to the public. MMWD records show that Phoenix Lake is one of its most heavily used recreational areas in the MMWD Watershed. Improvements to these trails are needed to keep up with the growing demand and maintain adequate access and safe conditions. Reduction in lake sedimentation is also needed to maintain the lake storage capacity for flood damage reduction and water supply.

Design Criteria and Other Design Considerations:
- The design flood for removal and replacement of the current Bill Williams Creek culvert crossing will be the 100-year flood. The possibility of future erosion and sediment delivery at the site will need to be addressed, and improvement to emergency and visitor access will need to be considered.
- Improving Phoenix Lake watershed trails will include improving drainage to reduce erosion, trail re-routing to avoid problem and/or sensitive habitat areas, constructing or rebuilding minor structures, such as crib walls, puncheons, and bridges, and installing trail signage to improve user safety and enjoyment.

Design Description:
The designed improvements include:
- Replacing the non-functioning stream crossing on Bill Williams Creek with a multi-plate arch culvert to reduce erosion, improve access, and provide fish passage;
- Improving trail conditions around Phoenix Lake to reduce erosion and sediment delivery, and to improve access and visitor safety;
- Upgrading visitor facilities, such as bathrooms, benches, and informational kiosks around Phoenix Lake to enhance the user experience, provide public education, and lessen user impacts to the surrounding environment;
- Constructing road-related sediment reduction projects to reduce erosion and sediment impacts to Phoenix Lake and its tributaries by storm proofing watershed maintenance and emergency access roads.

Design Drawing(s):
- Figure 1: Project Layout

- Figure 2: Bill Williams Creek Culvert Replacement Typical Details

Engineers Cost Estimate:

Total construction cost = $1,085,000

Recreation and Public Access Project - Construction Cost Estimation

Item	Description	Quantity	Unit	Unit Price	Total Cost
Bill Williams Culvert Replacement:					**$ 182,800**
1.1	Mobilization/Demobilization	1	LS	$ 40,000	$ 40,000
1.2	Clearing and Grubbing	160	CY	$ 80	$ 12,800
1.3	Clearing and Grubbing	40	LF	$ 60	$ 2,400
1.4	Earth Excavation W/O Backfill	200	CY	$ 80	$ 16,000
1.5	Bedrock Excavation W/O Backfill	40	CY	$ 400	$ 16,000
1.6	Furnish Arch Culvert	30	LF	$ 500	$ 15,000
1.7	Install and Backfill	50	LF	$ 60	$ 3,000
1.8	Install and Backfill	150	CY	$ 80	$ 12,000
1.9	Structural Concrete Footing	16	CY	$ 1,000	$ 16,000
1.10	Structural Concrete Headwall and Wing	15	CY	$ 1,800	$ 27,000
1.11	Class II Aggregate Base	30	Ton	$ 120	$ 3,600
1.12	1.5(H):1(V) Slope Protection Rip Rap	60	Ton	$ 200	$ 12,000
1.13	Erosion Control and Revegetation	1	LS	$ 7,000	$ 7,000
Trail Improvements:					**$ 39,935**
2.1	Ross Trail	1	mi	$ 24,500	$ 13,965
2.2	Gertrude-Ord Trail	1	mi	$ 24,500	$ 25,970
2.3	Bill Williams Trail	0	mi	$ 24,500	$ 11,760
2.4	Tucker Trail	2	mi	$ 24,500	$ 39,445
2.5	Harry Allan Trail	0	mi	$ 24,500	$ 9,555
Visitor Use Facilities:					**$ 58,500**
3.1	Kiosks	2	Each	$ 13,000	$ 26,000
3.2	Benches	4	Each	$ 1,000	$ 4,000
3.3	Self-contained Serviceable Restroom	1	Each	$ 28,500	$ 28,500
Road-Related Sediment Control (Stormproofing):					**$ 804,190**
4.1	Outsloping	4,941	LF	$ 15	$ 74,115
4.2	Rolling Dips	13	Each	$ 2,250	$ 29,250
4.3	Earth Excavation and Backfill	4,346	CY	$ 150	$ 651,900
4.4	Road Rock	378	CY	$ 30	$ 11,340
4.5	Rock Armor	97	CY	$ 30	$ 2,910
4.6	18" Diam. Culvert	205	LF	$ 15	$ 3,075
4.7	24" Diam. Culvert	390	LF	$ 25	$ 9,750
4.8	30" Diam. Culvert	380	LF	$ 35	$ 13,300
4.9	36" Diam. Culvert	80	LF	$ 45	$ 3,600
4.10	42" Diam. Culvert	90	LF	$ 55	$ 4,950
				Total Construction	**$ 1,085,000**

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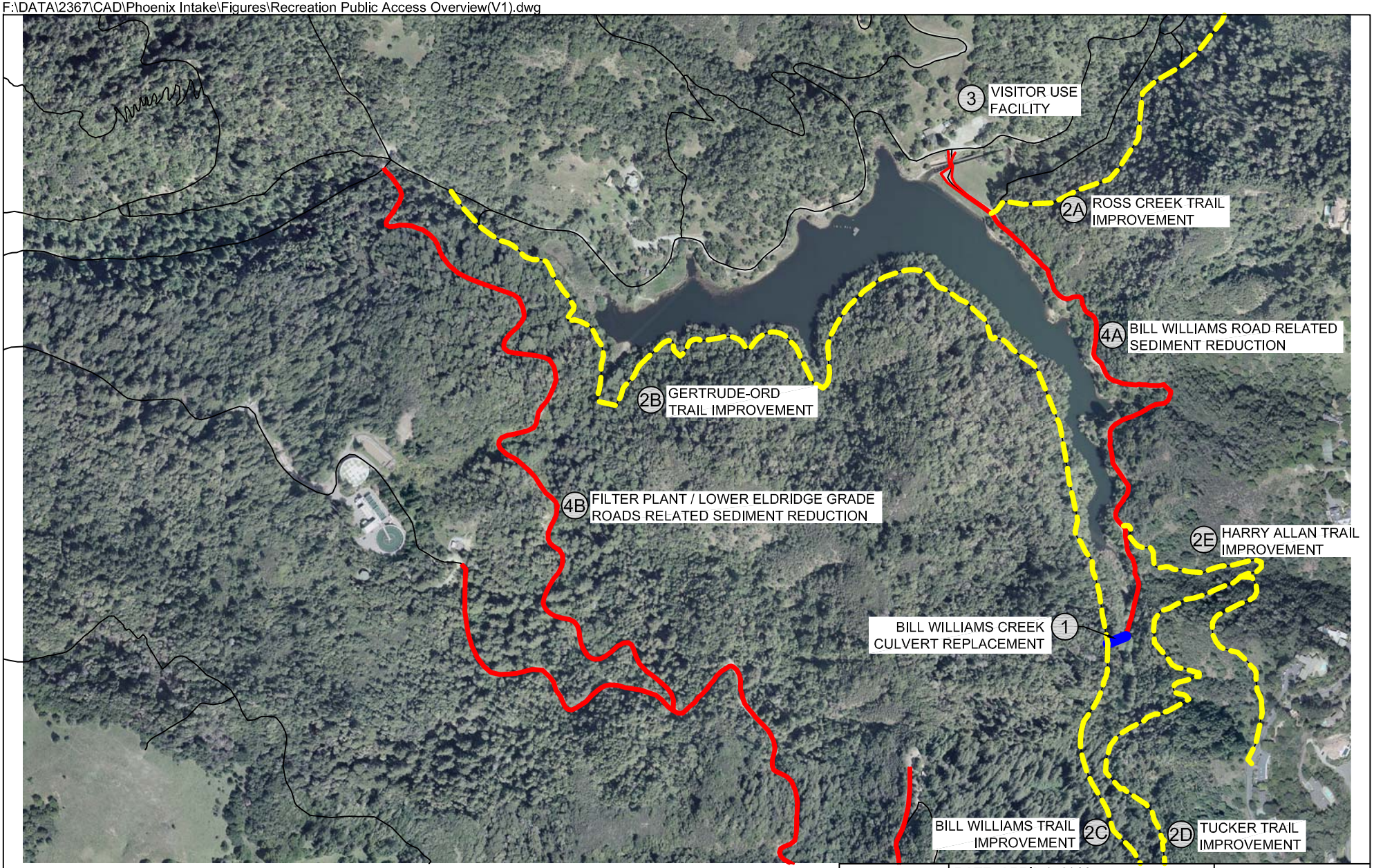

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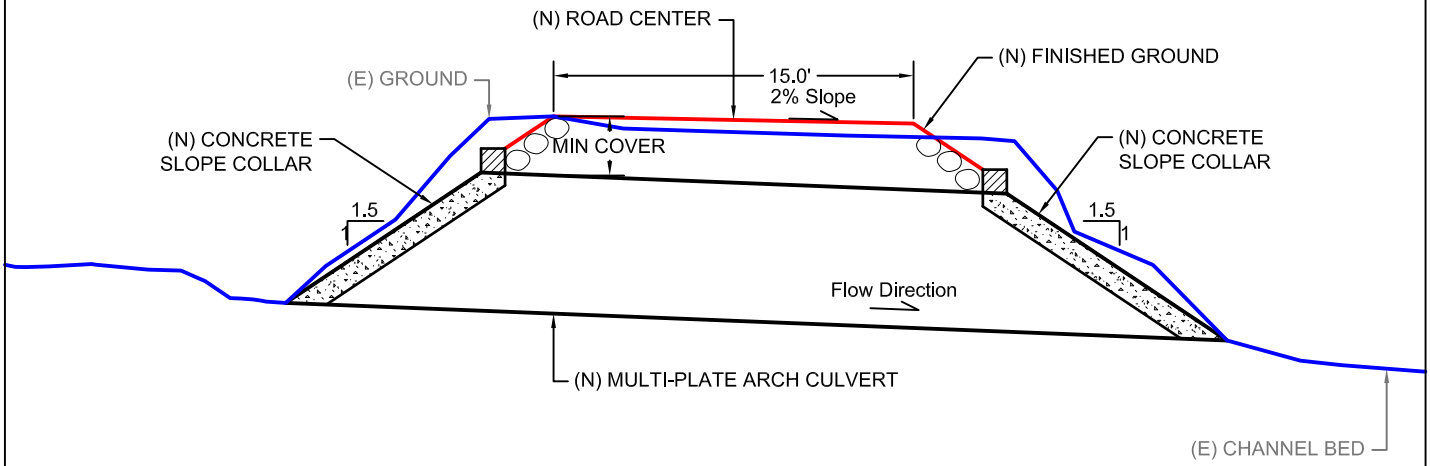
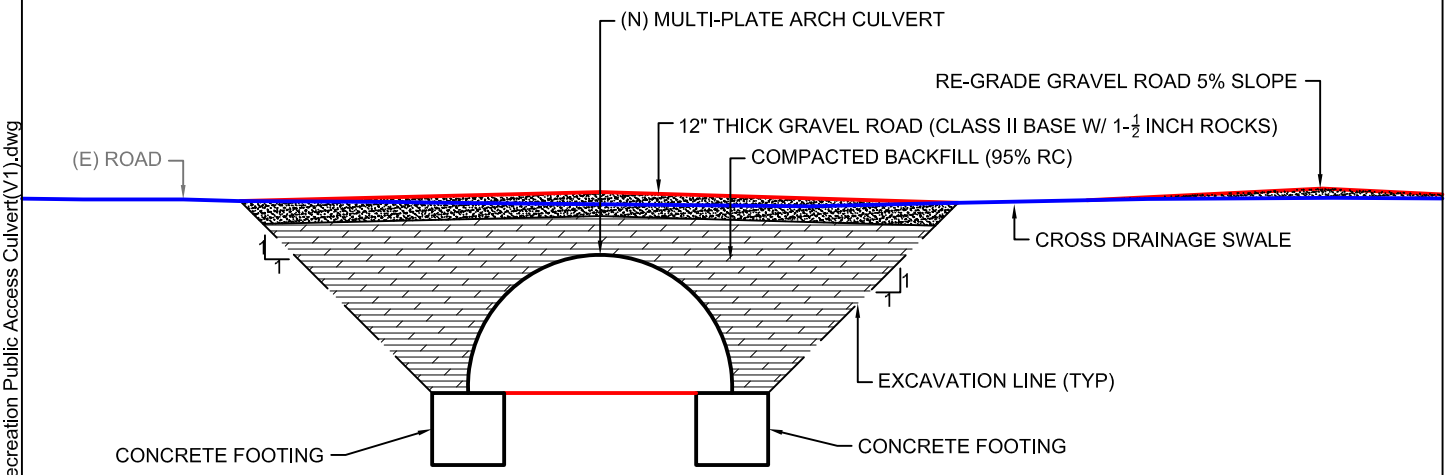
RECREATION / PUBLIC ACCESS PHOENIX LAKE

FIGURE 1

PROFILE AT CULVERT CENTERLINE



PROFILE AT ROAD CENTERLINE



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RECREATION / PUBLIC ACCESS
TYPICAL CULVERT REPLACEMENT DETAIL

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