# 2. Regional Setting

## 2.1. Area and Boundaries

The Mid and Upper Sacramento River (MUSR) Regions contain a diverse set of stakeholder groups in urban and rural-agricultural areas. Combined, the two regions encompass approximately 640,000 acres throughout seven counties (Tehama, Glenn, Lake, Colusa, Butte, Sutter, and Yolo). The major part of the Sacramento River Flood Control Project bypass system is located in the region, including the Sutter and Tisdale bypasses. About 68 percent of the Regions' floodplain area is classified as Prime and Statewide Importance Farmland. Large areas of the Regions are within the 100-year (1 percent annual chance) floodplain

As shown in Figure 2-1 and Figure 2-2, the Planning Area for these Regions (except the Lake County portion) is located within the north-central portion of the Sacramento River Valley, a broad, gently sloping valley that drains to the Sacramento River via the Fremont Weir. The Regions extend about 90 miles from north to south and approximately 25 miles from east to west. This portion of the Planning Area is dominated by the Upper Sacramento River and its numerous tributaries, which originate from the foothills of the Coastal Range west of the region and the Sierra Nevada Mountains to the north and east of the region. The Upper Sacramento River in this case is considered to be that part of the river above the Fremont Weir. Some of the primary tributaries of the Upper Sacramento River within the region include: Cottonwood Creek, Elder Creek, Deer Creek, Stony Creek, Mud Creek, and Butte Creek. Nearly all of these tributaries have at least one State Plan of Flood Control (SPFC) levee system protecting existing development, and the Planning Area is generally defined as areas protected by these SPFC levees.

The Regions are primarily dominated by farmland and a number of small communities, along with the cities of Colusa and Chico. The list of small communities within the Regions includes:

- Colusa
- Gerber
- Glenn
- Butte City
- Princeton
- Meridian
- Grimes
- Robbins
- Hamilton City
- Ord Bend
- Afton
- Richvale
- Nelson
- Durham
- Dayton
- Nord

**Figure 2-1. Overview of the Upper Sacramento River Region**

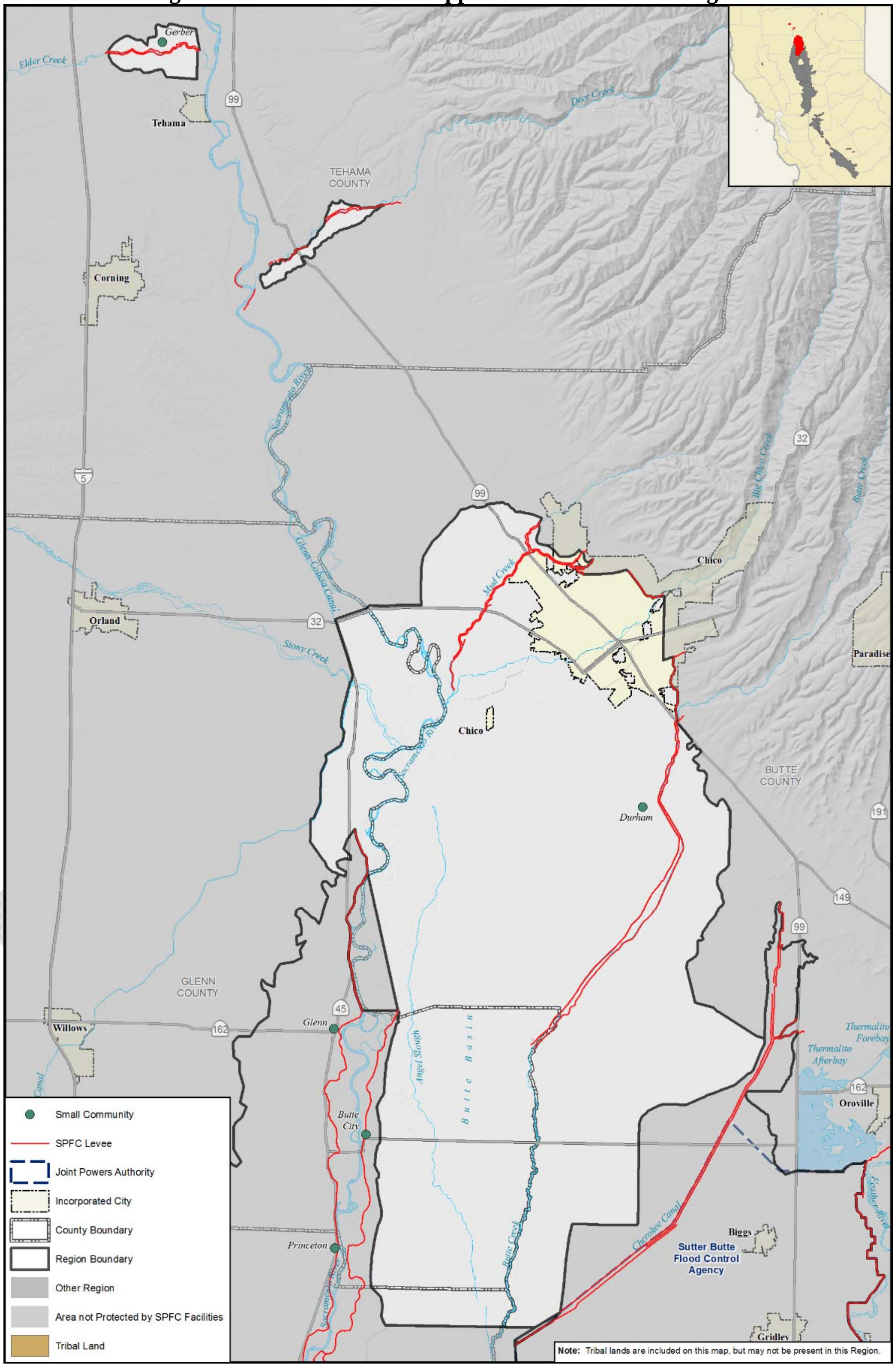
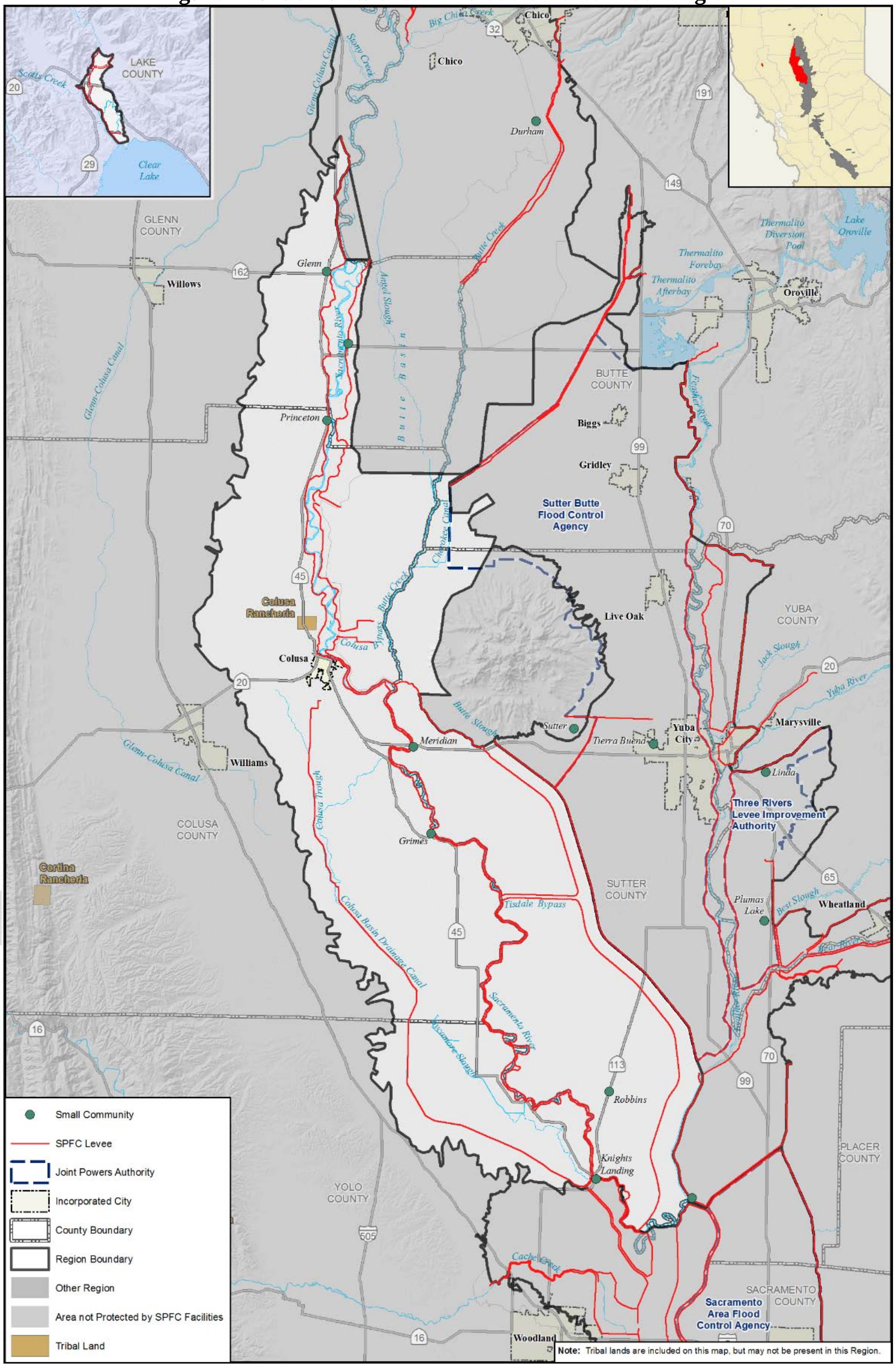


Figure 2-2.  Overview of the Mid Sacramento River Region



## 2.2. Population and Land Use

Per 2010 U.S. Census Bureau Information, the population within the Upper Sacramento River Region is approximately 108,000. The population within the Mid-Sacramento River Region is approximately 14,000. The only urban area of 10,000 people or more in the Upper Sacramento River Region is Chico. In general, growth rates for the Regions are estimated to average around 0.6 to 1.0 percent per year for the next five years. A breakdown of population for areas with the Regions is shown below in Table 2-1.

**Table 2-1. Mid and Upper Sacramento River Region 2013 Population Estimates**

| County/City/Small Community | 2010 Total Population | Population within Upper Sacramento River Region | Population within Mid Sacramento River Region |
|---|---|---|---|
| **Tehama County** | **63,463** | **1,627** | **0** |
| Tehama[1] | 418 | | |
| Gerber | 1,060 | | |
| Vina[1] | 237 | | |
| **Glenn County** | **28,122** | **3,177** | **867** |
| Hamilton City | 1,759 | | |
| Ord Bend | 37 | | |
| Glenn | 42 | | |
| Butte City | 107 | | |
| Afton | 18 | | |
| **Lake County** | **64,665** | **0** | **1,396** |
| Lakeport[1] | 4,753 | | |
| Upper Lake | 1,052 | | |
| **Butte County** | **220,000** | **102,893** | **97** |
| Chico | 86,187 | | |
| Nord | 320 | | |
| Durham | 5,518 | | |
| Nelson | 88 | | |
| Richvale | 244 | | |
| **Colusa County** | **21,419** | **86** | **9,067** |
| Colusa | 7,380 | | |
| Princeton | 303 | | |
| Grimes | 391 | | |
| **Sutter County** | **94,737** | **0** | **1,722** |
| Meridian | 358 | | |
| Robbins | 323 | | |
| **Yolo County** | **201,311** | **0** | **729** |

** Source: 2010 U.S. Census Bureau*
1. Located outside MUSR Regional Boundary

Land use in the MUSR Regions is primarily Prime and Statewide Importance Farmland with some large areas of Local and Unique Farmland and Native Vegetation and Grazing Land. Table 2-2 and the following figures show the land use summary for the MUSR Regions.

**Figure 2-3. Upper Sacramento River Region Land Use Summary**

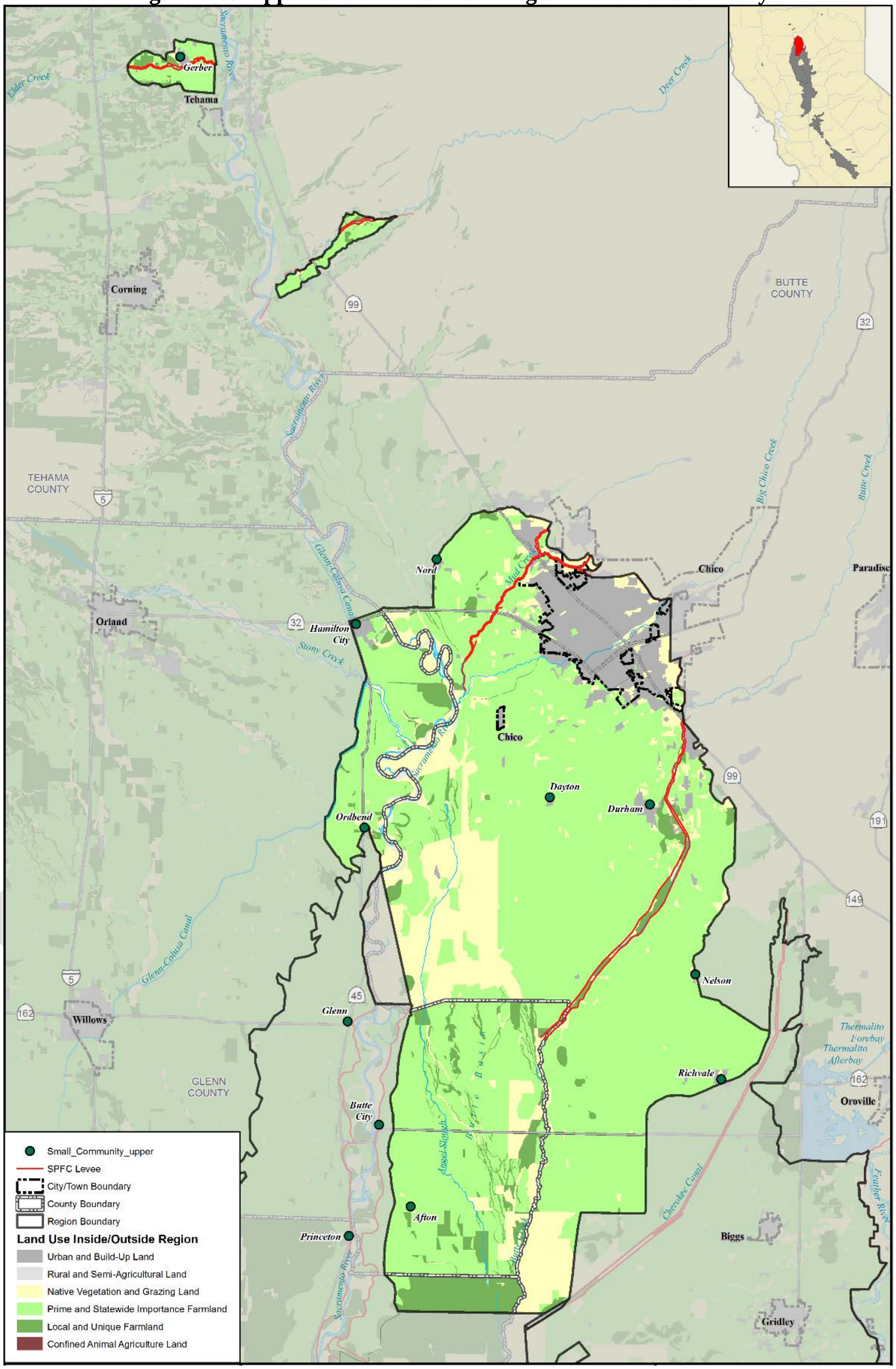


**Figure 2-4. Mid Sacramento River Region Land Use Summary**

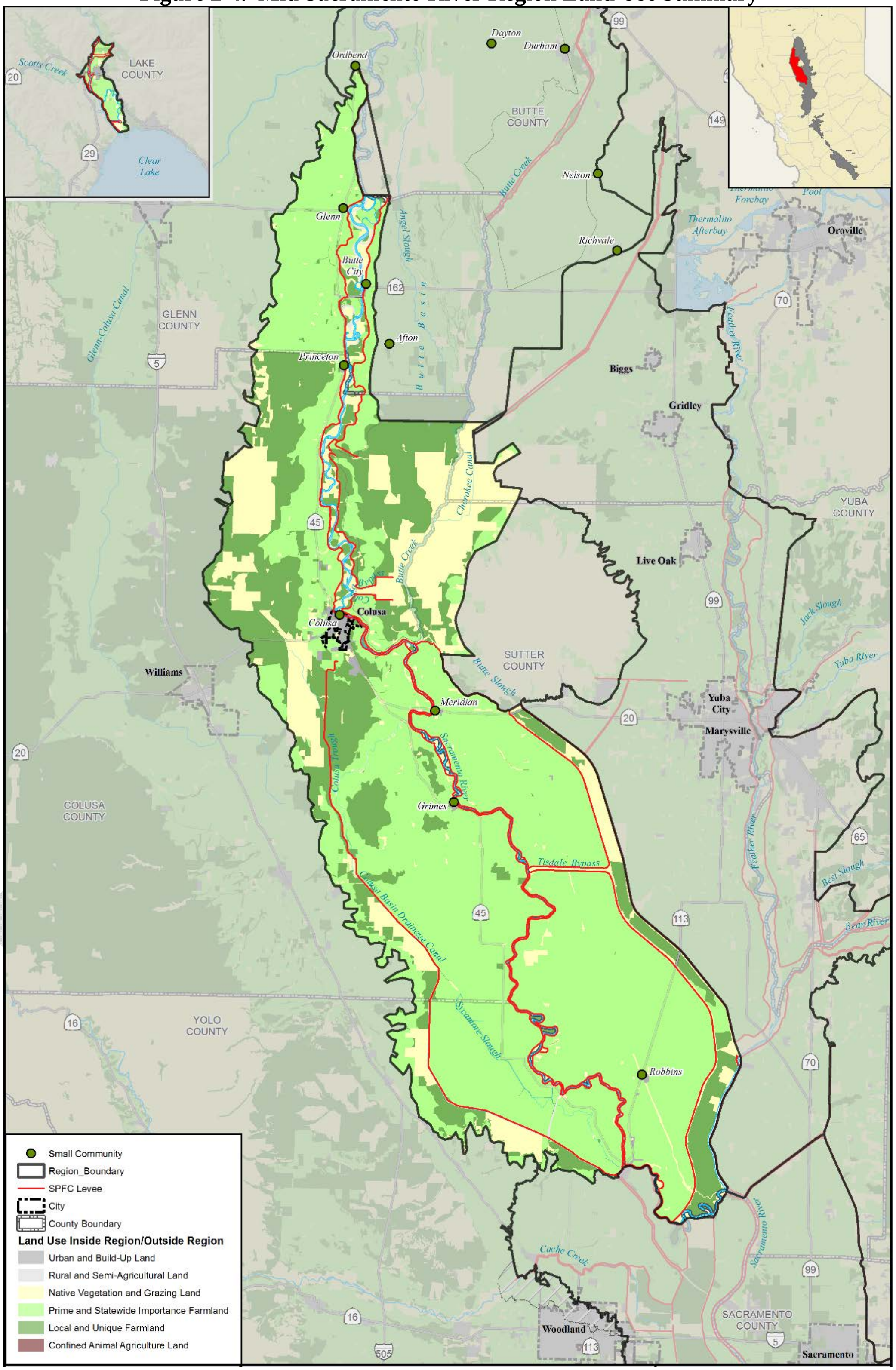
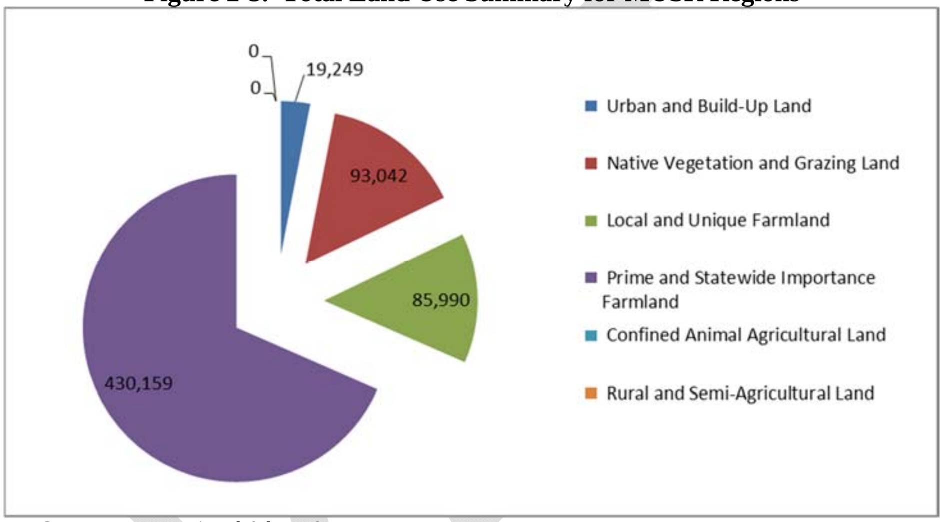


**Table 2-2. Mid and Upper Sacramento River Regions Land Use**

| Land Type Category | Acres in Mid-Sac Region | Total % of Mid-Sac Region | Acres in Upper-Sac Region | Total % of Upper-Sac Region |
|---|---|---|---|---|
| Urban and Built-Up Land | 3,293 | 1% | 15,956 | 7% |
| Native Vegetation and Grazing Land | 58,589 | 14% | 34,453 | 16% |
| Local and Unique Farmland | 72,476 | 18% | 13,514 | 6% |
| Prime and Statewide Importance Farmland | 277,778 | 67% | 152,381 | 71% |
| **Total** | **412,135** | **100%** | **216,304** | **100%** |

**Figure 2-5. Total Land Use Summary for MUSR Regions**




*Source: DWR Regional Atlas, 2013*

Land use information was obtained from the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP) Land Use Data. The data is based upon countywide land use surveys performed in 2010. Land use categories are characterized by the following:

<u>Urban and Build-Up Land:</u>

- Urban and built-up land is occupied by structures with a building density of at least 1 unit to 1.5 acres, or approximately 6 structures to a 10-acre parcel. Common examples include residential, industrial, commercial, institutional facilities, cemeteries, airports, golf courses, sanitary landfills, sewage treatment facilities, and water control structures

<u>Native Vegetation and Grazing Land:</u>

- Land on which the existing vegetation is suited to the grazing of livestock.
- Land that does not meet the criteria of any other category. Typical uses include low density rural development, heavily forested land, mined land, or government land with restrictions on use.
- Land that consists of open field areas that do not qualify for an agricultural category.

Prime and Statewide Importance Farmland:

- Prime Farmland: Irrigated land with the best combination of physical and chemical features able to sustain long term production of agricultural crops. This land has the soil quality, growing season, and moisture supply needed to produce sustained high yields. Land must have been used for production of irrigated crops at some time during the four years prior to the mapping date.
- Farmland of Statewide Importance: Irrigated land similar to Prime Farmland that has a good combination of physical and chemical characteristics for the production of agricultural crops. This land has minor shortcomings, such as greater slopes or less ability to store soil moisture than Prime Farmland. Land must have been used for production of irrigated crops at some time during the four years prior to the mapping date.

Local and Unique Farmland:

- Farmland of Local Importance: All farmable lands that do not meet the definitions of Prime, Statewide, or Unique. This includes land that is or has been used for irrigated pasture, dry land farming, confined livestock, and dairy, poultry facilities, aquaculture and grazing land.
- Unique Farmland: Lesser quality soils used for the production of the State's leading agricultural crops. Land must have been cropped at some time during the four years prior to the mapping date.
- Confined Animal Agriculture Land: This includes aquaculture, dairies, feedlots, and poultry facilities. Confined Animal Agriculture qualifies for Farmland of Local Importance in some counties.

## 2.3. Industry and Economy

The dominant industry in the MUSR Regions is agriculture and it plays a significant role in the economies for each of the encompassing counties. Rice, almonds and walnuts are the major crops. In 2011, total crop production was valued at more than $657 million for Colusa County (ranked 16th in the State in terms of gross value), $635 million for Butte County (ranked 17th in the State), $611 million for Glenn County (ranked 18th), $549 million for Yolo County (ranked 21st), $547 million for Sutter County (ranked 22nd), $245 million for Tehama County (ranked 29th), and $67 million for Lake County (ranked 42nd).

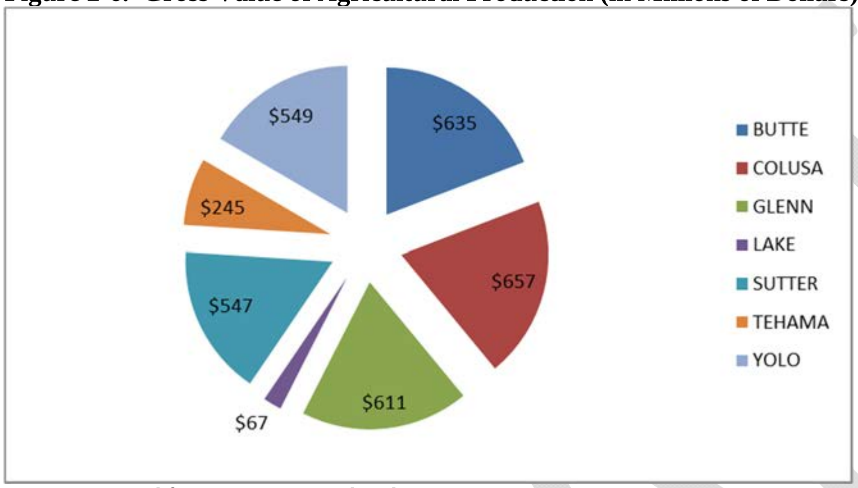
**Table 2-3. Leading Commodities for Gross Dollar Value of Agriculture Production by County**

| | Tehama | | | Yolo | |
|---|---|---|---|---|---|
| 1 | WALNUTS, ENGLISH | 93,799 | 1 | TOMATOES, PROCESSING | 106,793 |
| 2 | PLUMS, DRIED | 29,75 | 2 | RICE, MILLING | 58,159 |
| 3 | ALMONDS, ALL | 23,10 | 3 | GRAPES, WINE | 48,757 |
| 4 | MILK, MARKET, FLUID | 14,42 | 4 | HAY, ALFALFA | 45,935 |
| 5 | NURSERY PRODUCTS, MISC. | 11,10 | 5 | WALNUTS, ENGLISH | 33,507 |
| 6 | PASTURE, RANGE | 11,08 | 6 | VEGETABLES, UNSPECIFIED | 33,051 |
| 7 | CATTLE, STOCKERS, FEEDERS | 9,475 | 7 | FIELD CROPS, UNSPECIFIED | 31,132 |
| 8 | FRUITS & NUTS, UNSPECIFIED | 5,75 | 8 | ALMONDS, ALL | 26,480 |
| 9 | CATTLE, HEIFERS & STEERS, | 4,32 | 9 | CORN, GRAIN | 24,625 |
| 10 | CATTLE, CALVES ONLY | 4,05 | 10 | WHEAT, ALL | 20,675 |
| | **Butte** | | | **Glenn** | |
| 1 | WALNUTS, ENGLISH | 218,680 | 1 | RICE, MILLING | 139,695 |
| 2 | RICE, MILLING | 141,515 | 2 | ALMONDS, ALL | 120,476 |
| 3 | ALMONDS, ALL | 129,080 | 3 | WALNUTS, ENGLISH | 102,567 |
| 4 | PLUMS, DRIED | 33,291 | 4 | MILK, MARKET, FLUID | 73,543 |
| 5 | NURSERY PRODUCTS, MISC. | 21,728 | 5 | CATTLE & CALVES, UNSPECIFIED | 34,135 |
| 6 | RICE, SEED | 15,340 | 6 | CORN, GRAIN | 23,306 |
| 7 | FRUITS & NUTS, UNSPECIFIED | 11,169 | 7 | PLUMS, DRIED | 14,989 |
| 8 | CATTLE & CALVES, | 8,913 | 8 | HAY, ALFALFA | 13,922 |
| 9 | PEACHES, CLINGSTONE | 7,975 | 9 | APIARY PROD, POLLINATN FEES | 9,327 |
| 10 | FIELD CROPS, UNSPECIFIED | 7,076 | 10 | SEED, VEGETABLE & VINECROP | 8,553 |
| | **Lake** | | | **Colusa** | |
| 1 | GRAPES, WINE | 39,993 | 1 | RICE, MILLING | 243,32 |
| 2 | PEARS, BARTLETT | 17,930 | 2 | ALMONDS, ALL | 132,6 |
| 3 | WALNUTS, ENGLISH | 3,105 | 3 | SEED, VEGETABLE & VINECROP | 52,60 |
| 4 | CATTLE & CALVES, | 1,892 | 4 | TOMATOES, PROCESSING | 37,33 |
| 5 | PEARS, UNSPECIFIED | 1,773 | 5 | RICE, SEED | 33,99 |
| 6 | FIELD CROPS, UNSPECIFIED | 960 | 6 | WALNUTS, ENGLISH | 24,53 |
| 7 | NURSERY PRODUCTS, MISC. | 793 | 7 | VEGETABLES, UNSPECIFIED | 17,28 |
| 8 | PASTURE, RANGE | 450 | 8 | FRUITS & NUTS, UNSPECIFIED | 15,6 |
| 9 | VEGETABLES, UNSPECIFIED | 296 | 9 | HAY, ALFALFA | 14,6 |
| 10 | LIVESTOCK PRODUCTS, MISC. | 113 | 10 | CATTLE & CALVES, UNSPECIFIED | 13,1 |
| | **Sutter** | | | | |
| 1 | RICE, MILLING | 166,378 | | | |
| 2 | WALNUTS, ENGLISH | 144,674 | | | |
| 3 | PLUMS, DRIED | 38,220 | | | |
| 4 | PEACHES, CLINGSTONE | 33,247 | | | |
| 5 | TOMATOES, PROCESSING | 19,482 | | | |
| 6 | NRSRY, FRT/VNE/NT, NON- | 15,803 | | | |
| 7 | ALMONDS, ALL | 12,446 | | | |
| 8 | RICE, SEED | 12,367 | | | |
| 9 | BIOMASS, ORCHARD | 12,352 | | | |
| 10 | CORN, GRAIN | 9,895 | | | |

** Source: 2011 California County Agricultural Commissioners' Reports*

In total, the farming and agriculture industry accounts for more than $3.3 billion of the economies within the MUSR Regions. Note that this does not account for the indirect impacts from local "business-to-business" transactions necessary to support the agricultural industry (i.e., the local purchase of farm machinery, pesticides etc.), nor does it account for the induced impacts generated by the direct and indirect economic activity (i.e., when agricultural laborers or farm proprietors use earnings to purchase food, clothing, automobiles, real estate, education, and health and social services).

**Figure 2-6. Gross Value of Agricultural Production (in Millions of Dollars)**




*Source: 2011 California County Agricultural Commissioners' Reports*

In addition to the specific risks posed to the populated areas of Chico, Colusa, and the other identified small communities, a major flood event within the region has the potential to directly impact the statewide production of certain crops. For example, a very high percentage of the primary rice producing areas in the State are located in the Regions, with numerous large-scale/high-value agricultural facilities located within the floodplain. A major flood event would degrade the ability of an area to produce crops for one to two growing seasons (at minimum), and tree crops could be lost permanently with extended inundation.

Additional information regarding the Regions' economy is provided in the long-term socio-economic forecasts (completed by the California Department of Transportation Planning Division for each county), which are included in Appendix A.

## 2.4. Geologic Setting

The majority of the Mid-Sacramento and Upper Sacramento River Regions are located within the great Central Valley of California. This remarkable alluvial valley is about 430 miles long and about 75 miles wide, stretching from Redding to Bakersfield; the northern portion of the valley is known as the Sacramento Valley. The valley originated as a deep structural trough created by the subduction of the ancient Farallon oceanic plate starting in the Mesozoic Era, about 200 million years ago, and ending in the Cenozoic Era, approximately 25 million years ago. The structural trough remained below sea level and filled with oceanic sediments up to

40,000 feet thick, which formed rocks that are now known as the Great Valley Sequence. This subduction also resulted in the accretion and uplift of the Coast Ranges that now bound the great valley to the west and produced the volcanic range that resulted in the Sierra Nevada Mountains to the east. In the late Miocene, approximately 5 million years ago, as sedimentation continued, the sea withdrew and the great terrestrial Sacramento Valley began to emerge, filling with sediment from the rivers and streams from its bounding mountain ranges. Eroded sediment carried by powerful river systems filled the valley, with accelerated periods of sedimentation during glacial periods. In some places sediment accumulated up to 10,000 feet thick.

The Sutter Buttes, located about eight miles northwest of Marysville, is sometimes referred to as the world's smallest mountain range and is an anomaly in the generally flat alluvial valley floor with peaks rising to an elevation of 2,100 feet. The Sutter Buttes are a series of volcanic domes that formed about 1.6 million years ago and are considered the southernmost expression of the Cascade Range volcanism.

Recent geologic processes in the Sacramento valley prior to flood control structures included regular cyclic flooding of rivers and creeks in the rainy season. Typically occurring annually, these flood events could inundate portions of the valley for months and would deposit sediment creating the fertile soil that is now some of the richest agricultural land in the world. As the sediment load spilled from the rivers, heavier gravel and sand settled out close to the channel with finer silt and clay settling out further into the flood plain.

Hydraulic mining has also contributed to the valley sediment influx. In 1853, hydraulic mining began in California utilizing high pressure water jets to wash ancient river gravels from the highlands of the Sierra Nevada. This sediment was processed for gold and then washed down the streams and rivers of the Sierra's western slope into the Sacramento Valley. The vast quantities of sediment overwhelmed the streams and rivers leading to aggradation of the channels until the Sawyer decision of 1884 prohibited the in-stream disposal of hydraulic mining tailings.

Areas along the Sacramento River in the Mid-Sacramento Region are generally mapped as young Holocene alluvium that consist of unweathered gravel, sand, and silt deposited by the river (Helley and Harwood, 1985). Present in some locations is the older, lower member of the Modesto Formation described as slightly weathered gravel, sand, silt, and clay. In areas further from the Sacramento River, such as the Sutter Bypass and Colusa Drain, Holocene Basin Deposits dominate and are described as dark grey to black fine-grained silt and clay.

The Upper Sacramento River Region includes areas that are located in the eastern margins of the Sacramento Valley including the Chico area. These areas are dominated by older Quaternary alluvial fan formations such as the Upper Modesto, described as unweathered gravel, sand, silt and clay, and the Riverbank Formation described as weathered reddish gravel, sand, and silt.

The Mid Sacramento River region also includes an area just north of Clear Lake, near the City of Upper Lake, west of the Sacramento Valley in the Coast Ranges. The study area is a relatively small flood plain of Middle Creek that drains watersheds of the surrounding Coast Range highlands to Clear Lake. Clear Lake is at least 480,000 years old, one of the oldest lakes in North America. Due to various changes in the Clear Lake basin throughout its geologic history, the lake level has fluctuated and was once much higher. The majority of the Middle Creek flood plain is mapped as Quaternary Lake deposits described as thick unconsolidated silt deposited by the ancestral Clear Lake (McNitt, 1968).

## 2.5. Natural Resources

The rich, productive soils represent one of the most lucrative natural resources within the Regions. As note previously, the encompassing counties rely heavily on agriculture and related services, which bring in an estimated $3.3 billion annually.

The numerous rivers, streams, creeks, sloughs and channels are also a vital resource for the Regions. The Sacramento River is the main water supply for much of California's urban and agricultural areas. Annual runoff averages about 22.4 million acre-feet (MAF), which is nearly one-third of the State's total natural runoff. Major water supplies in the Regions are provided through surface storage reservoirs, with the largest being USBR's Shasta Lake (~4.5 MAF). The water runoff also plays an important role for dedicated natural flows, which support various environmental requirements, including in-stream fishery flows and flushing flows in the Delta.

The Regions also have significant natural resources such as: aquatic habitats, wetlands, riparian habitats, and wildlife foraging areas. Many of the habitat resources are located within wildlife refuge areas within the Regions, and a diversity of habitat resources are also located outside of the wildlife refuge area boundaries. Agricultural areas and private lands also provide valuable habitat. For example, rice fields provide habitat for wintering waterfowl and Giant Garter Snake, and alfalfa fields provide foraging habitat for Swainson's Hawk.

Riparian vegetation is a habitat characterized by trees, other vegetation, and physical features normally found on the stream banks and flood plains associated with streams, lakes, or other bodies of water. Riparian systems provide several important functions to both the aquatic and terrestrial ecosystems associated with them, and they support a great diversity of wildlife including sensitive invertebrates, amphibians, reptiles, birds, and mammals.

Within the Upper Sacramento Region, riparian vegetation is associated with the following waterways: Elder Creek, Deer Creek, Mud Creek, Sycamore Creek, and Butte Creek. The Mid-Sacramento River Region has areas of riparian, wetland, annual and perennial grassland, forbs, and evergreen and deciduous woodland.

Table 2-4 and Figure 2-7 shows an overview of the managed wildlife lands within the Regions.

**Table 2-4. Summary of Managed Environmental Lands for the Regions**

| Managed Land Type | Acres |
|---|---|
| **Upper Sacramento River Region** | |
| U.S. Fish and Wildlife Service Lands | 2,470 |
| Department of Fish and Wildlife Lands | 9,790 |
| Private Lands | 18,650 |
| **Upper Sacramento Total** | **30,910** |
| **Mid Sacramento River Region** | |
| U.S. Fish and Wildlife Service Lands | 12,650 |
| Department of Fish and Wildlife Lands | 5,400 |
| Private Lands | 35,650 |
| **Mid Sacramento Total** | **53,700** |

The managed lands within the Upper Sacramento River Region include:

Butte Creek Canyon Ecological Reserve

Butte Creek Canyon Ecological Reserve is located east of the Upper Sacramento River Region Boundary, along Butte Creek. The reserve supports various riparian community types, including Great Valley Oak and Great Valley Cottonwood Riparian Forests. In addition, special-status species including western pond turtle and red-legged frog are found at the reserve.

Merrill's Landing Wildlife Area

Merrill's Landing Wildlife Area, managed by the California Department of Fish and Wildlife, is located along the Sacramento River, outside the Upper Sacramento River Region Boundary. Merrill's Landing Wildlife Area is 296 acres of high terrace riparian habitat, contains a large river island, and supports a heron rookery as well as a diversity of bird and mammal species.

The Nature Conservancy Land

The Nature Conservancy manages conservation easements throughout California. There are several conservation easements occurring intermittently along the Sacramento River, with the intent of protecting and pre- serving riparian habitat. In addition, portions of Nature Conservancy lands occur within the Upper Sacramento River Region Boundary, north of the town of Chico, and are associated with Deer Creek.

Sacramento River Wildlife Area

The Sacramento River Wildlife Area is composed of approximately 3,770 acres of riparian habitat located along a seventy-mile reach of the Sacramento River. The Sacramento River Wildlife Area is managed by the California Department of Fish and Wildlife and occurs outside of the Upper Sacramento River Region Boundary.

Sacramento River National Wildlife Refuge

The Sacramento River National Wildlife Refuge, managed by US Fish and Wildlife Service, is composed of 27 units (properties) along a 77-mile stretch of the Sacramento River between Red Bluff and Princeton. The units occur outside of the Upper Sacramento River Region Boundary.

Refuge lands comprise 10,146 acres of riparian habitat, wetlands, uplands, and intensively managed walnut, almond, and prune orchards.

### Stone Ridge Ecological Reserve

Stone Ridge Ecological Reserve is located in east of the Upper Sacramento River Region Boundary, and is managed by The California Department of Fish and Wildlife. The reserve consists of 754 acres, is proposed for designation as an ecological reserve for the protection of blue oak woodland, vernal pools and swales, clay flats, ephemeral and intermittent creeks, and associated uplands for mountain lion, black bear, western spadefoot, burrowing owl, ferruginous hawk, bald eagle, black-shouldered kite, the rare Adobe lily, the rare Butte County checkerbloom, Ahart’s paronychia, and the federally endangered Butte County meadowfoam.

### Upper Butte Basin Wildlife Area

The Upper Butte Basin Wildlife Area, managed by The Department of Fish and Game, is located in Butte and Glenn Counties and comprises three units: Little Dry Creek, Howard Slough and Llano Seco for a total of 9,375 acres. The northern most portion of the Howard Creek Unit is located within the Upper Sacramento River Region Boundary, along Butte Creek. Numerous bird, mammal, reptile, amphibian, and fish species are found seasonally or year round at all three units of Upper Butte Basin Wildlife Area.

Managed environmental lands within the Mid-Sacramento Region include:

### Clear Lake Wildlife Area

Accessible only by boat, this area is one of the most significant bioregions of Lake County, comprises a combination of oak covered hills, dense tule marsh, and an extensive riparian habitat system. This habitat mix provides for a wide diversity of aquatic and terrestrial species of wildlife including herons, red-tailed hawks, osprey, songbirds, waterfowl, deer, gray fox, bobcat, and coyote.

### Collins Eddy Wildlife Area

The Collins Eddy Wildlife area has many different types of animal and plant species. The vegetation communities that exist in this area include riparian forest, woodland, scrub willow and oak woodlands. There are over 100 different species of birds, which include red-tailed hawks, Bullock’s oriole, horned lock, western kingbird, and many more. The mammals in the area are the American beaver, black-tailed deer, gray fox, and northern river otter.

### Colusa Bypass Wildlife Area

Managed by the California Department of Fish and Wildlife (CDFW), this 1,248 acre wildlife area is mostly grasslands. Several rows of willows and cottonwood trees line the eastern edge of the property. Excess water is diverted into the area from the Sacramento River during high flows in the winter. The area provides a significant amount of cover for mammals and both resident and migratory birds. The Colusa Bypass Wildlife area is just outside the eastern border of the region.

### Colusa National Wildlife Refuge

The 4,507-acre refuge primarily consists of intensively managed wetland impoundments, with some grassland and riparian habitat. Wetland impoundments are intensively managed to provide optimal habitat for the dense concentration of wintering waterfowl, as well as habitat for resident wildlife and spring/summer migrants. The grassland habitat supports several populations of endangered and sensitive species of plants. The refuge is a stronghold for populations of the endangered palmate-bracted bird's-beak and the threatened giant garter snake. About 35,000 visitors come to the refuge each year for wildlife viewing and 4,000 come to hunt waterfowl and pheasant.

### Delevan National Wildlife Refuge

The Delevan National Wildlife Refuge is a 5,797-acre refuge approximately 80 miles north of Sacramento and consists of over 4,500 acres of intensively managed wetlands and 1,200 acres of uplands. The refuge supports several endangered plants and animals: giant garter snake, wintering peregrine falcon and bald eagle, breeding tricolored blackbird, and a large colony of the endangered palmate-bracted bird's beak. Resident wildlife include grebe, heron, blackbird, beaver, muskrat, black tailed deer, and other species typical of upland and wetland habitats.

### Fremont Weir Wildlife Area

The Fremont Weir Wildlife Area, managed by the California Department of Fish and Wildlife, is located east of the Mid-Sacramento River Region boundary in the southern extent of the region. It consists of 1,461 acres of tall weedy vegetation, brush, valley oaks, willows, and cottonwood trees.

### Sacramento National Wildlife Refuge

The Sacramento National Wildlife Refuge includes 10,819 acres of seasonal marsh, permanent ponds, and uplands. The refuge is located west of the region at the northern extent.

### Sacramento River Wildlife Area

The Sacramento River Wildlife Area is 4,014 acres of riparian forest dominated by cottonwood, willow, ash, sycamore, box elder trees with dense understory of wild grape, pipevine, poison oak, and grasslands, oxbow lakes, and gravel bars. The wildlife area is managed by CDFW for recreation such as fishing, bird watching, nature study, and trapping. Among the diversity of species that can be seen along the river are otters, beavers, gray fox, bobcat, western pond turtles, ash-throated flycatchers, great blue herons, egrets, and a variety of birds of prey.

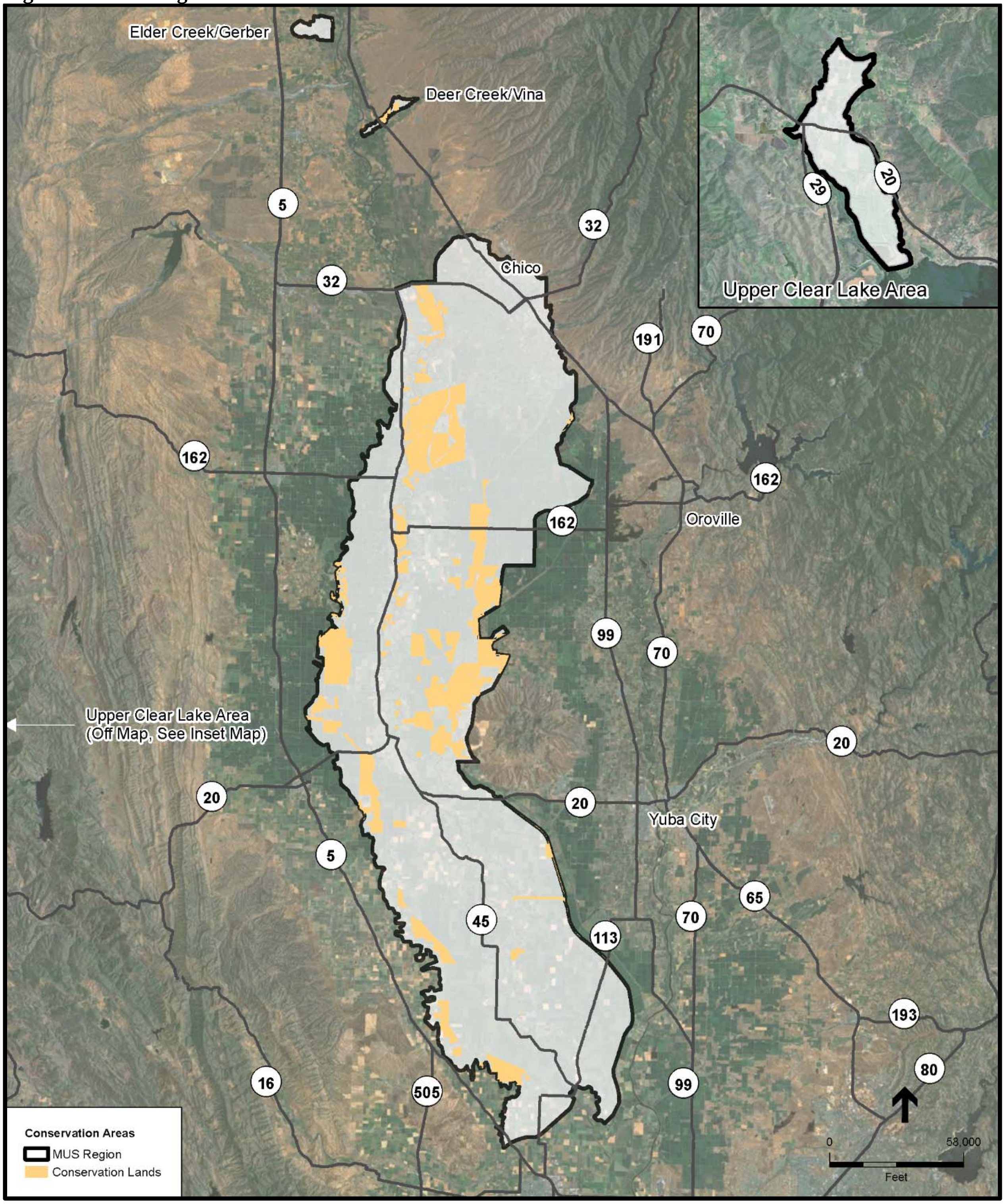
### Sutter Bypass Wildlife Area

The Sutter Bypass Wildlife Area is managed by California Department of Fish and Wildlife for fishing, hunting, and wildlife viewing. It consists of the Tisdale Bypass and two long, narrow parcels on either side of the Sutter Bypass, for a total of 3,204 acres. The wildlife area is located just east of the region at the southern extent.

### Sutter National Wildlife Refuge

The Sutter National Wildlife Refuge is about 2,600 acres consisting primarily of wetland impoundments with some riparian and grassland habitats. The refuge typically supports 175,000 ducks and 50,000 geese. The refuge is located within the Sutter Bypass east of the region.

**Figure 2-7. Existing Conservation Lands**




** Source: National Conservation Easement Database, 2013*

## 2.6. Climate

The region is dominated by a Mediterranean climate with dry summers and rain during the winter months. Historically, the region has experienced extreme runoff that inundated large areas of the valley floor, resulting in standing water and sediment deposition on the floodplain. This has produced a unique and productive agricultural landscape.

The northernmost area of the Sacramento River Hydrologic Region (SRHR) is mainly high desert plateau, characterized by cold, snowy winters with only moderate rainfall, and hot, dry summers. The mountainous parts in the north and east typically have cold, wet winters with large amounts of snow that provide runoff for summer water supplies. The Sacramento Valley floor has mild winters with less precipitation and hot, dry summers. Overall annual precipitation in the region generally increases from south to north and west to east. The snow and rain that fall in the SRHR contribute to the overall water supply for 60 percent of the State (CA Flood Future).

## 2.7. Flood Context and History of Flooding

Several flood threats exist within the area covered by the Mid and Upper Sacramento River Regions. In general, the threats can be broken down into the following main categories (note that this is only a generalization of the overall flood threats within the Planning Area boundary):

1) Sacramento River
2) Colusa Basin Drain
3) Big Chico, Little Chico, Mud, and Butte Creeks
4) Middle Creek
5) Cherokee Canal.

Sacramento River – Tehama, Glenn, Colusa, Sutter, and Yolo Counties

The primary regional flood threat comes from the Sacramento River and the channels, bypasses, and weirs making up the Sacramento River Flood Control Project. The Sacramento River is the largest river in California and its watershed encompasses 27,500 square miles. The Sacramento River has been shown to be ten times as volatile as the Mississippi River and flows in the system have reached Project design criteria in the past. Since individual components of the Project carry flows as high as 380,000 cfs (e.g., Sutter Bypass) by design, a breach in the system can be catastrophic in its impacts.

In recent times, major floods have occurred on the Sacramento River in 1982-83, 1986, 1995, and 1997. During the 1997 flood, a breach in the Sutter Bypass flooded thousands of acres of productive farmland, threatened the town of Meridian, and closed Highway 20. This event, coupled with flooding in the Colusa Basin, which closed west side roads, was instrumental in the subsequent virtual physical isolation of the City of Colusa. This experience, which can be duplicated again in various forms, fully demonstrated the interdependence of the Regions for life safety.

Below Red Bluff, the gradient of the Sacramento River flattens, requiring levees to contain flood waters within the designated floodways. Moving from north to south, the first area of concern is levees along the Sacramento River tributaries of Elder and Deer Creek in Tehama County. South of this potential flood threat is the “J” levee on the west side of the river protecting Hamilton City. County officials are concerned with the integrity of this levee and efforts are being made to re-organize a reclamation district originally created to maintain it. The Corps of Engineers is also being approached to help address needed improvements to this section of levee. Public safety concerns with this stretch of levee will remain well into the future.

A breach in the Hamilton City area could impact 2,500 residents and substantial farmland. Flood waters could also potentially impact Levee Districts 1 and 2 downstream. At a minimum, flood waters from a breach in this northerly area would eventually make their way into the Colusa Basin Drain, aggravating the flood threat from that waterway.

Moving south, one finds on the east bank of the river at the north end of the Butte Basin Overflow Area (BBOA) two structures that allow the Sacramento River, when the gage at the Ord Ferry Bridge is at 114 feet or higher, to overflow and inundate the BBOA. Those two locations are referred to respectively by locals as the “Murphy Plug” and the “3B’s”. During high flow events the 3B’s overflow area erodes, thus lowering the effective weir height of the structure. The lowering of the structure height in turn increases flood flows and the frequency of nuisance flooding in the upper end of the BBOA. These increasing flood impacts not only inundate the agricultural lands in this area longer than normal but also reduce the holding capacity of the BBOA when it is needed for major flood events. These longer than normal flow events also increase the time that major state and local roads in the area are inundated thus prohibiting their use by emergency response personnel. In addition to the 3B’s weir there is a serious bank erosion problem at R.M. 192.4 (Phelan Levee) on the east bank in the same vicinity. If the Phelan Levee is compromised additional and uncontrolled flood waters will enter the BBOA. The Phelan Levee and the 3B’s weir are private structures.

Moving further downstream one comes to Levee Districts 1 and 2 (Glenn County) on the west side of the river and Levee District 3 (Glenn County) on the east side. Ongoing erosion of river banks in proximity to the toes of district levees, particularly at sharp bends in the river near Princeton, has created public safety concerns among local officials responsible for this stretch of the river. A breach on the west levee with water elevations at previously reached high water marks could potentially inundate a highly productive almond and walnut growing area and the town of Princeton and areas to the south in Colusa County. A breach on the east side of the River could inundate the Town of Butte City and cause higher flows into the Butte Sink and subsequently into the Sutter Bypass.

From Princeton to Colusa, the Department of Water Resources maintains the flood control levees on both sides of the River. Maintenance Area 1 on the west side is an important levee stretch since a breach in that area could either flood the City of Colusa directly (if close enough to the city) or greatly increase flows into the Colusa Basin causing flood water to back up into the city (see discussion on Colusa Basin below). A breach on the east side of the River in this area would, again, greatly increase flows into the Sutter Bypass creating the possibility of exceeding its design capacity and thereby greatly increasing the threat to areas along either side of the Bypass.

Starting in Colusa, the Sacramento River West Side Levee District maintains the levee on the west side of the Sacramento River and RD108 and DWR maintain levees on the east side of the Colusa Basin Drain, which runs parallel to the River to the west. Breaches in this location would inundate a major rice growing area containing several large-scale rice drying and storage facilities that hold several hundred millions pounds of rice and potentially the City of Colusa and Town of Grimes. Failures in these levees could also further complicate flood flows in the vicinity of Knights Landing, thereby increasing the danger to urban areas and areas downstream.

Reclamation Districts 70, 1660, and 1500 and the Department of Water Resources Sutter Yard maintain the levees on the east side of the Sacramento River, the west side of the Sutter Bypass, and the Tisdale Bypass. Failures in these levees would inundate thousands of acres of productive farmland, potentially close Highway 20 and/or 113, and rapidly flood the towns of Robbins and/or Meridian.

<u>Colusa Basin Drain – Glenn, Colusa and Yolo Counties</u>

The Colusa Basin Drain serves to carry flow from Coast Range streams on the west side of the region to the Sacramento River Knights Landing Ridge Cut where flood waters are then channeled to the Yolo Bypass. Flow within the Basin Drain in high water events necessitates the presence of levees on its east side to prevent flooding of RD787, RD108, and the City of Colusa.

A gap exists in the east side levee system of the Colusa Basin/Drain in the vicinity of Highway 20 between Colusa and Williams. In the past, floodwaters in the Colusa Basin Drain have backed up toward the City of Colusa through this gap threatening structures and property and closing the highway. Flood waters in the Colusa Basin, even without a breach upstream on the Sacramento River, can close the few other roads leading from the west into the City of Colusa, the town of Grimes and rural areas along the Sacramento River. This has often occurred even when the system is operating as designed. A breach in the west bank of the Sacramento River would greatly exacerbate this flood threat from the Basin Drain with potentially significant impacts to the City of Colusa and areas to the south.

<u>Big Chico, Little Chico, Mud Creek, and Butte Creek – City of Chico and Butte County</u>

Big Chico Creek originates in the foothills and flows through the City of Chico. A diversion structure on the east side of the city controls flows through the city and diverts flood flows to the north into Lindo Channel and Mud Creek. Failure of these structures could flood portions of the City of Chico. Floodwaters from Little Chico Creek to the south are also diverted away from the City of Chico into Butte Creek by a diversion structure. While these streams rise rapidly and generally flow high for a limited duration, a prolonged storm event could potentially create an extended flow situation, which would greatly increase the flood threat on this system.

Butte Creek is a major leveed stream that runs south of the City of Chico in a northeast to southwest direction until it empties into the Butte Sink on the west side of the Sutter Buttes. The Butte Creek watershed is much larger than the Big Chico and Little Chico stream systems with subsequently larger flood flows of longer duration. The upper stretch of Butte Creek is of greatest concern because of the presence of populated areas, including the Town of Durham. Flows in this reach also have the tendency to back up due to vegetation and debris collection at railroad bridges.

In addition to these leveed waterways flooding is also a concern in the Rock Creek /Keefer Slough system in the North Chico area. There are no formal flood control structures along this system and all of the system is on private property. However, flooding events that have occurred here have closed State, county and private roads in the area. High flows have also closed Highway 99 where Keefer slough crosses the highway. Once the flows cross Highway 99 they flood the small community of Nord and the roads leading to Nord to the northwest of Chico.

<u>Middle Creek – Small Community of Upper Lake and Lake County</u>

The Middle Creek watershed is located to the North of Clear Lake and contains the town of Upper Lake. The streams in the area include: Middle Creek, Scotts Creek, Alley Creek, and Clover Creek. The USACE project levees were originally constructed in 1959 – 1966. Levees were built along Middle Creek and portions of Scotts Creek, Alley Creek, and Clover Creek. In addition to the levees, a diversion channel carries the flood water from Clover and Alley Creek around the town of Upper Lake and discharges it into Middle Creek. Past flooding has occurred in Upper Lake due to interior drainage issues (the drainage canal cannot empty when high water stages are observed in Middle Creek); the flooding inundates stores and closes Highway 20.

Recent historical flooding has occurred in 1995, 1997, 1998 and 2005. In 1995, overtopping occurred along the Scott Creek northern levee, upstream of Highway 29. This flooding resulted in water quality issues (flooding of a junkyard and machinery), damages to structures and closure of Highway 29. The levee was repaired in 1995 under PL 84-99. In 2005, overtopping again occurred along Middle Creek, flooding orchards, and the levee was repaired again under PL 84-99 in 2007.



<u>Cherokee Canal – Small Community of Richvale and Butte County</u>

Cherokee Canal is a channelized portion of Dry Creek that flows southwesterly from central Butte County to the Butte Sink. Other tributaries of Dry Creek and Cherokee Canal include Clear Creek, Gold Run Creek, and Cottonwood Creek. Cherokee Canal is mainly used for irrigation, drainage, and flood protection for agricultural lands, buildings, and homes. Cherokee Canal forms the majority of the northern boundary of the Sutter Basin area and is at the center of highly productive rice cultivation.

Cherokee Canal is a component of the SPFC that diverts excess floodwater originating in the foothills northeast of the Thermalito Afterbay, including the site of the Cherokee hydraulic mine, which continues to release sediments during high flow periods. The facilities consist of levees along Cherokee Canal, the lower reaches of Cottonwood Creek and Gold Run Creek, and irrigation and drainage structures from Butte Basin to high ground. The facilities reduce flood risk to adjacent communities, agricultural lands, area transportation facilities, and irrigation canals. The facilities are maintained by DWR Maintenance Area 13.

Major floods have occurred along Cherokee Canal in 1964, 1986, and 1997, with numerous reports of water at the levee crown. In 1986, the Cottonwood Creek levees broke at its confluence with Cherokee Canal. The right bank breach was approximately 20 feet to 30 feet wide and the breach caused ponding in the area northeast of the Cottonwood/Cherokee confluence. The left bank also failed in 1986 into the Richvale-Butte Canal. The canal contained the breach and flooding did not occur southward. Following the 1986 event, another breach occurred along the left bank of Cherokee Canal just upstream of Nelson Shippee Road Bridge.

A summarized list of historical flooding within the Regions and surrounding areas is presented in Table 2 7. For the purpose of providing statewide context, some flooding events in areas within the Central Valley, but outside the Planning Area, are included in the table.

**Table 2-5. Summary of Select Flood Events for the Regions**

| Date | Flood Type | Description | Impacted Counties within the Planning Area |
|---|---|---|---|
| 1805 | Slow Rise | Flood reportedly inundated "the entire valley floor." | Butte, Colusa, Glenn, Sutter, Tehama, Yolo |
| December 1861- January 1862 | Slow Rise | The "Great Flood" produced valley-wide damages along the Sacramento River basin, as early-day levees failed. | Sutter, Tehama |
| December 1937- March 1938 | Slow Rise | Many places in the valley suffered damage, including Chester, Downieville, Gerber, Tehama, and agricultural areas in Tehama, Glenn, and Colusa counties | Butte, Colusa, Glenn, Lake, Sutter, Tehama, Yolo |
| January-February 1942 | Slow Rise, Structure Failure | A Sutter County levee failed in the floods of January-February 1942, inundating developed lands. | All Counties |
| November 1950- January 1951 | Slow Rise, Structure Failure | A Yuba River levee breach flooded 43,000 acres of suburban and developed lands south of Marysville, damaging homes in Olivehurst and closing U.S. Highway 99 East. The American River flooded farms east of Sacramento and closed the Western Pacific Railroad. | Sutter |
| December 1955 "1955 Christmas Flood" | Slow Rise, Structure Failure | The flood was characterized by extremely high flows, including record flows at some locations. Most damage was along unregulated streams, which then included the Feather River. A levee failed on the west side of the Feather River, inundating Yuba City and vicinity and causing major damages. Portions of other towns and agricultural lands were also flooded; 38 persons died; total damages were estimated by USACE at $63 million. | Butte, Colusa, Glenn, Lake, Sutter, Tehama, Yolo |
| February 1958 | Slow Rise, Structure Failure | The Sacramento River flooded areas and caused bank erosion from Keswick to Butte City. Clear Lake rose, and its tributaries flooded, causing more than $1 million damage. Cache Creek overflowed and damaged property in locations from Rumsey to Yolo. Community damage, area flooding. Levees breached in an area east of McCormack-Williamson Tract and west of Galt, flooding about 5,800 acres. Dead Horse Island flooded in the Delta, a total of 1,865 acres. Precipitation from a warm, moist air mass caused widespread flooding within the region in 1958. | Colusa, Glenn, Lake, Sutter, Yolo |

| Date | Flood Type | Description | Impacted Counties within the Planning Area |
|---|---|---|---|
| October 1962 | Slow Rise, Coastal, Stormwater, Structure Failure | Local flooding caused crop inundation, substantial property damage, and 20 lives were lost. The Southern Pacific Railroad and State Highways 40A, 99W, and 99E were closed. Severe crop damage occurred near Chico. The North Fork Pit River flooded Alturas. Ash Creek and Dry Creek rose and flooded Adin, damaging infrastructure. The North Fork Feather River flooded Tobin and two trailer courts. Cattle drowned in the Feather River near Oroville. A levee breached on Yankee Slough near Wheatland and flooded walnut orchards. In the Delta, Prospect Island, Liberty Island, and Little Holland Tract flooded a total of about 7,300 acres. | Butte, Sutter, Yolo |
| January-February 1963 | Slow Rise, Structure Failure | Numerous communities were flooded and damaged in the American and Yuba River basins. In the Delta, Prospect Island, Liberty Island, and Little Holland Tract flooded a total of about 7,300 acres. | Colusa, Glenn, Lake, Sutter, Tehama, Yolo |
| December 1964-January 1965 | Slow Rise, Coastal, Structure Failure | Severe flooding occurred in the mountain communities of Chester, Downieville, and Coloma. Mountain highways, roads, bridges, public recreation areas, and cabins were extensively damaged. USACE estimated 383,500 acres in the region were flooded by stream overflow. The Southern Pacific Railroad suspended service over the Sierra Nevada due to flood damage. Highway damage closed Interstate 5 at the Oregon border and north of Redding. Daguerre Point Dam, a debris dam on the Yuba River, underwent a partial failure. Hell Hole Dam, under construction on the American River, collapsed. In the Delta, Prospect Island, Liberty Island, Little Holland Tract, Egbert Tract, and McCormack-Williamson Tract flooded, for a total of about 14,100 acres. USACE estimated $39 million flood damages in the Sacramento River basin. | Butte, Colusa, Glenn, Lake, Sutter, Tehama, Yolo |
| December 1966-March 1967 | Slow Rise | About 219,000 acres were inundated, nearly all of which were on the valley floor and used for agriculture. Developed properties were inundated by streams of the Fairfield Streams Group. USACE estimated about $2,700,000 in flood damages. | Butte, Colusa, Glenn, Lake, Sutter, Tehama, Yolo |
| December 1969-March 1970 | Slow Rise, | About 550,000 acres were flooded in the region, of which 82 percent was valley floor area and 50 percent was in dedicated floodways and natural overflow basins. The Pit River washed out bridges, flooded roads, and isolated Big Bend. The Sacramento River flooded parts of Anderson, Redding, Red Bluff, Hamilton City, and Tehama. Burney Creek overflowed and inundated Burney. Clear Lake rose and inundated shoreline property, particularly in Lakeport. High flows on Putah Creek above Lake Berryessa flooded resort areas and local roads in the region. USACE estimated more than $28 million in flood damage. A trailer park in the American River floodplain was flooded. Characterized by extremely large flows, including record flows at some locations. The Sacramento River Flood Control Project and other flood management programs had been implemented, and project levees, dams, reservoirs, and waterways were employed to control much of the flood flows through the Sacramento system. However, local flooding, mostly on agricultural lands, still occurred. | Butte, Colusa, Glenn, Tehama, Yolo |

| Date | Flood Type | Description | Impacted Counties within the Planning Area |
|---|---|---|---|
| January-April<br><br>1974 | Stormwater,<br><br>Structure Failure | From Mount Shasta City to Lakehead, the Sacramento River and tributaries caused extensive damage to infrastructure, homes, and a railroad. Residences were inundated due to failed levees, many roads were washed out by high flows and large sediment loads were deposited on agricultural lands. Characterized by extremely large flows, including record flows at some locations. The Sacramento River Flood Control Project and other flood management programs had been implemented, and project levees, dams, reservoirs, and waterways were employed to control much of the flood flows through the Sacramento system. However, local flooding, mostly on agricultural lands, still occurred. | Butte, Colusa, Glenn, Lake, Tehama, Yolo |
| December 1979<br><br>1980 March | Coastal,<br><br>Structure Failure | A combination of high tides and flood-level flows caused breaches and rapid deterioration of private levees. Clear<br><br>Lake rose to flood stage and damaged low-lying lakeshore development. In the Delta, approximately 1,400 acres of agricultural land were inundated when the levees of Prospect and Dead Horse Islands breached. | Colusa, Lake |
| 1982-1983 Winter Storm | Slow Rise,<br><br>Flash, Debris Flow, Coastal,<br><br>Stormwater | Major flooding along Cache Creek inundated the Capay Valley. Flood waters overtopped Hamilton City levees, flooding farmland, and closed nearly every road in Colusa County. Stream overflows caused major flooding and road closures throughout Glenn County, damaged stores and homes at Oroville, and flooded homes and businesses along State Highway 20 at Colusa. A mudslide killed an equipment operator and crushed a bus in Shasta County. Prospect Island levees failed in the Delta, flooding 1,228 acres. During February, high outflow of Lake<br><br>Berryessa damaged roads and parks. Stormwater inundated 80,000 acres of farmland in Butte County and businesses in the north part of Sacramento, and overflowed drains in Rocklin and Loomis, flooding streets and closing four major roads. | Butte, Colusa, Glenn, Lake, Sutter, Tehama, Yolo |
| February 1986 “St. Valentine’s Day | Slow Rise, Stormwater | The floods caused extensive damage to the flood management system of the Sacramento Valley and led to a substantial reassessment and repairs to flood management infrastructure. Record high tides and record Sacramento River inflow both occurred. The Yuba River levee at Linda failed, spreading floodwaters over 30 square miles, inundating Linda and Olivehurst, and causing an estimated $50 million in damage. Local stormwater flooding was widespread north and east of Sacramento because of high flows in American River tributaries. Stormwater flooded streets in Dixon, Vacaville, and Rio Vista. Levees protecting Tyler and Dead Horse Islands and McCormack- Williamson Tract failed, inundating 11,802 acres in the Delta. | Butte, Colusa, Glenn, Lake, Sutter, Tehama, Yolo |

| Date | Flood Type | Description | Impacted Counties within the Planning Area |
|---|---|---|---|
| Winter and Spring 1995 | Slow Rise, Structure Failure | Widespread stormwater and small stream flood damage was common. Numerous roadways and bridges washed out at Red Bluff. State Highway 32 was inundated between Chico and Hamilton City. Interstate 5 and State Highway 99 were also closed. Dry Creek overflows caused extensive damage in Roseville and suburban Sacramento. Orchards flooded at Hamilton City. Several local levees breached on Pine Creek and flooded the area south of Nord. A local levee breach near Wilson Landing received a repair using 43,000 sandbags. Cache Creek rose and stranded homeowners at Yolo. | Butte, Colusa, Glenn, Lake, Sutter, Tehama, Yolo |
| December 1996- January 1997 | Slow Rise, Structure Failure | Storms caused one of the worst floods of the century. There was widespread flooding and flood damage in the region from the major rivers and creeks in the Sierra Nevada. Sacramento River exceeded flood stage at Tehama Bridge, flooding Tehama, local roads, three mobile home parks, and orchards and fields in the area, leaving deep deposits of debris. In the Delta, McCormack-Williamson Tract and Dead Horse Island levees failed again, flooding 1,865 acres. The flooding caused five deaths in the region and damaged more than 587 homes. Widespread levee failures and damages that exceeded $301 million from this event highlighted the need for a concentrated effort to rehabilitate the flood management system. | All Counties |
| December 2005– January 2006 | Flash, Slow Rise | Levee overtopping, breaching, and river flooding, Sacramento weir was opened (1st time since 1997). Closed Interstate 5 near the Oregon border, damaged outdoor recreational facilities in Klamath National Forest and cut off power to many towns, including Trinidad and Blue Lake. Severe storms, flooding, mudslides, and landslides. | Glenn, Lake |

## 2.8. The Regional Flood Management System

The Mid and Upper Sacramento Regions lie within the Sacramento River Watershed, the State's largest watershed. At the core of this watershed is the Sacramento River, which collects water from over 27,000 square miles and discharges through the Sacramento-San Joaquin Delta into the San Francisco Bay. California's climate patterns produce distinct wet and dry seasons that result in high volumes of water coming in short periods of time. The Sacramento River and its tributaries experience short-lived but periodic peak flows that can strain or overwhelm their natural flow channels. The State, along with local and federal stakeholders, have constructed and implemented a vast and complex system to manage and provide flood control for both urban and non-urban areas in the Mid and Upper Sacramento River Regions.

**Figure 2-8. Upper Sacramento River Region SPFC Facilities**

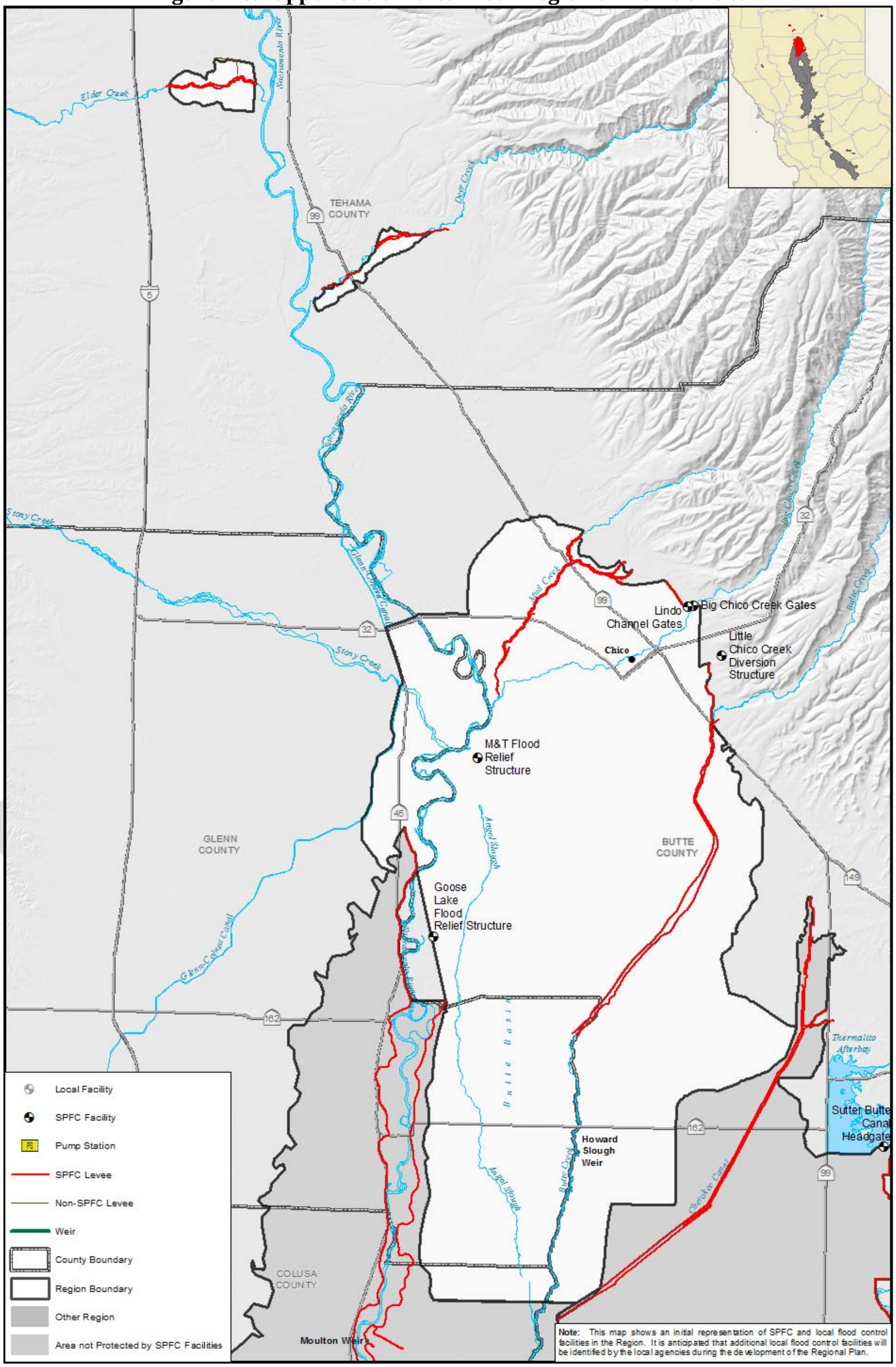
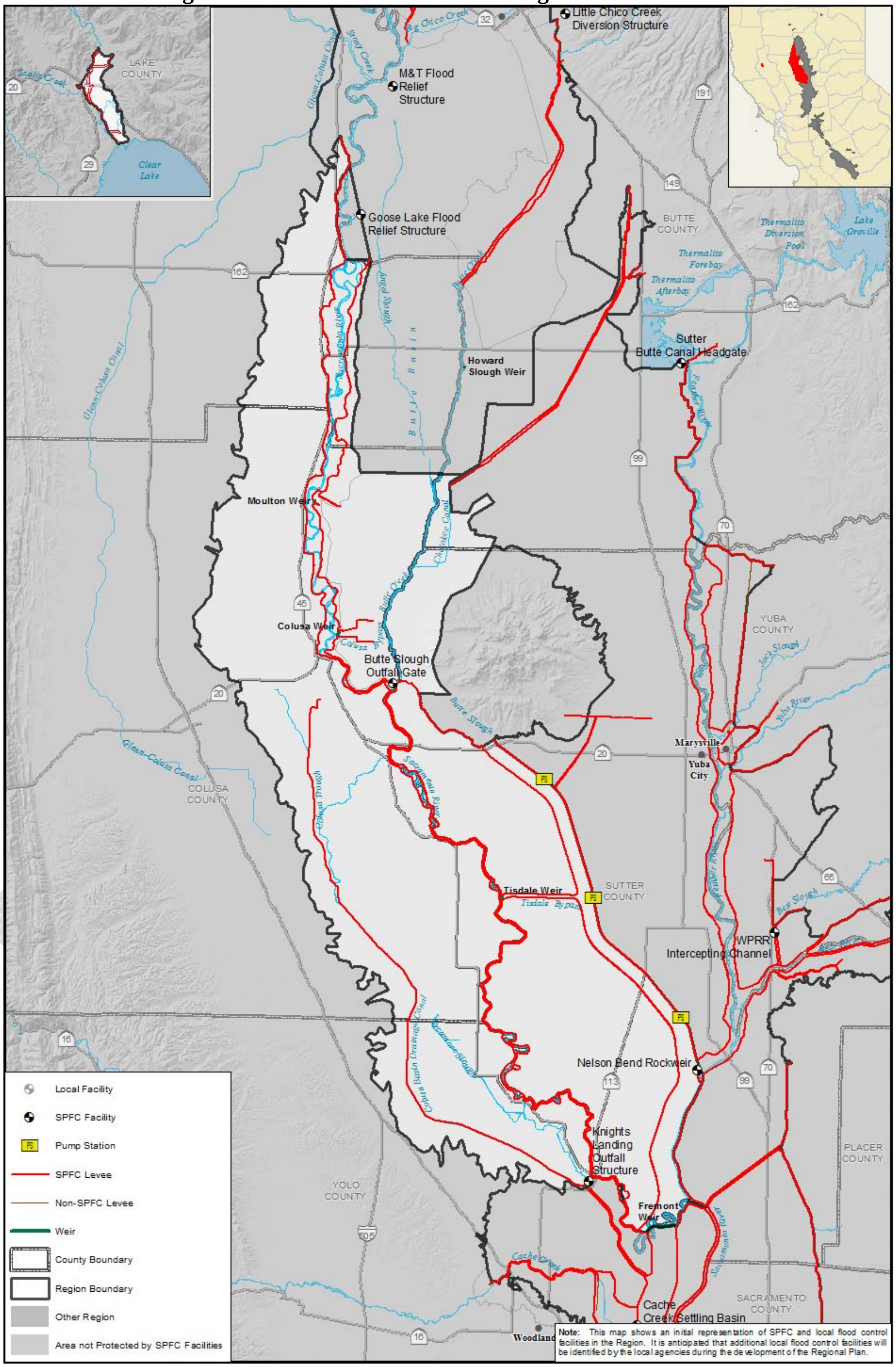


**Figure 2-9. Mid Sacramento River Region SPFC Facilities**



### 2.8.1. *Structural Elements*

Within the Mid and Upper Sacramento River Regions, the integrated structural system of flood protection includes reservoirs with active flood control space (upstream of the Planning Area boundaries), hundreds of miles of levees, multiple weirs, an outfall structure, diversion channels, massive bypasses, and drainage facilities, which pump interior runoff and seepage from levee protected areas back into the flood control channels. These structural elements work together to contain high flows within the main river channel, and when necessary, divert water out of the main river channel.

The primary structural component of this flood protection system are levees. Levees are earthen embankments constructed along the banks of rivers or manmade channels that act to constrain the lateral spread of water during high flows. There are nearly 400 miles of levees in the Mid and Upper Sacramento River Region.

Weirs and outfall structures control the diversion of water from one channel to another. The weirs within the Mid and Upper Sacramento River Regions are concrete embankments along a levee alignment that passively divert water into bypasses when the surface elevation of the river rises above the fixed elevation of the weir. There are four major weirs in the Mid and Upper Sacramento River Region: Moulton, Colusa, Tisdale and Fremont Weir, extending from north to south.

Outfall structures within the region are culverts through a levee with gates and/or flaps that can be operated to control the direction of flow between channels. The Butte Slough Outfall is the only outfall in the Mid and Upper Sacramento River Region. The bypasses within the Mid and Upper Sacramento River Region are large manmade diversion channels, bounded on both sides by levees, that serve as temporary waterways during high-water events to reduce the volume of water in the primary river channel. These include the Tisdale, Sutter, and Yolo Bypasses.

Below is a list and brief description of the major flood control structures in the Mid and Upper Sacramento Regions:

<u>Butte Basin Overflow Areas: M&T, 3B’s, Goose Lake:</u>
The M&T, 3 B’s and Goose Lake overflow areas and relief structures serve to divert a substantial portion of flood flows over the east bank of the Sacramento River into Butte Basin. DWR maintains all three of these flood relief structures (DWR, 2010). The existence and operation of these overflow areas is critical to downstream flood management as they relieve pressure off of the Sacramento River main channel levees.

<u>Mouton Weir:</u>
Located on the east bank of the Sacramento River, the Moulton Weir is nearly 500 feet long and diverts water from the Sacramento River into a low-lying area on the western side of the Sutter Buttes, known as the Butte Basin. Water flows through the Butte Slough and eventually into the Sutter Bypass. The Moulton Weir has a flood channel design flow of 25,000 cubic feet per second.

Colusa Weir:

Located just over 7 miles south of the Moulton Weir, the Colusa Weir is also located on the east bank of the Sacramento River. The Colusa Weir is more than 1,500 feet long and diverts water from the Sacramento River into the Butte Slough, which eventually flows into the Sutter Bypass. The Colusa Weir has a flood channel design flow of 70,000 cubic feet per second.

Butte Slough Outfall:

Butte Slough Outfall is a gated culvert structure through a levee on the east bank of the Sacramento River located several miles downstream of the Colusa Weir. The gates control flow between the Sacramento River and Butte Slough. During high-water conditions, the gates allow Sacramento River water to enter Butte Slough, which eventually flows into the Sutter Bypass. The Butte Slough Outfall has a flood design flow of 3,500 cubic feet per second.

Tisdale Weir:

Located on the east bank of the Sacramento River, the Tisdale Weir is approximately 13 miles southeast of the Butte Slough Outfall. The Tisdale Weir is almost 1,200 feet long and diverts water from the Sacramento River into the Tisdale Bypass. The Tisdale Weir has a flood channel design flow of 38,000 cubic feet per second.

Tisdale Bypass:

The Tisdale Bypass is a man-made leveed channel that connects the Sacramento River to the Sutter Bypass during high-water events when the Sacramento River is high enough to flow over the Tisdale Weir. The Bypass is approximately 4 miles long in the east-west direction and 1,000 feet wide.

Sutter Bypass:

The Sutter Bypass is a man-made leveed channel just east and parallel to the Sacramento River. The bypass begins at Long Bridge on the south side of the Sutter Buttes near Highway 20 and continues over 20 miles southeast until it connects to the Feather River levees and eventually to the confluence of the Feather and Sacramento Rivers. The bypass can be up to ¾ of mile wide.

Fremont Weir:

The Fremont Weir is located just south of the confluence of the Sacramento and Feather Rivers, near Knights Landing. This weir allows excess flows from the Sacramento River to enter the Yolo Bypass during high-water events. The weir is approximately 1½ miles long and has a flood channel design flow of 343,000 cubic feet per second.

Yolo Bypass:

The 3-mile-wide, 40-mile-long Yolo Bypass is a man-made leveed channel that extends from the Fremont Weir to a point above the City of Rio Vista, where it returns excess flows to the Sacramento River.

Big Chico Creek Culvert (Five Mile Dam):

Located on the northeastern side of Chico in Upper Bidwell Park, this structure is the first of three flow control structures that partially divert Big Chico Creek's flow during high-water events. The Big Chico Creek Culvert uses six box culverts with slide gates to divert flow from Big Chico Creek into Lindo Channel, which runs parallel to Big Chico Creek for almost 8 miles before rejoining the creek about 2½ miles from the confluence with the Sacramento River. The Big Chico Creek Culvert restricts the design channel flow of Big Chico Creek to 1,500 cubic feet per second.

<u>Lindo Channel Culvert (Lindo Channel Dam):</u>
The Lindo Channel Culvert is the second flow control structure on Big Chico Creek. Located just downstream from the Big Chico Creek Culvert, it also diverts water from Big Chico Creek during high-water events. This structure consists of seven box culverts with slide gates capable of diverting 6,000 cubic feet per second into the Lindo Channel.

<u>Sycamore Creek Weir and Diversion Channel:</u>
The third flow control structure for Big Chico Creek, the Sycamore Weir is located just upstream of the Lindo Channel Culvert. The weir is 178 feet long and has dissipaters that allow water to spill in a controlled fashion into the Sycamore Creek Diversion Channel. This channel is capable of diverting 8,500 cubic feet per second from Big Chico Creek and Lindo Channel to Sycamore Creek, which drains into Mud Creek, and eventually to the Sacramento River.

<u>Little Chico Creek Diversion Channel:</u>
Located southeast of Chico, this diversion channel uses a weir to divert water from Little Chico Creek to Butte Creek during high-water events. The Little Chico Creek Diversion Channel has a design flow of 3,000 cubic feet per second.

<u>Clover Creek Weir and Diversion Channel:</u>
Located in Upper Lake, Lake County, the Clover Creek Weir diverts flow from Clover Creek into the Clover Creek Diversion channel during high-water events. The Channel has a design flow of 8,500 cubic feet per second.

<u>Bloody Island Pump Station:</u>
Located about 1½ miles south of Upper Lake, Lake County, the Bloody Island Pump Station collects drainage from a 3.1-square mile area east of Middle Creek between Clover Creek and Bloody Island. The pump station has three 130 cubic feet per second (average rate) pumps and a sump with an active storage capacity of 185 acre-feet. The pump station also has reverse gravity flow capabilities from Middle Creek to the sump during low flow periods.

### 2.8.2. *Non-Structural Elements*

Non-structural flood risk management elements include a wide range of measures which limit the risk of flood damage primarily by avoiding or reducing the exposure to damaging flood waters rather than by confining those flood waters with larger and stronger hydraulic structures. These elements include raising and waterproofing structures so that they will be above anticipated flood levels or unharmed by flood waters, purchasing and relocating at-risk structures, limiting development in floodplains through the acquisition of agricultural conservation easements, open space easements, regulatory constraints, and incentive programs. Restoration of flood plains where feasible, to provide additional flood channel storage and conveyance capacity, is often regarded as a non-structural element because it reduces, rather than increases, the confinement of floodwaters in existing channels.

Some of the existing non-structural flood risk management elements within the Mid and Upper Sacramento River Regions are further described below.

<u>NFIP & Community Rating System:</u>
One of the most significant non-structural flood risk reduction programs is FEMA's National Flood Insurance Program (NFIP), which includes mapping flood hazard areas nationwide, and requiring that homes and other structures with federally backed mortgages must carry flood insurance if the flood risks warrant it. Butte, Colusa, Glenn, Lake, Sutter, Tehama, and Yolo Counties, the City of Chico, and other permitting agencies within the Regions participate in the NFIP program, which provides community residents with reduced flood insurance rates, provided the permitting agencies meet certain requirements.

The reduction in flood insurance rates depends on the Community Rating System (CRS) rating. The purpose of the CRS is to provide incentives for flood insurance customers in the form of premium discounts if the community meets or exceeds the minimum floodplain protection requirements. The rating system works by dividing discount levels in classes with Class 10 communities receiving the least discount (5%) and Class 1 communities receiving the largest discount (45%). Class level can vary based on numerous flood preparedness measures.

The regulatory framework of the NFIP is intended to limit the life, safety, and economic impacts of flooding, but may also have unintended economic impacts on farms, which may be prevented from upgrading structures and equipment to stay competitive, or rebuilding after a flood. Therefore revisions to the NFIP regulatory framework are among the potential nonstructural flood risk management options considered in this report.

<u>Senate Bill 5:</u>
Senate Bill 5 (SB 5) and companion legislation passed by the State Legislature in October 2007 established flood protection requirements for urban areas and small communities and require that further floodplain development be accompanied by appropriate levels of flood protection. Details regarding the full requirements of SB 5 are discussed later in this document.

<u>Public Law 84-99 (PL84-99) Program</u>
PL84-99 is another program in the Regions which aims to mitigate flood risk. The financial benefits associated with PL84-99 are indirect; levee systems that are compliant with PL84-99 are eligible for assistance to repair levees, in the event of damage during a flood event.

PL 84-99 gives USACE the authority to provide emergency management services to state and local agencies in need. Acting for the Secretary of the Army, the Chief of Engineers is authorized to undertake activities including disaster preparedness, emergency response operations, and the rehabilitation of flood control works threatened or destroyed by flooding.

Many of the levees in the MUSR Regions are project levees, and therefore participate in the PL 84-99 program. In order to benefit from the federal funding of rehabilitation, a federal flood protection system (i.e., a Project levee) must be enrolled in the PL 84-99 program prior to the flood event. An eligible system would be restored to its pre-disaster status at no cost to the local LMA.

In order to remain eligible for PL 84-99 damage assistance, project levees need to receive an Acceptable or Minimally Acceptable rating. If any part of a project receives an Unacceptable rating, the project is put on probation, and if it receives another Unacceptable rating the following year, it is placed on “inactive” status and is ineligible for the PL 84-99 program until the problem is fixed. As discussed later in this report, several LMAs have received Unacceptable ratings for one or more of a variety of reasons, jeopardizing their eligibility in the program.

<u>Flood System Repair Project</u>

DWR has developed the Flood System Repair Project (FSRP) to help Local Maintaining Agencies reduce flood risks in non-urban areas. Through FSRP, DWR will assist LMAs by providing them with technical and financial support to repair documented critical problems with flood control facilities of the SPFC in non-urban areas. Eligible projects include erosion repairs, access road repairs, hydraulic control structures and weir repairs, channel capacity restoration, and general levee repairs. The objectives of the FSRP are to repair documented critical problems, repair deteriorated levee patrol roads that provide all-weather access to the levees, and repair minor levee problems proactively, such as erosion sites shorter than 50 feet.

DWR is working with LMAs to finalize a list of critical repair sites and identify the levee patrol road reaches that require gravel or repair. After the list of critical sites and levee patrol road repair reaches is finalized:

1. DWR will issue a notice of eligibility to LMAs describing the eligible critical sites prioritized based on flood risk.
2. Interested LMAs will submit an “intent to participate” letter to DWR.
3. DWR and interested LMAs will work together to develop project agreements that describe the percentage of cost-share and the roles and responsibilities for each of the entities in implementing the repairs.
4. After the project agreements are finalized, DWR will commit funds for the repair projects. Funds will be released based on progress of planning, design, and construction activities.

<u>Hazard Mitigation Plans:</u>

Hazard mitigation planning is an important non-structural flood risk management tool, particularly with regard to public safety. It includes local, regional, State, and federal efforts to promote an awareness of flood risk, planning emergency response actions such as evacuations, stockpiling supplies and equipment, conducting training exercises, and improving notification and communication capabilities. The counties in the region have participated in the hazard mitigation planning prompted by the federal Disaster Mitigation Act of 2000, with federal and State grant support. Local agencies must have official Hazard Mitigation Plan (HMP) in order to qualify for FEMA disaster assistance.

<u>Emergency Response Programs:</u>

Flood emergency response programs and systems are intended to address the residual risk of flooding that remains after structural elements of the flood control system are put in place. Some of the common products of this comprehensive flood preparedness strategy include flood contingency maps, evacuation maps, acquisition of flood fight supplies and key response equipment, improved operational area logistics policies and procedures, and improved flood fight command and control.  These measures are discussed further in the Emergency Response Chapter of this document.