State of California
The Resources Agency
Department of Water Resources

SP-T3/5 PROJECT EFFECTS ON RIPARIAN RESOURCES, WETLANDS, AND ASSOCIATED FLOODPLAINS DRAFT FINAL REPORT

Oroville Facilities Relicensing
FERC Project No. 2100

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REPORT SUMMARY

Existing and future operations of the Oroville Facilities may impact riparian and wetland habitats within the Project area and/or within the Feather River downstream of the Project Area. Project operations and maintenance that may affect these resources include Feather River flow releases, altered sediment transport regimes, water level fluctuations, maintenance activities, gravel harvest, and recreational uses.

The Feather River has a long history of land uses which have affected natural river processes within its floodplain. Riparian systems provide a number of important functions to both the aquatic and terrestrial ecosystems associated with them. These include, but are not limited to, stream bank stabilization, flow moderation and flood control, sediment control, organic matter necessary to support aquatic communities, water quality improvement by filtration, temperature moderation by shading, and stream structural diversity (large-woody debris). Riparian and wetland habitats are important vegetation communities for wildlife. The diversity and density of species associated with these ecosystems is disproportionately high in comparison to other plant communities. Historically, these systems were flanked by extensive floodplains that supported riparian forests and associated wetlands (Katibah 1984). Extensive modification of these systems from land-use practices, levees, and flood control and water supply functions of dams has altered and decreased functioning floodplains, and riparian and wetland systems in California.

Currently, the Feather River riparian forests downstream of Oroville Dam are fragmented and narrow compared to historic riparian forest. Approximately 4,268 acres of riparian forests; 2,175 acres of riparian shrub; and 912 acres of wetlands were mapped within the FEMA 100-year floodplain of the Feather River below the Project Area. In many areas constrained by levees, urbanization, or agriculture, riparian vegetation is only a thin band of trees one tree canopy wide with little to no understory. In other areas, especially in areas of large meander bends, large patches of riparian habitats exist.

Cottonwood recruitment studies indicate that although some limited recruitment has occurred, recent recruitment has been scarce in the low flow and high flow reaches of the Feather River. The paucity of successful recruitment suggests that current project operations tend to prevent initial seedling survival, longer-term establishment of seedlings, or both. In the low flow reach, relatively steady flows may support germination and early survival of cottonwood seedlings along the bank edge, however, the mostly cobble substrate would preclude seed germination. Seedlings that may

establish at the water's edge would be under many feet of water when discharges are 10,000 cfs and under roughly 15 feet of water at 30,000.

The widespread failure of cottonwood recruitment in the riparian zone of the high flow reach may be attributable to failure during initial seedling survival, and the frequent occurrence of scouring discharges. Opportunities for seedling germination were evident for many of the years between 1992 and 2001. However, the rapid ramping down of flow after storm events and high summer flows may limit seedling survival.

A number of uncertainties concerning existing constraints on cottonwood recruitment in the Feather River preclude recommending feasible flow enhancement measures that would be considered very likely to effect improved recruitment. A ramping down of late spring flows for seedling establishment may increase initial recruitment. However, the relatively high summer flows would likely drown or scour out the young seedlings near the water's edge. The efficacy of this approach would need to be tested by monitoring seedling occurrence and survival at selected sites. Opportunity to implement a flow augmentation of this duration and magnitude would probably occur once every five to ten years. Opportunities do exist to restore riparian habitats by other methods in swales and old channels within the floodplain of the Feather River downstream of the Project area. Opportunities for cottonwood forest enhancement in the low flow reach appear limited to non-flow measures.

The wet margin of the Thermalito Afterbay has resulted in the development of extensive wetland vegetation which benefits numerous wildlife species and several wildlife and plant species of concern. Any changes to current operations of water levels in the Afterbay can have positive and negative effects to various aspects of wetland vegetation and wildlife habitat. Higher water levels for a longer period of time may improve nesting success by some species but will decrease mudflat acreages. Wetland plant species (such as cattails and bulrush) may also benefit from increased water levels. Lower water levels or greater levels in water fluctuation could cause similar shifts in vegetation and wildlife.

The large water level fluctuations in Lake Oroville, in addition to the reservoir's steep slopes and poor soils, limit vegetation establishment within the drawdown zone. Very little vegetation has come in on its own since filling of the reservoir. Riparian tree and shrub plantings by DFG and DWR fisheries biologists have survived within the upper elevations of the drawdown zone. Although there is a limited amount of acreage suitable for riparian plantings (areas with low slope and some soil development), enhancement efforts could be accomplished through plantings of cuttings and/or rooted plants in some areas, especially where a developed water supply is available.

Isolated wetlands (vernal pools and ponds) occur throughout the Project area below the Oroville Dam. Vernal pools are mainly concentrated in the grasslands surrounding the Thermalito Afterbay and below the Thermalito Forebay. A Vernal Pool Management

Plan has been prepared to address and modify DWR maintenance and land-use practices to reduce or eliminate impacts.

Ponds in the Oroville Wildlife Area and adjacent areas receive extensive public use. Potential impacts to ponds from gravel extraction and transportation use of existing roads is probably minimal. The existence of many ponds in the OWA is a direct result of past gravel harvest. Continued gravel harvest has the potential to create more ponds, to increase connectivity between ponds, and create conditions for increased vegetative establishment in areas that are now mostly barren dredger tailings.

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1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

Existing and future operations of the Oroville Facilities may impact wetland and riparian habitats within the Oroville Project boundary and/or in the downstream reach of the Feather River below the Project area. Potential project operations and management activities that may impact wetland and riparian habitats include water level fluctuations, Feather River flow releases, maintenance activities, gravel harvest, and recreational use.

Riparian habitats refer to those plant communities adjacent to and influenced by the surface and subsurface hydrologic regimes of aquatic systems. They support vegetation distinct from the upland habitats and are characterized by a mixture of plant species. Riparian systems provide a number of important functions to both the aquatic and terrestrial ecosystems associated with them. These include stream bank stabilization, flow moderation, sediment control, organic matter necessary to support aquatic communities, water quality improvement by filtration, temperature moderation by shading, stream structural diversity (large-woody debris), and wildlife habitat. The biological productivity of a stream is directly related to the health and proper functioning of the riparian system.

Wetlands are areas that are covered periodically or permanently with somewhat shallow water and support vegetation adapted to saturated soils. They include low-lying areas adjacent to lakes, streams, or channels that will periodically flood from both rainfall events and high water levels in the main water body. These include both natural and constructed wetlands such as marshes, lagoons, and the brood ponds around the Thermalito Afterbay. Isolated wetlands include ponds, impoundments created by dredger tailings, and vernal pools. Vernal pools occur in low-lying areas that are usually underlain by a substrate that limits drainage. These are filled by a combination of rainfall, overland runoff, and subsurface flows. These pools may remain inundated for a week to several months before they dry down. These types of wetlands tend to have a high number of native plant species and associated wildlife and in California provide critical habitat for a number of special status plant and animal species.

Riparian and wetland habitats are important vegetation communities for wildlife. The diversity and density of species associated with these ecosystems is disproportionately high in comparison to other plant communities. The influence of riparian and wetland ecosystems on wildlife is not limited to animal species that are restricted to the riparian or wetland zone. Population densities of species in adjacent upland habitats are directly related to the presence and health of the riparian or wetland areas.

Historically, these systems were flanked by extensive floodplains that supported riparian forests and associated wetlands (Katibah 1984). Extensive modification of these systems from land-use practices, levees, and flood control and water supply functions of dams has altered and decreased functioning floodplains, and riparian and wetland systems in California.

1.1.1 Statutory/Regulatory Requirements

In addition to meeting Federal Energy Regulatory Commission guidelines, the information provided in this report is required for compliance with State and federal environmental regulations.

1.1.2 Study Area

The study area for this investigation includes the Oroville Facilities Relicensing FERC Project boundary and the lower Feather River floodplain downstream from the Fish Barrier Dam to the Sacramento River.

1.2 DESCRIPTION OF FACILITIES

The Oroville Facilities were developed as part of the State Water Project (SWP), a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants. The main purpose of the SWP is to store and distribute water to supplement the needs of urban and agricultural water users in northern California, the San Francisco Bay area, the San Joaquin Valley, and southern California. The Oroville Facilities are also operated for flood management, power generation, to improve water quality in the Delta, provide recreation, and enhance fish and wildlife.

FERC Project No. 2100 encompasses 41,100 acres and includes Oroville Dam and Reservoir, three power plants (Hyatt Pumping-Generating Plant, Thermalito Diversion Dam Power Plant, and Thermalito Pumping-Generating Plant), Thermalito Diversion Dam, the Feather River Fish Hatchery and Fish Barrier Dam, Thermalito Power Canal, Oroville Wildlife Area (OWA), Thermalito Forebay and Forebay Dam, Thermalito Afterbay and Afterbay Dam, and transmission lines, as well as a number of recreational facilities. An overview of these facilities is provided on Figure 1.2-1. The Oroville Dam, along with two small saddle dams, impounds Lake Oroville, a 3.5-million-acre-feet (maf) capacity storage reservoir with a surface area of 15,810 acres at its normal maximum operating level.

The hydroelectric facilities have a combined licensed generating capacity of approximately 762 megawatts (MW). The Hyatt Pumping-Generating Plant is the

largest of the three power plants with a capacity of 645 MW. Water from the six-unit underground power plant (three conventional generating and three pumping-generating units) is discharged through two tunnels into the Feather River just downstream of Oroville Dam. The plant has a generating and pumping flow capacity of 16,950 cfs and 5,610 cfs, respectively. Other generation facilities include the 3-MW Thermalito Diversion Dam Power Plant and the 114-MW Thermalito Pumping-Generating Plant.

Thermalito Diversion Dam four miles downstream of the Oroville Dam creates a tail water pool for the Hyatt Pumping-Generating Plant and is used to divert water to the Thermalito Power Canal. The Thermalito Diversion Dam Power Plant is a 3-MW power plant located on the left abutment of the Diversion Dam. The power plant releases a maximum of 615 cubic feet per second (cfs) of water into the river.

The Power Canal is a 10,000-foot-long channel designed to convey generating flows of 16,900 cfs to the Thermalito Forebay and pump-back flows to the Hyatt Pumping-Generating Plant. The Thermalito Forebay is an off-stream regulating reservoir for the 114-MW Thermalito Pumping-Generating Plant. The Thermalito Pumping-Generating Plant is designed to operate in tandem with the Hyatt Pumping-Generating Plant and has generating and pump-back flow capacities of 17,400 cfs and 9,120 cfs, respectively. When in generating mode, the Thermalito Pumping-Generating Plant discharges into the Thermalito Afterbay, which is contained by a 42,000-foot-long earth-fill dam. The Afterbay is used to release water into the Feather River downstream of the Oroville Facilities, helps regulate the power system, provides storage for pump-back operations, and provides recreational opportunities. Several local irrigation districts receive water from the Afterbay.

The Feather River Fish Barrier Dam is downstream of the Thermalito Diversion Dam and immediately upstream of the Feather River Fish Hatchery. The flow over the dam maintains fish habitat in the low-flow channel of the Feather River between the dam and the Afterbay outlet, and provides attraction flow for the hatchery. The hatchery was intended to compensate for spawning grounds lost to returning salmon and steelhead trout from the construction of Oroville Dam. The hatchery can accommodate 15,000 to 20,000 adult fish annually.

The Oroville Facilities support a wide variety of recreational opportunities. They include: boating (several types), fishing (several types), fully developed and primitive camping (including boat-in and floating sites), picnicking, swimming, horseback riding, hiking, off-road bicycle riding, wildlife watching, hunting, and visitor information sites with cultural and informational displays about the developed facilities and the natural environment. There are major recreation facilities at Loafer Creek, Bidwell Canyon, the Spillway, North and South Thermalito Forebay, and Lime Saddle. Lake Oroville has two full-service marinas, five car-top boat launch ramps, ten floating campsites, and seven dispersed floating toilets. There are also recreation facilities at the Visitor Center and the OWA.

The OWA comprises approximately 11,000-acres west of Oroville that is managed for wildlife habitat and recreational activities. It includes the Thermalito Afterbay and surrounding lands (approximately 6,000 acres) along with 5,000 acres adjoining the Feather River. The 5,000 acre area straddles 12 miles of the Feather River, which includes willow and cottonwood lined ponds, islands, and channels. Recreation areas include dispersed recreation (hunting, fishing, and bird watching), plus recreation at developed sites, including Monument Hill day use area, model airplane grounds, three boat launches on the Afterbay and two on the river, and one primitive camping areas. California Department of Fish and Game's (DFG) habitat enhancement program includes a wood duck nest-box program and dry land farming for nesting cover and improved wildlife forage. Limited gravel extraction also occurs in a number of locations.

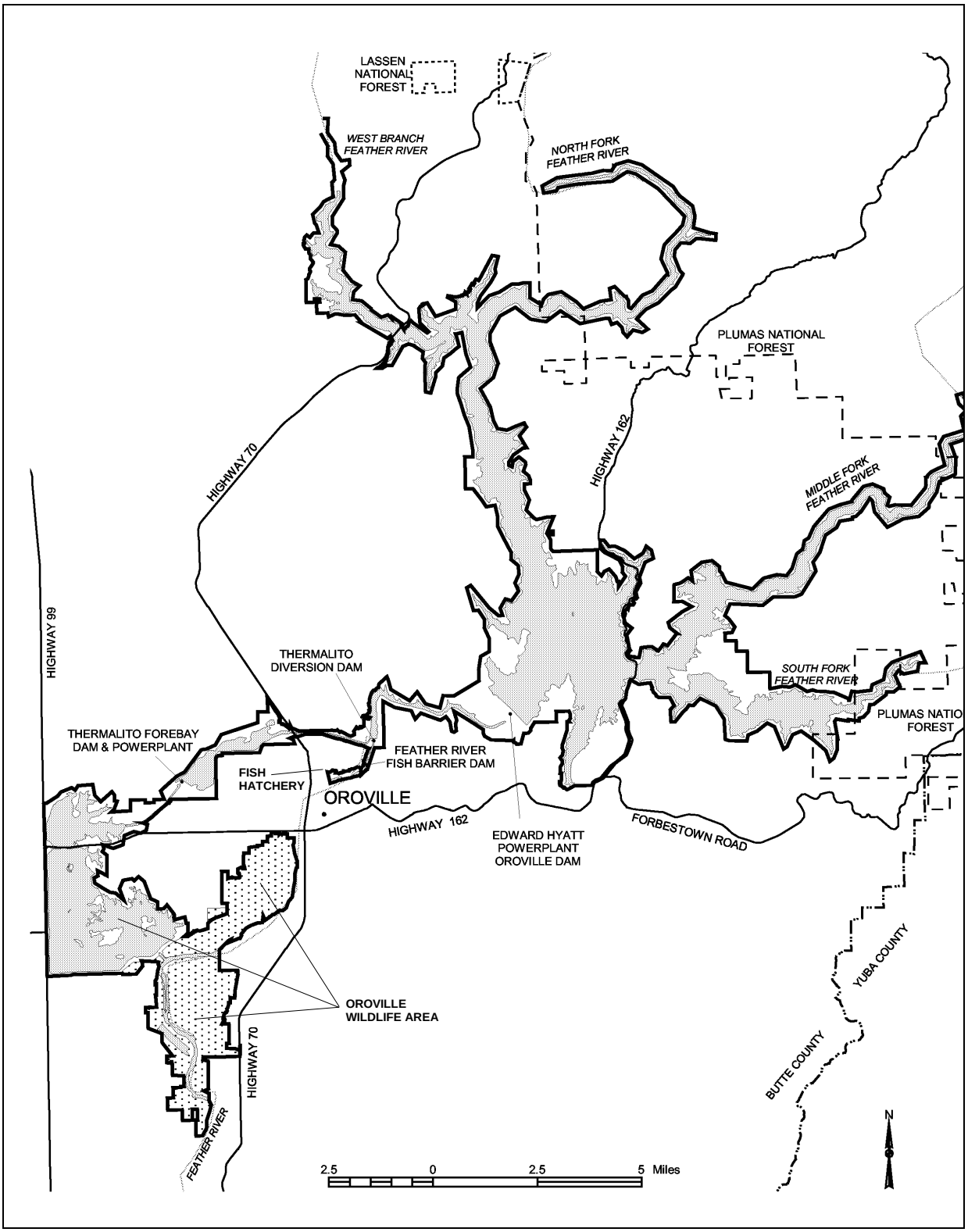

Figure 1.2-1. Oroville Facilities FERC Project Boundary

1.3 CURRENT OPERATIONAL CONSTRAINTS

Operation of the Oroville Facilities varies seasonally, weekly and hourly, depending on hydrology and the objectives DWR is trying to meet. Typically, releases to the Feather River are managed to conserve water while meeting a variety of water delivery requirements, including flow, temperature, fisheries, recreation, diversion and water quality. Lake Oroville stores winter and spring runoff for release to the Feather River as necessary for project purposes. Meeting the water supply objectives of the SWP has always been the primary consideration for determining Oroville Facilities operation (within the regulatory constraints specified for flood control, in-stream fisheries, and downstream uses). Power production is scheduled within the boundaries specified by the water operations criteria noted above. Annual operations planning is conducted for multi-year carry over. The current methodology is to retain half of the Lake Oroville storage above a specific level for subsequent years. Currently, that level has been established at 1,000,000 acre-feet (af); however, this does not limit draw down of the reservoir below that level. If hydrology is drier than expected or requirements greater than expected, additional water would be released from Lake Oroville. The operations plan is updated regularly to reflect changes in hydrology and downstream operations. Typically, Lake Oroville is filled to its maximum annual level of up to 900 feet above mean sea level (msl) in June and then can be lowered as necessary to meet downstream requirements, to its minimum level in December or January. During drier years, the lake may be drawn down more and may not fill to the desired levels the following spring. Project operations are directly constrained by downstream operational constraints and flood management criteria as described below.

1.3.1 Downstream Operation

An August 1983 agreement between DWR and DFG entitled, “Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish & Wildlife,” sets criteria and objectives for flow and temperatures in the low flow channel and the reach of the Feather River between Thermalito Afterbay and Verona. This agreement: (1) establishes minimum flows between Thermalito Afterbay Outlet and Verona which vary by water year type; (2) requires flow changes under 2,500 cfs to be reduced by no more than 200 cfs during any 24-hour period, except for flood management, failures, etc.; (3) requires flow stability during the peak of the fall-run Chinook spawning season; and (4) sets an objective of suitable temperature conditions during the fall months for salmon and during the later spring/summer for shad and striped bass.

1.3.1.1 Instream Flow Requirements

The Oroville Facilities are operated to meet minimum flows in the Lower Feather River as established by the 1983 agreement (see above). The agreement specifies that Oroville Facilities release a minimum of 600 cfs into the Feather River from the

Thermalito Diversion Dam for fisheries purposes. This is the total volume of flows from the diversion dam outlet, diversion dam power plant, and the Feather River Fish Hatchery pipeline.

Generally, the instream flow requirements below Thermalito Afterbay are 1,700 cfs from October through March, and 1,000 cfs from April through September. However, if runoff for the previous April through July period is less than 1,942,000 af (i.e., the 1911-1960 mean unimpaired runoff near Oroville), the minimum flow can be reduced to 1,200 cfs from October to February, and 1,000 cfs for March. A maximum flow of 2,500 cfs is maintained from October 15 through November 30 to prevent spawning in overbank areas that might become de-watered.

1.3.1.2 Temperature Requirements

The Diversion Pool provides the water supply for the Feather River Fish Hatchery. The hatchery objectives are 52°F for September, 51°F for October and November, 55°F for December through March, 51°F for April through May 15, 55°F for last half of May, 56°F for June 1-15, 60°F for June 16 through August 15, and 58°F for August 16-31. A temperature range of plus or minus 4°F is allowed for objectives, April through November.

There are several temperature objectives for the Feather River downstream of the Afterbay Outlet. During the fall months, after September 15, the temperatures must be suitable for fall-run Chinook. From May through August, they must be suitable for shad, striped bass, and other warmwater fish.

The National Marine Fisheries Service has also established an explicit criterion for steelhead trout and spring-run Chinook salmon. Memorialized in a biological opinion on the effects of the Central Valley Project and SWP on Central Valley spring-run Chinook and steelhead as a reasonable and prudent measure; DWR is required to control water temperature at Feather River mile 61.6 (Robinson's Riffle in the low-flow channel) from June 1 through September 30. This measure requires water temperatures less than or equal to 65°F on a daily average. The requirement is not intended to preclude pump-back operations at the Oroville Facilities needed to assist the State of California with supplying energy during periods when the California ISO anticipates a Stage 2 or higher alert.

The hatchery and river water temperature objectives sometimes conflict with temperatures desired by agricultural diverters. Under existing agreements, DWR provides water for the Feather River Service Area (FRSA) contractors. The contractors claim a need for warmer water during spring and summer for rice germination and growth (i.e., 65°F from approximately April through mid May, and 59°F during the remainder of the growing season). There is no obligation for DWR to meet the rice

water temperature goals. However, to the extent practical, DWR does use its operational flexibility to accommodate the FRSA contractor's temperature goals.

1.3.1.3 Water Diversions

Monthly irrigation diversions of up to 190,000 (July 2002) af are made from the Thermalito Complex during the May through August irrigation season. Total annual entitlement of the Butte and Sutter County agricultural users is approximately 1 maf. After meeting these local demands, flows into the lower Feather River continue into the Sacramento River and into the Sacramento-San Joaquin Delta. In the northwestern portion of the Delta, water is pumped into the North Bay Aqueduct. In the south Delta, water is diverted into Clifton Court Forebay where the water is stored until it is pumped into the California Aqueduct.

1.3.1.4 Water Quality

Flows through the Delta are maintained to meet Bay-Delta water quality standards arising from DWR's water rights permits. These standards are designed to meet several water quality objectives such as salinity, Delta outflow, river flows, and export limits. The purpose of these objectives is to attain the highest water quality, which is reasonable, considering all demands being made on the Bay-Delta waters. In particular, they protect a wide range of fish and wildlife including Chinook salmon, Delta smelt, striped bass, and the habitat of estuarine-dependent species.

1.3.2 Flood Management

The Oroville Facilities are an integral component of the flood management system for the Sacramento Valley. During the wintertime, the Oroville Facilities are operated under flood control requirements specified by the U.S. Army Corps of Engineers (USACE). Under these requirements, Lake Oroville is operated to maintain up to 750,000 af of storage space to allow for the capture of significant inflows. Flood control releases are based on the release schedule in the flood control diagram or the emergency spillway release diagram prepared by the USACE, whichever requires the greater release. Decisions regarding such releases are made in consultation with the USACE.

The flood control requirements are designed for multiple use of reservoir space. During times when flood management space is not required to accomplish flood management objectives, the reservoir space can be used for storing water. From October through March, the maximum allowable storage limit (point at which specific flood release would have to be made) varies from about 2.8 to 3.2 maf to ensure adequate space in Lake Oroville to handle flood flows. The actual encroachment demarcation is based on a wetness index, computed from accumulated basin precipitation. This allows higher levels in the reservoir when the prevailing hydrology is dry while maintaining adequate flood protection. When the wetness index is high in the basin (i.e., wetness in the

watershed above Lake Oroville), the flood management space required is at its greatest amount to provide the necessary flood protection. From April through June, the maximum allowable storage limit is increased as the flooding potential decreases, which allows capture of the higher spring flows for use later in the year. During September, the maximum allowable storage decreases again to prepare for the next flood season. During flood events, actual storage may encroach into the flood reservation zone to prevent or minimize downstream flooding along the Feather River.

2.0 NEED FOR STUDY

This study is needed to comply with State and federal regulations. Identification and quantification of Project effects on riparian and wetland habitats both within the Project area and downstream Feather River have been identified as issues by relicensing stakeholders. A description of existing conditions for wetland and riparian vegetation is a FERC requirement and will be included with the license application. Evaluation of Project effects is also required for CEQA/NEPA compliance.

3.0 STUDY OBJECTIVE(S)

3.1 APPLICATION OF STUDY INFORMATION

3.1.1 Environmental Documentation

The objectives of this study are to:

- provide information on riparian and wetland habitats in the project vicinity and downstream Feather River
- assess the effects of project management and operations on wetland and riparian habitats
- provide information that can be used to identify opportunities for protection, mitigation, and enhancement measures

Information provided in this report will be included in the FERC license application. It is also required for compliance with State and federal environmental regulations.

3.1.2 Settlement Agreement

This study provides information that will be used to develop Resource Actions that address riparian and wetland habitats in the Project area and downstream Feather River.

4.0 TASK 1 – RIPARIAN VEGETATION WITHIN AND DOWNSTREAM OF THE PROJECT AREA

4.1 INTRODUCTION

The Feather River watershed lies within the northern Sierra Nevada Mountain Range and a portion of the eastern Sacramento Valley. It flows in a westerly direction through steep forested mountains and broad intermountain valleys toward the foothills above the city of Oroville (DWR 2004 [1]). The four main forks of the Feather River flow westerly through deep, rugged canyons where they meet and are blocked by the Oroville Dam. The river flows out of the foothills below Oroville Dam in a southerly direction for about 68 miles before joining the Sacramento River. Within the Sacramento Valley, the stream gradient is less and the topography is mostly flat. Honcut Creek, the Yuba River, and the Bear River join the Feather River below Oroville. Elevations in the watershed range from 7800 ft at its crest, 900 ft at Oroville Dam, and 25 ft at the confluence with the Sacramento River.

The Feather River basin has a Mediterranean type climate with hot, dry summers and cool, wet winters. Rainfall within the watershed varies greatly. Precipitation within the upper end of the North Fork can be as much as 90 inches per year; 50 inches at Lake Oroville, 30 inches at the City of Oroville, and 18 inches at the confluence with the Sacramento River. About 50 percent of the streamflow is supplied by snowmelt runoff during the months of April, May, and June (CDWR 2004 [1]).

Lake Oroville and the Feather River below the dam are located within the Sacramento Valley and Sierra Nevada Foothills subregions of the California Floristic Province (Hickman 1993). Vegetation patterns in this area correspond with elevational changes from the valley floor to the upper elevations of the mountain range, ranging from valley grasslands to foothills woodlands (characterized by blue-oak/foothill pine woodlands with varying amounts of chaparral) to mixed conifer forests in the higher elevations. Riparian and wetland habitats are associated with the margins of streams, rivers, seeps, and other areas that have abundant soil moisture. Around Lake Oroville native riparian habitats were, and still are, restricted to narrow strips along drainages, consisting mostly of alders, willows, and occasional cottonwoods and sycamores. Historically, the major river and stream systems of the Sacramento Valley supported strips of dense riparian forests which developed on the natural levees of river-deposited silt (Katibah 1984). The riparian vegetation in this area has been restricted over time by regulations of flows to control flooding, levees, agriculture, and land clearing for urbanization.

In a natural river system (one not blocked and manipulated by dams) the physical appearance and character of a river are the result of continual modification of the river channel by streamflow and sediment deposition (Braatne et al. 1996). In general, a

river channel meanders within the alluvial floodplain. "These meanders reflect a balance between erosional and depositional processes within the river channel. Erosion of the concave bank is balanced by deposition on the adjacent convex bank. As the concave bank recedes due to erosion, the point bar builds outward from the convex bank into the channel. As a result, the form of the channel remains, but its position changes. Floodplains are typically built and continually modified by this process of point-bar extension" (Braatne et al. 1996).

Floodplains remain hydrologically linked to the main channel by the alluvial water table. During flood events, overflow of the bankfull stage connects the floodplains with the main channel. These high flow events are when most erosional and depositional events that affect channel morphology occur (Braatne et al. 1996). According to Leopold (1994) as cited in Braatne et al. (1996), flows characterized as bankfull stage occur approximately every other year and over-bank flooding events occurs every 5-10+ years. As flood waters recede, bare mineral soils are exposed within the alluvial floodplain, commonly along point and gravel bars. These barren, yet moist soils are critical microsites for early successional plant species. Over time, the floodplains accrete sediment and soil development occurs, providing conditions for less flood-dependent and more shade tolerant species to establish and eventually dominate.

The Feather River has a long history of land uses which have affected natural river processes within its floodplain, including hydraulic mining, gravel mining, gold dredging, timber harvesting, construction of levees and dams, water diversion, agricultural encroachment, and urbanization. Hydraulic mining introduced massive amounts of sediment into the system in the late 1800s. Much of the riparian vegetation within the floodplain has been removed and the lands put into agriculture. Each of these activities has had an impact on the riparian vegetation and a general decrease in the amount of active floodplain.

Numerous dams in the upper watershed have trapped sediment and altered streamflow. The construction of the Oroville Dam and the resulting regulation of the lower Feather River, added to this problem. Streamflow and sediment discharge are instrumental in channel formation (CDWR 2004 [1]). Streamflow alterations include attenuation of peak flows, decreased winter flows, increased summer flows, and changes in the historic high-flow frequencies. Sediment is now trapped behind the numerous dams in the watershed including Oroville Dam which changes downriver sediment deposition. These changes to the river hydrology and sedimentation patterns can change the channel morphology, including the channel shape, stability, and capacity (CDWR 2004 [1]).

4.2 OBJECTIVES

Project operations may affect riparian vegetation within the Feather River floodplain downstream of Oroville Dam. The objectives of this study were to:

- Identify hydrologic conditions required for cottonwood seed germination and seedling survival in the Feather River floodplain
- Assess the effects of project-water operations on riparian habitats and specifically cottonwood recruitment along the Feather River
- Identify hydrologic regimes that may aid in natural riparian/cottonwood regeneration along the river and/or alternative riparian restoration activities that may enhance riparian habitats.

4.3 METHODS

4.3.1 Characterization of Existing Conditions

4.3.1.1 Quantification and Distribution of Riparian Vegetation

Information on existing riparian vegetation within and downstream of the Project area was obtained from the vegetation cover type mapping produced in SP – T4: *Biodiversity, Vegetation Communities and Wildlife Habitat Mapping – Draft Final Report* (CDWR 2003).

4.3.1.2 Feather River Geomorphology

As part of the sediment transport and river geomorphology study of SP-G2, channel geomorphic types were described and mapped. The Rosgen stream classification system was used to classify channel geomorphic types. Data was obtained for channel morphology from work conducted for SP-G2: *Effects of Project Operations on Geomorphic Processes Downstream of Oroville Dam. Task 1.2 – Physiographic Setting and Mesohabitat* (CDWR 2004 [1]).

4.3.1.3 Hydrology

Hydrologic data was reviewed for both historic and current conditions in regards to seasonal and annual discharge patterns.

4.3.2 Cottonwood Recruitment Study

4.3.2.1 Literature Review

A literature review was conducted on western riparian vegetation processes. The focus of the review was Fremont cottonwood (*Populus fremontii*) due to its sensitivity to river flow management during the recruitment phase of its life-history, and its extensive use as an indicator species in river restoration efforts throughout the western United States. Relevant literature was identified through web-based articles, an on-line literature search service, NERAC, and on-line university library catalogues including the University of California Library's MELVYL system and web sites for the libraries at the University of California at Davis, California State University, Sacramento and California State University, Chico. Local seed release patterns were observed during field studies by CDWR personnel.

4.3.2.2 Field Studies

Field studies were conducted along the Feather River downstream of the Oroville Dam in order to help identify relationships between the distribution of early-growth cottonwood stems and river stage, and to characterize substrate and vegetative cover which might affect cottonwood recruitment.

4.3.2.2.1 Site Selection

The study sites were distributed among four reaches of the Feather River below Oroville Dam and were selected based on the presence of young cottonwoods.

- Reach 1: Thermalito Diversion Dam to Thermalito Afterbay Outlet (low flow channel)
- Reach 2: Thermalito Afterbay Outlet to the confluence with Honcut Creek
- Reach 3: Honcut Creek to the confluence with the Yuba River
- Reach 4: Yuba River to the confluence with the Bear River

Two sites were selected in each reach (three sites in Reach 3), with one to three transects at each study site. A total of sixteen transects were established. The transects originate at the riparian/upland interface and extend to the water's edge which at the time of sampling corresponded to a river stage of approximately 600 cfs in the low flow channel and 2,000 cfs in the Feather River below the Thermalito Afterbay Outlet. These transects extend perpendicular to the direction of river flow and were located with the intent to maximize interception of stems of early-growth cottonwoods.

4.3.2.2.2 Data Collection

Each transect was mapped with survey-grade Global Positioning System (GPS) equipment that recorded both location and elevation data. Vegetation cover, vegetation type, and substrate were recorded at one-foot intervals. Elevation (feet above mean sea level) was extrapolated for all one-foot points.

In order to collect information on the size class and number of young cottonwoods at each site, additional data was collected on species and stem diameter of riparian species at belt plots located perpendicular to the transect. These belt plots were located where the main transect intercepted groupings of early-growth cottonwoods. As few as one and as many as seven belt plots were located at each transect, for a total of 40. Woody stems in each belt plot were tallied by species and stem diameter (<0.5 cm, 0.5 to < 1.0 cm, 1 cm, 2 cm, etc.). All field data was collected from October 21 – 31, 2002.

Occurrence of cottonwood stems, cottonwood cover, and belt plots were charted against plot elevation or the river discharge calculated to bring river stage to plot elevation. River discharges were obtained from stage/discharge curves for each field transect (Appendix A).

4.4 RESULTS

4.4.1 Characterization of Existing Conditions

4.4.1.1 Quantification and Distribution of Riparian Vegetation along the Feather River

The Feather River extends for 68 miles south of the Oroville Dam to the confluence with the Sacramento River. Channel movement, geology, and hydrology are the main physical factors responsible for the development and maintenance of riparian vegetation along the river. As these processes are altered, so are the successional processes and physical composition of the riparian community. The establishment of riparian plant communities takes place through the biological process of succession as one plant community replaces another over time beginning with scoured surfaces and early successional species

Currently, the Feather River riparian forests downstream of Oroville Dam are fragmented and narrow compared to historic riparian forests. The majority of the trees associated with the riparian forests of the Feather River are broad leaved and

deciduous. Table 4.4-1 lists the most common tree, shrub, and vine species found along the Feather River during these surveys.

Table 4.4-1. Common riparian tree, shrub, and vine species found along the Feather River.

Scientific Name	Common Name
TREES	
Acer negundo	Box elder
**Ailanthus altissima*	Tree of heaven
Alnus rhombifolia	While alder
Fraxinum latifolia	Oregon ash
**Ficus carica*	Edible fig
***Juglans californica*	Northern California black walnut
Platanus racemosa	California sycamore
Populus fremontii	Fremont's cottonwood
Quercus lobata	Valley oak
**Robinia pseudoacacia*	Black locust
Salix goodingii	Black willow
Salix laevigata	Red willow
Salix lucida var. *lasiandra*	Yellow willow
SHRUBS	
Artemisia douglasiana	Mugwort
**Arundo donax*	Giant reed
Baccharis pilularis	Coyote bush
Baccharis salicifolia	Mule's fat
Calycanthus occidentalis	Spice bush
Cephalanthus occidentalis var. *californicus*	California buttonbush
**Rubus discolor*	Himalayan blackberry
Rubus ursinus	California blackberry
Salix exigua	Sandbar willow
Sambucus mexicana	Blue elderberry
VINES	
Aristolochia californica	California pipevine
Clematis ligusticifolia	Virgin's bower
Rosa californica	California rose
Toxicodendron diversilobum	Western poison oak
Vitis californica	California wild grape

*Non-native species
** Native vs. non-native status currently under investigation

Approximately 4,268 acres of riparian forest/woodlands; 2,175 acres of riparian shrub; and 912 acres of wetlands were mapped within the FEMA 100-year floodplain of the Feather River below the Project area (Table 4.4-2). Within the Project area, there are approximately 3,328 acres of riparian forest/woodlands; 215 acres of riparian shrub habitats; and over 900 acres of wetlands.

Table 4.4-2. Acreages of general riparian/wetland vegetation categories mapped within the study area.

Vegetation/Land-Use Category	Acreage	
	Project Area	**Feather River Floodplain**
Aquatic/Submerged	443.4	89.9
Riparian Forest/Woodland	3237.8	4268.5
Riparian Shrub/Scrub	214.6	2175.5
Wetland	911.7	210.1
Totals	4807.5	6744.0

A wide range of riparian conditions exist along the Feather River floodplain. In many areas constrained by levees, urbanization, or agriculture, riparian vegetation may be a thin band of trees only one tree canopy wide with little to no understory. In other areas where the river is less constrained, large patches of riparian habitats exist. The dominant riparian/wetland vegetation types and acreages found along the Feather River FEMA 100-year floodplain are listed in Table 4.4-3 and mapped in Appendix B. Vegetation communities or associations for this mapping project were based on a single species (i.e. Fremont cottonwood riparian forest) or two species (i.e. cottonwood/black willow riparian forest) where either the one or two species were clearly dominant and occupied at least 60-70% of the canopy cover. Mixed associations were vegetation types that had three or more equally dominant species in the canopy and/or ones in which the species were not discernible from the aerial photography and no field data was available (CDWR 2003). The valley mixed riparian community was, by far, the most common riparian woodland type along the river covering approximately 3,200 acres; Fremont cottonwood forests occupied approximately 635 acres; and cottonwood/black willow forests occupied 92 acres. The mixed riparian shrub community dominated the riparian shrub category occupying over 1,100 acres along the river, however, narrowleaf willow scrub and mixed willow scrub were also abundant occurring on over 537 acres and 471 acres respectively.

Table 4.4-3. Acreages of riparian/wetland vegetation found within the study area.

		Project Area	**Feather R Floodplain**
Aquatic/Submerged			
	Algae	1.3	2.6
	Mixed aquatic	14.9	11.1
	Mosquito fern	9.3	0.2

Table 4.4-3. Acreages of riparian/wetland vegetation found within the study area.

		Project Area	Feather R Floodplain
Aquatic/Submerged			
	Water primrose	398.5	68.6
	Water-meal	19.4	7.3
Gravel/Sandbar			
	Gravel/sandbar	65.0	520.6
Riparian Forest/Woodland			
	Black willow riparian forest	1.4	2.0
	Black willow/blackberry scrub	0.2	
	Black willow/white alder riparian forest		2.4
	Cottonwood/black willow riparian forest	117.2	92.5
	Disturbed riparian forest	0.3	1.3
	Foothill/montane mixed riparian forest	50.2	
	Fremont cottonwood riparian forest	2453.8	634.8
	Mixed willow riparian forest	99.5	37.7
	Non-native riparian forest	6.7	5.4
	Valley mixed riparian forest	490.3	3198.6
	Valley oak riparian forest	18.1	114.4
	Valley oak/cottonwood riparian forest		179.4
Riparian Shrub/Scrub			
	Arundo scrub		1.2
	Blackberry scrub	6.7	51.0
	Blackberry/willow scrub	6.0	
	Elderberry riparian scrub	5.6	
	Mixed riparian scrub	101.4	1103.2
	Mixed willow scrub	55.8	471.8
	Narrowleaf willow scrub	18.2	537.4
	Non-native riparian scrub	20.9	10.9
Emergent Wetland			
	Bulrush	0.3	
	Cattail	0.6	0.4
	Mixed emergent vegetation	286.5	209.7
	Rush	380.9	
	Rush/Verbena	200.8	
	Seep/wet area	6.6	
	Verbena	36.1	

Riparian vegetation and geomorphology along the river is described below. The river was divided into 11 reaches based upon geomorphic reaches described in SP-G2 (CDWR 2004 [1]).

River Reach 1(FR-1) extends from the mouth of the Feather River upstream to river mile (RM) 7 where it enters the Sutter Bypass (Appendix B: Figure B-a). The channel is entirely in the bypass in this reach and results in backwater effects during major floods.

The east bank is leveed. The tall river banks on the west side consist of floodplain deposits of sand and silt overlying slickens (a fine clay-rich, light yellow-brown deposit resulting from increased sediment from hydraulic mining). Riparian vegetation on the east bank is restricted to a thin band of trees, consisting mostly of cottonwoods and valley oaks with scattered buttonbush and Oregon ash. The band of riparian vegetation on the west side is much wider (100-200+ feet), with a well developed understory. Valley oak riparian and valley oak/cottonwood riparian is common along this stretch. Much of this area is bordered on the west by rice fields within the Sutter Bypass.

Reach 2 (FR-2) extends from RM 7 upstream to RM 12.5 (mouth of the Bear River) (Appendix B: Figures B-b and B-c). This reach is characterized by the presence of alternate bars on the channel margins and large sand waves within the channel. Islands occur in the channel with patches of riparian and wetland vegetation. Typically one side of the river has a bank consisting of floodplain silt and sand overlying slickens and the opposite bank with active point bar deposits of sand with some silt. Except for the lower east side, the river is bounded by setback levees up to 0.75 miles wide. Portions of the west side are State-owned properties (DFG) or within the Bobelaine Audubon Sanctuary. This area has a complex pattern of mostly native and non-native herbaceous fields and riparian forest and shrub vegetation. Riparian shrub communities are abundant both along the river and along the floodplain to the setback levees. The floodplain on the east side has mainly native forbland vegetation with smaller areas of cottonwood and valley oak riparian.

Reach 3 (FR-3) extends from RM 12.5 upstream to RM 17 (just downstream of Star Bend) (Appendix B: Figure B-c). The bed consists of sand. Point bar development is typical on the inside of the wide, sweeping, low curvature bends. Setback levees on both sides vary from 0.1 to 0.6 miles from the river channel. The floodplain to the west has a complex pattern of riparian forest, with small areas of riparian shrub types. The floodplain on the east consists of a large continuous stand (over 100 acres) of dense valley mixed riparian forest. Large stands of mixed riparian scrub occur between the forests types and the river.

Reach 4 (FR-4) extends from RM 17 upstream to RM 28 where the Yuba River joins the Feather (Appendix B: Figures B-d and B-e). Several large meanders occur near the bottom of the reach. Most banks consist of floodplain deposits overlying slickens. The bed consists mainly of sand. Levees are set back near the large river meander at Star Bend. The eastern floodplain within the meander bend consists of a large (over 150 acres) mixed riparian forest and mixed riparian shrubs. Upstream, the eastern floodplain is up to one mile wide and has an irregular mixture of large and small areas of riparian forest, urban/disturbed, and agriculture. The river is restricted by levees on the west bank and riparian vegetation mostly consists of strips of cottonwoods, valley oaks, and mixed riparian species.

Reach 5 (FR-5) extends from RM 28 upstream to RM 33.5, just east of Sullivan (Appendix B: Figure B-e). This reach is fairly straight, with minimal meanders. The river is a sand bed, with banks consisting of floodplain deposits overlaying slickens. There are minimal point bars or other depositional features. The setback levee on the west side is up to a mile wide; however, this area is covered almost completely by deciduous orchards. The tops of the river bank contain an intermittent narrow strip of riparian trees with little to no understory. On the east side, the levee is set back about 0.2 to 0.4 miles from the river upstream of Marysville to about RM 31.5. From here the levee is set back 0.2 to 0.8 miles. This area is mostly deciduous orchard, with a small band of mixed riparian vegetation along the bank. The understory along this reach is well developed with numerous riparian shrubs and vines in addition to the tall riparian overstory.

Reach 6 (FR-6) extends from RM 33.5 to RM 35.5 (Appendix B: Figure B-f). This short reach is unusual with very high sinuosity, active bank erosion, and the formation of point bars. The point bars consist of mostly sand and minor gravel. Meander cutoffs have occurred here in the past and will likely occur in the near future. This area has well developed riparian forests of cottonwoods and mixed riparian trees with riparian shrub and vine understories. This area has over 150 acres of developed riparian forests, with riparian shrubs near the point bars and developed wetlands.

Reach 7 (FR-7) extends from RM 35.5 to 39.5 (Appendix B: Figure B-f). This reach has low sinuosity, and minimal point bar development. The channel is narrow and incised into the floodplain with tall vertical banks. The bed composition is gravel. The western bank of the river is leveed. Very little riparian vegetation occurs here, much of which is only one tree wide with some understory shrubs and vines. Although the east side has a large setback levee, the floodplain is almost completely deciduous orchard. Riparian vegetation lies along the river bank and consists of large riparian cottonwoods and valley oaks with understory riparian shrub and vine species. No large blocks of riparian forest occur in this reach.

Reach 8 (FR-8) extends from RM 39.5 to RM 46.5 (about two miles upstream of the confluence of Honcut Creek) (Appendix B: Figures B-f and B-g). This meandering reach contains old meander scars, oxbow lakes, and active bank erosion. Bank recession of over 500 feet in the last 35 years is common. The bed is mostly gravel. The floodplain is over 1.5 miles in width at one point below Honcut Creek. The riparian strip along both banks is somewhat more diverse and wider than in other reaches, including a complex of different forest and shrub types. The riparian areas are concentrated at meander bends. Riparian forests consist of old cottonwoods with various riparian understory trees, shrubs, and vines. The river-bend riparian areas also include several wetland areas (up to six acres in size). A thin strip of riparian forests border Honcut Creek with the Feather River floodplain.

Reach 9 (FR-9) extends from RM 46.5 to 53.5 (approximately 1.5 miles above the Gridley bridge) (Appendix B: Figure B-g). This reach is sinuous and is characterized by multiple channels, mid-channel islands, point bars, and a gravel-cobble bed. The river is restricted on the west by levees. Vegetation is intermittent with little understory. The eastern floodplain is up to two miles wide at one point and consists almost entirely of deciduous orchards. A moderate amount of riparian forest and shrub communities are concentrated in the meander bends of the river. These bends include a complex of older channels/oxbows and support a diverse mosaic of small ponds, gravels, mixed riparian forest, and riparian shrub types.

Reach 10 (FR-10) extends from RM 53.5 to RM 64.4 and is contiguous with the OWA (Appendix B: Figures B-h and B-i). The lower portion of this reach is below the Thermalito Outlet and within the high flow channel of the Feather River. Above RM 59 it is within the low flow reach. Both reaches are characterized by coarse dredger tailings composing both the bed and the banks. Riffles, point bars, mid-channel islands, and multiple channels are common, but most of these depositional features are armored by cobbles and boulders. Levees severely constrict the floodplain along most of this reach. Overflow weirs into the OWA occur in at least four places. Much of this area has been mined for gravel.

Approximately 615 acres of barren gravel/cobble piles exist within the OWA below the Thermalito Outlet. The free draining nature of these cobbles preclude riparian vegetation establishment. Numerous ponds containing varying amounts of cottonwoods and willows occur in the southwestern portions of the OWA below the Thermalito Outlet. Most are small and have scattered trees with little understory. One Mile Pond is the exception. This large clear pond has pockets of large riparian trees (mostly cottonwoods) and many acres of marsh, emergent wetland vegetation on its southwest side. The D Area of the OWA (the area east and south of the Outlet and the river) is composed of open to moderate canopy forests of large cottonwoods. Much of this area has varying levels of surface water and is covered by aquatic vegetation (mainly water primrose). This area is discussed further in Section 7.0 of this report.

North of the Thermalito Outlet, the eastern side of the river is tightly constricted by urbanization. Riparian vegetation is limited, although large cottonwood trees and pockets of riparian shrubs are scattered throughout the area. On the west, the OWA and cottonwood riparian forests extend for over a mile from the active channel. Numerous dredger ponds occur throughout this area.

River Reach 11 (FR-11) extends from RM 64.4 to RM 68 and extends from Hwy 162 to the Thermalito Diversion Dam (Appendix B: Figure B-i). The bed material is bedrock that is covered in most places by a veneer of cobbles and boulders up to 10 feet thick. Riparian vegetation is restricted to the banks along the river and consists of intermittent mixed riparian species. Non-native riparian tree and shrub species are common in this reach from Hwy 162 to above the Diversion Dam.

4.4.1.2 Quantification of riparian vegetation within the Project Area

Approximately 3,238 acres of riparian forest/woodland; 214 acres of riparian shrub/scrub; and over 900 acres of wetlands occur within the Project area (Table 4.4-2). A very small percentage of these habitat acreages occur above the Dam. Around Lake Oroville, native riparian habitats were, and still are, restricted to narrow strips along drainages, consisting mostly of alders, willows, and occasional cottonwoods and sycamores (Appendix C). Individual sites are usually quite small and always less than one acre in size. Lake Oroville shoreline riparian vegetation is discussed under Section 6.0 of this report.

A small amount of riparian vegetation occurs around the Thermalito Complex (Appendix D). The north shore of the Forebay is lined with a thin strip of mixed riparian species (mostly willows) with an understory of emergent wetlands. Cottonwoods and willows occur in scattered areas around the high water elevation of the Afterbay. Thermalito wetlands are discussed under Section 5.0 of this report.

Over 2,450 acres of Fremont cottonwood forest occurs within the Project area, most of which occurs in the Oroville Wildlife Area (OWA). Although much of this acreage is open to moderate cover, large patches do occur with more than 60 percent canopy cover. Other riparian forest types with moderate acreages include valley mixed riparian (490 acres), mixed willow riparian (99 acres), and cottonwood/black willow riparian (117 acres). Over 615 acres of barren gravel tailings occur in the OWA.

4.4.1.3 Feather River Channel Geomorphology

Present-day stream channel substrates in the Feather River reflect hydraulic conditions which resulted in depositions of clay, silt, sand, gravel, cobbles, and boulders in various layers. Historically, hydraulic mining increased sediment in the lower Feather River, resulting in a thick deposit of fine clay-rich, light yellow-brown colored “slickens”. These slickens have been covered by more recent deposits, but are visible in eroding banks along most of the river. Dredger tailings resulting from gold mining activity are common along the river between Oroville and Gridley.

Rosgen Level 1 stream typing indicates that the Feather River may be classified into two stream types. River miles 67 to 64 are designated as stream type “C”; river miles 64 to 15 are stream type “F”; and river miles 15 to the confluence with the Sacramento River are stream type “C” (CDWR 2004 [1]).

According to Rosgen classification, stream type “C’ is described as a low gradient, meandering, point bar, riffle/pool, and alluvial channel with a broad, well-defined

floodplain. They are located in narrow to wide valleys constructed from alluvial deposition with well-developed floodplains; are generally relatively sinuous; and with slopes of two percent or less, width/depth ratios greater than 12, and sinuosities exceed 1.4 (CDWR 2004 [1]).

Stream type “F” is described as an entrenched meandering riffle/pool channel with low gradient and a large width-to-depth ratio. They are incised in valleys of relatively low relief containing erodable materials. The F stream systems are characterized by moderated riffle/pool sequences (CDWR 2004 [1]).

Rosgen Level II adds dominant channel materials and water surface slope to the criteria of the Level 1 analysis. The Feather River was divided into the 11 geomorphic reaches discussed under Section 4.4.1.1 above. These are based on a variety of geologic and channel configuration characteristics described in SP-G2 Task 1.2 (CDWR 2004 [1]).

4.4.1.4 Hydrology

Prior to the 1850s, flows in the Feather River were unchecked from the upper watershed to the confluence with the Sacramento River. Historically, winter rainfall and snowmelt kept the water levels in the river high through the late spring. Water levels in the river gradually decreased to the low base flows of summer and fall.

Winter flooding carried fresh sediments downstream to be deposited from overbank flooding onto the floodplain. Hydraulic mining introduced massive amounts of sediments into the stream system between the 1850s and 1890s (DWR 2004 [1]). Reservoirs constructed in the upper watershed trapped sediment and altered stream flow. After 1967, with the construction of Oroville Dam, streamflow and sediment discharge below the dam were altered. Over 97 percent of the sediment from the upstream watershed is trapped from entering the lower Feather River.

Currently, the regulated Feather River is managed to capture winter rains. The large winter flows that occurred historically are now atypical. A typical hydrograph includes low flows in the early spring and rising flows with the beginning of the irrigation season. Flows remain high from June through August and September then drastically drop during the fall when flow release demands have ceased and before winter rains begin.

4.4.2 Cottonwood Recruitment Study

4.4.2.1 Literature Review

Central Valley riparian forest initiation typically begins with the colonization of bare (scoured), moist alluvial surfaces such as often form after large floods. Seedlings of Fremont cottonwoods, willows and other fast growing pioneer species are physiologically adapted to the highly variable hydrologic and geomorphic regimes of alluvial river floodplain systems that characterize California rivers. For example, willows and cottonwoods can sustain high rates of root growth to keep up with rapid groundwater decline. Most riparian species are also physiologically adapted to survive flooding and scour, and they maximize dispersal through high seed output, clonal growth or long seed-floating time; cottonwoods have both high seed output and utilize clonal growth for reproduction.

Succession of riparian plant assemblages occurs over time, as floodplains accrete sediment and soil development occurs, providing conditions for less flood-dependent and more shade tolerant species to establish and eventually dominate. Succession rarely occurs as a continuous process, but occurs as an episodic disturbance and establishment event. The vegetation successional pattern at many sites is, therefore, patchy and depends on flood history, site topography, and local variations in physical disturbance. If biologically important physical condition changes in a river corridor and pioneer species no longer are able to establish, the riparian forest composition over time shifts from pioneer species to later-successional species. The plant diversity and the habitat become more simplified, favoring the successional mesic species over the more hydrophytic species.

Successful cottonwood establishment depends on the specific hydrology of the germination-site combined with favorable seed dispersal timing (Mahoney and Rood 1998) and these conditions may happen only once in five or once in ten years under natural conditions (Braatne et al. 1996).

Germination site hydrology is a function of river flow, topography, substrate composition and other hydrological conditions, such as groundwater sources. Historically, Sacramento Valley and its surrounding foothills received substantial rainfall in the winter and early spring (Katibah 1984). Consequently, prior to water flow regulation, the rivers in the Sacramento Valley experienced maximum flows from December through March, instead of May and June, as is characteristic of most western rivers (Mount 1995). Snowmelt kept the water levels high through the late spring (Mount 1995). Currently, the regulated Feather River is managed to capture winter rains. The large winter flows

that occurred historically are now atypical. The regulated hydrology also results in higher summer flows.

Along geomorphically active, wide rivers with low relief and relatively rich in sediment load, cottonwood riparian assemblages typically occur in sequential, arcuate bands at particular elevations above the stream (Amlin and Rood 2001), with the youngest stands closest to the active channel margin. This type of river has just enough energy to move the sediments and materials from uplands. In contrast, where natural hydrology is driven both by winter storms and spring run-off, such as in California and the southwest United States, highly variable and hard to predict flows result in high-energy water pulses through the system (Patten 1998), relatively impoverished of sediment (Rood and Mahoney 1990). Sediment depositional sites are less frequent and scouring is common on these rivers. Consequently, along high-energy rivers the riparian assemblages can be found in “safe sites” where the assemblages are protected from high-energy scouring flows that could be either natural or dam-related. Large, mature cottonwoods are generally found close to the main channel, while seedlings and saplings are located on the widest parts of the floodplain (USDA 2000 [2]). Abandoned secondary and tertiary stream channels are valuable cottonwood recruitment sites because subsurface water is available and some protection from scouring is provided (USDA [2] 2000 citing Asplund et Al., 1998). Conditions that physically constrain the river channel, such as canyons or levees, can also result in localized high-energy flows that limit recruitment success (Scott et al. 1996; Friedman et al. 1996).

Seed release timing varies for riparian trees and is often related to their dispersal mechanism; temperature and daily photoperiod are also important to seed-dispersal timing. Literature sources report a range of seed dispersal dates for Fremont cottonwoods (Appendix E), but they generally disperse their seed in the spring to early summer, when historic flows would most likely be receding following winter rain and during spring snowmelt.

To predict optimal conditions for cottonwood recruitment, Mahoney and Rood (1998) and others have synthesized the combination of hydrological conditions at the germination site (location in space) and seed-release timing (location in time) into the “recruitment box” model. The sloping line within the recruitment box represents the maximum survival rate of seedlings in terms of water table decline. If the hydrograph drops steeper than this line, successful establishment will not occur. The recruitment box is constrained by a seedling’s ability to maintain root contact with the receding water table following spring floods, and at lower elevations by inundation and scour the following winter.

Another model successfully used to predict seedling recruitment on the Bill Williams River in Arizona is the germination model developed by Shafroth et al. (1998). It accounts for water-table depth in additional to flow-stage relationships, as well as other sources of groundwater that may contribute to a seedling’s success. Stromber and

Patten (1991) suggest that cottonwoods confined to canyons, in comparison with those in wide alluvial valleys, may rely to a greater extent on water sources that are not in direct hydraulic connection with surface water.

Fremont cottonwood life history parameters and measures, as reported in various studies are summarized in Appendix E. Recruitment site parameters that affect cottonwood establishment are also included and if available, local information is reported. Salient findings about cottonwood life history include:

- Although always in the spring months, reported Fremont cottonwood seed dispersal dates vary. On the Sacramento River, CALFED (1999) reports a dispersal range of May-July and TNC (2002) reports a dispersal range of mid-April to mid-June.
- Observations of cottonwood seed dispersal along the Feather River in 2003 were from late April to mid-June.
- Seeds cannot get wet and stay viable. Once a seed is wet, it has only 1 to 2 days before it needs to germinate or it will die.
- A seedling can survive 8-16 days of inundations; a sapling can survive 3-4 weeks of inundation.
- A “dormant period” (when respiration has stopped) where inundation would not affect the cottonwoods was not found. This has implications for water level management. Cottonwoods must be able to breathe year-round.
- The ramping rate, or the rate of water-level decline, must not exceed the seedling root growth rate. Substrate dependent studies on cottonwoods along the Sacramento River indicate a seedling’s roots can grow on the order of 22 mm (.9 in) to 32 mm (1.3 in) per day.
- Saplings are most vulnerable to both drought-induced and inundation-induced mortality until their roots are 2 m (6.6 ft) or more in length; somewhere between 2 and 7 years of age.
- Various studies report that successful recruitment sites are generally 1 m (3.3 ft) to 3 m (9.9 ft) above the base flow.
- Cottonwood seedlings and saplings are quite vulnerable to scouring.
- Cottonwood seeds need bare ground, free of litter to germinate. Flow regimes that don’t include scouring flows would allow encroachment of upland vegetation onto riparian areas, effectively blocking cottonwood recruitment.
- Borman and Larson (2002) report that cottonwood recruitment was observed on rivers with a 2% gradient and Rosgen classifications of C and low-gradient B.

During field work performed on the Merced River, which has managed flows, it was observed that floodplain depressions, high flow channels, and other off-channel sites that historically received overbank flooding and sediment deposition were more likely to provide conditions conducive to successful establishment than sites lacking these features (Stillwater Sciences 2001). On the Sacramento River, which also has managed flows, Greco (1999) observed that abandoned channels such as meander

cutoffs, which are depositional sites for fine sediments suspended in overbank flows, are important cottonwood colonization sites. Colonization and succession in these abandoned channels create the largest areas of new riparian vegetation along the Sacramento under present processes (Greco 1999 quoted in CALFED 1999). This pattern was also observed on the Feather River during these studies.

4.4.2.2 Field studies

4.4.2.2.1 Feather River cottonwood recruitment study

The transect and belt plot locations for each study site are shown in Figures 4.4-1 through 4.4-10. Reach 1 (from the Thermalito Diversion Dam to the Thermalito Afterbay Outlet or low flow reach) contained Sites 1 and 2. Reach 2 (from the Thermalito Afterbay Outlet to the confluence with Honcut Creek contained Sites 3 and 4. Reach 3 (from Honcut Creek to the confluence with the Yuba River) contained Site 5 and 6. Reach 4 (from the Yuba River to the confluence with the Bear River) contained Sites 7A, 7B, and 8. The Sites, transects, and the number of belt plots along each transect is shown in Table 4.4-4.

Table 4.4-4. Cottonwood recruitment study sites, transects, and number of belt plots per transect.

	Transect	Number of Belt Plots
Reach 1		
Site 1	1a	2
	1b	1
Site 2	2a	2
	2b	1
Reach 2		
Site 3	3a	7
	3b	4
Site 4	4a	2
	4b	2
	4c	1
Reach 3		
Site 5	5a	3
	5b	2
Site 6	6a	2
Reach 4		
Site 7A	7a	2
Site 7B	7b	2
Site 8	8a	5
	8b	2
Total # of transects	16	

The transect profiles are charted in Appendix F. Transects ranged in length from about 100 to almost 1,000 feet, and descended five to 25 feet from the riparian/upland interface to water's edge. At the time of sampling, water's edge corresponded to a discharge of approximately 600 cfs in the low flow reach, and 2,000 cfs in the high flow reach between the Thermalito Afterbay discharge and Honcut Creek. Discharge data were not available for the reaches below Honcut Creek. Included on the charts are transect points that intercepted cottonwood cover and the location of belt plots.

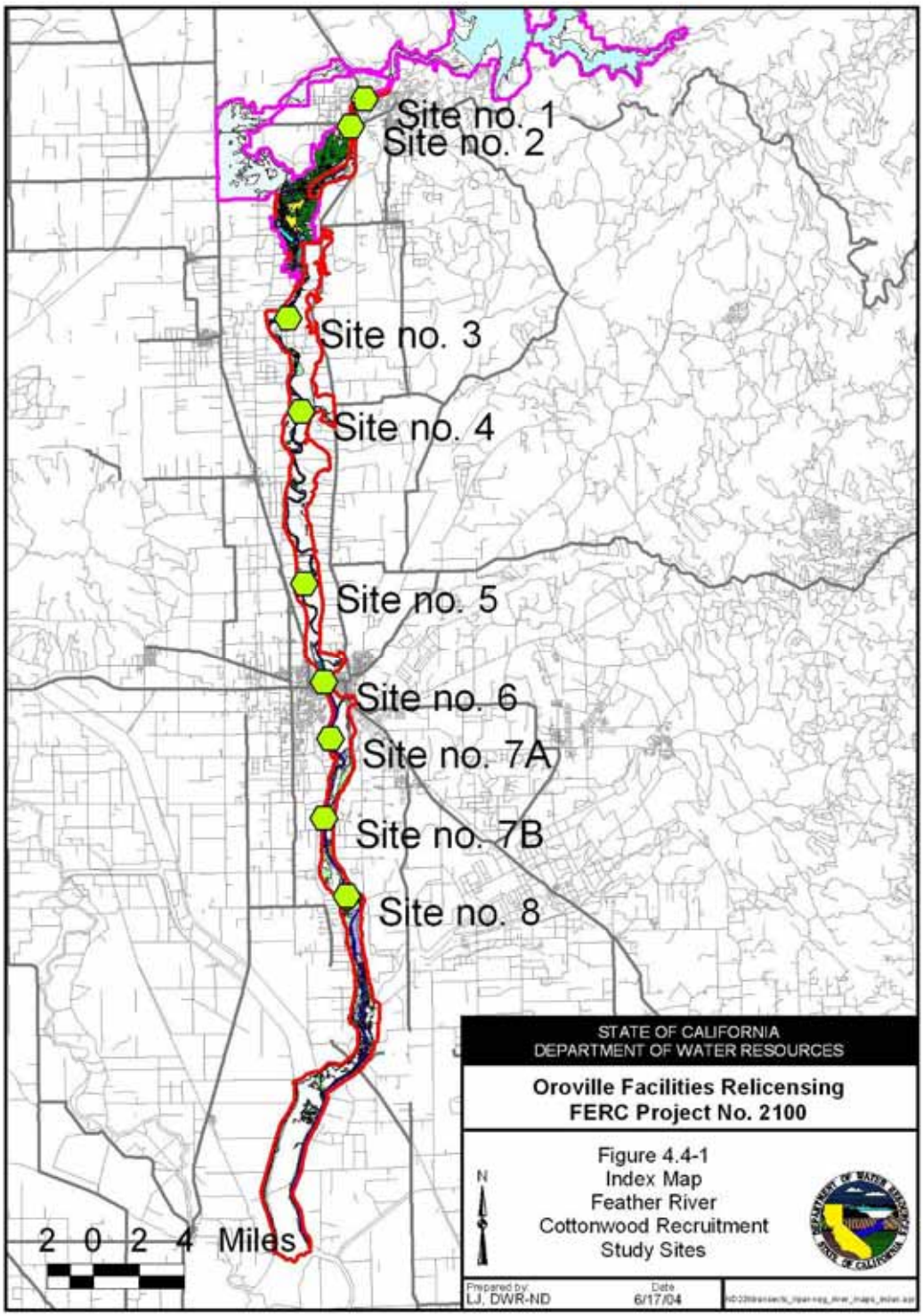

Figure 4.4-1. Index Map to Feather River cottonwood recruitment study sites.

Figure 4.4-2. Study Site 1 – Reach 1. Cottonwood recruitment study.

Figure 4.4-3. Study Site 2 – Reach 1. Cottonwood recruitment study.

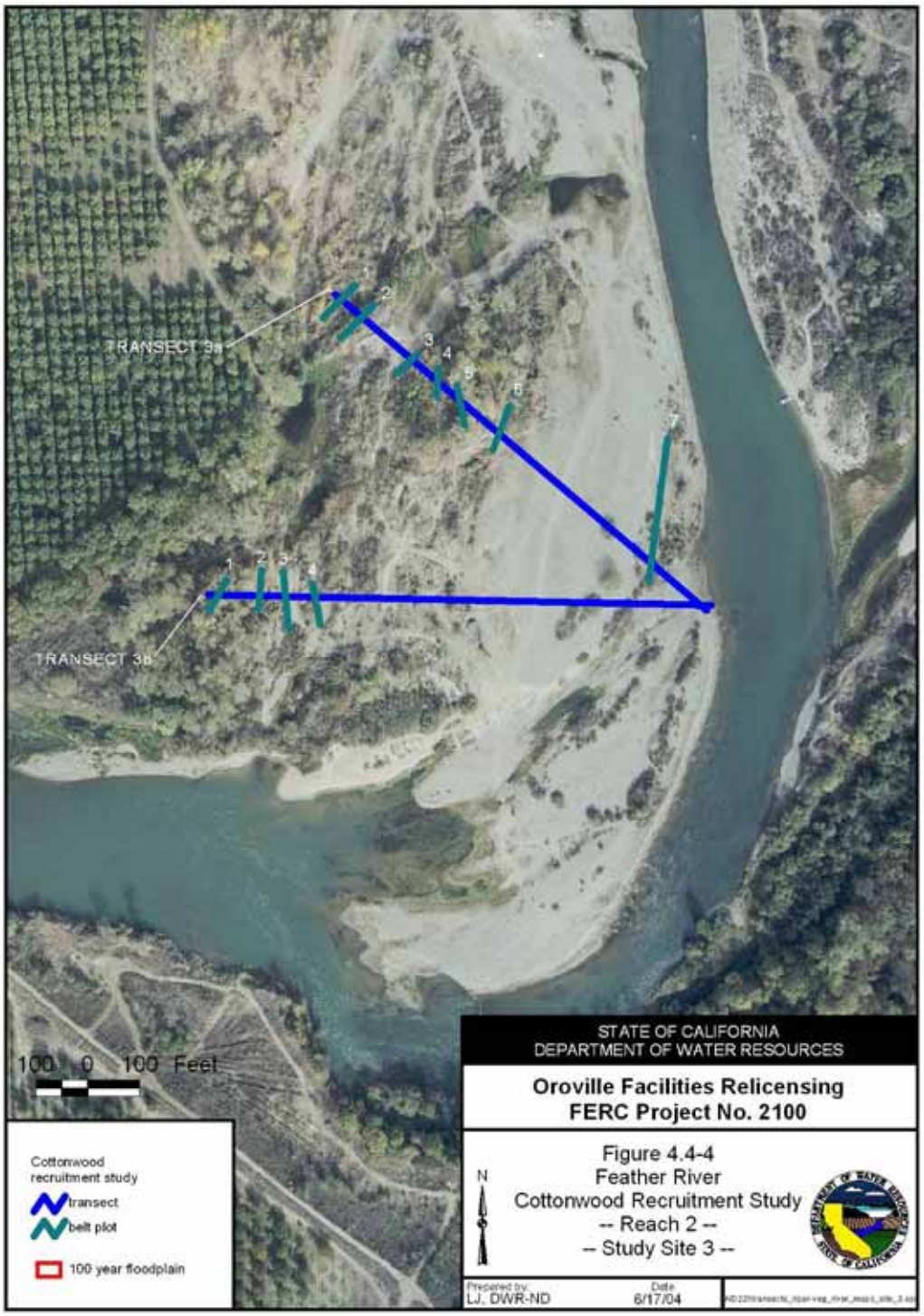

Figure 4.4-4. Study Site 3 – Reach 2. Cottonwood recruitment study.

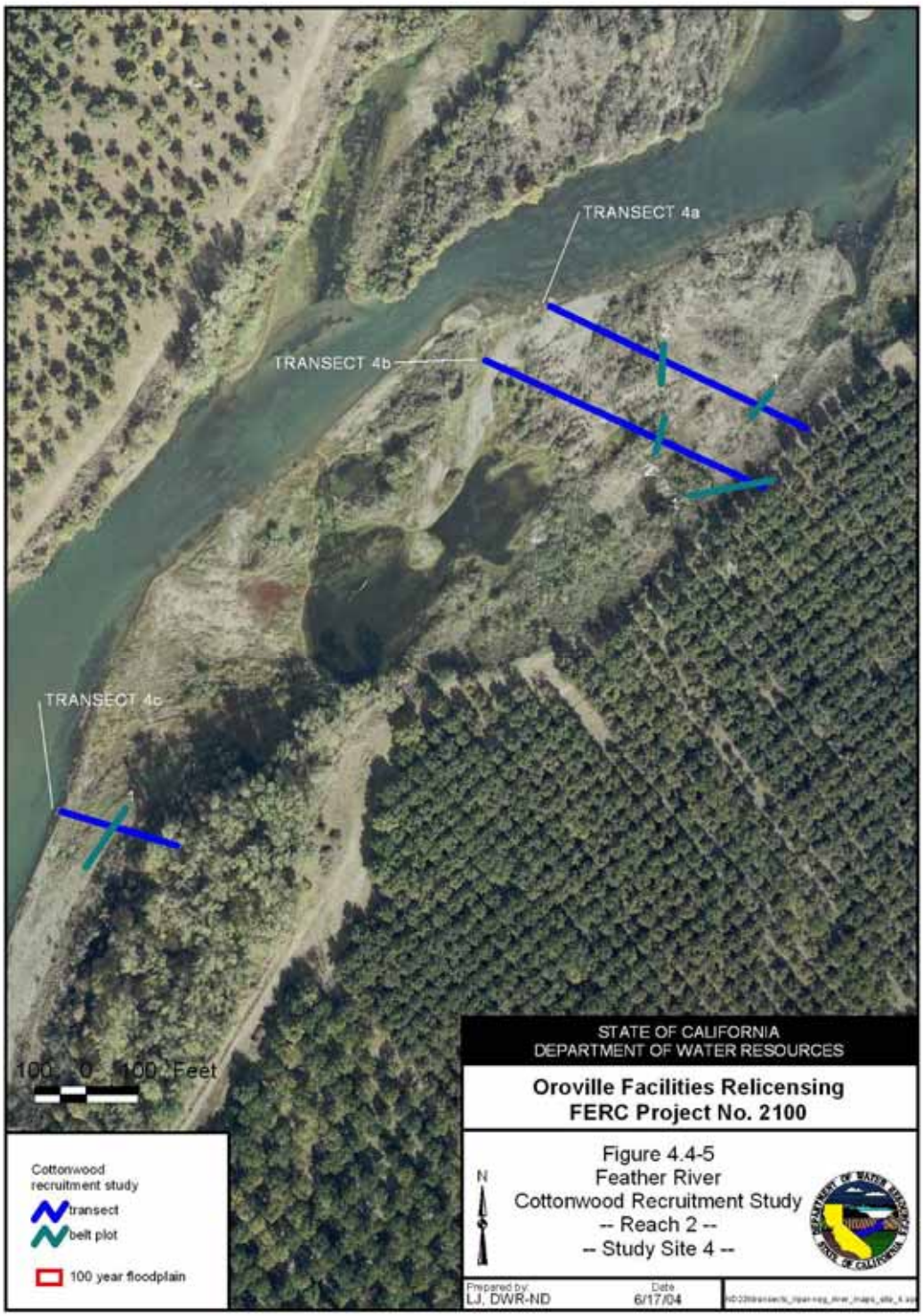

Figure 4.4-5. Study Site 4 – Reach 2. Cottonwood recruitment study.

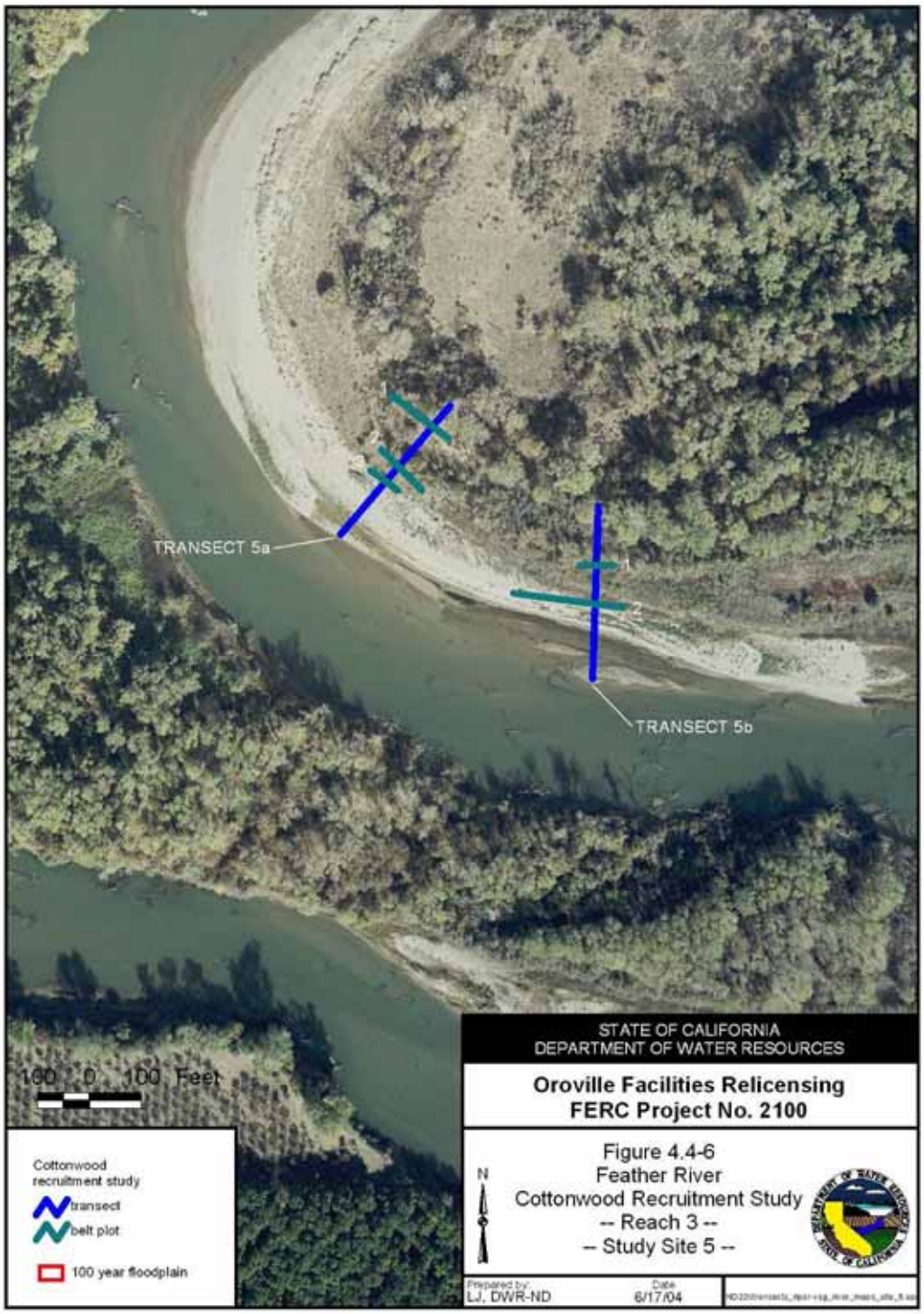

Figure 4.4-6. Study Site 5 – Reach 3. Cottonwood recruitment study.

Figure 4.4-7. Study Site 6 – Reach 3. Cottonwood recruitment study.

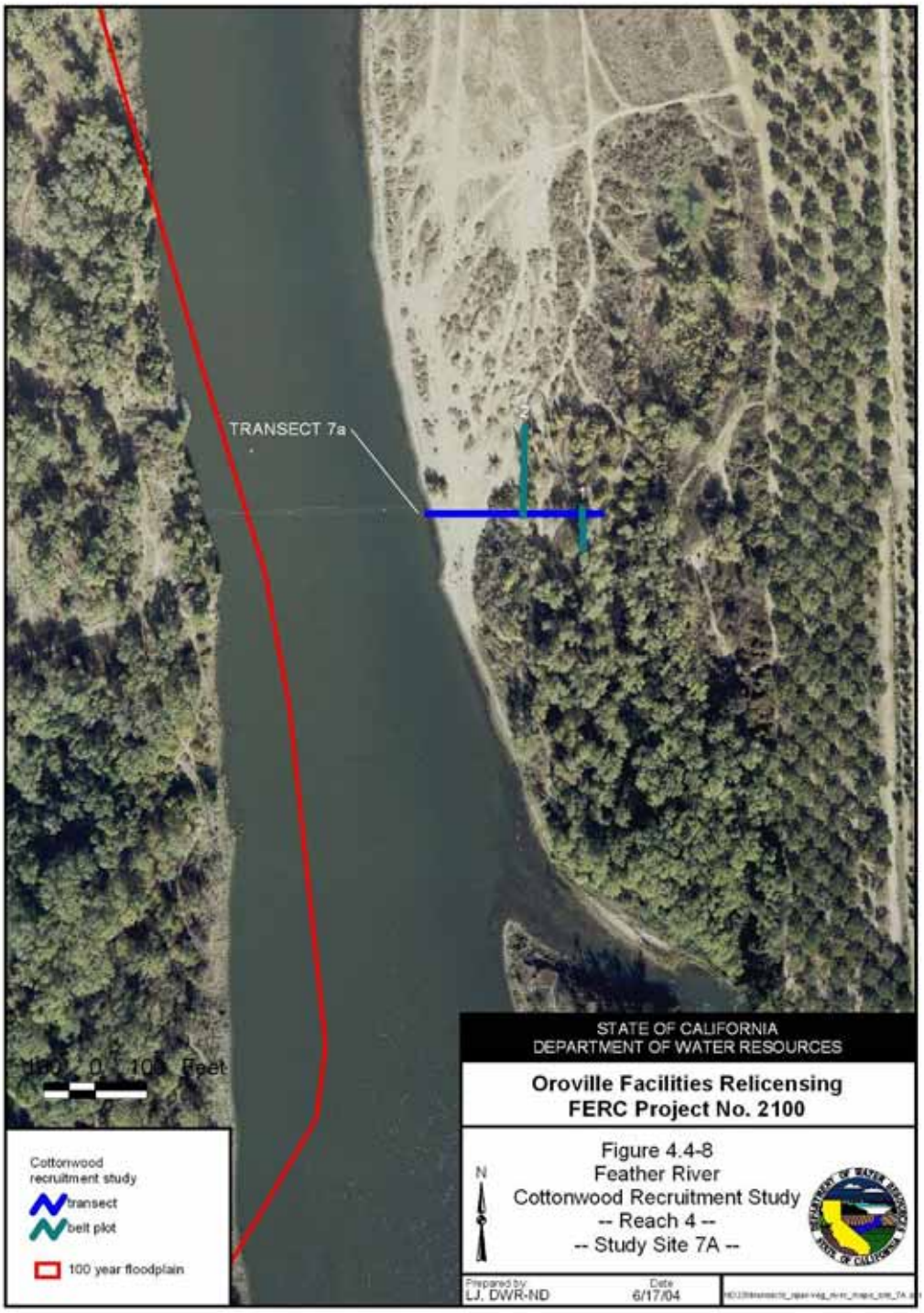

Figure 4.4-8. Study Site 7A – Reach 4. Cottonwood recruitment study.

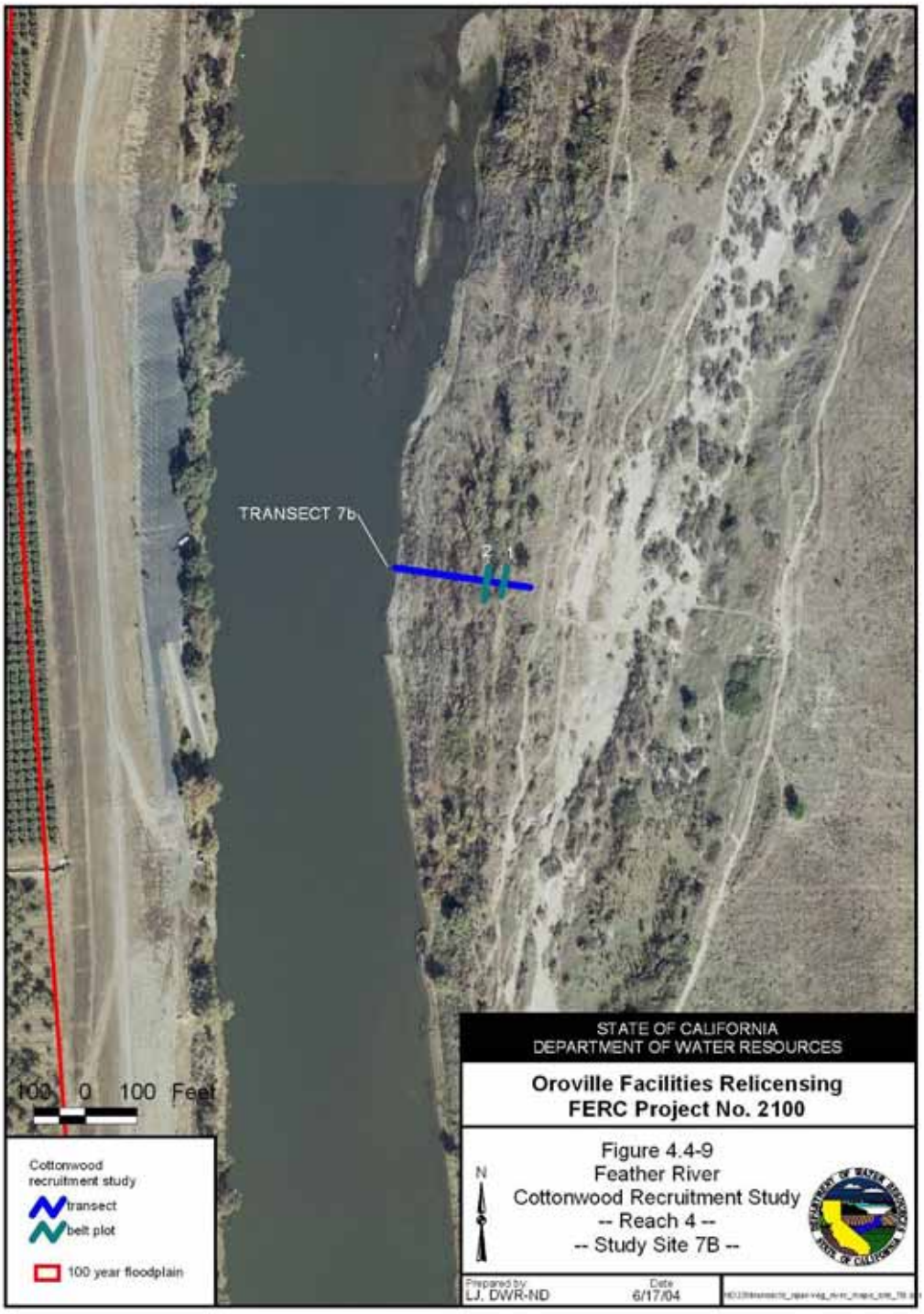

Figure 4.4-9. Study Site 7B – Reach 4. Cottonwood recruitment study.

Figure 4.4-10. Study Site 8 – Reach 4. Cottonwood recruitment study.

Flows in the low flow reach are maintained at about 600 cfs year-round (Figure 4.4-11). Between January 1, 1992 and September 30, 2001, the daily average discharge in the low-flow reach was maintained 87 percent of the time between 600 and 700 cfs. On 83 days during this period of time (two percent), discharges ranged between 10,000 to a maximum of 126,000 cfs. The longest duration of time when discharges ranged between 600 and 700 cfs without an appreciable spike, was about 30 months (March 1999 through August 2001).

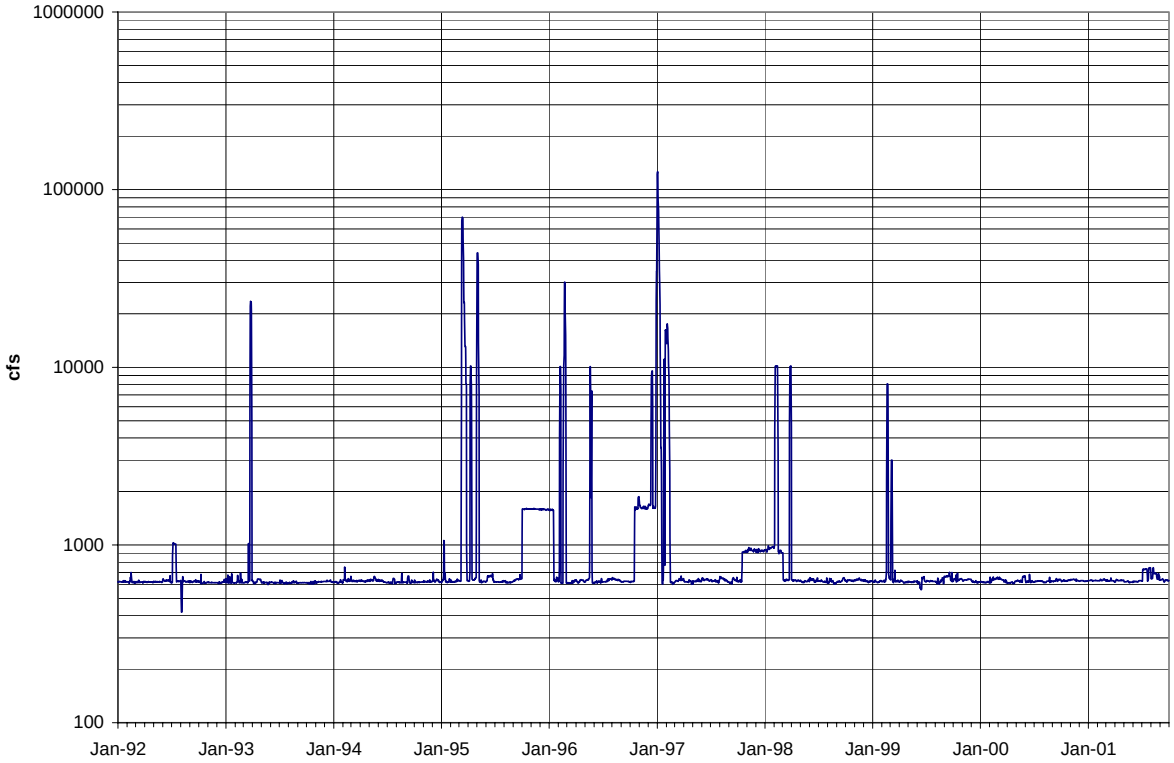

Figure 4.4-11. Feather River daily discharge at Oroville (low flow reach) from January 1, 1992 to September 30, 2001. USGS Gage 11407000.

Below the Thermalito Afterbay discharge, daily average flows vary markedly. A minimum flow of 1,000 cfs is maintained during April through September, an important period for cottonwood seed germination and initial seedling survival. Daily flows recorded at the Gridley gage (Reach 2) are charted for the ten-year period 1992-2001 in Figure 4.4-12. While annual minimum daily flow at Gridley ranged between about 1,000 and 2,000 cfs, maxima varied from about 3,000 cfs (1992) to about 163,000 cfs (1997). The Feather River at Yuba City gage has a limited record and is not comparable to the Gridley gage data. It does, however, include flow from Honcut Creek and best represent flows in the Feather River between the mouth of Honcut Creek and the mouth

of the Yuba River. The Feather River near Nicolaus gage includes the drainages of the Yuba and Bear Rivers. However, the gage ceased operations in 1983 after about 40 years of record. Peak flows were available for all the stream gages downstream of Oroville; however, the periods of record differed for each station.

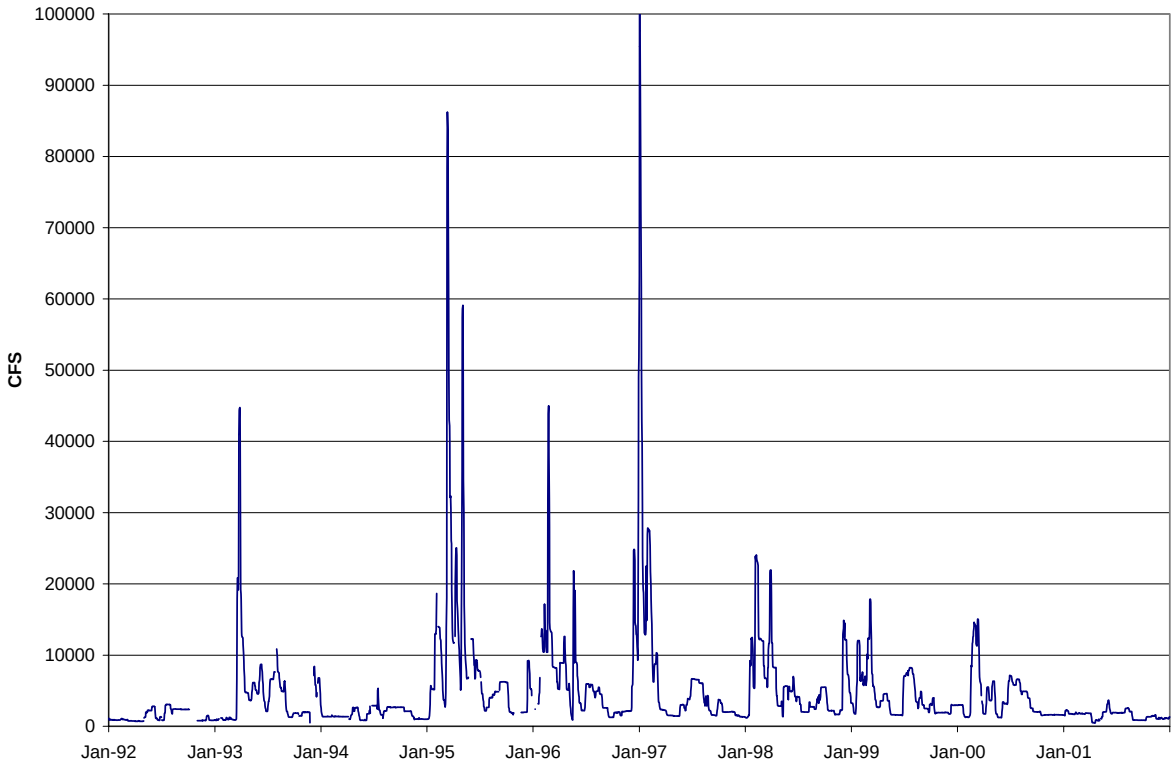

Figure 4.4-12. Feather River daily discharge (cfs) at Gridley, 1992 – 2001.

At both the low-flow reach (Figure 4.4-11) and the high-flow reaches (Reaches 2, 3 and 4) (Figure 4.4-12), the flows occurring at the time of field sampling appear to represent growing season low flows that occur with some degree of regularity. In the lower Feather River, however, daily flows are too variable to be usefully characterized by an "average low flow".

4.4.2.2. Cottonwood distributions

The frequency distributions of transect points that intercepted cottonwood canopy cover in relation to elevations above river stage at the time of sampling is charted for each river reach in Figure 4.4-13. In Reach 1 cottonwoods were encountered very close to the water's edge. In Reaches 2, 3, and 4, where flows are usually greater and more variable, the lowest transect points intercepting cottonwood cover were at an elevation

three to five feet higher than water's edge. Viewed together, the charts suggest that the zone of inhospitable conditions for cottonwood recruitment that typically occurs near the water's edge may increase in width with increasing distance downstream, possibly in response to greater flows, greater velocities and seasonal fluctuations, or other factors.

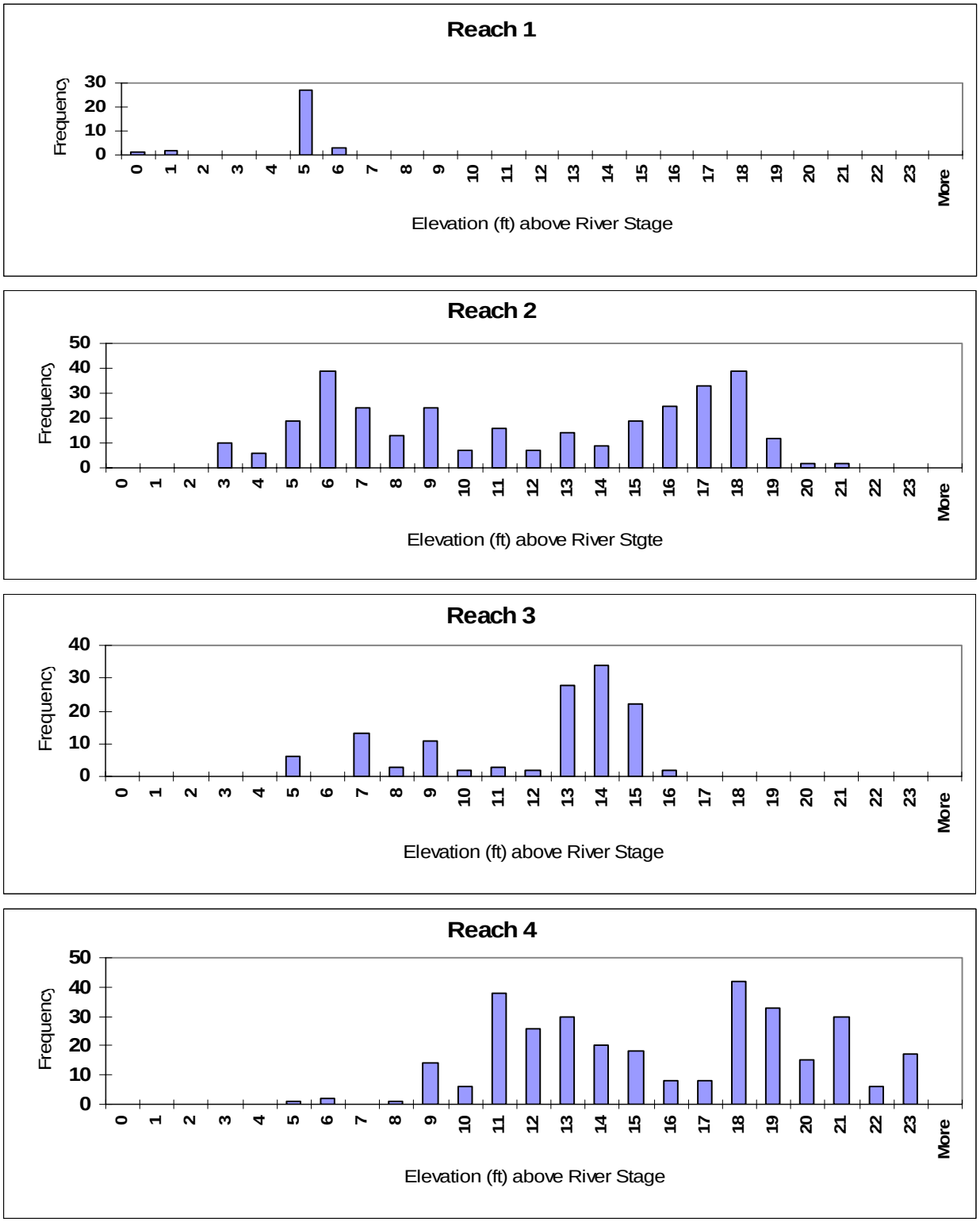

Figure 4.4-13. Occurrence of cottonwood cover and elevation above river stage at time of sampling.

Transect points intercepting cottonwood cover appear to be bimodally distributed in Reaches 2, 3 and 4 (Figure 4.4-13). Trees that comprise the mode nearest to the water's edge may have established when a sequence (or sequences) of river flows provided suitable moisture conditions. The second grouping of trees, located higher above the water's edge than the first group, may have established when a different sequence of flows characterized by higher water levels provided suitable conditions, or in "safe" sites where factors in addition to (or other than) river flow influenced seed germination and seedling survival.

The frequency of occurrence of belt plots relative to water's edge is charted in Figure 4.4-14. Because the belt plots were intentionally located to maximize number of stems, these data do not necessarily portray a representative distribution. Nevertheless, this figure also suggests that cottonwood recruitment has tended to occur at higher elevations above water's edge (at typical low-flow water levels) at downstream sites, compared to more upstream sites.

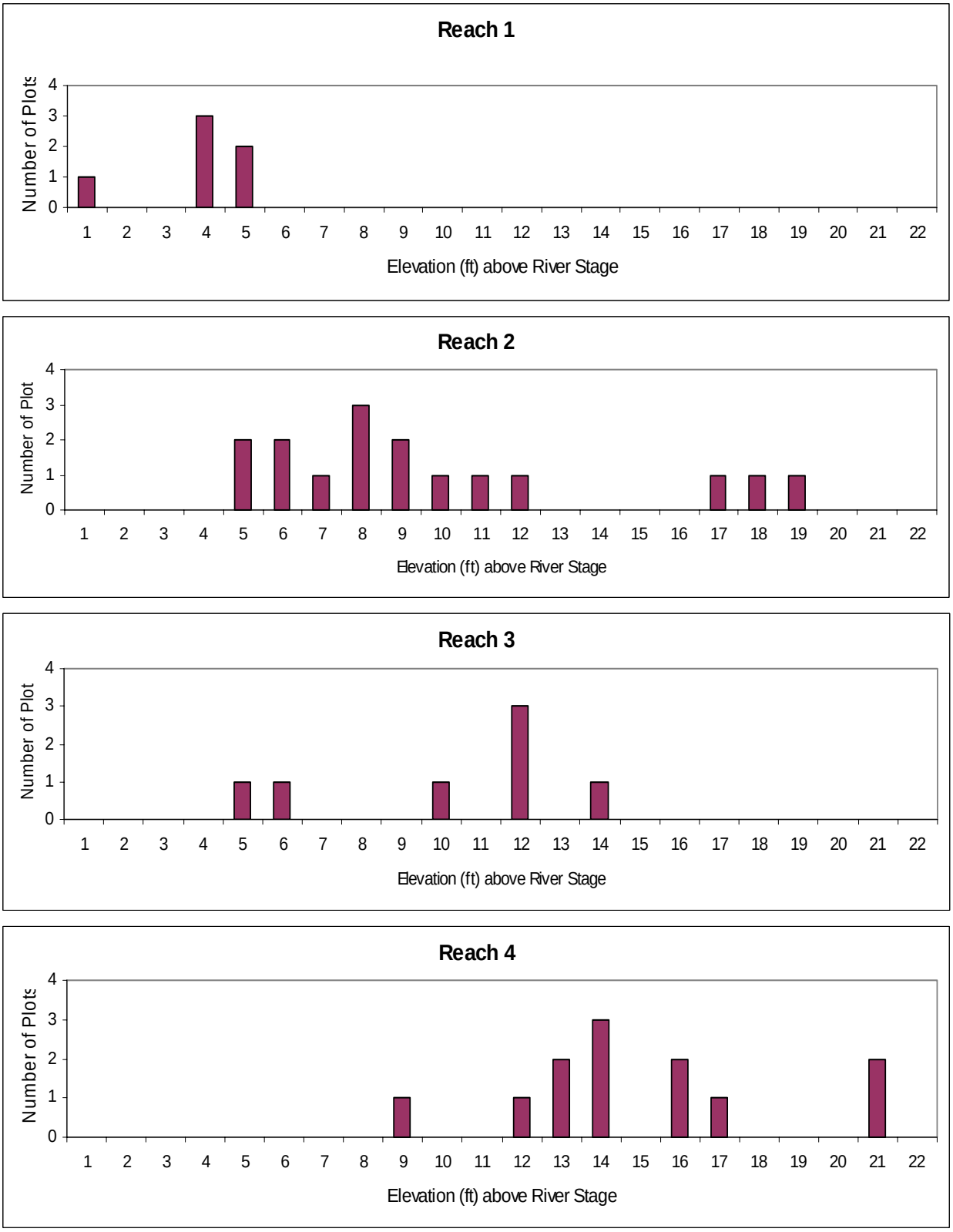

Figure 4.4-14. Occurrence of belt plots in relation to elevation above river stage.

The distributions of belt plots relative to the discharge that corresponds to river stage at plot elevations are charted in Figure 4.4-15. The elevations of the lowest belt plots located in the low-flow reach correspond to river stages that result from discharges of about 5,000 cfs (field site 1) and about 1,200 cfs (field site 2). In reaches 2 and 3 (field sites 3 through 6), the lowest belt plots occurred at elevations corresponding to discharges between 7,200 cfs (field sites 6) and 12,500 cfs (field site 5), and in reach 4, below the Yuba River, to discharges of 15,400 cfs (field site 8) and 17,640 cfs (field site 7). Half of all of the belt plots in reaches 2, 3 and 4 were located at elevations corresponding to discharges greater than 20,000 cfs. Values for discharges greater than 60,000 cfs derive from straight-line extrapolation of the stage/discharge curves and should be considered as very rough approximations.

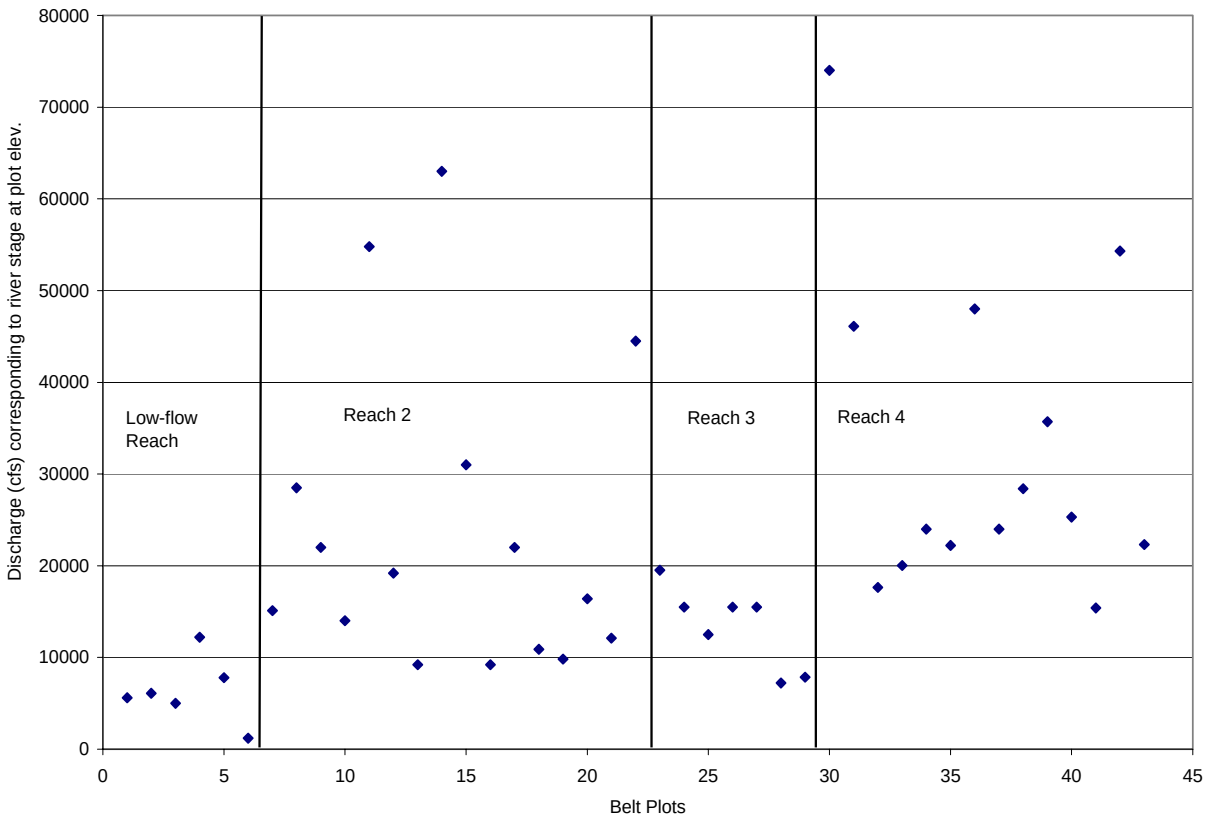

Figure 4.4-15. Discharge corresponding to river stage at belt plot elevation.

The occurrence of cottonwood stems (recorded from belt plots) in relation to discharge that corresponds to the river stage equal to belt plot elevation, is charted in Figure 4.4-16 (low-flow reach) and 4.4.17 (high-flow reaches). Cottonwood stem data are grouped into three stem diameter classes: less than 0.5 cm (0.2 in), equal to 1.0 cm (0.4 in), and between 2 and 5 cm (0.8 and 1.97 in). The stems less than 2 cm (0.8 in) probably represent recent recruitment, assuming they have not sprouted from buried stems.

Twenty-one stems of diameter less than 2 cm (0.8 in) were recorded from three of the six belt plots that were sampled in the low-flow reach (plots 1A-2, 1B-1 and 2B-1). The three belt plots that contained no stems in this size class were located at elevations corresponding to flows of approximately 5,600 cfs, 7,800 cfs and 12,200 cfs. Thirty-four stems of diameter 2-5 cm (0.8-1.97 in) were recorded from plots in the low-flow reach.

Small-diameter (less than 2 cm (0.8 in)) stems recorded from the high-flow reaches were distributed over a relatively wide range of elevations and corresponding discharges. The greatest numbers were recorded from belt plots located at elevations corresponding to discharges between 8,000 cfs and 16,000 cfs (Figure 4.4-17). The twelve plots (3A-1, 3A-4, 3A-7, 3B-3, 4A-1, 4A-2, 4B-2, 5A-2, 5A-3, 5B-1, 5B-2, and 8B-3) located at these elevations accounted for 89 percent of the stems less than 1 cm (0.4in) diameter, and 61 percent of the stems of diameter equal to 1 cm (0.4 in).

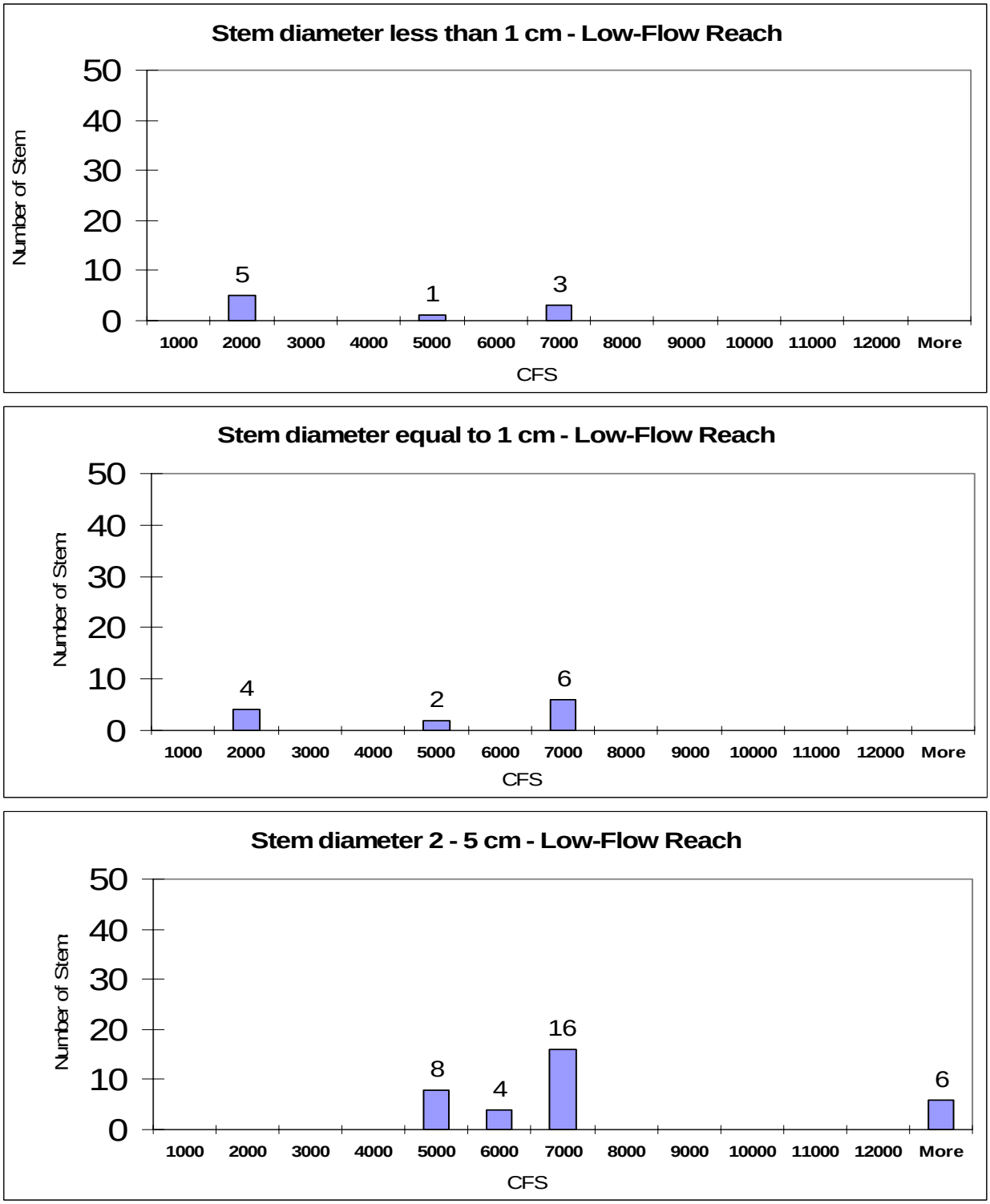

Figure 4.4-16. Number of cottonwood stems per size class occurring in elevation bands in the low flow reach.

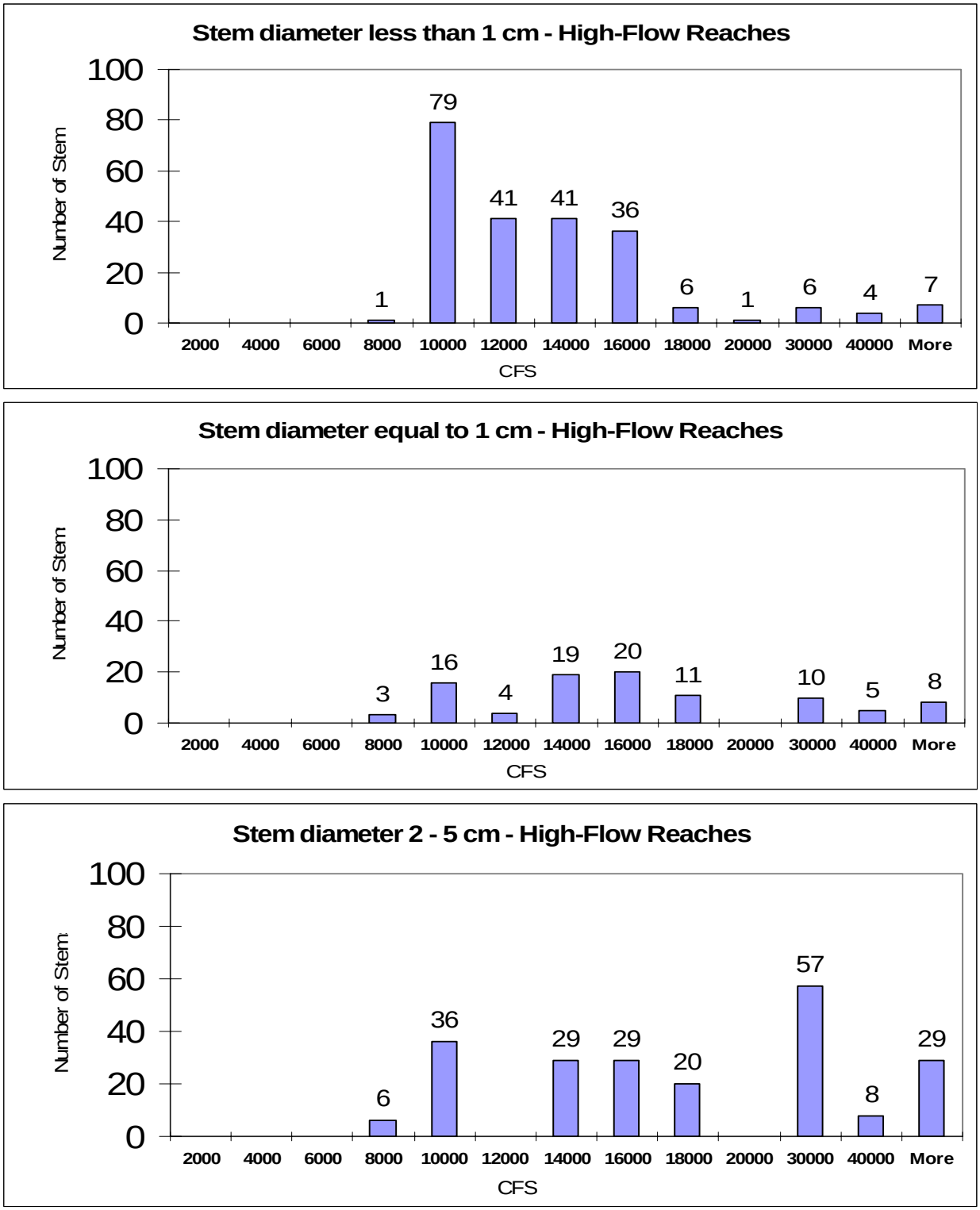

Figure 4.4-17. Number of cottonwood stems per size class occurring in elevation bands in the high flow reach.

Observations from the September 2002 field reconnaissance suggest that recent recruitment of cottonwood stems have been scarce in the low flow and high flow reaches of the Feather River. The analysis of field data indicates that some limited recruitment has occurred at elevations corresponding to a relatively wide range of discharges, from 1,200 cfs to 12,200 cfs in the low-flow reach, and 7,200 cfs to much greater than 50,000 cfs in high-flow reaches. Successful recruitment dependent on river hydrology requires a sequence of steady or decreasing daily flows that initiate during seed dispersal and provide adequate substrate moisture to support seedling growth, followed by a period of time when sediment-mobilizing flows are insufficient to scour or possibly bury the recently established stems. If recent cottonwood recruitment in the riparian zone of the Feather River has been dependent on moisture conditions provided by river hydrology, then the recorded elevations of young-growth cottonwood should approximately correspond with river stages occurring during the time of seed dispersal. For a period of time subsequent to successful seedling establishment, river flows should not recede so precipitously as to allow depletion of soil moisture at rooting depths, or be so high as to drown or scour the recently established stems.

Low flow reach: Small-diameter cottonwood stems were recorded in the low-flow reach from belt plots located at elevations corresponding to approximately 1,200 cfs (2B-1), 5,000 cfs (1B-1) and 6,100 cfs (1A-2). Inspection of daily average flows measured at the Oroville gage (USGS 11407000) between January 1, 1992 and September 30, 2001 indicates very few instances of flows greater than about 600 cfs, the target flow maintained in the low-flow reach (Figure 4.4-10). The timing of seed dispersal along the Feather River below Oroville Dam has not been documented but likely includes the period from April 1 through May 30, with variability from year to year. Two episodes of relatively prolonged discharges of about 1,600 cfs and one episode of about 900 cfs occurred between 1995 and 1998, but in winter months outside of the window of cottonwood seed dispersal. Flows of very short duration in the range of 1,200 – 5,000 cfs occurred for two or three days in May, associated with much higher peaks. One such event occurred in early May, 1995, and a second in late May, 1996. While these sharp peaks might have provided adequate substrate moisture to allow for seed germination, the rapid decline in river stage would likely have exceeded the capacity of seedling roots to grow to depths where adequate moisture was available. The seedlings would have desiccated unless moisture was provided by sources other than receding river stage. Such sources might include precipitation and/or capacity of the local environment to store and release water.

Precipitation in May is relatively frequent. In 1995, for example, 3.24 inches of rain were recorded at the Oroville Dam gage, occurring in three discrete events encompassing a total of seven days. Precipitation in June, however, is typically less than half that of May, and precipitation in July is rare (based on records for 1992-2001). All three plots with small-diameter cottonwood occurred at or near the base of steep slopes (Appendix D: Figures D-1, D-2, and D-4), where drainage from up-slope substrates might have influenced the moisture status of the plot substrate. Evaluation

of the influence of adjacent terrain on substrate moisture would require water level data derived from monitoring wells; the water levels at or near the belt plots could then be compared with co-occurring river stages.

High flow reaches: Small-diameter cottonwood stems sampled in the high-flow reaches were more prevalent in belt plots located at elevations equal to river stages that correspond to discharges between 8,000 and 16,000 cfs (Figure 4.4-17). Daily discharges recorded from the Feather River at Gridley are charted in Figures 4.4-18 and 4.4-19 for the months April through September 1992 through 2001. Gridley is located in reach 2 about 6.5 miles upstream of the confluence of Honcut Creek. The April through September time period is assumed to encompass the critical months for cottonwood seed germination (April and May) and initial seedling survival. Daily discharges at Gridley in the range of 8,000 to 16,000 cfs were rare, of short duration, and occurred in association with relatively sharp peaks or outside of the April-May window for seed germination.

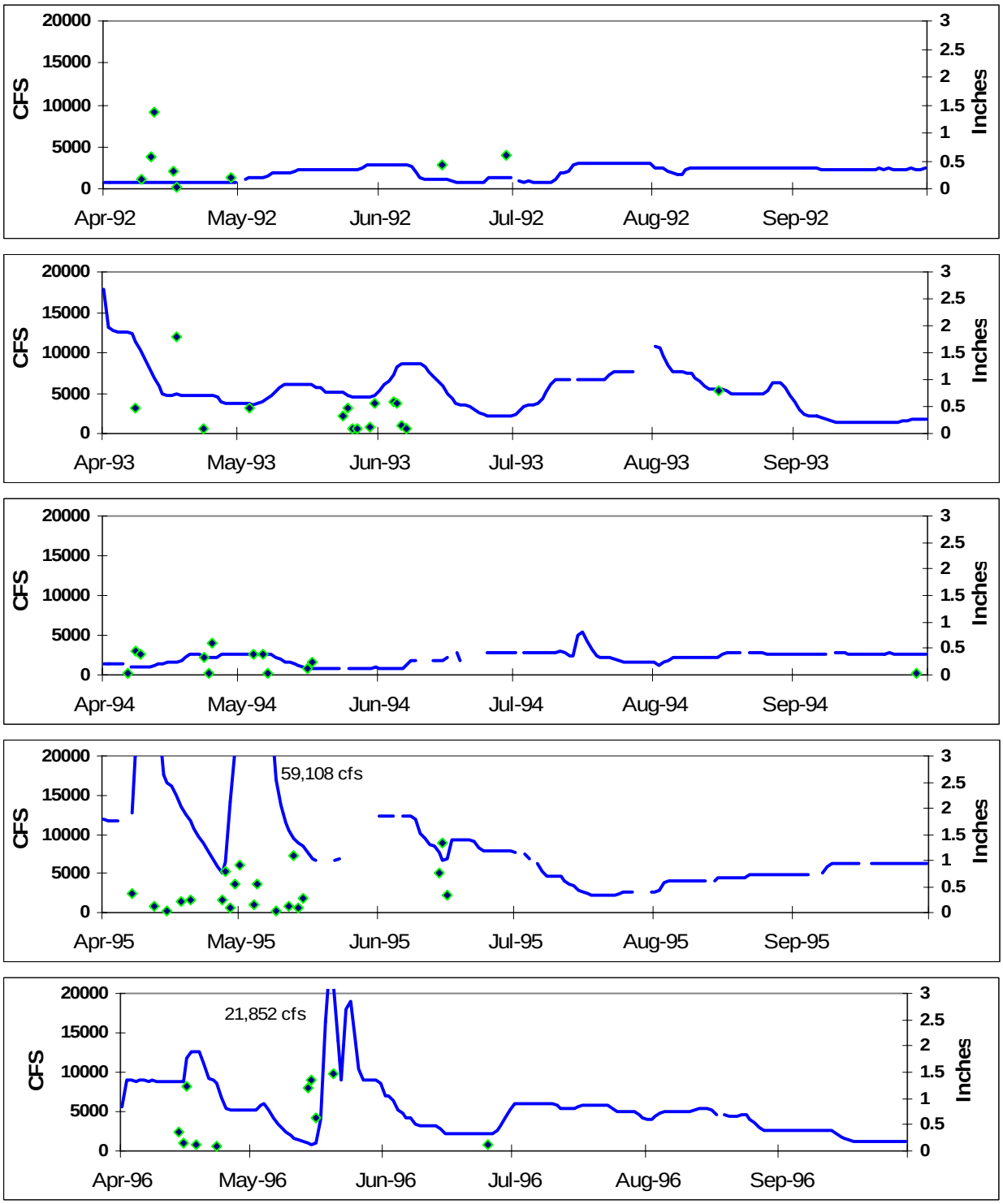

Figure 4.4-18. Daily discharge (cfs) at Gridley and daily precipitation at Oroville Dam (April – September 1992 -1996).

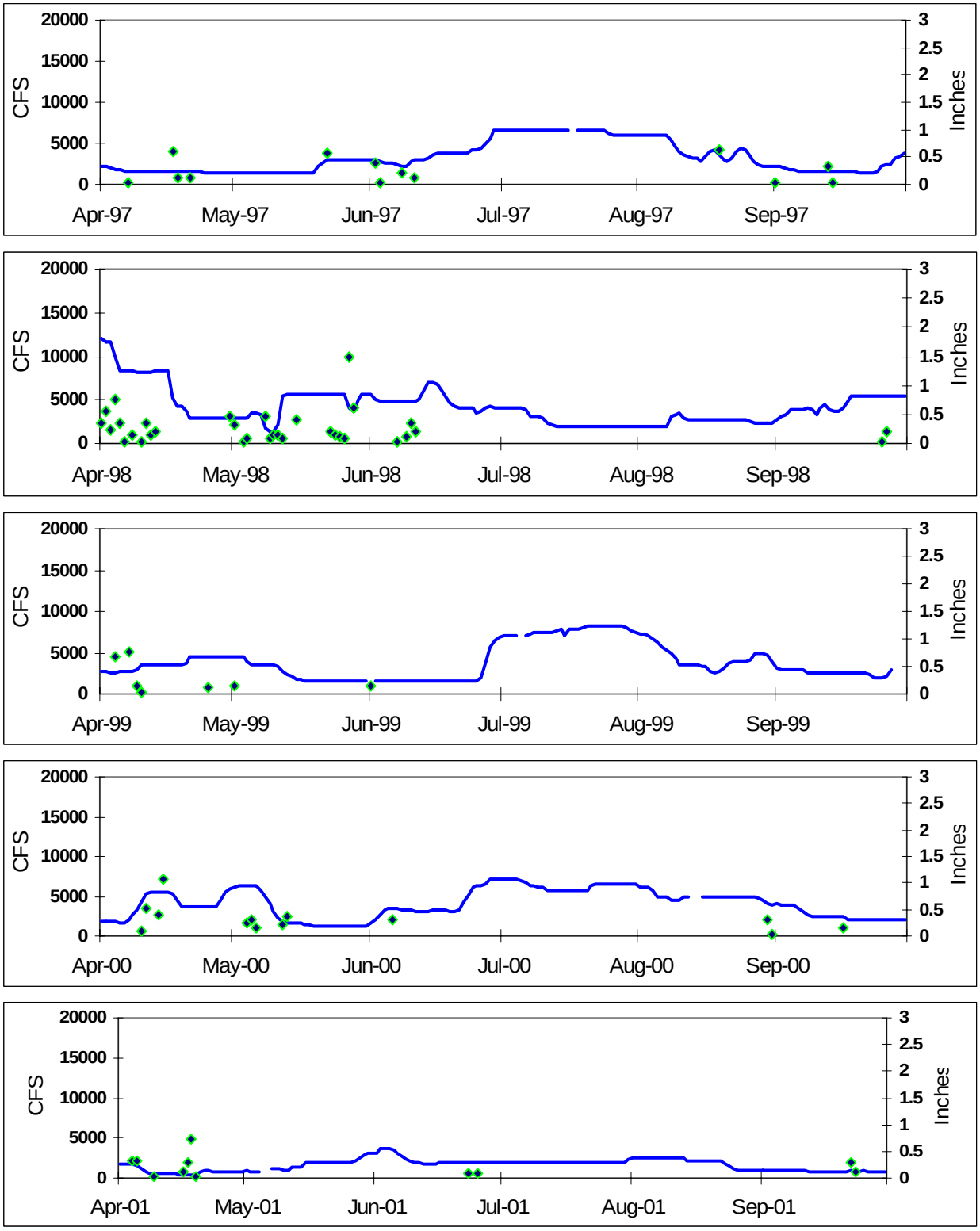

Figure 4.4-19. Daily discharge (cfs) at Gridley and daily precipitation at Oroville Dam (April – September 1997 -2001).

Discharges in April and May that were less than 8,000 cfs might have provided adequate substrate moisture at belt plots located at elevations near the stage resulting from 8,000 cfs, and/or located on a segment of transect where the stage/discharge rating curve is relatively flat. Because stage/discharge curves are approximations, bank elevations actually inundated by a particular discharge may, in some cases, be higher than predicted by the rating curves. And at plots where the rating curve is relatively flat, apparently large changes in discharge can translate into relatively small changes in stage. Belt plot 3B-3, for example, was located along a transect with a relatively flat rating curve (Appendix A). This plot included seventy-two cottonwood stems less than 1 cm (0.4 in) diameter, representing about one third of the cottonwood stems of this size class sampled during the October 2002 field study. Plot 3B-3 was located at 78.1 feet above sea level, which, based on the rating curve, corresponds to a discharge of approximately 9,200 cfs. At this elevation, discharges of approximately 6,200 cfs would have inundated bank substrate up to about 77.2 feet above mean sea level, which would likely have saturated surface substrate at plot 3B-3. Discharges near 6,200 cfs occurred for five consecutive days (at the Gridley gage) in early May, 2000, during which time 0.72 inches of rain were recorded at Oroville Dam. This combination of discharge and precipitation appears capable of supporting seed germination and early seedling survival, but low flows and absence of precipitation in late May and early June of 2000 may have lead to desiccating conditions.

Although historical discharge records are not available for reaches 3 (below Honcut Creek) and 4 (below the Yuba River), it appears likely that in these reaches also, flows approximately corresponding to river stages that wetted existing small-diameter cottonwood stems have occurred rarely in the last several years, except during winter and early spring months.

A small number of the belt plots sampled in October 2002 occur at elevations that correspond to discharges that have occurred during the growing season during the last several years. At these apparently few sites, such as 3B-3, river stage may be the driving factor influencing cottonwood seed germination and seedling survival. At many of the sites, it appears that successful seed germination and seedling survival has, under current operating conditions, been less directly influenced by river stage than by other factors. In addition to precipitation, other factors might include the effect of sand swales and berms acting as storage reservoirs, and occurrence of safe sites where backwater or sheltered locales may have developed substrate less permeable than the adjacent sand and gravel substrates. The high swales and berms that line much of the shore of the Feather River may slowly release water to seedling sites at lower elevations. Field reconnaissance conducted in September 2002 suggested frequent occurrence of sheltered locales. At such sites, fine particulate matter including organic debris can settle out of the water column and, over time, create a less permeable lens near ground surface. Water tables at these sites would likely drop more slowly compared to sites more exposed to river current.

Based on the analyses of the transect data, the literature review, and inspection of Feather River discharge time series, a number of important uncertainties that will affect cottonwood recruitment can be identified. These include hydrological factors as well as botanical factors. Hydrological factors include the effect of precipitation, drainage from higher terrain (berms and swales), localized less-permeable substrate, winter scouring, and the error associated with the rating curves. Botanical factors include sensitivity of cottonwood seedlings to desiccation, last date of seed dispersal, and stem diameter/age relationships.

4.5 DISCUSSION

4.5.1 Effects of project operations on riparian conditions and recruitment

Successful cottonwood recruitment can be viewed as comprising three stages: seed dispersal and germination; initial seedling survival; and longer-term seedling establishment. Seed dispersal requires wind or river water transport coupled with suitably exposed, saturated substrate. Inspection of Figures 4.4-10, 4.4-18 and 4.4-19 indicates that relatively steady river stages have occurred during the window of seed dispersal in the majority of years between 1992 and 2001, indicating that where cottonwood seed sources are present, ample opportunity for germination has occurred. CDWR biologists have observed stands of cottonwood seedlings at various sites along the banks of the high flow reaches, usually during the late spring/early summer months.

The paucity of successful recruitment on the Feather River suggests that current project operations tend to prevent initial seedling survival, longer-term establishment of seedlings, or both. Relatively steady flows near 600 cfs were maintained in the low flow reach for as long as two years without appreciable spikes of higher flows (Figure 4.4 - 10). Such constancy would support germination and early survival of cottonwood seedlings along the bank edge, although the mostly cobble substrate that is characteristic of this reach might be the major factor precluding seedling survival. Discharges equal to or greater than 10,000 cfs occurred in five out of the ten years in the low flow reach between 1992 and 2001, and may have scoured out seedlings that had managed to establish on cobble substrate in the intervening years between high flow events. Seedlings established at the water's edge at field site 1, when discharges were approximately 600 cfs, would be under more than seven feet of water when discharges were 10,000 cfs, and under roughly fifteen feet at 30,000 cfs.

The widespread failure of cottonwood recruitment in the riparian zone of the high flow reaches may be attributable to failure during initial seedling survival, and also the frequent occurrence of scouring discharges. As in the low flow reach, opportunities for seed germination and initial seedling survival are evident in the majority of years

between 1992 and 2001 (Figures 4.4-18 and 4.4-19). Seedling survival during the summer months, however, appears problematic given the absence of rain and, in half the years, a rise in stage during June, July or August. It is not known whether the seedlings recruited in April and May can extend roots deep enough to avoid desiccation, or grow sufficiently tall to avoid drowning during higher summer flows. Both processes may be limiting seedling survival.

Opportunities for seed germination and initial seedling survival in the high flow reaches appear limited to zones wetted by discharges during April-May between 8,000 cfs and 10,000 cfs. Between 1992 and 2001, annual maxima at the Gridley gage were much higher than 8,000 cfs in seven out of the ten years (Table 4.5-1).

Table 4.5-1. Annual maximum daily discharge at Gridley gage, 1992-2001.

Year	Discharge (cfs)	Date
1992	3,074	July 17
1993	44,340	March 28
1994	5,327	July 16
1995	86,213	March 12
1996	44,991	February 23
1997	124,997	January 2
1998	23,069	February 11
1999	17,409	March 8
2000	14,537	March 13
2001	3,655	June 4

Many, if not most, of these annual maxima were likely sufficient to scour out recently established seedlings. In the high flow reaches, cottonwood recruitment may be limited by the low flows occurring during seed dispersal, restricting seedling establishment to elevations susceptible to higher summer flows and the much higher annual maximum.

Under present operations, scattered, very limited, cottonwood recruitment will continue in the low flow and high flow reaches.

4.5.2 Flow enhancement measures for cottonwood recruitment

A number of uncertainties concerning existing constraints on cottonwood recruitment in the Feather River preclude recommending feasible flow enhancement measures that would be considered very likely to effect improved recruitment. The field studies

conducted in 2002 and subsequent analyses suggest, however, additional steps that could increase understanding of existing conditions in the high flow reaches, and possibly lead to identification of feasible flow enhancement measures that would have a reasonable likelihood of success.

Opportunities for flow enhancement are limited in the low-flow reach by its use for release of large volumes of water to ameliorate temperature or salinity conditions downstream. The large difference between the normal flow of 600 cfs and the occasional releases of at least 10,000 cfs at an approximate two-year return frequency, likely ensures that any recruitment associated with the normal lower flow is scoured away by the occasional much higher flow. Opportunities for cottonwood forest enhancement in the low-flow reach appear limited to non-flow measures.

Opportunities for flow enhancement in the high-flow reaches appear limited by the difference between the flows occurring at the time of seed germination and initial establishment, generally between 1,500 and 3,000 cfs, and the higher mid-to-late summer flows that occur in many years. The late-summer flows likely drown or scour the small-growth seedlings. In some years, however, relatively high flows in the range (at the Gridley gage) of 6,000 – 7,000 cfs occur earlier in the summer, commencing in late June (for example, 1997 and 2000). The timing of these higher flows approach the tail end of cottonwood seed dispersal and might support seed germination. Flow enhancement would consist of initiating discharges of 6,000 to 7,000 cfs a week or two earlier in June, particularly in years when cottonwood seed dissemination is delayed by weather conditions, and extending the flows in this range a week or two longer into the late summer. Flows would need to be ramped down gradually, so that river stage at desired sites declined by about one foot a day, allowing seedling roots to extend deeper into the ground as the water table dropped. The efficacy of this approach would need to be tested by monitoring seedling occurrence and survival at selected sites. Opportunity to implement a flow augmentation of this duration and magnitude would probably occur infrequently, perhaps every five or ten years.

5.0 TASK 2 – WETLAND COMMUNITIES IN THE PROJECT AREA

5.1 INTRODUCTION

According to the U.S. Environmental Protection Agency (EPA) wetlands are "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (EPA Website). They usually include swamps, marshes, bogs, and similar areas. Although wetlands are often wet, they may not be wet throughout the year. However, in the absence of obvious water or waterlogged soils, what all wetlands have in common are soils that show signs of persistent or regularly repeated saturation (hydric soils) and plants that are specially adapted to inundated or saturated soils (hydrophytes). Mudflats do not meet the definition of wetlands given above. However, the U.S. Fish & Wildlife Service (USFWS) follows the Cowardin classification of wetlands (USFWS 1979) wherein "wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water, and that have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year." This definition of wetlands does consider unvegetated aquatic sites such as mudflats or vegetated shallow water to be wetland areas (NCSU Website). Mudflats are referred to as "Mud Shores" in the Cowardin classification and, while generally unvegetated, they support diverse populations of invertebrates; vegetated shallow water in this classification is referring to a shore that supports non-perennial vegetation, commonly weedy species such as cocklebur (USFWS 1979).

Marshes are one of four major categories of wetlands. The other categories are swamps, bogs, and fens. Marshes can be defined as "wetlands frequently or continually inundated with water, characterized by emergent soft-stemmed vegetation adapted to saturated soil conditions" (USEPA Website). Marshes receive most of their water from surface water or groundwater. They tend to have plentiful nutrients and neutral pH levels, and thus generally support an abundance of plant and animal life, including a number of rare plant and animal species. Non-tidal marshes, most of which are freshwater marshes, are the most prevalent and widely distributed wetlands in North America (USEPA Website).

Wetlands are often called "nurseries of life" because they provide habitat for thousands of species of aquatic and terrestrial plants and animals. Wetlands support critical developmental stages for many species, and important habitat for waterfowl, fish, and mammals. Migrating birds also use wetlands to rest and feed during their long-distance journeys, as well as for nesting habitat after their migrations. Marshes in general are important for their role in recharge of groundwater supplies, moderation of high water

flows, settling out of sediments and pollutants, and biological filtering of excess nutrients. Freshwater marshes tend to have high levels of nutrients that can support a wide array of plant communities that in turn support "a diversity of life that is way out of proportion with its size." Wetlands on the margins of lakes and streams can protect shorelines and stream banks from erosion because wetland plants hold the soil with their roots and absorb the energy of waves (USEPA Website).

Wetland plants perform critical functions in the ecology of a wetland. They provide breeding and nursery sites, and refuge from predators, for many animal species from amphibians and reptiles to birds and fish. Decomposing plant material (detritus) in the water is food for many invertebrates and fish both in wetland and adjacent aquatic habitats (NCSU Website). The invertebrates in turn feed amphibians, reptiles, fish, and birds, and so on.

5.2 OBJECTIVES

Project management and operations have the potential to affect wetland habitats within the Project area. The abundance and distribution of wetland vegetation within the Thermalito Complex is based on water surface elevations that fluctuate with Project operations. The objectives of this study were to:

- describe current wetland conditions within the Project area
- evaluate potential effects of project operations on wetland habitats

5.3 METHODS

5.3.1 <u>Review existing information</u>

5.3.1.1 Vegetation Mapping

The distribution of wetland vegetation within the Project area was obtained from SP-T4 (CDWR 2003). Elevational data for the Thermalito Afterbay was used to determine vegetation patterns within contours. The acreage of exposed mudflats, or mud shores, around the Afterbay was calculated using ArcView GIS software to determine the area between the 127 ft elevation contour and the wetland vegetation along the lakeshore extracted from the SP-T4 spatial data.

5.3.1.2 Review wetlands and special status species

Wetland habitats have the potential to support a number of special status plant and animal species. Information from SP-T2: *Special Status Plant Species – Draft Final Report* (CDWR 2004 [2]) and SP-T2: *Special Status Wildlife Species – Draft Final Report* (CDWR 2004 [3]) was reviewed to determine special status species abundance

and distribution within the Project's wetlands. SP-T1: *Project Effects on Wildlife and Wildlife Habitat – Draft Final Report* (CDWR 2004 [4]) was reviewed for project effects on wildlife and wetland habitats.

5.3.1.3 Review wetlands and noxious/invasive weeds

Wetland habitats can be negatively impacted by noxious/invasive weed. SP-T7: *Noxious/Invasive Plant Species – Draft Final Report* (CDWR 2004 [5]) was reviewed to determine which species may impact wetlands habitats within the Project area.

5.3.1.4 Review reservoir operations

The operations of the Oroville Facilities in the form of water releases and pump-back operations vary seasonally, weekly and hourly. Project operations were reviewed with regard to fluctuating water levels both within the Thermalito Complex and in Lake Oroville (CDWR 2004 [6]).

5.4 RESULTS

5.4.1 Review existing information

5.4.1.1 Vegetation mapping

The total number of wetland vegetation mapped within the Project area is 912 acres. The distribution and amount in acres of the various wetland vegetation plant associations is shown in Table 5.4-1. Wetland vegetation around the Thermalito Afterbay accounts for 94% of the wetland vegetation within the Project area (Appendix D). The wetland vegetation reported here for the Thermalito Forebay exists around a number of small springs located upslope of the Forebay. Although wetland vegetation does exist around the margin of the Forebay, it was intermixed with riparian tree and shrub vegetation, thus was mapped under the appropriate riparian woodland or riparian shrubs categories. The small amount of wetland vegetation around Lake Oroville occurs mostly just above the high-water shoreline, and is associated with seeps and springs that are a natural part of the landscape apart from any shoreline effects (Appendix C). The very small amount of wetland vegetation around the Diversion Pool is similar to that around Lake Oroville (Appendix D). Approximately 42 acres of wetland vegetation was mapped within the Oroville Wildlife Area. Much of this occurs in and around One Mile Pond (Appendix B).

Table 5.4-1. Acreages of wetland vegetation types for major Project features.

	Afterbay	Forebay	Diversion Pool	Lake Oroville	OWA
Bulrush	<1	0	0	0	0
Cattail	<10	0	0	0	<1
Mixed emergent	234	10	0	<1	42
Rush	381	<1	0	<1	0
Rush/verbena	201	0	0	0	0
Verbena	36	<1	0	0	0
Seep/wet area	0	0	<1	6	0
Totals	**852**	**11**	**<1**	**6**	**42**

Around the Thermalito Afterbay, distinct patterns of wetland vegetation associations are observed (Appendix D). The lowest band of vegetation around the Afterbay shoreline that remains inundated the longest is dominated by Pacific rush or common rush (*Juncus effuses*), an obligate wetland species. This band generally starts between 128 ft and 129 ft elevation, although it can occasionally be found as low as 127 ft elevation. The upper elevation for this band is generally about 131 ft elevation where it transitions into the rush/verbena association. This vegetation is characterized by a mixture of Pacific rush or common rush, an obligate wetland species, and vervain [halberd-leaved vervain (*Verbena hastata*), seashore vervain (*Verbena litoralis*), or South American vervain (*Verbena bonariensis*)], facultative wetland species. This vegetation mostly extends up to 134 ft to 135 ft elevation, which is the high water line for the Afterbay, where it most often borders the dry land upland vegetation. Occasionally there is a narrow band of open riparian shrub and tree vegetation between the rush/verbena vegetation and the upland vegetation. In some places where the area of shallowest inundation is relatively broad, mixed emergent vegetation is found. These areas usually contain three or more equally dominant species or were areas that we were unable to discern what species were present from the aerial photography and no field data was available (CDWR 2003). A plant species of concern, four-angled spikerush (*Eleocharis quadrangulata*), an obligate wetland species, was most often found within wetland emergent vegetation.

Five waterfowl brood ponds exist in five inlets of the Afterbay. These ponds are contained by small earthen dams to maintain a relatively stable water surface elevation to allow the establishment of emergent vegetation and submerged aquatic habitat for enhanced waterfowl production. Four of these brood ponds are recharged during periods of Afterbay high water (134.1 ft or higher). The fifth brood pond is at an elevation slightly higher than the Afterbay waters can recharge it. Water can be pumped into this pond when the Afterbay level is 134.1 ft or higher. Four of the five ponds do not appear to have changed the distribution or extent of the wetland plant associations around the Afterbay. However, construction of the fifth brood pond

appears to have increased the amount of mixed emergent vegetation from 4.4 acres to 26.1. This results from the pond surface being higher than the Afterbay high water surface level, and the broad shoreline margin of the brood pond that is now mixed emergent vegetation was previously upland vegetation.

The acreage of mudflats, or mud shores, around the Afterbay is 222 acres. This is the area between the 127 ft elevation, below which the ground surface is inundated continually for most of the year, and the wetland vegetation, which generally starts between 128 ft and 129 ft elevation and continues up to the high water line at about 135 ft. This area of mudflats is the area that is exposed for some period of time on a weekly basis as a result of the peak power generating and pump-back operations. The creation of the two northern-most waterfowl brood ponds discussed above changed about 16.4 acres of mudflat into open water.

5.4.1.2 Review wetlands and special status species

Plants: Two special status plant species are associated with wetland emergent vegetation around the Afterbay: four-angled spikerush (*Eleocharis quadrangulata*) and Sanford's arrowhead (*Sagittaria sanfordii*). Within the Thermalito facilities, one small occurrence of four-angled spikerush occurs along the northern shore of Thermalito Forebay, and many large and small occurrences are found along the northern and eastern shores of Thermalito Afterbay. Four-angled spikerush is most abundant within all of the waterfowl brood ponds, where the water level is more stable than around the rest of the Afterbay. It is also often found in natural shallow hollows near the lake shore (often former vernal drainage swales and vernal pools) that also retain water when the water level in the Afterbay drops. Four-angled spikerush is mostly a component of the mixed emergent vegetation association. Sanford's arrowhead is only known from one location within the Project area. It is located within one of the brood ponds of the Afterbay, where it is growing at the transition between the rush and rush/verbena vegetation associations.

Wildlife: Wildlife habitat was assessed for potential species richness for all habitat types occurring within the Project area in SP-T4 (CDWR 2003). The California Wildlife Habitat Relations Analysis (WHR) predicts that 157 species make use of the freshwater emergent wetland habitat type – 11 amphibian species, 10 reptiles, 106 birds, and 30 mammals. The average Habitat Suitability Value for these 157 species is 0.50 (on a scale from 0 to 1). This compares with the lowest predicted species richness within the Project area of 23 species for the relatively uncommon evergreen orchard WHR habitat type and a high of 259 species for the valley foothill riparian habitat type (with a Habitat Suitability Value of 0.50). Of particular interest are 12 wildlife species that are almost completely restricted to the freshwater emergent wetland habitat type. These are American bittern, Clark's grebe, eared grebe, least bittern, marsh wren, pied-billed grebe, redhead, ring-necked duck, ruddy duck, sora, Virginia rail, and western grebe.

Of these, the American bittern is a Migratory Non-game Bird of Management Concern. Of the special status wildlife species with the potential to occur in the immediate project vicinity, 23 species of birds and 3 species of amphibians and reptiles are predicted to occur in the freshwater emergent wetland habitat type, 12 of the bird species and 3 of the amphibians and reptiles with 0.50 or greater Habitat Suitability Values (Table 5.4-2).

Table 5.4-2. Habitat suitability Values for special status wildlife species with potent to occur in the immediate project vicinity and to occur in freshwater emergent wetland (WHR) habitat type (on a scale from 0 to 1).

Species with Habitat Suitability Values greater than 0.50	Species with Habitat Suitability Values less than 0.50
American bittern	bank swallow
American peregrine falcon	California gull
black tern	double-crested cormorant
black-crowned night heron	ferruginous hawk
greater sandhill crane	golden eagle
long-billed curlew	merlin
northern harrier	osprey
short-eared owl	prairie falcon
snowy egret	purple martin
tricolored blackbird	southern bald eagle
western least bittern	Vaux's swift
white-faced ibis	
California red-legged frog	
western spadefoot toad	
northwestern pond turtle	

Although not a complete survey, a record was made of all wildlife species observed by habitat type during the course of the wildlife field studies (CDWR 2003). Throughout the Project area, 76 species were observed in the freshwater emergent wetland habitat type (2 amphibian species, 2 reptiles, 66 birds, and 6 mammals). Seventy of these wildlife species were observed in the wetlands around the Afterbay (CDWR 2004 [4]). Mudflats accounted for 13 species of migratory shorebirds, including 3 special status species: black tern, California gull, and white-faced ibis. The wetland margin (freshwater emergent wetland) has documented sightings of 25 species of wildlife: 5 mammal species, 14 bird species, 2 amphibian species, and 4 reptiles; including 2 special status species: northern harrier and short-eared owl. Presence in both habitats was documented for 32 species of wading birds and other waterfowl, including 3 special status species: American bittern, black-crowned night heron, and snowy egret. The wildlife habitats created by construction and operation of the Afterbay have resulted in one of the most diverse wildlife assemblages within the project area, although some

species that use the emergent vegetation for nesting and brooding can be adversely impacted by water level fluctuations. The five waterfowl brood ponds around the Afterbay provide a more stable water level in order to improve the productivity of the species that are adversely impacted by water level fluctuations.

In addition, emergent vegetation is potentially suitable habitat for California red-legged frog and giant garter snake, both federally and State listed species. Similar potential habitat is also present around the Forebay. Waterfowl brood ponds around the Afterbay also provide improved potential habitat quality for the giant garter snake. Neither of these species has been observed within the Project area.

5.4.1.3 Review wetlands and noxious/invasive weeds

A number of noxious weeds and non-native invasive species are found near the Thermalito Afterbay, Forebay, and Diversion Pool. Those species of particular concern to wetland vegetation are purple loosestrife (*Lythrum salicaria*), giant reed (*Arundo donax*), and scarlet wisteria (*Sesbania punicea*) (CDWR 2004 [5]).

Of greatest concern is purple loosestrife. It is frequent and abundant, growing within the wetland vegetation around the edges of the Afterbay (Table 5.4-3). Although frequent around the edges of the Forebay and scattered along the Diversion Pool, the Department of Parks and Recreation (DPR) has an active control program in place. The frequent water level fluctuations within the Afterbay have apparently created optimal conditions for rapid invasion by purple loosestrife, in addition to creating suitable conditions for the wetland vegetation now established there. Various efforts have been undertaken in the past several years to decrease the amount purple loosestrife around the Thermalito Facilities. Treatments by DPR around the Forebay and Diversion Pool has resulted in a reduction in number of plants though not a reduction in shoreline distribution. The California Department of Fish and Game (DFG) treated purple loosestrife around the Afterbay although no monitoring of effects on the loosestrife or on the wetland species has been conducted (CDWR [5]). Treatments to control purple loosestrife typically involve the use of herbicides, which can also have impacts to the native wetland plant species with which it grows and then also to the wildlife species that require wetland vegetation for part or all of their life cycles.

Table 5.4-3. Acreages of purple loosestrife within wetland vegetation associations around the Thermalito Afterbay.

Vegetation association	Acres
Mixed emergent vegetation	7
Rush	42
Rush/verbena	22
Verbena	<1
Total	72

Giant reed is found growing within the wetland vegetation around the Afterbay at 45 sites covering only 0.5 acres. None was found around the Forebay and Diversion Pool. It is a slower growing species that does not appear to be rapidly spreading in the Project area. Giant reed is a much larger, taller, and denser plant than the loosestrife, and has the potential to completely crowd out any other vegetation. There are no management efforts currently directed towards this species in the Project area.

Scarlet wisteria is found at 18 occurrences around the edges of the Forebay for a total of 31 plants. None were found around the Afterbay and Diversion Pool. This species is common along a portion of the low flow channel of the Feather River and in scattered locations in the OWA. DPR is currently treating the scarlet wisteria around the Forebay.

5.4.1.4 Review reservoir operations

The Oroville power production operations generate hydroelectric energy and provide other benefits to the State power grid. Except for water released from Lake Oroville specifically for the daily peak power generation and pump-back cycle, power is generated using the water released for flood management, downstream environmental and water quality concerns, and water supply operations. Water released for daily peak power generation and pump-back results in minimal water level change in Lake Oroville and in the Thermalito Diversion Pool, Power Canal, and Forebay, but results in a weekly cycle of water level fluctuation in the Thermalito Afterbay. Other releases of water from Lake Oroville result in an extreme annual cycle of water level change in Lake Oroville, but result in a fairly consistent water level in downstream facilities (Thermalito Diversion Pool, Power Canal, and Forebay).

Water released from Lake Oroville passes through the Hyatt Pumping-Generating Plant into the Thermalito Diversion Pool. Some water in the Thermalito Diversion Pool supplies the Feather River Fish Hatchery at the Thermalito Diversion Dam, some water passes through the Thermalito Diversion Dam Powerplant into the Feather River, and most passes into the Thermalito Power Canal. The Thermalito Power Canal conveys water to (and from) the Thermalito Forebay. Water in the Thermalito Forebay passes through the Thermalito Pumping-Generating Plant into the Thermalito Afterbay. The

Thermalito Afterbay Outlet regulates water releases into the Feather River (CDWR 2004 [6]).

The Hyatt Pumping-Generating Plant and the Thermalito Pumping-Generating Plant can pump water back into Lake Oroville and back into the Thermalito Forebay, respectively, and the Thermalito Power Canal can flow either direction between the Diversion Pool and the Forebay depending on whether the pumping-generating plants are generating power or pumping water. The two pumping-generating plants work in tandem, either generating power or pumping water, so that water between them in the Diversion Pool, Power Canal, and Forebay are all maintained at approximately the same elevation at all times. As mentioned earlier, except for pump-back operations and daily peak power generation, the water used for power generation is being released from Lake Oroville for flood management, downstream environmental and water quality concerns, and water supply operations. Water above this amount, released for daily peak power generation, is stored in the Afterbay until it can be pumped back into the Forebay and thence pumped back into Lake Oroville during times of off-peak power needs in the power grid on week nights and especially on weekends.

Lake Oroville. During the course of a “normal” year, the water level of Lake Oroville fluctuates more than 100 feet, with about 250 feet being the most it has ever fluctuated. Annually, the lowest water levels occur in the fall, the highest in late spring which is the main growing season for most plants. Full reservoir is at 900 ft elevation with a surface area of about 15,800 acres and 167 miles of shoreline. There are few natural sources of water along the reservoir shoreline during the drawdown period; springs and seeps are found in scattered locations but are uncommon features of the area.

Thermalito Diversion Pool. The Diversion Pool is contained within the natural steep-sided and mostly rocky canyon of the Feather River between Oroville Dam and the Thermalito Diversion Dam. The pool elevation remains fairly constant throughout the year, only varying about 2 ft within a range of 222.5 ft to 224.5 ft. Pool surface area is about 260 acres.

Thermalito Power Canal. The 10,000 ft long Power Canal is concrete lined for about 80% of its length, connecting the Diversion Pool to the Thermalito Forebay. It is designed to convey water from the Diversion Pool to the Forebay, which can flow back upstream to the Diversion Pool during pump-back operations. Water level is similar to that in the Diversion Pool and the Forebay, though it may vary 4-6 ft depending on flow conditions. Water surface area is about 32 acres.

Thermalito Forebay. The Forebay is an off-stream reservoir contained by a 19,500 ft long earth-fill dam. Roughly half of the shoreline of the reservoir has a rip-rapped bank. The pool elevation remains fairly constant throughout the year, only varying about 3.5 ft within a range of 221 ft to 224.5 ft. Pool surface area is about 560 acres.

Thermalito Afterbay. The Afterbay is an off-stream reservoir contained by a 42,000 ft long earth-fill dam with rip-rapped surfaces along the western and southern banks. In contrast to the minimal water level fluctuations in the Forebay and the Diversion Pool, the Afterbay experiences extensive weekly fluctuations in water level. This is because the Afterbay is operated as a temporary storage pool for pump-back operations. Water level fluctuation can be up to 12 ft, within a range of 124 ft to 136 ft, although the usual range is 8 ft, from 127 ft to 135 ft elevation. Total shoreline, which is quite convoluted by numerous inlets and bays, is about 250,000 ft and pool surface area is about 4000 acres.

5.5 DISCUSSION

The wet margin of the Afterbay has resulted in the development of extensive wetland vegetation. This benefits numerous wildlife species, especially, birds, reptiles, and amphibians, including several wildlife species of concern. Fluctuating water levels create conditions specific to the particular wetland vegetation associations found around the Afterbay. This wetland vegetation includes two special status plant species. Fluctuating water levels can also have negative impacts on nesting wildlife. Nests constructed within wetland vegetation when the water level is high become accessible to terrestrial animal predators when the water level drops. Conversely, nests built in wetland vegetation when water levels are low may be flooded when water levels rise. Some stranding of nests has been seen during drawdown periods but no abandonment or predation losses have been observed. However, high water levels have resulted in losses of waterfowl eggs. A number of wildlife brood ponds have been constructed within inlets of the Afterbay to provide areas with more steady high water levels to nesting wildlife. These brood ponds also appear to provide improved habitat for the two special status plant species. Sanford's arrowhead is only found here in one brood pond, and the other (four-angled spikerush) is most abundant in the brood ponds. Testing of alternative fluctuation regimes have been conducted with a resulting increase in reproductive success in monitored waterfowl species (CDWR 2004 [4]). Some of this success is due to less stranding of nests of some species during brooding, but other success came from more high water encouraging nest building higher than the inundation zone.

Any changes to the current operation of water levels within the Afterbay will result in a mixed bag of effects to vegetation and wildlife. Higher water levels for a longer period of time may improve nesting success by some species that build nests within the wetland vegetation, but may result in a narrowing of the band of wetland vegetation due to more extensive inundation. Other wetland species (such as cattails and bulrush) may be able to take advantage of the more flooded conditions, possibly resulting in an overall increase of wetland vegetation (or not), with a probable shift in what wildlife species are favored. Mudflat acreage would decrease under such conditions, resulting in a decrease in wildlife species that require that habitat. Lower water levels or greater levels of water fluctuation could cause similar shifts in wetland vegetation and wildlife.

Also, while short-timeframe changes in water level or fluctuation levels may cause only minimal changes in vegetation and wildlife use, longer-timeframe changes will result in greater changes to the wetland vegetation and wildlife. Illustrations of the importance of studying possible changes in water management in the Afterbay may be seen in comparing the amount of wetland vegetation around the Afterbay with the amount of wetland vegetation around the Forebay and around Lake Oroville. The Forebay has a relatively steady water level throughout the year, although it does have a narrow strip of wetland vegetation along the shore, riparian tree and shrub species also are present and inhabit most of the wet shore margin. Lake Oroville, with its water level fluctuating dramatically over the course of a year, has essentially no bordering wetland vegetation. Possible changes in distribution and abundance of noxious weeds in response to changes in water regime is also of concern. Thus, any change in operations management that affects water levels and the timing of water fluctuations needs to be carefully assessed for possible resulting changes in wetland vegetation composition and distribution as well as potential changes in wildlife suitability from the changed water regime and changed vegetation.

6.0 TASK 3 – SHORELINE VEGETATION AROUND LAKE OROVILLE

6.1 INTRODUCTION

Lake Oroville is located within the foothills of the northern Sierra Nevada. The majority of vegetation around the lake above the full-pool elevation consists of a variety of drought tolerant mixed oak woodlands, foothill pine/mixed oak woodlands, and oak/pine woodlands with a mosaic of chaparral (Figure 6.1-1) (CDWR 2003). The upper arms of the North, Middle, and South Forks of the lake, especially the north-facing slopes, transition into the mixed conifer forests more typical of middle elevations of the Sierra Nevada. Native riparian habitats were, and still are, restricted to narrow strips along drainages, consisting mostly of alders, willows, and occasional cottonwoods and sycamores (Figure 6.1-2).

Figure 6.1.1. Typical vegetation above the Lake Oroville shoreline.

Figure 6.1-2. Strips of riparian vegetation along drainages around Lake Oroville.

Reservoir drawdown zones provide a challenging environment for establishment and long-term survival of plants in general and woody vegetation in particular. In parts of the U.S. where there is adequate moisture, there are numerous techniques available for establishing vegetation within reservoir drawdown zones. However, in many areas of the western U.S., conditions are problematic due to extensive annual fluctuation between wet and dry periods. The Mediterranean climate that dominates much of California, including the Project area, has a rainy (or snowy) period that starts sometime in the fall and continues into the spring, followed by an extended dry period. Reservoirs are built not only for flood control but to provide a more constant source of water for urban and agricultural uses. A consequence of this is drawdown zones that are inundated during the winter and spring months and dry during the summer months. In drier years, the reservoir may not ever reach full capacity, resulting in a band below the full pool water elevation that may not receive any moisture after the rainfall evaporates.

Western reservoirs are generally located in deep canyons where the steep slopes are vastly dominated by upland vegetation; often woodland, forest, and chaparral. Soils are usually shallow on these slopes and subsurface recharge is slight. Year-round water may be found in the larger rivers and creeks in the bottoms of the canyons, which may also support narrow bands of riparian vegetation. Only seasonal water is available in the smaller drainages. Seeps and springs are generally widely scattered but only account for a very small acreage. Thus, the annual fluctuation of water levels in reservoirs hinders the establishment of riparian and other perennial vegetation within the drawdown zone.

As is typical for western reservoirs, there is little vegetation within Lake Oroville's drawdown zone. Lake Oroville is a large reservoir, with 167 miles of shoreline at its full pool elevation of 900 feet. The configuration of the reservoir limits the number of locations where vegetation can establish. Much of the reservoir's sides are steep and rocky, with very little soil. The upper reaches of the reservoir are located in deeply incised canyons. Constant wave action results in continual soil erosion that also hinders plant establishment. The overall result is that the reservoir shoreline and drawdown zone is predominantly bare soil and rock (Figure 6.1-3).

Figure 6.1-3. Lake Oroville reservoir shoreline.

Additional vegetation within this zone, especially woody plants, would have the positive effects of increasing wildlife habitat; increasing fish habitat complexity and enhancement of bass-friendly shoreline habitat (when inundated); reduce shoreline erosion and the need for shore stabilization structures; and greatly improve the aesthetic qualities of the shoreline.

6.2 OBJECTIVES

Project-related water level fluctuation hinders the establishment of riparian vegetation within the drawdown zone of Lake Oroville. Enhanced vegetation within the drawdown zone would increase riparian habitat for wildlife and fisheries, as well as improve the aesthetic quality of the shoreline. The objectives of this study are to:

- Identify conditions that facilitate the establishment of perennial vegetation within the Lake Oroville drawdown zone
- Identify locations where enhancement measures could reasonably be expected to result in successful establishment of perennial vegetation within the drawdown zone

6.3 METHODS

6.3.1 <u>Compile and review existing information</u>

6.3.1.1 Review vegetation mapping

The distribution of riparian vegetation within the drawdown zone of Lake Oroville was obtained from SP-T4 (CDWR 2003). However, the aerial photography that was used for this vegetation mapping study was flown at a time when the lake levels were close to the full pool elevation of 900 feet. Thus much of the existing vegetation within the

drawdown zone was not visible and was incompletely mapped. Additional photography that was flown for Cultural Resource studies was used to asses and remap the trees and shrubs within the drawdown zone. These photos were taken in October 2003 when the lake level was at 730 feet. Field surveys were conducted to determine species composition. All trees and shrubs within the 730 foot water elevation to the 900 foot full pool level were then remapped using Geographical Information System (GIS) software.

The slopes in the canyons, especially the North Fork, most of the Middle Fork, and the upper ends of the South Fork and West Branch, are all quite steep and rocky, often with a slope of more than 100% (45 degrees). These areas were, for the most part, excluded from the mapping since they are rocky, inaccessible, and tend to not support moisture-dependent vegetation.

6.3.1.2 Review riparian establishment and survival criteria

A potential species list was researched and prepared listing those species that are native to the Lake Oroville area and have potential to survive under the harsh conditions presented within the drawdown zone. A literature review was conducted on western riparian vegetation processes to identify specific establishment criteria for dominant native plant species relevant to survival within the reservoir shore's extreme water fluctuations. Literature was reviewed in relation to other western reservoirs and riparian/vegetation plantings within reservoir drawdown zones.

6.3.1.3 Review previous efforts to establish vegetation within the Lake Oroville drawdown zone

The Department of Fish and Game, the Department of Parks and Recreation, and the Department of Water Resources have planted native trees within the drawdown zones since the 1970s. Vegetation Retention Areas (areas within the reservoir where trees were left standing prior to the filling of the reservoir) and artificial fish habitat structures are also found in this area. Site selections, species, and methodologies were reviewed as well as successes and failures.

6.3.1.4 Review reservoir operations

The operations of Lake Oroville were reviewed, with regards to yearly and monthly water levels as well as weekly and daily water level changes due to power generation and irrigation releases.

6.3.2 <u>Constraints to enhancement</u>

Based on current plantings success and vegetation maps, it was determined that only slopes of 15%or less would be identified for enhancement. Maps of potential planting

areas based on percent slope were prepared using GIS software (ArcView plus Spatial Analyst). The area below the 900 foot contour level was divided into a grid of 10 m by 10 m cells. The slope within each cell was calculated from a digital file of the elevation contours within Lake Oroville using a Digital Elevation Model (DEM). Slopes of less than 10% and slopes between 10% and 15% were identified.

To help identify potential enhancement locations, the following information was combined for analysis:

- the reservoir inundation zone between the 850 ft and 900 ft contours
- slopes of 10% or less and slopes between 10% and 15% within the inundation zone
- vegetation mapped within this zone, including Vegetation Retention Areas
- locations of recreational facilities (potential water sources and areas where aesthetic concerns would be greatest)

6.4 RESULTS

6.4.1 Review existing information

6.4.1.1 Vegetation mapping

Most of the vegetation below the 900 foot elevation was removed prior to the filling of the reservoir. The remainder of the shoreline is mostly barren with the exception of approximately 175 acres of sparsely vegetated shoreline. Native willow (*Salix* sp.), buttonbush (*Cephalanthus occidentalis*), and other perennial riparian vegetation (Table 6.4-1) were mapped within the fluctuation zone of Lake Oroville (Figures 6.4-1 – 6.4-8). Approximately 142 of the 175 acres of vegetated areas within the drawdown zone occur above the 840 foot elevation and many are within areas of less than 15% slope.

Other herbaceous vegetation occurs sporadically within the drawdown zone ranging from 0.2 to 7 acres in size. Some small drainages have a near year-round water supply and support various wetland/riparian species, including an occasional sycamore (*Platanus racemosa*). A variety of native and non-native annual grasses and forbs occur sporadically after rains, but die back as the season progresses. Cocklebur (*Xanthium stumarium*), a native weedy species, was observed covering a few slopes. The special status plant species and noxious weed surveys noted rhizomatous sedge (*Carex aquatilis*, *C. barbarae, and C. nudata*) growing within the upper 10-30 feet of the inundation zone near spring-fed drainages. Clumps of perennial rush (*Juncus effuses*) and the rhizomatous Baltic rush (*J. balticus*) were also noted within and near the top of the drawdown zone. All of these species need a year-round source of moisture for survival.

Table 6.4-1. Distribution of riparian vegetation around Lake Oroville by dominant species.

Species	Acreage*
Willows	138
Buttonbush	20
Unknown	16
Cottonwood and Sycamore	1
*Acres portrayed here are sparsely vegetated	

The areas around Lake Oroville with the greatest concentrations of riparian vegetation are shown in Table 6.4-2.

Table 6.4-2. Areas of Lake Oroville drawdown zone with the greatest concentrations of riparian species.

Locality	Dominant species	Acres
Foreman Creek/Main Stem	Willows	25
Montgomery Bar Ravine/Middle Fork	Willows	22
Oregon Gulch/South Fork	Willows	18
Loafer Creek, Main Stem	Willows	15
Potter Ravine/ Main Stem	Buttonbush/willows	13
McCabe Ravine/South Fork	Willows	10
Stringtown Boat Ramp/South Fork	Willows	8
Sycamore Creek/Main Stem	Buttonbush/willows	6

6.4.1.2 Review riparian establishment and survival criteria

Few species can withstand inundation for periods of time typical within the drawdown zone of Lake Oroville as well as the dry harsh conditions of summer and fall. However, native willows are noted in the literature as able to withstand long periods of inundation much better than other riparian species such as native cottonwoods. Fremont cottonwoods (*Populus fremontii*) in general do not do well when inundated for extended periods. Willows and buttonbush have survived within the Lake Oroville drawdown zone, mostly above the 850 foot elevation (CDWR 2003 [1]).

In this area, naturally occurring riparian species are typically restricted to relatively moist locations along streams, rivers, and lakes or other types of wetlands where soils are present and slopes are gentle. Seedling establishment requires a moist ground surface for seed germination. The recession of the ground water levels should not exceed that at which the roots can grow to keep up with declining water levels. Excavation of seedlings of Fremont cottonwood on the Sacramento River indicates an average rate of

growth of 22 mm/day (.9 in/day) and a maximum of 32 mm/day (1.3 in/day) during the initial growing period or 50 days after germination (TNC 2002).

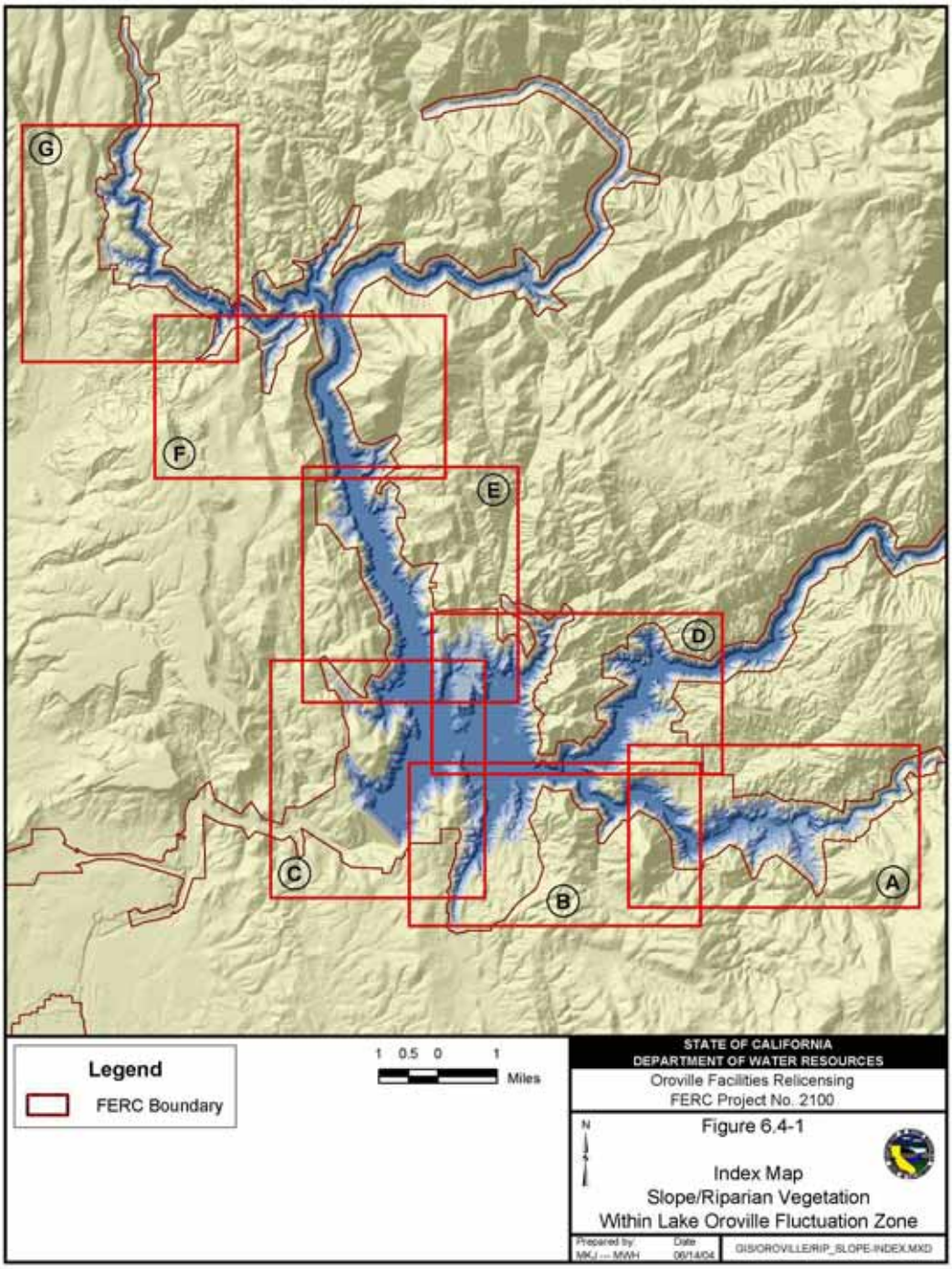

Figure 6.4-1. Index Map. Slope/riparian vegetation within Lake Oroville Fluctuation Zone.

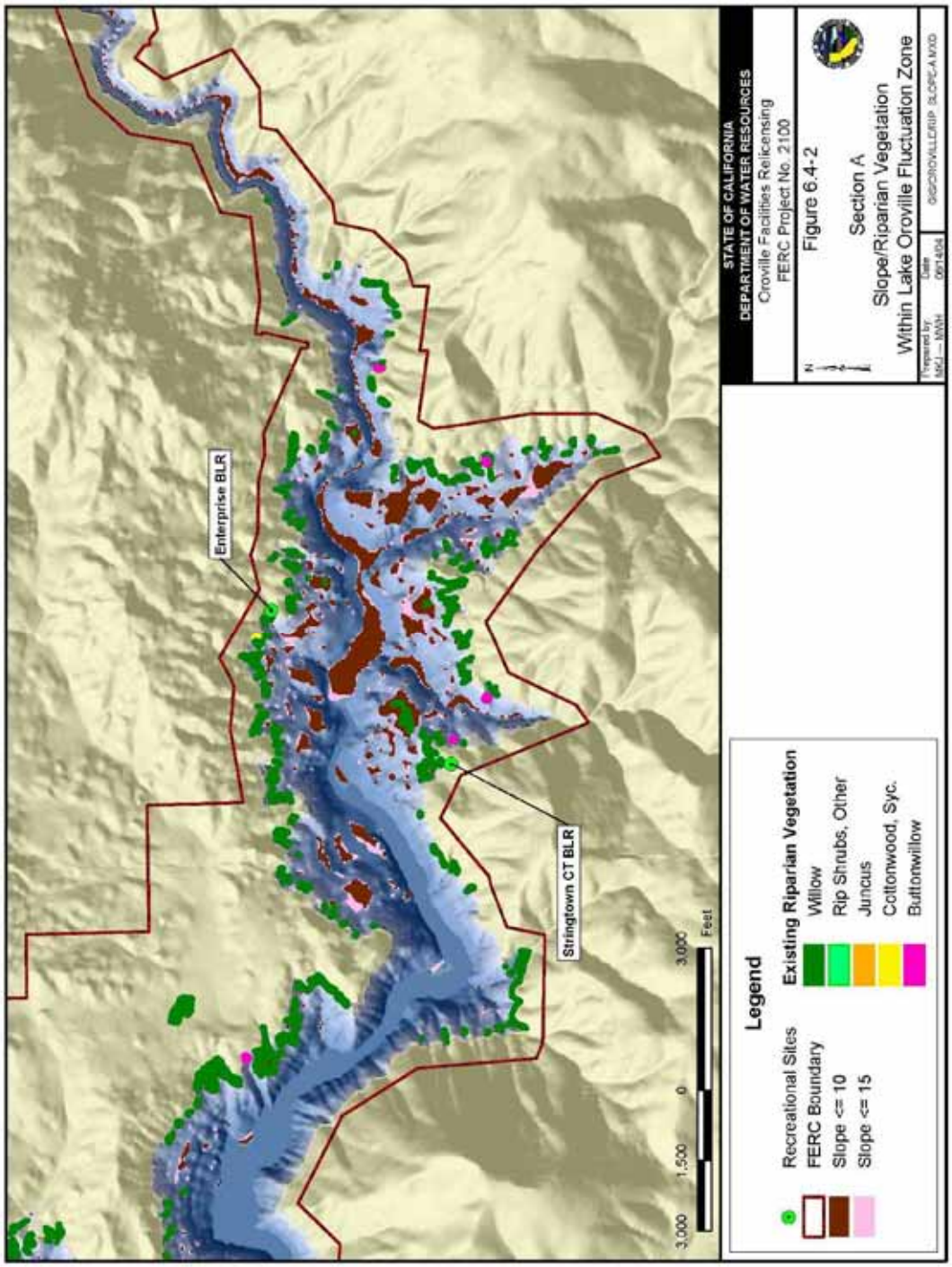

Figure 6.4-2. Slope/riparian vegetation within Lake Oroville fluctuation zone. South Fork.

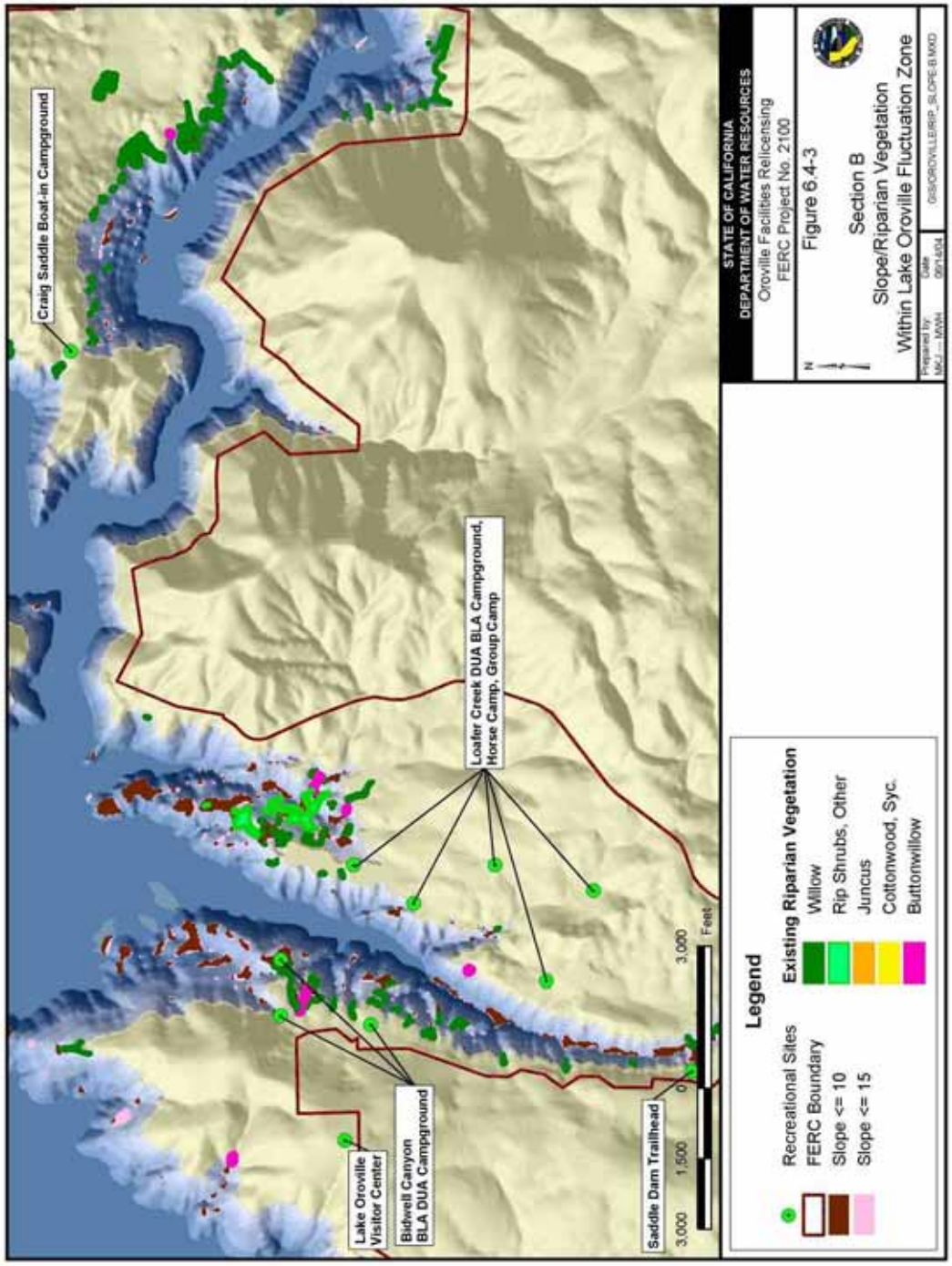

Figure 6.4-3. Slope/riparian vegetation within Lake Oroville fluctuation zone. South Fork and Bidwell Marina.

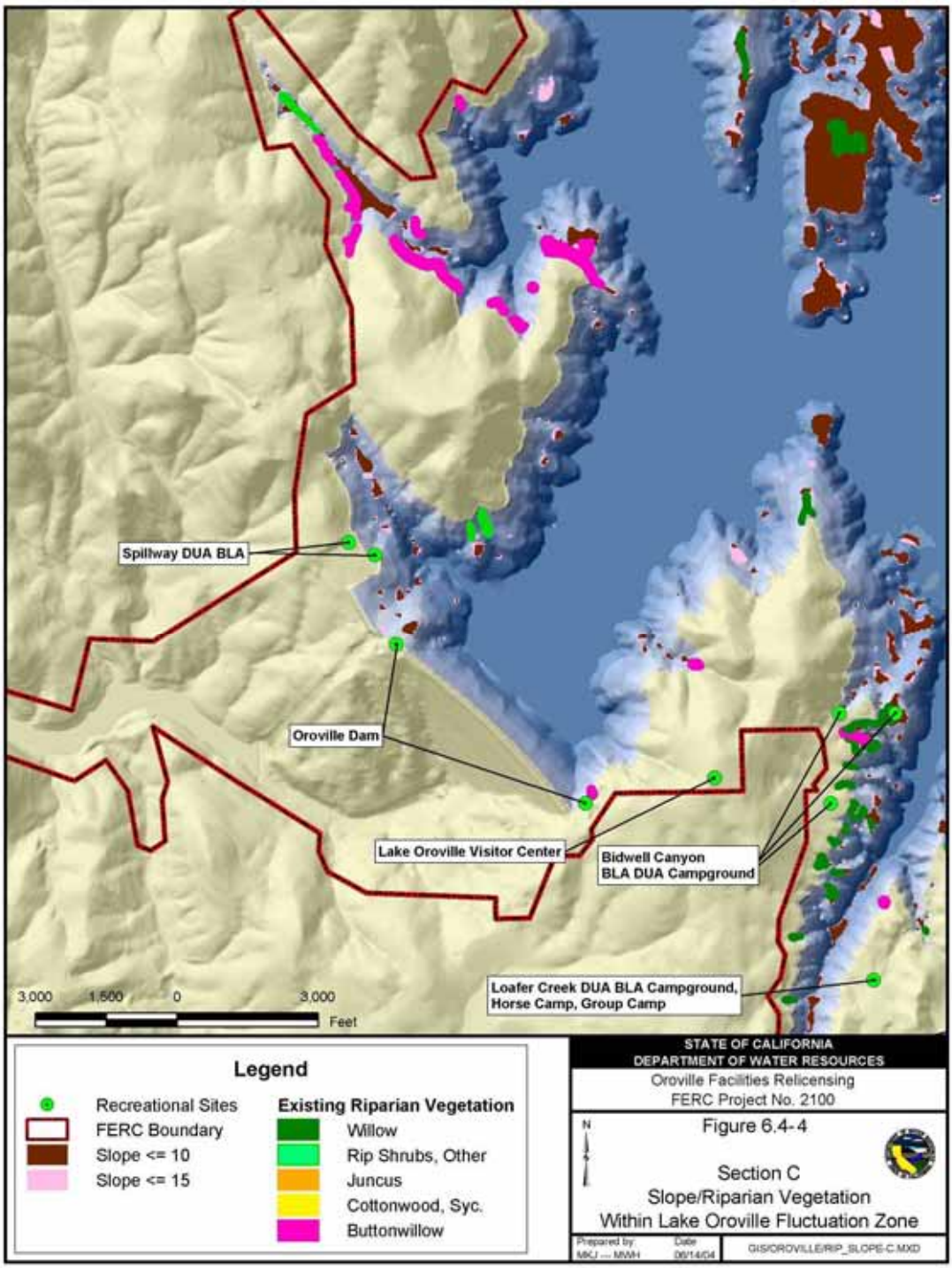

Figure 6.4-4. Slope/riparian vegetation within Lake Oroville fluctuation zone. Oroville Dam.

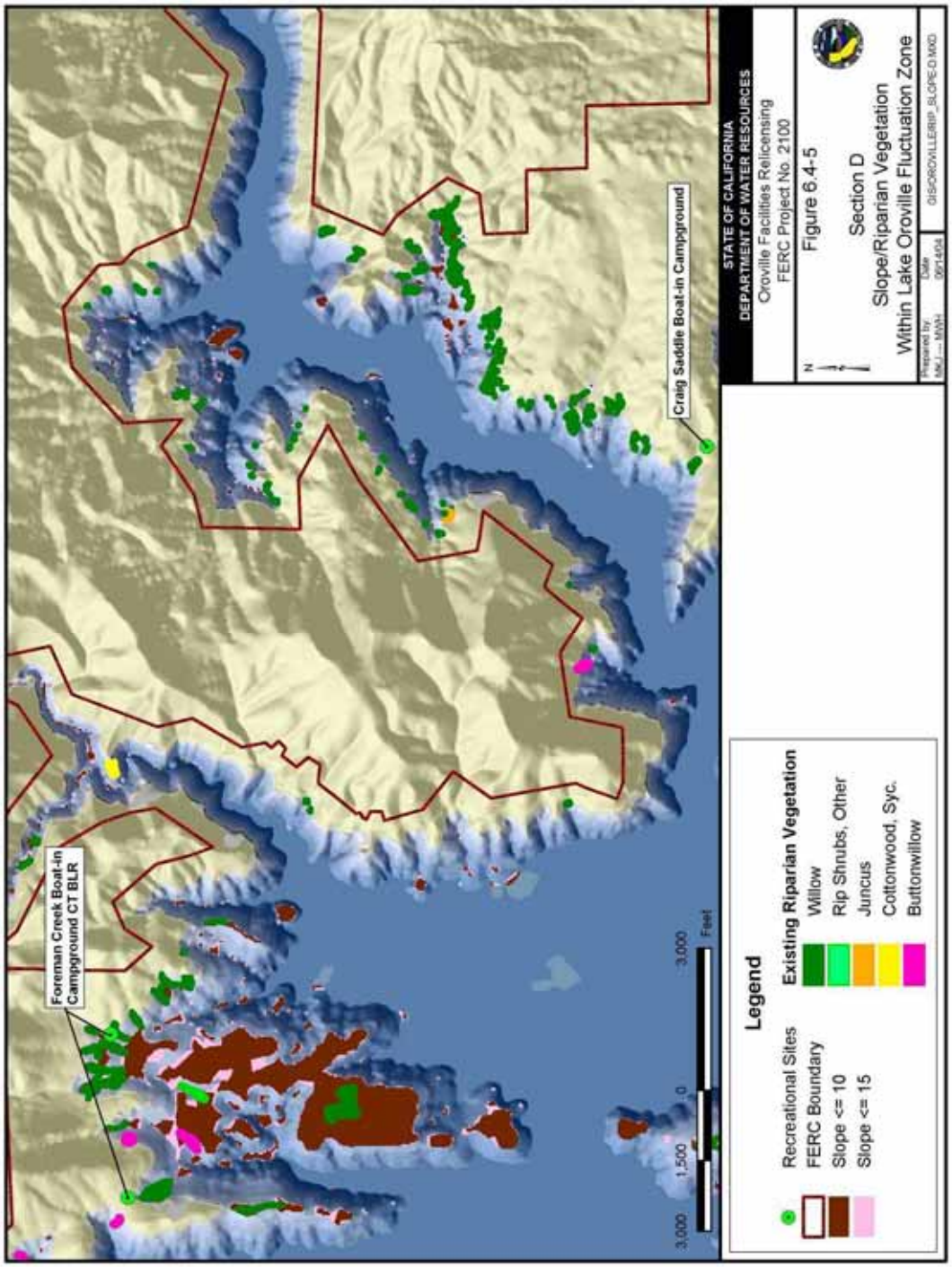

Figure 6.4-5. Slope/riparian vegetation within Lake Oroville fluctuation zone. Middle Fork and Foreman Creek Recreation Area.

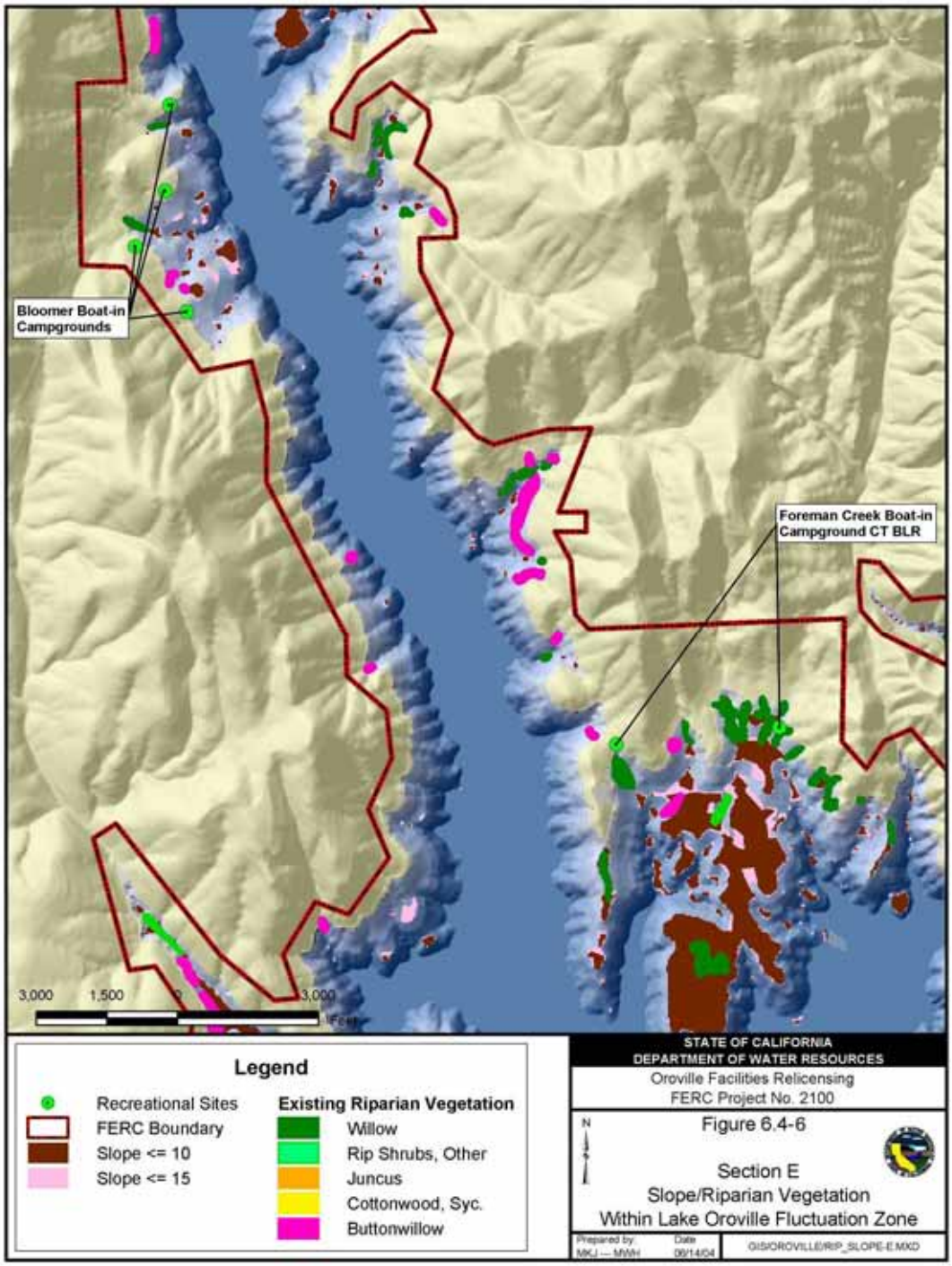

Figure 6.4-6. Slope/riparian vegetation within Lake Oroville fluctuation zone. Main Stem above Oroville Dam.

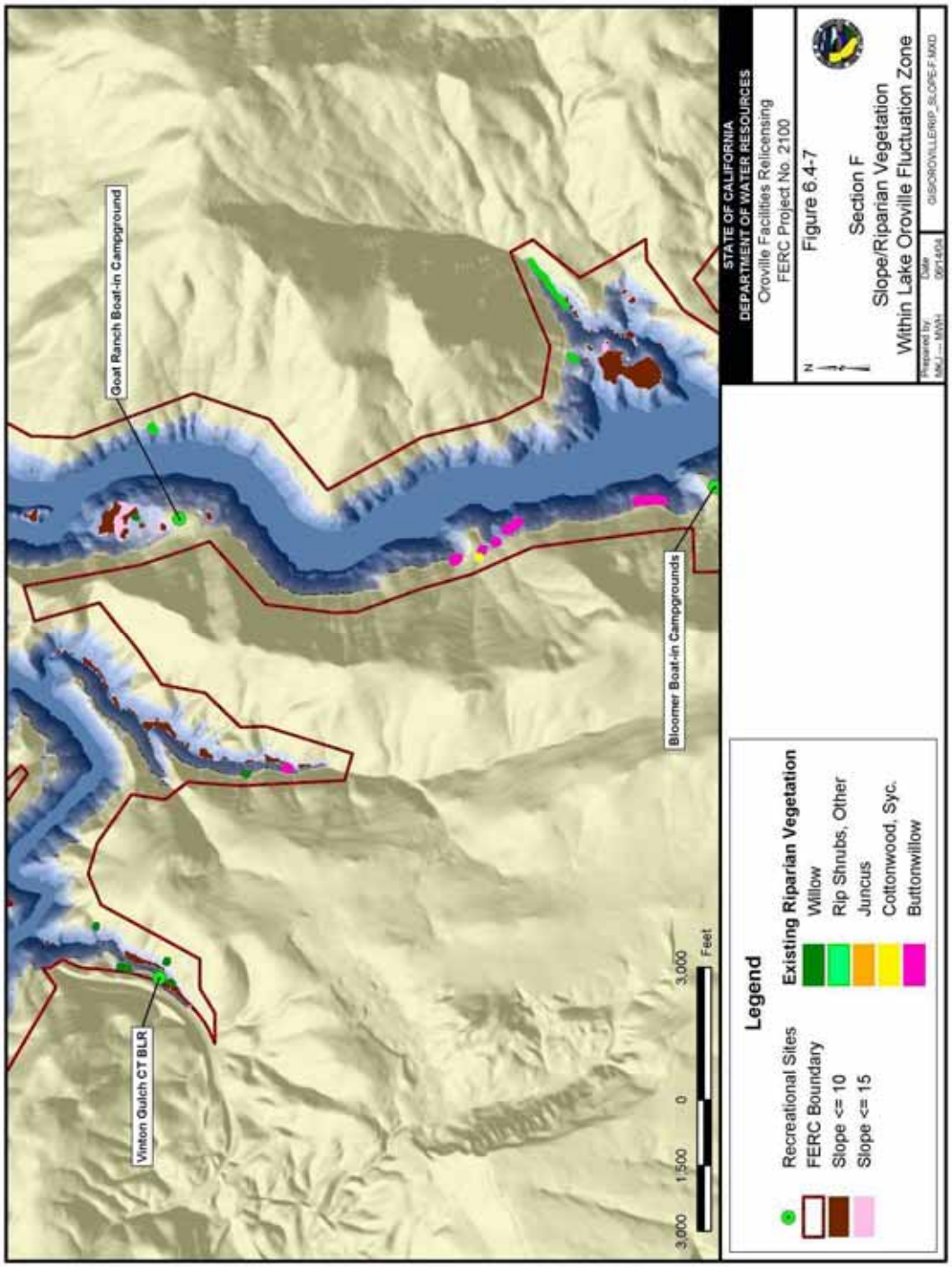

Figure 6.4-7. Slope/riparian vegetation within Lake Oroville fluctuation zone. Main Stem.

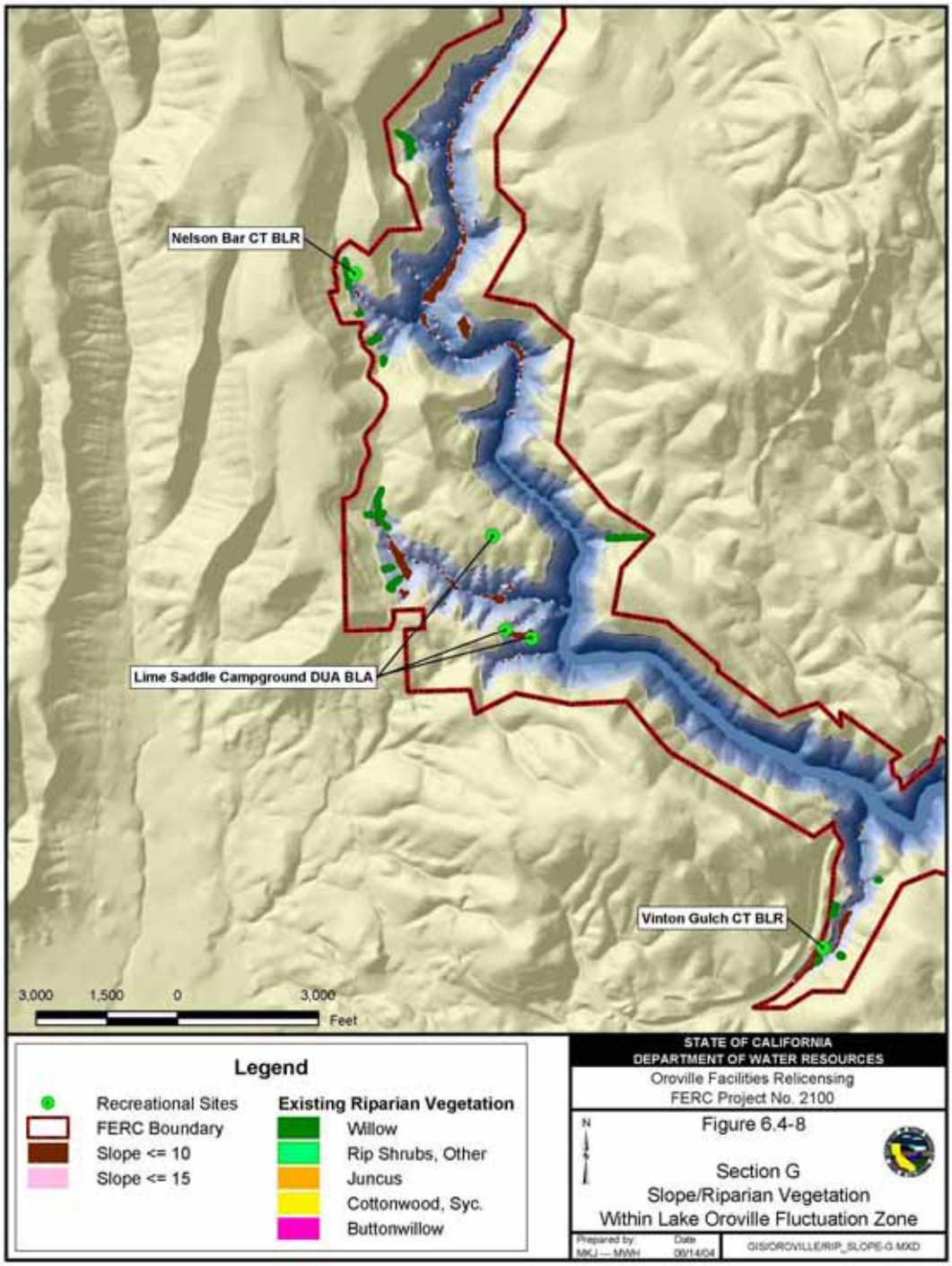

Figure 6.4-8. Slope/riparian vegetation within Lake Oroville fluctuation zone. West Branch.

6.4.1.3 Review previous efforts to establish vegetation within the Lake Oroville drawdown zone

The majority of vegetation within the drawdown zone was removed prior to the filling of the reservoir. Large woody debris, such as trees and logs, were left at a number of areas to provide macrocover for reservoir fisheries. Eighteen areas were designated as "Vegetation Retention Areas" totaling over 1100 acres (Figure 6.4-9). These areas have degraded over time and are not being replaced through natural processes.

Figure 6.4-9. Vegetation Retention Areas within the drawdown zone.

Since the 1970s, Department of Fish and Game (DFG) and DWR fisheries scientists have planted cuttings and seedlings of native willows and buttonbush at several locations in the 850 to 890 foot elevation range of the drawdown zone (Figure 6.4-10). These include the majority of the 175 acres of willows and buttonbush that were mapped for this report (Figure 6.4-1 – Figure 6.4-8). Many of these willows are now over 20 feet high. In the 1980s, a multi-agency stakeholder group experimented with spring hydroseeding of herbaceous species for aesthetics, wildlife habitat, and warmwater fisheries improvement. There efforts were unsuccessful. However, the timing and seed mix may not have been appropriate for this site.

Figure 6.4-10. Riparian planting within the drawdown zone of Lake Oroville.

6.4.1.4 Reservoir operations

Lake Oroville stores winter and spring runoff that is released into the Feather River for project purposes. During normal and wet hydrologic years, the reservoir typically reaches its maximum level (900 feet) in June. In dry years, it may reach it maximum as early as March and does not completely fill. Typically, it reaches its minimum water level for the year in the September to January period, primarily as a function of fall precipitation. Water levels can fluctuate more than 100 feet during the course of a "normal" year, with about 250 feet being the most it has even fluctuated. The record low elevation of the water level in Lake Oroville was 645 feet in September 1977. Daily reductions in lake levels due to flood control operations can be as much as four feet per day during the wet season. Daily decreases in water levels in July to September can be as much as two feet per day. In dry years, the reservoir may not reach full capacity, resulting in a band below the high water line that may not be inundated during this time and may not have any moisture after the rainfall evaporates.

6.4.2 Potential enhancement areas

Significant portions of Lake Oroville's shore are rock cliffs, which preclude any vegetation. Soils, slopes, and water supplies limit plant survival in the remaining areas of the drawdown zone. Areas that may have potential to support riparian vegetation based on percent slope are shown in Figures 6.4-1 through 6.4-8. Areas that are identified as having potential to support riparian vegetation plantings based on field surveys, slope information, and recommendations in EWG 31 include:

- The cove near the Spillway Boat Ramp near the north end of Oroville Dam. This area has a nearby developed water system already in place (Figure 6.4-5).
- A number of locations along the South Fork arm of the lake (Figure 6.4-4). This area already has a number of areas with willow plantings well established and may have potential to tap into the existing canal for irrigation.

- Areas near the Bidwell Campground (Figure 6.4-2). This area has a nearby developed water system already in place for irrigation.
- The peninsula and cove near Loafer Creek Campground (Figure 6.4-2). Existing water supply nearby.
- Potter Ravine – appropriate slopes but may be inundated for too long to support vegetation (Figure 6.4-4).
- Foreman Creek Boat-In Campground - this area already has existing riparian plantings. However, there is still a large amount of suitable slopes where planting could occur (Figures 6.4-4, 6.4-5, and 6.4-6). This area has no developed water source.
- An island below Bloomer Ravine across from Bloomer Boat-In Campground (Figure 6.4-7). This area has no developed water source.
- Cove north of Goat Ranch Boat-In Campground (Figure 6.4-7) – near the junction of the West Branch and North Fork arms of the lake. This area has no developed water source.
- Parrish Cove near Lime Saddle Boat Ramp on the West Branch (Figure 6.4-8). Existing water supply nearby.

No locations were located along the steep slopes of the North Fork Arm of the Lake. Although the Middle Fork has few slopes less than 15%, some do occur in the Montgomery Bar Ravine area. The upper elevations within the drawdown zone in this area were planted in the past and have numerous areas of medium-sized willows.

6.5 DISCUSSION

Lake Oroville is a large reservoir with 167 miles of shoreline at its full pool elevation. The large water level fluctuations in addition to the reservoir's steep slopes and poor soils limits vegetation establishment within the drawdown zone. Little to no vegetation has come in on its own within the drawdown zone.

Riparian species in this area typically are restricted to the relatively moist soil conditions along streams, rivers, lakes, and other types of wetlands. Natural regeneration within the drawdown zone is unlikely due to the timing of seed release when reservoir levels are high, lack of sediment necessary for seedling establishment, and high summer temperatures combined with low soil moisture levels. Seedling establishment usually requires a moist ground surface for seed germination and root development. Root development must be able to keep up with receding water levels. Studies along the Sacramento River indicate that Fremont cottonwood seedlings develop in that system at a rate of approximately .9 inches (2.2 cm) to 1.3 inches (3.2 cm) per day. Daily fluctuations within Lake Oroville from power generation can be as much as 6 inches per day during the summer months and can drop as much as 2 feet per day due to

downstream releases. Few species can withstand inundation for periods of time that are typical within the drawdown zone of the reservoir as well as the dry harsh conditions of summer and fall.

Native willows (*Salix* sp.) and buttonbush (*Cephalanthus occidentalis*) have survived within the upper elevations of the drawdown zone of Lake Oroville. These are mostly from cuttings and plantings by DFG and DWR fisheries biologists. Although there is a limited amount of acreage suitable for riparian planting, enhancement efforts could be accomplished through plantings of cuttings and/or rooted plants in some areas, especially where a developed water supply is available.

Herbaceous vegetation would also enhance aesthetic quality, wildlife value, and fisheries habitat within the drawdown zone of the lake. A few areas of perennial sedges and rushes are found within the drawdown zone where there is a year-round water supply. Although these species are most desirable, there is little probability of success within the drawdown zone unless water is available year round. Seeding the reservoir shoreline with a blend of native and non-native annual grasses and forbs in areas of high visibility would increase aesthetic quality if successful. The seed mixes would need to be applied within a short time following drawdown and at appropriate intervals as the water recedes. However, the success of seeding the shoreline will most likely only result in sporadic vegetation due to the severe summer temperatures and moisture conditions.

These enhancement efforts, if successful, could increase riparian vegetation/wildlife habitat, increase fish habitat complexity, enhance bass shoreline habitat, reduce shoreline erosion, reduce the amount of unnatural fish habitat enhancement structures needed, and improve aesthetic qualities along the reservoir shoreline.

7.0 TASK 4 – ISOLATED WETLANDS WITHIN THE PROJECT AREA

7.1 INTRODUCTION

Isolated wetland features occur throughout the Project lands. These include ponds, impoundments created by dredger tailings, and vernal pools. These wetlands can be affected by Project-related activities such as maintenance activities and recreational use.

Wetlands, according to the U.S. Environmental Protection Agency (EPA), are "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (USEPA Website). Wetlands generally included marshes, ponds, bogs, and vernal pools. Most types of wetlands are fairly obvious with periods of inundation and/or wetland vegetation. Vernal pools are often less obvious as wetlands because for much of the year they contain no water or vegetation. In the absence of obvious water or waterlogged soils, what all wetlands have in common are soils that show signs of persistent or regularly repeated saturation (hydric soils) and plants that are specially adapted to inundated or saturated soils (hydrophytes).

Vernal pools may be defined as rainfall-filled seasonal wetlands that are inundated when the temperature is warm enough for plant growth, followed by a brief period of saturated but not inundated soil, and concluding with a long period of extremely dry soil (Keeley and Zedler 1998). Inundation starts with the winter rains and continues into the spring growing season; pools will sometimes dry and refill with water more than once during the rainy season. By summer, almost all pools are completely dry, and stay dry until the winter rains start again. Water entering vernal pools is derived from a rather small ground and sub-surface area such that precipitation onto the pool itself provides a major portion of the pool's water. Vernal pools usually are depressions that overlie an essentially impermeable substrate, so that drying of the pool is mostly from evapotranspiration. In consequence, they tend to have low nutrient levels, resulting in unbuffered waters that undergo extreme daily fluctuations in pH and dissolved carbon dioxide and oxygen. Inundation of vernal pools during the general growing season excludes the typical surrounding upland plants and the extended dry period prevents the typical aquatic and wetland species from colonizing. In addition, variation in rainfall amount and pattern from year to year affects species composition. Vernal pools tend to support a number of species of wetland plants and animals that are not found in most other wetlands.

According to Keeler-Wolf et al. in the *California Vernal Pool Assessment Preliminary Report* (CDFG 1998), vernal pools in the Project vicinity are of the "northern hardpan"

type often found on old, acidic, iron and silica cemented soils, including the Corning and Redding soil series. While other Northern California vernal pool types occur in areas largely managed as rangelands and thus face a minimum of threats (CDFG 1998), northern hardpan vernal pools face extensive threats from urbanization (especially in the Chico, Oroville, and Gridley areas), agriculture, and intensive grazing.

Fifteen sensitive species of vernal pool plants and five sensitive species of vernal pool animals within the northeastern Sacramento Valley region are currently State and/or federally listed.

A pond can be defined as a kind of marsh. Marshes can be defined as wetlands that are frequently or continually inundated with water, characterized by emergent soft-stemmed vegetation that is adapted to saturated soil conditions (USEPA Website). Marshes and/or ponds tend to receive most of their water from surface water or groundwater. They tend to have plentiful nutrients and neutral pH levels, and thus generally support an abundance of plant and animal life, including a number of rare plant and animal species.

7.2 OBJECTIVES

Project-related activities have the potential to affect isolated wetlands within the Project area. The objectives of this study were to:

- assess isolated wetlands within the Project area
- assess management activities on isolated wetlands within the Project area

7.3 METHODS

7.3.1 Vernal Pools

7.3.1.1 Review existing information

Mapped soil associations (USDA 1967 [1]) were sorted for those soils that tend to support vernal pools; these were then overlain by the project area boundary. The California Natural Diversity Data Base (CNDDB) was checked for the presence of vernal pools in the Project vicinity. Information regarding vernal pool habitat, ecology, and function within the Project area was extracted and summarized from other Oroville Facilities Relicensing reports (SP-T1; SP-T2 wildlife: SP-T2 plants; SP-T4).

7.3.1.2 Mapping, field assessment, and species lists

Vernal pools were mapped with a combination of field observation and aerial photo interpretation. Field mapping was carried out mostly in tandem with special status plant

species surveys during 2002 and 2003. Vernal pools were mapped from georeferenced aerial photographs using ArcView software.

A list of plant species associated with vernal pools and vernal swales, and their associated uplands, was produced from field notes for special status species surveys, weed surveys, and vegetation mapping.

7.3.2 Ponds

7.3.2.1 Review existing information

Information regarding pond habitat, ecology, and function within the Project area was extracted and summarized from other Oroville Facilities Relicensing reports (SP-T1; SP-T2 wildlife: SP-T2 plants; SP-T4).

7.3.2.2 Mapping

Ponds were mapped as part of the larger mapping of vegetation within the Project area and to one mile outside the Project area (CDWR 2003). In this mapping process, open water pond areas were mapped as “ponds” if they had no vegetation covering the surface. Areas within the ponds that were covered with aquatic vegetation were mapped within the “Aquatic/submerged” category. For this analysis, these two categories were combined. Wetland plant communities which are dominated by various emergent wetland species are covered under Task 2 of this report.

7.4 RESULTS

7.4.1 Vernal Pools

7.4.1.1 Review existing information

Much of the Project area in and around the Thermalito Complex is of the Redding-Corning-Pentz association. The Redding and Corning soils have a hummocky topography and a subsoil of very dense clay. The Redding soils have a cemented hardpan (duripan) under the dense clay layer (USDA 1967 [1]). Approximately 2360 acres of Redding-Corning-Pentz soils occur within the Project area (excluding those acres presently inundated by Project waters). These soils are found around the Thermalito Forebay and Afterbay, the Power Canal, and in small areas at the edge of the Oroville Wildlife Area.

According to CNDDB records, northern hardpan vernal pools are reported approximately one mile west of the Afterbay and four miles southeast of the Oroville Wildlife Area.

7.4.1.2 Mapping, assessment, and species lists

Approximately 49 acres of vernal pools, ephemeral swales, and vernal pool/swale complexes were mapped within the Project area (Appendix G). Most of these vernal pools and swales were found scattered within the annual grasslands around the Thermalito Afterbay. A small number of pool/swale complexes were also found near the Forebay. These vernal pools range in size from very small (less than 3 ft diameter) to larger pools covering nearly an acre. Multiple-pool complexes within the Project area range in size from 0.5 to 5 acres. The majority of pools are fairly shallow, although large deep pools were also found (CDWR 2004 [2]). All of the mapped vernal pools lie within the Redding-Corning-Pentz soil association.

A total of 207 plant species were found associated with vernal pools, vernal swales, and their associated uplands (Appendix H). Twenty-nine percent of these species (60) were found in vernal pools and swales. Of these 60 species, 18% are non-native species. As a comparison 39% of the species found in the study area, excluding vernal pools and swales, are non-native. One occurrence of Ahart's paronychia (*Paronychia ahartii*), a special status species listed by the California Native Plant Society, was located in a vernal pool complex within the annual grasslands near the southern end of the Thermalito Forebay (CDWR 2004 [2]).

7.4.2 <u>Ponds</u>

7.4.2.1 Review existing information

It is generally thought that many of the deeper ponds along the Feather River are hydrologically connected to the river through the porous sand, gravel, and cobble alluvium that separates the ponds from the river. Although there is no documentation of this connection, the clear clean waters in many of these ponds may be due to the flushing action of the underground movement of water into and out of these ponds. One Mile Pond, the largest clear fresh water pond in the south part of the OWA occupying over 96 acres, is perhaps the best example.

Large shallow ponds, most with their surfaces covered by aquatic vegetation, dominate the part of the OWA east of the Feather River (D Area). Much of this area has become perennially flooded since 1997 when repairs to a broken levee allowed a continuous small flow of water into the area (CDWR 2004 [7]). This small flow of water, plus subsequent beaver dam construction, greatly increased the acreage of shallow ponds in the area. Prior to 1997, this area had scattered deeper ponds that may well have been hydrologically connected to the river, with occasional seasonal filling of larger areas by overflow from high flows in the Feather River. A review of historic photographs of the D Area shows that in 1963 this area was covered by mounded dredger tailings, and in

1967 it appears as a freshly barren floodplain. By 1986, the same area is covered largely by scattered riparian vegetation dominated by large Fremont cottonwood trees. Since the 1997 levee break, much of the area is now flooded; and 1999 aerial photographs show hundreds of dead mature-sized riparian trees in an area dominated by the large shallow ponds seen there today.

7.4.2.2 Mapping

Approximately 760 acres of ponds were mapped within the Project area (Appendix G). This includes 740 acres of dredger and gravel extraction ponds within the OWA and 20 acres of waterfowl brood ponds around the Afterbay. Several small ponds (less than one acre each) are also located around Lake Oroville. The acreage distribution of aquatic/submerged vegetation and open water ponds is shown in Table 7.4-1.

Table 7.4-1. Acreage of aquatic vegetation/open water ponds in the Project area.

Aquatic Vegetation/Open Water	Acres
Algae	1
Mixed aquatic	15
Mosquito fern	9
Water primrose	399
Water-meal	19
Open water/pond	318
Total	**760**

Approximately 490 of the 760 acres of ponds in the Project are found east of the Feather River in the D Area and below. Of the 490 acres, 395 acres are covered by aquatic vegetation.

Two special status plant species were found associated with ponds in the OWA (CDWR 2004 [2]). Four-angled spikerush is abundant within the emergent wetland vegetation around the edges of One Mile Pond and smaller ponds nearby, and around a pond near the outflow from the Afterbay. In this area, this species was only found in association with open water and not with floating aquatic vegetation. It is also common in the brood ponds around the Thermalito Afterbay. A second special status plant species, Columbian watermeal, was found covering several small open water ponds. A third special status species, fox sedge, was collected in 1990 from the edge of an open water pond in the D Area, but was not relocated during these studies.

Three animal species of concern were found in or associated with ponds within the Project area (CDWR 2004[3]). Snowy egrets were observed in the OWA and are known to prefer ponds, emergent wetlands, and other open waters. Ospreys were observed foraging over most of the aquatic habitat within the Project area, including several dredger ponds in the OWA. Western pond turtles were observed in dredger

ponds in the OWA and brood ponds around the Afterbay. In addition, dredger ponds in the OWA and brood ponds around the Afterbay are suitable habitat for California red-legged frogs and giant garter snakes.

7.5 DISCUSSION

Vernal pools and adjacent areas around the Thermalito Forebay and Afterbay are subject to maintenance and land-use practices that can directly or indirectly impact the pools. These impacts may result from sedimentation, earth moving, disking, off-road vehicle use, and pesticides. A Vernal Pool Invertebrate Land Management Plan has been prepared to address these issues and contains modifications of the existing maintenance and land-use practices to reduce or eliminate these impacts (CDWR 2004 [3]).

Ponds and adjacent areas receive extensive public use from camping, fishing and picnicking. In addition, gravel harvest activities provide material for project maintenance and for commercial enterprises. Potential impacts to ponds from gravel extraction and transportation, such as dust, disturbance, and habitat modification and loss, are probably minimal. The existence of many of the ponds within the OWA is a direct result of past gravel harvest. Continued gravel harvest has the potential to create more ponds within the OWA, to increase connectivity between existing ponds, and create conditions for increased vegetative establishment in areas that are now mostly barren dredger tailings (CDWR 2004 [4]). Approximately 615 acres of cobble/gravel tailings occur within the OWA. DWR is currently working with other agencies and mining interests to minimize negative impacts of gravel harvest while maximizing the potential benefits.

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APPENDICES