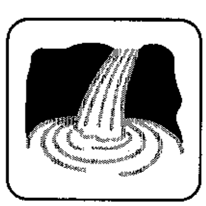
5. Physical Environment

5.1 Water Supply and Water Management

Distribution of the State's water supplies varies geographically and seasonally. Water supplies also vary climatically through cycles of drought and flood. The CALFED Bay-Delta Program would increase the reliability of water supplies and reduce the mismatch between Bay-Delta water supplies and the current and projected beneficial uses that are dependent on the Bay-Delta system.



5.1 Water Supply and Water Management

5.1.1 SUMMARY

The primary water supply reliability objective of the CALFED Bay-Delta Program (Program) is to reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system. Water supplies for agricultural and urban uses from Bay-Delta sources could be reduced under the No Action Alternative if environmental water needs increase or if water project operations are modified to improve drinking water quality. Water supply reliability could be enhanced under the Preferred Program Alternative by increasing the ability to store and transport water, improving the conveyance of water through the Delta, improving the quality of Bay-Delta water supplies, managing demands through increasing conservation and recycling, facilitating water transfer markets, and managing environmental water needs through an Environmental Water Account (EWA).

Water supply reliability could be enhanced under the Preferred Program Alternative by increasing the ability to store and transport water, improving the conveyance of water through the Delta, improving the quality of Bay-Delta water supplies, managing demands through increasing conservation and recycling, facilitating water transfer markets, and managing environmental water needs through an Environmental Water Account.

Preferred Program Alternative. Potential decreases in agricultural and urban water supplies from Bay-Delta sources could result from increased environmental water needs and drinking water quality requirements under the No Action Alternative. These potential consequences may be reduced or eliminated by several strategies included in the Preferred Program Alternative. Implementation of an Environmental Water Account may allow for more efficient use of water for environmental purposes and decrease the conflict in uses of Bay-Delta water supplies. Optimizing the use of alternative water management tools, including water use efficiency measures, water recycling, and water transfers may improve the availability and economic utility of water supplies. Implementing water quality improvement actions may enhance the quality of source water supplies, thereby providing additional operational flexibility to meet water supply reliability and quality goals. Conveyance improvements may also increase the flexibility of water project operations and improve water supply reliability. Finally, completing an Integrated Storage Investigation will help determine the proper role of storage in the context of a comprehensive water management framework. If shown to be appropriate, new storage could provide improved water management capability and enhanced water supply reliability.

Potential long-term adverse impacts on specific regional agricultural and urban water supplies could result from increased water transfers. Areas with adequate water supplies could transfer portions of those supplies to areas with higher economic return from the use of water. Water transfers can affect third parties (those not directly involved in the transaction), local groundwater, environmental conditions, or other resource areas. The Preferred Program Alternative includes mechanisms to provide protection from such impacts. Additional discussion on the potential impacts of water transfers on groundwater resources, agricultural social issues, and regional economics is included in Sections 5.4, 7.3, and 7.10, respectively.

Conversion of Delta land use from agriculture to wetlands and marshes under the Ecosystem Restoration Program could result in increased water use and potential negative impacts on agricultural and urban water supply reliability. The cumulative beneficial effect of all actions under the Preferred Program Alternative, including the Water Quality Program, Water Use Efficiency Program, Water Transfer Program, conveyance improvements, and potential new water storage facilities, is expected to significantly outweigh this potential loss of water supply, resulting in no potentially significant adverse impacts.

Temporary local impacts on water supply reliability could occur during construction of the Program's proposed facilities. Potential temporary interruptions in water supply due to turbidity of water during levee work could negatively impact water supply and water management. This impact can be mitigated to a less-than-significant level.

Alternatives 1, 2, and 3. The potential adverse impacts on water supply reliability and mitigation strategies associated with Alternatives 1, 2, and 3 are largely the same as described for the Preferred Program Alternative. The potential improved water management capability and enhanced water supply reliability could be greater under Alternative 3. Temporary local negative impacts on water supply reliability due to construction of Program facilities also could be greater under Alternative 3.

The following table presents the potentially significant adverse impacts and mitigation strategies associated with the Preferred Program Alternative. Mitigation strategies that correlate to each listed impact are noted in parentheses after the impact. Most potential negative consequences to water supply and water management are addressed through Program actions under the Preferred Program Alternative, as described above, and are not considered potentially significant adverse impacts.

The potential adverse impacts on water supply reliability and mitigation strategies associated with Alternatives 1, 2, and 3 are largely the same as described for the Preferred Program Alternative. The potential improved water management capability and enhanced water supply reliability could be greater under Alternative 3. Temporary local negative impacts on water supply reliability due to construction of Program facilities also could be greater under Alternative 3.

Most potential negative consequences to water supply and water management are addressed through Program actions under the Preferred Program Alternative, as described above, and are not considered potentially significant adverse impacts.

Potentially Significant Adverse Impacts and Mitigation Strategies
Associated with the Preferred Program Alternative

Potentially Significant Adverse Impacts	Mitigation Strategies
Potential temporary local water supply interruptions due to turbidity of water during construction of Program facilities and habitat restoration activities (1).	1. Use best construction and drainage management practices to avoid transport of soils and sediments to waterways.

No potentially significant unavoidable impacts related to water supply and water management are associated with the Preferred Program Alternative.

5.1.2 AREAS OF CONTROVERSY

Under CEQA, areas of controversy involve factors that are currently unknown or reflect differing opinions among technical experts. Unknown information is data that is not available and cannot readily be obtained. The opinions of technical experts can differ, depending on which assumptions or methodology they use. Below is a brief description of the area of controversy for this resource category.

Significant controversy exists over the projected magnitude of future water demands and the appropriate role of Bay-Delta water supplies in meeting those demands.

California's increasing population will result in the need for improved water management to meet growing demands. Significant controversy exists over the projected magnitude of future water demands and the appropriate role of Bay-Delta water supplies in meeting those demands. The following sections discuss the sources of uncertainty contributing to this controversy and the potential for Program elements to address water supply and water management issues.

5.1.2.1 UNCERTAINTIES IN THE ASSESSMENT

The assessment methods used in this programmatic evaluation link estimates of future Delta water demands, the primary area of uncertainty related to water supply and water management, to Program actions. Future Delta water demands are influenced by, among other things, population growth, future land use changes, and future environmental water requirements. Uncertainty in future water demands is attributable to:

Future Delta water demands are influenced by, among other things, population growth, future land use changes, and future environmental water requirements.

- Limited ability to forecast population growth, its geographic distribution, and changes in per capita water use due to socioeconomic factors and implementation of new water conservation measures.

- Limited ability to forecast agricultural land use changes (for example, shifts in cropping patterns, conversions to wetlands and marshes) and implementation of more efficient water management practices.

- Limited ability to forecast the ability of water users to implement other water management options such as new water recycling facilities or to acquire water through transfers.

- Limited ability to forecast the rate of recovery of the Bay-Delta ecosystem resulting from adaptively managed Program actions, leading to uncertainty in future environmental water requirements.

5.1.2.2 ADDRESSING UNCERTAINTY

The Program recognizes the importance of water supply reliability to regions potentially affected by Program actions. Although there are disagreements about the magnitude of future Delta water demands and the need for water supply facilities to meet these demands, the fact that water supply reliability is important to California is not an issue.

Water supply reliability evaluations rely on the development of assumptions and methodologies that may result in disagreements among technical experts and, therefore, constitute areas of controversy as used in CEQA. The use of different assumptions and methodologies may lead to conclusions that overestimate or underestimate the need for additional water supply facilities. Uncertainty in future Delta water demands is addressed in the assessment method through "bookending" the potential level of future demands and new storage facilities. This approach is described in Section 5.1.4.

Uncertainty in future Delta water demands is addressed in the assessment method through "bookending" the potential level of future demands and new storage facilities.

New storage facilities are considered in this programmatic evaluation, together with aggressive implementation of water conservation, recycling, and a protective water transfer market. Each Program alternative is evaluated with and without new storage facilities. Future decisions regarding new or expanded surface and/or groundwater storage will be made in the context of the Program's water management strategy and will be predicated upon complying with all Program linkages, including:

- Completion of the Integrated Storage Investigation which includes an assessment of groundwater storage, surface storage, reoperaion of power facilities and a fish barrier assessment.

- Demonstrated progress in meeting the Program's water use efficiency, water recycling, and water transfer program targets.

- Implementation of groundwater monitoring and modeling programs.

- Compliance with all environmental review and permitting requirements.

The total volume of new surface and groundwater storage considered in this evaluation ranges up to 6.0 MAF. Facility locations considered are in the Sacramento and San Joaquin Valleys and in the Delta.

5.1.3 AFFECTED ENVIRONMENT/ EXISTING CONDITIONS

This section discusses existing water supply and water management conditions in the Program study area. Existing conditions are characterized for each of the five regions defined within the study area. The regions used to describe water supply and water management are different from the regions used for analysis elsewhere in this document. The five Program regions described in Section 1.4.1 include: Delta, Bay, Sacramento

The regions used to describe water supply and water management are different from the regions used for analysis elsewhere in this document.

River, San Joaquin River, and Other SWP and CVP Service Areas. As defined in Section 1.4.1, the San Joaquin River Region receives water supplies from Delta tributaries and Delta exports. Water supply and water management impacts on these supply sources are distinct and not readily aggregated. On the other hand, Delta water supplies exported to the SWP and CVP Service Areas within the San Joaquin River Region and outside of the Central Valley are more readily aggregated for this programmatic evaluation. For these reasons, the boundaries of San Joaquin River Region and the Other SWP and CVP Service Areas were modified for analysis of water supply and water management. In this section, the San Joaquin River Region includes only those areas receiving water supplies directly from the San Joaquin River and its tributaries. The Other SWP and CVP Service Areas region is redefined as South-of-Delta SWP and CVP Service Areas, and includes all areas south of the Delta that receive Delta exports from the state and federal water projects.

Distribution of the State's water supplies varies geographically and seasonally. Water supplies also vary climatically through cycles of drought and flood. California's water development has generally been in response to managing this variability.

Distribution of the State's water supplies varies geographically and seasonally. Water supplies also vary climatically through cycles of drought and flood. California's water development has generally been in response to managing this variability. Figure 5.1-1 shows the location of some of the major surface water project facilities in the Program study area.

Average annual statewide precipitation is about 23 inches, corresponding to a water supply of nearly 200 MAF over California's land surface. About two-thirds of this precipitation is consumed through evaporation and transpiration by trees and other plants. The remaining one-third comprises the state's average annual runoff of about 71 MAF. Less than half this runoff is depleted by urban and agricultural use.

5.1.3.1 DELTA REGION

Several important water management facilities are located in the Delta. These include the CVP Pumping Plant at Tracy, the Delta Cross Channel at Walnut Grove, the SWP Clifton Court Forebay and Banks Pumping Plant, the SWP North Bay Aqueduct Pumping Plant, and the Contra Costa pumping plants at Rock Slough and Old River.

Several important water management facilities are located in the Delta. These include the CVP Pumping Plant at Tracy, the Delta Cross Channel (DCC) at Walnut Grove, the SWP Clifton Court Forebay (CCFB) and Banks Pumping Plant, the SWP North Bay Aqueduct (NBA) Pumping Plant, and the Contra Costa pumping plants at Rock Slough and Old River.

The CVP Tracy Pumping Plant has a maximum capacity of approximately 4,600 cfs, the nominal capacity of the Delta-Mendota Canal (DMC) at the pumping plant. The SWP Banks Pumping Plant supplies water for the South Bay Aqueduct (SBA) 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 maximum of 6,680 cfs, except between December 15 and March 15, when exports can be increased by 33% of San Joaquin River flow (if greater than 1,000 cfs). The SWP also pumps water from Barker Slough into the NBA for use in the Bay Region. While the maximum pumping capacity at Barker Slough is 175 cfs, the average annual pumping rate is approximately 35 cfs.

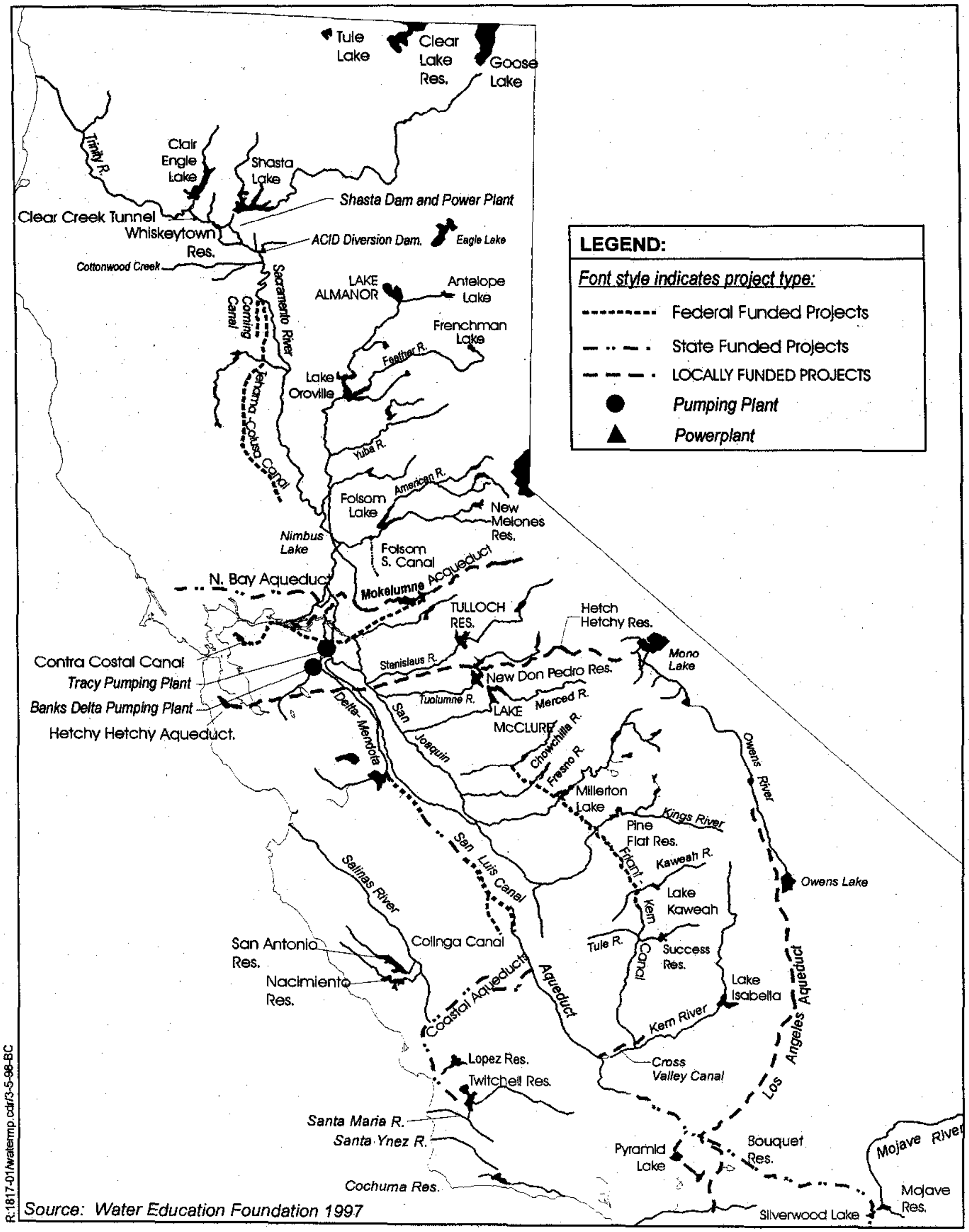


Figure 5.1-1 Surface Water Features Location Map

CCWD recently completed construction of the Los Vaqueros Reservoir and a second pumping plant on Old River. These facilities will provide CCWD with access to improved water quality and emergency water supplies. Los Vaqueros will be refilled by diversions only when source water chloride concentration is less than 65 milligrams per liter (mg/L). Los Vaqueros water will be used for delivery during low Delta outflow periods, when chloride concentration at Rock Slough and Old River is greater than 65 mg/L.

Delta inflow from the tributary basins is allocated to supply in-Delta diversions for agricultural and municipal water use, provide minimum Delta outflow required to satisfy 1995 WQCP and CVPIA objectives, and allow Delta exports within the 1995 WQCP export/inflow ratio and the permitted pumping capacity. Inflow that exceeds these uses contributes to total Delta outflow. Some Delta exports are used for direct deliveries to satisfy water supply demands and some of the exports are stored in San Luis Reservoir (or other local water storage facilities) for later delivery.

Average annual in-Delta use, Banks and Tracy Delta exports, and total Delta outflow under simulated 1995-level (existing) conditions are summarized in Table 5.1-1. Water supply comparisons are made here and elsewhere in the document based upon a 73-year historical hydrologic period, a sequence of years often referred to as the "long-term" period. Similar comparisons are made using a subset of the long-term period—the dry and critical years. Over the long-term period, 28 years are classified as dry or critical by the Sacramento Valley 40-30-30 Index.

Table 5.1-1. Delta Water Supply and Water Management under Existing Conditions (MAF)

MANAGEMENT COMPONENT	LONG-TERM PERIOD	DRY AND CRITICAL YEARS	RANGE
In-Delta use	1.0	1.1	0.06-1.3
Banks and Tracy exports	5.6	4.6	3-8
Total Delta outflow	14.8	6.0	4-70

Long-term period average annual Delta inflow is about 22 MAF under existing conditions, with a range of less than 8 MAF to more than 74 MAF. Dry and critical year Delta inflow averages about 12 MAF annually under existing conditions.

Long-term period average annual Delta inflow is about 22 MAF under existing conditions, with a range of less than 8 MAF to more than 74 MAF.

5.1.3.2 BAY REGION

The most prominent water-related feature in the Bay Region is San Francisco Bay. The San Francisco Bay system includes the Suisun, San Pablo, and South Bays. The outlet of San Francisco Bay at Golden Gate Bridge is located 74 kilometers (km) from Chipps Island, the approximate location of the confluence of the Sacramento and San Joaquin Rivers and the beginning of Suisun Bay. To the north of Suisun Bay and east of Carquinez Strait lies the Suisun Marsh, an extensive mosaic of variably-controlled tidal marshlands.

The San Francisco Bay system includes the Suisun, San Pablo, and South Bays.

San Francisco Bay receives freshwater flow from the Sacramento and San Joaquin Rivers in the Delta Region. Delta outflow provides the Bay with ecological and water quality benefits. In addition to Delta outflow, San Francisco Bay receives freshwater inflow from several streams, including the Napa, Petaluma, and Guadalupe Rivers and the Alameda, Coyote, Walnut, and Sonoma Creeks. The average annual Bay inflow from these tributaries, excluding Delta outflow, is about 350 TAF. Inflow from these tributaries is highly seasonal, with more than 90% of the annual runoff occurring between November and April.

Levees were constructed to convert formerly flooded marshlands to arable islands. Valley lands were drained for farming and Central Valley streams were dammed for water supply. Hydraulic mining in the Sierra foothills washed large amounts of sediment into streams and channels leading to the Bay. Untreated municipal and industrial wastes were discharged directly into the Bay. All of these activities caused changes in the quantity and quality of water reaching the Bay.

Many streams in the Bay Region have been channelized through urban areas for flood protection, and most streams are intermittent. In most areas, urban water supplies are imported and stored locally in reservoirs. Activities in the watersheds of these reservoirs are restricted to protect public water supplies.

5.1.3.3 SACRAMENTO RIVER REGION

The Sacramento River Region contains the entire drainage area of the Sacramento River and its tributaries and extends almost 300 miles from Collinsville in the Delta north to the Oregon border. The total land area within the region is 26,960 square miles. Average annual precipitation is 36 inches, and average annual runoff is approximately 22 MAF. The most intensive runoff occurs in the upper watershed of the Sacramento River above Lake Shasta and on the rivers originating on the west slope of the Sierra Nevada. These watersheds produce an annual average of 1 to more than 2 TAF of runoff per square mile.

> The Sacramento River Region contains the entire drainage area of the Sacramento River and its tributaries and extends almost 300 miles from Collinsville in the Delta north to the Oregon border.

The two major tributaries to the Sacramento River along its lower reach are the Feather River (which also includes flows from the Yuba River) and the American River. The combined flows of the Feather River and Sutter Bypass enter the river near Verona. The American River joins the Sacramento River north of downtown Sacramento. Smaller contributions are made by the Natomas Cross Canal, draining the area between the Bear River and American River drainages, and the Colusa Basin Drain, which drains the west side of the Sacramento Valley from about Willows south to Knights Landing.

> The Sacramento River Region contributes the majority of Delta inflow.

The Sacramento River Region contributes the majority of Delta inflow. Unimpaired flow from the four major rivers in the Sacramento River Region (Sacramento, Feather, Yuba, and American Rivers) averaged 17.9 MAF and ranged from 5.1 to 37.7 MAF during the 1906-1996 period. Of this, the Sacramento River (at Red Bluff) averaged 8.4 MAF (including Trinity River imports, described below), the Feather River averaged 4.5 MAF, the Yuba River averaged 2.4 MAF, and the American River averaged 2.6 MAF.

Since 1900, numerous reservoirs have been constructed in or have affected this region. These include Shasta, Oroville, Trinity, and Folsom, as well as numerous smaller reservoirs. Total reservoir capacity in or affecting the Sacramento River Region is approximately 15 MAF. Historically, these reservoirs have been operated to provide agricultural and domestic water supplies, flood control capacity and, more recently, recreation and ecological flows.

The Sacramento, Feather, and American River systems are described in greater detail below. River sections most likely to be affected by the Program include the Sacramento River below Lake Shasta, the Feather River below Lake Oroville, and the American River below Folsom Lake.

Sacramento River

The Sacramento River watershed upstream of Lake Shasta has an area of about 6,420 square miles. Lake Shasta stores and releases flows of the Sacramento, Pit, and McCloud Rivers. Shasta Dam is a 602-foot-high concrete gravity structure providing a storage capacity of approximately 4.5 MAF. Water can be released from Lake Shasta through the powerhouse, the low-level or high-level river outlets, or the spillway.

The Sacramento River watershed upstream of Lake Shasta has an area of about 6,420 square miles.

The average annual inflow to Lake Shasta is about 5.9 MAF. Inflows generally increase from November through March, with peak flows generally occurring in March. As snowmelt is not a dominant component of Lake Shasta inflows, inflows generally decrease in April and May, and are less than 5,000 cfs from June through October. The flows in these summer and fall months are relatively constant (between 3,000 and 4,000 cfs) because the volcanic geology of the watershed provides a large groundwater component that sustains the streamflow.

Maximum storage occurs in April or May, following the months with highest runoff. The reservoir's springtime storage level is reduced in wet years to provide greater flood control space. Lake Shasta storage usually decreases from May through September, and usually increases from January through April. The seasonal storage and subsequent releases from Lake Shasta average about 1.5 MAF. Shasta also provides some year-to-year carryover storage in drought periods. Average annual Shasta carryover storage is 2.8 MAF and has varied from a maximum of 3.7 MAF in 1974 to a minimum of 630 TAF in 1977.

The Sacramento River watershed upstream of the Feather River is about 14,050 square miles. The annual runoff upstream of the Feather River is about 11 MAF. About half of this runoff is potentially controllable in Shasta and the other half is runoff from the downstream tributaries. The downstream tributaries have very limited reservoir storage; therefore, runoff follows the natural (unimpaired) pattern.

The Trinity River watershed upstream of Lewiston Lake has a drainage area of about 692 square miles and an average annual basin runoff of 1.2 MAF. The Trinity River Division of the CVP develops water supply for export to the Sacramento River Region. In addition to Lewiston Lake, the principal features of the Trinity Division are the 2.4-MAF Trinity Lake, Clear Creek Tunnel, Spring Creek Tunnel and Powerplant, and Whiskeytown Lake.

The Trinity River watershed upstream of Lewiston Lake has a drainage area of about 692 square miles and an average annual basin runoff of 1.2 MAF.

The maximum storage in Trinity Lake is currently limited between 1.8 MAF (end of October) and 2.1 MAF (end of March) to provide necessary flood control storage. An annual drawdown of 500-800 TAF usually occurs during summer and fall. Annual average carryover storage is about 1.7 MAF and has varied from a maximum of 2.2 MAF in 1983 to a minimum of 240 TAF in 1977.

Whiskeytown Lake, located on Clear Creek, has a storage capacity of approximately 240 TAF. Although Whiskeytown Lake collects some natural inflow from Clear Creek, most of its inflow comes from Trinity River exports. Whiskeytown is operated with only limited seasonal storage fluctuations. Annual releases to Clear Creek of about 100 TAF provide in-stream flows and some downstream diversions. Some water supply diversions are made directly from Whiskeytown Lake. Most Trinity River exports and Clear Creek inflows are diverted through the Spring Creek Tunnel and Powerhouse to Keswick Reservoir.

Keswick Reservoir, a 159-foot-high concrete gravity structure, is located 8 miles downstream of Lake Shasta. With a storage capacity of approximately 25 TAF, Keswick is a regulating reservoir for releases from the Spring Creek and Shasta Powerhouses. Storage and elevation in Keswick Reservoir are maintained by concurrent operation of the powerhouses. The Keswick Powerhouse has a capacity of approximately 16,000 cfs.

Although in-stream flow requirements are specified downstream of Keswick Reservoir, they are generally less than 5,000 cfs and rarely control releases. In-stream flow requirements include the 1993 Biological Opinion for winter-run chinook salmon and the Sacramento River navigation control point (NCP). Additional summer and fall releases for temperature control between Keswick and Red Bluff were made beginning in 1991. These releases concluded in 1997 with the completion of the Shasta Dam Temperature Control Device. The regulated Keswick releases are much higher than unimpaired flows during the summer irrigation season.

The Red Bluff Diversion Dam (RBDD) is located on the Sacramento River just downstream of Red Bluff. Diversions are made to the Tehama-Colusa and Corning Canals from upstream of the RBDD, with a maximum annual diversion of about 600 TAF. Higher diversion rates to these canals are possible when the RBDD gates are closed; however, closure of the gates impacts passage of winter-run chinook salmon. Due to these concerns, the RBDD gates are closed only from May 15 through September 15. While the gates are open at the beginning and end of the irrigation season, diversions are limited to a pumping capacity of about 450 cfs. Several smaller diversions occur between Keswick and Red Bluff. Some water for the Tehama-Colusa Canal is obtained from Stony Creek (Black Butte Reservoir) when excess water is available.

Diversions are made to the Tehama-Colusa and Corning Canals from upstream of the Red Bluff Diversion Dam with a maximum annual diversion of about 600 TAF.

The major diversion downstream of Red Bluff is the Glenn-Colusa Irrigation District's Glenn-Colusa Canal, located downstream of Hamilton City, with an annual diversion of about 800 TAF. Several additional diversions along the Sacramento River result in a combined annual diversion of about 1.9 MAF. Annual diversions for the entire Sacramento River Region above the Feather River mouth are approximately 3.3 MAF.

Feather River

The Feather River is a major tributary to the Sacramento River, with a drainage area of about 4,255 square miles. Originating in the volcanic formations of the Sierra Nevada, the Feather River flows southwest to Lake Oroville and is joined by the Yuba and Bear

The Feather River is a major tributary to the Sacramento River, with a drainage area of about 4,255 square miles.

Rivers. The Yuba River joins the Feather River at the City of Marysville; the confluence with the Bear River is approximately 15 miles downstream of Marysville.

The average flow of the Feather River at Oroville is about 5,800 cfs. Both rainfall and snowmelt contribute to an unimpaired runoff that exceeds 2,000 cfs from January through June. Summer flow is sustained at about 1,000 cfs because of snowmelt and groundwater from the high-elevation watersheds. Upstream reservoirs contribute some seasonal storage that reduces runoff in spring and increases flow in summer and fall. Average annual unimpaired inflow to Lake Oroville is estimated at about 4.3 MAF. Due to several small upstream diversions, actual average annual inflow is about 4.0 MAF.

Lake Oroville has a storage capacity of approximately 3.5 MAF. Completed in 1968, the lake functions as the major storage facility for the SWP. Maximum storage at Oroville is achieved in the early summer months following spring runoff from snowmelt. The average annual storage diversion and release is approximately 1 MAF, with an average carryover storage of 2.2 MAF. Carryover storage was less than 1 MAF in 1977 and 1990.

Minimum flows in the Lower Feather River are established by a 1983 agreement between the DFG and DWR. The agreement provides for minimum flow standards between October and March for preservation of salmon spawning and rearing habitat. Current requirements are 1,700 cfs below Thermalito Afterbay from October to March and 1,000 cfs from April to September (some reductions are allowed in dry years). A maximum of 2,500 cfs is maintained in October and November to prevent spawning in overbank areas that might become dewatered. The flow requirements at Gridley range from 600 TAF in dry years to about 1 MAF in wet years.

In the past, substantial irrigation diversions were made from the Feather River in the vicinity of Oroville. These diversions are now made from the Thermalito complex. The maximum monthly diversions from Thermalito (approximately 150 TAF) are made during the May through August irrigation season. Annual Thermalito diversions are slightly less than 1 MAF.

The Yuba River drains a watershed of about 1,350 square miles of the western slope of the Sierra Nevada and is the major tributary to the Feather River. The average annual unimpaired runoff is about 2.3 MAF, with a range of 0.4 to 4.9 MAF. Several reservoirs have been constructed within the watershed. Englebright Dam, the lowermost dam, was completed in 1941. The major storage reservoir is New Bullards Bar on the North Fork, with a storage capacity of about 1 MAF and a watershed area of 490 square miles. More than 15 other reservoirs have a combined storage capacity of 400 TAF. A major portion of the Yuba watershed is unregulated, however, and very high flows are released from Englebright during major storms.

The Yuba River drains a watershed of about 1,350 square miles of the western slope of the Sierra Nevada and is the major tributary to the Feather River.

The major diversions from the Yuba River are made at or near Daguerre Dam by six water districts from three diversions. Several small unscreened diversions are downstream of Daguerre. Annual average diversions from the Yuba River are about 500 TAF. Yuba River minimum flows are maintained below Engelbright Reservoir.

The Bear River, the second largest tributary to the Feather River, has an average annual unimpaired runoff of about 270 TAF. Flows in the Bear River watershed are almost totally regulated by several storage and diversion facilities. The largest impoundment in the Bear River watershed is Camp Far West Reservoir, with a storage capacity of 100 TAF. Other small impoundments include Rollins Reservoir and Lake Combie, which store an additional 70 TAF. Approximately eleven Pacific Gas & Electric Company (PG&E) power plants with their forebays and afterbays also regulate Bear River flows.

The Bear River, the second largest tributary to the Feather River, has an average annual unimpaired runoff of about 270 TAF.

As part of the hydroelectric project operations in the Bear River, water is exchanged with the Yuba River and American River basins. Water from the South Fork Yuba River is conveyed by the Drum Canal into the Drum Forebay on the Bear River. The average annual flow through the Drum Canal is about 370 TAF. Water from the North Fork of the American River, diverted through Lake Valley Canal, also flows into the Drum Forebay. Average annual flow through the Lake Valley Canal is about 12 TAF.

From the Drum Forebay, water is diverted to two locations. The first is Canyon Creek, where the water either supplies the Alta Powerhouse or flows back into the American River. Portions of the Alta Powerhouse discharge may be diverted to the Bear River. The second diversion from the Drum Forebay is to Drum Powerhouses 1 and 2. All discharge from these power plants flows into the Bear River.

American River

The American River is another major tributary of the Sacramento River, entering just north of Sacramento. The American River drains a watershed of about 1,900 square miles that covers the western Sierra Nevada and foothills with three major branches: the South Fork, Middle Fork, and North Fork. Maximum elevations are about 10,000 feet, and a substantial portion of the runoff results from snowmelt.

The American River is another major tributary of the Sacramento River, entering just north of Sacramento. The American River drains a watershed of about 1,900 square miles.

The 13 largest reservoirs on the American River have a total storage capacity of about 2 MAF. Folsom Lake was constructed in 1956 and is the largest reservoir on the American River, with a storage capacity of about 1 MAF. Nimbus Dam, a regulating reservoir constructed downstream of Folsom Dam and about 23 miles upstream of the mouth, provides diversions to the Folsom South Canal.

Average annual inflow to Folsom Lake is about 2.6 MAF. Average annual storage diversion and release is about 460 TAF. Average Folsom carryover storage is about 560 TAF. The required flood control storage is dependent on upstream storage. Additional flood control space has been provided in recent years to increase flood protection along the American River.

Because summer releases are made into the Lower American River from Folsom to meet local demands and Delta export, outflow, and water quality requirements, summer and fall flows are much higher than unimpaired flows. (On an annual average, actual flow is about the same as the unimpaired flow.) Average annual diversions, totaling about 400 TAF under 1995-level conditions, are made from Folsom Lake, Folsom South Canal, and the Lower American River. Annual diversions from Folsom Lake are about 210 TAF.

Annual diversions from Folsom South Canal are about 70 TAF and Lower American River diversions are about 120 TAF. The seasonal diversion pattern is governed by municipal water supply uses along the American River. The two largest diversions are the San Juan Water District located in Folsom Lake and the City of Sacramento's Fairbairn Treatment Plant located about 7 miles upstream of the mouth of the American River.

In-stream flow requirements were established in the SWRCB's Decision- (D-) 893. The decision specifies 500 cfs during the fall spawning season and 250 cfs for the remainder of the year. Only during extreme droughts have American River flows been this low. DFG has determined that these flows are insufficient to maintain anadromous fishery resources. SWRCB's D-1400, following hearings from the proposed Auburn Dam, specified higher releases from Nimbus should the Auburn Dam be constructed. D-1400 flows are 1,250 cfs from October 15 to July 15, with 800 cfs for the remainder of the year. A 1990 court order (Hodge Decision) specified American River flow conditions that must be satisfied before allowing EBMUD to divert any water from the Folsom South Canal. The court-required flows for EBMUD diversions are 2,000 cfs from October 15 through February 28, 3,000 cfs from March 1 through June 30, and 1,750 cfs between July 1 and October 14.

Current Folsom operations use a relationship between storage and projected inflow to determine in-stream flow requirements.

Current Folsom operations use a relationship between storage and projected inflow to determine in-stream flow requirements. At relatively high storage and projected inflow values, in-stream flow requirements are set at the maximum Anadromous Fish Restoration Program (AFRP) monthly targets. As storage and projected inflow decreases, the in-stream flow requirements are reduced. This provides an adaptive balance between available water and in-stream flow benefits. During high flow periods, in-stream requirements are 2,500 cfs between July and February and 4,500 cfs between March and June. The maximum in-stream flow requirement is therefore about 2.3 MAF; however, the average in-stream flow requirement is about 1.5 MAF.

5.1.3.4 SAN JOAQUIN RIVER REGION

The San Joaquin River Region includes the Central Valley south of the watershed of the American River. It is generally drier than the Sacramento River Region, and flows into the Delta from the San Joaquin River are considerably lower than those into the Delta from the Sacramento River.

The San Joaquin River Region includes the Central Valley south of the watershed of the American River. It is generally drier than the Sacramento River Region, and flows into the Delta from the San Joaquin River are considerably lower than those into the Delta from the Sacramento River. The region is also subject to extreme variations in flow, as exemplified by flooding that occurred during January 1997.

Inflows from the Merced, Tuolumne, and Stanislaus Rivers historically contribute over 60% of the flows in the San Joaquin River, as measured at Vernalis.

The drainage area of the San Joaquin River above Vernalis is 13,356 square miles, including 2,100 square miles of drainage contributed by the James Bypass. Most of the inflow to the San Joaquin River region originates from the upper watershed tributary streams between the Mokelumne River and the San Joaquin River, on the west slope of the Sierra Nevada. Runoff intensity averages less than 1 TAF per square mile in this region. Inflows from the Merced, Tuolumne, and Stanislaus Rivers historically contribute over 60% of the flows in the San Joaquin River, as measured at Vernalis. Average annual precipitation in the lower reach of the river ranges from 10 to 12 inches per year.

The upper watershed of the San Joaquin River Region has historically been less developed than that of the Sacramento River Region, although the same general process of development has occurred, including mining, logging, housing construction, industrial development, and dam construction. As in the Sacramento River Region, the upper watershed contains major parks and wilderness areas. Most development has occurred in the lower foothills, near or below the snow line.

Annual average unimpaired runoff from the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers is about 5.5 MAF. Numerous dams and diversions have been constructed on these rivers and other rivers in this system. Of the 5.5 MAF of unimpaired runoff, about 3.5 MAF is diverted from the major rivers of the San Joaquin system. An average of about 3 MAF annually reaches Vernalis and contributes to Delta inflows. The Upper San Joaquin, Stanislaus, Tuolumne, and Merced River systems are described in more detail below.

Upper San Joaquin River

The Upper San Joaquin River has average unimpaired flows of about 1.7 MAF, with a range of 360 TAF to 4.6 MAF, from an area of approximately 1,638 square miles. Historically, about 70% of the river's runoff has been diverted to the Friant-Kern and Madera canals, primarily for agricultural uses. About 20% of historical water uses have been supplied from reservoir releases. Peak runoff caused by snowmelt occurs in May and June. Rainfall storms cause only moderate runoff from December through March. Late-summer and fall inflows are relatively low; the median flow is less than 100 TAF from September through February.

Historically, about 70% of the Upper San Joaquin River's runoff has been diverted to the Friant-Kern and Madera canals, primarily for agricultural uses.

The Upper San Joaquin River, originating in the Sierra Nevada, is regulated by a series of small hydroelectric projects and Friant Dam which forms Millerton Lake. Millerton Lake was constructed by U.S. Bureau of Reclamation (Reclamation) in 1941. From Friant Dam, the Madera Canal conveys water north and the Friant-Kern Canal conveys water south to the Bakersfield area. These two canals divert most of the water entering Millerton Lake.

Several reservoirs upstream of Millerton Lake have a combined storage capacity of about 600 TAF. Millerton Lake stores runoff from the Upper San Joaquin River and has a storage capacity of approximately 520 TAF. Because most of the water entering Millerton Lake is diverted through the Madera Canal and from the Friant-Kern Canals, river releases from Friant Dam are typically small, although they may increase during storm events and when runoff is large enough to require spilling. Because most of the San Joaquin River flow is now diverted at Friant Dam, diversions for previous water users (exchange contractors) along the San Joaquin River are now supplied by water pumped at the Tracy Pumping Plant from the Delta into the DMC to the Mendota Pool.

Millerton Lake is typically drawn below 200 TAF in fall and reaches a maximum of about 400 TAF in summer. The lake provides limited annual carryover storage of about 180 TAF. This carryover storage generally provides only small releases the following year.

Monthly diversions from the Upper San Joaquin River generally peak in July with a median diversion of approximately 225 TAF. The Friant-Kern and Madera canals support the largest diversions in the Upper San Joaquin River. Some of the water diverted by these canals during wet years is used for groundwater recharge. Annual diversions range from about 200 TAF to more than 2 MAF in several years, with an average of about 1.2 MAF.

Below Friant Dam, median San Joaquin River flow is over 620 TAF annually. In most years, release flows peak during summer. Monthly flow below the dam ranges from about 5 TAF (10^{th} percentile) to about 280 TAF (90^{th} percentile). No in-stream flow requirements exist for the San Joaquin River between Friant Dam and the Merced River. Downstream riparian diversions at Gravelly Ford are estimated to require about 100 TAF per year.

Stanislaus River

The Upper Stanislaus River's drainage area is approximately 1,804 square miles. The average annual unimpaired runoff is about 1.1 MAF, with a range of 155 TAF to more than 2 MAF. Peak snowmelt runoff occurs between April and June. Rainfall runoff generally occurs between November and March. Late summer and fall unimpaired flows are relatively low; the median flow is less than 200 cfs from July through October. Runoff from the upper watershed generally is captured and released for irrigation diversions. Total annual flows on the Stanislaus River average approximately 1.2 MAF. Average annual flow near the mouth of the Stanislaus River is about 680 TAF.

The Upper Stanislaus River's drainage area is approximately 1,804 square miles. The average annual unimpaired runoff is about 1.1 MAF, with a range of 155 TAF to more than 2 MAF.

The largest reservoir on the Stanislaus River is New Melones, which was completed by the Corps in 1978 and is operated by Reclamation. The reservoir was first filled in 1983 and remained at fairly high storage levels through 1986. The reservoir storage then declined from 1987 through 1991 during the drought. In wet years, when inflows are greater than beneficial uses, New Melones Reservoir storage increases to the flood control capacity. (The reservoir filled to capacity in 1993.) During summer months, storage releases from New Melones are needed to supply beneficial uses along the Stanislaus River.

Tulloch Reservoir has a storage capacity of about 70 TAF. Releases from Tulloch Powerhouse flow downstream to Goodwin Dam, where diversions are made into the Oakdale and South San Joaquin canals. More than 40 small pump diversions along the Stanislaus River supply irrigation water during spring and summer.

Water allocation has been approximately 200 TAF for in-stream flow use and about 500 TAF for diversions. Additional releases for downstream water quality control have been made since 1982. Releases were made prior to 1982 for flood control purposes. Maximum monthly diversions are about 100 TAF during the irrigation season from May through August.

Salmon spawn in the 23-mile reach between Goodwin Dam and Riverbank, and rear in the entire Lower Stanislaus River. Current in-stream flow requirements vary from about 135 cfs (average in dry years) to about 415 cfs (average in wet years). Water quality releases during the irrigation months increase average flow by 200 cfs. DFG and the AFRP recommend additional spring flow for outmigration. The AFRP suggests an adaptive management framework, with releases that depend on available water supply. Because of water rights and contract obligations, additional in-stream flow requirements may be difficult to meet in some years.

Tuolumne River

The Tuolumne River has a watershed of about 1,900 square miles that drains the Sierra Nevada Mountains and foothills, including the north half of Yosemite National Park. The average annual unimpaired runoff of the Tuolumne River is about 1.8 MAF and ranges from 380 TAF to about 4.6 MAF. Peak snowmelt runoff occurs between April and June. Rainfall can cause substantial runoff from December through March. Late summer and fall inflows are relatively low; the median inflow is less than 50 TAF (800 cfs) from July through December.

The Tuolumne River has a watershed of about 1,900 square miles that drains the Sierra Nevada Mountains and foothills, including the north half of Yosemite National Park. The average annual unimpaired runoff of the Tuolumne River is about 1.8 MAF and ranges from 380 TAF to about 4.6 MAF.

Over 2.5 MAF of storage capacity has been constructed on this river. Water is impounded and regulated by several dams in the high Sierra for municipal water supply and power generation. The Hetch-Hetchy Reservoir (located in Yosemite National Park), with a capacity of about 360 TAF, was constructed by the City and County of San Francisco in 1923 for drinking water supply. Cherry Lake (260-TAF capacity) was completed in 1953 to increase the aqueduct yield.

Downstream of the San Francisco facilities, the Tuolumne River is impounded and regulated by New Don Pedro Reservoir. New Don Pedro Reservoir was completed in 1971 by the Turlock and Modesto Irrigation Districts to increase the reliability of water supply diversions. New Don Pedro Reservoir has a capacity of about 2 MAF and allows the diversion of about 900 TAF each year from La Grange Dam, located downstream of New Don Pedro Reservoir.

Annual Tuolumne River inflow to New Don Pedro Reservoir is about 1.5 MAF. Of this, about 900 TAF is used for diversions and 200 TAF is used for in-stream flows. The inflow to New Don Pedro Reservoir is affected by San Francisco's upstream reservoirs and diversions. Annual average storage releases are 420 TAF and range from 90 to 910 TAF. Average carryover storage is 1.2 MAF.

La Grange Dam is the upstream limit for anadromous fish on the Tuolumne River. Salmon spawn in the 25-mile reach between La Grange Dam and the town of Waterford, and rear in the entire Lower Tuolumne River. Based on historical records between 1970 and 1997, median monthly flow below La Grange Dam is about 230 cfs and ranges between 10 cfs (10^{th} percentile) and 3,100 cfs (90^{th} percentile).

Almost all diversions from the Tuolumne River below New Don Pedro Reservoir are made by the Modesto and Turlock Irrigation Districts. Maximum diversions generally peak in July with a median diversion of approximately 180 TAF. The combined annual diversions made by these two irrigation districts range from 440 TAF to about 1.1 MAF, with an average of about 900 TAF.

In-stream flow requirements for the New Don Pedro hydropower FERC license were revised in 1997. The flows are specified for the October-to-March salmon spawning and rearing season, the April and May outmigration pulse, and the summer steelhead rearing season. The salmon rearing flows vary from 80 to 300 cfs, with pulse flows of 500-3,000 cfs. The summertime steelhead rearing flows vary from 50 to 200 cfs.

Merced River

The Merced River has a watershed of about 1,275 square miles and drains the Sierra Nevada Mountains and foothills, including the southern half of Yosemite National Park (Yosemite Valley). The Merced River has average unimpaired flows of about 1 MAF, with a range of 150 TAF to more than 2 MAF. Peak snowmelt runoff occurs from April through July. Rainfall storms can cause substantial runoff from December through March. Late-summer and fall unimpaired flows are relatively low; the median flow is less than 100 cfs from August through October. The highest flows occur during winter, when rainfall storms require reservoir flood control releases. The unimpaired flows generally are captured and released for irrigation diversions. Summer flows at Stevinson are generally less than 50 cfs, and median flows during the October-to-March salmon spawning and rearing season are between 250 and 500 cfs.

The Merced River has a watershed of about 1,275 square miles and drains the Sierra Nevada Mountains and foothills, including the southern half of Yosemite National Park (Yosemite Valley). The Merced River has average unimpaired flows of about 1 MAF, with a range of 150 TAF to more than 2 MAF.

Lake McClure is formed by New Exchequer Dam, which was completed by the Merced Irrigation District in 1967 to increase the reliability of water supply diversions from the Merced River. The storage capacity of Lake McClure is approximately 1 MAF. Annual diversions of about 600 TAF are made into the North Canal at the Merced Falls Dam and into the Main Canal at the Crocker-Huffman Dam. The Crocker-Huffman Dam near the town of Snelling is the upstream limit for anadromous fish on the Merced River. The Merced River Hatchery is located immediately below the Crocker-Huffman Dam. The available storage is utilized in the majority of years, with maximum storage levels achieved in May and June following the spring snowmelt season. Average carryover storage is 485 TAF. Annual storage releases average 350 TAF and range from about 150 to 550 TAF. Merced River inflow to Lake McClure is about 900 TAF. Of this, about 500 TAF is used for diversions and 400 TAF is used for in-stream flows.

Below the major Merced River diversions, average annual downstream flow is 430 TAF (590 cfs) and downstream riparian diversions are about 30 TAF. Maximum diversions occur in July and August, the peak irrigation months. At the mouth (near Stevinson), average annual flow is higher, about 500 TAF (700 cfs), indicating that some of this flow is contributed by irrigation return flows along the Lower Merced River. Several diversions occur downstream of Crocker-Huffman Dam. Annual diversion range from about 200 to more than 650 TAF, with an average of about 550 TAF.

In-stream flow requirements for the New Exchequer and McSwain hydropower FERC license range from 35 TAF in dry years to about 50 TAF in wet years, with an average requirement of about 42 TAF (58 cfs). The Davis-Grunsky contract between DFG and Merced Irrigation District includes flow requirements of 200 cfs from November through March. DFG and the AFRP have suggested in-stream flows that depend on available runoff. DFG and the AFRP flows are specified for the October-to-March salmon spawning and rearing season, the April and May outmigration pulse period, and the summer steelhead rearing season. Salmon rearing flows (recommended by DFG) vary from 200 to 300 cfs, with pulse flows of 300-500 cfs and summer flows of 200-300 cfs. Additional flow for temperature control are recommended in April and May. The AFRP recommended considerably greater releases during years with higher runoff.

5.1.3.5 SOUTH-OF-DELTA SWP AND CVP SERVICE AREAS

The SWP includes 20 reservoirs and 662 miles of aqueduct. Conveyance facilities serving south-of-Delta service areas include the Coastal Branch Aqueduct (serving the Central Coast Region) and the California Aqueduct (serving the South Coast Region). The capacity of the California Aqueduct at the Delta is 10,300 cfs. South of the Tehachapi Mountains at the southern end of the Central Valley, the capacity of the aqueduct is 4,480 cfs. The major SWP reservoirs serving these areas include Pyramid Lake and Castaic Lake (which receive water via the West Branch of the California Aqueduct) and Silverwood Lake and Lake Perris (which receive water via the East Branch of the California Aqueduct). Of the initial project contracts for 4.2 MAF annual delivery, about 2.5 MAF was contracted by southern California, about 1.3 MAF by the San Joaquin Valley, and about 0.4 MAF by the Bay, Central Coast, and Feather River areas. These water supplies were contracted for by regional and local water agencies for anticipated future demand; the full 4.2 MAF of entitlement has not been requested to date. Since about 1980, southern California has received about 60% of its full entitlement, while the San Joaquin Valley has received nearly all of its entitlement. It has been estimated that SWP facilities have about a 65% chance of making full deliveries of requested water supplies at the 1995 level of demand.

The SWP includes 20 reservoirs and 662 miles of aqueduct.

Reclamation's CVP is the largest water storage and delivery system in California, covering 29 of the State's 58 counties. The CVP currently consists of 21 reservoirs capable of storing 12 million acre-feet of water, 11 power plants, 500 miles of major canals and aqueducts, and many other tunnels, conduits, power transmission line. The CVP irrigates about 3.25 million acres of farmland and supplies water to more than 2 million people through more than 250 long-term water contractors in its service area. Most of the CVP service area is inside the Central Valley. Outside the Central Valley, the service area includes part of Santa Clara County, northwest San Benito County, a small region along both sides of the Santa Cruz/Monterey County line, and northeastern Contra Costa County. About 90% of the south-of-Delta contractual delivery is for agricultural uses.

Reclamation's CVP is the largest water storage and delivery system in California, covering 29 of the State's 58 counties. The CVP currently consists of 21 reservoirs capable of storing 12 million acre-feet of water, 11 power plants, 500 miles of major canals and aqueducts, and many other tunnels, conduits, power transmission line.

The CVP pumps water from the Delta at the Tracy Pumping Plant and conveys the water south via the DMC. Other key facilities south of the Delta include the San Luis Reservoir (shared with the SWP), the Contra Costa Canal, New Melones Dam, Friant Dam and the Friant-Kern Canal. In its south-of-Delta service area, the CVP includes the Delta, New Melones, San Felipe, San Luis and Friant Divisions. These areas hold approximately 5.8 MAF in total service contracts, including 1.4 MAF of Friant Division Class 2 supply available in wet years. Of the 5.8 MAF, 4.9 MAF is project water and 840 TAF is water right settlement water.

5.1.4 ASSESSMENT METHODS

5.1.4.1 TOOLS

Both qualitative and quantitative methods were used to access the potential impacts of the Program alternatives on water supply and water management. In general, qualitative methods were used to assess impacts from implementation of the Ecosystem Restoration, Water Quality, Levee System Integrity, Water Use Efficiency, Water Transfer, and Watershed Programs. Because of the availability of applicable computer-based models, quantitative methods were used to assess impacts from implementation of the Storage and Conveyance elements. Specifically, potential impacts of the Program alternatives were analyzed with DWR's project operations model (DWRSIM) and Bay-Delta hydrodynamic and water quality model (DSM2).

Both qualitative and quantitative methods were used to access the potential impacts of the Program alternatives on water supply and water management.

Project Operations Modeling

DWRSIM is a planning model used to simulate the CVP and SWP systems of reservoirs and conveyance facilities. The model calculates flows on a monthly time step using a historical 73-year hydrologic sequence (water-years 1922-94). Historical runoff patterns have been normalized to reflect 1995-level and 2020-level land use.

DWRSIM is designed to simulate operation of the CVP and SWP systems for the purposes of water supply, flood control, recreation, in-stream flows, power generation and Delta water quality and outflow requirements. The model is used to analyze the potential effects of proposed new features, such as additional reservoir storage or Delta export conveyance, as well as any changes to criteria controlling project operations.

To evaluate the various Program alternatives using DWRSIM, new facilities and operational assumptions are assigned to the CVP and SWP. For this programmatic-level evaluation, impacts are evaluated and discussed relative to study regions rather than specific water projects.

For this programmatic-level evaluation, impacts are evaluated and discussed relative to study regions rather than specific water projects.

Model results provide information on expected reservoir storage, river flow, Delta inflow, Delta outflow, exports, and water project deliveries. Project water deliveries are assumed to have priority access to available capacity of facilities. This analysis does not consider potential operational changes of non-project facilities with the Central Valley system. In addition to DWRSIM, electronic spreadsheet models and other analytical tools were used for the analyses. The monthly flows calculated by DWRSIM for the Sacramento and San Joaquin Rivers are used as input for Delta hydrodynamic and water quality modeling.

Bay-Delta Hydrodynamic and Water Quality Modeling

The hydrodynamic model, DSM2, simulates the channel flows, tidal effects, and water quality of the Bay-Delta estuary. For the purposes of this programmatic analysis, model simulations were conducted for a 16-year historical hydrologic sequence (water years 1976-91). This period was selected to cover a broad range of Delta inflows and exports and is generally representative of the 73-year historical hydrologic sequence used in DWRSIM.

A great number of variables must be simulated to describe flows in the Delta. The Delta is a network of interconnected channels. The water flowing in these channels is acted upon by a number of competing forces. Freshwater enters the Delta from tributary streams, including but not limited to the Sacramento, San Joaquin, Mokelumne, and Calaveras Rivers. During much of the year, these Delta inflows are largely controlled by upstream reservoir operations.

Another influence on the flow of water in Delta channels is tidal action. Tidal inflows move water into portions of the Delta where freshwater flows and channel geometry offer the least resistance. The relatively large freshwater inflows from the Sacramento River have the capacity to resist tidal inflows more than the smaller inflows from the San Joaquin River. Combined with pumping in the south Delta, saline Bay water tends to move further into the south Delta than it does into the north Delta. The pattern of flows is continually changing as a result of these competing forces, making it difficult to describe the dominant patterns.

X2 is a measure that describes Delta salinity resulting from hydrodynamic conditions. X2 is the distance upstream from the Golden Gate Bridge (in km) at which the mixing of freshwater from the Delta inflow and saltwater from the Bay results in a channel bottom salinity of two parts per thousand.

Salinity is an indirect measure of hydrodynamic conditions in the Delta. Delta salinity is primarily a result of seawater intrusion, although upstream sources, such as agricultural drainage from the San Joaquin Valley, contribute to Delta salinity. X2 is a measure that describes Delta salinity resulting from hydrodynamic conditions. X2 is the distance upstream from the Golden Gate Bridge (in km) at which the mixing of freshwater from the Delta inflow and saltwater from the Bay results in a channel bottom salinity of two parts per thousand. Changes in these variables are used in this programmatic analysis to describe the effects of Program actions on hydrodynamic conditions in the Delta.

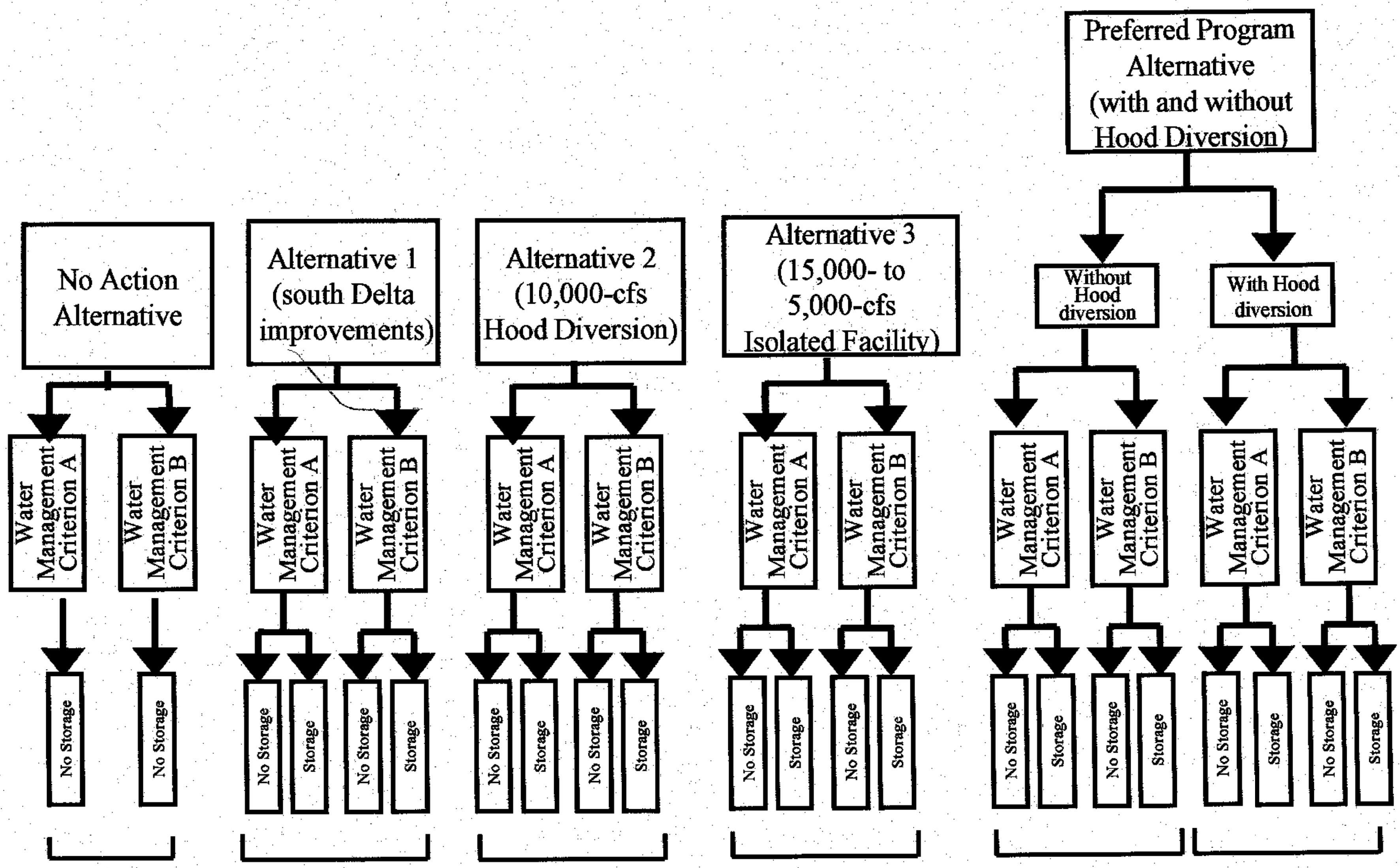
5.1.4.2 ADDRESSING UNCERTAINTY

The Program recognizes the need to address uncertainty in its assessment of Program alternatives. Project operations modeling and Delta hydrodynamic modeling rely on the formulation of reasonable assumptions to accurately reflect the consequences of present and future water management decisions. The use of different assumptions may lead to conclusions that overestimate or underestimate the impact or benefits of implementing the various Program elements. The modeling assumptions with the greatest uncertainty include future water demands and future environmental water requirements, as discussed in Section 5.1.2.

The modeling assumptions with the greatest uncertainty include future water demands and future environmental water requirements.

The Program has begun the formulation of a comprehensive water management strategy to determine the appropriate role of various water management tools in meeting Program

Figure 5.1-2. Assessment Approach for the CALFED Programmatic EIS/EIR



objectives. Different combinations of tools may be appropriate depending on future population growth, land use changes, technological improvements, willingness to pay for improved water supply reliability, and environmental water requirements. These factors can affect the level of future demands on the Bay-Delta system. To aid in developing a water management strategy, the Program has undertaken an economic evaluation of water management alternatives. The Program is performing economic assessments to identify cost-effective combinations of strategies (for example, conservation, recycling, transfers, and new facilities) that meet the Program's water supply reliability objectives. This study effort will help to quantify the uncertainty and risk associated with alternative water management strategies.

At present, a high level of uncertainty is associated with future environmental water requirements. Through the development of an EWA, the Program intends to provide flexibility in achieving environmental benefits while reducing uncertainties associated with environmental water requirements. Flexible management of water operations could achieve fishery and ecosystem benefits more efficiently than a fully prescriptive regulatory approach. The Program believes that operations using an EWA can achieve substantial fish recovery while providing for continuous improvement in water supply reliability and water quality. A variety of potential approaches are available to define and operate an EWA. Although an EWA has significant potential, a number of major issues and details must be resolved before this approach can be fully implemented, These include:

Through the development of an Environmental Water Account, the Program intends to provide flexibility in achieving environmental benefits while reducing uncertainties associated with environmental water requirements.

- Determine which environmental protections would be provided through prescriptive standards and which would be provided through an EWA.

- Investigate various approaches for implementing an EWA.

- Developing accounting methodologies.

- Determine reliability of existing legal mechanisms to assure intended use of EWA water released for in-stream purposes.

- Determine how much existing surface and groundwater storage, water purchase contract water, and water generated from conservation and recycling projects will be needed by an EWA.

To fully describe potential consequences of program actions, the Program has incorporated a reasonable range of uncertainty into this programmatic analysis. This range of uncertainty was quantified by formulating two distinct bookend water management criteria assumption sets. These two sets of assumptions, referred to as Criteria A and B, serve as boundaries for a range of possible Delta inflow, export, and outflow patterns in this programmatic analysis. The primary assumptions that differentiate the bookend assumption sets from each other and from existing conditions are Bay-Delta system water demands and various Delta water management criteria that regulate system operations. Figure 5.1-2 reflects the framework for evaluating the No Action Alternative and Program alternatives.

The Program has incorporated a reasonable range of uncertainty into this programmatic analysis. This range of uncertainty was quantified by formulating two distinct bookend water management criteria assumption sets.

The range of water demands defined by these water management criteria assumption sets represents uncertainty in the future need for Bay-Delta water supplies due to population growth, land use changes, implementation of water use efficiency measures, and water marketing. Criterion A assumes current Bay-Delta system demands apply throughout the Program planning horizon. Under this assumption, any future increase in demands in the Program study area would be met by alternative supply or demand management options. In contrast, Criterion B assumes a future increase of about 10% in Bay-Delta system demands. SWP demands vary annually from 3.6 to 4.2 MAF and CVP demands are 3.5 MAF per year using this criterion.

The range of water demands defined by these water management criteria assumption sets represents uncertainty in the future need for Bay-Delta water supplies due to population growth, land use changes, implementation of water use efficiency measures, and water marketing. The range of Delta water management criteria represents uncertainty related to future environmental water requirements.

The range of Delta water management criteria represents uncertainty related to future environmental water requirements. Under Criterion A, CVP and SWP facilities are operated to provide additional Delta protection above the existing conditions operation criteria. While specific assumptions regarding Delta water management criteria were made to complete the water simulation modeling, the Program's intention is to depict a general level of environmental protection. These assumptions should not be interpreted as specific predictions of future regulatory actions. Under Criterion B, existing Delta protective actions are assumed.

Ranges also were used to describe possible flow changes in the Trinity and American Rivers due to the Trinity River Flow Analysis Study and implementation of the EBMUD CVP contract. These activities could result in changes in the availability of water to meet Program objectives. The assumed ranges were included in the No Action Alternative assumptions to help decision-makers better understand the potential consequences to the Program. No decisions have been made about the Trinity River flows or American River diversions. Both of these efforts are currently undergoing environmental review.

Ranges also were used to describe possible flow changes in the Trinity and American Rivers due to the Trinity River Flow Analysis Study and implementation of the EBMUD CVP contract.

The CVPIA is included in the description of existing conditions and in the analyses of the No Action Alternative and Program alternatives in this programmatic evaluation. Section 3406(b)(2) of the CVPIA mandates that the Secretary of Interior dedicate and manage 800 TAF of CVP yield for the primary purpose of implementing fish, wildlife, and habitat restoration measures. Considerable controversy has surrounded interpretation and implementation of this provision. In November 1997, Interior issued its "Final Administrative Proposal on the Management of Section 3406(b)(2) Water," which describes Interior's plan to comply with this provision. Various legal actions followed the issuance of the Final Administrative Proposal. In March 1999, U.S. District Judge Oliver W. Wanger ruled in a Memorandum Opinion and Order that Interior did not adequately account for CVP yield in determining actions to be taken in compliance with Section 3406(b)(2) in its Final Administrative Proposal, and directed them to do so.

The CVPIA is included in the description of existing conditions and in the analyses of the No Action Alternative and Program alternatives in this programmatic evaluation.

Until Interior responds to the Court's order and the issue is resolved in court, it is impossible to determine how the November 1997 Final Administrative Proposal will be altered. The Program is therefore obligated to assess how changes in the interpretation of Section 3406(b)(2) could affect this programmatic evaluation. For the purposes of hydrologic and hydrodynamic modeling, the provisions of the Final Administrative Proposal are included as operational assumptions in simulations of existing conditions, the No Action Alternative, and all Program alternatives. Changes in interpretation of Section 3406(b)(2) could affect the Program's characterization of existing conditions. It

Table 5.1-2. Summary of Modeling Assumptions

Alternative Configuration		Operation Criteria: Baseline Operation Criteria	Operation Criteria: Water Management Criteria	Operation Criteria: South Delta Criteria	Operation Criteria: North Delta Hood Diversion Criteria	Operation Criteria: Isolated Facility Criteria	Delta Modifications: CVP-SWP Improvements	Delta Modifications: North Delta Channel Modifications	Delta Modifications: South Delta Modifications	Delta Modifications: Isolated Conveyance/Hood Facility (Conveyance Capacity in 1,000 cfs/Type)	Storage Components (Maximum Storage Volumes in MAF): Sacramento Valley Groundwater Storage	Storage Components (Maximum Storage Volumes in MAF): Upstream Surface Storage Sacramento River Tributaries	Storage Components (Maximum Storage Volumes in MAF): Upstream Surface Storage San Joaquin River Tributaries	Storage Components (Maximum Storage Volumes in MAF): San Joaquin Valley Groundwater Storage	Storage Components (Maximum Storage Volumes in MAF): South of Delta Aqueduct Surface Storage	DWRSIM Study	DWRDSM2 Study
Exist Cond.		1														771	1EX
No Action		1	A													785	1A-A
No Action		1	B													786	1A-B
Alternative 1		1	A	1			1		1,2,3							789	1C-A
Alternative 1		1	A	1			1		1,2,3		0.25	3.0	0.25	0.5	2.0	808	
Alternative 1		1	B	2			1		1,2,3							809	
Alternative 1		1	B	2			1		1,2,3		0.25	3.0	0.25	0.5	2.0	801	1C-BS
Alternative 2		1	A	1	1		1	1,4	1,2,3							790	2B-A
Alternative 2		1	A	1	1		1	1,4	1,2,3		0.25	3.0	0.25	0.5	2.0	810	
Alternative 2		1	B	2	2		1	1,4	1,2,3							811	
Alternative 2		1	B	2	2		1	1,4	1,2,3		0.25	3.0	0.25	0.5	2.0	803	2B-BS
Alternative 3	15K IF	1	A	2		1,3	1	4		15						804	3E-A
Alternative 3	15K IF	1	A	2		1,3	1	4		15	0.25	3.0	0.25	0.5	2.0	812	
Alternative 3	5K IF	1	B	2		2	1	4	1,2,3	5						820	
Alternative 3	5K IF	1	B	2		2	1	4	1,2,3	5	0.25	3.0	0.25	0.5	2.0	791	3B-BS
Preferred Program Alternative	w/o Hood Diversion	1	A	1			1		1,2,3							789	1C-A
Preferred Program Alternative	w/o Hood Diversion	1	A	1			1		1,2,3		0.25	3.0	0.25	0.5	2.0	808	
Preferred Program Alternative	w/o Hood Diversion	1	B	2			1		1,2,3							809	
Preferred Program Alternative	w/o Hood Diversion	1	B	2			1		1,2,3		0.25	3.0	0.25	0.5	2.0	801	1C-BS
Preferred Program Alternative	w/ Hood Diversion	1	A	1	1		1	2	1,2,3							793	2P-A
Preferred Program Alternative	w/ Hood Diversion	1	A	1	1		1	2	1,2,3		0.25	3.0	0.25	0.5	2.0	821	
Preferred Program Alternative	w/ Hood Diversion	1	B	2	2		1	3,4	1,2,3							822	
Preferred Program Alternative	w/ Hood Diversion	1	B	2	2		1	3,4	1,2,3		0.25	3.0	0.25	0.5	2.0	792	2P-BS

Please refer to the notes on the following page.

Table 5.1-2. Summary of Modeling Assumptions (continued)

OPERATION CRITERIA

Baseline Operation Criteria

1 1995-level hydrology and demands are assumed. South-of-Delta SWP demands vary between 3.5 MAF in drier years down to 2.6 MAF in wetter years based on local wetness indices. Annual south-of-Delta CVP demands are 3.4 MAF. CVP and SWP facilities are operated to meet the SWRCB May 1995 Water Quality Control Plan for the Bay-Delta (WQCP); the facilities are also operated to meet the CVPIA (b) (2) Delta actions. Trinity River minimum flows below Lewiston Dam are maintained at 340 TAF in all years.

Water Management Criteria

A 2020-level hydrology and 1995-level demands are assumed. CVP and SWP facilities are operated to meet additional prescriptive Delta actions above the baseline operation criteria. Trinity River minimum flows below Lewiston Dam are as defined per U.S. Bureau of Reclamation (Reclamation) Draft CVPIA PEIS. EBMUD American River Diversions at Nimbus Dam are assumed as defined in the EBMUD Supplemental Water Supply Project (maximum 115 TAF per year).

B 2020-level hydrology and demands are assumed. SWP demands vary annually from 3.6 to 4.2 MAF. CVP demands are 3.5 MAF per year.

South Delta Criteria

1 Full and unlimited joint point of diversion (JPOD) is assumed. Harvey O. Banks Delta Pumping Plant (Banks Pumping Plant) capacity is 10,300 cubic feet per second (cfs); actual pumping is constrained in accordance with 1981 U.S. Army Corps of Engineers (Corps) criteria.

2 Full and unlimited JPOD is assumed. Banks Pumping Plant capacity is 10,300 cfs.

North Delta Criteria

1 Hood diversions are limited to: (a) 50% of south Delta exports; (b) 5,000 cfs in May; (c) 35% of Sacramento flow in March and June, and 15% in April and May. Rio Vista flow criteria of 3,000 cfs in July and August are maintained. Delta Cross Channel (DCC) gates are closed for all months, except in June for dry, critical, and below-normal water-year types.

2 Hood diversions are limited to: (a) 100% of the south-of-Delta exports, and (b) 5,000 cfs in May. Rio Vista flow criteria of 3,000 cfs are maintained. DCC gates are closed, except for July and August.

Isolated Facility Criteria

1 Isolated facility diversions are limited to 5,000 cfs in May. Minimum through-Delta conveyance is 1,000 cfs from October-March and July-September. Rio Vista flow criteria of 3,000 cfs are maintained. DCC gates are closed, except June (in dry, critical, and below-normal water years), and July and August (in all water years). The isolated facility conveyance is included in export restrictions.

2 Isolated facility diversions are limited to: (a) 5,000 cfs in May, and (b) 35% of Sacramento flow in March and June, and 15% in April-May. Minimum through-Delta conveyance is 1,000 cfs from October-March and July- September. Rio Vista flow criteria of 3,000 cfs are assumed. DCC gates are closed, except for July and August. The isolated facility conveyance is not included in export restrictions.

3 Level II Delta agriculture diversions are delivered from the isolated Facility.

DELTA MODIFICATIONS

CVP and SWP Improvements

1 New fish screens operate at the Skinner Fish Facility and Tracy Pumping Plant intake. Interconnection between Tracy Pumping Plant and Clifton Court Forebay (CCFB) is assumed.

North Delta Modifications

1 A 10,000-cfs screened Hood intake is operational.

2 A 2,000-cfs screened Hood intake is operational.

3 A 4,000-cfs screened Hood intake is operational.

4 A 600-foot-wide alignment is assumed along the Mokelumne River from I-5 to the San Joaquin River.

South Delta Modifications

1 Increased permitted capacity of existing export pumps to physical capacity is assumed. A new CCFB intake structure is operational. An operable barrier (or equivalent) is installed at the head of Old River to maintain a positive flow down the San Joaquin River.

2 Flow and stage control structures (or equivalent) are installed on Middle River, Grant Line Canal, and Old River to control flow, stage, and south Delta salinity.

3 Channel enlargement along a 4.9-mile reach of Old River is assumed.

is unclear at this time if a new interpretation of Section 3406(b)(2) will be completed in time for consideration in this analysis. This, however, does not present an insurmountable obstacle for this programmatic evaluation.

As described above, the No Action Alternative and the Program alternatives were evaluated with a range of operating assumptions to consider uncertainty in future Bay-Delta system water demands and environmental water requirements. The range of uncertainty is bounded by two distinct bookend water management criteria assumptions sets (Criteria A and B). The provisions of Interior's November 1997 Final Administrative Proposal are included as operational assumptions in both of these bookend assumption sets. The Criterion A assumption set defines the highest environmental water requirements and lowest Delta exports considered in this analysis. Because ecosystem protections provided in Criterion A exceed those included in the 1994 Bay-Delta Accord and CVPIA, changes in interpretation of Section 3406(b)(2) would not affect the Criterion A assumption set. At the opposite end of the range of uncertainty, the Criterion B assumption set defines the lowest environmental water requirements and highest Delta exports considered in this analysis. A revised interpretation of Section 3406(b)(2) that results in a decrease in the allocation of CVP water for environmental purposes could affect the assumptions used to bound this end of the range. However, these potential differences would be consistent for all alternatives and are not expected to significantly change the magnitude of projected impacts.

5.1.4.3 Modeling Assumptions

A summary description of the Program alternative assumptions is provided in Table 5.1.-2. This table also provides a description of Delta modifications and storage components associated with each alternative. These assumptions and Program alternative configurations are the foundation of the DWRSIM and DSM2 assessments, which provide quantitative information utilized by several resource areas for impact evaluations of the Program alternatives. In some instances, assumptions are required for modeling purposes that incorporate more detail than needed for this programmatic evaluation. An example of this level of detail is the specific location of storage and conveyance facilities. These detailed modeling assumptions, provided in Attachment A, describe the analytical processes employed in this evaluation; these assumptions are not intended to imply the outcome of future project-specific decisions.

In some instances, assumptions are required for modeling purposes that incorporate more detail than needed for this programmatic evaluation.

5.1.4.4 Approach

The DWRSIM model was used to programmatically evaluate the effects of adding new facilities and changing existing facilities operating criteria on Central Valley flows, existing and new reservoir storage operations, Delta exports and outflow, and required water acquisition quantities.

The DWRSIM model was used to programmatically evaluate the effects of adding new facilities and changing existing facilities operating criteria on Central Valley flows, existing and new reservoir storage operations, Delta exports and outflow, and required water acquisition quantities.

The model was also used to assess changes in water deliveries to South-of-Delta SWP and CVP water users resulting from Program implementation. For each Program alternative, water supply reliability was assessed relative to the degree and frequency at which the facilities (and associated operations criteria) are able to meet future water demands. These demands include municipal, industrial, agricultural, environmental, power production, aesthetic, and recreational water needs. Specific beneficiaries and willingness of beneficiaries to pay for new facilities will not be determined until later stages of the Program. For this analysis, SWP and CVP water users were used as surrogates for all potential water supply beneficiaries.

Specific beneficiaries and willingness of beneficiaries to pay for new facilities will not be determined until later stages of the Program.

Assumptions regarding allocation of new storage capacity between agricultural, urban, and environmental beneficial uses are hypothetical and provided only for modeling purposes. Decisions about how to allocate potential benefits will be made based on several factors including the willingness of users to pay for new storage or conveyance facilities, operational opportunities and constraints associated with new storage or conveyance facilities, and environmental requirements associated with new storage or conveyance facilities.

5.1.5 SIGNIFICANCE CRITERIA

The significance of effects of Program actions on water supply and water management is evaluated with respect to the Program primary water supply objective of reducing the mismatch between Bay-Delta water supplies and the current and projected beneficial uses dependent on the Bay-Delta system. The Program has refined its primary water supply reliability objective to include the following sub-objectives:

- Reduce diversion conflicts between water users and environmental needs during average and drought periods.
- Increase access to economically efficient water supplies during average and drought periods for all beneficial uses.
- Increase water system operational flexibility so it is better suited to respond to biological and hydrological variability and be more resilient to potential disasters.
- Improve water quality so available water supplies are suitable for more uses and reuses.

Alternatives that would increase conflicts between water users and environmental needs, reduce assess to economically efficient water supplies for all beneficial uses, decrease system operational flexibility, or decrease water quality are deemed to have a significant adverse impact on water supply.

Program implementation is expected to occur over 20-30 years. Bay-Delta standards and management criteria, water management facilities, and other conditions are not expected to remain constant over this extended time period. The actual deviation between pre-implementation conditions and existing conditions is subject to a high degree of uncertainty.

5.1.6 NO ACTION ALTERNATIVE

To assess the consequences of the various Program alternatives on water supply and water management in the Program study area, a pre-implementation condition must be established. Typically, existing conditions provide an adequate basis for assessing the impacts of proposed projects. (See Section 5.1.3 for a description of existing conditions.) However, Program implementation is expected to occur over 20-30 years. Bay-Delta standards and management criteria, water management facilities, and other conditions are not expected to remain constant over this extended time period. The actual deviation between pre-implementation conditions and existing conditions is subject to a high degree of uncertainty. Section 5.1.2 elaborates on the uncertainties associated with the Program.

A 2020 No Action Alternative was defined to represent a reasonable range of uncertainty in the pre-implementation condition. This range of uncertainty was quantified for purposes of this programmatic document by formulating two distinct bookend water management criteria assumptions sets. These two sets of assumptions (Criteria A and B) serve as boundaries for a range of possible Delta inflow, export, and outflow patterns in the No Action Alternative programmatic analysis. The primary assumptions that differentiate the No Action Alternative bookends from each other (and from existing conditions) are Bay-Delta system water demands and various Delta water management criteria that regulate system operations. Further details on the bookend assumptions and other assumptions used in the evaluation of the No Action Alternative are presented in Section 5.1.4 and in Attachment A.

The programmatic comparisons presented in this section differentiate water supply and water management provided under the No Action Alternative and existing conditions for each of the five planning regions (described in Section 5.1.3). Water supply comparisons are made based upon a 73-year historical hydrologic period, a sequence of years often referred to as the "long-term" period. Similar comparisons are made using a subset of the long-term period—the dry and critical years.

Comparisons of water supply and water management characteristics under both No Action Alternative bookends were made with those same characteristics under existing conditions. For most parameters of interest, existing conditions fall between the two No Action Alternative bookends, within the range of uncertainty associated with the No Action Alternative. This trend applies to both the long-term period and dry and critical years. Specific comparisons of No Action Alternative and existing conditions water supply and water management characteristics for the Program's five planning regions are presented below.

5.1.6.1 DELTA REGION

Programmatic comparisons of Delta inflow and exports were made between the No Action Alternative and existing conditions using DWRSIM modeling results. Differences generally fall within the range of uncertainty associated with the No Action Alternative.

The range of Delta inflows and exports predicted for the No Action Alternative generally bracket inflows under existing conditions. The range of Delta exports predicted for the No Action Alternative generally bracket exports under the existing conditions.

The range of Delta inflows and exports predicted for the No Action Alternative generally bracket inflows under existing conditions. Over the long-term period, average annual Delta inflows could remain constant or decrease by as much as 330 TAF (-2%) under the No Action Alternative relative to existing conditions. Similarly, during dry and critical years, average annual Delta inflows could remain constant or decrease by as much as

280 TAF (-2%). Reductions in annual Delta inflows would result from greater upstream water use and smaller reservoir releases in response to export restrictions. The greatest average monthly percent reductions would occur during late spring and early summer, with deviations from existing conditions as high as -16% in June and July of dry and critical years.

The range of Banks and Tracy Delta exports predicted for the No Action Alternative generally bracket exports under the existing conditions. Figure 5.1-3 compares average monthly Delta exports for the long-term period. Similarly, Figure 5.1-4 compares average monthly Delta exports during dry and critical water-years.

Over the long-term period, annual Delta exports could decrease by as much as 570 TAF (-10%) or could increase by as much as 370 TAF (+7%) under the No Action Alternative compared to existing conditions. Reductions in annual Delta exports would result from more protective Delta water management criteria; increases in annual Delta exports would result from higher demands on the Bay-Delta system. The greatest average monthly percent reductions would occur during the spring, with deviations from existing conditions ranging from -20% to -60%. The greatest average monthly percent increases would occur during the winter, with deviations from existing conditions ranging from +10% to +20%.

During dry and critical years, annual Delta exports could decrease by as much as 610 TAF (-12%) or could increase by as much as 130 TAF (+3%) under the No Action Alternative compared to existing conditions. Higher Bay-Delta system demands have a relatively small impact on Delta exports during dry and critical years, as the system is generally supply-limited during droughts. The greatest average monthly percent reductions would occur during February through July, with deviations from existing conditions ranging from -20% to -50%. Similar to the long-term period, the greatest average monthly percent increases would occur during the winter, with deviations from existing conditions ranging from +5% to +10%.

5.1.6.2 BAY REGION

Programmatic comparisons of Delta outflow to San Francisco Bay were made between the No Action Alternative and existing conditions using DWRSIM modeling results. Differences generally fall within the range of uncertainty associated with the No Action Alternative. Figures 5.1-5 and 5.1-6 present Delta outflow comparisons for the long-term period and dry and critical years, respectively.

Over the long-term period, annual Delta outflow could decrease by as much as 390 TAF (-3%) or could increase by as much as 230 TAF (+2%) under the No Action Alternative compared to existing conditions. Reductions in annual Delta outflow would result from higher demands on the Bay-Delta system; increases in annual Delta outflow would result from more protective Delta actions. The greatest average monthly percent reductions would occur during the fall months, with deviations from existing conditions as much as -8%. The greatest average monthly percent increases would occur during the spring months, with deviations from existing conditions as much as +9%.

Over the long-term period, annual Delta outflow could decrease by as much as 400 TAF (-3%) or could increase by as much as 100 TAF (+1%) under the No Action Alternative compared to existing conditions.

Figure 5.1-3. Delta Exports at Banks and Tracy under the No Action Alternative and Existing Conditions for the Long-Term Period

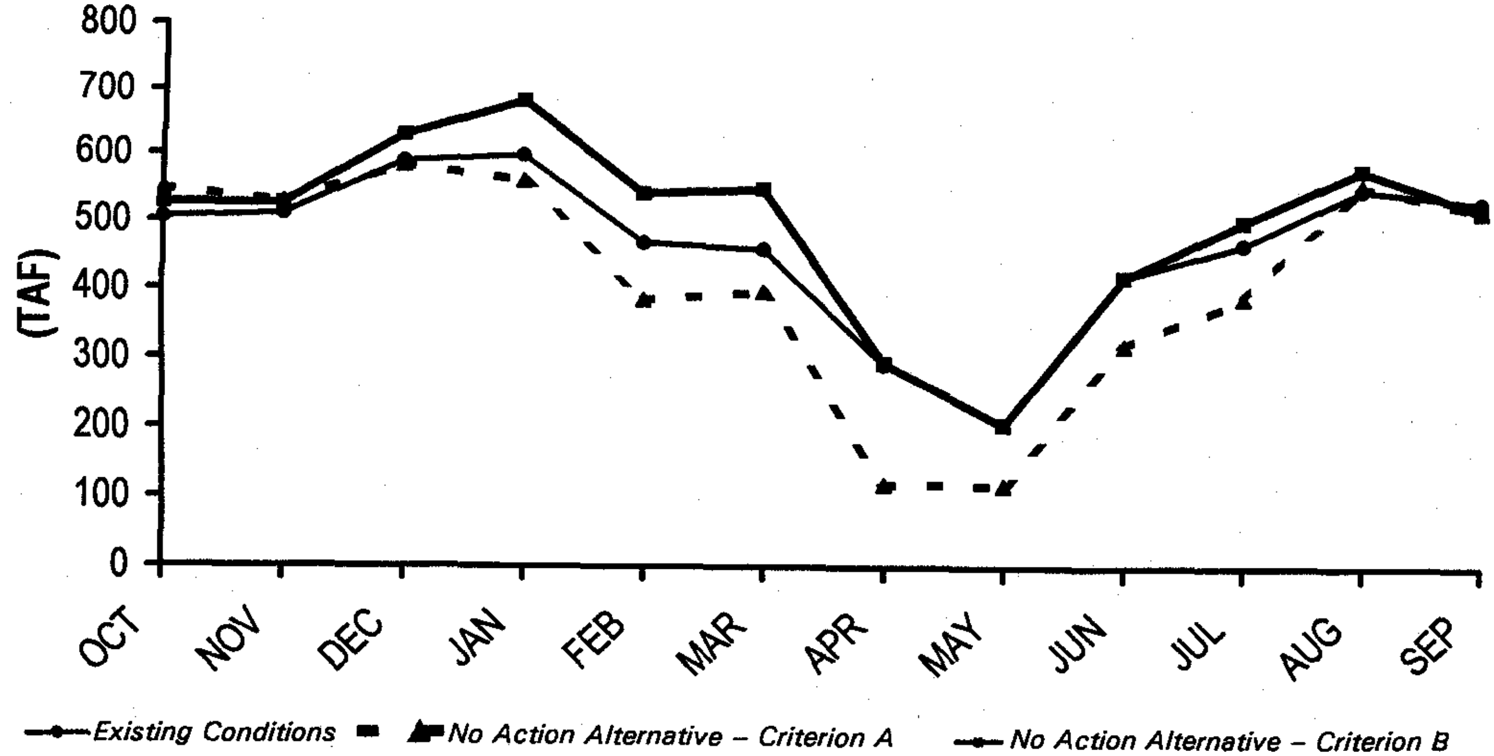


Figure 5.1-4. Delta Exports at Banks and Tracy under the No Action Alternative and Existing Conditions for Dry and Critical Years

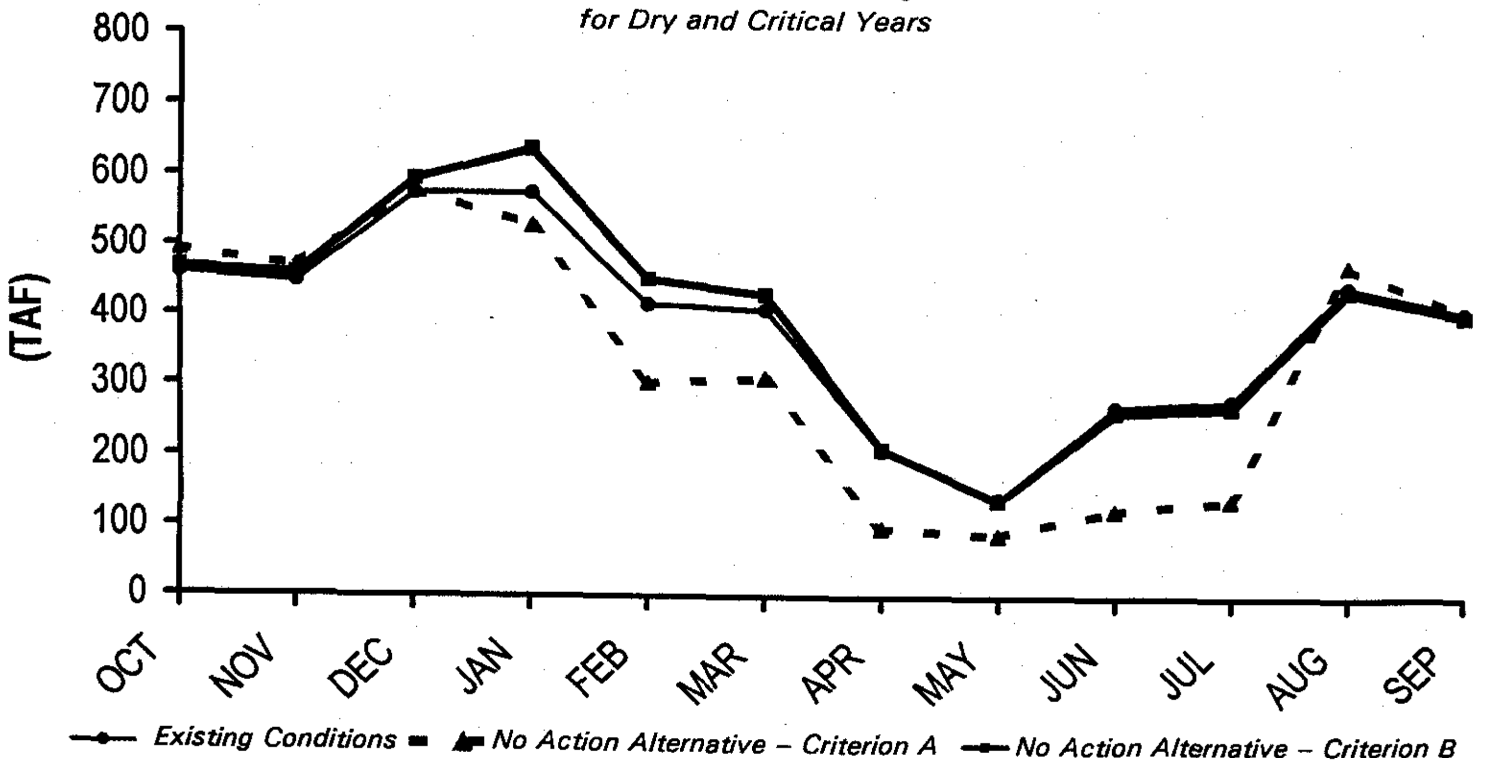
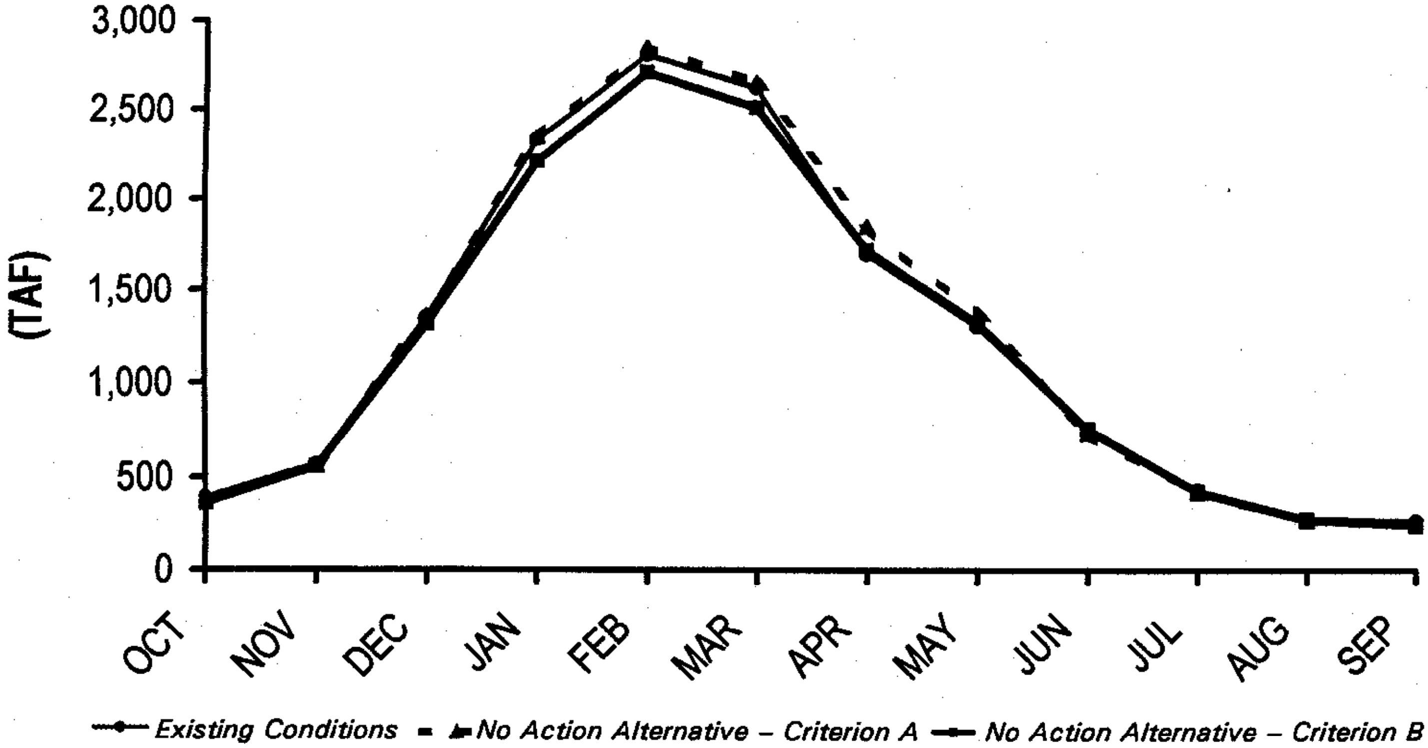
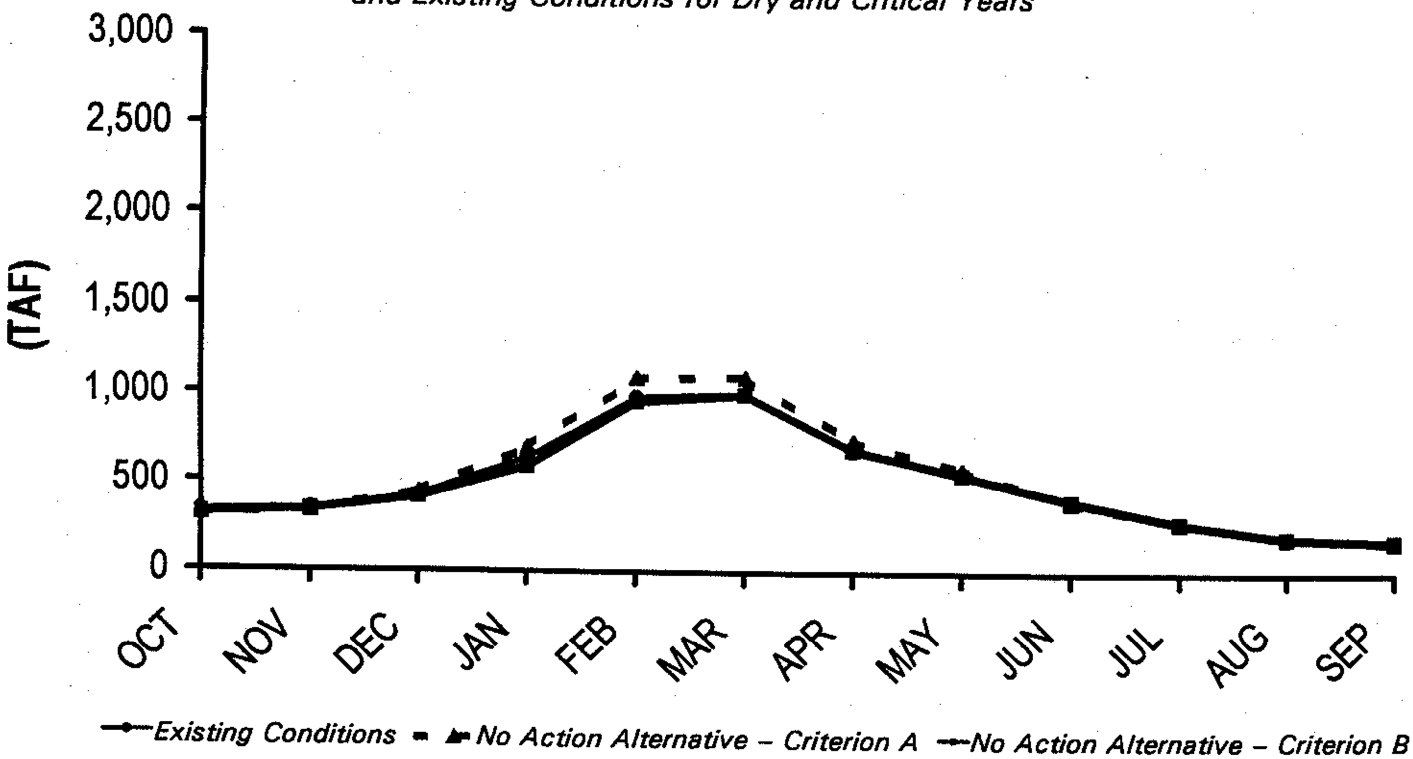


Figure 5.1-5. Delta Outflow under the No Action Alternative and Existing Conditions for the Long-Term Period



5.1-6. Delta Outflow under the No Action Alternative and Existing Conditions for Dry and Critical Years



During dry and critical years, annual Delta outflow could decrease by as much as 110 TAF (-2%) or could increase by as much as 330 TAF (+6%) under the No Action Alternative compared to existing conditions. Higher Bay-Delta system demands have a relatively small impact on Delta outflow during dry and critical years, as the system is generally supply-limited during droughts. The greatest average monthly percent reduction (-8%) would occur in January. The greatest average monthly percent increases would occur during the late winter and early spring, with deviations from existing conditions ranging from +5% to +11%.

During dry and critical years, annual Delta outflow could increase by as much as 110 TAF (+2%) under the No Action Alternative compared to existing conditions.

5.1.6.3 SACRAMENTO RIVER AND SAN JOAQUIN RIVER REGIONS

This section provides a comparison of existing conditions and the No Action Alternative with respect to water supply and water management in the Sacramento and San Joaquin River Regions. The programmatic comparison focuses on water use and surface water storage.

Although this programmatic-level document evaluates potential impacts with respect to the five Program study areas, water management and supply impacts may vary within each region by river basin. To provide a foundation on which to evaluate region-specific No Action conditions, the river basins are differentiated and discussed accordingly. This section considers three river basins in the Sacramento River Region: Sacramento, Feather, and American. The Yuba River, another key river basin in the region, is considered part of the Feather River basin for purposes of this analysis. This section also considers four river basins in the San Joaquin River Region: Upper San Joaquin, Stanislaus, Tuolumne, and Merced. Although the Calaveras, Mokelumne, and Cosumnes Rivers enter the Lower San Joaquin River, they are not evaluated as part of the San Joaquin River Region water supply and water management section. Flows from these rivers are considered in the Delta outflow analysis.

Water management and supply impacts may vary within each region by river basin.

Simulation results are presented in this section from a regional perspective, consistent with a programmatic-level evaluation. While changes in surface storage were estimated for the regions' larger facilities, results are aggregated for purposes of presentation. Facilities that were evaluated in the Sacramento River Region include Shasta, Oroville, and Folsom. Facilities that were evaluated in the San Joaquin River Region include New Melones, New Don Pedro, and McClure.

Water Use

A depletion analysis was conducted to determine the effect of water demands and diversions on the flows of river systems tributary to the Delta. In this evaluation, upstream depletions and accretions do not vary between the No Action Alternative bookend water management criteria.

Upstream water use assumed for the Sacramento River Region's No Action Alternative is based on 2020-level land use projections and long-term period historical inflow data. Water use is expected to increase in the Sacramento River Region under the No Action Alternative. Urban net water use was assumed to increase from 0.8 MAF under existing conditions to 1.1 MAF under the No Action Alternative. Agricultural net water use was assumed to decrease from 6.5 MAF under existing conditions to 6.4 MAF under the No Action Alternative. Average annual depletion of applied water is expected to increase in all three major river basins under the No Action Alternative. Annual depletions are expected to increase 140 TAF above existing conditions in the Sacramento River basin. Similarly, annual depletions are expected to increase 10 and 70 TAF above existing conditions in the Feather and American River basins, respectively.

Water use is expected to increase in the Sacramento River Region under the No Action Alternative.

Water use in the San Joaquin River Region is expected to decrease under the No Action Alternative based on an analysis of CVP demands conducted by the Bureau of Reclamation. Although urban net water use was assumed to increase from 0.4 MAF under existing conditions to 0.7 MAF under the No Action Alternative, agricultural net water use was assumed to decrease from 5.8 MAF under existing conditions to 5.3 MAF under the No Action Alternative. Average annual depletion of applied water is expected to decrease in all four major river basins under the No Action Alternative. Annual depletions are expected to decrease 25 TAF from existing conditions for the eastside San Joaquin Valley north of the Tuolumne River. Similarly, annual depletions are expected to decrease 27 TAF and 36 TAF from existing conditions between the Tuolumne and Merced Rivers and between the Merced and San Joaquin Rivers. Finally, annual depletions are expected to decrease 50 TAF from existing conditions for the DMC service area.

Water use in the the San Joaquin River Region is expected to decrease under the No Action Alternative.

Local inflows and diversions developed for the depletion study areas were incorporated into the DWRSIM modeling analysis. Figures 5.1-7 and 5.1-8 compare accretions and depletions in the Sacramento River and San Joaquin River Regions under existing conditions and the No Action Alternative for both long-term and dry and critical periods, respectively. These figures show minor differences in regional accretions and depletions.

Surface Storage

DWRSIM was used to identify potential changes in surface storage volumes under existing conditions and the No Action Alternative. The three primary surface storage facilities in the Sacramento River Region—Shasta, Oroville, and Folsom—exhibited similar characteristics under existing conditions and the No Action Alternative. The three primary surface storage facilities in the San Joaquin River Region—New Melones, New Don Pedro, and McClure—also exhibited similar characteristics under existing conditions and the No Action Alternative. These results were observed for both long-term and dry and critical periods. Figures 5.1-9 and 5.1-10 show end-of September carryover storage exceedance for the primary surface facilities in the Sacramento River and San Joaquin River Regions, respectively. Carryover storage is defined as the reservoir storage volume at the end-of-September.

The three primary surface storage facilities in the Sacramento River Region—Shasta, Oroville, and Folsom—exhibited similar characteristics under existing conditions and the No Action Alternative. The three primary surface storage facili-ties in the San Joaquin River Region—New Melones, New Don Pedro, and McClure—also exhibited similar characteristics under existing conditions and the No Action Alternative.

As shown in Figure 5.1-9, average Sacramento River Region long-term period carryover storage (similar to 50% exceedance) is about 5.5 MAF under existing conditions and ranges

Figure 5.1-7. Sacramento River Basin Depletion under the No Action Alternative and Existing Conditions for the Long-Term Period and Dry and Critical Years

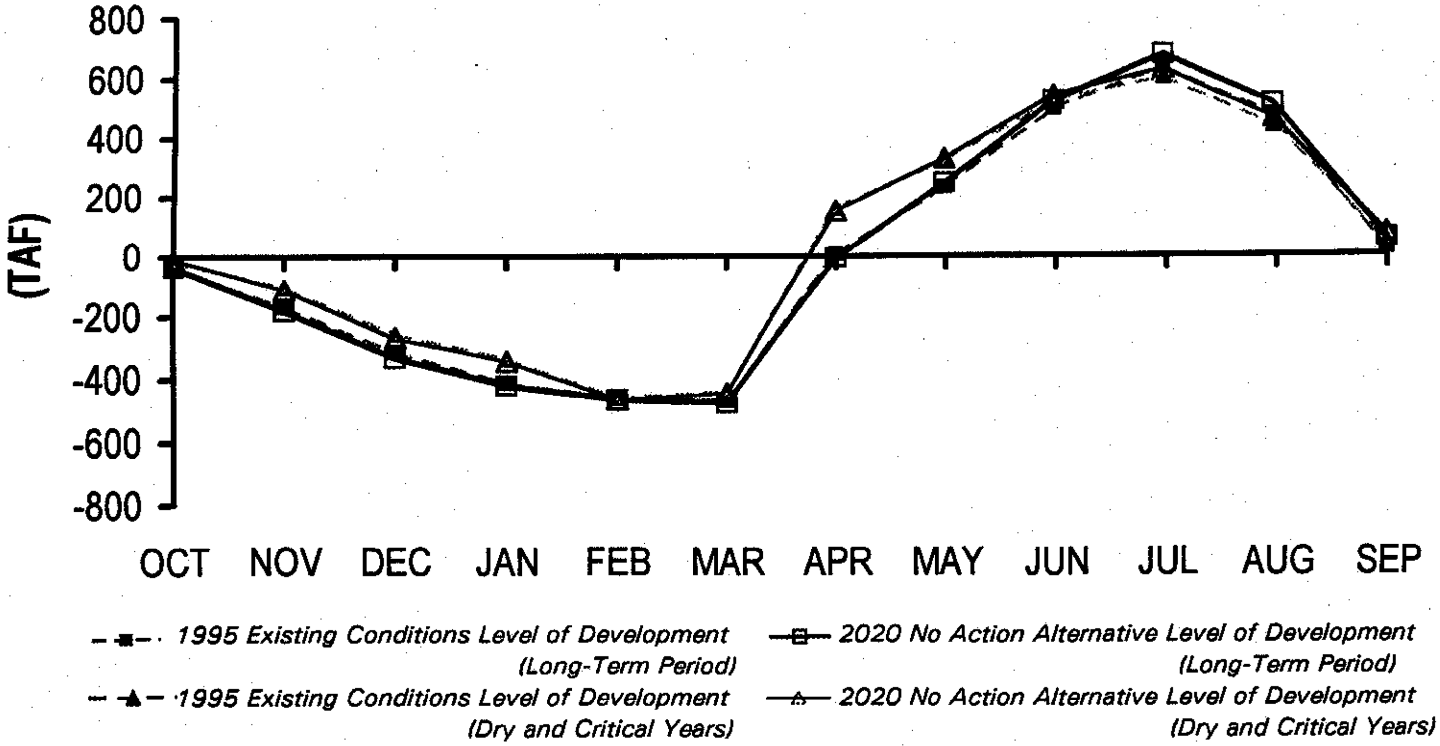


Figure 5.1-8. San Joaquin River Basin under the No Action Alternative and Existing Conditions for the Long-Term Period and Dry and Critical Years

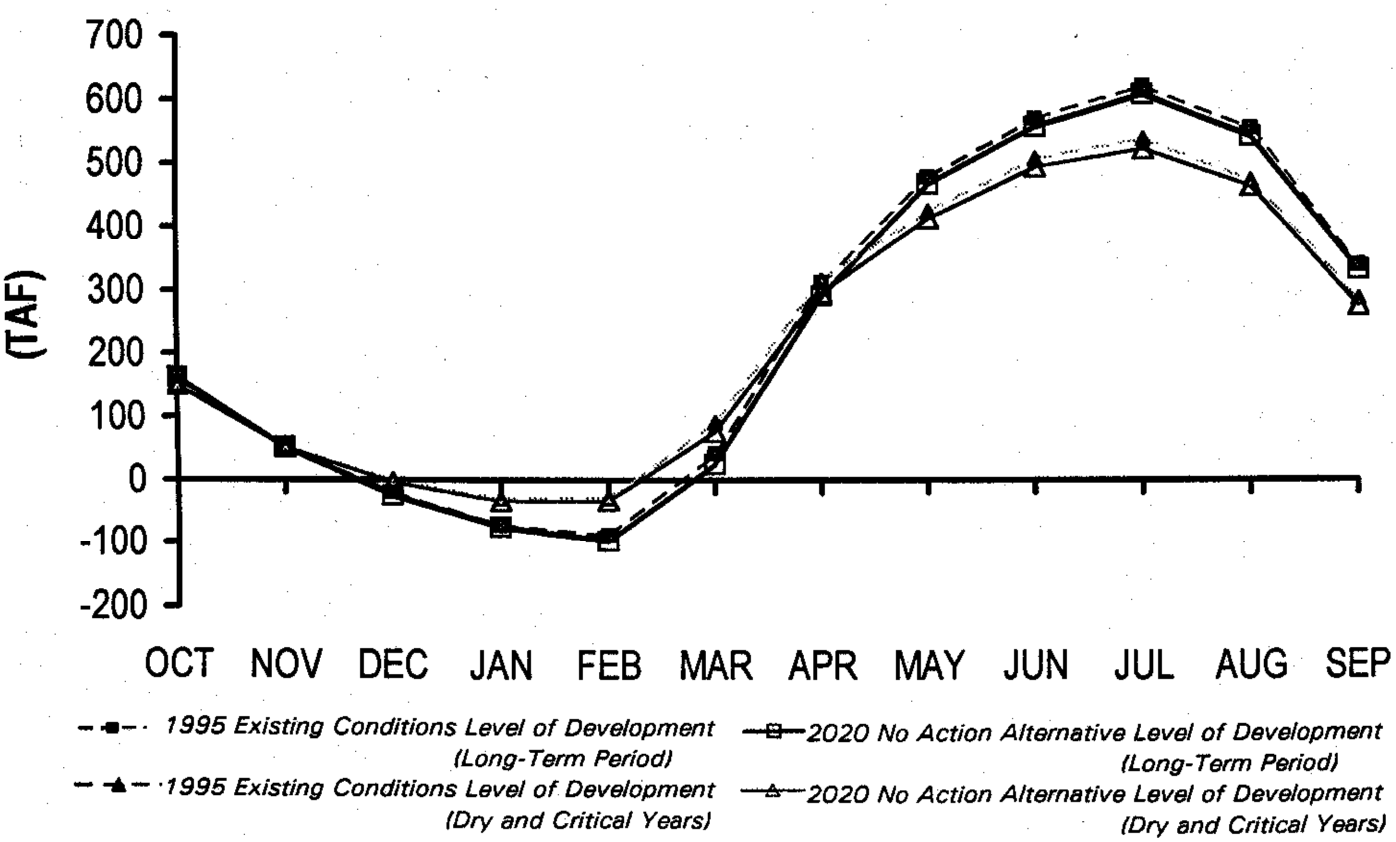


Figure 5.1-9. Carryover Storage for Existing Surface Reservoirs in the Sacramento River Region under the No Action Alternative and Existing Conditions

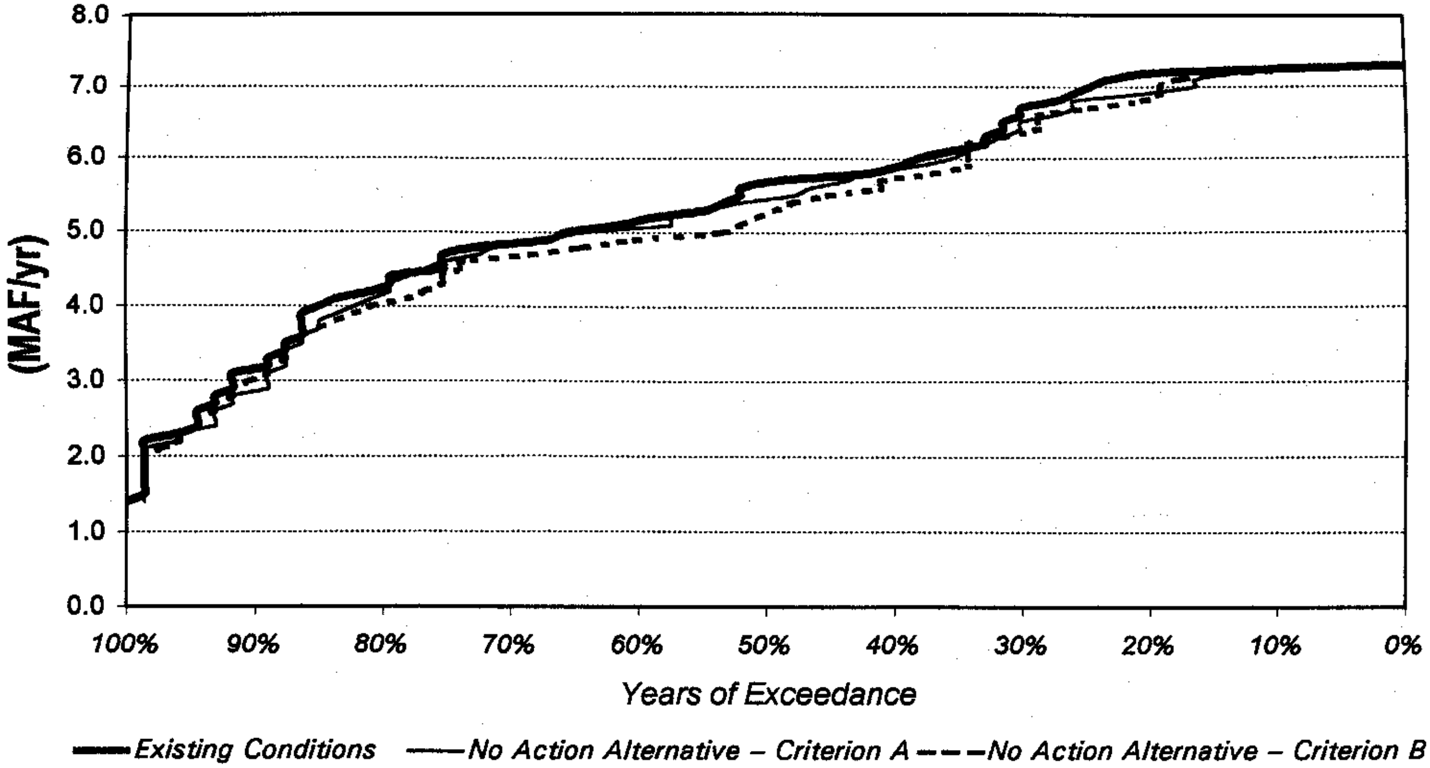
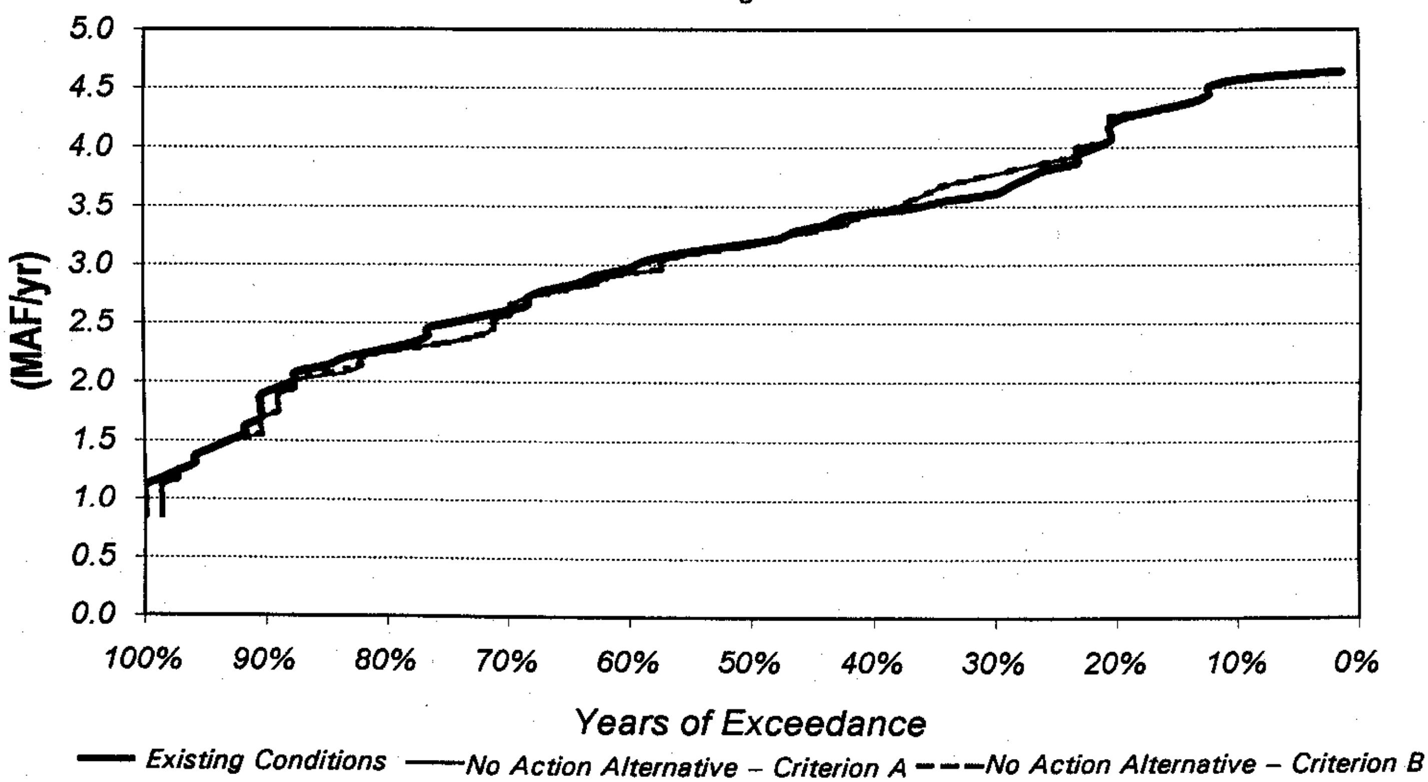


Figure 5.1-10. Carryover Storage for Existing Surface Reservoirs in the San Joaquin River Region under the No Action Alternative and Existing Conditions



from 5.3 to 5.4 MAF under the No Action Alternative. Average dry and critical year storage (similar to 80% exceedance) is about 3.9 MAF under existing conditions and ranges from 3.8 to 3.9 MAF under the No Action Alternative. Carryover storage is expected to be lower under the No Action Alternative to meet higher Bay-Delta system demands or provide water supplies for additional protective Delta water management criteria.

As shown in Figure 5.1-10, average San Joaquin River Region long-term period carryover storage is about 3.2 MAF under existing conditions and 3.1 MAF under the No Action Alternative. Average dry and critical year storage is about 2.3 MAF under existing conditions and 2.2 MAF under the No Action Alternative.

5.1.6.4 South-of-Delta SWP and CVP Service Areas

Programmatic comparisons of Delta deliveries to the South-of-Delta SWP and CVP Service Areas were made between the No Action Alternative and existing conditions using DWRSIM modeling results. Differences generally fall within the range of uncertainty associated with the No Action Alternative.

The range of average annual Delta deliveries predicted for the No Action Alternative generally bracket Delta deliveries under existing conditions. Figure 5.1-11 compares the reliability of average annual Delta deliveries under existing conditions with the expected range of delivery reliability expected under the No Action Alternative. The figure shows that, under existing conditions, average annual Delta deliveries are approximately 5.4 MAF for the long-term period (similar to 50% exceedance) and 4.5 MAF during dry and critical years (similar to 80% exceedance).

The range of average annual Delta deliveries predicted for the No Action Alternative generally bracket Delta deliveries under existing conditions.

Under the No Action Alternative, average annual deliveries could range from 4.8 to 5.7 MAF for the long-term period. Higher deliveries would result from higher Bay-Delta system demands and would generally take place in above normal and wet years when unallocated flows are available for export in the Delta. Lower deliveries would result from additional protective Delta water management criteria. During dry and critical years, annual deliveries could decrease by as much as 610 TAF. Because the system is supply-constrained in dry and critical years, the higher demands considered in Criterion B would not result in significantly higher deliveries relative to existing conditions.

Under existing conditions, the Program assumes that the Eastside Reservoir and the Coastal Aqueduct are not operating. Under Criterion B, the Program assumes these facilities are operational, resulting in some influence on demand patterns. However, the effects of the Eastside Reservoir on Delta deliveries are expected to be minimal. Water supply reliability benefits from Eastside Reservoir will be regional in scope. Although the facility is expected to increase regional operating flexibility during peak summer months, droughts, and emergencies, delivery of available Delta water supplies will still be necessary. Therefore, an increase in regional operating flexibility is expected to have little influence on SWP or CVP operations.

Figure 5.1-11. Average Annual Delta Deliveries under the No Action Alternative and Existing Conditions

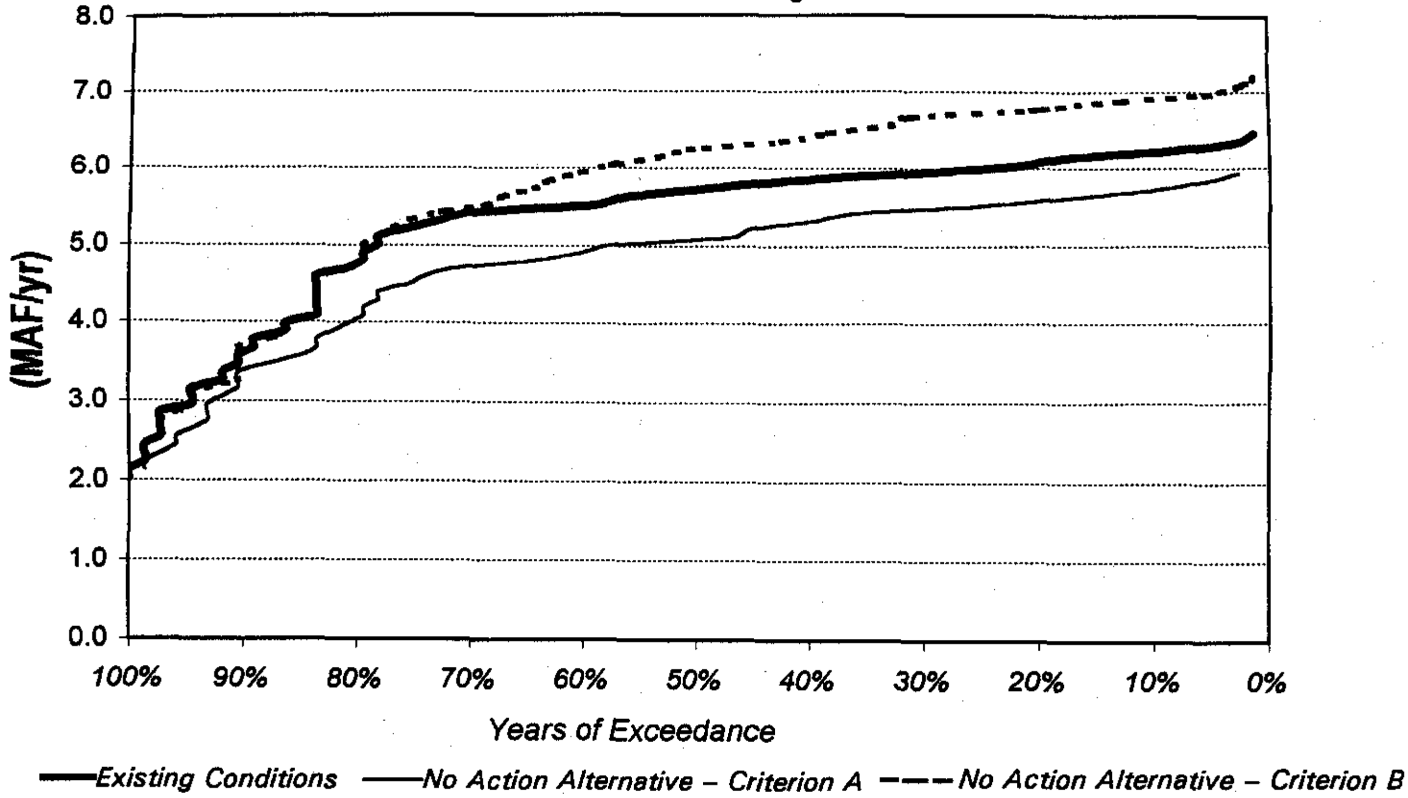
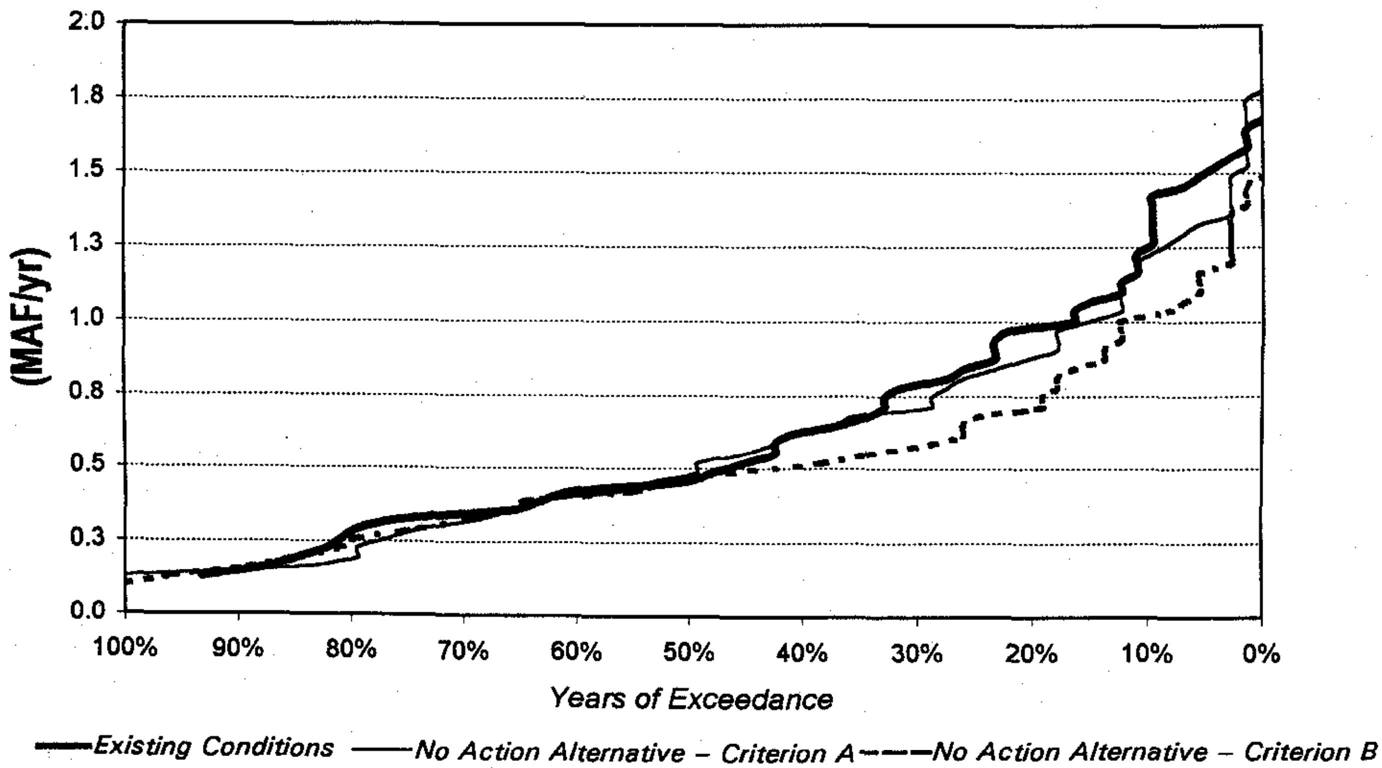


Figure 5.1-12. Carryover Storage for Existing Off-Aqueduct Reservoirs under the No Action Alternative and Existing Conditions



DWRSIM was also used to identify the potential changes in existing off-aqueduct operating storage volumes under existing conditions and the No Action Alternative. Figure 5.1-12 shows the estimated end-of-September carryover storage exceedance for San Luis Reservoir. As shown in the figure, average long-term period carryover storage (similar to 50% exceedance) is about 610 TAF under existing conditions and ranges from 520 to 580 TAF under the No Action Alternative. Average dry and critical year storage (similar to 80% exceedance) is about 300 TAF under existing conditions and ranges from 300 to 340 TAF under the No Action Alternative.

San Luis Reservoir typically fills in fall and winter months. During these months under existing conditions, storage volumes generally lie within the range of uncertainty associated with the No Action Alternative. This comparison is generally consistent for all water-year types.

San Luis Reservoir typically fills in fall and winter both and drains in spring and summer.

San Luis Reservoir typically drains in spring and summer months. During these months, the No Action Alternative provides lower long-term average storage volumes relative to existing conditions. This deviation from existing conditions is due to more protective Delta water management criteria (under Criterion A) and higher deliveries (under Criterion B). During dry and critical years, Criterion B provides storage volumes similar to existing conditions.

5.1.7 CONSEQUENCES: PROGRAM ELEMENTS COMMON TO ALL ALTERNATIVES

For water supply and water management, the environmental consequences of the Ecosystem Restoration, Levee System Integrity, Water Use Efficiency, and Water Transfer Program elements are similar under all Program alternatives and are described by study area in this section. The environmental consequences of the Storage and Conveyance elements vary among Program alternatives, as described in Section 5.1.8. General effects of the Water Quality and Watershed Program elements common to all study areas are summarized below.

The primary water quality constraints on use of water from the Delta for municipal, industrial, and agricultural purposes are salinity, bromide, dissolved organic carbon (DOC), and pathogens (microbes that are potential human health hazards). Improved water quality could increase the amount of water available for some beneficial uses. Improved water quality could provide improved operational flexibility by increasing the windows of opportunity for diversions from the Delta. Additional opportunities for diversions would allow temporal shifting of exports to decrease impacts on Delta fisheries while maintaining or improving water supply reliability. It is expected that the effects of the Water Quality Program on water supply and water management would be beneficial.

The primary water quality constraints on use of water from the Delta for municipal, industrial, and agricultural purposes are salinity, bromide, dissolved organic carbon, and pathogens (microbes that are potential human health hazards).

The various possible watershed projects proposed under the Watershed Program could alter flow regimes through the Delta and into the Bay. For example, vegetation and habitat restoration projects may increase retention of surface water in the watershed. Effects on water supply of these flow changes should be small and beneficial. Additional effects of the Watershed Program in the Sacramento River and San Joaquin River Regions are discussed below.

5.1.7.1 DELTA REGION

Ecosystem Restoration Program

The Ecosystem Restoration Program would result in additional water use in the Delta due to new flow targets and conversion of land use from agriculture to wetlands and marshes. Water users in the Delta have water rights that would not be altered by the Ecosystem Restoration Program.

The Ecosystem Restoration Program would result in additional water use in the Delta due to new flow targets and conversion of land use from agriculture to wetlands and marshes.

Levee System Integrity Program

Improving levee system integrity would reduce the risk of levee failure that could disrupt the diversion of water from the Delta. Levee failures due to high water levels would most likely occur during winter or spring, when dependence on Delta exports is low. However, failures due to seismic events could happen anytime of the year. Disruption of Delta pumping could significantly affect water supplies in areas that receive Delta water exports.

Improving levee system integrity would reduce the risk of levee failure that could disrupt the diversion of water from the Delta.

Levee rehabilitation would involve large-scale construction operations affecting considerable areas of land and water. Construction activities in or immediately adjacent to waterways could temporarily increase local water turbidity and, depending on the source of the material used for levee construction, could cause the release of nutrients, natural organic matter, and other toxic substances into the water. The significance of the impacts on water supply sources would depend on the scale and rate of construction activities. These impacts are expected to be mitigable.

Water Use Efficiency Program

Water use efficiency could allow water to be maintained in storage for a longer period of time during dry periods, and would help reduce the amount of water that is presently diverted for beneficial uses. Increasing water use efficiency also could affect the area's water use by changing the timing of diversions and reducing the amounts of water diverted for agricultural, municipal, industrial, and ecosystem purposes. The Water Use Efficiency Program would increase water supply reliability during very low-flow periods, resulting in a beneficial effect on water supply and water management.

The effects of water use efficiency would be similar to those of reduced water demand within a given area. However, the Water Use Efficiency Program would not necessarily equate to reduced water demand from a statewide perspective. Specifically, reduced demand would not be directly proportional to reduced Delta exports. Reduced water demand would simply increase available supply for consumption in another region of the state. This effect would be largely contingent upon the water-year type and delivery timing. For instance, if urban demand in the South Coast Region were reduced during a dry or critical water year, demands elsewhere in the state would be such that the foregone South Coast deliveries could be allocated to agriculture or urban consumption anywhere in the CVP and SWP service areas.

Water Transfer Program

Water transfers can result in more efficient distribution of water resources among water users during low-flow periods, increasing the reliability of supplies in the Delta during water supply shortages. The Delta environment is included as a potential beneficiary of water transfers either directly through environmental water transfers or indirectly by timing transfers to provide ecosystem benefits. These would be beneficial effects. Management of the EWA may magnify the effects of this program.

Water transfers can result in more efficient distribution of water resources among water users during low-flow periods, increasing the reliability of supplies in the Delta during water supply shortages.

5.1.7.2 BAY REGION

Ecosystem Restoration Program

The indirect impacts of the Ecosystem Restoration Program on the Bay Region could include improved water quality at Rock Slough during low-flow periods and reduced deliveries through CCFB. These are expected to be small and have no significant impacts for Bay Region water users.

Under the Ecosystem Restoration Program, the acreage of shallow water aquatic habitat and saline emergent wetlands will be increased adjacent to Suisun Bay and Marsh, San Pablo Bay, the Napa and Petaluma Rivers, and Sonoma Creek. The proposed lands for conversion are currently used for agriculture. These changes would have a small effect on the Bay Region's water use.

Levee System Integrity Program

A Suisun Marsh levee component would benefit surface water supply and water management issues. Some sediment loading may happen because of the levee rehabilitation but should be minimal since the construction material would be taken from the interior side of the levee. Channel geometry may be altered at a small level when levee rehabilitation takes place on exterior slopes. Channel depth may increase as levees are standardized to a uniform height and structure, but no alterations to channel hydraulics are expected. Water quality in the western Suisun Marsh would be protected with levee rehabilitation, providing a beneficial effect.

A Suisun Marsh levee component would benefit surface water supply and water management issues.

The Levee System Integrity Program is not discussed for regions other than the Delta and Bay Regions because its effects primarily are confined to these regions.

Water Use Efficiency Program

Water use efficiency could allow water to be maintained in storage for a longer period of time during dry periods, and would help reduce the amount of water that is presently diverted for beneficial uses. Increasing water use efficiency also could affect the area's water use by changing the timing of diversions and reducing the amounts of water diverted for agricultural, municipal, industrial, and ecosystem purposes. The Water Use Efficiency Program would increase water supply reliability during very low-flow periods, resulting in a beneficial effect on water supply and water management.

The effects of water use efficiency would be similar to those of reduced water demand within a given area. However, the Water Use Efficiency Program would not necessarily equate to reduced water demand from a statewide perspective. Specifically, reduced demand would not be directly proportional to reduced Delta exports. Reduced water demand would simply increase available supply for consumption in another region of the state. This effect would be largely contingent upon the water-year type and delivery timing. For instance, if urban demand in the Bay Region were reduced during a dry or critical water-year, demands elsewhere in the state would be such that the foregone Bay Region deliveries could be allocated to agriculture or urban consumption anywhere in the CVP and SWP service areas.

Increased water use efficiency could result in reduced water demands during dry periods and increased opportunities for storing water for future use. However, water saved through conservation measures is anticipated to be used locally to offset current or future unmet demands. During periods of low-flow, improved efficiency measures would allow reduced supplies to meet more demands, with potentially less impacts on the users. Increased levels of wastewater recycling can further improve the Bay Region water supply reliability, by generating a water supply that is nominally affected by drought conditions. Water use efficiency could marginally reduce the volume of wastewater generated, but is not expected to cause local reductions in water supplies to water users who supplement their water supplies with recycled water. The effects of the Water Use Efficiency Program in the Bay are expected to be beneficial to water supply and water management.

Increased water use efficiency could result in reduced water demands during dry periods and increased opportunities for storing water for future use. However, water saved through conservation measures is anticipated to be used locally to offset current or future unmet demands.

Water Transfer Program

Increased ability to transfer water could result in more voluntary and beneficial redistribution of water resources among water users. The degree to which redistribution would occur cannot be estimated accurately at the programmatic level. Management of the EWA may magnify the impacts of this program.

Water transfers would affect the Bay's flows primarily through changes to river flow and water temperatures. Increased water transfers change the timing of diversions and alter the amounts of water diverted for agricultural, municipal, industrial, and ecosystem purposes. Water transfers from areas upstream of the Delta to areas south of the Delta would impact Bay water supplies since it would be necessary to modify Delta water diversion schedules,

Water transfers would affect the Bay's flows primarily through changes to river flow and water temperatures.

possibly augmenting water delivery opportunities. This would cause negligible impacts for Bay water users.

5.1.7.3 SACRAMENTO RIVER AND SAN JOAQUIN RIVER REGIONS

Ecosystem Restoration Program

Implementation of the Ecosystem Restoration Program would result in beneficial effects on water supply within both Central Valley rivers and the Delta. During dry and below-normal water-year types, flows would be increased to meet minimum flow targets. This could result in long-term beneficial effects on hydraulic characteristics and channel water quality within the Sacramento River and San Joaquin River Regions. Short-term adverse impacts could be created by increased sediment loading during construction activities. Conversion of cultivated land to wetlands could increase water use. Also, reductions in channel velocities in some Delta reaches that are widened to encourage meanders could result in increases in water temperature during drier water-year types. Ecosystem restoration would increase the use of in-stream flows for environmental purposes but reduce water supplies available for diversion from rivers and the Delta.

Ecosystem restoration would increase the use of in-stream flows for environmental purposes but reduce water supplies available for diversion from rivers and the Delta.

Water Use Efficiency Program

Water use efficiency could allow water to be maintained in storage for a longer period of time during dry periods, and would help reduce the amount of water that is presently diverted for beneficial uses. Increasing water use efficiency also could affect the area's water use by changing the timing of diversions and reducing the amounts of water diverted for agricultural, municipal, industrial, and ecosystem purposes. The Water Use Efficiency Program would increase water supply reliability during very low-flow periods, resulting in a beneficial effect on water supply and water management.

The effects of water use efficiency would be similar to those of reduced water demand within a given area. However, the Water Use Efficiency Program would not necessarily equate to reduced water demand from a statewide perspective. Specifically, reduced demand would not be directly proportional to reduced Delta exports. Reduced water demand would simply increase available supply for consumption in another region of the state. This effect would be largely contingent upon the water-year type and delivery timing. For instance, if urban demand in the South Coast Region were reduced during a dry or critical water-year, demands elsewhere in the state would be such that the foregone South Coast deliveries could be allocated to agriculture or urban consumption anywhere in the CVP and SWP service areas.

Additionally, water use efficiency improvements may allow for modifications in the timing and amount of reservoir releases for agricultural or urban uses. Timing changes also could benefit fish and aquatic ecosystems by making supplies available when needed by these resources.

Water Transfer Program

Increased ability to transfer water from the Sacramento River and San Joaquin River Regions to other areas could result in more voluntary and beneficial redistribution of water resources among water users. The degree to which redistribution would occur cannot be estimated accurately at the programmatic level. Management of the EWA may magnify the impacts of this program.

Increased ability to transfer water from the Sacramento River and San Joaquin River Regions to other areas could result in more voluntary and beneficial redistribution of water resources among water users.

Water transfers would affect the regions primarily through changes to river flow and water temperatures. Increased water transfers change the timing of diversions and alter the amounts of water diverted for agricultural, municipal, industrial, and ecosystem purposes. Water transfers from the Sacramento River and San Joaquin River Regions to areas south of the Delta would modify water diversion schedules. The effects of the Water Transfer Program are expected to be beneficial to water supply and water management.

Watershed Program

Potential watershed projects could alter flow regimes in the upper watersheds as well as downstream, thus affecting water supply. Depending on the size and scale of the projects, effects could range from very limited quantity and temporal changes in flows to more pronounced regional alterations in flow regimes. Vegetation and habitat restoration projects may increase the retention of surface water in the watershed, resulting in less variable runoff (reduced peak flows and increased base flows in streams).

Depending on the size and scale of the projects, effects could range from very limited quantity and temporal changes in flows to more pronounced regional alterations in flow regimes.

Alteration of timber harvesting practices could change total runoff quantities if implemented over large areas. Reduced clear-cutting and overall reductions in logging could substantially reduce runoff from the forested areas. Maintained or reforested tree stands would increase evapotranspiration, interception, and infiltration of precipitation, all of which reduce runoff. In areas where snowmelt plays an important role in the flow regime, reducing the effects of timber harvesting would increase shading, which tends to reduce direct evaporation of snow pack and maintains the snow pack longer. Range improvement activities could increase vegetation cover and re-establish riparian habitat, both of which would tend to increase water retention in watersheds. The net effect of all of these potentially offsetting activities on water supply is unknown, but the relative impacts on water supply in the Program's study area are expected to be small.

5.1.7.4 SOUTH-OF-DELTA SWP AND CVP SERVICE AREAS

Ecosystem Restoration Program

Implementation of the Ecosystem Restoration Program could affect water supply within South-of-Delta SWP and CVP Service Areas. Meeting Delta flow targets could reduce water supply available for exports and/or affect water exports timing. Opportunities to

Meeting Delta flow targets could reduce water supply available for exports and/or affect water exports timing. Opportunities to purchase water through water transfers could be reduced, resulting in negative effects on water supply.

purchase water through water transfers could be reduced, resulting in negative effects on water supply.

Water Use Efficiency Program

Water use efficiency could allow water to be maintained in storage for a longer period of time during dry periods, and would help reduce the amount of water that is presently diverted for beneficial uses. Increasing water use efficiency also could affect the area's water use by changing the timing of diversions and reducing the amounts of water diverted for agricultural, municipal, industrial, and ecosystem purposes. The Water Use Efficiency Program would increase water supply reliability during very low-flow periods, resulting in a beneficial effect on water supply and water management.

The effects of water use efficiency would be similar to those of reduced water demand within a given area. However, the Water Use Efficiency Program would not necessarily equate to reduced water demand from a statewide perspective. Specifically, reduced demand would not be directly proportional to reduced Delta exports. Reduced water demand would simply increase available supply for consumption in another region of the state. This effect would be largely contingent upon the water-year type and delivery timing. For instance, if urban demand in the South Coast Region were reduced during a dry or critical water-year, demands elsewhere in the state would be such that the foregone South Coast deliveries could be allocated to agriculture or urban consumption anywhere in the CVP and SWP service areas.

Water use efficiency has the potential to supplement water supply reliability and subsequent environmental benefits. However, the potential may not exist for water use efficiency to completely replace the water supply reliability and water management flexibility of other water management tools.

Water Transfer Program

Increased ability to transfer water from the Sacramento River and San Joaquin River Regions to South-of-Delta SWP and CVP Service Areas could result in more voluntary and beneficial redistribution of water resources among water users. The degree to which redistribution would occur cannot be estimated accurately at this programmatic level. The effects of the Water Transfer Program are expected to be beneficial for water users. Management of the EWA may magnify the effects of this program.

5.1.8 CONSEQUENCES: PROGRAM ELEMENTS THAT DIFFER AMONG ALTERNATIVES

For water supply and water management, the Storage and Program Conveyance Element result in environmental consequences that differ among the alternatives as described below.

The programmatic comparisons presented in this section differentiate water supply and water management provided under the Program alternatives and No Action Alternative. These comparisons are made in consideration of assumptions regarding future water management actions effecting the Bay-Delta system. The water management criteria includes ranges of water demands and protective Delta water management criteria. The range of water demands represents uncertainty in the future need for Bay-Delta water supplies due to uncertainty in projections of population, land use, implementation of water use efficiency measures, and the effects of water marketing. The range of protective Delta water management criteria represents uncertainty related to future actions required to assure recovery of the Bay-Delta ecosystem.

To properly document and evaluate the results, impact ranges were methodically quantified. Impact ranges were estimated for key parameters representative of each Program study area. For instance, the range of impacts associated with the No Action Alternative is detailed for each evaluation. In addition, ranges were developed for potential changes associated with implementation of each respective Program alternative. Where applicable, a range of impacts for each alternative was developed under Criteria A and B without new storage as well as Criteria A and B with new storage. This provides an indication of a given parameter's sensitivity to the protective Delta water management criteria assumption sets. Lastly, a range of changes associated with new storage relative to each alternative is described where appropriate. Each range is presented for both the long-term period and dry and critical years.

5.1.8.1 ALTERNATIVE 1

Some improvements to water supply and water management would be realized from improved export pumping capacity under Alternative 1. Greater water supply and water management benefits may be obtained if additional storage facilities are constructed.

> Some improvements to water supply and water management would be realized from improved export pumping capacity under Alternative 1. Greater water supply and water management benefits may be obtained if additional storage facilities are constructed.

Delta Region

Programmatic comparisons of Delta inflows and exports were made between Alternative 1 and the No Action Alternative using DWRSIM modeling results. Both bookend water management criteria assumption sets (Criteria A and B) were used to define the range of uncertainty associated with each alternative. Delta inflow comparisons are based on the peak average monthly value, which typically occurs in February. The maximum deviation between Program alternatives typically occurs in this month. Delta export comparisons are based on peak and minimum monthly average values, as well as average annual values.

Average monthly Delta inflow is largely unaffected under Alternative 1 relative to the No Action Alternative. Over the long-term period, Delta inflow normally peaks in February. Average February flow is approximately 190 TAF under the No Action Alternative and is generally about the same under Alternative 1. The differences in Delta inflow are largest from April through October. This effect is more pronounced during dry and critical years. Additional storage as well as water management assumptions have no appreciable impacts on Delta inflow.

Average monthly Delta inflow is largely unaffected under Alternative 1 relative to the No Action Alternative.

The pattern of long-term average Delta exports would be modified somewhat by Alternative 1, with greater exports occurring August through January relative to the No Action Alternative. Figure 5.1-13 compares average monthly south-of-Delta exports for the long-term period. Similarly, Figure 5.1-14 compares average monthly south-of-Delta exports during dry and critical years. The range of average annual Delta exports under Alternative 1 for both hydrologic periods are compared to the No Action Alternative in Figure 5.1-15.

The pattern of long-term average Delta exports would be modified somewhat by Alternative 1, with greater exports occurring August through January relative to the No Action Alternative.

Combined exports from Banks and Tracy Pumping Plants peak in late winter months, with monthly long-term period values ranging from 560 to 680 TAF under the No Action Alternative and from 540 to 760 TAF under Alternative 1. Delta exports, at minimum values in spring months, change little under Alternative 1. Monthly long-term period exports range from 120 to 200 TAF under the No Action Alternative and range from 120 to 210 TAF under Alternative 1. On an annual basis, without additional storage, Alternative 1 increases long-term period Delta exports by an additional 270-390 TAF over the No Action Alternative. With additional storage, Alternative 1 increases annual Delta exports about 670-800 TAF over the No Action Alternative. Therefore, an annual long-term export increase of 400 TAF is directly related to additional storage under Alternative 1.

Alternative 1 has a similar influence on dry and critical year Delta exports. Under the No Action Alternative, monthly Delta exports range from 530 to 640 TAF in the peak winter months and from 90 to 140 TAF during the spring months. Under Alternative 1, monthly dry and critical year exports range from 530 to 720 TAF in the peak winter months and from 90 to 140 TAF during the spring months. On an annual basis, without additional storage, Alternative 1 increases dry and critical year Delta exports by an addi-tional 190 TAF over the No Action Alternative. With additional storage, Alternative 1 increases annual Delta exports by 240 to 640 TAF over the No Action Alternative. Therefore, annual dry and critical year export increases of 220-450 TAF are directly related to additional storage under Alternative 1.

Bay Region

Programmatic comparisons of Delta outflow to San Francisco Bay were made between Alternative 1 and the No Action Alternative using DWRSIM modeling results.

Figure 5.1-13. Delta Exports at Banks and Tracy under Alternative 1 for the Long-Term Period

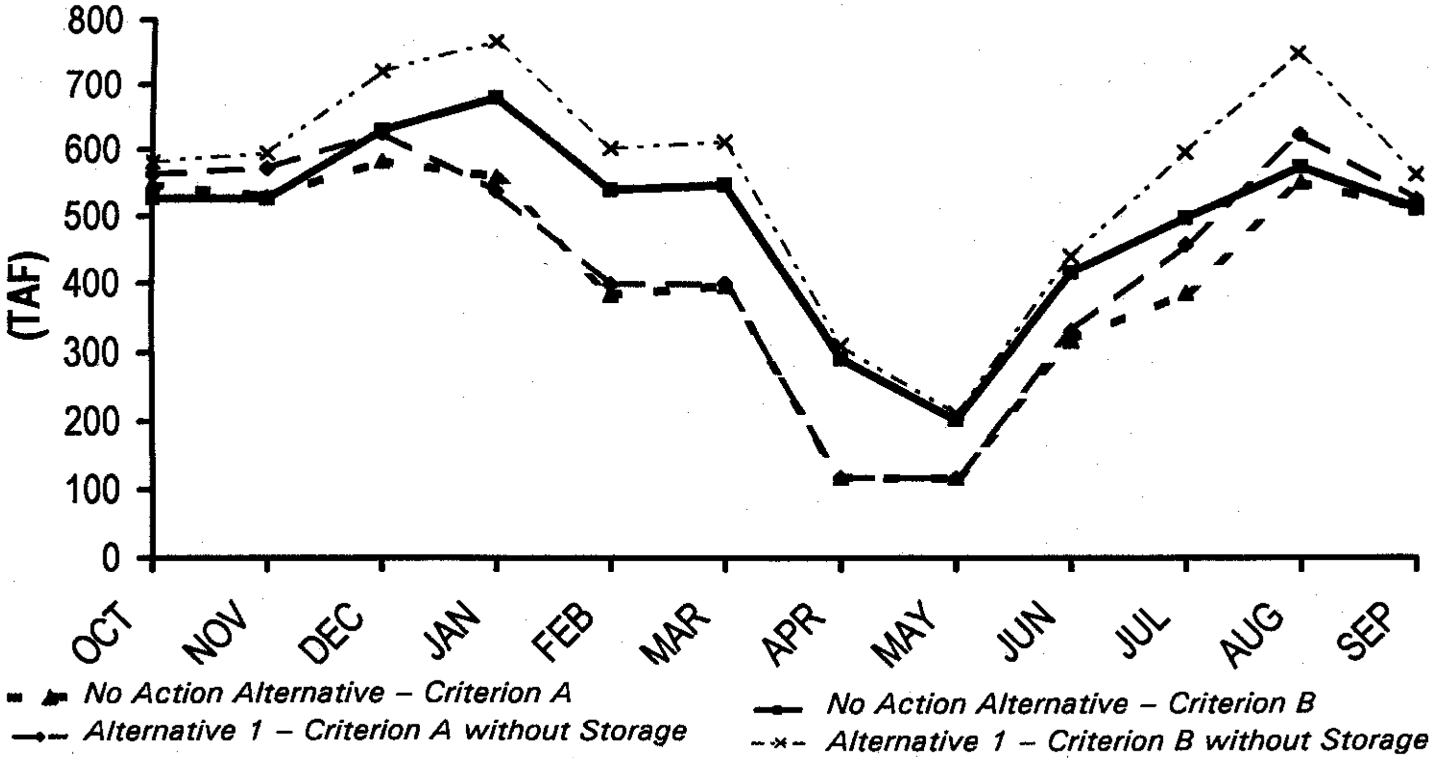


Figure 5.1-14. Delta Exports at Banks and Tracy under Alternative 1 for Dry and Critical Years

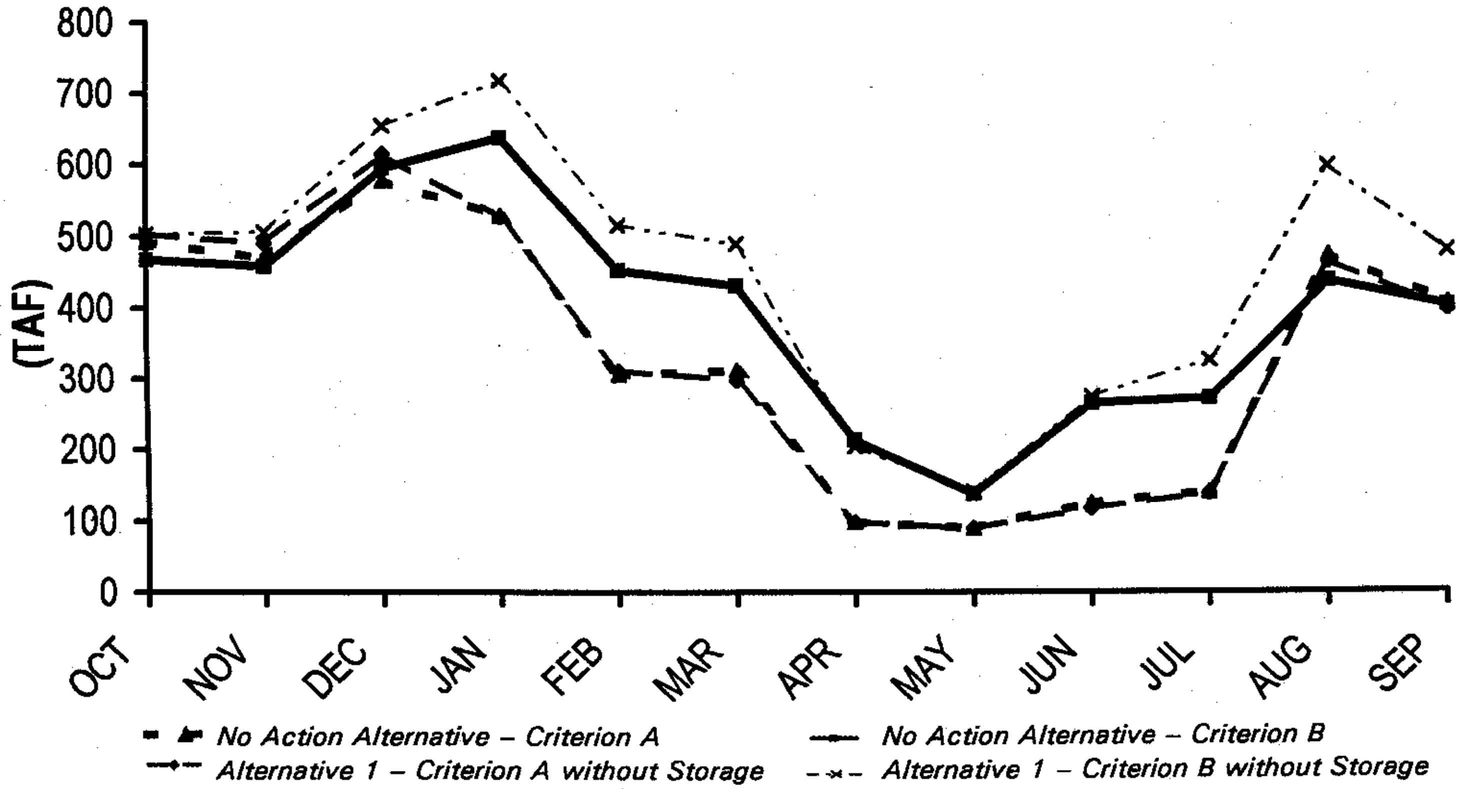
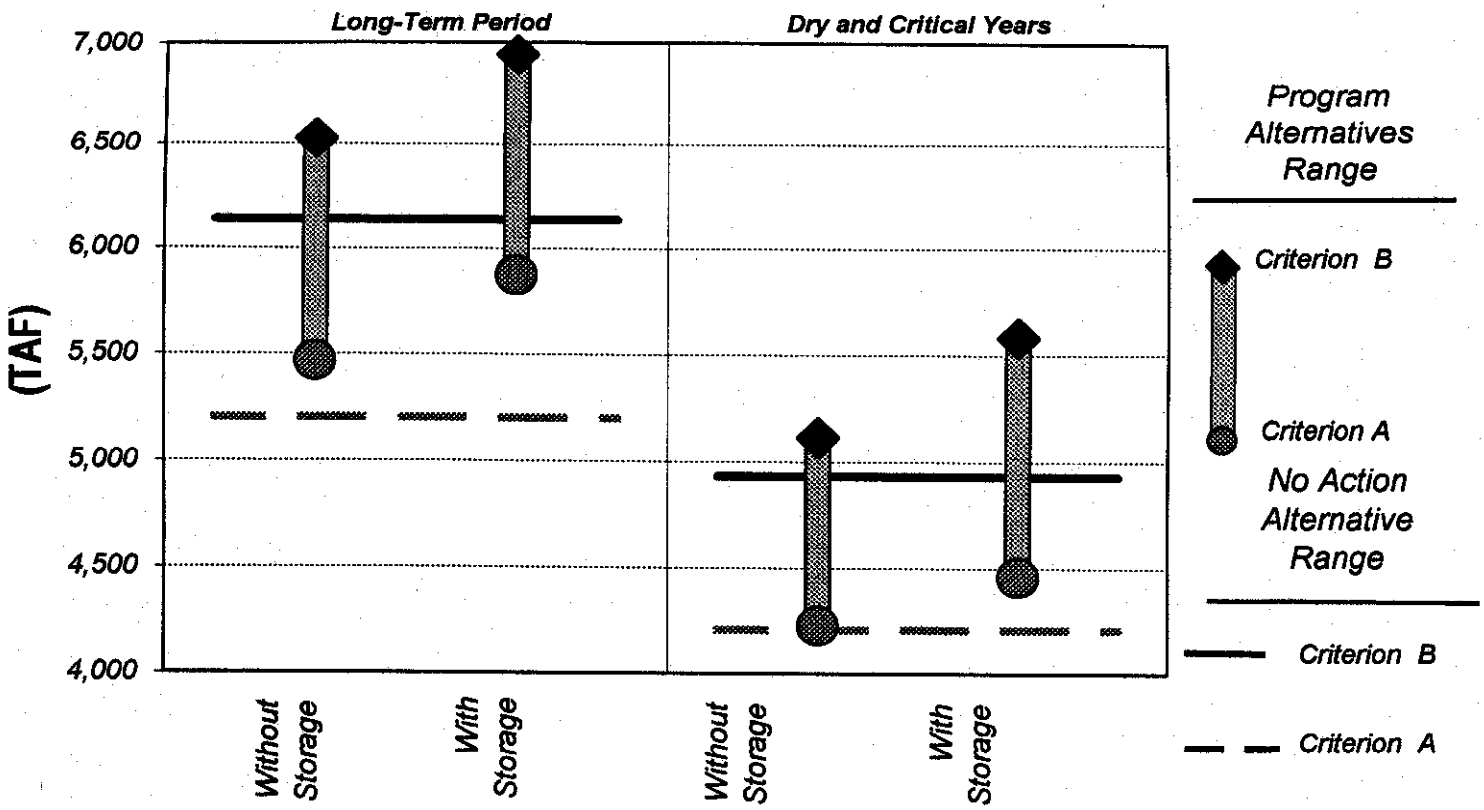


Figure 5.1-15. Average Annual Delta Exports at Banks and Tracy under Alternative 1 for the Long-Term Period and Dry and Critical Years



Figures 5.1-16 and 5.1-17 present monthly average Delta outflow comparisons for the long-term period and dry and critical years, respectively.

Delta outflow is typically lower under Alternative 1 than under the No Action Alternative during November through March. Percentage differences are typically small, however. Over the long-term period, Delta outflow normally peaks in February. Average February outflow ranges from 2.7 to 2.8 MAF under the No Action Alternative and ranges from 2.6 to 2.8 MAF under Alternative 1. The differences in Delta outflow are smaller from April through October. Ecosystem Restoration Program flows provide some additional May outflow under Alternative 1. On an annual basis, without additional storage, Alternative 1 could decrease average long-term period Delta outflows by as much as 80 TAF or could increase Delta Outflow by 30 TAF compared to the No Action Alternative. With additional storage, Alternative 1 decreases average annual Delta outflows about 460-660 TAF. Therefore, annual long-term Delta outflow decreases of 490-580 TAF are directly related to additional storage under Alternative 1.

Delta outflow is typically lower under Alternative 1 than under the No Action Alternative during November through March.

During dry and critical years, February outflows range from 950 TAF to 1.1 MAF under the No Action Alternative and range from 860 TAF to 1.1 MAF under Alternative 1. On an annual basis, without additional storage, Alternative 1 increases average dry and critical year Delta outflows up to 160 TAF over the No Action Alternative. With additional storage, Alternative 1 could decrease average dry and critical year outflows by 260 TAF or could increase outflows by 70 TAF relative to the No Action Alternative. Therefore, annual dry and critical year Delta outflow decreases of 80-310 TAF are directly related to additional storage under Alternative 1.

Sacramento River and San Joaquin River Regions

This section provides a comparison of Alternative 1 and the No Action Alternative with respect to water supply and water management in the Sacramento River and San Joaquin River Regions using DWRSIM modeling results. The programmatic comparison focuses on existing storage, new storage, and Ecosystem Restoration Program acquisitions.

Existing Storage. End-of-September carryover storage in the major Sacramento River Region surface storage facilities (Shasta, Oroville, and Folsom) was evaluated for Alternative 1 and the No Action Alternative. Figure 5.1-18 depicts the ranges of long-term period and dry and critical year carryover storage for Alternative 1 and the No Action Alternative.

Under the No Action Alternative, average carryover storage in Sacramento River Region reservoirs ranges from 5.3 to 5.4 MAF for the long-term period, and from 3.8 to 3.9 MAF for dry and critical years. Alternative 1 long-term period carryover storage ranges from 5.1 to 5.5 MAF, while dry and critical year carryover storage ranges from 3.6 to 4.0 MAF.

In the absence of new storage facilities, implementation of Alternative 1 has little impact on carryover storage under Criterion A water management assumptions. Alternative 1 results in a slight reduction in carryover storage under Criterion B water management assumptions. Without new storage, the reduction in average long-term carryover storage

In the absence of new storage facilities, implementation of Alternative 1 has little impact on carryover storage under Criterion A water management assumptions. Alternative 1 results in a slight reduction in carryover storage under Criterion B water management assumptions.

Figure 5.1-16. Delta Outflow under Alternative 1
for the Long-Term Period

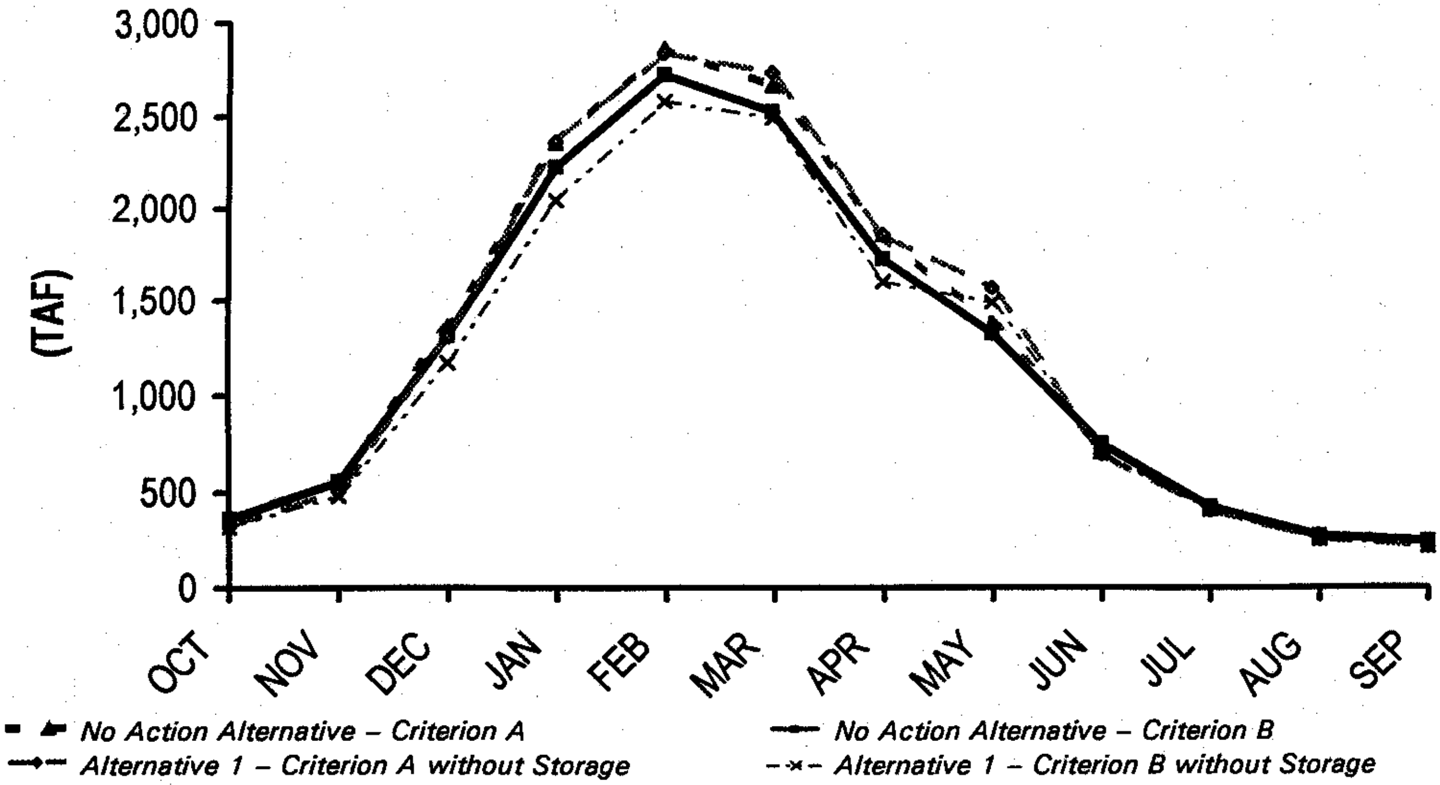


Figure 5.1-17. Delta Outflow under Alternative 1
for Dry and Critical Years

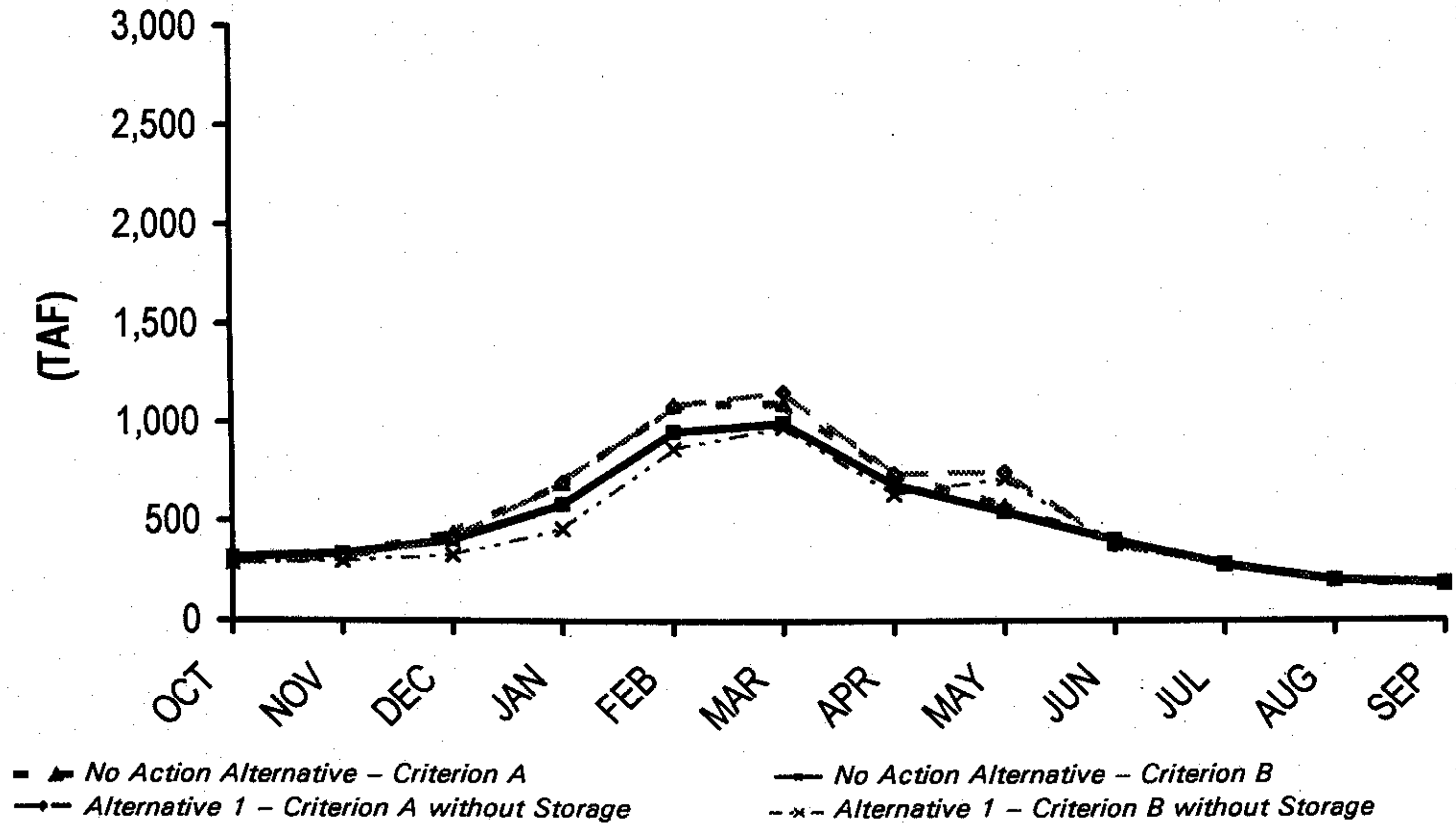


Figure 5.1-18. Carryover Storage for Existing Surface Reservoirs in the Sacramento River Region under Alternative 1 for the Long-Term Period and Dry and Critical Years

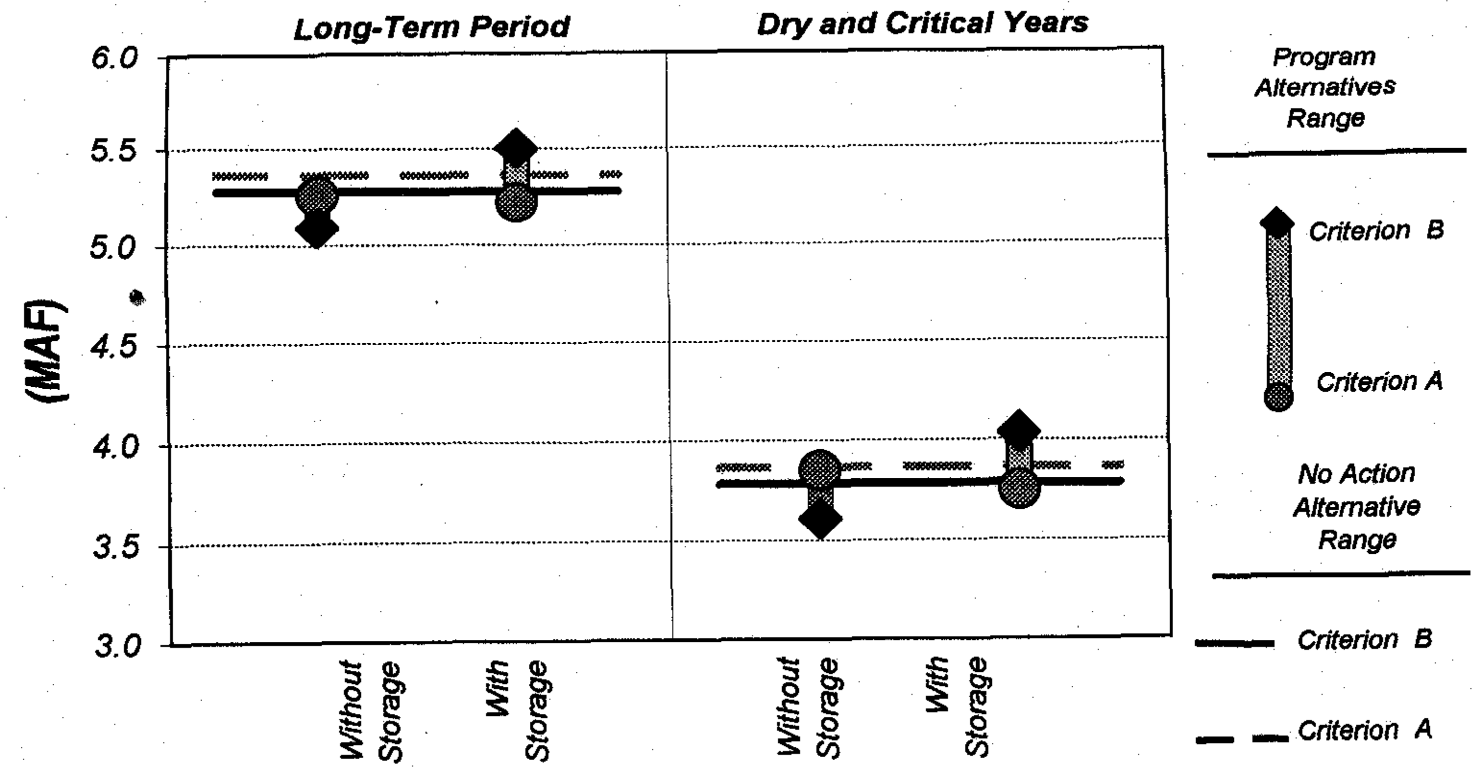
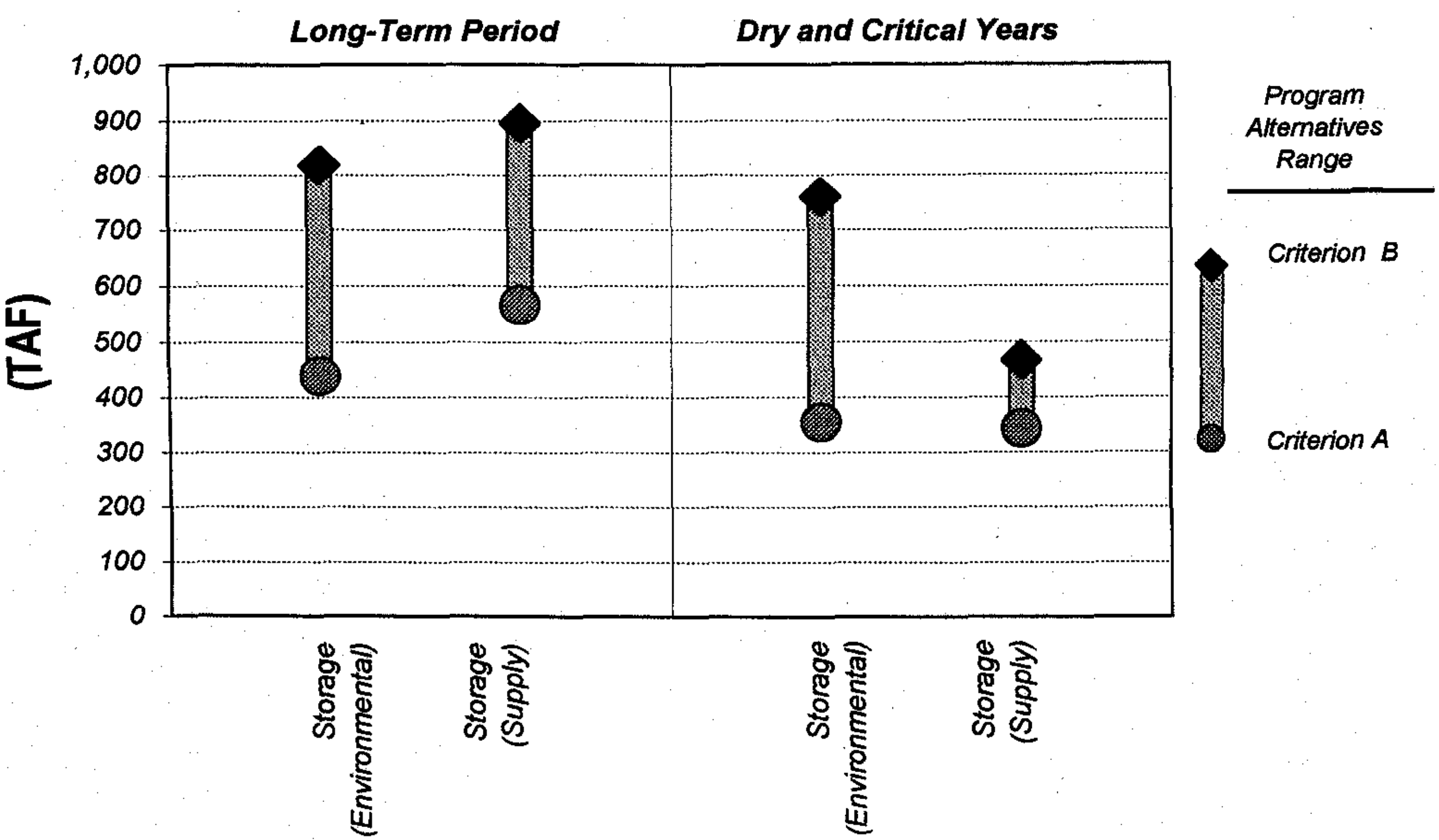


Figure 5.1-19. Carryover Storage for New Surface Reservoirs in the Sacramento River Region under Alternative 1 for the Long-Term Period and Dry and Critical Years



under Alternative 1 may vary from 100 to 190 TAF. The same trend is demonstrated for dry and critical years with the reduction in average carryover storage varying from 20 to 170 TAF.

With new storage facilities, implementation of Alternative 1 under Criterion A assumptions reduces long-term and dry and critical year carryover storage in existing facilities from on the order of 140 TAF relative to the No Action Alternative. Under Criterion B assumptions, Alternative 1 increases carryover storage from on the order of 260 TAF.

End-of-September carryover storage in the major San Joaquin River Region surface facilities (New Melones, New Don Pedro, and McClure) was also evaluated for Alternative 1 and the No Action Alternative. Implementation of Alternative 1 has no measurable effect on system carryover storage. Similarly, no variation is evident based on water management criteria or implementation of additional storage facilities.

Implementation of Alternative 1 has no measurable effect on system carryover storage in the San Joaquin River Region.

New Storage. New Sacramento River and San Joaquin River Region surface storage facilities were evaluated under Alternative 1. This evaluation distinguished between storage for water supply and storage for environmental enhancement.

Figure 5.1-19 presents Sacramento River Region surface storage comparisons for the long-term period and dry and critical years. Peak storage in the new facilities generally occurs in early summer under all hydrologic conditions. For the long-term period, peak water supply storage ranges from 740 TAF to 1.3 MAF, while dry and critical year peak storage typically ranges from 470 to 850 TAF. Carryover storage ranges from 570 TAF to 890 TAF for the long-term period, and from 340 to 470 TAF for dry and critical years. Criterion A water management assumptions consistently result in lower water supply storage. For the long-term period, peak Sacramento River Region environmental storage ranges from 510 to 910 TAF, while dry and critical year peak storage typically ranges from 440 to 870 TAF. Carryover storage ranges from 440 to 820 TAF for the long-term period, and from 350 to 760 TAF for dry and critical years. Criterion A water management assumptions consistently result in lower environmental storage.

New Sacramento River Region groundwater storage facilities also were evaluated under Alternative 1. These facilities are assumed to have a maximum capacity of 250 TAF with maximum inflow and discharge capacities of 500 cfs. Withdrawals from this groundwater storage are assumed to be made only in dry and critical years. The estimated average annual dry and critical year yield of these facilities ranges from 43 to 45 TAF. The long-term average was not calculated since the storage was operated for dry and critical year yield only.

In this evaluation, new San Joaquin River Region surface storage facilities were dedicated to providing water for Ecosystem Restoration Program flow targets. Peak average annual storage tends to occur in late spring and is approximately 240 TAF for the long-term period and 220-230 TAF for dry and critical years. Carryover storage ranges from 200 to 210 TAF for the long-term period and dry and critical years. Criterion B water management assumptions consistently resulted in lower storage.

Ecosystem Restoration Program Acquisition. All Program alternatives include Ecosystem Restoration Program flow targets described in Attachment A for the Sacramento River and San Joaquin River Regions. In the Sacramento River Region, surface water would be acquired from willing sellers on the Sacramento, Feather, Yuba, and American Rivers for in-stream purposes. Similarly, in the San Joaquin River Region, water would be acquired from willing sellers on the Stanislaus, Tuolumne, and Merced Rivers. It is assumed that water would be acquired from water right holders on these rivers and may result in short-term fallowing. The acquired water would be stored during the period of a contract year by reoperating upstream reservoirs and released in a manner to increase flow toward the in-stream flow targets on these rivers.

All Program alternatives include Ecosystem Restoration Program flow targets for the Sacramento River and San Joaquin River Regions.

The modeling analysis provides the Ecosystem Restoration Program acquisition flows through "add water" and does not reoperate existing reservoirs. Since the Ecosystem Restoration Program flow targets are in the spring, reservoir operations are likely to accommodate the release pattern for additional in-stream flows. In effect, the acquisition of water would involve a shift in the release pattern from storage reservoirs, combined with a reduction in the diversion of the released water.

Under the Ecosystem Restoration Program, release of acquired water would flow through the Delta and increase Delta outflow. The acquired water would not be exported by the CVP or SWP. However, the projects would receive some incidental benefit toward meeting Delta water quality and outflow requirements, since the increase in Delta outflow resulting from release of acquired water would reduce salinity intrusion into the Delta.

Under the Ecosystem Restoration Program, release of acquired water would flow through the Delta and increase Delta outflow.

Table 5.1-3 shows water acquisition quantities under Alternative 1 estimated to meet proposed Ecosystem Restoration Program flow targets. For locations in the Sacramento River Region, flow targets vary with the Sacramento Valley 40-30-30 water-year index. For locations in the San Joaquin River Region, flow targets vary with the San Joaquin Valley 60-20-20 water-year index. However, in Table 5.1-3 and subsequent Ecosystem Restoration Program tables, all water acquisition quantities vary with the 40-30-30 water-year index. Therefore, even though no critical year Ecosystem Restoration Program targets are specified for the Tuolumne and Merced Rivers based on the 60-20-20 index, these tables consistently show critical year Ecosystem Restoration Program acquisitions based on the 40-30-30 index.

Table 5.1-3. Estimated Ecosystem Restoration Program Water Acquisitions in the Sacramento River and San Joaquin River Regions without New Storage under Alternative 1 (TAF)

LOCATION	CRITICAL	DRY	BELOW NORMAL	ABOVE NORMAL	WET
Sacramento River	0	0-10	90	20	0
Yuba River	0	10	<10	0	0
Feather River	0	50	80	60	<10
American River	0	30	40	20	40
Lower Sacramento River	0	80-90	10	0	<10
Additional Delta flows	0	90-110	180-210	250-260	10
Stanislaus River	0	10	30	40	40
Tuolumne River	50	40	40	50	40
Merced River	40	20	20	40	30
Total acquisitions	**90**	**330-370**	**490-520**	**480-490**	**160**

Table 5.1-4. Estimated Ecosystem Restoration Program Water Acquisitions in the Sacramento River and San Joaquin River Regions with New Storage under Alternative 1 (TAF)

LOCATION	CRITICAL	DRY	BELOW NORMAL	ABOVE NORMAL	WET
Sacramento River	0	<10	30-50	0-10	0
Yuba River	0	10	<10	0	0
Feather River	0	40	70	40	0
American River	0	30	40	20	40
Lower Sacramento River	0	0-30	0	0	0
Additional Delta flows	0	30-40	110-120	180-210	<10
Stanislaus River	0	10	30	40	40
Tuolumne River	60	30	20	30	20
Merced River	30	10	0	10	10
Total acquisitions	**90**	**160-220**	**300-330**	**320-360**	**110**

Fewer water acquisitions are required to meet Ecosystem Restoration Program flow targets when Sacramento River and San Joaquin River Regions surface storage is included in Alternative 1. New storage also could be operated to provide Ecosystem Restoration Program flows for other tributaries by exchange agreements. These types of arrangement are not reflected in this analysis. Table 5.1-4 shows the water acquisitions quantities estimated to meet the proposed Ecosystem Restoration Program flow targets under Alternative 1 with new storage.

South-of-Delta SWP and CVP Service Areas

Programmatic comparisons of deliveries to the South-of-Delta SWP and CVP Service Areas were made between Alternative 1 and the No Action Alternative using DWRSIM modeling results. This section also evaluates storage in existing and new off-aqueduct facilities.

Delta Deliveries. The range of annual Delta deliveries under the No Action Alternative was compared to the range of deliveries expected under Alternative 1. Deliveries are generally higher under Alternative 1 with implementation of new storage facilities and Criterion B water management assumptions.

Under Alternative 1, the range of average annual deliveries over the long-term period is from 5.1 to 6.5 MAF. The low end of this range assumes no new storage facilities and Criterion A water management assumptions; the high end of this range assumes new storage facilities and Criterion B water management assumptions. The No Action Alternative results in a long-term average annual delivery range of 4.8-5.8 MAF. During dry and critical years, Alternative 1 average annual deliveries range between 3.9 and 5.6 MAF and the No Action Alternative deliveries range between 3.9 and 4.6 MAF.

Without additional storage facilities, Alternative 1 would increase long-term average annual deliveries by 270-380 TAF relative to the No Action Alternative. Dry and critical year deliveries would increase by up to 190 TAF under Alternative 1. Implementation of Alternative 1 in conjunction with new surface storage would increase long-term average

Without additional storage facilities, Alternative 1 would increase long-term average annual deliveries by 100-140 TAF relative to the No Action Alternative. Implementation of Alternative 1 in conjunction with new surface storage would increase long-term average annual deliveries by 580-730 TAF.

annual deliveries by 670-790 TAF. In dry and critical years, Alternative 1 would increase deliveries by 600-990 TAF. Therefore, annual long-term Delta delivery increases of 400-410 TAF are directly related to additional storage under Alternative 1. The range of average annual long-term and dry and critical water-year Delta deliveries for Alternative 1 compared to the No Action Alternative is depicted in Figure 5.1-20.

Existing Off-Aqueduct Storage Facilities. San Luis Reservoir is the primary existing off-aqueduct storage facility serving the South-of-Delta SWP and CVP Service Areas. San Luis Reservoir carryover storage and reservoir releases were evaluated under Alternative 1 and the No Action Alternative.

With no additional storage, Alternative 1 increases San Luis Reservoir carryover storage by 40-140 TAF for long term and by 60-100 TAF for dry and critical years (above the No Action Alternative). If additional storage is implemented, Alternative 1 increases long-term carryover storage by 100-270 TAF and dry and critical carryover storage by 100-170 TAF above the No Action Alternative. Therefore, a long-term average carryover storage increase of 60-130 TAF is directly attributed to additional storage under Alternative 1. The average carryover storage increase of 40-70 TAF for dry and critical years is directly related to additional storage under Alternative 1. Figure 5.1-21 presents carryover storage comparisons for the long-term period and dry and critical years.

The broadest range in monthly average storage releases from San Luis Reservoir generally occurs in summer months for both water management criteria under all hydrologic conditions. The smallest long-term summer releases are generally associated with Criterion A water management in the absence of new storage facilities, while the greatest summer releases are associated with Criterion B water management in conjunction with additional storage capacity. The broadest range of long-term monthly average reservoir releases under Alternative 1 is approximately 190-340 TAF. Under the No Action Alternative, long-term peak average monthly summer releases range from 270 to 310 TAF. Winter releases are similar under Alternative 1 and the No Action Alternative.

New Off-Aqueduct Storage Facilities. Carryover storage and releases associated with new off-aqueduct surface storage facilities were evaluated under Alternative 1. Such facilities would serve South-of-Delta SWP and CVP Service Areas similar to San Luis Reservoir.

Carryover storage and releases associated with new off-aqueduct surface storage facilities were evaluated under Alternative 1. Such facilities would serve South-of-Delta SWP and CVP Service Areas similar to San Luis Reservoir.

Over the long-term period, carryover storage in new off-aqueduct surface storage facilities ranges from 770 to 780 TAF under Alternative 1. For dry and critical years, carryover storage ranges from 310 to 390 TAF. Water management Criterion A provides higher carryover storage in wetter water-years while water management Criterion B provides higher carryover storage in drier water-years. The higher demands under Criterion B results in lower carryover storage in wetter water-years and more protective Delta actions under Criterion A results in lower carryover storage in drier water-years. Figure 5.1-22 presents carryover storage comparisons for the long-term period and dry and critical years.

Releases from new off-aqueduct surface storage facilities generally occur from spring to late summer under Alternative 1. Peak releases typically occur in midsummer for all hydrologic conditions. The peak monthly release is approximately 160 TAF for the long-

Figure 5.1-20. Average Annual Delta Deliveries under Alternative 1 for the Long-Term Period and Dry and Critical Years

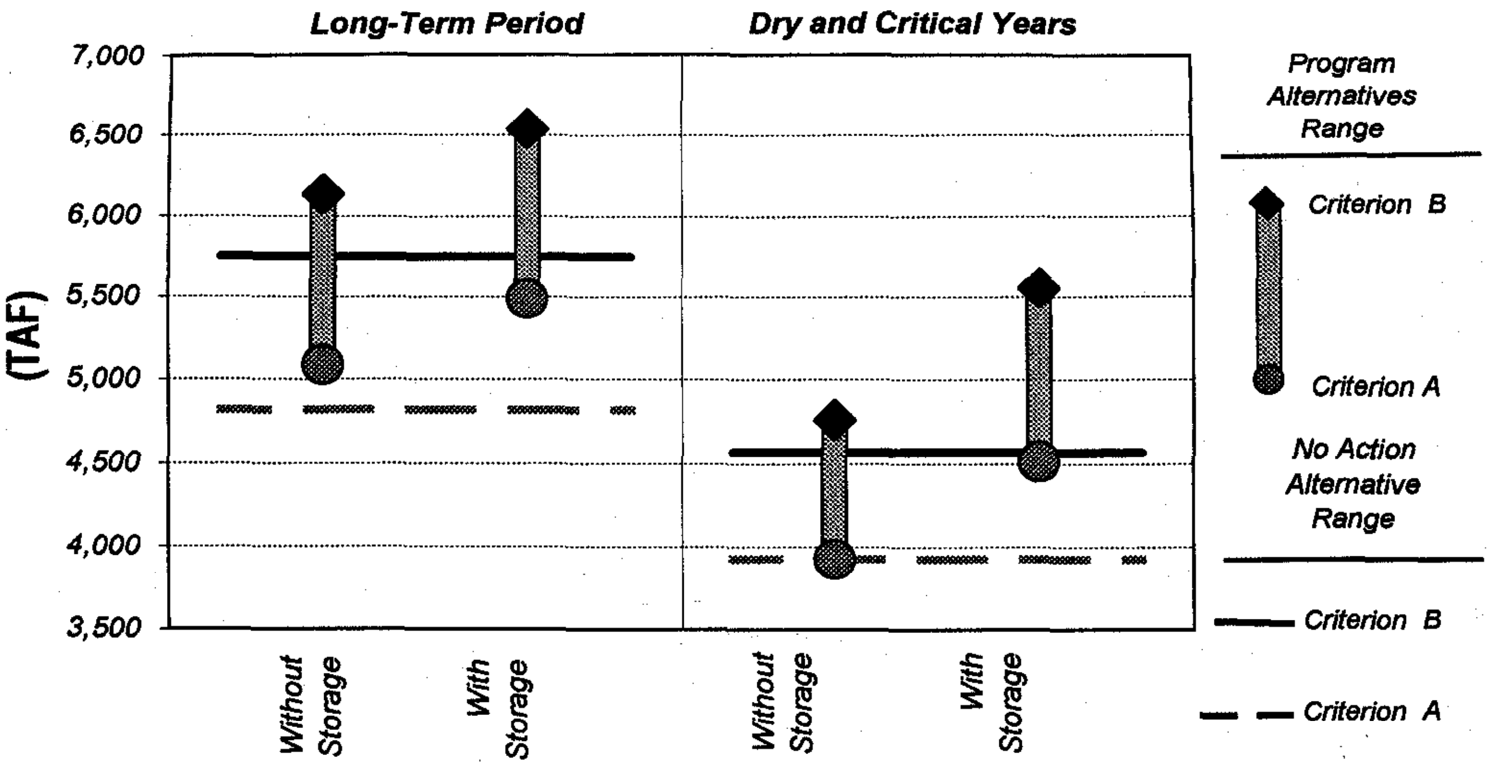


Figure 5.1-21. Carryover Storage for Existing Off-Aqueduct Reservoirs under Alternative 1 for the Long-Term Period and Dry and Critical Years

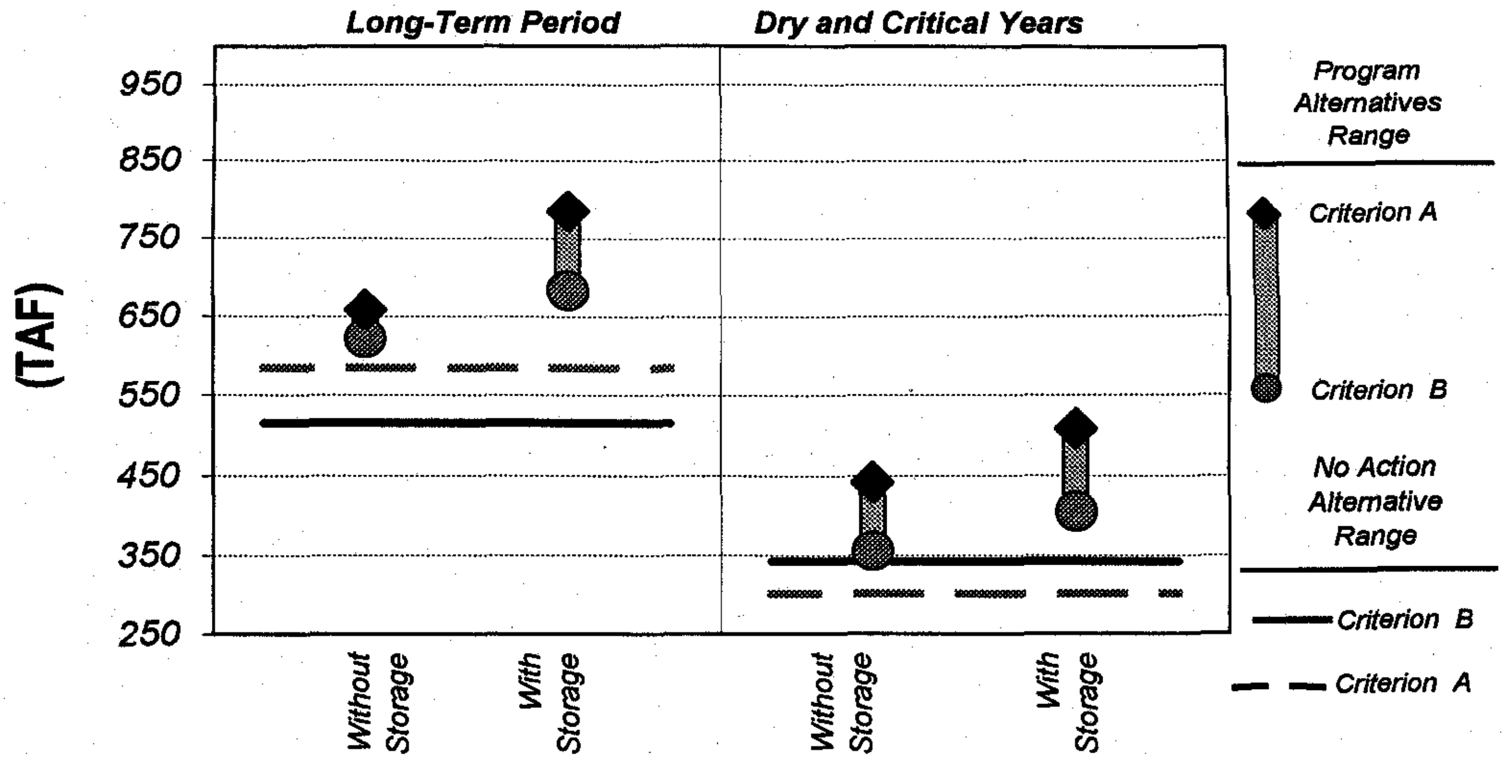
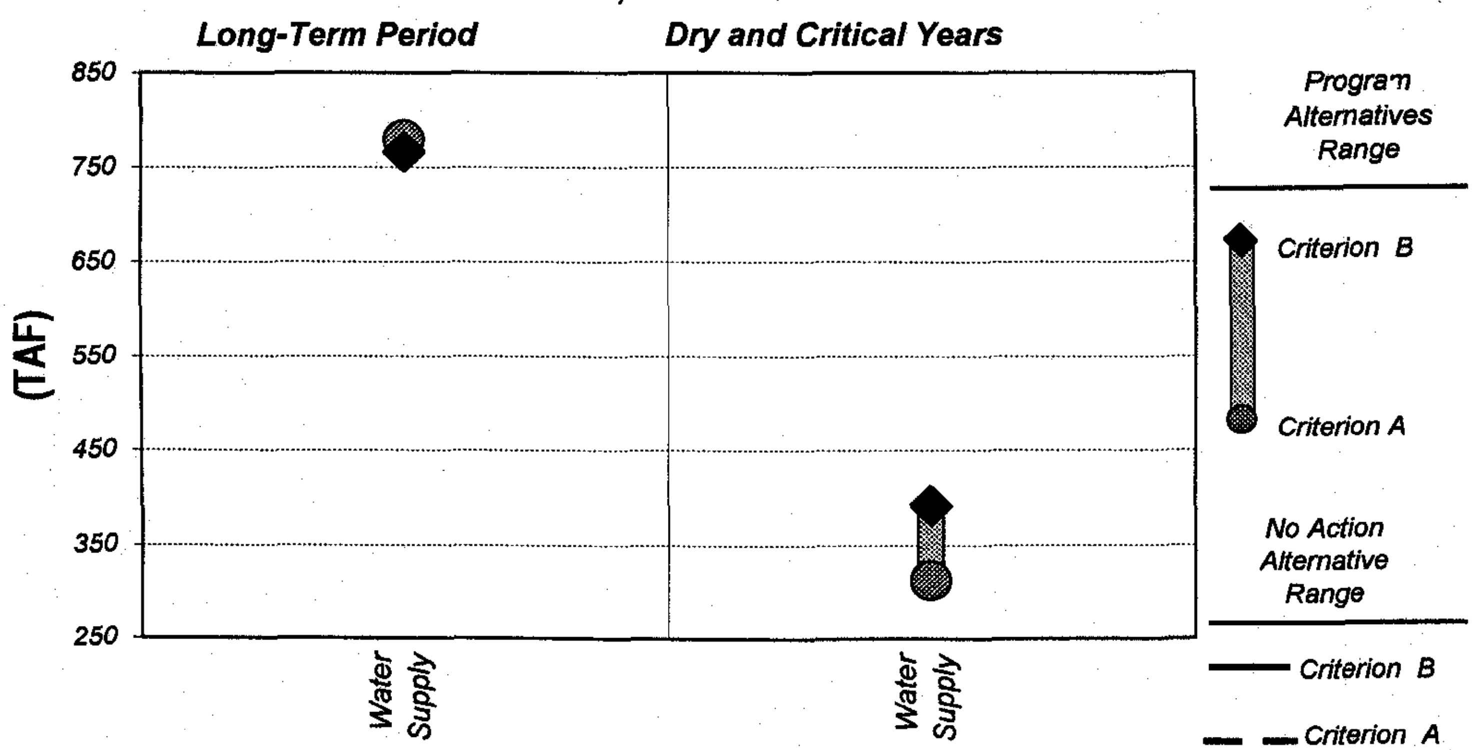


Figure 5.1-22. Carryover Storage for New Off-Aqueduct Reservoirs under Alternative 1 for the Long-Term Period and Dry and Critical Years



term period and ranges from 180 to 190 TAF for dry and critical years. In dry and critical years, monthly average releases tend to be similar under both water management criteria. Over the long-term period, Criterion A water management results in early spring peak releases while Criterion B results in late spring peak releases. Reduced Delta exports associated with Criterion A create more reliance on off-aqueduct storage releases to meet spring demands.

New off-aqueduct groundwater storage facilities also were evaluated under Alternative 1. These facilities are assumed to have a maximum capacity of 500 TAF with maximum inflow and discharge capacities of 500 cfs. Withdrawals from this groundwater storage are assumed to be made only in dry and critical years. The estimated average annual dry and critical year yield of these facilities ranges from 60 to 90 TAF. The long-term average was not calculated since the storage was operated for dry and critical year yield only.

5.1.8.2 ALTERNATIVE 2

Some improvements to water supply and water management would be realized from improved export pumping capacity under Alternative 2. Greater water supply and water management benefits may be obtained if additional storage facilities are constructed.

Some improvements to water supply and water management would be realized from improved export pumping capacity under Alternative 2. Greater water supply and water management benefits may be obtained if additional storage facilities are constructed.

Delta Region

Programmatic comparisons of Delta inflows and exports were made between Alternative 2 and the No Action Alternative using DWRSIM modeling results. Both bookend water management criteria (assumption sets Criteria A and B) were used to define the range of uncertainty associated with each alternative.

Average monthly Delta inflow is typically lower under Alternative 2 than under the No Action Alternative. Over the long-term period, Delta inflow normally peaks in February. Average February flow is approximately 190 TAF under the No Action Alternative and ranges from 160 to 180 TAF under Alternative 2. For dry and critical years, peak monthly flow ranges from 60 to 70 TAF under both the No Action Alternative and under Alternative 2. Additional storage slightly reduces total Delta inflow for the long-term average and dry and critical years.

The pattern of long-term average Delta exports would be modified somewhat by Alternative 2, with greater exports occurring August through January relative to the No Action Alternative. Figure 5.1-23 compares average monthly south-of-Delta exports for the long-term period. Similarly, Figure 5.1-24 compares average monthly south-of-Delta exports during dry and critical years. The range of average annual Delta exports under Alternative 2 for both hydrologic periods are compared to the No Action Alternative in Figure 5.1-25.

The pattern of long-term average Delta exports would be modified somewhat by Alternative 2, with greater exports occurring August through January relative to the No Action Alternative.

Combined exports from Banks and Tracy Pumping Plants peak in late winter months, with long-term period values ranging from 560 to 680 TAF under the No Action Alternative and from 540 to 760 TAF under Alternative 2. Delta exports, at minimum

Figure 5.1-23. Delta Exports at Banks and Tracy under Alternative 2 for the Long-Term Period

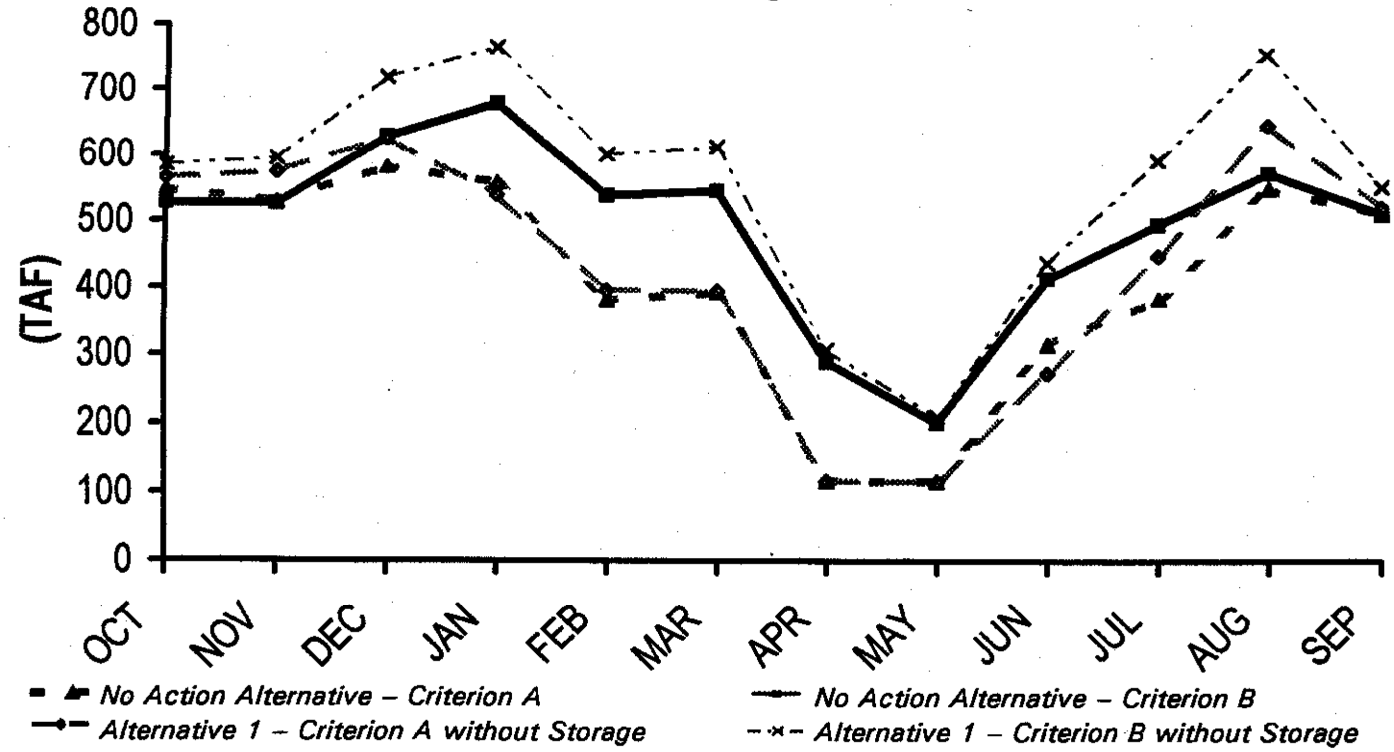


Figure 5.1-24. Delta Exports at Banks and Tracy under Alternative 2 for the Dry and Critical Years

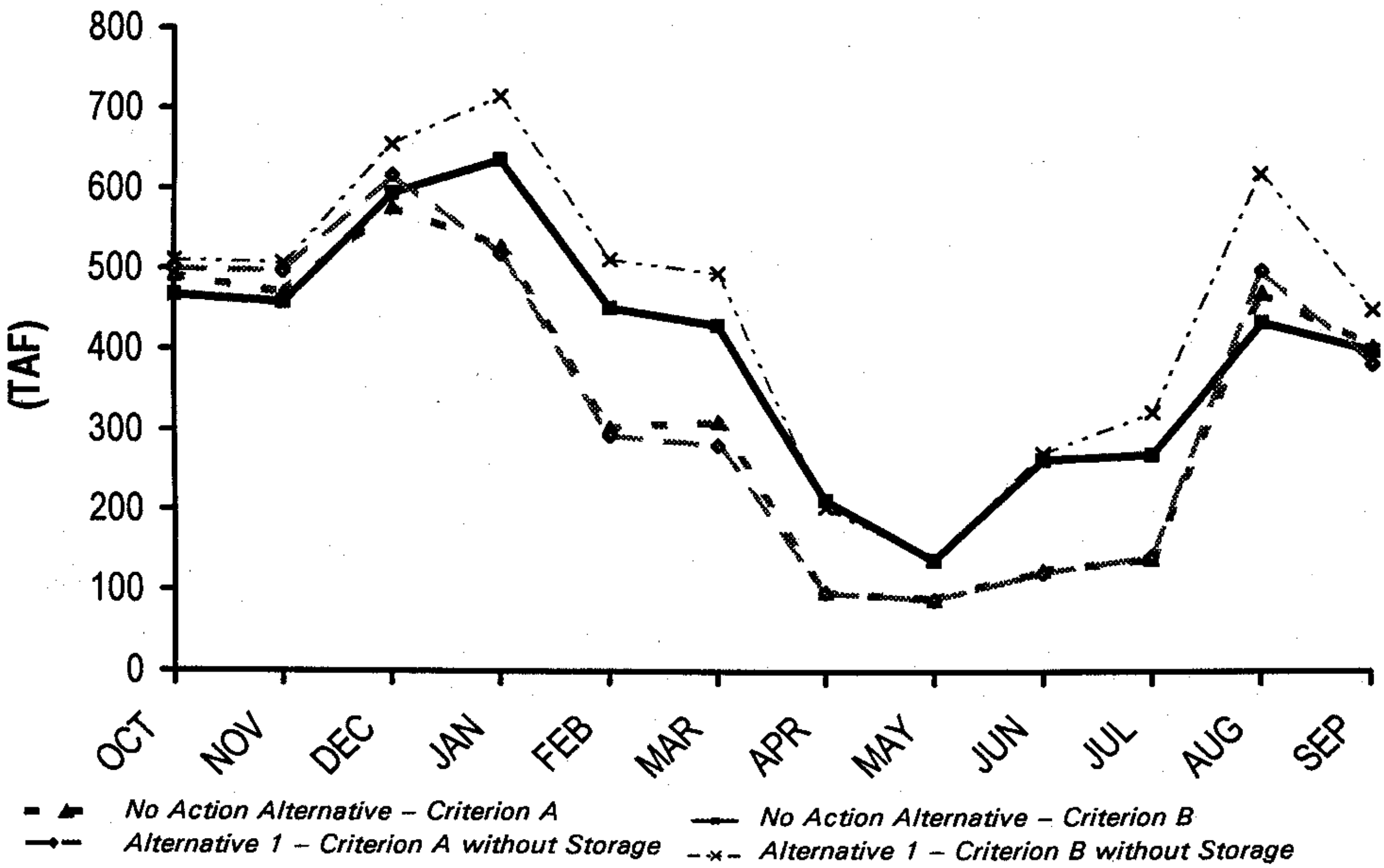
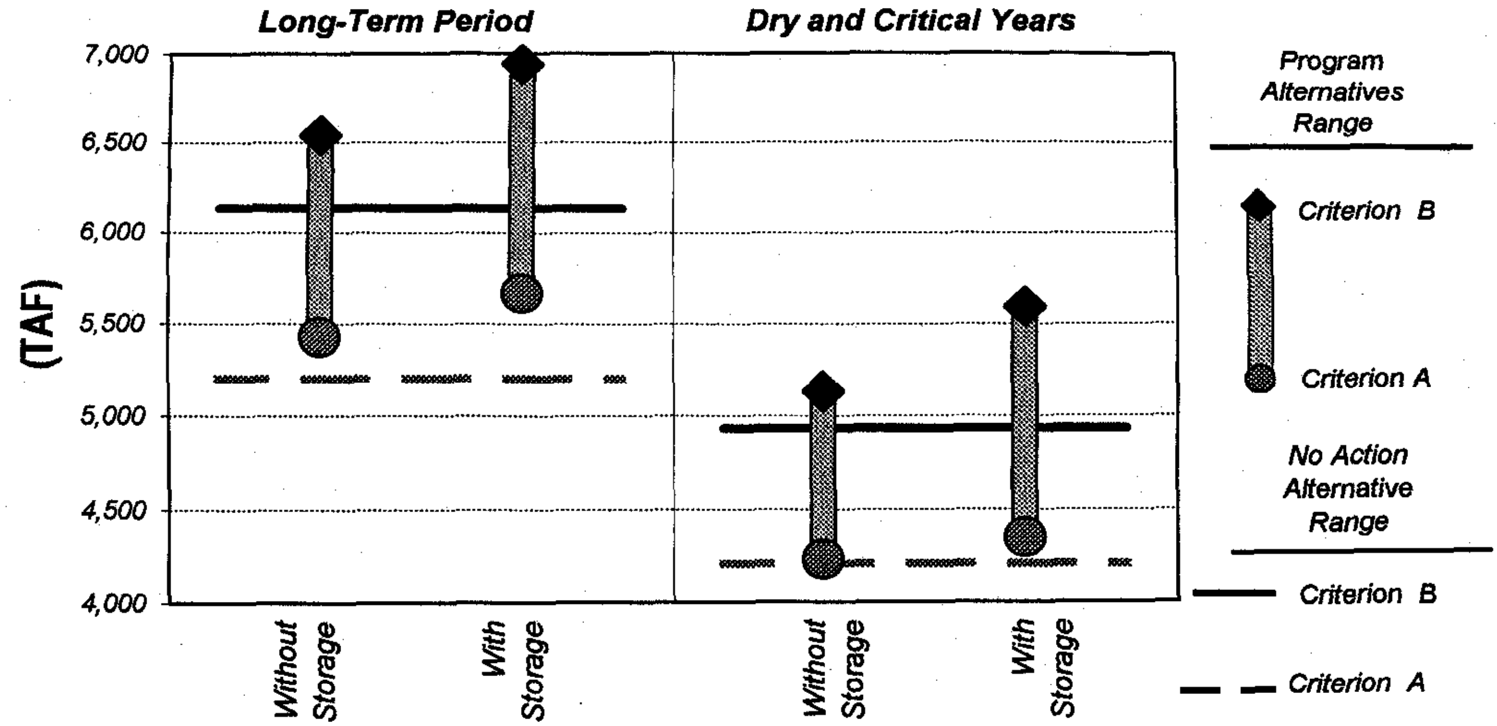


Figure 5.1-25. Average Annual Delta Exports at Banks and Tracy under Alternative 2 for the Long-Term Period and Dry and Critical Years



values in spring months, change little under Alternative 2. Long-term period exports range from 120 to 200 TAF under the No Action Alternative and range from 120 to 210 TAF under Alternative 2. On an annual basis, without additional storage, Alternative 2 increases long-term period Delta exports by an additional 230-410 TAF over the No Action Alternative. With additional storage, Alternative 2 increases annual Delta exports by 460-800 TAF over the No Action Alternative. Therefore, annual export increases of 230-390 TAF are directly related to additional storage under Alternative 2.

Alternative 2 has a similar influence on dry and critical year Delta exports. Under the No Action Alternative, Delta exports range from 530 to 640 TAF in the peak winter months and from 90 to 140 TAF during the spring months. Under Alternative 2, dry and critical year exports range from 520 to 710 TAF in the peak winter months and from 90 to 140 TAF during the spring months. On an annual basis, without additional storage, Alternative 2 increases dry and critical year Delta exports by an additional 200 TAF over the No Action Alternative. With additional storage, Alternative 2 increases annual Delta exports by 130 to 650 TAF over the No Action Alternative. Therefore, annual dry and critical year export increases of up to 480 TAF are directly related to additional storage under Alternative 2.

Under Alternative 2, diversions from the Sacramento River near Hood to the Mokelumne River system occur throughout the year. Details regarding the Hood diversion assumptions are presented in Section 5.1.4 and Attachment A. In general, the pattern of diversions peak in the early winter and midsummer months with lower diversions in the spring. Figure 5.1-26 compares average monthly Hood diversions for the long-term period. Similarly, Figure 5.1-27 compares average monthly Hood diversions during dry and critical years.

Under Alternative 2, diversions from the Sacramento River near Hood to the Mokelumne River system occur throughout the year.

Average monthly Hood diversions are typically greatest in winter, with long-term diversions ranging from 270 and 580 TAF. Lower average monthly diversions occur during spring due to more restrictive operation criteria, with long-term diversions ranging from 60 to 210 TAF. For dry and critical water-years, diversions range from 260 to 570 TAF in peak winter months and from 40 to 140 TAF in spring months.

Under Alternative 2 without additional storage, the average annual long-term period Hood diversions range between 2.6 and 4.7 MAF. For dry and critical years, the average annual diversions range from 2.0 to 3.6 MAF. When additional system storage is applied to Alternative 2, the annual long-term Hood diversions average from 2.7 to 5.2 MAF. For dry and critical years, annual Hood diversions average between 2.1 and 4.2 MAF. Additional Hood diversions directly attributable to additional storage range on average from 120 to 500 TAF and from 60 to 570 TAF annually, for the long-term period and dry and critical years, respectively.

Bay Region

Programmatic comparisons of Delta outflow to San Francisco Bay were made between Alternative 2 and the No Action Alternative using DWRSIM modeling results.

Figure 5.1-26. Hood Diversions under Alternative 2 for the Long-Term Period

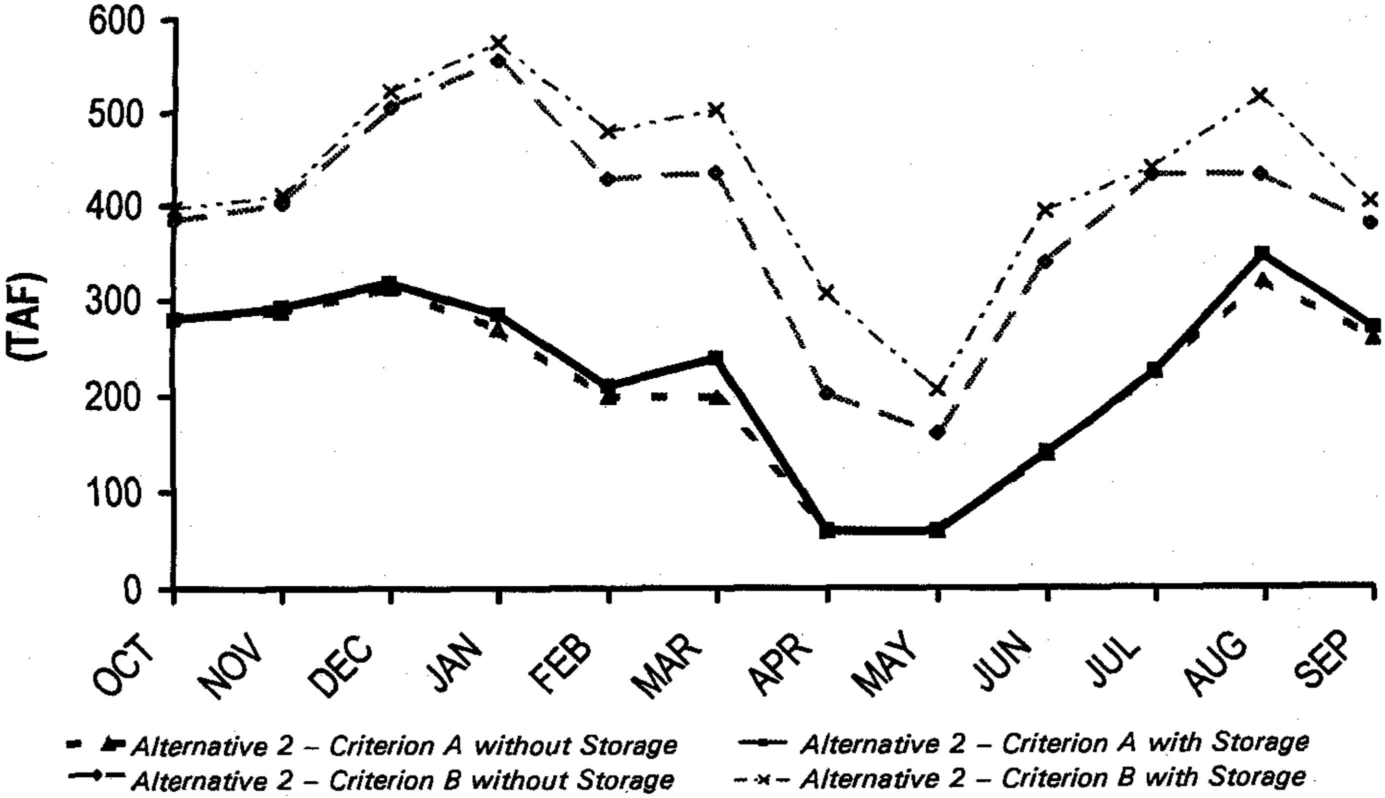
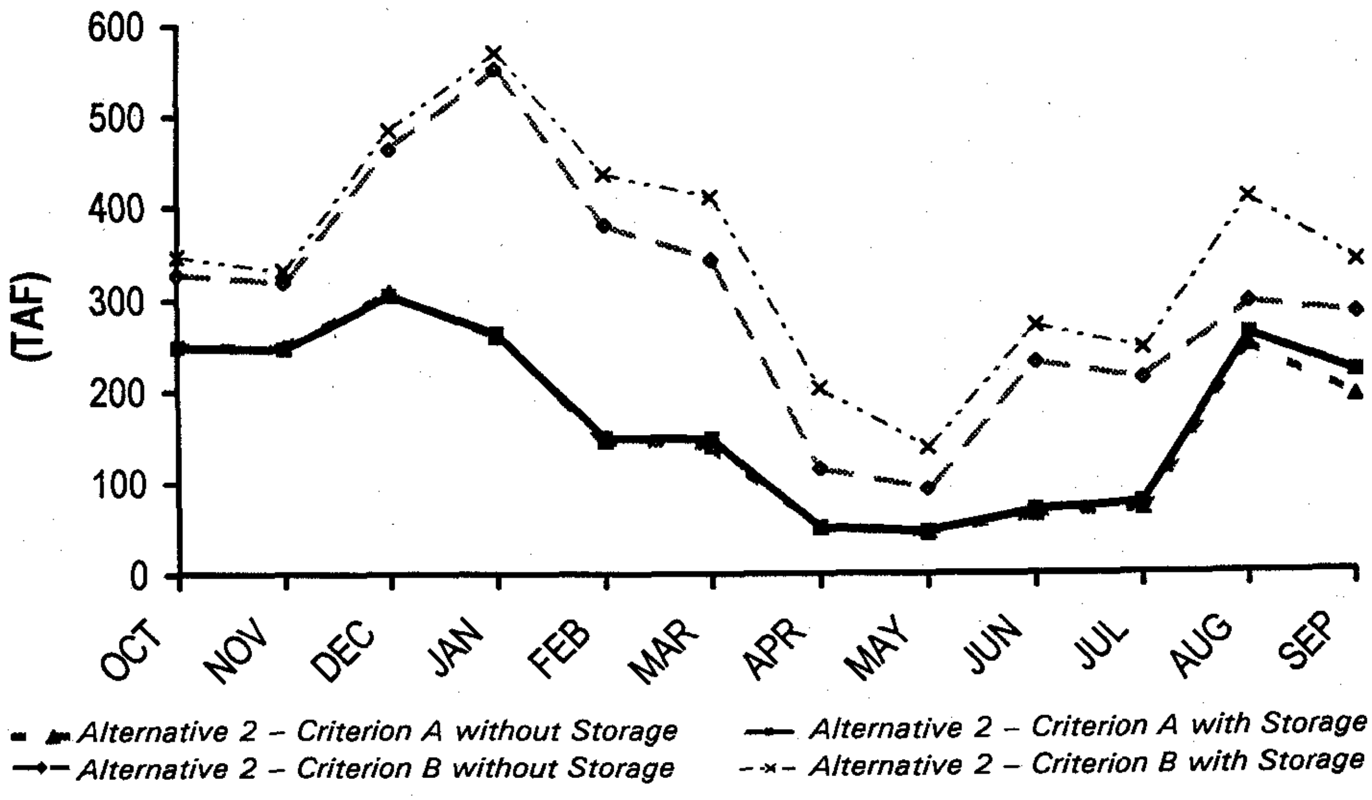


Figure 5.1-27. Hood Diversions under Alternative 2 for Dry and Critical Years



Figures 5.1-28 and 5.1-29 present monthly average Delta outflow comparisons for the long-term period and dry and critical years, respectively.

Delta outflow is typically lower under Alternative 2 than under the No Action Alternative during November through March. Percentage differences are typically small, however. Over the long-term period, Delta outflow normally peaks in February. Average February outflow ranges from 2.7 to 2.8 MAF under the No Action Alternative and ranges from 2.6 to 2.8 MAF under Alternative 2. The differences in Delta outflow are smaller from April through October. Ecosystem Restoration Program flows provide some additional May outflow under Alternative 2. On an annual basis, without additional storage, Alternative 2 modifies average long-term period Delta outflow by -90 to 60 TAF compared to the No Action Alternative. With additional storage, Alternative 2 decreases average annual Delta outflows by 270-660 TAF. Therefore, annual Delta outflow decreases of 330 to 570 TAF are directly related to additional storage under Alternative 2.

Delta outflow is typically lower under Alternative 2 than under the No Action Alternative during November through March.

During dry and critical years, February outflows range from 950 TAF to 1.1 MAF under the No Action Alternative, and from 870 TAF to 1.1 MAF under Alternative 2. On an annual basis, without additional storage, Alternative 2 increases average dry and critical year Delta outflows by as much as 210 TAF over the No Action Alternative. With additional storage, Alternative 2 modifies average dry and critical year outflow from -260 to 210 TAF relative to the No Action Alternative. Therefore, annual Delta outflow decreases up to 300 TAF are directly related to additional storage under Alternative 2.

Sacramento River and San Joaquin River Regions

This section provides a comparison of Alternative 2 and the No Action Alternative with respect to water supply and water management in the Sacramento River and San Joaquin River Regions using DWRSIM modeling results. The programmatic comparison focuses on existing storage, new storage, and Ecosystem Restoration Program acquisitions.

Existing Storage. End-of-September carryover storage in the major Sacramento River Region surface storage facilities (Shasta, Oroville, and Folsom) was evaluated for Alternative 2 and the No Action Alternative. Figure 5.1-30 depicts the ranges of long-term period and dry and critical year carryover storage for Alternative 2 and the No Action Alternative.

Under the No Action Alternative, average carryover storage in Sacramento River Region reservoirs ranges from 5.3 to 5.4 MAF for the long-term period, and from 3.8 to 3.9 MAF for dry and critical years. Alternative 2 long-term period carryover storage ranges from 5.1 to 5.5 MAF, while dry and critical year carryover storage ranges from 3.6 to 4.0 MAF.

In the absence of new storage facilities, implementation of Alternative 2 has little impact on carryover storage under Criterion A water management assumptions. Alternative 2 results in a slight reduction in carryover storage under Criterion B water management assumptions. Without new storage, the reduction in average long-term carryover storage under Alternative 2 may vary from 100 to 210 TAF. The same trend and magnitude is

Without new storage, the reduction in average long-term carryover storage under Alternative 2 may vary from 100 to 210 TAF.

Figure 5.1-28. Delta Outflow under Alternative 2 for the Long-Term Period

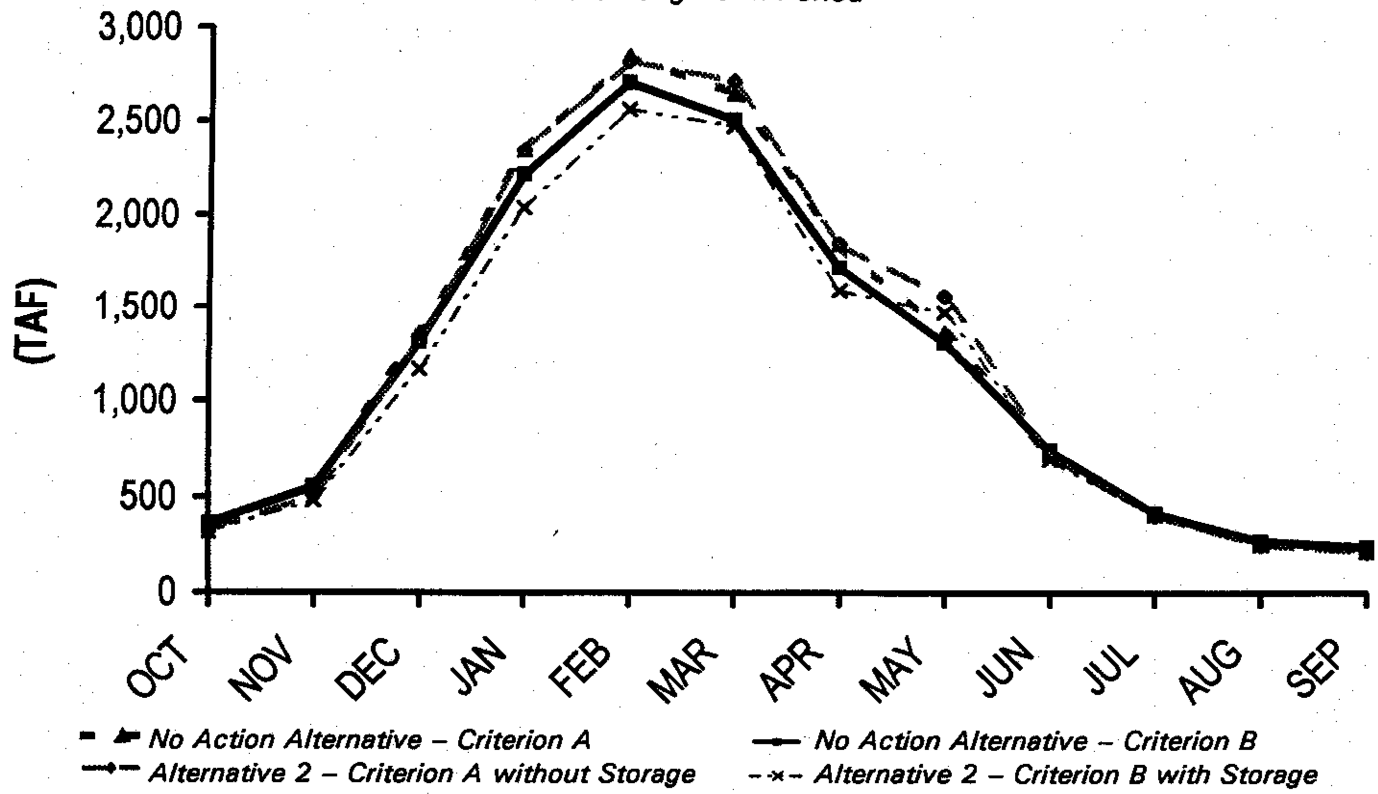


Figure 5.1-29. Delta Outflow under Alternative 2 for Dry and Critical Years

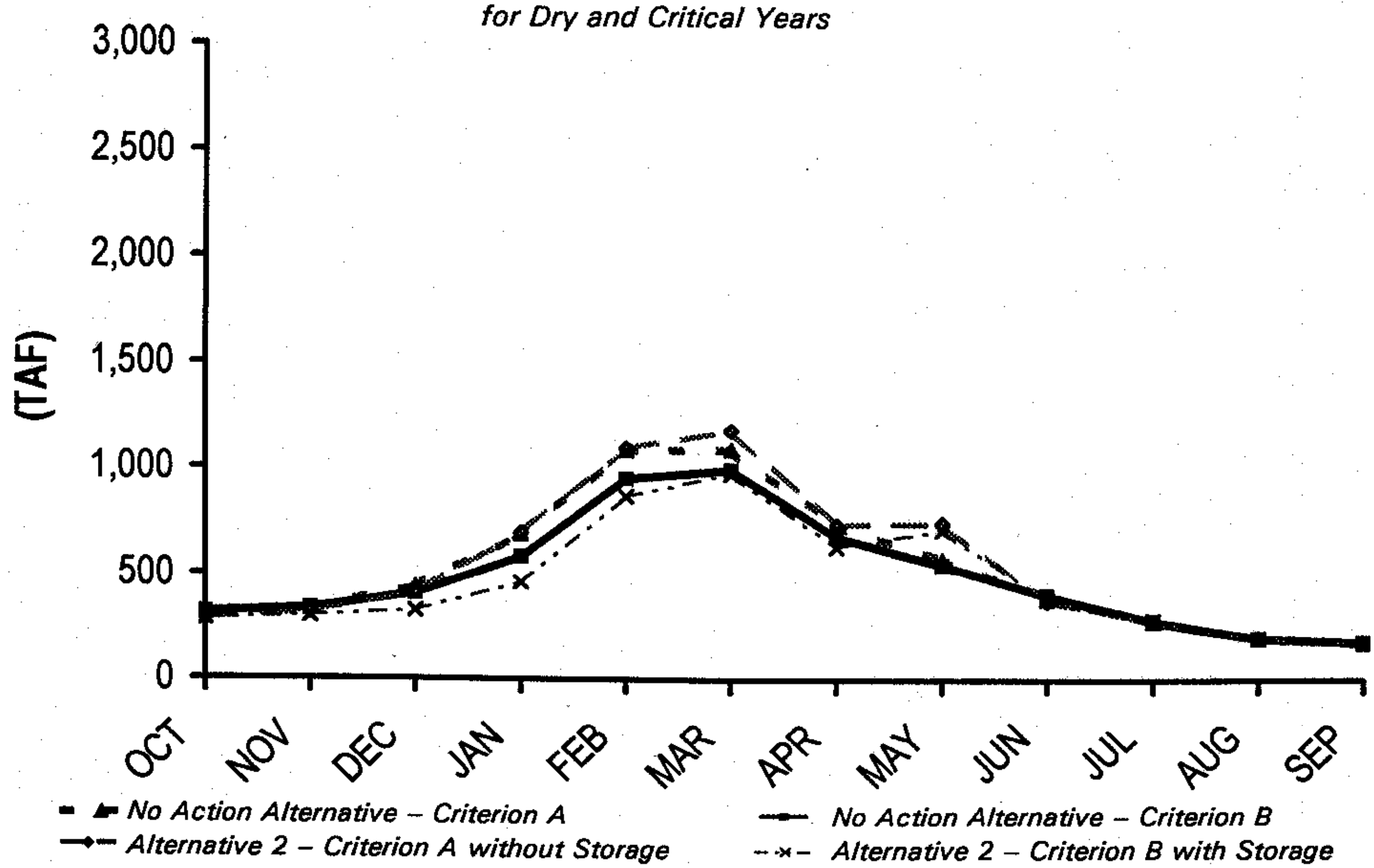
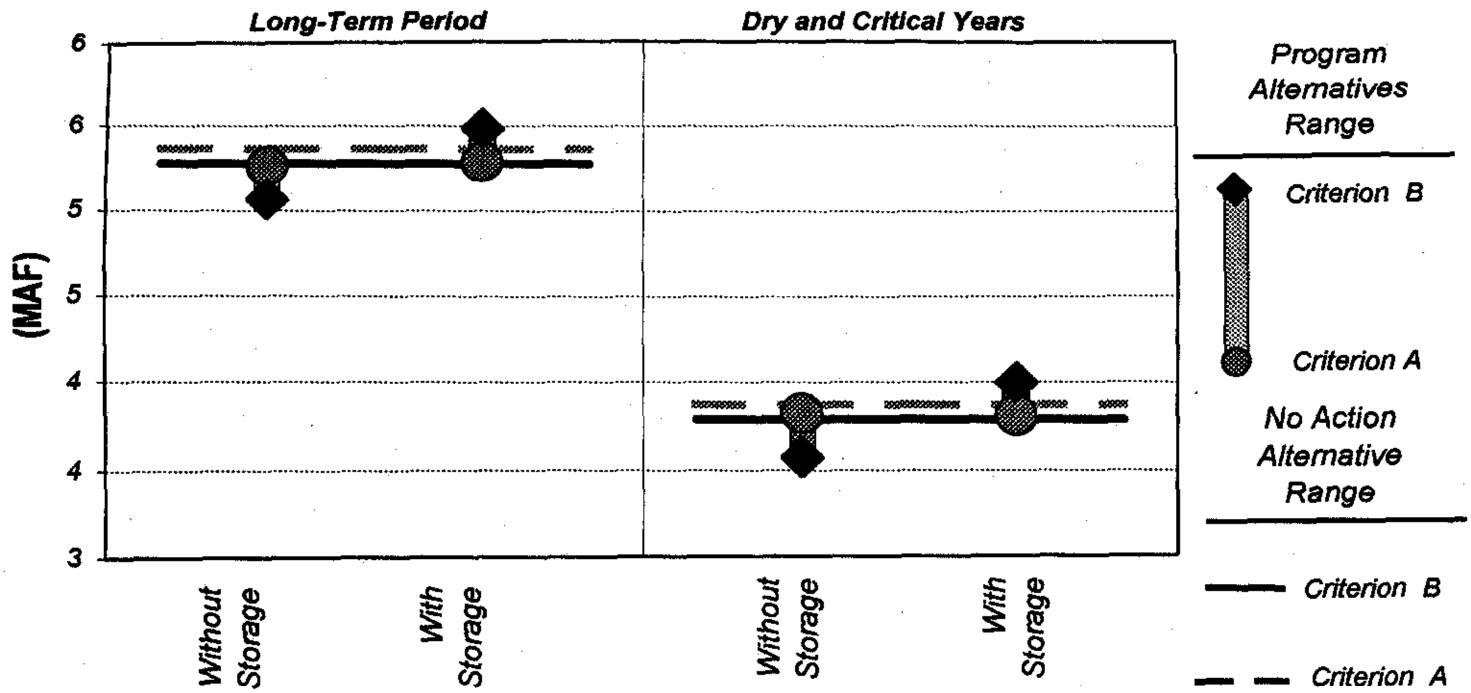
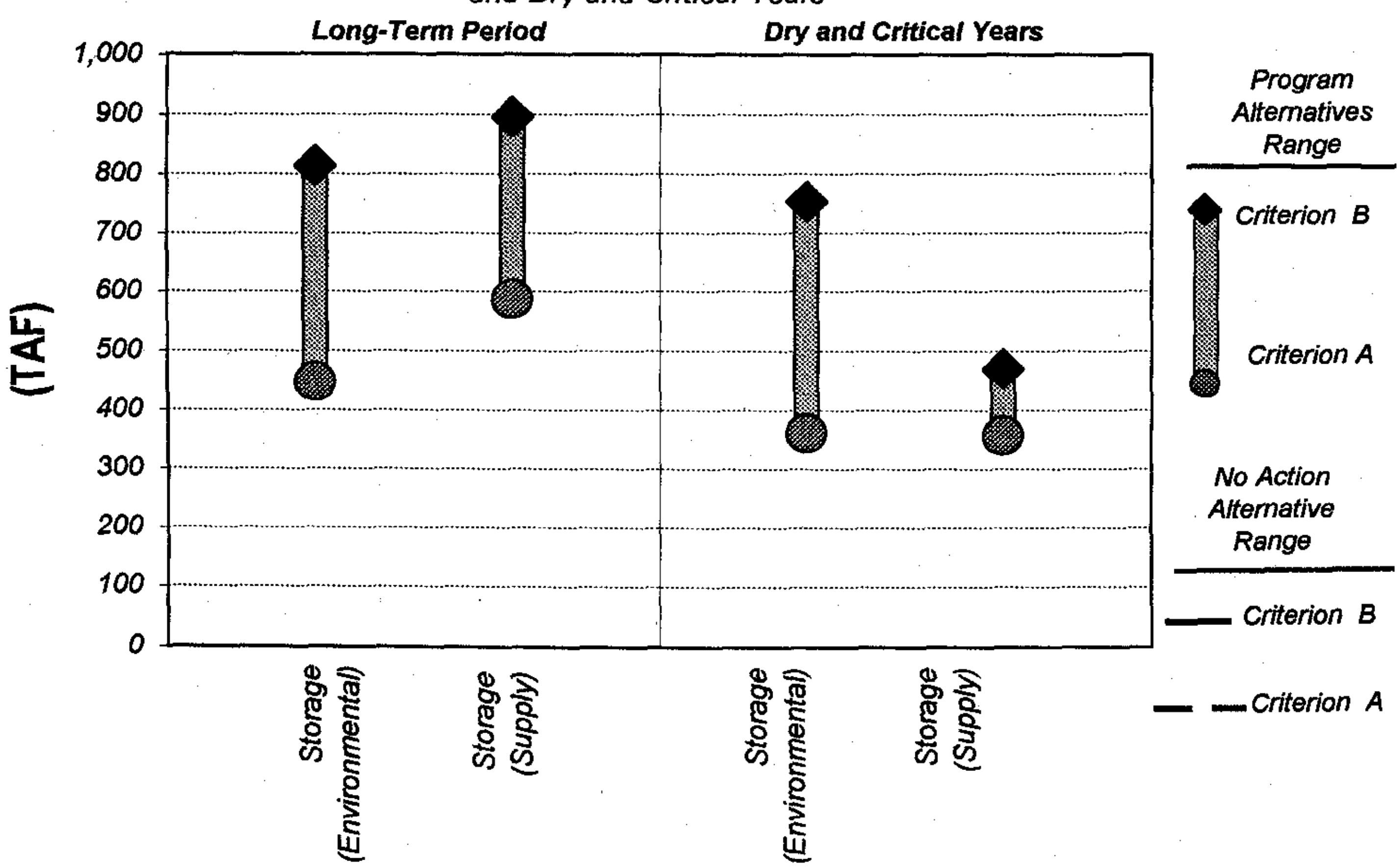


Figure 5.1-30. Carryover Storage for Existing Surface Reservoirs in the Sacramento River Region under Alternative 2 for the Long-Term Period and Dry and Critical Years



5.1-31. Carryover Storage for New Surface Reservoirs in the Sacramento River Region under Alternative 2 for the Long-Term Period and Dry and Critical Years



demonstrated for the dry and critical years with the reduction in average carryover storage from 50 to 210 TAF.

With new storage facilities, implementation of Alternative 2 under Criterion A assumptions reduces long-term and dry and critical carryover storage in existing facilities on the order of 70 TAF relative to the No Action Alternative. Under Criterion B assumptions, Alternative 2 increases carryover storage on the order of 220 TAF.

End-of-September carryover storage in the major San Joaquin River Region surface facilities (New Melones, New Don Pedro, and McClure) was also evaluated for Alternative 2 and the No Action Alternative. Implementation of Alternative 2 had no measurable effect on system carryover storage. Similarly, no variation is evident based on water management criteria or implementation of additional storage facilities.

New Storage. New Sacramento River and San Joaquin River Regions surface storage facilities were evaluated under Alternative 2. The evaluation distinguished between storage for water supply and storage for environmental enhancement.

New Sacramento River and San Joaquin River Regions surface storage facilities were evaluated under Alternative 2. The evaluation distinguished between stor-age for water supply and storage for environ-mental enhancement.

Figure 5.1-31 presents Sacramento River Region carryover storage comparisons for the long-term period and dry and critical years. Peak storage in the new facilities generally occurs in early summer under all hydrologic conditions. For the long-term period, peak water supply storage ranges from 770 TAF to 1.3 MAF, while dry and critical year peak storage typically ranges from 500 to 850 TAF. Carryover storage ranges from 590 TAF to 890 TAF for the long-term period, and from 360 to 470 TAF for dry and critical years. Criterion A water management assumptions consistently resulted in lower water supply storage. For the long-term period, peak environmental storage ranges from 520 to 900 TAF, while dry and critical year peak storage typically ranges from 450 to 860 TAF. Carryover storage ranges from 450 to 810 TAF for the long-term period, and from 360 to 750 TAF for dry and critical years. Criterion A water management assumptions consistently resulted in lower environmental storage.

New Sacramento River Region groundwater storage facilities also were evaluated under Alternative 2. These facilities are assumed to have a maximum capacity of 250 TAF with maximum inflow and discharge capacities of 500 cfs. Withdrawals from new groundwater storage facilities are made only in dry and critical years. The estimated average annual dry and critical year yield of these facilities ranges from 40 to 45 TAF. The long-term average was not calculated since the storage was operated for dry and critical year yield only.

In this evaluation, new San Joaquin River Region storage facilities were dedicated to providing water for Ecosystem Restoration Program flow targets. Peak average annual storage tends to occur in late spring at approximately 240 TAF for the long-term period and ranges from 220 to 230 TAF for dry and critical years. Carryover storage ranges from 200 to 220 TAF for the long-term period, and from 200 to 210 TAF for dry and critical years. Criterion B water management assumptions consistently resulted in lower storage.

Ecosystem Restoration Program Acquisition. Table 5.1-5 shows the water acquisitions quantities under Alternative 2 estimated to meet proposed Ecosystem Restoration Program flow targets.

When new storage in the Sacramento River and San Joaquin River Regions is included in Alternative 2, fewer water acquisitions would be necessary to meet Ecosystem Restoration Program flow targets. New storage also could be operated to provide Ecosystem Restoration Program flows for other tributaries by exchange agreements. These types of arrangement are not reflected in this analysis. Table 5.1-6 shows the water acquisitions quantities estimated to meet the proposed Ecosystem Restoration Program flow targets under Alternative 2 with new storage.

When new storage in the Sacramento River and San Joaquin River Regions is included in Alternative 2, fewer water acquisitions would be necessary to meet Ecosystem Restoration Program flow targets.

Table 5.1-5. Estimated Ecosystem Restoration Program Water Acquisitions in the Sacramento River and San Joaquin River Regions Without New Storage under Alternative 2 (TAF)

LOCATION	CRITICAL	DRY	BELOW NORMAL	ABOVE NORMAL	WET
Sacramento River	0	0-10	90	20	0
Yuba River	0	10	<10	0	0
Feather River	0	50	80	60	<10
American River	0	30	40	20	40
Lower Sacramento River	0	80-90	10	0	<10
Additional Delta flows	0	90-110	180-210	250-260	10
Stanislaus River	0	10	30	40	40
Tuolumne River	50	40	40	50-60	40
Merced River	40	20	20	40	30
Total acquisitions	**90**	**330-370**	**490-520**	**480-500**	**160**

Table 5.1-6. Estimated Ecosystem Restoration Program Water Acquisitions in the Sacramento River and San Joaquin River Regions with New Storage under Alternative 2 (TAF)

LOCATION	CRITICAL	DRY	BELOW NORMAL	ABOVE NORMAL	WET
Sacramento River	0	<10	30-50	0-10	0
Yuba River	0	10	<10	0	0
Feather River	0	40	70	40	0
American River	0	30	40	20	40
Lower Sacramento River	0	0-30	0	0	0
Additional Delta flows	0	30-40	110-130	180-210	<10
Stanislaus River	0	10	30	40	40
Tuolumne River	60	30	20	30	20
Merced River	30	10	<10	10	10
Total acquisitions	**90**	**150-190**	**300-340**	**320-360**	**110**

South-of-Delta SWP and CVP Service Areas

Programmatic comparisons of deliveries to the South-of-Delta SWP and CVP Service Areas were made between Alternative 2 and the No Action Alternative using DWRSIM modeling results. This section also evaluates surface water storage in existing and new off-aqueduct facilities.

Delta Deliveries. The range of annual Delta deliveries under the No Action Alternative was compared to the range of deliveries expected under Alternative 2. Deliveries are generally higher under Alternative 2 with implementation of new storage facilities and Criterion B water management assumptions.

Under Alternative 2, the range of average annual deliveries over the long-term period is from 5.1 to 6.5 MAF. The low end of this range assumes no new storage facilities and Criterion A water management assumptions; the high end of this range assumes new storage facilities and Criterion B water management assumptions. The No Action Alternative results in a long-term average annual delivery range from 4.8 to 5.8 MAF. During dry and critical years, Alternative 2 average annual deliveries range between 3.9 and 5.6 MAF and No Action Alternative deliveries range between 3.9 and 4.6 MAF.

Without additional storage facilities, Alternative 2 would increase long-term average annual deliveries by 240 to 400 TAF relative to the No Action Alternative. For dry and critical years, Alternative 2 would modify deliveries from -10 to 190 TAF. Implementation of Alternative 2 in conjunction with new surface storage would increase long-term average annual deliveries by 450-790 TAF. In dry and critical years, Alternative 2 would increase deliveries by 500-990 TAF. Therefore, annual long-term Delta deliveries increases of 210-390 TAF are related to additional storage under Alternative 2. The range of average long-term and dry and critical water-year Delta deliveries for Alternative 2 compared to the No Action Alternative is depicted in Figure 5.1-32.

Without additional storage facilities, Alternative 2 would increase long-term average annual deliveries by 240 to 400 TAF relative to the No Action Alternative. Implementation of Alternative 2 in conjunction with new surface storage would increase long-term average annual deliveries by 480-790 TAF.

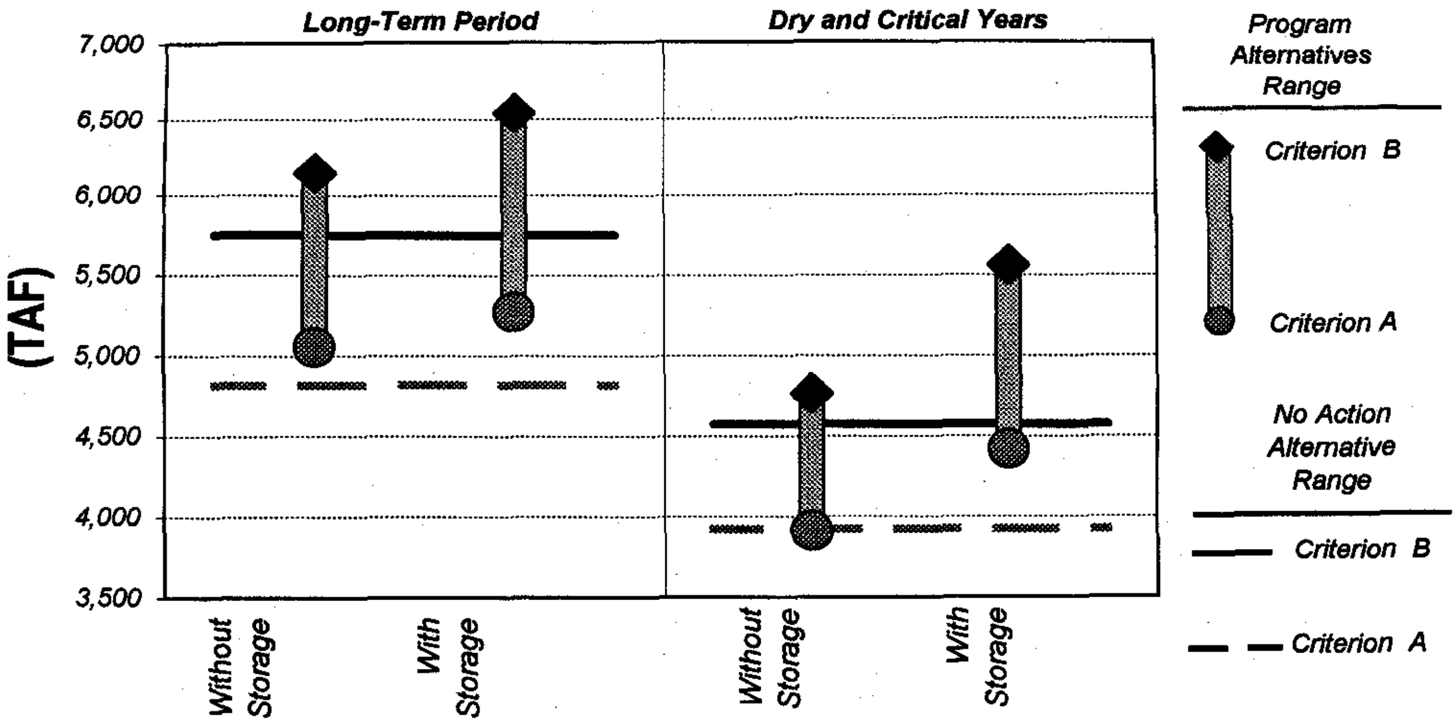
Existing Off-Aqueduct Storage Facilities. San Luis Reservoir is the primary existing off-aqueduct storage facilities serving the South-of-Delta SWP and CVP Service Areas. San Luis Reservoir carryover storage and reservoir releases were evaluated under Alternative 2 and the No Action Alternative.

With no additional storage, Alternative 2 modifies San Luis Reservoir carryover storage from -10 to 140 TAF for long term and by 10-140 TAF for dry and critical years (above the No Action Alternative). If additional storage is implemented, Alternative 2 increases long-term carryover storage by 170-280 TAF and dry and critical carryover storage by 130-200 TAF above the No Action Alternative. Therefore, a long-term average carryover storage increase of 140-180 TAF is directly attributed to additional storage under Alternative 2. The average carryover storage increase of 60-120 TAF for dry and critical years is directly related to additional storage under Alternative 2. Figure 5.1-33 presents carryover storage comparisons for the long-term period and dry and critical years.

The broadest range in monthly average storage releases from San Luis Reservoir generally occurs in summer months for both water management criteria under all hydrologic conditions. The largest long-term summer releases are generally associated with Criterion A water management in the absence of new storage facilities, while the lowest summer releases are associated with Criterion B water management in conjunction with additional storage capacity. The broadest range of long-term monthly average reservoir releases under Alternative 2 is approximately 190-390 TAF. Under the No Action Alternative, peak average monthly summer releases range from 270 to 310 TAF over the long-term period. Winter releases are similar under Alternative 2 and the No Action Alternative.

New Off-Aqueduct Storage Facilities. Carryover storage and releases associated with new off-aqueduct surface storage facilities were evaluated under Alternative 2. Such facilities would serve South-of-Delta SWP and CVP Service Areas similar to San Luis Reservoir.

Figure 5.1-32. Average Annual Delta Deliveries under Alternative 2 for the Long-Term Period and Dry and Critical Years.



5.1-33. Carryover Storage for Exisiting Off-Aqueduct Reservoirs under Alternative 2 for the Long-Term Period and Dry and Critical Years

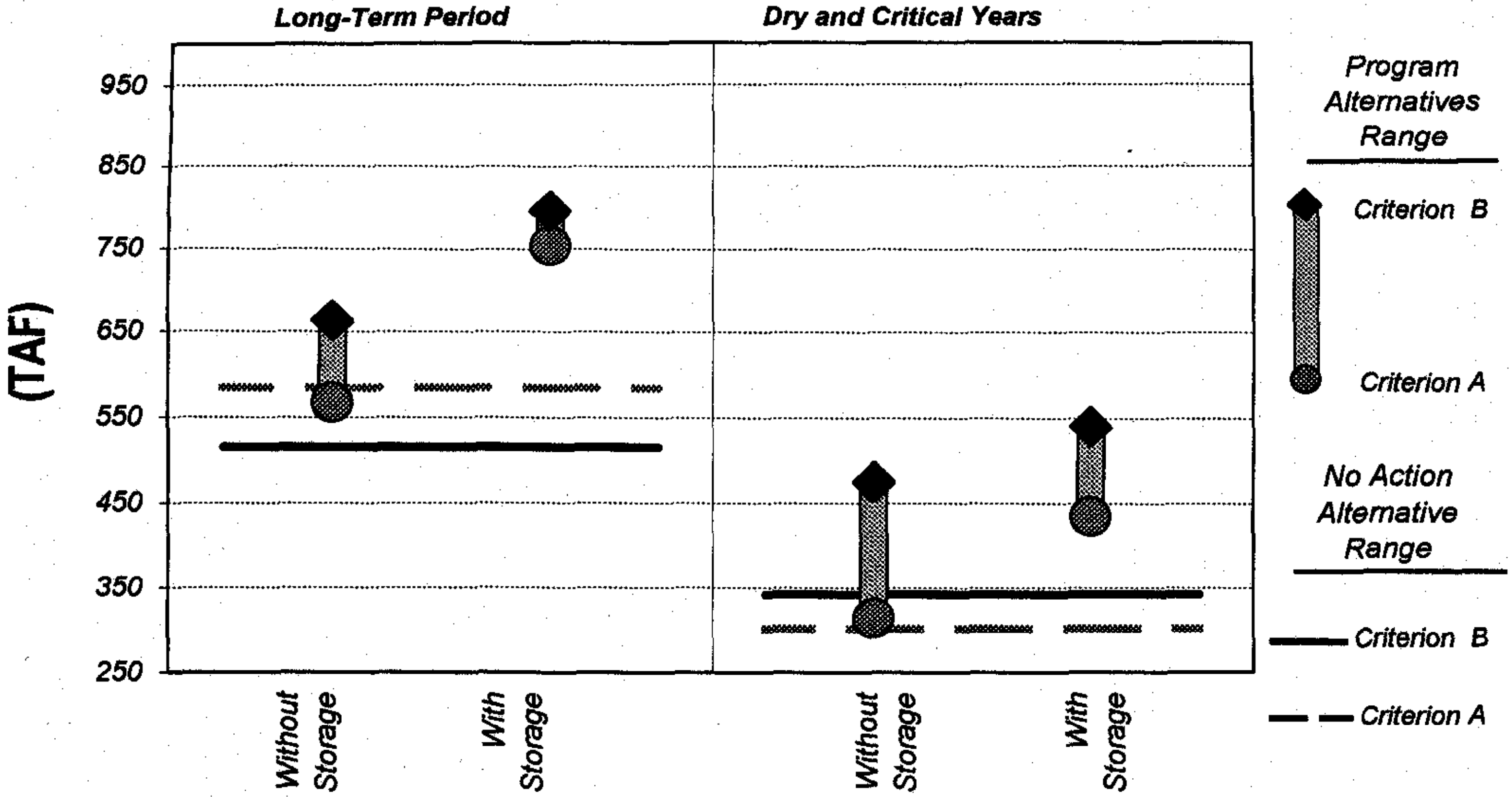
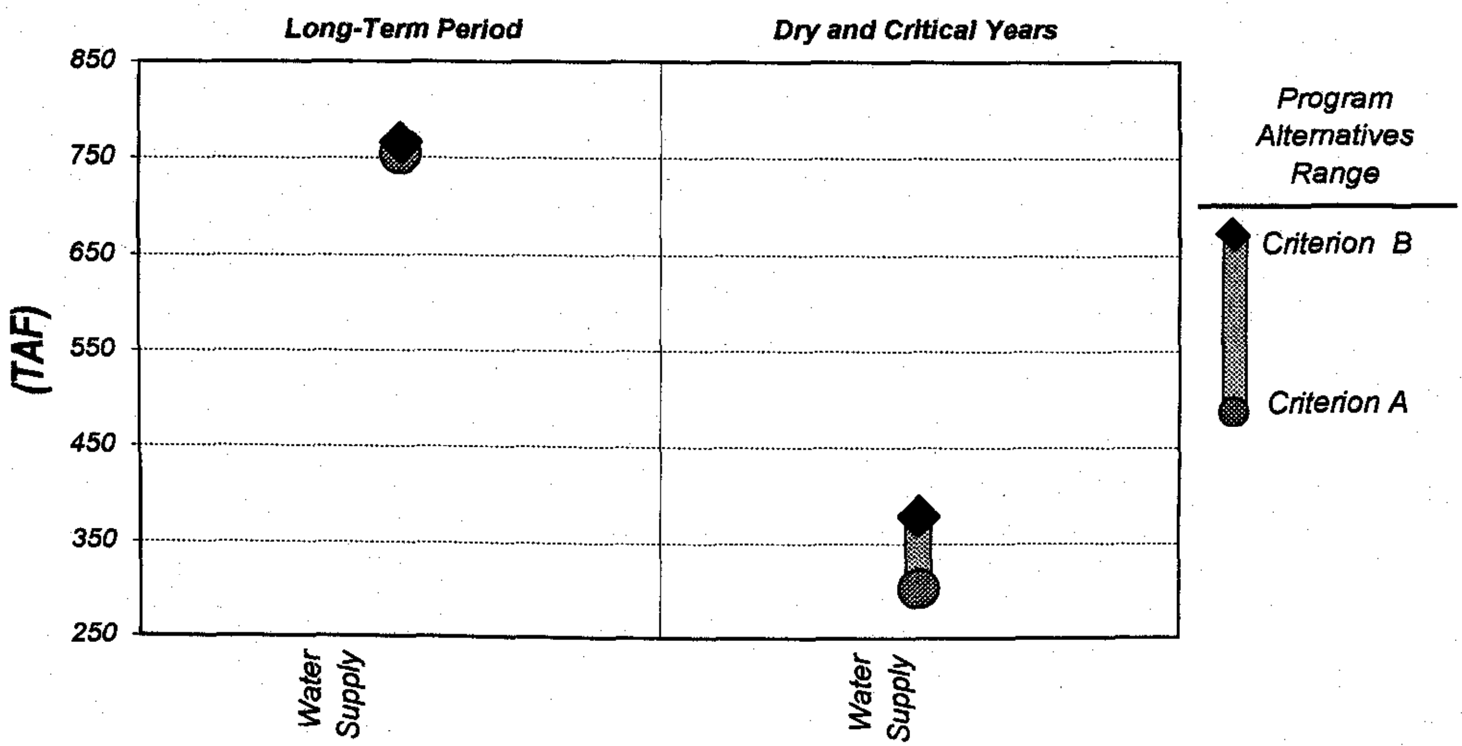


figure 5.1-34. Carryover Storage for New Off-Aqueduct Reservoirs under Alternative 2 for the Long-Term Period and Dry and Critical Years



Over the long-term period, carryover storage in new off-aqueduct surface storage facilities ranges from 750 to 770 TAF under Alternative 2. For dry and critical years, carryover storage ranges from 300 to 380 TAF. Criterion B provides higher carryover storage in both wetter and drier water-years. Figure 5.1-34 presents carryover storage comparisons for the long-term period and dry and critical years.

Releases from new off-aqueduct surface storage facilities generally occur from spring to late summer under Alternative 2. Peak releases typically occur in mid summer for all hydrologic conditions. The approximate peak releases are between 160 and 170 TAF for the long-term period and between 180 and 190 TAF for dry and critical years. In dry and critical years, monthly average releases tend to be similar under both water management criteria. Over the long-term period, Criterion A water management results in early spring peak releases while Criterion B results in late spring peak releases. Reduced Delta exports associated with Criterion A create more reliance on off-aqueduct storage releases to meet spring demands.

New off-aqueduct groundwater storage facilities also were evaluated under Alternative 2. These facilities are assumed to have a maximum capacity of 500 TAF with maximum inflow and discharge capacities of 500 cfs. Withdrawals from new groundwater storage facilities are made only in dry and critical years. The estimated average annual dry and critical year yield of these facilities ranges from 65 to 80 TAF. The long-term average was not calculated since the storage was operated for dry and critical year yield only.

5.1.8.3 ALTERNATIVE 3

For evaluation purposes, Alternative 3 was simulated with a 5,000- and 15,000-cfs isolated facility. Evaluation of the smaller configuration assumes full south Delta improvements are in place. Evaluation of the larger configuration assumes a subset of the south Delta improvements are in place and includes service to Delta islands along the route of the canal. To fully describe potential consequences of Alternative 3, the 15,000-cfs isolated facility is evaluated under Criterion A assumptions and the 5,000-cfs isolated facility is evaluated under Criterion B assumptions. See Attachment A for further details.

For evaluation purposes, Alternative 3 was simulated with a 5,000- and 15,000-cfs isolated facility. Evaluation of the smaller configuration assumes full south Delta improvements are in place. Evaluation of the larger configuration assumes a subset of the south Delta improvements are in place and includes service to Delta islands along the route of the canal.

Some improvements to water supply and water management would be realized from improved export pumping capacity under the Alternative 3. Greater water supply and water management benefits may be obtained if additional storage facilities are constructed.

Delta Region

Programmatic comparisons of Delta inflows and exports were made between Alternative 3 and the No Action Alternative using DWRSIM modeling results. Both bookend Delta water management criteria were used to define the range of uncertainty associated with each alternative.

Average monthly Delta inflow is typically lower under Alternative 3 than under the No Action Alternative. Over the long-term period, Delta inflow normally peaks in February.

Average monthly Delta inflow is typically lower under Alternative 3 than under the No Action Alternative.

Average February flow is approximately 190 TAF under the No Action Alternative and ranges from 160 to 170 TAF under Alternative 3. For dry and critical years, peak monthly flow is approximately 70 TAF under both the No Action Alternative and Alternative 3. Additional storage slightly reduces total Delta inflow for the long-term average and dry and critical years.

Under Alternative 3, south-of-Delta exports at Banks and Tracy Pumping Plants are comprised of diversions from south Delta channels and diversions through an isolated conveyance facility. Total south-of-Delta exports are described below, followed by a discussion of the diversions occurring through the isolated conveyance facility and through south Delta channels.

Under Alternative 3, south-of-Delta exports at Banks and Tracy Pumping Plants are comprised of diversions from south Delta channels and diversions through an isolated conveyance facility.

The pattern of long-term average Delta exports would be modified somewhat by Alternative 3, with greater exports occurring August through January relative to the No Action Alternative. Figure 5.1-35 compares average monthly Delta exports for the long-term period. Similarly, Figure 5.1-36 compares average monthly Delta exports during dry and critical years. The range of average annual Delta exports under Alternative 3 for both hydrologic periods are compared to the No Action Alternative in Figure 5.1-37.

The pattern of long-term average Delta exports would be modified somewhat by Alternative 3, with greater exports occurring August through January relative to the No Action Alternative.

Combined south Delta exports from Banks and Tracy Pumping Plants peak in winter months, with long-term period values ranging from 560 to 680 TAF in January under the No Action Alternative and from 560 to 760 TAF under Alternative 3. Delta exports, at minimum values in spring months, could change significantly under Alternative 3 depending on operation criteria. Long-term period exports range from 120 to 200 TAF in May under the No Action Alternative and range from 120 to 410 TAF under Alternative 3. On an annual basis, without additional storage, Alternative 3 increases long-term period Delta exports by an additional 140-590 TAF over the No Action Alternative. With additional storage, Alternative 3 increases annual south Delta exports by 410 TAF to 1.3 MAF over the No Action Alternative. Therefore, annual south Delta export increases of 280-710 TAF are directly related to additional storage under Alternative 3.

Alternative 3 has a similar influence on dry and critical year Delta exports. Under the No Action Alternative, Delta exports range from 530 to 640 TAF in the peak winter months and from 90 to 140 TAF in May. Under Alternative 3, dry and critical year exports range from 520 to 750 TAF in the peak winter months and from 80 to 350 TAF during the lower spring months. On an annual basis, without additional storage, Alternative 3 modifies dry and critical year Delta exports from -90 to 440 TAF over the No Action Alternative. With additional storage, Alternative 3 increases annual south Delta exports from 90 TAF to 1.2 MAF over the No Action Alternative. Therefore, annual dry and critical year export increases of 180-810 TAF are directly related to additional storage under Alternative 3.

Isolated facility diversions under Alternative 3 occur throughout the year. Details regarding the isolated conveyance facility diversion assumptions are presented in Section 5.1.4 and Attachment A. In general, the pattern of diversions peak in the early winter and midsummer months with lower diversions in the spring. Figure 5.1-38 compares average monthly isolated facility diversions for the long-term period. Similarly,

Isolated facility diversions under Alternative 3 occur throughout the year.

Figure 5.1-35. Delta Exports at Banks and Tracy under Alternative 3 for the Long-Term Period

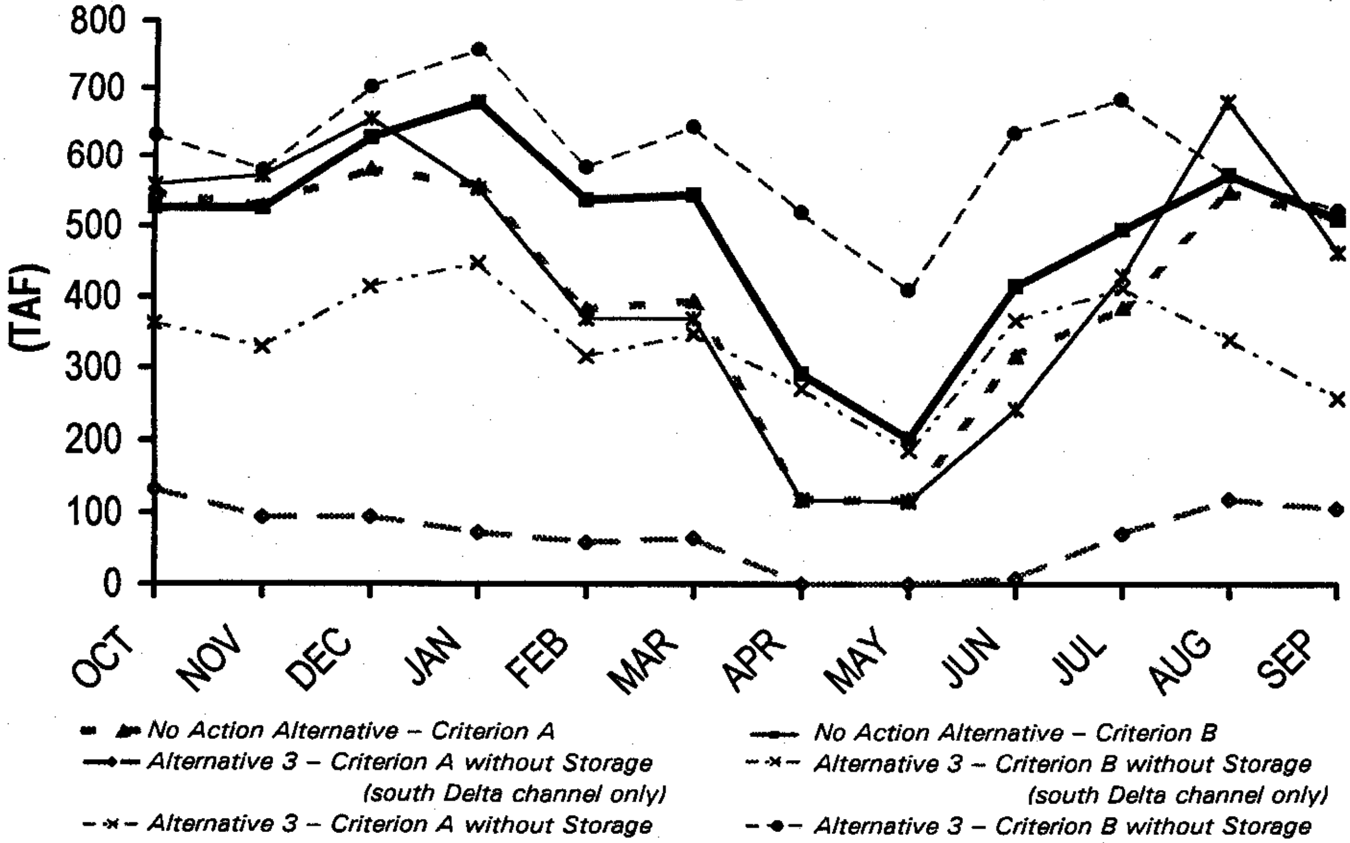


Figure 5.1-36. Delta Exports at Banks and Tracy under Alternative 3 for Dry and Critical Years

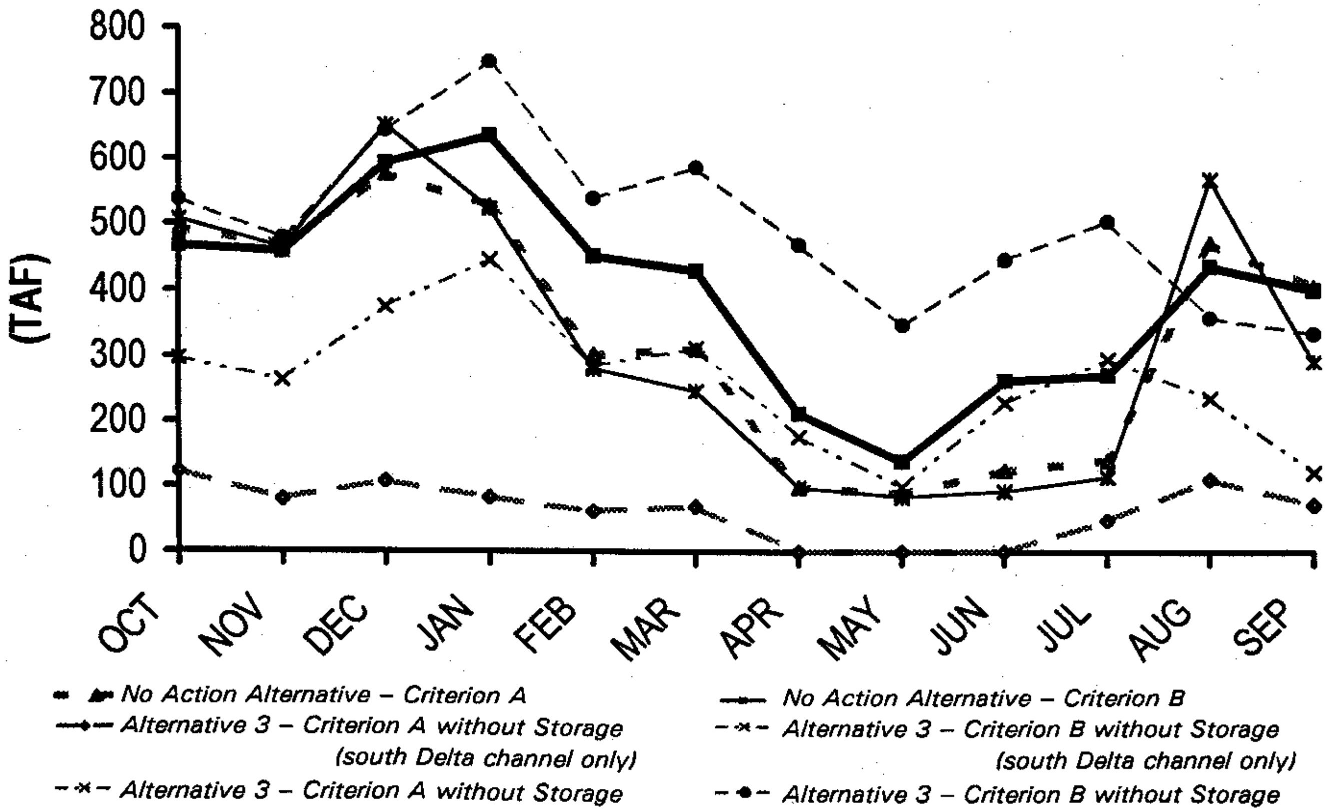


Figure 5.1-37. Average Annual Delta Exports at Banks and Tracy under Alternative 3 for the Long-Term Period and Dry and Critical Years

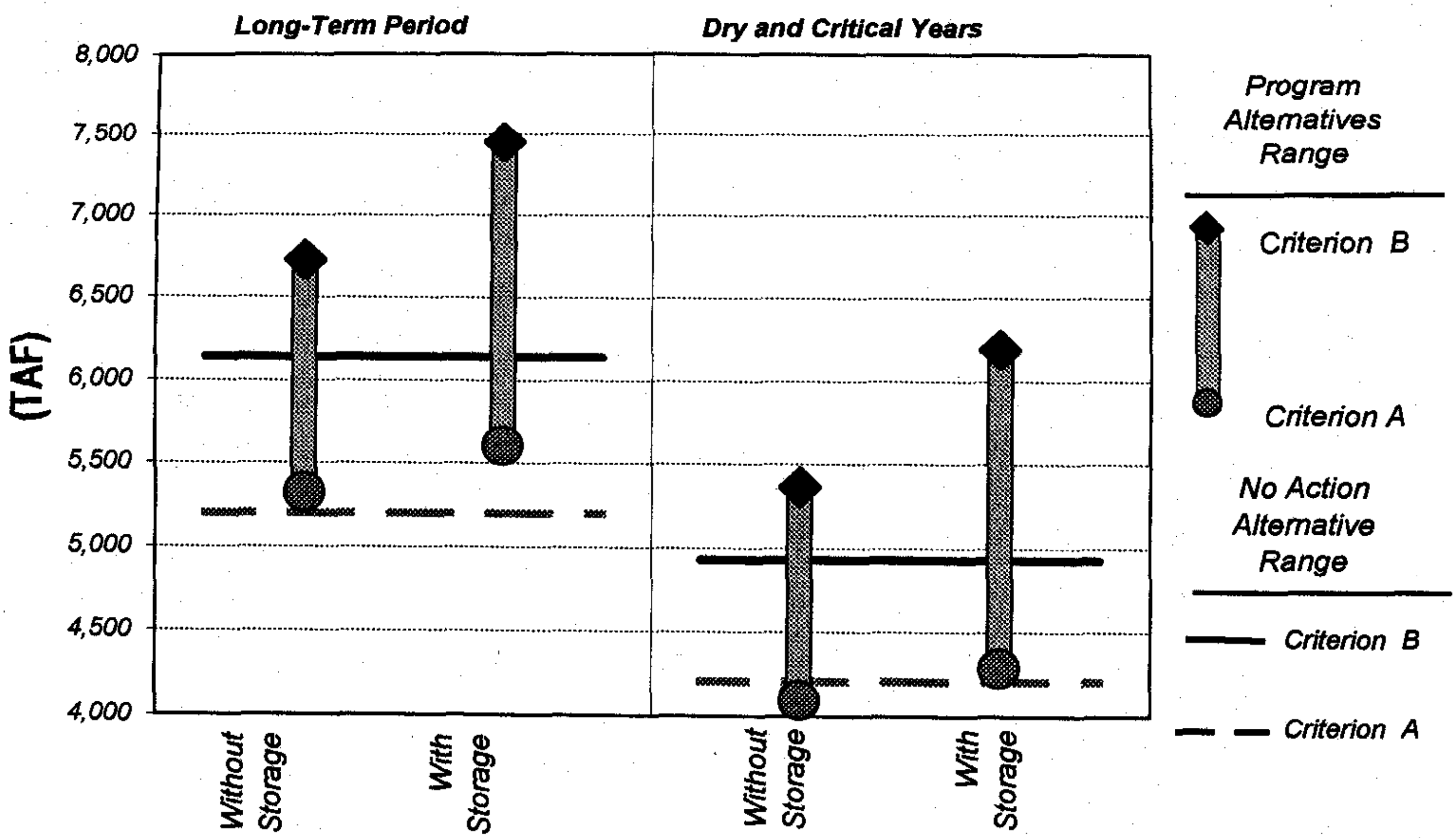


Figure 5.1-38. Isolated Facility Diversions under Alternative 3 for the Long-Term Period

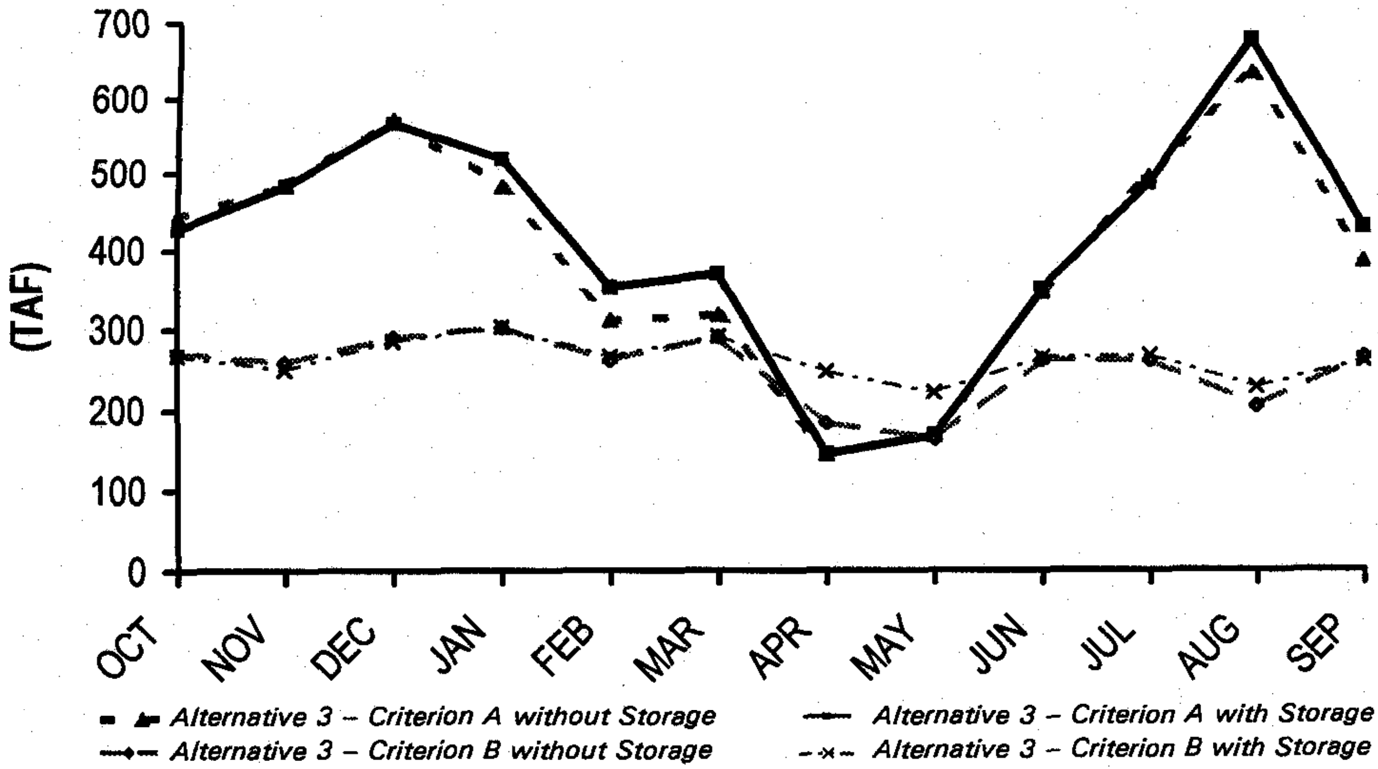


Figure 5.1-39. Isolated Facility Diversions under Alternative 3 for Dry and Critical Years

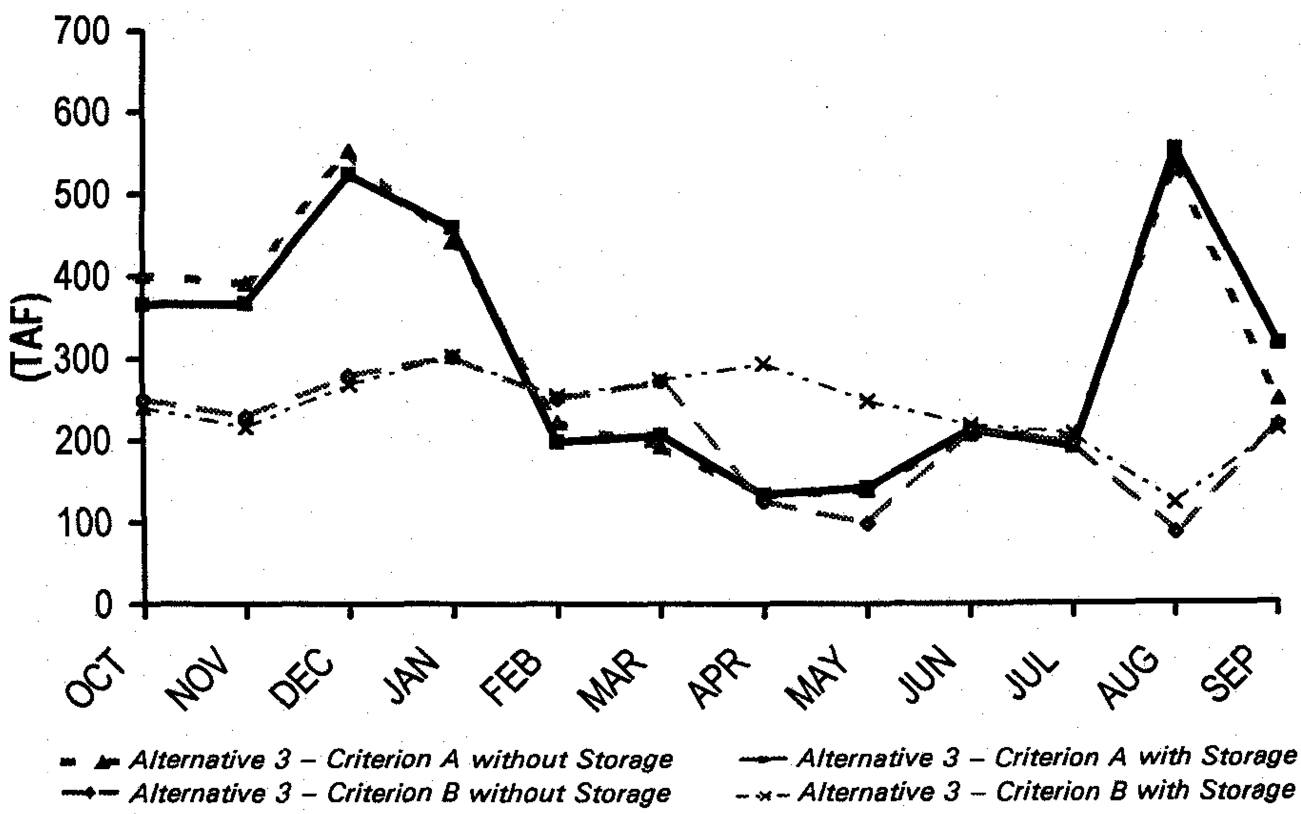


Figure 5.1-39 compares average monthly isolated facility diversions during dry and critical years.

Monthly average isolated facility diversions are typically greatest in winter, with long-term diversions between 300 and 520 TAF occurring in January. Lower monthly average diversions occur during spring due to more restrictive operation criteria, with long-term diversions ranging from 170 to 220 TAF in May. For dry and critical years, diversions range from 300 to 460 TAF in peak winter months and from 100 to 250 TAF in the lower spring months.

Monthly average isolated facility diversions are typically greatest in winter, with long-term diversions between 300 and 520 TAF in January. Lower monthly average diversions occur during spring due to more restrictive operation criteria, with long-term diversions ranging from 170 to 220 TAF in May.

Under Alternative 3 without additional storage, the annual average isolated facility diversions over the long-term period range between 3.0 and 4.8 MAF and for dry and critical years range between 2.5 and 3.7 MAF. When additional system storage is applied to Alternative 3, the annual long-term isolated facility diversions average from 3.2 to 5.0 MAF. For dry and critical years, annual diversions average between 2.9 and 3.7 MAF. Annual average isolated facility diversions directly attributable to new storage ranges from 140 to 190 TAF for the long-term period, and range from 10 to 340 TAF during dry and critical years.

In addition to isolated facility diversions, south Delta channel diversions contribute to total Banks and Tracy south-of-Delta exports under Alternative 3. South Delta channel diversions are typically greatest in the winter. Long-term diversions peak in January with monthly average diversions ranging between 70 and 450 TAF. Lower monthly average diversions occur during spring due to more fishery operation criteria, with long-term diversions ranging from 0 to 200 TAF in May. For dry and critical years, diversions range from 80 to 450 TAF in January and from 0 to 120 TAF in May.

South Delta channel diversions are typically greatest in the winter. Long-term diversions peak in January with monthly average diversions ranging between 70 and 450 TAF. Lower monthly average diversions occur during spring due to more fishery operation criteria, with long-term diversions ranging from 0 to 200 TAF in May.

On an annual basis, without additional storage, Alternative 3 decreases long-term period south Delta channel diversions by 2.4-4.2 MAF relative to the No Action Alternative. With additional storage, Alternative 3 decreases annual south Delta channel diversions by 1.9-4.1 MAF relative to the No Action Alternative. Therefore, additional storage increases the annual south Delta channel diversions by 90-570 TAF. For dry and critical years, Alternative 3 without additional storage decreases south Delta channel diversions by 2.1-3.2 MAF on an annual basis relative to the No Action Alternative. With additional storage, Alternative 3 decreases annual south Delta channel diversions by 1.6-3.1 MAF relative to the No Action Alternative. Therefore, annual dry and critical year south Delta channel diversions increases of 170-470 TAF are directly related to additional storage under Alternative 3.

Bay Region

Programmatic comparisons of Delta outflow to San Francisco Bay were made between Alternative 3 and the No Action Alternative using DWRSIM modeling results. Figures 5.1-40 and 5.1-41 present monthly average Delta outflow comparisons for the long-term period and dry and critical years, respectively.

Figure 5.1-40. Delta Outflow under Alternative 3 for the Long-Term Period

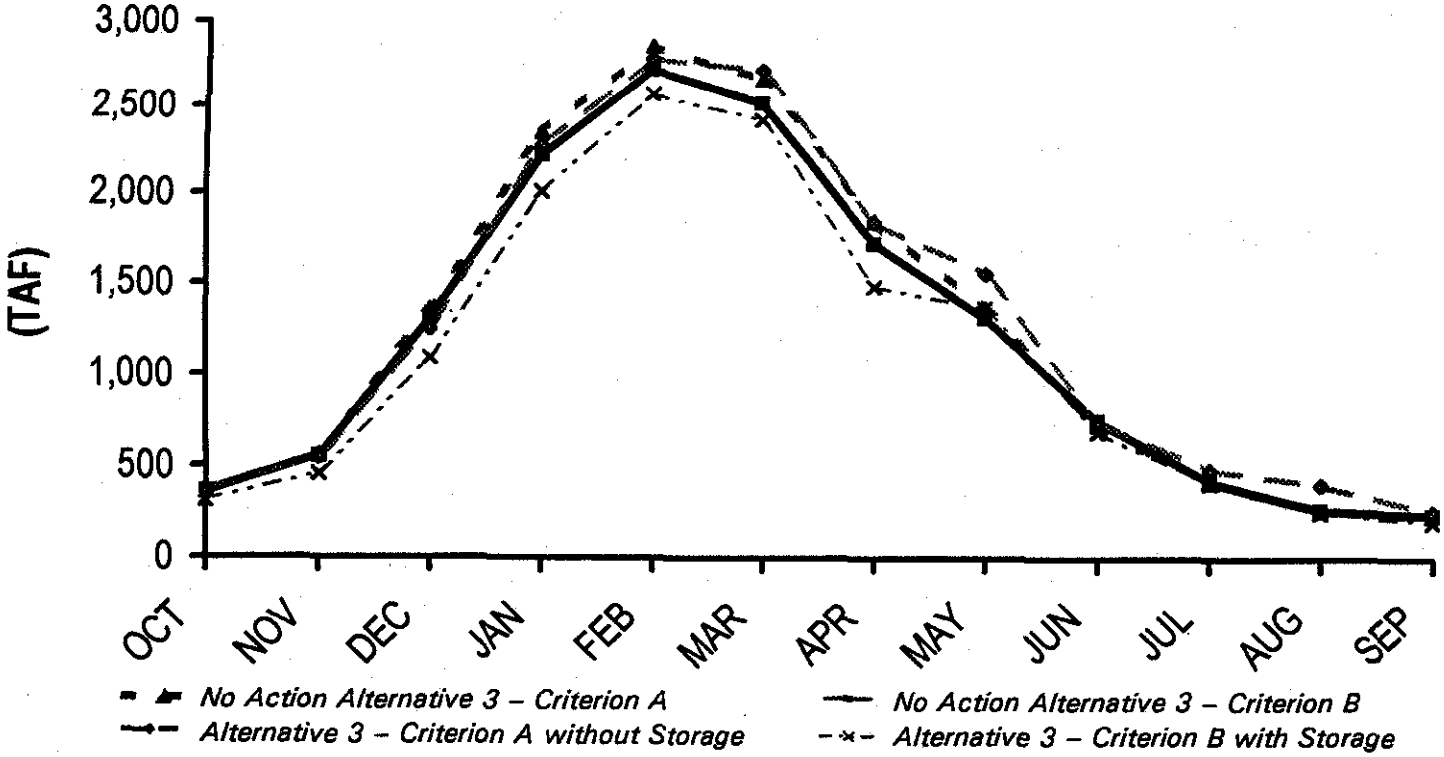
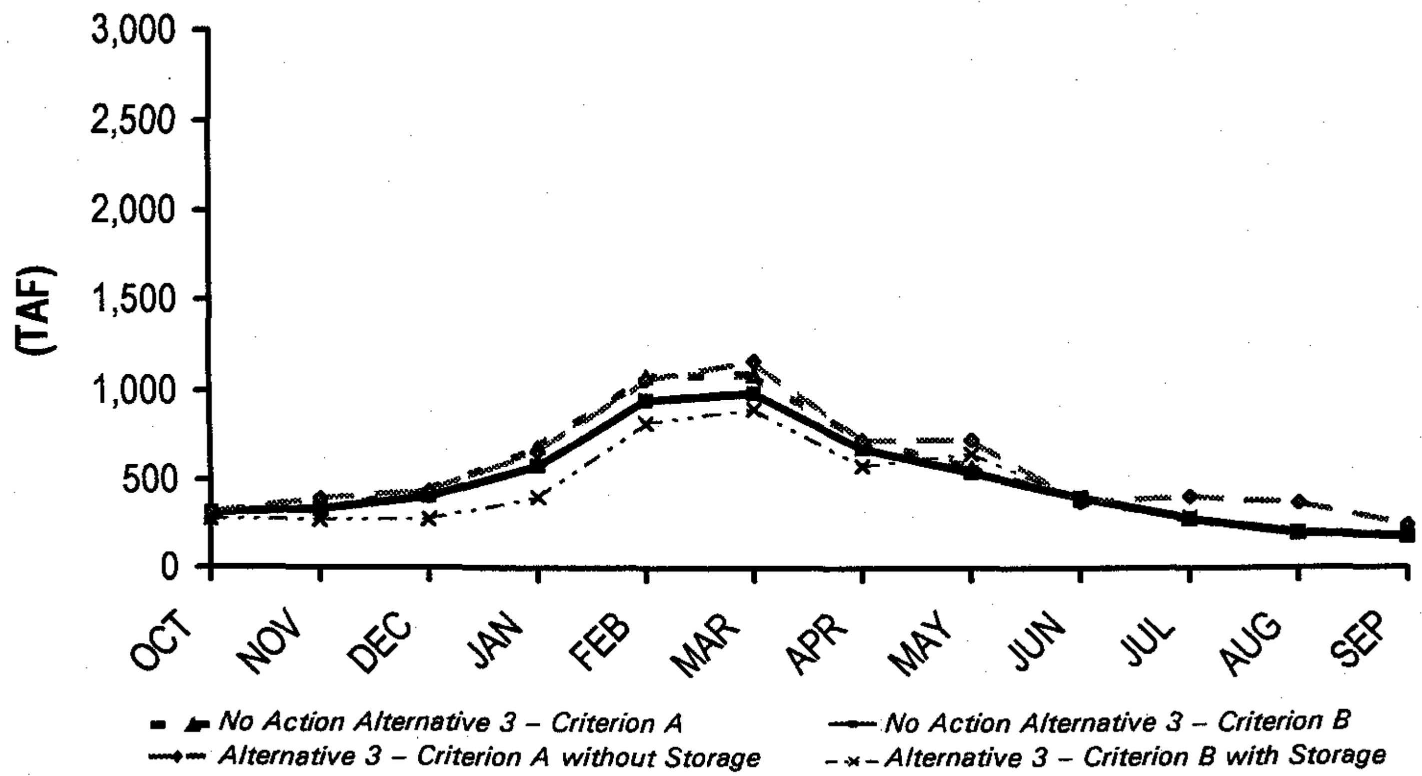


Figure 5.1-41. Monthly Average Delta Outflow under Alternative 3 for the Dry and Critical Years



Delta outflow is typically lower under Alternative 3 than under the No Action Alternative during November through March. Percentage differences are typically small, however. Over the long-term period, Delta outflow normally peaks in February. Average February outflow ranges from 2.7 to 2.8 MAF under the No Action Alternative and ranges from 2.6 to 2.8 MAF under Alternative 3. The differences in Delta outflow are smaller from April through October. Ecosystem Restoration Program flows provide some additional May outflow under Alternative 3. On an annual basis, without additional storage, Alternative 3 modifies average long-term period Delta outflow from -250 to 220 TAF compared to the No Action Alternative. With additional storage, Alternative 3 decreases average annual Delta outflow by 150 TAF to 1.1 MAF. Therefore, annual Delta outflow decreases of 360-850 TAF are directly related to additional storage under Alternative 3.

Delta outflow is typically lower under Alternative 3 than under the No Action Alternative during the months of November through March.

During dry and critical years, February outflow ranges from 950 TAF to 1.1 MAF under the No Action Alternative and ranges from 820 TAF to 1.1 MAF under Alternative 3. On an annual basis, without additional storage, Alternative 3 modifies average dry and critical year Delta outflow from -40 to 610 TAF over the No Action Alternative. With additional storage, Alternative 3 modifies average dry and critical year outflow from -610 to 500 TAF relative to the No Action Alternative. Therefore, annual Delta outflow decreases of 110-570 TAF are directly related to additional storage under Alternative 3.

Sacramento River and San Joaquin River Regions

This section provides a comparison of Alternative 3 and the No Action Alternative with respect to water supply and water management in the Sacramento River and San Joaquin River Regions using DWRSIM modeling results. The programmatic comparison focuses on existing storage, new storage, and Ecosystem Restoration Program acquisitions.

Existing Storage. End-of-September carryover storage in the major Sacramento River Region surface storage facilities (Shasta, Oroville, and Folsom) was evaluated for Alternative 3 and the No Action Alternative. Figure 5.1-42 depicts the ranges of long-term period and dry and critical year carryover storage for Alternative 3 and the No Action Alternative.

Under the No Action Alternative, average carryover storage in Sacramento River Region reservoirs ranges from 5.3 to 5.4 MAF for the long-term period, and from 3.8 to 3.9 MAF for dry and critical years. Alternative 3 long-term period carryover storage ranges from 4.8 to 5.2 MAF, while dry and critical year carryover storage ranges from 3.1 to 3.6 MAF.

In the absence of new storage facilities over the long-term period, implementation of Alternative 3 results in a carryover storage reduction ranging between 210 and 550 TAF. In dry and critical years, the reduction in carryover storage under Alternative 3 may vary from 330 to 810 TAF.

With new storage facilities, implementation of Alternative 3 under Criterion A assumptions reduces long-term and dry and critical carryover storage in existing facilities

Figure 5.1-42. Carryover Storage for Existing Surface Reservoirs in the Sacramento River Region under Alternative 3 for the Long-Term Period and Dry and Critical Years

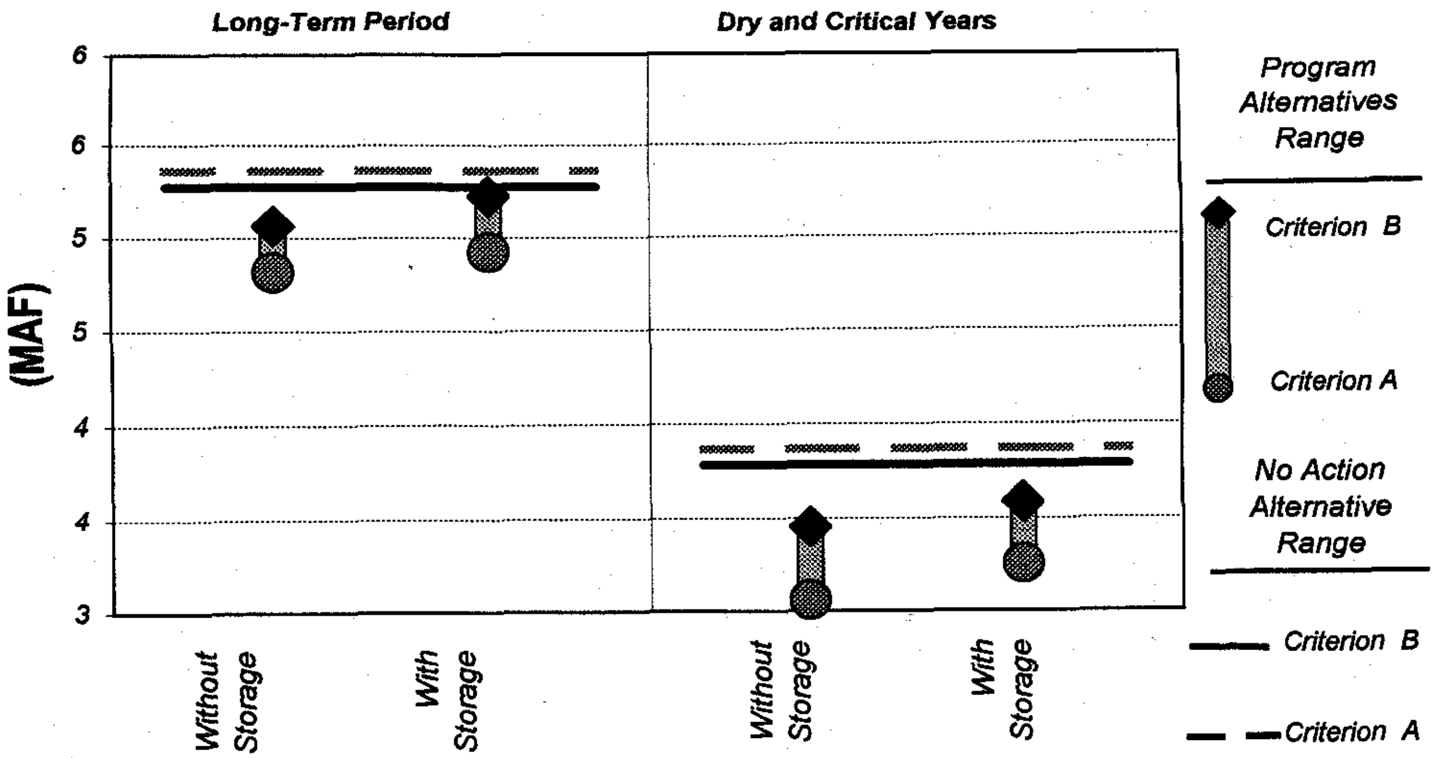
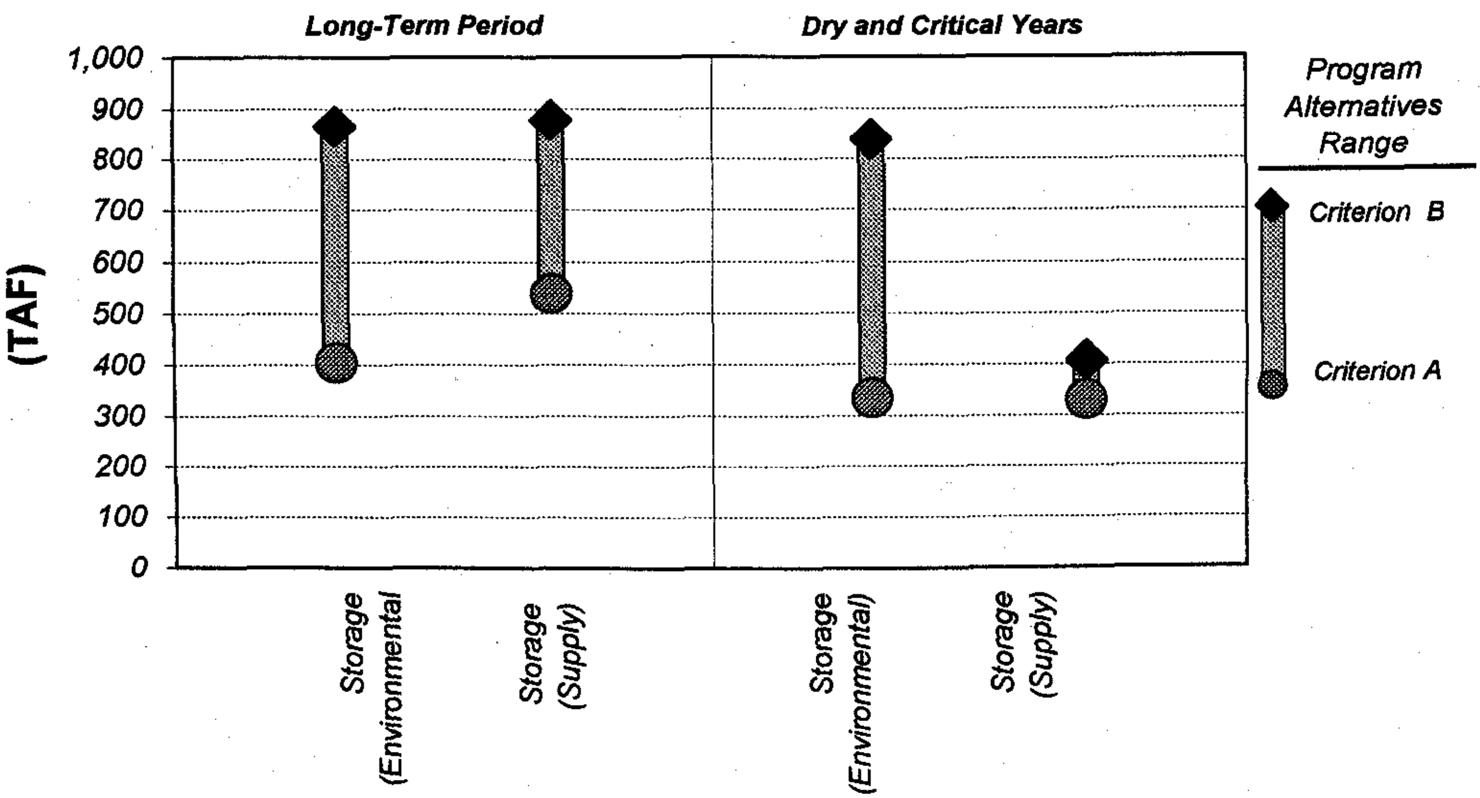


Figure 5.1-43. Carryover Storage for New Surface Reservoirs in the Sacramento River Region under Alternative 3 for the Long-Term Period and Dry and Critical Years



by 440 and 620 TAF, respectively. Under Criterion B assumptions, Alternative 3 reduces long-term and dry and critical years carryover storage by 50 and 190 TAF, respectively.

End-of-September carryover storage in the major San Joaquin River Region surface facilities (New Melones, New Don Pedro, and McClure) was evaluated for Alternative 3 and the No Action Alternative. Implementation of Alternative 3 had no measurable effect on system carryover storage. Similarly, no variation is evident based on water management criteria or implementation of additional storage facilities.

New Storage. New Sacramento River and San Joaquin River Region surface storage facilities were evaluated under Alternative 3. The evaluation distinguished between storage for water supply and storage for environmental enhancement.

Figure 5.1-43 presents Sacramento River Region carryover storage comparisons for the long-term period and dry and critical years. Peak storage in the new facilities generally occurs in early summer under all hydrologic conditions. For the long-term period, peak water supply storage ranges from 700 TAF to 1.3 MAF, while dry and critical year peak storage typically ranges from 460 to 840 TAF. Carryover storage ranges from 540 to 880 TAF for the long-term period. For dry and critical years, the carryover storage is very similar for both Criteria A and B. Criterion B water management assumptions consistently resulted in lower water supply storage. For the long-term period, peak environmental storage ranges from 470 to 940 TAF, while dry and critical year peak storage typically ranges from 410 to 910 TAF. Carryover storage ranges from 400 to 860 TAF for the long-term period, and from 330 to 840 TAF for dry and critical years. Criterion A water management assumptions consistently resulted in lower environmental storage.

Peak storage in the new facilities in the Sacramento River Region generally occurs in early summer under all hydrologic conditions.

New Sacramento River Region groundwater storage facilities also were evaluated under Alternative 3. These facilities are assumed to have a maximum capacity of 250 TAF with maximum inflow and discharge capacities of 500 cfs. Withdrawals from new groundwater storage facilities are made only in dry and critical years. The estimated average annual dry and critical year yield of these facilities ranges from 60 to 110 TAF. The long-term average was not calculated since the storage was operated for dry and critical year yield only.

In this evaluation, new San Joaquin River Region storage facilities were dedicated to providing water for Ecosystem Restoration Program flow targets. Peak average annual storage tends to occur in late spring and ranges from 230 to 240 TAF for the long-term period and 200-230 TAF for dry and critical years. Carryover storage ranges from 200 to 220 TAF for the long-term period, and from 180 to 200 TAF for dry and critical years. Criterion B water management assumptions consistently resulted in lower storage.

In this evaluation, new San Joaquin River Region storage facilities were dedicated to providing water for Ecosystem Restoration Program flow targets. Peak average annual storage tends to occur in late spring and ranges.

Ecosystem Restoration Program Acquisition. Table 5.1-7 shows the water acquisition quantities under Alternative 3 estimated to meet the proposed Ecosystem Restoration Program flow targets.

Table 5.1-7. in Estimated Ecosystem Restoration Program Water Acquisitions in the Sacramento River and San Joaquin River Regions Without New Storage under Alternative 3 (TAF)

LOCATION	CRITICAL	DRY	BELOW NORMAL	ABOVE NORMAL	WET
Sacramento River	0	0-10	90-100	20	0
Yuba River	0	10	<10	0	0
Feather River	0	50-60	80	60	<10
American River	0	30	40-50	20	40
Lower Sacramento River	0	50-110	10-20	0	<10
Additional Delta flows	0	90-140	180-240	250-290	10
Stanislaus River	0	10	30	40	40
Tuolumne River	50	40	40	50	40
Merced River	40	20	20	40	30
Total acquisitions	**90**	**300-430**	**490-580**	**480-520**	**160**

When new Sacramento River and San Joaquin River Region storage is included in Alternative 3, fewer water acquisitions are necessary to meet Ecosystem Restoration Program flow targets. New storage also could be operated to provide Ecosystem Restoration Program flows for other tributaries by exchange agreements. These types of arrangements are not reflected in this analysis. Table 5.1-8 shows the water acquisition quantities estimated to meet the proposed Ecosystem Restoration Program flow targets under Alternative 3 with new storage.

When new Sacramento River and San Joaquin River Region storage is included in Alternative 3, fewer water acquisitions are necessary to meet Ecosystem Restoration Program flow targets.

Table 5.1-8. Estimated Ecosystem Restoration Program Water Acquisitions in the Sacramento River and San Joaquin River Regions with New Storage under Alternative 3 (TAF)

LOCATION	CRITICAL	DRY	BELOW NORMAL	ABOVE NORMAL	WET
Sacramento River	0	<10	30-60	10-20	0
Yuba River	0	10	<10	0	0
Feather River	0	40	70-80	40	0
American River	0	30	40	20	40
Lower Sacramento River	0	0-50	0	0	0
Additional Delta flows	0	40-90	120-170	180-230	<10
Stanislaus River	0	10	30	40	40
Tuolumne River	60	30	20	30-40	20
Merced River	30	10	0	10	10
Total acquisitions	**90**	**170-270**	**310-400**	**330-400**	**110**

South-of-Delta SWP and CVP Service Areas

Programmatic comparisons of deliveries to the South-of-Delta SWP and CVP Service Areas were made between Alternative 3 and the No Action Alternative using DWRSIM modeling results. This section also evaluates surface water storage in existing and new off-aqueduct facilities.

Delta Deliveries. The range of annual Delta deliveries under the No Action Alternative was compared to the range of deliveries expected under Alternative 3. Deliveries are generally higher under Alternative 3 with implementation of new storage facilities and under Criterion B water management assumptions.

Under Alternative 3, the range of average annual deliveries over the long-term period is 5.0-7.0 MAF. The low end of this range assumes no new storage facilities and Criterion A water management assumptions; the high end of this range assumes new storage facilities and Criterion B water management assumptions. The No Action Alternative results in a long-term average annual delivery range of 4.8-5.8 MAF. During dry and critical years, Alternative 3 average annual deliveries range between 3.8 and 5.9 MAF and No Action Alternative deliveries range between 3.9 and 4.6 MAF.

Without additional storage facilities, Alternative 3 would increase long-term average annual deliveries between 140 and 560 TAF relative to the No Action Alternative. For dry and critical years, Alternative 3 would modify deliveries from -170 to 380 TAF.

> Without additional storage facilities, Alternative 3 would increase long-term average annual deliveries between 140 and 560 TAF relative to the No Action Alternative. Implementation of Alternative 3 in conjunction with new surface storage would increase long-term average annual deliveries from 380 TAF to 1.3 MAF.

Implementation of Alternative 3 in conjunction with new surface storage would increase long-term average annual deliveries from 380 TAF to 1.3 MAF. In dry and critical years, Alternative 3 would increase deliveries by 370 TAF to 1.4 MAF. Therefore, annual long-term Delta deliveries increases of 240 to 690 TAF are directly related to additional storage under Alternative 3. The range of average long-term and dry and critical water-year Delta deliveries for Alternative 3 compared to the No Action Alternative is depicted in Figure 5.1-44.

Existing Off-Aqueduct Storage Facilities. San Luis Reservoir is the primary existing off-aqueduct storage facility serving the South-of-Delta SWP and CVP Service Areas. San Luis Reservoir carryover storage and reservoir releases were evaluated under Alternative 3 and the No Action Alternative.

With no additional storage, Alternative 3 increases average annual long-term period San Luis Reservoir carryover storage up to 350 TAF above the No Action Alternative. If additional storage is implemented, Alternative 3 increases carryover storage by 260-480 TAF above the No Action Alternative. Therefore, a long-term average carryover storage increase of 130-230 TAF is directly attributed to additional storage under Alternative 3.

With no additional storage, Alternative 3 increases average annual carryover storage during dry and critical years from 130 to 330 TAF above the No Action Alternative. If additional storage is implemented, Alternative 3 increases carryover storage by 310-480 TAF above the No Action Alternative. Therefore, a dry and critical year carryover storage increase of 150-180 TAF is directly attributed to additional storage under Alternative 3. Figure 5.1-45 presents carryover storage comparisons for the long-term period and dry and critical years.

> With no additional storage, Alternative 3 increases average annual carryover storage during dry and critical years from 130 to 330 TAF above the No Action Alternative. If additional storage is implemented, Alternative 3 increases carryover storage by 310-480 TAF above the No Action Alternative.

The broadest range in monthly average storage releases from San Luis Reservoir generally occurs in summer months for both alternatives under all hydrologic conditions. The greatest long-term summer releases are generally associated with Criterion A water management in the absence of new storage facilities, while the lowest summer releases are associated with Criterion B water management in conjunction with additional storage capacity. The broadest range of long-term monthly average reservoir releases under Alternative 3 is approximately 170-400 TAF. Under the No Action Alternative, peak

Figure 5.1-44. Average Annual Delta Deliveries under Alternative 3 for the Long-Term Period and Dry and Critical Years

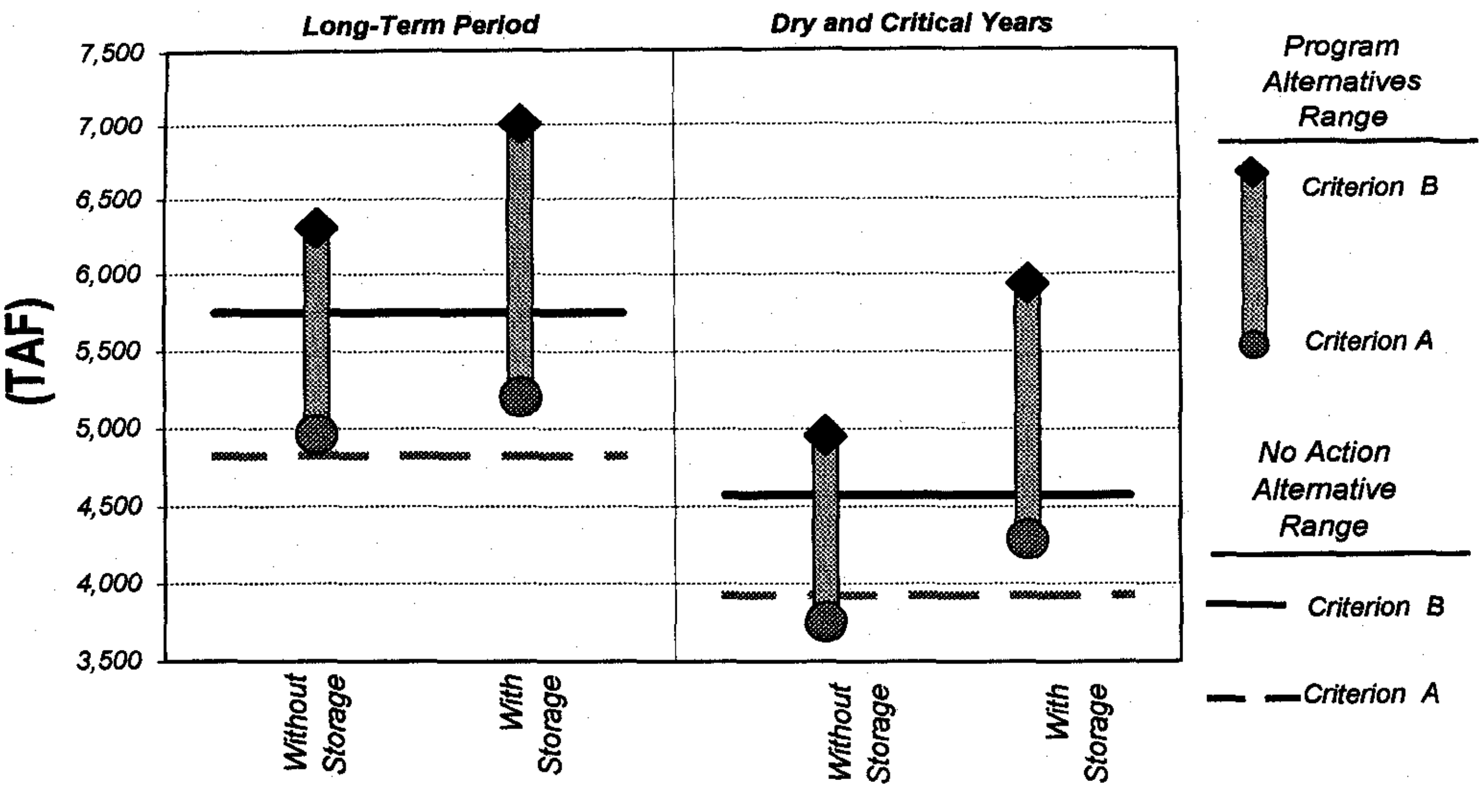


Figure 5.1-45. Carryover Storage for Existing Off-Aqueduct Reservoirs under Alternative 3 for the Long-Term Period and Dry and Critical Years

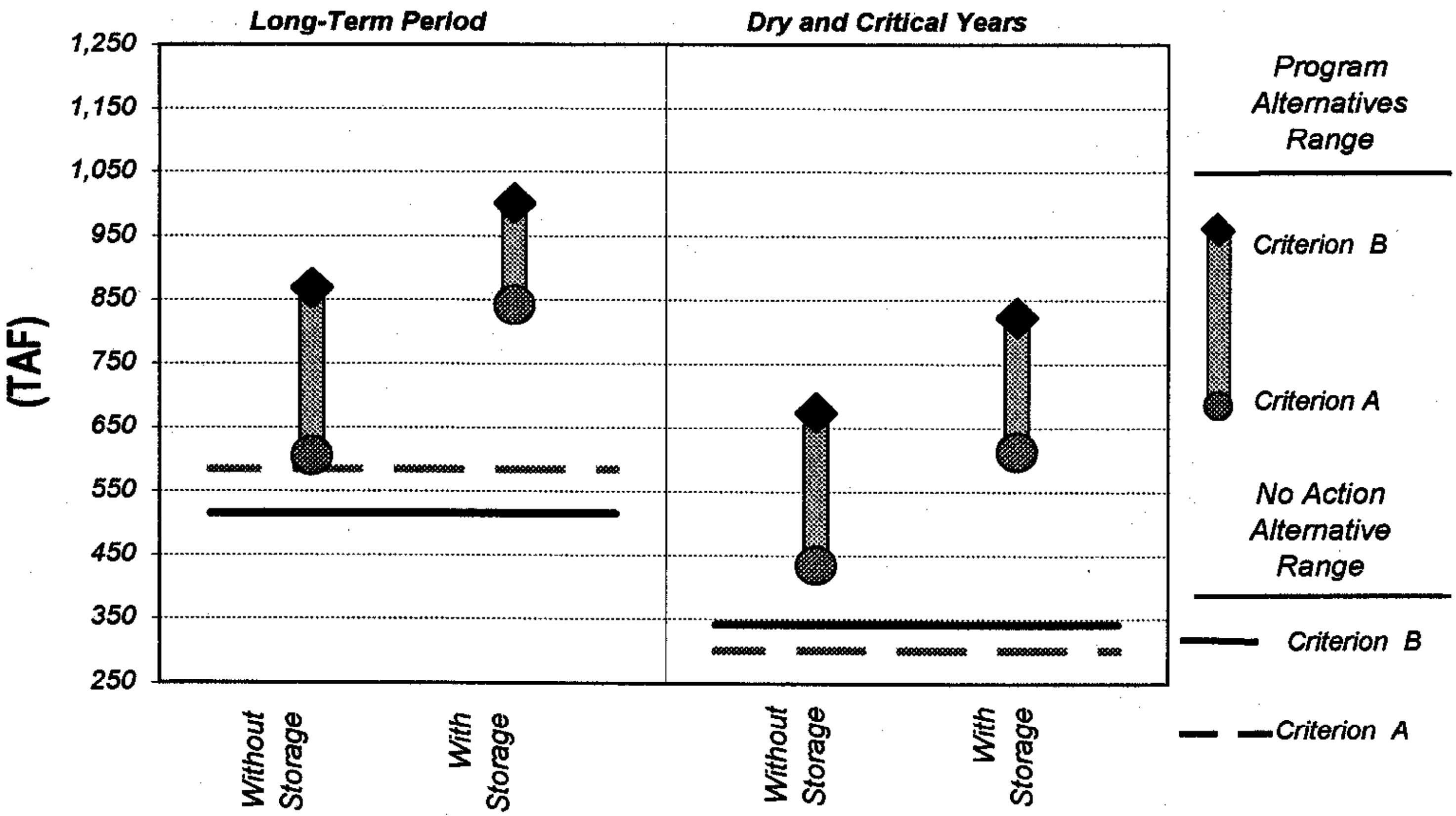
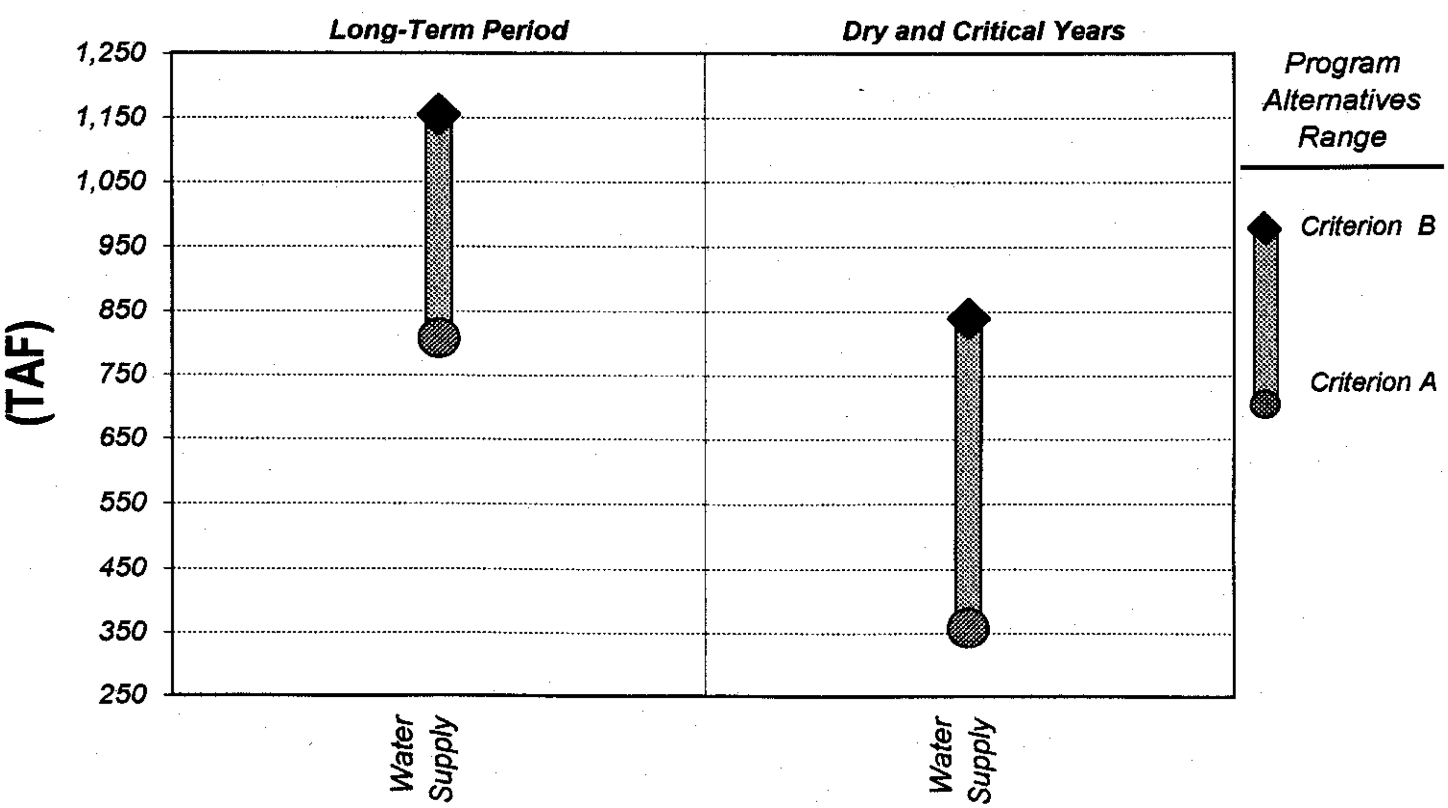


Figure 5.1-46. Carryover Storage for New Off-Aqueduct Reservoirs under Alternative 3 for the Long-Term Period and Dry and Critical Years



average monthly summer releases range from 270 to 310 TAF over the long-term period. Winter releases are similar under Alternative 3 and the No Action Alternative.

New Off-Aqueduct Storage Facilities. Carryover storage and releases associated with new off-aqueduct surface storage facilities were evaluated under Alternative 3. Such facilities would serve the South-of-Delta SWP and CVP Service Areas similar to San Luis Reservoir.

Over the long-term period, carryover storage in new off-aqueduct surface storage facilities ranges from 810 TAF to 1.2 MAF under Alternative 3. For dry and critical years, carryover storage ranges from 360 to 840 TAF. Water management Criterion A provides higher carryover storage in wetter water-years while water management Criterion B provides higher carryover storage in wetter and drier water-years. Figure 5.1-46 presents carryover storage comparisons for the long-term period and dry and critical years.

Over the long-term period, carryover storage in new off-aqueduct surface storage facilities ranges from 810 TAF to 1.2 MAF under Alternative 3.

Releases from new off-aqueduct surface storage facilities generally occur from spring to late summer under Alternative 3. Peak releases typically occur in midsummer for all hydrologic conditions. The approximate peak releases are between 170 and 190 TAF for the long-term period and dry and critical years, respectively. Over the long-term period, Criterion A water management results in early spring peak releases while Criterion B results in late spring peak releases. Reduced Delta exports associated with Criterion A create more reliance on off-aqueduct storage releases to meet spring demands.

New off-aqueduct groundwater storage facilities also were evaluated under Alternative 3. These facilities are assumed to have a maximum capacity of 500 TAF with maximum inflow and discharge capacities of 500 cfs. Withdrawals from new groundwater storage facilities are made only in dry and critical years. The estimated average annual dry and critical year yield of these facilities ranges from 80 to 90 TAF. The long-term average was not calculated since the storage was operated for dry and critical year yield only.

5.1.8.4 PREFERRED PROGRAM ALTERNATIVE

For evaluation purposes, the Preferred Program Alternative was simulated with and without a new screened diversion (2,000-4,000 cfs) from the Sacramento River near Hood to the Mokelumne River system. Without a new diversion, consequences of the Preferred Program Alternative to water supply and water management are similar to consequences under Alternative 1, as described in Section 5.1.8.1. With a new diversion, consequences of the Preferred Program Alternative to water supply and water management are described below.

Some improvements to water supply and water management would be realized from improved export pumping capacity under the Preferred Program Alternative relative to the No Action Alternative. Greater water supply and water management benefits may be obtained if additional storage facilities are constructed.

Some improvements to water supply and water management would be realized from improved export pumping capacity under the Preferred Program Alternative relative to the No Action Alternative. Greater water supply and water management benefits may be obtained if additional storage facilities are constructed.

Delta Region

Programmatic comparisons of Delta inflows and exports were made between the Preferred Program Alternative and the No Action Alternative using DWRSIM modeling results. Both bookend Delta water management criteria were used to define the range of uncertainty associated with each alternative.

Average monthly Delta inflow is typically lower under the Preferred Program Alternative than under the No Action Alternative. Over the long-term period, Delta inflow normally peaks in February. Average February flow is approximately 190 TAF under the No Action Alternative and is approximately 180 TAF under the Preferred Program Alternative. For dry and critical years, peak monthly flow ranges from 70 to 80 TAF under both the No Action Alternative and the Preferred Program Alternative. Additional storage appears to slightly reduce total Delta inflow for the long-term average and dry and critical years.

> Average monthly Delta inflow is typically lower under the Preferred Program Alternative than under the No Action Alternative.

The pattern of long-term average Delta exports would be modified somewhat by the Preferred Program Alternative, with greater exports occurring August through January relative to the No Action Alternative. Figure 5.1-47 compares average monthly Delta exports for the long-term period. Similarly, Figure 5.1-48 compares average monthly Delta exports during dry and critical years.

Combined exports from Banks and Tracy Pumping Plants peak in January, with long-term period values ranging from 560 to 680 TAF under the No Action Alternative and from 540 to 790 TAF under the Preferred Program Alternative. Delta exports, at minimum values in May, change little under the Preferred Program Alternative. Long-term period exports range from 120 to 200 TAF under the No Action Alternative and range from 120 to 210 TAF under the Preferred Program Alternative. On an annual basis, without additional storage, the Preferred Program Alternative increases long-term period Delta exports by an additional 250-380 TAF over the No Action Alternative. With additional storage, the Preferred Program Alternative increases annual Delta exports by 490-900 TAF over the No Action Alternative. Therefore, annual export increases of 250-530 TAF are directly related to additional storage under the Preferred Program Alternative.

> The pattern of long-term average Delta exports would be modified somewhat by the Preferred Program Alternative, with greater exports occurring August through January relative to the No Action Alternative.

The Preferred Program Alternative has a similar influence on dry and critical year Delta exports. Under the No Action Alternative, Delta exports range from 530 to 640 TAF in January and from 90 to 140 TAF in May. Under the Preferred Program Alternative, dry and critical year exports range from 520 to 720 TAF in the peak winter months and from 90 to 140 TAF during the spring months. On an annual basis, without additional storage, the Preferred Program Alternative increases dry and critical year Delta exports by an additional 50 to 180 TAF over the No Action Alternative. With additional storage, the Preferred Program Alternative increases annual Delta exports from 180 to 670 TAF over the No Action Alternative. Therefore, annual dry and critical year export increases of 130-490 TAF are directly related to additional storage under the Preferred Program Alternative.

Figure 5.1-47. Delta Exports at Banks and Tracy under the Preferred Program Alternative for the Long-Term Period

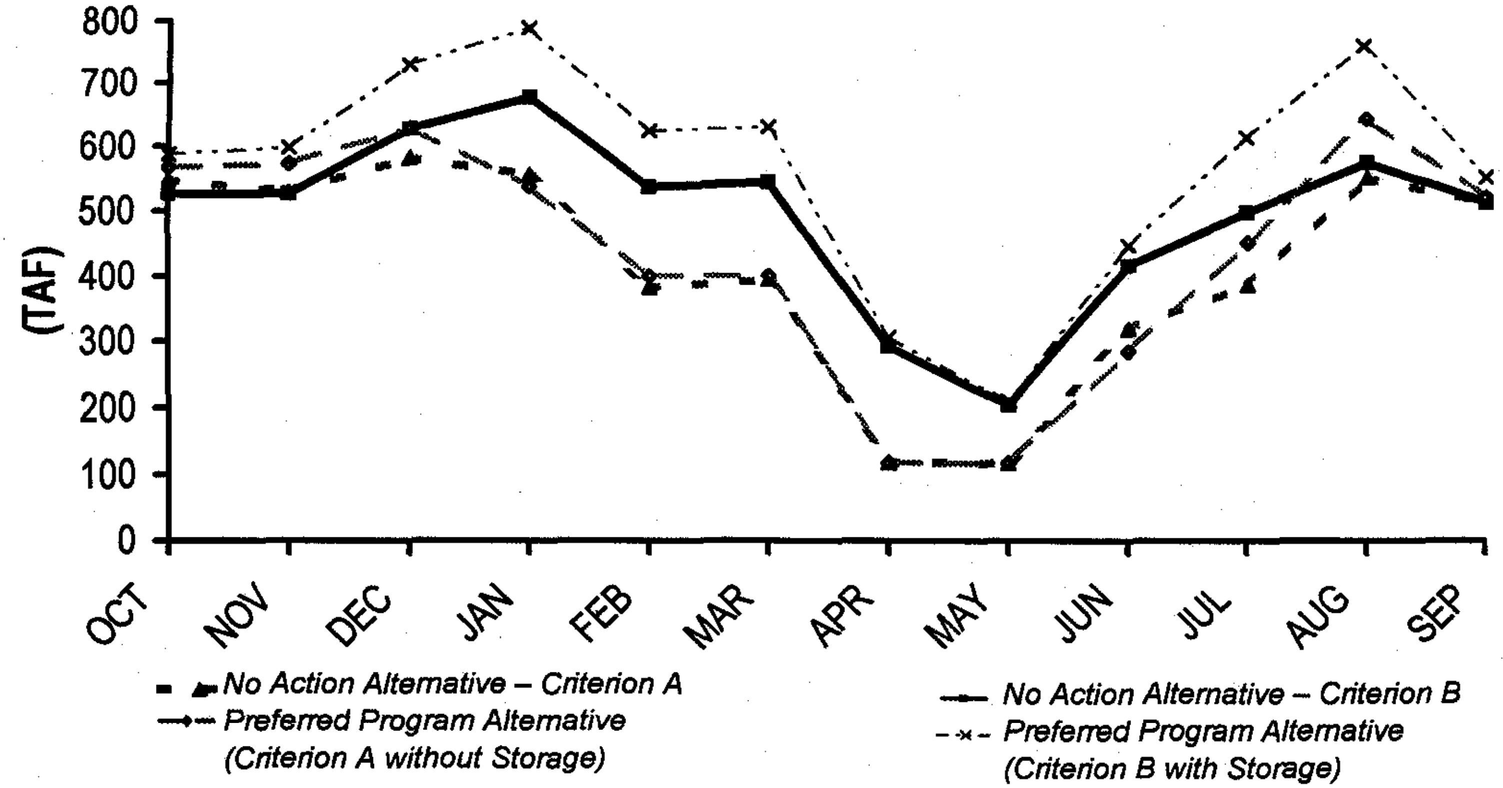
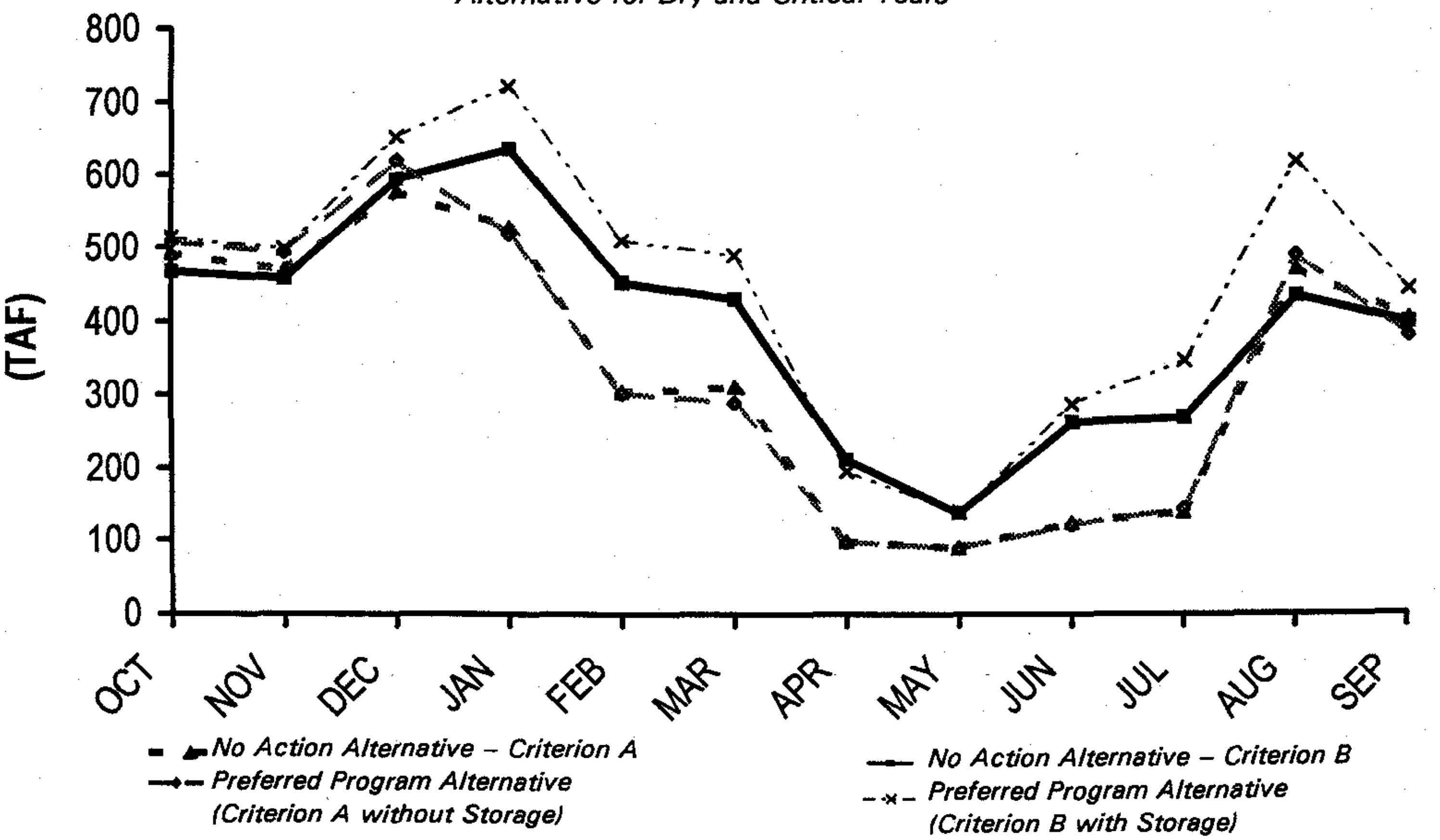


Figure 5.1-48. Delta Exports at Banks and Tracy under the Preferred Program Alternative for Dry and Critical Years



Delta exports under the Preferred Program Alternative also were compared to Delta exports under the other Program alternatives. The long-term period comparison is summarized in Table 5.1-9. The dry and critical year comparison is summarized in Table 5.1-10. Additionally, Figures 5.1-49 and 5.1-50 present Delta export comparisons for the long-term period and dry and critical years, respectively.

Table 5.1-9. Banks and Tracy Exports under All Program Alternatives for the Long-Term Period (TAF)

PERIOD	NO ACTION ALTERNATIVE	ALTERNATIVE 1/PPA (Without Hood)	ALTERNATIVE 2	ALTERNATIVE 3	PPA (With Hood)
High export month (January)	560-680	540-760	540-760	560-760	540-790
Low export month (May)	120-200	120-210	120-210	120-200	120-210
Annual difference without storage	-	270-390	230-400	140-590	250-380
Annual difference with storage	-	670-800	460-800	410-1,300	490-900

Note:
PPA = Preferred Program Alternative.

Table 5.1-10. Banks and Tracy Exports under All Program Alternatives for Dry and Critical Years(TAF)

PERIOD	NO ACTION ALTERNATIVE	ALTERNATIVE 1/PPA (Without Hood)	ALTERNATIVE 2	ALTERNATIVE 3	PPA (With Hood)
High export month (January)	530-640	530-720	520-710	520-750	520-720
Low export month (May)	90-140	90-140	90-140	90-140	90-140
Annual difference without storage	-	30-190	30-200	(-90)-440	50-180
Annual difference with storage	-	240-640	130-650	90-1,240	180-670

Note:
PPA = Preferred Program Alternative.

Hood diversions under the Preferred Program Alternative occur throughout the year. Details regarding the Hood diversion assumptions are presented in Section 5.1.4 and Attachment A. In general, the pattern of diversions peak in early winter and midsummer, with lower diversions in the spring. Figure 5.1-51 compares average monthly Hood Diversion for the long-term period. Similarly, Figure 5.1-52 compares average monthly Hood exports during dry and critical years.

Hood diversions under the Preferred Program Alternative occur throughout the year.

Hood diversions are typically greatest in January, with long-term diversions peaking on average from 120 to 250 TAF. May reflects lower average diversions due to more

Figure 5.1-49. Average Annual Delta Exports at Banks and Tracy under All Program Alternatives for the Long-Term Period

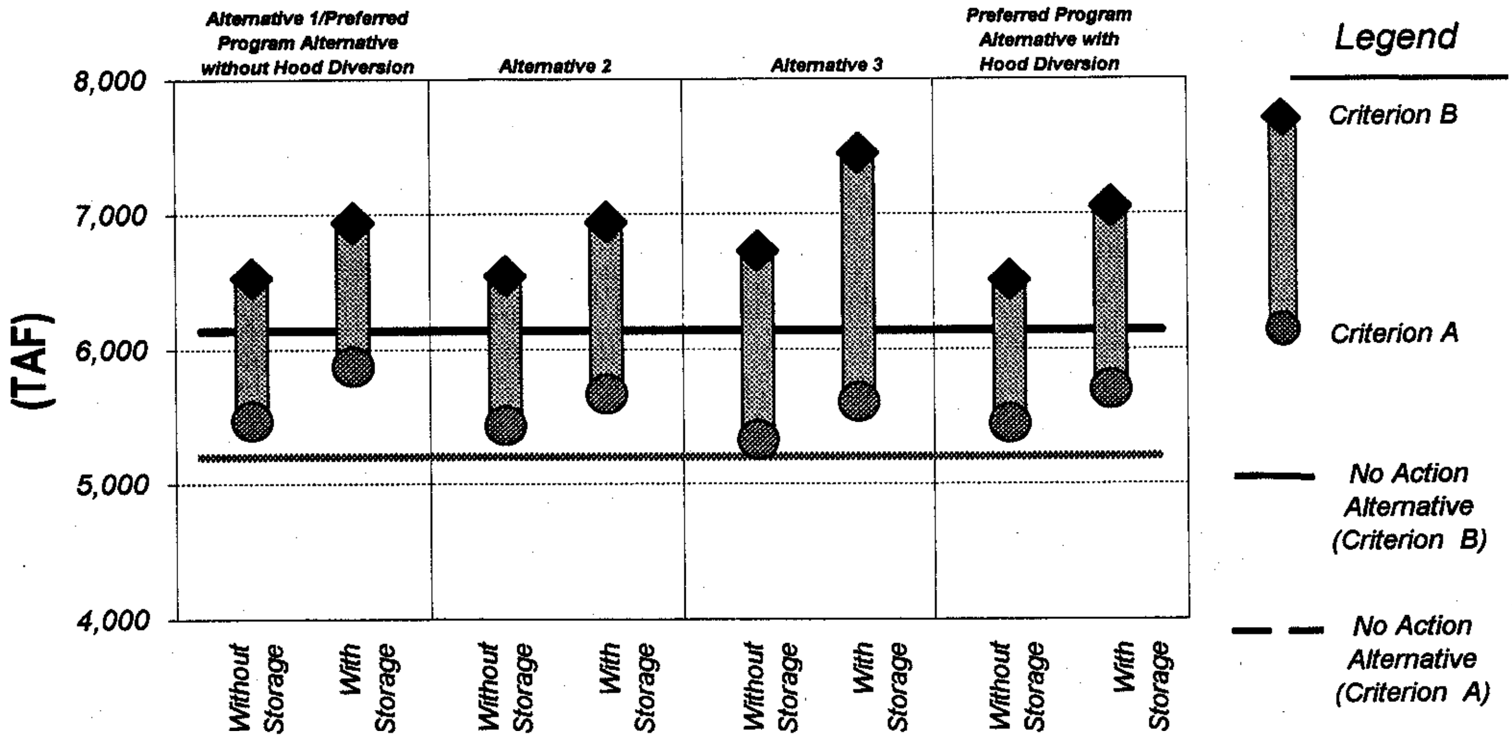


Figure 5.1-50. Average Delta Exports at Banks and Tracy under all Preferred Program Alternatives for Dry and Critical Years

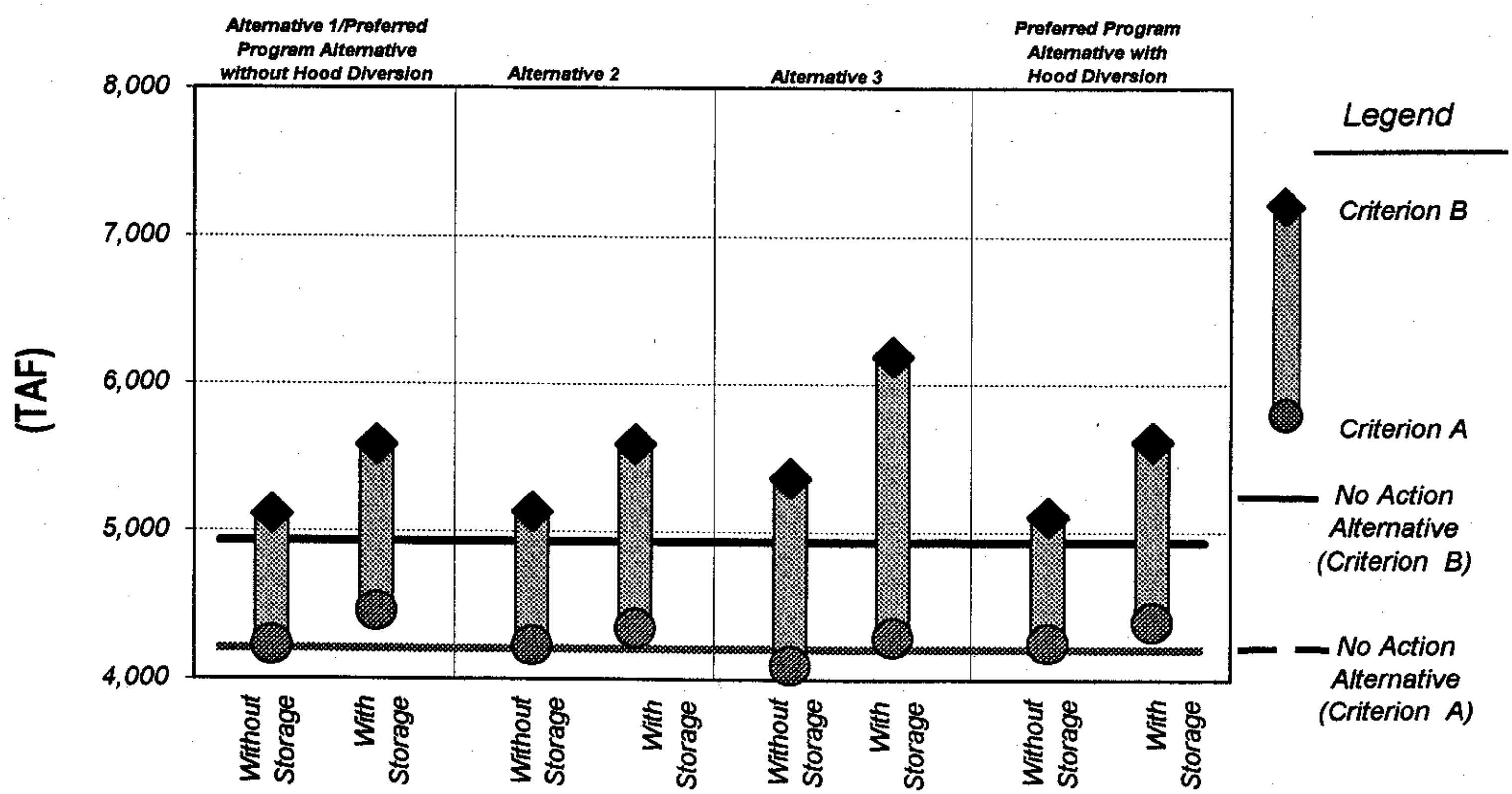


Figure 5.1.51. Hood Diversions under the Preferred Program Alternative for the Long-Term Period

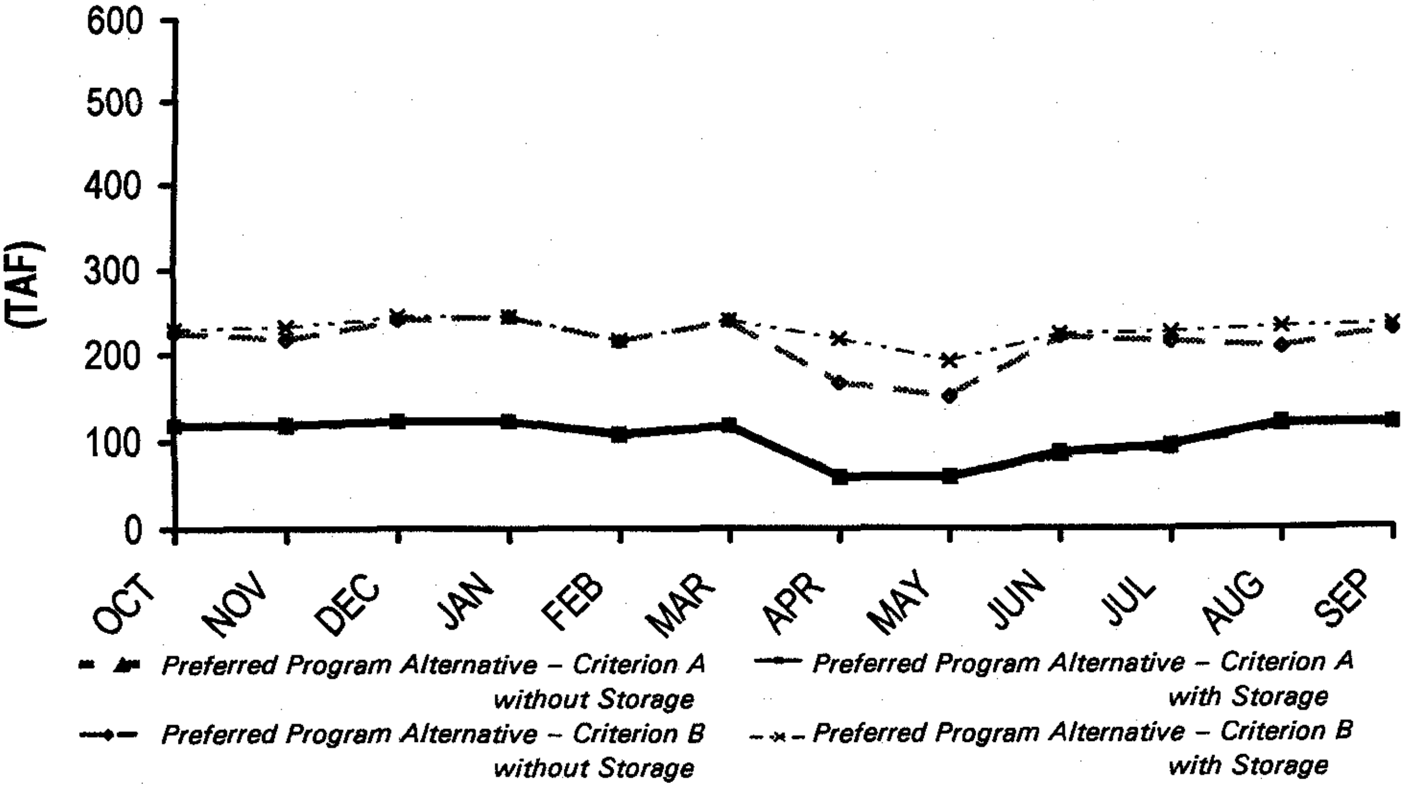
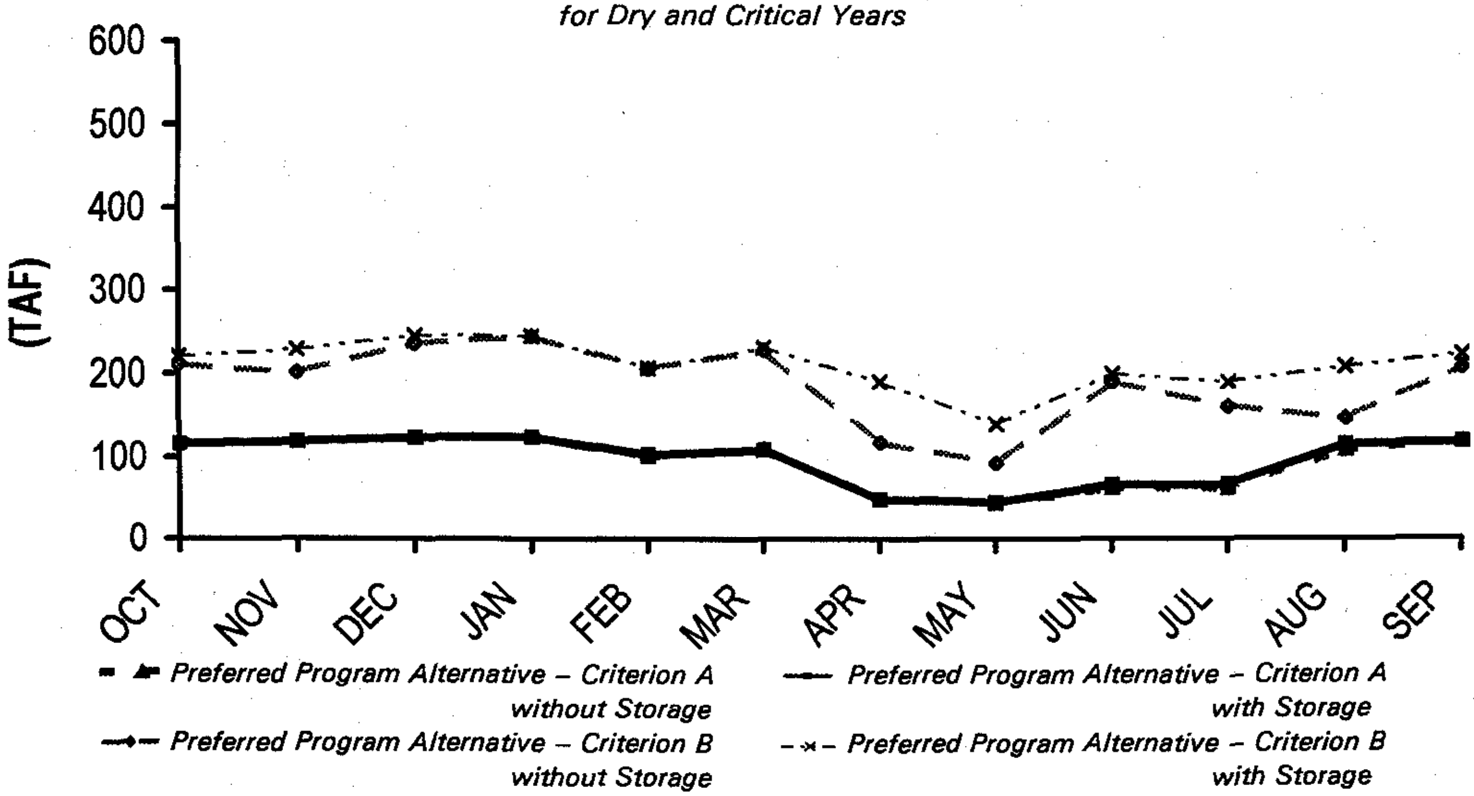


Figure 5.1-52. Hood Diversions under the Preferred Program Alternative for Dry and Critical Years



restrictive operation criteria, ranging from 60 to 190 TAF. For dry and critical water-years, diversions average from 120 to 240 TAF in peak winter months and from 40 to 140 TAF in spring months.

Under the Preferred Program Alternative without additional storage, annual Hood diversions over the long-term period range from 1.2 to 2.6 MAF. For dry and critical years, average annual diversions range from 1.1 MAF to 2.2 MAF. When additional system storage is applied to the Preferred Program Alternative, annual long-term Hood diversions average 1.2- 2.7 MAF. For dry and critical years, annual Hood diversions range on average between 1.2 and 2.5 MAF. Average annual Hood diversion directly attributed to additional storage range from 0 to 160 TAF for the long-term period, and from 10 to 290 TAF for dry and critical years.

Bay Region

Programmatic comparisons of Delta outflow to San Francisco Bay were made between the Preferred Program Alternative and the No Action Alternative using DWRSIM modeling results. Figures 5.1-53 and 5.1-54 present monthly average Delta outflow comparisons for the long-term period and dry and critical years, respectively.

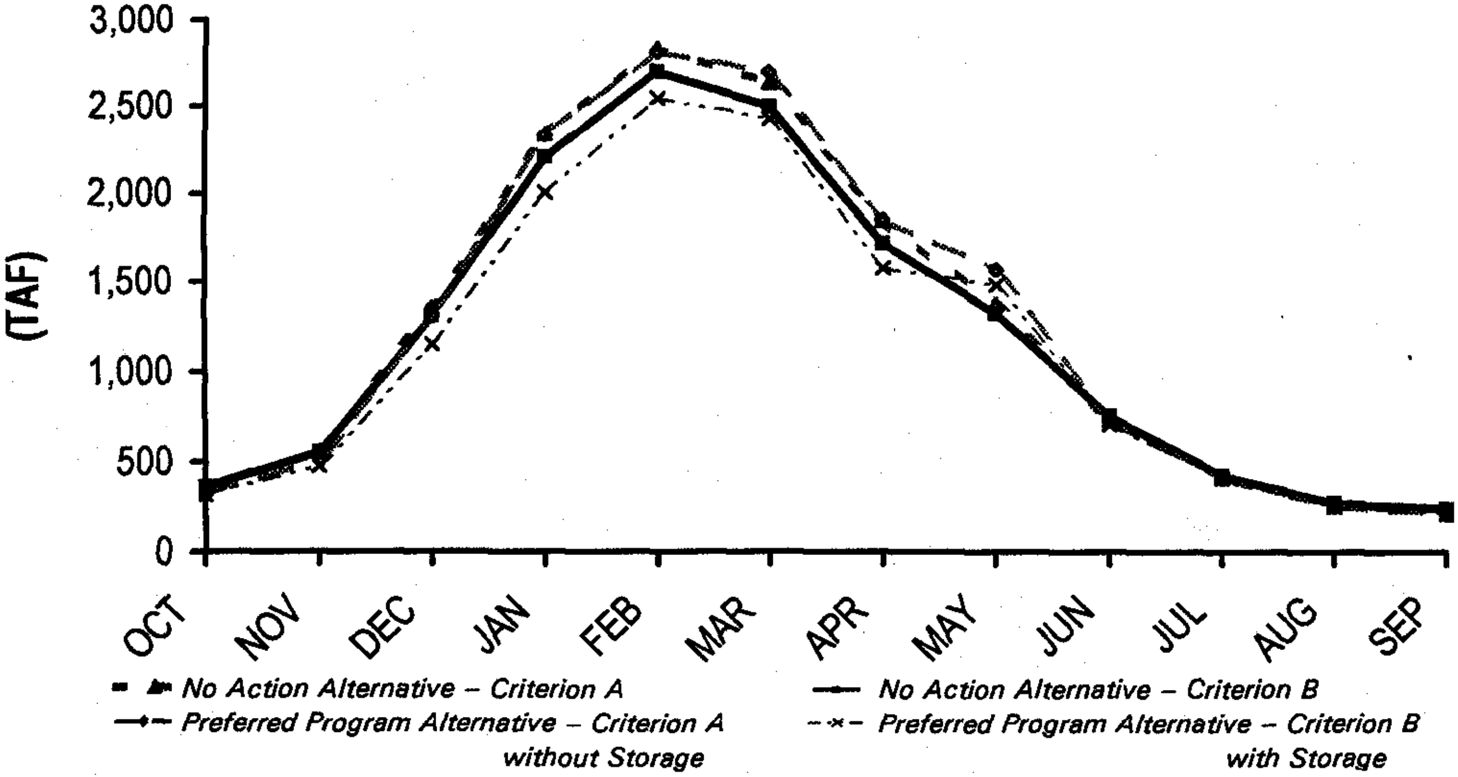
Delta outflow is typically lower under the Preferred Program Alternative than under the No Action Alternative during November through March. Percentage differences are typically small, however. Over the long-term period, Delta outflow normally peaks in February. Average February outflow ranges from 2.7 to 2.8 MAF under the No Action Alternative and ranges from 2.6 to 2.8 MAF under the Preferred Program Alternative. The differences in Delta outflow are smaller from April through October. Ecosystem Restoration Program flows provide some additional May outflow under the Preferred Program Alternative. On an annual basis, without additional storage, the Preferred Program Alternative modifies average long-term period Delta outflow from -70 to 50 TAF compared to the No Action Alternative. With additional storage, the Preferred Program Alternative decreases average annual Delta outflow from 290 to 760 TAF. Therefore, annual Delta outflow decreases of 340-700 TAF are directly related to additional storage under the Preferred Program Alternative.

Delta outflow is typically lower under the Preferred Program Alternative than under the No Action Alternative during November through March.

During dry and critical years, February outflow ranges from 950 TAF to 1.1 MAF under the No Action Alternative and ranges from 870 TAF to 1.1 MAF under the Preferred Program Alternative. On an annual basis, without additional storage, the Preferred Program Alternative increases average dry and critical year Delta outflow from 70 to 180 TAF over the No Action Alternative. With additional storage, the Preferred Program Alternative could decrease average dry and critical year outflow by 280 TAF or could increase outflow by 170 TAF relative to the No Action Alternative. Therefore, annual Delta outflow decreases of 20-350 TAF are directly related to additional storage under the Preferred Program Alternative.

Delta outflow under the Preferred Program Alternative was also compared to Delta outflow under the other Program alternatives. The long-term period comparison is summarized in Table 5.1-11. The dry and critical year comparison is summarized in Table 5.1-12.

Figure 5.1-53. Delta Outflow under the Preferred Program Alternative for the Long-Term Period



5.1-54. Delta Outflow under the Preferred Program Alternative for Dry and Critical Years

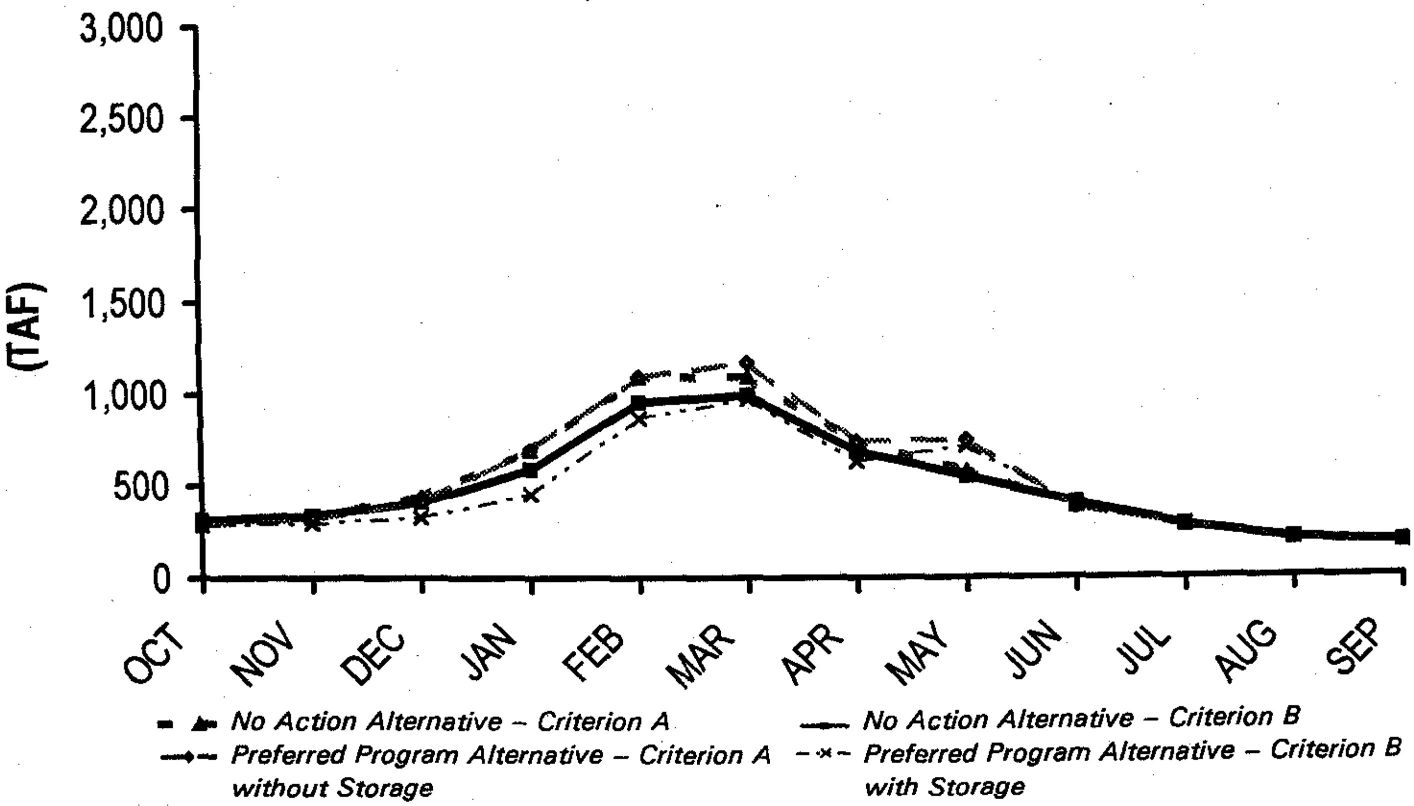


Table 5.1-11. Delta Outflow under All Program Alternatives for the Long-Term Period(TAF)

PERIOD	NO ACTION ALTERNATIVE	ALTERNATIVE 1/PPA (Without Hood)	ALTERNATIVE 2	ALTERNATIVE 3	PPA (With Hood)
High outflow month (February)	2,700-2,840	2,560-2,840	2,560-2,840	2,560-2,760	2,550-2,810
Annual difference without storage	-	(-80)-30	(-90)-60	(-250)-220	(-70)-50
Annual difference with storage	-	(-660)-(-460)	(-660)-(-270)	(-1,100)-(-150)	(-760)-(-290)

Note:
PPA = Preferred Program Alternative.

Table 5.1-12. Delta Outflow under All Program Alternatives for Dry and Critical Years (TAF)

PERIOD	NO ACTION ALTERNATIVE	ALTERNATIVE 1/PPA (Without Hood)	ALTERNATIVE 2	ALTERNATIVE 3	PPA (With Hood)
High outflow month (February)	950-1,080	860-1080	870-1,090	820-1,080	870-1,090
Annual difference without storage	-	70-180	40-210	(-40)-610	70-180
Annual difference with storage	-	(-260)-70	(-260)-210	(-610)-500	(-280)-170

Note:
PPA = Preferred Program Alternative.

Sacramento River and San Joaquin River Regions

This section provides a comparison of the Preferred Program Alternative and the No Action Alternative with respect to water supply and water management in the Sacramento River and San Joaquin River Regions using DWRSIM modeling results. The programmatic comparison focuses on existing storage, new storage, and Ecosystem Restoration Program acquisitions.

In the absence of new storage facilities, implementation of the Preferred Program Alternative has little impact on carryover storage under Criterion A water management assumptions. The Preferred Program Alternative results in a slight reduction in carryover storage under Criterion B water management assumptions.

Existing Storage. End-of-September carryover storage in the major Sacramento River Region surface storage facilities (Shasta, Oroville, and Folsom) was evaluated for the Preferred Program Alternative and the No Action Alternative. Figure 5.1-55 depicts the ranges of long-term period and dry and critical year carryover storage for the Preferred Program Alternative and the No Action Alternative.

Under the No Action Alternative, average carryover storage in Sacramento River Region reservoirs ranges from 5.3 to 5.4 MAF for the long-term period, and from 3.8 to 3.9 MAF for dry and critical years. The Preferred Program Alternative long-term period carryover storage ranges from 5.1 to 5.5 MAF, while dry and critical year carryover storage ranges from 3.6 to 4.0 MAF.

Figure 5.1-55. Carryover Storage for Existing Surface Reservoirs in the Sacramento River Region under the Preferred Program Alternative for the Long-Term Period and Dry and Critical Years

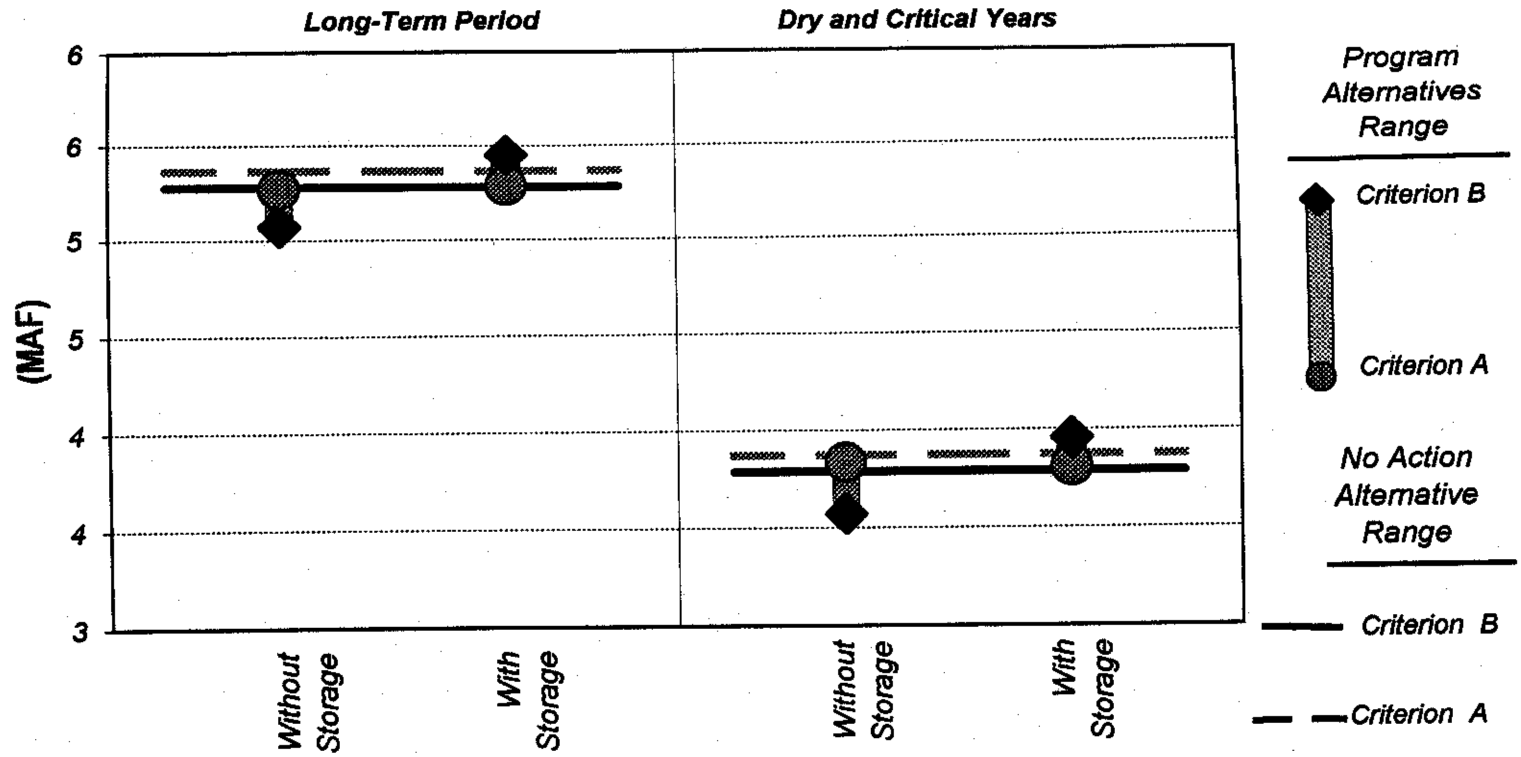
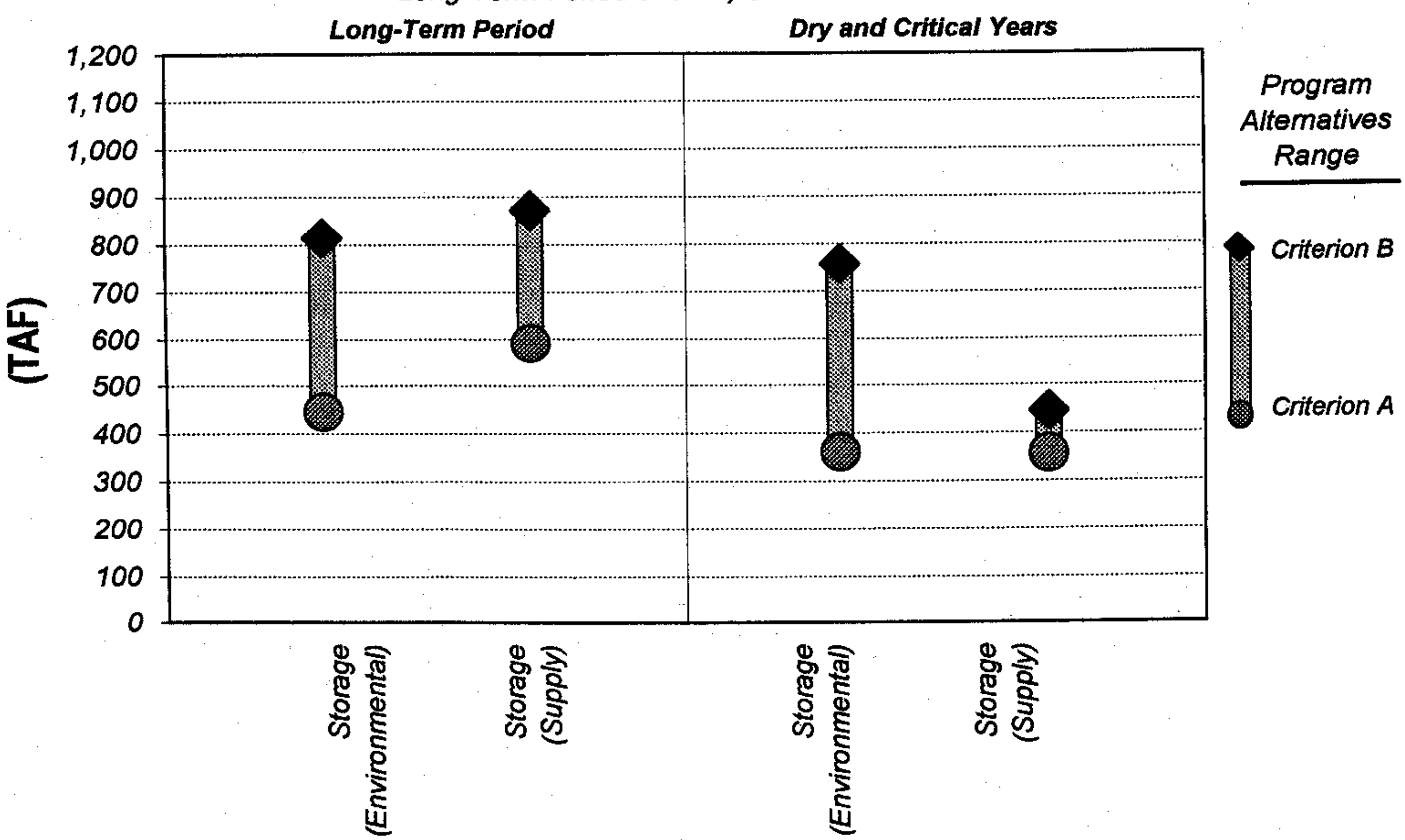


Figure 5.1-56. Carryover Storage for New Surface Reservoirs in the Sacramento River Region under the Preferred Program Alternative for the Long-Term Period and Dry and Critical Years



In the absence of new storage facilities, implementation of the Preferred Program Alternative has little impact on carryover storage under Criterion A water management assumptions. The Preferred Program Alternative results in a slight reduction in carryover storage under Criterion B water management assumptions. Without new storage, the reduction in average long-term carryover storage under the Preferred Program Alternative may vary from 90 to 210 TAF. The same trend is demonstrated for the dry and critical years with the reduction in carryover storage varying from 40 to 210 TAF.

With new storage facilities, implementation of the Preferred Program Alternative under Criterion A assumptions reduces average long-term period and dry and critical year carryover storage in existing facilities on the order of 80 TAF relative to the No Action Alternative. Under Criterion B assumptions, the Preferred Program Alternative increases average carryover storage on the order of 180 TAF.

End-of-September carryover storage in the major San Joaquin River Region surface facilities (New Melones, New Don Pedro, and McClure) was evaluated for the Preferred Program Alternative and the No Action Alternative. Implementation of the Preferred Program Alternative has no measurable effect on system carryover storage. Similarly, no variation is evident based on water management criteria or implementation of additional storage facilities.

New Storage. New Sacramento River and San Joaquin River Regions surface storage facilities were evaluated under the Preferred Program Alternative. The evaluation distinguished between storage for water supply and storage for environmental enhancement.

Figure 5.1-56 presents Sacramento River Region carryover storage comparisons for the long-term period and dry and critical years. Peak storage in the new facilities generally occurs in early summer under all hydrologic conditions. For the long-term period, peak water supply storage ranges from 770 TAF to 1.3 MAF, while dry- and critical-year peak storage typically ranges from 510 to 810 TAF. Carryover storage ranges from 590 TAF to 870 TAF for the long-term period, and from 360 to 450 TAF for dry and critical years. Criterion A water management assumptions consistently results in lower water supply storage. For the long-term period, peak environmental storage ranges from 520 to 900 TAF, while dry- and critical -year peak storage typically ranges from 450 to 870 TAF. Carryover storage ranges from 450 to 810 TAF for the long-term period, and from 360 to 760 TAF for dry and critical years. Criterion A water management assumptions consistently results in lower environmental storage.

New Sacramento River and San Joaquin River Regions surface storage facilities were evaluated under the Preferred Program Alternative. The evaluation distinguished between storage for water supply and storage for environmental enhancement.

New Sacramento River Region groundwater storage facilities also were evaluated under the Preferred Program Alternative. These facilities are assumed to have a maximum capacity of 250 TAF with maximum inflow and discharge capacities of 500 cfs. Withdrawals from new groundwater storage facilities are made only in dry and critical years. The estimated average annual dry and critical year yield of these facilities ranges from 40 to 60 TAF. The long-term average was not calculated since the storage was operated for dry and critical year yield only.

In this evaluation, new San Joaquin River Region storage facilities were dedicated to providing water for Ecosystem Restoration Program flow targets. Peak average annual storage tends to occur in late spring and is approximately 240 TAF for the long-term period and ranges from 210 to 230 TAF for dry and critical years. Carryover storage ranges from 200 to 220 TAF for the long-term period, and from 190 to 210 TAF for dry and critical years. Criterion B water management assumptions consistently result in lower storage.

Ecosystem Restoration Program Acquisition. Table 5.1-13 shows water acquisitions quantities under the Preferred Program Alternative estimated to meet proposed Ecosystem Restoration Program flow targets.

When new Sacramento River and San Joaquin River Regions surface storage is included in the Preferred Program Alternative, fewer water acquisitions are required to meet Ecosystem Restoration Program flow targets. New storage also could be operated to provide Ecosystem Restoration Program flows for other tributaries by exchange agreements. These types of arrangements are not reflected in this analysis. Table 5.1-14 shows the water acquisition quantities estimated to meet the proposed Ecosystem Restoration Program flow targets under the Preferred Program Alternative with new storage.

New storage also could be operated to provide Ecosystem Restoration Program flows for other tributaries by exchange agreements.

Table 5.1-13. Estimated Ecosystem Restoration Program Water Acquisitions in the Sacramento River and San Joaquin River Regions Without New Storage under the Preferred Program Alternative (TAF)

LOCATION	CRITICAL	DRY	BELOW NORMAL	ABOVE NORMAL	WET
Sacramento River	0	0-10	90	20	0
Yuba River	0	10	<10	0	0
Feather River	0	50	80	60	<10
American River	0	30	40	20	40
Lower Sacramento River	0	80-100	10	0	<10
Additional Delta flows	0	90-110	180-210	250-270	10
Stanislaus River	0	10	30	40	40
Tuolumne River	50	40	40	50	40
Merced River	40	20	20	40	30
Total acquisitions	**90**	**330-380**	**490-520**	**480-500**	**160**

South-of-Delta SWP and CVP Service Areas

Programmatic comparisons of Delta deliveries to the SWP and CVP Service Areas were made between the Preferred Program Alternative and the No Action Alternative using DWRSIM modeling results. This section also evaluates surface water storage in existing and new off-aqueduct facilities.

Delta Deliveries. The range of annual Delta deliveries under the No Action Alternative was compared to the range of deliveries expected under the Preferred Program Alternative. Deliveries are generally higher under the Preferred Program Alternative with implementation of new storage facilities and Criterion B water management assumptions.

Table 5.1-14. Estimated Ecosystem Restoration Program Water Acquisitions in the Sacramento River and San Joaquin River Regions with New Storage under the Preferred Program Alternative (TAF)

LOCATION	CRITICAL	DRY	BELOW NORMAL	ABOVE NORMAL	WET
Sacramento River	0	<10	30-50	0-10	0
Yuba River	0	10	<10	0	0
Feather River	0	40	70	40	0
American River	0	30	40	20	40
Lower Sacramento River	0	0-30	0	0	0
Additional Delta flows	0	30-40	110-120	180-200	<10
Stanislaus River	0	10	30	40	40
Tuolumne River	60	30	20	30	20
Merced River	30	10	0	10	10
Total acquisitions	**90**	**160-200**	**300-330**	**320-350**	**110**

Under the Preferred Program Alternative, the range of average annual deliveries over the long-term period is from 5.1 to 6.7 MAF. The low end of this range assumes no new storage facilities and Criterion A water management assumptions; the high end of this range assumes new storage facilities and Criterion B water management assumptions. The No Action Alternative results in a long-term average annual delivery range from 4.8 to 5.8 MAF. During dry and critical years, the Preferred Program Alternative average annual deliveries range between 3.9 and 5.6 MAF and No Action Alternative deliveries range between 3.9 and 4.6 MAF.

Without additional storage facilities, the Preferred Program Alternative would increase long-term average annual deliveries by 250-370 TAF relative to the No Action Alternative. Dry and critical year deliveries would increase by up to 190 TAF under the Preferred Program Alternative. Implementation of the Preferred Program Alternative in conjunction with new surface storage would increase long-term average annual deliveries by 470-910 TAF. In dry and critical years, the Preferred Program Alternative would increase deliveries by 530-990 TAF. Therefore, annual long-term Delta delivery increases of 220-540 TAF are directly related to additional storage under the Preferred Program Alternative. Delta deliveries under the Preferred Program Alternative also were compared to Delta deliveries under the other Program alternatives. The long-term period comparison is summarized in Table 5.1-15. The dry and critical year comparison is shown in Table 5.1-16. Additionally, Figures 5.1-57 and 5.1-58 present average annual Delta delivery comparisons for the long-term period and dry and critical years, respectively.

Without additional storage facilities, the Preferred Program Alternative would increase long-term average annual deliveries by 250-370 TAF relative to the No Action Alternative. Implementation of the Preferred Program Alternative in conjunction with new surface storage would increase long-term average annual deliveries by 470-910 TAF.

Existing Off-Aqueduct Storage Facilities. San Luis Reservoir is the primary existing off-aqueduct storage facility serving the South-of-Delta SWP and CVP Service Areas. San Luis Reservoir carryover storage and reservoir releases were evaluated under the Preferred Program Alternative and the No Action Alternative.

With no additional storage, the Preferred Program Alternative modifies San Luis Reservoir carryover storage from -10 to 170 TAF for the long-term period, and from 10 to 140 TAF for dry and critical years above the No Action Alternative. If additional storage is implemented, the Preferred Program Alternative increases long-term carryover storage from 150 to 190 TAF and dry and critical carryover storage by 140-160 TAF

Figure 5.1-57. Average Annual Delta Deliveries under All Program Alternatives for the Long-Term Period

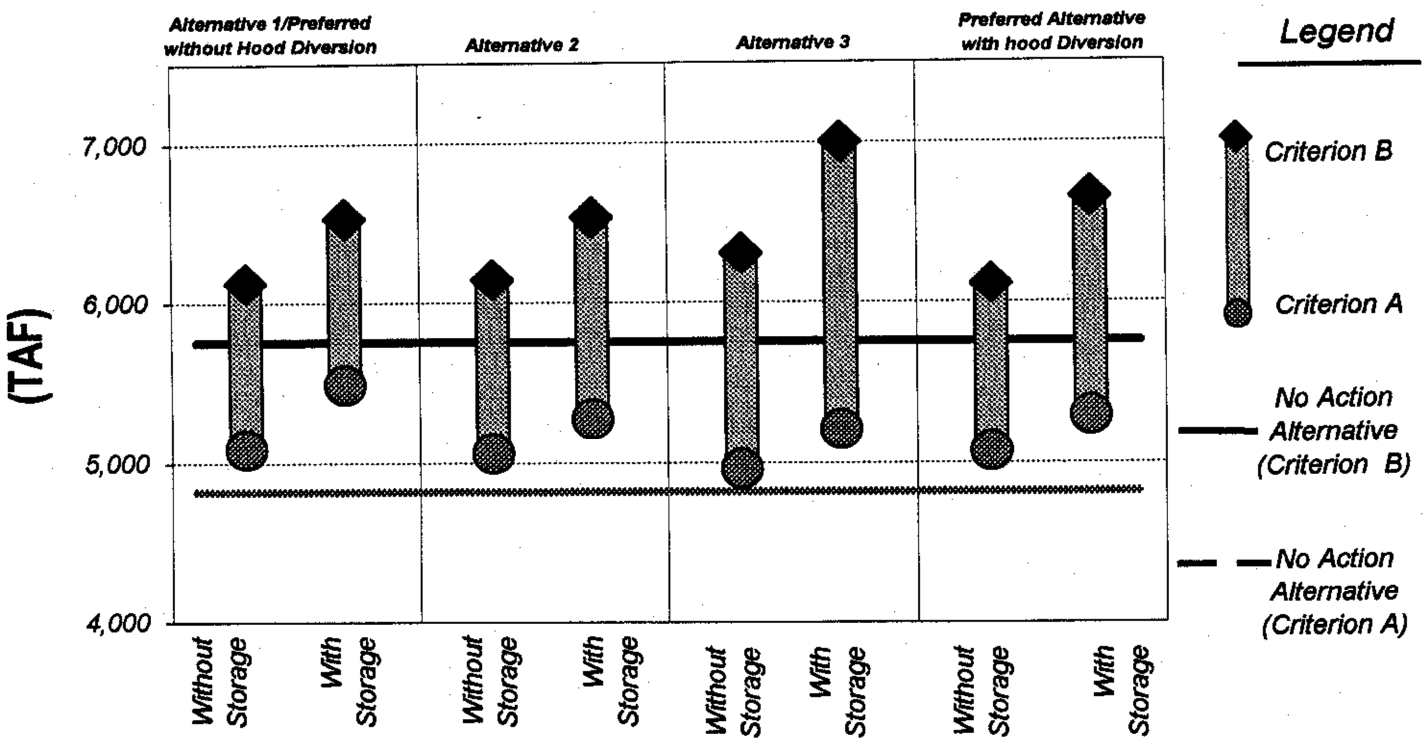


Figure 5.1-58. Average Annual Delta Deliveries under All Program Alternatives for Dry and Critical Years

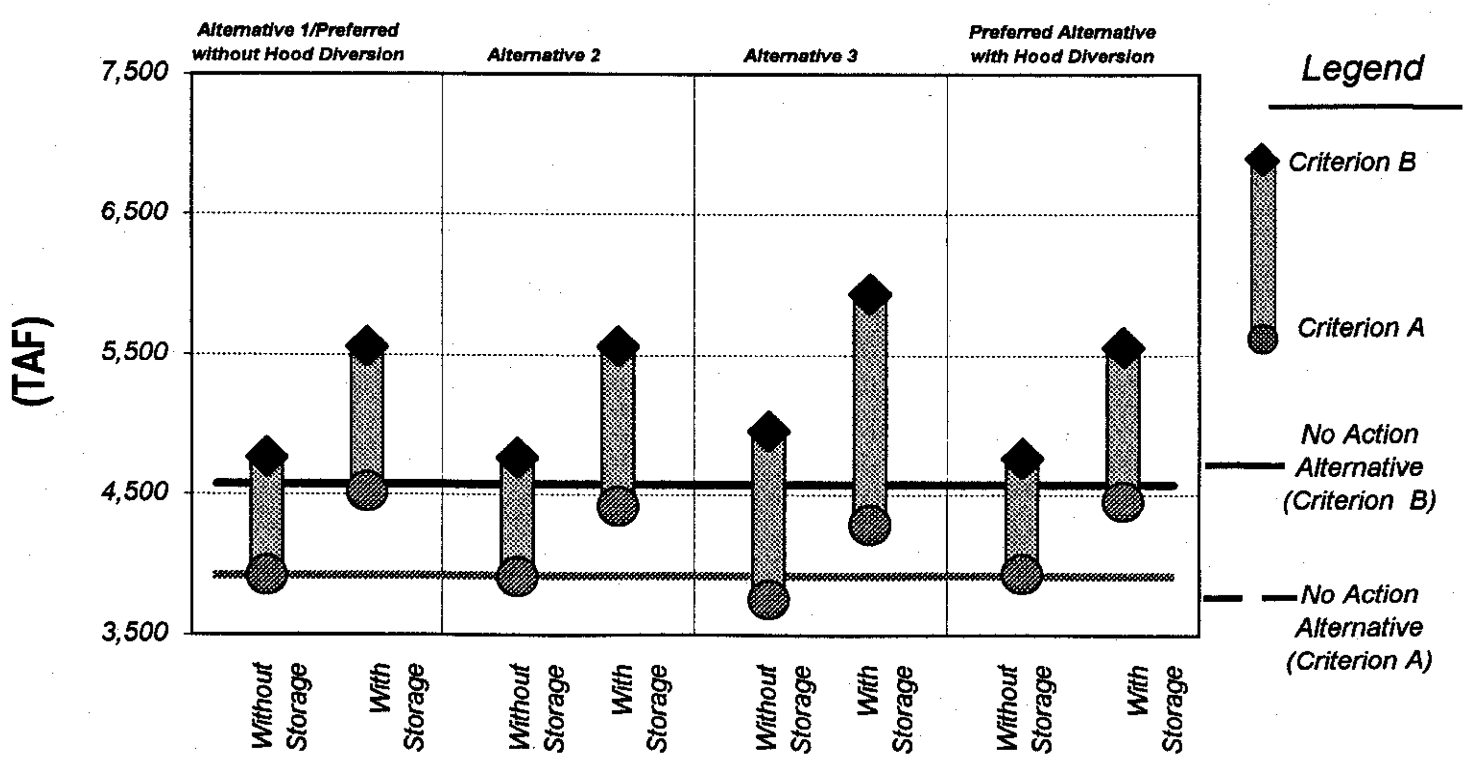


Table 5.1-15. Delta Deliveries under All Program Alternatives for the Long-Term Period (TAF)

DELTA DELIVERIES	NO ACTION ALTERNATIVE	ALTERNATIVE 1/PPA (Without Hood)	ALTERNATIVE 2	ALTERNATIVE 3	PPA (With Hood)
Total annual deliveries	4,820-5,750	5,090-6,540	5,060-6,540	4,960-7,000	5,070-6,660
Annual difference without storage	-	270-380	240-400	140-560	250-370
Annual difference with storage	-	670-790	450-790	380-1,250	470-910

Note:
PPA = Preferred Program Alternative.

Table 5.1-16. Delta Deliveries under All Program Alternatives for Dry and Critical Years (TAF)

DELTA DELIVERIES	NO ACTION ALTERNATIVE	ALTERNATIVE 1/PPA (Without Hood)	ALTERNATIVE 2	ALTERNATIVE 3	PPA (With Hood)
Total annual deliveries	3,920-4,570	3,920-5,560	3,910-5,560	3,750-5,940	3,940-5,560
Annual difference without storage	-	0-190	(-10)-190	(-170)-380	20-190
Annual difference with storage	-	600-990	500-990	370-1,370	530-990

Note:
PPA = Preferred Program Alternative.

above the No Action Alternative. Therefore, a long-term average carryover storage storage under the Preferred Program Alternative. The average carryover storage increase of approximately 20-130 TAF for dry and critical years is directly related to additional storage under the Preferred Program Alternative. Figures 5.1-59 presents carryover storage comparisons for existing off-aqueduct reservoirs the long-term period and dry and critical years.

The broadest range in monthly average storage releases from San Luis Reservoir generally occurs in summer months for both water management criteria under all hydrologic conditions. The largest long-term summer releases generally are associated with Criterion A water management in the absence of new storage facilities, while the lowest summer releases are associated with Criterion B water management in conjunction with additional storage capacity. The broadest range of long-term monthly average reservoir releases under the Preferred Program Alternative is approximately 200-380 TAF. Under the No Action Alternative, long-term peak average monthly summer releases range from 270 to 310 TAF. Winter releases are similar under the Preferred Program Alternative and the No Action Alternative.

Figure 5.1-59. Carryover Storage for Existing Off-Aqueduct Reservoirs under the Preferred Program Alternative for the Long-Term Period and Dry and Critical Years

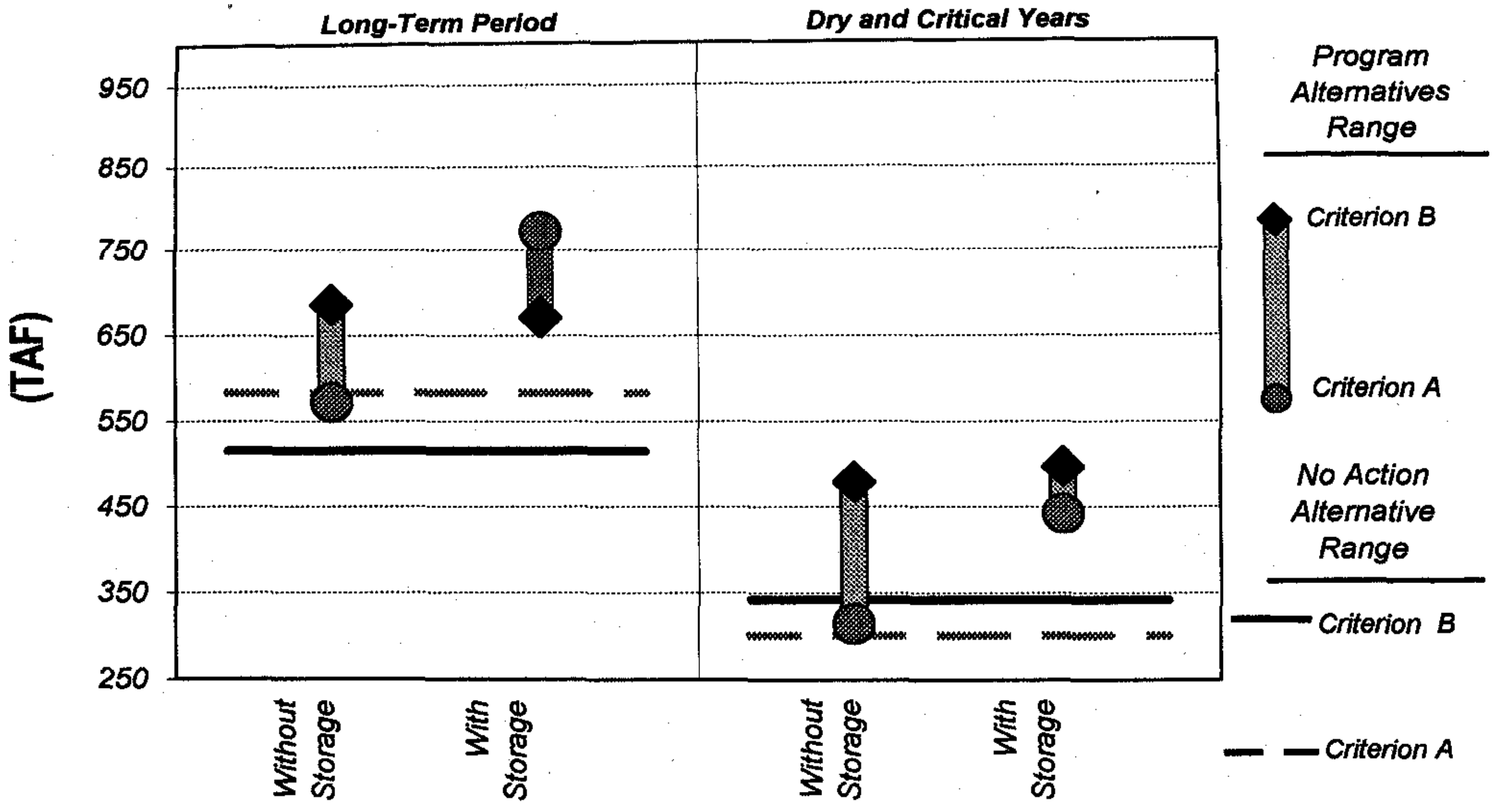
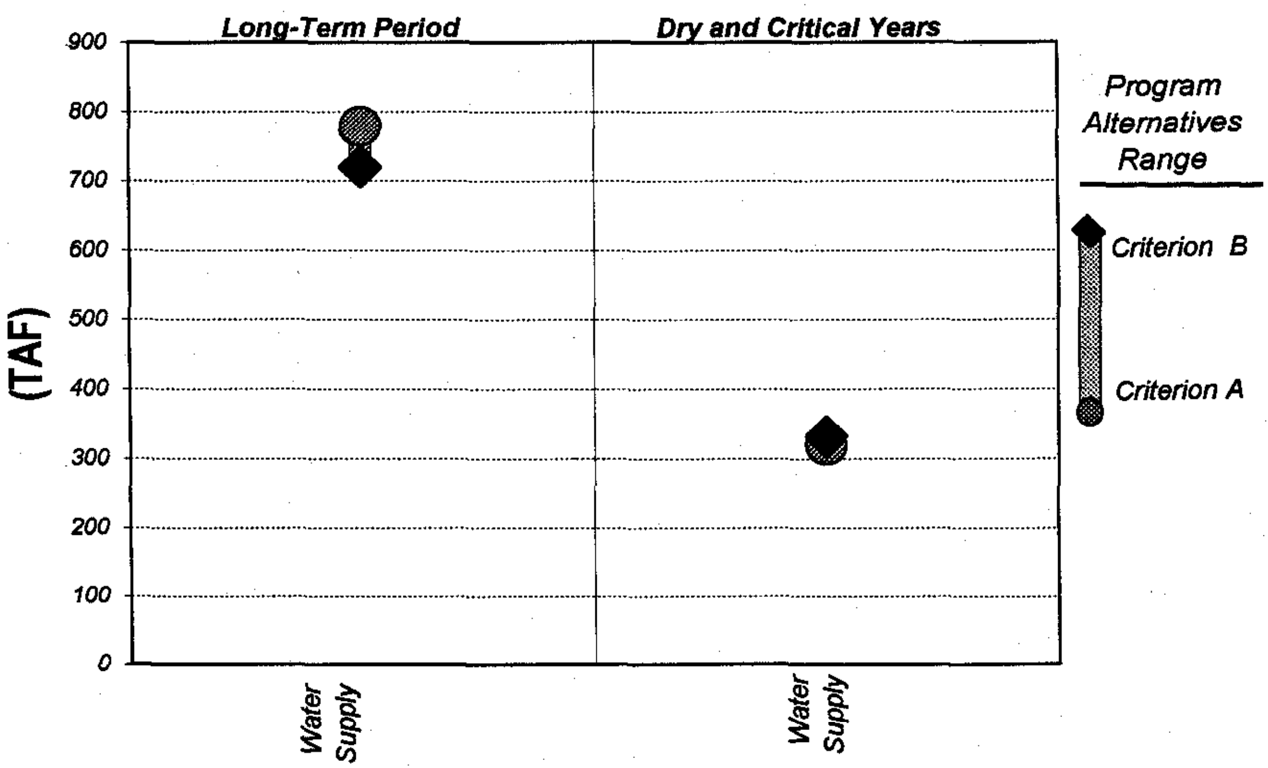


Figure 5.1-60. Carryover Storage for New Off-Aqueduct Reservoirs under the Preferred Program Alternative for the Long-Term Period and Dry and Critical Years



New Off-Aqueduct Storage Facilities. Carryover storage and releases associated with new off-aqueduct surface storage facilities were evaluated under the Preferred Program Alternative. Such facilities would serve the South-of-Delta SWP and CVP Service Areas similar to San Luis Reservoir.

Over the long-term period, carryover storage in new off-aqueduct surface storage facilities ranges from 720 to 780 TAF under the Preferred Program Alternative. For dry and critical years, carryover storage ranges from 320 to 330 TAF. Criterion A provides higher carryover storage in both wetter and drier water-years. Figure 5.1-60 presents carryover storage comparisons for the long-term period and dry and critical years.

Releases from new off-aqueduct surface storage facilities generally occur from spring to late summer under the Preferred Program Alternative. Peak releases typically occur in midsummer for all hydrologic conditions. The approximate peak releases are 160 TAF for the long-term period, and the peak releases range from 170 to 180 TAF for dry and critical years, respectively. In dry and critical years, monthly average releases tend to be similar under both water management criteria. Over the long-term period, Criterion A water management results in early spring peak releases while Criterion B results in late-spring peak releases. Reduced Delta exports associated with Criterion A create more reliance on off-aqueduct storage releases to meet spring demands.

Releases from new off-aqueduct surface storage facilities generally occur from spring to late summer in the South-of-Delta SWP and CVP Services Areas under the Preferred Program Alternative. Peak releases typically occur in midsummer for all hydrologic conditions.

New off-aqueduct groundwater storage facilities also were evaluated under the Preferred Program Alternative. These facilities are assumed to have a maximum capacity of 500 TAF with maximum inflow and discharge capacities of 500 cfs. Withdrawals from new groundwater storage facilities are made only in dry and critical years. The estimated average annual dry- and critical-year yield of these facilities ranges from 85 to 90 TAF. The long-term average was not calculated since the storage was operated for dry and critical year yield only.

5.1.9 PROGRAM ALTERNATIVES COMPARED TO EXISTING CONDITIONS

This section presents a comparison of the environmental consequences of the Program alternatives relative to existing conditions. The programmatic analysis found that the potentially beneficial and adverse impacts from implementing any of the Program alternatives when compared to existing conditions are within the same range of potentially beneficial and adverse impacts as those identified in Sections 5.1.7 and 5.1.8.

The programmatic analysis found that the potentially beneficial and adverse impacts from implementing any of the Program alternatives when compared to existing conditions are within the same range of potentially beneficial and adverse impacts as those identified in Sections 5.1.7 and 5.1.8.

As discussed in Section 5.1.4, in order to make programmatic comparisons between the No Action Alternative and Program alternatives, existing conditions were simulated based on an extensive set of modeling assumptions. The No Action Alternative was defined to represent a reasonable range of uncertainty in the pre-implementation condition. This range of uncertainty was quantified for purposes of this programmatic document by formulating two distinct bookend water management criteria assumptions sets. These two sets of assumptions (Criteria A and B) serve as boundaries for a range of possible Delta inflow, export, and outflow patterns in the No Action Alternative programmatic analysis. The primary assumptions that differentiate the No Action Alternative bookends from each other (and from existing conditions) are Bay-Delta system water demands and various Delta water management criteria that regulate system operations.

A comparison of elements of the Program alternatives to existing conditions indicates that:

- All potentially significant adverse impacts that were identified when compared to the No Action Alternative also are considered potentially significant when compared to existing conditions. These impacts include potential temporary local water supply interruptions due to turbidity of water during construction of Program facilities and habitat restoration activities.

- No additional potentially significant environmental consequences have been identified when Program effects are compared to existing conditions as opposed to the No Action Alternative.

- The beneficial effects on water supply availability and reliability also are considered beneficial when compared to existing conditions.

5.1.10 ADDITIONAL IMPACT ANALYSIS

Cumulative Impacts. The incremental impact of the Preferred Program Alternative, when added to other past, present, and reasonably foreseeable future actions, could result in cumulative impacts on water supply and water management resources. Refer to Chapter 3 for a summary of cumulative impacts for all resource categories. Refer to Attachment A for a list and descriptions of projects and programs considered in this cumulative impact analysis.

Projects and actions that are included in the analysis of existing conditions and the No Action Alternative were described earlier, along with a discussion of impacts of the No Action Alternative compared to the existing conditions. Related past, present, and probable future projects and actions have been evaluated for their potential to contribute to cumulative effects. The cumulative impacts of all of these projects combined with the Preferred Program Alternative are listed below.

Projects and actions that are included in the analysis of existing conditions and the No Action Alternative were described earlier, along with a discussion of impacts of the No Action Alternative compared to the existing conditions.

The following projects would result in negligible or beneficial effects on water supply and water management in the Bay-Delta system: American River Watershed Project, CCWD Multi-Purpose Pipeline Project, Hamilton City Pumping Plant Fish Screen Improvement Project, Montezuma Wetlands Project, Sacramento River Flood Control System Evaluation, West Delta Watershed Program, and the Sacramento River Conservation Area Program. The Trinity River Restoration Project, ISDP, and urbanization would cause water supply effects. These effects were evaluated in Sections 5.1.7 and 5.1.8.

Consequently, these projects would not contribute to cumulative impacts on water supply and water management and are not considered further in this analysis.

The following projects could lead to or involve increased storage and diversion of water for consumptive use: American River Water Resource Investigation, the CVPIA's AFRP and other CVPIA actions not yet fully implemented, Delta Wetlands Project, Pardee Reservoir Enlargement Project, Red Bluff Diversion Dam Fish Passage Program, Sacramento Water Forum process, Supplemental Water Supply Project, Sacramento County municipal and industrial water supply contracts, and Program actions. These projects could reduce the availability of water supplies or water management options and cause cumulative impacts.

Mitigation strategies have been identified that would reduce the impacts associated with Program actions and the projects included in Attachment A. These mitigation strategies would involve project operation and coordination to minimize adverse effects on water supply. Effects on water supplies will be addressed during project authorization or establishment of water rights. Nevertheless, the cumulative effects related to water supply and water management are considered potentially significant.

Mitigation strategies have been identified that would reduce the impacts associated with Program actions and the projects included in Attachment A. Nevertheless, the cumulative effects related to water supply and water management are considered potentially significant.

Growth-Inducing Impacts. The Preferred Program Alternative is expected to result in more water available for beneficial use in the Bay Region, Sacramento River and San Joaquin River Regions, and South-of-Delta SWP and CVP Service Areas. The amount of water supply increase made possible by the Program is small relative to the amount of water used in these affected regions. The Water Use Efficiency Program will increase water supply reliability by more efficient use and reuse of existing water supplies. The Water Transfer Program may increase some water supplies by better enabling water to be transferred between regions. Through water quality improvements, the Water Quality Program may reduce demands for certain beneficial uses, thereby increasing available water supply. Improvements from the Conveyance element may allow more water to be exported from the Delta while meeting in-Delta needs. Any storage of water under the Storage element may be used for additional water supply.

For this programmatic analysis, it is assumed that any increase in water supply is growth inducing. Many factors must be considered in future project-specific analyses of growth-inducing effects. Some of these require that the specific location and use of the water supply be known so that land use plans can be reviewed and the potential for new growth be determined. In other cases, knowledge of whether other water supplies are available to the end water user is needed. In some cases, new supplies are sought to improve water quality or reduce groundwater overdraft, for example, and not to service new population or agricultural growth.

For this programmatic analysis, it is assumed that any increase in water supply is growth inducing.

If additional water was used to expand agricultural production or urban housing development, the proposed action would foster economic and population growth. Expansion of agricultural production and population could cause adverse environmental impacts on many resources as described in the "Growth-Inducing Impacts" sections for the resource categories presented in this document. A summary of these effects is presented in Chapter 3.

Short- and Long-Term Relationships. The Preferred Program Alternative generally would maintain and enhance long-term productivity of water supply resources. However, the Preferred Program Alternative may also cause adverse impacts on water supply resources resulting from short-term uses of the environment.

Significant overall benefits to the long-term productivity of water supply resources result from Program actions. Benefits resulting from increased water use efficiency, improved water transfer processes, better water quality, improved Delta water conveyance and additional water storage opportunities outweigh the short-term adverse impacts.

Benefits resulting from increased water use efficiency, improved water transfer processes, better water quality, improved Delta water conveyance and additional water storage opportunities outweigh the short-term adverse impacts.

Construction of water facilities may result in local construction-, operation-, and maintenance-induced impacts on the environment like temporary increase of water use due to workers and their families living in the area. Specific local construction-related impacts depend on the specific project and would be addressed at project-level analysis.

Short-term construction-related impacts on water supply resources would be localized and cease after construction is completed. Where possible, avoidance and mitigation measures would be implemented as a standard course of action to lessen impacts on these resources. Potentially significant long-term unavoidable impacts are discussed below.

Irreversible and Irretrievable Commitments. The Water Use Efficiency, Water Transfer, Water Quality, Storage, Conveyance, and other Program elements of the Preferred Program Alternative can be considered to cause significant irreversible changes to water supply resources. Avoidance and mitigation measures could be implemented to lessen adverse effects, but changes will be experienced by future generations. The long-term beneficial irreversible changes include the beneficial effects of improved water supplies to urban and agricultural sectors. Long-term adverse irreversible changes include potential displacement of water supplies from regions or uses to other areas or uses.

5.1.11 MITIGATION STRATEGIES

Potential decreases in agricultural and urban water supplies from Bay-Delta sources could result from increased environmental water needs and drinking water quality requirements under the No Action Alternative. These potential consequences may be reduced or eliminated by several strategies included in the Preferred Program Alternative. Implementation of an EWA may allow for more efficient use of water for environmental purposes and decrease the conflict in uses of Bay-Delta water supplies. Optimizing the use of alternative water management tools, including water use efficiency measures, water recycling, and water transfers may improve the availability and economic utility of water supplies. Implementing water quality improvement actions may enhance the quality of source water supplies, thereby providing additional operational flexibility to meet water supply reliability and quality goals. Conveyance improvements may also increase the flexibility of water project operations and improve water supply reliability. Finally, completing an Integrated Storage Investigation will help determine the proper role of storage in the context of a comprehensive water management framework. If shown to be

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appropriate, new storage could provide improved water management capability and enhanced water supply reliability.

Potential long-term adverse effects on specific regional agricultural and urban water supplies could result from increased water transfers. Areas with adequate water supplies could transfer portions of those supplies to areas with higher economic return from the use of water. Water transfers can affect third parties (those not directly involved in the transaction), local groundwater, environmental conditions, or other resource areas. The Preferred Program Alternative includes mechanisms to provide protection from such impacts. Additional discussion on the potential impacts of water transfers on groundwater resources, agricultural social issues, and regional economics is included in Sections 5.4, 7.3, and 7.10, respectively.

Conversion of Delta land use from agriculture to wetlands and marshes under the Ecosystem Restoration Program could result in increased water use and potential negative impacts on agricultural and urban water supply reliability. The cumulative beneficial effect of all actions under the Preferred Program Alternative, including the Water Quality Program, Water Use Efficiency Program, Water Transfer Program, conveyance improvements, and potential new water storage facilities, is expected to significantly outweigh this potential loss of water supply, resulting in no significant adverse impacts.

Temporary local impacts on water supply reliability could occur during construction of the Program's proposed facilities. Potential temporary interruptions in water supply due to turbidity of water during levee work could negatively impact water supply and water management. This impact can be mitigated to a less-than-significant level.

Additional mitigation strategies will be considered during project planning and development. Specific mitigation measures will be adopted, consistent with the Program goals and objectives and the purposes of site-specific projects. Not all mitigation strategies will be applicable to all projects because site-specific projects will vary in purpose, location, and timing.

5.1.12 POTENTIALLY SIGNIFICANT UNAVOIDABLE IMPACTS

Despite the many effects on water supply caused by the Preferred Program Alternative, no potentially significant unavoidable impacts are expected.

Despite the many effects on water supply caused by the Preferred Program Alternative, no potentially significant unavoidable impacts are expected.

5.2 Bay-Delta Hydrodynamics and Riverine Hydraulics

The CALFED Bay-Delta Program alternatives could result in changes to Delta inflow and export patterns, and modifications to the configuration of Delta channels. Environmental implications of changes in Bay-Delta hydrodynamics and riverine hydraulics are discussed in other sections of this report in the context of each of the resources affected by the changes.