SEARSVILLE LAKE SEDIMENT IMPACT STUDY: BIOTIC RESOURCES SYNTHESIS REPORT

Prepared by:

H. T. HARVEY & ASSOCIATES

Daniel Stephens, B.S., Principal
Patrick H. Reynolds, M.S., Project Manager
Patrick Boursier, Ph.D., Senior Plant Ecologist
Scott Terrill, Ph.D., Senior Wildlife Ecologist
Craig Benson, M.S., Restoration Ecologist
Dave Johnston, Ph.D., Wildlife Biologist
Jeff Wilkinson, Ph.D., Herpetologist
Brian Cleary, M.S., Botanist
With
Jerry Smith, Ph.D., Fisheries Biologist, San Jose State University

Prepared for:

NORTHWEST HYDRAULIC CONSULTANTS, INC.
3950 Industrial Boulevard, Suite 100 C
West Sacramento, CA 95691-3430

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1.1 PROJECT GOALS

Searsville Lake is rapidly filling with sediment due to historical and current episodes of erosion and sedimentation. The patterns of deposition in lower Corte Madera Creek and Searsville Lake, as well as the reduced flood retention capacity of the lake appears to be responsible for upstream flooding problems in the vicinity of Family Farm Road. It appears inevitable that the lake will be completely filled at some point in the near future and that localized flooding problems could worsen. Several possible solutions have been proposed, including lowering Searsville Dam by 16 feet or allowing the dam to fill naturally.

Recognizing the potential for downstream impacts in either scenario, Stanford University Facilities Operations issued a request for proposals for the Searsville Lake Sediment Impact Study. This study called for an analysis of existing conditions and a forecast of future conditions in San Francisquito Creek below Searsville Dam given no intervention, or lowering of Searsville Dam. This report provides an analysis of the potential impacts to biotic resources under each scenario on Searsville Lake was recognized and is therefore included in this report.

1.2 EXISTING CONDITIONS ANALYSIS OVERVIEW

Biotic Habitats. The dominant biotic habitat throughout the study area is Valley Foothill Riparian. Open Water habitat dominates Searsville Lake itself, with Fresh Emergent Wetland habitat sub-dominating the fringe of Searsville Lake. Saline Emergent Wetland dominates where San Francisquito Creek merges into the bay tidelands. Small pockets of other biotic habitats, including Herbaceous, Shrub, Urban, Eucalyptus, Redwood, and Coastal Oak Woodland, occur along the creek.,

Non federally-listed wildlife species (and non-breeding federally-listed species). Some special-status wildlife species may only be occasional visitors, migrants, or transients, or may only forage (rather than breed) in small numbers in the project area. These species include the Double-crested Cormorant (*Phalacrocorax auritus*), Osprey (*Pandion haliaetus*), Northern Harrier (*Circus cyaneus*), Sharp-shinned Hawk (*Accipiter striatus*), American Peregrine Falcon (*Falco peregrinus anatum*), Merlin (*Falco columbarius*), Golden Eagle (*Aquila chrysaetos*), Vaux's Swift (*Chaetura vauxi*), Sharp-shinned Hawk (*Accipiter striatus*), Tricolored Blackbird (*Agelaius tricolor*), and the Willow Flycatcher (*Empidonax traillii*).

Several special-status species may occur on the site more regularly or may breed on or very close to the project area. The western pond turtle (*Clemmys marmota*), Cooper's Hawk (Accipiter cooperi), California Yellow Warbler (*Dendroica petechia brewsteri*), Loggerhead Shrike (*Lanius ludovicianus*), White–tailed Kite (*Elanus caeruleus*), Townsend's big-eared bat (*Corynorhinus townsendii*), Pallid bat (*Antrozous pallidus*) and ringtail (*Brassariscus astutus*) are known or expected to occur and breed along the San Francisquito Creek riparian corridor and Searsville lake areas.

Invasive Aquatic Species of Concern. Several invasive aquatic species are present in San Francisquito Creek that can adversely affect California red-legged frogs (*Rana aurora draytonii*) including bullfrogs (*Rana catesbeiana*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomismacrichirus*), green sunfish (*L. cyanelus*), bullhead catfish (*Ictalurus nebulosus*), mosquitofish (*Gambusia affinis*), Louisiana red-swamp crayfish (*Procambarus clarkii*), signal crayfish, (*Pacifasticus leniusculus*) and Chinese mitten crabs (*Eriocheir sinensus*). Bullfrogs are concentrated within the first 1000 meters downstream from Searsville Dam. Both the Louisiana red-swamp crayfish and the signal crayfish are found in abundance where there are many deep, slow moving pools, and a relatively large population of mitten crabs, are found as far upstream as Webb Ranch and the Stanford Shopping Center.

Key Special Status Species. California red-legged frogs are concentrated at the following 3 reaches of San Francisquito Creek: 1) from the Dennis Martin House site downstream to the northwest edge of the Boething Treeland, 2) the southeast end of Boething Treeland downstream approximately 750 meters, and 3) at Webb Ranch (Launer and Holtgrieve 2000). Within these reaches of creek, almost all red-legged frogs were observed to be at or near pools, with most pools being at or greater than 1 meter deep. Also, most red-legged frogs were seen on steep sections of bank or in vegetation along the water's edge.

In average and wet years steelhead rainbow trout (*Oncorhynchus mykiss*) probably have access during storm flows to much of the spawning and rearing habitat in the San Francisquito Creek watershed. Except for immediately downstream of Searsville Lake, spawning habitat is sufficient to seed available steelhead rearing habitat. The watershed is dry, and low summer streamflows are the major factor constraining steelhead rearing. Bear and Los Trancos creeks are steeper and provide better rearing habitat than San Francisquito Creek. In San Francisquito Creek, steelhead summer rearing is probably restricted to riffles, runs and heads of pools, but larger pools provide good overwintering habitat. Low spring streamflows that restrict successful smolt outmigration through the downstream portions of San Francisquito Creek, are probably the major limiting factor to the number of adult steelhead produced by the watershed.

1.3 IMPACTS OF NATURAL FILLING OF SEARSVILLE RESERVOIR

1.3.1 Potential Impacts

Biotic Habitats. The most significant changes to vegetative communities in the study area will occur in Searsville Lake as a result of the natural filling of the lake over time. We expect a steady increase in the extent of riparian habitats in the former lakebed and a progressive decline in aquatic habitats as sedimentation of the lake progresses. The lake bed is expected to undergo several overlapping phases of vegetative succession based on the tolerance of particular plant associations to inundation, aggradation, shading, and ultimately, drying of large portions of the former lake bed. Open Water habitat, which currently dominates Searsville Valley, will convert to a complex mosaic of lentic, lotic, and terrestrial habitats until a single-thread efficient stream channel evolves. The "new" San Francisquito Creek will flow from the confluence of the tributary creeks to Searsville Dam and will likely be characterized by a corridor of early-successional Valley Foothill Riparian habitat on the floodplains within the meander belt and ultimately develop late-successional Coastal Oak Woodland habitat at higher elevations in the floodplain.

Plant associations that currently occupy the banks of San Francisquito Creek below the dam are not expected to be substantially altered. Emergent vegetation in the creek channel is extremely limited due to summer drying. Any increase in deposition could increases the duration of summer drying of the creek and thus further reduce the extent of emergent vegetation. The predicted increase in turbidity during storms and reduction in turbidity after storms is not expected to have any substantial effect on vegetation.

The development of sandier floodplains adjacent to portions of the channel that may invite colonization by invasive species, such as giant reed (*Arundo donax*), acacia (*Acacia* spp.), and eucalyptus (*Eucalyptus* spp.). However, extensive canopy cover and periodic flood control maintenance in the lower reaches, which includes removal of native and non-native woody vegetation on streambed sandbars, tends to mitigate this trend.

There may be an increase in small woody debris, vegetative material, and seed from Searsville Valley and the upper watershed. Both woody and herbaceous vegetation may increase slightly in depositional areas from Highway 280 to Junipero Serra Boulevard following episodic delivery of sediment and source materials. The extensive canopy cover and summer drying of the creek will limit this trend.

Non–Federally Listed Animal Species. Several special-status species occur along the San Francisquito Creek riparian corridor and at Searsville Lake. The natural filling of Searsville Reservoir will have no effect on the breeding success of any of these species, although it will result in a small reduction of foraging habitat available to some of them regionally. Due to the abundance of similar habitats regionally and the infrequency with which most of these species occur on the project site, the project is expected to have a substantial impact on these species. In general, the filling of Searsville Lake will increase habitat for most non-federally-listed, but special-status, species of wildlife.

Invasive Aquatic Species of Concern. Both bullfrogs and Louisiana red-swamp crayfish are expected to initially increase in number in San Francisquito Creek due to a greater influx of these species from Searsville Reservoir. However, bullfrogs will gradually decline due to a reduction in the source population associated with loss of breeding habitat of Searsville Lake. Chinese mitten crabs are not expected to be impacted by the natural filling of Searsville Reservoir.

Key Special Status Species. Of the five special-status plant species that have the potential to occur within the project area, fountain thistle (*Cirsium fontinale* var. *fontinale*) has the greatest likelihood of occurring within the bed of San Francisquito Creek because it is moisture loving. The other four species, i.e. San Mateo woolly sunflower (*Eriophyllum latilobum*), Dudley's lousewort (*Pedicularis dudleyi*), Santa Clara red ribbons (*Clarkia concinna* ssp. *Automixa)*, and Western leatherwood (*Dirca occidentalis)* are generally less moisture tolerant of high soil moisture and tend to occur on the banks and above the top of bank of streams where changes are not expected to occur. The predicted increase in suspended sediment flowing through the system is not expected to negatively impact fountain thistle that may occur in the channel bed.

California red-legged frogs are not expected to be negatively impacted by the increased amount of sediment expected to flow through the system. Increased turbidity; and a larger number of bullfrogs and Louisiana red-swamp crayfish being introduced from Searsville Reservoir may negatively impact the red legged frogs in the short-term. However, breeding habitat for bullfrogs in Searsville Reservoir is expected to decrease in the long-term with loss of Open Water habitat. This should result in a reduction of the source population from Searsville Reservoir to the creek downstream.

The natural filling of Searsville Lake should have a net beneficial impact on steelhead, depending upon the extent that channel aggradation downstream will affect the extent, frequency and timing of drying of the streambed.

1.4 IMPACTS OF LOWERING SEARSVILLE DAM

1.4.1 Potential Impacts

Biotic Habitats. A reduction in Searsville Lake water levels would expose a significant area of unvegetated ground around the edges of the lake and sharply diminish Fresh Emergent Marsh habitat. This exposed area would be susceptible to the establishment of undesirable non-native invasive plant species and would require active revegetation and management. Exotic species most prevalent in upstream areas outside of Jasper Ridge Biological Preserve that are likely to colonize the former lakebed are, in order of concern, broom (*Cytisus* spp.), pampas grass (*Cortaderia jubata*), and yellow star thistle (*Centaurea sulphurea*).

The linear extent of shoreline areas of Searsville Reservoir would be sharply reduced. Open Water habitats would not be expected to persist in the embayments of arroyos and draws or in meander depressions as would be expected under the natural filling scenario. The alluvial fan and deltaic apron, which is currently dominated by Valley Foothill Riparian habitat, may also undergo succession to a more xeric Coastal Oak Woodland habitat. As a deeper, high-banked, efficient channel develops, the floodplain may begin drying and the water table may drop. Riparian forest furthest from the channel would likely be gradually replaced by upland species, such as oaks, bay, and buckeye. These areas may also be more susceptible to colonization by non-native invasive plants as the floodplain and delta areas convert to a more xeric habitat type.

Potential changes to biotic habitats in San Francisquito Creek resulting from the lowering of Searsville Dam are not expected to differ substantially from those previously described for the natural filling scenario above. The accelerated timing of the increase in suspended and bedload sediments to this reach will not sufficiently change depositional patterns, channel geometry, or hydrology such that current plant communities within the bed and banks of San Francisquito Creek are substantially altered.

Non-Federally Listed Animal Species. As indicated for the filling of Searsville Lake above, the project will have no effect on the breeding success of any non-federally listed, but special-status species, although it will result in a small reduction of foraging habitat available to some of them regionally. Due to the abundance of similar habitats regionally and the infrequency with which most of these species occur on the project site, the project is not expected to have a substantial impact on species that do not breed within the project area.

However, the Townsend's big-eared bat (*Corynorhinus townsendii*) roosts in cavernous areas in the rocky banks of San Francisquito Creek immediately below and adjacent to the dam face. Construction activities to lower of the dam may result in the permanent loss of roosting habitat for this California species of special concern. This species may be proposed as a federally listed species by a consortium of public agencies. The loss of individuals and this rocky grotto habitat could be considered a substantial impact.

Invasive Aquatic Species of Concern. Both bullfrogs and Louisiana red-swamp crayfish are expected to initially increase in number in San Francisquito Creek due to a greater influx of these species from Searsville Reservoir. However, bullfrogs are expected to decline due to a reduction in the source population associated with the loss of breeding habitat of Searsville Lake. overwintering tadpoles being removed from the system. Chinese mitten crabs are not expected to be impacted by the lowering of the Searsville Dam.

Key Special Status Species. Of the five special-status plant species that have the potential to occur within the project area, fountain thistle has the greatest likelihood of occurring within the bed of San Francisquito Creek because it is moisture loving. The other four special-status plant species are less tolerant of high soil moisture and tend to occur on the banks and above the top of bank where changes are not expected to occur. In any case, the increase in suspended sediment being transported through the system is not expected to substantially impact fountain thistle.

California red-legged frogs are not expected to be negatively impacted by the increased amount of sediment expected to flow through the system. Increased turbidity; and a larger number of bullfrogs and Louisiana red-swamp crayfish being introduced from Searsville Reservoir may negatively impact the red-legged frogs in the short-term. However, breeding habitat for bullfrogs in Searsville Reservoir is expected to sharply decrease once the dam is lowered resulting in a reduction of the long-term source population from Searsville Reservoir to the creek downstream. Additionally the timing of the lowering may negatively impact red-legged frogs if it is performed during red-legged frog breeding and larval development seasons.

The natural filling of Searsville Lake should have a net beneficial impact on steelhead, depending upon the extent that channel aggradation downstream will affect the extent, frequency and timing of drying of the streambed.

Management Recommendations. While we offer no recommendations for managing the gradual ecological changes expected in the natural filling scenario, the lowering of Searsville Dam presents several management opportunities. In particular, the methods utilized in lowering the dam crest and the timing in which it is lowered could either lessen or intensify potential impacts to biotic habitats above, within, and below Searsville Lake. In all cases, to the extent possible, lowering of the lake should be managed adaptively to minimize potential impacts and maximize potential benefits to biotic resources. The release of additional waters from Searsville Lake should also be timed such that metamorphosis of red-legged frog tadpoles has already occurred but prior to breeding and egglaying. Similarly, the lake should be lowered in a manner that enables upstream migration of steelhead rainbow trout and before excavation of redds and egglaying. The exposed lakebed sediments resulting from a rapid lowering of Searsville Lake should be immediately mitigated by extensive and well-timed revegetation and erosion control treatments. Construction on the dam should commence after the conclusion of potential breeding season for bats and before potential bats hibernate to the extent possible. Consideration should be given to lowering the lake level gradually to minimize impacts to riparian and emergent wetland vegetation that has established around the lake's shoreline. Lake lowering could also be timed to provide a wetted soil perimeter during periods of native species seed dispersal. Similarly, releases from the dam could be timed to provide periodic flooding downstream during or just before native seed dispersal.

2.0 INTRODUCTION

Searsville Lake in Stanford University's Jasper Ridge Biological Preserve is quickly approaching the end of its effective life as a reservoir as it is nearly filled with sediment. Predictions of exactly when the lake will be filled vary depending on assumptions of future weather patterns. Patterns of deposition in the lower reaches of Corte Madera Creek and other locations within Searsville Lake appear to be responsible for localized flooding just above the lake in the Family Farm Road area.

A study of possible solutions to upstream flooding problems has suggested that Searsville Dam be lowered –16' to the current silt level. Recognizing the potential for downstream impacts in either scenario (natural filling of the lake or lowering of the dam) the San Francisquito Joint Powers Authority and Stanford University feel that it is important to study and quantify the potential impacts in order to make an informed decision whether or not to modify the dam (Searsville Lake Sediment Impact Study RFP, 2000).

H.T. Harvey & Associates was included as a member of the sub-consultant team to map and analyze the existing biotic conditions within San Francisquito Creek from Searsville Dam to San Francisco Bay and to provide qualitative descriptions of the potential impacts and changes to the affected ecological system for both scenarios. An analysis of potential impacts to biotic resources in Searsville Lake was added to the project scope as it became more apparent that the most substantial changes in the project area would occur in and upstream of Searsville Lake.

Through the utilization of existing biological studies, the firm's extensive knowledge of the biotic resources of San Francisquito Creek, additional field surveys, data collection, and data analysis, H.T. Harvey & Associates has prepared several synthesis maps of the biotic resources of Searsville Lake and San Francisquito Creek. The body of the text includes an inventory of existing conditions, descriptions of ecosystem evolution in Searsville Lake, and analysis of potential impacts to identified habitats following episodic delivery of large volumes of sediment expected in either reservoir sedimentation or lowering scenario. The synthesis report involved an analysis of biotic resources, particularly those factors relating to federally listed threatened or endangered species with California red-legged frog and steelhead trout being the primary listed species of concern in the project area.

2.1. PROJECT BACKGROUND

2.1.1 Regional Setting

San Francisquito Creek is the last open-channel urban creek in the area and is a vital natural resource to the communities that border it, and to the larger ecology. The watershed is biotically diverse in both its flora and fauna. The vegetation ranges from valley foothill riparian and redwood forest in the upper reaches of the watershed to oak woodland and grassland in the middle reaches. From Highway 101 to San Francisco Bay there are both fresh and salt-water marshes. Where the creek enters the bay was once a large willow thicket and salt marsh. Only a portion of this marsh exists today but remains important in the regional goal to retain and restore both fresh and salt water marshes.

From Highway 280 to Searsville Dam and the area around Searsville Lake are part of the regionally significant Jasper Ridge Biologic Preserve. Mediterranean in climate, Jasper Ridge Biological Preserve is a 482 ha protected area in the eastern foothills of the Santa Cruz Mountains, five kilometers west of the main campus of Stanford University. Vegetation is diverse, representing all inland plant communities of the California central coast range. The preserve includes roughly: 15 hectares of rare serpentine grassland, critically important because it hosts a species-rich community of native grasses and forbs and is chemically hostile to the non-native species that invade most other native ecosystems; 15 hectares of blue oak savanna; 150 hectares of mixed evergreen forest typified by California bay (*Umbellaria californica*), coast live oak (*Quercus agrifolia*), and madrone (*Arbutus menziesii*), with several stands of redwood (*Sequoia sempervirens*) and some Douglas fir (*Pseudotsuga menziesii*); 140 hectares of chaparral, including some on serpentine soil; 150 hectares each of open lake, willow swamp, marsh with pondweed (*Potamogeton* spp.), knotweed (*Polygonum* spp.), and cattail (*Typha* ssp.), and riparian corridors typified by alder (*Alnus* spp.), dogwood (*Cornus occidentalis*), cottonwood (*Populus* spp.), and box elder (*Acer negundo*); and 100 hectares of grassland dominated by dense Eurasian annuals. There has been little disturbance in the 389 ha central body of Jasper Ridge Biological Preserve since the logging period in the 1870's, except for grazing which ended in 1960 (JRBP, 1998).

The local topography has always constrained the width of the riparian zone and urbanization has reduced it further. Nonetheless, portions of San Francisquito Creek and Los Trancos Creek remain a key refugia for steelhead trout in the southern San Francisco Bay Area.

The San Francisquito Creek watershed area is approximately 45 square miles extending from Skyline Boulevard to the San Francisco Bay (Figure 1). The watershed contains three manmade lakes including, Searsville, Lagunita and Felt Lakes. Searsville Lake is located at the western edge of the Stanford campus in unincorporated San Mateo County near the towns of Woodside and Portola Valley. Five creeks with headwaters in the upper San Francisquito watershed feed Searsville Lake; Corte Madera Creek, West Ridge Creek, Sausal Creek, Dennis Martin Creek and Alambique Creek (Figure 2). San Francisquito Creek drains into Searsville Lake in Upper Portola Valley and resumes as a dam overflow, flowing through communities from Portola Valley to the San Francisco Bay.

The deeply incised creek flows through both natural and urban settings. The area of focus for this study is an approximately 12-mile reach of San Francisquito Creek, top of bank to top of bank, from below Searsville Dam to the San Francisco Bay. The creek and adjacent lands are both publicly and privately owned. Development exists, or is planned, above the banks on the 8.7 miles of San Francisquito Creek from Highway 280 to where the mouth of the creek empties into the San Francisco Bay. Whereas the 3.4 miles of San Francisquito Creek from Highway 280 to

Figure 1. Vicinity Map

Figure 2. San Francisquito Creek Watershed and Project Area

Searsville Dam flows through a rural landscape primarily owned by Stanford University with a few agricultural parcels held in private ownership. The Stanford University lands are comprised of the Stanford Linear Accelerator to the north and Jasper Ridge Biological Preserve to the southwest. Webb Ranch occupies the land above the bank to the southeast of San Francisquito Creek

San Francisquito Creek establishes the boundary between Santa Clara and San Mateo Counties within the study area. It is located within the Santa Clara Valley Water District's Northwest Flood Control Zone and San Mateo County's San Francisquito Creek Flood Control Zone. In the study area, the City of Palo Alto and Stanford University border the creek on the southeast; to the northwest are the Cities of Menlo Park and East Palo Alto.

2.1.2 Local Setting

San Francisquito Creek provides a lush backdrop to residences, businesses, institutions, agricultural lands, recreational and conservation areas. The 12-mile study area initiates in the rural, bedrock controlled reaches below Searsville Dam and continues downstream adjacent to the north central boundary of Jasper Ridge Biological Preserve and the Stanford Linear Accelerator. Further downstream, the creek flows adjacent to Boething Treeland, Webb Ranch and the Portola Valley Training Center until it reaches Highway 280 roughly one-third the distance to the San Francisco Bay. There are two road crossings within the 3.4 miles between Highway 280 and Searsville Dam. These consist of rural Webb Bridge upstream of Highway 280 and a seasonal cement ford just downstream of the Bear Creek confluence.

Above Highway 280, the creek edge is a natural riparian corridor, displaying a moderately incised, unchannelized stream that is unaltered by hardscape erosion control interventions. The reaches above Highway 280 include a well-developed native overstory and understory. Conversely, the creek edge below Highway 280 is defined in most cases by public streets and parking easements, commercial development, backyards, paths, parks or barriers such as fences, walls, and levees. Its steeply sloping banks limit access into the creek with few formal accessible routes to the water. Erosion continues to jeopardize top-of-bank access. Several small public parks adjoin the creek including El Palo Alto Park, Timothy Hopkins Creekside Park and a City of Palo Alto Community Garden.

Below Highway 280, San Francisquito Creek enters into the alluvial controlled reaches adjacent to the Stanford Golf Course and other developed Stanford lands, into the urban center, through low-rise commercial and residential communities. Roadway crossings in the lower 8.7 miles occur at Junipero Serra Boulevard, Sand Hill Road, El Camino Real, Middlefield Road, Chaucer Street, University Avenue, Newell Road and Highway 101.

The creek edge below Highway 280 remains heavily wooded but consists of a more diverse group of plant types, including a significant presence of non-native species. The character of the creek has evolved over time in part due to human intervention and associated land use pressures. Pesticide and roadway runoff, homeless encampments, vandalism, graffiti, and litter affect the creek.

2.1.3 Vegetative History

The entire length of San Francisquito Creek is rich with historical significance. However, each of the five historical periods described below had a significant impact on the type and distribution of vegetation within the watershed. The following is an abridged look at land use activity along San Francisquito Creek having historical, cultural, and/or ecological impact, presented chronologically.

Prehistoric Culture. Remains of the native Ohlone Indian culture in the San Francisquito Watershed have been radiocarbon dated at more than 5000 years old. With an abundant food source and adequate year-round water flow, numerous Ohlone villages populated the banks of the San Francisquito Creek and adjacent meadows until Spaniard settlement in the mid-1700s (Jones, 1998). Grasses, bulbs and legumes such as red maids (*Calandrinia ciliata*), miner's lettuce (*Claytonia perfoliata*), goosefoot (*Chenopodium* spp.), and sunflower (*Helianthus* spp.) seeds as well as fruit from the holly-leafed cherry (*Prunus ilicifolia*), hazelnut (*Corylus cornuta*) and buckeye (*Aesculus californica*) were all a part of the Ohlone diet and the rich botanical context of the study area (Reese, 1995). Historical record of native vegetation is helpful in selecting native species as part of the habitat restoration plan.

Fire was the most powerful tool used by Native Americans prior to the arrival of Europeans. From the earliest accounts of Spanish explorers in the early 1770's, fire was commonly used to clear brush for hunting and for settlements. Fire was also utilized to culture oaks for acorns and to select for particular useful understory plants. The intentional use of fire combined with fires set by lightning undoubtedly resulted in periodic changes in vegetation species composition, as well as changes in storm runoff and sedimentation rates (Balance Hydrologics, 1996).

Archaeological resources located in the urbanized setting in the lower reaches are under constant threat. The volatile nature of this urban creek site, with constantly shifting and eroding soil, further endangers archaeological resources.

Early Settlers. Spaniard Don Gaspar de Portolá came to the area in 1769, searching for the Monterey harbor in an attempt to establish the first California Missions (Spector, 1994). Modern lore tells of his party camping under El Palo Alto, the renowned redwood tree and Palo Alto City icon, located near the banks of San Francisquito Creek. While his expedition did not achieve its goal, by 1777 Mission Dolores and Mission Santa Clara were established with the creek forming the boundary between the two properties (PCC, 1994).

In the 1830s, lands surrounding the creek were divided into large Ranchos, including: Rincon de San Francisquito, Rinconanda del Arroyo de San Francisquito and San Francisquito (Spector, 1994), and granted by the Mexican government to Don Rafael Soto, and Don Antonio Buelna. Buelna's Rancho San Francisquito land tract was located on the southwest side of San Francisquito Creek and extended upstream from "El Palo Alto" and today comprises much of the Stanford University campus (Wood, 1939). The Buelna adobe and grounds - later the Buelna/Rodrigues adobes were established along the northern end of the study area, near what is now the Stanford Golf Course and Oak Creek Apartments. The Buelna Adobe survived into the

1890s, with ruins of the adobe still visible in the creek well into the 20th Century (Johnson, 2000).

During the Spanish-Mexican period, cattle grazing was the principal land use. Settlers of this period also used fire to convert various biotic habitats into grassland. The predominance of oak woodland and grassland in the lower watershed are likely a remnant effect cultural use of fire.

Starting in the 1840's, extensive commercial logging and road building in the upper watershed began to significantly alter the landscape. The removal of large tracts of old growth redwood, tanoak, Douglas fir, madrone, and oak (*Quercus spp.*), opened up significant portions of the upper watershed for scattered agriculture and residential development. At the same time, squatters had begun to settle on many choice portions of Rancho San Francisquito hoping that the U.S. Government would open the land to homesteaders. Most of the remaining small stands of merchantable timber in the lower watershed were logged during the homesteading period.

Logging in the San Francisquito watershed is likely to have significantly increased the sediment yields to San Francisquito Creek by the initial disturbance, associated use of fire to burn slash and ease access, and by destabilizing slopes (Balance Hydrologics, 1996). It does not appear that the San Francisquito Creek was used as a transport corridor for logs. At this time, San Francisquito Creek was navigable by small boat, during winter, approximately to where Newell Road is today (Spector, 1994). A crossing near present-day Sand Hill Road was used as a "doubling-up station." Teams of oxen, hauling redwood logs from the mountain, could take on a double load for the easy stretch southward to San Jose and north to Redwood City (Wood, 1939).

Governor Leland Stanford's Influence. Former Governor Leland Stanford's huge influence on this area began in 1876 when he acquired 8,800 acres to make up his stock farm and later the University. His property spanned approximately from El Camino Real to Junipero Serra with San Francisquito Creek as the border (Jones, Reese, Rick, 1996). Stanford's stately Palo Alto Home, built around 1863, was located near the present-day Stanford Shopping Center. The conversion of mixed evergreen and riparian forest to oak woodland and grassland that had been initiated by the Spaniards, intensified on Stanford's 8,800-acre stock farm.

Searsville Dam and Town Growth. In 1887, Stanford arranged for the Manzanita Water Company to construct Searsville Dam on San Francisquito Creek, located near the west end of Stanford University property in Woodside (PCC, 1994). The dam, completed in 1891 by the Spring Valley Waterworks, was intended to supply water to Stanford University. Due to fine suspended sediment and odor, the water was non-potable and used for irrigation only (Johnson, 2000).

In the early 1900s, gravel and rocks left in the creek after the winter rains were excavated the following summers to be used for roads, sidewalks, etc. (Palo Alto Historical Association, 1993). After the 1906 earthquake, fragments of the destroyed architecture of Memorial Church were dumped into the creek, portions of which still can still be found after floods recede (Johnson, 2000). Adjacent to Menlo Park was a railroad stop that eventually developed into a small town and, along with newly formed Palo Alto, continued to grow and prosper in the 20th century.

Searsville Lake, whose reliability as a source of potable water was questionable from the outset, was designated for irrigation use and fire protection in the early 20th century. Stanford records indicate concern regarding sedimentation, reservoir capacity and water quality as far back as 1913 (Balance Hydrologics, 1996).

In an effort to reduce the sedimentation in the main portion of Searsville Lake, a causeway was constructed in 1929 to shift sedimentation to portions of Corte Madera, Sausal, and Alambique Creeks just above lake level. In 1970, as an effort to reduce flooding at Family Farm Road, the 1929 causeway was breached and a channel was dug through the willow woodland in the lowermost reach of Corte Madera Creek. Following this action, the Corte Madera Creek delta then prograded into Searsville Lake (Balance Hydrologics, 1996).

Currently, flooding in the vicinity of Family Farm Road has become more problematic. The flooding results from high flows on Dennis Martin, Sausal, and Corte Madera Creeks. Sediment deposition and floodplain aggradation on the Corte Madera alluvial fan, alluvial plain, and Searsville Lake delta has significantly increased flood risk to adjacent properties. The floodplain aggradation will continue, further aggravating the degree of flood risk. At present, flooding does not directly impact any structures in the project area. However, access to the properties has been seriously affected by storm waters from Sausal and Corte Madera Creeks over-banking and flooding driveways and Family Farm Road, most recently in February of 1998.

Modern Influences on San Francisquito Creek. Presently there are a variety of land uses along the creek: single- and multi-family residences, commercial buildings, recreation, Stanford University and its holdings, among others.

Stanford University lands that are adjacent to the creek above Highway 280 are primarily occupied by the Jasper Ridge Biological Preserve, the Stanford Linear Accelerator, and agricultural users. University lands below Highway 280 are occupied by the Stanford Linear Accelerator command center, the Golf Course, and the Stanford Main Campus.

Also below Highway 280, several parks have been established along the creek including El Camino Park and El Palo Alto Park, which honors the redwood/City icon 'El Palo Alto' and the historic significance of the site. In the 1960s, the Native Sons of the Golden West deeded land surrounding El Palo Alto to the City of Palo Alto. By the late 1980s, the redwood was in poor health, but recent restorative efforts have improved the tree's new growth (Johnson, 2000). Timothy Hopkins Creekside Park is a collection of small parks and pathways extending along the Palo Alto edge between El Camino Park and Chaucer Street. Much of the linear portion of the park has been lost to bank erosion. A City of Palo Alto community garden is also located adjacent to the creek.

Local residents struggle with management of flood and erosion at their creek-fronting properties and have taken measures to preserve their property with a variety of bank stabilization techniques. Highly engineered solutions are apparent throughout the reach.

In 1991, studies showed a hazardous level of human waste found in the creek. In October of 1997, police evacuated a large homeless encampment under the El Camino bridge, after reports by the County Health Department that the encampment was a health hazard. Enforcement by the cities of new trespassing laws continues, and the amount of trash and debris in the creek continues to decrease.

In recent years, there has been significant public involvement in the preservation and rehabilitation of San Francisquito Creek. The community-based Friends of San Francisquito Creek was formed in 1989 by a group of citizens to clean, preserve, and enhance the creek's natural setting. The San Francisquito Creek Coordinated Resource Management and Planning group was formed in November 1993 by a group of concerned individuals, organizations, and local agencies, providing a forum for collaborative issues related to the creek. Sponsored by the Peninsula Conservation Center, The San Francisquito Creek Coordinated Resource Management and Planning published their "Draft Watershed Management Plan" in 1997, which set forth watershed-planning goals and proposed implementation actions. Published in early 1998, their "Reconnaissance Investigation Report of San Francisquito Creek," discussed flood-related issues.

The San Francisquito Creek Joint Powers Authority was formed in May 1999 through an agreement by and among the Cities of Menlo Park, Palo Alto, East Palo Alto, as well as the Santa Clara Valley Water District and the San Mateo County Flood Control District. Joined by the San Francisquito Creek Coordinated Resource Management and Planning group and Stanford University in 2000, the Joint Powers Authority conducts long-term flood control planning, maintenance, enhancement, and restoration activities related to San Francisquito Creek and Searsville Lake.

The quality of an urban creek development is dependent upon the interaction of many political, physical and biological processes. Over the years, a loss of native vegetation and improper bank stabilization along San Francisquito Creek has caused severe bank erosion in several locations. In addition, invasive non-native plants have displaced many of the native plant species. These non-native plants reduce the diversity necessary to support a rich riparian habitat, and may have limited erosion control properties controlled to native, woody species. This combination of unplanned and unconnected bank stabilization efforts and the uncontrolled spread of non-natives influenced the creek's capability to successfully withstand flood events. A properly designed bank stabilization project will be an effective method of reducing erosion and flood damage while at the same time improving habitat, limiting maintenance costs, and minimizing effects on water velocities. Replacement of non-native plant species with native species will help improve water quality and promote proper absorption of rainfall, reducing erosion and damage to property.

2.2. PROJECT OBJECTIVES

In June of 2000, the Joint Powers Authority, led by Stanford University Facilities Operations, issued a request for proposals for the Searsville Lake Sediment Impact Study. This study called for an analysis of existing conditions, analysis of future conditions given no intervention, and analysis of conditions given certain potential modifications to Searsville Dam. The Joint Powers Authority and Stanford University will use this report in order to inform its decision whether or not to modify the dam in order to reduce flooding in the vicinity of Family Farm Road.

2.2.1. Organization of the Report

The report consists of four main components, divided into five sections, which cover the following subjects:

- Project and Purpose

  Section 1 – *This Executive Summary*, describes the goals of the project and summarizes the three main report components;

  Section 2 – *Introduction*, describes the project background, including the regional and local setting of the study area, as well as a brief history of the land use that shaped the current setting. This section describes the organization of the report and provides a summary of study methodology;

- Synthesis of Existing Conditions

  Section 3 – *Existing Conditions Analysis,* describes the existing biotic habitats, special-status species, invasive aquatic species of concern, and other vertebrates within San Francisquito Creek from Searsville Dam to San Francisco Bay. The biotic resources within Searsville Lake itself are summarily described.

- Environmental Overlays

  Section 4 – *Natural Filling of Searsville Reservoir,* describes the predicted ecosystem evolution of Searsville Lake and San Francisquito Creek in this scenario, including expected changes to biotic habitats, special-status species, invasive species, and other non-listed vertebrates.

  Section 5 – *Lowering of Searsville Dam,* describes the predicted ecosystem evolution of Searsville Lake and San Francisquito Creek as described above under this scenario.

- Appendices – Includes additional reference materials.

2.2.2 Acknowledgements

In addition to the dedicated project team whose involvement informed and inspired the process, many individuals lent their expertise to the creation of this document. The authors wish to acknowledge Dr. Alan Launer (Stanford University Center for Conservation Biology), who provided survey data, reports, and maps relating to both aquatic and terrestrial wildlife species in the watershed. Dr. Launer also proffered key biological information from the large body of work produced by he and his colleagues, in addition to helpful logistical insights. Similarly, Dr. Philippe Cohen (Director of the Jasper Ridge Biological Preserve) supplied multiple references to studies describing ecological conditions in and around Searsville Lake.

2.3. PROJECT METHODS

The Biotic Resources Synthesis Report involved two phases of inquiry with two discrete sets of methodologies; those methods used to determine the existing conditions and those used to conduct an environmental overlay to determine the predicted ecosystem evolution following the natural filling or lowering of Searsville Dam.

2.3.1 Methods Utilized to Determine Existing Conditions

In the first phase of the study, H.T. Harvey & Associates assembled existing information resulting from site evaluations, field surveys, and studies conducted in the San Francisquito Creek watershed within the period from early 1996 through early 2001. The most relevant sources of existing information, those resulting from studies in San Francisquito Creek and Searsville Lake, were requested of and provided by Northwest Hydraulic Consultants, Balance Hydrologics, Dr. Alan Launer of the Stanford University Center for Conservation Biology, Dr. Philippe Cohen of the Jasper Ridge Biologic Preserve, Coyote Creek Riparian Station, and the Coordinated Resources Management Planning Committee. Personal communication with the above persons and project team members supplemented technical reports and other sources of written information. Other sources of information utilized to synthesize current conditions originated from public agencies such as the Soil Conservation Service (soils maps), the California Natural Diversity Data Base, United States Geological Survey (aerial photos and topographical maps) and public interest groups like the California Native Plant Society (rare & endangered plant data).

Data was shared among the project team in order to maximize interdisciplinary collaboration between team members and to evaluate where existing information was insufficient. Identified data gaps requiring additional research and field surveys were as follows:

- Vegetation in the channel bottom
- Woody debris in San Francisquito Creek
- Special-status plant species in San Francisquito Creek
- Bullfrogs, crayfish, and Chinese mitten crab encroachment on red-legged frog habitat
- Habitats supporting steelhead rainbow trout in San Francisquito Creek.

Joint field reconnaissance was conducted from November 2000 through January 2001 not only to verify existing conditions but also to fill in data gaps and further identify issues, opportunities, and constraints not readily apparent in the available existing information. Through the utilization of existing biological studies, H.T. Harvey & Associates' extensive knowledge of the biotic resources of San Francisquito Creek, and additional field surveys, H.T. Harvey & Associates then prepared the existing conditions section of this report. The development of several synthesis maps that depict biotic resources in the project area were included in this task. Synthesis maps were developed through transfer of information from existing reports, studies, and databases as described above. Descriptive text was developed from a thorough analysis of vegetative habitats, riparian corridor ecology, wildlife use, and biotic resources, particularly those factors relating to the existing habitat conditions for California red-legged frog and steelhead rainbow trout being the primary federally listed species of concern in the project area.

Dr. Jeffrey Wilkinson evaluated existing red-legged frog habitat and Dr. Jerry Smith evaluated existing steelhead rainbow trout habitat.

Specific methods utilized to evaluate the existing conditions of vegetation, non federally listed wildlife, invasive aquatic species of concern, special-status plant species, and federally listed species are described individually as follows:

Biotic Habitats. H. T. Harvey & Associates primarily analyzed vegetation and habitat types along San Francisquito Creek below Searsville Dam using a hybridized habitat classification system (Figure 3 and Figure 4). This system is based on three sources of existing information: 1) previous biotic habitat types identified spatially throughout the entire length of San Francisquito Creek by the Coyote Creek Riparian Station (1998), 2) qualitative vegetative data for the lower reaches of the creek contained within the *San Francisquito Creek Existing Conditions* report prepared by H. T. Harvey & Associates, and 3) descriptions of vegetation in Searsville Lake summarized from the *Biotic Assessment of Upper Searsville Lake and the Lower Floodplain of Corte Madera Creek* (Launer, Fee, and Rottenborn, 1996). Vegetation data contained within the *San Francisquito Creek Existing Conditions* and the *Biotic Assessment of Upper Searsville Lake and the Lower Floodplain of Corte Madera Creek* reports were used to supplement the primary biotic habitat data provided by Coyote Creek Riparian Station. These two sources expanded on the Coyote Creek Riparian Station's WHR-based system and described vegetative succession, habitat trends, habitat quality, the extent of non-native vegetation, and the invasive threat posed by non-native plants in portions of the project area. Because these three systems are not dissimilar, characterizations have been consolidated in the text. However, only spatial data from the Coyote Creek Riparian Station report was utilized in Figures 3 and 4 to represent biotic habitats in San Francisquito Creek. Biotic habitats in and around Searsville Lake were interpreted from aerial photographs and transferred to United States Geological Survey digital orthophoto quadrangles used as the common base map for the project.

The most significant data gap hindering analysis of existing vegetation in San Francisquito Creek was the lack of survey information of vegetation in the channel bottom. The channel bottom is generally described as being "unvegetated" in the reference surveys. As vegetation in the channel bottom is the most susceptible to alteration due to significant changes in the sediment regime, channel vegetation was identified and characterized at several stream crossings in the project area. This reconnaissance level data was then used to describe trends in channel vegetation throughout the system.

Non-Federally Listed Wildlife Species. A number of sources (California Natural Diversity Data Base 2000), Launer and Spain 1998, Launer and Holtgrieve 2000, and Evelyn, Stiles and Cohen 2000) were consulted prior to field surveys to determine the special-status animal species occurring and potentially occurring on site. Additionally, Dr. Alan Launer of the Stanford University Center for Conservation Biology and Dr. Philippe Cohen of the Jasper Ridge Biologic Preserve were interviewed over the phone for specific information regarding the occurrence of various special-status species on site. The project site was then surveyed in its entirety by H. T. Harvey & Associates' wildlife biologist, Dr. Dave Johnston, to determine whether special-status animals were present and to assess the potential for occurrence of such species on site. As

Figure 3. Biotic Habitats Upstream of Highway 280

Figure 4. Biotic Habitats Downstream of Highway 280

previously mentioned, Dr. Jeffrey Wilkinson evaluated existing red-legged frog habitat and Dr. Jerry Smith evaluated existing steelhead rainbow trout habitat.

Invasive Aquatic Species of Concern. Launer and Holtgrieve (2000) were consulted to determine present distribution of invasive aquatic species. Journal articles and reference material on general ecology and impacts on California red-legged frogs were researched from sources such as the libraries of the California Academy of Sciences and H. T. Harvey & Associates.

Special-Status Plant Species. A query of the California Natural Diversity Database 2000 was performed to identify special-status plant species potentially occurring in the project vicinityIn addition, the California Native Plant Society Inventory 1994 was used to identify and assess additional species occurring in similar habitats throughout Santa Clara and San Mateo counties. All species identified in these queries were then cross referenced with the most recent state and federal listing update according to the California Department of Fish and Game 2001 (CDFG 2001) to verify their status and identify recently listed species.

Geographic Information System base data from Jasper Ridge Biological Preserve, including geological maps, soil series maps, and vegetation maps were analyzed to determine where special-status plant species have the potential to occur in the project area. Section 3 of this report summarizes the results of this interdisciplinary study with respect to the existing conditions.

Federally Listed Animal Species.

Steelhead Rainbow Trout. All accessible steelhead habitat in the Bear Creek Watershed was walked in June and July 2000 to determine migration barriers and habitat conditions. San Francisquito Creek between the dam and Junipero Serra Boulevard was walked in November through January 2000-2001 to assess migration barriers and habitat conditions. Habitat conditions in Los Trancos Creek between the Stanford diversion and the mouth were reassessed in November 2000 for comparison with conditions in spring 1995. Barriers in the lower portion of San Francisquito Creek and on upper Los Trancos Creek were assessed in April 2001. Electroshock fish sampling data collected by Alan Launer was used to evaluate fish abundance, size class distribution and microhabitat use for lower Bear Creek, Los Trancos Creek and San Francisquito Creek.

Red-legged Frog. Launer and Holtgrieve (2000) were consulted to determine present distribution of California red-legged frogs within San Francisquito Creek. Journal articles and reference material on general ecology were researched from sources such as the libraries of the California Academy of Sciences and H. T. Harvey & Associates. In addition, a site visit was performed in November of 2000 to observe and evaluate existing habitat conditions for red-legged frogs.

2.3.2 Methods Used in the Evironmental Overlays

After H.T. Harvey & Associate's project team evaluated the biotic and abiotic requirements of the habitat types present in Searsville Lake and San Francisquito Creek, the second phase of the study focused on the environmental overlays. Summary data from hydraulic modeling, the bathymetric survey, and the geomorphic assessment was provided by Northwest Hydraulic Consultants and Balance Hydrologics and reviewed by the H.T. Harvey & Associates and Dr. Jerry Smith. The team then assessed how the natural filling or lowering of Searsville Dam could impact ecosystem evolution in Searsville Lake and identified downstream habitats following hydrologic and geomorphic changes. Sections 4 and 5 of this report summarize the results of this interdisciplinary study with respect to the environmental overlays.

3.0 EXISTING CONDITIONS ANALYSIS

San Francisquito Creek traverses diverse urban and natural settings as it flows from its headwaters at Searsville Lake on Stanford University's Jasper Ridge Biologic Preserve and its broad network of tributary creeks to San Francisco Bay. Within the project area, San Francisquito Creek borders urban, suburban, and less developed settings that influence the habitats and plant species present along the Creek. Highway 280 roughly divides the rural, bedrock controlled reaches up to Searsville Dam from the urbanized, alluvium controlled reaches down to San Francisco Bay.

Above the dam, Searsville Lake is an artificial impoundment of San Francisquito Creek. The Searsville Lake watershed is a subwatershed of the larger San Francisquito Creek watershed. Most of Searsville Lake's inflow comes from Corte Madera Creek. Alambique Creek flows into the Upper Marsh on the west side of Portola Road and then through two 48-inch concrete culverts into the Middle Marsh. Sausal Creek and Dennis Martin Creek also contribute inflow into the Middle Marsh, which then drains into the main body of Searsville Lake.

As the study area for this project is confined to Searsville Lake and the bed and banks of San Francisquito Creek, the dominant vegetation types discussed in this report are the aquatic and terrestrial associations found in riparian corridors throughout the south San Francisco Bay area. Biotic habitats below the top of bank are described in detail, while biotic habitats above the top of bank are not described.

3.1 BIOTIC HABITATS

H. T. Harvey & Associates primarily analyzed vegetation and habitat types along San Francisquito Creek below Searsville Dam using a hybridized habitat classification system previously described in Section 2.3 Project Methods. However, as the study of existing vegetation progressed, the importance of integrating an analysis of the vegetation in and around Searsville Lake became more apparent. The results of a reconnaissance level survey of emergent and riparian vegetation in the floodplains, deltas, and lakebed of Searsville Reservoir are also included. Hence, biotic habitats in both Searsville Lake and San Francisquito Creek are described in this section of the Biotic Resources Synthesis Report and are depicted in Figure 3 and Figure 4.

The following vegetation categories describe the major habitats present along San Francisquito Creek and within the riparian zones around Searsville Lake. Biotic habitats existing within Jasper Ridge Biologic Preserve are described only where they intersect with the project area.

Shrub. Shrub habitat consists of areas dominated by shrubs with little or no trees present. Native and non-native shrubs are included.

Valley Foothill Riparian. Valley Foothill Riparian consists of riparian habitat dominated by mixed, native trees and shrubs. Native tree species include red willow (*Salix laevigata*), arroyo willow (*Salix lasiolepis*), Fremont cottonwood (*Populus fremontii* ssp. *fremontii*), and others.

Native shrub species include California blackberry, California rose (*Rosa californica*), mugwort (*Artemisia douglasiana*), and others.

Urban. Urban habitat consists of areas where non-native species comprise more than 50% of the habitat.

Eucalyptus. Eucalyptus habitat consists of areas dominated by one or more non-native species of eucalyptus. Common species include blue gum (*Eucalyptus globulis*) and red river gum (*Eucalyptus camaldulensis*).

Redwood. Redwood habitat consists of areas dominated by California redwood.

Valley Oak Woodland. Valley Oak Woodland habitat consists of areas dominated by valley oak trees (*Quercus lobata*).

Coastal Oak Woodland. Coastal Oak Woodland habitat consists of areas dominated by coast live oak trees and can include other native trees such as California bay (*Umbellularia California*) or California buckeye and native shrubs like California blackberry (*Rubus ursinus*) or coyote brush (*Baccharis pilularis*).

Fresh Emergent Wetland. Fresh Emergent Wetland habitat consists of areas dominated by pockets of freshwater marshes with wetland plants such as cattails .

Saline Emergent Wetland. Saline Emergent Wetland habitat consists of areas dominated by brackish marshes with saline tolerant plants such as pickleweed (*Salicornia virginica*) or saltgrass (*Distichlis spicata*).

Open Water. Open Water Habitat consists of bodies of very slow-moving or standing (lentic) fresh water of sufficient size and depth to preclude the growth of rooted marsh vegetation. Algae and some floating plants may be present in this deeper limnetic habitat, but shoreline plants such as rushes and tules are confined to the littoral areas of this habitat type.

Dominant Biotic Habitats. The dominant biotic habitat throughout the study area is Valley Foothill Riparian. Open Water habitat dominates Searsville Lake itself, with Fresh Emergent Wetland habitat sub-dominating the fringe of Searsville Lake. Saline Emergent Wetland dominates where San Francisquito Creek merges into the bay tidelands. Small pockets of other biotic habitats, including Herbaceous, Shrub, Urban, Eucalyptus, Redwood, and Coastal Oak Woodland), exist above the top of bank, in small pockets, and within natural or anthropogenically generated breaks in the dominant Valley Foothill Riparian canopy.

The existing vegetation is described in three discrete reaches correlating to three conceptual hydrological reaches, the *source reach*, *zone of transport*, and *zone of deposition*. They are, respectively, Searsville Lake, the Searsville Dam to Highway 280, and Highway 280 to San Francisco Bay. They are described in detail below.

3.1.1 Searsville Lake

The riparian zones around Searsville Lake (Figure 3) represent a complex mosaic of aquatic and terrestrial habitats. This habitat mosaic is produced and maintained by the dynamic nature of stream channels, sediments, and water levels in the floodplain which act in concert to determine the distribution of plant species with varying tolerances for flooding and shading (Fee, Launer and Rottenborn, 1996). Open Water, Fresh Emergent Wetland, and Valley Foothill Riparian habitat types dominate the limnetic and littoral zones of Searsville Lake, as well as those of the Middle and Upper Marsh areas. Approximately 47 acres of Valley Foothill Riparian forest habitat is present at the margins of Searsville Lake near the Corte Madera and Sausal Creek delta, and at the margins of the Middle and Upper Marshes (Figure 3).

While the deeper open water areas have little to no vegetation, shallow slow-moving waters in upper Searsville Lake and the two marshes support aquatic vegetation. Submerged woody debris increases the structural variation of aquatic habitats. Large dense stands of emergent perennial and floating annual herbaceous vegetation, mostly cattails (*Typha latifolia, T. angustifolia*, and *T. domingensis*), rushes (*Scirpus acutus*, *S. macrocarpus,* and *S. robustus*), knotweed (*Polygonum coccineum* and *P. punctatum*), and pondweed (*Potamogeton illinoensis, P. pectinatus, P. pusillus,* and *P. foliosus*), are present throughout the littoral areas of the lake and marshes.

Also present are smaller assemblages of aquatic plants, including American water fern (*Azolla filiculoides*), broad-fruited burreed (*Sparganeum eurycarpum*), common water nymph (*Naias guadalupensis*), common water plantain (*Alisima plantago-aquatica*), upright burhead (*Echinodorus berteroi*), duckweed (*Lemna minor* and *L. minima*), hornwort (*Ceratopyllum demersum*), Pacific marsh purslane (*Ludwigia palustris*), whorl-leafed milfoil (*Myriophyllum verticillatum*), and Pacific oenanthe (*Oenanthe sarmentosa*) (Philippe Cohen, JRBP). The extent to which this annual and perennial herbaceous vegetation is inundated depends on rainfall patterns.

Several non-native aquatic species, introduced from Europe, Eurasia, and South America, are present in low density in Searsville Lake. They include curl-leaved pondweed (*Potamogeton crispus*), yellow iris (*Iris pseudocorus*), parrot feather (*Myriopyllum aquaticum*), and several species of knotweed (*Polygonum aviculare, P. persicaria,* and *P. lapathifolium*) (Phllippe Cohen, JRBP)..

Vegetation around the Middle and Upper Marsh displays a regular succession from perennial herbaceous vegetation followed by willow thicket. Moving to the margins of the marsh, dense stands of young willow thin out leaving more mature willows (*Salix* spp.) and some cottonwoods. Seasonal inundation of the "bathtub fringe" of the Middle and Upper Marshes precludes the establishment of shade-tolerant, late-successional species such as California bay and oaks.

Valley Foothill Riparian habitat on the floodplains of the Corte Madera - Sausal delta in upper Searsville Lake are more dynamic than those in the marshes above (Figure 3). Multiple channels of Corte Madera Creek and other tributary streams change location throughout the floodplain from one flood event to the next as the delta extends into upper Searsville Lake. Continued growth of the deltaic apron has significantly increased the extent of terrestrial riparian habitat in Searsville Lake and reduced the area of aquatic habitat. Fresh Emergent Wetland occupies the edge of the deltaic apron and early successional Valley Foothill Riparian habitat becomes increasingly prevalent further up the floodplain. The riparian forest increases in age and seral stage the further up the delta with increasing distance away from the bathtub fringe.

Valley Foothill Riparian habitat around Searsville Lake generally exhibits a well-developed overstory and understory made up of a relatively small suite of native species and very few exotics. Dominant canopy tree species are limited to black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) and four willow species (*Salix lucida, S. lasiolepsis, S. laevigata* and *S. rhombifolia*) all considered to be early-successional species. Both dogwood and box-elder are abundant understory species, with some box-elder reaching canopy height in mid-seral stage areas. White alder (*Alnus rhombifolia*) is found at scattered locations but represents a relatively small proportion of the canopy trees overall. Only a few individuals of redwood, oak, and California bay (*Umbellaria caifornica*) are present. Poison oak (*Toxicodendron diversilobum*) is common only in the upper portion of the study area (Rottenborn, et al., 1996).

Introduced aquatic species, such as pondweeds, knotweeds, and yellow iris are mostly confined to the margins of Searsville Lake, the Middle Marsh and Upper Marsh. It is likely that both native and non-native aquatic species that have established in Searsville Lake disperse downstream and occupy pockets of suitable habitat in backwater areas beneath gaps in the canopy.

Other than a few scattered stands of giant reed, few exotic tree and shrub species are present in the floodplain above Searsville Lake. Broom, Pampas grass, and yellow star thistle are the primary invasive exotics in the uplands around Searsville Lake (personal communication with Philippe Cohen).

3.1.2 Searsville Dam to Highway 280

In the upstream portion of the project area, the creek abuts undeveloped portions of Stanford University lands above Highway 280 to Searsville Dam (Figure 3). The length of this reach is approximately 3.4 miles. In this reach, the creek assumes a natural form with gradual, sloping banks, wider channels, and few human modifications. The riparian corridor is vegetated by moderate to dense riparian forest that is widest immediately below the dam, followed by a narrowing in width along the right bank opposite JRBP. The riparian corridor becomes relatively narrow from Boething Treeland to Highway 280 where the land on both sides of San Francisquito Creek was formerly cleared for agriculture just beyond the top of bank.

Banks are generally stable and well vegetated. However, there are segments in which banks are nearly vertical and eroding. Canopy closure ranges from approximately sixty to one hundred percent in the majority of the riparian corridor. There appears to be a strong correlation between a high percent of canopy closure and bank stability. There are a few bank segments, particularly in the lower part of this reach from Boething Treeland to Webb Ranch that exhibit a moderate, forty to sixty percent canopy cover and have numerous failing banks where hydraulic forces are maximized.

The occurrences of non-native tree and shrub species are relatively low from Highway 280 to Searsville Lake, with the exception of non-native grasses. Non-native species will be addressed for the project area as a whole in Section 3.1.5.

3.1.2.1 Dominant Habitat Type.

The methods set forth by CCRS state that the dominant biotic habitat is that which occupies the top of bank position to the low bank position where it intersects the channel bottom. According to the CCRS survey, Valley Foothill Riparian is the dominant biotic habitat throughout this reach of San Francisquito Creek. Ground truthing activities support this result but reveal that the biotic habitat types reflect a gradient from mesic conditions at the toe of bank to xeric condition at the top of bank positions. The dominant habitat type within the bed, low bank, and mid bank position is indeed Valley Foothill Riparian but Coastal Oak Woodland tends to dominate in the upper bank and beyond the top of bank positions. Riparian forest vegetation in this reach is composed of moderate to dense stands of native trees and shrub species including coast live oak, California buckeye, California bay at middle bank and upper bank positions; white alder, streamside dogwood (*Cornus sericea*), box elder, big leaf maple (*Acer macrophyllum*) predominantly from mid bank to low bank positions; and black cottonwood and various willow tend to occupy the toe of bank and floodplains contributing to high quality habitat. The size class of the trees in this association range from sapling trees, 1 – 6 inches in diameter at breast height (dbh), to large trees >30 inches in diameter. The predominant size classes of trees in the riparian corridor are small trees (6 – 12 inches) and medium sized trees (12 – 30 inches).

For the purposes of this study, the tendency of the CCRS surveyors to choose to designate a section as Valley Foothill Riparian habitat rather than Coastal Oak Woodland habitat is preferable. This is because Valley Foothill Riparian habitat occupies the mid to lower portions of the channel bank that could have the greatest potential response to hydrologic and geomorphic changes resulting from proposed modifications of Searsville dam.

Searsville Dam to Bear Creek. The reach from Searsville dam to the confluence with Bear Creek is unique in several ways. First, San Francisquito Creek is not deeply incised immediately below Searsville dam for several hundred yards. Rather it flows through rocky floodplains and overbank areas with very little soil deposition or soil development. Secondly, the riparian corridor is at its widest in this reach and is dominated by deciduous riparian forest of a medium to large size class made up of alder, cottonwood, and big leaf maple with occasional California bay. Oaks are present only above the top of bank. The deciduous forest floor is covered by a dense carpet of gnarled woody roots that scarcely penetrate the rocky floodplain. This rocky and somewhat "sediment starved" condition is not uncommon at the base of dams. Further downstream, the floodplains decrease in size and San Francisquito Creek becomes more deeply incised. As a result the suite of deciduous riparian tree species decrease as the banks are dominated by California bay and coast live oak above the Bear Creek confluence. Nonetheless, the deciduous riparian forest in this reach may be an important source of seeds and reproductive plant parts that are seasonally transported downstream.

Lastly, a wide band of serpentine, running along Jasper Ridge to the southeast and trending northwest along Bear Creek, is bisected by this 0.2-mile reach of San Francisquito Creek. Soils developed in serpentine parent material offer potential habitat for an entire suite of rare plant species. While no special-status species were seen under the riparian canopy during field reconnaissance, the potential exists for several rare species in San Francisquito Creek. A list of potential special-status plant species is presented in Table 3 and will be discussed in detail in Section 3.4.1 of this report.

Bear Creek to Highway 280. Large stands of alder and big leaf maple occupy the lower banks, particularly on the north-facing left bank within JRBP. Fewer cottonwood, box elder, and dogwood are present. Also scattered along the creek within the JRBP boundary are three small stands of medium sized, second growth redwood trees on floodplain terraces. Redwood stands typically consist or three to five individual trees or one or more multiple stemmed trees or "fairy rings". These small stands do not enclose a large enough area to be considered a separate biotic habitat. Similar to redwoods, madrone trees were observed singly or in clusters throughout the reach above the top of bank near locations where thin rocky soils or rock outcrops intersect the creek. Valley oaks were seen singly or in sparse clusters throughout the reach within grasslands on older alluvial terraces above the top of bank, particularly along the JRBP fire road from downstream of the Bear Creek confluence to the veterinary center (formerly the Jane Goodall Primate Reserve).

Understory. The dominant understory shrubs present within the Valley Foothill Riparian habitat types vary, primarily according to canopy cover and secondarily to bank position. Breaks in riparian canopy are occupied by native shrubs, such as coyote brush and toyon (*Heteromeles arbutifolia*). Both native and non-native grasses also occupy these areas. Shrubs preferring partial shade, including California coffee berry (*Rhamnus californica*), red flowering current (*Ribes sanguineum*), mugwort (*Artemesia douglasiana*) and poison oak, are found throughout the riparian corridor. Valley Foothill Riparian habitats with full canopy closure exhibit a suite of understory shrubs preferring full shade, including California blackberry (*Rubus ursinus*), woodland strawberry (*Fragaria californica*) and common sword fern (*Polystichum munitum*).

Where longer breaks in the riparian canopy exist, small pockets of shrubs, dominated by coyote brush toyon and toyon, with the addition of California rose, and mule fat (*Baccharis salicifolia*), have evolved in full sun near the top of bank. However, these small shrub associations do not encompass a large enough area to be considered a separate biotic habitat. They exist at highly localized gaps in the riparian canopy. Other riparian forest/shrub ecotones having local moisture from seeps or agricultural runoff, support California blackberry, snowberry (*Symphoricarpos rivularis*), Douglas iris (*Iris douglasiana*), horsetail fern (*Equisetum* spp.), and wood mint (*Stachys bullata*).

3.1.2.2 Vegetation in the Channel

The establishment and re-establishment of vegetation in the channel bed is highly dynamic. Coarse woody debris is stored on flood terraces and in the channel creating blockages that help create pools and trap sediment. Sprouting woody vegetation is abundant in San Francisquito Creek and stabilizes some of the deposited sediment, a process which begins slowly and becomes progressively more effective as the vegetation matures. Perennial herbaceous vegetation, such as sedges, migrate downstream following sediment waves from episodic events over several years. Annual herbaceous vegetation that establishes from seed moving through the riparian corridor, such as watercress is short lived in San Francisquito Creek. It may establish in late spring following a winter sediment pulse, die as the creek dries, and wash seed further downstream or into the bay in the first winter storm.

Willow thickets have become established on several channel bed sections in San Francisquito Creek which receive adequate sunlight. Sand bar willow in particular has established on sandbars that are somewhat protected by upstream thickets, large boulders or bedrock outcrops. Red willow and arroyo willow were seen on overbank deposits in partial shade nearer to canopy margins. Multiple willow species, as well as alder were observed in several backwater areas with a mostly open canopy.

Herbaceous aquatic vegetation is present in discrete locations throughout the channel but has not been extensively surveyed. Reconnaissance of San Francisquito Creek from Highway 280 to Searsville Dam revealed aquatic vegetation on sandbars, pool margins, and abandoned channels. Herbaceous aquatic vegetation was most prevalent in portions of San Francisquito Creek adjacent to the Portola Training Center and Webb Ranch. Aquatic vegetation was least prevalent in the deeply incised segments of the creek having a dense riparian canopy. Little to no aquatic vegetation was seen in the channel adjacent to Boething Treeland or above the Bear Creek confluence.

3.1.3 Highway 280 to San Francisco Bay

The San Francisquito Creek from Highway 280 downstream to San Francisco Bay comprises primarily Valley Foothill Riparian and Coast Live Oak Woodland but also exhibits a high occurrence of non-native tree and shrub species throughout (Figure 4). The length of this reach is approximately 8.7 miles. While the project area, overall, supports vegetation of relatively high value, the non-native invasive species present on the Creek reduce the overall value of the vegetation.

Generally, the vegetation within the San Francisquito Creek follows the evolution of the Creek as it flows through less developed, suburban, and urban settings from Highway 280 upstream to San Francisco Bay downstream. The Creek supports vegetation of higher value upstream where it borders less developed Stanford University lands, open areas, and the Stanford University golf course. The creek channel is wider and less incised in these upstream areas, and fewer homes abut the Creek. In addition, the presence of non-native species is substantially lower.

Downstream, where the Creek enters residential neighborhoods below Stanford Golf Course, homes and lots border the Creek banks. These structures have contributed to unstable banks and erosion. This phenomenon has on occasion necessitated installation of hardscape features such as rock rip-rap, gabions, and concrete walls to bolster the banks. Often, these environments have encouraged pervasive, non-native species like English ivy (*Hedera helix*), Cape ivy (*Senecio mikaniodes*), Himalayan blackberry (*Rubus discolor*), giant reed, tree-of-heaven (*Alianthus altissima*) and others to out compete and replace native species.

3.1.3.1 Dominant Habitat Type.

Similar to the upper reach, Valley Foothill Riparian remains the dominant biotic habitat type. Coastal Oak Woodland habitat occasionally co-dominates. The predominant tree size class for both Valley Foothill Riparian and Coastal Oak Woodland habitat types remain small (6 – 12 inches) to medium sized (12 – 30 inches) throughout the lower riparian corridor. Canopy closure ranges from approximately forty to one hundred percent, but tends to be more moderate in the lower reaches. The width of the riparian corridor is somewhat narrow throughout all reaches below the Golf Course.

Unlike the upper reach in which high quality native vegetation persists in all portions of the stream, the dominant riparian forest vegetation in this reach is composed of significant non-native trees and shrubs. Urban habitat exhibiting more than 25% non-native species is dominant along forty-six portions of the channel that are greater than 150 feet in length. Eucalyptus, Shrub and Herbaceous habitats, comprised of greater than 50% non-natives, predominated on a combined total of 15 bank portions that exceed 150 in length.

Highway 280 to El Camino Real. Below Highway 280, the creek borders the Stanford University golf course, other University lands with limited development, and a few residential homes. Habitat quality in this area is relatively high due to the prevalence of native vegetation and the absence of hardscape features. Valley Foothill Riparian habitat is dominant throughout. Redwood, Valley Oak Woodland, and Eucalyptus habitat types also occur occasionally. Non-native shrubs occur in quantities less than 25% in the understory in this reach (Figure 4).

Patches of redwoods are scattered along the upstream end of this reach, particularly near Stanford University lands paralleling Sand Hill Road. According to Jim Johnson, Stream Keeper with the Coordinated Resource Management and Planning group (CRMP), these redwoods are native to the San Francisquito Creek riparian corridor and are at a transition point in their range due to the shift from more marine influenced areas of the northern peninsula to the more mesic Santa Clara Valley watersheds (Johnson pers. int.). Johnson notes that Spanish explorers recorded these redwoods during the late 1700s. Only 1.5% of the Creek from Highway 280 to Highway 101 is composed of Redwood habitat.

Valley Oak Woodland is relatively scarce, covering only 0.5% of the San Francisquito Creek from Highway 280 to El Camino Real. The few areas that do exist are mostly found at the upstream end of the project area adjacent to the Stanford University golf course. Valley oak trees are much less dominant than coast live oak trees on San Francisquito Creek.

Stands of eucalyptus are prevalent along Stanford University lands near Sand Hill Road where more open and undeveloped areas border the Creek. Although non-native species, eucalyptus trees were separated from the Urban category since they form such dense and prominent groves.

El Camino Real to Highway 101. Where the Creek passes El Camino Real and borders the Cities of Menlo Park and Palo Alto, it enters a more pronounced suburban environment as residential homes and lots abut the Creek's banks. Due to the prevalence of adjacent houses, additional improvements such as hardscape features and bridges have been added to stabilize the channel. Non-native and ornamental vegetation becomes more pronounced within the riparian corridor and the creek exhibits a moderate habitat quality. While native Valley Foothill Riparian habitat is prevalent, this area is composed of more Urban habitat than the upstream reaches. Eucalyptus groves, however, become increasingly scarce downstream as the Creek becomes more channelized and enters suburban and urban areas.

Highway 101 to San Francisco Bay. At the downstream end of the project area where the Creek borders the City of East Palo Alto to the north and the City of Palo Alto to the south, the Creek continues moving through a more urbanized setting until it approaches Palo Alto Municipal Golf Course and ultimately San Francisco Bay. In those reaches, it has been heavily modified with lengthy expanses of continuous concrete walls. Saline Emergent Wetland habitat predominates within the low inter-tidal zone of this reach. Hence, it only comprises a small percent of the entire project area. Tidal water enters pockets of freshwater emergent wetland along the Creek from the bay encouraging the growth of saline emergent wetland plants such as pickleweed (*Salicornia* ssp.) and saltgrass. Upstream of where the creek enters the bay, a small stand of willows is present within the brackish marsh.

The 1.1-mile reach from Highway 101 through the Palo Alto Municipal Golf Course to San Francisco Bay was not extensively inventoried for this study because it is periodically dredged. Thus, biotic impacts based on potential geomorphic and hydrological changes originating at Searsville Lake are considered to be negligible compared to the current effects of dredging.

Understory. The dominant understory shrubs present within the biotic habitat types in the reach from Highway 280 to San Francisco Bay vary to a greater degree than the native understory above Highway 280. Below Highway 280 through the Stanford Golf Course the understory association initially mirrors that described for Highway 280 to Searsville Dam. Then from Sand Hill Road through El Camino Real, Highway 101, and down to the Bay, the percentage of native plants in the understory steadily reduces until it comprises less than 50 % of the understory. The non-native component of the understory in these reaches includes invasive exotic species described in Section 3.1.5, as well as, multiple ornamental shrubs commonly used by homeowners for landscaping. Several portions of the stream are occupied by dense stands of eucalyptus trees whose leaf litter inhibits the establishment of understory shrubs and herbs. Non-native grasses occupy the understory in many of the portions of the creek in these reaches that have a sparse or open canopy.

3.1.3.2 Vegetation in the Channel.

The establishment and re-establishment of vegetation in the stream channel remains very dynamic in depositional reaches from Highway 280 to Highway 101. Sprouting woody and herbaceous vegetation stabilizes deposited sediments on sandbars, protected areas downstream of outcrops, backwater pool margins, and overbank areas where the creek bisects canopy breaks and/or stream crossings, particularly in reaches adjacent to the Stanford Golf Course and University lands. Willow thickets, alder, and cottonwood have become established on several channel bed sections with open to sparse canopies. Tules, rushes, sedges, watercress, and other emergent herbaceous species are most prevalent in open creek areas within the Stanford Golf

Course in which the riparian canopy has been deliberately reduced to maintain access roads, cross-creek fairways, and viewsheds.

In-channel woody and herbaceous vegetation is sharply reduced from El Camino Real to Highway 101 due to the highly incised nature of the channel, the prevalence of hardscape features, and drying of the stream in summer. The presence of extensive hardscape in the channel further reduces the amount of perennial moist, protected areas for the establishment of aquatic vegetation and increases the vulnerability of that vegetation to episodic events. Summer drying of the streambed also results in shorter establishment periods for woody perennials and thus increases the prevalence of herbaceous vegetation in the streambed. Lastly, stream channel vegetation in this reach is periodically reduced or removed during flood control maintenance activities. Streambed vegetation adjacent to Palo Alto Golf Course from Highway 101 to San Francisco Bay is also periodically removed during dredging activities.

3.1.4 Native Plant Species in All Reaches

Table 1 lists the common native tree and shrub species found within the project area, the habitat type in which they would generally fall, as well as their typical location along the creek bank or top of bank region. Table 1 was modified from the San Francisquito Creek Existing Conditions Report (H.T. Harvey & Associates, 1999) to include species occurring above Junipero Serra Boulevard to Searsville Dam. Of the eleven habitat types identified, the Valley Foothill Riparian, the Coast Live Oak Woodland, and the Shrub types are the categories in which the bulk of the common native plants fall. If a stream segment is characterized by one of the other eight habitat types, some native species may exist within it, but the Valley Foothill Riparian , Coastal Oak Woodland, and Shrub biotic habitat types generally have the highest concentration of native plants.

The overall riparian corridor is dominated by coast live oak trees on the mid to upper banks and the upland areas. These trees normally characterize the Coast Live Oak Woodland habitat type. Other native trees that fall within this assemblage and are prevalent along the Creek include California bay and California buckeye. These trees not only form a protective overstory canopy creating shaded riverine aquatic habitat, but the acorns from the oak and the buckeye flowers are a good food source for wildlife. Shrubs like California blackberry, California rose, coyote brush, mugwort, poison oak, and toyon form a native understory layer. The plants within the Coast Live Oak Woodland habitat type are generally drought tolerant and are adapted to upper bank locations.

Table 1. Common Native Species, Their Bank Location, and General Habitat Type Within the Project Area.								
Common Name	**Scientific Name**	**Bank Location***				**Habitat Type**		
		LB	**MB**	**UB**	**UP**	**COW**	**VRI**	**SHRUB**
alder	*Alnus rhombifolia*	x					x	
arroyo willow	*Salix lasiolepis*	x					x	
big-leaf maple	*Acer macrophyllum*		x	x			x	
box elder	*Acer negundo*		x	x	x		x	
California bay	*Umbellularia californica*			x	x	x		
California blackberry	*Rubus ursinus*	x	x	x		x	x	x
California buckeye	*Aesculus californica*		x	x	x	x	x	
California rose	*Rosa californica*	x	x	x		x	x	x
California sycamore	*Platanus racemosa*	x	x				x	
coast live oak	*Quercus agrifolia*		x	x	x	x		
coyote brush	*Baccharis pilularis*		x	x	x	x		x
Fremont cottonwood	*Populus fremontii* ssp. *fremontii*	x	x				x	
Mexican elderberry	*Sambucus mexicana*			x	x		x	
mugwort	*Artemisia douglasiana*	x	x			x	x	x
Oregon ash	*Fraxinus latifolia*	x	x				x	
poison oak	*Toxicodendron diversilobum*		x	x	x	x	x	x
red willow	*Salix laevigata*	x	x				x	
sand bar willow	*Salix exigua*	x					x	
toyon	*Heteromeles arbutifolia*		x	x	x	x		

* LB=Lower Bank, MB=Mid Bank, UB=Upper Bank, UP=Upland

However, the project area of greatest concern, comprises the mid to low bank positions and streambed itself where Valley Foothill Riparian habitat type dominates. Red willow, arroyo willow, and Fremont cottonwood are the three main species that characterize the Valley Foothill Riparian habitat. Adapted to moist conditions and frequent inundation, these species are primarily located on the lower creek banks, within the channel itself, and throughout upper Searsville Lake and the Middle and Upper Marsh. Sand bar willow was observed less frequently but is a part of this assemblage. Other tree species adapted to moist conditions that are common within the project area include alder, big-leaf maple, box elder, California sycamore, and Oregon ash. Most of these species are found on the lower creek banks as opposed to within the creek channel itself. A shrub layer may also be present and includes many of the same species found within the Coast Live Oak Woodland habitat such as California blackberry, California rose, mugwort, and poison oak. These four species can tolerate moister conditions.

California blackberry, California rose, coyote brush, mugwort, poison oak, and Mexican elderberry are some common, native shrub species present within San Francisquito Creek. The Shrub habitat type was used when only shrubs were present and an overstory was lacking.

3.1.5 Non-Native Species in All Reaches

The occurrence of non-native species within the San Francisquito Creek riparian corridor increases from upstream to downstream as the creek evolves from a more natural setting to a more suburban and urban environment closer to San Francisco Bay. Fewer non-natives exist upstream of Highway 280, with the exception of introduced aquatic species within Searsville Lake itself previously described in Section 3.1.1.

Common, non-native tree and shrub species within the bed and banks of San Francisquito Creek from below the dam to the bay are shown in Table 2. Table 2 was modified from the San Francisquito Creek Existing Conditions Report (H.T. Harvey & Associates, 1999) to include species occurring above Junipero Serra Boulevard to Searsville Dam.

Table 2. Common Non-Native Tree and Shrub Species Within the Project Area.

Common Name	Scientific Name
acacia	*Acacia* spp.
black locust	*Robinia pseudoacacia*
broom	*Cytisus* spp.
Cape ivy	*Senecio mikaniodes*
English ivy	*Hedera helix*
eucalyptus	*Eucalyptus* spp.
fennel	*Foeniculum vulgare*
giant reed	*Arundo donax*
Himalayan blackberry	*Rubus discolor*
periwinkle	*Vinca major*
pampas grass	*Cortaderia jubata*
tamarisk	*Tamarix* spp.
tree-of-heaven	*Ailanthus altissima*

Many of these common non-native species are found on the California Exotic Pest Plant Council list of exotic pest plants of greatest concern (Cal EPPC 1996). Giant reed, broom, fennel, English ivy, Himalayan blackberry, and German ivy are located on Cal EPPC's List A1: Most Invasive Wildland Pest Plants; Widespread. Tree-of-heaven, black locust, and periwinkle are found on List B: Wildland Pest Plants of Lesser Invasiveness.

Invasive Non-native Trees within the Bed and Banks. Of the main, non-native trees present along San Francisquito Creek, species of eucalyptus are the most common, occurring in extensive groves particularly in the portion of the project area below Highway 280. Regions particularly dense with eucalyptus stands include the stretch of the Creek paralleling Sand Hill

Road where the Creek borders the City of Menlo Park and Stanford University lands. Native to Australia, eucalyptus may pose specific problems to native species due to their allelopathic properties. Because of toxins and tannins present within their leaves and bark, these substances can leach into the surrounding soil, altering the ability of native plants to colonize these areas. Eucalyptus trees do, however, provide habitat for nesting raptors. Acacia, black locust, and tree-of-heaven are smaller, non-native trees that have infiltrated the San Francisquito Creek project area and can be found in patches below Highway 280.

Few non-native trees were seen from Highway 280 to Searsville Dam. Occasional black walnut (*Juglans hindsii*) and fruit trees were observed near the top of bank in the agricultural areas east of the JRBP boundary from Boething Treeland to Webb Ranch.

Invasive Non-native Shrubs on the Stream Banks. English ivy, Cape ivy, Himalayan blackberry, and periwinkle are some of the most extensive non-native shrubs that span the project area from Highway 280 to Highway 101. All four are low-lying species that form dense thickets that limit colonization by native species. English ivy and Cape ivy are both capable of growing atop hardscape features like concrete walls and gabion baskets and up tree trunks and limbs. Cape ivy also has the ability to root at every leaf node and along the stem. Tiny portions of stem can survive for long periods of time before resprouting making this species highly invasive. Himalayan blackberry, a native of Eurasia, often displaces the native California blackberry. However, the fruit of Himalayan blackberry provides some value to wildlife and therefore is not viewed as having a high invasive threat.

Fennel, giant reed, and species of broom are also common non-native shrub species that occur along San Francisquito Creek. All three have the ability to form clonal patches that preclude colonization by native species. Giant reed can clog waterways because of its dense growth form. Fennel, giant reed, and broom are particularly noxious because of their abilities to invade rapidly and form monocultural areas. Fennel and broom are the most pervasive non-native shrubs above Highway 280 to Searsville Dam.

Invasive Non-native Species in the Streambed. Of the invasive non-native species described above, giant reed, acacia, and eucalyptus tend to colonize sandy floodplains in the reaches below Highway 280. These species may clog waterways leading to flow reduction and flood dangers in some segments of the creek. However, periodic flood control maintenance in the lower reaches, which includes removal of native and non-native woody vegetation on streambed sandbars, tends to mitigate this trend. English ivy, Cape ivy, periwinkle and Himalayan blackberry commonly occupy banks down to the ordinary high water mark but tend to stop at the water's edge.

Introduced aquatic species in Searsville Lake, the Middle and Upper Marsh such as pondweeds yellow iris, and knotweeds are relatively confined to the margins of open water in the Fresh Emergent Marsh biotic habitats. Nonetheless, both native and non-native aquatic species that have established in Searsville Lake have likely dispersed downstream to occupy small pockets of suitable habitat in the streambed. Such aquatic plant assemblages have been observed in the fringe of backwater ponds, scour pools, protected areas downstream of outcrops, and sandbar margins where the creek bisects large gaps in the tree canopy. Such assemblages were more prevalent upstream of Highway 280 where perennial pools exist. Fewer aquatic plant communities exist in reaches downstream of Highway 280 where San Francisquito Creek runs dry in summer.

3.1.6 Woody Debris

The size and amount of woody debris upstream of Highway 280 is greater than that in the more urbanized reach below Highway 280. Where earthen banks dominate in the upper portions of San Francisquito Creek, episodic erosional events tend to disrupt a wider swath of the riparian corridor and yield much greater amounts of large woody debris. Conversely, in the lower reach of the creek where hardscape structure inhibit lateral movement of the channel, there is little large woody debris but a greater amount of small depositional woody debris. There are numerous sections above Highway 280 where greater incision and/or lateral movement of the stream have undercut banks, there is a correlating increase in woody debris in the channel downstream of eroded banks. The presence of large woody debris in the stream increases channel diversity and habitat for amphibians and fish. Since the dam acts as an effective barrier to recruitment of large woody debris from the upper watershed, most of the large woody debris appears to have been recruited from within San Francisquito Creek and its tributaries.

Reconnaissance-level survey of San Francisquito Creek from Highway 280 to Searsville dam revealed the presence of large woody debris, including snags, root wads, and stumps in the channel, as well as multiple fallen logs on the banks awaiting recruitment during a large flood event. There are also several large pipes and steel debris in the bed and banks. Large woody debris was observed throughout the reach, but particularly at sharp bends in the creek below the Bear Creek, East, Central, and West Tributaries. Alan Launer's students in every 250-meter segment surveyed from Webb Ranch to Searsville Dam recorded an average of one piece of large woody debris. The two largest "log jams" were recorded below where the Boething Treeland trail crosses San Francisquito Creek and the other approximately 500 meters downstream of the Bear Creek confluence.

3.1.7 Response of Riparian Vegetation to Seasonal Drying of Creek

Little is known regarding the seasonal changes in the water table in San Francisquito Creek from Searsville Lake to San Francisco Bay. While lower portions of the creek below Junipero Serra Boulevard go dry by late summer, most of the reaches above Junipero Serra Boulevard retain some perennial flow. Most of the riparian species that has established within the bed and banks of San Francisquito Creek are adapted to the seasonal variation associated with periods of flooding, as well as periods of drought when water in the channel and underlying alluvium decreases consistent with a Mediterranean climate. Most riparian species have highly individualized physiological responses and adaptive strategies to such wet and dry periods. Plants occupying the toe of slope position closest to the channel are most tolerant of frequent inundation, hydric conditions, and varying levels of scouring.

Conversely, species occupying the top of bank or beyond tend to be drought tolerant and adapted to minimal moisture inputs from the creek. A characteristic common to most riparian vegetation is that they are adapted to episodic flooding and drought. Transient increases and decreases in riparian evapotranspirative rates follow such events and ameliorates effects on populations.

However, the upper limits of tolerance for the severity, extent, and frequency of flood or drought events varies greatly from species to species. Limits of tolerance to drought for example, would be reached earlier in the aquatic herbaceous plant communities in the perennial backwater pools than in the valley oak /grassland community at the top of bank.

3.1.8 Trends

3.1.8.1 Eradication of Non-native Species

Over the years, invasive non-native plants have displaced many of the native plant species along San Francisquito Creek below Sand Hill Road. These non-native plants reduce the diversity necessary to support a rich riparian habitat, and usually provide reduced food and habitat for wildlife species. Non-native species threaten the creek by reducing or preventing the colonization of an area by native plants. However, non-natives do have some value as they stabilize banks and provide vegetation cover but may have limited erosion control properties compared to native, woody species.

Replacement of non-native plant species with native species will help improve water quality and promote proper absorption of rainfall, reducing erosion and damage to property. Programs of non-native species removal should be a gradual effort taking into account geomorphic constraints and including a program of native species replanting and continuous maintenance efforts to control resprouting and new recruitment of invasive non-natives.

The Coordinated Resource Management and Planning group (CRMP) has begun limited programs of non-native removal of some of the most pervasive species at targeted locations along San Francisquito Creek. According to Jim Johnson, CRMP has removed patches of giant reed, German ivy, and tamarisk (*Tamarix* spp.) along San Francisquito Creek and begun to revegetate the areas with native plants (Johnson, pers. int.) Two clumps of giant reed directly upstream of the University Avenue Bridge in East Palo Alto were cut and sprayed with a glyphosate herbicide comprised of a non-ionic surfactant approved by the California Department of Fish and Game (CDFG). The CRMP plans to focus on other regions of non-natives such as Cape ivy, pampas grass, and other giant reed patches in the future.

3.1.8.2 Bank Stabilization

The combination of unplanned and unconnected bank stabilization efforts below Sand Hill Road and the uncontrolled spread of non-natives have reduced the creek's capability to successfully withstand flood events and have caused severe bank erosion in several locations. A properly designed bank stabilization project will be an effective method of reducing erosion and flood damage while at the same time improving habitat, limiting maintenance costs, and minimizing effects on water velocities. To that end, the San Francisquito Creek Bank Revegetation Project was initiated in 1998. The project consisted of two phases. Phase One resulted in the San Francisquito Creek Existing Conditions Report (H.T. Harvey & Associates, 1998) and Phase Two resulted in the development of the San Francisquito Creek Bank Stabilization and Revegetation Master Plan Report (H. T. Harvey & Associates, et. al., 2000). Data from both of these reports has supplemented this current study.

3.1.8.3 Creek Restoration

Since the completion of the Master Plan, the San Francisquito Creek Joint Powers Authority has been successful in securing several grants to implement restoration programs, as well as long-term funding sources to further study flood control problems in the San Francisquito Creek watershed.

Current funding totals over $1.6 million from a combination of sources, including Proposition 12 Water Bond and the Coastal Conservancy. Congress is expected to approve a seven-year, $10 million U.S. Army Corps of Engineers study in May of 2001.

3.2 NON FEDERALLY-LISTED WILDLIFE SPECIES

Searsville Lake

The open water habitats within the Searsville Lake support several species of fishes, including the California roach (*Hysperculus symmetricus*), threespine stickleback (*Gasterosteus aculateus*), mosquitofish, bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), and pumpkinseed (*Lepomis gibbosus*). Amphibians such as the western toad, Pacific treefrog, and bullfrog are present in the lake as well. Western pond turtles (*Clemmys marmorata*) are present in the lake and likely move through the site. Waterbirds such as the Mallard (*Anas platyrhynchos*), Common Merganser (*Mergus merganser*), Green Heron (*Butorides virescens*), and Belted Kingfisher (*Ceryle alcyon*) forage in these lakes. Several species of bats, such as Yuma myotis (*Myotis yumanensis*), California myotis (*M. californicus*), Mexican free-tailed bat (*Tadarida brasiliensis*), hoary bat (*Lasiurus cinereous*), and western red bat (*L. blossevillii*) forage over the open waters of the lake.

Searsville Dam to Highway 280

Lowland riparian habitats support the highest wildlife diversity of any habitat type in western North America. Although much of the riparian habitat along the San Francisco Peninsula has been severely degraded by a number of factors, the riparian habitat along parts of the San Francisquito Creek is of fairly high quality in terms of its value to wildlife. Urban encroachment and the high number of exotic plants in this habitat do limit the value of these sites; however, the dense vegetation with the adjacent perennial San Francisquito Creek provides cover and foraging habitat for a wide variety of terrestrial vertebrates (Figures 3 and 4).

Amphibians expected to occur in the riparian habitats on the project site include species such as the western toad, Pacific treefrog, bullfrog, California slender salamander (*Batrachoceps attenuatus*), California coast newt (*Taricha tarosa*) and arboreal salamander (*Aneides lugubris*). The western pond turtle could potentially occur in the upper reaches of the creek riparian, and could possibly breed or hibernate in this habitat. Also present in these riparian habitats are lizards, such as the western fence lizard (*Sceloporus occidentalis*), western skink (*Eumeces skiltonianus*), and southern alligator lizard (*Elgaria multicarinata*), and snakes, such as the gopher snake (*Pituophis melanoleucus*), common garter snake (*Thamnophis sirtalis*), and racer (*Coluber constrictor*). Mammals present include the deer mouse (*Peromyscus maniculatus*), broad-footed mole (*Scapanus latimanus*), fox squirrel (*Sciurus niger*), eastern gray squirrel (*S. carolinensis*), opossum (*Didelphis virginianus*), raccoon (*Procyon lotor*), and striped skunk (*Mephitis mephitis*). Several species of bats tolerant of anthropogenic influences, including the Yuma bat (*Myotis yumanensis*), big brown bat (*Eptesicus fuscus*), and Mexican free-tailed bat (*Tadarida brasiliensis*), forage over these riparian habitats. Townsend's big-eared bat, and possibly the pallid bat, roost in rocky grottos below and immediately adjacent to the dam face.

Birds using these riparian habitats represent the most diverse vertebrate community present. A number of bird species on the site are resident year-round, breeding in the riparian habitats in spring and summer and using them for cover and foraging during the non-breeding season. Common species nesting and foraging primarily in the canopies of coast live oaks, willows, and other trees include the Chestnut-backed Chickadee (*Poecile rufescens*), Bushtit (*Psaltriparus minimus*), and Downy Woodpecker (*Picoides pubescens*). Other resident species, such as the Bewick's Wren (*Thryomanes bewickii*), California Towhee (*Pipilo crissalis*), and Song Sparrow (*Melospiza melodia*), nest and forage on or very close to the ground, usually in dense vegetation. Several species of raptors, including the Cooper's (*Accipiter cooperii*) and Red-shouldered Hawks (*Buteo lineatus*), and other birds such as the Anna's Hummingbird (*Calypte anna*) may nest in the riparian habitat and are found here year-round.

In addition to the permanent residents, several species of Neotropical migrants use this habitat from spring through fall, with a few breeding on the site. The Bullock's Oriole (*Icterus bullockii*) and Allen's Hummingbird (*Selasphorus sasin*) breed in these habitats, and the Pacific-slope Flycatcher (*Empidonax dificilis*), Warbling Vireo (*Vireo gilvus*), Black-headed Grosbeak (*Pheucticus melanoleucus*), California Yellow Warbler (*Dendroica petechia brewsteri*), and other Neotropical migrants are present during migration.

Other species are present primarily during winter, when they use these riparian habitats for foraging and cover. These species include the Ruby-crowned Kinglet (*Regulus calendula*), Hermit Thrush (*Catharus guttatus*), Yellow-rumped Warbler (*Dendroica coronata*), and Fox (*Passerella iliaca*), Lincoln's (*Melospiza lincolnii*), White-crowned (*Zonotrichia leucophrys*), and Golden-crowned (*Zonotrichia atricapilla*) Sparrows.

3.2.3 Highway 280 to San Francisco Bay

Riparian woodlands found in the upper watershed represent some of the most important wildlife habitats due to their high floristic and structural diversity, high biomass (and therefore high food abundance), and high water availability. In addition to providing breeding, foraging, and roosting habitat for a diverse array of animals, riparian habitats also provide movement corridors for some species, connecting a variety of habitats throughout the region. The riparian habitat along these reaches is less disturbed (and therefore more intact) than the lower watershed. Many of the species occurring in the lower watershed also occur in the upper watershed, but the Searsville Reservoir complex in the upper watershed provides habitats for many species of waterfowl and other vertebrates not occurring in the lower watershed. However, high numbers of non-native predatory species occur in the Searsville Reservoir that may limit the successful breeding of some native species (e.g., large-mouth bass prey on Wood Duck [*Aix sponsa*] chicks.

Leaf litter, fallen tree branches, and logs provide cover for the California newt, slender salamander, arboreal salamander, western toad, and Pacific treefrog. The western fence lizard, western skink, and southern alligator lizard are also expected to occur here, as are several snake species, including the western rattlesnake (*Crotalus viridis*), western terrestrial garter snake, and common kingsnake (*Lampropeltis getula*).

The cottonwoods, willows, and alders along San Francisquito Creek may attract a number of avian species to the riparian habitat. A number of bird species on the site are resident year-round, breeding in these riparian habitats in spring and summer and using them for cover and foraging during the non-breeding season. Common species nesting and foraging primarily in the riparian tree canopies include the Chestnut-backed Chickadee, Bushtit, Oak Titmouse, White-breasted Nuthatch (*Sitta carolinensis*), Hutton's Vireo (*Vireo huttoni*), and Nuttall's (*Picoides nuttallii*) and Downy Woodpeckers (*Picoides pubescens*). Other resident species, such as the Bewick's Wren (*Thryomanes bewickii*), California and Spotted Towhees (*Pipilo maculatus*), and Song Sparrow (*Melospiza melodia*), nest and forage on or very close to the ground, usually in dense vegetation. Several species of raptors, including the Cooper's Hawk, Red-shouldered Hawk, Western Screech-Owl (*Otus kennicottii*), and others may nest in the riparian habitat and are found here year-round.

Acorn Woodpeckers maintain graineries (caches of acorns), and may nest, in some of the white alder snags as well as in the dead branches of the sycamores. In addition, these deadwood areas provide nesting habitat for many of the cavity-nesting songbirds, such as Ash-throated Flycatcher (*Myiarchus cinerascens*), House Wren (*Troglodytes aedon*), and Nutall's Woodpecker.

The large stands of willows and alders together with other larger trees surrounding the Searsville Reservoir complex provides habitat for numerous passerine bird species. In addition to the permanent residents, many species of Neotropical migrants use this habitat from spring through fall, with many breeding on the site. The Allen's Hummingbird (*Selasphorus sasin*), Ash-throated and Pacific-slope Flycatchers (*Empidonax dificilis*), Olive-sided Flycatcher (*Contopus cooperi*), Western Wood-Pewee (*Contopus sordidulus*), Warbling Vireo (*Vireo gilvus*), Swainson's Thrush (*Catharus ustulatus*), Black-headed Grosbeak (*Pheucticus melanoleucus*), House Wren, Orange-crowned Warbler (*Vermivora celata*), Wilson's Warbler (*Wilsonia pusilla*), and possibly the California Yellow Warbler could potentially breed in the riparian habitat on the project site. Other Neotropical migrants, including the Rufous Hummingbird (*Selasphorus rufus*), Willow Flycatcher (*Empidonax traillii*), Western Tanager (*Piranga ludoviciana*), and others are likely to occur on the study site only as migrants. During spring and fall migration, Neotropical migrant densities can be quite high in these habitats.

Other species are present in these riparian habitats primarily during winter, when they use these habitats for foraging and cover. These species include the Red-breasted Sapsucker (*Sphyrapicus ruber*), Ruby-crowned Kinglet, Winter Wren (*Troglodytes troglodytes*), Hermit Thrush (*Catharus guttatus*), Yellow-rumped (*Dendroica coronata*) and Townsend's Warblers (*Dendroica townsendii*), and Fox (*Passerella iliaca*), Lincoln's (*Melospiza lincolnii*), White-crowned (*Zonotrichia leucophrys)*, and Golden-crowned (*Zonotrichia atricapilla*) Sparrows.

A variety of mammals also occur in these woodlands. Small mammals, such as the ornate shrew (*Sorex ornatus*), California vole (*Microtus californicus*), Botta's pocket gopher, and deer mouse may burrow or find refuge in dense grass or brushy thickets in riparian areas. Black-tailed deer frequently use riparian habitats. Predators, such as the raccoon, long-tailed weasel (*Mustela frenata*), coyote (*Canis latrans*), and bobcat (*Lynx rufus*), are attracted to riparian woodlands by the abundance of prey and cover. In addition, the taller sycamores provide daytime roosts for nocturnal species such as the raccoon, Virginia opossum (*Didelphis virginiana*), and possibly the ringtail (*Bassariscus astutus*).

The base of the reservoir has several pockets or small caves along the rocky walls, possibly created during the bedrock excavation for the dam installation. These small caves provide roosting habitat for some bats, including the Townsend's big-eared bat and the coastal pallid bat (*Antrozous pallidus pacificus*). Other bat species, such the hoary and red bats (*Lasiurus cinereus* and *L. blossevillii*) roost in riparian-associated trees.

3.3 INVASIVE AQUATIC SPECIES OF CONCERN

Several exotic species suspected or known to impact California red-legged frogs are present in San Francisquito Creek. These species include bullfrogs, largemouth bass, bluegill, green sunfish, bullhead catfish, mosquitofish, Louisiana red-swamp crayfish, signal crayfish and Chinese mitten crabs.

3.3.1 Bullfrogs

Bullfrogs are large aquatic frogs attaining lengths in excess of 6 inches. The dorsal color is usually a dull green, but may be brownish. Some specimens are dark gray to black. There are usually no markings on the dorsal surface. The ventral surface often ranges between shades of white to yellow. They have little or no dorsolateral ridges. The tympanic membrane is large, in females it is roughly equal to the size of the eye and in males it is considerably larger than the eye.

3.3.1.1 Ecology

Adults are opportunistic feeders taking both aquatic and terrestrial prey items. Invertebrates are the primary food (Frost 1935, Korschgen and Moyle 1955, Cohen and Howard 1958, Taylor and Michael 1971). Vertebrate prey such as fish, salamanders, frogs (including bullfrogs) and tadpoles, snakes, turtles, birds, and mice are also taken. Adult bullfrogs in San Francisquito Creek were found to have been preying on a variety of prey from small insects to other bullfrogs, crayfish, and even a small bird (Launer and Holtgrieve 2000). Tadpoles feed primarily on algae and diatoms, but may also consume plant material (Dickerson 1906, Treanor and Nicola 1972) and animal food (Stebbins 1951, Brown 1972, Treanor and Nicola 1972).

Bullfrogs inhabit quiet waters of ponds, lakes, reservoirs, irrigation ditches, streams, marshes, and other permanent water (e.g., Searsville Reservoir, Skipper's Pond, and Felt Pond; Stebbins 1954). Permanent water is required for the completion of larval development, which usually takes two years. Wright and Wright (1949) indicated shoreline cover, and shallow water as important habitats for adults and tadpoles, respectively. Dickerson (1906) suggested that bullfrogs prefer deep water with shallow margins and a cover of submerged and emergent vegetation. The survival of larval and adult bullfrogs was reduced in ponds where vegetation cover and debris were lacking (Brown 1972). This habitat preference overlaps with that of California red-legged frogs, except that shallow margins are not particularly favored by California red-legged frogs. In cold climates, adults may hibernate underwater beneath submerged debris or mud (Willis et al. 1956).

Although, this species occurs near permanent or semi-permanent water, adults often travel considerable distances from water during storm events. Dispersal of juveniles away from breeding sites may occur without rain. These movements by adults are commonly observed during warm fall, winter, or spring rains. No significant migration by adults from breeding sites has been recorded. In August and September, newly transformed juveniles are often seen over 50 m (155 ft) from water in the Central Valley. They are presumably dispersing from rapidly drying ponds where their development took place. At a pond in Ontario, Currie and Bellis (1969) reported that average bullfrog activity areas had radii of about 3.2 m (10 ft). The longest intrapond movement observed was 12 m (37 ft). Males had larger areas of activity than females, and large frogs moved more than small ones. Observations of bullfrogs away from water were not reported in surveys of San Francisquito Creek.

Males defend areas around themselves for sexual display during the breeding season. Males may use emergent vegetation and floating debris to call from. Territories are defended against other bullfrogs by stereotyped postures, vocalizations, and physical combat (Wiewandt 1969, Ryan 1980). Females lay eggs within the territories of chosen males.

In California, breeding and egg-laying occur from March to July (Stebbins 1972). Females deposit 10,000 to 20,000 eggs in disk-shaped masses about 1 egg thick and 1 to 5 ft in diameter (Stebbins 1972). The eggs are deposited among aquatic plants growing on the bottom (Stebbins 1954). In some localities they may produce more than one clutch per season (Emlen 1977). Tadpoles use shallow waters near shore for at least six months while completing development. Tadpoles may reach 14 cm (5.5 in) in length and require at least six months to transform. However, individuals in many populations overwinter as tadpoles and transform during their second year (Treanor and Nicola 1972). This overwintering of tadpoles can be a determining factor in a population successfully occupying a particular area. For example, if a pond dries up annually or a stream (ie., San Francisquito Creek) experiences high winter flows then a population may never be able to become established (see below). Bullfrog tadpoles are preyed upon by aquatic insects, fish, garter snakes, wading birds, and probably a few nocturnal mammals (Nussbaum et al. 1983). Juvenile and adult bullfrogs are taken by a wide variety of vertebrate predators.

3.3.1.2 Distribution

Native to the eastern United States, the bullfrog was introduced to California several times early this century (Heard 1904; Storer 1922). It is now widespread and common in the state (Bury and Luckenbach 1976). Bullfrogs are absent from the high Sierra, with few populations above 1220 m (4026 ft). In desert regions, they occur along the Mojave and Colorado rivers and in areas where irrigation creates suitable habitat. Elevation ranges from sea level to 1830 m (6000 ft).

Within the San Francisco Bay Area, bullfrogs are known from all major rivers and creeks, especially in the urbanized lowland areas where these creeks have become channelized, but they have also spread to the foothills (Gilchrist et al 1995). Within San Francisquito Creek, bullfrogs are found to be concentrated within the first 1000 meters downstream from Searsville Dam (Figure 5). In particular, 14 adult, 3 juvenile, and 21 tadpole bullfrogs were observed within pools 9 and 44 of Launer and Holtgrieve (2000). This number is a decrease from the 23 adults and more than 135 tadpoles observed the proceeding year. Individuals have also been found in further downstream segments of the creek, (i.e., Webb Ranch and Stanford Golf Course) but in much lower densities than below the dam (Figure 5). This distribution is probably due to the fact that the Searsville Reservoir complex contains a large actively reproducing population (161 bullfrogs were observed in 1999; Launer and Holtgrieve 2000), which is acting as a source for individuals spilling over into San Francisquito Creek. Though no egg masses have been observed, bullfrogs may be reproducing within the creek due to the presence of both tadpoles and adults. Even if breeding and reproduction are occurring, since the tadpoles probably overwinter before metamorphosing, it is possible that most are removed from the creek during the winter floods.

3.3.1.3 Effects on Federally-Listed Species

The bullfrog is the largest frog in California and is known to feed on a wide variety of invertebrate and vertebrate prey, including other amphibians (Bury and Whelan 1986, Beringer and Johnson 1995, Werner et al. 1995, Crayon 1998). Some researchers have suggested that it is partially if not mostly responsible for native frog population declines (including the red-legged frog) in California (Moyle 1973, Bury and Luckenbach 1976, Bury et al. 1980, Nussbaum et al 1983, Blaustein and Wake 1990, Blaustein 1994, Fisher and Bradley 1996). Others have suggested that habitat alteration due to agriculture and urbanization may be more responsible for the declines and that bullfrogs are simply able to tolerate and invade these altered habitats (Banta and Morafka 1966, Hayes and Jennings 1986, Adams 1999).

However, recent studies have shown that bullfrogs probably negatively influence native frog, and in particular, red-legged frog survival through both competition and predation. It is known that adult and tadpole bullfrogs eat tadpoles of other frog species (Ehrlich 1979, Bury and Whelan 1986, Werner et al. 1995) and in particular, red-legged frogs (Kiesecker and Blaustein 1997b). In addition, bullfrog tadpoles usually overwinter and thus are much larger than red-legged frog tadpoles at the beginning of the growing season. Cook (1997) and Lawler et al. (1999) found that the larger overwintering bullfrog tadpoles could dramatically decrease the survival of the smaller red-legged frog tadpoles.

Since bullfrogs are an introduced species, it has been shown that allotopic (native) populations of red-legged frogs are not responsive to the presence of tadpole and adult bullfrogs, thus significantly reducing their survival rate (due to predation) over syntopic populations, which display an antipredator response of seeking refuge and reducing activity (Kiesecker and Blaustein 1997). However, this continued antipredator response in syntopic populations leads to

Figure 5. Distribution of True Frogs, Chinese Mitten Crabs, and Crayfish within the Project Area

a significant decrease in growth, development, and survival to metamorphosis, because the developing red-legged frog tadpoles avoid the bullfrog tadpoles by moving to the deeper and thus colder parts of their microhabitat with less food, and they reduce their activity, which usually consists of searching for food and feeding (Kiesecher and Blaustein 1997). This decrease in growth and development in the larval stage in turn would transmit into smaller adults with less reproductive potential (Berven and Gill 1983, Woodward 1983, 1987, Smith 1987, Berven 1990, Scott 1994). In addition, adult bullfrogs are known to prey upon metamorph and adult frogs (Kupferberg 1995, Crayon 1998), including red-legged frogs (Twedt 1993, Kiesecher and Blaustein 1997a, U.S. Fish and Wildlife Service 2000). Therefore, due to the pressure of competing with and being preyed upon by the larger bullfrog tadpoles and adults, it is conceivable that over time a local red-legged frog population would eventually decline and become extinct.

In addition, if non-native predatory fish (ie., smallmouth bass) are also present, then red-legged frog tadpoles can fall prey to the fish when responding to bullfrog presence by seeking deeper water, and it has been shown that this has a significant impact on tadpole survival to metamorphosis (Kiesecher and Blaustein 1997). However, bullfrog tadpoles may be unpalatable to predatory fish and therefore not impacted (Kruse and Francis 1977).

Bullfrogs were observed to be concentrated within the first 1000 meters of Searsville Reservoir Dam. In addition, non-native predatory fish, such as largemouth bass, were also observed to be concentrated immediately downstream of the Searsville Reservoir Dam. However, the relative abundance of red-legged frogs and bullfrogs in portions of San Francisquito Creek where they both exists (ie., pond 44, immediately below Searsville Reservoir Dam) were not observed to be negatively correlated. In addition, though various food items were identified from stomach contents of bullfrogs within San Francisquito Creek, no red-legged frogs (adults or tadpoles) were observed to have been eaten by bullfrogs (Launer and Holtgrieve 2000). Therefore, the effects of bullfrogs on California red-legged frogs within San Francisquito Creek are presently unknown.

3.3.2 Crayfish

There are two introduced crayfish present in the San Francisquito Creek, the Louisiana red-swamp crayfish and the signal crayfish. The Louisiana red-swamp crayfish is native to the Gulf Coastal plains region of the eastern United States, extending from eastern Alabama to western Texas, whereas the signal crayfish is native to Oregon, Washington, and Idaho. Both species were introduced into the Bay Area as aquacultural species.

The signal crayfish is identified by its smooth outer shell, its large size (up to seven or eight inches) and by a pale white spot near the hinge of the pincer. The male signal crayfish may reach a length of up to 16 cm, while females are maximally only about 12 cm long. At 10 cm the crayfish become sexually mature, some individuals already at 8 cm in length.

Adults of the red-swamp crayfish are colored dark red (nearly black on the carapace), and have a wedge-shaped black stripe on the abdomen. Juveniles are a uniform gray, sometimes overlain by dark wavy lines. The pincers are narrow and long. The carapace is not separated at the middle by a space (areola). The carapace is conspicuously granular (roughened) in adults. The rostrum has lateral spines or notches near its tip. Adults are about 2.2 to 4.7 inches in length.

3.3.2.1 Ecology

Crayfish are most abundant in swamps, sloughs and sluggish ditches, and generally avoid streams and ditches with strong flow. This habitat preference probably influences their distribution within San Francisquito Creek (as discussed below). Recently hatched juveniles are found in littoral and riffle areas where they rapidly grow. Larger juveniles inhabit deeper water and only return to shallower areas after becoming adults. Males of the Louisiana red-swamp crayfish exhibit sexual dimorphism from a breeding to a nonbreeding form (Price and Payne 1980, Taylor 1985), however those of the signal crayfish do not. Breeding usually takes place in the fall by initiating copulation (Hobbs and Jass 1988). Oviposition usually occurs after copulation for the signal crayfish and in the spring or early summer for the red-swamp crayfish, at which time the eggs are attached to the abdominal pleopods by a short stalk.

After hatching, the first juvenile instar attaches to the mother. By the third instar, the juvenile leaves the mother intermittently and is considered free living (Price and Payne 1984). Crayfish can become sexually mature by the fall of the same year but usually do not breed until the following year. Most adults can breed multiple times and live an average of 3 years for the red-swamp crayfish or longer for the signal crayfish (Momot 1984).

Crayfish are opportunistic generalists, feeding on both plants and animals, living or dead (Momot et al 1978). They are able to switch diets based on food availability. Crayfish are known to prey on both invertebrates and vertebrates (Hobbs and Jass 1991) including their eggs (Horns and Magnuson 1981).

Though red-swamp crayfish live in open waters, they burrow during periods of drought or cold, and to brood eggs (Hobbs 1981). The signal crayfish is nonburrowing and is found in greatest abundance in rocky areas that provide it with ample hiding places. Louisiana red-swamp crayfish can also leave the water during humid conditions to disperse or forage. Both species of crayfish are intolerant of much heat or sunshine, so they are more active in the evening and at night. During the day they seek shelter under rocks, logs, overhanging banks, and in burrows, which they dig themselves. Crayfish are less active during very cold weather.

3.3.2.2 Distribution

Both the Louisiana red-swamp crayfish and the signal crayfish were introduced into California. The signal crayfish can be found in both high and low elevations, (ie., in lakes in the Sierra Nevada, and in fast-flowing rivers and small coastal streams). The signal crayfish is most abundant in the Sacramento San Joaquin River system and even in the brackish waters of the Delta. The red swamp crayfish was introduced into Los Angeles County in 1924. Today, this crayfish is the most widespread species in California and is found in most counties south of Colusa County.

Within San Francisquito Creek, both the Louisiana red-swamp crayfish and the signal crayfish are found in abundance where there are many deep, slow moving pools (Figure 5). However, they are usually not found together in the same pool or show a skewed ratio of relative abundance towards one species or the other (probably due to competitive exclusion and difference in habitat preference). The red-swamp crayfish has been found from immediately below the Searsville Reservoir Dam to the cement crossing approximately 500 meters downstream (a total of 117 crayfish captured during a 1999 trapping season; Launer and Holtgrieve 2000). Only red-swamp crayfish are known to inhabit Searsville Reservoir, and this population is probably the source for the individuals sampled in this reach of San Francisquito Creek (Launer and Holtgrieve 2000). However, only signal crayfish have been sampled from a pool approximately 1300 meters downstream from the Searsville Reservoir Dam (78 crayfish captured during a single trapping event; Launer and Holtgrieve 2000). At a cement crossing downstream of the Alpine Sand Hill Rd. crossing, both Louisiana red-swamp crayfish and signal crayfish were captured during two sampling events, though the relative abundance was skewed towards the signal crayfish with 189 to 15 individuals respectively (Launer and Holtgrieve 2000). No crayfish have been found within Bear Creek during three survey seasons (Launer and Holtgrieve 2000), suggesting that both species are unable to colonize this reach of creek, probably due to the lack of deep sluggish pools.

3.3.2.3 Effects on Federally-Listed Species

The Louisiana red-swamp crayfish has been alleged to prey upon the eggs and tadpoles of the California red-legged frog (Jennings and Hayes 1994a). However, other than the observations of the absence of red-legged frogs where crayfish are abundant, there is no published account of this supposed predation. Yet, crayfish are known to prey upon amphibian eggs and larvae (Axelsson et al. 1997), and in particular, the introduced Louisiana red-swamp crayfish has been shown to consume eggs and larvae of the California newt (*Taricha torosa)*; Gamradt and Kats 1996). In addition, the antagonistic behavior of the red-swamp crayfish has been hypothesized to deter reproduction of adult newts (Gamradt et al 1997).

Because of their omnivorous and opportunistic feeding behavior, it can be speculated that crayfish prey on red-legged frog eggs and tadpoles immediately after hatching when they remain attached to benthic substrates and move only occasionally (Caldwell et al 1980), which makes them most vulnerable to predation (Herreid and Kinney 1966; Calef 1973; Efford and Tsumura 1973; Licht 1974). However, whether the two species in San Francisquito Creek actually prey on or interfere with reproduction of red-legged frogs require substantiation through observation and/or experiment.

3.3.3 Chinese Mitten Crab

The Chinese mitten crab is native to the coastal rivers and estuaries of the Yellow Sea (Panning 1939). It was first discovered in South San Francisco Bay in 1992 and quickly spread throughout the estuary during the next several years. This species is characterized by brown setae densely covering the front claws in adults (though very small juveniles rarely have setae on their claws (Ingle 1980).

3.3.3.1 Ecology

The mitten crab is catadromous, the adults reproduce in salt water and the offspring migrate to fresh water to rear. During their fourth or fifth year, males and females migrate downstream attaining sexual maturity in the tidal estuaries. In the San Francisco Estuary, the mitten crab probably matures in 2 to 3 years, although it reportedly matures from 1 to 5 years elsewhere, depending on water temperature (Panning 1939; Cohen and Carlton 1995). Males and females grow to a maximum carapace width of approximately 80 mm (3 inches) in the estuary. This migration occurs during late summer. Mating and fertilization occur in late fall and winter, generally at salinities over 20‰. After mating the females continue seaward, over-wintering in the deeper water and returning to brackish water in the spring to hatch their eggs (Anger 1991). The females carry their eggs until hatching and both sexes die soon after reproduction (Kaestner 1970). A single female can carry 250,000 to 1 million eggs (Panning 1939; Cohen and Carlton 1995). After hatching, larvae are planktonic for approximately 1 to 2 months. The small juvenile crabs settle in salt or brackish water in late spring and migrate to freshwater to rear (Anger 1991).

Young juvenile mitten crabs are found in tidal freshwater areas, and usually burrow in banks and levees between the high and low tide marks (Panning 1939; Kaestner 1970; Ingle 1986; Veldhuizen and Hieb 1998). Mitten crabs apparently do not burrow as extensively in non-tidal areas, probably because they are not subject to desiccation during low tides. Older juveniles are found further upstream than younger juveniles, and in China and Europe they have been reported several hundred miles from the sea (Panninng 1939). Mitten crabs can walk on land, and, in their upstream migration, they can move across banks or levees to bypass obstructions, such as dams or weirs (Panning 1939). Maturing crabs move from shallow areas to the channels in late summer and early fall and migrate to salt water in late fall and early winter to complete the life cycle (Panning 1939; Kaestner 1970, Anger 1991).

Mitten crabs are omnivores, with juveniles eating mostly vegetation, but preying upon animals, especially small invertebrates, as they grow (Tan et al. 1984). In the Delta, anglers using a variety of baits, ranging from ghost shrimp to shad, have incidentally caught adult crabs. Relatively little is known about the predators of the mitten crab, although white sturgeon, striped bass, bullfrogs, loons, and egrets have been reported to prey upon them in the estuary (Veldhuizen and Hieb 1998). Other predatory fish, including largemouth bass and larger sunfishes, river otters, racoons, and other wading birds are assumed to also consume mitten crabs.

3.3.3.2 Distribution

The Chinese mitten crab originates from the Far East, with a native distribution from the Province of Fukien, China, northwards to the Korean Peninsula. In 1912 the first specimen was recorded from the River Aller near Weser in Germany (Panning 1939). During the 1920s and 1930s the mitten crab spread rapidly throughout northern Europe. Its present estimated distribution ranges from Finland, through Sweden, Russia, Poland, Germany, the Czech Republic (Prague), Netherlands, Belgium and England to France (Ingle 1986; Jazdzewshi and Konopacka 1993; Attrill and Thomas 1996; Vincent 1996).

The crab has also been reported from North America with reports from the Detroit River and Great Lakes (without establishment) as well as an isolated occurrence from Hawaii (Edmondson 1959; Nepszy and Leach 1973). In the San Francisco Estuary, the mitten crab was first collected in 1992 by commercial shrimp trawlers in South San Francisco Bay and has spread rapidly throughout the estuary. The most probable mechanism of introduction to the estuary was either deliberate release to establish a fishery or accidental release via ballast water (Cohen and Carlton 1997).

Mitten crabs were first collected in San Pablo Bay in fall 1994, Suisun Marsh in February 1996, and the Delta in September 1996 (Hieb 1997). As of January 1999, the known distribution of the Chinese mitten crab extends north of Delevan National Wildlife Refuge in the Sacramento River drainage, north of Marysville in the Feather River drainage, east of Roseville in the American River drainage, eastern San Joaquin County near Calaveras County (Mormon Slough and Littlejohns Creek), south in the San Joaquin River near San Luis National Wildlife Refuge, and south in the California Aqueduct near Kettleman City and Taft (Veldhuizen and Hieb 1998; Veldhuizen and Stanish 1999). The crab is also distributed throughout San Pablo, Suisun, and South bays (Veldhuizen and Hieb 1998).

Mitten crabs have been known in San Francisquito Creek since 1996. In 1999, a relatively large population of mitten crabs, depicted in Figures 7 and 8, was reported as far upstream as between Webb Ranch and the Stanford Shopping Center (approximately 350 crabs; Launer and Holtgrieve 2000). The mitten crab can potentially become distributed throughout all waterways of the San Francisco watershed up to any migration barrier, such as large dams, and is known to circumvent small dams and weirs that would block its migration route. One individual was observed at the cement crossing in Jasper Ridge Biological Preserve suggesting that it may reach the Searsville Reservoir Dam (Launer and Holtgrieve 2000).

3.3.3.3 Destabilization of Streambanks

As aforementioned, Chinese mitten crabs burrow in banks and levees between the high and low tidal marks. They retreat into these burrows during low tide and during the day to escape predation and desiccation. The burrows angle slightly downward and are elliptical in shape (Panning 1939). In south San Francisco Bay creeks these burrows have been reported to be approximately 20 to 30 cm deep (Halat 1996). Most burrows are found in areas of low salinity but tidally influenced, and are found less in non-tidal areas probably because the crabs are not subject to desiccation.

Mitten crab burrows have been known to accelerate bank erosions in Germany (Peters and Panning 1933; Panning 1939). However, there are no reports of mitten crab burrows being the cause of bank erosions in south San Francisco Bay creeks even though densities of nearly 30 burrows/m^2 have been reported (Halat 1996). It is suspected that if any negative effects of mitten crab burrows occur on San Francisquito Creek they will be concentrated along steep clay banks in the alluvial controlled reaches that are tidally influenced.

3.3.3.4 Effects on Vegetation

Though mitten crabs are omnivorous, juveniles eat mostly vegetation (Tan et al. 1984), either detritus or submerged vegetation (Veldhuizen and Stanish 1999). Known diets contain filamentous algae, *Potomogeton*, *Elodea*, and *Lemna* (Thiel 1938). Mitten crabs have been reported to damage rice crops by consuming young rice shoots (Halat 1996). However, the effects of a large mitten crab population on the native flora of San Francisquito Creek is presently unknown.

3.3.3.5 Effects on Federally-Listed Species

Although juveniles primarily consume vegetation, they do prey upon animals, especially invertebrates, as they grow. A large population of mitten crabs could reduce populations of native invertebrates through predation and change the structure of the San Francisco Estuary's fresh and brackish water benthic invertebrate communities, and thus impact the entire reach of San Francisquito Creek.

The mitten crab overlaps in dietary and habitat preferences with the introduced Louisiana red-swamp crayfish in South San Francisco Bay creeks and negative interactions between the two species have been observed in the field (Halat 1996). Since, crayfish have been alleged to prey upon eggs and tadpoles of red-legged frogs (as discussed above), mittens crabs may similarly influence the frog's survival, especially since many crabs were found within red-legged frog habitat and can reach high population densities relatively rapidly. However, as with crayfish, further research is required to document specific impacts on red-legged frogs.

3.4 SPECIAL-STATUS PLANT AND ANIMAL SPECIES

3.4.1 Special-Status Plant Species

A query of the California Natural Diversity Database (CNDDB 2000) was performed to identify special-status plant species potentially occurring in the project vicinity. The results are reported for the entire project area rather than described by discrete stream reaches. In addition, the California Native Plant Society Inventory (CNPS 1994) was used to identify and assess additional species occurring in similar habitats throughout Santa Clara and San Mateo counties. All species identified in these queries were then cross referenced with the most recent state and federal listing update according to the California Department of Fish and Game (CDFG 2000) to verify their status and identify recently listed species. A total of 27 special-status plant species were identified in the project vicinity in these queries, of which only five have potential to occur in the project area, i.e. Searsville Lake and within the bed and banks of San Francisquito Creek. These species are fountain thistle, Santa Clara red ribbons, western leatherwood, San Mateo woolly sunflower, and Dudley's lousewort. The legal status, habitat preferences, and likelihood of occurrence for these five plants are given in Table 3. Additionally, more detailed descriptions for these six species are given below. Four other species have the potential to occur in the downstream portion of the project site, below U.S. 101. These four species are Point Reyes bird's-beak (*Cordylanthus maritimus* ssp. *palustris*), Contra Costa goldfields (*Lasthenia conjugens*), slender-leaved pondweed (*Potamogeton filiformis*), and California seablite (*Sueda*

Table 3. Special-Status Plant and Animal Species, Their Status, and Potential Occurrence in the Project Area

NAME	*STATUS	HABITAT	POTENTIAL FOR OCCURRENCE ON SITE
Federal or State Endangered or Threatened Species			
fountain thistle (*Cirsium fontinale* var. *fontinale*)	FE, SE, CNPS 1B	Serpentine seeps in valley and foothill grassland and chaparral habitats	Potentially suitable habitat is present and this species may occur on site.
San Mateo woolly sunflower (*Eriophyllum latilobum*)	FE, SE, CNPS 1B	Cismontane woodland habitat, often in roadcuts, prefers serpentine soils	Potentially suitable habitat is present and this species may occur on site.
Steelhead Rainbow Trout (*Oncorhynchus mykiss*)	FT (Central Calif. Coast ESU)	Cool streams with suitable spawning habitat and conditions allowing migration. Prefers streams with dense canopy.	Known to be present in San Francisquito Creek below Searsville Dam which acts as a barrier to upstream movement of anadromous fishes.
California Red-legged Frog (*Rana aurora draytonii*)	FT, SP, CSSC	Streams, freshwater pools, and ponds with emergent vegetation or overhanging roots.	No recent records in Searsville Reservoir. Due to the presence of bullfrogs, sunfishes, and crayfishes, this species is not expected to breed near or in the lake nor to occur there. Red-legged frogs were found breeding in San Francisquito Creek between Searsville Reservoir and Route 280 during 1997.
American Peregrine Falcon (*Falco peregrinus anatum*)	FE, SE, SP	Nests on cliffs or very high bridges and buildings, forages in a variety of habitats.	Infrequent visitor on site; no suitable breeding habitat on site.
Federal or State Rare Species			
Dudley's lousewort (*Pedicularis dudleyi*)	SR, CNPS 1B	Valley and foothill grassland habitat, maritime chaparral, and deep, shady woods of older coast redwood forests	Potentially suitable habitat is present and this species may occur on site.
Federal or State Candidate Species			
California Tiger Salamander (*Ambystoma californiense*)	FC, CSSC	Vernal or temporary pools in annual grasslands or open stages of woodlands.	No suitable habitat and presumed absent.
California Species of Special Concern			
Western Pond Turtle (*Clemmys marmorata*)	CSSC	Permanent or nearly permanent water in a variety of habitats.	No recent records on the site. Steeply incised banks and urban encroachment limits this species ability to breed on the site. It is known to occur in San Francisquito Creek and it could hibernate or breed in very low numbers on-site.
Double-crested Cormorant (*Phalacrocorax auritus*)	CSSC	Colonial nester on coastal cliffs, offshore islands, electrical transmission towers, and along interior lake margins. Feeds on fish.	Forages at Searsville Reservoir on occasion. No suitable nesting habitat on or near site.
Cooper's Hawk (*Accipiter cooperi*)	CSSC	Nests in woodlands, forages in many habitats in winter and migration.	Occasional forager on site; Suitable breeding habitat on site.
Osprey (*Pandion haliaetus*)	CSSC	Nests in tall trees or cliffs on freshwater lakes and rivers and along seacoast; feeds on fish.	Forages on the project area on occasion. No suitable nesting habitat on-site; not known to breed in Santa Clara County.
Northern Harrier (*Circus cyaneus)*	CSSC	Forages in marshes, grasslands, and ruderal habitats; nests in extensive marshes and wet fields.	Forages on the preserve on occasion. No breeding habitat occurs on the site currently, but potential breeding habitat may occur in newly developed marshlands.
Sharp-shinned Hawk (*Accipiter striatus*)	CSSC	Nests in woodlands, forages in many habitats in winter and migration.	Migrant and winter visitor. Not expected to breed on site.
Golden Eagle (*Aquila chrysaetos*)	CSSC	Breeds on cliffs or in large trees or structures; forages in open habitats.	Occasional forager on site; No suitable breeding habitat on site.

Table 3. Special-Status Plant and Animal Species, Their Status, and Potential Occurrence in the Project Area			
NAME	***STATUS**	**HABITAT**	**POTENTIAL FOR OCCURRENCE ON SITE**
Merlin (*Falco columbarius*)	CSSC	Uses many habitats in winter and migration.	Occasional forager during migration and winter.
Burrowing Owl (*Athene cunicularia*)	CSSC	Nests and forages in flat, open habitats, such as grasslands and ruderal areas, having suitable nesting and roosting burrows.	No known population of Burrowing Owls have bred in the project vicinity, and no ground squirrel burrows were observed on the site. Presumed absent.
Loggerhead Shrike (*Lanius ludovicianus*)	CSSC	Nests in tall shrubs and dense trees, forages in grasslands, marshes, and ruderal habitats.	Potential breeding and foraging habitat occurs on-site, expected to occur on the site.
Tricolored Blackbird (*Agelaius tricolor*)	CSSC	Breeds near fresh water in dense emergent vegetation.	No breeding habitat on the site, but may move through the site.
California Mastiff Bat (*Eumops perotis californicus*)	CSSC	Forages over many habitats, requires tall cliffs or buildings for roosting.	No roosting habitat on-site. No records for Santa Clara County. Presumed absent.
Townsend's big-eared bat (*Corynorhinus townsendii*)	CSSC	Roosts in caves, mine tunnels, and buildings in a variety of habitats.	Known roosts occur at base of reservoir on the project site. These roosts may include maternity roosts and hibernacula.
Pallid Bat (*Antrozous pallidus*)	CSSC	Forages in many habitats, roosts in crevices of buildings, rocky outcrops and trees	Forages on the project site and potential roosting habitat occurs in rocky crevices below the reservoir and in large old trees north of Route 280.
State Protected Species or CNPS Species			
Santa Clara red ribbons (*Clarkia concinna* ssp. *automixa*)	CNPS 4	Cismontane woodland habitat	Potentially suitable habitat is present and this species may occur on site.
western leatherwood (*Dirca occidentalis*)	CNPS 1B	Broad-leaved upland forests, closed-cone coniferous forests, chaparral, cismontane woodland, north coast coniferous forests, riparian forests, and mesic areas in riparian woodlands	Potentially suitable habitat is present and this species may occur on site.
White-tailed Kite (*Elanus caeruleus*)	SP	Nests in tall shrubs and trees; forages in grasslands, marshes, and ruderal habitats.	Potential breeding habitat on the site.
San Francisco Dusky-footed Woodrat (*Neotoma fuscipes annectens*)	CSSC	Found in hardwood forests and oak riparian habitat	Not observed on the site, but this species was observed in the area and is expected to occur on the site
Ringtail (*Brassariscus astutus*)	CSSC	Prefers riparian and heavily wooded habitats near water.	Marginal habitat due to urban encroachment in some areas but this species may visit and possibly breed on the project site.

SPECIAL-STATUS SPECIES CODE DESIGNATIONS

FE = Federally listed Endangered
FT = Federally listed Threatened
FC = Federal Candidate. Sufficient biological information to support a proposal to list the species as Endangered or Threatened
CSSC = California Species of Special Concern
SP = State Protected Species
SE = State Endangered
CNPS 1A = Plants presumed by CNPS to be extinct in California
CNPS 1B = Plants considered by CNPS to be rare, threatened, or endangered in California and elsewhere
CNPS 2 = Plants considered by CNPS to be rare, threatened, or endangered in California, but more numerous elsewhere

californica). Expanded descriptions are not given for these four plants because the potential habitat locations are far enough downstream that increased sediment deposits caused by lowering the Searsville Dam are not likely to impact these species. These four species are also not included in Table 1.

The remaining 18 species were dismissed as potentially occurring due to the absence of suitable microhabitats, and/or they have been regarded as either extirpated from Santa Clara and San Mateo counties, the most recent occurrences are historic, or they are considered extinct. These species include: San Mateo thornmint (*Acanthomintha duttonii*), Santa Cruz manzanita (*Arcostaphylos andersonii*), alkali milk-vetch (*Astragalus tener* var. *tener*), Congdon's tarplant (*Centromadia parryi* ssp. *congdonii*), San Francisco Bay spineflower (*Chorizanthe cuspidata* var. *cuspidata*), Palo Alto thistle (*Cirsium praeteriens*), Ben Lomond buckwheat (*Eriogonum nudum* var. *decurrens*), Hillsborough chocolate lily (*Fritillaria biflora* var. *ineziana*), fragrant fritillary (*Fritillaria liliacea*), San Marin dwarf flax (*Hesperolinon congestum*), legenere (*Legenere limosa*), Crystal-Springs lessingia (*Lessingia arachnoidea*), woolly-headed lessingia (*Lessingia hololeuca*), robust monardella (*Monardella villosa* ssp. *globosa*),white-rayed pentachaeta (*Pentachaeta bellidiflora*), hairless popcorn-flower (*Plagiobothrys glaber*), San Francisco campion (*Silene vericunda*), and caper-fruited tropidocarpum (*Tropidocarpum capparideum*). Future surveys for these species are not warranted.

Fountain thistle Federal Listing Status: Endangered; State Listing Status: Endangered; CNPS List 1B. This perennial herb occurs in serpentine seeps in valley and foothill grassland and chaparral habitats. The blooming period extends from June through October. This species is endemic only to San Mateo County. The CNDDB reports five records within the quadrangle search area, three in the San Mateo quadrangle and two in the Woodside quadrangle. The three records from the San Mateo are all near the Crystal Springs Reservoir and date from 1988 to 1996. The two records from the Woodside quadrangle are both near Edgewood County Park and date from 1993 and 1997. All occurrences except the 1993 record are believed to be extant (CNDDB 2000). Potentially suitable habitat may be present in the vicinity of Searsville Lake. This species may occur within the bed and banks of San Francisquito Creek on site.

San Mateo woolly sunflower. Federal Listing Status: Endangered; State Listing Status: Endangered; CNPS List 1B. This perennial herb occurs in serpentinite soils in cismontane woodland habitat, often on roadcuts. The blooming period extends from May to June. This species is endemic only to San Mateo County. The CNDDB reports two records within the quadrangle search area, one in the San Mateo quadrangle and one in the La Honda quadrangle. The San Mateo quadrangle record, dating from 1997, is on Crystal Spring Road from the Eugene A. Doran Bridge eastward past Woodridge Road. The La Honda quadrangle record, dating from 1988, is believed extirpated, but was southwest of La Honda on the road to Pescadero Beach (CNDDB 2000). Potentially suitable habitat may be present in the vicinity of Searsville Lake. This species may occur within the banks of San Francisquito Creek on site.

Dudley's lousewort. Federal Listing Status: None; State Listing Status: Rare; CNPS List 1B. This perennial herb occurs in maritime chaparral; deep, shady woods of older coast redwood forest; and valley and foothill grasslands. The blooming period extends from April through June. The range of this species includes Monterey, Santa Cruz, San Luis Obispo, and San Mateo counties. The CNDDB reports two records within the quadrangle search area, in the Mindego

Hill quadrangle. The first record is for multiple colonies within Portola State Park along Peters Creek and proceeding south toward Iverson Creek. The second record is for an occurrence near Portola State Park. Potentially suitable habitat may be present in the vicinity of Searsville Lake. This species may occur within the banks of San Francisquito Creek on site.

Santa Clara red ribbons. Federal Listing Status: None; State Listing Status: None; CNPS List 4. This annual herb occurs in cismontane woodlands, particularly on slopes and in drainages. The blooming period extends from April through July. The range of this species includes Alameda and Santa Clara counties. The CNDDB has no records for this species within the quadrangle search area because the species was recently downlisted from CNPS List 1B to CNPS List 4 (CDFG 2001). The CNDDB does not track list 4 plants. However, potentially suitable habitat may be present in the vicinity of Searsville Lake. This species may occur within the banks of San Francisquito Creek on site.

Western leatherwood. Federal Listing Status: None; State Listing Status: None; CNPS List 1B. This deciduous shrub occurs in a variety of habitats including cismontane and riparian woodland, preferably on moist, shady slopes. The blooming period extends from January through April. The range of this species includes Alameda, Contra Costa, Marin, Santa Clara, San Mateo, and Sonoma counties. The CNDDB has nine records within the quadrangle search area, in the Cupertino, La Honda, Mindego Hill, Mountain View, Palo Alto, and Woodside quadrangles. The most recent occurrence records are three from 1993 within the Eastwood County Park, in the Woodside quadrangle. Two historic records exist within the Palo Alto quadrangle: one, from 1941, of an occurrence on a hillside near the south side of Searsville Lake and the second, from 1929, of an occurrence along Los Trancos Creek within Stanford University. Potentially suitable habitat may be present in the vicinity of Searsville Lake. This species may occur within the banks of San Francisquito Creek on site.

3.4.2 Federally-Listed Animal Species

Both steelhead rainbow trout and California red-legged frog are known to be present in portions of San Francisquito Creek between Searsville Dam and Highway 280. California red-legged frogs have been found along San Francisquito Creek only, but their breeding areas have not been specifically identified. Conversely, steelhead rainbow trout have been previously surveyed in two tributaries, Los Trancos Creek and Bear Creek, which provide critical spawning habitat for this species in the San Francisquito watershed. Both of these species are known federally listed species and will be discussed in Sections 3.4.2.1 and 3.4.2.2 below. Surveys for the Searsville Reservoir (Launer and Spain, 1997) indicated that non-native predatory species (e.g. bullfrogs, bass, etc.) are abundant, and therefore California red-legged frogs are not expected to breed in the Searsville Reservoir complex. Because of Searsville Dam and other drop structures, steelhead rainbow trout are also excluded from these waters. Hence, this report will discuss the distribution of these two species in San Francisquito Creek and its' tributaries below Searsville Dam.

3.4.2.1 Steelhead Rainbow Trout

3.4.2.1.1 Ecology

Rainbow trout occur as both resident fish and as "steelhead," which migrate to and from the ocean (anadromous). Where access to the ocean is available, the faster growth and larger potential size (and egg production) at reproduction provided by the ocean usually result in steelhead dominating the population. Above barriers that always or regularly block upstream migration, fish that migrate downstream remove most of that tendency in the population that remains above the barrier. Few fish with the anadromous trait remain. After the barrier is removed the speed at which the steelhead trait may become dominant depends upon how quickly steelhead adults will stray to the newly available habitat. If steelhead regularly spawn immediately below the barrier, some will readily continue upstream once it is removed.

Adult steelhead return to their rearing stream after spending 1-2 or more years in the ocean at lengths of 15 to 30 inches. Some straying occurs, but, if possible, most fish apparently spawn in the same stream reach or tributary where they reared as juveniles. Waterfalls and other natural and man-made barriers to upstream migration are often important factors in steelhead distribution and abundance. However, adult steelhead can migrate quickly during storm periods, and the majority of fish can often gain access to upstream areas even when flows are sufficient for passage during only small portions of the winter. In streams where the migrations are long and/or difficult, larger stronger adults tend to be most common. In streams with short or easy migrations many adults return younger and smaller, but potentially return to reproduce many times (a trait that differentiates steelhead from pacific salmons). In most central coast streams a mixture of adult sizes is present, reflecting year-to-year differences in the success of the two strategies.

Steelhead spawn (reproduce) by constructing nests in relatively clean pea to apple-sized gravels. Where the streambed is sandy or contains fine silts the nests are more likely to be washed away by later storms or have the eggs smothered by fine sediments that block water and oxygen flow through the nest. Where gravels are large or very angular, female steelhead have difficulty moving them to dig successful nests. In addition, suitable gravels must be located at appropriate positions within the channel, where depth is sufficient to submerge the fish and where water will percolate through the nest to provide oxygen. Gravels at the tail crest of a pool will be used for spawning, but similar gravels within a flat, shallow riffle will not. Spawning fish also prefer sites close to escape cover, such as undercut banks or deep pools; sites within long reaches of shallow habitat are rarely used. Since a single successful nest can produce several thousand fingerlings, spawning habitat may be sufficient to saturate the stream with small fish, even where gravels are scarce or widely scattered in their distribution. Adult steelhead migration and spawning takes place from January through early April. Newly hatched steelhead tend to spread downstream, and by summer juvenile distribution and abundance usually reflects rearing habitat conditions rather than concentrations of spawning activity. Upstream dispersal by young fish rarely occurs, because recently emerged fry are too small to move upstream against the current in spring, and shallow riffles restrict juvenile upstream movement in summer. In most streams home ranges are established, and little movement occurs in either direction, by mid to late summer.

Juvenile steelhead usually spend 1 to 2 years in fresh water. Where stream flows are strong in summer, and insects as food are abundant, steelhead may get large enough to enter the ocean after only one year in freshwater. In central California streams, such habitats are mostly downstream of reservoirs (such as Stevens Creek). There the augmented summer flows for streambed percolation provide the fast-water feeding lanes and high riffle insect production needed for rapid steelhead growth; the most efficient way for steelhead to feed is by swimming in place in fast water and feeding on insects drifting to them. However, in most central California streams summer stream flows are very low and juvenile steelhead grow little in mid to late summer. Therefore, they usually require two years to reach a size sufficient to migrate to the ocean.

Other factors that impact food and feeding are important in controlling steelhead growth and abundance. As water temperature increases, so do the metabolic demands and appetites of steelhead. Fish require twice as much food at 73 degrees as they require at 55 degrees. In warmer streams steelhead are concentrated in the few fast-water habitats (riffles, heads of pools) capable of supplying their heavy food needs. Heavy stream shading keeps the water cooler (reducing food demands), but also restricts algal growth, as a base of the food chain, ultimately reducing insects as food for juvenile steelhead. In addition, in very shady habitats fish have difficulty seeing and capturing floating or drifting insects. Turbid (muddy) water also affects the ability of fish to feed on drifting insects; this problem occurs primarily in winter and spring due to storm runoff or turbid reservoir releases. Silt and sand in the streambed provide unstable habitats and fill crevices in gravels and cobbles, thereby reducing insect and steelhead abundance and reducing steelhead growth.

Escape or hiding cover, provided by undercut banks, fallen trees, and boulders is also an important part of year-round rearing habitat for juvenile steelhead, especially for the larger yearling fish. Steelhead feeding in shallow riffles and runs prefer overhead cover, provided by surface turbulence or overhanging vegetation.

Since juvenile steelhead must spend 1 or 2 winters in the stream, overwintering habitat that protects them from winter storms is very important. If juvenile steelhead cannot overwinter for 1 or 2 years they may never reach sizes sufficient for ocean survival. Therefore, the abundance of larger, yearling steelhead is a good index to the quality of yearlong habitat in most streams. Deep and/or complex pools provide overwintering habitat, by supplying undercut banks, woody backwaters, calm eddies and other refuges from storm flows. Large logjams may provide calm eddies and pockets even during extreme floods, and may be critically valuable habitat features in wet years.

Most adult steelhead return quickly to the ocean after spawning in winter. In contrast, juvenile steelhead begin their physiological preparation for entering the ocean (smolting) and have a continuous, extended migration period in late March through May. This late migration allows them to feed and grow one additional time during the most productive time of the year, increasing their size and potential ocean survival. However, April and May are also a time of rapidly declining streamflows, making downstream passage over shallow riffles or seasonally drying stream reaches very risky. Larger steelhead juveniles require less additional spring growth and tend to migrate earlier. For many drier and/or urbanized central coast streams the outmigration period in spring is the major bottleneck to maintaining abundant and persistent steelhead populations. Adult access and spawning and good rearing habitat are insufficient for steelhead success if smolt migrations are blocked in most years.

3.4.2.1.2 Distribution

Upstream of Searsville Dam there is about 5 miles of resident rainbow trout habitat in Corte Madera Creek and up to 3 miles of resident rainbow trout habitat in the lower gradient (less than 10% slope) portions of its tributaries. Resident trout habitat may also exist in some of the steeper portions of both Corte Madera Creek and its tributaries, but fish movement within the very steep sections would be difficult following droughts that would dry much of the streambed. Prior to construction of Searsville Dam this resident trout habitat would have been accessible to steelhead.

Additional resident rainbow trout habitat in the watershed is upstream of the California Water Service Dam on upper Bear Gulch (immediately upstream of Highway 84). About 2 miles of habitat, with more than half of it upstream of a natural series of waterfalls, exists above the dam.

Steelhead habitat in the watershed is depicted in Figure 6. Steelhead habitat includes San Francisquito Creek from Searsville Dam downstream in wet years to at least Junipero Serra Boulevard, a channel distance of about 5 ¼ miles. In addition, in wet years steelhead utilize all 2 ½ miles of Bear Creek, ¾ miles of Bear Gulch, the lower 2 ½ miles of West Union Creek and about 1/2 mile of accessible habitat on each of two West Union Creek tributaries, Squealer and McGarvey gulches. On Los Trancos Creek about 2 ½ miles of steelhead habitat exists downstream of the Stanford University diversion dam. Laddering the dam has allowed steelhead access to an additional 3 ½ miles of potential habitat. However, three difficult barriers to passage occur in the reach.

3.4.2.1.3 Migration Barriers

One man-made barrier to adult steelhead migration is present in the lower reach of San Francisquito Creek. The barrier, a concrete weir near El Camino Real, is a significant barrier between storms, but is passable during peak winter storms (100-200 cfs). The weir at the USGS gage upstream of Junipero Serra Blvd.(Figure 6) is passable at storm flows (50-100 cfs); passage could be improved by moving some of the boulders at the downstream base of the weir to improve pool depth and hydraulic conditions at the base. A low dam ½ mile downstream of Piers Lane has a functioning (Denil) fish ladder, and is not a barrier unless debris blocks the ladder. Steep and/or shallow riffles and bedrock chutes in the remaining portions of the San Francisquito Creek channel are probably passable at flows of 20–30 cfs. Overall, it is likely that most adult steelhead are able to access San Francisquito Creek spawning and rearing habitats in average and wet years. Even in drier years many steelhead adults probably still can access spawning and rearing habitats by migrating during the few large storms.

Figure 6. Steelhead Spawning and Rearing Habitat

Access to the approximately 7 miles of steelhead rearing and spawning habitat in the Bear Creek/West Union Creek watershed is presently more problematic than in the rest of the San Francisquito Creek Watershed. The most difficult barrier is a concrete dam only 0.2 miles upstream of Sand Hill Road (Figure 5). The dam is only 4.2 feet high but spills to pool only 1.5-2.0 feet deep at the base of the dam. The California Department of Fish and Game and the landowner removed a concrete block below the dam and also constructed a high flow bypass around the dam in 2000. However, the dam is still the worst passable barrier in that watershed, and can be passed only during heavy storm flows. In past dry years few adult steelhead were likely to negotiate the dam and access the remainder of the watershed; in those years most spawning would likely have occurred in the 0.4 miles of habitat between San Francisquito Creek and the concrete dam. The dam should be modified, by notching, in 2001 to provide for adult passage during regular winter flows. Other barriers in the Bear Creek/West Union Creek watershed are passable at common winter flows (20+ cfs), with the exception of the culvert at the Fox Hollow Road bridge, which would probably require 50-70+ cfs for passage; that culvert is passable only during storms.

A series of easily passed weirs are present on Los Trancos Creek near and under Highway 280. No other significant barriers exist between the mouth and the Stanford Diversion and fish ladder. Riffles are probably passable to adult fish at flows of 5-8 cfs, which should occur regularly in average and wet years. The channel has generally narrowed and deepened since 1995, and wide, shallow riffles produced by the January and March storms in 1995 are more easily passable now. In the 3+ miles upstream of the diversion and fish ladder two culverts and one old dam are present. They restrict passage to storm events only.

The biggest migration problem for steelhead in the San Francisquito Creek watershed is the problem of downstream migration of smolts in April and May. In all but the wettest years the lowermost reaches of the creek (Middlefield Road to San Francisco Bay) are likely to be dry or very shallow during much of the April to May period. In many years a large portion of the migrating smolts probably are trapped and killed. In drier years few smolts probably successfully migrate; the few successful fish would be those larger fish, which might migrate earlier in the spring.

3.4.2.1.4 Spawning Habitat

Spawning habitat is scarce in portions of the San Francisquito Creek watershed (Figure 5). However, even in reaches with little suitable spawning habitat, a few suitable sites are probably capable of saturating the available rearing habitat. In addition, fry dispersal from upstream spawning sites may provide additional juveniles to utilize available rearing habitat. The only reach that appears to lack some suitable spawning habitat is the short reach (0.2 miles) of San Francisquito Creek between Searsville Dam and the mouth of Bear Creek. In that reach, the dam has blocked recruitment of new gravels from upstream, and floods since the construction of the dam have gradually removed most gravels. In addition, this reach cannot receive downstream dispersing steelhead fry. In 1998-2000 the reach between the dam and Bear Creek had very low trout densities compared to other reaches sampled in the watershed (data of Alan Launer). Some adult steelhead may regularly use the very marginal spawning habitat in the reach. However, the high percentage of larger fish among those captured may indicate that many (most?) of the fish are resident rainbow trout washed down from habitat upstream of Searsville Lake.

In San Francisquito Creek between Bear Creek and Junipero Serra Boulevard juvenule densities appear to be unrelated to spawning habitat availability. Suitable spawning gravels are common in the first ¾ mile downstream of Bear Creek and again between about 1.5 and 2.2 miles downstream of Bear Creek (from Boething Tree farm to Webb Ranch). In the remainder of the channel between Bear Creek and Los Trancos Creek, bedrock outcrops dominate much of the streambed, and spawning gravels in proper hydraulic locations are very scarce and scattered. Cobbles tend to dominate riffles, step-runs and pool tail crests. Downstream of Los Trancos Creek suitable spawning gravels are similarly very scarce. Cobbles are present in riffles, runs and at the tail crests of most pools. Finer gravels are present primarily in slower, silty areas of glides and the large pools. Since rearing habitat is also scarce, even reaches with limited spawning habitat are probably able to saturate that habitat with steelhead fry.

Spawning habitat is common in Los Trancos Creek and in the lower reach of Bear Creek (Figure 5). Both streams probably provide some fry for stretches of San Francisquito Creek downstream of their mouths.

3.4.2.1.5 Rearing Habitat

Steelhead rearing habitat is depicted in Figure 5 and described below. Rearing habitat throughout the San Francisquito Creek watershed is constrained by very low late summer streamflows, even in wet years. In September 2000 portions of West Union Creek and much of Bear Gulch were reduced to isolated pools. Flow was continuous in Bear Creek, but was only about 0.1 cfs at Sand Hill Road. Los Trancos Creek flow was only about 0.05 cfs at the Stanford Diversion dam, and less than 0.1 cfs at Highway 280. In drought years much of the habitat in these streams is likely to be dry by the end of summer. In 1997 much of the San Francisquito Creek channel between Searsville Dam and Bear Creek was dry, as was a ½ mile stretch upstream of the Boething Tree Farm (Launer and Spain 1998). Surface flows are more likely to be maintained in reaches where bedrock forces the flow to the surface; in the deep alluvial portions of the channel flow will be subsurface during droughts.

When streamflows are low, insect production is sharply reduced and confined primarily to riffles, runs and other shallow, fast habitats. Low streamflows also reduce the ability of steelhead to feed on drifting insects, except in faster habitats or at the heads of pools. Los Trancos Creek downstream of the Stanford Diversion has mostly a channel gradient of 1.3 to 2.5 percent. Much of the habitat is steeper, faster riffle and run habitats likely to support moderate insect production and steelhead feeding even under late summer flow conditions. Most pools are small and heads of the pools are also likely to provide drifting insects for feeding juvenile steelhead. Similarly, the lower mile of Bear Creek has a gradient of 1 to1.5 percent, with the riffles, runs and small pools likely to support more and faster-growing juvenile steelhead in summer.

In San Francisquito Creek between Searsville Dam and Junipero Serra Boulevard the channel gradient generally is only about 0.5 percent, except for a 2/3 mile reach downstream of the mouth of Los Trancos Creek, which averages 1.2 percent gradient. Most of the habitat is dominated by large pools, which provide limited feeding opportunities for steelhead in summer. As might be expected by the flatter gradient, more silt is also present in the substrate of San Francisquito Creek, further reducing aquatic insects. Since water temperatures are probably warm (65-70+ degrees) in summer in San Francisquito Creek, the resulting high metabolic rates of juvenile steelhead probably restrict steelhead to the relatively scarce riffles, runs and pool heads, where sufficient food is available to prevent starvation. Even during January 1998 electroshock sampling at Piers Lane almost all steelhead were captured in fast-water habitats.

One pass electroshocker sampling in 1997-2000 (Launer and Spain 1998, Launer and Holtgrieve 2000, and data of Launer) was concentrated primarily in pools. It showed 4-5 times higher abundance of small steelhead (less than 100 mm long) in Los Trancos and Bear creeks than in San Francisquito Creek. Most of these fish were probably young-of-year.

The large pools on San Francisquito Creek do provide high flow refuges for steelhead to overwinter, which can result in higher survival of yearling fish. About 1/3 of the fish captured in San Francisquito Creek were larger than 100 mm and were yearling and older steelhead (data of Alan Launer). Abundance of these larger fish was similar to that of lower Bear Creek. However, even these larger fish were 4 times as abundant in Los Trancos Creek samples as in San Francisquito Creek.

All of the streams in the San Francisquito Creek watershed run turbid with storm flows, but Los Trancos Creek, with a relatively undeveloped watershed, appears to clear most rapidly after storms and has relatively clean substrate. San Francisquito Creek has prolonged (1week) turbid conditions following storms. Part of the reason for the prolonged turbid flows may be the gradual release of storm water stored in Searsville Lake. The effect is similar to, but much weaker than, that of reservoirs such as Stevens Creek and Lexington, where turbid storm runoff stored in the reservoirs is released for months in late winter and spring. The turbid runoff reduces the ability of juvenile steelhead to feed and grow in late winter and spring.

3.4.2.2 Red-Legged Frog

The California red-legged frog is the largest native frog in California with adults obtaining lengths of 3.4-5.4 inches (85-138 millimeters) from the tip of the snout to the rear of the vent (Jennings and Hayes 1994a). Dorsally, the background color appears brown, gray, or reddish-brown, normally with a pattern of dark flecks and spots (Stebbins 1985). The distribution of red or red-orange pigment is highly variable, but usually restricted to the belly and the undersurfaces of the thighs, legs, and feet (Jennings and Hayes 1994a). There are two prominent folds of skin (dorsolateral folds) that run from the rear of the eyes to the groin (Wright and Wright 1949). The groin has a distinct black mottling on a white or yellow background.

Juvenile frogs are 1.5-3.4 inches (40-84 millimeters) from the tip of the snout to the rear of the vent and have the same coloration as adults except that the dorsolateral folds are normally yellow or orange colored, especially in very young individuals (Stebbins 1985). Larval frogs range from 0.6-3.1 inches (14-80 millimeters) in length. Young tadpoles are generally blackish in color, and gradually change to a brown background color with darker marbling or spots (Storer 1925).

3.4.2.2.1 Ecology

Adult California red-legged frogs have been observed to breed from late November through early May after the onset of warm rains (Storer 1925, Jennings and Hayes 1994a). Male frogs typically call in small mobile groups of 3-7 individuals that attract females (Jennings and Hayes 1994a). Females move toward the calling groups and amplex a male. Following amplexus, the females move to oviposition sites where they attach an egg mass of 2,000-6,000 moderate-sized (2.0-2.8 mm diameter) eggs to an emergent vegetation brace such as tule or cattail stalks, grasses, or willow roots just below the water surface (Storer 1925, Livezey and Wright 1947). These oviposition sites are present within the bedrock controlled reaches (non-urbanized) of San Francisquito Creek. The egg mass is about the size of a softball after it swells with water for 24 hours. After reproduction, males usually remain at the breeding sites for several weeks before removing to foraging habitats, while females immediately remove to these foraging habitats (Jennings, unpubl. data).

Embryos of California red-legged frogs hatch in about 6-14 days after fertilization and resulting larvae (8.8-10.3 mm total length) require 3.5-7 months to attain metamorphosis at 65-85 mm total length (Storer 1925; Jennings, unpubl. data). Larvae are thought to graze on algae, but they are rarely observed in the field because they spend most of their time concealed in submergent vegetation or detritus (Jennings and Hayes 1994a). Most larvae metamorphose into juvenile frogs (at 25-30 mm total length) between July and September, although there are scattered observations of overwintering larvae in perennial ponds such as at the arboretum at Golden Gate Park in San Francisco (Jennings, unpubl. data) or the Quarry Pond of the Stanford "Dish" area near Matadero Creek (Launer and Holtgrieve 2000). Post-metamorphic frogs within San Francisquito Creek probably feed on a wide variety of invertebrates including Amphipods, Isopods, Orthoptera, Isoptera, Hemiptera, Homoptera, Neuroptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera, Arachnids, Gastropoda, and grow rapidly (Stebbins 1972, Hayes and Tennant 1985, Baldwin and Stanford 1987). Most males reach sexual maturity in 2 years and females reach sexual maturity in 3 years. However, frogs of both sexes may reach sexual maturity in 1 year if resources are sufficient (Jennings, unpubl. data), or frogs may take 3-4 years to reach maturity during extended periods of drought (Jennings and Hayes 1994a). Based on limited field data, California red-legged frogs appear to live about 8-10 years in the wild (Jennings, unpubl. data). Adult frogs apparently eat a wide variety of animal prey including invertebrates, small fishes, frogs, and small mammals (Hayes and Tennant 1985, Arnold and Halliday 1986). In the San Francisco Bay Area, including San Francisquito Creek, California red-legged frogs are probably active throughout most the year except for the coldest portions of the winter when temperatures dip below freezing.

California red-legged frogs have been observed in a number of aquatic and terrestrial habitats throughout their historic range. Larvae, juveniles, and adult frogs have been collected from natural lagoons, dune ponds, pools in or next to streams, streams, marshlands, sag ponds, and springs, as well as human-created stockponds, secondary and tertiary sewage treatment ponds, wells, canals, golf course ponds, irrigation ponds, sand and gravel pits (containing water), and large reservoirs (Jennings 1988). In Santa Clara County, frogs have been observed in all of the above except natural lagoons and dune ponds. Within San Francisquito Creek, frogs have been observed in pools in the stream proper. The key to the presence of frogs in these habitats is the presence of perennial (or near perennial) water and the general lack of introduced aquatic predators such as centrarchid fishes (e.g., largemouth bass, green sunfish, and bluegill), crayfish, and bullfrogs, as discussed below. As long as there is standing water present of at least several inches in depth and introduced aquatic predators are rare or nonexistent, red-legged frogs may be present. If the aquatic habitat favors the introduced aquatic predators, then it is suggested that red-legged frogs will probably disappear over time unless there is a nearby breeding site available for this frog that excludes the introduced predators. The habitats observed to contain the largest densities of red-legged frogs are associated with deep-water pools (27 inches [>0.7 meters] deep) with stands of overhanging willows and an intermixed fringe of cattails, tules, or sedges (Hayes and Jennings 1988). However, California red-legged frogs have also been observed to inhabit stockponds, sewage treatment ponds, and artificial (=concrete) pools completely devoid of vegetation (Storer 1925; Jennings, unpubl. data). Continued survival of frogs in all aquatic habitats seems to be based on the continued presence of ponds, springs, or pools that are disjunct from perennial streams. Such habitats provide the continued basis for successful reproduction and recruitment year after year into nearby drainages that may lose frog populations due to stochastic events such as extreme flooding or droughts. These disjunct ponds may be present within the San Francisquito Creek floodplain, however, red-legged frogs have only been observed in within stream pools.

In lagoon systems and brackish water environments, field and laboratory observations indicate that California red-legged frogs cannot successfully reproduce at salinities >4.5‰, larvae cannot survive in salinities >7.0‰, and juvenile and adult frogs avoid salinities >9.0‰ (Jennings and Hayes 1990; Jennings, unpubl. data). Thus, frogs are largely restricted to freshwater and slightly brackish water habitats. However, no red-legged frogs have been observed within the alluvial controlled reaches of San Francisquito Creek where salinities may reach these values (Royston Hanamoto Alley & Abey et al. 2000). It is likely that the frogs were historically present in this reach of the creek but have disappeared do to channelization of and urbanization near the creek.

Besides the aquatic habitats, juvenile and adult California red-legged frogs have been observed in areas of riparian vegetation, usually within a few meters of the water's edge. Frogs have been found utilizing small mammal burrows (often in or under vegetation), willow root wads, and hiding under old boards and other debris within the riparian zone (Jennings, pers. obs.). Observations of red-legged frogs within San Francisquito Creek have been restricted to steep sections of creek bank or in vegetation along the water's edge (Launer and Holtgrieve 2000). Juvenile frogs are often observed sunning themselves during the day in the warm, surface-water layer associated with floating and submerged vegetation (Hayes and Tennant 1985). Adult frogs are largely nocturnal and are known to sit on stream banks or on the low hanging limbs of willow trees over pools of water where they can detect small mammal prey (Hayes and Tennant 1985, Jennings and Hayes 1994a). This behavior is consistent with observations made within San Francisquito Creek (Launer and Holtgrieve 2000).

Radio telemetry studies conducted in lagoons and the lower portions of streams along the Central Coast of California show that adult red-legged frogs will move within the riparian zone from well-vegetated areas to pools of water to hydrate during periods of time when many of the Central Coast streams are dry except for isolated pools (Rathbun et al. 1993). During wet periods (especially in the winter and early spring months), red-legged frogs can move long distances (e.g., 1 mile [1.6 km]) between aquatic habitats, often over areas that are considered to be unsuitable for frogs (e.g., roads, open fields, croplands, etc.). Such activities can result in frogs ending up in isolated aquatic habitats well away from the nearest known frog populations. Such movement over upland areas is best documented in mesic coastal areas. However, this type of movement may

California red-legged frogs are eaten by a wide variety of natural predators during each of their life stages. Known predators include: black-crowned night herons (*Nycticorax nycticorax*), bitterns (*Botaurus lentiginosus*), raccoons, and garter snakes (*Thamnophis* spp.). Bullfrogs, and introduced centrarchid fishes are also suspected to prey on red-legged frogs (Jennings and Hayes 1994a, 1994b; see below). Juvenile and adult frogs may also still be taken from time to time by humans, especially children, although such activities are thought to be rare (Miller et al. 1996).

3.4.2.2.2 Distribution

The present range of the California red-legged frog extends from Shasta Co. south along the coastal counties to the Mexican border. Within the Bay Area and in particular, San Mateo County, the California red-legged frog is distributed in the foothill and mountain ranges but has essentially disappeared from the urbanized lowland areas and the brackish marshlands bordering San Francisco Bay (H. T. Harvey & Associates 1997).

California red-legged frog distribution within the upper watershed of San Francisquito Creek is concentrated at the following 3 reaches of the creek (Figure 5): 1) from the Dennis Martin House site downstream to the northwest edge of the Treeland Nursery, 2) the southeast end of Treeland downstream approximately 750 meters, and 3) at Webb Ranch (Launer and Holtgrieve 2000). Within these reaches of creek, almost all red-legged frog observations were at or near pools, with most pools being at or greater than 1 meter deep. Also, most red-legged frogs were seen on steep sections of bank or in vegetation along the water's edge.

No red-legged frogs have been observed above the aforementioned reach of creek within Searsville Reservoir, or in Corte Madera Creek, which feeds into Searsville Reservoir (Launer and Holtgrieve 2000). Though, it is unclear why red-legged frogs have not been observed in Searsville Reservoir, it is believed that the presence of bullfrogs and predator fish may be the reason. Also, no red-legged frogs have been observed in the alluvial controlled reach (urbanized) of San Francisquito Creek (Royston Hanamoto Alley & Abey et al. 2000). This is probably due to the reduction of the riparian habitat associated with the creek and extensive urbanization, which would negatively impact red-legged frog survival. In addition, no red-legged frogs have recently been observed in Los Trancos Creek and Bear Creek, both of which feed into San Francisquito Creek (Launer and Holtgrieve 2000). Red-legged frogs may be absent from these creeks because of a lack of habitat in the form of pools deep enough to be utilized by adults. Red-legged frogs have been observed in the Matedero Creek Watershed, of Matedero Creek, Deer Creek, and the Quarry Pond of the Stanford "Dish" area, adjacent to Madadero Creek (Launer and Holtgrieve 2000; Figure 5). It is believed that these frogs constitute a separate population distinct from that within the San Francisquito Creek Watershed. However, further research is needed to confirm this hypothesis.

3.4.2.2.3 Existing Habitat Conditions

It is believed that red-legged frogs in San Francisquito Creek are successfully reproducing and maintaining their limited range between the Searsville Reservoir Dam and just upstream of I-280 (Figure 5), because the existing conditions in this reach of the creek are conducive to red-legged frog reproduction and survival. These conditions are believed to be: 1) the existence of small tributaries and within-channel side pools that allow frogs to escape being washed downstream during flood events; 2) down woody debris that provide habitat for foraging and reproduction in the form of deep within channel pools and cover along the water's edge; 3) very little sediment moving through and subsequently depositing in this reach of the creek due to the presence of the Searsville Reservoir Dam, thus maintaining the previously mentioned deep pools; and 4) the relative lack of possible non-native predators and competitors, such as predatory fish (largemouth bass, bluegill, green sunfish, mosquitofish, and bullhead catfish), bullfrogs, crayfish, and mitten crabs .

4.0 ENVIRONMENTAL OVERLAY-NATURAL FILLING OF SEARSVILLE RESERVOIR

4.1 PREDICTED ECOSYSTEM EVOLUTION

As the delta front of Corte Madera Creek advances across Searsville Lake, we expect a stream to advance with the sediment. The stream channel will contain the flows of Corte Madera, Sausal and Dennis Martin Creeks, as well as Alambique Creek. We expect the channel to be poorly defined, possibly braided, closer to the delta front. Farther upstream from the delta front, we would expect a meandering channel with better-defined banks and more developed pool riffle sequences. Initially the new channel will be approximately 30 to 40 feet wide and about a foot deep. As the channel matures it will likely narrow slightly (to about 30 feet wide) and gain higher banks five to six feet high (Balance Hydrologics, 2001).

During floods, water will spill out of the main channel across the flood plain, depositing sediment as the water spreads out and slows down. This process should gradually build the height of the floodplain and lead to a deeper, better-defined channel. The edges of Searsville Valley may develop small wetland areas as the valley fills in with sediment. This might preferentially occur where small catchments enter the lake, or where an abandoned portion of the main channel once carved a pool. Where small catchments enter the lake, the sediment entering the valley may effectively dam the drainage from those catchments. These wetland areas might be up to several feet deep and would preferentially trap fine sediment. (Balance Hydrologics, 2001).

Before Searsville Lake is fully filled with sediment, we expect the deltaic apron of Corte Madera and Sausal Creeks to extend across the lake, separating the Middle Marsh and Lower Lake areas. Sedimentation in the Middle Marsh is likely to accelerate, and deposition may slow near the dam (Balance Hydrologics, 1996).

Once Searsville Lake fills with sediment, bedload consisting primarily of sand will be transported over the dam for the first time in more than 100 years. Bedload, which currently remains in the lake, will increase over time from 0 tons/day to 4,500 tons/day passing over the spillway. Suspended sediment, which constitutes 10% of the current load at 8,150 tons/day that passes over the dam spillway, will slowly increase to 100% of the suspended load at 20,800 tons/day (Balance Hydrologics, 2001).

The bulk of both suspended sediment bedload are not expected to deposit in the channel of San Francisquito Creek but rather be transported through the system into San Francisco Bay during winter storms. Very small amounts of bedload may deposit in pools within the bedrock-controlled portion of San Francisquito Creek from Searsville Dam to Highway 280. However, pools are not expected to become significantly shallower or broader. Neither are the depositional features in this reach, (*i.e.* sandbars, floodplains, log jams), expected to substantially increase in size. The most evident effect is likely to be increased sedimentation in the lowermost, tidally-influenced reaches of San Francisquito Creek, below Newell Road bridge (Balance Hydrologics, 1996). It is predicted that approximately 12 inches of sediment will deposit in the alluvial-controlled reaches of San Francisquito Creek from Highway 280 to San Francisco Bay over the next fifty years (Balance Hydrologics, 2001). That is roughly ¼ inch of deposition per year. Periodic dredging occurs from Highway 101 to San Francisco Bay, so there is little concern that this small increase in sediment deposition will adversely impact the lower reaches of San Francisquito Creek.

As the amount of suspended sediment flowing over the Searsville dam will more than double as the dam fills, the turbidity of the water in San Francisquito Creek will increase during storm events. However, turbidity persistence in San Francisquito Creek is expected to diminish, because turbid storm runoff will pass quickly down the creek instead of being detained in the lake and released slowly throughout the runoff season (Balance Hydrologics, 1996).

The summer temperature of the water in Searsville Lake may increase as the lakebed becomes shallower but the water flowing over Searsville dam during winter storms is not expected to differ from that in the existing condition. Dissolved oxygen levels should not change substantially.

There may be an increase in the quantity of small woody debris entering San Francisquito Creek as Searsville Lake fills and an efficient channel is formed. As the channel widens and deepens, its capacity to strain out woody debris coming from the upper watershed will be reduced. The developing channel may also mobilize woody debris buried in the deltaic apron. Large woody debris located on floodplains above where the efficient channel forms will probably remain in Searsville Valley and not be transported over the dam.

4.2 POTENTIAL CHANGES TO RIPARIAN VEGETATION

4.2.1 Searsville Lake

The most significant changes to vegetative communities in the study area will occur in Searsville Lake as a result of the natural filling of the lake over time. We expect a steady increase in the extent of terrestrial riparian habitats in the former lake bed and a progressive decline in aquatic habitats as sedimentation of the lake progresses. The lake bed is expected to undergo several overlapping phases of vegetative succession based on the tolerance of particular plant associations to inundation, aggradation, shading, and ultimately, drying of large portions of the former lake bed. Open Water habitat, which currently dominates Searsville Valley, will rapidly convert to a complex mosaic of lentic, lotic, and terrestrial habitats until a single-thread efficient stream channel evolves. The "new" San Francisquito Creek will flow from the confluence of the tributary creeks to Searsville Dam and will likely be characterized by a corridor of early-successional Valley Foothill Riparian habitat on the floodplains within the meander belt and ultimately develop late-successional Coastal Oak Woodland habitat at higher elevations in the floodplain.

Vegetative communities within the Corte Madera/Sausal Creek floodplains and deltaic apron, the Upper and Middle Marshes, as well the portions of San Francisquito Creek below the dam provide living models for how the new Searsville Valley is predicted to evolve. Several unknown factors will determine the rate of succession from one biotic habitat to another in

Searsville Lake. They include the amount of aggradation, the duration and frequency of flooding, the ultimate depth of the efficient channel, changes in the depth of groundwater, potential colonization by invasive species, and management intervention, among others.

In general, if the current rate of sedimentation from the upper watershed remains high, then the area occupied by fast-growing emergent herbaceous vegetation (Fresh Emergent Wetland) will rapidly increase. If the rate of sedimentation slows for several years, the greater the development of slowly-maturing willow thicket and cottonwood (Valley Foothill Riparian). Willow and cottonwood are expected to thin out as they mature due to competition. Willow and cottonwood debris from tree fall that is carried further out into the deltaic apron and buried by sediment may sprout and could vigorously establish dense, young thickets. A reduction in sediment inputs will also encourage the development of dogwood and box-elder in the understory of more mature willow/cottonwood forest, particularly at the margins of the floodplain where the water table may be lower. Where Searsville Valley remains inundated, Fresh Emergent Wetland and flood-tolerant tree species, such as willows and cottonwoods will persist. If sedimentation causes drainage to improve and minimizes the frequency of inundation in higher floodplain areas, late-successional tree species, such as coast live and valley oak, California bay, and buckeye are likely to establish.

Accurate predictions of successional patterns would require additional research and analysis that are not in the scope of the current study. Nonetheless, a brief summary of the expected trends in vegetative succession are presented as follows:

1. Near future – Open Water habitat will continue to dominate Searsville Valley for several more decades. However, as sediments are transported into the open water of the lake, deltaic deposits accumulate and are quickly colonized by vegetation. Fresh Emergent Wetland habitat is expected to increase rapidly as the delta extends into the lake and creates shallows. Early-successional Valley Foothill Riparian habitat originating from more mature riparian forest further upstream is expected to establish throughout the deltaic apron as transitory debris dams fail and multiple channels braid across the delta.

2. Medium future – The deltaic apron of Corte Madera and Sausal Creeks is expected to extend all the way across Searsville Lake, separating the Middle Marsh from Searsville Lake. Sedimentation into Searsville Lake will continue until the lake is almost filled but is expected to slow nearer to the dam. Searsville Valley will look like ”Searsville Swamp”. The former lake bed will be co-dominated by a mosaic of Freshwater Emergent Marsh and Valley Foothill Riparian habitats. The stream channel will likely remain braided near the Corte Madera/Sausal Creek delta but form a broad meander belt that extends toward the Dam. Frequent flooding during storms will continue to build floodplains and terraces and replenish early-successional riparian forests. During summer, Open Water habitat will persist in oxbows and other meander belt depressions, and as small ponds in the embayments of the arroyos and draws which presently drain directly into the lake (Balance Hydrologics, 1996). Fresh Emergent Marsh is expected to occupy the margins of ponds at the edges of Searsville Valley and Searsville Dam.

3. Far future – The stream channel is expected to mature and incise within its' meander belt and overtop its' banks to deposit sediment on the floodplains only during floods. Floodplains will continue to build until Searsville Lake is completely filled and becomes a valley traversed by a single-thread, efficient channel. Valley Foothill Riparian habitat is expected to occupy the banks and floodplains of the new San Francisquito Creek. The riparian woodland will slope gently upward from the dam to a point near the existing delta front just north of the causeway (Balance Hydrologics, 1996) Older dry flood terraces and well-drained side slopes at higher elevations are expected to be colonized by late-successional Coastal Oak Woodland habitat. Open Water and Fresh Emergent Marsh habitats at tributary draws and along the valley margins will diminish in size as the riparian canopy grows around them. Mid-successional riparian tree species, such as white alder and big leaf maple are expected to occupy the margins of remaining Open Water and Fresh Emergent Wetland habitats. The new stream will transport sandy bedload over the dam and into San Francisquito Creek.

4.2.2 Searsville Dam to Highway 280

This portion of San Francisquito Creek is a bedrock-controlled, transport reach with a deeply incised channel and moderate to steep vegetated banks. The vegetation has been characterized as Valley Foothill Riparian habitat and is described in detail Section 3.1.2 of this report. Vegetation in this reach with the most potential to be impacted by any significant changes in channel morphology, hydrologic, and/or sediment regime includes woody riparian vegetation occupying the mid-bank, low-bank, and floodplains, as well as the emergent aquatic vegetation in the channel bottom.

The amount of additional sediment from above Searsville Dam expected to deposit in this reach of the channel is negligible. Expected changes in channel geometry are negligible as well. The traces of sediment from Searsville Valley that may settle out in this reach are most likely to deposit either in pools or on small depositional features, such as sandbars, floodplains or log jams. Some of this additional sediment may deposit on mid-bank terraces during peak floods.

Plant species that currently occupy the mid-bank, low-bank, and in channel positions in this reach are adapted to the seasonal variation associated with periods of flooding and aggradation. These plant species have highly individualized physiological responses and adaptive strategies to wet and dry periods and episodic deposition of sediment. Herbaceous emergent vegetation in the channel bed, as well as early-successional woody riparian tree species occupying the toe of slope position and floodplains are most tolerant of frequent inundation, hydric conditions, and varying levels of aggradation and scour.

The trace amount of sediment expected to deposit in this reach will likely have a beneficial effect on riparian vegetation in the channel and low-bank positions. A stand of riparian forest that may particularly benefit from an increase in sediment exists immediately below Searsville Dam where San Francisquito Creek exhibits a rocky and somewhat "sediment starved" condition with very little soil deposition or soil development. This condition is not uncommon at the base of dams. The deciduous forest floor in this reach is covered by a dense carpet of gnarled woody roots that scarcely penetrate the rocky floodplain. An addition of sediment on this floodplain would benefit this stand of trees. The increase in turbidity during storms and reduction in turbidity after storms is not expected to have any substantial effect on vegetation. The potential effects of turbidity are a greater concern for fish and amphibians.

Once Searsville Lake is filled up with sediment, there may be an increase in small woody debris, vegetative material, and seed from Searsville Valley and the upper watershed to San Francisquito Creek. Both woody and herbaceous vegetation may increase slightly in depositional areas, such as sandbars and floodplain, following episodic delivery of sediment and source materials. However, this is more likely further downstream in the alluvial-controlled reaches.

4.2.3 Highway 280 to San Francisco Bay

This portion of San Francisquito Creek is an alluvial-controlled, depositional reach with a deeply incised channel and steep to very steep banks. Large segments of the streambank have been covered with hardscape to control bank erosion in this reach. The vegetation has been characterized as predominantly Valley Foothill Riparian habitat, co-dominated by Coastal Oak Woodland, with pockets of Herbaceous, Eucalyptus, Urban, and Saline Emergent Wetland habitats. Non-native vegetation, some of it highly invasive, occupies much of this reach. All native and non-native biotic habitats in this reach are described in detail Section 3.1.3 of this report. As in the bedrock-controlled reach described previously, the woody riparian vegetation occupying the mid-bank, low-bank, and floodplains, as well as the emergent aquatic vegetation in the channel bottom have the most potential to be impacted by any significant changes in channel morphology and hydrology. The covering of natural floodplains and terraces with hardscape concentrates sediment deposition to the channel bottom. The persistent aggradation of the channel bottom increases the duration of summer drying of the creek in most of this reach.

Natural episodic events cause significant sedimentation in this reach and loss of aquatic habitat values. However, the amount of additional sediment from above Searsville Dam expected to deposit in this reach of the channel is not substantial compared to the sediment it already receives. No significant changes in channel geometry resulting from additional sediment inputs from Searsville Valley are expected in this reach.

Plant species that currently occupy the mid-bank, low-bank, and in channel positions in this reach are not expected to be substantially altered. Nonetheless, any increase in deposition increases the duration of summer drying of the creek. Emergent vegetation in this reach of the creek is extremely limited due to summer drying, with tules, rushes, sedges, watercress, and iris occurring in a few places. The increase in turbidity during storms and reduction in turbidity after storms is not expected to have any substantial effect on vegetation in this reach.

The development of sandier floodplains in portions of the channel that are seasonally dry may invite colonization by drought tolerant invasive species, such as giant reed, acacia, and eucalyptus. However, periodic flood control maintenance in the lower reaches, which includes removal of native and non-native woody vegetation on streambed sandbars, tends to mitigate this trend. Other invasive exotics, such as English ivy, Cape ivy, periwinkle, and Himalayan blackberry will likely only colonize down to the level of ordinary high water.

An increase in small woody debris, vegetative material, and seed from Searsville Valley and the upper watershed is not likely to increase vegetation in the channel due to summer drying of most of the reach. However, an increase in woody debris may exacerbate log jams and other barriers to fish passage.

The 1.1-mile reach from Highway 101 to San Francisco Bay consists of Saline Emergent Wetland habitat which only exists in this reach. Tidal water enters pockets of freshwater emergent wetland along the Creek from the bay encouraging the growth of saline emergent wetland plants such as pickleweed and saltgrass. Upstream of where the creek enters the bay, a small stand of willows is present within the brackish marsh. This habitat was not extensively inventoried for this study because it is periodically dredged. Thus, biotic impacts based on potential geomorphic and hydrological changes originating at Searsville Lake are considered to be negligible compared to the current effects of dredging.

4.3 POTENTIAL IMPACT TO NON FEDERALLY-LISTED WILDLIFE SPECIES

The filling of Searsville Lake will increase upland habitat for most terrestrial species of wildlife. Although the sedimentation of the lake decreases potential habitat for the western pond turtle, this aquatic reptile has not been recorded in the lake or along San Francisquito Creek in recent years. Therefore the loss of the existing lacustrine conditions is not expected to impact this species. Western pond turtle is expected to continue to occur along the creek in low densities.

Potential habitat for the San Francisco garter snake (*Thamnophis sirtalis tetrataenia*) a federally-listed species, will increase as a result of the sedimentation of Searsville Lake. The existing lake provides little potential habitat. Although this species was not observed at the lake during recent surveys, the conversion of the lake to wetlands with marshes and braided streams should greatly increase potential habitat. Viable populations occur to the north and west, and the addition of wetland habitat in the area may recruit from these populations.

Sedimentation of the lake will result in a loss of habitat for most of the waterfowl including numerous migratory species. Some species (e.g., Ruddy Duck (*Oxyura jamaicensis*) and Gadwall (*Anas strepera*) may currently breed in the emergent vegetation at the edges of the lake. With only a few acres of lacustrine waters, these species will likely still occur and breed, but in fewer numbers. With the complete loss of the lake, only the most flexible species, such as the Mallard, will continue to breed along the creek flowing through the filled-in reservoir. Likely, foraging habitat for the Double-crested Cormorant, Forster's Tern (*Sterna forsteri*), and Caspian Tern (*S. caspia*) will be lost. Because other similar habitat is abundant in the region, this loss of this open water habitat would not be considered substantial.

Newly created uplands may provide additional habitat for several California Species of special concern. The addition of short grasslands or ruderal habitat with non-native plant species may provide additional habitat for the Horned Lark (*Eremophila alpestris*) and the Burrowing Owl (*Athene cunicularia*). Likewise, the Loggerhead Shrike (*Lanius ludovicianus*) may nest in the invading coyote brush. After a climax community of coast live oak trees is established with dense, closed canopies, raptors such as the Cooper's Hawk and Sharp-shinned Hawk (*Accipiter striatus*) may also breed here.

As the lake fills in with sediment the creation of marshlands will initially increase potential breeding habitat for other special-status species, such as the Salt Marsh Common Yellowthroat (*Geothlypis trichas sinuosa*), Tricolored Blackbird (*Agelaius tricolor*), and the Northern Harrier (*Circus cyaneus*). Much of the newly created marshlands will probably eventually change to drier habitats. However, the remnant areas of emergent vegetation should be greater than those found with the existing conditions, so there should be a net gain in breeding habitat for these birds.

The California Yellow Warbler currently breeds in willows found along San Francisquito Creek and in the upper lake areas. Newly established willows alongside the new creek channel should provide additional, fairly permanent breeding habitat for this species.

The expected increase in sediment load and floating debris is not expected to significantly change the potential habitat for most non federally-listed wildlife species found in riparian habitats of San Francisquito Creek. Therefore, there are no anticipated substantial impacts to these non federally-listed wildlife species from Searsville Dam to San Francisco Bay.

4.4 POTENTIAL IMPACTS ON INVASIVE AQUATIC SPECIES OF CONCERN

4.4.1 Bullfrogs

At present the bullfrog population within San Francisquito Creek is relatively small and concentrated below the Searsville Dam, and is thought to be the result of individuals spilling over the dam into the creek from the larger population within Searsville Reservoir during winter flood events. As the lake fills with sediment to the present top level of the dam, it is expected that habitat in the form of shoreline will be created for bullfrogs at the dam face. This may allow more individual bullfrogs to be present at the dam face and susceptible to spilling over the dam during flood events. Additionally, as the reservoir gradually changes from open water to a marsh to a stream, the bullfrog population is expected to increase due to a more suitable marsh habitat and a reduction of predatory fish (eg., largemouth bass) within the reservoir, but eventually may become reduced below present numbers as the habitat becomes a more channelized stream within Searsville Valley.

The effect of this transition will probably be an initial increase in the annual introduction of bullfrogs into San Francisquito Creek from Searsville Reservoir. A higher number of bullfrogs within San Francisquito Creek may negatively impact the California red-legged frog population through greater predation and competition. However, bullfrogs are not expected to become established within San Francisquito Creek due to the continued annual removal of overwintering tadpoles during the winter flood events, and an eventual reduced population above the dam.

4.4.2 Crayfish

As with bullfrogs above, an initial increase in crayfish entering San Francisquito Creek from Searsville Reservoir is expected to occur due to more crayfish being present at the dam face and an increase in the crayfish population as the succession from open water to marsh proceeds.

4.4.3 Chinese Mitten Crabs

No change in density of the Chinese mitten crab population due to an increase in sediment flow resulting from the natural filling of Searsville Reservoir is expected. However, an increase in density and distribution of crabs to the dam face may occur regardless due to upstream migration.

4.5 POTENTIAL IMPACTS TO SPECIAL-STATUS PLANT AND WILDLIFE SPECIES

4.5.1 Potential Impacts to Special-Status Plants

Fountain Thistle Fountain thistle may occur within the bed of San Francisquito Creek. Therefore, potential impacts may occur from an increase in sediment flow along the upper portion of San Francisquito Creek located within the vicinity of Searsville Lake.

San Mateo Woolly Sunflower San Mateo woolly sunflower may occur along the opposing banks of San Francisquito Creek. However, no substantial impacts are anticipated from an increase in sediment flow along the banks in the upper portion of San Francisquito Creek located within the vicinity of Searsville Lake.

Dudley's Lousewort Dudley's lousewort may occur along the opposing banks of San Francisquito Creek. However, no substantial impacts are anticipated from an increase in sediment flow along the banks in the upper portion of San Francisquito Creek located within the vicinity of Searsville Lake.

Santa Clara Red Ribbons Santa Clara red ribbons may occur along the opposing banks of San Francisquito Creek. However, no substantial impacts are anticipated from an increase in sediment flow along the banks in the upper portion of San Francisquito Creek located within the vicinity of Searsville Lake.

Western Leatherwood Western Leatherwood may occur along the opposing banks of San Francisquito Creek. However, no substantial impacts are anticipated from an increase in sediment flow along the banks in the upper portion of San Francisquito Creek located within the vicinity of Searsville Lake.

4.5.2 Potential Impacts to Federally-Listed Animal Species

4.5.2.1 Steelhead Rainbow Trout

As the dam fills the amount of suspended sediment passing through during storm flows will slowly increase to 100% of the load entering the lake, compared to about 10% passing through at the present time. This suspended sediment is expected to generally flow through the creek to the bay. Substrate conditions in the stream below the lake will not be adversely affected, especially in the steeper sections upstream of Junipero Serra Boulevard, where steelhead spawn and rear. The duration of turbid events should progressively decrease, as turbid storm water passes through the filled lake, rather than being gradually metered out for several days following the storm from water stored in the lake. The impact of turbidity from late season storms on winter and spring feeding by steelhead will be somewhat reduced. In addition, deposition of fine sediment in the streambed may also actually be reduced, because fine sediment will pass through during storms, rather than also during the lower flow periods immediately following storms.

Bedload sediments are presently trapped by the lake, but will move over the dam once the lake is filled. This coarse sand and gravel is expected to cause 12 inches of channel aggradation over fifty years. Pools present between Searsville Lake and Junipero Serra Boulevard are primarily associated with scour at bedrock outcrops, roots or wood from riparian trees or sharp channel bends. Therefore, filling should be minimal and mostly confined to the largest pools, which provide overwintering habitat. The most heavily used summer rearing habitats are probably the fast-water riffles, runs and heads of pools, where increased bedload is less likely to have effects on water depth or substrate conditions. However, if substantial aggradation increases the amount of water that flows subsurface, more of the streambed will go dry on the surface more often. Presently, the reach between Searsville and Bear Creek and a ½ mile reach upstream of the Boething Tree Farm lack late summer surface flow in dry years; those reaches may dry more often.Substantial aggradation in the downstream reaches (downstream of El Camino) could result in earlier drying of the streambed, and reduce the period for successful steelhead smolt outmigration.

Within the San Francisquito Creek watershed, spawning gravels are presently very scarce only in the 0.2-mile reach between Searsville and Bear Creek, because of bedload trapping by the dam. Spawning habitat will improve in this reach after filling of the dam.

The present effect of Searsville Lake on water temperatures downstream is to slightly increase them, because the surface water that spills over the dam is warmer than the inflow water to the lake. After filling of the lake this effect will be eliminated.

Nonnative fish presently spill from Searsville Lake during wet years. Apparently most of the fish wash through or fail to survive in San Francisquito Creek, as the few non-natives collected in the creek are mostly in the pools immediately downstream of the lake (Launer and Spain 1998; Launer and Holtgrieve 2000). As the lake gradually fills, flushing of these fish may occur more often, because smaller floods can flush them from the lake. Spill of these fish will then decline as the filling of the lake eliminates suitable lake habitat for them.

The net effect of the filling of the lake should be slightly beneficial to steelhead downstream of the lake, depending upon the extent that aggradation downstream will increase the extent, frequency and timing of surface drying of the streambed.

4.5.2.2 Red-Legged Frog

Increased suspended sediment in the form of fine grain sand may impact breeding and larval development if deposition occurs. If sediment deposits in deep pools making them substantially shallower then it will impact all life stages. However, increased sediment through the system is not expected to result in increased deposition in this reach of the creek. Increased turbidity through the system is not expected to directly impact adults or juveniles. However, increased turbidity could impact tadpoles if it results in reduced dissolved oxygen and/or hinders their ability to breathe. This is not expected due to the material being fine grain sand, which is not known to clog gills and because the turbidity is expected to be short-lived, occurring only during storm events.

Initial higher numbers of bullfrogs and crayfish from Searsville Reservoir may impact red-legged frogs through increased predation and competition. However, eventually the red-legged frog population may increase in distribution above the Searsville Dam as habitat becomes more suitable.

4.6 MANAGEMENT RECOMMENDATIONS

We recommend that continued monitoring of Searsville Lake, San Francisquito Creek, and Bear Creek be conducted to determine if changes in the distribution and density of California red-legged frogs are occurring due to the natural filling of Searsville Lake. If it is found that the red-legged frog population within San Francisquito Creek is declining and the cause of this decline is suspected then appropriate actions to remove this cause are recommended (e.g., if increased predation by bullfrogs is found to be occurring then a bullfrog management program should be initiated).

We recommend that vegetative successional patterns be permitted to evolve naturally as Searsville Lake fills with sediment. Periodic maintenance activities, i.e. clearing out woody vegetation in the lower channel of San Francisquito Creek, should be continued in order to reduce flood risk and to enable fish passage.

5.0 ENVIRONMENTAL OVERLAY-LOWERING OF SEARSVILLE DAM

5.1 PREDICTED ECOSYSTEM EVOLUTION

The lowering of Searsville Dam by 16 feet is expected to result in downstream ecological conditions similar to those previously described for the natural filling scenario. However, several distinct differences in the evolution of Searsville Valley are expected from lowering the dam as compared to allowing the lake to fill naturally. The spatial extent of Fresh Emergent Wetland will be comparatively reduced as the ecological succession from Open Water habitat to Coastal Oak Woodland will not include a lengthy transition as "Searsville Swamp". The predicted successional pattern described as the "Near future" scenario in Section 4.1 will bypass the "Medium Future" scenario in favor of the "Far future" scenario.

After the lake surface elevation is lowered, the development of an efficient, single-thread channel from the lowered spillway through the Corte Madera/ Sausal Delta will rapidly initiate. A headcut will proceed upstream and lower the elevation of the efficient channel. We are uncertain at this time how changes in the physical environment will ultimately effect the riparian and wetland habitats associated with Corte Madera Creek and Searsville Lake. Depending on changes in water table hydrology and patterns of sedimentation, the existing riparian forest nearer the margins of the floodplain may begin to dry out. It is unknown whether the degree of desiccation will result in high mortality of the existing riparian forest.

Lowering the dam is expected to expose approximately 15 acres of lake bottom sediment currently below the Open Water habitat (Northwest Hydraulic Consultants, 1999). Exposed sediment creates a high potential for both surface erosion and the establishment of non-native invasive plant species in disturbed areas.

The amount of suspended sediment passing through the new Searsville Valley during storm flows will sharply increase to 100% of the load entering the developing channel, compared to about 10% passing through at the present time. Contributions of sediment from surface erosion of the exposed former lake bottom will be high until these areas are revegetated. As before, the majority of this suspended sediment and bedload is expected to generally flow through the creek into San Francisco Bay. Channel geometry and substrate conditions in the stream below the lake will not be adversely affected, especially in the steeper sections upstream of Highway 280. Pools present between Searsville Lake and Highway 280 are primarily associated with scour at bedrock outcrops, roots or wood from riparian trees or sharp channel bends. Therefore aggradation should be minimal, mostly confined to the largest pools, floodplains, sand bars, and behind log jams.

If substantial aggradation increases towards the end of the rainy season when flows can be insufficient to transport sediment to the bay, the timing and location of streambed drying may alter somewhat. Presently, the reach between Searsville and Bear Creek and a ½ mile reach upstream of the Boething Tree Farm lack late summer surface flow in dry years; those reaches may dry more often.

The duration of turbid events should progressively decrease, as turbid storm water passes through the filled lake, rather than being gradually metered out for several days following the storm from water stored in the lake. The temperature of water entering San Francisquito Creek from the upper watershed are expected to be slightly cooler since they will not be warmed in previously existing Open Water habitat.

5.2 POTENTIAL CHANGES IN RIPARIAN VEGETATION

5.2.1 Searsville Lake

As mentioned above, a reduction in Searsville Lake water levels would expose a significant area of unvegetated ground around the edges of the lake and sharply diminish Fresh Emergent Marsh habitat. This exposed area would be susceptible to the establishment of undesirable non-native invasive plant species and would require active revegetation and management to minimize the infestation. The linear extent of shoreline habitat would be sharply reduced. Open Water habitats would not be expected to persist in the embayments of arroyos and draws or meander depressions as described in the dam filling scenario.

The alluvial fan and deltaic apron, which is currently dominated by Valley Foothill Riparian habitat, may also undergo succession to a more xeric Coastal Oak Woodland habitat. As the deeper, high-banked, efficient channel develops, the floodplain may begin drying and the water table may drop. Riparian forest furthest from the channel would likely be replaced by upland oaks, bay, and buckeye. These areas may also be more susceptible to colonization by non-native invasive plants as the delta converts to a more xeric habitat type. Exotic species most prevalent in upstream areas outside of Jasper Ridge Biological Preserve and likely to colonize the former lake bed are, in order of concern, Scotch broom, pampas grass, and yellow star thistle.

If a high mortality of willow and cottonwood trees in the Corte Madera/Sausal Creek floodplains occurs, some of this woody debris may initially be transported into San Francisquito Creek. The alluvial fan would likely retain more and more of this woody debris as the efficient channel incises. Woody debris would increase microclimate conditions for late-successional tree species, as well as create good habitat for rodent, snakes, and other wildlife.

5.2.2 Searsville Dam to Highway 280

Potential changes to biotic habitats in this reach of San Francisquito Creek resulting from the lowering of Searsville Dam are not expected to differ substantially from those previously described for the natural filling scenario in Section 4.2.2. The accelerated timing of the increase in suspended and bedload sediments to this reach will not sufficiently change depositional patterns, channel geometry, or hydrology to alter the current plant communities within the bed and banks of this reach of San Francisquito Creek.

The amount of woody and vegetative debris that may enter San Francisquito Creek as a result of potential mortality of the early-successional riparian forest in the floodplain and delta areas is as yet unknown. Thus it is premature to suggest that there may be an increase in log jams which may cause sediment to deposit rather than be transported through this reach.

5.2.3 Highway 280 to San Francisco Bay

Potential changes to biotic habitats in this reach of San Francisquito Creek resulting from the lowering of Searsville Dam are not expected to differ substantially from those previously described for the natural filling scenario in Section 4.2.3. The potential increase in deposition of sediment, vegetative material, and woody debris in the lower reaches of San Francisquito Creek are predicted to be insubstantial as compared to the sediment and debris burden already carried by the channel. Deposition of additional sediments and colonization of woody plants in the channel are likely to be somewhat mitigated as a result of periodic removal of vegetation in the channel bottom, as well as dredging of the channel below Highway 101.

5.3 POTENTIAL IMPACT TO NON FEDERALLY-LISTED SPECIAL-STATUS WILDLIFE SPECIES

Lowering of the Searsville Dam will produce similar effects to most of the aforementioned non federally-listed wildlife species mentioned in Section 4.3. However, there may be less marsh and lacustrine water habitat, providing less potential habitat for the western pond turtle, San Francisco garter snake, Salt Marsh Common Yellowthroat, Tricolored Blackbird, and the Northern Harrier. Initially, upland species most tolerant to disturbed areas, such as the Loggerhead Shrike, may take advantage of an increase in developed ruderal habitat with pioneer plants such as coyote brush. The Salt Marsh Common Yellowthroat may also initially increase with the development of cattails on the receding lake's edge. However, coast live oak woodland is expected to replace these ruderal areas, greatly reducing the potential habitat for Loggerhead Shrike and Salt Marsh Common Yellowthroat. As coast live oak forest develops a dense closed-canopy forest, special status species such as the Cooper's Hawk and possibly the Sharp-shinned Hawk may ultimately breed in the climax coast live oak woodland. The pallid bat may night-roost or day-roost in cracks of the rocky grottos immediately below and adjacent to the reservoir. Because pallid bats have ample potential roosting habitat in adjacent areas of Jasper Ridge, the loss of this habitat would not be considered substantial. Preconstruction surveys for pallid bats should prevent the potential disturbance to, or loss of, individuals. Therefore the lowering of the dam is not expected to substantially impact any of these aforementioned species.

The Townsend's big-eared bat roosts in cavernous areas in the rocky banks along San Francisquito Creek immediately below and adjacent to the dam face. Construction activities to lower the dam may result in the loss of individuals and the permanent loss of roosting habitat for this California species of special concern. Although this species is not currently federally-listed, several federal agencies published a Species Conservation Assessment and Conservation Strategy (Pierson et. al 1999) for this now rare species. The loss of individuals and this habitat would be considered a substantial impact.

5.4 POTENTIAL IMPACTS ON INVASIVE AQUATIC SPECIES OF CONCERN

5.4.1 Bullfrogs

An initial increase in the numbers of bullfrogs entering into San Francisquito Creek from Searsville Reservoir is expected during and after dam lowering. However, this increase is not expected to persist due to the continued annual removal of overwintering tadpoles during the winter flood events, and an eventual reduced population above the dam associated with the loss of breeding habitat.

5.4.2 Crayfish

As with bullfrogs above, an initial increase in Louisiana red-swamp crayfish entering San Francisquito Creek from Searsville Reservoir is expected to occur due to the dam lowering and more crayfish being present at the dam face after lowering. However, an increase in distribution within San Francisquito Creek is not expected.

5.4.3 Chinese Mitten Crabs

No change in density of the Chinese mitten crab population due to the dam lowering is expected.

5.5 POTENTIAL IMPACTS TO SPECIAL-STATUS PLANT AND ANIMAL SPECIES

5.5.1 Potential Impacts to Special-Status Plants

Fountain Thistle. Fountain thistle may occur within the bed of San Francisquito Creek. Therefore, potential significant impacts may occur from an increase in sediment flow along the upper portion of San Francisquito Creek located within the vicinity of Searsville Lake.

San Mateo Woolly Sunflower. San Mateo woolly sunflower may occur along the opposing banks of San Francisquito Creek. However, no significant impacts are anticipated from an increase in sediment flow along the banks in the upper portion of San Francisquito Creek located within the vicinity of Searsville Lake.

Dudley's Lousewort. Dudley's lousewort may occur along the opposing banks of San Francisquito Creek. However, no significant impacts are anticipated from an increase in sediment flow along the banks in the upper portion of San Francisquito Creek located within the vicinity of Searsville Lake.

Santa Clara Red Ribbons. Santa Clara red ribbons may occur along the opposing banks of San Francisquito Creek. However, no significant impacts are anticipated from an increase in sediment flow along the banks in the upper portion of San Francisquito Creek located within the vicinity of Searsville Lake.

Western Leatherwood. Western leatherwood may occur along the opposing banks of San Francisquito Creek. However, no significant impacts are anticipated from an increase in sediment flow along the banks in the upper portion of San Francisquito Creek located within the vicinity of Searsville Lake.

5.5.2 Potential Impacts to Federally-Listed Animal Species

5.5.2.1 Steelhead Rainbow Trout

The improvement in spawning habitat in the 0.2 mile reach immediately downstream of the lake, and the slight improvements in post-storm turbidity, water temperature, and spilling of nonnative fishes indicated for natural filling of the lake will begin to occur immediately after lowering the dam. Potential aggradation effects on downstream surface flows will occur sooner than by natural filling.

As would occur for natural filling of the lake, the net effects upon steelhead appear to be slightly beneficial, depending upon the extent that downstream aggradation will increase the extent, frequency and timing of surface drying of the streambed.

5.5.2.2 Red-Legged Frog

An immediate and dramatic increase in suspended sediment may impact breeding and larval development if deposition occurs. If this sediment deposits in deep pools making them substantially shallower then it will impact all life stages. However, it should be noted that substantial changes in pool depth. Increased and prolonged turbidity due to continued erosion of the exposed lake bed sediment could impact tadpoles if it results in reduced dissolved oxygen and/or hinders their ability to breathe. The timing of the lowering may also impact red-legged frogs if it is performed during the breeding and larval developing season. Additionally, an initial large increase in bullfrogs, crayfish, and predatory fish from Searsville Reservoir when the dam is lowered may substantially impact red-legged frogs through increased predation and competition.

5.6 MANAGEMENT RECOMMENDATIONS

The natural filling scenario, by definition precludes making management recommendations, but several key factors should be considered for the dam lowering scenario. In particular, the methods utilized in lowering the dam crest and the timing in which it is lowered could either lessen or intensify potential impacts to biotic habitats above, within, and below Searsville Lake.

Our two greatest concerns both relate to the opportunities potentially afforded to exotic plant and animal species as a result of dam modification. The first is that lowering of the dam will likely result in approximately 15 acres of exposed lake bottom sediment with a high potential for colonization by invasive plant species. Rapid colonization by invasive broom, pampas grass, star thistle, and non-native grasses may preclude natural recruitment of nativve species and/or may compete with species planted for revegetation. The second is that lowering the dam may spill unknown quantities of non-native fishes and amphibians into San Francisquito Creek Non-native fish and bull frogs may have deleterious effects on federally-listed red-legged frog and steelhead rainbow trout.

Several management options have already been described in the *Family Farm Road Flood and Sedimentation Control Study* (Northwest Hydraulic Consultants, 1999). H.T. Harvey &

Associate's biologists support several of the options presented by Northwest Hydraulic Consultants and have included those and added additional recommendations below.

Timing of lake level lowering - The timing of lake level lowering should be analyzed to determine how it affects habitat establishment of the exposed lake bed. For example, lake level lowering could be performed during the periods of seed dispersal of native plants to encourage establishment of native species.

Lake level lowering may also impact successful recruitment of the year's progeny of California red-legged frogs in San Francisquito Creek if it occurs during the breeding and/or larval developing season. Therefore, lake level lowering could be performed after metamorphosis but before breeding and egg laying occurs to reduce this impact.

During the operation to lower the dam, construction methods should be considered that divert the inflows to the lake in order to reduce downstream turbidity impacts from the partial dam removal. Methods should be considered to remove or strain out all nonnative fish, frogs and turtles from outflow at the time of loweringin order to reduce the quantity of non-native animal species flushed in the stream below the lake during the first winter.

Gradual versus rapid lake level lowering. The rate of lake level lowering should be analyzed to determine the affects of gradual versus rapid lake level lowering on the establishment of native species. For example, rapid lowering of the lake could adversely affect existing riparian vegetation around the shoreline, in Middle Lake, and along the aggrading alluvial fan. There are several possible strategies to minimize these effects, including incrementally lowering the dam crest over 3 to 5 growing seasons or reducing the depth of lowering from 16 feet to 12 feet. This method would also allow for incremental revegetation of lake sediments, if necessary, since not all lake sediments would be exposed in one growing season. Conversely, this approach could create a situation of continuous disturbance and may only impede successful revegetation or natural recruitment of the exposed lake bed sediments. Rapid lowering of the water level would leave a bare dirt "bathtub ring" that would require extensive and well-timed restoration treatments.

Periodic controlled flooding. The effects of periodically flooding the exposed lake bed (via water control structure or sizing of the spillway) on the establishment of riparian and wetland habitats should be analyzed. Periodic controlled flooding could encourage the establishment of native habitats by timing flooding to correspond with native species seed fall. This could also assist in controlling non-native invasive plants. Periodic flooding could also serve as the method of irrigating revegetation zones.

The exposed sediments would be susceptible to the establishment of non-native invasive plant species. Management and control of non-native invasive plants, particularly yellow star thistle, Scotch broom, and pampas grass, will be critical during the first five years after implementation of this activity. The restoration measures discussed below offer several strategies to reduce weed species invasion; however, the exposed lake sediments will require intensive management to prevent non-native invasive plant establishment until the native vegetation provides adequate canopy cover to shade out non-native invasive plants.

Erosion Control - Rill erosion could become problematic during the first several years after the lake sediments are exposed. Sediments would need to be protected with a quick growing seed mix and mulch. A natural mulch of dry tules, collected from the existing marsh and crimped into the soil, may provide adequate protection without introducing a non-native material into the project area.

Monitoring - We recommend that continued monitoring of Searsville Lake, San Francisquito Creek and Bear Creek be conducted to determine if changes in the distribution and density of California red-legged frogs are occurring due to the lake level lowering. If it is found that the red-legged frog population within San Francisquito Creek is declining and the cause of this decline is suspected then appropriate actions to remove this cause are recommended (e.g., if increased predation by bullfrogs is found to be occurring then a bullfrog management program should be initiated).

Restoration Measures - The restoration associated with lowering the dam could include the following measures.

1. Seed erosion control species. An erosion control mix of appropriate locally native grass and forb species should be seeded immediately following construction. The seed mix should include rhizomatous species to stabilize the disturbed soils. It is likely that helicopter seeding, a common practice for seeding rice fields in the Central Valley, will be the only practical means to broadcast seed on the saturated lakebed sediments.

2. Plant riparian cuttings. Cuttings from riparian plants adjacent to the disturbed site should be collected and planted when dormant to re-establish woody plant species. The entire lakebed area cannot be planted with riparian cuttings; however, selected areas can be planted to recolonize highly erosive areas or reaches of the lake that are furthest from existing seed sources.

3. Install biotechnical bank stabilization materials. Biotechnical bank stabilization materials, including cellulose-based erosion control blankets, straw wattles, and mulch, could be incorporated into the design to stabilize the disturbance area and reduce erosion. As mentioned in the key considerations section above, tule thatch from the existing marshes can be collected, spread, and crimped into the exposed lakebed to control erosion as an alternative to straw mulch (rice straw mulch is another alternative).

6. Plant container stock of high floodplain terrace vegetation. Locally native vegetation for the high floodplain terrace (e.g., along the 3 acres of exposed old hillside in the narrowest portion of Searsville Lake) should be planted from nursery grown material. These plant species, including, but not limited to, valley oak, coast live oak, madrone, California bay, and California buckeye, would be collected from plants on-site and grown in a local or on-site nursery until ready for installation. Plants could be drip-irrigated with a temporary above ground system or flood irrigated during the first few years of establishment if necessary.

7. Plant native grass plugs. Native grasses from local seed sources could be grown in a nursery environment and planted in appropriate areas. Native grasses provide excellent erosion control once established. The entire lakebed area cannot be planted with native grass plugs, however, selected areas can be planted to re-colonize highly erosive areas and establish new seed banks.

8. Establish non-native invasive plant management program. As mentioned in the key considerations for this flood control activity, the establishment of non-native plant species invasion will be an on going challenge after lowering the dam crest and exposing the lakebed. To minimize non-native invasive plant establishment, the site should be thoroughly revegetated and a management program established. Non-native invasive plant species should be removed manually and chemically. It is recommended that the University consider dedicating an individual or contracting with a qualified contractor to manage weed species for at least the first five years.

9. Plant tule plugs. Tule plugs excavated from the existing delta and other shoreline areas should be replanted in appropriate locations in the new marsh zone once the dam has been lowered.

10. Establish monitoring program. A monitoring program as described in the restoration methodology section above should be established to assist with restoration strategies. Permanent monitoring transects should be established laterally and longitudinally across Searsville Lake and the existing Corte Madera Creek floodplain and delta. From the transects, soils, vegetation, and groundwater information could be collected. Monitoring would initially focus on understanding the current (with-out project) relationship of groundwater and riparian vegetation, predicting hydric vegetation patterns around Searsville Lake after the dam is lowered, and evaluating sediment texture and its water retention characteristics for predicting future vegetation recruitment. Once the project is implemented, monitoring would focus on evaluating the success of restoration efforts and modifying management practices.

11. The Townsend's big-eared bat is known to roost in the rocky grottos above the creek immediately adjacent to the dam face. Since being classified as California species of special concern in 1984, researchers and resource managers at the Western Bat Working Group meeting in March of 2001 discussed listing this species as a federally-endangered species. Members of the group also concluded that numbers of both Townsend's big-eared bat and Pacific pallid bat occurring in coastal California have continued to decline substantially in recent years. A pre-distubance survey for roosting bats should be conducted prior to any construction activities on the dam face. The survey should be conducted by a qualified bat biologist (i.e., a biologist holding a CDFG collection permit and a Memorandum of Understanding with CDFG allowing the biologist to handle and collect bats). No activities that would result in disturbance to active roosts would proceed prior to the completed surveys. If no active roosts are found, then no further action would be warranted. If a maternity roost is present, a qualified bat biologist would determine the extent of construction-free zones around active nurseries since these species are known to abandon young when disturbed.

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