

APPENDIX M

Lower Feather River Corridor Management Plan
Conceptual Restoration Plan

APPENDIX M LOWER FEATHER RIVER CORRIDOR MANAGEMENT PLAN CONCEPTUAL RESTORATION PLAN

M.1 INTRODUCTION

This Conceptual Restoration Plan for the Lower Feather River Corridor Management Plan (LFRCMP) describes restoration actions and target habitats suitable for the Feather River setback (FRS) area and other managed floodplains of the LFRCMP study area. It also presents a conceptual layout for the distribution of vegetation types recommended for use in future restoration projects. This plan's restoration actions complement and are integrated with the actions described in LFRCMP Chapter 6, "Proposed Management Actions," and with restoration actions proposed by Three Rivers Levee Improvement Authority (TRLIA) and River Partners for 940 acres in the FRS area.

The target habitat types for restoration in the LFRCMP study area consist of riparian habitats (dense riparian forest and riparian willow scrub) and native upland habitats (valley oak woodland, oak savanna/perennial grassland, and native upland scrub). Expanding and connecting riparian and native upland habitats is a particular focus of restoration efforts for the LFRCMP study area because the area historically supported such habitats and because riparian and oak woodland vegetation communities contain the most species-rich and abundant communities of birds and provide critically important habitat for many other wildlife species (Knopf et al. 1988). Increasing the extent and connectivity of these habitats is also important because the number of wildlife species in riparian and oak woodland corridors increases with corridor size, width, and continuity (e.g., Hagar 1999, Heath and Ballard 2003).

Widening and connecting riparian and oak woodland corridors is crucial because narrow or fragmented corridors are not suitable for the dispersal of some species, particularly smaller, less mobile animals (Rosenberg et al. 1997). For more widely distributed species, the value of wide, contiguous corridors may be related to increased habitat heterogeneity in larger corridors; to the absence of interior habitats in narrower, fragmented corridors; and to the ability of larger corridors to support species with larger home ranges.

Upland habitats in the LFRCMP study area also provide valuable resources for terrestrial wildlife, particularly where those uplands occur as a mosaic with riparian forest, riparian willow scrub, valley oak woodland, native perennial grassland, and other native plant communities. Many wildlife species require several habitat features and use different vegetation types at various times during their life cycles. In the Sacramento Valley, many riparian-associated species use—and often require—both riparian and other adjacent habitats (including uplands) for reproduction, cover, and/or foraging (Placer County Planning Department 2005). Therefore, a mosaic of riparian habitats, and habitats with diverse vegetation species and physical habitat structure, are more likely than homogenous habitats to accommodate a wider variety of wildlife species (RHJV 2004). For this reason, creating upland habitat that is intermixed with riparian and other habitats is a high priority for restoration efforts in the LFRCMP study area.

The restoration actions described in this plan, and the management actions discussed in Chapter 6 of the LFRCMP, would better reflect historic habitat conditions, and would increase the extent and quality of riparian, valley oak woodland, and upland habitat for terrestrial wildlife in the LFRCMP study area. The management actions described in Chapter 6 would create topographic and hydrologic conditions that support natural riverine and successional processes. These actions, augmented by the plantings described in this plan, would create a

mosaic of riparian and upland habitats more closely replicating primordial conditions. Varying successional stages of riparian habitat would be intermixed with native upland habitats. Fragmentation of native habitats would be diminished, a diverse vegetative structure for riparian and upland wildlife species would be established, and high-quality nutrient inputs would be provided to aquatic food chains.

The restoration actions would expand and connect existing swaths of riparian habitat in the LFRCMP study area, improve the diversity and quality of existing riparian forests, and replace ruderal areas and annual grassland with native oak savanna/perennial grassland and valley oak woodland. Some of the wildlife benefits of these restoration actions would be achieved in a relatively short time frame; for example, increased species richness of neotropical migratory birds is often seen within 3 years of restoration (RHJV 2004).

The following goals important to the overall management of the LFRCMP study area shaped the development of the restoration actions described in this plan:

- ▶ **No Increase in Flood Risk.** Restoration actions will not increase flood risk, decrease levee freeboard, adversely affect flood management infrastructure, or otherwise diminish public safety.
- ▶ **Promote Natural Hydrologic Processes.** Restoration actions will promote natural dynamic hydrologic and geomorphic processes to the extent feasible, with an emphasis on frequently inundated floodplains.
- ▶ **Expand and Connect Native Plant Communities.** Restoration actions will increase the extent, quality, diversity, and connectivity of riparian habitat, including shaded riverine aquatic habitats, and mosaics of native upland/riparian plant communities.
- ▶ **Promote Recovery and Stability of Native Fish and Wildlife Populations.** Restoration actions will promote the recovery and stability of special-status fish and wildlife and other populations of native species, as well as enhance overall biotic diversity.

These principles are consistent with the Central Valley Flood Protection Plan (CVFPP) Conservation Framework (DWR 2012) (see LFRCMP Chapter 1, “Introduction,” for a discussion of the relationship of the LFRCMP to the CVFPP and the Conservation Framework).

Table M-1 summarizes the extent to which the proposed restoration would increase high-value habitat types and decrease undesirable vegetation types throughout the LFRCMP study area. Exhibit M-1 depicts the location of current and future vegetation types in the LFRCMP study area.

M.2 COMPLETED AND PROPOSED RESTORATION PROJECTS IN THE LFRCMP STUDY AREA

Several major restoration and habitat mitigation efforts have already been completed in the LFRCMP study area. Exhibit M-2 shows the locations of these restoration sites, and Table M-2 summarizes the targeted habitat types and the extent of habitat restored. Collectively, these projects substantially enhanced and will continue enhancing biological resource values in the LFRCMP study area. These projects have expanded and enhanced native plant communities, including riparian forest and scrub, freshwater marsh, shaded riverine aquatic habitat, native perennial grasslands, and valley oak woodland. The restored plant communities have created and enhanced habitat for special-status species such as Chinook salmon, Central Valley steelhead, Sacramento splittail, valley elderberry longhorn beetle, Swainson’s hawk, and western yellow-billed cuckoo.

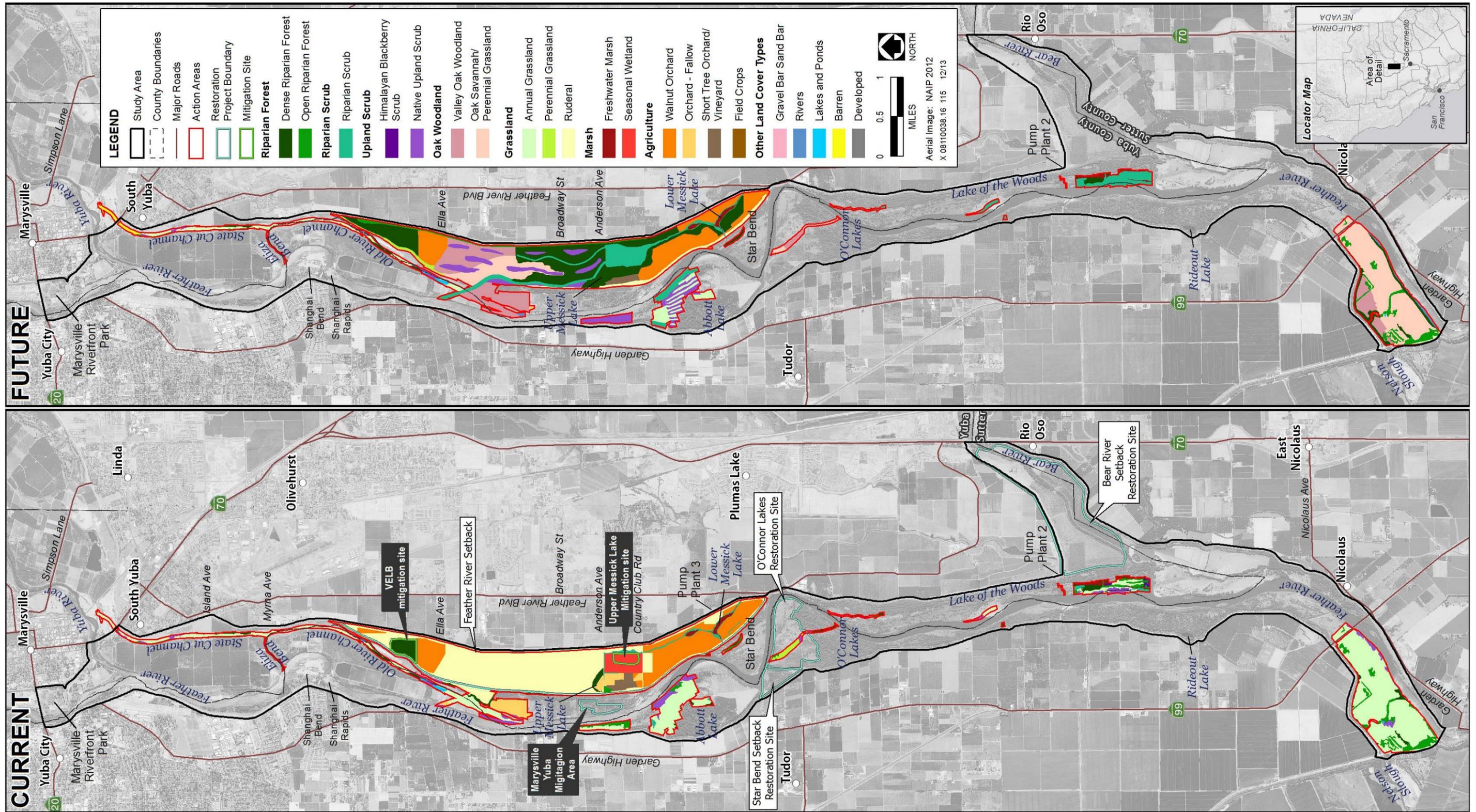
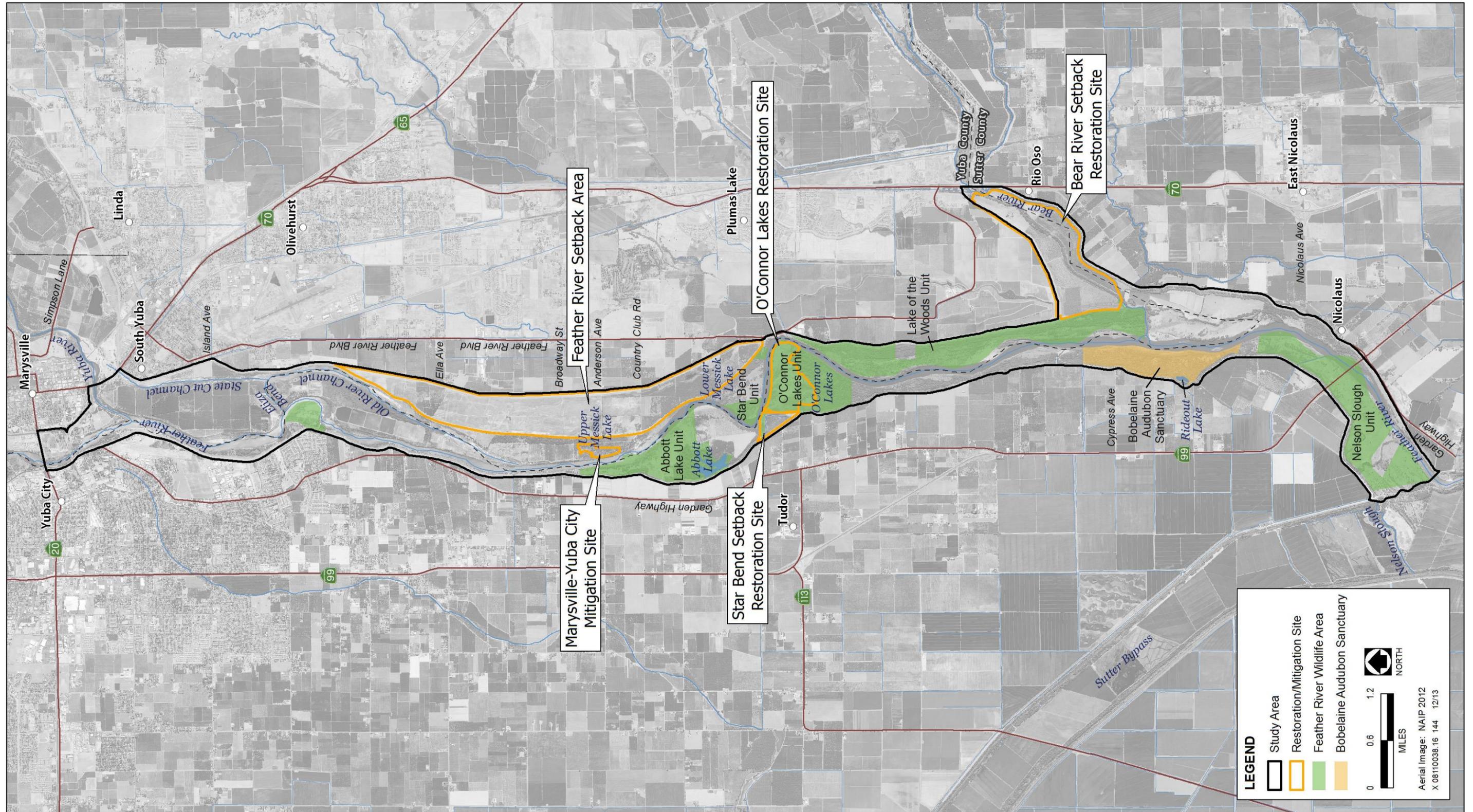


Exhibit M-1

Current and Future Vegetation in the LFRCMP Study Area



Source: AECOM 2013

Exhibit M-2

Existing Restoration/Mitigation Sites in the LFRCMP Study Area

**Table M-1
Net Vegetation Change in the Lower Feather River Study Area, Baseline to Future**

Vegetation and Cover Types	Baseline (acres)	Future (acres)	Net Change (acres)	Notes
Barren	0.0	14.5	14.5	Recently graded or other disturbed areas
Gravel Bar/Sandbar	0.3	0.0	-0.3	Includes only bars exposed above water surface
Annual Grassland	787.1	146.9	-640.2	535% decrease; primarily non-native grasses
Ruderal	892.6	59.8	-832.8	1,488% decrease; weedy herbaceous
Perennial Grassland	14.9	26.2	11.3	Dominated by native grass species
Oak Savanna/Perennial Grassland	0.0	512.4	512.4	Net increase; scattered oaks throughout a predominantly grassland ground cover
Valley Oak Woodland	0.0	317.1	317.1	Net increase; not mapped in baseline vegetation survey because could not distinguish from other riparian tree canopies in aerial photos
Dense Riparian Forest	121.1	595.4	474.3	492% increase; does not include valley oak woodland acres
Open Riparian Forest	128.9	108.4	-20.6	No creation of open riparian forest is proposed
Riparian Willow Scrub	43.3	307.2	263.9	712% increase
Freshwater Marsh	15.0	29.6	14.6	
Seasonal Wetland	91.9	0.0	-91.9	Not an actual loss of wetland; the basin at Upper Messick Lake mitigation site was flooded at the time of botanical survey and therefore was mapped as seasonal wetland, but it actually supports existing (and planned future expansion of) riparian willow scrub and riparian forest
Native Upland Scrub	85.6	222.1	136.5	260% increase
Himalayan Blackberry Scrub	6.4	0.0	-6.4	Existing cover of blackberry brambles may be more extensive because of unmapped understory cover in riparian forest and scrub
Lakes and Ponds	6.8	6.8	0.0	
Rivers	9.2	16.3	7.1	
Orchard—Fallow	90.4	1.6	-88.9	Fallow and abandoned orchard sites would be converted to native vegetation types
Short Tree Orchard	30.7	21.0	-9.7	Orchard was removed after completion of baseline vegetation survey
Walnut Orchard	377.5	316.8	-60.7	60 acres of frequently flooded orchards at Lower Messick Lake would be converted to riparian forest/willow scrub
Total	2,702	2,702	0	

Source: Data compiled by AECOM in 2013

**Table M-2
Completed Restoration/Mitigation Projects in the LFRCMP Study Area**

Restoration/Mitigation Project	Habitat Types and Approximate Acres Restored
Feather River Setback Levee Project	VELB habitat via elderberry shrub transplanting (38 acres) Open water, Great Valley buttonbush scrub, Great Valley mixed riparian, and Great Valley valley oak woodland (30.4 acres) (River Partners 2009a)
Bear River Setback Levee and Riparian Restoration Project	Riparian forest and scrub, native perennial grassland, shaded riverine aquatic habitat, freshwater marsh, and a drainage swale connected to the Bear River (639 acres) (River Partners 2005)
Star Bend Setback Levee and Habitat Enhancement Project	Riparian scrub, including VELB habitat via elderberry shrub transplanting (20 acres) (River Partners 2009b)
O'Connor Lakes Unit Riparian Restoration Plan	Riparian forest and scrub (228 acres connecting existing disjunct patches) and native perennial grasslands (River Partners 2006)
Marysville–Yuba City Area Levee Reconstruction Project (mitigation site)	Riparian forest and scrub, freshwater marsh, VELB habitat (35 acres) (DWR 2011)
Note: VELB = valley elderberry longhorn beetle Sources: DWR 2011; River Partners 2005, 2006, 2009a, 2009b	

In addition to these completed projects, TRLIA has proposed to restore 500 acres of riparian and upland habitat in the FRS area as part of the Feather River Floodway Corridor Restoration Project (TRLIA 2013). This project, recommended for direct Proposition 1E funding by the California Department of Water Resources’ (DWR’s) FloodSAFE Environmental Stewardship and Statewide Resources Office (FESSRO), would establish approximately 300 acres of mixed riparian forest, riparian scrub, and valley oak woodland and approximately 200 acres of grassland (Exhibit M-3).

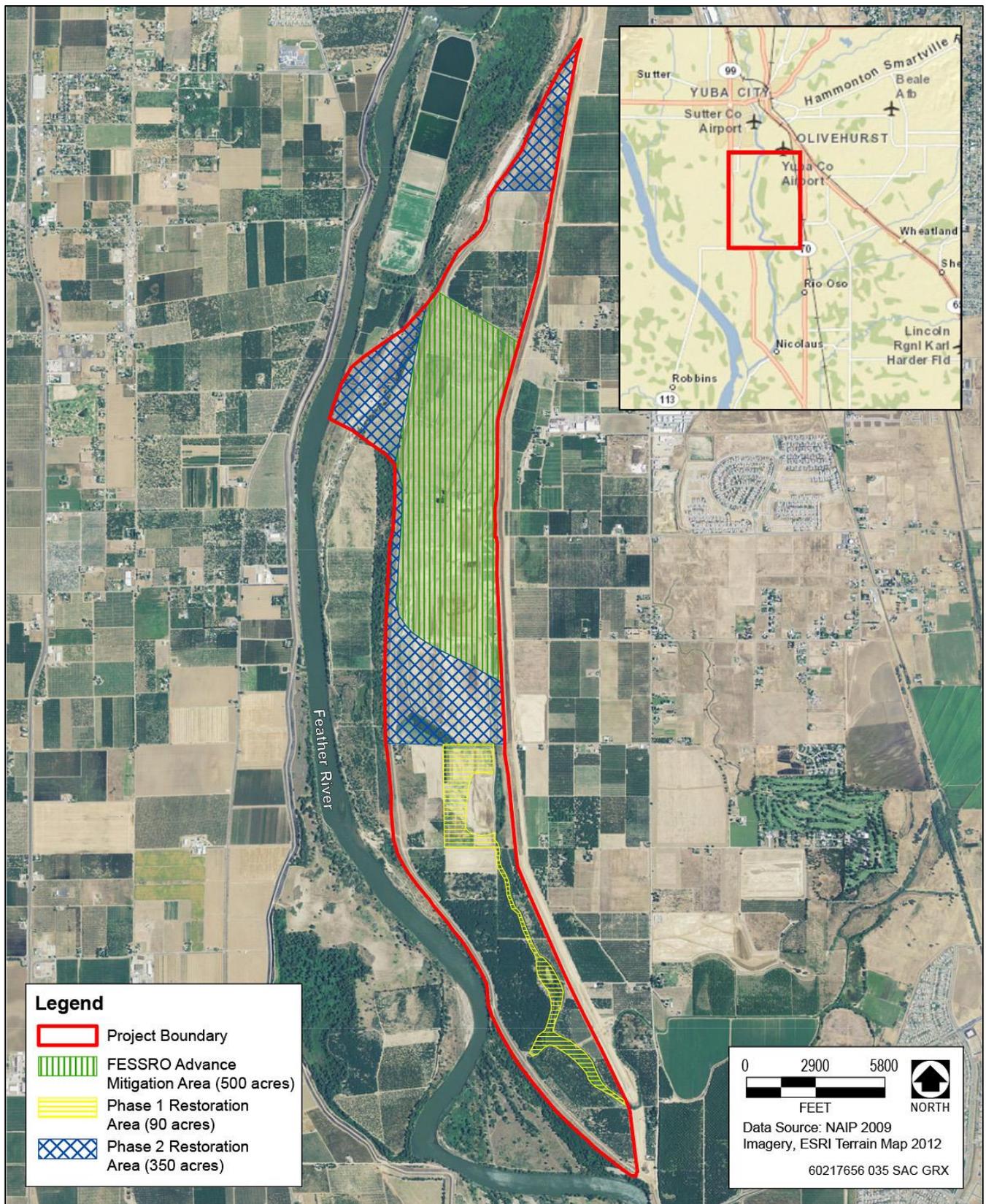
TRLIA has also proposed restoration under DWR’s Flood Protection Corridor Program for the Three Rivers Flood Corridor Project. This proposal specifically requested funding to complete a design analysis of the conceptual ecological restoration elements described in LFRCMP Chapter 4, “Management Goals, Challenges, and Opportunities”: a system of excavated swales connecting the Feather River to the Upper and Lower Messick Lake complex, upland refugia, and lowered floodplains within the FRS area. Implementing the TRLIA Three Rivers Flood Corridor Project would result in restoration of 440 additional acres of dense riparian forest, riparian scrub, valley oak woodland, and oak savanna/perennial grasslands.

M.3 MAJOR CONSTRAINTS TO RESTORATION SUCCESS

M.3.1 INUNDATION FREQUENCY

As described in LFRCMP Chapter 5, “Hydraulic, Hydrologic, and Sediment Transport Modeling of Potential Future Conditions,” natural river processes such as frequent floodplain inundation and channel meander migration have been significantly altered on the Lower Feather River by historical hydraulic mining deposits, subsequent channel incision, dam and levee construction, water diversions, and reservoir storage operations.

In particular, floodplain inundation is an ecosystem process that is vital to the sustenance of riverine and riparian ecosystems. Frequent, ecologically significant flood flows, referred to as the Floodplain Activation Flood (FAF)



Source: TRLIA 2013

Exhibit M-3 Location of Restoration Areas Proposed by TRLIA in the Feather River Setback Area

(PWA 2005), are typically associated with storms occurring more frequently than once every 2 years. These FAF flows support highly beneficial ecological functions and outcomes such as producing organic matter and invertebrates to fuel food webs, creating habitat that supports spawning and rearing by native fishes, and promoting conditions that support recruitment of riparian vegetation.

As detailed in Chapter 5, the Feather River channel in the LFRCMP study area has become so incised, and the river floodplain so disconnected from the channel by the combined effect of incision and dam operations, that these ecologically significant FAF flows are more or less nonexistent under current conditions. The Feather River and Bear River levee setback projects removed levees that separated the river floodplain from the river, offering tremendous restoration opportunities in the new setback areas. Still, the high elevation of the floodplain relative to the incised river channel in the FRS area remains a barrier to restoring the full natural dynamic processes that support aquatic and terrestrial floodplain ecosystems.

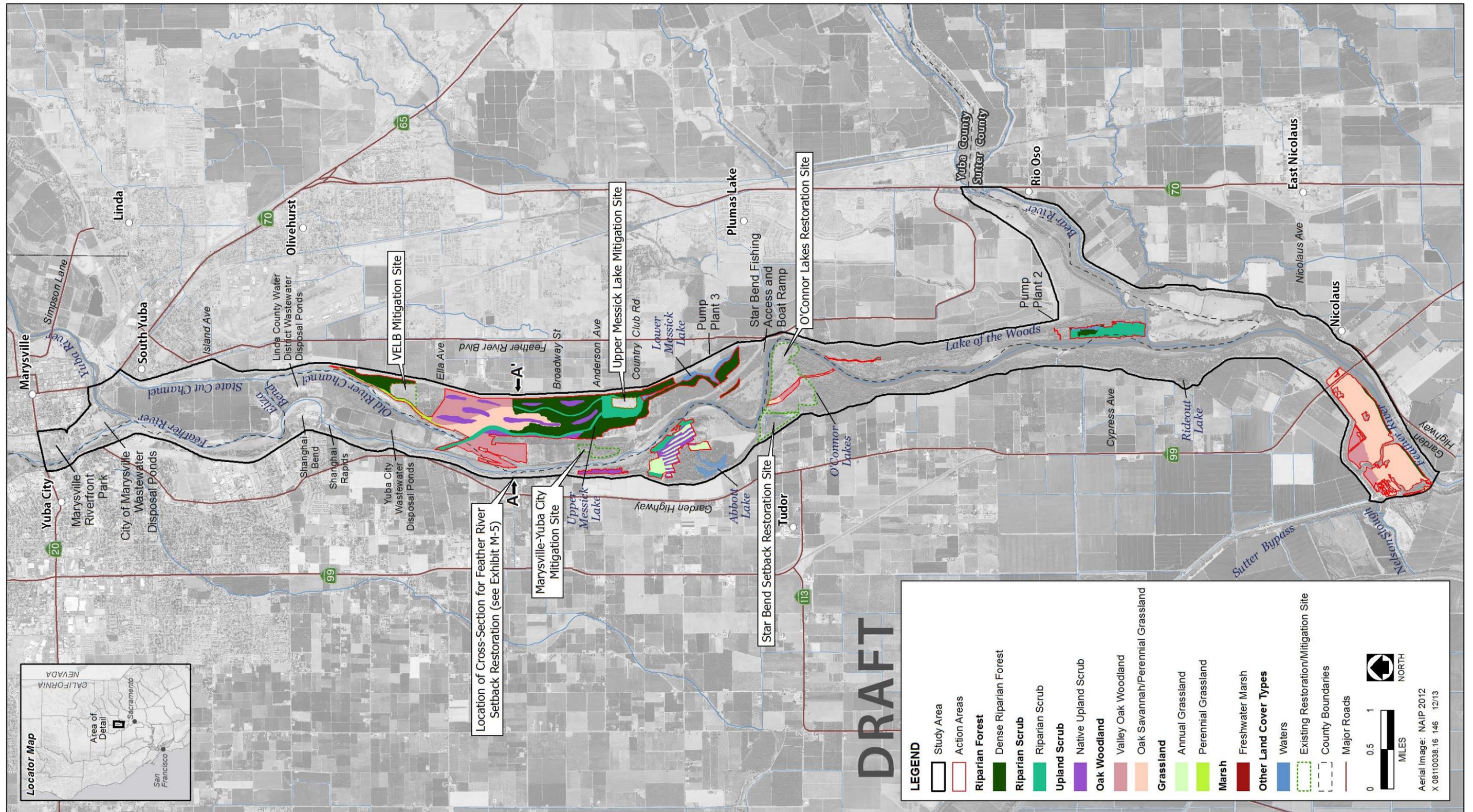
Several management actions described in LFRCMP Chapter 6 would help restore natural floodplain inundation processes by strategically excavating high-flow diversion swales, improving flow-through at existing basins and drainages, opening access to old river channels, and creating low benches that would be subject to frequent inundation. These actions would create conditions supporting a dynamic succession and mosaic of floodplain habitat types.

The natural recruitment of native plants that would occur as frequent flooding is restored would be augmented by planting native shade trees and shrubs along swale margins and benches, and by planting a mosaic of riparian forest and scrub, oak woodland, and native perennial grassland. These plantings would occur throughout the FRS area's floodplain and swale complex, and on ruderal floodplains and swales within the Abbott Lake, O'Connor Lakes, Lake of the Woods, and Nelson Slough units of the Feather River Wildlife Area (FRWA). Exhibit M-4 shows the locations of these proposed plantings.

Exhibit M-5 depicts a conceptual cross section at River Mile 22.2 of the FRS area, showing the locations of native plant communities relative to the levees, active and old river channels, proposed swales, and lowered floodplains. Exhibit M-4 shows the location of this cross section in the LFRCMP study area.

M.3.2 HYDRAULIC ROUGHNESS THRESHOLDS

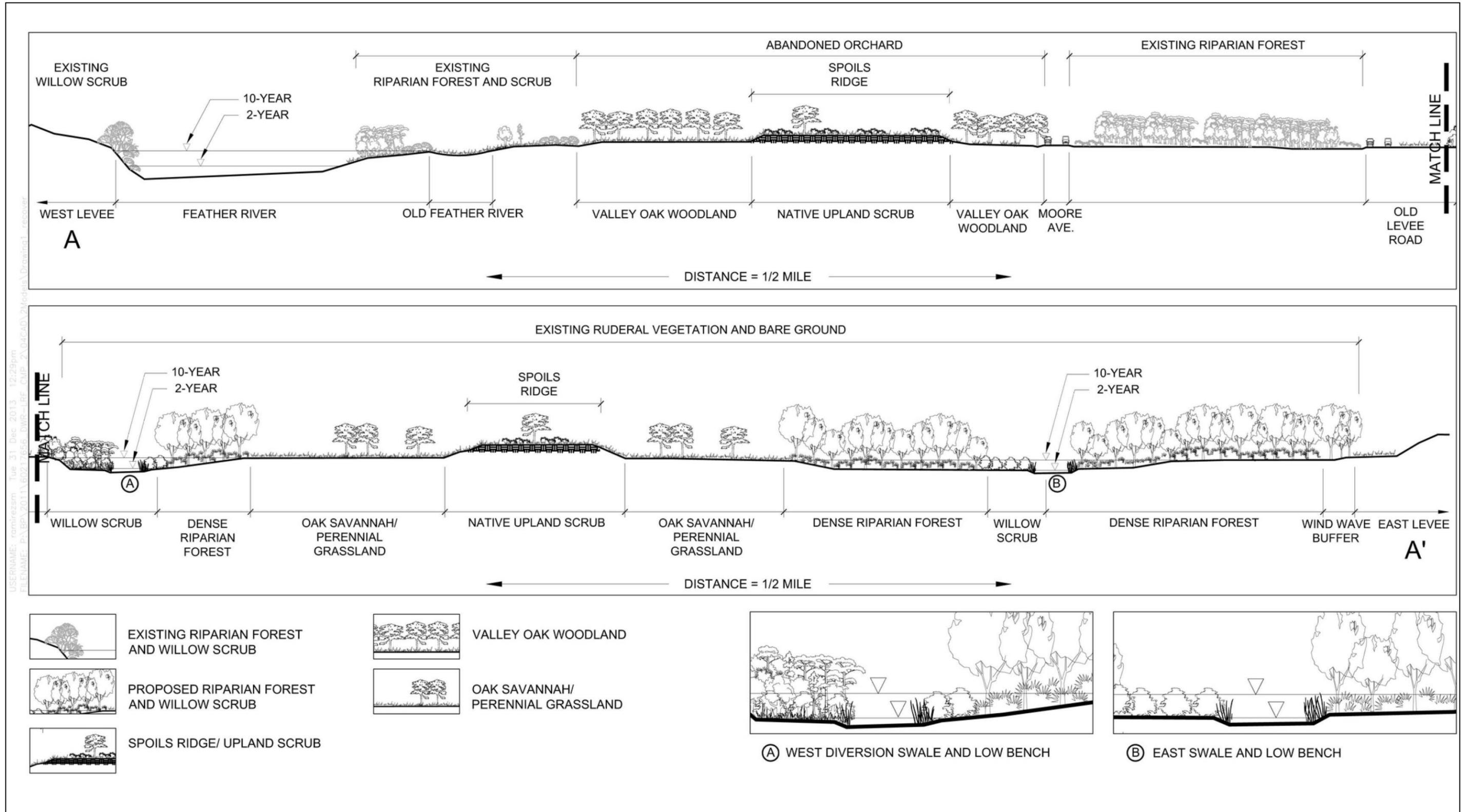
Proposed restoration in the LFRCMP study area must be “flood-neutral”; that is, the hydraulic roughness of planted trees and shrubs must not reduce the floodway's design conveyance capacity or cause floodwater elevation to increase above design standards. As described in Appendix B, “LFRCMP Flood Hydraulic Analysis of Future Conditions,” MBK Engineers used a two-dimensional hydraulic computer model to assess the effects of large flood events under both existing conditions in 2011 and proposed future conditions described in the LFRCMP. This analysis simulated the effects of potential future conditions on water surface elevations, levee freeboard, and velocity. The model calculates flow velocity, flow direction, and depth in 200-foot by 200-foot cells across the entire floodway area between the levees. The modeler can change hydraulic roughness values in each cell based on the type and density of vegetation (e.g., trees, shrubs, or grass). The results of each modeling run reveal how the future vegetation would affect the direction of flow, its velocity, and its water surface elevation. Exhibit M-6 depicts the maximum roughness thresholds that should not be exceeded for any planting design proposed for the LFRCMP study area.



Source: AECOM 2013

Exhibit M-4

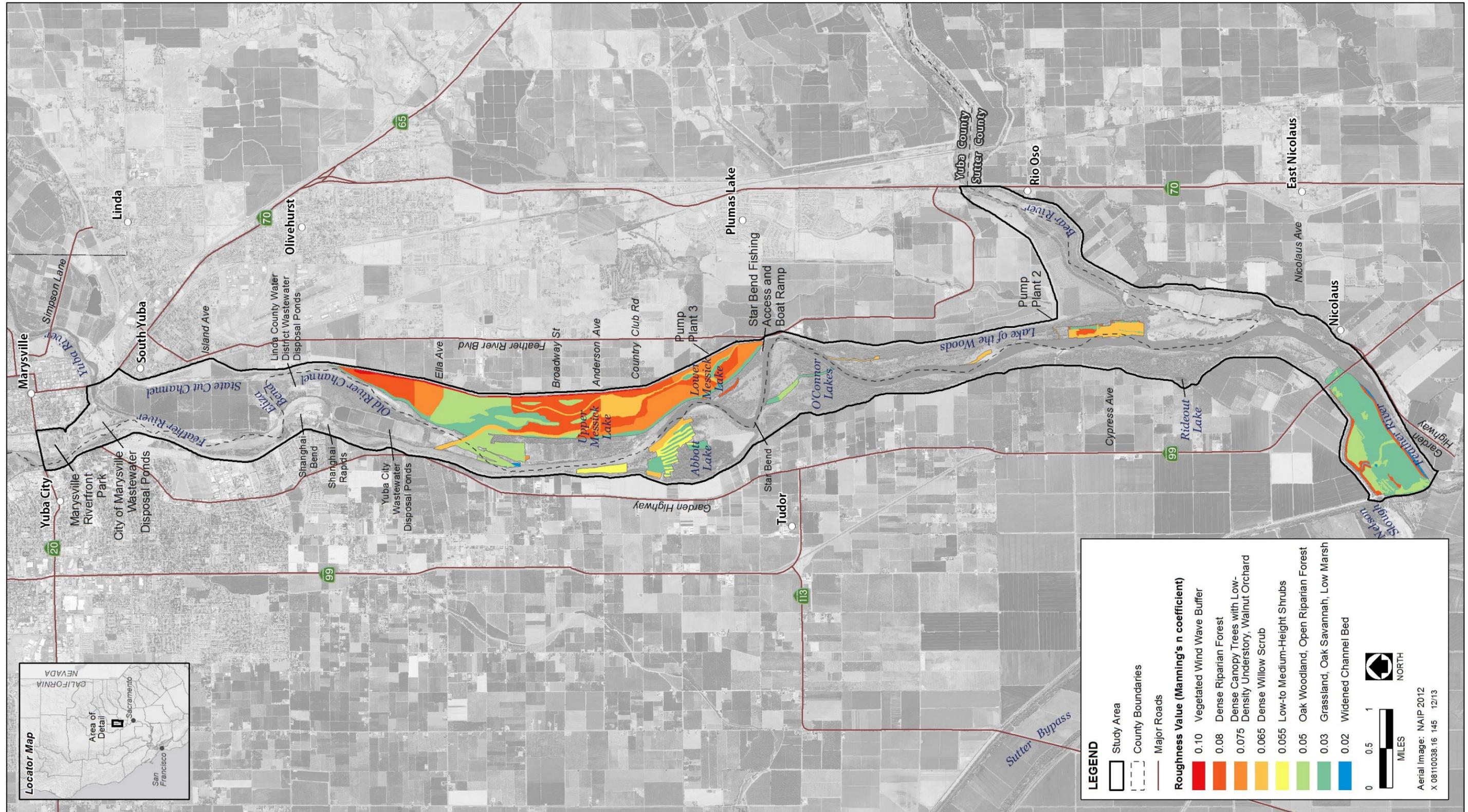
Location of Potential Future Restoration Projects in the LFRCMP Study Area



Source: AECOM 2013

Exhibit M-5

Typical Cross Section of Proposed Restoration in Feather River Setback Area at River Mile 22.2, Lower Feather River-Future Vegetation



Source: AECOM 2013, CBEC 2013

Exhibit M-6

Modeled Roughness Values for Future Vegetation at Proposed Restoration Sites in the LFCRMP Study Area

M.3.3 SOILS AND DEPTH TO GROUNDWATER

Soil conditions are a crucial determining factor in the survival and growth of restoration plantings and natural colonization. Soil analysis conducted by TRLIA suggests that the FRS area supports conditions conducive to riparian restoration, including deep soils with high moisture-holding capacity and few barriers to plant growth (TRLIA 2013).

Depth to groundwater is also an important constraint in the survival and growth of riparian plantings. Depth to the water table must be determined at several points across the proposed restoration sites using deep soil–auger cores and soil pit samples, or with piezometers. Cottonwoods and willows must grow their roots into the upper portion of the water table or capillary moisture zone within the 3- to 5-year maintenance period, or they may not survive or thrive when irrigation is stopped.

With this need in mind, this Conceptual Restoration Plan has concentrated riparian planting sites at lower, more frequently inundated elevations and in swales, and in valley oak woodland, native grassland, and upland scrub plantings at higher elevations relative to the base-flow water surface. Absent any empirical information about depth to groundwater, it is reasonably assumed that seasonal groundwater elevation is comparable to river stage in adjacent channels.

M.3.4 NON-NATIVE INVASIVE PLANTS

Invasive plant species that degrade habitat quality and alter ecosystem processes have become especially abundant in stream reaches where geomorphic processes have been disturbed. Dense stands of invasive species can alter channel morphology by retaining sediments and increasing the channel’s hydraulic roughness, thereby restricting flows and reducing flood conveyance (Bossard et al. 2000). Species with shallow root systems, such as giant reed (*Arundo*) and red sesbania, promote bank undercutting, collapse, and erosion (Bossard et al. 2000). Invasive plants can also reduce the integrity of native riparian and upland plant communities by outcompeting native plant species and reducing habitat quality and food supply for invertebrates and wildlife (Bossard et al. 2000; Cal-IPC 2011).

Non-native invasive species such as giant reed, tree-of-heaven, perennial pepperweed, star thistle, and Himalayan blackberry are established throughout the LFRCMP study area. Some of these species, particularly giant reed and tree-of-heaven, can impede the flow of floodwaters and raise water surface elevations, and can capture sediment and create depositional mounds. Tree-of-heaven forms clonal colonies that can take over native riparian plant communities and may destabilize levee banks. Giant reed is highly flammable, increasing the risk of wildfire in the corridor. Riparian tree species have a low tolerance of wildfire and may not recover naturally after a hot fire in an understory of giant reed. All of these invasive species can alter the structure, function, and composition of plant communities in riparian and adjacent habitats, and they compete with and displace native vegetation in the LFRCMP study area. They also generally provide low-quality wildlife habitat.

M.3.5 HERBIVORES

Herbivory and stem girdling by deer, beavers, ground squirrels, pocket gophers, voles, rabbits, and hares can adversely affect restoration efforts during the establishment phase that follows planting and seeding. Measures such as cages and exclusion fencing can help control or minimize the effects of herbivores on young plants. In

addition, restoration sites are typically “overplanted” to allow for plant damage and loss by herbivores, without affecting the overall success of the restoration project.

M.4 RESTORATION OBJECTIVES AND IMPLEMENTATION

M.4.1 HABITAT ENHANCEMENT FOR WILDLIFE

One of the primary objectives of the restoration activities described in this plan is to enhance habitat for special-status wildlife species that currently occur or could potentially occur in the LFRCMP study area, and to promote the general health and diversity of wildlife populations. Many studies have demonstrated the value to biological diversity of the riparian and oak woodland habitats that are proposed for restoration.

More than 225 species of birds, mammals, reptiles, and amphibians depend on California’s riparian habitats, and riparian ecosystems support the most diverse bird communities in the arid and semiarid portions of the western United States (RHJV 2004). Increasing the expanse of riparian habitat in the LFRCMP study area would certainly enhance the area’s overall habitat value to many species. Specifically, such an increase would help to achieve the optimal goal of protecting and restoring riparian habitat in patches collectively totaling more than 1,200 acres within a river reach, to promote conditions suitable for western yellow-billed cuckoo (RHJV 2004).

Recent studies have highlighted the importance of the Sacramento Valley population of western yellow-billed cuckoo to its recovery in California. Continued efforts to restore riparian habitat and the river processes that maintain them are needed to aid cuckoo recovery (Dettling and Howell 2011). Although no cuckoos were documented in the study area during focused surveys conducted in 2012 (Dettling and Seavy 2013), they have occurred in the past. In addition, the number and locations of cuckoo detections are known to fluctuate considerably between years in areas with known breeding populations.

Other neotropical migrant birds that nest in the region, such as black-headed grosbeak, blue grosbeak, yellow-breasted chat, and yellow warbler, would benefit from restoration of structurally complex areas of riparian forest and scrub. These habitats are also preferred by least Bell’s vireo. Although this species had not nested in the Central Valley for the previous 50 years, least Bell’s vireos have nested in recently restored riparian habitat at the San Joaquin River National Wildlife Refuge in recent years, and breeding populations in Southern California have increased considerably in recent decades. This subspecies may continue to expand northward and reoccupy additional areas from which it has been extirpated. These vireos prefer dense shrubby vegetation that tends to mature into taller forests with a less dense, less desirable understory. Therefore, ecologists have highlighted the importance of riparian restoration designs that promote a thick understory, management that promotes understory growth, and restoration of natural processes (e.g., flooding) that promote growth of new vegetation (Howell et al. 2010). Such restoration and management approaches would also benefit many additional bird species and other wildlife.

Like riparian habitat, oak woodlands proposed for restoration in the LFRCMP study area are used by a wide variety of species. These woodlands have the richest wildlife-species abundance of any habitat in California; more than 330 species of birds, mammals, reptiles, and amphibians depend on them at some stage in their life cycle (CalPIF and PRBO 2002). Wilson and others (1991) have suggested that California oak woodlands rank among the top three habitat types in North America for bird species richness. These habitats can sustain such high wildlife diversity and abundance largely because they produce acorns. Acorns are a very high-quality food type that, in turn, supports an abundant and diverse community of invertebrates and other species that depend on the

acorns and invertebrates for food. Oak woodlands also provide important sheltering and breeding habitat for a wide variety of reptiles, amphibians, and mammals.

The proposed target upland habitats would also provide foraging habitat for Swainson’s hawk and numerous other species. Tall sycamore, cottonwood, and valley oak trees in riparian forest and oak woodlands would provide nesting and perching sites for Swainson’s hawk, Cooper’s hawk, white-tailed kite, and other raptors. Wide-ranging mammals such as grey fox, Sacramento valley red fox, and black-tailed deer would benefit from the increased connectivity of riparian forest/scrub, oak woodland, and native upland scrub. In addition, creating high ridges with material excavated from swales would provide wildlife refugia for terrestrial species during flood events that otherwise would inundate all natural habitat within the floodway. These artificial upland areas would have relatively arid soil conditions, and would therefore be vegetated with grassland, scrub, and scattered oaks that provide food and cover for a variety of wildlife species.

Table M-3 outlines overall restoration objectives for diverse plant and wildlife species, vegetation, and habitats; for floodway maintenance activities; and for flood flow conveyance. The table also provides some corresponding design considerations to help achieve these objectives.

Objective	Design Consideration
Maintain high structural diversity of plant species and vegetation	Vary density across the site to allow light gaps and create structural differences (grouping trees creates pockets of shade and light gaps); create vegetation patches (grouping small shrubs together mimics larger plants and may attract desirable wildlife species faster than if they are grown apart); and consider herbaceous plantings between plant rows. Bird diversity is highest in areas with five to seven shrub species over an area of 50 square meters.
Provide immediate (< 3 years) habitat benefits	In the short term, use relatively transient species (cottonwood and arroyo willow) to provide several generations of targeted bird species with nesting and foraging habitat. Planting a mixed riparian forest maximizes quality habitat as the slow-growing but shade-tolerant oaks mature. Coyote brush, rose, elderberry, and blackberry grow quickly and create habitat for quail and many neotropical migrants.
Create migratory and nesting/roosting corridor for yellow-billed cuckoo	Plant a high density of cottonwood and sycamore trees within a 300-foot-wide mixed riparian plant community.
Provide foraging and nesting sites for Swainson’s hawk	Plant tall riparian trees to provide nesting and perching areas for Swainson’s hawks and other raptors and perennial grassland to provide foraging habitat.
Seek opportunities to promote natural riverine processes and development of SRA habitat and bank swallow nesting habitat	Evaluate the feasibility of revetment removal in areas where bank protection is no longer deemed necessary, in order to promote restoration of natural riverine processes and habitat (SRA habitat and bank swallow nesting sites).
Minimize sources of weeds; provide habitat along project edges	Use native plants to displace weeds in areas outside the main plantable area. Use spreading plants and native understory species to outcompete invasive species that currently grow on-site.
Provide foraging, roosting, and nesting habitat for neotropical migrant and riparian-dependent bird species	Plant dense shrub clusters to provide cover for roosting and protection from predators. Annual vegetation provides foraging habitat for seed eaters, a dense and open mixed riparian plant community and valley oak riparian forest provides habitat for woodland species, and native grasslands provide habitat for species that utilize open landscapes.

**Table M-3
General Restoration Objectives and Design Considerations for the LFRCMP Study Area**

Objective	Design Consideration
Minimize future impacts on maintenance areas	Do not plant trees within 20 feet of any levee, road, or other infrastructure.
Noelderberry shrubs in floodway maintenance areas	Do not plant elderberry shrubs within 200 feet of levees, levee operations and maintenance roads, or stormwater pump outfalls.
Maintain general flood flow conveyance patterns	Orient rows parallel to general flow direction and do not direct flows toward levees.

Source: RHJV 2009, adapted by AECOM in 2013

M.4.2 TARGET HABITATS AND ASSOCIATED PLANTINGS

Restoration areas and habitat categories proposed for the LFRCMP study area are depicted in Exhibit M-4. The following specific target habitats are described separately below.

- ▶ Dense riparian forest
- ▶ Dense willow scrub
- ▶ Native perennial grassland:
 - Dry upland perennial grassland
 - Moist meadow perennial grassland
- ▶ Oak savanna/perennial grassland
- ▶ Valley oak woodland
- ▶ Native upland scrub

DENSE RIPARIAN FOREST

Dense riparian forest would be restored primarily in the FRS area. Specifically, restoration would occur in the area’s north end, north of and surrounding the Upper Messick Lake basin, on each side of the connection between Upper and Lower Messick lakes, and west of Lower Messick Lake. This habitat is also proposed for small areas adjacent to the slough and the river in the Nelson Slough Unit of the FRWA.

Table M-4 lists the species that would be planted in areas proposed for dense riparian forest and identifies the growth form and planting method for each species. The focus would be on restoring large and medium-sized trees and augmenting these with shrubs, vines, and herbs.

RIPARIAN WILLOW SCRUB

Riparian willow scrub would be restored in the Upper Messick Lake basin and swales proposed for excavation in the FRS area. This habitat also would be restored in the Lake of the Woods Unit of the FRWA and along the river in the Abbott Lake Unit. Table M-5 lists the species that would be planted in areas proposed for dense willow scrub and identifies the growth form and planting method for each species. Plantings would include shrubs and medium-sized trees.

NATIVE PERENNIAL GRASSLAND

Restoration of native perennial grassland would involve restoring both dry upland grassland and moist meadow grassland. The locations and acreage of each perennial grassland type would depend on local site conditions. Tables M-6 and M-7 list the grass species that would be seeded in perennial grassland restoration areas; Table M-7 also identifies optional sedges and rushes that could be planted by plug in moist meadow areas.

OAK SAVANNA/PERENNIAL GRASSLAND

Oak savanna/perennial grassland would be restored primarily in the Nelson Slough Unit of the FRWA. Additional areas would be planted in a portion of the north-central FRS area and in the O'Connor Lakes Unit of the FRWA. Table M-8 lists the species that would be used for restoration of oak savanna/perennial grassland and identifies the growth form and planting method for each species. The focus would be on restoring perennial grasses interspersed with large trees and augmenting these with by smaller trees, shrubs, and other herbs.

Table M-4
Species, Growth Form, and Planting Method for Restoration of Dense Riparian Forest in the LFRCMP Study Area

Botanical Name	Common Name	Growth Form	Planting Method
<i>Acer negundo</i>	Box elder	Tree—medium	Container
<i>Alnus rhombifolia</i>	White alder	Tree—medium	Container
<i>Aristolochia californica</i>	Dutchman's pipevine*	Vine	Container
<i>Artemisia douglasiana</i>	Mugwort	Herb	Seed
<i>Carex barberae</i>	Santa Barbara sedge	Herb	Plug
<i>Carex praegracilis</i>	Slender sedge	Herb	Plug
<i>Clematis angustifolia</i>	Virgin's bower	Vine	Container
<i>Fraxinus latifolia</i>	Oregon ash	Tree—medium to large	Container
<i>Lonicera involucrata</i>	Twinberry	Vine	Container
<i>Platanus racemosa</i>	California sycamore	Tree	Container
<i>Populus fremontii</i>	Cottonwood	Tree—large	Cutting
<i>Quercus lobata</i>	Valley oak	Tree—large	Container
<i>Rosa californica</i>	California wild rose	Shrub	Container
<i>Rubus ursinus</i>	California blackberry	Vine	Container
<i>Salix gooddingii</i>	Black willow	Tree—large	Cutting
<i>Salix laevigata</i>	Red willow	Tree—medium	Cutting
<i>Salix lasiolepis</i>	Arroyo willow	Shrub	Cutting
<i>Vitis californica</i>	California grape	Vine	Container

Notes:
Restoration of dense riparian forest in the LFRCMP study area would encompass 474 total acres, with an average of 270 plants per acre.
*Host plant of pipevine swallowtail butterfly.
Source: Data compiled by AECOM in 2013

**Table M-5
Species, Growth Form, and Planting Method for Restoration of Riparian Willow Scrub in the LFRCMP Study Area**

Botanical Name	Common Name	Growth Form	Planting Method
<i>Acer negundo</i>	Box elder	Tree—medium	Container
<i>Alnus rhombifolia</i>	White alder	Tree—medium	Container
<i>Baccharis salicifolia</i>	Mulefat	Shrub	Container
<i>Cephalanthus occidentalis</i>	Buttonbush	Shrub	Container
<i>Rosa californica</i>	California wild rose	Shrub	Container
<i>Salix exigua</i>	Sandbar willow	Shrub	Cutting
<i>Salix laevigata</i>	Red willow	Tree—medium	Cutting
<i>Salix lasiolepis</i>	Arroyo willow	Shrub	Cutting

Notes:
Restoration of riparian willow scrub in the LFRCMP study area would encompass 264 total acres, with an average of 300 plants per acre.
Source: Data compiled by AECOM in 2013

**Table M-6
Species and Planting Method for Restoration of Dry Upland Perennial Grassland in the LFRCMP Study Area**

Botanical Name	Common Name	Planting Method
<i>Elymus glaucus</i>	Blue wildrye	Seed*
<i>Elymus trachycaulus</i>	Slender wheatgrass	Seed
<i>Hordeum brachyantherum</i> ssp. <i>californicum</i>	California barley	Seed
<i>Leymus triticoides</i>	Creeping wildrye	Seed
<i>Melica californica</i>	California melic	Seed
<i>Nassella pulchra</i>	Purple needlegrass	Seed
<i>Poa secunda</i> ssp. <i>secunda</i>	Pine bluegrass	Seed

Notes:
*Seed mix application rate varies based on site conditions, typically 13–22 pounds per acre.
Source: Data compiled by AECOM in 2013

**Table M-7
Species and Planting Method for Moist Meadow Perennial Grassland Restoration in the LFRCMP Study Area**

Botanical Name	Common Name	Planting Method
<i>Agrostis exarata</i>	Bentgrass	Seed*
<i>Elymus trachycaulus</i>	Slender wheatgrass	Seed
<i>Hordeum brachyantherum</i>	Meadow barley	Seed
<i>Leymus triticoides</i>	Creeping wildrye	Seed
<i>Muhlenbergia rigens</i>	Deergrass	Seed or plug

<i>Carex barberae</i> (optional)	Santa Barbara sedge	Plug
<i>Carex praegracilis</i> (optional)	Slender sedge	Plug
<i>Eleocharis macrostachya</i> (optional)	Common spikerush	Plug
<i>Juncus balticus</i> (optional)	Baltic rush	Plug
<i>Juncus hesperius</i> (optional)	Common rush	Plug
<i>Juncus xiphiodes</i> (optional)	Flat-bladed rush	Plug
Notes: * Seed mix application rate varies based on site conditions, typically 13–22 pounds per acre. Source: Data compiled by AECOM in 2013		

Table M-8 Species, Growth Form, and Planting Method for Restoration of Oak Savanna/Perennial Grassland in the LFRCMP Study Area			
Botanical Name	Common Name	Growth Form	Planting Method
<i>Acer negundo</i>	Box elder	Tree—medium	Container
<i>Artemisia douglasiana</i>	Mugwort	Herb	Seed
<i>Baccharis pilularis</i>	Coyote brush	Shrub	Container
<i>Carex barberae</i>	Santa Barbara sedge	Herb	Plug
<i>Carex praegracilis</i>	Slender sedge	Herb	Plug
<i>Platanus racemosa</i>	California sycamore	Tree—large	Container
<i>Quercus lobata</i>	Valley oak	Tree—large	Container
<i>Sambucus mexicana</i>	Elderberry	Shrub	Container
Perennial grass seed mix (dry upland or moist meadow, depending on site conditions)		Herb	Seed
Note: Restoration of oak savanna/perennial grassland in the LFRCMP study area would encompass 512 total acres, with an average of 20 or fewer trees per acre. Source: Data compiled by AECOM in 2013			

VALLEY OAK WOODLAND

Restoration of valley oak woodland is proposed for a large portion of the north-central FRS area. This habitat would also be restored in the O’Connor Lakes and Nelson Slough units of the FRWA. Table M-9 lists the species that would be planted in valley oak woodland restoration areas and identifies the growth form and planting method for each species. The focus would be on restoring large and medium-sized trees and augmenting these with a variety of shrubs, vines, and herbs.

NATIVE UPLAND SCRUB

Native upland scrub would be restored in the central FRS area and at two locations in the Abbott Lake Unit of the FRWA. Plantings in the FRS area would be associated with upland ridges constructed with material excavated

from the proposed swales. In the Abbott Lake Unit, a large contiguous area of upland scrub would be planted in the northern portion of the unit between the river and the levee, and strips of upland scrub would be planted parallel to the river in the southern portion of the unit. Table M-10 lists the species that would be planted in upland scrub restoration areas and identifies the growth form and planting method for each species. The variety of shrubs would be augmented by California buckeye, mugwort, and native grasses.

M.4.3 RESTORATION PLANTING AND MAINTENANCE GUIDELINES

PLANTING SCHEDULE

Table M-11 provides an overview of the proposed schedule for planting activities in the LFRCMP study area.

Table M-9 Species, Growth Form, and Planting Method for Restoration of Valley Oak Woodland in the LFRCMP Study Area			
Botanical Name	Common Name	Growth Form	Planting Method
<i>Acer negundo</i>	Box elder	Tree—medium	Container
<i>Aesculus californica</i>	California buckeye	Tree—medium to large	Container
<i>Aristolochia californica</i>	Dutchman's pipevine*	Vine	Container
<i>Artemisia douglasiana</i>	Mugwort	Herb	Seed
<i>Baccharis pilularis</i>	Coyote brush	Shrub	Container
<i>Carex barberae</i>	Santa Barbara sedge	Herb	Plug
<i>Carex praegracilis</i>	Slender sedge	Herb	Plug
<i>Cercis occidentalis</i>	Western redbud	Shrub	Container
<i>Lonicera involucrata</i>	Twinberry	Vine	Container
<i>Fraxinus latifolia</i>	Oregon ash	Tree—medium to large	Container
<i>Heteromeles arbutifolia</i>	Toyon	Shrub	Container
<i>Juglans californica</i> var. <i>hindsii</i>	Black walnut	Tree—medium to large	Container
<i>Platanus racemosa</i>	California sycamore	Tree—large	Container
<i>Quercus lobata</i>	Valley oak	Tree—large	Container
<i>Rhamnus californica tomentella</i>	Hoary coffeeberry	Shrub	Container
<i>Rosa californica</i>	California wild rose	Shrub	Container
<i>Rubus ursinus</i>	California blackberry	Vine	Container
<i>Sambucus mexicana</i>	Elderberry	Shrub	Container
Perennial grass seed mix (dry upland or moist meadow, depending on site conditions)		Herb	Seed
Notes:			
Restoration of valley oak woodland in the LFRCMP study area would encompass 317 total acres, with an average of 100 trees per acre.			
*Host plant of pipevine swallowtail butterfly.			
Source: Data compiled by AECOM in 2013			

**Table M-10
Species, Growth Form, and Planting Method for Restoration of Native Upland Scrub in the
LFRCMP Study Area**

Botanical Name	Common Name	Growth Form	Planting Method
<i>Aesculus californica</i>	California buckeye	Tree—medium to large	Container
<i>Artemesia douglasiana</i>	Mugwort	Herbaceous	Seed
<i>Baccharis pilularis</i>	Coyote brush	Shrub	Container
<i>Cercis occidentalis</i>	Western redbud	Shrub	Container
<i>Heteromeles arbutifolia</i>	Toyon	Shrub	Container
<i>Rhamnus californica tomentella</i>	Hoary coffeeberry	Shrub	Container
<i>Sambucus mexicana</i>	Elderberry	Shrub	Container
Perennial grass seed mix (dry upland or moist meadow, depending on site conditions)		Herb	Seed

Notes:
Restoration of native upland scrub in the LFRCMP study area would encompass 137 total acres, with range of 100 - 300 shrubs per acre.
Source: Data compiled by AECOM in 2013

**Table M-11
Proposed Planting Schedule for Restoration in the LFRCMP Study Area**

Restoration Year	Months	Activity
Year 1		Seed and cutting collection for nursery growth; soil testing
Year 2	June	Site preparation: Preservation fencing, staking, clearing, BMPs
Year 2	June–August	Earthwork: Excavation, grading, topsoil conservation, geotechnical measures, BMPs
Year 2	August–September	Irrigation system: Water tanks, water tank pads, pipes, bubbler systems
Year 2	October–November	Planting: Container plants, cutting and plug collections, seeding and mulching
Years 3–6		Maintenance period: Irrigation, weed control, debris removal, replanting/reseeding (as needed), vegetation monitoring

Note: BMPs = best management practices
Source: Data compiled by AECOM in 2013

SITE PREPARATION AND GRADING

All restoration sites should be cleared of all trimmings, trash, and debris. Using the appropriate machinery (e.g., a low-ground-pressure dozer or tractor equipped with hydraulic controls necessary for selected tillage and leveling equipment), surfaces in the area to be restored should be disced and leveled. Leveling would not occur when planting is associated with swales, ridges, or other topographic features. The goal is a weed- and thatch-free soil surface that is uniform, free of ridges or depressions, and tilled to a depth of at least 6 inches. Grading typically occurs during the dry season, when there is no flow in the streams and with ample time before fall rains, to minimize the potential for soil compaction, erosion, and sediment. Best management practices (BMPs) should be implemented throughout the restoration area during construction, especially downslope and downstream of potential construction-generated sediment source materials.

For most vegetation types, plant layout would be based on pulled planting berms running in curving, sinuous rows parallel to flood flows (Exhibit M-7). This method helps create a more natural layout and avoid an orchard-like appearance over time. Pulled planting berms are created using angled twin disc blades pulled along predetermined centerline locations. Dimensions, locations, orientation, and sinuosity would be determined based on site conditions.

HORTICULTURAL SOIL TESTING

Soil testing is a critical step in designing and implementing a successful restoration program because soil toxicity or incompatibility problems such as excessive salinity or alkalinity, the overabundance of certain elements such as magnesium, or low soil nutrition cannot be readily determined in the absence of agricultural suitability tests. If left undetected, these problems have the potential to result in widespread plant mortality or poor growth performance. The primary goals of soil testing are to finalize the planting lists, identify difficult soils and possible soil treatments, detect variation in the soils throughout the site, and determine agricultural regimes during establishment maintenance.

Soil analysis reveals several chemical and physical characteristics, such as salinity, pH, fertility, and permeability. Understanding these characteristics of the native soils provides a “restoration template” and assists in selection of an appropriate plant palette. Recommendations for soil amendments and improvements in soil conditions may correct for pH or fertility problems or may improve permeability. However, certain soil conditions should dictate changing the plants used rather than the soils themselves, if the soils support a unique plant community.

PRE-PLANTING WEED MANAGEMENT

The purpose, methods, and timing of weed management are designed to remove weed species that threaten the establishment of native species to be planted or can displace those native species, and to prevent the dispersal of weed seed by killing weeds before flowering or development of viable seed. Invasive exotics that are allowed to become established frequently require repeated control efforts.

Weed control in the restoration areas should follow an Integrated Pest Management (IPM) approach. IPM is a decision-making and management process that uses knowledge from a broad base of expertise, a combination of treatment methods, and a monitoring and evaluation system to solve pest problems in an environmentally sound and cost-effective manner. IPM programs emphasize preventing weeds by using knowledge about the biology and behavior of weed species to identify and remove the conditions that support weeds.

A wide array of methods are available for weed biomass control: physical/mechanical control (e.g., mowing, discing, brush cutting, hand pulling), biological controls (e.g., grazing, insect parasites), other control methods (e.g., prescribed burns, use of a flaming device), and in some cases localized application of herbicides (chemical control). Mechanical, manual, and grazing methods of eradicating exotic species should take precedence over chemical eradication. When needed, herbicides should be used in conjunction with physical and/or mechanical or other non-chemical methods, rather than being used as the sole management tool. This integrated approach helps to minimize use of herbicides in the long term; it also enhances the efficacy of the lowest risk chemical products and formulations because they are augmented with other methods. After plants have been installed, spot treatments rather than broadcast sprays are preferred to limit or avoid impacts on non-target organisms.



Source: Google Earth image dated August 13, 2013 of Natomas Basin mitigation site along Sacramento River levee

Exhibit M-7

Example of Restoration Project Using a Sinuous Planting Pattern

Species-specific weed control recommendations should be developed for invasive exotics that require control in restoration areas. These recommendations should take into account weed characteristics such as flowering time, life form, and germination period, as well as common proven control methods. Grazing, mowing, prescribed burning, and chemical treatment are discussed below as they pertain to weed-control efforts.

Grazing

Small-hoofed animals, such as sheep or goats, can be used to manage upland and wetland vegetation and suppress the proliferation of postplanting weed populations. Grazing techniques can be used to either trim vegetation tops (similar to mowing) or remove vegetation more thoroughly (similar to burning). Grazing may also be employed to remove aquatic vegetation if a ditch or seasonal swale is dewatered.

Grazing for control of noxious weeds should typically occur in spring, after the dominant noxious weed species have flowered but before they have set seed. Preferred timing varies depending on weather conditions, and should be based on field observations. Grazing should not occur between May 1 and July 1 to allow native perennial grasses to set seed. Grazing to control vegetation height should occur between July 1 and October 1.

The use of grazing animals should be evaluated to ensure that hoofed animals are not causing bank erosion, excessive browsing or girdling of woody plants, or damage to perennial grassland cover.

Mowing

Mowing can be used to control vegetation height and excessive biomass, and to discourage the spread of noxious broad-leaved weeds. Mowing would be conducted with a wheeled tractor with boom-mounted flail mower and/or a rear-attached flail mower, or a with a self-contained riding-type mower. All mowers should be equipped with height gauges set to leave the remaining vegetation approximately 6–12 inches tall, except for access roads where vegetation can be cut to leave the access roads clean of cover.

Mowing for control of noxious weeds should typically occur in spring, after the dominant noxious weed species have flowered but before they have set seed. Preferred timing varies depending on weather and soil conditions, and should be based on field observations. Mowing generally should not occur between May 1 and July 1 to allow native perennial grasses to set seed, unless controlling noxious weeds or reducing fire-hazard biomass is a high priority. Mowing to control vegetation height should typically occur between July 1 and October 1.

Prescribed Burning

Prescribed burning is the practice of using controlled fires to reduce or eliminate unwanted organic matter in grasslands and ruderal vegetation areas. If conditions are conducive and safe (e.g., favorable wind conditions, vegetation moisture content, and sufficient fuel material), burning has been shown to be effective in reducing organic matter (i.e., thatch), broad-leaved weeds, and annual grasses, and in promoting growth of native perennial grasses.

Prescribed burning should occur infrequently, primarily to control thatch buildup, if not adequately controlled with other vegetation management methods. Prescribed burning must be conducted in coordination with the local fire district and in accordance with all laws and local ordinances. Timing of prescribed burns should take into account the habits of protected and other native wildlife species.

Chemical Treatment

Use of contact, pre-emergent, and systemic herbicides can be valuable and highly effective in suppressing terrestrial weedy plants. Selective herbicides can be used instead of broad-spectrum herbicides that may cause mortality of desirable vegetation. Herbicides may be used before planting to eliminate weeds and weed seeds present in the soil. The type and timing of herbicide application must be selected to prevent herbicide persistence in the soil and any adverse effect on woodland plantings and germination of native grass seedlings.

PLANT AND SEED PROCUREMENT

The plant species listed in Tables M-4 through M-10 are native to the region and have been carefully selected for the habitats to be created. When properly planted and cared for, these species offer the best chance of successful establishment in the absence of permanent irrigation. Therefore, only these or other carefully considered native species should be used in restoration projects.

To preserve ecotype differences of local native plant populations, local sources of container plants, cuttings, plugs, and seed should be used to the greatest extent feasible. A lead time of 12–18 months is required from time of seed or cutting collection to transplant maturity for plants grown in containers at a nursery. Suppliers and nurseries providing stock should certify the origin of their source material.

Care should be taken to protect plants from wind, heat, and other conditions that can damage or impair viability, both during delivery and when temporarily stored on-site before planting. Once transported to the planting site, container stock should be planted promptly unless properly protected and irrigated.

SOIL PREPARATION

Planting areas must be thoroughly wetted to settle the soil and confirm irrigation coverage and operation before planting. The soil would then be allowed to dry to render it workable. Seeded planting areas are typically tilled to a depth of 6 inches or greater, in two directions, before planting operations begin. Should restoration activities encounter large rocks, roots of existing trees, or other underground obstructions that interfere with excavation for plants, or should clay-based areas be encountered that are not acceptable for good root growth, a restoration ecologist may need to modify the planting plans for affected areas in the field.

SEEDING TECHNIQUES

Planting should begin in the fall to early winter, once rains have “flushed” winter weeds; herbicides should be applied just before planting to kill sprouting winter weeds. Several seeding methods—drill seeding, broadcast seeding, hydroseeding, and ridge-roller-seeding—are available for seed application. Using either a ridge-roller-seeder or a native-grass seed drill (e.g., Truax Grass Drill) with supplemental surface preparation is the recommended method for seeding uplands.

A ridge-roller-seeder is a specialized type of seeding equipment similar to a typical rice roller. Seed is typically drilled in rows at a maximum distance of 8 inches apart and to a depth of 1/2 to 1 inch. In areas that are too constricted to operate a grass seed drill, mechanical broadcast seeding is recommended. Following broadcast seeding, the seed must be worked into the soil surface by hand raking or lightly harrowing and the seed must be

covered with adjacent soil to a 1/4-inch depth. A light-duty ring roller or Fuerst tine harrow or equivalent is used after broadcast seeding, or is attached to the seeder, to ensure light soil coverage of broadcast seed.

Areas to be seeded near and within the driplines of existing vegetation to remain or of recently planted shrubs or trees should be seeded by hand and these areas should be hand-raked to cover the seeds and avoid damaging the root zone, the trunk, or any vegetation to remain. Upon completion of seeding, certified weed-free straw mulch can be blown or spread by hand, as appropriate, then "tucked in" or anchored into the soil.

LOCAL PLUG COLLECTION AND PLANTING TECHNIQUES

Plug salvage/collection and planting should occur in the fall, concurrent with other planting activities. Sedges and rushes typically can be planted at the edges of perennial waters well into the summer, but this is ultimately dependent on specific site characteristics.

Planting can be accomplished using a long-handled dibble for smaller plugs, or trowels or shovels for larger plugs. Holes dug for the plugs should be only slightly larger than the plugs, and the sides and bottoms of holes should not be compacted. When backfilling the planting hole with native soil, care must be taken to remove all air pockets. Ensuring that the plug roots are in contact with the soil and completely covered is critical to making certain that the plugs will not dry out. The plugs should be thoroughly watered-in on the day they are planted. Irrigation may be required to keep the transplanted plugs alive, especially through the first summer season.

CONTAINER PLANTING TECHNIQUES

For optimal results, planting should be done when the soil is moist to a depth of 12 inches, usually after the first fall rains. Alternatively, plant locations must be watered for a minimum of 8 hours immediately before plant installation. In a normal season, November is the preferred month for planting. The physiological state of the plants is optimal during the fall and winter; therefore, adhering to appropriate planting schedules enhances restoration success. Furthermore, planting during the fall drastically reduces the need for supplemental irrigation because roots have more time to develop before aboveground shoot growth begins.

Before plants are installed, the irrigation system must be installed and any weeds that have sprouted since clearing operations should be removed by mechanical or manual methods within a 48-inch radius of individual planting sites and disposed of off-site. These weeds would otherwise compete for moisture and sunlight critical to the establishing plants.

Restoration drawings and specifications should be organized by planting zone and should include plant name, container type and size (e.g. Treepot⁴, Deepot, and Tree Band), spacing, quantity of each plant species, and year to be installed. Plants should be set out on the same day they are to be planted. Nurseries that specialize in plants for large-scale restoration projects typically offer relatively small plants grown in containers that are longer than the width of the container to accommodate deeper roots, minimize irrigation dependency, and promote root soil exploration.

The locations of individual plantings along the pulled planting berms should be field marked (e.g., painted, staked or flagged) by plant species. Plants are installed in the center of pulled planting berms, typically in a linear spacing of between 10 and 20 feet on-center. Plants are laid out at a typical density shown on the plan set, and are located somewhat irregularly in clusters by species to avoid an orchard-like appearance and to mimic a natural

layout (Exhibit M-8). Plants should not be located too close to access roads, staging locations, mowed perimeters, irrigation ditches, utility corridors, or other known exclusion areas.

Soil preparation is intended to expand and improve the rooting area for each plant by decompacting (aerating) the soil at individual planting sites. Planting pits may be excavated using one or more methods such as hand digging and using a pry bar, hydraulic bar, and/or auger. Planting holes are typically dug to a depth of 18 inches by 24 inches wide, then are backfilled with native soil free of amendments up to the level of the rootball. Each plant is placed in the planting hole and the hole is filled with moist, pulverized backfill, which is then tamped and watered. The plant is positioned with the root crown set no more than ½ inch above grade at the time of planting, and is covered with a maximum of ¼ inch of backfill. Backfill material should be firmly packed in place and should make good contact with the rootball, leaving no air pockets. Additional fill may be required in case of soil settlement.

Watering basins, which eventually settle and erode, may be necessary to prevent water from running off. These basins around individual plants typically measure 4 inches high and 36 inches in diameter, or are created using pulled berms and parallel irrigation gutters as shown in Exhibit M-8. Planting techniques on slopes differ slightly from planting techniques on level ground. To accommodate slope plantings, a small planting terrace is excavated approximately 20 inches wide and 15 inches deep and sloped slightly to the hill. A 4-inch berm is built on the open side to collect water. At the time of planting, all watering basins should be filled to capacity to check for soil berm stability and basin drainage. Basins are not necessary for live willow cuttings.

Plant protection cages or tubes must be installed around all container-grown shrubs and trees at the time of planting, and all plants must be watered thoroughly regardless of soil moisture conditions.

CUTTING COLLECTION AND PLANTING

Cuttings collected from willow and cottonwood donor plants should be collected from various representative sources in the vicinity of the restoration site to preserve the genetic diversity and viability of the cuttings. Cutting materials are harvested when the trees are dormant, typically during January and February, from green wood that is disease free and healthy, with a maximum of 1 year of growth. The source-plant collection area must be able to physically and visually recover to undisturbed conditions within a reasonable period. Live cuttings of willow and cottonwood should be a minimum of 30 inches long, tapered from a minimum of ½ inch to a maximum of 1½ inches in diameter, and cut at a right angle at the wide end of the cutting. Each bundle of cuttings is wrapped in burlap or other approved material that protects the cuttings from sunlight and allows air to circulate within the bundle. Immediately after bundling, the cuttings must be kept cool, at a temperature less than 60 degrees Fahrenheit, and saturated in water until just before installation.

Planting holes for cuttings typically measure approximately 24–36 inches deep by approximately 8 inches wide. Depending on the planting surface, it is expected that excavation of a planting pit may require the use of such methods as hand digging or use of a pry bar, hydraulic bar, and/or auger. Alternatively, in loamy, sandy soil with adequate soil moisture, cutting stock may be hammered into the ground. All cuttings should be installed with two-thirds of their length below grade, with the angled end placed in the ground. The planting hole is then filled with moist, pulverized backfill and tamped in place to remove air pockets.

PLANT PROTECTION

Restoration projects must cope with the destructive effects of herbivores during the first few years of establishment. Beaver, deer, ground squirrels, pocket gophers, rabbits and hares, and voles all pose a challenge, so plants must be protected to prevent damage by browsing animals. Several measures can help control or minimize the effects of herbivores on young plants.

Installing browse cages around all container plants on the day of planting is recommended (Exhibit M-9). These lidded cages are typically constructed of aviary wire approximately 3 feet high and 2 feet in diameter, and secured with wooden stakes to provide for at least 2 years of growth.

Agricultural practices such as mowing or spraying unpalatable emulsions can also discourage most herbivores. Some damage by herbivores is tolerable and should not affect the success of the planting because restoration areas are typically overplanted to accommodate loss for various reasons. However, beavers can cause extensive damage to restoration sites near perennial water, such as the LFRCMP study area. Barriers or daily monitoring should be an integral part of the initial planting plan at such locations.

In some areas, the detrimental impact of beavers on newly installed woody species is significant enough to necessitate installing beaver exclusion fencing along the river or perennial water bodies where beaver populations are or may be present.

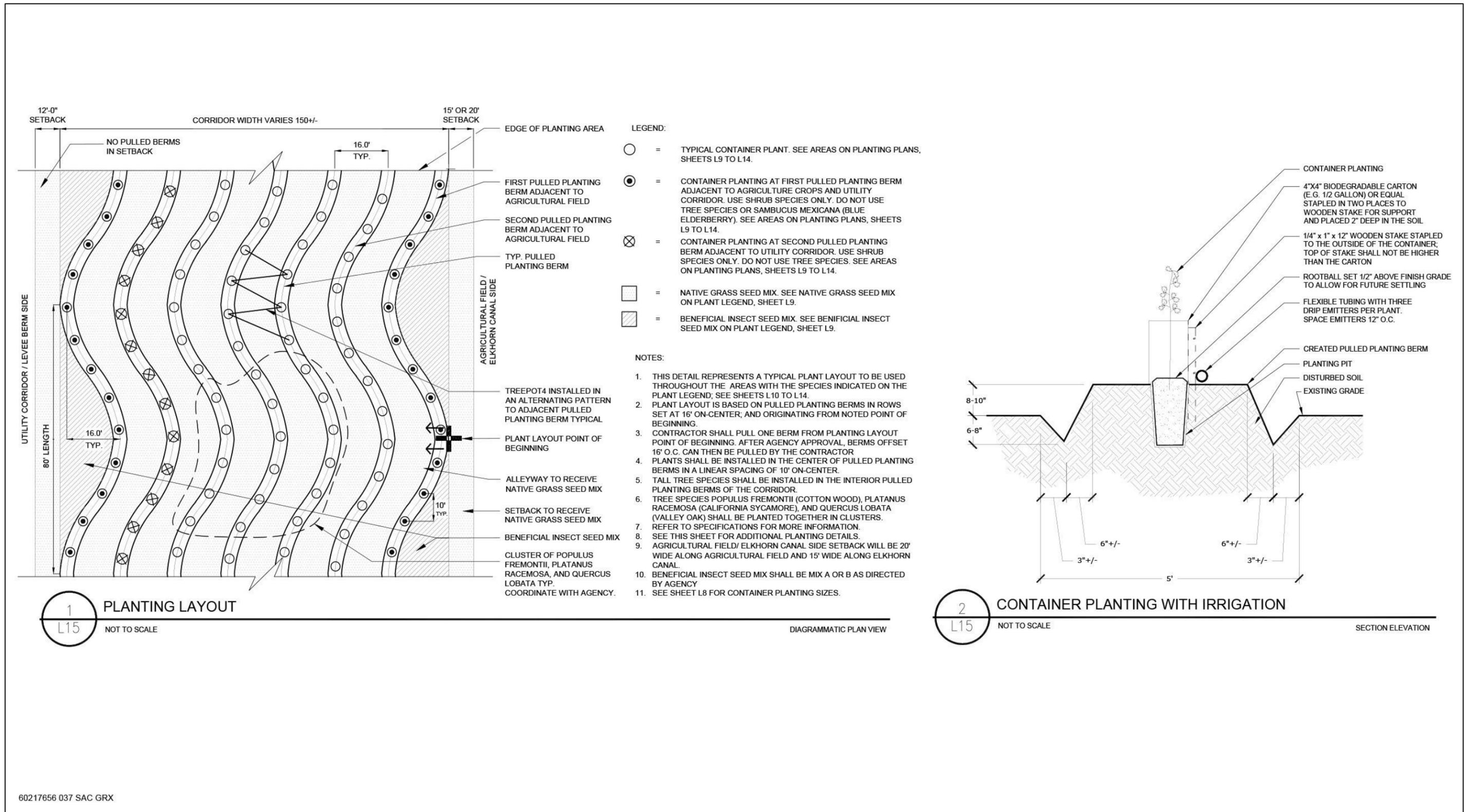
FLOOD AND FIRE CONTINGENCIES

Care should be taken to rid the restoration site of excess flammable material such as dry thatch or undergrowth to reduce the risk of wildfire. Throughout implementation, the restoration contractor should also periodically mow between rows and clusters, and along the perimeter of the restoration area, to reduce potential fire hazards. In areas frequented by humans, intentional or accidental wildfire is a constant threat to new planting sites. Exhibit M-10 shows where a wildfire occurred in 2012 at a restoration site in the O'Connor Lakes Unit of the FRWA. The best fire prevention measures are reducing biomass fuel (dry thatch and annual grasses) in planted areas and creating firebreaks by mowing or discing perimeters. Before flood season (which typically begins November 15), all equipment, planting debris, and stockpiled material should also be removed.

IRRIGATION

Because of the dry summers typical of the climate in the area, irrigation would be required for the first 2–5 years after installation to ensure plant establishment and survival. Soil characteristics at the restoration sites would determine whether drip emitters, spray heads, and/or flood irrigation should be used. A plan view of a typical container planting with drip emitter irrigation system is depicted in Exhibit M-8.

In the first growing season, the rapidly growing seedlings have roots only near the surface (the top 1–2 feet) of the soil profile. During the first year, using soil moisture probes to monitor and maintain moisture throughout the soil column is recommended to keep the shallow roots of young plants moist, ensuring optimum growth and survival. The intervals between irrigations depend on soil texture, depth to water table, weather conditions, and plant water stress. Because there would likely be a mixture of species with different water demands, the plants must be observed carefully to maintain a balance of soil moisture that is acceptable for xeric species like valley oak and elderberry as well as more mesic species like cottonwood and willow.



1
L15
PLANTING LAYOUT
NOT TO SCALE

DIAGRAMMATIC PLAN VIEW

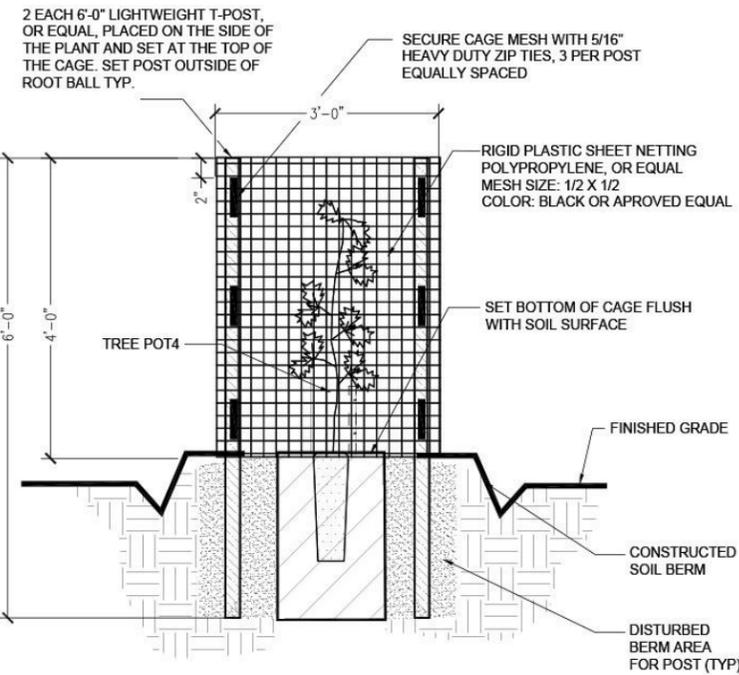
2
L15
CONTAINER PLANTING WITH IRRIGATION
NOT TO SCALE
SECTION ELEVATION

60217656 037 SAC GRX

Source: AECOM 2011

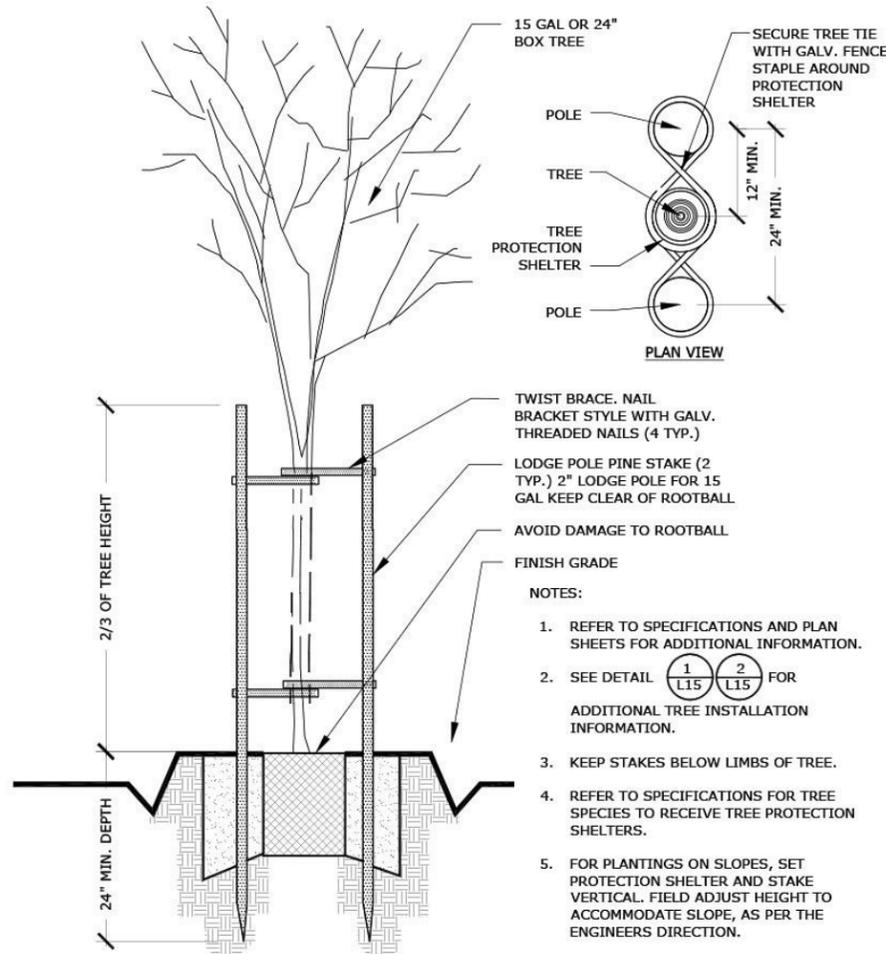
Exhibit M-8

Typical Plan View of Woodland Planting Design and Cross Section of Container Planting with Irrigation Gutters



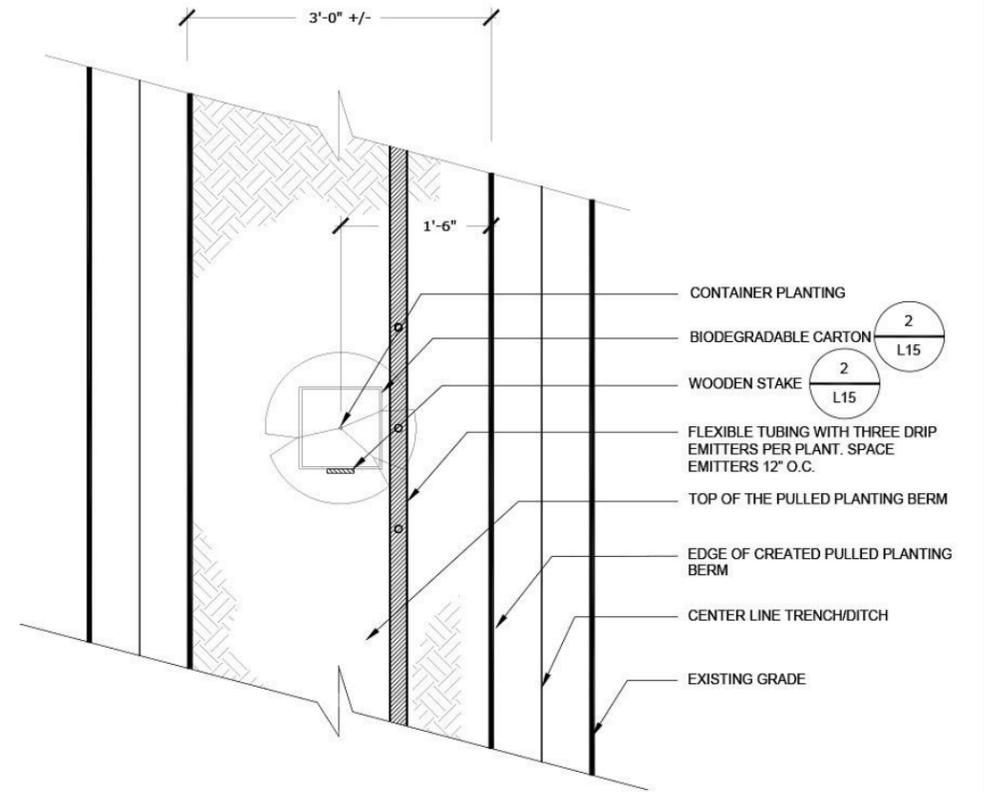
- NOTES:
1. INSTALL REBAR IN TWO PLACES FOR BEST FIT TO AVOID INSTALLED IRRIGATION TUBING AND ROOTBALL
 2. PLANT PROTECTION CAGE SHALL BE INSTALLED ON SELECTED PLANTS DETERMINED BY AGENCY IN THE MAINTENANCE PERIOD.

3
L15
PLANT PROTECTION CAGE
NOT TO SCALE SECTION ELEVATION



- NOTES:
1. REFER TO SPECIFICATIONS AND PLAN SHEETS FOR ADDITIONAL INFORMATION.
 2. SEE DETAIL **1** L15 **2** L15 FOR ADDITIONAL TREE INSTALLATION INFORMATION.
 3. KEEP STAKES BELOW LIMBS OF TREE.
 4. REFER TO SPECIFICATIONS FOR TREE SPECIES TO RECEIVE TREE PROTECTION SHELTERS.
 5. FOR PLANTINGS ON SLOPES, SET PROTECTION SHELTER AND STAKE VERTICAL. FIELD ADJUST HEIGHT TO ACCOMMODATE SLOPE, AS PER THE ENGINEERS DIRECTION.
 6. SEE MAINTENANCE SECTION 32 98 00 FOR ADDITIONAL INFORMATION.

4
L15
TREE SUPPORT STAKING
NOT TO SCALE



5
L15
CONTAINER PLANTING WITH IRRIGATION
NOT TO SCALE DIAGRAMMATIC PLAN VIEW

60217656 038 SAC GRX

Source: AECOM 2011

Exhibit M-9

Cross Section of Plant Protection Cage and Tree Support Staking and Plan View of Container Planting with Irrigation



Source: Google Earth image dated June 19, 2012

Exhibit M-10 Scar from 2012 Wildfire at O'Connor Lakes Unit in the LFRCMP Study Area

The strategy for the second and third years is to “train” the roots to grow deep. Less frequent, deep watering will encourage roots to grow deeper, well below the roots of the weeds, allowing the tree or shrub exclusive use of this deep moisture. As the tree’s roots grow deeper, the times between irrigations become longer. This allows the soil surface layers to dry, thereby further reducing weed vigor. Site conditions such as soil moisture storage and permeability will determine the length of time that irrigation will be in place.

The irrigation system is typically composed of a connection to a water source (e.g., a modified agricultural well head, or pumping from a nearby river or water body with portable pumps), a backflow preventor, sediment filters, pumps, pipe, shut-off valves, drip emitters, and soaker tube. The project’s planting irrigation specifications should describe the connection to the water source.

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