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Chapter 8 Tulare Lake Hydrologic Region

The Tulare Lake Hydrologic Region covers approximately 10.9 million acres (17,650 square miles) and includes all of Kings and Tulare counties and most of Fresno and Kern counties (Figure 8-1). The southern portion of the San Joaquin Valley is subdivided into two separate basins, the San Joaquin and the Tulare, by a rise in the valley floor resulting from an accumulation of alluvium between the San Joaquin River and the Kings River fan called the Sanjon de San Jose. The valley floor in this region had been a complex series of interconnecting natural sloughs, canals, and marshes.

PLACEHOLDER Figure 8-1 Tulare Lake Hydrologic Region

The economic development of the region is tightly linked to the surface water and groundwater resources of the Tulare Lake Hydrologic Region (Tulare Lake region). Major rivers draining into the Tulare Lake region include the Kings, Kaweah, Tule, and Kern rivers. The ecological original character of the area has been changed dramatically, largely from the taming of local rivers for farming. Significant geographic features include the Buena Vista/Kern Lake and Tulare Lake hydrologic basins, comprising the southern half of the San Joaquin Valley; the Coast Range to the west; the Tehachapi Mountains to the south; and the southern Sierra Nevada to the east.

The Tulare Lake Hydrologic Region is one of the nation’s leading agricultural production areas, growing a wide variety of crops on about 3-million irrigated acres. Agricultural production has been a mainstay of the region since the late-1800s. However, since the mid-1980s, other economic sectors, particularly the service sector, have been growing.

Setting

The Tulare Lake region, now the driest region of the Central Valley, once contained the largest single block of wetland habitat in California and provided more than 500,000 acres of permanent and seasonal wetlands. This provided habitat for millions of migrant waterfowl and shorebirds. Today, these areas are intensively farmed.

The California Aqueduct extends the entire length of the west side of the region, delivering water to the State Water Project (SWP) and Central Valley Project (CVP) contractors in the region and exporting water over the Tehachapi Mountains to Southern California.

All of the Tulare Lake Hydrologic Region’s streams are diverted for irrigation or other purposes, except in the wettest years. Historically, they drained into Tulare Lake, Buena Vista Lake, or adjacent Kern Lake. The latter basins ultimately drained to Tulare Lake, which is about 30 feet lower in elevation. Four main rivers emanate from the western flanks of the southern Sierra Nevada, and one substantial creek enters from the Coast Range. The largest river in terms of runoff is the Kings River, which originates high in Kings Canyon National Park and generally trends southwest into Pine Flat Lake. Downstream of Pine Flat Dam the river flows south and west toward Tulare Lake. During high water, distributaries of the Kings River flow northwest into the Fresno Slough/James Bypass system (along the historically high-water outlet of Tulare Lake), emptying into the San Joaquin River. The Kaweah River begins in Sequoia National Park, flows west and southwest, and is impounded by Terminus Dam. It subsequently spreads into many distributaries around Visalia and Tulare trending toward Tulare Lake. The Tule River begins in Sequoia National Forest and flows southwest through Lake Success toward Tulare Lake. The Kern River has the largest drainage basin area and produces the second highest runoff. It
originates in Inyo and Sequoia national forests and Sequoia National Park, flowing southward into Lake Isabella. The river downstream of Isabella Dam flows southwest and in high discharge years empties into the ancient Buena Vista/Kern Lake bed; in very high discharge years, Buena Vista Lake historically spilled into Tulare Lake via sloughs and floodwater channels. Los Gatos Creek, arising in the Coast Range, flows northeast onto the valley floor north of Tulare Lake. In extreme floods it may join the Kings River, flowing south toward the lake.

Watersheds

The Tulare Lake Hydrologic Region encompasses approximately 17,650 square miles. It is divided into several main hydrologic subareas: the alluvial fans from the Sierra foothills and the basin subarea (in the vicinity of the Kings, Kaweah, and Tule rivers and their distributaries); the Tulare Lake bed; and the southwestern uplands. The alluvial fan/basin subarea is characterized by southwest- to south-flowing rivers, creeks, and irrigation canal systems that convey surface water from the Sierra Nevada. The dominant hydrologic features in the alluvial fan/basin subarea are the Kings, Kaweah, Tule, and Kern rivers and their major distributaries.

Critical concerns for watersheds in the region are varied depending upon the particular watershed in question. In the Sierra, some of the concerns among stakeholders include,

- Soil erosion
- Watershed/wetlands
- Agriculture/rangeland
- Vegetation management
- Wildlife habitat
- Environmental eEducation
- Air quality
- Weed control – noxious weeds
- Sand and gravel mines within rivers and streams
- Water rights on rivers
- Funding for water conservation projects

In the valley portion of the region, concerns include,

- Salinity
- Water erosion,
- Wind erosion,
- Brackish agricultural drainage water
- Areas of toxic salt accumulation
- Excess use of groundwater and water penetration problems
- Extensive flooding of agricultural lands
- Perched water conditions
- Water quality and quantity
- Erosion and sedimentation both in agricultural lands and subdivisions
- Irrigation water management problems
- Rangeland - fire and brush control
• Drainage problems both surface and subsurface
• Environmental education
• Alternate energy sources
• Groundwater depletion/recharge
• Groundwater/surface water quantity/quality
• Surface/irrigation water management/availability
(from RCDs in Tulare Lake Basin; Critical Concerns section)

The watersheds east of the valley floor range in elevation from 381 feet to 14,478 feet; the mean elevation is 4,080 feet (DWR 2005). The Tulare Lake region’s watershed is essentially a closed basin because surface water drains north into the San Joaquin River only in years of extreme rainfall. Its 10 subwatersheds are:

• Kings River subwatershed,
• Kaweah River subwatershed,
• Kern River subwatershed,
• South Valley Floor subwatershed,
• Grapevine subwatershed,
• Coast Range subwatershed,
• Fellows subwatershed,
• Temblor subwatershed,
• Sunflower subwatershed, and
• Southern Sierra subwatershed.

The State and Regional Water Boards are responding to watershed challenges through the Watershed Management Initiative (WMI). The WMI is designed to integrate various surface water and groundwater regulatory programs while promoting cooperative, collaborative efforts within a watershed (www.swrcb.ca.gov/centralvalley/water_issues/watershed_management/r5_wmi_chapter.shtml).

PLACEHOLDER: Table 8-1 Watershed characteristics of Tulare Lake Basin

PLACEHOLDER: Box 8-1 California Watershed Council

PLACEHOLDER: Box 8-2 Recent Legislation and Agency and Watershed Community Activities in California

The Information Center for the Environment follows water-related projects and conducts surveys of watershed groups regarding their projects, interests, and concerns. See its Web site at http://ice.ucdavis.edu/projects/water

Flood parameters for all the major flood-producing streams are listed in Appendix 8-A Flood Management in Table 8A-x Flood parameters for principal streams.
Groundwater Basins and Recharge Areas

The Tulare Lake Hydrologic Region has 12 distinct groundwater basins and 7 subbasins of the San Joaquin Valley Groundwater Basin, which crosses north into the San Joaquin River Hydrologic Region (Figure 8-2). These basins underlie approximately 5.33-million acres (8,330 square miles) or 49 percent of the entire hydrologic region. Groundwater has historically been important to both urban and agricultural uses, accounting for 41 percent of the region’s total annual supply and 35 percent of all groundwater use in the state. Groundwater use in the region represents about 10 percent of the state’s overall water supply for agricultural and urban uses.

Water agencies in the Tulare Lake region have been practicing conjunctive use for many years to manage groundwater and assist dry year supplies. Groundwater recharge is primarily from rivers and natural streams, irrigation water percolating below the root zone of irrigated fields, direct recharge from developed ponding basins and water banks, and in-lieu recharge where surface water is made available in-lieu of groundwater pumping. Some water agencies accomplish recharge by directing available water into existing natural streams and sloughs while others encourage application of water, when available, on farmed fields. The Deer Creek and Tule River Authority provides an example of how groundwater management activities can be coordinated with other resources. The authority, in conjunction with the US Bureau of Reclamation, has constructed more than 200 acres of recharge basins as part of its Deer Creek Recharge-Wildlife Enhancement Project. When available, the project takes surplus water during winter months and delivers it to the basins, which serve as winter habitat for migrating waterfowl, creating a significant environmental benefit. Most of the water also recharges into the underlying aquifer, thereby benefiting the local groundwater system (www.dpla2.water.ca.gov/publications/groundwater/bulletin118/Bulletin118-Chapter3.pdf).

Some of the developed groundwater recharge facilities in the Tulare Lake Basin are

- Kern Water Bank
- Arvin-Edison Water Storage District
- Rosedale-Rio Bravo WSD
- Semitropic WSD
- North Kern WSD
- Tehachapi-Cummings County Water District
- Lower Tule Irrigation District
- City of Clovis
- City of Fresno
- Fresno Metropolitan Flood Control District
- Consolidated ID
- Fresno ID
- Apex Conjunctive Use Project (Kings Countyu WD – proposed)
- McMullin Recharge Group (Raisin City area-proposed)
Ecosystems

The Tulare Lake Hydrologic Region once supported vast Tule marshes, riparian corridors, and other wetlands; however, development of the area largely for farming, and the taming of the region’s major rivers, has changed the ecological character dramatically. The valley portion of the region once supported a diverse array of perennial bunchgrass ecosystems including prairies, oak-grass savannas, desert grasslands, as well as a mosaic of riparian woodlands, freshwater marshes, and vernal pools. In its original state, it comprised one of the most diverse, productive, and distinctive grasslands in temperate North America and over 500,000 acres of permanent and seasonal wetlands (www.worldwildlife.org, California Central Valley grasslands (NA0801).

Although most basins in California have lost the majority of their wetlands habitat, changes in the Tulare region have been especially detrimental for waterfowl. It once contained a series of shallow lakebeds that provided 260,000 acres of seasonal wetlands and more than 250,000 acres of permanent and semi-permanent tule marshes.

The Central Valley provides some of the most important bird habitat in North America, hosting one of the largest concentrations of migratory birds in the world during the fall and winter. More than 95 percent of historical wetlands and 98 percent of all riparian habitats have been destroyed or modified (Table 8-3 Tulare Basin current and historical acres of riparian habitat). The remnant intensively managed wetlands and associated agricultural habitats now support an average of 5.5 million waterfowl annually. Few places on earth have greater concentrations of wintering waterfowl than the Central Valley. Of the approximate 205,000 acres of managed wetlands remaining in the Central Valley, two-thirds are in private ownership.

<table>
<thead>
<tr>
<th>Basin</th>
<th>Current acres</th>
<th>Historic acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tulare</td>
<td>7,195</td>
<td>272,158</td>
</tr>
</tbody>
</table>

**Annual water requirements (af/acre) by habitat type and basin**

<table>
<thead>
<tr>
<th>Basin</th>
<th>Seasonal wetlands (af/acre)</th>
<th>Semi-permanent wetlands (af/acre)</th>
<th>Winter flooded agriculture (af/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tulare</td>
<td>5.25</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total annual water needs for existing wetland habitats in Tulare Basin**

<table>
<thead>
<tr>
<th>Basin</th>
<th>Seasonal wetland needs (acres)</th>
<th>Seasonal wetland water needs (af)</th>
<th>Semi-permanent wetlands needs (acres)</th>
<th>Semi-permanent wetland water needs (af)</th>
<th>Winter flooded agriculture (af)</th>
<th>Total (af)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tulare</td>
<td>20,212</td>
<td>106,113</td>
<td>2,245</td>
<td>17,960</td>
<td>0</td>
<td>124,073</td>
</tr>
</tbody>
</table>

**Total annual water needs for additional wetland habitats that must be restored to fully meet integrated bird habitat objectives**

<table>
<thead>
<tr>
<th>Basin</th>
<th>Seasonal wetland needs (acres)</th>
<th>Seasonal wetland water needs (af)</th>
<th>Semi-permanent wetland water needs (af)</th>
<th>Agricultural winter flooding (af)</th>
<th>Total (af)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tulare</td>
<td>21,263</td>
<td>111,631</td>
<td>47,480</td>
<td>159,111</td>
<td></td>
</tr>
</tbody>
</table>

**Total annual water needs for wetland and winter-flooded agricultural habitats in the Central Valley when integrated bird habitat objectives are met**

<table>
<thead>
<tr>
<th>Basin</th>
<th>Seasonal wetland water needs (af)</th>
<th>Semi-permanent wetland water needs (af)</th>
<th>Agricultural winter flooding (af)</th>
<th>Total (af)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tulare</td>
<td>217,744</td>
<td>65,440</td>
<td>0</td>
<td>283,184</td>
</tr>
</tbody>
</table>

Note: acre-feet (af); acre feet per acre (af/acre)
(Central Valley Joint Venture, 2006 Implementation Plan)
(San Joaquin River National Wildlife Refuge, Comprehensive Conservation Plan, USFW 2006)
Interest in restoring historical wetland habitat conditions within the Tulare region has greatly increased since the passage of the Central Valley Project Improvement Act (CVPIA). While private wetlands within this area did not directly benefit from provisions of the CVPIA, the vast improvements that have resulted in other wetland basins that receive CVPIA water supplies has sparked renewed discussion at regional, State, and federal levels.

Climate
The climate in combination with the fertile soil in the valley portion of the region is well-suited for farming. Runoff from the adjacent Sierra Nevada provides good quality water for irrigation. The San Joaquin Valley’s long growing season (April through October), warm/hot summers, and a fall harvest period usually sparse in rain provides a near ideal environment for production of many crops. Winters are moist and often blanketed with tule fog. Nearly all of the year's precipitation falls in the six months from November to April. The valley floor is surrounded on three sides by mountain ranges, resulting in a comparative isolation of the valley from marine effects. Because of this and the comparatively cloudless summers, normal maximum temperature advances to a high of 101 degrees Fahrenheit during the latter part of July. Valley winter temperatures are usually mild, but during infrequent cold spells air temperature occasionally drops below freezing. Heavy frost occurs during the winter in most years, and the geographic orientation of the valley generates prevailing winds from the northwest.

The mean annual precipitation in the valley portion of the region ranges from about 6 to 11 inches, with 67 percent falling from December through March, and 95 percent falling during the winter months from October through April. The region receives more than 70 percent of the possible amount of sunshine during all but four months, November through February. During periods of tule fog, which can last up to two weeks, sunshine is reduced to a minimum.

Demographics

Population
Until the recent housing slow down, the rate of population growth throughout the San Joaquin Valley had been among the highest in the state, creating a strong demand for housing and urban infrastructure (Figure 8-3 Rate of population growth, running 5-year rate, 1960-2006). The rate of growth since the late 1990 far exceeded the statewide rate.

PLACEHOLDER Figure 8-3 Rate of population growth, running 5-year rate, 1960-2006

The region is home to many American Indian Tribes. There are five federally recognized tribes in the Tulare Lake Basin, residing on the Santa Rosa, Tule River, Table Mountain, Big Sandy, and Cold Springs rancherias (Table 8-3). However, there are many more non-recognized tribes and members not residing on rancherias, with some involved in efforts to become federally recognized. The Table Mountain, Big Sandy, and Cold Spring Rancherias are near the San Joaquin River and Millerton Lake. The Santa Rosa Rancheria is south of the City of Lemoore and situated on the southern end of Mud Slough. The Tule River Rancheria is south of Porterville and is the only Tribe in the region to date to have entered into water rights settlement negotiations. All of the rancherias operate gaming facilities except the Cold Springs Rancheria. For many Tribes, the gaming facilities are providing much needed funding and allowing the exercise of sovereignty long neglected due to inadequate funding from historical sources.
The population in the Tulare Lake region is now about XX percent of the entire San Joaquin Valley population. Although many communities in the region welcome the growth and income from a diversifying economy, the rapid urban growth is generating negative impacts on farming and the agricultural industry. Much of the development is occurring on prime soils and creating housing tracts directly abutting fields under intensive agricultural production creating conflicts along this fringe. In six years, between 1992 and 1998, nearly XXXX acres of farmland were converted to urban uses, according to Department of Conservation statistics. Recently, the American Farmland Trust released the publication highlighting how one of California’s most precious natural resources—its highly productive farmland—is being lost at an alarming rate. This report, “Paving Paradise”, indicates unless a different approach to land-use planning and development is adopted, another 2 million acres could be gone by mid-century. Of great concern is that the land most likely to be lost is also the very best, most productive farmland that has more fertile soils and more reliable water supplies tends to produce consistently higher crop yields at lower cost. (Find this report at www.farmland.org/programs/states/ca/Feature%20Stories/documents/PavingParadise_AmericanFarmlandTrust_Nov07.pdf.)

PLACEHOLDER: Box 8-3 Q&A from Regional Economic Vitality Conversations, San Joaquin Region

Senate Bill 18 (Chapter 905, Statutes of 2004) requires cities and counties to consult with Native American Indian Tribes during the adoption or amendment of local general plans or specific plans. A contact list of appropriate Tribes and representatives within a region is maintained by the Native American Heritage Commission. The following is a list of the Tribes in this region, according to the commission. A Tribal Consultation Guideline, prepared by the Governor’s Office of Planning and Research, is available online at http://www.opr.ca.gov/programs/docs/09_14_05%20Updated%20Guidelines%20(922).pdf

- Big Sandy Rancheria of Mono Indians
- Chumash Council of Bakersfield
- Cold Springs Rancheria of Mono Indians
- Dumna Tribal Government
- Dumna Wo-Wah Tribal Government
- Dunlap Band of Mono Indians
- Kern Valley Indian Council
- Kings River Choinumni Farm Tribe
- North Fork Mono Tribe
- Salinan Tribe of Monterey, San Luis Obispo and San Benito Counties
- Santa Rosa Rancheria
- Table Mountain Rancheria
- Table Mountain Rancheria
- Tejon Indian Tribe
- Traditional Choinumni Tribe
- Tubatulabals of Kern Valley
- Tule River Indian Tribe
Land Use Patterns

According to land use surveys by the Department of Water Resources (DWR), the amount of land cultivated in the region was XXX acres in 2005. This compares to XX in 1985. The amount of land area identified as urban in 1985 was XX, while in 2005 XX acres was identified, a XX acreage increase. State and federal land have remained relatively stable at XX and XX acres respectively. Most of the urban growth has occurred adjacent to the agricultural towns along Highway 99. Cities such as Fresno, Visalia, and Bakersfield have become major urban centers, with between 100,000 and 500,000 residents. Metropolitan Fresno now approaches 1 million people.

A large portion of the land area in the Tulare Lake region consists of forest and similar land cover in the foothill and mountain areas of the region, with a large part of that consisting of in federal or other public lands. The State and federal government agencies own about 30 percent of the land in this region, including about 1.7-million acres of national forest, 0.8-million acres of national parks and recreation areas, and 1-million acres of land managed by the US Bureau of Land Management. Privately owned land totals about 7.4-million acres. Most of the valley floor is under private ownership and intensively farmed. However, urbanization of the valley floor has grown rapidly in the last century, and especially in the last 25 years.

Between 1984 and 2006, the trend is declining field crop acreage and rising acreage of deciduous, truck crops, and urban-related land use. DWR 1958 and 2005 surveys indicate a 20 percent overall increase in irrigated cropped acreage in Kern north to Stanislaus County. See tables in Appendix 8C (Table 8C-xx Change in cropped acreage by county from DWR land use survey, 1984 and 2006 and Table 8C-xx Irrigated cropped acreage, Kern north to Stanislaus County percent change, 1958-2005 (DWR surveys))

Tulare County is the largest dairy county in the state. Bulk milk production was 10,585,433 pounds in 2007, nearly twice that produced in Stanislaus County, second dairy county in California. The region also contains about 37 percent of the state’s total diaries, however, these dairies account for more than 56 percent of the total number of cows. The average number of cows per dairy in the region is 1,678, 76 percent higher than the state average.

Agriculture will continue to dominate land uses in the Tulare Lake Hydrologic Region. It will also continue to be an important economic driver in the regional economy as well as a factor in the socioeconomic structure of the San Joaquin Valley and will likely continue to play a decisive role as it adapts to changing market, technological, and regulatory forces. Increased public concerns about clean water, pesticide use, groundwater contamination, air quality, food safety, and long-term impacts on ecosystems will likely increasingly shape the future role of agriculture in the Tulare Lake Hydrologic Region and the entire Central Valley. Intensification of production in fruits and nuts and vegetables and movement away from field crop acreage is likely to continue in coming years. For more information on agriculture, see Appendix 8C.

Tribal Lands

Except for the Santa Rosa Rancheria, most of the land is remote and located in the foothills and not economically viable farming crops. Ranching livestock is more suited for these areas. The Santa Rosa Rancheria is in the San Joaquin Valley, but the soils were originally very poor with salinity and alkalinity problems. There are also about 35 public domain allotments in the Tulare Lake region. They consist of about 3,148 acres in the counties of Kern (1192 acres), Tulare (520 acres), and Fresno (1,436 acres).
### Table 8-3 Granted Tribal lands with acreage, Tulare Lake Hydrologic Region

<table>
<thead>
<tr>
<th>Rancheria/reservation</th>
<th>Acres</th>
<th>Tribal owner(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Springs Reservation</td>
<td>155</td>
<td>Western Mono Indians</td>
</tr>
<tr>
<td>Santa Rosa Rancheria</td>
<td>170</td>
<td>Tache, Tachi, and Yokuts Indians</td>
</tr>
<tr>
<td>Tule River Reservation</td>
<td>55,356</td>
<td>Yokuts Indians</td>
</tr>
<tr>
<td>Big Sandy Rancheria</td>
<td>228*</td>
<td></td>
</tr>
<tr>
<td>Table Mountain Rancheria</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>

* 25 acres of Big Sandy Rancheria are allotted

### Regional Water Conditions

Tulare Lake region’s groundwater use rises and falls contingent on the availability of both local and imported surface supplies. The management of water resources within this region is a complex activity and critical to the region’s agricultural operations. Local annual surface supplies are determined by the amount of runoff occurring from the Sierra Nevada watersheds, the flows captured in local reservoirs, and carry-over storage over a series of years. However, imported surface supply availability is contingent not only on runoff in any year or series of years but also by regulations determining the amount of water that can be pumped month to month from the Sacramento-San Joaquin River Delta due to fishery and other concerns. The recent San Joaquin River settlement will reduce the overall volume of water available for diversion into the Friant-Kern Canal.

The region was developed with the prospects of a water-short year or possibility of experiencing drought conditions in any year. Multiple layers of water sources, conveyance systems, and water management practices provide some insurance during dry times. Surface water is highly utilized and/or banked directly or indirectly (in-lieu) in water-plentiful years, for use in dry years. In water-short years, groundwater use rises with surface water cuts. In addition, summer row crop acreage may decline due to fallowing, winter crops may increase, and drought tolerant crops plantings may occur, all done to adjust current year water use to water availability. Also, water management both on-farm and by water agencies continues to evolve improving water use efficiency and reducing energy needed to move water around through the use of agency water exchanges. These arrangements have resulted in the increased occurrence of interconnected water distribution systems among water agencies, increasing the ability to “wheel” water where and when needed, and optimizing the use of an often short resource. Several water banks have agreements to store surface water from agencies outside the region. During water-short years, stored water will be pumped and delivered or arrangements by locals made to use out-of-region banked water in exchange for the local surface water reducing energy usage. Some locally stored water has also been used in fulfilling the needs of the Environmental Water Account.

Groundwater recharge is primarily from streams, from deep percolation of applied irrigation water, and from impoundment of surface water in developed water bank/percolation ponds.

Any reductions in imported supplies interfere with carefully planned long-term water management strategies of many areas in the Tulare Lake region and result in more reliance on stressed groundwater supplies.
Environmental Water

Background
The natural communities in the Tulare Lake Hydrologic Region include the mountain and foothill, valley, the riverine (intermittent and continuous), lacustrine, and estuarine (wetland) communities. Efforts continue to secure water for riverine and wetland environments. In addition, efforts to protect areas containing remaining natural vernal pools (valley and terrace) have increased the past several years.

All of the major rivers in the Tulare Lake Hydrologic Region are regulated. The last rivers with active anadromous fish populations were the San Joaquin and Kings rivers. The San Joaquin system supported large populations of anadromous fish, which used the rivers to varying degrees. By far the most abundant and widely distributed of these were the Chinook salmon, though steelhead and white sturgeon were reported in the system as far as the Kings River and Tulare Lake.

Current
In 1988, Natural Resource Defense Council (NRDC) and a broad coalition of anglers and conservation groups brought suit in US district court in an effort to bring the San Joaquin River and its native fisheries back to life. In August 2004, the court ruled that the operation of Friant Dam violates one of California's most important fishery protection statutes. The San Joaquin River Settlement Act (H.R. 24 and S. 27: January 2007) aims to restore continuous flows downstream of Friant Dam and revive the river’s salmon runs. The settlement also mitigates water supply impacts and provides certainty to Friant water users. It is expected to far-reaching benefits for all of California, including improved water quality, enhanced flood protection, healthier wildlife habitat, economic development, and recreational opportunities.

Some recent efforts to restore and enhance environmental water needs have been addressed through the Central Valley Project Improvement Act (CVPIA).

The Wild and Scenic water dedications in the Tulare Lake region are for the designated stretches along the Kings and Kern Rivers and are based on unimpaired runoff or natural flows. The Table 8-4 presents flows for the years 1998-2005:

Table 8-4 Dedicated natural flows (taf) for Kings and Kern rivers scenic regions, 1998-2005

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<th>1998</th>
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<tr>
<td>Kings River</td>
<td>1,788.7</td>
<td>745.1</td>
<td>900.3</td>
<td>601.0</td>
<td>680.5</td>
<td>847.2</td>
<td>695.2</td>
<td>1,210.6</td>
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<tr>
<td>Kern River – No. Fork</td>
<td>1,136.3</td>
<td>363.5</td>
<td>396.1</td>
<td>317.1</td>
<td>314.4</td>
<td>467.9</td>
<td>370.0</td>
<td>871.4</td>
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<tr>
<td>Kern River – So. Fork</td>
<td>280.0</td>
<td>41.9</td>
<td>34.7</td>
<td>46.0</td>
<td>24.4</td>
<td>71.5</td>
<td>32.8</td>
<td>202.7</td>
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Kings River from segment of main stem from Tulare-Kern Co. line to its headwaters in Sequoia National Park.
North Fork Kern River from headwaters in Inyo Nat’l Forest to southern boundary of the Domelands Wilderness in Sequoia Nat’l Forest.
South Fork Kern River designation includes Middle Fork from headwaters at Lake Helen to main. South Fork from its headwaters at Lake 11599 to main. Main stem from confluence of middle and south forks to the pt. at elev.1595’ m.s.l.

In addition, water is delivered to the Kern National Wildlife Refuge. The surface water received by the refuge is a direct result of the CVPIA. Reported deliveries for 1998 through 2005 are in Table 8-5 (Surface water deliveries to Kern National Wildlife Refuge (acre-feet)).
At Pine Flat Dam on the Kings River, the Kings River Fisheries Management Program was established in 1999. The program is a cooperative effort between Kings River Conservation District, the Kings River Water Association, and the California Department of Fish and Game. The program endeavors to enhance the fishery and wildlife resources below the dam and protect the water rights held by Kings River water users.

**Water Supplies**

Numerous water supply issues have arisen in the Tulare Lake Hydrologic Region. A growing urban footprint and population increases have resulted in new demand for water for municipal and industrial purposes. However, even though the region enjoys significant natural and imported water supplies, these supplies are already allocated, and in some cases, are over-allocated, making it difficult to accommodate new demands.

Runoff from local streams within the region, most of which is from the Kings, Kern, Kaweah, and Tule rivers, is stored in reservoirs or is distributed in most years except the very wet with the Basin Table 8-6 Reservoir statistics). Most of this water is conveyed via gravity through natural stream channels (St. Johns River, Deer Creek, James By-Pass, etc.) and constructed canals and ditches, along with routine pumping of surface water into canal and rivers. In general, surface waters do not leave the region in average and drier years. However, surface waters in the Kern Water Bank and Cross Valley Canal may be mixed with pumped groundwater that occasionally flows to the California Aqueduct in drier years. (SOI: Tulare Lake Basin; Hydrology and Hydrography: A Summary of the Movement of Water and Aquatic Species; 12Apr07; for EPA by ECORP Consulting, Inc.).

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<tr>
<th>Source</th>
<th>1998</th>
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<td>CVPIA</td>
<td>12,223</td>
<td>14,859</td>
<td>7,544</td>
<td>18,784</td>
<td>19,315</td>
<td>21,060</td>
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**Table 8-6 Reservoir statistics, Tulare Lake Hydrologic Region**

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<tr>
<th>River</th>
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<tr>
<td>Pine Flat Dam</td>
<td>1952</td>
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<tr>
<td>Courtwright Reservoir</td>
<td>1958</td>
<td>123,300</td>
<td>PG&amp;E</td>
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<tr>
<td>Wishon Reservoir</td>
<td>1957</td>
<td>128,600</td>
<td>PG&amp;E</td>
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<tr>
<td>Kaweah River</td>
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<tr>
<td>Terminus Dam</td>
<td>1951</td>
<td>143,000</td>
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<tr>
<td>Spillway raise</td>
<td>2004</td>
<td>185,630</td>
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<td>Tule River</td>
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<tr>
<td>Success Dam</td>
<td>1961</td>
<td>82,300</td>
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<td>Kern River</td>
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<tr>
<td>Isabella Dam</td>
<td>1953</td>
<td>568,000</td>
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USACE = US Army Corps of Engineer

Most of the agricultural water districts below the western slopes of the Sierra Nevada capture and use runoff from major and minor streams as well as rely on groundwater supplies. Multiple purpose reservoirs have been constructed on all major streams for flood control and storage. These are multipurpose reservoirs and provide conservation of water for flood control, fish and wildlife protection, recreation, irrigation, and municipal and industrial water supplies, and hydroelectric power generation. Long-held water rights determine the amount of water that can be delivered to any particular user in any particular year based on projected volume of runoff. Water districts in the western area of the valley floor depend heavily on imported water from the CVP.
and SWP and corresponding contracts. These two projects follow a coordinated operation agreement for water shortages, water quality, and environmental requirements. Groundwater quality is often poor, and availability is highly variable. In addition, drainage problem areas have developed with high water tables.

Water management is a high priority in the region. Projects and programs to augment water supplies through infrastructure improvements and management have resulted in the extension of available supplies. Improvements in conjunctive use, on-farm water management and irrigation systems, water exchange agreements, water optimization studies and projects, water transfers and the utilization of water banking facilities all emphasize long-term water management objectives. Several water banking efforts include agencies from other regions whose water is banked during sufficient water supply years. In water supply-deficient years the surface supply of districts in the region is conveyed out of region while the Tule Lake region becomes more reliant on local groundwater.

CALFED was started as a way to forestall what many believed could have resulted in significantly reduced water supplies due to possible non-compliance of the CVP and the parallel SWP with Clean Water Act and Endangered Species Act (ESA) requirements. Implementation of these laws combined with the CVPIA in 1992 (which included a dedication of 0.8 million acre-feet of CVP water supplies to fish and wildlife) have resulted in reduced water deliveries to agricultural contractors in some cases and remain an ongoing tension for water management and water supply reliability in the Tulare Lake region.

The water balance table for the Tulare Lake Hydrologic Region (Table 8-7) summarizes all of the water supplies, uses, and outflows for years 1998 through 2005. In wet years surface water adds to groundwater storage through a variety of recharge mechanisms. Table 8-8 details water use and dedicated water supplies. Tables 8-7, 8-8, and 8-9 and Figure 8-4 summarize the water supplies, uses, and outflows for years 1998 through 2005.

[Develop text as data become available]

PLACEHOLDER Table 8-7 Tulare Lake Hydrologic Region water balance summary (taf)
PLACEHOLDER Table 8-8 Tulare Lake Hydrologic Region water use and distribution of dedicated supplies (taf)
PLACEHOLDER Table 8-9 Tulare Lake region water portfolio (taf)
PLACEHOLDER Figure 8-4 Tulare Lake region water balance for water years 1998-2005

**Water Uses**

Agricultural water use is the region’s largest user of water, followed by environmental and urban. On average, agriculture water use is XX percent, environmental XX percent and urban water use is XX percent. The percentage of urban water use has been increasing over the years, climbing from XX percent in 1980 to XX in 2005. Over the years agriculture water use has remained relatively constant as irrigated acreage has risen, a credit to water use efficiency efforts in the industry.

Normally, all native surface water supplies, imported water supplies, and direct precipitation percolate into valley ground water if not lost through consumptive use, evapotranspiration, or
evaporation. Because of its closed nature, Tulare Lake Hydrologic Region has little subsurface outflow. Thus, salts accumulate within the basin due to importation and evaporative use of the water.

**Water Quality**

The Tulare Lake Hydrologic Region corresponds to approximately the southern one-third of Regional Water Quality Control Board’s Region 5. Below are key water quality issues in this region. For further discussion, see Appendix 8B Water Quality.

Salinity: Salinity is the primary contaminant affecting water quality and habitat in the Tulare Lake Region. Because the groundwater basin in the San Joaquin Valley portion of the region is an internally drained and closed basin, Salts, much of which are introduced into the basin with imported water supplies build up in the soil and groundwater.

Salt in supply water imports is the primary source of salt circulating in the Tulare Lake Basin. The Delta Mendota Canal and California Aqueduct supply most of the higher quality surface irrigation water in the Tulare Lake Basin. The quality of this supply may be impaired by the recirculation of salts from the San Joaquin River to the Delta Mendota Canal intake pump, leading to a greater net accumulation of salts in the basin. Delivery data from the two major water projects in California indicate there is a substantial amount of salt being transported from the Delta to other basins throughout the State. Annual import of salt into the Tulare Lake Basin is estimated to be 1206 thousand tons of salt. In situ dissolution of salts and pumping from the underlying confined aquifer are important secondary sources. The Tulare Lake Basin does not have an outlet and all of the salt loading introduced from outside of the basin becomes a part of the confined aquifer in the basin.

Sedimentation and Erosion: In the Central Valley, erosion is occurring from the headwaters down to the valley floor. Although naturally occurring, erosion can be accelerated by timber harvest activities, land use conversion, rural development, and grazing. Excessive soil erosion and sediment delivery can impact the beneficial uses of water by: 1) silting over fish spawning habitats; 2) clogging drinking water intakes; 3) filling in pools creating shallower, wider, and warmer streams, and increasing downstream flooding; 4) creating unstable stream channels; and 5) losing riparian habitat. Timber harvesting in the riparian zone can adversely affect stream temperatures by removing stream shading which is especially a concern for spawning and rearing habitat for salmonids. Thousands of miles of streams are potentially impacted and the lack of resources has prevented a systematic evaluation of these impacts.

During the past five years, in the Tulare Lake Hydrologic Region, timberland owners have submitted 18 timber harvest plans that allow harvesting on almost ten thousand acres.

Another major source of erosion is construction activities that expose or loosen soils. In the past five years, the Central Valley Water Board has documented 15 incidents that could result in water quality impacts if not corrected.

Nitrates and Groundwater Contaminates: Ground water is a primary water supply in many instances but in many places it is impaired or threatened because of elevated levels of nitrates and salts that are derived principally from irrigated agriculture, dairies, discharges of wastewater to land, and from disposal of sewage from both community wastewater systems and septic tanks. The areas of high TDS content are primarily along the west side of the San Joaquin Valley and in...
the trough of the valley. High TDS content of west-side water is due to recharge of stream flow originating from marine sediments in the Coast Range.

Naturally occurring arsenic and man-made organic chemicals—pesticides and industrial chemicals—in some instances have contaminated groundwater used as domestic water supplies in this region.

Agricultural pesticides and herbicides have been detected throughout the valley, but primarily along the east side where soil permeability is higher and depth to groundwater is shallower. The most notable agricultural contaminant is DBCP, a now-banned soil fumigant and known carcinogen once used extensively on grapes.

Legacy Mine Impacts: In the Tulare Lake Hydrologic Region, San Carlos, Silver, and Panoche creeks in the northwest part of the Region are impacted by discharges from legacy mercury mining activities. Asbestos is also a concern in the western part of this hydrologic region where there are two asbestos mines in the Los Gatos Creek watershed that are part of EPA Superfund remediation efforts.

Dairies, Stockyards, and Poultry Ranches: Concern in the region for their loadings of pathogens, nutrients, salts, and emerging contaminants (such as antibiotics) to water bodies has increased. Some dairies and other agricultural operations are already subject to regulatory review.

Water Project Operations
The two largest water projects in the region are the CVP (Friant and San Luis units) delivering water along the eastern areas of the San Joaquin Valley and the State Water Project (California Aqueduct) delivering most water along the western San Joaquin Valley from Kings County south. The majority of local surface water originates from the reservoir projects on the Kings, Kern, Kaweah and Tule Rivers delivering water to numerous eastside water agencies and Kern County water agencies (see Figure 8-5 Water agency map).

Water Governance
Today’s water governance in the Tulare Lake Hydrologic Region is strongly tied to the period following the Gold Rush, reclamation law, the passage of the Wright Act in the 1860s, the Municipal Utility District Act of 1921, and various related historical legislation. Most of the large irrigation districts can trace their origins to private investors efforts to build water distribution systems to divert local rivers and streams to outlying land and expansion of farmland, land reclamation and levee maintenance.

The region’s water management, planning, and flood control activities are generally governed by counties, cities, private companies, and special districts created to perform specific functions. Table 8-10 (Agencies and roles in relation to DWR water management strategies) lists various types of special districts.
## Table 8-10 Agencies and roles in relation to DWR water management strategies

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<td>Corps of Engineers</td>
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<td>Fish and Wildlife Service, USDI, Fish</td>
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<td>Environmental Protection Agency</td>
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</tbody>
</table>

1 DWR Water Management Strategies as detailed in the California Water Plan Update 2009. Strategies not applicable to the Tulare Lake Region include Desalinization and Surface Storage-CALLED.

The interregional water conveyance systems of the CVP and SWP are operated by the federal and State governments, respectively. Local developed surface water systems include the diversion points and canals along the Kings River for the Fresno Irrigation District, Alta ID, Consolidated ID, along the Tule River for Porterville ID and Lower Tule River ID and along the Kern River for Kern Delta ID and North Kern Water Storage District to name a few.
Many organizations are involved in the sale, delivery, management, maintenance, planning, reuse, and flood control aspects of water in the Tulare Lake region. Table 8-11 (Selection of organizations in Tulare Lake Hydrologic Region involved in water governance) lists a selection of organizations involved in water governance in the region.

Table 8-11 Selection of organizations in Tulare Lake region involved in water governance

<table>
<thead>
<tr>
<th>Entity</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Federal</strong></td>
<td></td>
</tr>
<tr>
<td>Friant-Kern Canal (CVP)</td>
<td>Interregional water supply</td>
</tr>
<tr>
<td>US Bureau of Reclamation</td>
<td>Operation of Friant Dam</td>
</tr>
<tr>
<td>US Corps of Engineers</td>
<td>Operation of Pine Flat, Isabella, Kaweah Dams</td>
</tr>
<tr>
<td><strong>State</strong></td>
<td></td>
</tr>
<tr>
<td>Kern County Water Agency</td>
<td>Water Supply and Flood Control</td>
</tr>
<tr>
<td>State Water Project</td>
<td>Inter-regional water supply</td>
</tr>
<tr>
<td><strong>Local</strong></td>
<td></td>
</tr>
<tr>
<td>Alpaugh Joint Powers Authority</td>
<td>Alpaugh ID and Tulare Co. Water Works District</td>
</tr>
<tr>
<td>Bear Valley Springs CSD</td>
<td>water, police, roads, wastewater, Solid waste</td>
</tr>
<tr>
<td>City of Fresno, Water Division</td>
<td>water</td>
</tr>
<tr>
<td>Deer Creek and Tule River Authority</td>
<td>water conservation, groundwater management</td>
</tr>
<tr>
<td>Dudley Ridge Water District</td>
<td>SWP contractor</td>
</tr>
<tr>
<td>Fresno Metro Flood Control District</td>
<td>Local Flood Control</td>
</tr>
<tr>
<td>Friant Water Authority</td>
<td>Friant-Kern Canal maintenance</td>
</tr>
<tr>
<td>Henry Miller Recreation District 2131</td>
<td>evacuate runoff and maintain internal drainage</td>
</tr>
<tr>
<td>Kaweah Delta Water Cons Dist.</td>
<td>Management of Kaweah River water</td>
</tr>
<tr>
<td>Kings River Conservation District</td>
<td>flood protection, water supply, power</td>
</tr>
<tr>
<td>Kings River Water Agency</td>
<td>Kings River entitlements, deliveries, water quality environment</td>
</tr>
<tr>
<td>Panoche Drainage District</td>
<td>maintain internal drainage</td>
</tr>
<tr>
<td>Pinedale CWD</td>
<td>water, wastewater, solid waste</td>
</tr>
<tr>
<td>So. San Joaquin Municipal Utility District</td>
<td>agricultural water from CVP, WAPA Power</td>
</tr>
<tr>
<td>Tulare Lake Basin WSD</td>
<td>Delivery, storage of SWP water</td>
</tr>
<tr>
<td>Tulare Lake Drainage District</td>
<td>Drainage Management</td>
</tr>
</tbody>
</table>

**Flood Management**

**Historic Floods**

Flood events in the Tulare Lake region are caused by rainfall, snowmelt, and the resultant rising of normally dry lakes. Recent notable events have been

- the rainfall and snowmelt floods of December 1955, February 1969, January 1997, and winter 1998,
- the region-wide rainfall floods in winter 1966-67 and March of the 1995 El Niño year, and

For more information on these floods see Appendix 8A Flood Management.

**Flood Hazards**

Although significant progress has been made to contain floodwaters in the Tulare Lake Hydrologic Region, improvements to the flood control system are still needed to lessen the flood risk to life and property.

- Flood control structures are inadequate to protect the California Aqueduct from floodwaters of Los Gatos Creek flowing through Arroyo Pasajero.
• Regulation of floodwaters from Caliente Creek and associated tributaries is inadequate and floods often threaten agricultural and residential areas around Bakersfield.
• The Kings River near Laton lacks the channel capacity to contain 100-year floodflows.
• The White River west of Tulare County Road 208 lacks the channel capacity to contain 100-year flood flows.
• Many levees in the Visalia area are not adequately maintained and are in poor condition.
• The flood storage capacity of Lake Success has been reduced due to dam instability, increasing risk for urban and suburban Porterville.
• Leakage in Lake Isabella’s auxiliary dam has reduced flood storage capacity, threatening Bakersfield and communities along the Lower Kern River.
• *Arundo donax* proliferates in the region’s waterways. The plant is an extremely fast growing exotic and a high water user. It increases siltation and interferes with the flow of water.
• Flood control infrastructure on Fancher and Redbank creeks east of Clovis and Fresno, now being improved, is urgently needed to protect these communities.
• Resources need to be provided to restore, analyze, and certify levees in urban Tulare County in order to contain the 200-year floodflow.

Flood Governance
Flood management is a cooperative effort in which federal, State, and local agencies play a significant part. The principal participants are listed in Box 8-4 Flood Management Agencies. For more information on the agencies’ roles, see Table 8A-2 Flood management participants in Appendix 8A.

Box 8-4 Flood Management Agencies

**Federal**
Federal Emergency Management Agency  
Natural Resources Conservation Services  
US Geological Survey  
US Army Corps of Engineers

**State**
California Conservation Corps  
Central Valley Flood Protection Board  
Department of Corrections  
Department of Forestry and Fire Protection  
Department of Water Resources  
Office of Emergency Services

**Local**
County emergency services units  
County planning departments  
County building departments  
Local conservation corps  
Local initial response agencies  
City of Bakersfield  
Levee Districts 1 and 2 of Tulare County
Reclamation districts (10)
Kings River Conservation District

Flood Risk Management

Regulation
The Central Valley Flood Protection Board has designated the following streams as floodways: Kings, Kaweah, Tule, and Kern rivers; and Porter Slough. Fresno, Kings, Tulare, and Kern counties regulate floodplain development and restrict floodway encroachment with their zoning ordinances. General plans for the four counties discuss flood hazards and control measures in the context of projected population growth, and provide guidelines for future flood control strategies.

Information and Education
DWR’s Awareness Floodplain Mapping project provides an easy-to-use computer interface that allows a quick determination of a channel’s 100-year floodplain. All of Fresno and Tulare counties have been mapped as part of the project; large swaths of Kern and Kings counties have yet to be evaluated. However, 100-year floodplains in all developing areas within Kings and Kern counties should be demarcated by 2012.

Most urban areas in the region have been mapped by the Federal Emergency Management Agency. Flood Insurance Rate Maps (FIRMS) were completed for the flood-prone cities of Fresno and Clovis in 2001; numerous revisions have occurred since then. In Tulare County, Porterville and Three Rivers were mapped in 1985 and 1986, respectively; FIRMs became effective for Visalia and unincorporated areas in 1998. In Kern County, FIRMs were established for Bakersfield and surrounding areas in the mid 1980s; a few subsequent revisions have taken place. FEMA is updating all flood-zone maps for California.

For the Region, the California Data Exchange Center provides gage data from DWR (33 gages), USACE (28), Pacific Gas and Electric Company (28), Kern County (27), the National Weather Service (11), the National Park Service (10), and more than eight other federal, State, and local agencies (total 54 gages).

CDEC provides real-time flow and stage data for the Kings, Tule and Kern rivers. CDEC also provides statistics relevant to flooding for dams in all four of the region’s major drainages.

The US Geological Survey (USGS) maintains and publishes statistics for stream gages nationwide, including 21 in the Tulare Lake region that are useful for flood management. USGS gages are the source of data for the eight stations listed in Table 8A-1 Flood parameters for principal streams in Appendix 8A.

Accurate hydrologic and hydraulic models inform the design of effective flood control structures and emergency actions before, during, and after floods. The National Weather Service’s Advanced Hydrologic Prediction Service uses historical data, current river and watershed conditions, and near-term meteorological outlooks to forecast river flows. The service is publicly available for all four of the major Tulare Lake Hydrologic Region’s streams just below their respective reservoirs.
A number of other models describing the hydrology of the region’s rivers provide data relevant to flooding issues. The Kings River Water Agency has an operational streamflow-prediction model that is used to estimate the amount of water available for beneficial uses. The Kings River Conservation District and Upper Kings Basin Water Forum have developed a regional model which simulates the ground- and surface-water systems of the Kings Basin. Norman Miller at the Berkeley National Laboratory has modeled Kings River flows based on two climate change scenarios (one dry and cool, the other wet and warm). For the Tule River, researchers at the University of California, Davis created a conjunctive use model; Lyle Engineering modeled the river’s hydraulics near East Porterville for a bridge replacement project. The Central Valley Ground-Surface Water model calculates a water budget for all four of the region’s major rivers.

**Event Management**

Of 35 cities and 6 counties within the region, a city and 2 counties participate in the National Flood Insurance Program Community Rating System. As of October 2007, Kern and Fresno counties and the City of Fresno were in CRS Class 8.

In general, flood emergency response proceeds from the local level through the county (Operational Area), Office of Emergency Services region and OES headquarters, with DWR and USACE supporting throughout. Details of the procedures for flood preparedness, emergency response, and recovery are discussed in Volume 2, Chapter 28 Flood Risk Management. Table 8A-x Flood emergency response organizations in Appendix 8A is a listing of specific response organizations.

As a part of that responsibility, the board has designated floodways on portions of the Kings, Kern, Kaweah and Tule Rivers, Cross and Cottonwood Creeks, and Porter Slough in the Region.

**Structural Works**

Floodwaters from Big Dry and Dog creeks headed toward Fresno and Clovis are captured by Big Dry Creek Dam and rerouted via a diversion channel into Little Dry Creek. The Redbank and Fancher Creeks Project enlarged Big Dry Creek Dam and constructed Fancher Dam, Redbank Detention Basin, Pup Creek Detention Basin, and Alluvial Detention Basin. With the exception of Fancher Creek, these features provide 200-year protection to the cities of Clovis and Fresno. The Fancher Creek Detention Basin is currently being constructed as a local multiyear phased project to further control flows in Fancher Creek before they reach the urban area of Fresno. The Fancher Creek Detention Basin can now provide protection to the southeast Fresno area from the 100-year event. A project with both agricultural drainage and flood control functions consisting of channel modifications, pipelines, and an offstream sump has been constructed on Stone Corral Creek, resulting in protection for 11,000 acres of agricultural lands around Visalia. A sedimentation basin and intertie between the Kern River and California Aqueduct has been constructed, which funnels floodflows from the Kern into the aqueduct for beneficial uses in Southern California.

Major reservoirs constructed on the region’s four major rivers all contain floodwater as their primary function. These reservoirs and their pertinent parameters are listed in Appendix 8A, Flood Management, in Table 8A-x Flood control reservoirs.
**Floodplain Restoration**

Much former floodplain area in the Tulare Lake region consists of the beds of Tulare Lake and Buena Vista/Kern lakes, which have been converted to agricultural operations for many years and are not amenable to restoration to floodplain status. Agricultural strategy in the area includes much effort devoted to containing floodwaters in as small an area as possible, leaving the remainder for use in the long growing season. [Insert info about Kern River Restoration Program, if it includes floodplain restoration.]

**Operating Procedures**

Flood reservation space in the region’s reservoirs is determined by a trapezoidal diagram of space against date; the space is modified toward the end of the flood season. Diagrams usually require an increasing flood reservation space through fall, which then declines through spring to early summer. Conditional reservation space in Pine Flat Lake can be credited to Wishon and Courtright reservoirs if the upstream lakes together contain more than 20,000 acre-feet of space. Runoff forecasts or antecedent precipitation indices (API) are superimposed upon the diagrams to better gauge the amount of flood reservation space required. The trapezoid and time period are both reduced in API-controlled diagrams; conversely, those diagrams controlled by runoff increase both the trapezoid and the time frame.

No coordinated agreements exist for the Tulare Lake Hydrologic Region. However, during high water periods reservoir operators coordinate with DWR and the USACE during daily operations conferences at the Flood Operation Center in Sacramento. These conferences often result in changes to reservoir operations.

In flood events, the Kings River may spill into the San Joaquin River via Fresno Slough and James Bypass. Coordination of reservoir releases to both rivers is paramount to minimizing flooding risks in the San Joaquin and Tulare Lake hydrologic regions. Thus, Kings River Water Authority and the USACE cooperate closely on reservoir operations during high water periods. These agencies also participate in daily conferences at the State-Federal Flood Operations Center in Sacramento. Additionally, cooperation between Pacific Gas and Electric Company and the USACE in the Kings River Basin has resulted in more effective reservoir flood control operations.

**Relationship with Other Regions**

**Flood Diversions**

Kings River outflow normally flows toward Tulare Lake and usually is intercepted for irrigation use or stored in Pine Flat Lake. In flood events, the Kings may flow northward into the San Joaquin River Hydrologic Region, generally along the path of historical distributaries. Although this flow may correspond to a natural occurrence, northward disposal of excess flows is encouraged by river operators to protect agricultural interests in Tulare Lake. Disposal of floodwaters into the region is limited by flood conditions on the San Joaquin River itself and the area’s susceptibility to flood damage.

Similarly, high flows in the Kern River can damage agricultural lands in the Buena Vista Lake basin and, theoretically, can overflow into Tulare Lake. Some excess floodwater can be routed into the California Aqueduct through the Kern River Intertie. This water is transported to the
South Coast Hydrologic Region. Quantities are limited by the flow capability of the aqueduct and by available space in the SWP reservoirs in Southern California.

**Regional Water and Flood Planning and Management**

Tulare Lake regions’ growing interest in the regional planning process is indicated by the rising number of proposals submitted for funding considerations to DWR and the State Water Board. Some of the factors that are commonly considered in these regional planning efforts include the following.

- Population growth, impacts, and resulting water needs
- Groundwater overdraft and associated problems
- Preservation of prime agricultural lands
- Reliability of water supplies in foothill and mountain communities
- Reliability of water supplies for fish, refuges, and the environment
- Potential water transfers and exchanges and their effects
- Groundwater banking programs
- Groundwater quality issues, particularly for drinking and municipal use

**Box 8-5 California Partnership for the San Joaquin Valley, Strategic Plan**

“The California Partnership for the San Joaquin Valley has developed a strategic plan to address water planning and is currently working to develop a Regional Water Plan. Several other local groups are in the process of developing IRWM plans. In addition, the Council of Governments within the Tulare Basin are activity involved in a Blueprint Planning process in an attempt to reconcile “pro-growth” and “anti-growth” forces and attitudes, such as concerns about the need for housing production and regional economic development, on the one hand, and resistance to community change and environmental disruption, on the other. Blueprint planning seeks mainly to coordinate long-range regional and local plans for transportation investment, air quality, and housing, although in some cases such policy areas as energy and habitat planning are also incorporated. An exception is the California Environmental Quality Act (CEQA) – California’s version of NEPA.”

**Integrated Regional Water Management**

There are currently three Integrated Regional Water Management (IRWM) plans in the Tulare Lake Hydrologic Region at varying stages of function and development. An additional plan is being redeveloped. These plans are located throughout the hydrologic region, but portions of the region are void of IRWM planning. Table 8-12 and Figure 8-6 present the IRWM planning efforts. IRWMPs are living documents and IRWMPs may change as planning efforts mature, opportunities for collaboration and partnership are discovered, and State guidance is further refined.
Table 8-12 Strategies of Integrated Regional Water Management efforts in Tulare Lake Hydrologic Region

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Poso Creek IRWMP</th>
<th>Upper Kings IRWMP</th>
<th>Westside Integrated Water Resources Plan 1</th>
<th>Kaweah Delta Regional Water Management Implementation Program 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adopt water dispute resolution procedure</td>
<td>July 2007</td>
<td>Jul 2007</td>
<td>May 2007 revised</td>
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<tr>
<td>Conjunctive water management</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>Desalination (R/O)</td>
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<tr>
<td>Ecosystem restoration</td>
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<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>Environmental and habitat protection and improvement</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Flood management</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>Get stakeholders involved</td>
<td></td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Groundwater management</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Implement third-party banking programs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Imported water</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>Increase operational flexibility</td>
<td>✓</td>
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<tr>
<td>Land acquisition</td>
<td></td>
<td>✓</td>
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<td>Land use planning</td>
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<tr>
<td>Monitoring inelastic land subsidence due to water pumping</td>
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<tr>
<td>Nonpoint source pollution control</td>
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<tr>
<td>Participate in regional groundwater committee</td>
<td>✓</td>
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<tr>
<td>Prevent saline water intrusion</td>
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<tr>
<td>Recreation</td>
<td>✓</td>
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<tr>
<td>Secure grant funding to offset capital cost</td>
<td>✓</td>
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<tr>
<td>Storm water capture and management</td>
<td>✓</td>
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<tr>
<td>Strengthen relationship and cooperation with other agencies</td>
<td>✓</td>
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<tr>
<td>Support District’s water supply pricing policy</td>
<td>✓</td>
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<tr>
<td>Surface storage</td>
<td></td>
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<tr>
<td>Water and wastewater treatment</td>
<td>✓</td>
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<tr>
<td>Water conservation</td>
<td>✓</td>
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<tr>
<td>Water quality protection and improvement</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Water recycling</td>
<td>✓</td>
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<tr>
<td>Water supply reliability</td>
<td>✓</td>
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<tr>
<td>Water transfers</td>
<td>✓</td>
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<tr>
<td>Watershed planning</td>
<td></td>
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<tr>
<td>Wetlands enhancement and creation</td>
<td>✓</td>
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</tbody>
</table>

Note: The summary information contained in these tables was obtained from various IRWM plans. For additional details or information related to a specific plan, please consult the current version of the plan or its authors.

1 The Westside Integrated Water Resources Plan regional boundaries overlap multiple CWP regions. This plan can also be found in the San Joaquin River HR section.
2 The Kaweah Delta Regional Water Management Implementation Program consisted of a groundwater management plan, water management agreement and supporting elements, and it was used as a functionally equivalent IRWM plan.
Figure 8-6 Integrated Regional Water Management efforts in Tulare Lake Hydrologic Region (map)

Two of the regional water management plans in the region address flood control. The Westside IRWM plan has proposed constructing flood detention reservoirs on Arroyo Pasajero and Panoche Creek within retired farm lands. The Upper Kings River IRWM Plan addresses the importance of curtailing flood damages through structural works, floodplain management, and conjunctive uses; it has two projects directed toward enhanced flood control and a number of conjunctive use projects that have ancillary flood reduction benefits.

Accomplishments

The region has always strived to ensure adequate, reliable supply of water to supplement local surface and groundwater and incorporation of water management strategies and infrastructure that improves water use efficiency at all levels. Many projects and programs have minimized flooding, saving lives and millions of dollars over the years. The following is a list of accomplishments within the region toward this effort.

- Agricultural Water Management Planning and adoption of EWMPs; 27 of the 79 signatories are in the Tulare Lake region accounting for 43 percent of the irrigated acreage (see Appendix 8C).
- Kern County, California Multi-Hazard Mitigation Plan, adopted in 2005
- Pine Flat Lake, 1954
• Lake Kaweah (Terminus Dam), 1962
• Terminus Dam Enlargement, 2005
• Lake Success, 1961
• Lake Isabella, 1953
• Big Dry Creek Diversion and Dam Project, 1993
• Kern River-California Aqueduct Intertie, 1977
• Redbank Detention Basin, 1990
• Fancher Dam, 1991
• Fancher Creek Detention Basin, 1991
• Little Panoche Reservoir, 1966
• Stone Corral Creek Project, 1978
• Lower Kings River Channel Improvements, 1976
• Pup Creek and Alluvial Drain detention basins, 1993
• Jerry Slough Improvements, 1969
• Conservation efforts of the Tulare Basin Wildlife Partners
• Water districts are working with individual growers to improve on-farm irrigation water management systems and efficiency through loans, irrigation services, delivery scheduling changes/modification, water transfers and other resources.
• Growers are steadily accomplishing irrigation system changes/upgrades, especially in permanent crops allowing more efficient application of irrigation.
• Increasing grower adoption of irrigation scheduling programs and data which is reducing applied water requirements; fertigation, fertilizing through irrigation systems, particularly micro irrigation systems which is reducing leaching of fertilizer below crop root zone.
• Efforts to reconcile inconsistent year to year contract deliveries from the CVP and SWP through local optimization studies, shared infrastructure and cooperation.
• Urban Water Management Plans; increasing number of urban areas preparing UWMPs and becoming members of the California Urban Water Conservation Council and MOU cities with approved plans.
• Increasing number of areas with prepared Groundwater Management Plans; Groundwater Management Act of 1992, AB 3030, areas with approved GWM Plans Table XX; AB 255; AB 255; SB 1938.
• Diversifying urban water sources and increasing water quality delivered; several urban areas are adding surface water treatment plants.
• New sewage treatment systems are improving quality of water release back into the environment, into recharge basins and for irrigation.
• Increasing number of cooperative conjunctive use projects, distribution system interconnections, management strategies, water banks, etc.
• US Department of Agriculture and US Natural Resources Conservation Service agricultural and environmental enhancement programs.
• The Lake Kaweah Enlargement Project
• The Coordinated Resource Management and Planning (CRMP) groups in the Tulare Lake region include the Panoche/Silver Creek CRMP, the Stewards of the Arroyo Pasajero Watershed CRMP, and the Cantua/Salt Creek Watersheds CRMP.
In California, 107 groundwater management plans have been adopted, 25 of the areas lie within the Tulare Lake Hydrologic Region.

Surface water availability can vary widely year to year in the Tulare Lake region. Consequently, local conjunctive use water management and groundwater banking projects are continually being expanded and updated. Recently, the Upper Kings Basin Water Forum received a $6-million grant to help reverse the depletion of groundwater. Nearly $3.6 million of it will go to a local water banking project in northern Kings County. The grant money is part of the DWR's $3.4-billion program enabled by Proposition 50 passed by California voters in 2002. The forum achieved that through the development of an IRWM plan for the upper Kings River region, which spans from Fresno to Kings counties.

Challenges

The San Joaquin Valley most notable issues surround water supply and quality, air quality, and growth and urban sprawl. Although significant progress has been achieved in addressing some of these issues, the San Joaquin Valley continues to face major environmental issues that are closely related to existing economic sectors and can affect economic development planning for the future. This includes prosperous growing urban economies, maintaining prosperous agricultural, diary, and processing industries economies, to name a few.

Growing urbanization and population increases have resulted in new demand for water for municipal and industrial purposes; local environmental enhancement efforts have increased the need for water; Sacramento-San Joaquin River Delta water quality needs and environmental needs are reducing the export volume of water pumped and available in the Tulare Lake Hydrologic Region; the San Joaquin River Settlement will impact water diverted into the Friant-Kern Canal; water costs influence the crop types that can be grown profitable; water delivery contractual obligations and priority of water use brings many questions.

Some of the challenges ahead relate to flood protection.

- Taking measures to reduce flood impacts for the hazards identified on page [insert page], “Flood Hazards.”
- Developing and gaining USACE acceptance for higher standards for design floods for facilities in urban and urbanizing areas.
- Taking steps to ameliorate the effects of unprecedented urbanization of agricultural lands, which include increased runoff peaks and totals and degraded water quality.
- Assisting the public in making choices whether to live in floodplains and how to prepare for and insure against flooding, by linking land use decisions to flood risk and flood protection costs.
- Mapping the floodplain around Exeter as quickly as possible in order to provide sound guidelines for flood control projects and flood insurance rates.
- Expediting flood map updates for Visalia, Porterville, Bakersfield, and surrounding areas to reflect recent changes in flood control infrastructure, particularly structural and operational changes to dams.
- Formalizing coordination of high water flows on the San Joaquin and Kings rivers using coordination agreements.
Such limitations of surface water deliveries will continue to exacerbate groundwater overdraft in the Tulare Lake Hydrologic Region where groundwater often is used to replace surface water shortfall.

For many years, portions of the Tulare Lake region have experienced significant drainage problems. See Appendix 8C for more discussion on drainage and movement of salt in the Central Valley.

**Drought and Flood Planning**

The Tulare Lake Hydrologic Region has experienced water short conditions for more than 100 years, which has resulted in a water industry that has consciously developed—through careful planning, management and facility design—the possibility of a shortage occurring in any year. Water demand is more or less controlled by available, reliable long-term water supplies. Over the years, agricultural acreage has risen and then dropped largely based on water supplies. The region initially developed on surface water supplies, which soon taught local water users could widely vary in volume year to year and could develop into drought conditions. The introduction of deep well turbines resulted in a dramatic rise in groundwater use in the early 1900s and provided a supply of water that could be used during surface water deficient years. This resulted in a regional reliance on conjunctive water use in the development of the local water economy.

During drought periods in the region, those who feel the effects of water shortages the most are small water systems and their customers whose reliance on marginal wells, springs, and small creeks make them especially sensitive to annual rainfall totals. Following a recommendation made by the Governor’s Advisory Drought Planning Panel, California Rural Water Association will bring small water systems a myriad of resources to aid in dealing with water shortages.

Program Assistance or Functional Assistance: The Emergency Services Act establishes the OES; provides for the evaluation of hazards and preparation of emergency plans to deal with a wide range of disaster events including drought, and provides for emergency powers at the local and state levels to respond to disasters posing threats to life and property. The OES monitors situations which may evolve into disaster situations and participates on the state drought task force together with DWR and other State agencies. (Statute or Authority: CA Gov't code sections 8550-8668)

Hazard Mitigation Plans: The Disaster Mitigation Act (Congress 2000) makes mitigation funds available for states and local entities that have these plans. Kern County has adopted a HMP that identifies flood-prone areas and presents measures for lessening the impacts of floods.

Regional flood management plans: FloodSAFE is a strategic initiative of DWR that is guiding development of these plans, which encourage regional cooperation in identifying and addressing flood hazards and will include flood-hazard identification, risk analyses, existing measures, and potential projects and funding strategies. The plans will emphasize multiple objectives, system resiliency, and compatibility with State goals and IRWM plans.

Governor’s Plan for California’s water future: This plan proposes to invest $4.5 billion to develop additional surface and groundwater storage to capture more water from storms and prepare California for the impacts of global warming, invest $1 billion to protect the Delta following the recommendation of the Delta Vision Blue Ribbon Commission Task Force, and provide $450 million for restoration and conservation projects throughout the state.
Looking to the Future

In the Tulare Lake Hydrologic Region, the efficiency of water diversions from local rivers and streams is continually being optimized to meet agricultural and urban purposes. In addition, water agencies have worked with the CVP and SWP to find ways to improve delivery capabilities. The predominantly agricultural economy is now adapting to share water resources with the rapidly growing urban economy. New projects have been identified as necessary to better manage the local water supplies, as well as to adhere to more stringent water quality standards and environmental regulations. IRWM will be an important part of the region’s future water management and projects. Supply augmentation, water use efficiency, demand reduction, flood control improvement, and salt management will all be part of the effort of meeting this challenge.

Future Scenarios

To be added

Climate Change

In general, climate change models are predicting annual average statewide temperature rises of up to 4 degrees Celsius and up to 5 degrees Celsius for individual months. These changes will vary by location with the smallest increases forecast for the Tulare Lake Hydrologic Region. The months of February, March, and May are shown to have the largest temperature response. The net result is milder winter temperatures, an earlier arrival of spring, and increased summer temperatures. Under this model, snow accumulation is significantly decreased in all months, with snow accumulation still beginning in November but with lower monthly accumulations and ending about a month earlier (large decreases in April 1 snowpack.) The impact would be much less in the higher elevation of southern Sierra. For example in the San Joaquin River and Tulare Lake hydrologic regions, about 70 percent of the snow zone would remain. It is anticipated that the overall evapotranspiration will increase while soil moisture will generally decline except in areas where precipitation will significantly increase. The higher water consumption with warmer temperatures will likely only be partially offset by the carbon dioxide-based reductions. Thus, the net result could be slightly higher agricultural water requirements. Warmer winter temperatures between storms would be expected to increase evapotranspiration, thereby drying out the soil between storms. Changes in recharge will result from changes in effective rainfall as well as a change in the timing of the recharge season. (Paper No. 02153 of the Journal of the American Water Resources Association (JAWRA))

More information regarding climate change models and forecast effects, see Appendix 8C.

Response Strategies

[To be developed]

The following strategies are in response to the challenges of flood management in the region. More information is available in Appendix 8A.

- **Multipurpose projects**—Opportunities for efficient use of funding and conservation of limited resources.
- **Emergency Coordination**—Coordination of reservoir operation on the San Joaquin River and its tributaries, including the Kings River.
• **Emergency Flood Response Agreements**—Define responsibility for emergency response and payment of response costs using bilateral or multilateral mutual aid pacts.

• **Increased Design Standards**—Design for at least 200-year floodflows in urban or urbanizing areas and 100-year flows in agricultural areas.

• **Emergency Plan for Rural Washouts**—Emergency plans for steep, isolated areas, outlining emergency response, identifying resources, and locating refuges.

• **Climate Change**—Dynamic hydrology, infrastructure improvements, operational changes, improved data collection, and reorganized financing.

### Implementation: Next Steps

#### Regional and Interregional Planning

Continue efforts to identify the interrelationship of water agencies within a region and between regions regarding water and resource management. Pursue regional meetings among interested local water, flood and energy agencies, municipalities, and private organizations. Key issues will include alternatives for water conservation, storage, water use efficiency, water conveyance, treatment, distribution, use, air quality. Additional efforts may include:

- Financing – developing a plan to include grants to pursue, loans, etc.
- Develop additional IRWM plans
- Continued long-term planning – such as regular updates of the IRWM plans
- Develop a Regional Response Package
- Coordinate and complete environmental process outlined in the (CEQA) and National Environmental Policy Act (NEPA)
- Execute operating agreements
- Construct new facilities/construction/implementation
- Improve and/or institute monitoring – such as monitoring of groundwater levels, water quality, water supply, etc.
- Improve basin understanding – such as, modeling USGS study, etc.
- Groundwater protection
- Governance – explore ways to improve water governance/regional authority
- Water agencies need to reach out to city and county planning agencies
- Include county health departments (vectors and recharge facilities)
- Land use planning and development needs to relate to water supply (“will serve” and entitlement conditions)
- Salinity/Water Quality objectives
- Climate Change, develop plans and alternatives

#### Flood Management

Immediate steps that can be taken to improve flood management are listed below. More information about each item is provided in Appendix 8A.
• **Floodplain Mapping**—Continue current DWR and FEMA efforts to improve floodplain mapping.

• **Emergency Coordination**—Formalize interagency cooperation in San Joaquin River emergency operations. Begin by convening a System Reoperation Task Force to study optimum methods of regulation.

• **Isabella Dam and Success Dam**—Address structural problems and complete repairs at an early date. Develop an interim emergency plan.

• **Aqueduct Protection**—Develop a project to provide 200-year protection for the California Aqueduct at Arroyo Pasajero.

• **Levee Maintenance Study**—Begin a study of levee maintenance and financing of levee maintenance, repair and reconstruction.

• **Emergency Flood Response Agreements**—Begin consultation on a Model Emergency Flood Agreement to facilitate developing actual bilateral agreements.

• **Climate Change**—Continue developing a statewide Climate Adaptation Strategy and convene and support a National Research Council panel on long-term sea level rise. Begin to assess hydrometeorological gage needs.

**Water Portfolios from 2002–2005**
Figure 8-2 Groundwater basins in the Tulare Lake Region

List of Basins, Basin/Subbasin (Basin Name) - 5-22 (San Joaquin Valley), 5-22.08 (Kings), 5-22.09 (Westside), 5-22.10 (Pleasant Valley), 5-22.11 (Kaweah), 5-22.12 (Tulare Lake), 5-22.13 (Tule), 5-22.14 (Kern County), 5-23 (Panoche Valley), 5-25 (Kern River Valley), 5-26 (Walker Basin), Creek Valley, 5-27 (Cummings Valley), 5-28 (Tehachapi Valley West), 5-29 (Castaic Lake Valley), 5-71 (Vallecitos), Creek Valley, 5-80 (Brite Valley), 5-82 (Cuddy Canyon Valley), 5-83 (Cuddy Ranch Area), 5-84 (Cuddy Valley), 5-85 (Mil Potrero Area)
Figure 8-3 Rate of population growth, running 5-year rate, 1960-2006