Chapter 6
Hydrology, Hydraulics, and Water Management

6.1 Affected Environment

The environmental setting section first presents background information and then describes storage and diversion facilities, and hydrology, hydraulics, and water management (H&H), including flood management, south Delta water levels, and groundwater resources. For a more in-depth description of the affected environment, see the *Hydraulics, Hydrology, and Water Management Technical Report*.

6.1.1 Storage Facilities

Facilities described below include Shasta Dam and Powerplant, Keswick Dam and Powerplant, Anderson-Cottonwood Irrigation District Diversion Dam, and Red Bluff Diversion Dam (RBDD).

Shasta Lake and Vicinity

This section describes storage facilities in the Shasta Lake area.

Shasta Dam and Powerplant Shasta Dam is a curved, gravity-type, concrete structure that rises 533 feet above the streambed with a total height above the foundation of 602 feet. The dam has a crest width of about 41 feet and a length of 3,460 feet. Shasta Reservoir has a storage capacity of 4,550,000 acre-feet, and water surface area at full pool of 29,600 acres. Maximum seasonal flood management storage space in Shasta Reservoir is 1.3 million acre-feet (MAF). Releases from Shasta Dam can be mad e through the power plant, over the spillway, or through the river outlets. The power plant has a maximum release capacity of nearly 20,000 cubic feet per second (cfs), the river outlets can release a maximum of 81,800 cfs at full pool, and the maximum release over the drum-gated spillway is 186,000 cfs.

Upper Sacramento River (Shasta Dam to Red Bluff)

This section describes storage facilities along the Upper Sacramento River.

Keswick Dam and Powerplant Keswick Dam is about 9 miles downstream from Shasta Dam. In addition to regulating outflow from the dam, Keswick Dam controls runoff from 45 square miles of drainage area. Keswick Dam is a concrete, gravity-type structure with a spillway over the center of the dam. The spillway has four 50- by 50-foot fixed wheel gates with a combined discharge capacity of 248,000 cfs at full or full pool elevation (587 feet). Storage capacity below the top of the spillway gates at full pool is 23,800 acre-feet. The powerplant has a nameplate generating capacity of 105,000 kilowatts and can pass about 15,000 cfs at full pool.

6.1.2 Diversion Facilities

Below Keswick Dam, two diversion dams regulate flows on the Sacramento River, the Anderson-Cottonwood Irrigation District Diversion Dam and RBDD. The primary purpose of these two facilities is to divert water into canals for local agricultural use.

In the Delta, the CVP and SWP primarily make diversions through two pumping plants, the CVP C.W. “Bill” Jones (Jones) and SWP Harvey O. Banks (Banks) pumping plants. These two pumping plants supply water to the CVP/SWP service areas south of the Delta. While other diversion facilities are located between the RBDD and the Delta, they have less of an effect on project operations than those discussed above.

6.1.3 Hydrology and Hydraulics

The Sacramento Valley contains the Sacramento, Feather, and American River basins, covering an area of more than 24,000 square miles in the northern portion of the Central Valley. The Sacramento Valley encompasses three major drainage basins: the McCloud River, Pit River, and the Sacramento River in the north; the Delta in the south; the Sierra Nevada Mountains and Cascade Ranges in the east; and the Coast Range and Klamath Mountains in the west. Drainage in the northern portion of the Central Valley is provided by the Sacramento, Feather, and American Rivers, and major and minor streams and rivers that drain the east and west sides of the valley.

Shasta Lake and Vicinity

The most northern portion of the Sacramento River basin, upstream from Shasta Dam, is drained by the Pit River, the McCloud River, Squaw Creek, and the headwaters of the Sacramento River.

The four major tributaries to Shasta Lake are the Sacramento River, McCloud River, Pit River, and Squaw Creek, in addition to numerous minor tributary creeks and streams.

Upper Sacramento River (Shasta Dam to Red Bluff)

Flows in the Sacramento River in the 65-river-mile (RM) reach between Shasta Dam and Red Bluff (RM 244) are regulated by Shasta Dam and reregulated downstream at Keswick Dam (RM 302). In this reach, flows are influenced by tributary inflow. Major west side tributaries to the Sacramento River in this reach of the river include Clear and Cottonwood creeks. Major east side tributaries to the Sacramento River in this reach of the river include Battle, Bear, Churn, Cow, and Paynes creeks.

Lower Sacramento River and Delta

The Sacramento River enters the Sacramento Valley about 5 miles north of Red Bluff. From Red Bluff to Chico Landing (52 miles), the river receives flows from Antelope, Mill, Deer, Big Chico, Rock, and Pine creeks on the east side and Thomes, Elder, Reeds, and Red Bank creeks on the west side. From Chico Landing to Colusa (50 miles) the Sacramento River meanders through alluvial deposits between widely spaced levees. Stony Creek is the only major tributary in this segment of the river. There are no tributaries entering the Sacramento River between Stoney Creek and its confluence with the Feather River.

Floodwaters in the Sacramento River overflow the east bank at three sites in a reach referred to by the State as the Butte Basin Overflow Area. In this river reach, several Federal projects begin, including the Sacramento River Flood Control Project, Sacramento River Major and Minor Tributaries Project, and Sacramento River Bank Protection Project. Levees of the Sacramento River Flood Control Project begin in this reach, downstream from Ord Ferry on the west (RM 184), and downstream from RM 176 above Butte City on the east side of the river.

Shasta Reservoir is also operated to meet a flow requirement in the Sacramento River, at Wilkins Slough near Grimes (RM 125), also known as the Navigation Control Point. Downstream from Wilkins Slough, the Feather River, the largest east side tributary to the Sacramento River, enters the river just above Verona. Between Wilkins Slough and Verona, floodwater is diverted at two places in this segment of the river – Tisdale Weir into the Tisdale Bypass and Fremont Weir into the Yolo Bypass. The bypass system routes floodwater away from the mainstem Sacramento River to discharge into the Delta.

Below Verona, the Sacramento River flows 79 miles to the Delta, passing the City of Sacramento. The Yolo Bypass parallels this river reach to the west. Flows enter this river reach at various points. First, flows from the Natomas Cross Canal enter the Sacramento River approximately 1 mile downstream from the Feather River mouth. The American River flows into the Sacramento River in the City of Sacramento. When Sacramento River system flood flows are the highest, a portion of the flow is diverted into the Yolo Bypass at the Sacramento Weir about 3 miles upstream from the American River confluence in downtown Sacramento. At the downstream end, Yolo Bypass flows reenter the Sacramento River near Rio Vista. As the river enters the Delta, Georgiana Slough branches off from the mainstem of the Sacramento River, routing a portion of the flow into the central Delta.

The hydraulics of the Delta are complicated by tidal influences, a multitude of agricultural and municipal and industrial (M&I) diversions for use within the Delta itself, and by CVP and SWP exports. The principal factors affecting Delta hydrodynamics are (1) river inflow and outflow from the Sacramento River and San Joaquin River systems, (2) daily tidal inflow and outflow through San

Francisco Bay, and (3) export pumping from the south Delta, primarily through the Jones and Banks pumping plants.

The Jones Pumping Plant consists of six pumps, with a maximum export capacity of 4,600 cfs during the irrigation season, and 4,200 cfs during the winter nonirrigation season. Limitations at the Jones Pumping Plant are the result of a Delta-Mendota Canal freeboard constriction near O'Neill Forebay and current water demand in the upper sections of the Delta-Mendota Canal. The Jones Pumping Plant is at the end of an earth-lined intake channel about 2.5 miles long.

The SWP Banks Pumping Plant supplies water for the South Bay Aqueduct and the California Aqueduct, with an installed capacity of 10,300 cfs. Under current operational constraints, exports from Banks Pumping Plant are generally limited to a daily average of 6,680 cfs, except between December 15 and March 15, when exports can be increased by 33 percent of San Joaquin River flow. The Banks Pumping Plant exports water from the Clifton Court Forebay, a 31,000 acre-foot reservoir that provides storage for off-peak pumping, and moderates the effect of the pumps on the fluctuation of flow and stage in adjacent Delta channels.

Contra Costa Water District (CCWD) supplies CVP water to its users via a pumping plant at the end of Rock Slough. The Rock Slough diversion capacity of 350 cfs gradually decreases to 22 cfs at the terminus. CCWD also constructed and operates the 100,000 acre-foot Los Vaqueros Reservoir, which has an intake and pumping plant on the Old River for diverting surplus Delta flows to reservoir storage or contract water to CCWD users. Because tidal inflows are approximately equivalent to tidal outflows during each daily tidal cycle, tributary inflows and export pumping are the principal variables that define the range of hydrodynamic conditions in the Delta. Excess outflow occurs almost entirely during the winter and spring months. Average winter outflow is about 32,000 cfs, while the average summer outflow is 6,000 cfs.

CVP/SWP Service Areas

This section describes the hydrology and hydraulics of the CVP/SWP service areas south of the primary study area.

Downstream from the Jones Pumping Plant, CVP water flows in the Delta-Mendota Canal and can be either diverted by the O'Neill Pumping-Generating Plant into the O'Neill Forebay, or can continue down the Delta-Mendota Canal for delivery to CVP contractors. The O'Neill Pumping-Generating Plant consists of six pump-generating units, with a capacity of 700 cfs each.

The O'Neill Forebay is a joint CVP/SWP facility, with a storage capacity of about 56,000 acre-feet. In addition to its interactions with the Delta-Mendota Canal via the O'Neill Pumping-Generating Plant, it is a part of the SWP California Aqueduct. The O'Neill Forebay serves as a regulatory body for San

Luis Reservoir; the William R. Gianelli Pumping-Generating Plant, also a joint CVP/SWP facility, can pump flows from the O'Neill Forebay into San Luis Reservoir, and also make releases from San Luis Reservoir to the O'Neill Forebay for diversion to either the Delta-Mendota Canal or the California Aqueduct. Also, several water districts receive diversions directly from the O'Neill Forebay. The William R. Gianelli Pumping-Generating Plant consists of eight units, with 1,375 cfs of capacity each.

San Luis Reservoir provides offstream storage for excess winter and spring flows diverted from the Delta. It is sized to provide seasonal carryover storage, with a total capacity of 2,027,840 acre-feet. The CVP share of the storage is 965,660 acre-feet; the remaining 1,062,180 acre-feet are the SWP share. During spring and summer, water demands and schedules are greater than the capability of Reclamation and DWR to pump water from the Jones and Banks pumping plants; water stored in San Luis Reservoir is used to make up the difference. The CVP share of San Luis Reservoir is typically at its lowest in August and September, and at its maximum in April. The San Felipe Division of the CVP supplies water to customers in Santa Clara and San Benito counties from San Luis Reservoir. The operation of San Luis Reservoir has the potential to affect the water quality and reliability of these supplies if reservoir storage drops below 300 thousand acre-feet (TAF).

South of the O'Neill Forebay, the Delta-Mendota Canal terminates in the Mendota Pool, about 30 miles west of Fresno. From the Delta-Mendota Canal, the CVP makes diversions to multiple water users and refuges. Delta-Mendota Canal capacity at the terminus is 3,211 cfs. Parallel to the Delta-Mendota Canal, the San Luis Canal-California Aqueduct is a joint-use facility for the CVP and SWP. It begins on the southeast edge of the O'Neill Forebay and extends about 101.5 miles southeasterly to a point near Kettleman City. Water from the canal serves the San Luis Federal service area, mostly for agricultural purposes and for some M&I uses. The canal has a capacity ranging from 8,350 cfs to 13,100 cfs.

South of Banks Pumping Plant, the California Aqueduct flows into Bethany Reservoir, a 5,000-acre-foot forebay for the South Bay Pumping Plant. Exiting the Bethany Forebay, the California Aqueduct flows through a series of checks to the aforementioned O'Neill Forebay, and is either pumped into San Luis Reservoir or released to the San Luis Canal, the CVP/SWP joint-use portion of the California Aqueduct. Deliveries are made from the California Aqueduct to agricultural and M&I contractors.

6.1.4 Surface Water Supply

While water supply reliability is one of the two primary planning objectives of the SLWRI, operations for Shasta Reservoir are primarily focused on delivering water supply to CVP contractors. However, because of the interconnectivity of the CVP and SWP, water supply operations of the SWP could be affected by changes in operations of the CVP associated with the SLWRI.

CVP/SWP Service Areas

This section describes surface water supply to CVP and SWP contractors.

CVP Contractors At certain times of the year, operations of Shasta Reservoir are driven by water supply needs of the CVP contractors. The CVP provides water to settlement contractors in the Sacramento Valley, exchange contractors in the San Joaquin Valley, agricultural and M&I water service contractors in both the Sacramento and San Joaquin Valleys, and wildlife refuges both north and south of the Delta. At the beginning of each year, Reclamation evaluates hydrologic conditions throughout California and uses this information to forecast CVP operations, and to estimate the amount of water to be made available to the Federal water service contractors for the year.

The majority of the Federal water service contractors have service areas located south of the Delta. In general, allocations to CVP water service contractors south of the Delta are lower than allocations to service contractors in the Sacramento Valley. Because of water rights secured before construction of the CVP, Sacramento Valley settlement contractors and San Joaquin Valley exchange contractors have a higher level of reliability for their supplies; except in extremely dry years, when the water year type, as defined by the Shasta Hydrologic Index, is classified as critical, settlement and exchange contractors receive 100 percent of their contract amounts. In Shasta critical years, settlement and exchange contractors receive 75 percent of their contract amounts. A Shasta critical year is defined as a year when the total inflow to Shasta Reservoir is below 3.2 MAF, or the average inflow for a 2-year period is below 4.0 MAF and the total 2-year deficiency for deliveries is higher than 0.8.

SWP Contractors The CVP and SWP are intrinsically linked through the Delta; shared responsibilities under their respective water rights and coordinated operations agreements mean that a change in flow from one project could result in a flow change from the other. Accordingly, SWP water supply operations are discussed below.

The SWP operates under long-term contracts with public water agencies throughout California. These agencies, in turn, deliver water to wholesalers or retailers, or deliver it directly to agricultural and M&I water users (DWR 1999). The SWP contracts between DWR and individual State water contractors define several classifications of water available for delivery under specific circumstances.

6.1.5 Flood Management

This section describes major features of the flood management system in the primary and extended study areas, including reservoirs, levees, weirs, and bypasses. Historical operation of these facilities is also described.

Shasta Lake and Vicinity

Releases from Shasta Dam are often made for flood management. Releases for flood management either occur in the fall, beginning in early October, to reach the prescribed vacant flood space, or to evacuate space during or after a storm event to maintain the prescribed vacant flood space in the reservoir. During a storm event, releases for flood management occur either over the spillway during large events or through river outlets for smaller events. Between 1950 and 2006, flows over the spillway occurred in 12 years, or in 21 percent of years. During the same time interval, releases for flood management (either for seasonal space evacuation or during a flood event, and including spills over the spillway) occurred in about 37 years, or nearly 70 percent of the years.

Upper Sacramento River (Shasta Dam to Red Bluff)

Historically, the largest flood events along the upper Sacramento River have been from heavy rainfall, with a relatively smaller component of the flows coming from snowmelt in the upper basin. Flood management operations at Shasta Dam include forecasting runoff into Shasta Lake as well as runoff of unregulated creek systems downstream from Keswick Dam. A critical component of upper Sacramento River flood operations is the forecast of local runoff entering the Sacramento River between Keswick Dam and Bend Bridge near Red Bluff.

The unregulated creeks (major tributaries include Cottonwood, Cow, and Battle creeks) discharging into the Sacramento River between Keswick Dam and Bend Bridge can produce high runoff rates into the Sacramento River in short periods of time. During large flood events, the local runoff between Keswick Dam and Bend Bridge can exceed 100,000 cfs.

Lower Sacramento River and Delta

Flood management facilities along the lower Sacramento River and in the Delta include the levees, weirs, and bypasses of upper and lower Butte Basin, the Sacramento River between Colusa and Verona, and the Sacramento River between Verona and Collinsville. The levees, weirs, and bypasses are features of the Sacramento River Flood Control Project, which began operation in the 1930s and was significantly expanded in the 1950s.

When Sacramento River flows exceed between 90,000 and 100,000 cfs at Ord Ferry, water flows naturally over the banks of the river into Butte Basin. In addition to the Sacramento River overbank flows at Ord Ferry, the basin receives inflow over the Colusa and Moulton weirs and from tributary streams draining from the northeast, principally Cherokee Canal and Butte Creek. Before construction of the Feather River levees, Butte Basin also received overflows from the Feather River north of the Sutter Buttes. Outflows from Butte Basin move through the Sutter Bypass when the Sacramento River is high or through the Butte Slough outfall gates (RM 139) into the Sacramento River when the river is low.

The Sacramento River meanders through the 64 miles between Colusa (RM 143) and Verona (RM 79). The levee system continues along both sides of this river reach. The levee spacing (or channel width), east to west, is wider between the upstream sections, from RM 176 to RM 143 at Colusa, than the levee spacing downstream from Colusa. The Feather River, the largest east side tributary to the Sacramento River, enters the river just above Verona. Flood management diversions occur at two places in this segment of the river: at the Tisdale Weir and Fremont Weir.

Below Verona, the Sacramento River flows 79 miles to Collinsville, at the mouth of the Delta, passing the City of Sacramento along the way. The Yolo Bypass parallels this river reach to the west. Flows enter this river reach at various points. First, flows from the Natomas Cross Canal enter the Sacramento River approximately 1 mile downstream from the Feather River mouth (RM 80). The American River (RM 60), the southernmost major Sacramento River tributary, enters the river at the City of Sacramento. Flows in the Yolo Bypass reenter the river near Rio Vista (RM 12). As the river enters the Delta, Georgiana Slough branches off from the mainstream Sacramento River, routing flows into the central Delta. The one diversion point for flood management is at Sacramento Weir, where floodwaters are diverted from the Sacramento River through the Sacramento Bypass to the Yolo Bypass under the highest flow conditions.

CVP/SWP Service Areas

This section describes flood management facilities in the CVP/SWP service areas by river basin, including the Feather River, American River, San Joaquin River, and east side tributaries to the Delta (Littlejohns Creek, Calaveras River, and Mokelumne River).

The primary flood management feature of the Feather River basin is Oroville Reservoir, with a flood management reservation volume of 750 TAF. Oroville Reservoir releases are used to help meet the objective flow on the Feather River of 150,000 cfs, and in conjunction with New Bullards Bar Reservoir on the Yuba River, to meet an objective flow below the Yuba River confluence of 300,000 cfs. Levees line the Feather River from its confluence with the Sacramento River up to the City of Oroville (RM 63).

The lower American River is primarily protected from flooding by Folsom Dam. The Folsom Reservoir flood management reservation volume is variable, ranging from 400 TAF to 670 TAF. The objective release on the American River is 115,000 cfs; however, some damage to infrastructure along the American River occurs at flows above 20,000 cfs. The American River is leveed from its confluence with the Sacramento River to near the Carmichael Bluffs on the north bank, and to near the Sunrise Boulevard Bridge on the south bank (RM 19).

The San Joaquin River basin is protected by an extensive reservoir system, including the following:

- Friant Dam and Millerton Lake (RM 270), with a flood management reservation volume of 170 TAF.
- Big Creek Dam, on Big Creek, with a flood management reservation of 30.2 TAF.
- Hidden Dam and Hensley Lake on the Fresno River, with a flood management reservation of 65 TAF.
- Buchanan Dam and H.V. Eastman Lake on the Chowchilla River, with a flood management reservation of 45 TAF.
- Los Banos Detention Dam on Los Banos Creek, with a flood management reservation of 14 TAF.
- Merced County Stream Group Project, consisting of five dry dams (Bear, Burns, Owens, Mariposa, and Castle) and two diversion structures, with a total flood storage capacity of 30.5 TAF.
- New Exchequer Dam and Lake McClure on the Merced River, with a flood management reservation of 350 TAF.
- Don Pedro Dam and Lake on the Tuolumne River, with a flood management reservation of 340 TAF.
- New Melones Dam and Lake on the Stanislaus River, with a flood management reservation of 450 TAF.

The streams in the northern portion of the San Joaquin River basin, between the American and Stanislaus rivers, are commonly referred to as the eastside tributaries to the Delta. These rivers flow into the San Joaquin River within the boundaries of the Delta. Flood management features on the eastside tributaries to the Delta include the following:

- Farmington Dam and Reservoir on Littlejohns Creek, with a flood management reservation of 52 TAF.
- New Hogan Dam and Lake on the Calaveras River, with a flood management reservation of 165 TAF.
- Camanche Dam and Reservoir on the Mokelumne River, with a flood management reservation of 200 TAF.

6.1.6 South Delta Water Levels

This section discusses the variability of water levels in the south Delta, as part of CVP/SWP operations in the extended study area.

In the south Delta, decreases in water levels due to CVP and SWP export pumping are a concern for local agricultural diverters because during periods of low water levels, sufficient pump draft cannot be maintained and irrigation can be interrupted. Historically, the highest minimum stage in the Middle River typically occurs in February and is about 0.1 foot below mean sea level (msl). The lowest minimum stage typically occurs in August and is about 0.8 foot below msl. During dry and critical years, under existing conditions, the highest minimum stage in the Middle River typically occurs in April and is about 0.6 foot below msl. The lowest minimum stage typically occurs in September and is about 0.7 foot below msl (CALFED 2000a).

6.1.7 Groundwater Resources

The use and sustainable management of groundwater resources is an important component in meeting water demands in California. Information specific to groundwater resources includes groundwater levels and budget and groundwater quality.

Shasta Lake and Vicinity

Shasta Lake and vicinity are located in the foothill area northwest of the Redding groundwater basin. Small groundwater basins underlying Shasta Lake and vicinity do not have significant groundwater availability for use as a source of supply (Shasta County Water Agency 1998). Groundwater basins underlying Shasta County include the Fall River Valley groundwater basin, Lake Britton groundwater basin, and North Fork Battle Creek. Of these three groundwater basins, the Fall River Valley groundwater basin covers the largest area (54,800 acres) and groundwater extraction for agricultural use in this basin is the highest (approximately 19,000 acre-feet). Estimated groundwater extraction for M&I use in these subbasins ranges from 5 acre-feet to 240 acre-feet. Deep percolation from applied water is minor, ranging from 10 acre-feet to 4,800 acre-feet. Groundwater quality in Shasta Lake and vicinity is typically good. Total dissolved solids (TDS) concentrations in the Fall River Valley groundwater basin are low, ranging from 115 to 232 milligrams per liter (mg/L).

Upper Sacramento River (Shasta Dam to Red Bluff)

The upper Sacramento River study area extends from Redding to Red Bluff, and includes the Redding groundwater basin and the northern portion of the Sacramento groundwater basin.

The Redding groundwater basin underlies most of the upper Sacramento River area between Shasta Dam and Red Bluff. The basin is bordered on the north, east, and west by foothills, and on the south by the Sacramento Valley groundwater basin (Tehama GMP 1996). The foothill areas that constitute the eastern and western portions of Shasta and Tehama counties, adjacent to the

Redding groundwater basin, are designated as "highland" areas, noted for their relative scarcity of groundwater resources. DWR Bulletin 118 (2003b) subdivides the Redding groundwater basin into six subbasins: Anderson, Enterprise, Millville, Rosewood, Bowman, and South Battle Creek.

The Sacramento groundwater basin extends from the Redding groundwater basin to the San Joaquin Valley, and includes Tehama, Glenn, Butte, Yuba, Colusa, Placer, and Yolo counties.

In general, groundwater flows southeasterly on the west side of the Redding groundwater basin and southwesterly on the east side, toward the Sacramento River (Reclamation and DWR 2003). Historically, groundwater levels in the Redding groundwater basin have remained relatively stable, with no apparent long-term trend of declining or increasing levels. Generally, groundwater levels have a seasonal fluctuation of approximately 2 to 15 feet (Reclamation and DWR 2003). DWR has estimated the total quantity of groundwater storage in the Redding groundwater basin at approximately 6.9 MAF (Reclamation and DWR 2003).

In the northern portion of the Sacramento groundwater basin, the following three subbasins are included in upper Sacramento River study area: Red Bluff, Antelope, and Bend subbasins. Groundwater extraction in the Red Bluff subbasin is nearly 90,000 acre-feet.

Groundwater in the Redding area is of good quality, as shown by low TDS concentrations, ranging from 70 to 360 mg/L. This range is below the U.S. Environmental Protection Agency and California Environmental Protection Agency secondary drinking water standard of 500 mg/L and also below the agricultural water quality goal of 450 mg/L. Areas of high salinity and poor quality are generally found on the basin margins where groundwater is derived from marine sedimentary rock (Reclamation and DWR 2003).

Groundwater quality in the Sacramento groundwater basin is generally good, and sufficient for agricultural and M&I uses, with TDS levels ranging from 200 to 500 mg/L (Reclamation and DWR 2003). Localized groundwater quality issues occur as a result of natural water quality impairments at the north end of the Sacramento Valley, where marine sedimentary rocks containing brackish to saline water are near the surface (Reclamation and DWR 2003).

Lower Sacramento River and Delta

The groundwater basins underlying the lower Sacramento River and Delta areas include the Sacramento Valley groundwater basin, and North and South San Joaquin Valley groundwater basins.

In the Sacramento groundwater basin, groundwater flows inward from the edges of the basin and south parallel to the Sacramento River. Groundwater extraction in some local areas resulted in groundwater depressions and local groundwater gradients (Reclamation and DWR 2003). Before the completion of CVP facilities (1964 through 1971), pumping along the west side of the basin caused groundwater levels to decline. In the Sacramento groundwater basin, a slight decline of 2 to 12 feet was experienced in groundwater levels as a result of the 1976 through 1977 and 1987 through 1994 droughts. This was followed by a recovery to predrought conditions of the early 1970s and 1980s. Generally, groundwater level data show an average seasonal fluctuation ranging from 2 to 15 feet. Groundwater production in the basin increased from 500,000 acre-feet in the 1940s to 2 MAF annually in the mid-1990s.

As mentioned, groundwater quality in the Sacramento groundwater basin is generally good, and sufficient for agricultural and M&I uses, with TDS levels ranging from 200 to 500 mg/L (Reclamation and DWR 2003).

CVP/SWP Service Areas

The groundwater basins underlying the CVP/SWP service areas include the San Joaquin Valley, Santa Clara Valley, Antelope Valley, Fremont Valley, Coastal Plain of Los Angeles, and Coastal Plain of Orange County groundwater basins, and multiple other smaller groundwater basins underlying areas that receive water from the CVP/SWP system.

The San Joaquin Valley Groundwater Basin is a regional basin and is the largest in California, extending approximately from the Delta to Bakersfield. Areas within the San Joaquin Valley Groundwater Basin are heavily groundwater-reliant. Groundwater accounts for about 30 percent of the annual supply used for agricultural and urban purposes (Reclamation and DWR 2003). Groundwater production in the north San Joaquin Valley Groundwater Basin alone increased from 1.5 MAF annually in the 1920s to more than 3.5 MAF annually in 1990 (Reclamation and DWR 2003). In the south San Joaquin Valley Groundwater Basin, groundwater production for agriculture rose from approximately 3.0 MAF per year in the 1920s to more than 5.0 MAF per year 1980s (Reclamation and DWR 2003). Much of the San Joaquin groundwater basin is in overdraft conditions due to extensive groundwater pumping and irrigation, although the extent of overdraft varies widely from region to region.

Groundwater quality throughout the San Joaquin Valley is in general suitable for most urban and agricultural uses. Average TDS concentrations range from 218 to 1,190 mg/L. Areas of high TDS concentration, primarily along the west side of the San Joaquin Valley, are the result of streamflow recharge that originates from marine sediments. High TDS concentrations are also seen in the trough of the Sacramento Valley due to concentration of salts resulting from evaporation and poor drainage (Reclamation and DWR 2003). Agricultural pesticides and herbicides have been detected in groundwater throughout the region, but primarily along the east side of the San Joaquin Valley, where soil permeability is higher and depth to groundwater is shallower. From 1994 to 2000, 523 public wells out of 689 wells sampled met the State primary maximum contamination levels for drinking water. The remaining wells have constituents that exceed one or more maximum contamination levels (Reclamation and DWR 2003).

6.2 Regulatory Setting

The regulatory setting for this report includes Federal, State, and local applicable laws, regulations, standards, and plans.

6.2.1 Federal

The following Federal laws, regulations, standards, and plans are discussed as part of the regulatory setting:

- NMFS 1993 and 2004 Winter-Run Chinook salmon Biological Opinion (BO) (NMFS 1993, NMFS 2004)
- Central Valley Project Improvement Act (CVPIA) (Reclamation 1999)
- CVP long-term water service contracts
- Trinity River Record of Decision (ROD) (Reclamation 2000)
- Flow objective for navigation (Wilkins Slough)
- Flood management requirements

National Marine Fisheries Service 2004 Biological Opinion

The regulatory conditions for the SLWRI alternatives include BOs from the NMFS (2004) and USFWS (2005). In response to litigation, the 2004 and 2005 BOs were remanded to the USFWS and NMFS for revision, but were not vacated. The USFWS and NMFS released revised BOs in 2008 and 2009 (USFWS 2008, NMFS 2009), respectively; since the revised BOs continue to be locked in controversy and litigation, the 2004 and 2005 BOs are assumed to be govern operations for SLWRI analysis. Further revised BOs are anticipated before the release of the final version of this document; final analysis will consider conditions dictated by the BOs in place at that time.

In October 2004, NMFS issued the Long-Term BO for operation of the CVP and SWP for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead (NMFS 2004). The BO includes a Reasonable and Prudent Alternative (RPA) that addresses CVP operations criteria for temperature control objectives. The Shasta-Trinity Division section of the 2004 RPA includes operational elements relating to temperature control objectives, as described in this section.

Under the current RPA, Reclamation must make its February 15 forecast of deliverable water based on an estimate of precipitation and runoff at least as conservative as the 90 percent probability-of-exceedence forecast. Subsequent updates of water delivery commitments must also be based on the 90 percent probability of exceedence forecast or a more conservative value.

Under the current RPA, Reclamation must target a minimum end-of-water-year (September 30) carryover storage in Shasta Reservoir of 1.9 MAF. The 1.9 MAF Shasta Reservoir carryover target is intended to increase the probability of sufficient cold-water resources to maintain suitable water temperature conditions for the following water year winter-run incubation and spawning season needs.

The BO requires that Reclamation manage the cold-water supply within Shasta Reservoir and make cold-water releases from Shasta Reservoir to provide suitable habitat between Keswick Dam and Bend Bridge. Reclamation was instructed to target daily average Sacramento River water temperatures between Keswick Dam and Bend Bridge such that water temperatures not exceed 56 degrees Fahrenheit (°F) at compliance locations between Balls Ferry and Bend Bridge from April 15 through September 30, and not exceed 60°F at the same locations between Balls Ferry and Bend Bridge between October 1 and October 31, provided operations and temperature forecasts demonstrate the capability to achieve and sustain compliance. If conditions were not sufficient to support compliance at Balls Ferry, Reclamation was instructed to reinitiate consultation and convene the Sacramento River Temperature Task Group (SRTTG) to provide input regarding annual cold-water management alternatives before announcement of the CVP water service delivery allocations. Selection of downstream compliance locations is determined through an annual adaptive management process initiated by Reclamation in consultation with NMFS, with recommendations from the SRTTG, and based on a technical assessment of cold-water resources. The annual adaptive management process focuses efforts to analyze annual cold-water management flexibility to provide thermal protection to winter-run Chinook salmon, spring-run Chinook salmon, and steelhead, as envisioned in the State Water Resources Control Board (SWRCB) Order 90-5. The initial technical analysis considers the compliance location shown in Table 6-1, based on projected cold-water availability and spawning distribution in the upper Sacramento River (NMFS 2004).

Table 6-1. Relationship Between Shasta Cold-Water Volume and Sacramento River Water Temperature Compliance Location

May 1, Shasta Reservoir Cold-Water Volume Below 52°F	Compliance Location
<3.3 MAF	Balls Ferry
>3.3 MAF but <3.6 MAF	Jellys Ferry
>3.6 MAF	Bend Bridge

Key:
°F = degrees Fahrenheit
MAF = million acre-feet

In almost every year since 1993, Reclamation has reconsulted with NMFS to modify the compliance point or allow short-term fluctuation above the 56°F objective because of insufficient cold-water resources, extreme ambient air temperature events, or high downstream tributary flows of warm water. The reconsultation actions have been coordinated through the SRTTG to the extent possible. Decisions by Reclamation to reconsult, and resulting decisions by NMFS, have reflected the best available information on cold-water resources and locations of Chinook salmon spawning activity.

Central Valley Project Improvement Act

Reclamation's evolving mission was written into law on October 30, 1992, with the passage by Congress, and signing by President George H. W. Bush, of Public Law 102-575, the Reclamation Projects Authorization and Adjustment Act of 1992. Included in the law was Title 34, the CVPIA (Reclamation 1999). The CVPIA amended previous authorizations of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic water supply uses, and fish and wildlife enhancement having equal priority with power generation. Among the changes mandated by the CVPIA are the following:

- Dedicating 800,000 acre-feet annually to fish, wildlife, and habitat restoration.
- Authorizing water transfers outside the CVP service area.
- Implementing the Anadromous Fish Restoration Program.
- Creating a restoration fund financed by water and power users.
- Providing for the Shasta Dam temperature control device (TCD).
- Implementing fish passage measures at the RBDD.
- Planning to increase the CVP yield.
- Mandating firm water supplies for Central Valley wildlife refuges.
- Meeting Federal trust responsibility to protect fishery resources on the Trinity River.

The CVPIA is being implemented on a broad front. The Final Programmatic Environmental Impact Statement (Reclamation 1999) for the CVPIA analyzes projected conditions in 2022, 30 years from the CVPIA's adoption in 1992. The Final Programmatic Environmental Impact Statement was released in October 1999, and the CVPIA ROD was signed on January 9, 2001.

Operations of the CVP reflect provisions of the CVPIA, particularly Sections 3406 (b)(1), (b)(2), and (b)(3). The Department of the Interior Decision on Implementation of Section 3406 (b)(2) of the CVPIA, October 5, 1999, provides the basis for implementing upstream and Delta actions with CVP delivery capability. The Vernalis Adaptive Management Program assumes that San Joaquin River water will be acquired under Section 3406 (b)(3) to support increased Vernalis flows during certain times of the year. Similarly, the Anadromous Fish Restoration Program assumes Sacramento River water will be acquired under Section 3406 (b)(2).

Central Valley Project Long-Term Water Service Contracts

In accordance with CVPIA Section 3404c, Reclamation is renegotiating long-term water service contracts. As many as 113 CVP water service contracts located within the Central Valley of California may be renewed during this process. Reclamation issued a Notice of Intent for long-term contract renewal in October 1998. Environmental documentation was prepared on a regional basis. In February 2005, Reclamation issued decisions (a ROD or Finding of No Significant Impact) for renewing contracts of the Sacramento River, San Luis, and Delta-Mendota Canal divisions, the Sacramento River settlement contracts, and several individual contracts. Preparation of environmental documents for other divisions and contracts is ongoing.

Trinity River Record of Decision

Export of Trinity River water to the Sacramento basin provides increased water supply for the CVP and is a major source of CVP power generation. The amounts and timing of the Trinity exports are determined after consideration is given to forecasted Trinity water supply available and Trinity in-basin needs, including carryover storage. Trinity exports are also a key component of water temperature control operations on the upper Sacramento River.

Based on the December 19, 2000, Trinity River Mainstem ROD (Reclamation 2000), 368.6 to 815 TAF are allocated annually for Trinity River flows. After several challenges and injunctions, on July 13, 2004, the Ninth Circuit Court upheld the ROD flows for the Trinity River.

Flow Objective for Navigation (Wilkins Slough)

Historical commerce on the Sacramento River resulted in the requirement to maintain minimum flows of 5,000 cfs at Chico Landing to support navigation. There is currently no commercial traffic between Sacramento and Chico Landing, and USACE has not dredged this reach to preserve channel depths since 1972. However, long-time water users diverting from the river have set their pump intakes just below this level. Therefore, the CVP is operated to meet the navigation flow requirement of 5,000 cfs to Wilkins Slough under all but the most critical water supply conditions to facilitate pumping.

At flows below 5,000 cfs at Wilkins Slough, diverters have reported increased pump cavitation as well as greater pumping head requirements. Diverters operate for extended periods at flows of 4,000 cfs at Wilkins Slough, but pumping operations are severely affected and some pumps become inoperable at flows lower than 4,000 cfs. Flows may drop as low as 3,500 cfs for short periods while changes are made in Keswick releases to reach target levels at Wilkins Slough, but using the 3,500 cfs rate as a target level for an extended period would have major impacts on diverters.

No criteria have been established that specify when the navigation minimum flow should be relaxed. However, the basis for Reclamation's decision to operate at less than 5,000 cfs is the increased importance of conserving water when water supplies are not sufficient to meet full contractual deliveries and other operational requirements.

Flood Management Requirements

Shasta Dam provides flood protection to the nearby communities of Redding, Anderson, Red Bluff, and Tehama, as well as to agricultural lands, industrial developments, and communities downstream along the Sacramento River. Shasta Dam is operated for an objective release of 100,000 cfs at Bend Bridge in Red Bluff, subject to consideration of the following:

- Releases are not to be increased more than 15,000 cfs or decreased more than 4,000 cfs in any 2-hour period.
- The 2,500-square-mile uncontrolled drainage area between Keswick Dam and Bend Bridge can produce flows well in excess of the design channel capacity of 100,000 cfs. These high-magnitude flows can occur very rapidly, requiring release changes based on official flow forecasts, and are complicated by the 8- to 12-hour travel time between Keswick Dam and Bend Bridge.
- Recently installed gages on major east side tributaries (Cow, Battle, and Paynes creeks) between Keswick Dam and Red Bluff are very helpful in coordinating operations of Shasta Dam and Reservoir with flows from uncontrolled downstream areas. The most critical flood forecast for the Sacramento River is that of local runoff entering the Sacramento River between Keswick Dam and Bend Bridge. As the Bend Bridge flow is projected to recede, Keswick Dam releases are increased to evacuate water stored in the flood management space in Shasta Reservoir.

The following constraints are considered when making release changes at Keswick Dam:

- The maximum capacity of the Shasta Powerplant is about 18,000 cfs, but this varies considerably with head. Maximum powerplant release is required when Shasta Reservoir storage encroaches on the flood management space by 25 percent or less, with actual or forecasted inflows of 40,000 cfs or less.

- The capacity of the Keswick Powerplant is about 16,000 cfs, which represents a maximum release rate when no flood management space is being used. The Keswick Dam release must include discharge from the Spring Creek Powerplant, releases from Spring Creek Debris Dam, and local flows into Keswick Reservoir.

- Flows greater than 36,000 cfs begin to cause flood coordination efforts in the local Redding area to close riverfront roads and parks. These coordination efforts require some advance notice to increase Keswick releases above this rate.

All outflows from Shasta Dam flow into and through Keswick Reservoir, located about 5 miles west of Redding. Keswick Reservoir also receives inflow from the 45-square-mile drainage area of Whiskeytown Reservoir on Clear Creek.

Flood Management Space Requirements Shasta Reservoir capacity is 4,552 TAF, with a maximum objective release capacity of 79,000 cfs. The end-of-September storage target for Shasta Reservoir is 1,900 TAF, except in the driest 10 percent of water years, to conserve sufficient cold water for meeting temperature criteria for the winter-run Chinook incubation period (summer to early fall). Storage levels are lowest by October to provide sufficient flood protection and capture capacity during the following wet months. The storage target gradually increases from October to full pool in May. Storage is then withdrawn for high water demand (i.e., municipal, agricultural, fishery, and water quality uses) during summer.

A storage space of up to 1.3 MAF below a full pool elevation of 1,067 feet is also kept available for flood management purposes in the reservoir in accordance with the Shasta Dam and Lake Flood Control Diagram (USACE 1977) , as prescribed by USACE (USACE 1977) (see Exhibit B to the *Hydrology, Hydraulics, and Water Management Technical Report*). Under the diagram, flood management storage space increases from zero on October 1 to 1.3 MAF (elevation 1,018.55) on December 1 and is maintained until December 23. From December 23 to June 15, the required flood management space varies according to parameters based on the accumulation of seasonal inflow. This variable space allows for the storage of water for conservation purposes, unless it is required for flood management based on basin wetness parameters and the level of seasonal inflow. Daily flood management operation consists of determining the required flood storage space reservation, and scheduling releases in accordance with flood operations criteria.

Objective Flow The current regulation of Shasta Dam for flood management requires that releases be restricted to quantities that will not cause downstream flows or stages to exceed, insofar as possible, (1) a flow of 79,000 cfs at the tailwater of Keswick Dam and (2) a stage of 39.2 feet for the Sacramento River at the Bend Bridge gaging station near Red Bluff (corresponding roughly to a flow of 100,000 cfs).

Tributary Inflows Shasta Lake collects flow in the upper Sacramento River watershed, but many uncontrolled tributaries enter the Sacramento River downstream from the dam. Stream gages have been added to major uncontrolled tributaries entering downstream from Shasta Lake (Cow, Battle, Cottonwood, and Thomes creeks). To a limited extent, operators of Shasta Dam can adjust releases containing these uncontrolled flows to try to reduce downstream peak flows. Accordingly, the influence of Shasta Dam and Reservoir operation on reducing peak flood flows diminishes downstream on the Sacramento River.

6.2.2 State

The following State laws, regulations, standards, and plans are discussed as part of the regulatory setting:

- SWRCB Orders 90-05 and 91-01
- 1960 DFG-Reclamation Memorandum of Agreement (DFG 1960)
- Water Quality Control Plan (WQCP) for the San Francisco Bay/San Joaquin Delta Estuary (SWRCB 1995)
- SWRCB Revised Water Right Decision 1641 (RD-1641) (SWRCB 2000)
- Coordinated Operations Agreement (COA) (Reclamation and DWR 1986)
- Groundwater regulations

State Water Resources Control Board Orders 90-05 and 91-1

In 1990 and 1991, SWRCB issued Water Right Orders 90-05 and 91-01 modifying Reclamation’s water rights for the Sacramento River. The orders included a narrative water temperature objective for the Sacramento River, and stated that Reclamation shall operate Keswick and Shasta dams and the Spring Creek Powerplant to meet a daily average water temperature of 56°F at the RBDD in the Sacramento River during periods when higher temperatures would be harmful to fisheries.

Under the orders, the water temperature compliance point may be modified when the objective cannot be met at the RBDD. The SRTTG, a multiagency group, develops temperature operational plans for the Shasta and Trinity divisions of the CVP pursuant to SWRCB Water Rights Orders 90-5 and 91-1. These temperature plans consider the impacts to winter-run Chinook salmon and other races of Chinook salmon from project operations. Previous plans have included releases of water from the low-level outlets at Shasta Dam and Trinity Dam, operation of the TCD, warm water releases, and manipulating the timing of Trinity River diversions through the Spring Creek Powerplant. Warm water releases from the upper level outlets have been made to conserve cold water in Shasta Lake for temperature control in the late summer and to induce winter-run Chinook salmon to spawn as far upstream as possible. The SRTTG typically first meets in the spring once the cold-water availability in Shasta Lake is known. In every year since the SWRCB issued the orders, those plans have included modifying the RBDD compliance point to make the best use of the cold-water resources based on the location of spawning Chinook salmon (NMFS 2004).

The water right orders also recommended construction of a TCD to improve management of the limited cold-water resources. Reclamation constructed the TCD on Shasta Dam in 1997. This device releases cool water from Shasta Lake through low-level river outlets that bypass the power plant. The TCD provides flexibility to Shasta Dam operations and allows downstream temperature goals to be consistently achieved (Reclamation 2004).

Reclamation operates the Shasta, Sacramento River, and Trinity River divisions of the CVP to meet, to the extent possible, the provisions of SWRCB Order 90-05 and 91-01 and the NMFS 2004 Operations Criteria and Plan BO, shown as in Table 1-33.

1960 California Department of Fish and Game-Reclamation Memorandum of Agreement

An April 5, 1960, Memorandum of Agreement between DFG and Reclamation (DFG 1960) originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. The agreement provided for minimum releases into the natural channel of the Sacramento River at Keswick Dam for normal and critically dry years. Since October 1981, Keswick Dam has been operated based on a minimum release of 3,250 cfs for normal years from September 1 through the end of February, in accordance with an agreement between DFG and Reclamation. This release schedule was included in Order 90-05, which maintains a minimum release of 3,250 cfs at Keswick Dam and the RBDD from September through the end of February in all water years, except critically dry years.

Water Quality Control Plan for the San Francisco Bay/San Joaquin Delta Estuary

The 1995 Bay-Delta WQCP (SWRCB 1995) established water quality control objectives for the protection of beneficial uses in the Delta. The 1995 WQCP identified (1) beneficial uses of the Delta to be protected, (2) water quality objectives for the reasonable protection of beneficial uses, and (3) a program of implementation for achieving the water quality objectives. Because these new beneficial objectives and water quality standards were more protective than those of the previous SWRCB Water Right Decision 1485, the new objectives were adopted in 1995 through a water right order for operation of the CVP and SWP. Key features of the 1995 WQCP include estuarine habitat objectives for Suisun Bay and the western Delta (consisting of salinity measurements at several locations), export/inflow (E/I) ratios intended to reduce entrainment of fish at the export pumps, Delta Cross Channel gate closures, and San Joaquin River electrical conductivity (EC) and flow standards. The SWRCB adopted a new Bay-Delta WQCP on December 13, 2006. However, this new WQCP made only minor changes to the 1995 WQCP.

State Water Resources Control Board Revised Water Right Decision 1641

The 1995 Bay-Delta WQCP contains current water quality objectives. SWRCB RD-1641 (SWRCB 2000) and Water Right Order 2001-05 contain the current water right requirements to implement the 1995 WQCP. RD-1641 incorporates water right settlement agreements between Reclamation and DWR and certain water users in the Delta and upstream watersheds regarding contributions of flows to meet water quality objectives. However, SWRCB imposed terms and conditions on water rights held by Reclamation and DWR that require these two agencies, in some circumstances, to meet many of the water quality objectives established in the 1995 WQCP. RD-1641 also authorizes the CVP and SWP to use joint points of diversion (JPOD) in the south Delta, and recognizes the CALFED Bay-Delta Program (CALFED) Operations Coordination Group process for operational flexibility in applying or relaxing certain protective standards.

Delta Outflow Requirement Delta outflow, inflow that is not exported or diverted, is the primary factor controlling water quality in the Delta. When Delta outflow is low, seawater is able to intrude further into the Delta, impacting water quality at drinking water intakes. RD-1641 specifies minimum monthly Delta outflow objectives to maintain a reasonable range of salinity in the estuarine aquatic habitat based on the Net Delta Outflow Index (NDOI). The NDOI is a measure of the freshwater outflow and is determined from a water balance that considers river inflows, precipitation, agricultural consumptive demand, and project exports. The NDOI does not take into account the semidiurnal and spring-neap tidal cycles.

The monthly minimum values of the NDOI specified in RD-1641 depend on the water year type. Minimum flows are specified for the months of January and July to December. The outflow objectives from February to June are determined based on the X2[1] objective.

Delta Salinity Objectives Salinity standards for the Delta are stated in terms of EC (for protection of agricultural and fish and wildlife beneficial uses), and chloride (for protection of M&I uses). Compliance values vary with water year

[1] X2 is the most downstream location of either the maximum daily average or the 14-day running average of 2.64 millimhos per centimeter (mmhos/cm) isohaline, as measured in river kilometers from the Golden Gate Bridge.

and month. The salinity objectives at Emmaton on the Sacramento River, and at Jersey Point on the San Joaquin River, often control Delta outflow requirements during the irrigation season from April through August, requiring additional releases from upstream CVP and SWP reservoirs.

X2 Objective The location of X2, the 2 parts per thousand salinity unit isohaline at 1 meter above the bottom of the Sacramento River channel, is used as a surrogate measure of ecosystem health in the Delta. The X2 objective requires specific daily surface EC criteria to be met for a certain numbers of days each month, from February through June. Compliance can also be achieved by meeting a 14-day running average salinity or 3-day average outflow equivalent. These requirements were designed to provide improved shallow water habitat for fish species in the spring. Because of the relationship between seawater intrusion and interior Delta water quality, the X2 objective also improves water quality at Delta drinking water intakes.

Maximum Export/Inflow Ratio RD-1641 includes a maximum E/I standard to limit the fraction of Delta inflows that are exported. This requirement was developed to protect fish species and to reduce entrainment losses. Delta exports are defined as the combined pumping of water at Banks and Jones pumping plants. Delta inflows are the gaged or estimated river inflows. The maximum E/I ratio is 0.35 for February through June and 0.65 for the remainder of the year. If the January eight-river runoff index is less than 1.0 MAF, the February E/I ratio is increased to 0.45. The CVP and SWP have agreed to share the allowable exports equally if the E/I ratio is limiting exports.

Joint Point of Diversion The JPOD refers to the CVP and SWP use of each other’s pumping facilities in the south Delta to export water from the Delta. The CVP and SWP have historically coordinated use of Delta export pumping facilities to assist with deliveries and to aid each other during times of facility failures. In 1978, by agreement with DWR, and with authorization from SWRCB, the CVP began using the SWP Banks Pumping Plant for replacement pumping (195 TAF per year) for pumping capacity lost at Jones Pumping Plant because of striped bass pumping restrictions in SWRCB Water Right Decision 1485. In 1986, Reclamation and DWR formally agreed that “either party may make use of its facilities available to the other party for pumping and conveyance of water by written agreement” and that the SWP would pump CVP water to make up for striped bass protection measures (Reclamation and DWR 1986).

Reclamation filed a number of temporary petitions with SWRCB to use Banks Pumping Plant for purposes other than replacement pumping and CVP deliveries that contractually relied on SWP conveyance. Such uses included deliveries to Cross Valley Contractors, the Musco Olive Company, and the San Joaquin National Cemetery. In RD-1641, the SWRCB conditionally approved the use of the JPOD in three separate stages:

- Stage 1 is the use of the JPOD to serve Cross Valley Canal contractors, the Musco Olive Company and the San Joaquin National Cemetery; to support a recirculation study; and to recover export reductions made to benefit fish. Authorization for Stage 1 JPOD pumping to recover export reductions prohibits the CVP and SWP from annually exporting more water than each would have exported without the use of each other's pumping facilities. Stage 1 pumping is subject to SWRCB approval of a water level response plan, and a water quality response plan.

- Stage 2 is the use of the JPOD for any purpose authorized in the water rights permits up to the limitations contained in the USACE permit. In addition to the Stage 1 requirements, Stage 2 pumping is subject to SWRCB approval of an operations plan to protect aquatic resources and other legal users of water.

- Stage 3 is the use of the JPOD for any purpose authorized under the water right permits up to the physical capacity of the export pumps. Stage 3 is subject to the operation of barriers or other means to protect water levels in the south Delta, an SWRCB-approved operations plan that adequately protects aquatic resources and other legal users of water, and certification of a project-level Environmental Impact Report by DWR for the South Delta Improvements Program.

It has been the policy of SWRCB that all water transfers must meet similar criteria and conditions, as set forth for the JPOD, and SWRCB has mandated a "response plan" evaluation process for real-time incremental export operations to determine the effects of water transfers and JPOD operations. SWRCB approval of the 2006 and 2007 Accord Pilot Programs included the provision that rediversion of transfer water at Banks and Jones pumping plants must be in compliance with the various plans under RD-1641 that are prerequisites for the use of the JPOD by Reclamation and DWR.

Reclamation and DWR have produced the following response plans:

- Water Level Response Plan to address incremental effects of additional export, at the time of the export, to water levels in the south Delta environment (Reclamation and DWR 2004a).

- Water Quality Response Plan to address incremental effects of additional export, at the time of the export, to water quality in the Delta, and south Delta specifically (Reclamation and DWR 2004b).

- Operations Plan to protect fish and wildlife, and other legal uses of water.

Coordinated Operations Agreement

The COA defines how Reclamation and DWR share their joint responsibility to meet Delta water quality standards and the water demands of senior water right holders, and how the two agencies share surplus flows (Reclamation and DWR 1986). The COA defines the Delta as being in either "balanced water conditions" or "excess water conditions." Balanced water conditions are periods when Delta inflows are just sufficient to meet water user demands within the Delta, outflow requirements for water quality and flow standards, and export demands. Under excess water conditions, Delta outflow exceeds the flow required to meet the water quality and flow standards. Typically, the Delta is in balanced water conditions from June to November, and in excess water conditions from December through May. However, depending on the volume and timing of winter runoff, excess or balanced water conditions may extend throughout the year.

With the goal of using coordinated management of surplus flows in the Delta to improve Delta export and conveyance capability, the COA received Congressional approval in 1986 and became Public Law 99-546. The COA, as modified by interim agreements, coordinates operations between the CVP and SWP, and provides for the equitable sharing of surplus water supply. The COA requires that the CVP and SWP operate in conjunction to meet State water quality objectives in the San Francisco Bay/Sacramento-San Joaquin River Delta (Bay-Delta) estuary, except as specified. Under this agreement, the CVP and SWP can each contract from the other for the purchase of surplus water supplies, potentially increasing the efficiency of water operations.

Since 1986, the COA principles have been modified to reflect changes in regulatory standards, facilities, and operating conditions. At its inception, the COA water quality standards were those of the 1978 WQCP; these were subsequently modified in the 1991 WQCP. The adoption of the 1995 WQCP by SWRCB superseded those requirements. The Environmental Water Account was established by CALFED in 2000 to protect the fish of the Bay-Delta estuary via changes in the operations of the CVP and SWP, without incurring uncompensated cost to the projects' water users. Evolution of the Clean Water Act over time has also impacted implementation of the COA.

Groundwater Regulations

Groundwater use is subject to limited statewide regulation; however, all water use in California is subject to constitutional provisions that prohibit waste and unreasonable use of water (SWRCB 1999). In general, groundwater is subject to a number of provisions in the Water Code. Assembly Bill 3030, Water Code Section 10750, commonly referred to as the Groundwater Management Act, permits local agencies to develop groundwater management plans (Reclamation and DWR 2003).

Other groundwater regulation is related primarily to water quality issues, which are addressed by several different State agencies, including SWRCB and nine

Regional Water Quality Control Boards, the California Department of Toxic Substances Control, Department of Pesticide Regulation, and Department of Health Services.

The California Legislature and Governor, as well as private citizens, have become increasingly concerned about recent public well closures regarding the detection of chemicals, such as methyl tertiary-butyl ether from gasoline, and various solvents from industrial sources. As a result of increased awareness of groundwater quality, the Supplemental Report of the 1999 Budget Act required SWRCB to develop a comprehensive ambient groundwater monitoring plan. To meet this mandate, SWRCB created the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The primary objective of the GAMA Program is to assess water quality and relative susceptibility of groundwater resources. The GAMA Program has two sampling components: the California Aquifer Susceptibility Assessment for addressing public drinking water wells, and the Voluntary Domestic Well Assessment Project for addressing private drinking water wells.

The GAMA Program is being directed by the SWRCB Division of Water Quality, Land Disposal Section, Groundwater Special Studies Unit. The Voluntary Domestic Well Assessment Project samples domestic wells for various constituents commonly found in domestic well water, and provides that information to domestic well owners. In addition, the Voluntary Domestic Well Assessment Project includes a public education component to aid the public in understanding water quality data and water quality issues affecting domestic water wells. The Voluntary Domestic Well Assessment Project focuses on specific areas, as resources permit. The focus areas are chosen based on existing knowledge of water quality and land use, in coordination with local environmental agencies. SWRCB incurs the costs of sampling and analysis, and results are provided to domestic well owners as quickly as possible.

6.2.3 Regional and Local

The following local laws, regulations, standards, and plans are discussed as part of the regulatory setting:

- Local surface water regulations (water supply master plans, general plans, habitat and conservation plans, land use ordinances)
- Local groundwater regulations (management plans, county ordinances)

Local Surface Water Regulations

Local surface water regulations include goals, objectives, and policies pertaining to the primary and extended study areas, including the following:

- Local water supply master plans
- County general plans

- City general plans
- Local habitat and conservation plans (i.e., Natomas Basin Habitat Conservation Plan)
- Local land-use ordinances

Local Groundwater Regulations

Local regulatory setting documents on groundwater resources in the study areas include local groundwater management plans and county ordinances. Table 6-2 lists current groundwater management plans and county ordinances that apply to agencies in the Redding and Sacramento groundwater basins. Groundwater management plans and county ordinances in the North and South San Joaquin groundwater basins are presented in Table 6-3. These documents typically involve provisions to limit or prevent groundwater overdraft, protect groundwater quality, and regulate transfers.

Table 6-2. Groundwater Management Plans and County Ordinances for Redding and Sacramento Groundwater Basins

Groundwater Basin	Groundwater Management Plans, Agreements, and County Ordinances
Redding	• Shasta County Ordinance No. SCC-98-1 • Tehama County Urgency Ordinance No. 1617 • Tehama County Coordinated GMP (1996) • Redding Basin GMP (1998) • ACID GMP (2006) • El Camino ID GMP (1995)
Sacramento	• Glenn County Ordinance No. 1115 • Colusa County Ordinance No. 615 • Yolo County Export Ordinance No. 615 • Glenn-Colusa Irrigation District GMP (1995) • Feather WD GMP (2005) • Chapter 33 of the Butte County Code • Butte County Well Spacing Ordinance • Glenn County Ordinance No. 1115 and BMOs • Biggs-West Gridley WD GMP (1995) • Richvale ID GMP (1995) • Butte WD GMP (1996) • Western Canal WD GMP (1995) • Sutter Extension GMP (1995) • Yuba County transfer policies • Thermalito ID GMP (1995) • Yuba County Water Agency GMP (2005) • Browns Valley ID transfer policies • Water Forum Agreement • NCMWC GMP (2002) • Sacramento County Water Agency Act, Sections 32-33 • SGA GMP (2003) • Central Sacramento County GMP (2006) • City of Lincoln GMP (2003) • Dunnigan WD GMP (2001) • West Placer GMP (2003) • RD 787 GMP (2005) • RD 2035 GMP (1995) • RD 2068 GMP (2005) • RD 1500 GMP (1997)

Key:
ACID = Anderson-Cottonwood Irrigation District
BMO = basin management objective
GMP = groundwater management plan
ID = irrigation district
NCMWC = Natomas Central Mutual Water Company
RD = Reclamation District
SGA = Sacramento Groundwater Authority
WD = water district

Table 6-3. Groundwater Management Plans and County Ordinances for North and South San Joaquin Groundwater Basins

Groundwater Basin	Groundwater Management Plans, Agreements, and County Ordinances
North San Joaquin	• Merced ID GMP (1997) • Turlock Groundwater Basin GMP (1997) • Camanche Valley Springs GMP (2001) • Tracy Regional GMP (1996) • Eastside WD GMP (1994) • El Nido ID GMP (1997) • Modesto ID GMP (1996) • Oakdale ID GMP (1995) • Eastern San Joaquin Groundwater Basin GMP (2004) • Merced Groundwater Basin GMP (1997) • North San Joaquin WCD GMP (1996) • San Joaquin River Exchange Contractors Water Authority GMP (1997) • Merced County Wellhead Protection Program • Water Supply Plan and Update • South San Joaquin ID GMP (1994) • Southeast Sacramento County Agricultural Water Authority GMP (2002) • Stockton East Water District GMP (1995) • GMP for the Northern Agencies in the Delta-Mendota Canal Service Area and a portion of San Joaquin County (1997)
South San Joaquin	• Chowchilla WD GMP (1997) • Consolidated ID GMP (1995) • Fresno County GMP (1997) • Fresno ID GMP (1996) • Draft Gravelly Ford WD GMP (1998) • Amended GMP for James Irrigation District (2001) • Kaweah Delta Water Conservation District GMP (1995) • Kern Delta WD GMP (1996) • Kings County WD GMP (2001) • GMP for the Kings River Conservation District Area “A” (1995) • GMP for the Kings River Conservation District Area “B” (1996) • GMP for the Kings River Conservation District Area “C” (1998) • Deer Creek and Tule River Authority GMP (1995) • Madera ID GMP (1997) • North Kern Water Storage District GMP (1993) • Orange Cove GMP (1997) • Pleasant Valley WD GMP (2000) • Riverdale ID GMP (2005) • Root Creek WD GMP (1997) • Rosamond CSD GMP (1995)

Table 6-3. Groundwater Management Plans and County Ordinances in North and South San Joaquin Groundwater Basins (contd.)

Groundwater Basin	Groundwater Management Plans, Agreements, and County Ordinances
South San Joaquin (continued)	• Rosedale-Rio Bravo Water Storage District GMP (1997) • Semitropic Water Storage District GMP (2003) • Shafter-Wasco ID GMP (1993) • Tulare Lake Bed Coordinated GMP (1997) • Westside Groundwater Basin GMP (1996) • Westlands WD GMP (1996) • Kern Water Bank MOU • Kern Water Bank Joint Powers Agreement • Kern Water Bank Proposed Monitoring Plan • Pioneer Groundwater Recharge and Recovery Project MOU • Pioneer Project Joint Operating Agreement • Agreement on the Coordinated Operation of Recharge and Recovery Project Kern River Fan • The Pioneer Project Participation Agreement • Berrenda Mesa Project Agreement • Berrenda Mesa Project MOU between Berrenda Mesa WD and KCWA • MOU between Semitropic WSD and the adjoining entities • Agreement between Arvin-Edison WSD and MWDSC for a Water Management Program

Key:
CSD = County Sanitation District
GMP = groundwater management plan
ID = irrigation district
KCWA = Kern County Water Agency
MOU = memorandum of understanding
MWDSC = Metropolitan Water District of Southern California
WCD = Water Conservation District
WD = water district
WSD = water storage district

6.3 Environmental Consequences and Mitigation Measures

The purpose of this chapter is to provide information about the environmental consequences of the SLWRI study alternatives on hydraulics and hydrology, including water management, and impacts on existing facilities. This chapter describes the methods and assumptions, criteria for determining significant impacts, and impacts and mitigation measures associated with the H&H effects of each of the SWLRI alternatives. Implementation of the action alternatives considered in the study would affect the H&H of the Sacramento River, Feather River, American River, and the CVP/SWP systems. Impacts on the H&H of the CVP/SWP systems would translate to potential impacts on related surface and groundwater supplies available for CVP/SWP water users.

6.3.1 Methods and Assumptions

A suite of modeling tools was used to evaluate the potential impacts of the No-Action Alternative and various SLWRI action alternatives on the H&H of the project, and to quantify potential benefits. CalSim-II was used to simulate CVP and SWP operations, determining the surface water flows, storages, and deliveries associated with each alternative. A detailed description of CalSim-II is included in Chapter 2 of the Modeling Appendix. Delta Simulation Model 2 (DSM2) was used to simulate Delta hydrodynamics, providing the data used to discuss the water-level-related impacts of each alternative. A detailed description of DSM2 and the assumptions used in the SLWRI analysis are included in Chapter 8 of the Modeling Appendix. Analysis and modeling results are summarized below; more detailed results of the CalSim-II output can be found in Attachment A of the *Hydrology, Hydraulics, and Water Management Technical Report*. Attachment B of the *Hydrology, Hydraulics, and Water Management Technical Report* contains detailed results of the DSM2 modeling.

CalSim-II

CalSim-II is the application of the Water Resources Integrated Modeling System software to the CVP/SWP. This application was jointly developed by Reclamation and DWR for planning studies relating to CVP/SWP operations. The primary purpose of CalSim-II is to evaluate the water supply reliability of the CVP and SWP at current and/or future levels of development (e.g., 2005, 2030), with and without various assumed future facilities, and with different modes of facility operations. Geographically, the model covers the drainage basin of the Delta, and CVP/SWP exports to the San Francisco Bay Area, San Joaquin Valley, Central Coast, and Southern California.

CalSim-II typically simulates system operations for an 83-year period using a monthly time step. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over this period, representing a fixed level of development (e.g., 2005, 2030). The historical flow record of October 1921 to September 2003, adjusted for the influences of land use changes and upstream flow regulation, is used to represent the possible range of water supply conditions. Major Central Valley rivers, reservoirs, and CVP/SWP facilities are represented by a network of arcs and nodes. CalSim-II uses a mass balance approach to route water through this network. Simulated flows are mean flows for the month; reservoir storage volumes correspond to end-of-month storage.

CalSim-II models a complex and extensive set of regulatory standards and operations criteria. Descriptions of both are contained in Chapter 2 of the Modeling Appendix. The hydrologic analysis conducted for this PDEIS used the Common Assumptions Common Modeling Package Version 8D CalSim-II models, which are the best available hydrological modeling tools, to approximate system-wide changes in storage, flow, salinity, and reservoir system reoperation associated with the SLWRI alternatives. Although CalSim-II is the best available tool for simulating system-wide operations, the model also contains simplifying assumptions in its representation of the real system. CalSim-II's predictive capability is limited and cannot be readily applied to analyzing flood flows and hourly, daily, or weekly time steps for hydrologic conditions. The model, however, is useful for comparing the relative effects of alternative facilities and operations within the CVP/SWP system.

A general external review of the methodology, software, and applications of CalSim-II was conducted in 2003 (Close et al. 2003). Recently, an external review of the San Joaquin River Valley CalSim-II model was also conducted (Ford et al. 2006). Several limitations of the CalSim-II models were identified in these external reviews. The main limitations of the CalSim-II models are as follows:

- Model uses a monthly time step
- Accuracy of the inflow hydrology is uncertain
- Model lacks a fully explicit groundwater representation

In addition, Reclamation, DWR, and external reviewers have identified the need for a comprehensive error and uncertainty analysis for various aspects of the CalSim-II model. DWR has issued the CalSim-II Model Sensitivity Analysis Study (DWR 2005) and Reclamation has recently completed a similar sensitivity and uncertainty analysis for the San Joaquin River basin (Reclamation and DWR 2006a). This information will improve understanding of model results.

Despite these limitations, monthly CalSim-II model results remain useful for comparative purposes. It is important to differentiate between “absolute” or “predictive” modeling applications and “comparative” applications. In “absolute” applications, the model is run once to predict a future outcome; errors or assumptions in formulation, system representation, data, operational criteria, etc., all contribute to total error or uncertainty in model results. In “comparative” applications, the model is run twice, once to represent a base condition (no-action) and a second time with a specific change (action) to assess the change in the outcome due to the input change. In the comparative mode (the mode used for this PDEIS), the difference between the two simulations is of principal importance. Most potential errors or uncertainties affecting the “no-action” simulation also affect the “action” simulation in a similar manner; as a result, the effect of errors and uncertainties on the difference between the simulations is reduced. However, not all limitations are fully eliminated by the comparative analysis approach; small differences between the alternatives and the bases of comparison are not considered to be indicative of an effect of the alternative.

DSM2

DSM2 is a branched 1-dimensional model used to simulate hydrodynamics, water quality, and particle tracking in a network of riverine or estuarine channels. The hydrodynamic module can simulate channel stage, flow, and water velocity. The water quality module can simulate the movement of both conservative and nonconservative constituents. DWR uses the model to perform operational and planning studies of the Delta.

IMpact analysis for PLANning studies of the Delta is typically performed for a 72-year period (1922 to 1994). In model simulations, EC is typically used as a surrogate for salinity. Results from CalSim-II are used to define Delta boundary inflows. CalSim-II-derived boundary inflows include the Sacramento River flow at Hood, the San Joaquin River flow at Vernalis, inflow from the Yolo Bypass, and inflow from the eastside streams. In addition, Net Delta Outflow from CalSim-II is used to calculate the salinity boundary at Martinez.

Details of the model, including source codes and model performance, are available from the DWR Bay-Delta Office, Modeling Support Branch, Web site. Documentation on model development is discussed in annual reports to SWRCB (*Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh,* by the Delta Modeling Section of DWR) (DWR 2009).

6.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an environmental impact statement must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect on the environment means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project" (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

The significance criteria were developed based on the guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on hydraulics, hydrology, and water management would be significant if project implementation would cause the results in the second column of Table 6-4 to occur. Simulated stream flow and reservoir storage data, generated as part of the hydrology, hydraulics and water management impact assessment, were used in the impact assessments for groundwater, hydropower, flood control, water quality, fisheries, terrestrial biology, recreation, and cultural resources. Accordingly, a detailed description of changes in flow and storage resulting from each of the SLWRI alternatives is included in addition to the impact analysis.

Table 6-4. Impact Indicators and Significance Criteria for Water Management

Impact Indicator	Significance Criterion
Flood management	Increase frequency or severity of damaging flood flows, as indicated by the following: • Increase frequency of daily flows above 100,000 cfs on the Sacramento River below Bend Bridge • Place housing or other structures within a 100-year flood hazard area as mapped on a Federal flood hazard boundary or Flood Insurance Rate Map or other flood hazard delineation map • Place within a 100-year flood hazard area structures that would impede or redirect flood flows
Water Supply Reliability	Reduce water supply reliability to the following CVP/SWP contractors: • North-of-Delta CVP Water Service Contractors or Refuges • South-of-Delta CVP Water Service Contractors or Refuges • SWP Table A Contractors south of the Delta
Water levels in the south Delta [1]	Reduce water surface elevation, relative to the basis of comparison, with sufficient frequency and magnitude to adversely affect south Delta water users' abilities to divert water during the irrigation season.
X2 location	Increase in X2 that adversely affects CCWD's ability to fill Los Vaqueros Reservoir: • Movement of X2 location to west of Chipps Island from February through May • Movement of X2 location to west of Collinsville during December, January, and June
Delta excess water conditions	Reduction in the duration of Delta excess conditions during the November-to-June period that adversely affects CCWD's ability to fill Los Vaqueros Reservoir.
Groundwater resources	A change in groundwater level or quality that would adversely affect users, as indicated by the following: • A change in groundwater level resulting in long-term overdraft conditions for the groundwater basins • A change groundwater quality resulting in substantially adverse effects to designated beneficial uses of groundwater.

Note:
[1] Changes in south Delta water levels are estimated using the DSM2 Model.

Key
CCWD = Contra Costa Water District
cfs = cubic feet per second
Delta = Sacramento-San Joaquin Delta

Significance statements are relative to both existing conditions (2005) and future conditions (2030) unless stated otherwise.

Flood Management

To prevent an increase in flood damages in the study area, the SLWRI must not cause a significant increase in the frequency or magnitude of flood flows on the Sacramento River. The current regulation of Shasta Dam for flood control requires that releases be restricted to quantities that will not cause downstream flows or stages to exceed, insofar as possible, (1) a flow of 79,000 cfs at the tailwater of Keswick Dam, and (2) a stage of 39.2 feet at the Sacramento River Bend Bridge gaging station near Red Bluff (corresponding roughly to a flow of 100,000 cfs). Because of the uncontrolled nature of the inflows between Keswick Dam and Bend Bridge, the 100,000 cfs flow objective at Bend Bridge is the critical objective for minimizing flood damage. It is also important to ensure that the project does not increase potential flood damages by locating any new facilities within the 100-year floodplain or in a location that could impede or redirect flood flows, thereby potentially increasing damage to other property.

Water Supply Reliability

To prevent a decrease in water supply, the SLWRI must not cause a significant reduction in water supply reliability to CVP and SWP contractors. A significant reduction in reliability would be a reduction in average annual or average dry and critical year reliability of a magnitude and frequency that could not reliably be replaced from other sources, such as groundwater pumping or water transfers. Also, it is recognized that there is limited flexibility to change water usage between months, so monthly reliability is considered in addition to average annual delivery volumes.

The CVP provides water to a range of contract types; Settlement and Exchange contractors have the highest degree of reliability due to water rights senior to the CVP. Due to their high priority, these contractors would not be affected by any of the SLWRI alternatives. Water service contractors and refuges are subject to shortages according to water availability and their geographic location; due to conveyance constraints, south-of-Delta water service contractors and refuges have a lower degree of reliability than north-of-Delta water service contractors and refuges. While the SWP has several contractors north of the Delta, the vast majority of recipients of SWP water supplies are south of the Delta. SWP contractors have several types of water in their contract; the Table A contracts (DWR 2003a) are most susceptible to variability of supply.

South Delta Water Levels

Water levels in the south Delta are influenced to varying degrees by natural tidal fluctuations, San Joaquin River flows, barrier operations, CVP and SWP export pumping, local agricultural diversions and drainage return flows, channel capacities, siltation, and dredging. When the CVP and SWP are exporting water, water levels in local channels can be drawn down, particularly during low water years. The South Delta Water Agency and local farmers in the south and central Delta have interests in maintaining the water levels so that their siphons and pumps, which are installed at fixed locations in the Delta, can continue to be used for irrigation diversions. The SLWRI alternatives could affect the ability of the South Delta Water Agency to divert water if changes in Delta operations reduce Delta channel water levels during the irrigation season, from April to October.

The South Delta Temporary Barriers Program was initiated by DWR in 1991 to improve water conditions in the south Delta and to provide design data for permanent gates. Since 1991, DWR has seasonally installed four barriers. Three barriers, located on the Middle River, Grant Line Canal, and Old River, ensure adequate water levels and water quality for agricultural diversions. The barriers are constructed from rock fill and incorporate overflow weirs and gated culverts. These barriers are installed in spring and removed in fall. A fourth barrier is seasonally installed at the Head of the Old River for fish control. The existing seasonal barriers (and proposed permanent tidal gates) significantly affect water levels in the south Delta. In October 2005, Reclamation and DWR released a DEIS for the South Delta Improvements Program (Reclamation 2005). This DEIS discusses the proposed operation and evaluates the impacts of the proposed permanent tidal and fish control gates in the south Delta. The Final Environmental Impact Statement/Environmental Impact Report for the South Delta Improvements Program was released in December 2006 (Reclamation and DWR 2006b) but the document has not yet been certified.

To evaluate water level effects, modeling results were examined for sites in the vicinity of three monitoring locations. South Delta agricultural irrigation users are primarily concerned with the water level at low-low tide because this is the minimum water surface elevation they experience. The impact analysis considers the maximum change in water elevation at the low-low tide for each day of each month. Channel tidal levels at three south Delta locations have been selected to describe the possible impacts of the SWLRI alternatives on south Delta tidal hydraulics. The three locations are as follows:

- **Old River at Tracy Boulevard Bridge (Road Bridge).** This station is a tidal level and EC monitoring location, and is upstream from the temporary barrier and proposed permanent barrier just east (upstream) from the Delta-Mendota Canal intake and fish facility.

- **Grant Line Canal Above the Grant Line Canal Barrier.** This station is upstream from the temporary barrier on Grant Line Canal and upstream from the proposed permanent tidal gate.

- **Middle River near the Howard Road Bridge.** This station is located just upstream from the temporary barrier near Victoria Canal and the proposed permanent tidal gate.

A change in water level of greater than 0.1 foot during the irrigation season of April to October, at a level of recurrence substantially adversely affecting south Delta water users, is considered to be significant.

X2 Location

CCWD depends almost entirely on the Delta for water supply. CCWD’s raw water system consists of three Delta pumping plants (Mallard Slough, Rock Slough, and Old River), and a 100 TAF reservoir (Los Vaqueros). The pumping plants on Rock Slough and on the Old River are the primary source for CCWD. The third intake at Mallard Slough is used only when water quality conditions in the western Delta permit, usually following a prolonged period of surplus Delta outflow. Water diverted at the Old River Pumping Plant is either used directly or stored in Los Vaqueros Reservoir for later use. CCWD's current operational priority is to fill Los Vaqueros Reservoir with high quality water whenever possible.

CCWD diversions to fill Los Vaqueros Reservoir are constrained by the Delta Smelt BO (NMFS 2004; USFWS 2005), as subsequently modified by agreements among CCWD, USFWS, DFG, and SWRCB. From February through May, the BO precondition for filling the reservoir is that the X2 location is west of Chipps Island. In December, January, and June, the X2 location must be west of Collinsville. Filling Los Vaqueros Reservoir is unconstrained in December if no delta smelt are present at the diversion location. Through agreement with DFG and USFWS, the X2 restrictions on filling Los Vaqueros Reservoir have subsequently been modified for a temporary trial period through 2010 to conform with X2 requirements specified in RD-1641.

For the impact analysis, it is assumed that from February to June, the X2 requirement for filling Los Vaqueros Reservoir will be met by Reclamation and DWR as part of their responsibilities under RD-1641.[2] Changes in simulated Delta conditions are considered to be potentially significant only for the months of December and January, and only when all of the following conditions are met:

- The Delta is not in balanced condition[3]
- Under the basis of comparison, X2 is west of Collinsville
- Under the SLWRI alternatives, X2 is east of Collinsville

It is noted that Reclamation and DWR are not authorized to use the JPOD when the Delta is in excess conditions, and when such diversions would cause the location of X2 to shift upstream and prevent CCWD from filling Los Vaqueros Reservoir under its water right permits.

Delta Excess Water Conditions

Changes from Delta excess water conditions to balanced conditions could adversely affect CCWD's ability to fill Los Vaqueros Reservoir. Under SWRCB Water Right Decision 1629, filling Los Vaqueros Reservoir is restricted to the parts of the period from November 1 to June 30 when the Delta is in excess water conditions. Changes in simulated Delta conditions are

[2] When the Eight River Index is less than 8.1 MAF, the RD-1641 X2 requirements for May and June are relaxed, potentially impacting filling of Los Vaqueros Reservoir. Model simulations show that this would occur eight times during the historical record for water years 1922 to 1994, but in these circumstances the Delta would be in balanced water conditions.

[3] Balanced water conditions are periods when it is agreed by Reclamation and DWR that releases from upstream reservoirs plus unregulated flows approximately equal the water supply needed to meet Sacramento Valley in-basin uses plus required Delta outflows and exports (Reclamation and DWR 1986).

considered to be potentially significant if during this period the following conditions are met:

- Under the basis of comparison, the Delta is in excess conditions
- Under the SLWRI alternatives, the Delta is in balanced conditions

Groundwater Resources

Impacts on groundwater resources would be considered significant if actions related to the SLWRI alternatives would cause the groundwater resources impacts described in Table 6-4. Improvements in water supply reliability under the SLWRI alternatives may affect groundwater levels, budget, and quality in the primary and extended study areas. In general, potential impacts of the SLWRI in the primary and extended study areas would result from a reduction in water extraction due to increased surface water supply reliability. Currently, CVP and SWP water users in the primary and extended study areas pump groundwater to supplement surface water supply.

Potential impacts on groundwater resources, particularly groundwater levels, budget, and water quality, are evaluated qualitatively based on changes in surface water supply. This approach is based on the assumption that the actual reduction in groundwater extraction would be proportional to the increase in surface water supply reliability that would occur in the study areas under the SLWRI alternatives. Changes in groundwater pumping in the study areas would be relatively small compared to the estimated millions of acre-feet of annual groundwater pumping. Nevertheless, the SLWRI alternatives would have a positive, albeit limited, impact by reducing reliance on groundwater in the study areas. Because effects on groundwater basins would be limited and positive, groundwater impacts are discussed qualitatively.

6.3.3 Direct and Indirect Effects

This section describes the environmental consequences of the SLWRI alternatives, and proposed mitigation measures for any impacts determined to be significant or potentially significant. All alternatives are compared to a basis of comparison. For the existing condition (2005 level of development), a CalSim-II simulation for the existing condition is used. Similarly, the future condition (2030 level of development) uses a CalSim-II simulation of the No-Action/No-Project Alternative as a basis of comparison. Each of the alternatives is simulated using the same level of development so that any changes from the basis of comparison in H&H can be attributed to the alternative.

Alternatives Description

The six SLWRI alternatives are described in the following subsections.

No-Action Alternative NEPA and CEQA require the analysis of a baseline alternative, representing a scenario in which the project is not implemented. For all Federal feasibility studies of potential water resources projects, the NEPA No-Action Alternative is intended to account for existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area by 2030. Reasonably foreseeable actions include actions with current authorization, complete funding for design and construction, and complete environmental permitting and compliance.

Under CEQA, the No-Project Alternative is similar to NEPA's No-Action Alternative, but it involves the review of two scenarios: the Existing Condition baseline, which represents only current conditions at the time the Notice of Preparation is published, and "reasonably foreseeable" future conditions without the project (which is equivalent to the NEPA No-Action Alternative). Table 2-1 of the Modeling Appendix describes the Existing Condition, and shows what actions were assumed to be part of the Future Condition (or No-Project/No-Action Alternative).

For the SLWRI, under the No-Action Alternative, the Federal Government would take reasonably foreseeable actions, as defined above, but would take no additional action toward implementing a specific plan to help increase anadromous fish survival in the upper Sacramento River, nor help address the growing water reliability issues in California. This alternative is used as a basis of comparison to determine effects of the action alternatives under future conditions.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability CP1 focuses on increasing water supply reliability while contributing to increased anadromous fish survival, actions that are consistent with the 2000 CALFED ROD (CALFED 2000b). In addition to the common features above, CP1 primarily consists of raising Shasta Dam 6.5 feet, an elevation change that increases the reservoir's full pool by 8.5 feet, and enlarges the total storage space in the reservoir by 256,000 acre-feet. Under this plan, Shasta Dam normal operational guidelines would continue essentially unchanged, with the additional storage retained for water supply reliability. This scenario helps to reduce future water shortages through increasing drought and average year water supply reliability. This plan would also include the potential to revise the operational rules for flood control for Shasta Dam and Reservoir, which could benefit flood damage reduction and recreation. Reservoir reoperation would likely include increasing the bottom of the flood control pool elevation based on increased dam height and reservoir capacity. The increased Shasta Reservoir pool depth and volume would also contribute to maintaining lower seasonal water temperatures for anadromous fish on the upper Sacramento River.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability As with CP1, this comprehensive plan focuses on enlargement of Shasta Dam and Lake consistent with the goals of the 2000 CALFED ROD, and was formulated for the primary purposes of increased water supply reliability and increased anadromous fish survival. In addition to the common features above, CP2 consists of raising Shasta Dam 12.5 feet, an elevation change that increases the full pool by 14.5 feet, and enlarges the total storage space in the reservoir by 443,000 acre-feet. This alternative would help reduce future shortages by increasing drought and average year water supply reliability. The increased cold-water pool also would contribute to improved seasonal water temperatures for anadromous fish on the upper Sacramento River.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability CP3 is similar to CP1 and CP2. It focuses on the greatest practical enlargement of Shasta Dam and Lake consistent with the goals of the 2000 CALFED ROD, and was formulated for the primary purposes of increased water supply reliability and increased anadromous fish survival. In addition to the common features above, CP3 consists of raising Shasta Dam 18.5 feet, an elevation change that increases the full pool by 20.5 feet, and enlarges the total storage space in the reservoir by 634,000 acre-feet to 5.19 MAF. This comprehensive plan would help reduce future shortages by increasing water supply reliability in relatively dry years. The increased pool depth and volume would also contribute to improving seasonal water temperatures for anadromous fish on the upper Sacramento River.

CP4 – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability The primary function of CP4 is to address anadromous fish survival, while still improving water supply reliability. It focuses on increasing the volume of cold water available to the Shasta Lake TCD through reservoir reoperations, and on raising Shasta Dam by 18.5 feet. As with CP3 and the common features above, this raise would increase the full pool by 20.5 feet and enlarge total reservoir storage space by 634,000 acre-feet. This additional storage space would expand Shasta Reservoirs cold-water supply available to the TCD by 378,000 acre-feet, a feature that would help improve cooler water temperatures in the upper Sacramento River.

CP5 – 18.5-Foot Dam Raise, Combination Plan CP5 would address both the primary and secondary planning objectives. CP5 includes enlarging Shasta Dam 18.5 feet, which is consistent with the objectives of the 2000 CALFED ROD, and also includes the common features above. In addition, CP5 includes (1) implementing environmental restoration features along the lower reaches of major tributaries to Shasta Lake, (2) constructing shoreline fish habitat around Shasta Lake, and (3) constructing either additional or improved recreation features at various locations around Shasta Lake to increase the value of the recreational experience. Specific environmental restoration features and increased recreation components are presented in the Alternatives Description portion of the PDEIS and the Draft Feasibility Report.

Changes to CVP/SWP Operations

Each of the SWLRI alternatives would have similar impacts on CVP and SWP operations compared to either the existing condition or the No-Action

Alternative. However, the magnitude of the impacts would vary according to the alternative. Detailed tables of the estimated monthly flows and storages associated with each alternative, in addition to changes from the bases of comparison, are included in Attachment A of the *Hydrology, Hydraulics, and Water Management Technical Report*. Results are summarized below.

The analysis assumed that the SLWRI alternatives would not alter existing operational rules or protocols; no formal changes to CVP or SWP operating criteria and associated with the SLWRI. At a base level, each action alternative would store some additional flows behind Shasta Dam during periods when the flows would have otherwise been released downstream. The resulting increase in storage would then be used to both create an expanded cold-water pool, thus benefiting fisheries, and for subsequent release downstream when there are opportunities to put the water to beneficial use.

Reductions in Shasta releases under the various SLWRI alternatives would typically occur during winter (November through March) in relatively wet years, and increases in releases would typically occur in the late spring and summer (June through September) of drier years. Shasta Dam typically makes releases for one of six purposes:

- Flood management
- Sacramento River flow requirements both below Keswick and at Wilkins Slough
- Sacramento River water temperature requirements at Bend Bridge
- Delta water quality requirements
- Senior water rights along the Sacramento River
- CVP water supply contracts needs both north and south of the Delta

However, release for one purpose may also be sufficient for meeting another; for instance, releases for Sacramento River water temperatures may also be used to both meet Delta water quality requirements and for export to south-of-Delta contractors. While releases for flood management purposes typically occur in winter, water temperature and water quality requirements exist year-around. Releases for water supply purposes primarily occur in late spring, summer, and early fall.

For the SLWRI alternatives, existing water quality and temperature requirements would typically be met in most years; therefore, additional water in storage would primarily be released for water supply purposes. Accordingly, minimal increases in flow would be expected in months when Delta exports are constrained, or when flow is not usable for water supply purposes.

Table 6-5 summarizes monthly flows and changes below Shasta Dam. Releases from Shasta Dam would typically be increased in the summer months, corresponding with the periods of greatest agricultural demands. Similarly, releases would be reduced in the winter months, when the increased storage would be used to capture additional runoff rather than releasing to the downstream river.

Table 6-5. Simulated Monthly Average Sacramento River Flows Below Shasta Dam

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	5,529	-27 (0%)	-9 (0%)	1 (0%)	5,194	-60 (-1%)	6 (0%)	49 (1%)
Nov	5,304	-70 (-1%)	-32 (-1%)	51 (1%)	5,077	-81 (-2%)	-50 (-1%)	4 (0%)
Dec	6,770	-210 (-3%)	-318 (-5%)	-409 (-6%)	6,585	-193 (-3%)	-377 (-6%)	-510 (-8%)
Jan	7,558	-77 (-1%)	-74 (-1%)	-134 (-2%)	7,591	-129 (-2%)	-131 (-2%)	-195 (-3%)
Feb	10,242	-184 (-2%)	-197 (-2%)	-421 (-4%)	10,111	4 (0%)	-192 (-2%)	-283 (-3%)
Mar	8,054	-1 (0%)	-39 (0%)	-63 (-1%)	8,061	-146 (-2%)	-173 (-2%)	-120 (-1%)
Apr	6,419	76 (1%)	92 (1%)	116 (2%)	6,463	56 (1%)	70 (1%)	87 (1%)
May	7,519	-19 (0%)	-11 (0%)	13 (0%)	7,590	-28 (0%)	-12 (0%)	1 (0%)
Jun	10,267	23 (0%)	29 (0%)	80 (1%)	10,186	33 (0%)	162 (2%)	140 (1%)
Jul	10,900	105 (1%)	159 (1%)	164 (2%)	11,028	210 (2%)	273 (3%)	199 (2%)
Aug	8,187	177 (2%)	160 (2%)	243 (3%)	8,453	191 (2%)	222 (3%)	308 (4%)
Sep	4,939	75 (2%)	18 (0%)	43 (1%)	5,355	29 (1%)	-18 (0%)	7 (0%)
Total (TAF)	5,523	-7 (0%)	-13 (0%)	-18 (0%)	5,524	-7 (0%)	-13 (0%)	-18 (0%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node C4)

Note:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = Comprehensive Plan
TAF = thousand acre-feet

Storage in Shasta Reservoir fluctuates greatly throughout a year; storage is typically highest at the end of winter, in April and May, as the need for flood control reservation space in the reservoir is reduced. Storage is typically at its lowest in September and October, after the irrigation season and before the winter refill begins. As a result of the increased storage capacity attributed to each alternative, and the flow reductions described above, Shasta Reservoir storage would be generally higher under the SLWRI alternatives than under the existing condition or the No-Action Alternative (future condition). This additional storage would typically be greatest in the winter (February or March), and would be lowest at the end of summer (September or October), as shown in Table 6-6, consistent with Shasta Reservoir's current operation. Additional runoff captured by the increased storage increment would typically remain in storage until it could be used to meet one of the purposes described above. Conversely, under either of the bases of comparison, if water in storage were insufficient to meet all of the project purposes, the first increment to be reduced would be deliveries to water service contractors. Therefore, increased releases would typically be made on a schedule providing increased reliability of deliveries to water service contractors, typically in July through October of relatively dry years.

Table 6-6. Simulated Average End-of-Month Shasta Reservoir Storage

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (TAF)	Change from Base				No-Action Alt (TAF)	Change from Base			
		CP1 (TAF)	CP2 (TAF)	CP3 and CP5 (TAF)	CP4 (TAF)		CP1 (TAF)	CP2 (TAF)	CP3 and CP5 (TAF)	CP4 (TAF)
Oct	2,671	144	263	377	522	2,635	142	258	386	520
Nov	2,690	148	265	374	526	2,667	147	261	385	525
Dec	2,815	160	284	399	538	2,804	158	284	416	536
Jan	3,067	165	288	407	543	3,054	166	292	428	544
Feb	3,291	175	299	430	553	3,284	166	302	443	544
Mar	3,624	175	301	434	553	3,617	174	313	450	552
Apr	3,919	170	295	426	548	3,910	171	308	444	549
May	3,950	171	295	424	549	3,936	172	308	443	550
Jun	3,642	169	293	418	547	3,634	170	297	434	548
Jul	3,187	162	282	407	540	3,171	156	279	420	534
Aug	2,879	150	271	390	528	2,846	144	265	399	522
Sep	2,782	145	269	386	523	2,725	141	265	397	519

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node S4+S44)

Notes:

Simulation period: 1922-2003

Key:

Alt = alternative

CP = Comprehensive Plan

TAF = thousand acre-feet

A key indicator of water temperature benefits of the SLWRI alternatives to the Sacramento River between Keswick Dam and Red Bluff is the amount of cold water available in Shasta Reservoir before the water temperature operation season, about May through October. As previously described, Shasta Reservoir generally reaches its maximum storage during late April or early May. Also, the cold-water pool volume in the lake accumulates during the winter and early spring and is not likely to increase after April. Therefore, the expected increase in spring storage for each dam raise alternative should also result in an incremental increase in the cold-water pool volume.

Reclamation operates the Shasta Dam TCD to manage water temperatures in the Sacramento River to (1) improve habitat for the endangered winter-run Chinook salmon and other threatened runs, (2) withdraw warmer surface water in the winter and spring to preserve cold-water storage for release during the temperature operation season, and (3) enable power generation to continue while controlling release temperatures, which eliminates the need to bypass the powerplant penstocks via the low-level river outlets. Generally, to accomplish these temperature objectives during the temperature operation season, the TCD functions to select water temperatures in the 47 degrees Fahrenheit (˚F) to 52˚F range. Therefore, a good index of the temperature-related benefits of the alternative is the volume of the cold-water pool less than 52˚F at the end of April. In the context of historical project operation, reservoir storage and cold-water pool conditions in mid-spring represent the available cold-water "bank" managed throughout the temperature operation season (July through October), as prescribed by the SRTTG. The simulated end-of-April volume of water less than 52˚F for the two bases of comparison, and the change in cold-water pool volume for each of the SLWRI alternatives, are shown by Sacramento Valley Index in Table 6-7. As expected, the higher dam raise alternatives generally reflect a larger cold-water pool volume.

Table 6-7. Simulated Average Volume of Water Less than 52˚F in Shasta Reservoir at the End of April

SVI Year Type	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (TAF)	Change from Base				No-Action Alt (TAF)	Change from Base			
		CP1 (TAF)	CP2 (TAF)	CP3 and CP5 (TAF)	CP4 (TAF)		CP1 (TAF)	CP2 (TAF)	CP3 and CP5 (TAF)	CP4 (TAF)
Average of All Years	1,577	90	152	220	348	1,570	103	169	240	362
Wet	1,807	137	237	349	437	1,799	156	255	374	457
Above Normal	1,721	110	182	284	324	1,722	131	203	270	350
Below Normal	1,743	72	130	214	341	1,723	86	153	223	352
Dry	1,451	71	111	130	310	1,450	80	120	152	314
Critical	928	16	22	17	241	920	15	41	69	251

Source: Common Assumptions Common Modeling Package Version 8D SRWQM 2005 and 2030 simulations
Notes:
Simulation period: 1922-2003
Year types as defined by the Sacramento Valley Index
Key:
ºF = degrees Fahrenheit
Alt =Alternative
CP = Comprehensive Plan
SVI = Sacramento Valley Index
TAF = thousand acre-feet

Downstream from Shasta Dam, the Sacramento River combines with releases from Trinity Reservoir through Whiskeytown Reservoir and the Spring Creek Tunnel above Keswick Dam. Because of the connected nature of Shasta Reservoir and Trinity Reservoir for meeting instream flow requirements and water supply demands below Keswick Dam, changes in Shasta Reservoir operations would possibly result in changes to operations of Trinity Reservoir. Table 6-8 shows changes in Trinity Reservoir storage that would result from SLWRI alternatives. These changes are very small relative to the reservoir storage and should not result in noticeable changes at Trinity Reservoir. To limit the effect of the enlarged Shasta Reservoir on Trinity Reservoir operations, the relationship in CalSim-II between Shasta Reservoir storage and Trinity Reservoir exports to the Sacramento River was modified through interpolation to approximately maintain the export level of the basis of comparison in the action alternatives.

Table 6-8. Simulated Average End-of-Month Trinity Lake Storage

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (TAF)	Change from Base			No-Action Alt (TAF)	Change from Base		
		CP1 and CP4 (TAF)	CP2 (TAF)	CP3 and CP5 (TAF)		CP1 and CP4 (TAF)	CP2 (TAF)	CP3 and CP5 (TAF)
Oct	1,344	12	18	19	1,333	13	13	15
Nov	1,356	10	16	20	1,347	11	13	17
Dec	1,405	7	13	17	1,399	7	8	12
Jan	1,466	10	18	22	1,463	9	12	15
Feb	1,574	10	18	21	1,572	10	12	15
Mar	1,698	7	14	16	1,696	7	9	12
Apr	1,845	11	19	21	1,844	11	14	17
May	1,841	11	19	21	1,840	11	15	18
Jun	1,800	9	16	18	1,799	8	14	15
Jul	1,658	7	14	14	1,657	8	11	10
Aug	1,520	8	15	16	1,513	12	12	11
Sep	1,402	13	18	18	1,392	16	14	13

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node S1)

Note:

Simulation period: 1922-2003

Key:

Alt =Alternative

CP = Comprehensive Plan

TAF = thousand acre-feet

Below Keswick Dam, Sacramento River flows would be increasingly affected by tributary inflows rather than releases from Shasta Lake. Table 6-9 shows the simulated monthly average tributary inflows to the Sacramento River between Keswick Dam and the RBDD. The tributary inflows are consistent between the 2005 and 2030 levels of development simulations and for each alternative. Below the RBDD, flow changes associated with the SLWRI alternatives would be considerably smaller relative to total flow in the river. Comparing the flows in Table 6-5 and Table 6-10 for the existing condition and No-Action Alternative, the tributary influence on river flow becomes apparent. Similarly, with increases in flow for the existing condition and No-Action Alternative, the influence of the SLWRI alternatives on the flow in the river would be reduced.

Table 6-9. Simulated Monthly Average Tributary Inflow to the Sacramento River Between Keswick Dam and the Red Bluff Diversion Dam

Month	Cottonwood Creek (cfs)	Paynes Creek (cfs)
October	109	23
November	335	77
December	1,073	145
January	1,848	179
February	2,252	174
March	1,803	128
April	1,139	70
May	619	37
June	298	23
July	108	10
August	64	7
September	70	13
Total (AF)	584,937	53,402

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node I108 and I110)

Notes:
Simulation period: 1922-2003
Key:
AF = acre-feet
Alt = alternative
cfs = cubic feet per second

Table 6-10. Simulated Monthly Average Sacramento River Flows Below the Red Bluff Diversion Dam

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alts (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	7,341	-20 (0%)	-20 (0%)	-16 (0%)	7,057	-39 (-1%)	-11 (0%)	41 (1%)
Nov	8,012	-7 (0%)	11 (0%)	57 (1%)	7,848	-39 (0%)	-44 (-1%)	-61 (-1%)
Dec	12,049	-190 (-2%)	-297 (-2%)	-391 (-3%)	11,877	-147 (-1%)	-314 (-3%)	-642 (-5%)
Jan	15,414	-137 (-1%)	-164 (-1%)	-234 (-2%)	15,436	-186 (-1%)	-200 (-1%)	-331 (-2%)
Feb	18,866	-192 (-1%)	-210 (-1%)	-428 (-2%)	18,738	-11 (0%)	-189 (-1%)	-92 (0%)
Mar	14,868	27 (0%)	-24 (0%)	-48 (0%)	14,915	-116 (-1%)	-161 (-1%)	-130 (-1%)
Apr	10,416	-15 (0%)	-9 (0%)	8 (0%)	10,480	-20 (0%)	-22 (0%)	53 (1%)
May	9,385	-48 (-1%)	-50 (-1%)	-40 (0%)	9,468	-47 (-1%)	-59 (-1%)	5 (0%)
Jun	11,020	25 (0%)	41 (0%)	73 (1%)	10,923	60 (1%)	140 (1%)	22 (0%)
Jul	12,006	98 (1%)	141 (1%)	178 (1%)	12,111	197 (2%)	271 (2%)	176 (1%)
Aug	9,356	118 (1%)	108 (1%)	156 (2%)	9,690	120 (1%)	187 (2%)	345 (4%)
Sep	6,755	-23 (0%)	-34 (-1%)	-18 (0%)	7,246	-46 (-1%)	-63 (-1%)	-68 (-1%)
Total (TAF)	8,147	-21 (0%)	-30 (0%)	-41 (-1%)	8,166	-17 (0%)	-27 (0%)	-41 (-1%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node C112)

Notes:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = thousand acre-feet

In addition to the multiple tributary inflows between Keswick Dam and Red Bluff, downstream flows on the Sacramento River would be affected by diversions above the RBDD. Specifically, contractors off the Tehama-Colusa Canal receive supplies from above the RBDD. Since contractors off the Tehama-Colusa Canal are all water service contractors, and thus would be subject to delivery shortages when CVP storage is low, the SLWRI alternatives would result in increased deliveries to the Tehama-Colusa Canal contractors in relatively dry years. Table 6-11 shows simulated diversions from the RBDD to the Tehama-Colusa Canal in dry and critical years. Agricultural diversions typically occur between April and September, with some additional diversions in March and October; accordingly, deliveries on the Tehama-Colusa Canal increase in the agricultural diversion months, but see no changes in months with little or no irrigation.

Table 6-11. Simulated Monthly Average Diversions to the Tehama-Colusa Canal in Dry and Critical Years

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	115	3	4	5	114	1	3	5
Nov	10	0	0	0	10	0	0	0
Dec	0	0	0	0	0	0	0	0
Jan	0	0	0	0	0	0	0	0
Feb	7	0	0	0	6	0	0	0
Mar	20	4	5	7	19	1	4	7
Apr	148	25	27	32	151	7	10	25
May	289	33	43	55	285	24	44	65
Jun	437	47	53	68	428	29	51	80
Jul	519	53	60	77	516	34	57	91
Aug	468	42	48	61	465	27	45	72
Sep	125	15	14	18	119	5	12	23
Total (TAF)	130	13	15	20	129	8	14	22

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node C112)

Notes:

Simulation period: 1922-2003

Dry and critical years as defined by the Sacramento Valley Index

Key:

Alt = alternative

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = thousand acre-feet

While Tehama-Colusa Canal water users are the primary recipient of CVP water service contract deliveries north of the Delta, other north-of-the-Delta users are subject to changes in water supply, including wildlife refuges. Average monthly deliveries to CVP water service contractors and refuges north of the Delta are included in Table 6-12.

Table 6-12. Simulated Monthly Average Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	286	4 (1%)	4 (1%)	5 (2%)	339	2 (1%)	4 (1%)	6 (2%)
Nov	173	0 (%)	0 (%)	0 (%)	220	0 (0%)	0 (0%)	0 (0%)
Dec	109	0 (%)	0 (%)	0 (%)	137	0 (0%)	0 (0%)	0 (0%)
Jan	54	0 (%)	0 (%)	0 (%)	67	0 (0%)	0 (0%)	0 (0%)
Feb	50	0 (%)	0 (%)	0 (%)	62	0 (0%)	0 (0%)	0 (0%)
Mar	35	3 (8%)	3 (9%)	5 (13%)	37	1 (3%)	3 (8%)	5 (12%)
Apr	371	22 (6%)	23 (6%)	30 (8%)	356	11 (3%)	20 (6%)	32 (9%)
May	657	29 (4%)	31 (5%)	40 (6%)	680	15 (2%)	29 (4%)	45 (7%)
Jun	923	36 (4%)	38 (4%)	49 (5%)	967	19 (2%)	37 (4%)	57 (6%)
Jul	1,076	40 (4%)	42 (4%)	55 (5%)	1,136	22 (2%)	42 (4%)	65 (6%)
Aug	914	32 (4%)	33 (4%)	44 (5%)	978	17 (2%)	33 (3%)	52 (5%)
Sep	544	14 (3%)	15 (3%)	20 (4%)	601	8 (1%)	15 (2%)	23 (4%)
Total (TAF)	315	11 (3%)	12 (4%)	15 (5%)	339	6 (2%)	11 (3%)	17 (5%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = thousand acre-feet

As would be expected, the change in deliveries increases with the greater enlargement volumes, and increases in deliveries are much greater in the dry and critical years than in average years, corresponding to the increased likelihood of shortages during drier periods. Table 6-13 shows average deliveries in dry and critical years.

Table 6-13. Simulated Monthly Average Deliveries to North-of-Delta CVP Water Service Contractors and Refuges in Dry and Critical Years

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	280	4 (2%)	5 (2%)	7 (2%)	332	2 (1%)	4 (1%)	6 (2%)
Nov	170	0 (%)	0 (%)	0 (%)	217	0 (0%)	0 (0%)	0 (0%)
Dec	108	0 (%)	0 (%)	0 (%)	135	0 (0%)	0 (0%)	0 (0%)
Jan	53	0 (%)	0 (%)	0 (%)	66	0 (0%)	0 (0%)	0 (0%)
Feb	54	0 (%)	0 (%)	0 (%)	64	0 (0%)	0 (0%)	0 (0%)
Mar	33	4 (13%)	5 (16%)	8 (23%)	36	2 (4%)	5 (13%)	7 (21%)
Apr	249	33 (13%)	36 (14%)	47 (19%)	236	17 (7%)	32 (13%)	52 (22%)
May	382	42 (11%)	47 (12%)	60 (16%)	389	25 (6%)	43 (11%)	69 (18%)
Jun	522	51 (10%)	58 (11%)	75 (14%)	537	32 (6%)	56 (10%)	88 (16%)
Jul	608	58 (10%)	66 (11%)	85 (14%)	631	37 (6%)	63 (10%)	100 (16%)
Aug	541	47 (9%)	53 (10%)	68 (12%)	574	30 (5%)	51 (9%)	80 (14%)
Sep	357	21 (6%)	24 (7%)	31 (9%)	399	13 (3%)	22 (5%)	35 (9%)
Total (TAF)	204	16 (8%)	18 (9%)	23 (11%)	219	10 (4%)	17 (8%)	27 (12%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Dry and critical years as defined by the Sacramento Valley Index

Key:

Alt = alternative

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = thousand acre-feet

Table 6-14 shows the simulated monthly average tributary inflows to the Sacramento River below the RBDD. The tributary inflows are the same in the 2005 and 2030 levels of development simulations.

Table 6-14. Simulated Monthly Average Tributary Inflow to the Sacramento River Below the Red Bluff Diversion Dam

Month	Thomes and Elder Creeks (cfs)	Antelope, Mill, and Deer Creeks (cfs)
October	32	397
November	227	712
December	626	1,412
January	881	1,878
February	1,115	2,122
March	976	1,919
April	791	1,699
May	503	1,350
June	172	817
July	36	454
August	8	350
September	10	335
Total (AF)	323,806	811,287

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node I1301 and I1305)

Notes:

Simulation period: 1922-2003

Key:

AF = acre-feet

Alt = alternative

cfs = cubic feet per second

As described in Chapter 1 of the *Hydrology, Hydraulics, and Water Management Technical Report*, during high flow periods, Sacramento River flows below Red Bluff can be diverted into the Sutter Bypass near Ord Ferry, or from the Moulton, Colusa, or Tisdale weirs. Similarly, flows can be diverted into the Yolo Bypass from the Fremont and Sacramento weirs. Table 6-15 shows the recurrence of annual spills over the various Sacramento Valley weirs into the Sutter and Yolo bypasses.

Table 6-15. Simulated Number of Years of Sacramento Valley Weir Spill

Location	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Spill Above Moulton Weir	5	0	-1	-1	5	-1	-1	-1
Moulton Weir	17	0	0	-1	17	0	0	0
Colusa Weir	39	-1	-1	-1	39	-1	-1	-1
Tisdale Weir	57	0	0	0	58	0	0	0
Fremont Weir	29	-1	-1	-1	28	0	0	0
Sacramento Weir	24	-1	-1	-1	23	0	0	0

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node D117, D124, D125, D126, D160, D166A)
Note:
Simulation period: 1922-2003
Key:
Alt = alternative
cfs = cubic feet per second
CP = Comprehensive Plan

As the Sacramento River nears the Delta, the basis-of-comparison flow would increase considerably so that flow changes associated with SLWRI alternatives would be immeasurable in most months. Table 6-16 shows the simulated monthly average Sacramento River flow below Freeport. Flow changes due to each alternative are very small compared to the bases of comparison; average monthly flow changes are typically between 0 percent and 2 percent. Larger flow increases are due to operations specifically for export; since conditions typically only allow for increased exports in July and August, the majority of the benefits are observed during those months.

Table 6-16. Simulated Monthly Average Sacramento River Flows Below Freeport

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	12,719	31 (0%)	19 (0%)	55 (0%)	12,068	-15 (0%)	41 (0%)	56 (0%)
Nov	15,858	-53 (0%)	-29 (0%)	-11 (0%)	15,501	-15 (0%)	0 (0%)	4 (0%)
Dec	26,148	-98 (0%)	-116 (0%)	-134 (-1%)	25,710	-14 (0%)	-139 (-1%)	-200 (-1%)
Jan	34,680	-151 (0%)	-167 (0%)	-184 (-1%)	34,363	-93 (0%)	-126 (0%)	-167 (0%)
Feb	40,650	-272 (-1%)	-198 (0%)	-344 (-1%)	40,345	83 (0%)	-71 (0%)	-115 (0%)
Mar	35,093	5 (0%)	-106 (0%)	-115 (0%)	35,018	-83 (0%)	-117 (0%)	-179 (-1%)
Apr	24,190	-49 (0%)	-33 (0%)	-34 (0%)	24,317	-41 (0%)	-15 (0%)	-10 (0%)
May	20,098	-41 (0%)	-55 (0%)	-56 (0%)	20,119	-59 (0%)	-106 (-1%)	-102 (-1%)
Jun	17,718	50 (0%)	57 (0%)	64 (0%)	18,092	18 (0%)	63 (0%)	31 (0%)
Jul	15,270	327 (2%)	304 (2%)	320 (2%)	16,870	132 (1%)	195 (1%)	277 (2%)
Aug	12,649	232 (2%)	272 (2%)	290 (2%)	13,790	72 (1%)	88 (1%)	97 (1%)
Sep	13,697	6 (0%)	4 (0%)	-5 (0%)	13,863	78 (1%)	114 (1%)	133 (1%)
Total (TAF)	16,142	1 (0%)	-2 (0%)	-7 (0%)	16,223	3 (0%)	-4 (0%)	-10 (0%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node C169)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt = alternative
cfs = cubic feet per second
CP = Comprehensive Plan
TAF = thousand acre-feet

Because of the interconnected nature of CVP and SWP operations for meeting shared Sacramento River flow requirements and Delta water quality obligations, changes in Shasta Reservoir operations could potentially affect operations of both Oroville Reservoir on the Feather River and Folsom Reservoir on the American River. For example, an increase in Shasta Reservoir releases may create opportunities for increased SWP export of releases from Oroville Reservoir by improving Delta water quality. An increase in releases from Oroville Reservoir would result in a decrease in storage. Tables 6-17 and 6-18 show simulated end-of-month storage at Oroville Reservoir and Feather River flow below the Thermalito Afterbay, respectively.

Similarly, an increase in Shasta Reservoir releases in a particular month may result in improved Delta water quality, allowing for a possible reduction in CVP releases from the American River, and a corresponding increase in Folsom Reservoir storage. Tables 6-19 and 6-20 show simulated end-of-month storage at Folsom Reservoir and on the American River near the H-Street Bridge, respectively.

Table 6-17. Simulated Average End-of-Month Oroville Reservoir Storage

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (TAF)	Change from Base			No-Action Alt (TAF)	Change from Base		
		CP1 and CP4 (TAF)	CP2 (TAF)	CP3 and CP5 (TAF)		CP1 and CP4 (TAF)	CP2 (TAF)	CP3 and CP5 (TAF)
Oct	2,228	-47 (-2%)	-45 (-2%)	-46 (-2%)	2,095	-20 (-1%)	-23 (-1%)	-34 (-2%)
Nov	2,240	-43 (-2%)	-40 (-2%)	-40 (-2%)	2,121	-21 (-1%)	-25 (-1%)	-35 (-2%)
Dec	2,305	-41 (-2%)	-41 (-2%)	-43 (-2%)	2,216	-23 (-1%)	-26 (-1%)	-38 (-2%)
Jan	2,430	-34 (-1%)	-34 (-1%)	-35 (-1%)	2,362	-18 (-1%)	-21 (-1%)	-32 (-1%)
Feb	2,569	-28 (-1%)	-27 (-1%)	-29 (-1%)	2,514	-21 (-1%)	-21 (-1%)	-31 (-1%)
Mar	2,722	-23 (-1%)	-20 (-1%)	-23 (-1%)	2,686	-20 (-1%)	-21 (-1%)	-27 (-1%)
Apr	2,988	-22 (-1%)	-19 (-1%)	-22 (-1%)	2,953	-17 (-1%)	-20 (-1%)	-25 (-1%)
May	3,102	-23 (-1%)	-20 (-1%)	-22 (-1%)	3,068	-17 (-1%)	-18 (-1%)	-23 (-1%)
Jun	2,953	-26 (-1%)	-24 (-1%)	-26 (-1%)	2,898	-18 (-1%)	-18 (-1%)	-22 (-1%)
Jul	2,675	-36 (-1%)	-32 (-1%)	-33 (-1%)	2,565	-17 (-1%)	-18 (-1%)	-25 (-1%)
Aug	2,473	-46 (-2%)	-44 (-2%)	-45 (-2%)	2,329	-15 (-1%)	-14 (-1%)	-21 (-1%)
Sep	2,350	-48 (-2%)	-44 (-2%)	-45 (-2%)	2,196	-20 (-1%)	-21 (-1%)	-31 (-1%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node S8)

Note:

Simulation period: 1922-2003

Key:

Alt = alternative

CP = Comprehensive Plan

TAF = thousand acre-feet

Table 6-18. Simulated Monthly Average Feather River Flow Below the Thermalito Afterbay

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	3,687	8 (0%)	18 (0%)	35 (1%)	3,444	17 (0%)	45 (1%)	52 (1%)
Nov	2,986	-82 (-3%)	-84 (-3%)	-106 (-4%)	2,738	14 (0%)	27 (1%)	23 (1%)
Dec	4,704	-20 (0%)	14 (0%)	36 (1%)	4,201	38 (1%)	21 (0%)	38 (1%)
Jan	5,974	-122 (-2%)	-123 (-2%)	-120 (-2%)	5,619	-81 (-1%)	-86 (-1%)	-94 (-2%)
Feb	6,857	-100 (-1%)	-118 (-2%)	-113 (-2%)	6,624	46 (1%)	6 (0%)	-14 (0%)
Mar	6,917	-88 (-1%)	-116 (-2%)	-104 (-1%)	6,560	-10 (0%)	22 (0%)	-53 (-1%)
Apr	3,235	-21 (-1%)	-21 (-1%)	-13 (0%)	3,197	-47 (-1%)	-23 (-1%)	-29 (-1%)
May	4,018	14 (0%)	15 (0%)	2 (0%)	4,006	-8 (0%)	-23 (-1%)	-24 (-1%)
Jun	4,329	50 (1%)	62 (1%)	65 (1%)	4,727	15 (0%)	-4 (0%)	-19 (0%)
Jul	4,352	165 (4%)	138 (3%)	111 (3%)	5,310	0 (0%)	-7 (0%)	50 (1%)
Aug	3,338	171 (5%)	190 (6%)	190 (6%)	3,953	-30 (-1%)	-59 (-2%)	-71 (-2%)
Sep	2,381	27 (1%)	17 (1%)	3 (0%)	2,505	72 (3%)	124 (5%)	180 (8%)
Total (TAF)	3,179	1 (0%)	0 (0%)	0 (0%)	3,186	1 (0%)	2 (0%)	2 (0%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node C203)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = Comprehensive Plan
TAF = thousand acre-feet

Table 6-19. Simulated Average End-of-Month Folsom Reservoir Storage

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (TAF)	Change from Base			No-Action Alt (TAF)	Change from Base		
		CP1 and CP4 (TAF)	CP2 (TAF)	CP3 and CP5 (TAF)		CP1 and CP4 (TAF)	CP2 (TAF)	CP3 and CP5 (TAF)
Oct	514	5 (1%)	12 (2%)	14 (3%)	491	7 (1%)	11 (2%)	13 (2%)
Nov	475	3 (1%)	9 (2%)	12 (3%)	459	7 (1%)	11 (2%)	12 (3%)
Dec	482	1 (0%)	5 (1%)	6 (1%)	468	5 (1%)	7 (1%)	8 (2%)
Jan	494	1 (0%)	4 (1%)	4 (1%)	488	2 (0%)	3 (1%)	5 (1%)
Feb	506	5 (1%)	5 (1%)	6 (1%)	503	4 (1%)	5 (1%)	7 (1%)
Mar	607	3 (0%)	6 (1%)	7 (1%)	604	4 (1%)	5 (1%)	7 (1%)
Apr	725	4 (1%)	6 (1%)	8 (1%)	717	3 (0%)	4 (0%)	5 (1%)
May	834	4 (1%)	7 (1%)	9 (1%)	823	3 (0%)	5 (1%)	6 (1%)
Jun	797	6 (1%)	10 (1%)	13 (2%)	784	6 (1%)	9 (1%)	11 (1%)
Jul	689	2 (0%)	8 (1%)	11 (2%)	657	9 (1%)	13 (2%)	9 (1%)
Aug	623	4 (1%)	11 (2%)	14 (2%)	584	10 (2%)	14 (2%)	14 (2%)
Sep	549	4 (1%)	9 (2%)	13 (2%)	523	6 (1%)	11 (2%)	12 (2%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node S6)
Note:
Simulation period: 1922-2003
Key:
Alt = alternative
CP = Comprehensive Plan
TAF = thousand acre-feet

Table 6-20. Simulated Monthly Average American River Flow Near the H Street Bridge

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	1,745	-20 (-1%)	-42 (-2%)	-26 (-2%)	1,534	-10 (-1%)	-12 (-1%)	-19 (-1%)
Nov	2,682	33 (1%)	40 (1%)	36 (1%)	2,457	5 (0%)	12 (0%)	13 (0%)
Dec	3,379	33 (1%)	70 (2%)	95 (3%)	3,237	32 (1%)	57 (2%)	67 (2%)
Jan	4,465	10 (0%)	21 (0%)	33 (1%)	4,232	45 (1%)	70 (2%)	46 (1%)
Feb	5,222	-70 (-1%)	-29 (-1%)	-40 (-1%)	5,046	-41 (-1%)	-38 (-1%)	-34 (-1%)
Mar	3,751	32 (1%)	-2 (0%)	-6 (0%)	3,645	1 (0%)	-4 (0%)	-7 (0%)
Apr	3,359	-22 (-1%)	-15 (0%)	-17 (-1%)	3,188	16 (0%)	20 (1%)	24 (1%)
May	3,672	-7 (0%)	-18 (0%)	-17 (0%)	3,389	-3 (0%)	-22 (-1%)	-18 (-1%)
Jun	3,693	-29 (-1%)	-49 (-1%)	-78 (-2%)	3,318	-58 (-2%)	-74 (-2%)	-78 (-2%)
Jul	3,151	67 (2%)	30 (1%)	33 (1%)	3,012	-50 (-2%)	-60 (-2%)	25 (1%)
Aug	2,246	-44 (-2%)	-36 (-2%)	-43 (-2%)	1,981	-9 (0%)	-37 (-2%)	-85 (-4%)
Sep	2,497	6 (0%)	22 (1%)	14 (1%)	2,005	55 (2%)	57 (2%)	27 (1%)
Total (TAF)	1,745	-20 (-1%)	-42 (-2%)	-26 (-1.5%)	1,534	-10 (-1%)	-12 (-1%)	-19 (-1%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node C302)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = Comprehensive Plan
TAF = thousand acre-feet

The Delta is the confluence of the Sacramento, San Joaquin, Cosumnes, Calaveras, and Mokelumne rivers in addition to several other smaller streams and creeks. As the "central hub" of California's water supplies, minor changes in operations in one region could result in other minor changes throughout the system. As previously described, changes in operations associated with the SLWRI alternatives could possibly result in minor changes in operations to other CVP and SWP facilities. While New Melones Reservoir on the Stanislaus River is operated by the CVP to meet water quality requirements in the South Delta and lower San Joaquin River, and could potentially be affected by changes in Sacramento River flow or Delta exports, simulations indicate the SLWRI alternatives would not result in any changes to New Melones operations. (See Attachment A of the *Hydrology, Hydraulics, and Water Management Technical Report*, for details about New Melones Reservoir and Stanislaus River operations.)

Besides potentially changing exports to south-of-Delta water users, changes in Delta inflow could also be reflected in changes in Delta outflow. Changes in Sacramento River flow, as shown above in Table 6-16, are typically reflected as a combination of Delta outflow and export. Table 6-21 shows changes in Delta outflow associated with each alternative.

Table 6-21. Simulated Monthly Average Change in Delta Outflow

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	5,313	-25 (0%)	-29 (-1%)	-38 (-1%)	5,016	-16 (0%)	0 (0%)	7 (0%)
Nov	9,688	-150 (-2%)	-160 (-2%)	-137 (-1%)	9,258	-82 (-1%)	-89 (-1%)	-104 (-1%)
Dec	22,933	-197 (-1%)	-263 (-1%)	-352 (-2%)	22,291	-109 (0%)	-286 (-1%)	-433 (-2%)
Jan	40,954	-299 (-1%)	-320 (-1%)	-363 (-1%)	40,173	-210 (-1%)	-192 (0%)	-283 (-1%)
Feb	52,699	-531 (-1%)	-537 (-1%)	-713 (-1%)	52,325	-95 (0%)	-341 (-1%)	-455 (-1%)
Mar	42,610	-149 (0%)	-202 (0%)	-188 (0%)	42,084	-98 (0%)	-90 (0%)	-167 (0%)
Apr	27,104	-43 (0%)	-32 (0%)	-9 (0%)	27,086	-53 (0%)	-48 (0%)	-39 (0%)
May	20,470	-40 (0%)	-56 (0%)	-43 (0%)	20,307	-94 (0%)	-124 (-1%)	-123 (-1%)
Jun	13,104	-8 (0%)	-41 (0%)	-46 (0%)	13,117	-59 (0%)	-47 (0%)	-67 (-1%)
Jul	7,927	43 (1%)	29 (0%)	42 (1%)	8,262	33 (0%)	47 (1%)	50 (1%)
Aug	4,501	37 (1%)	47 (1%)	48 (1%)	4,473	-7 (0%)	2 (0%)	10 (0%)
Sep	5,595	-19 (0%)	-29 (-1%)	-42 (-1%)	5,259	18 (0%)	11 (0%)	2 (0%)
Total (TAF)	15,127	-81 (-1%)	-94 (-1%)	-109 (-1%)	14,931	-47 (0%)	-69 (0%)	-95 (-1%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node C406)

Notes:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = thousand acre-feet

The CVP and SWP divert water via the Jones Pumping Plant and the Banks Pumping Plant, respectively. The increased water supply made available from the SLWRI alternatives would typically be moved through the Jones Pumping Plant; however, under each of the bases of comparison, capacity at Jones is often fully used in the wetter years, leaving little ability to export available water. Accordingly, while unmet CVP demand south of the Delta may exist in some relatively wet years, conveyance restrictions would limit opportunities to export available water in those years. In drier years, however, typically capacity is available for increased exports through the Jones Pumping Plant. Thus, there are greater increases in average annual pumping volumes in those years. Table 6-22 shows the average annual exports through Jones Pumping Plant.

Table 6-22. Simulated Monthly Average Exports Through Jones Pumping Plant

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	4,084	0 (0%)	-17 (0%)	7 (0%)	4,032	5 (0%)	21 (1%)	42 (1%)
Nov	4,019	4 (0%)	14 (0%)	18 (0%)	4,196	23 (1%)	26 (1%)	22 (1%)
Dec	3,922	12 (0%)	17 (0%)	15 (0%)	4,172	4 (0%)	28 (1%)	85 (2%)
Jan	4,034	25 (1%)	27 (1%)	9 (0%)	4,192	-28 (-1%)	-6 (0%)	26 (1%)
Feb	3,705	68 (2%)	56 (2%)	43 (1%)	3,461	21 (1%)	91 (2%)	147 (4%)
Mar	3,147	83 (3%)	42 (1%)	14 (0%)	2,682	40 (1%)	-2 (0%)	14 (0%)
Apr	2,126	-8 (0%)	-8 (0%)	-7 (0%)	2,093	10 (0%)	12 (1%)	-6 (0%)
May	1,857	5 (0%)	9 (1%)	7 (0%)	1,879	17 (1%)	21 (1%)	4 (0%)
Jun	2,536	11 (0%)	37 (1%)	43 (2%)	2,469	-16 (-1%)	16 (1%)	38 (1%)
Jul	3,264	139 (4%)	155 (5%)	190 (6%)	3,572	56 (2%)	102 (3%)	170 (5%)
Aug	3,709	50 (1%)	76 (2%)	112 (3%)	3,589	21 (1%)	68 (2%)	153 (4%)
Sep	4,021	-7 (0%)	6 (0%)	19 (0%)	4,155	39 (1%)	62 (2%)	45 (1%)
Total (TAF)	2,438	23 (1%)	25 (1%)	28 (1%)	2,444	12 (0%)	26 (1%)	44 (2%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node D418)

Notes:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = thousand acre-feet

Table 6-23 shows the Sacramento Valley Index (SVI) dry and critical year exports through Jones Pumping Plant. As would be expected, the increased available capacity at Jones results in larger increases in exports.

Table 6-23. Simulated Monthly Average Exports Through Jones Pumping Plant in Dry and Critical Years

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	3,932	15 (0%)	-3 (0%)	7 (0%)	3,874	20 (1%)	36 (1%)	49 (1%)
Nov	3,773	22 (1%)	54 (1%)	61 (2%)	3,884	39 (1%)	75 (2%)	70 (2%)
Dec	3,699	14 (0%)	19 (1%)	13 (0%)	3,887	-4 (0%)	31 (1%)	173 (5%)
Jan	3,866	38 (1%)	45 (1%)	29 (1%)	4,025	-30 (-1%)	14 (0%)	106 (3%)
Feb	3,265	129 (4%)	98 (3%)	117 (4%)	3,079	49 (1%)	199 (6%)	329 (10%)
Mar	2,809	76 (3%)	63 (2%)	44 (2%)	2,474	55 (2%)	10 (0%)	91 (3%)
Apr	1,526	4 (0%)	9 (1%)	24 (2%)	1,521	8 (1%)	13 (1%)	-18 (-1%)
May	1,429	13 (1%)	24 (2%)	21 (1%)	1,446	22 (2%)	33 (2%)	-13 (-1%)
Jun	2,015	31 (2%)	87 (4%)	103 (5%)	1,799	15 (1%)	68 (3%)	96 (5%)
Jul	2,280	268 (12%)	327 (14%)	417 (18%)	2,942	138 (6%)	218 (10%)	309 (14%)
Aug	2,428	161 (7%)	218 (9%)	279 (11%)	2,062	51 (2%)	184 (8%)	399 (16%)
Sep	3,277	-15 (0%)	30 (1%)	63 (2%)	3,482	104 (3%)	153 (5%)	108 (3%)
Total (TAF)	2,069	45 (2%)	59 (3%)	71 (3%)	2,080	28 (1%)	62 (3%)	102 (5%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node D418)

Notes:

Simulation period: 1922-2003

Dry and critical years as defined by the Sacramento Valley Index

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = thousand acre-feet

Recipients of exports through the Jones Pumping Plant include San Joaquin Valley Exchange Contractors, Federal wildlife refuges, and water service contractors. Since the Exchange Contractors have substantially higher levels of reliability of delivery compared to the refuges and water service contractors, their deliveries will not change under any of the SLWRI alternatives. Deliveries to the refuges and water service contractors would increase with an enlargement of Shasta Dam. Table 6-24 shows monthly average deliveries to the CVP south-of-Delta refuges and water service contractors.

Table 6-24. Simulated Monthly Average Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	1,694	11 (1%)	11 (1%)	13 (1%)	1,631	3 (0%)	12 (1%)	20 (1%)
Nov	1,157	8 (1%)	9 (1%)	10 (1%)	1,116	5 (0%)	11 (1%)	15 (1%)
Dec	925	11 (1%)	12 (1%)	14 (1%)	916	7 (1%)	15 (2%)	21 (2%)
Jan	1,178	19 (2%)	21 (2%)	24 (2%)	1,208	12 (1%)	26 (2%)	37 (3%)
Feb	1,434	25 (2%)	27 (2%)	31 (2%)	1,478	16 (1%)	33 (2%)	47 (3%)
Mar	853	25 (3%)	28 (3%)	38 (4%)	906	9 (1%)	27 (3%)	45 (5%)
Apr	1,376	26 (2%)	31 (2%)	31 (2%)	1,428	19 (1%)	33 (2%)	45 (3%)
May	2,307	38 (2%)	40 (2%)	46 (2%)	2,344	25 (1%)	50 (2%)	70 (3%)
Jun	3,587	62 (2%)	67 (2%)	77 (2%)	3,674	42 (1%)	83 (2%)	116 (3%)
Jul	3,838	75 (2%)	81 (2%)	92 (2%)	3,980	51 (1%)	100 (3%)	140 (4%)
Aug	2,897	54 (2%)	59 (2%)	67 (2%)	2,987	7 (0%)	50 (2%)	78 (3%)
Sep	1,780	18 (1%)	19 (1%)	22 (1%)	1,743	12 (1%)	24 (1%)	34 (2%)
Total (TAF)	1,392	22 (2%)	24 (2%)	28 (2%)	1,415	13 (1%)	28 (2%)	40 (3%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

cfs = cubic feet per second

CVP = Central Valley Project

CP = Comprehensive Plan

TAF = thousand acre-feet

As would be expected, while there are some increases in deliveries when all years are averaged, the increases in deliveries in SVI dry and critical years are much greater, as shown in Table 6-25. This is primarily due to several factors, including increased available capacity at the Jones Pumping Plant in dry and critical years, and because of the CVP shortage policies, there is a substantially increased demand in dry and critical years. None of the SLWRI alternatives will provide a noticeable change in deliveries in relatively wet years because contractors are typically already receiving their full contract amount in those years.

Table 6-25. Simulated Monthly Average Deliveries to South-of-Delta CVP Water Service Contractors and Refuges in Dry and Critical Years

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	1,551	16 (1%)	19 (1%)	25 (2%)	1,488	8 (1%)	18 (1%)	26 (2%)
Nov	1,051	12 (1%)	15 (1%)	19 (2%)	1,010	6 (1%)	13 (1%)	19 (2%)
Dec	788	17 (2%)	20 (3%)	26 (3%)	780	8 (1%)	18 (2%)	27 (3%)
Jan	946	29 (3%)	35 (4%)	45 (5%)	974	14 (1%)	32 (3%)	47 (5%)
Feb	1,134	37 (3%)	45 (4%)	59 (5%)	1,176	19 (2%)	42 (4%)	61 (5%)
Mar	500	47 (9%)	59 (12%)	68 (14%)	502	33 (7%)	56 (11%)	78 (16%)
Apr	945	45 (5%)	54 (6%)	52 (6%)	943	43 (5%)	66 (7%)	94 (10%)
May	1,529	70 (5%)	82 (5%)	90 (6%)	1,512	60 (4%)	101 (7%)	147 (10%)
Jun	2,307	116 (5%)	137 (6%)	150 (7%)	2,302	100 (4%)	167 (7%)	245 (11%)
Jul	2,323	139 (6%)	164 (7%)	180 (8%)	2,353	120 (5%)	201 (9%)	294 (13%)
Aug	1,792	102 (6%)	120 (7%)	131 (7%)	1,806	80 (4%)	146 (8%)	213 (12%)
Sep	1,373	33 (2%)	40 (3%)	43 (3%)	1,314	29 (2%)	48 (4%)	71 (5%)
Total (TAF)	980	40 (4%)	48 (5%)	54 (5%)	976	31 (3%)	55 (6%)	80 (8%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes: Simulation period: 1922-2003

Dry and critical years as defined by the Sacramento Valley Index

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

cfs = cubic feet per second

CP = comprehensive plan

CVP = Central Valley Project

TAF = thousand acre-feet

When evaluating project effects on water supply reliability, CVP south-of-Delta allocations are a valuable indicator of benefits resulting from each alternative. Tables 6-26 and 6-27 show the simulated annual allocations to south-of-Delta agricultural and M&I refuges and water service contractors for the existing condition and the No-Action Alternative, and the simulated change in allocation for each of the SLWRI alternatives. Simulated allocations are calculated by dividing annual deliveries of each contract type by the demand. The contract period for CVP allocations is assumed to be March through February; the assumed simulated demand for each contract type is as follows:

- **Agricultural water service contractors –** 1,987.2 TAF/year (both 2005 and 2030 level of development).
- **M&I water service contractors –** 164.2 TAF/year (both 2005 and 2030 level of development).
- **Federal refuges –** 304.6 TAF/year (2005 level of development)/281.1 TAF/year (2030 level of development).

Tables 6-26 and 6-27 show that while allocations would typically increase, there could also be years with small decreases in allocations. Simulations of CP2 with a 2030 level of development indicate an average decrease in allocations; however, as indicated in Table 6-24, there would be an average annual increase in deliveries. This apparent contradiction is likely due to differences in averaging methodology for the two tables. More important than the average annual change in allocation is the increase in allocation in years with low allocations under either the existing condition or No-Action Alternative, such as in 1928, 1944, and 1976. Some decreases in allocations would occur in years in the latter parts of prolonged droughts. This is likely due to changes in CalSim-II north-of-Delta reservoir storage–water supply relationships.

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Table 6-26. Simulated Annual Delivery Allocations to South-of-Delta CVP Water Service Contractors and Refuges for a 2005 Level of Development

Year	Existing Conditions (2005)			Change from Existing Conditions								
				Alt CP1 and CP4 (2005)			Alt CP2 (2005)			Alt CP3 and CP5 (2005)		
	Ag	Refuges	M&I	Ag	Refuges	M&I	Ag	Refuges	M&I	Ag	Refuges	M&I
1922	73%	100%	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1923	64%	100%	83%	4%	0%	0%	1%	0%	0%	1%	0%	0%
1924	3%	75%	48%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1925	45%	100%	67%	-1%	0%	0%	0%	0%	0%	0%	0%	0%
1926	25%	100%	67%	-4%	0%	0%	-1%	0%	0%	-1%	0%	0%
1927	68%	100%	87%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1928	65%	100%	83%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1929	21%	100%	65%	-6%	0%	0%	-2%	0%	0%	-2%	0%	0%
1930	33%	100%	67%	-2%	0%	0%	-1%	0%	0%	-1%	0%	0%
1931	6%	75%	51%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1932	11%	75%	55%	9%	0%	0%	7%	0%	0%	7%	0%	0%
1933	4%	75%	49%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1934	10%	75%	55%	9%	0%	0%	6%	0%	0%	6%	0%	0%
1935	34%	100%	65%	0%	0%	0%	1%	0%	0%	1%	0%	0%
1936	52%	100%	71%	8%	0%	0%	3%	0%	0%	3%	0%	0%
1937	38%	100%	67%	3%	0%	0%	4%	0%	0%	4%	0%	0%
1938	94%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1939	56%	100%	75%	-3%	0%	0%	-5%	0%	0%	-5%	0%	0%
1940	52%	100%	72%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%
1941	74%	100%	88%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1942	70%	100%	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1943	81%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1944	51%	100%	71%	-2%	0%	0%	0%	0%	0%	0%	0%	0%
1945	66%	100%	84%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1946	59%	100%	78%	-1%	0%	0%	0%	0%	0%	0%	0%	0%
1947	59%	100%	78%	-4%	0%	0%	-4%	0%	0%	-4%	0%	0%
1948	50%	100%	70%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1949	57%	100%	77%	1%	0%	0%	-2%	0%	0%	-2%	0%	0%
1950	51%	100%	71%	-5%	0%	0%	-4%	0%	0%	-4%	0%	0%
1951	67%	100%	85%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1952	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1953	60%	100%	79%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1954	63%	100%	82%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1955	46%	100%	68%	-2%	0%	0%	0%	0%	0%	0%	0%	0%
1956	65%	100%	84%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1957	70%	100%	88%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1958	91%	100%	88%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1959	55%	100%	74%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1960	33%	100%	67%	-4%	0%	0%	-2%	0%	0%	-2%	0%	0%
1961	49%	100%	69%	3%	0%	0%	2%	0%	0%	2%	0%	0%
1962	61%	100%	79%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%
1963	67%	100%	85%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1964	46%	100%	68%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1965	63%	100%	82%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1966	63%	100%	82%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1967	93%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1968	67%	100%	86%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1969	94%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1970	67%	100%	84%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1971	54%	100%	73%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1972	60%	100%	79%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1973	58%	100%	77%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1974	74%	100%	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1975	59%	100%	78%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1976	31%	100%	67%	-7%	0%	0%	-5%	0%	0%	-5%	0%	0%
1977	6%	75%	51%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1978	91%	100%	90%	0%	0%	0%	-1%	0%	0%	-1%	0%	0%
1979	58%	100%	77%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1980	79%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1981	67%	100%	85%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1982	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1983	95%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1984	62%	100%	82%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1985	62%	100%	81%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1986	86%	100%	90%	-10%	0%	0%	-8%	0%	0%	-8%	0%	0%
1987	53%	100%	73%	1%	0%	0%	-2%	0%	0%	-2%	0%	0%
1988	18%	100%	62%	-11%	0%	0%	-1%	0%	0%	-1%	0%	0%
1989	34%	100%	65%	1%	0%	0%	0%	0%	0%	0%	0%	0%
1990	0%	100%	45%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1991	13%	75%	58%	1%	0%	0%	0%	0%	0%	0%	0%	0%
1992	41%	75%	67%	1%	0%	0%	5%	0%	0%	5%	0%	0%
1993	56%	100%	75%	0%	0%	0%	-1%	0%	0%	-1%	0%	0%
1994	66%	75%	85%	2%	0%	0%	2%	0%	0%	2%	0%	0%
1995	94%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1996	73%	100%	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1997	62%	100%	81%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1998	95%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1999	64%	100%	83%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2000	67%	100%	86%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2001	53%	100%	73%	-3%	0%	0%	-3%	0%	0%	-3%	0%	0%
2002	62%	100%	81%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2003	46%	50%	49%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Avg	56%	97%	76%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 simulations (Nodes DEL_CVP_PAG_S, DEL_CVP_PRF_S, and DEL_CVP_PMI_S for delivery information, and CACMP Delivery Specifications for demand information)

Notes:

Simulation period: 1922-2003

(%) indicates change from either existing condition or No-Action Alternative

Key:

Ag = Agricultural Water Service Contractor
Alt = alternative
Avg = average
M&I = Municipal and Industrial contractor
Refuge = Level 2 Federal Refuge

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Table 6-27. Simulated Annual Delivery Allocations to South-of-Delta CVP Water Service Contractors and Refuges for a 2030 Level of Development

Year	No-Action/ No Project Alternative (2030)			Change from No-Action/ No Project Alternative								
				Alt CP1 and CP4 (2030)			Alt CP2 (2030)			Alt CP3 and CP5 (2030)		
	Ag	Refuges	M&I	Ag	Refuges	M&I	Ag	Refuges	M&I	Ag	Refuges	M&I
1922	78%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1923	61%	100%	80%	-1%	0%	-1%	9%	0%	8%	-2%	0%	-2%
1924	3%	75%	48%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1925	46%	100%	68%	1%	0%	0%	-4%	0%	0%	-2%	0%	0%
1926	26%	100%	67%	-1%	0%	0%	-5%	0%	-2%	0%	0%	0%
1927	68%	100%	87%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1928	62%	100%	81%	9%	0%	6%	2%	0%	2%	14%	0%	6%
1929	17%	100%	61%	-4%	0%	-4%	-5%	0%	-5%	0%	0%	0%
1930	30%	100%	67%	0%	0%	0%	-1%	0%	0%	-1%	0%	0%
1931	5%	75%	49%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1932	15%	75%	59%	-2%	0%	-2%	-2%	0%	-2%	0%	0%	0%
1933	3%	75%	48%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1934	11%	75%	55%	-2%	0%	-2%	-1%	0%	-1%	-1%	0%	-1%
1935	30%	100%	64%	0%	0%	0%	0%	0%	0%	-2%	0%	0%
1936	46%	100%	67%	1%	0%	0%	2%	0%	1%	-1%	0%	0%
1937	33%	100%	67%	0%	0%	0%	1%	0%	0%	-1%	0%	0%
1938	95%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1939	51%	100%	71%	8%	0%	7%	-9%	0%	-3%	15%	0%	14%
1940	59%	100%	78%	-3%	0%	-3%	7%	0%	5%	-4%	0%	-4%
1941	79%	100%	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1942	75%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1943	86%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1944	48%	100%	68%	4%	0%	4%	-5%	0%	-1%	10%	0%	9%
1945	68%	100%	86%	2%	0%	2%	2%	0%	2%	2%	0%	2%
1946	62%	100%	81%	1%	0%	1%	-2%	0%	-1%	1%	0%	1%
1947	46%	100%	67%	3%	0%	2%	-4%	0%	0%	6%	0%	4%
1948	64%	100%	83%	-1%	0%	-1%	-3%	0%	-3%	-2%	0%	-1%
1949	62%	100%	82%	0%	0%	0%	5%	0%	4%	0%	0%	0%
1950	40%	100%	67%	3%	0%	0%	-3%	0%	0%	3%	0%	0%
1951	71%	100%	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1952	94%	99%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1953	66%	100%	85%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1954	68%	100%	87%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1955	43%	100%	67%	4%	0%	0%	-4%	0%	0%	11%	0%	6%
1956	70%	100%	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1957	72%	100%	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1958	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1959	66%	100%	85%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1960	27%	100%	67%	2%	0%	0%	-2%	0%	-1%	2%	0%	1%
1961	61%	100%	80%	3%	0%	2%	-4%	0%	-3%	1%	0%	1%
1962	63%	100%	82%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1963	73%	100%	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1964	45%	100%	67%	7%	0%	5%	-3%	0%	0%	13%	0%	10%
1965	72%	100%	87%	0%	0%	2%	-5%	0%	-2%	0%	0%	2%
1966	68%	100%	86%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1967	94%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1968	67%	100%	86%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1969	95%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1970	68%	100%	87%	1%	0%	1%	-2%	0%	-2%	1%	0%	1%
1971	65%	100%	84%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1972	62%	100%	82%	2%	0%	1%	2%	0%	1%	2%	0%	1%
1973	69%	100%	87%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1974	79%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1975	68%	100%	86%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1976	18%	100%	62%	8%	0%	5%	3%	0%	2%	11%	0%	5%
1977	6%	73%	50%	0%	2%	1%	0%	2%	1%	0%	2%	1%
1978	92%	100%	89%	1%	0%	1%	1%	0%	1%	1%	0%	1%
1979	69%	100%	87%	3%	0%	2%	0%	0%	0%	4%	0%	2%
1980	84%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1981	72%	100%	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1982	93%	99%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1983	95%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1984	67%	100%	86%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1985	69%	100%	87%	0%	0%	1%	0%	0%	0%	0%	0%	1%
1986	64%	100%	83%	8%	0%	6%	-6%	0%	-6%	21%	0%	7%
1987	43%	100%	67%	3%	0%	0%	1%	0%	0%	7%	0%	3%
1988	21%	100%	65%	0%	0%	0%	-2%	0%	-2%	-1%	0%	-1%
1989	39%	100%	65%	2%	0%	0%	0%	0%	0%	1%	0%	0%
1990	0%	100%	45%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1991	18%	75%	61%	-2%	0%	-2%	-2%	0%	-2%	-2%	0%	-2%
1992	42%	75%	67%	-2%	0%	0%	-1%	0%	0%	1%	0%	0%
1993	64%	100%	82%	0%	0%	0%	-1%	0%	-1%	0%	0%	0%
1994	77%	75%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1995	94%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1996	78%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1997	67%	100%	86%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1998	95%	99%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1999	68%	100%	87%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2000	72%	100%	87%	0%	0%	0%	0%	0%	2%	0%	0%	0%
2001	40%	100%	67%	5%	0%	0%	-6%	0%	0%	7%	0%	0%
2002	68%	100%	86%	0%	0%	0%	-2%	0%	-2%	0%	0%	0%
2003	48%	50%	48%	0%	0%	0%	-3%	0%	0%	0%	0%	0%
Avg	58%	97%	78%	1%	0%	0%	-1%	0%	0%	1%	0%	1%

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2030 simulations (Nodes DEL_CVP_PAG_S, DEL_CVP_PRF_S, and DEL_CVP_PMI_S for delivery information, and CACMP Delivery Specifications for demand information)

Notes:

Simulation period: 1922-2003

(%) indicates change from either existing condition or No-Action Alternative

Key:

Ag = Agricultural Water Service Contractor

Alt = alternative

Avg = average

M&I = Municipal and Industrial contractor

Refuge = Level 2 Federal Refuge

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While the Banks Pumping Plant typically provides water supply to SWP contractors, the SLWRI alternatives may provide opportunities for increased CVP and SWP exports through the Banks Pumping Plant by improving Delta water quality (i.e., salinities). Furthermore, CVP/SWP water rights in the Delta (RD-1641) provide opportunities for the CVP to export its supplies through the Banks Pumping Plant under certain conditions. Accordingly, there would be increases in exports at the Banks Pumping Plant under the SLWRI alternatives, but since the Banks Pumping Plant export capacity would be fully used less often than the Jones Pumping Plant, increases in exports would be relatively similar in average annual and SVI dry and critical years. Table 6-28 shows average annual exports through Banks Pumping Plant for the various SLWRI alternatives.

Table 6-28. Simulated Monthly Average Exports Through the Banks Pumping Plant

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	4,855	4 (0%)	13 (0%)	33 (1%)	4,343	2 (0%)	27 (1%)	-6 (0%)
Nov	4,872	92 (2%)	115 (2%)	109 (2%)	4,745	21 (0%)	39 (1%)	25 (1%)
Dec	6,039	9 (0%)	29 (0%)	75 (1%)	5,947	23 (0%)	16 (0%)	-10 (0%)
Jan	6,547	24 (0%)	29 (0%)	35 (1%)	6,858	11 (0%)	-22 (0%)	-34 (-1%)
Feb	5,686	98 (2%)	120 (2%)	85 (1%)	5,960	84 (1%)	48 (1%)	-4 (0%)
Mar	4,948	36 (1%)	22 (0%)	23 (0%)	5,562	-44 (-1%)	-37 (-1%)	-26 (-1%)
Apr	3,187	-6 (0%)	-5 (0%)	-6 (0%)	3,286	3 (0%)	21 (1%)	-23 (-1%)
May	3,030	-7 (0%)	-9 (0%)	-20 (-1%)	3,098	-4 (0%)	-24 (-1%)	-22 (-1%)
Jun	3,111	45 (1%)	60 (2%)	66 (2%)	3,602	30 (1%)	31 (1%)	-49 (-2%)
Jul	2,970	145 (5%)	120 (4%)	87 (3%)	3,791	72 (2%)	75 (3%)	77 (3%)
Aug	3,905	143 (4%)	148 (4%)	130 (3%)	5,005	42 (1%)	3 (0%)	-38 (-1%)
Sep	5,030	31 (1%)	27 (1%)	18 (0%)	5,206	24 (0%)	43 (1%)	1 (0%)
Total (TAF)	3,265	37 (1%)	40 (1%)	38 (1%)	3,461	16 (0%)	13 (0%)	-7 (0%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Node D419)
Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No–Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = Comprehensive Plan
TAF = thousand acre-feet

As described in Chapter 1 of the *Hydrology, Hydraulics, and Water Management Technical Report*, the SWP delivers water supplies to contractors both north and south of the Delta, and makes all of its exports through the Banks Pumping Plant. Because of the increased exports described in Table 2-25, it is reasonable to expect a similar increase in deliveries to SWP contractors south of the Delta. Of the approximately 4.2 MAF of Table A contracts, about 4 MAF are held by contractors south of the Delta. Table 6-29 shows the average monthly increases in SWP Table A deliveries to contractors south of the Delta.

Since a large portion of the SWP Table A demands south of the Delta are for M&I use, the monthly pattern of deliveries is fairly even throughout the year, compared to the CVP contractors, who are primarily agricultural, and only require water supply during the irrigation season.

Table 6-29. Simulated Monthly Average Deliveries to SWP Table A Contractors South of the Delta

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	4,101	61 (1%)	73 (2%)	63 (2%)	4,169	26 (1%)	18 (0%)	26 (1%)
Nov	3,408	58 (2%)	69 (2%)	60 (2%)	3,634	27 (1%)	20 (1%)	25 (1%)
Dec	3,109	57 (2%)	72 (2%)	63 (2%)	3,509	54 (2%)	47 (1%)	53 (2%)
Jan	345	10 (3%)	11 (3%)	10 (3%)	1,394	100 (7%)	99 (7%)	95 (7%)
Feb	783	13 (2%)	13 (2%)	13 (2%)	2,576	12 (0%)	9 (0%)	3 (0%)
Mar	2,025	26 (1%)	33 (2%)	31 (2%)	3,044	55 (2%)	39 (1%)	20 (1%)
Apr	5,298	54 (1%)	63 (1%)	54 (1%)	6,019	52 (1%)	44 (1%)	48 (1%)
May	6,586	58 (1%)	67 (1%)	56 (1%)	7,376	28 (0%)	17 (0%)	22 (0%)
Jun	8,721	85 (1%)	95 (1%)	74 (1%)	8,970	-10 (0%)	-23 (0%)	-39 (0%)
Jul	8,466	80 (1%)	83 (1%)	75 (1%)	8,762	-4 (0%)	-18 (0%)	-10 (0%)
Aug	7,889	83 (1%)	86 (1%)	79 (1%)	8,146	10 (0%)	-1 (0%)	2 (0%)
Sep	5,949	65 (1%)	70 (1%)	64 (1%)	6,135	8 (0%)	-1 (0%)	6 (0%)
Total (TAF)	3,434	39 (1%)	45 (1%)	39 (1%)	3,855	22 (1%)	15 (0%)	15 (0%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

cfs = cubic feet per second

CP = Comprehensive Plan

SWP = State Water Project

TAF = thousand acre-feet

In SVI dry and critical years, SWP Table A deliveries are relatively lower because of less available water supply. In these periods, the ability of the SWP to deliver more water under the SLWRI alternatives would be improved because of increased releases from Shasta Reservoir improving Delta water quality. Table 6-30 shows the SWP Table A deliveries to south-of-Delta contractors in SVI dry and critical years.

Differences in timing between exports through the Jones and Banks pumping plants and deliveries to CVP and SWP contractors would be due to the ability of both projects to store water in San Luis Reservoir during winter months, and to use that storage to augment Delta exports in summer months with releases from San Luis Reservoir. (Attachment A of the *Hydrology, Hydraulics, and Water Management Technical Report*, includes information about San Luis Reservoir storage.

Table 6-30. Simulated Monthly Average Deliveries to SWP Table A Contractors South of the Delta in Dry and Critical Years

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	3,598	61 (2%)	70 (2%)	49 (1%)	3,675	45 (1%)	37 (1%)	41 (1%)
Nov	2,876	59 (2%)	67 (2%)	51 (2%)	3,086	45 (1%)	41 (1%)	42 (1%)
Dec	2,605	58 (2%)	67 (3%)	51 (2%)	2,945	82 (3%)	78 (3%)	77 (3%)
Jan	242	7 (3%)	8 (3%)	5 (2%)	643	63 (10%)	58 (9%)	59 (9%)
Feb	490	17 (3%)	17 (3%)	16 (3%)	1,155	54 (5%)	48 (4%)	44 (4%)
Mar	1,116	56 (5%)	70 (6%)	68 (6%)	1,424	52 (4%)	14 (1%)	-18 (-1%)
Apr	4,710	79 (2%)	90 (2%)	67 (1%)	4,836	114 (2%)	105 (2%)	110 (2%)
May	5,625	92 (2%)	91 (2%)	70 (1%)	5,840	55 (1%)	35 (1%)	41 (1%)
Jun	7,507	125 (2%)	116 (2%)	76 (1%)	7,389	-34 (0%)	-65 (-1%)	-112 (-2%)
Jul	7,354	110 (1%)	89 (1%)	74 (1%)	7,256	-27 (0%)	-56 (-1%)	-43 (-1%)
Aug	6,561	119 (2%)	103 (2%)	88 (1%)	6,518	-4 (0%)	-28 (0%)	-17 (0%)
Sep	4,750	95 (2%)	84 (2%)	74 (2%)	4,778	10 (0%)	-7 (0%)	4 (0%)
Total (TAF)	2,874	53 (2%)	53 (2%)	42 (1%)	3,000	27 (1%)	15 (1%)	14 (0%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Dry and critical years as defined by the Sacramento Valley Index
Key:
Alt = alternative
cfs = cubic feet per second
CP = Comprehensive Plan
SWP = State Water Project
TAF = thousand acre-feet

Changes in Delta export operations could also result in changes in reservoir operations south of the Delta along the San Joaquin River. Any changes in operations of South-of-Delta reservoirs would be reflected in changes in San Joaquin River flows near its confluence with the Delta. The San Joaquin River at Vernalis is commonly used as the downstream end of the San Joaquin River. Table 6-31 shows simulated San Joaquin River flow at Vernalis. According to modeling, the SLWRI alternatives do not affect San Joaquin River flows at Vernalis.

Table 6-31. Simulated Monthly Average San Joaquin River flows at Vernalis

Month	Existing Condition (2005)				Future Condition (2030)			
	Existing Condition (cfs)	Change from Base			No-Action Alt (cfs)	Change from Base		
		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)		CP1 and CP4 (cfs)	CP2 (cfs)	CP3 and CP5 (cfs)
Oct	2,486	0 (0%)	0 (0%)	0 (0%)	2,472	0 (0%)	0 (0%)	0 (0%)
Nov	2,561	0 (0%)	0 (0%)	0 (0%)	2,533	0 (0%)	0 (0%)	0 (0%)
Dec	3,354	0 (0%)	0 (0%)	0 (0%)	3,313	0 (0%)	0 (0%)	0 (0%)
Jan	4,772	0 (0%)	0 (0%)	0 (0%)	4,737	0 (0%)	0 (0%)	0 (0%)
Feb	6,434	0 (0%)	0 (0%)	0 (0%)	6,340	-1 (0%)	-1 (0%)	-1 (0%)
Mar	6,339	0 (0%)	0 (0%)	-1 (0%)	6,211	0 (0%)	0 (0%)	0 (0%)
Apr	6,006	0 (0%)	0 (0%)	0 (0%)	5,973	0 (0%)	0 (0%)	0 (0%)
May	6,022	0 (0%)	0 (0%)	0 (0%)	5,997	0 (0%)	0 (0%)	0 (0%)
Jun	4,631	0 (0%)	0 (0%)	0 (0%)	4,575	0 (0%)	0 (0%)	0 (0%)
Jul	3,221	1 (0%)	1 (0%)	1 (0%)	3,217	0 (0%)	1 (0%)	1 (0%)
Aug	2,113	0 (0%)	0 (0%)	1 (0%)	2,082	0 (0%)	1 (0%)	1 (0%)
Sep	2,366	0 (0%)	0 (0%)	0 (0%)	2,361	0 (0%)	0 (0%)	0 (0%)
Total (TAF)	3,024	0 (0%)	0 (0%)	0 (0%)	2,994	0 (0%)	0 (0%)	0 (0%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

cfs = cubic feet per second

CP = Comprehensive Plan

SWP = State Water Project

TAF = thousand acre-feet

No-Action Alternative

Under the No-Action Alternative, Shasta Dam would not be modified, and the CVP would continue operating similar to the existing condition. Changes in regulatory conditions and water supply demands would result in differences in flows on the Sacramento River and at the Delta. Possible changes include the following:

- Firm Level 2 Federal refuge needs
- Implementation of the Sacramento Area Water Forum Agreement on the American River
- Increased CCWD contract supply and water rights
- SWP deliveries based on full Table A amounts
- Use of the Delta-Mendota Canal–California Aqueduct Intertie
- Implementation of the San Joaquin River Salinity Management Program
- CVP use of Banks Pumping Plant to move 50,000 acre-feet/year of Level 2 refuge water
- Implementation of permanent operable Delta barriers

For a complete list of the differences between the No-Action Alternative and the existing conditions, see Table 2-1 in the Modeling Appendix.

Each of these changes could result in different operations of Shasta Reservoir, and could result in impacts to the various impact indicators. As described above, modeling indicates that the No-Action Alternative would continue to meet water supply demands at levels of compliance similar to the existing conditions, and would not result in any appreciable changes in water supply reliability.

Shasta Lake and Vicinity The significance criteria for H&H are not expected to apply in the Shasta Lake and Vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this PDEIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (No-Action): Change in Frequency of Flows Above 100,000 cfs on the Sacramento River Below Bend Bridge Flood management operations would not change under the No-Action Alternative as compared to the existing condition. There would be no impact.

Flood management operations at Shasta Dam would not be expected to change under the No-Action Alternative as compared to the existing condition.

Therefore, the recurrence of flows above 100,000 cfs on the Sacramento River below Bend Bridge would be expected to be the same.

Therefore, Impact H&H-1 (No-Action) would have no impact. Mitigation is not required for the No-Action Alternative.

Impact H&H-2 (No-Action): Place Housing or Other Structures Within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map No new structures will be built in the 100-year flood plain. Therefore, there would be no impact.

No new structures would be built in the flood plain under the No-Action Alternative, and flood management operations at Shasta Dam would not be expected to change under the No-Action Alternative as compared to the existing condition.

Therefore, Impact H&H-2 (No-Action) would have no impact. Mitigation is not required for the No-Action Alternative.

Impact H&H-3(No-Action): Place Within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows No new structures will be built in the 100-year flood plain. Therefore, there would be no impact.

No new structures would be built in the flood plain under the No-Action Alternative, and flood management operations at Shasta Dam would not be expected to change under the No-Action Alternative compared to the existing condition.

Therefore, Impact H&H-3 (No-Action) would have no impact. Mitigation is not required for the No-Action Alternative.

Lower Sacramento River and Delta

Impact H&H-4 (No-Action): Change in Water Levels in the Old River near Tracy Road Bridge Water levels in the Old River near Tracy Road Bridge could be substantially lower under the No-Action Alternative than the existing condition. Therefore, this impact would be potentially significant.

As shown in Table 6-32, there will be some noticeable differences in water level in the Old River near the Tracy Road Bridge. These differences are due to the construction of permanent operable barriers rather than the temporary barriers included in the existing condition. Specifically, the permanent barriers will use different gate operations than the temporary barriers, resulting in typically decreased water levels under the No-Action Alternative.

Therefore, Impact H&H-4 (No-Action) would be potentially significant. Mitigation is not required for the No-Action Alternative.

Table 6-32. Simulated Monthly Maximum 15-Minute Change in Water Levels at Various Locations in the South Delta at Low-Low Tide

Month	Change from Existing Condition		
	Old River near Tracy Road Bridge (feet)	Grant Line Canal near the Grant Line Canal Barrier (feet)	Middle River near the Howard Road Bridge (feet)
April	-0.38 (11)	-0.79 (14)	-1.26 (30)
May	-2.66 (63)	-2.55 (68)	-1.72 (36)
June	-3.38 (73)	-3.05 (72)	-1.24 (68)
July	-3.06 (73)	-2.72 (73)	-1.10 (72)
August	-2.76 (73)	-2.46 (73)	-1.13 (73)
September	-2.38 (73)	-1.76 (73)	-1.15 (73)
October	-2.09 (73)	-2.14 (73)	-1.16 (73)

Source: Common Assumptions Common Modeling Package Version 8D DSM2 2005 and 2030 simulations (Node 071_0, 206_5533, and 129_0)

Notes:

Simulation period: 1922-1994

Number in parentheses indicates number of months with a maximum decrease in water level exceeding 0.1 foot

Impact H&H-5 (No-Action): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Water levels in the Grant Line Canal near the Grant Line Canal Barrier could be substantially lower under the No-Action Alternative than the existing condition. Therefore, this impact would be potentially significant.

Similar to Impact H&H-4, as shown in Table 6-32, water levels under the No-Action Alternative will typically be lower than under the existing condition because of differences in operation of south Delta barriers.

Therefore, Impact H&H-5 (No-Action) would be potentially significant. Mitigation is not required for the No-Action Alternative. *Impact H&H-6 (No-Action): Change in Water Levels in the Middle River near the Howard Road Bridge* Water levels in the Middle River near Howard Road Bridge could be substantially lower under the No-Action Alternative than the existing condition. Therefore, this impact would be potentially significant.

Similar to Impact H&H-4, as shown in Table 6-32, water levels under the No-Action Alternative will typically be lower than under the existing condition because of differences in operation of south Delta barriers.

Therefore, Impact H&H-6 (No-Action) would be potentially significant. Mitigation is not required for the No-Action Alternative.

Impact H&H-7 (No-Action): Change in X2 Position X2 Position would not change from west of either Collinsville or Chipps Island, whichever is the controlling location, from the existing condition to the No-Action Alternative. Therefore, there would be no impact.

Examination of simulation output indicates that compared to the existing condition there would be no months when the No-Action Alternative would cause the X2 position to shift westward from either Collinsville or Chipps Island, depending on the applicable standard, to east of the respective location.

Therefore, there would be no impact for Impact H&H-7 (No-Action Alternative). Mitigation is not required for the No-Action Alternative.

Impact H&H-8 (No-Action): Change in Recurrence of Delta Excess Conditions The No-Action Alternative could result in a change of recurrence of Delta excess conditions at a frequency potentially impacting CCWD's ability to fill Los Vaqueros Reservoir. Therefore, this impact would be potentially significant.

As shown in Table 6-33, the No-Action Alternative would cause many changes from excess to balanced conditions compared to the existing condition.

Because of the large number of occurrences, Impact H&H-8 (No-Action) would be potentially significant. Mitigation is not required for the No-Action Alternative.

Table 6-33. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition											
Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
63 (76%)	55 (66%)	49 (59%)	59 (71%)	60 (72%)	26 (31%)	5 (6%)	9 (11%)	22 (27%)	18 (22%)	32 (39%)	46 (55%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
Number in parentheses indicates percentage of months Delta condition change occurs

CVP/SWP Service Areas

Impact H&H-9 (No-Action): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to north-of-Delta CVP water service contractors and refuges would be greater under the No-Action Alternative relative to the existing condition, but there may be potentially large decreases in certain months. Therefore, this impact would be potentially significant.

As shown in Table 6-34, average annual deliveries under the No-Action Alterative to North-of-Delta CVP water service contractors and refuges would be greater than under existing conditions, but April deliveries could potentially decrease by 5 percent under both average annual and dry and critical years.

Therefore, Impact H&H-9 (No-Action) would be potentially significant. Mitigation is not required for the No-Action Alternative.

Table 6-34. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Change from Existing Conditions	
	Average All Years (cfs (%))	Dry and Critical Years (cfs (%))
October	53 (18%)	52 (19%)
November	47 (17%)	46 (17%)
December	28 (10%)	28 (10%)
January	13 (5%)	13 (5%)
February	12 (4%)	10 (4%)
March	2 (1%)	3 (1%)
April	-15 (-5%)	-13 (-5%)
May	24 (8%)	7 (2%)
June	45 (16%)	15 (5%)
July	60 (21%)	22 (8%)
August	64 (23%)	33 (12%)
September	56 (20%)	42 (15%)
Total (TAF)	24 (8%)	16 (6%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-1994. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index

Key:

cfs = cubic feet per second

TAF = Thousand acre-feet

Impact H&H-10 (No-Action): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to south-of-Delta CVP water service contractors and refuges would increase under the No-Action Alternative relative to the existing condition, but there may be potentially large average .decreases in some months. Therefore, this impact would be potentially significant.

As shown in Table 6-35, annual deliveries to South-of-Delta CVP water service contractors and refuges would increase by 8 percent and 6 percent in average annual and dry and critical years, respectively. However, average April deliveries under both average annual and dry and critical years could decrease by 5 percent on average.

Therefore, Impact H&H-10 (No-Action) would be potentially significant. Mitigation is not required for the No-Action Alternative.

Table 6-35. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Change from Existing Conditions	
	Average All Years (cfs (%))	**Dry and Critical Years (cfs (%))**
October	-63 (-4%)	-63 (-4%)
November	-42 (-2%)	-42 (-3%)
December	-9 (-1%)	-8 (-1%)
January	30 (2%)	29 (2%)
February	45 (3%)	42 (3%)
March	53 (3%)	2 (0%)
April	52 (3%)	-2 (0%)
May	37 (2%)	-18 (-1%)
June	87 (5%)	-4 (0%)
July	142 (8%)	30 (2%)
August	91 (5%)	14 (1%)
September	-37 (-2%)	-60 (-4%)
Total (TAF)	23 (1%)	-5 (0%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes:

Simulation period: 1922-1994. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index

Key:

cfs = cubic feet per second

TAF = thousand acre-feet

Impact H&H-11 (No-Action): Change in Deliveries to SWP Table A Contractors South of the Delta Average annual deliveries to SWP Table A contractors south of the Delta would increase, but average deliveries in some month could decrease, therefore, this impact would be potentially significant.

As shown in Table 6-36, average annual and monthly deliveries to SWP Table A contractors south of the Delta would increase under the No-Action Alternative relative to existing conditions when averaging all years. However, when averaging dry and critical years, there are decreases in average deliveries in June, July, and August of 3 percent, 2 percent, and 1 percent, respectively.

Therefore, Impact H&H-11 (No-Action) would be potentially significant. Mitigation is not required for the No-Action Alternative.

Table 6-36. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors South-of-Delta

Month	Change from Existing Conditions	
	Average All Years (cfs (%))	Dry and Critical Years (cfs (%))
October	68 (2%)	76 (2%)
November	226 (6%)	210 (6%)
December	400 (10%)	340 (9%)
January	1,049 (26%)	401 (11%)
February	1,793 (44%)	665 (18%)
March	1,019 (25%)	308 (9%)
April	721 (18%)	126 (4%)
May	790 (19%)	216 (6%)
June	249 (6%)	-118 (-3%)
July	296 (7%)	-98 (-3%)
August	258 (6%)	-43 (-1%)
September	187 (5%)	29 (1%)
Total (TAF)	420 (10%)	125 (3%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:

Simulation period: 1922-1994. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index

Key:

cfs = cubic feet per second

TAF = Thousand acre-feet

Impact H&H-12(No-Action): Change in Groundwater Changes in groundwater levels under the No-Action Alternative as compared to the existing condition would not be noticeable. Therefore, this impact would be less than significant.

As shown in Tables 6-12, 6-13, 6-24, 6-25, 6-29, and 6-30, surface water deliveries to CVP and SWP contractors would be expected to increase for the No-Action Alternative compared to the existing condition. However, these increases in deliveries are likely associated with increases in demands rather than increases in water supply. Therefore, while groundwater pumping would still be required, groundwater usage in the CVP/SWP service area would not be expected to change noticeably.

Thus, Impact H&H-12 (No-Action) would be less than significant. Mitigation is not required for the No-Action Alternative.*Impact H&H-13 (No-Action): Change in Groundwater Quality* Changes in groundwater quality under the No-Action Alternative as compared to the existing condition would not be noticeable. Therefore, this impact would be less than significant.

As shown in Tables 6-12, 6-13, 6-24, 6-25, 6-29, and 6-30, surface water deliveries to CVP and SWP contractors would be expected to increase for the No-Action Alternative compared to the existing condition. However, these increases in deliveries are likely associated with increases in demands rather than increases in water supply. Therefore, while groundwater pumping would still be required, groundwater usage in the CVP/SWP service area would not be expected to change noticeably.

Thus, Impact H&H-13 (No-Action) would be less than significant. Mitigation is not required for the No-Action Alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Operations under CP1 would be similar to the bases of comparison, but Shasta Reservoir would be raised by 6.5 feet, and would have 256 TAF increased storage. With the enlarged storage capacity, at Shasta Reservoir, there would be minor changes in operations. This section describes the environmental consequences of CP1.

Shasta Lake and Vicinity The significance criteria for H&H are not expected to apply in the Shasta Lake and Vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this PDEIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP1): Change in Frequency of Flows Above 100,000 cfs on the Sacramento River Below Bend Bridge CP1 would slightly reduce the frequency of flows greater than 100,000 cfs. Therefore, this impact would be beneficial.

SLWRI modeling uses a monthly time step, which is inappropriate for flood control analysis. However, flood management operations for downstream objectives would not change with an increase in reservoir storage. While a slight decrease in recurrence of high flows would be possible, CP1 would not increase the frequency of flows above 100,000 cfs.

Therefore, Impact H&H-1 (CP1) would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP1): Place Housing or Other Structures Within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map No new structures would be built downstream from Shasta Dam. Therefore, there would be no impact.

All project construction would be done at the Shasta Dam site, and while the reservoir area would be expanded, any structures located within the reservoir area would be removed. Since reservoir operations for downstream objectives would not change, no additional structures downstream from the dam would be located within the 100-year flood hazard area.

Therefore, there would be no impact for Impact H&H-2 (CP1). Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP1): Place Within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows No new structures would be built downstream from Shasta Dam. Therefore, there would be no impact.

All project construction would be done at the Shasta Dam site, and while the reservoir area would be expanded, any structures located within the reservoir area would be removed. Since reservoir operations for downstream objectives would not change, no additional structures downstream from the dam would be located within the 100-year flood hazard area which would impede or redirect flood flows.

Therefore, there would be no impact for Impact H&H-3 (CP1). Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP1): Change in Water Levels in the Old River near Tracy Road Bridge Delta export operations associated with CP1 would result in increased Delta exports during some months. Accordingly, there would be a possibility of changes in south Delta water levels at times. This impact would be less than significant.

During the agricultural season (April through October), the maximum change in water level at low-low tide compared to the existing condition exceeds 0.1 foot in 2 months, May and June, 1954. As shown in Table 6-37, compared to the No-Action Alternative, CP1 would result in water level changes in excess of 0.1 foot in 15 months during the agricultural season, representing 3 percent of months in the irrigation season. The greatest decrease would be 0.27 foot in July 1930.

Because of the rare incidence of maximum water level changes exceeding 0.1 foot, Impact H&H-4 (CP1) would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-37. Simulated Monthly Maximum 15-Minute Change in Old River Water Levels near Tracy Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP1 (2005) Change (feet)	CP1 (2030) Change (feet)
April	-0.06 (0)	-0.13 (2)
May	-0.14 (1)	-0.13 (1)
June	-0.13 (1)	-0.16 (2)
July	-0.09 (0)	-0.27 (5)
August	-0.06 (0)	-0.13 (2)
September	-0.04 (0)	-0.18 (2)
October	-0.04 (0)	-0.13 (1)

Source: Common Assumptions Common Modeling Package Version 8D DSM2 2005 and 2030 simulations (Node 071_0)

Notes:

Simulation period: 1922-1994

Number in parentheses indicates number of months with a maximum decrease in water level exceeding 0.1 foot

Key:

CP = Comprehensive Plan

Impact H&H-5 (CP1): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Similar to Impact H&H-4 (CP1), CP1 would have the potential to affect water levels in the Grant Line Canal above the Grant Line Canal Barrier. This impact would be less than significant.

As shown in Table 6-38, maximum monthly changes in minimum daily water level associated with CP1 would exceed 0.1 foot in 2 months during the irrigation season, June 1987 and July 1955, compared to the existing condition. When compared to the No-Action Alternative, maximum monthly changes in excess of 0.1 foot occur in 10 months during the irrigation season, representing 2 percent of months.

Because of the low incidence of changes in water level greater than 0.1 foot, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-38. Simulated Monthly Maximum 15-Minute Change in the Grant Line Canal Water Levels near the Grant Line Canal Barrier at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP1 (2005) Change (feet)	CP1 (2030) Change (feet)
April	-0.05 (0)	-0.12 (1)
May	-0.11 (1)	-0.13 (1)
June	-0.11 (1)	-0.15 (1)
July	-0.09 (0)	-0.21 (3)
August	-0.07 (0)	-0.13 (1)
September	-0.04 (0)	-0.16 (2)
October	-0.05 (0)	-0.11 (1)

Source: Common Assumptions Common Modeling Package Version 8D DSM2 2005 and 2030 simulations (Node 206_5533)

Notes:

Simulation period: 1922-1994

Number in parentheses indicates number of months with a maximum decrease in water level exceeding 0.1 foot

Key:

CP = Comprehensive Plan

Impact H&H-6 (CP1): Change in Water Levels in the Middle River near the Howard Road Bridge This impact is similar to both Impacts H&H-4 (CP1) and H&H-5 (CP1), and would be less than significant.

As shown in Table 6-39, maximum monthly changes in minimum daily water levels in the Middle River near the Howard Road Bridge would exceed 0.1 foot in 2 months compared to the existing condition, and in 16 months compared to the No-Action Alternative. A change in 16 months out of the 73 year period of record represents 3 percent of the months during the irrigation season.

Because of the low incidence of changes in water level greater than 0.1 foot, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-39. Simulated Monthly Maximum 15-Minute Change in Middle River Water Levels near the Howard Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP1 (2005) Change (feet)	CP1 (2030) Change (feet)
April	-0.04 (0)	-0.13 (2)
May	-0.08 (0)	-0.12 (1)
June	-0.12 (1)	-0.13 (2)
July	-0.10 (1)	-0.24 (5)
August	-0.04 (0)	-0.15 (3)
September	-0.02 (0)	-0.17 (2)
October	-0.02 (0)	-0.12 (1)

Source: Common Assumptions Common Modeling Package Version 8D DSM2 2005 and 2030 simulations (Node 129_0)

Notes:

Simulation period: 1922-1994

Number in parentheses indicates number of months with a maximum decrease in water level exceeding 0.1 foot

Key:

CP = Comprehensive Plan

Impact H&H-7 (CP1): Change in X2 Position Changes in X2 position from west of either Collinsville or Chipps Island, depending on the applicable standard, would be extremely rare, so this impact would be less than significant.

Examination of simulation output indicates that compared to the existing condition, there would be no months when the No-Action Alternative would cause the X2 position to shift from either west of Collinsville or Chipps Island, depending on the applicable standard, to east of the respective location.

Compared to the No-Action Alternative, there would be 1 month, December 1929, when the X2 position would change from west to east of Collinsville. Under the No-Action Alternative, the X2 position would be at 80.97 kilometers (km), and under CP1, it would be at 81.05 km, a 0.08 km shift.

Because of the extremely rare occurrence and the very low magnitude of change, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP1): Change in Recurrence of Delta Excess Conditions Changes from excess to balance Delta conditions would be very rare, so this impact would be less than significant.

As shown in Table 6-40, CP1 would cause one February, one March and one September to switch from excess to balanced Delta conditions when compared to the existing condition, and three Julys, two Augusts, and one each of January, June, September, November, and December when compared to the No-Action Alternative.

Because of the low number of occurrences, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-40. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

	Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition or No-Action Alternative											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CP1 (2005)	0 (0%)	1 (1%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)
CP1 (2030)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	3 (4%)	2 (2%)	1 (1%)	0 (0%)	1 (1%)	0 (0%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
Number in parentheses indicates percentage of months Delta condition change occurs
Key:
CP = Comprehensive Plan

CVP/SWP Service Areas

Impact H&H-9 (CP1): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual and monthly deliveries would increase under both existing and future conditions. Therefore, this impact would be beneficial.

As shown in Table 6-41, average annual and average monthly deliveries under both existing and future conditions would increase relative to the basis of comparison when averaging all years, and dry and critical years.

Therefore, Impact H&H-9 (CP1) would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Table 6-41. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP1 Change (cfs (%))	Existing Condition (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))
Oct	286	4 (1%)	280	4 (2%)	339	2 (1%)	332	2 (1%)
Nov	173	0 (0%)	170	0 (0%)	220	0 (0%)	217	0 (0%)
Dec	109	0 (0%)	108	0 (0%)	137	0 (0%)	135	0 (0%)
Jan	54	0 (0%)	53	0 (0%)	67	0 (0%)	66	0 (0%)
Feb	50	0 (0%)	54	0 (0%)	62	0 (0%)	64	0 (0%)
Mar	35	3 (8%)	33	4 (13%)	37	1 (3%)	36	2 (5%)
Apr	371	22 (6%)	249	33 (13%)	356	11 (3%)	236	17 (7%)
May	657	29 (4%)	382	42 (11%)	680	15 (2%)	389	25 (6%)
Jun	923	36 (4%)	522	51 (10%)	967	19 (2%)	537	32 (6%)
Jul	1,076	40 (4%)	608	58 (10%)	1,136	22 (2%)	631	37 (6%)
Aug	914	32 (4%)	541	47 (9%)	978	17 (2%)	574	30 (6%)
Sep	544	14 (3%)	357	21 (6%)	601	8 (1%)	399	13 (4%)
Total (TAF)	315	11 (3%)	204	16 (8%)	339	6 (2%)	219	10 (5%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-1994. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = Thousand acre-feet

Impact H&H-10 (CP1): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual and monthly deliveries would increase under both existing and future conditions. Therefore, this impact would be beneficial.

As shown in Table 6-42, average annual and average monthly deliveries under both existing and future conditions would increase relative to the basis of comparison when averaging all years, and dry and critical years.

Therefore, Impact H&H-10 (CP1) would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Table 6-42. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP1 Change (cfs (%))	Existing Condition (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))
Oct	1,694	11 (1%)	1,551	16 (1%)	1,631	3 (0%)	1,488	8 (1%)
Nov	1,157	8 (1%)	1,051	12 (1%)	1,116	5 (0%)	1,010	6 (1%)
Dec	925	11 (1%)	788	17 (2%)	916	7 (1%)	780	8 (1%)
Jan	1,178	19 (2%)	946	29 (3%)	1,208	12 (1%)	974	14 (2%)
Feb	1,434	25 (2%)	1,134	37 (3%)	1,478	16 (1%)	1,176	19 (2%)
Mar	853	25 (3%)	500	47 (9%)	906	9 (1%)	502	33 (7%)
Apr	1,376	26 (2%)	945	45 (5%)	1,428	19 (1%)	943	43 (5%)
May	2,307	38 (2%)	1,529	70 (5%)	2,344	25 (1%)	1,512	60 (4%)
Jun	3,587	62 (2%)	2,307	116 (5%)	3,674	42 (1%)	2,302	100 (4%)
Jul	3,838	75 (2%)	2,323	139 (6%)	3,980	51 (1%)	2,353	120 (5%)
Aug	2,897	54 (2%)	1,792	102 (6%)	2,987	7 (0%)	1,806	80 (4%)
Sep	1,780	18 (1%)	1,373	33 (2%)	1,743	12 (1%)	1,314	29 (2%)
Total (TAF)	1,392	22 (2%)	980	40 (4%)	1,415	13 (1%)	976	31 (3%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes:

Simulation period: 1922-1994. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = Thousand acre-feet

Impact H&H-11 (CP1): Change in Deliveries to SWP Table A Contractors South of the Delta Average annual deliveries would increase under both existing and future conditions, but there could be some less than significant decreases in monthly deliveries under future conditions. Therefore, this impact would be less than significant.

As shown in Table 6-43, average annual deliveries to SWP Table A contractors south of the Delta would increase under Alternative CP1 in both existing and future conditions relative to the bases of comparison in both average years and in dry and critical years. Under existing conditions, the average monthly deliveries would increase in all months, but there could be some decreases in deliveries under Alternative CP1 relative to the No-Action Alternative under Future Conditions in both average annual and dry and critical years. These decreases would be less than 1 percent, and would therefore not be significant.

Therefore, Impact H&H-11 (CP1) would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-43. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors South-of-Delta

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP1 Change (cfs (%))	Existing Condition (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))
Oct	4,101	61 (1%)	3,598	61 (2%)	4,169	26 (1%)	3,675	45 (1%)
Nov	3,408	58 (2%)	2,876	59 (2%)	3,634	27 (1%)	3,086	45 (1%)
Dec	3,109	57 (2%)	2,605	58 (2%)	3,509	54 (2%)	2,945	82 (3%)
Jan	345	10 (3%)	242	7 (3%)	1,394	100 (7%)	643	63 (10%)
Feb	783	13 (2%)	490	17 (3%)	2,576	12 (0%)	1,155	54 (5%)
Mar	2,025	26 (1%)	1,116	56 (5%)	3,044	55 (2%)	1,424	52 (4%)
Apr	5,298	54 (1%)	4,710	79 (2%)	6,019	52 (1%)	4,836	114 (2%)
May	6,586	58 (1%)	5,625	92 (2%)	7,376	28 (0%)	5,840	55 (1%)
Jun	8,721	85 (1%)	7,507	125 (2%)	8,970	-10 (0%)	7,389	-34 (0%)
Jul	8,466	80 (1%)	7,354	110 (1%)	8,762	-4 (0%)	7,256	-27 (0%)
Aug	7,889	83 (1%)	6,561	119 (2%)	8,146	10 (0%)	6,518	-4 (0%)
Sep	5,949	65 (1%)	4,750	95 (2%)	6,135	8 (0%)	4,778	10 (0%)
Total (TAF)	3,434	39 (1%)	2,874	53 (2%)	3,855	22 (1%)	3,000	27 (1%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:

Simulation period: 1922-1994. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = Thousand acre-feet

Impact H&H-12 (CP1): Change in Groundwater Levels CP1 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. Therefore, this impact would be beneficial for groundwater levels.

With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP1. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. With less groundwater pumping, groundwater basins that are in overdraft conditions would be anticipated to recover as a result of increasing groundwater levels.

Accordingly, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP1): Change in Groundwater Quality CP1 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping could improve groundwater quality. Therefore, this impact would be less than significant for groundwater quality.

This impact would be beneficial for groundwater levels and less than significant for groundwater quality. With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP1. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. Because CP1 would have a positive, albeit limited, impact by reducing reliance on groundwater, it is anticipated that the impacts of CP1 on groundwater quality would be also limited.

Accordingly, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Operations under CP2 would be similar to CP1, except the Shasta Dam and Reservoir enlargement would be 12.5 feet and 443 TAF, respectively, rather than 6.5 feet and 256 TAF, respectively. With the increased storage capacity at Shasta Reservoir, there would be minor changes in operations. However, all impacts would be similar to those observed under CP1. This section describes the environmental consequences of CP2.

Shasta Lake and Vicinity The significance criteria for H&H are not expected to apply in the Shasta Lake and Vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this PDEIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP2): Change in Frequency of Flows Above 100,000 cfs on the Sacramento River Below Bend Bridge This impact would be similar to Impact H&H-1 (CP1) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP2): Place Housing or Other Structures Within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map This impact would be the same as Impact H&H-2 (CP1) and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP2): Place Within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows This impact would be the same as Impact H&H-3 (CP1) and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP2): Change in Water Levels in Old River near Tracy Road Bridge Impact H&H-4 (CP2) would be very similar to Impact H&H-4 (CP1), except the amount of annual exports would be slightly greater under CP2. This impact would be less than significant.

Table 6-44, shows maximum monthly changes in minimum daily Old River water levels near Tracy Road Bridge. Under the existing condition, CP2 would result in 3 months during the irrigation season when the maximum change in water level at low-low tide would exceed 0.1 foot. Compared to the No-Action Alternative, there would be 24 months with maximum changes in water levels exceeding 0.1 foot. A change of 24 months represents less than 5 percent of the irrigation season during the period of record.

Because of the low incidence of changes in minimum daily water level exceeding 0.1 foot, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-44. Simulated Monthly Maximum 15-Minute Change in Old River Water Levels near Tracy Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP2 (2005) Change (feet)	CP2 (2030) Change (feet)
April	-0.06 (0)	-0.30 (3)
May	-0.14 (1)	-0.13 (2)
June	-0.13 (1)	-0.16 (2)
July	-0.11 (1)	-0.30 (9)
August	-0.06 (0)	-0.20 (3)
September	-0.07 (0)	-0.18 (2)
October	-0.07 (0)	-0.13 (3)

Source: Common Assumptions Common Modeling Package Version 8D DSM2 2005 and 2030 simulations (Node 071_0)

Notes:

Simulation period: 1922-1994

Number in parentheses indicates number of months with a maximum decrease in water level exceeding 0.1 foot

Key:

CP = Comprehensive Plan

Impact H&H-5 (CP2): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Impact H&H-5 (CP2) would be very similar to Impact H&H-5 (CP1), except the amount of Delta exports would be slightly greater under CP2. This impact would be less than significant.

Table 6-45 shows maximum monthly changes in minimum daily Grant Line Canal water levels above the Grant Line Canal Barrier. Under existing condition, CP2 would result in 4 months during the irrigation season when the maximum change in water level at low-low tide would exceed 0.1 foot. Compared to the No-Action Alternative, there would be 15 months with maximum changes in water levels exceeding 0.1 foot. A change of 15 months represents less than 3 percent of the irrigation season during the period of record.

Because of the low incidence of changes in minimum daily water level exceeding 0.1 foot, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-45. Simulated Monthly Maximum 15-Minute Change in Grant Line Canal Water Levels near the Grant Line Canal Barrier at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP2 (2005) Change (feet)	CP2 (2030) Change (feet)
April	-0.05 (0)	-0.24 (2)
May	-0.11 (1)	-0.13 (1)
June	-0.11 (1)	-0.10 (0)
July	-0.11 (2)	-0.25 (7)
August	-0.07 (0)	-0.19 (1)
September	-0.07 (0)	-0.17 (2)
October	-0.08 (0)	-0.11 (2)

Source: Common Assumptions Common Modeling Package Version 8D DSM2 2005 and 2030 simulations (Node 206_5533)

Notes:

Simulation period: 1922-1994

Number in parentheses indicates number of months with a maximum decrease in water level exceeding 0.1 foot

Key:

CP = Comprehensive Plan

Impact H&H-6 (CP2): Change in Water Levels in the Middle River near the Howard Road Bridge Impact H&H-6 (CP2) would be very similar to Impact H&H-6 (CP1), except the amount of Delta export would be slightly greater under CP2, resulting in slightly different south Delta water levels. This impact would be less than significant.

Table 6-46 shows maximum monthly changes in minimum daily Middle River water levels near the Howard Road Bridge. Under the existing condition, CP2 would result in 2 months during the irrigation season when the maximum change in water level at low-low tide would exceed 0.1 foot. Compared to the No-Action Alternative, there would be 21 months with maximum changes in water levels exceeding 0.1 foot. A change of 21 months represents 4 percent of the irrigation season during the period of record.

Because of the low incidence of changes in minimum daily water level exceeding 0.1 foot, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-46. Simulated Monthly Maximum 15-Minute Change in Middle River Water Levels near the Howard Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP2 (2005) Change (feet)	CP2 (2030) Change (feet)
April	-0.04 (0)	-0.30 (3)
May	-0.08 (0)	-0.12 (1)
June	-0.12 (1)	-0.10 (1)
July	-0.10 (1)	-0.26 (9)
August	-0.04 (0)	-0.21 (2)
September	-0.02 (0)	-0.17 (2)
October	-0.02 (0)	-0.12 (3)

Source: Common Assumptions Common Modeling Package Version 8D DSM2 2005 and 2030 simulations (Node 129_0)
Notes:
Simulation period: 1922-1994
Number in parentheses indicates number of months with a maximum decrease in water level exceeding 0.1 foot
Key:
CP = Comprehensive Plan

Impact H&H-7 (CP2): Change in X2 Position Changes in X2 position from west of either Collinsville or Chipps Island, depending on the applicable standard, would be extremely rare, so this impact would be less than significant.

Similar to Impact H&H-7 (CP1) examination of simulation output indicates that compared to the existing condition, there would be no months when the No-Action Alternative would cause the X2 position to shift from either west of Collinsville or Chipps Island, depending on the applicable standard, to east of the respective location. Compared to the No-Action Alternative, there would be 1 month, December 1929, when the X2 position would change from west to east of Collinsville. Under the No-Action Alternative, the X2 position would be at 80.97 km, and under CP2, it would be at 81.04 km, a 0.07 km shift.

Because of the extremely rare occurrence and the very low magnitude of change, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP2): Change in Recurrence of Delta Excess Conditions Changes from excess to balance Delta conditions would be very rare, so this impact would be less than significant.

As shown in Table 6-47, CP2 would cause one February and one September to change from excess to balanced Delta conditions when compared to the existing condition, and three Julys, two Augusts, and one each of January, June, September, and November when compared to the No-Action Alternative.

Because of the low number of occurrences, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-47. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

	Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition or No-Action Alternative											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CP1 (2005)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)
CP1 (2030)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	3 (4%)	2 (2%)	1 (1%)	0 (0%)	1 (1%)	0 (0%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
Number in parentheses indicates percentage of months Delta condition change occurs
Key:
CP = Comprehensive Plan

CVP/SWP Service Areas

Impact H&H-9 (CP2): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Impact H&H-9 (CP2) would be similar to Impact H&H-9 (CP1) except the increase in deliveries would be greater under CP2. Therefore, this impact would be beneficial.

As shown in Table 6-48, average annual and average monthly deliveries under both existing and future conditions would increase relative to the basis of comparison when averaging all years, and dry and critical years.

Therefore, Impact H&H-9 (CP2) would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Table 6-48. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP2 Change (cfs (%))	Existing Condition (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))
Oct	286	4 (1%)	280	5 (2%)	339	4 (1%)	332	4 (1%)
Nov	173	0 (0%)	170	0 (0%)	220	0 (0%)	217	0 (0%)
Dec	109	0 (0%)	108	0 (0%)	137	0 (0%)	135	0 (0%)
Jan	54	0 (0%)	53	0 (0%)	67	0 (0%)	66	0 (0%)
Feb	50	0 (0%)	54	0 (0%)	62	0 (0%)	64	0 (0%)
Mar	35	3 (9%)	33	5 (16%)	37	3 (8%)	36	5 (14%)
Apr	371	23 (6%)	249	36 (14%)	356	20 (6%)	236	32 (13%)
May	657	31 (5%)	382	47 (12%)	680	29 (4%)	389	43 (11%)
Jun	923	38 (4%)	522	58 (11%)	967	37 (4%)	537	56 (11%)
Jul	1,076	42 (4%)	608	66 (11%)	1,136	42 (4%)	631	63 (10%)
Aug	914	33 (4%)	541	53 (10%)	978	33 (4%)	574	51 (9%)
Sep	544	15 (3%)	357	24 (7%)	601	15 (3%)	399	22 (6%)
Total (TAF)	315	12 (4%)	204	18 (9%)	339	11 (4%)	219	17 (8%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-1994. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = Thousand acre-feet

Impact H&H-10 (CP2): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Impact H&H-10 (CP2) would be similar to Impact H&H-10 (CP1) except the increase in deliveries would be greater under CP2. Therefore, this impact would be beneficial.

As shown in Table 6-49, average annual and average monthly deliveries under both existing and future conditions would increase relative to the basis of comparison when averaging all years, and dry and critical years.

Therefore, Impact H&H-10 (CP2) would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Table 6-49. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP2 Change (cfs (%))	Existing Condition (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))
Oct	1,694	11 (1%)	1,551	19 (1%)	1,631	12 (1%)	1,488	18 (1%)
Nov	1,157	9 (1%)	1,051	15 (1%)	1,116	11 (1%)	1,010	13 (1%)
Dec	925	12 (1%)	788	20 (3%)	916	15 (2%)	780	18 (2%)
Jan	1,178	21 (2%)	946	35 (4%)	1,208	26 (2%)	974	32 (3%)
Feb	1,434	27 (2%)	1,134	45 (4%)	1,478	33 (2%)	1,176	42 (4%)
Mar	853	28 (3%)	500	59 (12%)	906	27 (3%)	502	56 (11%)
Apr	1,376	31 (2%)	945	54 (6%)	1,428	33 (2%)	943	66 (7%)
May	2,307	40 (2%)	1,529	82 (5%)	2,344	50 (2%)	1,512	101 (7%)
Jun	3,587	67 (2%)	2,307	137 (6%)	3,674	83 (2%)	2,302	167 (7%)
Jul	3,838	81 (2%)	2,323	164 (7%)	3,980	100 (3%)	2,353	201 (9%)
Aug	2,897	59 (2%)	1,792	120 (7%)	2,987	50 (2%)	1,806	146 (8%)
Sep	1,780	19 (1%)	1,373	40 (3%)	1,743	24 (1%)	1,314	48 (4%)
Total (TAF)	1,392	24 (2%)	980	48 (5%)	1,415	28 (2%)	976	55 (6%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes:

Simulation period: 1922-1994. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = Thousand acre-feet

As shown in Table 6-50, average annual deliveries to SWP Table A contractors south of the Delta would increase under Alternative CP2 in both existing and future conditions relative to the bases of comparison in both average years and in dry and critical years. Under existing conditions, the average monthly deliveries would increase in all months, but there could be some decreases in deliveries under Alternative CP2 relative to the No-Action Alternative under future conditions in both average annual and dry and critical years. These decreases would be less than 1 percent, and would therefore not be significant.

Therefore, Impact H&H-11 (CP2) would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-50. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors South-of-Delta

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP2 Change (cfs (%))	Existing Condition (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))
Oct	4,101	73 (2%)	3,598	70 (2%)	4,169	18 (0%)	3,675	37 (1%)
Nov	3,408	69 (2%)	2,876	67 (2%)	3,634	20 (1%)	3,086	41 (1%)
Dec	3,109	72 (2%)	2,605	67 (3%)	3,509	47 (1%)	2,945	78 (3%)
Jan	345	11 (3%)	242	8 (3%)	1,394	99 (7%)	643	58 (9%)
Feb	783	13 (2%)	490	17 (3%)	2,576	9 (0%)	1,155	48 (4%)
Mar	2,025	33 (2%)	1,116	70 (6%)	3,044	39 (1%)	1,424	14 (1%)
Apr	5,298	63 (1%)	4,710	90 (2%)	6,019	44 (1%)	4,836	105 (2%)
May	6,586	67 (1%)	5,625	91 (2%)	7,376	17 (0%)	5,840	35 (1%)
Jun	8,721	95 (1%)	7,507	116 (2%)	8,970	-23 (0%)	7,389	-65 (-1%)
Jul	8,466	83 (1%)	7,354	89 (1%)	8,762	-18 (0%)	7,256	-56 (-1%)
Aug	7,889	86 (1%)	6,561	103 (2%)	8,146	-1 (0%)	6,518	-28 (0%)
Sep	5,949	70 (1%)	4,750	84 (2%)	6,135	-1 (0%)	4,778	-7 (0%)
Total (TAF)	3,434	45 (1%)	2,874	53 (2%)	3,855	15 (0%)	3,000	15 (1%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:

Simulation period: 1922-1994. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = Thousand acre-feet

Impact H&H-12 (CP2): Change in Groundwater Levels CP2 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. Therefore, this impact would be beneficial for groundwater levels.

With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP2. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. With less groundwater pumping, groundwater basins that are in overdraft conditions would be anticipated to recover as a result of increasing groundwater levels.

Accordingly, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP2): Change in Groundwater Quality CP2 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping could improve groundwater quality. Therefore, this impact would be less than significant for groundwater quality.

With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP2. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. Because CP2 would have a positive, albeit limited, impact by reducing reliance on groundwater, it is anticipated that the impacts of CP2 on groundwater quality would be also limited.

Accordingly, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Operations under CP3 would be similar to CP1, except the Shasta Dam and Reservoir enlargement would be 18.5 feet and 634 TAF, respectively, rather than 6.5 feet and 256 TAF, respectively. With the increased storage capacity of Shasta Reservoir, there would be minor changes in operations. However, all impacts would be similar to those observed under CP1. This section describes the environmental consequences of CP3.

Shasta Lake and Vicinity The significance criteria for H&H are not expected to apply in the Shasta Lake and Vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this PDEIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP3): Change in Frequency of Flows Above 100,000 cfs on the Sacramento River Below Bend Bridge This impact would be similar to Impact H&H-1 (CP1) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP3): Place Housing or Other Structures Within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map This impact would be the same as Impact H&H-2 (CP1) and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP3): Place Within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows This impact would be the same as Impact H&H-3 (CP1) and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP3): Change in Water Levels in Old River near Tracy Road Bridge Impact H&H-4 (CP3) would be very similar to Impact H&H-1 (CP1), except export amounts would be slightly higher under CP3, resulting in slightly different water levels. This impact would be less than significant.

Table 6-51 shows the maximum monthly change in minimum daily Old River water levels near Tracy Road Bridge. Under existing condition, Alternative CP3 would result in 4 months during the irrigation season when the maximum change in water level at low-low tide would exceed 0.1 foot. Compared to the No-Action Alternative, there would be 33 months with maximum changes in water levels exceeding 0.1 foot. A change of 33 months represents 6 percent of the irrigation season during the period of record.

Because of the low incidence of changes in minimum daily water level exceeding 0.1 foot, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-51. Simulated Monthly Maximum 15-Minute Change in Old River Water Levels near Tracy Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP3 (2005) Change (feet)	CP3 (2030) Change (feet)
April	-0.07 (0)	-0.32 (4)
May	-0.14 (1)	-0.14 (2)
June	-0.13 (2)	-0.16 (2)
July	-0.11 (1)	-0.26 (10)
August	-0.08 (0)	-0.26 (6)
September	-0.06 (0)	-0.18 (6)
October	-0.07 (0)	-0.14 (3)

Source: Common Assumptions Common Modeling Package Version 8D DSM2 2005 and 2030 simulations (Node 071_0)

Notes:

Simulation period: 1922-1994

Number in parentheses indicates number of months with a maximum decrease in water level exceeding 0.1 foot

Key:

CP = Comprehensive Plan

Impact H&H-5 (CP3): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Impact H&H-2 (CP3) would be very similar to Impact H&H-5 (CP1), except Delta export amounts would be slightly higher under CP3. This impact would be less than significant.

Table 6-52 shows the maximum monthly change in minimum daily Grant Line Canal water levels above the Grant Line Canal Barrier. Under the existing condition, CP3 would result in 6 months during the irrigation season when the maximum change in water level at low-low tide would exceed 0.1 foot. Compared to the No-Action Alternative, there would be 26 months with maximum changes in water levels exceeding 0.1 foot. A change of 26 months represents 5 percent of the irrigation season during the period of record.

Because of the low incidence of changes in minimum daily water level exceeding 0.1 foot, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-52. Simulated Monthly Maximum 15-Minute Change in Tyrant Line Canal Water Levels near the Grant Line Canal Barrier at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP3 (2005) Change (feet)	CP3 (2030) Change (feet)
April	-0.07 (0)	-0.25 (3)
May	-0.11 (1)	-0.13 (1)
June	-0.11 (2)	-0.10 (0)
July	-0.11 (3)	-0.25 (11)
August	-0.09 (0)	-0.25 (5)
September	-0.06 (0)	-0.17 (4)
October	-0.08 (0)	-0.13 (2)

Source: Common Assumptions Common Modeling Package Version 8D DSM2 2005 and 2030 simulations (Node 206_5533)

Notes:

Simulation period: 1922-1994

Number in parentheses indicates number of months with a maximum decrease in water level exceeding 0.1 foot

Key:

CP = Comprehensive Plan

Impact H&H-6 (CP3): Change in Water Levels in the Middle River near the Howard Road Bridge Impact H&H-6 (CP3) would be very similar to Impact H&H-6 (CP1), except Delta export amounts would be slightly higher under CP3, resulting in slightly different south Delta water levels. Changes in water levels would be very rare; therefore, this impact would be less than significant.

Table 6-53 shows maximum monthly changes in minimum daily Middle River water levels near the Howard Road Bridge. Under the existing condition, CP3 would result in 4 months during the irrigation season when the maximum change in water level at low-low tide would exceed 0.1 foot. Compared to the No-Action Alternative, there would be 30 months with maximum changes in water levels exceeding 0.1 foot. A change of 30 months represents less than 6 percent of the irrigation season during the period of record.

Because of the low incidence of changes in minimum daily water level exceeding 0.1 foot, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-53. Simulated Monthly Maximum 15-Minute Change in Middle River Water Levels near the Howard Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP3 (2005) Change (feet)	CP3 (2030) Change (feet)
April	-0.05 (0)	-0.31 (3)
May	-0.09 (0)	-0.12 (1)
June	-0.17 (1)	-0.10 (1)
July	-0.13 (3)	-0.26 (11)
August	-0.07 (0)	-0.27 (5)
September	-0.03 (0)	-0.17 (6)
October	-0.04 (0)	-0.14 (3)

Source: Common Assumptions Common Modeling Package Version 8D DSM2 2005 and 2030 simulations (Node 129_0)

Notes:

Simulation period: 1922-1994

Number in parentheses indicates number of months with a maximum decrease in water level exceeding 0.1 foot

Key:

CP = Comprehensive Plan

Impact H&H-7 (CP3): Change in X2 Position Changes in X2 position from west of either Collinsville or Chipps Island, depending on the applicable standard, would be extremely rare, so this impact would be less than significant.

Similar to Impact H&H-7 (CP1), examination of simulation output indicates that compared to the existing condition there would be no months when the No-Action Alternative would cause the X2 position to shift from either west of Collinsville or Chipps Island, depending on the applicable standard, to east of the respective location. Compared to the No-Action Alternative, there would be 1 month, December 1929, when the X2 position would change from west to east of Collinsville. Under the No-Action Alternative, the X2 position would be at 80.97 km, and under CP3, it would be at 81.05 km, a 0.08 km shift.

Because of the extremely rare occurrence and the very low magnitude of change, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP3): Change in Recurrence of Delta Excess Condition Changes from excess to balance Delta conditions would be very rare, so this impact would be less than significant.

As shown in Table 6-54, CP3 would cause three Februarys and one September to change from excess to balanced Delta conditions when compared to the existing condition, and three Julys, two Augusts, and one each of January, June, September, and November when compared to the No-Action Alternative.

Because of the low number of occurrences, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-54. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

	Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition or No-Action Alternative											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CP1 (2005)	0 (0%)	3 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)
CP1 (2030)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	3 (4%)	2 (2%)	1 (1%)	0 (0%)	1 (1%)	0 (0%)

Source: Common Assumptions Common Modeling Package Version 8D CalSim-II 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
Number in parentheses indicates percentage of months Delta condition change occurs
Key:
CP = Comprehensive Plan

CVP/SWP Service Areas

Impact H&H-9 (CP3): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Impact H&H-9 (CP3) would be similar to Impact H&H-9 (CP1) except the increase in deliveries would be greater under CP3. Therefore, this impact would be beneficial.

As shown in Table 6-55, average annual and average monthly deliveries under both existing and future conditions would increase relative to the basis of comparison when averaging all years, and dry and critical years.

Therefore, Impact H&H-9 (CP3) would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Table 6-55. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP3 Change (cfs (%))	Existing Condition (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))
Oct	286	5 (2%)	280	7 (2%)	339	6 (2%)	332	6 (2%)
Nov	173	0 (0%)	170	0 (0%)	220	0 (0%)	217	0 (0%)
Dec	109	0 (0%)	108	0 (0%)	137	0 (0%)	135	0 (0%)
Jan	54	0 (0%)	53	0 (0%)	67	0 (0%)	66	0 (0%)
Feb	50	0 (0%)	54	0 (0%)	62	0 (0%)	64	0 (0%)
Mar	35	5 (13%)	33	8 (23%)	37	5 (13%)	36	7 (22%)
Apr	371	30 (8%)	249	47 (19%)	356	32 (9%)	236	52 (21%)
May	657	40 (6%)	382	60 (16%)	680	45 (7%)	389	69 (18%)
Jun	923	49 (5%)	522	75 (14%)	967	57 (6%)	537	88 (17%)
Jul	1,076	55 (5%)	608	85 (14%)	1,136	65 (6%)	631	100 (16%)
Aug	914	44 (5%)	541	68 (12%)	978	52 (6%)	574	80 (15%)
Sep	544	20 (4%)	357	31 (9%)	601	23 (4%)	399	35 (10%)
Total (TAF)	315	15 (5%)	204	23 (11%)	339	17 (5%)	219	27 (13%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-1994. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = Thousand acre-feet

Impact H&H-10 (CP3): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Impact H&H-10 (CP3) would be similar to Impact H&H-10 (CP1) except the increase in deliveries would be greater under CP3. Therefore, this impact would be beneficial.

As shown in Table 6-56, average annual and average monthly deliveries under both existing and future conditions would increase relative to the basis of comparison when averaging all years, and dry and critical years.

Therefore, Impact H&H-10 (CP3) would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Table 6-56. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP3 Change (cfs (%))	Existing Condition (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))
Oct	1,694	13 (1%)	1,551	25 (2%)	1,631	20 (1%)	1,488	26 (2%)
Nov	1,157	10 (1%)	1,051	19 (2%)	1,116	15 (1%)	1,010	19 (2%)
Dec	925	14 (1%)	788	26 (3%)	916	21 (2%)	780	27 (3%)
Jan	1,178	24 (2%)	946	45 (5%)	1,208	37 (3%)	974	47 (5%)
Feb	1,434	31 (2%)	1,134	59 (5%)	1,478	47 (3%)	1,176	61 (5%)
Mar	853	38 (4%)	500	68 (14%)	906	45 (5%)	502	78 (16%)
Apr	1,376	31 (2%)	945	52 (6%)	1,428	45 (3%)	943	94 (10%)
May	2,307	46 (2%)	1,529	90 (6%)	2,344	70 (3%)	1,512	147 (10%)
Jun	3,587	77 (2%)	2,307	150 (7%)	3,674	116 (3%)	2,302	245 (11%)
Jul	3,838	92 (2%)	2,323	180 (8%)	3,980	140 (4%)	2,353	294 (13%)
Aug	2,897	67 (2%)	1,792	131 (7%)	2,987	78 (3%)	1,806	213 (12%)
Sep	1,780	22 (1%)	1,373	43 (3%)	1,743	34 (2%)	1,314	71 (5%)
Total (TAF)	1,392	28 (2%)	980	54 (5%)	1,415	40 (3%)	976	80 (8%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes:

Simulation period: 1922-1994.

Change as measured from either existing condition or No-Action Alternative.

Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = Comprehensive Plan

TAF = Thousand acre-feet

Impact H&H-11 (CP3): Change in Deliveries to SWP Table A Contractors South of the Delta Impact H&H-11 (CP3) would be similar to Impact H&H-11 (CP1) except the increase in average annual deliveries would be greater, and potential decreases in average monthly deliveries in some months could be slightly larger under CP3. Therefore, this impact would be less than significant.

As shown in Table 6-57, average annual deliveries to SWP Table A contractors south of the Delta would increase under Alternative CP2 in both existing and future conditions relative to the bases of comparison in both average years and in dry and critical years. Under existing conditions, the average monthly deliveries would increase in all months, but there could be some decreases in deliveries under Alternative CP3 relative to the No-Action Alternative under future conditions in both average annual and dry and critical years. These decreases would be around 1 percent, and would therefore not be significant.

Therefore, Impact H&H-11 (CP3) would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-57. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors South-of-Delta

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP3 Change (cfs (%))	Existing Condition (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))
Oct	4,101	63 (2%)	3,598	49 (1%)	4,169	26 (1%)	3,675	41 (1%)
Nov	3,408	60 (2%)	2,876	51 (2%)	3,634	25 (1%)	3,086	42 (1%)
Dec	3,109	63 (2%)	2,605	51 (2%)	3,509	53 (2%)	2,945	77 (3%)
Jan	345	10 (3%)	242	5 (2%)	1,394	95 (7%)	643	59 (9%)
Feb	783	13 (2%)	490	16 (3%)	2,576	3 (0%)	1,155	44 (4%)
Mar	2,025	31 (2%)	1,116	68 (6%)	3,044	20 (1%)	1,424	-18 (-1%)
Apr	5,298	54 (1%)	4,710	67 (1%)	6,019	48 (1%)	4,836	110 (2%)
May	6,586	56 (1%)	5,625	70 (1%)	7,376	22 (0%)	5,840	41 (1%)
Jun	8,721	74 (1%)	7,507	76 (1%)	8,970	-39 (0%)	7,389	-112 (-2%)
Jul	8,466	75 (1%)	7,354	74 (1%)	8,762	-10 (0%)	7,256	-43 (-1%)
Aug	7,889	79 (1%)	6,561	88 (1%)	8,146	2 (0%)	6,518	-17 (0%)
Sep	5,949	64 (1%)	4,750	74 (2%)	6,135	6 (0%)	4,778	4 (0%)
Total (TAF)	3,434	39 (1%)	2,874	42 (1%)	3,855	15 (0%)	3,000	14 (0%)

Source: Common Assumptions Common Modeling Package, version 8D CalSim-II 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:
Simulation period: 1922-1994.
Change as measured from either existing condition or No-Action Alternative.
Dry and critical years as defined by the Sacramento Valley Index.
Key:
cfs = cubic feet per second
CP = Comprehensive Plan
TAF = Thousand acre-feet

Impact H&H-12 (CP3): Change in Groundwater Levels CP3 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. Therefore, this impact would be beneficial for groundwater levels.

With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP3. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. With less groundwater pumping, groundwater basins that are in overdraft conditions would be anticipated to recover as a result of increasing groundwater levels.

Therefore, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP3): Change in Groundwater Quality CP3 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping could improve groundwater quality. Therefore, this impact would less than significant for groundwater quality.

With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP3. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. Because CP3 would have a positive, albeit limited, impact by reducing reliance on groundwater, it is anticipated that the impacts of CP3 on groundwater quality would be also limited.

Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP4 – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

CP4 would differ from the No-Action Alternative primarily through a 634 TAF enlargement of Shasta Reservoir, with 256 TAF operated for water supply reliability, and 378 TAF of the storage dedicated to anadromous fish survivability, through an increase in available cold water for release to the Sacramento River. This section describes the environmental consequences of CP4.

Shasta Lake and Vicinity The significance criteria for H&H are not expected to apply in the Shasta Lake and Vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this PDEIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP4). Change in Frequency of Flows Above 100,000 cfs on the Sacramento River Below Bend Bridge This impact would be similar to Impact H&H-1 (CP1) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP4). Place Housing or Other Structures Within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map This impact would be the same as Impact H&H-2 (CP1) and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP4). Place Within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows This impact would be the same as Impact H&H-3 (CP1) and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP4). Change in Water Levels in Old River near Tracy Road Bridge This impact would be the same as Impact H&H-4 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-5 (CP4). Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier This impact would be the same as Impact H&H-5 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-6 (CP4). Change in Water Levels in Middle River near the Howard Road Bridge This impact would be the same as Impact H&H-6 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-7 (CP4): Change in X2 Position This impact would be the same as Impact H&H-7 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP4): Change in Recurrence of Delta Excess Conditions This impact would be the same as Impact H&H-8 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact H&H-9 (CP4): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges This impact would be the same as Impact

H&H-9 (CP1) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-10 (CP4): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges This impact would be the same as Impact H&H-10 (CP1) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-11 (CP4): Change in Deliveries to SWP Table A Contractors South of the Delta This impact would be the same as Impact H&H-11 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-12 (CP4). Change in Groundwater Levels This impact would be the same as Impact H&H-12 (CP1) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP4). Change in Groundwater Quality This impact would be the same as Impact H&H-13 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise Combination Plan

CP5 would differ from the No-Action Alternative primarily through a 634 TAF enlargement of Shasta Reservoir with additional recreation facilities at Shasta Lake and environmental restoration to the lower ends of the Shasta Lake tributaries. This section describes the environmental consequences of CP5.

Shasta Lake and Vicinity The significance criteria for H&H are not expected to apply in the Shasta Lake and Vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this PDEIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP5). Change in Frequency of Flows Above 100,000 cfs on the Sacramento River Below Bend Bridge This impact would be similar to Impact H&H-1 (CP1) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP5): Place Housing or Other Structures Within a 100-year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map This impact would be the same as Impact H&H-2 (CP1) and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP5): Place Within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows This impact would be the same as Impact H&H-3 (CP1) and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP5). Change in Water Levels in Old River near Tracy Road Bridge This impact would be the same as Impact H&H-4 (CP3) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-5 (CP5): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier This impact would be the same as Impact H&H-5 (CP3) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-6 (CP5): Change in water levels in Middle River near the Howard Road Bridge This impact would be the same as Impact H&H-6 (CP3) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-7 (CP5): Change in X2 Position This impact would be the same as Impact H&H-7 (CP3) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed..

Impact H&H-8 (CP5): Change in Recurrence of Delta Excess Conditions This impact would be the same as Impact H&H-8 (CP3) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact H&H-9 (CP5): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges This impact would be the same as Impact H&H-9 (CP3) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-10 (CP5): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges This impact would be the same as Impact H&H-10 (CP3) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-11 (CP5): Change in Deliveries to SWP Table A Contractors South of the Delta This impact would be the same as Impact H&H-11 (CP3) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-12 (CP5): Change in Groundwater Levels This impact would be the same as Impact H&H-12 (CP3) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP5): Change in Groundwater Quality This impact would be the same as Impact H&H-13 (CP3) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

6.3.4 Mitigation Measures

Table 6-58 presents a summary of the impacts related to hydrology, hydraulics, and water management. No significant impacts have been identified, and therefore no mitigation measures are proposed.

No-Action Alternative

No feasible mitigation is available to reduce the impacts of changes in level of development or new facility construction. Therefore, these potential impacts would remain significant and unavoidable.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation measures are required for this alternative.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation measures are required for this alternative.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation measures are required for this alternative.

CP4 – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

No mitigation measures are required for this alternative.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation measures are required for this alternative.

Table 6-58. Summary of Mitigation Measures for Hydrology, Hydraulics, and Water Management

Impact		No-Action Alternative	CP1	CP2	CP3	CP4	CP5
Impact H&H-1: Change in Frequency of Flows Above 100,000 cfs on the Sacramento River Below Bend Bridge	LOS before Mitigation	NI	B	B	B	B	B
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	B	B	B	B	B
Impact H&H-2: Place Housing or Other Structures Within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact H&H-3: Place Within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact H&H-4: Change in Water Levels in the Old River near Tracy Road Bridge	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	PS	LTS	LTS	LTS	LTS	LTS
Impact H&H-5: Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	PS	LTS	LTS	LTS	LTS	LTS
Impact H&H-6: Change in Water Levels in the Middle River near the Howard Road Bridge	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	PS	LTS	LTS	LTS	LTS	LTS
Impact H&H-7: Change in X2 Position	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 6-58. Summary of Mitigation Measures for Hydrology, Hydraulics, and Water Management (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4	CP5
Impact H&H-8: Change in Recurrence of Delta Excess Conditions	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	PS	LTS	LTS	LTS	LTS	LTS
Impact H&H-9: Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges	LOS before Mitigation	PS	B	B	B	B	B
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	PS	B	B	B	B	B
Impact H&H-10: Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges	LOS before Mitigation	PS	B	B	B	B	B
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	PS	B	B	B	B	B
Impact H&H-11: Change in Deliveries to SWP Table A, Contractors South of the Delta	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	PS	LTS	LTS	LTS	LTS	LTS
Impact H&H-12: Change in Groundwater	LOS before Mitigation	LTS	B	B	B	B	B
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	B	B	B	B	B
Impact H&H-13: Change in Groundwater Quality	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Notes:
B = beneficial
LOS = level of significance
LTS = less than significant
NI = No Impact
PS = potentially significant

6.3.5 Cumulative Effects

Chapter 3, “Considerations for Describing the Affected Environment and Environmental Consequences” discusses overall cumulative impacts of the project alternatives and, including the relationship to CALFED Programmatic Cumulative Impacts Analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria.

This section provides an analysis of overall cumulative impacts of the project alternatives with other past, present, and reasonably foreseeable future projects producing related impacts.

The projects listed in the quantitative analysis section of Chapter 3, “Considerations for Describing the Affected Environment and Environmental Consequences” are included in the 2030 level of development alternatives above. Accordingly, quantitative effects of the projects combined with the SLWRI alternatives are described in the Environmental Consequences section. The discussion below focuses on the qualitative effect of the SLWRI alternatives and the other past, present, and reasonably foreseeable future projects.

The effects of climate change on operations at Shasta Lake could potentially result in changes to hydrology, hydraulics, and water management. As described in the Climate Change Projection Appendix, climate change could result in higher reservoir releases in the winter and early spring due to an increase in runoff during these times. The change in winter and early spring releases could necessitate managing flood events resulting from potentially larger storms. Similarly, climate change could result in lower reservoir inflows and Sacramento tributary flows during the late spring and summer due to a decreased snow pack. This reduction in inflow and tributary flow could result in Shasta Lake storage being reduced due to both a reduced ability to capture flows, and an increased need to make releases to meet downstream requirements.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As described in Section 6.3.3 above, CP1 would not result in potentially significant impacts.

When combined with other past, present, and reasonably foreseeable future projects, it is likely there would be a change in flows in the Sacramento River. Since Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and Delta, a new project or program along the Sacramento River and in the Delta could potentially affect the hydraulics, hydrology, and water resources of CP1. For instance, if the Shasta River Water Reliability Study (SRWRS) were implemented, Shasta Reservoir would be reoperated, resulting in changes to the Sacramento River flow regime and Delta inflow. However, with the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume there would not be a reduction in flow requirements, or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Even though regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP1 combined with other projects could result in changes to water levels during the irrigation season at a magnitude and frequency that would affect south Delta water users. Accordingly, it is possible that CP1 combined with a number of other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and Delta outflow are primarily products of Delta inflow and export pumping. A previously mentioned, CP1 combined with other projects could result in changes to Delta inflow and export pumping. While CP1 results in very rare changes to either the X2 position or Delta outflow of a magnitude affecting CCWD's ability to fill Los Vaqueros Reservoir, and result in less than significant impacts to the X2 position, it is possible CP1 combined with other projects could result in potentially significant and unavoidable impacts.

As previously described, CP1 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is extremely unlikely that CP1, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to the bases of comparison. Accordingly, there would not be an effect on groundwater levels or groundwater quality. Therefore, CP1, combined with other projects, would likely have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect Shasta Reservoir's ability to fill its flood management obligations. Consequently, when combined with CP1, the cumulative effect would be no impact or a beneficial effect on flood management.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP1 would potentially diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Potential impacts associated with flood management, water supply, south Delta water levels, and groundwater management would be less than significant under CP1. Therefore, even with the addition of anticipated effects of climate change, CP1 would not have a significant cumulative effect, and could be potentially beneficial.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As described in Section 6.3.3 above, CP2 would not result in potentially significant impacts.

When combined with the other past, present, and reasonably foreseeable future projects, it is likely there would be a change in flows in the Sacramento River. Since Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and Delta, a new project or program along the Sacramento River and in the Delta could potentially affect the hydraulics, hydrology, and water resources of CP2. For instance, if the SRWRS were implemented, Shasta Reservoir would be reoperated, resulting in changes to the Sacramento River flow regime and Delta inflow. However, with the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume there would not be a reduction in flow requirements, or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Even though regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP2 combined with other projects could result in changes to water levels during the irrigation season at a magnitude and frequency that would affect south Delta water users. Accordingly, it is possible that CP2 combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and Delta outflow are primarily products of Delta inflow and export pumping. A previously mentioned, CP2 combined with other projects could result in changes to Delta inflow and export pumping. While CP2 results in very rare changes to either the X2 position or Delta outflow of a magnitude affecting CCWD’s ability to fill Los Vaqueros Reservoir, and result in less–than-significant impacts to the X2 position, it is possible CP2 combined with other projects could result in potentially significant and unavoidable impacts.

As previously described, CP2 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is extremely unlikely that CP2, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to the bases of comparison. Accordingly, there would not be an effect on groundwater levels or groundwater quality. Therefore, CP2, combined with other projects, would likely have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect Shasta Reservoir’s ability to fill its flood management obligations. Consequently, when combined with CP2, the cumulative effect would be no impact or a beneficial effect on flood management.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP2 would potentially diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Potential impacts associated with flood management, water supply, south Delta water levels, and groundwater management would be less than significant under CP2. Therefore, even with the addition of anticipated effects of climate change, CP2 would not have a significant cumulative effect, and could be potentially beneficial.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply
As described in Section 6.3.3 above, CP3 would not result in potentially significant impacts.

When combined with the other past, present, and reasonably foreseeable future projects, it is likely there would be a change in flows in the Sacramento River. Since Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and Delta, a new project or program along the Sacramento River and in the Delta could potentially affect the hydraulics, hydrology, and water resources of CP3. For instance, if the SRWRS were implemented, Shasta Reservoir would be reoperated, resulting in changes to the Sacramento River flow regime and Delta inflow. However, with the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume there would not be a reduction in flow requirements, or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Even though regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP3 combined with other projects could result in changes to water levels during the irrigation season at a magnitude and frequency that would affect south Delta water users. Accordingly, it is possible that CP3 combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and Delta outflow are primarily products of Delta inflow and export pumping. A previously mentioned, CP3 combined with other projects could result in changes to Delta inflow and export pumping. While CP3 results in very rare changes to either the X2 position or Delta outflow of a magnitude affecting CCWD’s ability to fill Los Vaqueros Reservoir, and result in less than significant impacts to the X2 position, it is possible CP3 combined with other projects could result in potentially significant and unavoidable impacts.

As previously described, CP3 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is extremely unlikely that CP3, when combined with a number of other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to the bases of comparison. Accordingly, there would not be an effect on groundwater levels or groundwater quality. Therefore, CP3, combined with a number of other projects, would likely have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect Shasta Reservoir's ability to fill its flood management obligations. Consequently, when combined with CP3, the cumulative effect would be no impact or a beneficial effect on flood management.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP3 would potentially diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Potential impacts associated with flood management, water supply, south Delta Water levels, and groundwater management would be less than significant under CP3. Therefore, even with the addition of anticipated effects of climate change, CP3 would not have a significant cumulative effect, and could be potentially beneficial.

CP4 – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

As described in Section 6.3.3 above, CP4 would not result in potentially significant impacts.

When combined with the other past, present, and reasonably foreseeable future projects, it is likely there would be a change in flows in the Sacramento River. Since Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and Delta, a new project or program along the Sacramento River and in the Delta could potentially affect the hydraulics, hydrology, and water resources of CP4. For instance, if the SRWRS were implemented, Shasta Reservoir would be reoperated, resulting in changes to the Sacramento River flow regime and Delta inflow. However, with the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume there would not be a reduction in flow requirements, or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Even though regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP4 combined with other projects could result in changes to water levels during the irrigation season at a magnitude and frequency that would affect south Delta water users. Accordingly, it is possible that CP4 combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and Delta outflow are primarily products of Delta inflow and export pumping. A previously mentioned, CP4 combined with other projects could result in changes to Delta inflow and export pumping. While CP4 results in very rare changes to either the X2 position or Delta outflow of a magnitude affecting CCWD's ability to fill Los Vaqueros Reservoir, and result in less than significant impacts to the X2 position, it is possible CP4 combined with other projects could result in potentially significant and unavoidable impacts.

As previously described, CP4 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is extremely unlikely that CP4, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to the bases of comparison. Accordingly, there would not be an effect on groundwater levels or groundwater quality. Therefore, CP4, combined with other projects, would likely have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect Shasta Reservoir's ability to fill its flood management obligations. Consequently, when combined with CP4, the cumulative effect would be no impact or a beneficial effect on flood management.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP4 would potentially diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Potential impacts associated with flood management, water supply, south Delta water levels, and groundwater management would be less than significant under CP4. Therefore, even with the addition of anticipated effects of climate change, CP4 would not have a significant cumulative effect, and could be potentially beneficial.

CP5 – 18.5-Foot Dam Raise, Combination Plan

As described in Section 6.3.3 above, CP5 would not result in potentially significant impacts.

When combined with the other past, present, and reasonably foreseeable future projects, it is likely there would be a change in flows in the Sacramento River.

Since Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and Delta, a new project or program along the Sacramento River and in the Delta could potentially affect the hydraulics, hydrology, and water resources of CP5. For instance, if the SRWRS were implemented, Shasta Reservoir would be reoperated, resulting in changes to the Sacramento River flow regime and Delta inflow. However, with the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume there would not be a reduction in flow requirements, or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Even though regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP5 combined with other projects could result in changes to water levels during the irrigation season at a magnitude and frequency that would affect south Delta water users. Accordingly, it is possible that CP5 combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and Delta outflow are primarily products of Delta inflow and export pumping. A previously mentioned, CP5 combined with other projects could result in changes to Delta inflow and export pumping. While CP5 results in very rare changes to either the X2 position or Delta outflow of a magnitude affecting CCWD’s ability to fill Los Vaqueros Reservoir, and result in less than significant impacts to the X2 position, it is possible CP5 combined with other projects could result in potentially significant and unavoidable impacts.

As previously described, CP5 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is extremely unlikely that CP5, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to the bases of comparison. Accordingly, there would not be an effect on groundwater levels or groundwater quality. Therefore, CP5, combined with other projects, would likely have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect Shasta Reservoir’s ability to fill its flood management obligations. Consequently, when combined with CP5, the cumulative effect would be no impact or a beneficial effect on flood management.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP5 would potentially diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Potential impacts associated with flood management, water supply, south Delta water levels, and groundwater management would be less than significant under CP5. Therefore, even with the addition of anticipated effects of climate change, CP5 would not have a significant cumulative effect, and could be potentially beneficial.