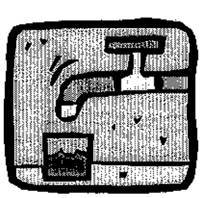
5.3 Water Quality

The CALFED Bay-Delta Program is expected to produce continuous overall improvements over the term of the Program to ensure that good-quality water is provided to serve all beneficial uses dependent on the water resources of the Bay-Delta system and its tributary watersheds.



5.3 Water Quality

5.3.1 SUMMARY

The Delta and its tributaries are key surface water sources of drinking water for the majority of Californians. These water resources also replenish reservoirs and groundwater basins that are relied on to maintain the continuity of water supplies throughout most of the state. The continued availability of good-quality water supplies from these sources is crucial to the maintenance of agriculture and other important water-dependent industries. The Sacramento-San Joaquin Delta and Bay (Bay-Delta) is the ecological hub of the Central Valley, and provides critical habitat for diverse fish and wildlife populations. Although individual criteria for beneficial uses vary, these beneficial uses require sustainable high-quality water for their maintenance and improvement. To be utilized effectively, source water supplies for municipal and industrial uses should be free of potentially harmful concentrations of contaminants that are infeasible, or unreasonably expensive, to remove. Population growth and future industrial development may increase waste loads to the Bay-Delta, which in turn would increase the burden on water resources, infrastructure, and drinking water treatment capabilities. Improved and increased measures will be needed to prevent or to reverse the potentially adverse effects of increased waste loads. Left unchecked, these pressures would lead to serious water quality degradation—potentially resulting in losses of agricultural, industrial, and biological productivity; increases in water treatment costs and associated secondary impacts; and increased risks to public health and welfare.

Preferred Program Alternative. The Water Quality and Watershed Programs would improve overall water quality by reducing the loadings of many constituents of concern that enter Delta tributaries from point and nonpoint sources. Actions under these program elements would reduce adverse concentrations of key contaminants contained in receiving waters, especially the Bay-Delta system. Principal targeted constituents include heavy metals, pesticide residues, salts, selenium, pathogens, suspended sediments, adverse temperatures, and disinfection byproduct precursors (DBPs) such as bromide and total organic carbon (TOC). Conversion of Delta islands from agriculture to wetlands could increase TOC loadings to the Delta channels, potentially contributing to the formation of DPBs in water treatment processes.

The Water Quality and Watershed Programs would improve overall water quality by reducing the loadings of many constituents of concern that enter Delta tributaries from point and nonpoint sources.

The Water Use Efficiency Program could result in beneficial and adverse effects, depending on conditions. For example, program actions such as conservation would reduce diversions from channels and reduce loads of contaminants returned to the channels, resulting in general water quality benefits. However, some actions could result in increased releases of contaminants and produce localized increases in concentrations that in most cases would be limited to the mixing zone around the discharge. The Water Use Efficiency Program is focusing on achieving multiple benefits related to water quantity, quality, and timing; therefore, the adverse impacts from this program are expected to be minimal.

Improvements to the Delta levee system under the Levee System Integrity Program would greatly reduce the risk of rapid sea-water intrusion contaminating the Delta and disrupting water supplies following major levee failures, particularly seismically induced failures. All program actions (particularly channel dredging and construction of new levees and setback levees) could produce short-term adverse impacts during construction activities. Dredging may expose mercury-laden sediments, which could contribute to increased mercury availability to aquatic organisms and increased mercury concentrations in sediment; dredging also may mobilize other toxic elements. However, potentially significant impacts can be mitigated to less-than-significant levels.

Based on ranges of results obtained from model runs, the Preferred Program Alternative generally would improve in-Delta and export water quality, and dependent beneficial uses because of increased inflows of higher quality water from Sacramento River and the north Delta, and improved circulation in Delta channels. Electrical conductivity (EC, an index of salinity) would be reduced in the northeast Delta, central Delta, south Delta, and southwest Delta, and on the San Joaquin River in the west Delta. These improvements generally would occur from November through March of average, dry, and critical years, and in September of dry and critical years. Similar improvements in EC would occur at the CVP and SWP intakes, and at both of the Contra Costa Water District (CCWD) diversions from Old River. EC would increase at some times in the Lower Sacramento River.

The Preferred Program Alternative should result in increased cross-Delta flows, improved circulation, and resultant increases in dispersion and dilution of ocean salt. Given that sea-water intrusion is the major source of bromide in the Delta, bromide concentrations should decrease along Old and Middle Rivers, which would benefit the primary diversion and export facilities. This would depend on Delta Cross Channel (DCC) gate operation in coordination with the Hood to Mokelumne River channel operations.

Additional upstream storage will increase flexibility to provide additional fresh-water releases and Delta inflows that will improve water quality.

Although the effects of additional upstream storage may differ depending on its location and operations, additional upstream storage generally would increase the flexibility to provide for additional fresh-water releases and Delta inflows that will improve Delta water quality. These benefits would be most apparent in dry months and seasons when additional water would be needed to meet consumptive and environmental demands. Upstream storage releases also could benefit export water quality during dry years. Additional off-aqueduct south-of-Delta storage could relieve export pressures in the south Delta, thereby avoiding some of the potential for pumping-induced water quality degradation. Storage- and nonstorage-dependent operational changes being considered by the Program could significantly extend or magnify the ranges of water quality effects of the Preferred Program Alternative, depending on existing and antecedent hydrologic conditions. Releases from storage also could augment Delta outflows when needed to control sea-water intrusion and optimize estuarine conditions for the ecosystem and dependent fish species (as indicated by the position of the X2 [isohaline] index compared to standards). X2 refers to the mean tidal distance of the 2,000 milligrams per liter (mg/L) isohaline (a line of equal salinity) upstream from the Golden Gate Bridge. (Note that although this standard is based on temporal variations in salinity, it is used to regulate flow; therefore the topic is covered in Section 5.2, "Bay-Delta Hydrodynamics and Riverine Hydraulics".

Construction of Delta facilities could result in potentially significant impacts on water quality that are associated with earth moving and dredging. Impacts would consist primarily of increased sediment loads caused by erosion and sediment disturbance. Releases of nutrients, natural organic matter, and toxicants into the water column could increase to various degrees, depending on the types of construction methods, materials, and mitigation strategies used. Disturbances to previously farmed soils could release residual agricultural pesticides, including organochlorinated pesticides, mercury, nutrients, and other chemicals that may adversely affect water quality. Most of these impacts would be relatively short term in duration. In general, potentially significant impacts that are associated with construction of Delta facilities can be mitigated to less-than-significant levels.

Alternatives 1, 2, and 3. Under Alternatives 1, 2, and 3, the water quality impacts of Program elements other than Conveyance would be similar to those described for the Preferred Program Alternative. In terms of the impacts of Conveyance on in-Delta and export water quality, Alternative 1 would cause water quality conditions in the Delta and export service areas to worsen. Alternative 2 generally would improve water quality compared to the No Action Alternative in the central Delta and at the export facilities. Alternative 3, compared to the No Action Alternative, would result in significant decreases in average salinities and bromides in the south Delta, along Old River, and at the two CCWD intakes, during all or most months of most years. Alternative 3 also would result in greatly improved export water quality at Clifton Court Forebay (CCFB) (and at the Delta-Mendota Canal [DMC] intake if an intertie is constructed), and in the SWP and CVP service areas to the south and west—particularly for the following parameters: EC, total dissolved solids (TDS), bromide, chloride, and dissolved organic carbon (DOC). Salinities are projected to increase compared to the No Action Alternative in the northeast Delta, the central Delta, and in the south Delta along Middle River.

Under Alternatives 1, 2, and 3, the water quality impacts of Program elements other than Conveyance would be similar to those described for the Preferred Program Alternative.

The following table presents the potentially significant adverse impacts associated with the Preferred Program Alternative. Mitigation strategies that correlate to each listed impact are noted in parentheses after the impact.

5.3.2 AREAS OF CONTROVERSY

Under CEQA, areas of controversy involve factors that are currently unknown or reflect differing opinions among technical experts. Unknown information includes data that are

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

Potentially Significant Adverse Impacts

Potential releases of inorganic and organic suspended solids into the water column during construction, dredging, or drainage of flooded lands (7,8,9).

Potential releases of toxic substances, such as pesticide, selenium, and heavy metal residues, into the water column during construction and dredging (7,8,9).

Potential net increases in salinity, if evaporation increases after irrigated croplands are converted to wetlands (2,3,13).

Although the Preferred Program Alternative would improve water quality at many locations in the Delta, it would cause water quality to deteriorate in local areas. Increased total dissolved solids (TDS) content of water in certain Delta channels would result in a potentially significant unavoidable impact on the local suitability of the water as a source for agricultural irrigation.

The Preferred Program Alternative would allow an increase in the total amount of water that could be diverted from the south Delta, with a concomitant reduction in the total volume of fresh water outflow from the Delta to San Francisco Bay. Consequently, the average salinity of Bay waters could increase very slightly, and South Bay flushing could be slightly reduced during high outflow periods.

Potential growth induced by the Preferred Program Alternative would result in an increase in discharge of point and nonpoint source pollutants to water bodies, with a consequent adverse effect on in-stream water quality. Nonpoint sources largely are unregulated, and mitigation depends on local voluntary efforts. The potentially significant impacts related to the increased discharge of nonpoint source pollutants from growth induced by the Preferred Program Alternative are likely to be unavoidable.

Potential increases of TOC in river water caused by the increased contact between flowing or ponded water and vegetation or peat soils that would result from conversion of agricultural lands to wetlands (4,5,10,11,12).

Increased water temperatures and resultant decreased dissolved oxygen concentrations due to the increased residence time of water in channels that are widened or restored to meandering patterns (13).

Potential decreases in in-stream water quality if water use efficiency measures or water transfers reduce diluting flows (1).

Potential increases in concentrations of constituents of concern if water transfers reduce in-stream flows and deplete river assimilative capacities (2,3,6).

Mitigation Strategies

1. Improving treatment levels provided at municipal wastewater treatment plants to upgrade the quality of the constituents of concern (other than dissolved inorganic solids) discharged to receiving waters in order to compensate for the reduction in dilution caused by improved water use efficiency or water transfers.

2. Releasing additional water from enlarged or additional off-stream surface storage, or from additional groundwater storage.

3. Releasing additional water from storage in existing reservoirs or groundwater basins.

4. Improving water treatment facilities, either at the point of consumption or at the source, to remove TOC.

5. Using innovative, cost-effective disinfection processes (for example, ultra-filtration, UV irradiation, and ozonation—in combination with other agents) that form fewer or less harmful DBPs.

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

6. Using existing river channels for water transfers and timing the transfers to avoid adverse water quality impacts.

7. Using best construction and drainage management practices to avoid transport of soils and sediments into waterways.

8. Using cofferdams to construct levees and channel modifications in isolation from existing waterways.

9. Using sediment curtains to contain turbidity plumes during dredging.

10. Separating water supply intakes from discharges of agricultural and urban runoff.

11. Applying agricultural and urban BMPs, and treating drainage from lands with concentrations of potentially harmful constituents to reduce contaminants. Treating drainage from agricultural lands underlain by peat soils to remove TOC.

12. Relocating diversion intakes to locations with better source water quality.

13. Restoring additional riparian vegetation to increase shading of channels.

Bold indicates a potentially significant unavoidable impact.

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 areas of controversy for this resource category. Given the programmatic nature of this document, many of these areas of controversy cannot be addressed; however, subsequent project-specific environmental analysis will evaluate these topics in more detail.

Total Organic Carbon Drinking Water Concerns. Water Quality Program actions are aimed at controlling organic carbon, a precursor to DBPs. Treatment of Delta island drainage is being studied as a potential means of reducing organic carbon loading. Source control may offer more cost-effective means than downstream treatment to meet regulatory requirements. Controversy exists concerning the contribution of natural or developed wetlands to TOC concentrations found in Delta waters at drinking water intakes. The proposed restoration of wetlands through the Ecosystem Restoration Program may increase the total amount of TOC and DOC at drinking water intakes, increasing the potential to form DBPs. This controversy is likely to exist until further studies determine the extent that restored wetlands may influence Delta drinking water quality and what levels of DBPs are considered safe.

Water Quality Program actions are aimed at controlling organic carbon, a precursor to DBPs.

Pathogens. The drinking water objective of the Water Quality Program is to sufficiently improve source water quality to allow production of drinking water that is safe, meets anticipated regulatory standards, and is acceptable to the consumers. Of primary importance is the reduction and maintenance of pathogen loadings in source waters to required levels. Based on limited data, levels for pathogens in routine sampling of Delta water appear to be lower than the national averages. However, the limited data, along

Based on limited data, levels for pathogens in routine sampling of Delta water appear to be lower than the national averages.

with significant technical limitations in measuring techniques, do not enable a reliable impact analysis to be performed at this time. Utilities using Delta water sources primarily disinfect with chlorine, which is effective for total coliform, viruses, and *Giardia lamblia*, at reasonably feasible concentrations and contact times. However, chorine is not able to inactivate some microorganisms, such as *Cryptosporidium parvum*, which may be present in source waters and may be regulated in the near future. An increasing number of utilities are using ozone or a combination of disinfectants that more effectively inactivates most pathogenic microorganisms, including *Cryptosporidium parvum*. Utilities are anticipating stricter requirements from the EPA for the control of pathogenic microorganisms. Since the Delta is a relatively unprotected and unknown source of pathogens, and treatment technology continues to be advanced, controversy exists on whether taking water from the Delta constitutes adequate source water protection.

Bromide. The Revised Phase II Report Appendix identifies bromide as a critical constituent concerning selection of the Preferred Program Alternative. Bromide is critical because the selection of storage and conveyance options can profoundly affect bromide concentrations in municipal water supplies diverted from the Delta. It is believed that the primary source of bromide in Delta waters is sea-water intrusion. Other possible sources of bromide have been hypothesized, as follows:

Bromide is critical because the selection of storage and conveyance options can profoundly affect bromide concentrations in municipal water supplies diverted from the Delta.

- Bromide loading in the San Joaquin River from agricultural application of the fumigant, methyl bromide.
- Bromide leached from the geological strata in the watershed of the San Luis Reservoir.
- Connate groundwater sources (sources of ancient sea-water origin) of bromide in or around Empire Tract in the Delta.

The limited available data suggest that none of these sources is a highly significant source of bromide when compared to sea water.

Although the following issue does not meet the CEQA criteria as an area of controversy, the subject is one of concern to CALFED agencies.

Good Samaritan Protection. Water Quality Program actions include remedial activities to clean up abandoned mine sites in order to reduce metals that enter water bodies. A step-wide approach would be conducted, leading to implementation of what are expected to be the cost effective remediation strategies. An agency or entity performing a clean-up of an abandoned mine, however, may be subject to liability for its efforts. A major concern, for example, is liability under the Clean Water Act. Some CALFED implementing agencies are unlikely to undertake abandoned mine remediation due to the risk of liability under the present law. Some people recommend that federal law provides additional "Good Samaritan" protections to reduce the liability risk and thus encourage mine remediation. Others object to such provisions, arguing that current law better balances the goals of encouraging clean-ups and avoiding unwarranted litigation with other goals, such as providing incentives to ensure that clean-ups are completed with proper care and providing citizens with appropriate relief if they are harmed.

Water Quality Program actions include remedial activities to clean up abandoned mine sites in order to reduce metals that enter water bodies.

5.3.3 AFFECTED ENVIRONMENT/ EXISTING CONDITIONS

5.3.3.1 DELTA REGION

Activities and Sources That Affect Water Quality in the Delta

Hydraulic and hard-rock mining for gold in the late 1800s produced the first significant impacts on water quality in the Delta. Mercury, mined in the Coast Ranges, was used to separate gold in the Sierra Foothills. Hydraulic mining created large amounts of sediment that contained high levels of heavy metals (cadmium, copper, zinc, and mercury). This sediment was washed from the hillsides, carried downstream, and deposited in river beds, Delta tidal marshes, and mudflats. These metals still are considered contaminants of concern because of their continuing potential to adversely affect beneficial uses in the Delta. Sampling in the Sacramento River from 1987 to 1992 indicates that about 75% of the mass of these metals found in sediments can be traced to past mining activities.

Hydraulic mining created large amounts of sediment containing high levels of heavy metals (cadmium, copper, zinc, and mercury).

The growth of agriculture, enabled by the diversion of irrigation water from the rivers and Delta during this century, also has led to water quality concerns. The application of fertilizers and pesticides on 500,000 acres of farmland in the Delta and another 4.5 million acres in the San Joaquin and Sacramento Valleys has adversely affected the beneficial uses of water for drinking, fishery resources, recreation, and agricultural uses.

Water quality in the San Joaquin River and the south Delta has been affected by salts and natural deposits of selenium-rich soils. Salts and selenium that are concentrated in shallow groundwater on the west side of the San Joaquin Valley are mobilized when subsurface water must be pumped to drain agricultural lands. The San Joaquin Valley Drainage Program (1990) includes plans to curtail discharges of drain water to the river, reduce the amount of applied irrigation, and retire some irrigated lands.

Salts and selenium are mobilized when subsurface water must be pumped to drain agricultural lands.

Compared to historical conditions, Delta salinity during low-flow periods is much lower since the construction of dams, which allow storage and fresh-water releases during dry and critical periods. Sea-water intrusion into the Delta can be intensified by diversion of fresh water and the corresponding decrease of fresh-water outflow from the Delta. As a result, the west Delta often experiences increased salinity during summer and fall, although to a substantially lessened extent since construction of the upstream dams. High salinity adversely affects the quality of drinking and irrigation water.

More recently, urban development and population growth in and around the Delta have contributed to adverse impacts on water quality, and simultaneously have increased demand for better water quality. Disinfection to treat water for domestic consumption may produce DBPs, some of which are suspected to be carcinogenic in humans.

Water quality in the Delta also is affected by various point and nonpoint pollutant sources—some of which are located in the Delta, most of which occur in the Sacramento and San Joaquin Valleys.

Industrial and municipal wastewater treatment plant discharges are strictly regulated to minimize adverse impacts on water quality; however, much of the runoff from urban and agricultural areas is unregulated and more difficult to control. Runoff, containing oil, grease, metals, pesticides, fertilizers, and many other pollutants, contributes to the pollution of Delta and Bay waters.

Much of the runoff from urban and agricultural areas is unregulated and more difficult to control.

Recreational uses also have contributed to deterioration of the water quality in the Bay-Delta. Key contaminants associated with recreational uses are pathogens caused by human and animal detritus; and oil, grease, fuel, and fuel additive discharges from recreational vehicles.

The principal sources of pollutants to the Delta include:

- Drainage from inactive and abandoned mines that contribute metals, such as cadmium, copper, zinc, and mercury.
- Stormwater inflows and urban runoff that contribute metals, sediment, pathogens, organic carbon, nutrients, pesticides, dissolved solids (salts), petroleum products, and other chemical residues.
- Municipal and industrial wastewater discharges that can contribute salts, metals, trace elements, nutrients, pathogens, pesticides, organic carbon, oil and grease, and turbidity.
- Surface agricultural irrigation return flows and nonpoint discharges that can contribute salts (including bromide), organic carbon, nutrients, pesticides, pathogens, and sediment.
- Subsurface agricultural drainage that can contribute salts (including bromide), selenium, nutrients, and some agricultural chemical residues.
- Water-based recreational activities (such as boating) that can contribute hydrocarbon compounds, nutrients, turbidity, and pathogens.
- Atmospheric deposition that can contribute metals, pesticides, and other synthetic organic chemicals, and may lower pH.
- Sea-water intrusion that can contribute salts, including bromide.

In addition to these sources, natural processes, such as high flows, and anthropogenic activities, such as dredging, can mobilize constituents that originate from these sources.

Beneficial Uses, Water Quality Objectives, and Pollutants of Concern

Specific beneficial uses and water quality objectives for the Bay-Delta waters have been identified by the San Francisco Bay and Central Valley Regional Water Quality Control Boards. Similar lists of beneficial uses have been developed for surface water in other regions.

Drinking water standards are designed to protect human health and to maintain the aesthetic qualities of appearance, taste and odor, and color. Water quality objectives to protect environmental beneficial uses are often more stringent than drinking water standards. One of the most important distinctions between drinking water standards and environmental water quality objectives may be the point at which they apply. Environmental water quality objectives typically are applied to discharges and to receiving waters. For drinking water, some standards are designed to apply at the drinking water source, some at the treatment plants, and some at the customer's tap.

Water quality objectives to protect environmental beneficial uses are often more stringent than drinking water standards.

Water treatment requires disinfection to kill pathogens and to guard against contamination in the supply system. However, disinfection of water containing TOC and bromide can result in the formation of DBPs, which are believed to cause cancer. As a result, TOC and bromide are undesirable in drinking water supplies. Some of the water quality parameters that are very important for agriculture or industry (for example, temperature, boron, and sodium adsorption ratio) are less important for drinking water.

Recreational beneficial uses include in-stream uses. Water quality standards may be designed to reduce the hazards that are associated with contacting contaminated water, to prevent bioconcentration of contaminants in fish and wildlife, or to prevent degradation of such qualities as water clarity.

Under Section 303(d), the Clean Water Act requires regulatory agencies to periodically evaluate the extent to which water bodies are supporting these beneficial uses, based on an evaluation of exceedances of water quality objectives. The result is a list of impaired water bodies and the constituents and sources that may be causing that impairment. A Section 303(d) list was compiled for the Program in the Water Quality Program Plan Appendix. Based on this and other sources of information, the stakeholders and CALFED staff developed the list of parameters of concern shown in Table 5.3-1.

Factors That Affect Variability of Water Quality in the Delta

Water quality in the Delta is continually changing over time and space in response to natural hydrologic conditions, operation of upstream reservoirs, agricultural and water supply diversions, and discharges into the system. Seasonal trends reflect the effects of higher spring/summer runoff and fall/winter low-flow periods. Yearly changes in water quality are associated with different water-year types, as defined in the SWRCB's D-1485.

Table 5.3-1. Water Quality Parameters of Concern to Beneficial Uses

METALS AND TOXIC ELEMENTS	ORGANICS/ PESTICIDES	DISINFECTION BY-PRODUCT PRECURSORS	OTHER
Cadmium	Carbofuran	Bromide	Ammonia
Copper	Chlordane[a]	Total Organic Carbon	Dissolved oxygen
Mercury	Chlorpyrifos		Salinity (TDS, EC)
Selenium	DDT[a]		Temperature
Zinc	Diazinon		Turbidity
	PCBs[a]		Toxicity of unknown origin[b]
	Toxaphene[a]		Pathogens
			Nutrients[c]
			pH (Alkalinity)
			Chloride
			Boron
			Sodium adsorption ratio

Notes:
EC = Electrical conductivity.
TDS = Total dissolved solids.
[a] These compounds are no longer used in California. Toxicity from these compounds is remnant from past use.
[b] Toxicity of unknown origin refers to observed aquatic toxicity, the source of which is unknown.
[c] Nutrients includes nitrate, nitrite, ammonia, organic nitrogen, total phosphorus, and soluble reactive phosphorus.

Source:
CALFED Bay-Delta Program Water Quality Program Plan Appendix.

Spatial trends of water quality in the Delta reflect the effects of inflows, exchange with the Bay, diversions, and pollutant releases within the Delta. The north Delta tends to have better water quality, in large part because of the inflow from the Sacramento River, which is fed by reservoirs containing high-quality water. The quality of water in the west Delta is strongly influenced by exchange with the Bay; during low-flow periods, sea-water intrusion causes poorer water quality. In the south Delta, water quality tends to be poorer because of the combination of inflows of poorer water quality from the San Joaquin River, discharges from Delta islands, and the effects of diversions that can sometimes increase sea-water intrusion from the Bay.

The quality of water in the west Delta is strongly influenced by exchange with the Bay; during low-flow periods, sea-water intrusion causes poorer water quality.

Water Quality Issues in the Delta

Based on the above discussion, the significant water quality issues in the Delta Region are as follows:

- Discharges from Delta islands have elevated concentrations of TOC (a DBP precursor) and salts that affect industrial, municipal, and agricultural uses.
- High-salinity water from Suisun and San Francisco Bays intrudes into the Delta during periods of low Delta outflow. Salinity adversely affects most beneficial uses. Bromides associated with sea water leads to the formation of brominated DBPs in treated water.

Bromides associated with sea water leads to the formation of brominated DBPs in treated water.

- Synthetic chemicals (such as pesticides and herbicides) and natural contaminants (heavy metals) have accumulated in sediments in the Delta, and can accumulate in aquatic organisms. For example, mercury and DDT, which bioaccumulate through the food web in fish and shellfish, can exceed acceptable limits for human consumption. Disturbance of contaminated sediments can release these constituents into the water column.

- Agricultural drainage to the Delta can contain elevated levels of nutrients, suspended solids, organic carbon, salinity, selenium, and boron, in addition to chemical residues. All of these constituents may adversely affect the beneficial uses of Delta water.

- Heavy metals, including cadmium, copper, mercury, and zinc, continue to enter the Delta. Sources of these metals include runoff from abandoned mine sites, tailings deposits, downstream sediments where the metals have been deposited over the past 150 years, urban runoff, and industrial and municipal wastewater discharges.

- The estuarine salinity gradient and its associated entrapment zone (where biological productivity is relatively high because of the mixing dynamics and accumulation of suspended materials) affect the quality and extent of habitat for some estuarine species. The entrapment zone and adjacent habitats support fish food production in the Delta. The location of the entrapment zone and its extent are controlled by Delta outflow, and directly affect environmental and dependent recreational beneficial uses.

The location of the entrapment zone and its extent are controlled by Delta outflow, and directly affect environmental and dependent recreational beneficial uses.

- Oxygen depletion adversely affects aquatic organisms. It is caused by discharges of inadequately treated wastes, and discharges of nutrients that promote the growth and decay of natural vegetation. Sources of oxygen-demanding materials and nutrients include discharges from industrial and municipal treatment plants, and from agricultural and urban sources. Such problems are of particular concern in the lower San Joaquin River and in the south Delta.

Oxygen depletion is caused by discharges of inadequately treated wastes, and discharges of nutrients that promote the growth and decay of natural vegetation.

Summary of Data for Key Water Quality Constituents

The following section describes the results of water quality sampling in the Delta for some key constituents.

Bromide. The primary source of bromide in Delta waters is sea-water intrusion. Other sources include drainage returns in the San Joaquin River and within the Delta, connate water (saline water trapped in sediment when the sediment was deposited) beneath some Delta islands, and possibly agricultural applications of methyl bromide. The river and agricultural irrigations sources are primarily a "recycling" of bromide that originated from sea-water intrusion. Dissolved bromide concentrations at sampling stations for the Municipal Water Quality Investigation (MWQI) shown in Table 5.3-2 indicate a gradient in bromide such that mean concentrations range from about 0.46 mg/L at Rock Slough to 0.27 mg/L at CCFB. The effect of recycling bromide in the lower San Joaquin River is indicated by a mean concentration of about 0.27 mg/L at the DMC and 0.31 mg/L at Vernalis. In contrast, the mean bromide concentration on the Sacramento River at Greene's Landing is about 0.018 mg/L.

Table 5.3-2. Mean Concentration of Constituents

DELTA AREA	LOCATION	BROMIDE, DISSOLVED (mg/L)	CHLORIDE, DISSOLVED (mg/L)	DOC (mg/L)	SELENIUM, DISSOLVED (mg/L)	SPECIFIC CONDUCTANCE (μmhos/cm)	TDS (mg/L)
North	Sacramento River at Greene's Landing	0.018	6.8	2.5	0.000	160	100
	North Bay Aqueduct at Barker Slough	0.015	26	5.3	0.000	332	192
South	SWP Clifton Court Forebay	0.269	77	4.0	0.000	476	286
	CVP Banks Pumping Plant	0.269	81	3.7	0.000	482	258
	San Joaquin River at Vernalis	0.313	102	3.9	0.002	749	459
	Contra Costa Intake at Rock Slough	0.455	109	3.4	0.000	553	305

Notes:
mg/L = Milligram per liter.
μmhos/cm = Micromhos per centimeter.

Source:
DWR Municipal Water Quality Investigation (MWQI) data. Sampling period varies, depending on location and constituent, but generally is between 1990 and 1998.

Total and Dissolved Organic Carbon. The sources of organic carbon are primarily decayed vegetation. Important sources to the Delta include the Sacramento River, the San Joaquin River, and in-Delta island drainage return flows. Based on diversion estimates from DWR's Delta Island Consumptive Use Model (1995a), and DWR data on concentrations in the Delta and in return flows (1995b), in-Delta sources are estimated to contribute about 40-50% of the TOC to the Delta.

The sources of organic carbon are primarily decayed vegetation.

Monitoring data show that most of the TOC in the Delta is in the dissolved form, called DOC. DOC concentrations in the Delta channels vary seasonally, showing a peak during the wet season (from January through March) when runoff occurs. Mean annual concentrations of DOC in the Delta channels generally range from about 2-6 mg/L, with the higher concentrations occurring in areas like Barker Slough where local drainage dominates water quality (Table 5.3-2).

The contribution of DOC from agricultural drains varies, depending on conditions on the island and especially the peat (organic) content of the soils. Sampling data obtained through DWR's MWQI Program show that mean annual concentrations of DOC may range from 17 mg/L at Brannan Island to 44 mg/L at Empire Tract. A strong seasonal variation, with concentrations increasing by about a factor of 2 during the wet season, also is indicated in the data.

More monitoring data and research are needed to determine the quality and quantity of sources of TOC and DOC from various land use practices in the Delta.

Salinity, Total Dissolved Solids, and Electrical Conductivity. These parameters are measures of dissolved salts in water. Salinity is a measure of the mass fraction of salts (measured in parts per thousand [ppt]), whereas TDS is a measure of the concentration of salts (measured in mg/L). Since EC of water generally changes proportionately to changes in dissolved salt concentrations, EC is a convenient surrogate measure for TDS. Based on DWR's MWQI data for Delta channels, TDS is approximately equal to EC times 0.58.

Excess salinity in Delta waters affects agricultural, industrial, and municipal water supply beneficial uses, as well as habitat quality for aquatic biota in the Delta. For example, the monthly average TDS objective in the SWP water service contract is 440 mg/L. Sources of salinity include sea-water intrusion, agricultural drainage, municipal wastewater, urban runoff, connate groundwater, and evapotranspiration of plants. Sea-water intrusion is the major source of salinity in the Delta. Agricultural drainage, particularly from the San Joaquin Valley also is an important source; however, much of the San Joaquin River salt load reflects recycling of salts from the agricultural irrigation water that is obtained from the DMC.

Much of the San Joaquin River salt load reflects recycling of salts from the agricultural irrigation water that is obtained from the Delta-Mendota Canal.

TDS concentrations, as indicated in Table 5.3-2 are highest in the west Delta and the south Delta channels affected by the San Joaquin River. The mean concentration at CCFB is about 286 mg/L; at the Contra Costa intake at Rock Slough, the mean concentration is about 305 mg/L. The high concentrations in the San Joaquin River at Vernalis (459 mg/L) reflect the accumulation of salts in agricultural soils and the effects of recycling salts via the DMC. At Barker Slough in the north Delta, which is not substantially affected by sea-water intrusion, the mean TDS concentration is about 192 mg/L. Mean TDS in the Sacramento River at Greene's Landing is relatively low, around 100 mg/L.

Pathogens. The term "pathogens" refers to viruses, bacteria, and protozoa that are a potential threat to human health. Of particular concern, from the point of view of water supply, are protozoa such as *Giardia lamblia* and *Cryptosporidium parvum*, which are resistant to traditional disinfection methods. The frequency of detection of *Giardia lamblia* and *Cryptosporidium parvum* in samples obtained by DWR's Coordinated Pathogen Monitoring Program (1998) at 14 stations located in the SWP or SWP service area indicated positive detection of *Giardia lamblia* cysts in about 26% of all the samples (wet and dry weather) and positive detection of *Cryptosporidium parvum* cysts in about 8% of all the samples. The frequency of detection increased in those samples obtained during runoff events (wet-weather events), which suggests sources such as urban and agricultural runoff, and wet-weather bypass flows from wastewater treatment plants. However, the limited data and significant technical limitations in analysis techniques do not enable reliable conclusions to be drawn at this time.

Certain protozoa such as *Giardia lamblia* and *Cryptosporidium parvum* are resistant to traditional disinfection methods.

Mercury. Mining-related activities are known to be a significant source of mercury in the Delta. The Coast Ranges, on the west side of the Sacramento Valley, contain a large deposit of cinnabar. At one time, mines in the area supplied the majority of mined

Mining-related activities are known to be a significant source of mercury in the Delta.

mercury in the United States. The majority of the mercury mines in the Coast Ranges are abandoned and remain unclaimed. During the late 1800s and early 1900s, mercury was intensively mined and refined in the Coast Ranges, and transported across the Central Valley to the Sierra Nevada for use in placer gold mining operations. The Central Valley Regional Water Quality Control Board (CVRWQCB) (1998) has estimated that approximately 7,600 tons of refined mercury (commonly called quicksilver) were deposited in the Mother Lode region during the Gold Rush mining era. Studies by UC Davis and, more recently, by Bouse et al. (1996) and Harnberger et al. (1999) at the U.S. Geological Survey (USGS) show that the sediments mobilized by hydraulic mining ultimately were transported to the Bay-Delta, where they formed marshes and islands or were deposited in shallow water. USGS studies show that mercury concentrations in Bay sediments containing hydraulic mining debris range from 0.3 to 1 microgram per gram (μg/g). More importantly, certain conditions in these sediments can cause the formation of methyl mercury, the most bioavailable form of mercury.

Pesticides (Diazinon and Chlorpyrifos). Organophosphate pesticides, such as diazinon and chlorpyrifos, are used in the Central Valley on orchard crops (about half a million acres), including almonds, peaches, and prunes. The pesticides are applied during the dormant spray season from December through February. In 1993, Domagalski (1996) at the USGS estimated that over 45,000 kilograms (kg) of diazinon and 300 kg of chlorpyrifos were used predominantly in the Central Valley during the dormant spray season. Diazinon and chlorpyrifos also are used by commercial applicators and home owners to control common pests.

Diazinon and chlorpyrifos have been detected in surface water during winter and early spring from applications to orchards, in irrigation return water during summer, and in urban runoff samples during both winter and summer. Concentrations of diazinon measured in the Sacramento River in Sacramento during a January 1994 runoff event peaked at around 350 nanograms per liter (ng/L). In the Sacramento Slough north of the Delta, concentrations exceeded 1,000 ng/L. Toxicity identification evaluations (TIEs) were conducted by Foe (1995) from the CVRWQCB on samples to determine the presence of toxics in *Ceriodaphnia* bioassays from the Sacramento and San Joaquin Rivers. The results confirmed that diazinon was a primary toxicant.

Concentrations of organochlorine pesticides are generally much lower in bed sediment and biota in the Sacramento River basin compared to the San Joaquin River basin.

Organochlorine Pesticides. Organochlorine pesticides (DDT, toxaphene, dieldrin, and chlordane) were widely used in the Central Valley until the 1970s and remain very persistent. Residues of these agents are still widespread in the Central Valley and are mobilized during winter storms, by irrigation and dredging and by construction activities. Fish tissue analyses indicate that levels of these pesticides can exceed recommended safe levels for human consumption. According to Fox and Archibald (1996), concentrations of organochlorine pesticides are generally much lower in bed sediment and biota in the Sacramento River basin compared to the San Joaquin River basin.

Selenium is naturally abundant in the marine sedimentary rocks and soils weathered from the rocks of the Coast Ranges west of the San Joaquin Valley.

Selenium. Selenium is naturally abundant in the marine sedimentary rocks and soils weathered from the rocks of the Coast Ranges west of the San Joaquin Valley. Mobilization and transport of selenium occurs during large runoff events or by land uses, such as road building, over-grazing, mining, and irrigated agriculture. Between 1986 and

1995, annual selenium loads in the San Joaquin River near Vernalis averaged 4,040 kg (8,906 pounds [lbs]), with a range of from 1,615 to 7,819 kg (from 3,558 to 17,238 lbs). Wastewater discharges from the refineries in the San Francisco Bay Area are another important source of selenium. Alpers and others from the USGS indicate that in 1991, the average riverine selenium loads that reached the Estuary was around 2 kg per day (730 kg per year), while refinery loads averaged 7.1 kg per day (2,592 kg per year) and municipal loads averaged 2.2 kg per day (803 kg per year). (Alpers et al. 1999a, 1999b.)

Trace Metals. Heavy metal loading in the watershed has been suspected as a possible source of aquatic toxicity throughout the Bay-Delta and its tributaries. The major sources of metals are abandoned mines, agriculture, and urban runoff. For example, data collected by Alpers et al. (1999a, 1999b) from USGS indicate copper loads from the Colusa Basin Drain were 39.7 lbs per day, based on sampling conducted in June 1997; whereas the loads from Iron Mountain in Spring Creek were about 26 lbs per day, based on measurements conducted in May 28, 1997. In May and September, DWR measured concentrations of 9 trace metals at 11 stations in the Bay-Delta and Suisun Bay from 1975 to 1993. Trace metals frequently exceeded the guidelines for marine and fresh-water toxicity. Trace metals (most frequently copper) exceeded the guidelines for fresh-water acute and chronic toxicity on 34 occasions. Marine acute and chronic toxicity guidelines were exceeded 181 times; copper accounted for 160 of these exceedances. In a USGS study conducted by Alpers et al., (1999a) to determine the role of Iron Mountain as a source of toxicity in the Sacramento River, lead-isotope data in suspended colloidal material and sediments were analyzed, indicating that the effects of Iron Mountain were relatively minor downstream of Red Bluff.

Heavy metal loading in the watershed has been suspected as a possible source of aquatic toxicity throughout the Bay-Delta and its tributaries.

5.3.3.2 Bay Region

Water quality in San Francisco Bay is affected by flows from the Delta, runoff from the surrounding urban areas, municipal and industrial wastewater discharges, and drainage from abandoned mines. Water quality monitoring has been conducted in the Bay by the San Francisco Estuary Institute as part of its Regional Monitoring Program (RMP), as well as by industrial and sanitary dischargers. The contaminants of concern identified by the RMP include diazinon and chlorpyrifos in water; DDTs, chlordanes, polycyclic aromatic hydrocarbons (PAHs) in sediment; and PCBs, cadmium, mercury, selenium, PAHs, chlordanes, dieldrin, and DDTs in bivalve and fish tissue. Copper and nickel in the South Bay are currently the subject of a total maximum daily load (TMDL) evaluation. TMDLs identify the maximum amount of contaminant allowed in a water body that would not harm any beneficial uses of the water body. Selenium discharges from refineries and other sources in the Bay Area also are of concern. Dioxin discharges, especially from combustion sources, typify chemicals whose origin in part is atmospheric but may adversely affect water quality. Methyl tert-butyl ether (MTBE) has been found in a number of drinking water reservoirs in the Bay Area, which has prompted restrictions on certain types of water recreation.

Copper and nickel in the South Bay are currently the subject of a total maximum daily load evaluation.

5.3.3.3 SACRAMENTO RIVER REGION

Past mining practices, particularly hydraulic mining, have resulted in the discharge of huge quantities of sediment into major tributaries in gold-producing areas. Areas where mining operations were conducted continue to be a major source of toxic chemical loading to streams in some areas, including the Clear Creek watershed and local watersheds of the Sierra Nevada. Logging operations increased erosion and discharge of sediments into streams and rivers over widespread areas in upper watersheds of the Sierra Nevada and Cascade Ranges. Other water quality issues in the Sacramento River Region are similar to those described for the Delta Region.

In general, water quality in the Sacramento River is good, although the possible adverse effects associated with metals contamination from abandoned mercury and other hard-rock mining activities are of concern. Mercury is likely to be found in sediments and aquatic tissue rather than in the water column. In 1986, the CVRWQCB surveyed mercury contamination in fish and sediment in the Sacramento River watershed. The CVRWQCB detected elevated mercury levels in sediment in the Yuba and Bear Rivers and in Cache, Putah, and Stony Creeks. Recent sampling by the USGS National Water Quality Assessment (NAWQA) Program and reported by Domalgalski (1999) has confirmed the continued presence of elevated concentrations of mercury in the sediments of the Yuba River, Bear River, and Cache Creek, as well as in the sediments of other streams and rivers in the Sacramento River basin.

Data collected by researchers at UC Davis (Slotten et al. 1997) and as part of the Sacramento River Watershed Program Mercury Control Planning Project (Larry Walker and Associates 1997) also indicates that mercury in a bioavailable form is affecting the aquatic food chain. Survey results of bioavailable mercury throughout the northwestern Sierra Nevada (from the Feather River south to the Cosumnes River) found the most highly elevated mercury in the aquatic food webs of the South and Middle Forks of the Yuba River, the North Fork of the Cosumnes River, tributaries throughout the Bear River drainage, the mid-section of the Middle Fork of the Feather River, and Deer Creek.

Evidence indicates that mercury in a bioavailable form is affecting the aquatic food chain.

Other metals, such as copper, cadmium, lead, and zinc, are of concern in the Sacramento River Region. The influence of metal-laden acidic drainage from the Iron Mountain Mine site (via Spring Creek and the Spring Creek arm of Keswick Reservoir) is apparent in water samples from the site below Keswick Dam, where occasional exceedances of water quality standards for copper have been noted. Sample analysis using very small filtrates (0.005-micrometer-equivalent pore size) indicated that much of the copper and, to a lesser extent, zinc were in the colloidal form. Available data from agricultural drain samples indicate that trace-metal loading from agricultural drainage may be significant during certain flow conditions.

5.3.3.4 SAN JOAQUIN RIVER REGION

Water quality conditions in the San Joaquin River Region are influenced by agricultural activities that are associated with irrigation and agricultural chemical applications. Selenium in the lower San Joaquin River comes primarily from subsurface agricultural drainage discharged from the Grasslands area on the west side of the San Joaquin Valley through Mud Slough. Selenium also is conveyed to the San Joaquin River in natural storm runoff during wet years, primarily from Panoche and Silver Creeks. Annual selenium loads in the San Joaquin River near Vernalis between 1986 and 1995 averaged 4,040 kg (8,906 lbs) per year. The riverine load seldom reaches the estuary, as flows are generally insufficient and south Delta diversions draw most of the San Joaquin River water from the Delta. A report by Alpers et al. (1999a, 1999b) indicated that in 1991, for example, the average San Joaquin River selenium load that reached the estuary was around 2 kg per day (730 kg), compared to an average load from Bay Area refineries of 7.1 kg per day (2,592 kg) and municipal loads that averaged 2.2 kg per day (803 kg).

Water quality conditions in the San Joaquin River Region are influenced by agricultural activities that are associated with irrigation and agricultural chemical applications.

Salt loading can lead to impairment of water quality in the lower San Joaquin River, in the south Delta, and at diversion facilities. Surface and subsurface agricultural drainage waters are the major source of salts in the San Joaquin River. The mean annual salt load exported out of the basin was approximately 770,000 tons per year from 1985 to 1994. Recycling of salt from the Delta, via the DMC to the west side of the San Joaquin Valley and through accumulation of salts in the soils and shallow groundwater in the west side of the Valley, are the major sources of salts in the San Joaquin River. Data reported by Grober (1999) at the CVRWQCB indicate that concentrations in the San Joaquin River at Vernalis, expressed in terms of specific conductance (μmhos/centimeter [cm]) exceeded the 700-μmhos/cm 30-day running average objective for April through August in about 54% of the time from 1986 to 1997. These concentrations exceed desirable levels for agricultural irrigation and cause problems for south Delta farmers and for export water.

Salt loading can lead to impairment of water quality in the lower San Joaquin River, in the south Delta, and at diversion facilities.

Low dissolved oxygen conditions occur in the Stockton reach of the San Joaquin River and in urban waterways around the City of Stockton. After storms, dissolved oxygen concentrations as low as 0.34 mg/L have been recorded in Smith Canal, Mosher Slough, 5-Mile Slough, and the Calaveras River. These conditions also occur during late summer and fall because of a combination of high water temperature, nutrients, algal blooms, and discharge. Effluent from the Stockton Regional Wastewater Control Facility is considered to be a relatively large source of oxygen-depleting substances, as is water from the Stockton Turning Basin. Although the data are not conclusive, other sources such as urban runoff, runoff from confined animal facilities, and sediment demand also may contribute significantly to lowering dissolved oxygen.

5.3.3.5 OTHER SWP AND CVP SERVICE AREAS

Two distinct, noncontiguous areas are included in the Other SWP and CVP Service Areas: in the north are the CVP's San Felipe Division and the SWP's South Bay service areas, and to the south are the other SWP service areas. The northern section of this region encompasses parts of the central coast counties of Santa Clara, San Benito, Santa Cruz, and Monterey. The southern portion includes parts of Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, and Ventura Counties.

The quality of water from the Delta delivered to the Other SWP and CVP Service Areas is of major concern, particularly with respect to salinity and drinking water quality. Salinity is an issue because excessive salinity may adversely affect crop yields and require more water for salt leaching, may require additional municipal and industrial treatment, may increase salinity levels in agricultural soils and groundwater, and is the primary water quality constraint to recycling wastewater. Also, according to a Salinity Management Study, conducted by The Metropolitan Water District of Southern California (MWD) (1997), alternative sources for MWD's service area generally have quite high levels of salinity. The TDS of Colorado River water averages about 700 mg/L, whereas the TDS average at the SWP terminal reservoirs is about 300 mg/L. The lack of alternate sources of low-salinity water reduces opportunities to stretch water supplies by blending.

Salinity is the primary water quality constraint to recycling wastewater. The lack of alternate sources of low-salinity water reduces opportunities to stretch water supplies by blending.

Constituents that affect drinking water quality include bromide, natural organic matter, microbial pathogens, nutrients, TDS, hardness, alkalinity, pH, and turbidity. Of particular concern to water purveyors are anticipated drinking water regulations that may require reductions in the levels of DBPs that are formed during water treatment disinfection and oxidation while also implementing more stringent disinfection regulations. The problem of formation of brominated DBPs is specific to the Delta as a drinking water source. Brominated DBPs are formed by the reaction of bromide and TOC with the disinfectant chemicals used in water treatment. Brominated DBPs are of concern because of their link to miscarriages and cancer. Elevated levels of bromide (primarily from sea-water intrusion) and elevated levels of TOC that are associated in large part with Delta island drainage contribute to the formation of brominated DBPs. The Delta has higher average levels of bromide than 95% of the source waters in the rest of the country, making the water more difficult to treat.

The problem of formation of brominated DBPs is specific to the Delta as a drinking water source. The Delta has higher average levels of bromide than 95% of the rest of the country, making the water more difficult to treat.

5.3.4 ASSESSMENT METHODS

Qualitative and quantitative methods were used to assess the impacts of the Preferred Program Alternative and the Program alternatives on water quality. Primarily qualitative methods were used to determine water quality impacts from implementation of the Ecosystem Restoration, Water Quality, Levee System Integrity, Water Use Efficiency, Water Transfer, and Watershed Programs. The effects of constructing surface water and groundwater storage were assessed qualitatively, but the effects of storage (nonconstruction) and conveyance of each option under the alternatives were quantitatively assessed based on modeling results.

The effects of constructing surface water and groundwater storage were assessed qualitatively, but the effects of storage (nonconstruction) and conveyance of each option under the alternatives were quantitatively assessed based on modeling results.

Quantitative methods were used to predict changes in the concentrations of constituents of concern from implementing the Storage and Conveyance elements. Specifically, the impacts of the Program alternatives on water quality were analyzed with DWR's Delta Simulation Models (DSM1 and DSM2).

The generation of modeling results, which help to predict impacts, evolved in response to decisions on the Preferred Program Alternative and Alternatives 1, 2, and 3. Since spring 1997, there have been several DSM2 model runs; and assumptions for these runs have not been uniform. Work in progress includes the generation of a set of modeling runs which predict the ranges of impacts of each Program Alternative under a reasonable range of water management scenarios, referred to as "bookends." The set of assumptions for the bookends include a range of water demands and regulatory requirements. The assumed ranges also were included in the No Action Alternative. A more detailed description of the bookends are in Sections 5.1.4.1 and 5.1.4.2. These relatively new modeling results, although available at the time of this water quality impact analysis, are considered preliminary.

The initial study (dated March 1997) uses DWRDSM1 and simulates five alternatives, including Existing Delta Geometry, Interim South Delta Program (ISDP), North Delta Program, North Delta Program with Hood Diversion, and California Urban Water Agency (CUWA) Alternative C Geometry. Similarly, the next study (dated August 1997) uses DWRDSM1 to simulate Program Alternatives 1A, 1C, 2B, 2D, and 3E. The January 1998 study uses DWRDSM2 to simulate Program Alternatives 1A, 1C, 2B, 3E, and 3X. Finally, the June 1998 study also uses DWRDSM2 to simulate Program Alternatives 1C, 2B, and 3X (DWR 1998). The difference between the January and June studies, however, is a variation in the DWRSIM studies that was incorporated into the simulations. Further descriptions of the Delta hydrology and operating assumptions for each alternative for each run are presented in each of the above-referenced documents.

In February 1998, Delta modeling studies were performed for the Diversion Effects on Fisheries Team (DEFT) and were completed using DWRDSM2. These modeling results were used to predict the performance of the Preferred Program Alternative for a range of assumptions that would affect water operations.

Delta modeling of flow, EC, and water levels in the south Delta were used to predict water quality impacts of the Program alternatives. Additionally, the simulations were used to describe Delta inflows and exports under various alternatives over an extended period of time.

Delta modeling of flow, EC, and water levels in the south Delta were used to predict water quality impacts of the alternatives.

During the past year, the Delta Modeling Section has been conducting EC-based water quality model runs for the Program. EC is a convenient water quality indicator because it is a good index for salinity. EC is easily measured in the field, and therefore provides good records for model calibration and verification. In evaluating the overall environmental consequences of alternatives, model predictions of mean annual EC values for a 16-year hydrologic sequence were used to compare the predicted long-term performance of each alternative against the No Action Alternative or existing conditions. In evaluating the performance of each alternative for "worst-case" conditions, model predictions of mean monthly EC during dry and critical years were used. However, the results of these runs may not predict the concentrations of other water quality constituents that are not directly related to salinity.

A different approach was introduced, called "fingerprinting," to help facilitate predictions of constituents other than salinity. The idea behind fingerprinting is to track the water coming from each source separately. It was assumed that six major sources of water enter the Delta: the Sacramento River, San Joaquin River, east side streams, Yolo Bypass, water from Martinez, and in-Delta agricultural drainage returns. Tracking these inflows to the Delta is called "source tracking." In addition, the water entering the Delta at different times is tracked separately, called "time tracking." For most model runs, the hydrology is assumed to change monthly; therefore, time tracking was performed in a monthly mode. For example, the water that enters the Delta in February is monitored separately from the water that enters the Delta in January. In the fingerprinting mode, DSM2 is simulating a total of 72 constituents (from 6 sources and for 12 months in the year). The results can be applied to any conservative constituent. A conservative water quality constituent is a relatively stable constituent that does not change chemical composition in an aquatic environment. The analysis was verified by comparing the results of the fingerprinting analyses with the EC modeling, using DWRDSM2.

The output from a fingerprinting run consists of 72 numbers at any given location and time. In essence, these numbers represent the "source blending ratios" that depend on location and time. Once these blending ratios are known, they can be applied to any conservative water quality constituent, provided the concentration for that constituent is known for all the sources of water in the Delta at all times.

The output from a fingerprinting run consists of 72 numbers at any given location and time.

To verify this approach, the Delta Modeling Section applied the fingerprinting approach to predict EC concentrations and compared their results to actual EC predictions by DSM2 in standard water quality runs. The results are quite consistent.

The modeling effort is a valuable tool developed to predict the effects of the proposed storage and conveyance facilities. Models are subject to continued refinement and improvement, and cannot provide all of the information needed to analyze the impacts of the Program alternatives. A more complete description of modeling assessment methods is given in Attachment A. Where the modeling results are incomplete or not applicable, impacts were estimated based on other available information and professional judgement.

5.3.5 SIGNIFICANCE CRITERIA

The significance of both adverse and beneficial effects on water quality was assessed based on modeling studies and programmatic analyses. Impacts on water quality are considered potentially significant if implementing the Preferred Program Alternative has the potential to result in any of the following conditions:

- Beneficial uses of the water are adversely affected.

- Existing regulatory standards are exceeded.
- An undesirable effect on public health or environmental receptors is produced.

Program effects are considered beneficial if implementing the Preferred Program Alternative would result in the reverse of one or more conditions listed above. Given that model predictions are subject to error, potentially significant water quality changes are defined as those that exceed the probable uncertainty in the modeling results. Predicted effects that fell within the probable uncertainty in the modeling results could not be interpreted and were considered less than significant. The uncertainty in the modeling results is estimated at approximately ±10%.

The uncertainty in the modeling results is estimated at approximately ±10%.

5.3.6 NO ACTION ALTERNATIVE

By 2020, state-wide water use is projected to increase from 79.49 MAF (based on 1995 demands) to 80.50 MAF during near-normal years, and from 64.79 to 65.96 MAF during drought years. Although water use is projected to decrease slightly in agricultural regions, reductions in alternative supplies and proportionately larger increases in urban area demands would result in increased overall demands for Delta exports. As a result, total annual demands for Delta exports could increase from the current range of 5.9-6.9 MAF, to a range of 7.1-7.6 MAF in 2020, depending on the annual hydrology.

Although water use is projected to decrease slightly in agricultural regions, reductions in alternative supplies and proportionately larger increases in urban area demands would result in increased overall demands for Delta exports.

The No Action Alternative supplements the existing conditions with some reoperation of system facilities to accommodate changes in flow timing resulting from 2020 demands. Under the No Action Alternative, future SWP and CVP operations, and resultant controlled flow conditions in the Bay-Delta system and its tributaries are assumed to be managed essentially as they are today, with one exception. Increased Delta export demands are projected to be satisfied largely by increased south Delta pumping during August through March in near-normal and wet years, and December through February in dry and critical years.

The following elements of the No Action Alternative are particularly pertinent to water quality:

- Water storage and conveyance facilities currently under construction would be completed. These facilities include the Eastside Reservoir and Inland Feeder; interim reoperation of Folsom Reservoir; levee restoration along selected reaches of the Sacramento River, its tributaries, and flood bypasses; and Stone Lakes NWR.

Under the No Action Alternative, water storage and conveyance facilities currently under construction would be completed.

- Wastewater and water treatment facilities would be expanded to meet the needs of growing populations.

- Treatment levels would remain at current levels, increase if source water becomes more degraded, or improve in response to new regulations.

Other operations and factors that would affect Bay-Delta channel and export water quality conditions include hydrologic and environmental conditions in the watersheds, population and land use, the quality of point and nonpoint source discharges, upstream reservoir releases and diversions, Delta outflows and sea-water intrusion, the provisions of the CVPIA and Bay-Delta Accord, and compliance with the State and Regional Water Quality Control Boards' Basin Plans and the State Board and Delta Water Quality Control Plan standards. Future changes in the Bay-Delta Accord, flow requirements, water quality standards, and water rights decisions could impose additional regulatory controls over SWP and CVP operations and Delta inflows controlled by upstream users. Changes in such regulatory controls could result in proportionately larger effects on water quality during dry and critically dry water-year types.

Tables 5.3-3a and 5.3-3b summarize the results of model predictions of salinity changes (expressed as EC) throughout the Delta for the No Action Alternative compared to existing conditions for the long term hydrologic sequence and the dry and critical water-year types, respectively. Separate predictions are shown for the water management Criterion A without storage and for water management Criterion B with storage. For each criterion, changes are shown for the annual average value and for the month during which the higher salinities are projected.

No Action Alternative conditions are projected to result in less-than-significant increases in salinity concentrations.

Tables 5.3-3a and 5.3-3b indicate that the No Action Alternative is projected to result in less-than-significant changes throughout the Delta Region when compared to modeled existing conditions. For example, during the long-term hydrologic sequence at CCFB, the annual average salinity is projected to increase by 10-40 μmhos/cm (2-8%), and the mean monthly salinity for December is projected to increase by about 40-70 μmhos/cm (4-8%). (A percentage change between $\pm$10 μmhos/cm is considered within the margin of error of the model analysis and is defined as less than significant.) During dry and critical years, Table 5.3-3b shows that these ranges increase by 0-60 μmhos/cm (0-10%) for the annual average and by 10-70 μmhos/cm (1-6%) on average for December.

Project levee maintenance is assumed to continue in accordance with current requirements and practices, but no major rehabilitation efforts would be undertaken. Despite maintenance actions, levees could continue to deteriorate, increasing the risk of their failure due to seismic events, erosion, and overtopping. Such levee failures could threaten water quality at the CVP and SWP pumps, and at other water supply intake locations. The severity and extent of any degradation caused by the potential influx of ocean salinity (including bromide), TOC, soils, and sediment, and by the potential release of a variety of chemicals and wastes used or stored in areas protected by levees would depend on many factors. These factors include the season, hydrology, available reservoir storage, location of the breaks and storage, and extent of any flooding. In the worst case (foreseeable only in the event of a series of earthquake-induced west Delta levee failures that occurred during summer to late fall or during drought periods), water could become temporarily unusable for municipal and agricultural supplies for extended periods until the contaminants could be flushed from the system. The resultant pooling of ocean salts, including bromide, in the Delta would cause potentially significant adverse impacts on water users and could cause a prolonged interruption of supply from the state's predominant water source.

Table 5.3-3a. Predicted Salinity Changes Between the No Action Alternative and Existing Conditions for All Water-Year Types (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	Jan	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
North Bay Aqueduct Intake at Barker Slough	7*	-10	0	0	0	-4%	0%	0%	0%	Mar	LTS
Mokelumne River at Terminous	8	0	0	0	0	0%	0%	0%	0%	Jan	LTS - B
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	30	40	0	20	7%	6%	0%	3%	Nov	LTS - B
Turner Cut	29	40	40	0	0	9%	6%	0%	0%	Jan	LTS - B
San Joaquin River at Prisoner's Point	12	20	70	10	60	4%	8%	2%	7%	Dec	LTS - B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-10	0	-10	-10	-2%	0%	-2%	-1%	Dec	LTS
San Joaquin River at Brandt Bridge	10	-10	-30	0	-10	-2%	-4%	0%	-1%	Dec	LTS
Middle River at Tracy Road	21	40	40	10	20	8%	5%	2%	3%	Jan	LTS - B
Grant Line Canal at Tracy Road	24	-10	0	-10	0	-2%	0%	-2%	0%	Dec	LTS
Old River at Tracy Road	17	-10	-10	-10	0	-2%	-1%	-2%	0%	Dec	LTS - B
Old River at Rock Slough	19	30	90	20	60	5%	8%	4%	5%	Dec	LTS - B
Contra Costa Canal Intake at Rock Slough	28*	40	90	20	60	6%	8%	3%	5%	Dec	LTS - B
Old River at SR 4 (and New CCWD Intake)	18*	40	80	10	60	7%	8%	2%	6%	Dec	LTS - B
Clifton Court Forebay	27*	40	70	10	40	8%	8%	2%	4%	Dec	LTS - B
Delta-Mendota Canal Intake from Old River	26*	30	50	0	30	5%	6%	0%	3%	Dec	LTS - B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	10	40	20	60	1%	2%	2%	3%	Sep	LTS
Sacramento River at Collinsville	4	0	130	70	90	0%	2%	2%	2%	Sep	LTS
San Joaquin River at Jersey Point	14	30	150	40	80	3%	7%	4%	4%	Nov	LTS - B
San Joaquin River at Antioch	15	0	200	70	170	0%	4%	3%	4%	Oct	LTS
Suisun Bay at Port Chicago	5	-100	260	180	130	-1%	1%	2%	1%	Sep	LTS
Carquinez Strait at Martinez	6	-120	240	210	130	-1%	1%	1%	1%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

Table 5.3-3b. Predicted Salinity Changes Between the No Action Alternative and Existing Conditions for Dry and Critical Years (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	Jan	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
North Bay Aqueduct Intake at Barker Slough	7*	-10	-10	-10	-10	-5%	-4%	-5%	-4%	Mar	LTS
Mokelumne River at Terminous	8	0	0	0	0	0%	0%	0%	0%	Jan	LTS - B
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	40	40	0	10	9%	5%	0%	1%	Dec	LTS - B
Turner Cut	29	50	50	0	-20	10%	7%	0%	-3%	Jan	LTS - B
San Joaquin River at Prisoner's Point	12	20	70	10	30	4%	6%	2%	3%	Dec	LTS - B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-10	-20	-10	-30	-1%	-2%	-1%	-3%	Feb	LTS
San Joaquin River at Brandt Bridge	10	-10	-20	0	-20	-1%	-2%	0%	-2%	Feb	LTS
Middle River at Tracy Road	21	50	50	0	0	9%	5%	0%	0%	Jan	LTS - B
Grant Line Canal at Tracy Road	24	-10	-20	-10	-20	-1%	-2%	-1%	-2%	Feb	LTS
Old River at Tracy Road	17	-10	-20	0	-20	-1%	-2%	0%	-2%	Feb	LTS - B
Old River at Rock Slough	19	30	90	10	30	4%	7%	1%	2%	Dec	LTS - B
Contra Costa Canal Intake at Rock Slough	28*	40	90	10	30	6%	7%	1%	2%	Dec	LTS - B
Old River at SR 4 (and New CCWD Intake)	18*	50	80	10	30	8%	7%	2%	2%	Dec	LTS - B
Clifton Court Forebay	27*	60	70	0	10	10%	6%	0%	1%	Dec	LTS - B
Delta-Mendota Canal Intake from Old River	26*	40	50	0	10	6%	5%	0%	1%	Dec	LTS - B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	-10	-20	20	20	-1%	-1%	2%	1%	Sep	LTS
Sacramento River at Collinsville	4	-60	-20	60	20	-2%	0%	2%	0%	Sep	LTS
San Joaquin River at Jersey Point	14	10	150	30	90	1%	6%	2%	3%	Dec	LTS - B
San Joaquin River at Antioch	15	-60	30	50	-10	-2%	1%	2%	0%	Sep	LTS
Suisun Bay at Port Chicago	5	-210	0	190	0	-1%	0%	1%	0%	Sep	LTS
Carquinez Strait at Martinez	6	-230	0	210	-10	-1%	0%	1%	0%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

The growing imbalance between Delta-dependent water demands and the available supplies of good-quality water could be exacerbated in some regions. This could occur in the service areas if providers were required to replace good-quality Delta water with poorer quality water obtained from less desirable alternative sources. Regardless of the source of the degradation, resultant water quality impacts also could produce potentially significant adverse impacts on dependent water treatment costs, economic productivity, fish and wildlife habitats, public health, and social well-being.

> In some regions, providers would be required to replace good-quality Delta water with poorer quality water obtained from less desirable alternative sources.

5.3.7 CONSEQUENCES: PROGRAM ELEMENTS COMMON TO ALL ALTERNATIVES

For water quality, the environmental consequences of the Ecosystem Restoration, Water Quality, Levee System Integrity, Water Use Efficiency, Water Transfer, and Watershed Program elements are similar under all Program alternatives, as described below. This section also discusses the environmental consequences of the Storage and Conveyance elements that are common to all alternatives—those related to construction. The environmental consequences of actions in the Storage and Conveyance elements that are not related to construction of facilities vary among Program alternatives, as described in Section 5.3.8.

The discussions below relate to all Program regions.

5.3.7.1 ECOSYSTEM RESTORATION PROGRAM

The Ecosystem Restoration Program involves expanding floodplains and creating wetland habitat in the Bay-Delta system, and altering the management of storage reservoirs to provide more water for environmental purposes. The program would result in both short- and long-term effects on water quality. The short-term effects would occur during and in the years immediately following construction.

Construction activities necessary to implement the Ecosystem Restoration Program would include breaching and demolishing existing levees, and constructing new setback levees. Most of the construction activities would occur in dry conditions, but some construction in waterways would be necessary. Total suspended solids (TSS) is the primary contaminant of concern that would be affected by construction activities. Quantities of soil would be released into the water column during in-water construction, and flowing water would dislodge soil particles from new levees and wetlands during the initial water-soil contact period. Soil particles would increase the TSS content of Delta waters in the vicinity of construction activities. Nutrients and organic matter also are likely to be released during construction. Because some of the older levees may have been built with dredge spoils when environmental regulations were less stringent, there is a possibility that toxic substances could be released during their demolition. Before

Quantities of soil would be released into the water column during in-water construction, and flowing water would dislodge soil particles from new levees and wetlands during the initial water-soil contact period.

construction occurs, soils will be tested to determine potentially toxic substances. Such substances may be avoided or mitigated, depending on the type and concentration. It is expected that impacts of the Ecosystem Restoration Program that are associated with construction can be reduced to a less-than-significant level.

The long-term effects of the Ecosystem Restoration Program would include both beneficial and adverse changes in water quality. Expanding the floodplains and wetland areas in the Delta, in the northern portions of the Bay Region, and along the Sacramento and San Joaquin Rivers and their tributaries would restore some of the natural self-purification capacity of the waterways. Some contaminants are removed by various physical, chemical, and biological processes as river water flows through vegetated areas. The increased acreage of wetlands under the Ecosystem Restoration Program would increase the opportunity for these processes to occur. Also, most of the land that would be converted to wetlands or floodplain now is used for irrigated agriculture. Conversion of irrigated cropland or pasture to wetlands would reduce the discharge of nutrients and other agricultural chemicals into waterways, which also would benefit water quality in the Bay-Delta system.

Inundation of soils could cause changes in the degree to which the organic content of organic (peat) soils is mobilized into Delta waters.

Replacing irrigated cropland with wetlands could result in a net increase in water salinity because evaporation would increase. However, the conversion from irrigated crops to wetlands, also could reduce salinity due to the reduction or elimination of applied salts through fertilizer application. The concentration of TOC in river water also may change, but it is unknown whether concentrations would be increased or decreased. Wetlands have a demonstrated capacity to generate organic carbon. Inundation of soils could cause changes in the degree to which the organic content of organic (peat) soils is mobilized into Delta waters. Some theorize that the change from cropland to wetlands would extend the period in which water is in contact with peat soils, thus increasing TOC concentrations. Others theorize that opportunities for contact with peat soils would be reduced because sediment would be deposited in the wetlands, separating river water from direct contact with the underlying peat soils. Some studies currently are being conducted to evaluate how TOC is assimilated in the environment through microorganisms. Additional studies are needed to establish the relationship between management of riverside lands and TOC concentrations in river water.

Changing the TOC concentrations in Delta channels has the potential to affect ecosystem productivity, probably by increasing it. The increase in salinity would marginally reduce the suitability of Delta and Sacramento and San Joaquin River waters as sources of municipal and agricultural water supply. Potentially significant impacts can be mitigated to less-than-significant levels.

An increase in TOC concentrations in Delta waters in the vicinity of municipal water intakes could significantly affect municipal water supplies.

An increase in TOC concentrations in Delta waters in the vicinity of municipal water intakes could significantly affect municipal water supplies, in turn affecting water system customers in the Central Valley and in the Other SWP and CVP Service Areas. Some forms of TOC react with the chemicals used to disinfect water at the treatment plant and form chemical compounds believed to be hazardous to humans. The significance of the adverse impact would depend on the magnitude of the increase in TOC concentrations and its reactivity with disinfectants. Mitigation may not be available to reduce impacts to less-than-significant levels.

Under the Ecosystem Restoration Program, flow regimes in the Sacramento and San Joaquin Rivers, their tributaries, and the Delta would be established that emulate natural seasonal flows. These large flows would be allowed to pass through the Delta and on to San Francisco Bay. Their long-term effects would include lowering water salinity and temperature, and increasing dissolved oxygen concentrations in Delta waterways at certain times of the year. These effects would benefit water quality for ecosystem restoration.

Reestablishing natural flow regimes would help to lower water salinity and temperature, and increase dissolved oxygen concentrations in Delta waterways at certain times of the year.

5.3.7.2 WATER QUALITY PROGRAM

The Water Quality Program calls for a range of actions that would reduce the discharge to waterways of contaminants in municipal and industrial wastewater, urban and agricultural runoff, and drainage from abandoned mines. Water supply intakes would be relocated to areas with better water quality. Research and monitoring programs would be undertaken to improve understanding of the significance of various contaminants in water and the effectiveness of remedial actions. The actions are described in detail in the Water Quality Program Plan Appendix.

The cumulative and long-term effect of the Water Quality Program would be to reduce the mass of contaminants entering the Bay-Delta system and its tributaries which would, in turn, generally improve the water quality in the Sacramento and San Joaquin Rivers, the Delta, and San Francisco Bay. Improved water quality would more readily support designated beneficial uses, including the use of Delta and river water for ecosystem restoration and municipal water supply. A specific action addresses reducing the discharge of oxygen-demanding substances in the vicinity of the City of Stockton. As a result, this action would improve the dissolved oxygen content of waters in the southeast Delta. Another action addresses reducing the discharge of selenium from oil refineries, which would reduce selenium concentrations in the waters of San Francisco Bay.

The cumulative and long-term effect of the Water Quality Program would be to reduce the mass of contaminants entering the Bay-Delta system and its tributaries.

Drinking water actions would benefit municipal water supply customers in the Central Valley and in the Other SWP and CVP Service Areas who obtain their water supplies from the Delta and its tributaries. Municipal and agricultural users of Delta water also would benefit from the water quality actions to relocate water supply intakes to areas with better water quality. The Water Quality Program would not result in any long-term adverse environmental impacts.

Some actions in the Water Quality Program involve construction (for example, increased treatment of municipal and industrial wastewater and urban runoff, and agricultural irrigation system improvements). Construction activities would occur in the Bay, Delta, Sacramento River, and San Joaquin River Regions. It is expected that the adverse impacts of construction on water quality, primarily the discharge of soil particles and consequent increase of TSS concentrations and the associated release of toxicants in the vicinity of construction sites, could be reduced to a less-than-significant level by the application of appropriate mitigation measures.

5.3.7.3 LEVEE SYSTEM INTEGRITY PROGRAM

The Levee System Integrity Program involves extensive construction to raise and strengthen levees in the Delta. The program would result in short-term adverse effects on water quality in the Delta. The program would result in long-term beneficial effects on water quality in the Delta and on the quality of water supplied to municipal and agricultural water users in the Central Valley and in the Other SWP and CVP Service Areas.

The Levee System Integrity Program involves extensive construction to raise and strengthen levees in the Delta.

Waterside construction activities for the Levee System Integrity Program would result in short-term effects on water quality similar to the levee modifications components of the Ecosystem Restoration Program, except that they would occur only in the Delta. Local increases in the TSS content of waters in Delta channels are expected. Some increase in nutrient and TOC concentrations also may occur. Toxic substances contained in old levees or in channel sediments could be released during waterside levee work or dredging. However, it is expected that short-term construction impacts can be reduced to a less-than-significant level.

If the levees are not improved, the risk of failure during earthquakes and floods or as a result of gradual structural deterioration is considerable. A catastrophic levee failure could cause saline waters from the Bay to penetrate deep into the Delta. This would be most pronounced in dry or critically dry years when the fresh-water flow from the Central Valley is insufficient to repel saline waters. Intrusion of sea water would result in a potentially significant adverse impact on beneficial uses of Delta waters, including municipal and agricultural water supply and possibly the protection of aquatic life. Water customers in the Central Valley and in the Other SWP and CVP Service Areas could be deprived of water from the Delta for months or years. The Levee System Integrity Program would reduce the risk of catastrophic levee failure and consequently the risk of a sudden deterioration in water quality. The Levee System Integrity Program would not result in any long-term adverse effects on water quality.

A catastrophic levee failure would cause saline waters from the Bay to penetrate deep into the Delta.

5.3.7.4 WATER USE EFFICIENCY PROGRAM

A number of measures in the Water Use Efficiency Program provide incentives for water conservation and reduce institutional barriers to water recycling. Because little construction would be involved, short-term adverse environmental impacts are considered less than significant.

The primary long-term effect of the Water Use Efficiency Program would be reducing the amount of water needed to support a given level of population and economic activity in California. Because diverting water from streams for human use generally results in adverse impacts on water quality (such as increased temperature and less dilution of contaminants), an increase in water use efficiency would result in an overall benefit to water quality. However, the beneficial effect would not be distributed evenly across all surface waters and may be partially offset by adverse impacts. Increased water use

The primary long-term effect of the Water Use Efficiency Program would be reducing the amount of water needed to support a given level of population and economic activity in California.

efficiency would adversely affect water quality when the volume of municipal wastewater or agricultural tailwater discharged to a stream is reduced but the mass load of salts and other contaminants in the discharge remains the same. However, since the Water Use Efficiency Program is also focusing on achieving benefits related to water quality and flow timing, it is expected that many of these potentially significant adverse effects would be offset by other water quality improvements. Any potentially significant adverse effect would be most pronounced in streams where municipal or agricultural discharges represent a substantial proportion of streamflow.

The water quality benefits of the Water Use Efficiency Program primarily would occur in the Bay and Delta Regions, and in river reaches in the Central Valley downstream of municipal and agricultural water supply intakes. The quality of water diverted from the Delta could be improved, which could benefit municipal and agricultural water users in the Central Valley and in the Other SWP and CVP Service Areas. Any adverse effects of the Water Use Efficiency Program would occur most acutely in small streams in the Sacramento River and San Joaquin River Regions, downstream of municipal and agricultural wastewater discharges. In most cases, it is expected that the localized adverse water quality impacts of the Water Use Efficiency Program can be mitigated to a less-than-significant level by increasing treatment of wastewater before it is discharged to waterways, increasing fresh-water releases from reservoirs to provide more dilution water, or altering the timing of agricultural return flows to coincide with periods when receiving water bodies have greater assimilative capacity.

5.3.7.5 WATER TRANSFER PROGRAM

The Water Transfer Program proposes a framework of actions, policies, and processes that, collectively, would facilitate water transfers and further development of a state-wide water transfers market. This could result in the transfer of water from areas of abundance to areas of scarcity. The program does not include specific water transfer proposals. These would occur between willing sellers and willing buyers as they do now. Little construction would be involved; consequently, short-term adverse impacts are considered less than significant.

Unlike the Water Use Efficiency Program, the Water Transfer Program would not reduce the total amount of water needed to support a given level of population and economic activity. Rather, it would temporarily or permanently reallocate water supplies among various users, including the environment.

> Water transfers would delay or eliminate the need to develop new water supply sources, probably new storage reservoirs, which would result in the potential to improve water quality.

Water transfers could affect water quality primarily through changes to river flow and water temperatures. In addition, the source of water for a transfer, the timing, magnitude, and pathway of each transfer would affect the potential for potentially significant impacts. Potential beneficial water quality impacts are a function of the ability of a transfer to decrease the concentration of various contaminants through both increased streamflow and the potential for obtaining higher quality water from several sources. Because specific transfers can invoke both beneficial and adverse impacts, at times on the same resource, net effects must be considered on a case-by-case basis.

The Water Transfer Program could benefit the Other SWP and CVP Service Areas when water of higher quality than local sources is imported into the region through a water transfer. For example, water transferred into southern California from the Central Valley can be of better quality than existing sources imported from the Colorado River.

5.3.7.6 WATERSHED PROGRAM

The Watershed Program would provide technical and financial assistance to local watershed programs. It would support projects, including ecological restoration projects, that would reduce the discharge of contaminants from nonpoint sources to waterways. The contaminant most likely to be affected is TSS, but some reduction in the discharge of nutrients, pesticides, and pathogenic microorganisms also may occur. Because most of the nonpoint source control measures are likely to be nonstructural, little construction is expected. Consequently, short-term adverse impacts of the program on water quality are expected to be less than significant.

Long-term impacts of the Watershed Program on water quality are expected to be exclusively beneficial. By reducing the mass of pollutants reaching the Delta from tributary streams, the program would improve in-stream water quality and the quality of water diverted for municipal and agricultural use. In-stream water quality would be improved in the Sacramento River and San Joaquin River Regions, and the reduced contaminant load in Delta outflow would benefit the Bay Region. Improvements in the quality of water diverted from the Delta would benefit municipal and agricultural uses in the Central Valley and in the Other SWP and CVP Service Areas.

Long-term impacts of the Watershed Program on water quality are expected to be exclusively beneficial.

5.3.7.7 IMPACTS RELATED TO CONSTRUCTION FOR STORAGE AND CONVEYANCE ELEMENTS

The Program alternatives may include new storage projects. Water storage may occur in surface or groundwater reservoirs. The storage projects would result in short-term and long-term effects on water quality. The short-term effects on water quality from construction of surface water reservoirs primarily would result from ground disturbance and consequent increased soil erosion rates. Excess sediment could be discharged to streams from construction activities being performed in streams and from precipitation falling on exposed soils.

Groundwater storage projects could use injection wells or spreading basins to convey water to underground storage. Because construction of injection wells would involve little ground disturbance or increased soil erosion, minor adverse effects on water quality are expected.

Groundwater storage projects could use injection wells or spreading basins to convey water to underground storage.

Short-term impacts on water quality from surface water reservoir construction would affect the Delta, Sacramento River, and San Joaquin River Regions. Short-term adverse effects on water quality from groundwater storage construction would affect the

Sacramento River and San Joaquin River Regions. Mitigation is available to reduce all potentially significant impacts to less-than-significant levels.

Storing water in surface reservoirs may affect water quality in a number of ways. The reservoir pool would inundate previously dry lands. Depending on geologic characteristics, trace elements may be mobilized, particularly in the deeper parts of the reservoirs where dissolved oxygen concentrations may become depressed. Mercury compounds are present in rocks in some parts of the Sacramento Valley. Under certain conditions, these compounds may be converted into biologically available methyl mercury. Reservoirs in California generally experience algal blooms in the first years of operation due to mobilization of nutrients. Periodic blooms can continue indefinitely.

Typically, surface water reservoirs would be used to store abundant spring flows for later release and use in dry months or years. Off-stream reservoirs would alter the hydrology of the intermittent or small perennial streams on which they are built. Spring flows would be reduced or eliminated compared to unimpaired flows, and flow in naturally dry periods would be increased. Because reservoirs trap sediment, the TSS content of water released into the downstream channel would be less than the TSS content of stream water prior to reservoir construction. The reduction in TSS content would be greatest during high-flow conditions. Nutrients and organic matter in particulate form also would be trapped in the reservoir, and their concentrations in stream water below the reservoir would be reduced. Depending on the design of the reservoir outlet, the dissolved oxygen content of released water could be less than that of the stream to which is it discharged, resulting in lowered oxygen in the stream. Conversely, when the reservoir is spilling, water may become supersaturated with oxygen and nitrogen.

Off-stream reservoirs would alter the hydrology of the intermittent or small perennial streams on which they are built. Spring flows would be reduced or eliminated compared to unimpaired flows, and flow in naturally dry periods would be increased.

During periods of low unimpaired streamflow, releasing water from reservoirs could substantially reduce water temperatures in the downstream river reaches. Water released from reservoirs initially would be cooler than unimpaired stream waters and would remain cooler due to the increased flow volume.

Groundwater storage would be used conjunctively with surface waters to meet various needs and demands for water. During periods of high streamflow, groundwater aquifers with available space would be artificially recharged with surface water, using spreading basins or injection wells. Water would be pumped from the aquifers to meet municipal and agricultural water demand when surface water supplies are limited. Pumped water may be used directly or returned to surface streams for diversion at a downstream location.

Groundwater storage would be used conjunctively with surface waters to meet various needs and demands for water.

The quality of water diverted from surface streams, temporarily stored in the ground, and then withdrawn for use would be altered. Water pumped from the ground would contain less suspended solids, more dissolved solids, and generally higher nitrates than the source water. If the water is used directly by municipalities or agricultural, its suitability for use would be reduced somewhat by its increased mineral concentrations. If the water is pumped into a surface stream during low-flow periods, it would result in similar effects to those described for releasing water from surface reservoirs, with the possible addition of increased biological productivity due to the presence of nitrate.

The quality of water diverted from surface streams, temporarily stored in the ground, and then withdrawn for use would be altered.

The diversion of water into storage from the Sacramento River, San Joaquin River, or other large streams tributary to the Delta during high-flow periods would reduce the magnitude and duration of high flows. Although the effects of the diversions on in-stream water quality in the rivers and in the Delta would be minor, they could be of greater consequence to San Francisco Bay. Periodic high flows from the Delta profoundly affect salinity concentrations in the Bay and may play an important role in initiating water circulation in the South Bay. Increased diversion of water from the Delta for transfer to storage reservoirs via the California Aqueduct or the DMC could reduce Delta outflow and adversely affect water quality in San Francisco Bay.

The potentially significant impacts of a reduction in the magnitude and frequency of high Delta outflows on water quality in San Francisco Bay would be unavoidable.

Release of water down the Sacramento River, the San Joaquin River, or other major streams during low-flow periods would improve water quality in the rivers and in the Delta. Contaminants discharged by cities, industries, and agriculture would be diluted; and in-stream contaminant concentrations would be reduced in the rivers and in the Delta. Improved water quality in the Delta would benefit municipal and agricultural water users in the Delta, Central Valley, and the Other SWP and CVP Service Areas.

Most of the long-term adverse effects of surface and groundwater storage on water quality can be reduced to a less-than-significant level by various mitigation measures.

5.3.8 CONSEQUENCES: PROGRAM ELEMENTS THAT DIFFER AMONG ALTERNATIVES

The generation of modeling results, which helps to predict impacts, evolved in response to decisions on the Preferred Program Alternative and Alternatives 1, 2, and 3. Since spring 1997, there have been several DSM2 model runs, and assumptions for these runs have not been uniform. Recent modeling work includes the generation of a set of modeling runs that predict the ranges of impacts of each Program Alternative under a reasonable range of water management scenarios, referred to as bookends. The set of assumptions for the bookends include a range of water demands and regulatory requirements. The assumed ranges also were included in the No Action Alternative. A more detailed description of the bookends are in Sections 5.1.4.1 and 5.1.4.2 of Chapter 5.1. These results, although available and incorporated in this analysis, are considered preliminary.

For water quality, the Storage and Conveyance element actions that are not related to construction are integrated and result in environmental consequences that differ among the alternatives, as described below.

5.3.8.1 PREFERRED PROGRAM ALTERNATIVE

Delta Region

The Preferred Program Alternative is a phased process that does not approve the construction of the diversion facility unless certain criteria are met. The Preferred Program Alternative would function similarly to Alternative 1 if a diversion facility is not constructed. The remainder of this section assumes that a diversion facility is in place.

The Preferred Program Alternative is a phased process that does not approve the construction of the diversion facility unless certain criteria are met.

The four primary sources that transport contaminants into the Delta are San Francisco Bay, the Sacramento and San Joaquin Rivers, and waste discharges into the system. Other primary variables include high-quality inflows from tributaries, especially the Sacramento River and east side streams, and the timing and distribution of their flows throughout the Delta. The capacity of conveyance features and new storage facility capacities and locations (if any) will greatly influence the overall and localized water quality effects of the Preferred Program Alternative (and the other Program alternatives evaluated) on constituent sources and their circulation within the Delta, the Central Valley, and areas of use. The locations of key water quality simulation stations and the Delta subregions that they represent which are used to gauge the water quality effects of primary concern are shown in Figure 5.3-1. The subregions were delineated on the basis of common hydrodynamic and water quality characteristics that help to determine the water quality impacts of the Program alternatives.

Water quality conditions in the Delta would be best where and when good-quality water, primarily from the Sacramento River, flows in optimal patterns across the Delta to discharge to Suisun Bay and to the diversion pumps. During this process, whether the flows are natural or induced, they would continue to intermix with, dilute, and flush poorer quality water from the San Joaquin River and other channels containing constituents from point and nonpoint waste discharges. It is believed that to prevent increases in salinity from ocean salt intrusion, net tidal flow reversals (especially negative QWEST flows) should be minimized. The actual water quality improvements achieved would depend on the capacities and configurations selected for the pilot Hood diversion facility, and other north Delta and south Delta channel modifications. (Note that if the Hood diversion and other North Delta improvements were not constructed, the impacts would be similar to those for Alternative 2.) Water quality also would be affected by the number and type of south Delta water quality control facilities; Delta facility and pump operations; local discharges, including island drainage; and the locations, timing, and magnitudes of any additional flow releases from upstream reservoirs.

Water quality conditions in the Delta would be best where and when good-quality water, primarily from the Sacramento River, flows in optimal patterns across the Delta to discharge to Suisun Bay and to the diversion pumps.

Table 5.3-4a summarizes the results of model predictions of average salinity changes (expressed as EC) throughout the Delta for the Preferred Program Alternative compared to the No Action Alternative for a representative long-term hydrologic sequence that includes all water-year types See Section 5.2. Separate predictions are shown based on modeling assuming water management Criterion A without storage, and water management Criterion B with storage which define the bookends for the analysis of water quality. For both sets of criteria, changes are shown for the annual average value over the period of the simulation, and for the month of the year during which the salinity is the

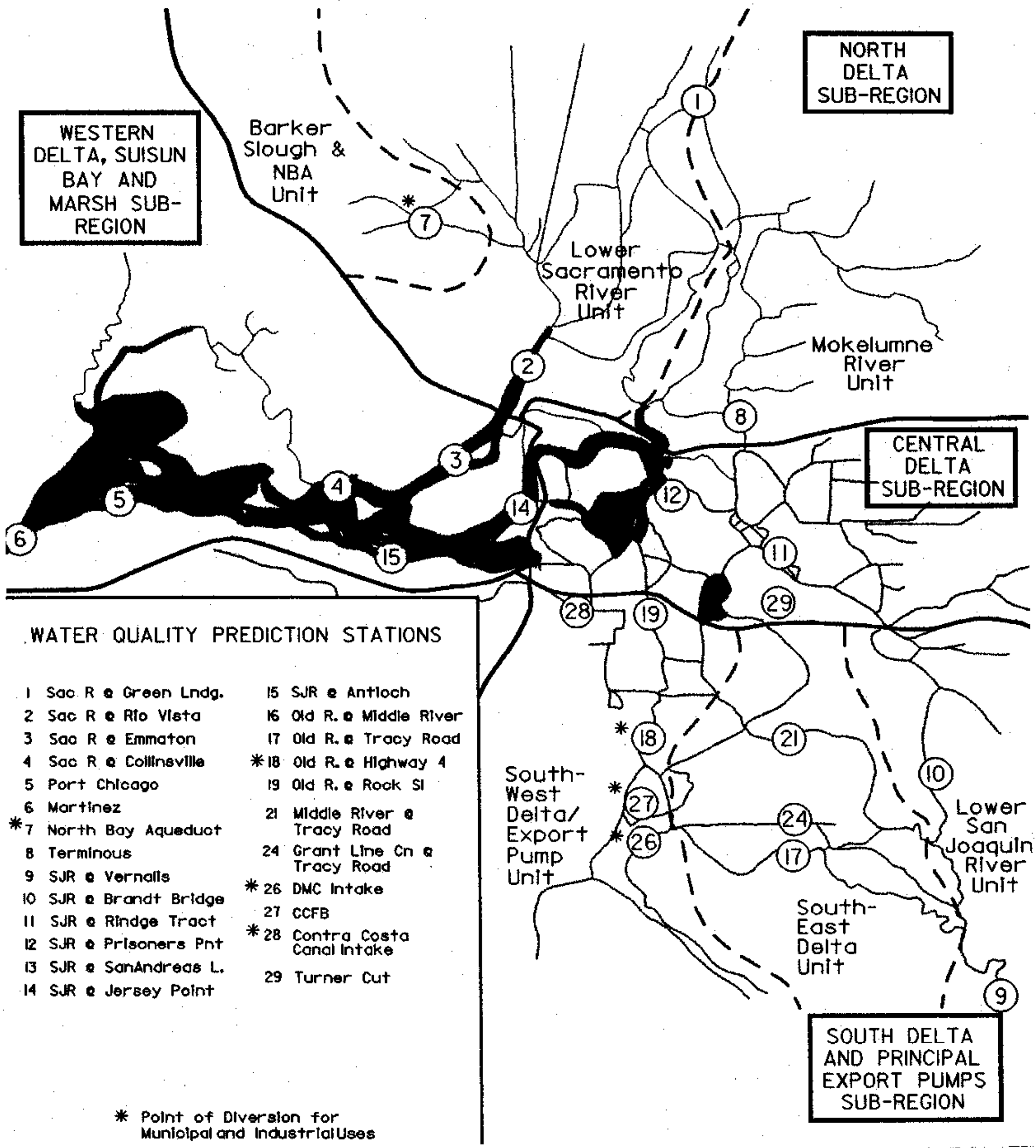


Figure 5.3-1. Key Delta Water Quality Simulation Stations and Delta Subregions

Table 5.3-4a. Predicted Salinity Changes Between the Preferred Program Alternative and the No Action Alternative for All Water-Year Types (Salinity Expressed as EC)

		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE			
DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	ANNUAL CHANGE (µmhos/cm)	MONTH OF MAXIMUM EC (µmhos/cm)	ANNUAL CHANGE (µmhos/cm)	MONTH OF MAXIMUM EC (µmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
North Bay Aqueduct Intake at Barker Slough	7*	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Mokelumne River at Terminous	8	-10	-30	-10	-20	-6%	-14%	-6%	-9%	Jan	LTS - B
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	-10	-220	-50	-330	-2%	-32%	-12%	-50%	Dec	LTS - B
Turner Cut	29	30	-110	0	-200	6%	-16%	0%	-31%	Jan	LTS - B
San Joaquin River at Prisoner's Point	12	-20	-230	-120	-430	-4%	-24%	-26%	-46%	Dec	LTS - B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-10	0	-10	0	-2%	0%	-2%	0%	Dec	LTS
San Joaquin River at Brandt Bridge	10	20	30	10	20	3%	4%	2%	3%	Dec	LTS
Middle River at Tracy Road	21	-10	-130	-70	-230	-2%	-16%	-15%	-29%	Jan	LTS - B
Grant Line Canal at Tracy Road	24	-20	0	-60	-10	-3%	0%	-10%	-1%	Dec	LTS - B
Old River at Tracy Road	17	-20	70	-70	-90	-3%	10%	-11%	-13%	Oct	LTS - B
Old River at Rock Slough	19	-20	-250	-140	-480	-3%	-21%	-24%	-42%	Dec	LTS - B
Contra Costa Canal Intake at Rock Slough	28*	-20	-250	-140	-470	-3%	-21%	-22%	-40%	Dec	LTS - B
Old River at SR 4 (and New CCWD Intake)	18*	-30	-250	-120	-450	-5%	-23%	-22%	-43%	Dec	LTS - B
Clifton Court Forebay	27*	-10	-200	-110	-370	-2%	-20%	-21%	-39%	Dec	LTS - B
Delta-Mendota Canal Intake from Old River	26*	-20	-190	-90	-290	-3%	-21%	-16%	-33%	Dec	LTS - B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	20	-110	60	-80	2%	-5%	7%	-4%	Sep	LTS
Sacramento River at Collinsville	4	30	390	110	490	1%	7%	4%	9%	Oct	LTS
San Joaquin River at Jersey Point	14	30	-150	-120	-440	3%	-7%	-11%	-20%	Dec	LTS - B
San Joaquin River at Antioch	15	60	210	10	30	3%	4%	0%	1%	Oct	LTS
Suisun Bay at Port Chicago	5	-10	350	190	250	0%	2%	2%	1%	Sep	LTS
Carquinez Strait at Martinez	6	-20	400	370	420	0%	2%	2%	2%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
µmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

Table 5.3-4b. Predicted Salinity Changes Between the Preferred Program Alternative and the No Action Alternative for Dry and Critical Years (Salinity Expressed as EC)

		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE			
DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	ANNUAL CHANGE (µmhos/cm)	MONTH OF MAXIMUM EC (µmhos/cm)	ANNUAL CHANGE (µmhos/cm)	MONTH OF MAXIMUM EC (µmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
North Bay Aqueduct Intake at Barker Slough	7*	0	0	-10	-10	0%	0%	-5%	-4%	Mar	LTS
Mokelumne River at Terminous	8	-10	-40	-10	-30	-5%	-17%	-5%	-13%	Feb	LTS - B
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	-10	-280	-70	-410	-2%	-35%	-15%	-53%	Dec	LTS - B
Turner Cut	29	30	-190	-20	-320	5%	-23%	-4%	-43%	Jan.	LTS - B
San Joaquin River at Prisoner's Point	12	-30	-290	-160	-560	-5%	-25%	-30%	-50%	Dec	LTS - B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-20	0	-20	0	-3%	0%	-3%	0%	Feb	LTS
San Joaquin River at Brandt Bridge	10	20	0	20	0	3%	0%	3%	0%	Feb	LTS
Middle River at Tracy Road	21	-20	-210	-100	-350	-3%	-21%	-19%	-37%	Jan.	LTS - B
Grant Line Canal at Tracy Road	24	-40	0	-90	0	-5%	0%	-12%	0%	N/A	LTS - B
Old River at Tracy Road	17	-50	0	-110	0	-7%	0%	-15%	0%	N/A	LTS - B
Old River at Rock Slough	19	-30	-300	-180	-610	-4%	-21%	-26%	-44%	Dec	LTS - B
Contra Costa Canal Intake at Rock Slough	28*	-30	-300	-180	-590	-4%	-21%	-25%	-43%	Dec	LTS - B
Old River at SR 4 (and New CCWD Intake)	18*	-40	-310	-460	-560	-6%	-24%	-49%	-45%	Dec	LTS - B
Clifton Court Forebay	27*	-20	-230	-140	-460	-3%	-20%	-23%	-42%	Dec	LTS - B
Delta-Mendota Canal Intake from Old River	26*	-40	-210	-120	-350	-6%	-20%	-18%	-35%	Jan.	LTS - B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	30	-160	60	-200	3%	-6%	5%	-7%	Sep	LTS
Sacramento River at Collinsville	4	30	-210	80	-360	1%	-3%	2%	-5%	Sep	LTS
San Joaquin River at Jersey Point	14	0	-170	-180	-630	0%	-6%	-13%	-22%	Dec	LTS - B
San Joaquin River at Antioch	15	40	280	-60	10	1%	5%	-2%	0%	Oct	LTS
Suisun Bay at Port Chicago	5	-120	-20	140	-230	-1%	0%	1%	-1%	Sep	LTS
Carquinez Strait at Martinez	6	-140	-10	350	-30	-1%	0%	2%	0%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
µmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

highest. Compared to the No Action Alternative, Table 5.3-4a shows that under the Preferred Program Alternative, salinity is projected to improve overall in the northeast Delta, in the central Delta, in the south and southwest Delta, and on the San Joaquin River in the west Delta (as indicated by Jersey Point). Salinity decreases of more than 10% are considered to be beneficial, as shown in the table. For example, at the intake to CCFB, the mean long-term salinity is projected to decrease by 10-110 μmhos/cm (2-21%), and the mean monthly salinity for December, the month of highest projected salinity, is projected to decrease by about 200-370 μmhos/cm (20-39%). Changes during other months could be both significant and larger.

Under the Preferred Program Alternative, salinity is projected to improve overall in the northeast Delta, in the central Delta, in the south and southwest Delta, and on the San Joaquin River in the west Delta.

During dry and critical years, Table 5.3-4b shows that the decreases in salinity become larger, ranging from 10 to 110 μmhos/cm (2-21%) for the long-term maximum salinity at CCFB, and from 200 to 370 μmhos/cm (20-39%) on average for the month of maximum salinity, December. Compared to the "all year" predictions, the only change in level of significance occurs at Grant Line Canal at Tracy Road where the change in EC is sufficiently large during September of dry and critical years to qualify as a beneficial effect. Significant improvements during months of maximum salinity are projected to occur during winter months from December through February, and most frequently during December and January.

Overall, the Preferred Program Alternative is projected to improve in-Delta and export water quality and dependent beneficial uses because of the resultant increases in the flow of good-quality water from the north Delta (especially with new upstream storage). Other contributing factors include corresponding decreases in the quantities of sea-water intrusion and improved water circulation in affected Delta channels.

The Preferred Program Alternative is projected to improve in-Delta and export water quality and dependent beneficial uses because of the resultant increases in the flow of good-quality water from the north Delta.

Potential improvements in Delta water quality compared to the No Action Alternative would be greatest in the central and south Delta, especially in the reach of the San Joaquin River in the central Delta where flows would enter from the north, and in Old River and other southwest Delta channels that convey water directly toward the pumps. A shift in export water quality based on reduced San Joaquin River flows entering the pumps would allow selenium in the San Joaquin River to enter the Delta and Bay.

The actual magnitudes of the salinity changes would vary tidally, seasonally, and spatially throughout the Delta, depending on factors such as the mixtures of source waters attained at each location that result from variations in the pathways and timing of flows through Delta channels. The magnitude of the changes also would depend on variations in annual hydrology. In general, the improvements in water quality would increase during dry and critical years, and be attenuated during above-normal and wet years.

Average monthly salinities during the summer months would be slightly increased in the San Joaquin River, in the west Delta, and in Old River. Whereas the above-referenced tables show the salinity changes relative to the No Action Alternative, Figures 5.3-2 through 5.3-6 show the predicted ranges of mean annual and peak EC values for the Preferred Program Alternative and the No Action Alternative at the following five stations, respectively: Old River at CCFB, San Joaquin River at Prisoner's Point, San Joaquin River at Jersey Point, Middle River at Tracy Road, and Old River at Rock

Figure 5.3-2. Ranges of Salinity (expressed as EC) at Clifton Court Forebay for the Preferred Program Alternative

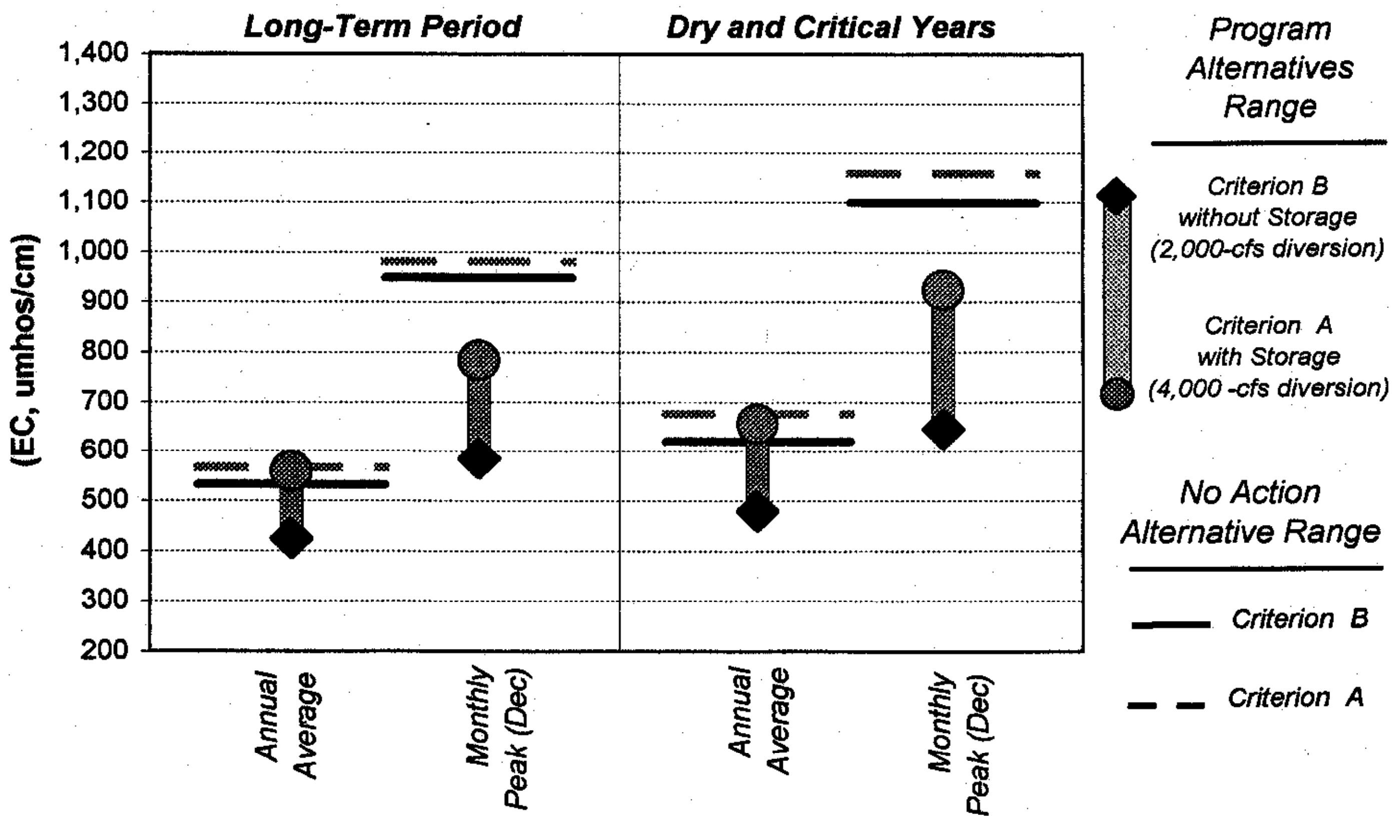


Figure 5.3-3. Ranges of Salinity (expressed as EC) at Prisoner's Point for the Preferred Program Alternative

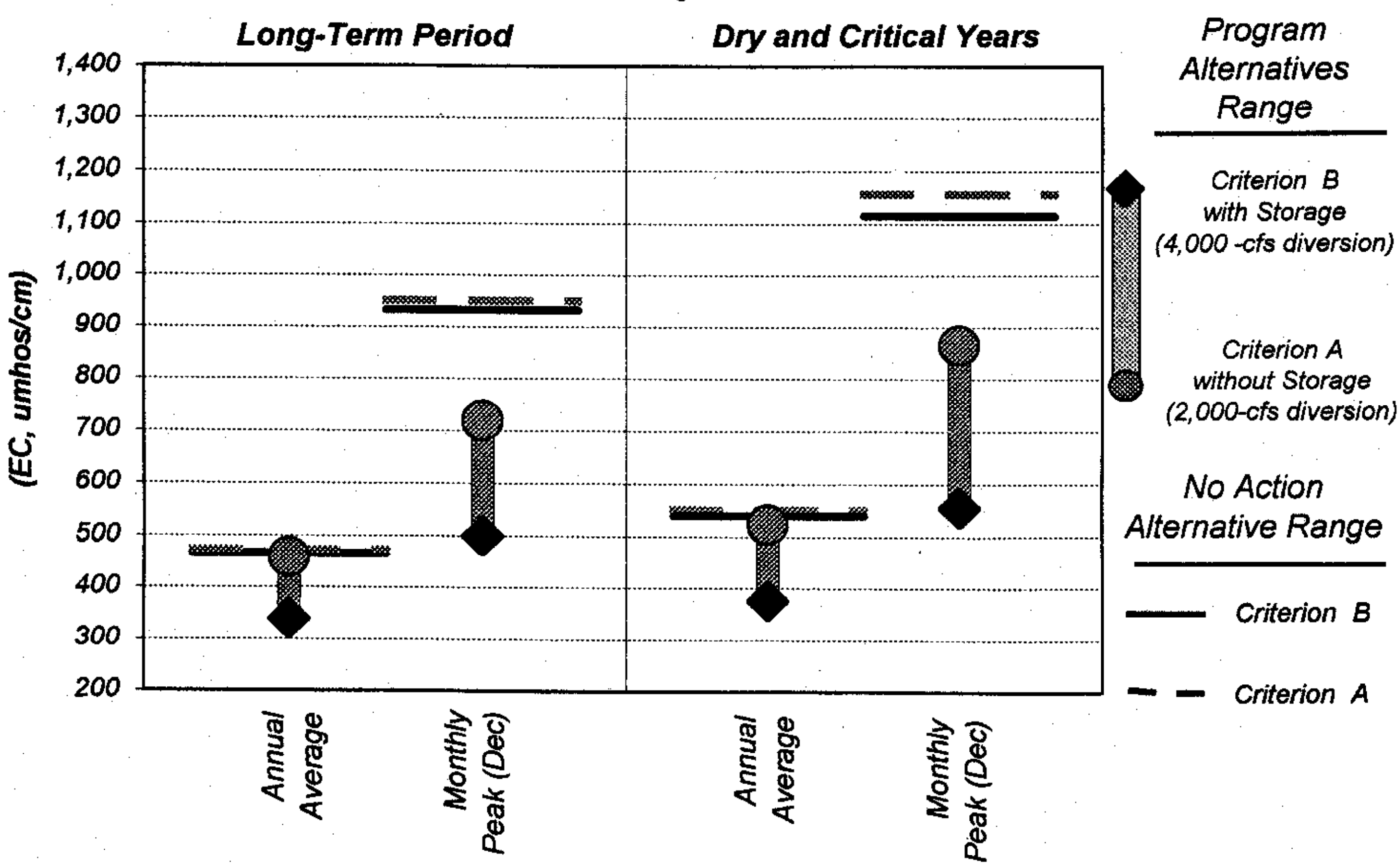


Figure 5.3-4. Ranges of Salinity (expressed as EC) at Jersey Point for the Preferred Program Alternative

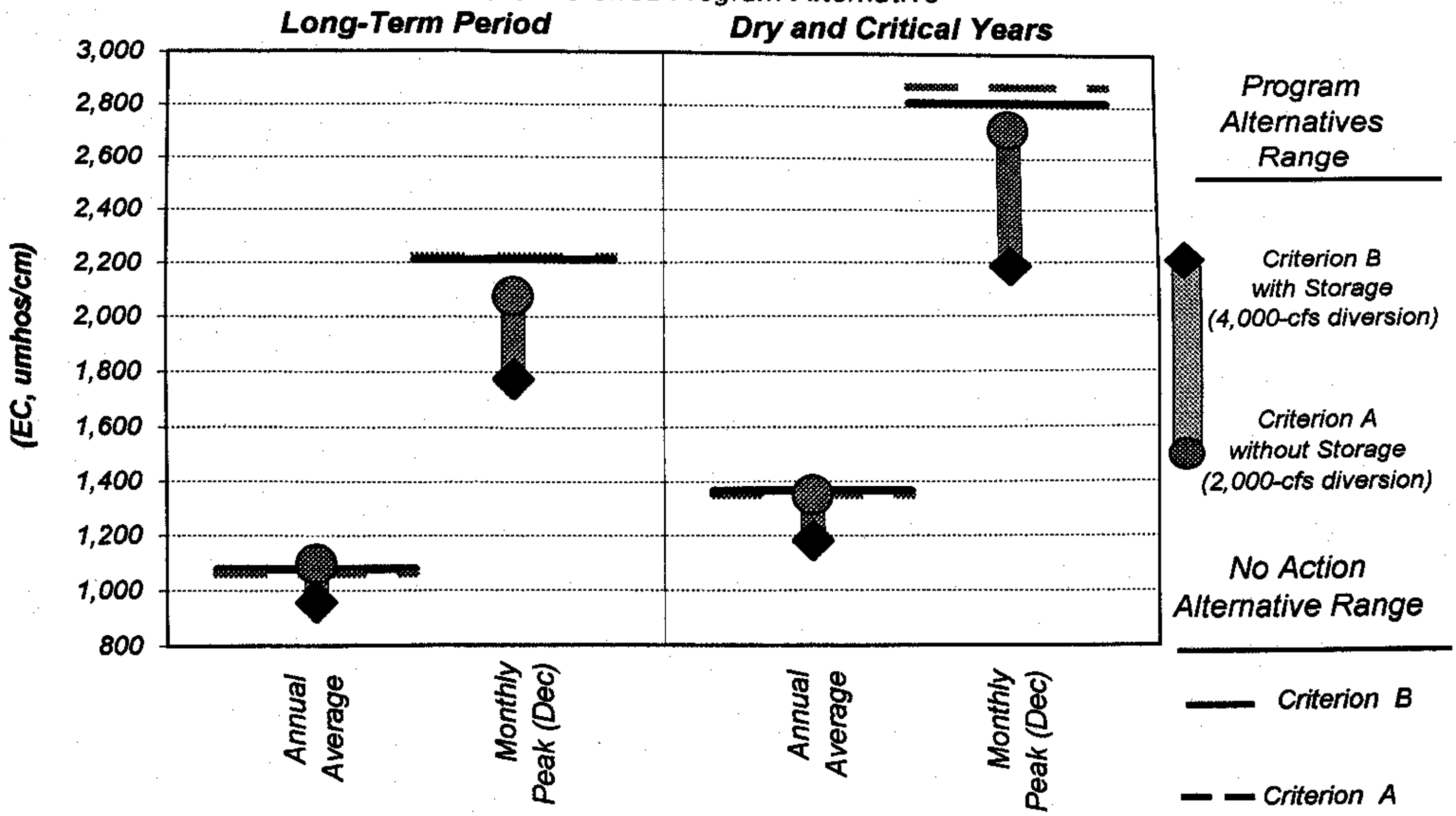


Figure 5.3-5. Ranges of Salinity (expressed as EC) at Middle River at Tracy Road for the Preferred Program Alternative

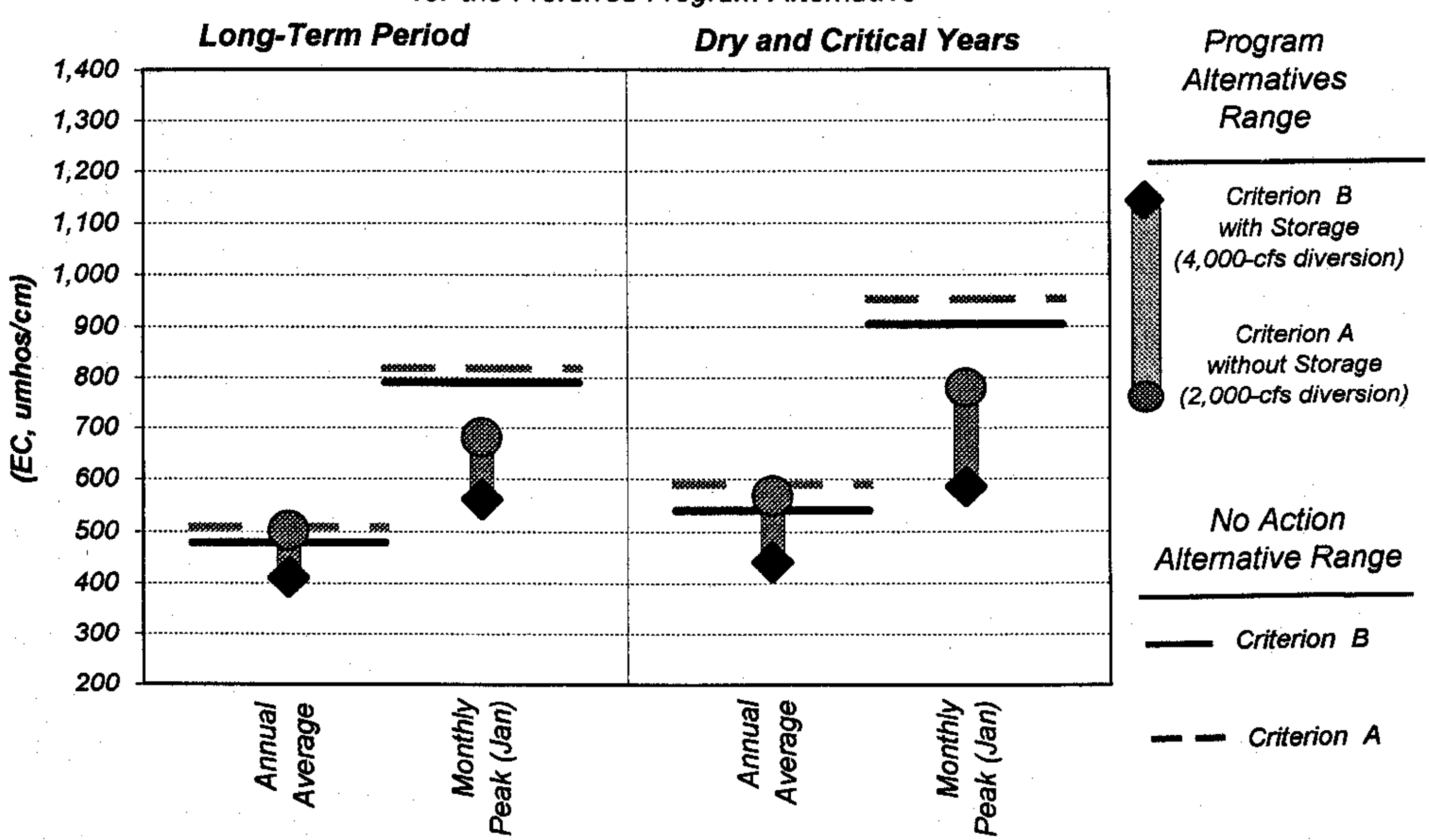
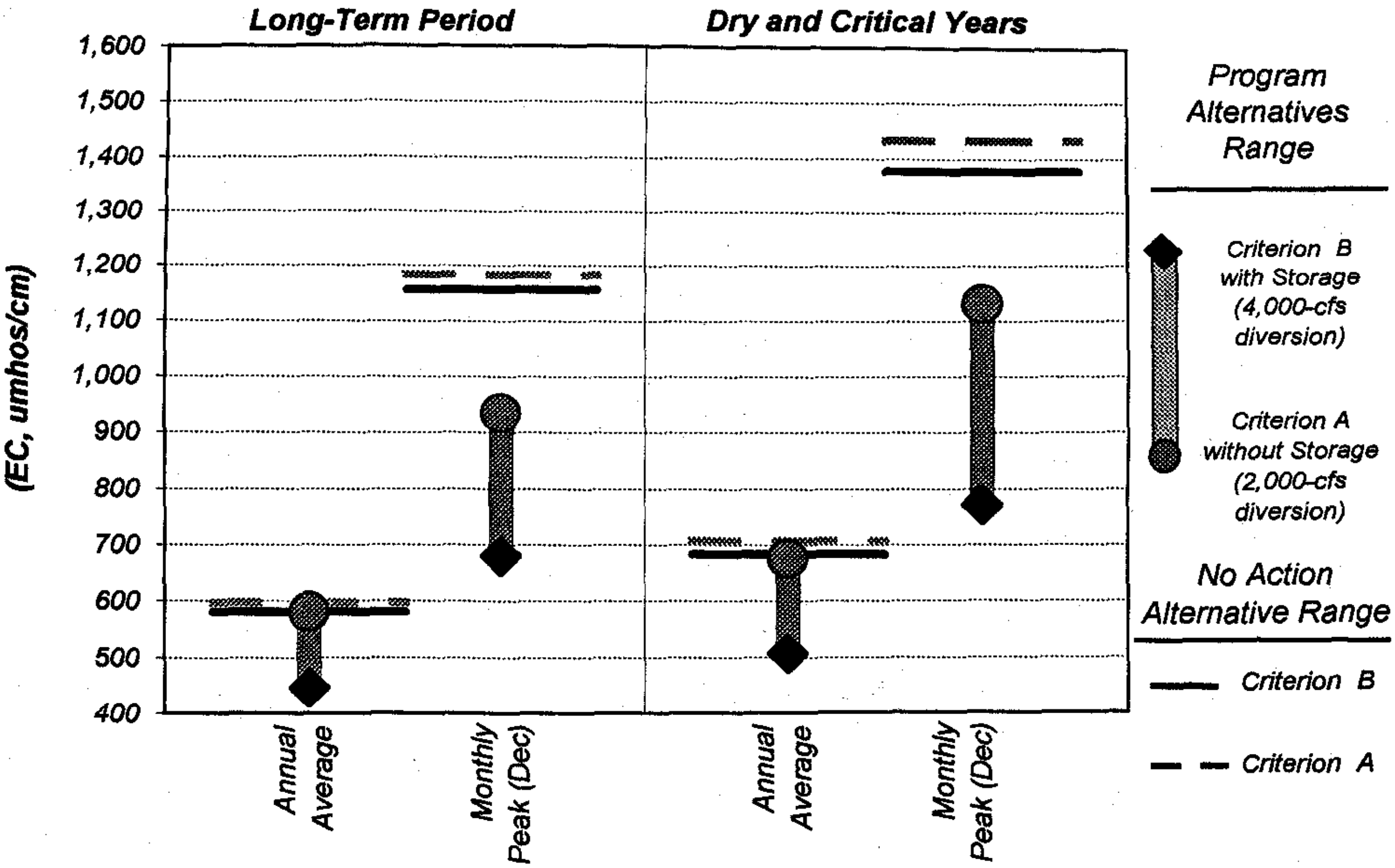


Figure 5.3-6. Ranges of Salinity (expressed as EC) at Rock Slough for the Preferred Program Alternative



Slough. These locations were selected to be representative of locations in the central, south, and west Delta, including several key export locations.

The range of values for each alternative plotted in the figures are indicative of the range of uncertainty in potential outcomes considering variations in conveyance capacities, storage, hydrology, and water management and operations. At Old River at Rock Slough, the Preferred Program Alternative ranges for dry and critical years and the long term are distinctly lower and do not overlap with the No Action Alternative range. At the remaining selected stations, the ranges do overlap slightly; however, the Preferred Program Alternative ranges are still distinctly lower. This indicates that the EC values under the Preferred Program Alternative are definitively lower at all of the selected stations than those of the No Action Alternative. The distribution of the ranges (that is, increasing from Jersey Point to Middle River at Tracy Road and CCFB) can be explained by the increased effects of salinity intrusion associated with water management Criterion B with storage.

At Old River at Rock Slough, the Preferred Program Alternative ranges for dry and critical years and the long term are distinctly lower and do not overlap with the No Action Alternative range.

The increased cross-Delta flows and increased sea-water intrusion, coupled with increases in the concentrations of salts drawn from the San Joaquin River and interior Delta drainage, could act in concert to increase the frequency of higher bromide concentrations at Old and Middle Rivers.

Bay Region

The addition of new storage could improve water quality and dependent conditions for estuarine biological resources in the west Delta as a result of increased Delta outflows, especially during low-outflow periods.

With increased exports from the Delta, the Preferred Program Alternative could slightly reduce net Delta outflows, resulting in greater sea-water intrusion into the Bay and resultant increases in salinity, including bromide, in the San Francisco, San Pablo, and Suisun Bays (the Suisun Bay is contiguous with Delta channels and diversion points). However, these increases are projected to be less than significant.

With increased exports from the Delta, the Preferred Program Alternative could slightly reduce net Delta outflows, resulting in greater sea-water intrusion into the Bay and resultant increases in salinity.

Sacramento River Region

Without new storage, the Preferred Program Alternative is not expected to affect surface water flows in the Sacramento River Region or the resultant water quality conditions. Impacts on surface water quality in the Sacramento River Region would result from changes in streamflows due to releases from, and diversions to, storage; and from construction, operation, and maintenance of new off-stream storage facilities, if built.

With additional new storage, the Preferred Program Alternative could produce water quality benefits in the Sacramento River Region when reservoir releases are made. Releases of high-quality water from storage could result in increased flows during low-flow periods. These increases could result in dilution of constituents carried by the

With additional new storage, the Preferred Program Alternative could produce water quality benefits in the Sacramento River Region when reservoir releases are made.

More frequently, stored water would be delivered to water users via canals, in exchange for reduced in-stream diversions. This would benefit in-stream conditions for indigenous aquatic life.

streams and could provide water quality benefits for municipal, agricultural, and ecosystem beneficial uses. The increased flows should not be sufficiently large to significantly accelerate channel scouring. Turbidities and suspended sediment deposition probably would be reduced overall.

Temperatures could increase or decrease in the Sacramento River if inflows of warmer or cooler waters occur from new off-stream reservoirs. For this reason, surface water releases from Sacramento tributary storage may be confined to those needed to meet consumptive uses in adjacent service areas in order to prevent temperature changes to the Sacramento River. For example, inflows of water 5 degrees warmer than the water in the trunk stream, at a rate equal to 10% of the flow in the trunk stream, could increase the average temperature of the trunk stream by about half a degree (Celsius or Fahrenheit). However, inflows to streams from off-tributary reservoirs would be uncommon. More frequently, stored water would be delivered to water users via canals, in exchange for reduced in-stream diversions. This would benefit in-stream conditions for indigenous aquatic life.

San Joaquin River Region

The potential for significant changes in the quality (and quantity) of the water exported to the San Joaquin River Region as a result of decisions made during the term of this Program is substantial, and other programs also could produce potentially significant effects.

General impacts of storage and conveyance options on upstream water quality in the San Joaquin River Region are expected to be similar to those described for the Sacramento River Region. However, the potential for significant changes in the quality (and quantity) of the water exported to the region as a result of decisions made during the term of this Program and other non-CALFED Programs mentioned under "Cumulative Impacts" in Section 5.3.10 is substantial. As indicated in Table 5.3-5a, the average annual improvement in the salinity of water exported to the San Joaquin Valley Region is projected to average from 2 to 39%, a small to potentially substantial benefit compared to the No Action Alternative.

The range of potential long-term water supply variations (possibly in the realm of 800 TAF of gains with new storage to 500 TAF of losses without new storage) and source-dependent water quality characteristics are sufficiently large to significantly alter prevailing water quality and the resultant salt balance in the SWP and CVP service areas and throughout the San Joaquin Valley. The effects of the potential variations would be most pronounced in those areas that are already deficient in both quality and quantity of water. Resultant changes in land use in the service areas that could secondarily affect water quality, water supply, demands, and beneficial uses of water resources would in turn depend on the magnitude of the variations in the delivered water supplies and their quality. Despite the variability, overall improvements in water quality in the areas served by exports would benefit municipal, agricultural, and ecological uses of the water. Improvements would reduce the salt loads entering the basin and reduce the amount of salt recycling that occurs between the basin and the Delta.

Despite the variability, overall improvements in water quality in the areas served by exports would benefit municipal, agricultural, and ecological uses of the water.

Additional upstream storage capacity would produce additional beneficial impacts on export water quality. Releases of high-quality water from new upstream storage during periods when salinities and other constituents otherwise would be higher at the export pumps could reduce salinities in the SWP and CVP service areas in the valley further,

Table 5.3-5a. Predicted Salinity Changes Between Alternative 1 and the No Action Alternative for All Water Year-Types (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	Jan	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
North Bay Aqueduct Intake at Barker Slough	7*	0	0	0	-10	0%	0%	0%	-3%	Mar	LTS
Mokelumne River at Terminous	8	0	0	0	0	0%	0%	0%	0%	Jan	LTS
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	20	20	40	50	5%	3%	10%	8%	Dec	LTS
Turner Cut	29	40	30	60	70	8%	4%	13%	11%	Jan	LTS - PS
San Joaquin River at Prisoner's Point	12	20	50	70	130	4%	5%	15%	14%	Dec	LTS - PS
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-10	0	-10	0	-2%	0%	-2%	0%	Dec	LTS
San Joaquin River at Brandt Bridge	10	20	40	10	20	3%	6%	2%	3%	Dec	LTS
Middle River at Tracy Road	21	30	40	60	90	6%	5%	13%	11%	Jan	LTS - PS
Grant Line Canal at Tracy Road	24	-20	170	-20	180	-3%	24%	-3%	26%	Nov	LTS - PS
Old River at Tracy Road	17	-30	180	-30	190	-5%	26%	-5%	27%	Nov	LTS - PS
Old River at Rock Slough	19	20	50	80	150	3%	4%	14%	13%	Dec	LTS - PS
Contra Costa Canal Intake at Rock Slough	28*	20	40	70	130	3%	3%	11%	11%	Dec	LTS - PS
Old River at SR 4 (and New CCWD Intake)	18*	10	30	60	100	2%	3%	11%	9%	Dec	LTS - PS
Clifton Court Forebay	27*	30	70	70	140	5%	7%	13%	15%	Dec	LTS - PS
Delta-Mendota Canal Intake from Old River	26*	-10	70	20	100	-2%	8%	4%	12%	Nov	LTS - PS
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	10	60	10	40	1%	3%	1%	2%	Sep	LTS
Sacramento River at Collinsville	4	-10	160	70	210	0%	3%	2%	4%	Sep	LTS
San Joaquin River at Jersey Point	14	40	120	160	290	4%	5%	15%	13%	Dec	LTS - PS
San Joaquin River at Antioch	15	20	180	140	270	1%	4%	6%	6%	Oct	LTS
Suisun Bay at Port Chicago	5	0	440	340	520	0%	2%	3%	3%	Sep	LTS
Carquinez Strait at Martinez	6	10	420	370	450	0%	2%	2%	2%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

depending on the locations and months of the releases—especially during dry and critical years. Additional off-aqueduct storage could afford opportunities for additional pumping to storage during high-outflow periods, when water quality is good and environmental constraints allow, for later use when Delta water quality or environmental conditions are less favorable.

Other SWP and CVP Service Areas

The Preferred Program Alternative could benefit export water quality outside the Central Valley. Benefits could result from the changes in flow and salinity patterns throughout the Delta, as described for the Delta Region. Benefits and potential impacts could be somewhat similar to those described above for the water service areas in the San Joaquin Valley, although more of these service areas are served by SWP exports from CCFB than from the CVP. However, increased fresh-water inflows from additional upstream releases from storage would be needed to produce optimal beneficial effects in these areas.

A variation of the Preferred Program Alternative would extend the Tehama-Colusa Canal to connect to the North Bay Aqueduct (NBA). Construction of such an extension would improve the quality of water exported through the NBA. Presently, organic carbon in NBA exports is the most significant source of water quality degradation for the North Bay municipalities using the water, as it promotes formation of harmful chemical byproducts in the drinking water disinfection process. Linkage of the Tehama-Colusa Canal to the NBA would significantly reduce organic carbon concentrations in the export water by avoiding local sources of organic carbon. Negative impacts of this action might include reduced supply available to other users of the Tehama-Colusa Canal and, possibly, less dilution of pollutants in Barker Slough and contiguous channels as a result of reduced flows caused by reduced NBA diversions.

Linkage of the Tehama-Colusa Canal to the North Bay Aqueduct would significantly reduce organic carbon concentrations in the export water by avoiding local sources of organic carbon.

Another variant of the Preferred Program Alternative would relocate the intake of the NBA to a source that is less subject to local contributions of organic carbon, such as the Sacramento River. The positive impacts of this action would be similar to those described for the Tehama-Colusa Canal extension variant with regard to reducing concentrations of organic carbon. Negative impacts of this action would include reduced downstream flows in the water body where the intake was relocated, and reduced dilution of pollutants in Barker Slough and contiguous channels as a result of reduced flow caused by reduced NBA diversions.

Additional upstream storage capacity would produce increased beneficial impacts on export water quality. Releases of high-quality water from new upstream storage during periods when salinities and other constituents would otherwise be higher at the export pumps could reduce salinities in the Other SWP and CVP Service Areas somewhat further, depending on the location and month of the releases—especially during dry and critical years. During these times, service areas such as the San Felipe Division of the CVP would benefit in two ways: (1) both agricultural and municipal supplies would benefit from lower salinities, while (2) the municipal supplies would also benefit from lower bromide levels. Additional off-aqueduct storage could afford opportunities for additional

Additional upstream storage capacity would produce increased beneficial impacts on export water quality.

pumping for storage during high outflow periods when water quality is good and environmental constraints allow, for later use when Delta water quality or environmental conditions are less favorable.

Simulations of bromide concentrations at key Delta export facilities were calculated based on fingerprint modeling data for the alternatives completed in 1998. The data were analyzed for dry and critical years, the most critical times of high bromide concentrations. The data were updated for the most recent model results, using the bromide-to-EC ratios in the older modeling exercise and the EC values generated in the latest model exercise. Based on changes in EC, bromide concentrations would not differ significantly between Alternative 2 and the Preferred Program Alternative with the future diversion facility option in place. Without the proposed future diversion facility, bromide concentrations under the Preferred Program Alternative would be more comparable to Alternative 1. Bromide concentrations from the two alternatives should be referenced for an estimate of bromide concentrations anticipated in the Preferred Program Alternative.

5.3.8.2 ALTERNATIVE 1

Delta Region

Water quality conditions in the Delta would be best where and when good-quality water, primarily from the Sacramento River, flows in optimal patterns across the Delta to discharge to Suisun Bay and to the diversion pumps. The actual water quality improvements achieved would depend on the capacities and configurations selected for north Delta and south Delta channel modifications. Water quality also would be affected by the number and type of south Delta water quality control facilities; Delta facility and pump operations; local discharges, including island drainage; and the locations, timing, and magnitudes of any additional flow releases from upstream reservoirs.

Water quality would be affected by the number and type of south Delta water quality control facilities; Delta facility and pump operations; local discharges; and the locations, timing, and magnitudes of any additional flow releases from upstream reservoirs.

Table 5.3-5a summarizes the results of model predictions of salinity changes (expressed as EC) throughout the Delta for Alternative 1 compared to the No Action Alternative for a representative long-term hydrologic sequence that includes all water-year types (see Section 5.2). Separate predictions are shown based on modeling assuming water management Criterion A without storage, and water management Criterion B with storage which define the bookends for the analysis of water quality. For both sets of criteria, changes are shown for the annual average value over the period of the simulation and for the month of the year when salinity is the highest.

Compared to the No Action Alternative, Table 5.3-5a shows that under Alternative 1, salinity is projected to be significantly affected in the central Delta, in the south Delta, and in the San Joaquin River in the west Delta (as indicated by Jersey Point). For example, at CCFB, the mean long-term salinity is projected to increase by 30-70 μmhos/cm (5-13%), and the mean monthly salinity for December , the month of highest projected salinities, is projected to increase by about 70-140 μmhos/cm (7-15%). During dry and critical years, Table 5.3-5b shows that these ranges increase to 40-100 μmhos/cm (6-16%) for the long term and to 90-270 μmhos/cm (8-25%) on average for the month of maximum salinity,

Potential reductions in Delta water quality compared to the No Action Alternative would be greatest in the south Delta, especially in Old River and other southwest Delta channels that convey water directly toward the pumps.

Table 5.3-5b. Predicted Salinity Changes Between Alternative 1 and the No Action Alternative for Dry and Critical Years (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	Jan.	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
North Bay Aqueduct Intake at Barker Slough	7*	0	0	-10	-10	0%	0%	-5%	-4%	Jan.	LTS
Mokelumne River at Terminous	8	0	0	0	-10	0%	0%	0%	-4%	Feb	LTS
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	40	30	60	80	8%	4%	13%	10%	Dec	LTS - PS
Turner Cut	29	60	40	80	100	11%	5%	16%	13%	Jan.	LTS - PS
San Joaquin River at Prisoner's Point	12	30	80	100	170	5%	7%	19%	15%	Dec	LTS - PS
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-20	0	-20	10	-3%	0%	-3%	1%	Feb	LTS
San Joaquin River at Brandt Bridge	10	20	0	20	10	3%	0%	3%	1%	Feb	LTS
Middle River at Tracy Road	21	30	60	80	160	5%	6%	15%	17%	Jan.	LTS - PS
Grant Line Canal at Tracy Road	24	-40	180	-50	170	-5%	23%	-7%	22%	Nov	LTS - PS
Old River at Tracy Road	17	-60	170	-60	180	-8%	22%	-8%	24%	Nov	LTS - PS
Old River at Rock Slough	19	30	80	110	190	4%	6%	16%	14%	Dec	LTS - PS
Contra Costa Canal Intake at Rock Slough	28*	30	70	100	180	4%	5%	14%	13%	Dec	LTS - PS
Old River at SR 4 (and New CCWD Intake)	18*	20	50	-210	140	3%	4%	-22%	11%	Dec	PS - B
Clifton Court Forebay	27*	40	90	100	270	6%	8%	16%	25%	Jan.	LTS - PS
Delta-Mendota Canal Intake from Old River	26*	-10	-40	20	70	-1%	-4%	3%	7%	Jan.	LTS
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	10	40	-10	-80	1%	1%	-1%	-3%	Sep	LTS
Sacramento River at Collinsville	4	-40	40	40	-50	-1%	1%	1%	-1%	Sep	LTS
San Joaquin River at Jersey Point	14	40	200	210	390	3%	7%	15%	14%	Dec	LTS - PS
San Joaquin River at Antioch	15	-20	260	140	380	-1%	5%	4%	7%	Oct	LTS
Suisun Bay at Port Chicago	5	-120	60	310	50	-1%	0%	2%	0%	Sep	LTS
Carquinez Strait at Martinez	6	-110	10	360	10	-1%	0%	2%	0%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

January. Changes during other months could be both significant and larger. Alternative 1 would potentially degrade overall in-Delta and export water quality and dependent beneficial uses because of the resultant increases in sea-water intrusion (see Figures 5.2-36 and 37 in Section 5.2). This degradation is projected to occur despite the increased potential for reservoir releases and increased inflows of better quality water across the Delta from the Mokelumne and Sacramento Rivers southward, and the potentially improved water circulation in affected Delta channels.

The actual magnitudes of the salinity changes would vary tidally, seasonally, and spatially throughout the Delta, depending on factors such as the mixtures of source waters attained at each location that result from variations in the pathways and timing of flows through Delta channels. The magnitude of the changes also would depend on variations in annual hydrology. In general, the magnitude of impacts would be increased in dry and critical years, and attenuated in above-normal and wet years.

Whereas the above tables show the salinity changes relative to the No Action Alternative, Figures 5.3-7 through 5.3-11 show the ranges of predicted mean annual and peak EC values (μs/cm) for Alternative 1 and the No Action Alternative at the following five stations respectively: Old River at CCFB, San Joaquin River at Prisoner's Point, San Joaquin River at Jersey Point, Middle River at Tracy Road, and Old River at Rock Slough. These locations were selected to be representative of locations in the central, south, and west Delta, including export locations.

Average monthly salinities would be increased in the central Delta, in the San Joaquin River in the west Delta, in Old River at Rock Slough, in Old River at SR 4, and at CCFB compared to the No Action Alternative.

The range of values for each alternative indicated in the figures are indicative of the range of uncertainty. In general, the ranges do not overlap, indicating that EC values under Alternative 1 are distinctly different (and higher) than under the No Action Alternative. The distribution of the ranges (that is, decreasing from Jersey Point to Middle River at Tracy Road and CCFB) can be explained by the increased effects of salinity intrusion associated with water management Criterion B with storage.

Increased cross-Delta flows and increased sea-water intrusion, coupled with increases in the concentrations of salts drawn from the San Joaquin River and interior Delta drainage, could act in concert to increase the frequency of higher bromide concentrations at Old and Middle Rivers.

The actual magnitudes of monthly variations in salinity, including bromide, from No Action Alternative conditions would depend on annual, seasonal, and geographically determined differences in the proportion of sea water present. Bromide is of particular concern to municipal water users because it is an inorganic precursor to several of the most potentially harmful known DBPs (for example, bromodichloromethane, bromate, and brominated halo-acetic acids—known for their roles as carcinogens and potential causes of increased birth defects).

Figure 5.3-7. Ranges of Salinity (expressed as EC) at Clifton Court Forebay for Alternative 1

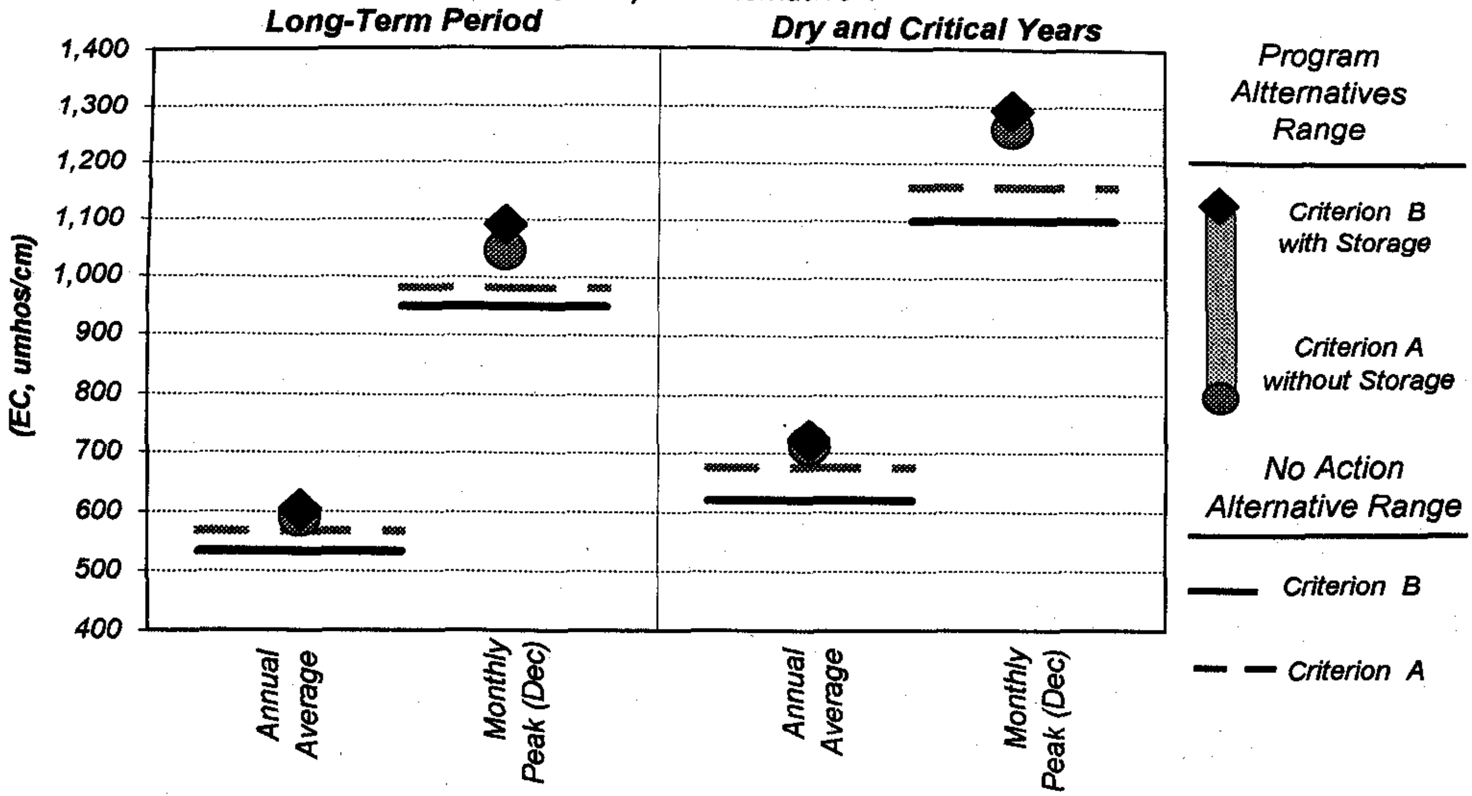


Figure 5.3-8. Ranges of Salinity (expressed as EC) at Prisoner's Point for Alternative 1

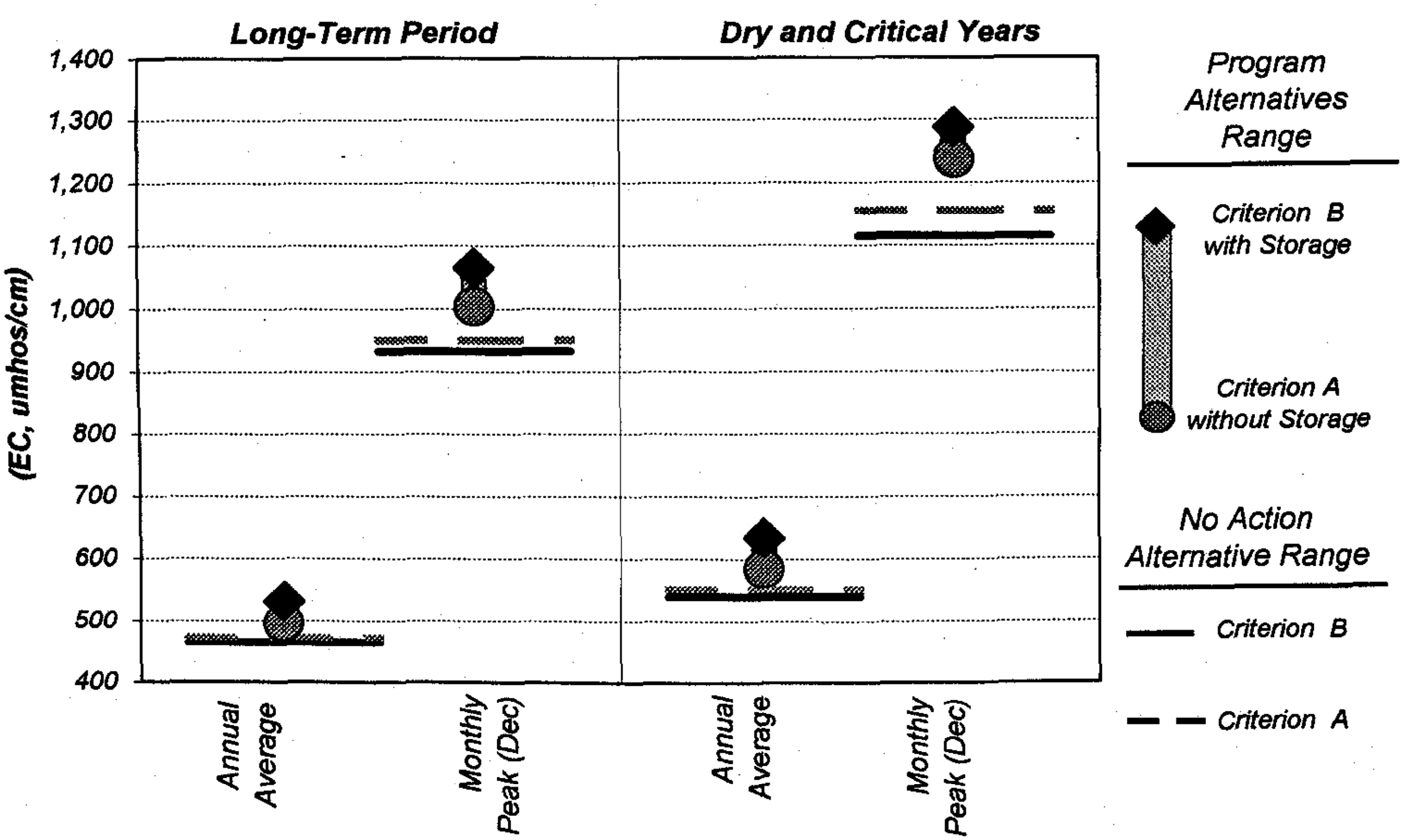


Figure 5.3-9. Ranges of Salinity (expressed as EC) at Jersey Point for Alternative 1

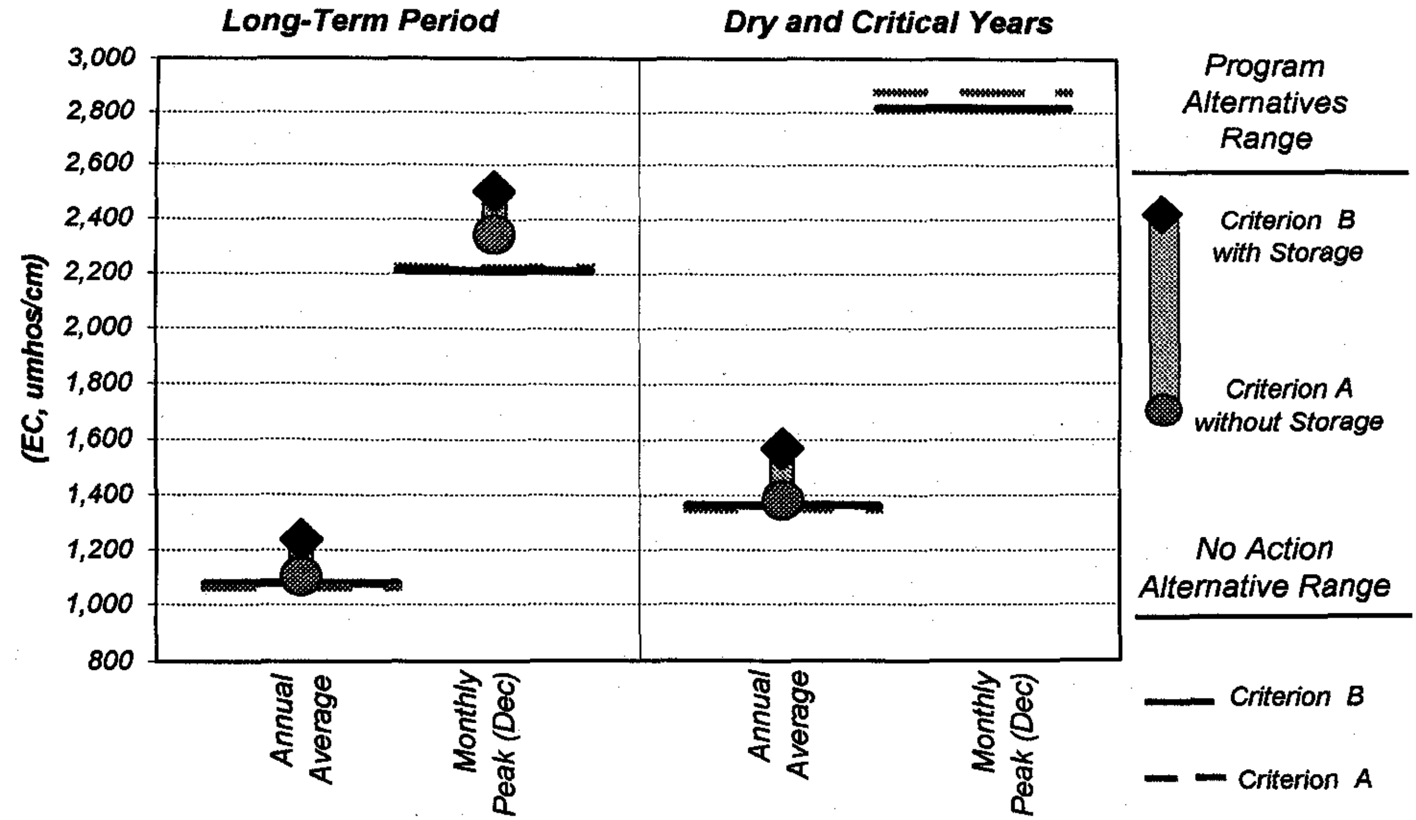


Figure 5.3-10. Ranges of Salinity (expressed as EC) at Middle River at Tracy Road for Alternative 1

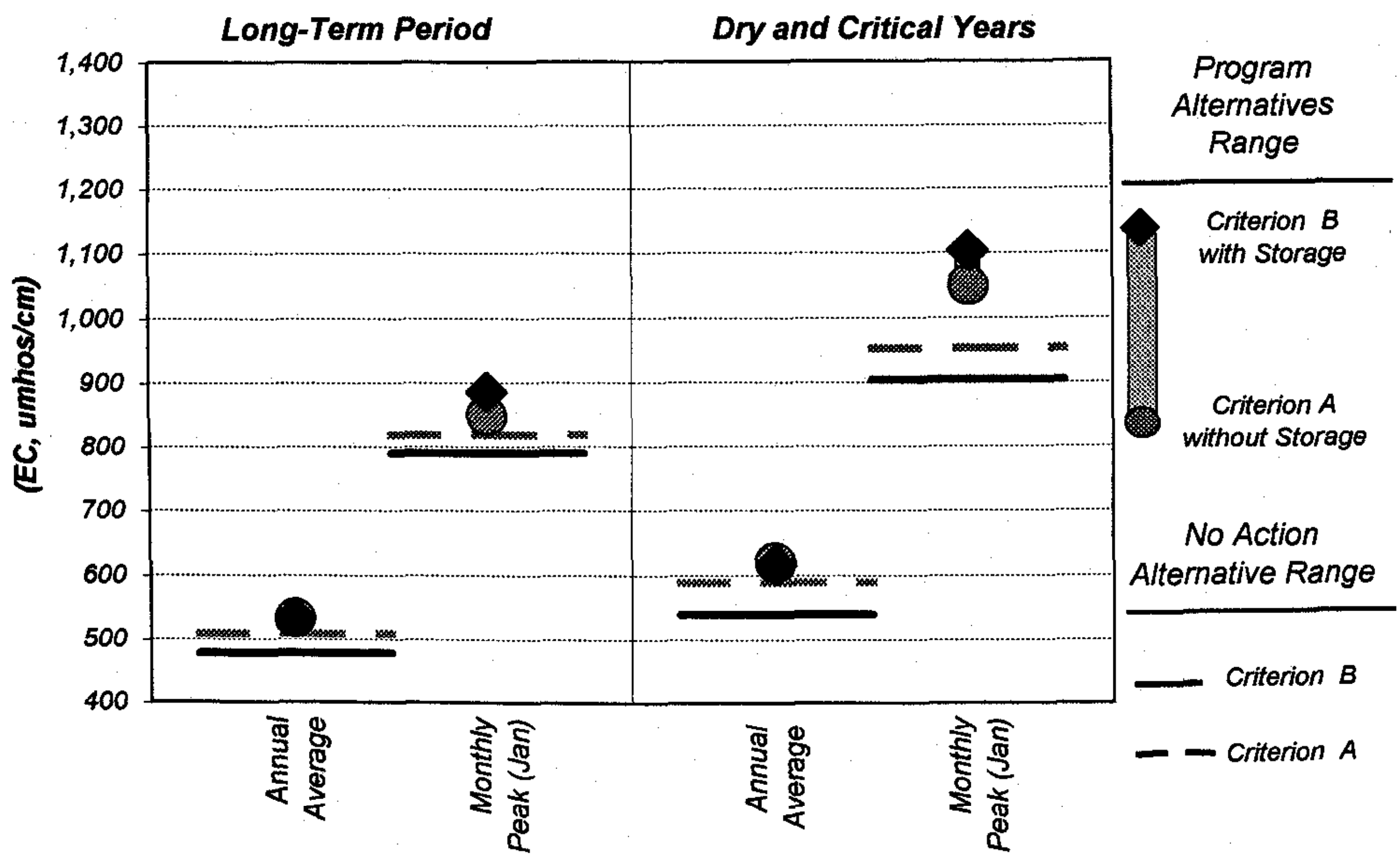
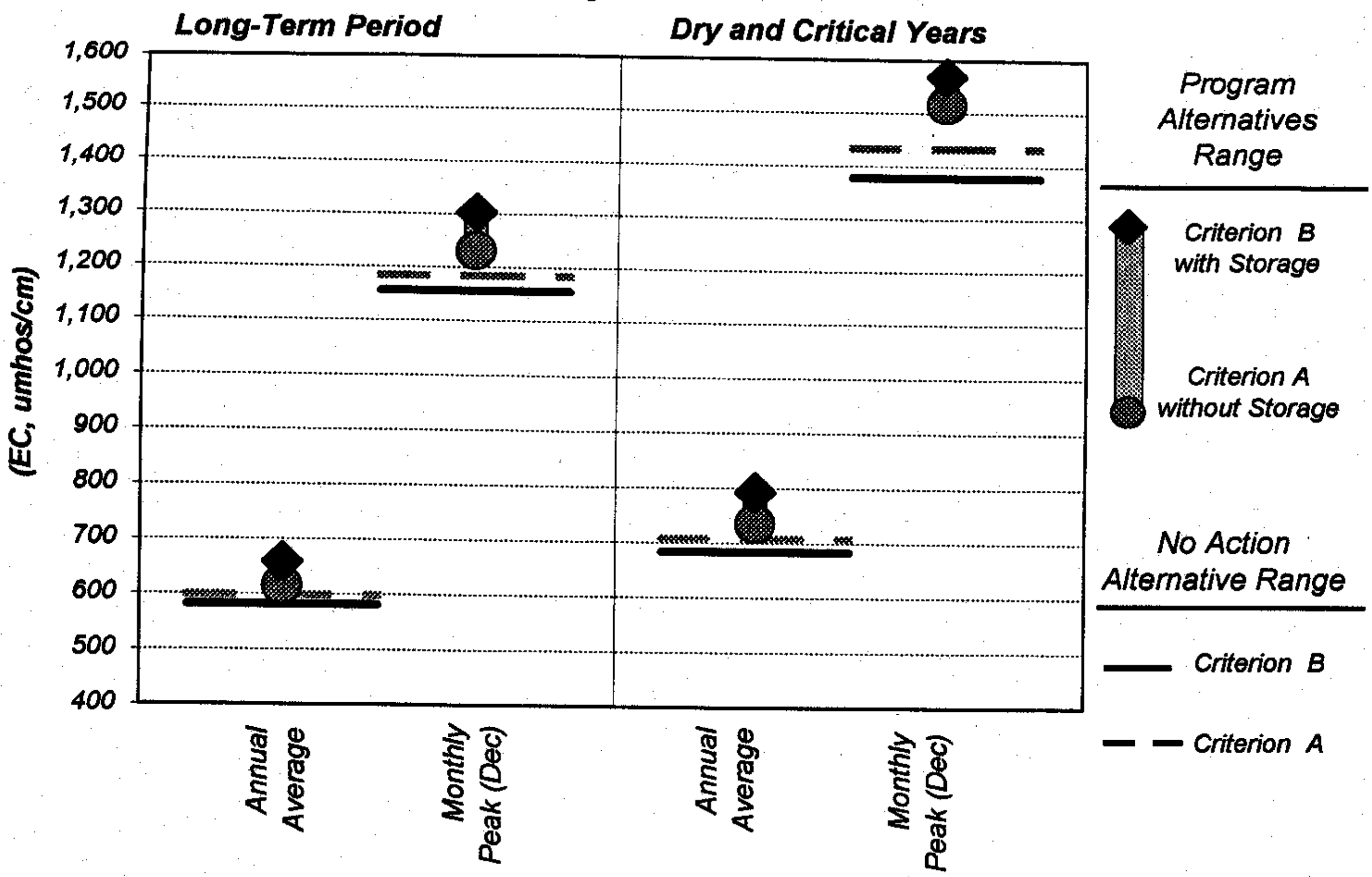


Figure 5.3-11. Ranges of Salinity (expressed as EC) at Rock Slough for Alternative 1



Bay Region

With increased exports from the Delta, Alternative 1 could result in potentially significant impacts by reducing net Delta outflows, resulting in greater sea-water intrusion into the Bay. This could result in increases in salinity, including bromide, in San Francisco, San Pablo, and Suisun Bays.

The addition of new storage could improve water quality and dependent conditions for estuarine biological resources in the west Delta as a result of increased Delta outflows, especially during low-outflow periods.

Sacramento River Region

Impacts on water quality associated with Alternative 1 in the Sacramento River Region would be similar to those described for the Preferred Program Alternative.

Impacts on water quality associated with Alternative 1 in the Sacramento River Region would be similar to those described for the Preferred Program Alternative.

San Joaquin River Region

General impacts of storage and conveyance options on upstream water quality in the San Joaquin River Region are expected to be similar to those described for the Sacramento River Region under the Preferred Program Alternative. However, the potential for significant changes in the quality (and quantity) of the water exported to the region as a result of decisions made during the term of this Program is great, and other non-CALFED programs also will produce effects (see "Cumulative Impacts" in Section 5.3.10). As indicated in Table 5.3-5a, the average annual increase in the salinity of water exported to the San Joaquin River Region via the DMC (assuming an intertie with CCFB) compared to the No Action Alternative is projected to range from -2 to 13% for long term averages. The resultant net change in salt loads delivered to the valley is more difficult to project because it also would depend on changes in water deliveries, the locations where the water is applied, and source control actions taken. However, the effect would be to increase salt loads and the resultant recycling of salts in the San Joaquin Valley.

The range of potential long-term water supply variations (possibly in the realm of 800 TAF of gains with new storage to 500 TAF of losses without new storage) and source-dependent water quality characteristics are sufficiently large to significantly degrade prevailing water quality and the resultant salt balance in the SWP and CVP service areas and throughout the San Joaquin Valley. The effects of the potential variations would be most pronounced in those areas that are already deficient in both quality and quantity of water. Resultant changes in land use in the service areas that could secondarily affect water quality, water supply, demands, and beneficial uses of water resources would in turn depend on the magnitude of the reductions in the quality of delivered water supplies. Despite the variability, overall degradation of water quality in the areas served by exports would adversely affect municipal, agricultural, and ecological uses of the water.

The range of potential long-term water supply variations and source-dependent water quality characteristics are sufficiently large to significantly degrade prevailing water quality and the resultant salt balance in the SWP and CVP service areas in the San Joaquin Valley and throughout the valley.

Other SWP and CVP Service Areas

Alternative 1 also could result in detrimental impacts on export water quality outside the Central Valley. Impacts on export water quality could result from the changes in flow and salinity patterns throughout the Delta as described above for the Delta Region. Potential impacts would be similar to but less than those described for the water service areas in the San Joaquin Valley. Increased fresh-water inflows from additional upstream releases from storage could reduce the magnitude of the effects in these areas.

Additional off-aqueduct storage could afford opportunities for additional pumping for storage during high-outflow periods when water quality is better and environmental constraints allow, for later use when Delta water quality or environmental conditions are less favorable.

Simulations of bromide concentrations at key Delta export facilities were calculated based on fingerprint modeling data for the alternatives completed in 1998. The data were analyzed for dry and critical years, the most critical times of high bromide concentrations. The data were updated for the most recent model results, using the bromide-to-EC ratios in the older modeling exercise and the EC values generated in the latest model exercise. Based on changes in EC, bromide concentrations would not differ significantly between the No Action Alternative and Alternative 1. The bromide concentrations at Contra Costa Canal under Alternative 1 are expected to be about 2.0 μg/L under both Criterion A and Criterion B scenarios during December, the month of highest projected bromide levels. The annual average bromide concentrations are projected to range from 0.64 to 0.89 μg/L under Criterion A and Criterion B, respectively.

At CCFB the peak bromide concentrations are projected to range from 1.2 to 1.3 μg/L under Criterion A and Criterion B, respectively. The annual bromide concentrations are projected to be about 0.64 μg/L for both Criterion A and Criterion B.

5.3.8.3 ALTERNATIVE 2

Delta Region

Based on the results of model runs, Alternative 2 generally would improve in-Delta and export water quality, and dependent beneficial uses because of the resultant increased inflows of higher quality water from the Sacramento River and north Delta, and the improved circulation in Delta channels. Potential improvements to Delta water quality would be greatest in the channels that convey water directly toward the pumps (primarily Old and Middle Rivers) and in the San Joaquin River in the central Delta. Potential improvements would be least in distant channels or areas that are isolated by constricted channels and reduced circulation. The magnitude of the changes would vary continuously throughout the Delta and would depend on the mixtures of source waters that result at each location, the pathways and timing of flows through Delta channels, and the locations and magnitudes of local discharges. Water quality improvements would be greatest where

Potentially significant adverse impacts on average annual salinities would be restricted primarily to Vernalis and to the lower Sacramento River (for example, Emmaton) due to the diversion of upstream flows into the central and south Delta.

good-quality Sacramento River waters are drawn across the Delta (intermixing with San Joaquin River and other channel flows) to feed flows into the channels leading toward the diversion pumps. The amounts of improvement achieved would depend on the capacities of any north Delta and south Delta channel modifications and the locations, timing, and magnitude of any additional flow releases from upstream reservoirs. A shift in export water quality based on reduced San Joaquin River flows entering the pumps would allow selenium in the San Joaquin River to enter the Delta and Bay.

Table 5.3-6a summarizes the results of model predictions of salinity changes (expressed as EC) throughout the Delta for Alternative 2 compared to the No Action Alternative for a representative long-term hydrologic sequence that includes all water-year types (see Section 5.2). Separate predictions are shown based on modeling assuming water management Criterion A without storage, and water management Criterion B with storage, which define the bookends for the analysis of water quality. For both sets of criteria, changes are shown for the annual average value over the period of the simulation and for the month of the year when salinity is the highest.

Compared to the No Action Alternative, Table 5.3-6a shows that under Alternative 2, salinity is projected to improve throughout most of the Delta and at the export facilities. For example, at CCFB, the mean long-term salinity is projected to decrease by 140-180 μmhos/cm (25-34%), and the mean monthly salinity for December, the month of highest projected salinities, is projected to decrease by 470-560 μmhos/cm (48-59%). During dry and critical years, Table 5.3-6b shows that salinity is projected to decrease by 170-220 μmhos/cm (25-35%) for the long term, and to decrease by 560-660 μmhos/cm (48-60%) on average for the month of maximum salinity, December. The improvement in water quality is caused by increased flows of higher quality water across the Delta from the Mokelumne and Sacramento Rivers southward, and the improved water circulation in affected Delta channels. Based on these comparisons, potential benefits to Delta water quality compared to the No Action Alternative would be greatest in the south Delta, especially in Old River and in other southwest Delta channels that convey water directly toward the pumps. Salinities also would be substantially reduced in Middle River in the southeast Delta, and also in the south Delta channels where circulation could be further improved by the installation of optional tidal flow control facilities. Salinities would be reduced in the San Joaquin River in the west Delta, where the intrusion of ocean salts from the Bay would be lessened by reductions in net tidal flow reversals.

The increased cross-Delta flows, reduced sea-water intrusion, improved circulation, and resultant increases in disper-sion and dilution of smaller quantities of ocean salts would act in concert to decrease bromide concentrations at drinking water supply intakes in the Delta.

Potentially significant adverse impacts on average annual salinities would be restricted primarily to Vernalis and to the lower Sacramento River (for example, Emmaton) due to the diversion of upstream flows into the central and south Delta.

Whereas the above tables show the salinity changes relative to the No Action Alternative, Figures 5.3-12 through 5.3-16 show the range of predicted mean annual and peak EC values (μs/cm) for Alternative 2 and the No Action Alternative at the following five stations respectively: Old River at CCFB, San Joaquin River at Prisoner's Point, San Joaquin River at Jersey Point, Middle River at Tracy Road, and Old River at Rock Slough. These locations were selected to be representative of locations in the central, south, and west Delta, including export locations.

Table 5.3-6a. Predicted Salinity Changes Between Alternative 2 and the No Action Alternative for All Water-Year Types (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	Jan	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
North Bay Aqueduct Intake at Barker Slough	7*	0	10	0	-50	0%	3%	0%	-15%	Mar	B
Mokelumne River at Terminous	8	0	-20	-10	-50	0%	-9%	-6%	-23%	Jan	LTS - B
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	-50	-360	-70	-410	-12%	-53%	-17%	-62%	Dec	B
Turner Cut	29	10	-180	0	-300	2%	-26%	0%	-46%	Jan	LTS - B
San Joaquin River at Prisoner's Point	12	-140	-540	-230	-680	-30%	-57%	-50%	-73%	Dec	B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-10	0	40	170	-2%	0%	6%	24%	Aug	LTS - PS
San Joaquin River at Brandt Bridge	10	20	30	50	-10	3%	4%	8%	-1%	Dec	LTS
Middle River at Tracy Road	21	-80	-380	-120	-460	-16%	-47%	-25%	-58%	Jan	B
Grant Line Canal at Tracy Road	24	-50	-150	-30	-230	-8%	-21%	-5%	-33%	Nov	LTS - B
Old River at Tracy Road	17	-60	-130	-30	-210	-10%	-18%	-5%	-30%	Nov	LTS - B
Old River at Rock Slough	19	-180	-610	-270	-780	-30%	-52%	-46%	-67%	Dec	B
Contra Costa Canal Intake at Rock Slough	28*	-180	-590	-270	-760	-28%	-49%	-43%	-65%	Dec	B
Old River at SR 4 (and New CCWD Intake)	18*	-160	-550	-230	-700	-27%	-51%	-41%	-66%	Dec	B
Clifton Court Forebay	27*	-140	-470	-180	-560	-25%	-48%	-34%	-59%	Dec	B
Delta-Mendota Canal Intake from Old River	26*	-100	-340	-210	-500	-17%	-37%	-37%	-56%	Dec	B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	50	-30	260	510	6%	-1%	29%	25%	Sep	LTS - PS
Sacramento River at Collinsville	4	50	-70	200	410	2%	-1%	7%	7%	Sep	LTS
San Joaquin River at Jersey Point	14	-210	-700	-460	-1270	-20%	-31%	-43%	-57%	Dec	B
San Joaquin River at Antioch	15	-70	-60	-310	-800	-3%	-1%	-13%	-17%	Oct	LTS - B
Suisun Bay at Port Chicago	5	-190	170	60	350	-2%	1%	0%	2%	Sep	LTS
Carquinez Strait at Martinez	6	-40	390	160	380	0%	2%	1%	2%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

Table 5.3-6b. Predicted Salinity Changes Between Alternative 2 and the No Action Alternative for Dry and Critical Years (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
North Bay Aqueduct Intake at Barker Slough	7*	0	10	10	-40	0%	4%	5%	-16%	Mar	LTS - B
Mokelumne River at Terminous	8	0	-30	-20	-60	0%	-13%	-11%	-26%	Feb	LTS - B
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	-60	-450	-90	-500	-12%	-56%	-20%	-65%	Dec	B
Turner Cut	29	0	-310	-10	-440	0%	-38%	-2%	-59%	Jan.	LTS - B
San Joaquin River at Prisoner's Point	12	-180	-670	-290	-840	-33%	-58%	-54%	-75%	Dec	B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-20	0	70	280	-3%	0%	9%	35%	Aug	LTS - PS
San Joaquin River at Brandt Bridge	10	20	0	80	-40	3%	0%	11%	-5%	Feb	LTS - PS
Middle River at Tracy Road	21	-110	-420	-160	-570	-19%	-43%	-30%	-61%	Jan.	B
Grant Line Canal at Tracy Road	24	-80	0	-40	-30	-11%	0%	-5%	-3%	Feb	LTS - B
Old River at Tracy Road	17	-90	0	-40	-30	-12%	0%	-5%	-3%	Feb	LTS - B
Old River at Rock Slough	19	-220	-740	-340	-950	-31%	-52%	-50%	-69%	Dec	B
Contra Costa Canal Intake at Rock Slough	28*	-220	-720	-330	-920	-29%	-51%	-46%	-68%	Dec	B
Old River at SR 4 (and New CCWD Intake)	18*	-200	-670	-590	-840	-29%	-52%	-62%	-68%	Dec	B
Clifton Court Forebay	27*	-170	-560	-220	-660	-25%	-48%	-35%	-60%	Dec	B
Delta-Mendota Canal Intake from Old River	26*	-120	-410	-260	-590	-17%	-38%	-39%	-58%	Jan.	B
WESTERN DELTA, SUISUN BAY AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	50	-100	310	500	4%	-4%	26%	18%	Sep	LTS - PS
Sacramento River at Collinsville	4	20	-230	180	250	1%	-3%	5%	3%	Sep	LTS
San Joaquin River at Jersey Point	14	-280	-890	-580	-1610	-21%	-31%	-42%	-57%	Dec	B
San Joaquin River at Antioch	15	-130	-80	-450	-990	-4%	-1%	-14%	-18%	Oct	LTS - B
Suisun Bay at Port Chicago	5	-350	-220	-100	-40	-2%	-1%	-1%	0%	Sep	LTS
Carquinez Strait at Martinez	6	-170	-20	10	10	-1%	0%	0%	0%	N/A	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

Figure 5.3-12. Ranges of Salinity (expressed as EC) at Clifton Court Forebay for Alternative 2

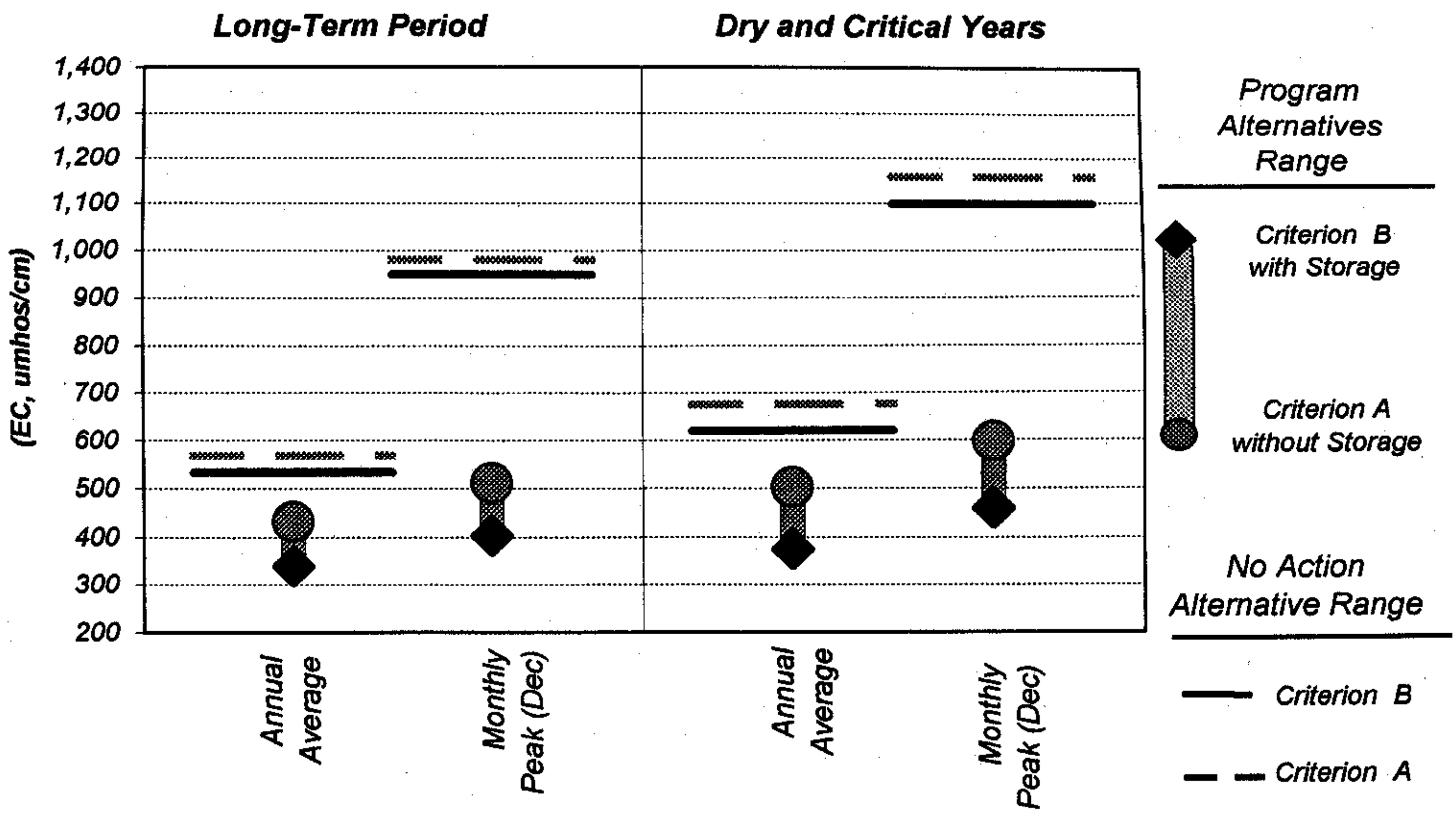


Figure 5.3-13. Ranges of Salinity (expressed as EC) at Prisoner's Point for Alternative 2

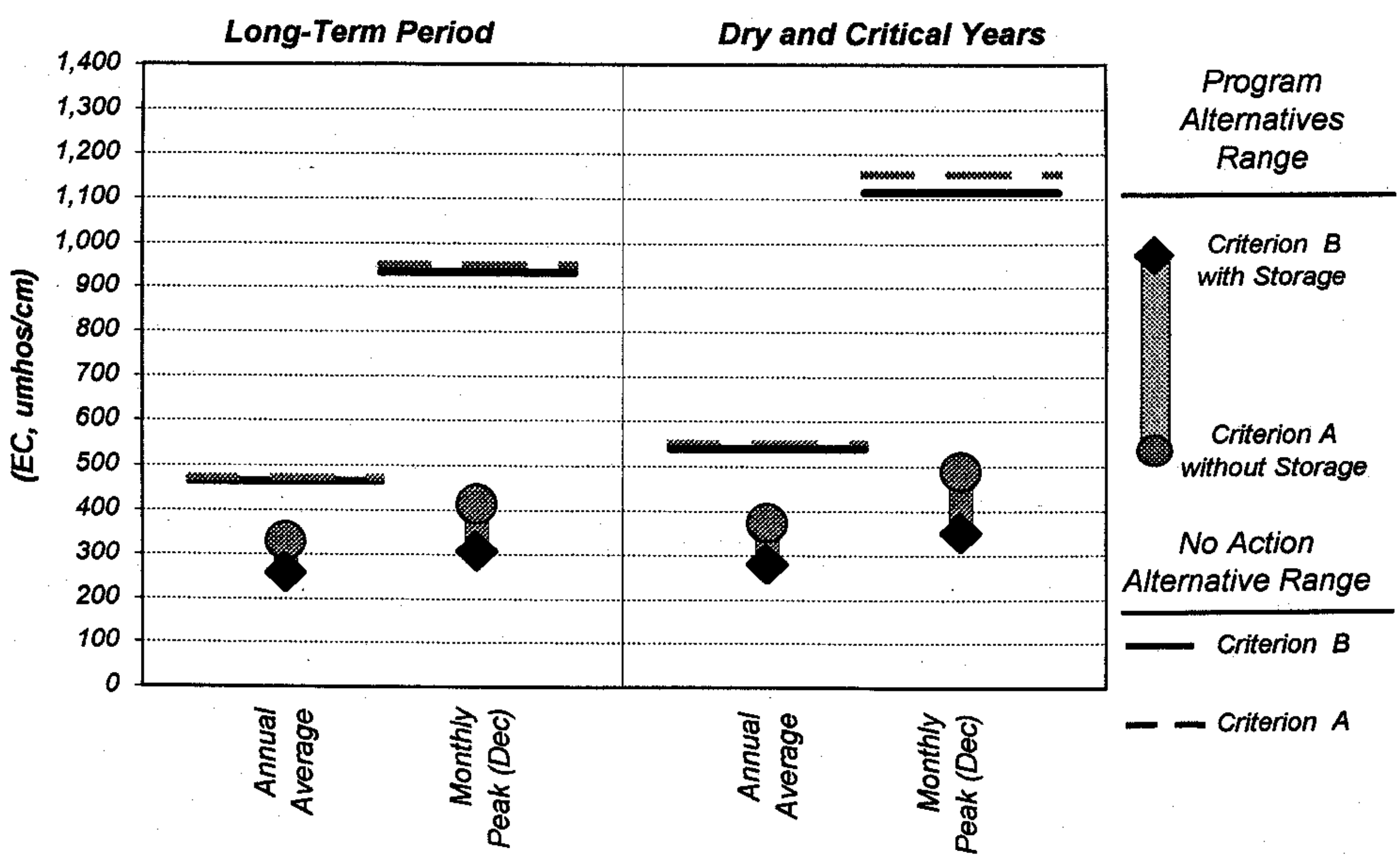


Figure 5.3-14. Ranges of Salinity (expressed as EC) at Jersey Point for Alternative 2

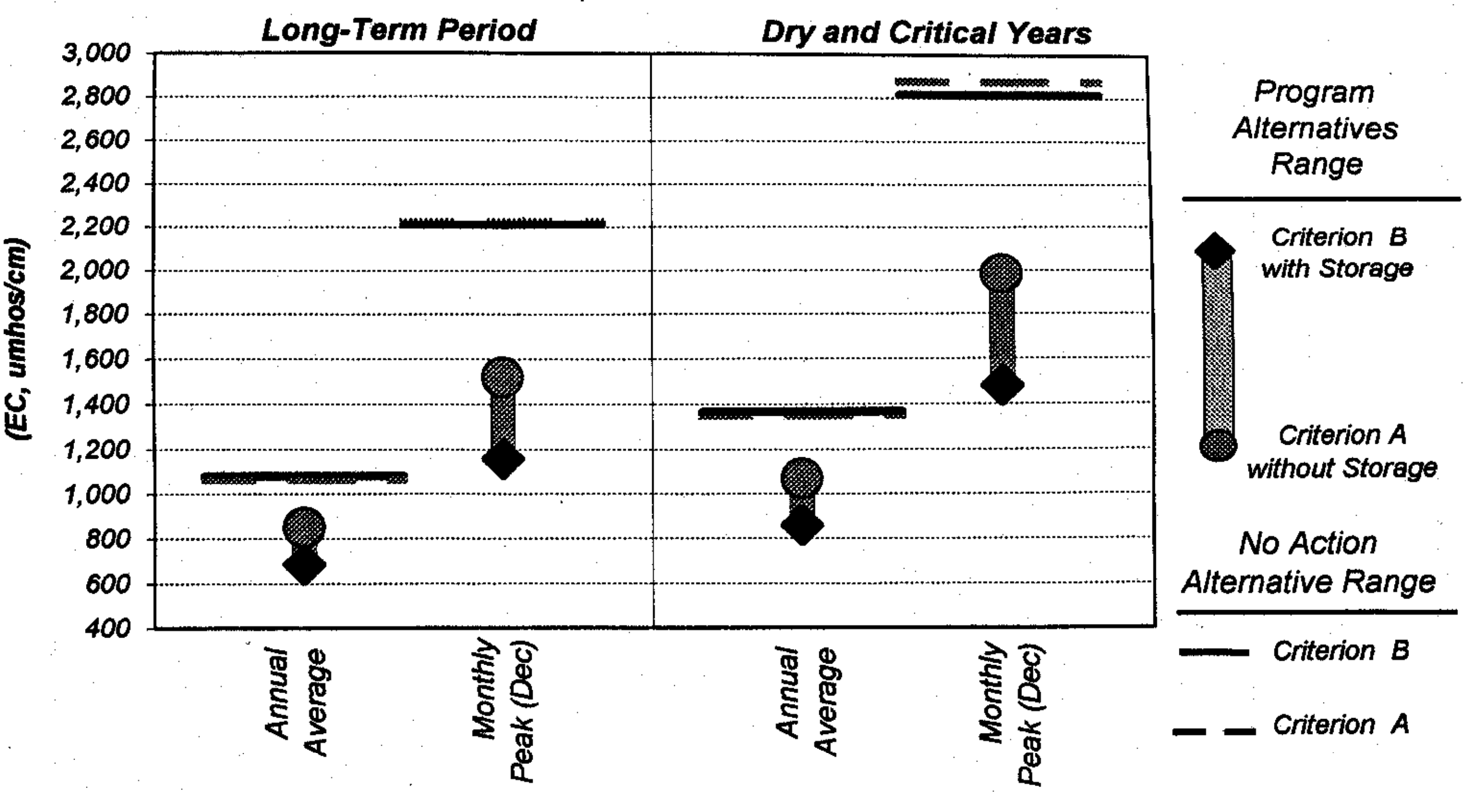


Figure 5.3-15. Ranges of Salinity (expressed as EC) at Middle River at Tracy Road for Alternative 2

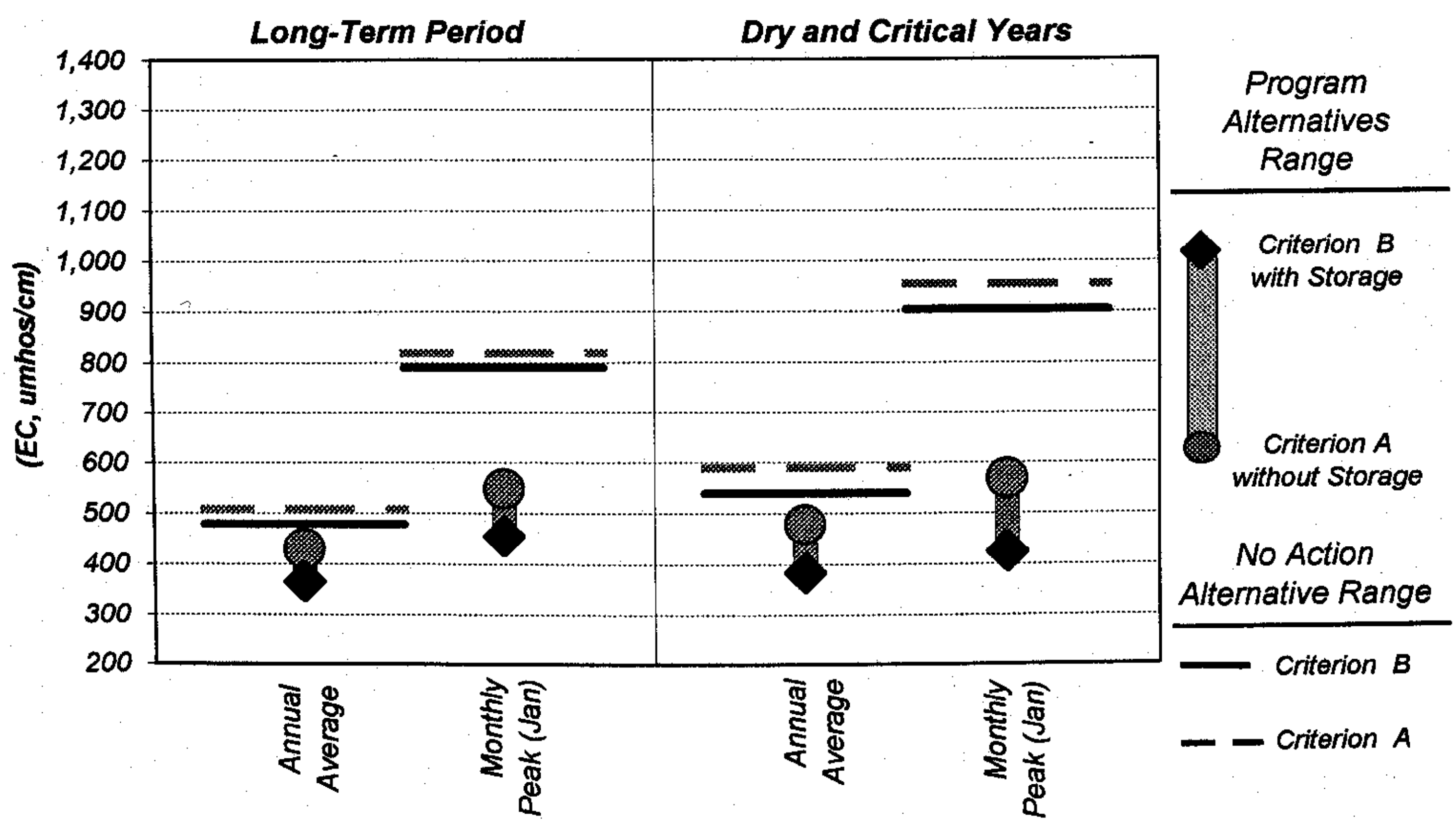
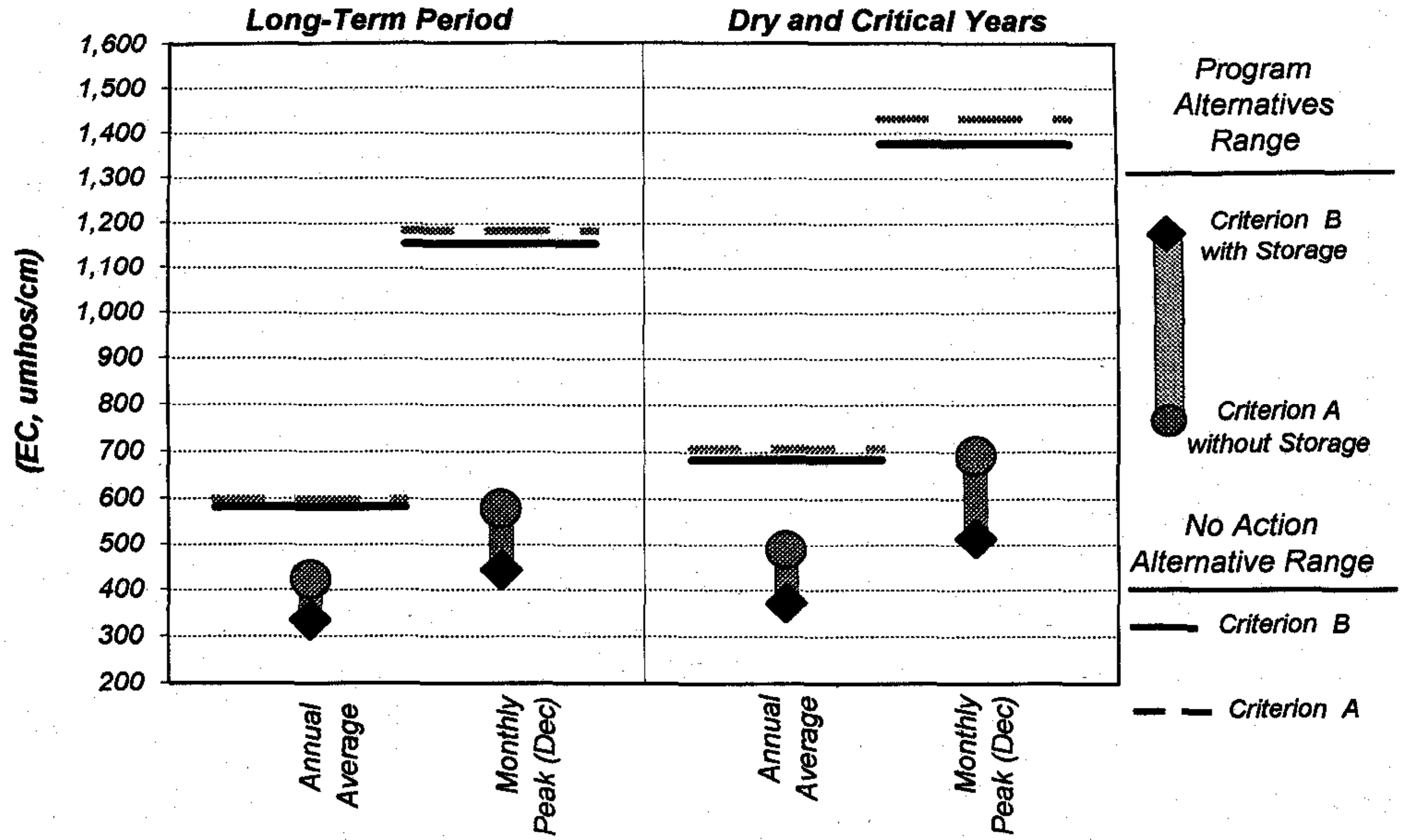


Figure 5.3-16. Ranges of Salinity (expressed as EC) at Rock Slough for Alternative 2



The range of values for each alternative indicated in the figures are indicative of the range of uncertainty. In general, the ranges do not overlap, indicating that EC values under Alternative 2 are distinctly different (and lower) than under the No Action Alternative. Although improvements are indicated at all five stations, the effects of improved conveyance are seen most dramatically at the San Joaquin River at Jersey Point. These figures also show that this alternative performs even better during dry and critical years.

In general, the ranges do not overlap, indicating that EC values under Alternative 2 are distinctly different (and lower) than under the No Action Alternative.

Increased cross-Delta flows, reduced sea-water intrusion, improved circulation, and resultant increases in dispersion and dilution of smaller quantities of ocean salts would act in concert to decrease bromide concentrations at drinking water supply intakes in the Delta. The actual magnitudes of monthly variations from No Action Alternative conditions would depend on hydrologic, seasonal, and geographically determined differences in the proportion of sea water present.

Bay Region

With increased exports from the Delta, Alternative 2 could result in potentially significant impacts by reducing net Delta outflows, resulting in greater sea-water intrusion into the Bay. This could result in increases in salinity in San Francisco, San Pablo, and Suisun Bays.

With increased exports from the Delta, Alternative 2 could result in potentially significant impacts by reducing net Delta outflows, resulting in greater sea-water intrusion into the Bay.

The addition of new storage could improve water quality in the west Delta as a result of increased Delta outflows, especially during low-outflow periods.

Sacramento River Region

Impacts of Alternative 2 in the Sacramento River Region would be similar to those described for the Preferred Program Alternative.

San Joaquin River Region

General impacts of the Storage and Conveyance elements on upstream water quality in the San Joaquin River Region are expected to be similar to those described for the Sacramento River Region. However, the potential for significant changes in the quality (and quantity) of the water exported to the region as a result of decisions made during the term of this Program is great, and other non-CALFED programs also will produce effects (see "Cumulative Impacts" in Section 5.3.10). As indicated in Table 5.3-6a, there is a significant projected decrease in salinity (ranging from 17 to 37%) of water exported to the San Joaquin River. The resultant net change in salt loads delivered to the San Joaquin Valley is difficult to project because it would depend on water delivery operations, and other factors; however, based on this analysis alone, long-term salinity loads to the Valley could be significantly reduced. Overall improvements in water quality in the areas served by exports would benefit municipal, agricultural, and ecological uses of the water.

Alternative 2 could significantly reduce long-term salinity loads to the San Joaquin Valley.

Improvements also would reduce salt loads entering the basin and reduce the amount of salt recycling that occurs between the basin and the Delta.

Other SWP and CVP Service Areas

Alternative 2 also would result in beneficial impacts on export water quality outside the Central Valley. Benefits would result from the improved export water quality as described for the Delta Region. Benefits and potential impacts would be similar to those described earlier for the water service areas in the San Joaquin Valley. Overall water quality improvement benefits should be somewhat greater because more of these service areas are served by SWP exports from CCFB, which receives higher quality water than the CVP.

Under Alternative 2, benefits would result from the improved export water quality in the Other SWP and CVP Service Areas.

Simulations of bromide concentrations at key Delta export facilities were calculated based on fingerprint modeling data for the alternatives completed in 1998. The data were analyzed for dry and critical years, the most critical times of high bromide concentrations. The data were updated for the most recent model results, using the bromide-to-EC ratios in the older modeling exercise and the EC values generated in the latest model exercise. Based on changes in EC, bromide concentrations would not differ significantly between the No Action Alternative and Alternative 1. The bromide concentrations at Contra Costa Canal under Alternative 2 are expected to range from 0.59 to 0.44 μg/L under Criterion A and Criterion B, respectively, during December, the month of highest projected bromide levels. These concentrations represent a 71% and 78% drop, respectively, from the bromide concentrations under Alternative 1. The annual average bromide concentrations are projected to range from 0.38 to 0.30 μg/L under Criterion A and Criterion B, respectively. These concentrations represent a 39% and 66% drop, respectively, from concentrations in Alternative 1.

At CCFB the peak bromide concentrations are projected to range from 0.39 to 0.30 μg/L under Criterion A and Criterion B, respectively. These concentrations represent a projected 68% and 76% drop, respectively, in bromide compared to Alternative 1. The annual bromide concentrations are projected to range from 0.36 to 0.27, respectively, for Criterion A and Criterion B. These concentrations represent a 43% and 58% drop, respectively, in bromide compared to Alternative 1.

5.3.8.4 ALTERNATIVE 3

Delta Region

Water quality would be affected by the capacity of the isolated facility, the number and type of south Delta water quality control facilities; Delta facility and pump operations; local discharges; and the locations, timing, and magnitudes of any additional flow releases from upstream reservoirs.

Water quality conditions in the Delta would be best where and when good-quality water, primarily from the Sacramento River, can be at least partially tapped to flow in optimal patterns through the Delta to discharge to Suisun Bay and toward the diversion pumps. The actual water quality improvements achieved would depend on the capacities and configurations selected for north Delta and south Delta channel modifications. A shift in export water quality based on reduced San Joaquin River flows entering the pumps would allow selenium in the San Joaquin River to enter the Delta and Bay.

Water quality conditions in the Delta would be best where and when good-quality water, primarily from the Sacramento River, can be at least partially tapped to flow in optimal patterns through the Delta to discharge to Suisun Bay and toward the diversion pumps.

Consistent with prior analysis, Table 5.3-7a summarizes the results of model predictions of average salinity changes (expressed as EC) throughout the Delta for Alternative 3 compared to the No Action Alternative for a representative long-term hydrologic sequence that includes all water-year types. Separate sets of predictions are shown based on modeling assuming water management Criterion A without storage, and water management Criterion B with storage, which define the bookends for the analysis of water quality. For both sets of criteria, changes are shown for the annual average value over the period of the simulation, and for the month of the year when salinity is the highest. Salinity increases or decreases of more than 10% are considered to be significantly adverse or beneficial, respectively, as shown in the table.

Compared to the No Action Alternative, Table 5.3-7a shows that under Alternative 3, salinities are projected to increase in the northeast Delta (especially in the lower Mokelumne River), at most stations in the central Delta, and in the south Delta in Middle River at Tracy Road. For example, on the San Joaquin River at Turner Cut, the mean long-term salinity is projected to increase by 110-130 μmhos/cm (25-29%); and the mean monthly salinity for January, the month of highest project salinities, is projected to increase by about 40-90 μmhos/cm (6-13%).

Salinities are projected to decrease and produce beneficial effects in the southwest Delta, all export locations, and throughout the west Delta most of the time. For example, on Old River at Rock Slough, the mean long term salinity is projected to decrease by 50-140 μmhos/cm (9-23%), and the mean monthly salinity for December, the month of highest projected salinities, is projected to decrease by about 320-610 μmhos/cm (27-50%).

Salinities are projected to decrease and produce beneficial effects in the southwest Delta, all export locations, and throughout the west Delta most of the time.

During dry and critical years, Table 5.3-7b shows that the increases in salinity at Turner Cut and the decreases in salinity on Old River near the intake to the Contra Costa Canal off Rock Slough become even larger. They range from increases of 150 μmhos/cm (26-29%) for the long term and from 150-170 μmhos/cm (20-26%) on average for the month of February to decreases of 60-180 μmhos/cm (9-25%) for the long term and from 420-840 μmhos/cm (31-59%) on average for the month of December. The increases in salinity cause one impact assessment adjective in the table to change from less than significant to beneficial in Suisun Bay at Port Chicago in September. Significant improvements during months of maximum salinity are projected to occur during December, or from September through October. However, changes during other months may be both significant and larger.

Through careful water management, Alternative 3 is projected to improve both in-Delta and export water quality and dependent beneficial uses because of the overall resultant increases in the flow and export of good-quality water from the north Delta (especially with new upstream storage).

Water quality is projected to improve most dramatically at CCFB due to the transfer of high-quality water from Hood both around and through the Delta to be blended with Old

Table 5.3-7a. Predicted Salinity Changes Between Alternative 3 and the No Action Alternative for All Water-Year Types (Salinity Expressed as EC)

		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE			
DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
North Bay Aqueduct Intake at Barker Slough*	7*	0	0	0	0	0%	0%	0%	0%		LTS
Mokelumne River at Terminous	8	30	50	30	40	17%	23%	17%	19%	Jan	PS
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	90	-50	80	-50	21%	-7%	20%	-8%	Dec	LTS - PS
Turner Cut	29	130	90	110	40	27%	13%	25%	6%	Jan	LTS - PS
San Joaquin River at Prisoner's Point	12	-120	-530	-30	-250	-25%	-56%	-6%	-27%	Dec	LTS - B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-10	0	-10	0	-2%	0%	-2%	0%	N/A	LTS
San Joaquin River at Brandt Bridge	10	20	30	10	10	3%	4%	2%	1%	Dec	LTS
Middle River at Tracy Road	21	80	-50	30	-50	16%	-6%	6%	-6%	Jan	LTS - PS
Grant Line Canal at Tracy Road	24	-10	0	-40	0	-2%	0%	-6%	0%	N/A	LTS
Old River at Tracy Road	17	-10	10	-40	0	-2%	1%	-6%	0%	Dec	LTS
Old River at Rock Slough	19	-140	-650	-50	-320	-23%	-55%	-9%	-28%	Dec	LTS - B
Contra Costa Canal Intake at Rock Slough*	28*	-130	-610	-50	-320	-20%	-50%	-8%	-27%	Dec	LTS - B
Old River at SR 4 (and New CCWD Intake)	18*	-80	-480	-30	-280	-14%	-44%	-5%	-26%	Dec	LTS - B
Clifton Court Forebay*	27*	-390	-830	-280	-640	-69%	-85%	-53%	-67%	Dec	B
Delta-Mendota Canal Intake from Old River*	26*	-240	-480	-90	-260	-40%	-53%	-16%	-29%	Dec	B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	-100	-790	90	-340	-11%	-39%	10%	-17%	Sep	LTS - B
Sacramento River at Collinsville	4	-500	-2030	170	-700	-18%	-36%	6%	-12%	Sep	LTS - B
San Joaquin River at Jersey Point	14	-590	-1550	-190	-670	-56%	-68%	-18%	-30%	Nov	B
San Joaquin River at Antioch	15	-800	-1620	-20	20	-34%	-33%	-1%	0%	Oct	LTS - B
Suisun Bay at Port Chicago	5	-670	-1730	410	-370	-6%	-9%	3%	-2%	Sep	LTS
Carquinez Strait at Martinez	6	-520	-1250	500	-190	-3%	-5%	3%	-1%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

Table 5.3-7b. Predicted Salinity Changes Between Alternative 3 and the No Action Alternative for Dry and Critical Years (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%		LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
North Bay Aqueduct Intake at Barker Slough*	7*	0	0	-10	-10	0%	0%	-5%	-4%	Mar	LTS
Mokelumne River at Terminous	8	30	60	40	60	16%	26%	21%	26%	Jan	PS
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	110	-120	110	-60	22%	-15%	24%	-8%	Dec	LTS - PS
Turner Cut	29	150	150	150	170	26%	20%	29%	26%	Feb	PS
San Joaquin River at Prisoner's Point	12	-170	-700	-50	-350	-31%	-61%	-9%	-31%	Dec	LTS - B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-20	0	-20	10	-3%	0%	-3%	1%	Feb	LTS
San Joaquin River at Brandt Bridge	10	20	0	20	10	3%	0%	3%	1%	Feb	LTS
Middle River at Tracy Road	21	110	-100	40	-80	19%	-10%	7%	-9%	Jan.	LTS - PS
Grant Line Canal at Tracy Road	24	-10	0	-60	10	-1%	0%	-8%	1%	Feb	LTS
Old River at Tracy Road	17	-10	10	-70	10	-1%	1%	-9%	1%	Feb	LTS
Old River at Rock Slough	19	-180	-840	-60	-420	-25%	-59%	-9%	-31%	Dec	LTS - B
Contra Costa Canal Intake at Rock Slough*	28*	-160	-800	-60	-420	-21%	-56%	-8%	-31%	Dec	LTS - B
Old River at SR 4 (and New CCWD Intake)*	18*	-110	-650	-40	-360	-16%	-50%	-6%	-29%	Dec	LTS - B
Clifton Court Forebay*	27*	-490	-1000	-360	-790	-72%	-86%	-58%	-72%	Dec	LTS - B
Delta-Mendota Canal Intake from Old River*	26*	-290	-570	-140	-380	-41%	-53%	-21%	-37%	Dec	LTS - B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	-150	-1240	80	-780	-13%	-45%	7%	-28%	Sep	LTS - B
Sacramento River at Collinsville	4	-690	-2870	100	-1700	-18%	-40%	3%	-24%	Sep	LTS - B
San Joaquin River at Jersey Point	14	-780	-2030	-280	-870	-58%	-71%	-21%	-31%	Dec	B
San Joaquin River at Antioch	15	-1080	-1700	-150	130	-34%	-30%	-5%	2%	Oct	LTS - B
Suisun Bay at Port Chicago	5	-910	-2590	320	-1450	-6%	-13%	2%	-7%	Sep	LTS - B
Carquinez Strait at Martinez	6	-740	-2040	420	-1120	-4%	-8%	2%	-4%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

River water at ratios varying from 50:50 to 95:05. Long-term improvements are projected to range from 280-390 μmhos/cm (53-69%), and monthly improvements are projected to range from 640-830 μmhos/cm (67-85%) during December, the month of maximum salinity concentrations.

Through careful water management, Alternative 3 is projected to improve both in-Delta and export water quality and dependent beneficial uses because of the overall resultant increases in the flow and export of good-quality water from the north Delta (especially with new upstream storage). Other contributing factors include corresponding decreases in the quantities of sea-water intrusion caused by reverse flows in the west Delta, and improved water circulation in many affected Delta channels.

Potential improvements in Delta water quality compared to the No Action Alternative would be greatest in the southwest Delta, especially in the Old River and the other southwest Delta channels that convey water directly toward the export pumps.

The actual magnitudes of the salinity changes would vary tidally, seasonally, and spatially throughout the Delta, depending on factors such as the mixtures of source waters attained at each location that result from variations in the pathways and timing of flows through Delta channels. The magnitude of the changes also would depend on variations in annual hydrology. In general, the improvements in water quality would increase during dry and critical years, and be attenuated during above-normal and wet years.

The actual magnitudes of the salinity changes would vary tidally, seasonally, and spatially throughout the Delta.

Whereas the above tables show the salinity changes relative to the No Action Alternative, Figures 5.3-17 through 5.3-21 show the predicted ranges of mean annual and peak EC values (μs/cm) for Alternative 3 and the No Action Alternative at the following five stations respectively: Old River at CCFB, San Joaquin River at Prisoner's Point, San Joaquin River at Jersey Point, Middle River at Tracy Road, and Old River at Rock Slough. These locations were selected to be representative of locations in the central, south, and west Delta, including several key export locations.

The range of values for each alternative plotted in the figures are indicative of the range of uncertainty in potential outcomes considering variations in conveyance capacities, storage, hydrology, and water management and operations. At Middle River at Tracy Road Bridge, the Preferred Program Alternative ranges for the long term overlap with the No Action Alternative range and are somewhat higher. The monthly peak ranges at Middle River at Tracy Road Bridge and all ranges at the remaining selected stations do not overlap, and the Alternative 3 ranges (in the southwest Delta, west Delta, and San Joaquin in the central Delta) are distinctly lower than those of the No Action Alternative. This indicates that the EC values under Alternative 3 are definitively lower at these stations than those of the No Action Alternative. The distribution of the ranges (that is, decreasing from Jersey Point to Middle River at Tracy Road and CCFB) can be explained by the decreased effects of salinity intrusion associated with water management Criterion B with storage.

The range of values for each alternative plotted in the figures are indicative of the range of uncertainty in potential outcomes considering variations in conveyance capacities, storage, hydrology, and water management and operations.

Figure 5.3-17. Ranges of Salinity (expressed as EC) at Clifton Court Forebay for Alternative 3

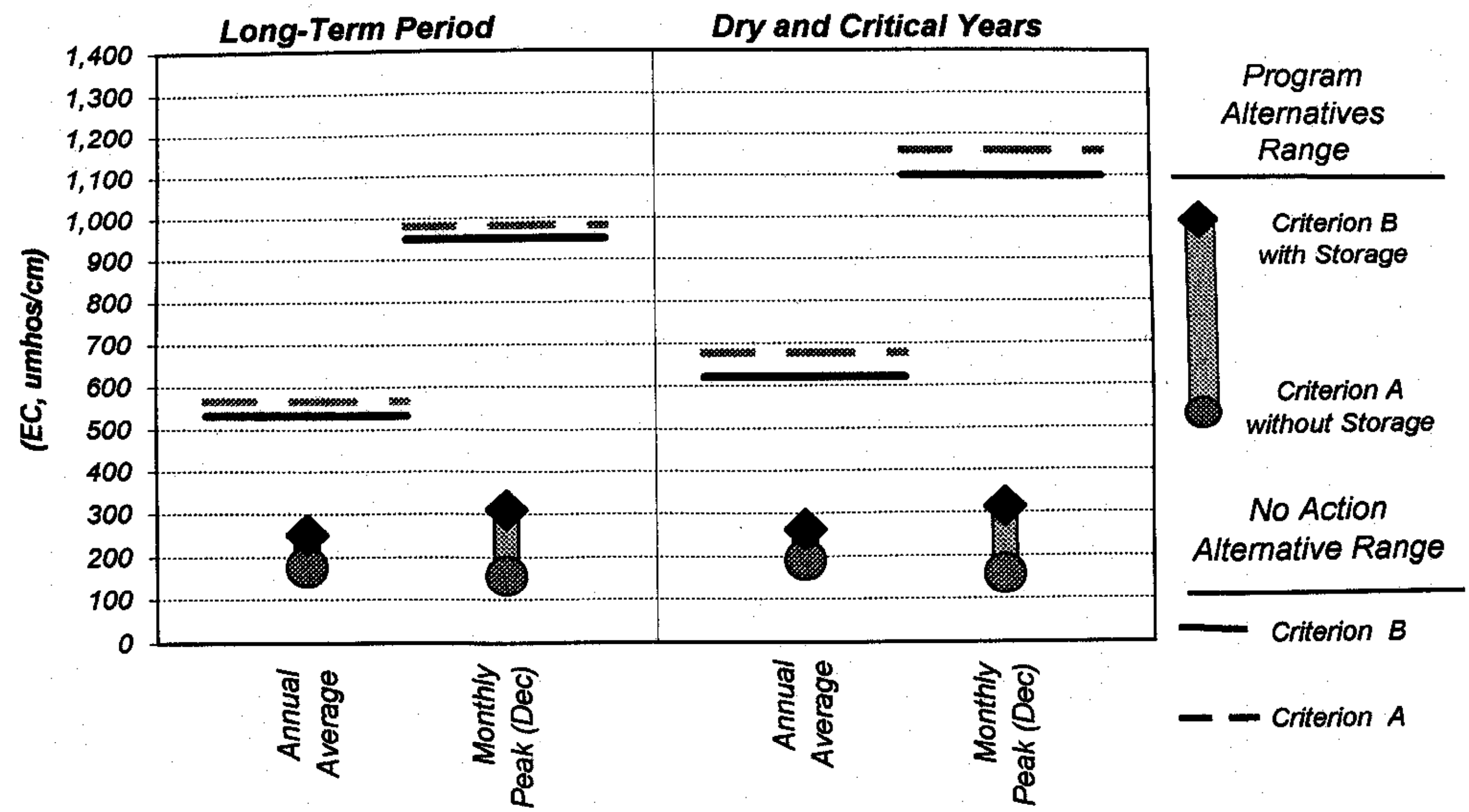


Figure 5.3-18. Ranges of Salinity (expressed as EC) at Prisoner's Point for Alternative 3

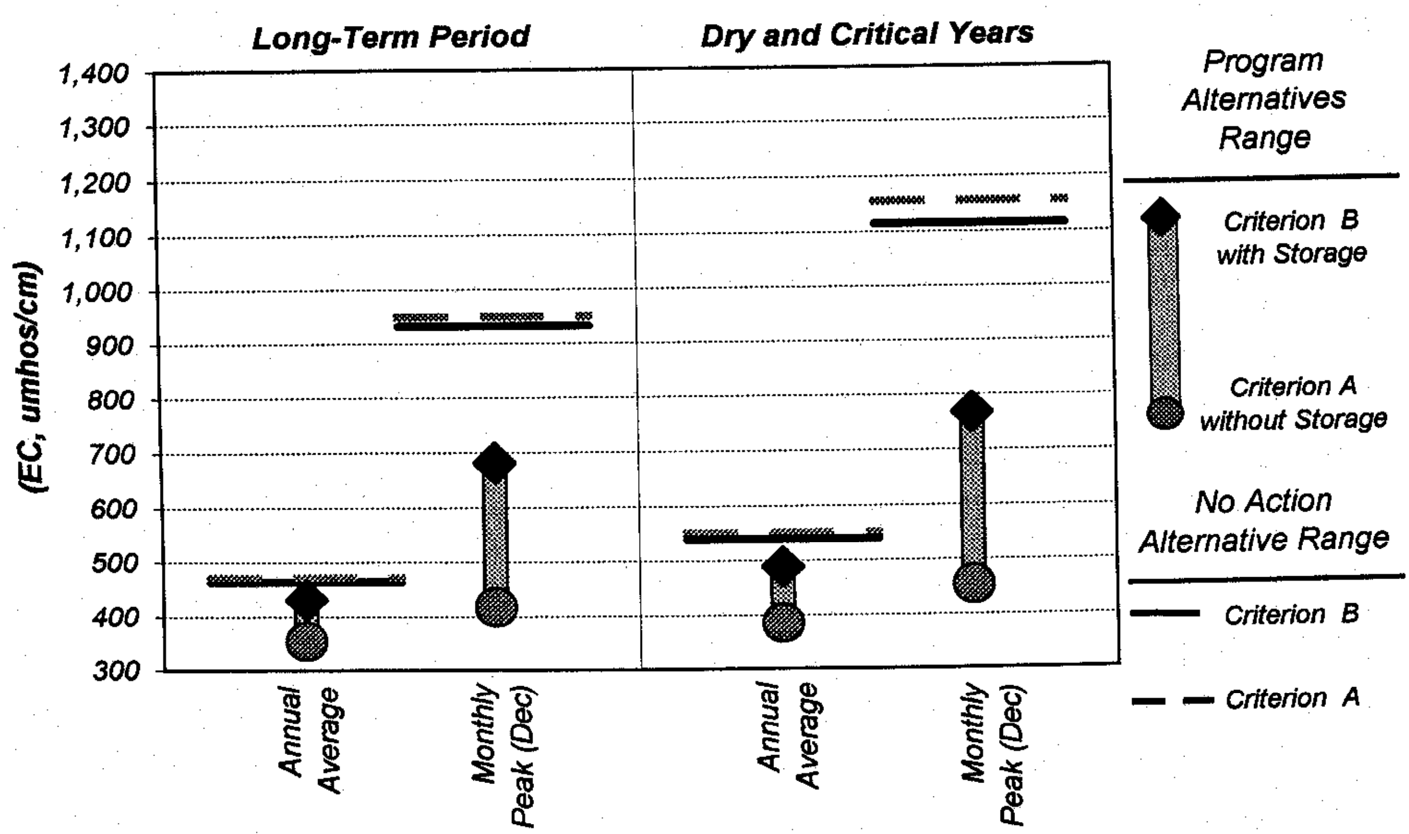


Figure 5.3-19. Ranges of Salinity (expressed as EC) at Jersey Point for Alternative 3

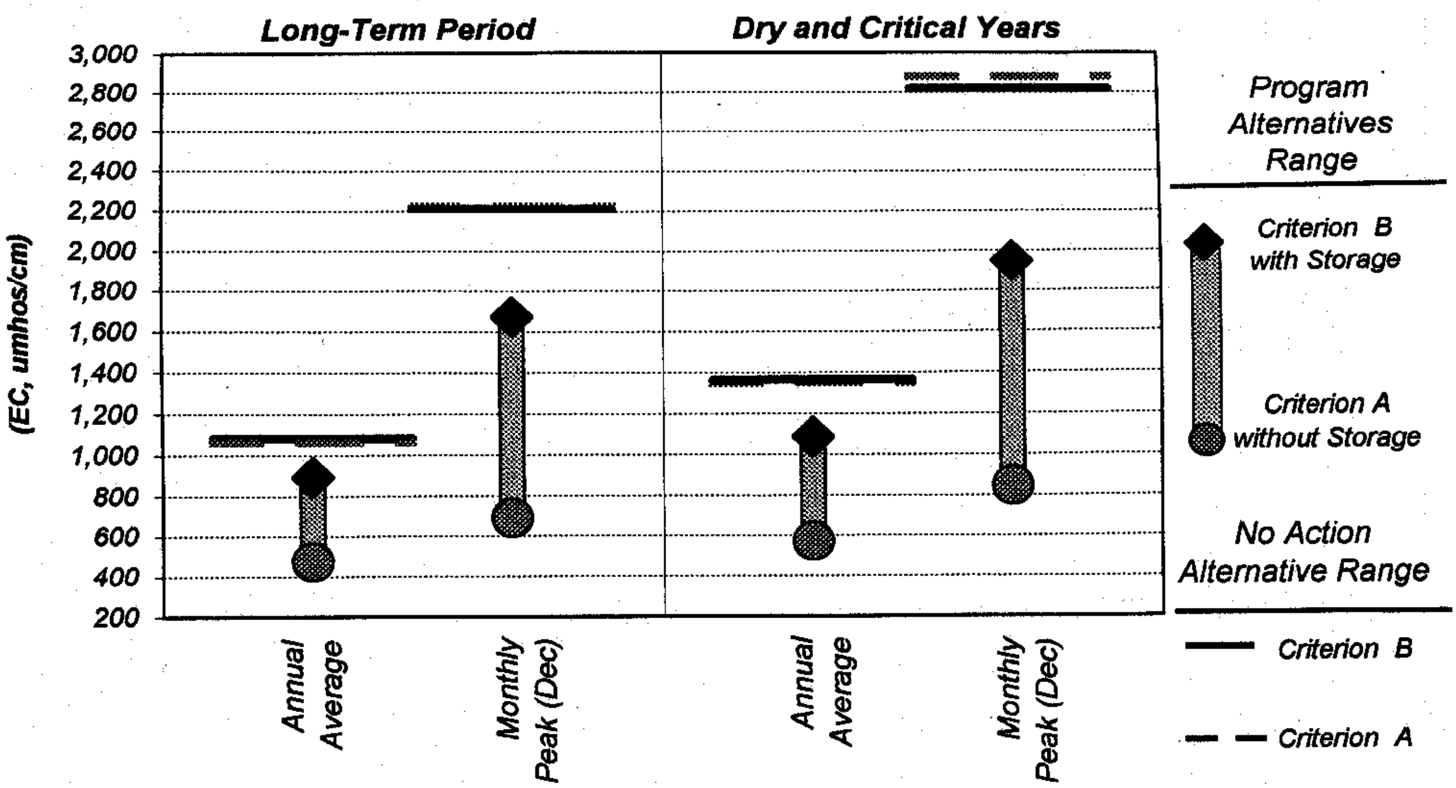


Figure 5.3-20. Ranges of Salinity (expressed as EC) at Middle River at Tracy Road for Alternative 3

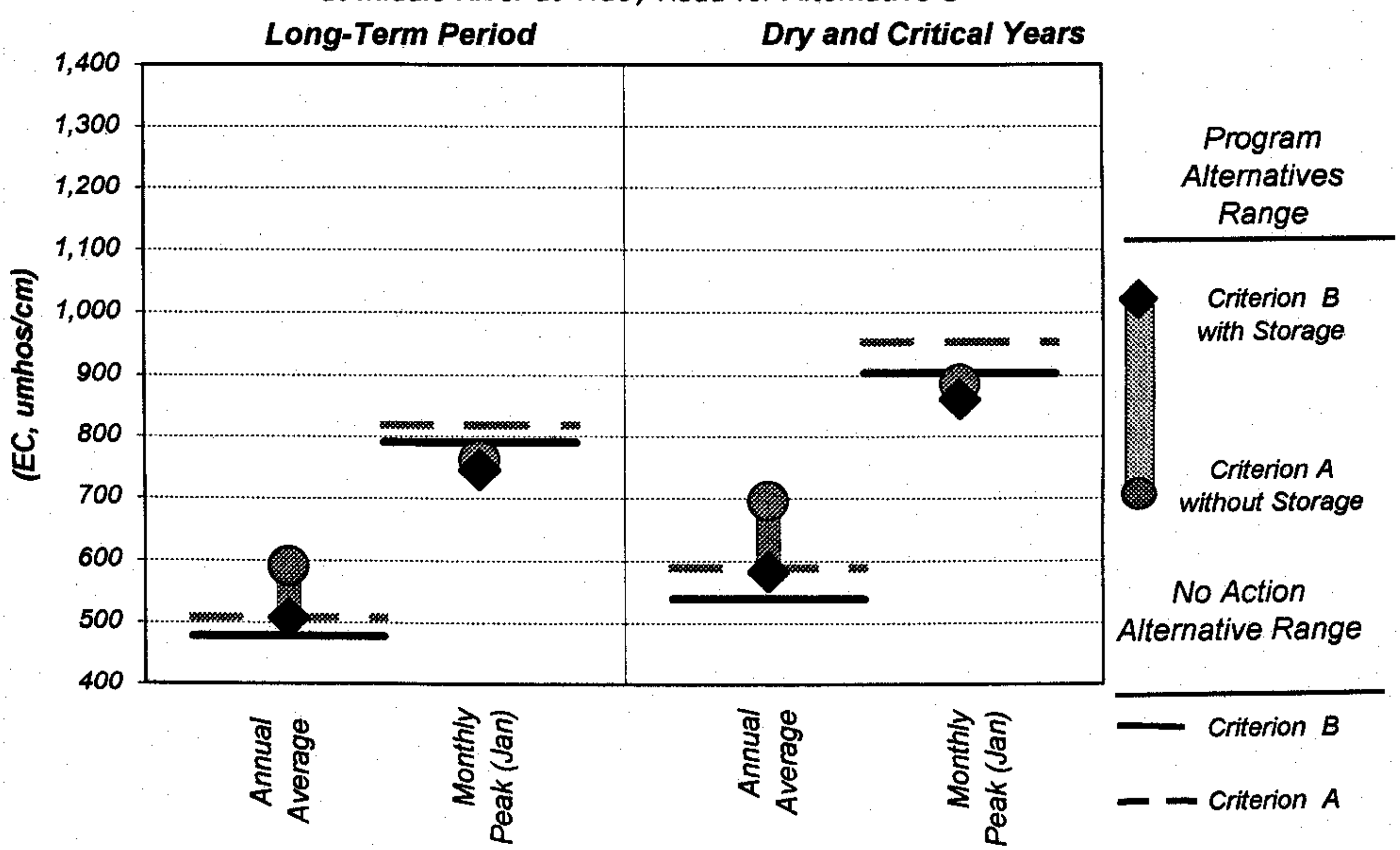
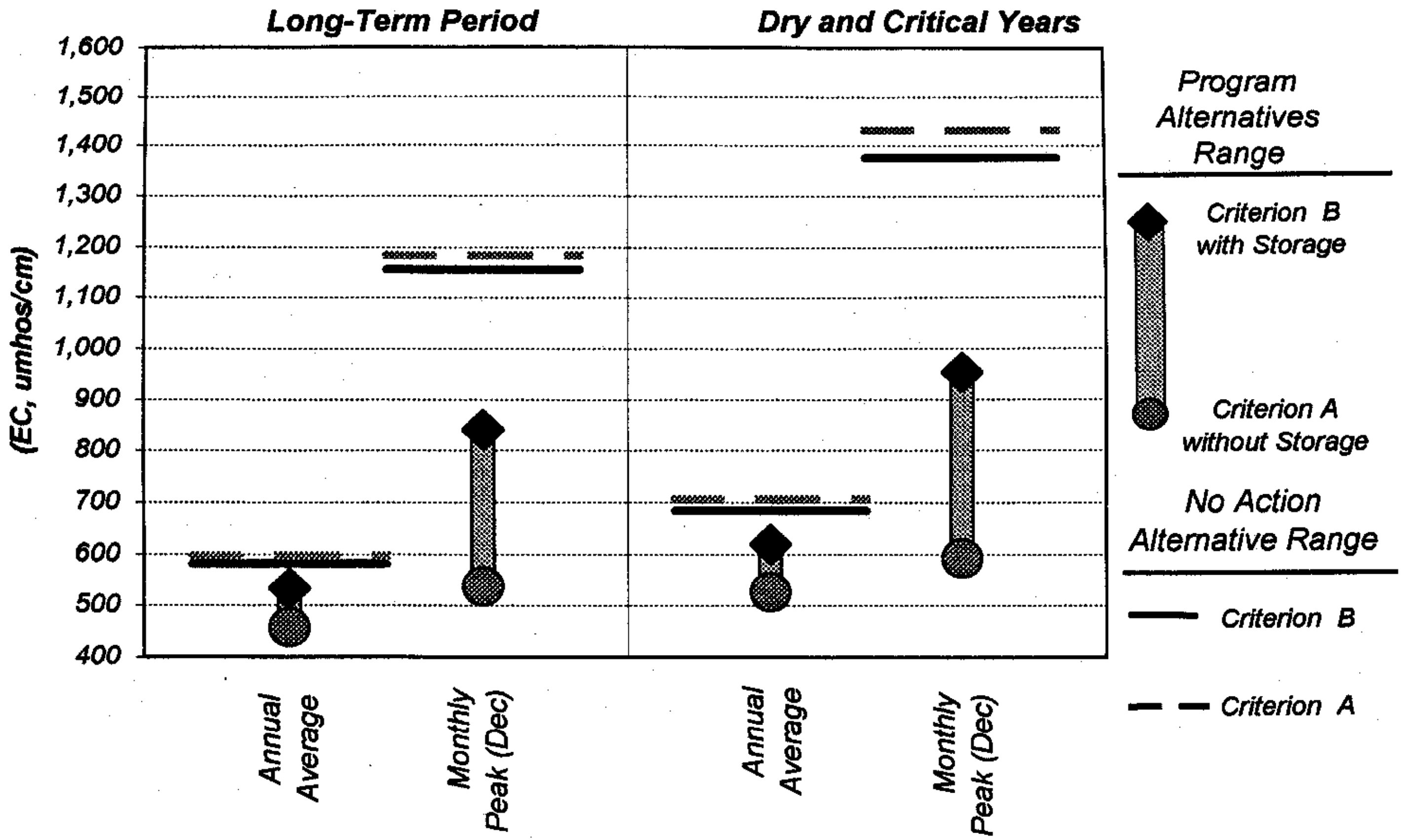


Figure 5.3-21. Ranges of Salinity (expressed as EC) at Rock Slough for Alternative 3



Bay Region

With increased exports from the Delta, Alternative 3 could slightly reduce net Delta outflows, resulting in greater sea-water intrusion into the Bay and resultant increases in salinity in San Francisco, San Pablo, and Suisun Bays (Suisun Bay is contiguous with Delta channels and diversion points). However, these increases are projected to be less than significant because of the application of environmental and water quality standards would preclude any facility operations that could cause adverse impacts in the Bay Region.

The addition of new storage could improve water quality and dependent conditions for estuarine biological resources in the west Delta as a result of increased Delta outflows, especially during low-outflow periods.

The addition of new storage could improve water quality and dependent conditions for estuarine biological resources in the west Delta as a result of increased Delta outflows, especially during low outflow periods.

Sacramento River Region

Impacts on water quality associated with Alternative 3 in the Sacramento River Region would be similar to those described for the Preferred Program Alternative.

Impacts on water quality associated with Alternative 3 in the Sacramento River Region would be similar to those described for the Preferred Program Alternative.

San Joaquin River Region

General impacts of storage and conveyance options on upstream water quality in the San Joaquin River Region are expected to be similar to those described for the Sacramento River Region under the Preferred Program Alternative. However, as indicated in Table 5.3-7a, the average annual decrease in the salinity of water exported to the San Joaquin River Region via the California Aqueduct and the DMC compared to the No Action Alternative is projected to range from 16 to 74% over the long term (see table for predicted ECs). The resultant net reduction in salt loads delivered to the valley is more difficult to project because it also would depend on changes in water deliveries, the locations where the water is applied, and source control actions taken. However, the overall effect would be to dramatically decrease salt loads and the resultant recycling of salts in the San Joaquin Valley and River.

The overall effect of Alternative 3 in the San Joaquin River Region would be to dramatically decrease salt load and the resultant recycling of salts in the San Joaquin Valley and River.

Use of the isolated facility would reduce the recirculation of contaminants contained in San Joaquin River flows by greatly reducing the return of river outflows to the vicinity of the export pumps. Instead, San Joaquin River flows would drain in a more natural pattern toward the Bay and the ocean. The resultant low salinity and associated constituent concentrations in the exported water would greatly reduce demands on treatment technologies; reduce costs; enable more efficient use to be made of existing supplies; and increase the potential for conjunctive use, source water blending, wastewater reuse, and recycling.

Alternative 3 has the potential to produce the best water quality for export to the Other SWP and CVP Service Areas of all the alternatives because much of the exported water would be diverted from the Sacramento River via the isolated facility and would not be subject to degradation in the Delta.

Additional upstream storage capacity could reduce adverse impacts and could even produce additional beneficial impacts on export water quality. Releases of high-quality water from new upstream storage during periods when salinities and other constituents otherwise would be higher at the export pumps could reduce salt loads in the SWP and

CVP service areas in the valley further, depending on the locations and timing of the releases—and especially during dry and critical years. Additional off-aqueduct storage could afford opportunities for additional pumping to storage during high-outflow periods, when water quality is good and environmental constraints allow, for later use when Delta water quality or environmental conditions are less favorable.

Other SWP and CVP Service Areas

Potential impacts and benefits on water quality in the Other SWP and CVP Service Areas would be similar to those described for the water service areas in the San Joaquin Valley.

Additional off-aqueduct storage could afford opportunities for additional pumping for storage during high outflow periods when water quality is highest and environmental constraints allow, for later use when Delta water quality or environmental conditions are less favorable.

Alternative 3 has the potential to produce the best water quality for export to the service areas of all the alternatives because much of the exported water would be diverted from the Sacramento River via the isolated facility and would not be subject to degradation in the Delta. Tables 5.3-7a and 5.3-7b show the comparative mean annual salinities (expressed as EC) of each of the primary points for out-of-basin export diversion from the Delta for the Management Criterion. With the isolated system, water also could be pumped from the Delta when environmental constraints and water quality standards permit, and periods of poorer water quality could be largely avoided. Water quality benefits could be enhanced still further by releases from new or enlarged storage facilities. The low salinity and associated constituent concentrations that would be achievable would further reduce the demands on treatment technologies; reduce costs; enable more efficient use to be made of existing supplies; and further increase the potential for conjunctive use, source water blending, wastewater reuse and recycling.

Simulations of bromide concentrations at key Delta export facilities were calculated based on fingerprint modeling data for the alternatives completed in 1998. The data were analyzed for dry and critical years, the most critical times of high bromide concentrations. The data were updated for the most recent model results, using the bromide-to-EC ratios in the older modeling exercise and the EC values generated in the latest model exercise. Based on changes in EC, bromide concentrations would not differ significantly between the No Action Alternative and Alternative 1. The bromide concentrations at Contra Costa Canal under Alternative A are expected to range from 0.51 to 0.76 μg/L under Criterion A and Criterion B, respectively, during December, the month of highest projected bromide levels. These concentrations represent a 75% and 63% drop, respectively, in bromide compared to Alternative 1. The annual average bromide concentrations are projected to range from 0.43 to 0.46 μg/L under Criterion A and Criterion B, respectively. These concentrations represent a 48% and 52% drop, respectively, in bromide compared to Alternative 1.

Concentrations of bromide at CCFB under Alternative 3 would be roughly equivalent to concentrations of bromide in the Sacramento River, assuming very little mixing of Sacramento River water with Delta water near the forebay. Bromide concentrations in the Sacramento River are negligible.

Concentrations of bromide at CCFB under Alternative 3 would be roughly equivalent to concentrations of bromide in the Sacramento River, assuming very little mixing of Sacramento River water with Delta water near the forebay. Bromide concentrations in the Sacramento River are negligible.

5.3.9 PROGRAM ALTERNATIVES COMPARED TO EXISTING CONDITIONS

5.3.9.1 PREFERRED PROGRAM ALTERNATIVE

This programmatic analysis found that the potentially beneficial and adverse impacts from implementing any of the Program alternatives when compared to existing conditions were generally the same impacts as those identified in Sections 5.3.7 and 5.3.8, which compares the Program alternatives to the No Action Alternative. Additionally, the comparison of the Program alternatives to existing conditions did not identify any additional potentially significant environmental consequences that were not identified in the comparison of Program alternatives to the No Action Alternative.

Table 5.3-8a summarizes the results of model simulations of average annual salinity (expressed as EC) throughout the Delta for the Preferred Program Alternative compared to existing conditions. Table 5.3-8b summarizes the results of model simulations of average annual EC during dry and critical years throughout the Delta for the Preferred Program Alternative compared to existing conditions. The impacts associated with the Preferred Program Alternative, when compared to existing conditions, generally would be similar to those compared to the No Action Alternative, except that the benefits would be less pronounced. In other words, the degree of water quality improvement that would be achieved in the future with the Preferred Program Alternative is projected to almost always be significantly greater than it would be if the facilities were constructed today.

The degree of water quality improvement achieved in the future under the Preferred Program Alternative is projected to almost always be significantly greater than it would be if the facilities were constructed today.

The overall geographic variations in the improvements and Delta locations where the changes were less than significant may be observed by comparing Table 5.3-8a with Table 5.3-4a. The differences between the comparisons of average annual ECs for the Preferred Program Alternative with average annual existing conditions, and annual ECs for the Preferred Program Alternative during dry and critical years with existing conditions during dry and critical years generally were less than significant.

Table 5.3-8a. Predicted Salinity Changes Between the Preferred Program Alternative and Existing Conditions for All Water-Year Types (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (µmhos/cm)	MONTH OF MAXIMUM EC (µmhos/cm)	ANNUAL CHANGE (µmhos/cm)	MONTH OF MAXIMUM EC (µmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
North Bay Aqueduct Intake at Barker Slough	7*	0	0	-10	0	0%	0%	-4%	0%	N/A	LTS
Mokelumne River at Terminous	8	-10	-30	-10	-20	-6%	-14%	-6%	-9%	Jan	LTS - B
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	20	-180	-50	-300	5%	-28%	-12%	-47%	Dec	LTS - B
Turner Cut	29	70	-70	0	-200	16%	-11%	0%	-31%	Jan	LTS - B
San Joaquin River at Prisoner's Point	12	10	-160	-110	-380	2%	-18%	-24%	-43%	Dec	LTS - B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-20	0	-20	-10	-3%	0%	-3%	-1%	Dec	LTS
San Joaquin River at Brandt Bridge	10	10	10	10	10	2%	1%	2%	1%	Dec	LTS
Middle River at Tracy Road	21	30	-90	-60	-210	6%	-12%	-13%	-27%	Jan	LTS - B
Grant Line Canal at Tracy Road	24	-30	0	-70	-10	-5%	0%	-11%	-1%	Dec	LTS - B
Old River at Tracy Road	17	-30	70	-80	-100	-5%	10%	-13%	-14%	Oct	LTS - B
Old River at Rock Slough	19	20	-160	-120	-410	4%	-15%	-21%	-37%	Dec	LTS - B
Contra Costa Canal Intake at Rock Slough	28*	20	-160	-120	-410	3%	-14%	-19%	-37%	Dec	LTS - B
Old River at SR 4 (and New CCWD Intake)	18*	20	-170	-110	-390	4%	-17%	-20%	-39%	Dec	LTS - B
Clifton Court Forebay	27*	40	-130	-100	-330	8%	-14%	-19%	-36%	Dec	LTS - B
Delta-Mendota Canal Intake from Old River	26*	10	-140	-90	-260	2%	-16%	-16%	-30%	Dec	LTS - B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	30	-70	80	-20	3%	-4%	9%	-1%	Sep	LTS
Sacramento River at Collinsville	4	30	600	180	690	1%	11%	6%	13%	Oct	LTS - PS
San Joaquin River at Jersey Point	14	60	10	-80	-300	6%	0%	-8%	-14%	Dec	LTS - B
San Joaquin River at Antioch	15	60	410	70	190	3%	9%	3%	4%	Oct	LTS
Suisun Bay at Port Chicago	5	-110	610	-20	380	-1%	3%	2%	-1%	Sep	LTS - B
Carquinez Strait at Martinez	6	-140	640	580	550	-1%	3%	3%	2%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
µmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

Table 5.3-8b. Predicted Salinity Changes Between the Preferred Program Alternative and Existing Conditions for Dry and Critical Years (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE ANNUAL CHANGE (μmhos/cm)	CRITERION A NO STORAGE MONTH OF MAXIMUM EC (μmhos/cm)	CRITERION B WITH STORAGE ANNUAL CHANGE (μmhos/cm)	CRITERION B WITH STORAGE MONTH OF MAXIMUM EC (μmhos/cm)	CRITERION A NO STORAGE ANNUAL CHANGE (%)	CRITERION A NO STORAGE MONTH OF MAXIMUM EC (%)	CRITERION A WITH STORAGE ANNUAL CHANGE (%)	CRITERION A WITH STORAGE MONTH OF MAXIMUM EC (%)	MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
North Bay Aqueduct Intake at Barker Slough*	7*	0	0	-10	-10	0%	0%	-5%	-4%	Mar	LTS
Mokelumne River at Terminous	8	-10	-40	-10	-40	-5%	-17%	-5%	-17%	Feb	LTS - B
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	30	-240	-70	-400	7%	-31%	-15%	-52%	Dec	B
Turner Cut	29	80	-140	-20	-330	16%	-18%	-4%	-43%	Jan	PS - B
San Joaquin River at Prisoner's Point	12	-10	-220	-150	-530	-2%	-20%	-28%	-49%	Dec	LTS - B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-30	-20	-30	-20	-4%	-2%	-4%	-2%	Feb	LTS
San Joaquin River at Brandt Bridge	10	20	-10	20	-10	3%	-1%	3%	-1%	Feb	LTS
Middle River at Tracy Road	21	30	-160	-100	-350	6%	-17%	-19%	-37%	Jan	LTS - B
Grant Line Canal at Tracy Road	24	-60	-20	-100	-20	-8%	-2%	-13%	-2%	Feb	LTS - B
Old River at Tracy Road	17	-60	-20	-130	-20	-8%	-2%	-17%	-2%	Feb	LTS - B
Old River at Rock Slough	19	0	-210	-170	-570	0%	-16%	-25%	-42%	Dec	LTS - B
Contra Costa Canal Intake at Rock Slough*	28*	10	-220	-160	-560	1%	-16%	-23%	-42%	Dec	LTS - B
Old River at SR 4 (and New CCWD Intake)*	18*	10	-220	-150	-530	2%	-18%	-23%	-44%	Dec	LTS - B
Clifton Court Forebay*	27*	40	-160	-140	-450	6%	-15%	-23%	-41%	Dec	LTS - B
Delta-Mendota Canal Intake from Old River*	26*	10	-180	-130	-360	1%	-18%	-19%	-36%	Jan	LTS - B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	20	-180	80	-180	2%	-7%	7%	-7%	Sep	LTS
Sacramento River at Collinsville	4	-20	-230	140	-340	-1%	-3%	4%	-5%	Sep	LTS
San Joaquin River at Jersey Point	14	10	-10	-160	-540	1%	0%	-12%	-20%	Dec	LTS - B
San Joaquin River at Antioch	15	-20	460	-10	120	-1%	9%	0%	2%	Oct	LTS
Suisun Bay at Port Chicago	5	-330	-20	330	-230	-2%	0%	2%	-1%	Sep	LTS
Carquinez Strait at Martinez	6	-370	-10	560	-40	-2%	0%	3%	0%	N/A	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

5.3.9.2 ALTERNATIVE 1

Delta Region

Potentially beneficial and adverse impacts from implementing Alternative 1 when compared to existing conditions are generally the same as identified in Section 5.3.8.2, where Alternative 1 is compared to the No Action Alternative. Additionally, the comparison of Alternative 1 to existing conditions did not identify any additional potentially significant environmental consequences that were not identified in Section 5.3.8.2.

Table 5.3.9a summarizes the results of model predictions of salinity changes (expressed as EC) throughout the Delta for Alternative 1 compared to existing conditions for a representative long-term hydrologic sequence that includes all water-year types (see Section 5.2). Separate predictions are shown based on modeling assuming water management Criterion A without storage and water management Criterion B with storage, which define the bookends for the analysis of water quality. For both sets of criteria, changes are shown for the annual average value over the period of the simulation and for the month of the year during which the higher salinities are projected.

Compared to existing conditions, Table 5.3.9a shows that under Alternative 1, salinity is projected to be significantly affected in the central Delta, in the south Delta, and in the San Joaquin River in the west Delta (as indicated by Jersey Point). For example, at CCFB, the mean long-term salinity is projected to increase by 70-80 μmhos/cm (13-15%), and the mean monthly salinity for December is projected to increase by about 140-180 μmhos/cm (15-20%). During dry and critical years, Table 5.3.9b shows that these ranges increase from 100 to 110 μmhos/cm (16-18%) for the long term and from 170 to 210 μmhos/cm (16-19%) on average for the month of December. Alternative 1 would potentially degrade overall in-Delta and export water quality and dependent beneficial uses because of the resultant increases in sea-water intrusion (see Figures 5.2-36 and 37 in Section 5.2). This degradation is projected to occur despite the increased potential for reservoir releases and increased inflows of better quality water across the Delta from the Mokelumne and Sacramento Rivers southward, and the potentially improved water circulation in affected Delta channels.

Compared to existing conditions, salinity is projected to be significantly affected under Alternative 1 in the central Delta, in the south Delta, and in the San Joaquin River in the west Delta (as indicated by Jersey Point).

The actual magnitudes of the salinity changes would vary tidally, seasonally, and spatially throughout the Delta, depending on factors such as the mixtures of source waters attained at each location that result from variations in the pathways and timing of flows through Delta channels. The magnitude of the changes also would vary from variations in annual hydrology. In general, the magnitude of impacts would be increased in dry and critical years, and attenuated in above-normal and wet years.

The actual magnitudes of the salinity changes would vary tidally, seasonally, and spatially throughout the Delta.

Increased cross-Delta flows and increased sea-water intrusion, coupled with increases in the concentrations of salts drawn from the San Joaquin River and interior Delta drainage, could act in concert to increase the frequency of higher bromide concentrations at Old and Middle Rivers.

Table 5.3-9a. Predicted Salinity Changes Between Alternative 1 and Existing Conditions for All Water-Year Types (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
North Bay Aqueduct Intake at Barker Slough	7*	0	0	-10	-10	0%	0%	-4%	-3%	Mar	LTS
Mokelumne River at Terminous	8	0	0	0	0	0%	0%	0%	0%	N/A	LTS
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	50	20	40	20	12%	3%	10%	3%	Nov	LTS - PS
Turner Cut	29	80	70	60	60	18%	11%	13%	9%	Jan	LTS - PS
San Joaquin River at Prisoner's Point	12	50	130	80	190	11%	15%	18%	22%	Dec	PS
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-20	0	-20	0	-3%	0%	-3%	0%	N/A	LTS
San Joaquin River at Brandt Bridge	10	10	10	10	10	2%	1%	2%	1%	Dec	LTS
Middle River at Tracy Road	21	60	80	60	120	13%	10%	13%	16%	Jan	PS
Grant Line Canal at Tracy Road	24	-30	10	-30	0	-5%	1%	-5%	0%	Dec	LTS
Old River at Tracy Road	17	-30	10	-30	10	-5%	1%	-5%	1%	Dec	LTS
Old River at Rock Slough	19	50	140	100	210	9%	13%	18%	19%	Dec	LTS - PS
Contra Costa Canal Intake at Rock Slough	28*	50	130	90	190	8%	12%	15%	17%	Dec	LTS - PS
Old River at SR 4 (and New CCWD Intake)	18*	50	110	80	160	9%	11%	15%	16%	Dec	LTS - PS
Clifton Court Forebay	27*	70	140	80	180	13%	15%	15%	20%	Dec	PS
Delta-Mendota Canal Intake from Old River	26*	30	20	20	50	5%	2%	4%	6%	Dec	LTS
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	10	110	30	100	1%	6%	3%	5%	Sep	LTS
Sacramento River at Collinsville	4	-10	280	130	300	0%	5%	5%	5%	Sep	LTS
San Joaquin River at Jersey Point	14	70	200	200	360	7%	9%	19%	17%	Nov	LTS - PS
San Joaquin River at Antioch	15	10	380	200	430	0%	8%	8%	9%	Oct	LTS
Suisun Bay at Port Chicago	5	-100	690	520	650	-1%	4%	4%	4%	Sep	LTS
Carquinez Strait at Martinez	6	-110	650	580	580	-1%	3%	3%	2%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

Table 5.3-9b. Predicted Salinity Changes Between Alternative 1 and Existing Conditions Alternative for Dry and Critical Years (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
North Bay Aqueduct Intake at Barker Slough	7*	0	0	-10	-20	0%	0%	-5%	-8%	Mar	LTS
Mokelumne River at Terminous	8	0	0	0	0	0%	0%	0%	0%	N/A	LTS
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	80	70	60	80	18%	9%	13%	10%	Dec	LTS - PS
Turner Cut	29	110	80	70	90	21%	10%	14%	12%	Jan	LTS - PS
San Joaquin River at Prisoner's Point	12	50	150	110	200	9%	14%	21%	18%	Dec	LTS - PS
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-30	-20	-30	-20	-4%	-2%	-4%	-2%	Feb	LTS
San Joaquin River at Brandt Bridge	10	20	-10	20	-10	3%	-1%	3%	-1%	Feb	LTS
Middle River at Tracy Road	21	70	110	80	170	13%	12%	15%	18%	Jan	PS
Grant Line Canal at Tracy Road	24	-60	-20	-60	-10	-8%	-2%	-8%	-1%	Feb	LTS
Old River at Tracy Road	17	-70	-20	-80	-10	-9%	-2%	-10%	-1%	Feb	LTS
Old River at Rock Slough	19	60	170	120	230	9%	13%	18%	17%	Dec	LTS - PS
Contra Costa Canal Intake at Rock Slough	28*	70	160	110	200	10%	12%	16%	15%	Dec	LTS - PS
Old River at SR 4 (and New CCWD Intake)	18*	70	140	100	170	11%	12%	16%	14%	Dec	PS
Clifton Court Forebay	27*	100	170	110	210	16%	16%	18%	19%	Dec	PS
Delta-Mendota Canal Intake from Old River	26*	30	20	20	40	4%	2%	3%	4%	Dec	LTS
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	0	20	10	-50	0%	1%	1%	-2%	Sep	LTS
Sacramento River at Collinsville	4	-100	30	100	-30	-3%	0%	3%	0%	N/A	LTS
San Joaquin River at Jersey Point	14	50	350	230	480	4%	13%	17%	18%	Dec	LTS - PS
San Joaquin River at Antioch	15	-70	180	190	220	-2%	3%	6%	4%	Sep	LTS
Suisun Bay at Port Chicago	5	-330	60	500	50	-2%	0%	3%	0%	Sep	LTS
Carquinez Strait at Martinez	6	-340	10	570	0	-2%	0%	3%	0%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

The actual magnitudes of monthly variations in salinity, including bromide, from existing conditions would depend on annual, seasonal, and geographically determined differences in the proportion of sea water present. Bromide is of particular concern to municipal water users because it is an inorganic precursor to several of the most potentially harmful known DBPs (for example, bromodichloromethane, bromate, and brominated halo-acetic acids—known for their roles as carcinogens and potential causes of increased birth defects).

Bay Region

With increased exports from the Delta, Alternative 1 could result in potentially significant impacts by reducing net Delta outflows, resulting in greater sea-water intrusion into the Bay. This could result in increases in salinity in San Francisco, San Pablo, and Suisun Bays.

The addition of new storage could improve water quality and dependent conditions for estuarine biological resources in the west Delta as a result of increased Delta outflows, especially during low-outflow periods.

The addition of new storage could improve water quality and dependent conditions for estuarine biological resources in the west Delta as a result of increased Delta outflows, especially during low-outflow periods.

Sacramento River Region

Impacts on water quality associated with Alternative 1 in the Sacramento River Region would be similar to those described for the Preferred Program Alternative.

San Joaquin River Region

When comparing Alternative 1 to existing conditions, general impacts of storage and conveyance options on upstream water quality in the San Joaquin River Region are expected to be similar to those described for the Sacramento River Region under the Preferred Program Alternative. However, the potential for significant changes in the quality (and quantity) of the water exported to the region as a result of decisions made during the term of this Program is great, and other non-CALFED programs also will produce effects (see "Cumulative Impacts" in Section 5.3.10). As indicated in Table 5.3-9a, the average annual increase in the salinity of water exported to the San Joaquin River Region via the DMC (assuming an intertie with CCFB) compared to existing conditions is projected to range from 2 to 20% for long-term averages. The resultant net change in salt loads delivered to the valley is more difficult to project because it also would depend on changes in water deliveries, the locations where the water is applied, and source control actions taken. However, the effect would be to increase salt loads and the resultant recycling of salts in the San Joaquin Valley.

The range of potential long-term water supply variations (possibly in t\he realm of 790 TAF of gains with new storage to 270 TAF without new storage) and source-dependent water quality characteristics are sufficiently large to significantly degrade prevailing water quality and the resultant salt balance in the SWP and CVP service areas

The range of potential long-term water supply variations and source-dependent water quality characteristics are sufficiently large to significantly degrade prevailing water quality and the resultant salt balance in the SWP and CVP service areas in the San Joaquin Valley and throughout the valley.

and throughout the San Joaquin Valley. The effects of the potential variations would be most pronounced in those areas that are already deficient in both quality and quantity of water. Resultant changes in land use in the service areas that could secondarily affect water quality, water supply, demands, and beneficial uses of water resources would in turn depend on the magnitude of the reductions in the quality of delivered water supplies. Despite the variability, overall degradation of water quality in the areas served by exports would adversely affect municipal, agricultural, and ecological uses of the water.

Other SWP and CVP Service Areas

Alternative 1 also could result in detrimental impacts on export water quality outside the Central Valley. Impacts on export water quality could result from the changes in flow and salinity patterns throughout the Delta as described above for the Delta Region. Potential impacts would be similar to but less than those described for the water service areas in the San Joaquin Valley.

Impacts on export water quality could result from the changes in flow and salinity patterns throughout the Delta.

5.3.9.3 ALTERNATIVE 2

Delta Region

Potentially beneficial and adverse impacts from implementing Alternative 2 when compared to existing conditions are generally the same as identified in Section 5.3.8.3, where Alternative 2 is compared to the No Action Alternative. Except at Collinsville, the comparison of Alternative 2 to existing conditions did not identify any additional potentially significant environmental consequences that were not identified in Section 5.3.8.3.

Table 5.3-10a summarizes the results of model predictions of salinity changes (expressed as EC) throughout the Delta for Alternative 2 compared to the existing conditions for a representative long-term hydrologic sequence that includes all water-year types (see Section 5.2). Separate predictions are shown based on modeling assuming water management Criterion A without storage, and water management Criterion B with storage, which define the bookends for the analysis of water quality. For both sets of criteria, changes are shown for the annual average value over the period of the simulation and for the month of the year when salinity is the highest.

Compared to existing conditions, Table 5.3-10a shows that under Alternative 2, salinity is projected to improve throughout the Delta and at the export facilities. For example, at CCFB, the mean long-term salinity is projected to decrease by 90-190 μmhos/cm (17-39%), and the mean monthly salinity for December is projected to decrease by 400-510 μmhos/cm (44-56%). During dry and critical years, Table 5.3-10b shows that salinity is projected to decrease by 110-240 μmhos/cm (18-39%) for the long term, and to decrease by 490-630 μmhos/cm (45-58%) on average for the month of December. The improvement in water quality is caused by increased flows of higher quality water across

Under Alternative 2, compared to existing conditions, salinity is projected to improve throughout the Delta and at the export facilities.

Table 5.3-10a. Predicted Salinity Changes Between Alternative 2 and Existing Conditions for All Water-Year Types (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
North Bay Aqueduct Intake at Barker Slough	7*	0	0	0	0	0%	0%	0%	0%	Mar	LTS
Mokelumne River at Terminous	8	0	-20	-10	-30	0%	-9%	-6%	-14%	Jan	LTS - B
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	-20	-320	-80	-370	-5%	-50%	-20%	-58%	Dec	LTS - B
Turner Cut	29	40	-150	-20	-260	9%	-23%	-4%	-40%	Jan	LTS - B
San Joaquin River at Prisoner's Point	12	-120	-460	-190	-570	-27%	-53%	-42%	-65%	Dec	B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-20	0	-20	0	-3%	0%	-3%	0%	N/A	LTS
San Joaquin River at Brandt Bridge	10	10	10	10	10	2%	1%	2%	1%	Dec	LTS
Middle River at Tracy Road	21	-40	-220	-110	-320	-8%	-29%	-23%	-42%	Jan	LTS - B
Grant Line Canal at Tracy Road	24	-60	-10	-80	-20	-10%	-1%	-13%	-3%	Dec	LTS - B
Old River at Tracy Road	17	-70	-80	-100	-120	-11%	-11%	-16%	-17%	Sep	B
Old River at Rock Slough	19	-140	-520	-230	-650	-25%	-48%	-41%	-59%	Dec	B
Contra Costa Canal Intake at Rock Slough	28*	-140	-500	-230	-630	-23%	-45%	-37%	-56%	Dec	B
Old River at SR 4 (and New CCWD Intake)	18*	-120	-590	-200	-640	-22%	-59%	-37%	-64%	Dec	B
Clifton Court Forebay	27*	-90	-400	-190	-510	-17%	-44%	-36%	-56%	Dec	B
Delta-Mendota Canal Intake from Old River	26*	-60	-290	-130	-350	-11%	-34%	-23%	-41%	Dec	B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	60	20	160	210	7%	1%	18%	11%	Sep	LTS - PS
Sacramento River at Collinsville	4	40	800	280	930	1%	15%	10%	18%	Oct	LTS - PS
San Joaquin River at Jersey Point	14	-180	-550	-350	-920	-17%	-27%	-34%	-44%	Dec	B
San Joaquin River at Antioch	15	-70	140	-100	-110	-3%	3%	-4%	-2%	Oct	LTS
Suisun Bay at Port Chicago	5	-290	420	400	420	-2%	2%	3%	2%	Sep	LTS
Carquinez Strait at Martinez	6	-160	630	570	560	-1%	3%	3%	2%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

Table 5.3-10b. Predicted Salinity Changes Between Alternative 2 and Existing Conditions for Dry and Critical Years (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
North Bay Aqueduct Intake at Barker Slough	7*	0	0	-10	-10	0%	0%	-5%	-4%	Mar	LTS
Mokelumne River at Terminous	8	0	-30	-20	-50	0%	-13%	-11%	-22%	Feb	LTS - B
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	-30	-410	-110	-480	-7%	-54%	-24%	-63%	Dec	LTS - B
Turner Cut	29	50	-270	-50	-430	10%	-35%	-10%	-56%	Jan	LTS - B
San Joaquin River at Prisoner's Point	12	-160	-600	-250	-730	-30%	-55%	-47%	-67%	Dec	B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-30	-20	-30	-20	-4%	-2%	-4%	-2%	Feb	LTS
San Joaquin River at Brandt Bridge	10	20	-10	20	-10	3%	-1%	3%	-1%	Feb	LTS
Middle River at Tracy Road	21	-60	-370	-160	-510	-11%	-39%	-30%	-54%	Jan	B
Grant Line Canal at Tracy Road	24	-90	-20	-120	-10	-12%	-2%	-16%	-1%	Feb	LTS - B
Old River at Tracy Road	17	-100	-20	-150	-10	-13%	-2%	-20%	-1%	Feb	B
Old River at Rock Slough	19	-190	-650	-300	-830	-28%	-48%	-45%	-62%	Dec	B
Contra Costa Canal Intake at Rock Slough	28*	-180	-630	-300	-800	-26%	-47%	-43%	-60%	Dec	B
Old River at SR 4 (and New CCWD Intake)	18*	-150	-590	-270	-740	-23%	-49%	-42%	-61%	Dec	B
Clifton Court Forebay	27*	-110	-490	-240	-630	-18%	-45%	-39%	-58%	Dec	B
Delta-Mendota Canal Intake from Old River	26*	-80	-360	-180	-450	-12%	-35%	-27%	-44%	Dec	B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	40	-120	170	60	3%	-4%	14%	2%	Sep	LTS - PS
Sacramento River at Collinsville	4	-40	-250	260	-90	-1%	-3%	7%	-1%	Sep	LTS
San Joaquin River at Jersey Point	14	-270	-740	-480	-1240	-20%	-27%	-36%	-46%	Dec	B
San Joaquin River at Antioch	15	-190	110	-220	-230	-6%	2%	-7%	-4%	Oct	LTS
Suisun Bay at Port Chicago	5	-550	-220	360	-170	-4%	-1%	2%	-1%	Sep	LTS
Carquinez Strait at Martinez	6	-400	-20	550	-40	-2%	0%	3%	0%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

the Delta from the Mokelumne and Sacramento Rivers southward, and the improved water circulation in affected Delta channels.

Potentially significant adverse impacts on average annual salinities would be restricted primarily to the lower Sacramento River (for example, Emmaton) due to the diversion of upstream flows into the central and south Delta.

Increased cross-Delta flows, reduced sea-water intrusion, improved circulation, and resultant increases in dispersion and dilution of smaller quantities of ocean salts would act in concert to decrease bromide concentrations at drinking water supply intakes in the Delta. The actual magnitudes of monthly variations from existing conditions would depend on hydrologic, seasonal, and geographically determined differences in the proportion of sea water present.

> Increased cross-Delta flows; reduced sea-water intrusion, improved circulation, and resultant increases in dispersion and dilution of smaller quantities of ocean salts would act in concert to decrease bromide concentrations at drinking water supply intakes in the Delta.

Bay Region

With increased exports from the Delta, Alternative 2 could result in potentially significant impacts by reducing net Delta outflows, resulting in greater sea-water intrusion into the Bay. This could result in increases in salinity in San Francisco, San Pablo, and Suisun Bays.

Sacramento River Region

Impacts of Alternative 2 in the Sacramento River Region would be similar to those described for the Preferred Program Alternative.

San Joaquin River Region

General impacts of storage and conveyance options on upstream water quality in the San Joaquin River Region are expected to be similar to those described for the Sacramento River Region. However, the potential for significant changes in the quality (and quantity) of the water exported to the region as a result of decisions made during the term of this Program is great, and other non-CALFED programs also will produce effects (see "Cumulative Impacts" in Section 5.3.10).

As indicated in Table 5.3-10a, a significant long-term decrease in the salinity (ranging at the DMC from 11 to 36%) of water exported to the San Joaquin River Region is projected under Alternative 2. The resultant net change in salt loads delivered to the San Joaquin River Valley is difficult to project because it would depend on water delivery operations, and other factors; however, based on this analysis alone, long-term salinity loads to the Valley could be significantly reduced. Overall improvements in water quality in the areas served by exports would benefit municipal, agricultural, and ecological uses of the water. Improvements also would reduce the amount of salt recycling that occurs between the basin and the Delta.

> A significant long-term decrease in the salinity of water exported to the San Joaquin River Region is projected under Alternative 2.

Other SWP and CVP Service Areas

Alternative 2 also would result in beneficial impacts on export water quality outside the Central Valley. Benefits would result from the improved export water quality as described for the Delta Region. Benefits and potential impacts would be similar to those described earlier for the water service areas in the San Joaquin Valley. Overall water quality improvement benefits should be somewhat greater because more of these service areas are served by SWP exports from CCFB, which receives higher quality water than the CVP.

> Alternative 2 also would result in beneficial impacts on export water quality outside the Central Valley.

5.3.9.4 ALTERNATIVE 3

Table 5.3-11a summarizes the results of model simulations of average annual salinity (expressed as EC) throughout the Delta for Alternative 3 compared to existing conditions. Table 5.3-11b summarizes the results of model simulations of average annual EC during dry and critical years throughout the Delta for Alternative 3 compared to existing conditions. The impacts associated with Alternative 3, when compared to existing conditions, generally would be similar to those compared to the No Action Alternative, except in some cases at Emmaton, where the impacts compared to existing conditions would be significant. During dry and critical years, impacts also would be similar to the comparison with the No Action Alternative. In general, potentially significant impacts would be larger in magnitude where they occur, especially with Criterion A. In other words, future water quality impacts with Alternative 3 are projected to almost always be somewhat larger in magnitude than they would be if the facilities were constructed today.

The overall geographic variations in the improvements, and Delta locations where the changes were significant and less than significant may be observed by comparing Table 5.3-11a with Table 5.3-7a. The differences between the comparisons of average annual ECs for Alternative 3 with average annual existing conditions, and annual ECs for Alternative 3 during dry and critical years with existing conditions during dry and critical years generally showed the differences to be more pronounced during the dry and critical years.

5.3.10 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 quality resources. For a summary of cumulative impacts for all resource categories, please refer to Chapter 3. For the list and a description of the projects and programs considered in this analysis of cumulative impacts, please see Attachment A.

> 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 quality resources.

Projects and actions that are assumed to be included under existing conditions and under the No Action Alternative were described earlier, along with the discussion of impacts of

Table 5.3-11a. *Predicted Salinity Changes Between Alternative 3 and Existing Conditions for All Water-Year Types (Salinity Expressed as EC)*

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE		CRITERION B WITH STORAGE		CRITERION A NO STORAGE		CRITERION B WITH STORAGE		MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
		ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (μmhos/cm)	MONTH OF MAXIMUM EC (μmhos/cm)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)	ANNUAL CHANGE (%)	MONTH OF MAXIMUM EC (%)		
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
North Bay Aqueduct Intake at Barker Slough	7*	0	-10	-10	0	0%	-3%	-4%	0%	Mar	LTS
Mokelumne River at Terminous	8	30	50	30	40	17%	23%	17%	19%	Jan	PS
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	120	-10	80	-20	30%	-2%	20%	-3%	Dec	LTS - PS
Turner Cut	29	170	130	110	40	38%	20%	25%	6%	Jan	LTS - PS
San Joaquin River at Prisoner's Point	12	-100	-460	-20	-190	-22%	-53%	-4%	-22%	Dec	LTS - B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-20	0	-20	-10	-3%	0%	-3%	-1%	Dec	LTS
San Joaquin River at Brandt Bridge	10	10	0	10	0	2%	0%	2%	0%	N/A	LTS
Middle River at Tracy Road	21	120	-10	40	-30	25%	-1%	8%	-4%	Jan	LTS - PS
Grant Line Canal at Tracy Road	24	-10	0	-40	-10	-2%	0%	-6%	-1%	Dec	LTS
Old River at Tracy Road	17	-10	0	-50	-10	-2%	0%	-8%	-1%	Dec	LTS
Old River at Rock Slough	19	-110	-560	-30	-250	-20%	-51%	-5%	-23%	Dec	LTS - B
Contra Costa Canal Intake at Rock Slough	28*	-90	-520	-30	-260	-15%	-46%	-5%	-23%	Dec	LTS - B
Old River at SR 4 (and New CCWD Intake)	18*	-40	-400	-20	-220	-7%	-40%	-4%	-22%	Dec	LTS - B
Clifton Court Forebay	27*	-350	-760	-270	-600	-67%	-83%	-52%	-66%	Dec	B
Delta-Mendota Canal Intake from Old River	26*	-210	-430	-90	-240	-38%	-50%	-16%	-28%	Dec	B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	-90	-750	110	-290	-10%	-38%	13%	-15%	Sep	PS - B
Sacramento River at Collinsville	4	-500	-1900	240	-610	-18%	-34%	9%	-11%	Sep	LTS - B
San Joaquin River at Jersey Point	14	-560	-1410	-140	-590	-54%	-66%	-14%	-28%	Nov	B
San Joaquin River at Antioch	15	-800	-1420	40	180	-34%	-30%	2%	4%	Oct	LTS - B
Suisun Bay at Port Chicago	5	-760	-1470	590	-240	-6%	-8%	5%	-1%	Sep	LTS
Carquinez Strait at Martinez	6	-640	-1010	710	-60	-4%	-4%	4%	0%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
μmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

Table 5.3-11b. Predicted Salinity Changes Between Alternative 3 and Existing Conditions for Dry and Critical Years (Salinity Expressed as EC)

DELTA/SUISUN BAY SUB-REGION AND LOCATION	STATION NO.	CRITERION A NO STORAGE ANNUAL CHANGE (µmhos/cm)	CRITERION A NO STORAGE MONTH OF MAXIMUM EC (µmhos/cm)	CRITERION B WITH STORAGE ANNUAL CHANGE (µmhos/cm)	CRITERION B WITH STORAGE MONTH OF MAXIMUM EC (µmhos/cm)	CRITERION A NO STORAGE ANNUAL CHANGE (%)	CRITERION A NO STORAGE MONTH OF MAXIMUM EC (%)	CRITERION B WITH STORAGE ANNUAL CHANGE (%)	CRITERION B WITH STORAGE MONTH OF MAXIMUM EC (%)	MONTH OF MAXIMUM EC	IMPACT ASSESSMENT
NORTH DELTA SUB-REGION											
Sacramento River at Greene's Landing	1	0	0	0	0	0%	0%	0%	0%	N/A	LTS
Sacramento River at Rio Vista	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
North Bay Aqueduct Intake at Barker Slough	7*	0	0	-10	-10	0%	0%	-5%	-4%	Mar	LTS
Mokelumne River at Terminous	8	30	60	40	50	16%	26%	21%	22%	Jan	PS
CENTRAL DELTA SUB-REGION											
San Joaquin River at Ridge Tract	11	150	-80	110	-50	33%	-10%	24%	-7%	Dec	LTS - PS
Turner Cut	29	200	210	150	150	39%	31%	29%	22%	Feb	PS
San Joaquin River at Prisoner's Point	12	-150	-630	-40	-320	-28%	-58%	-8%	-30%	Dec	LTS - B
SOUTH DELTA AND PRINCIPAL EXPORT PUMPS SUB-REGION											
San Joaquin River at Vernalis	9	-30	-20	-30	-20	-4%	-2%	-4%	-2%	Feb	LTS
San Joaquin River at Brandt Bridge	10	20	-10	20	-10	3%	-1%	3%	-1%	Feb	LTS
Middle River at Tracy Road	21	160	-50	40	-80	30%	-5%	7%	-9%	Jan	LTS - PS
Grant Line Canal at Tracy Road	24	-20	-20	-80	-10	-3%	-2%	-10%	-1%	Feb	LTS
Old River at Tracy Road	17	-20	-10	-80	-20	-3%	-1%	-10%	-2%	Feb	LTS
Old River at Rock Slough	19	-150	-750	-50	-390	-22%	-56%	-7%	-29%	Dec	LTS - B
Contra Costa Canal Intake at Rock Slough	28*	-120	-710	-50	-400	-17%	-53%	-7%	-30%	Dec	LTS - B
Old River at SR 4 (and New CCWD Intake)	18*	-60	-560	-30	-330	-9%	-46%	-5%	-27%	Dec	LTS - B
Clifton Court Forebay	27*	-430	-930	-350	-780	-70%	-85%	-57%	-72%	Dec	B
Delta-Mendota Canal Intake from Old River	26*	-250	-520	-150	-370	-37%	-51%	-22%	-36%	Dec	B
WEST DELTA, SUISUN BAY, AND MARSH SUB-REGION											
Sacramento River at Emmaton	3	-160	-1260	100	-750	-13%	-46%	8%	-27%	Sep	LTS - B
Sacramento River at Collinsville	4	-750	-2880	170	-1680	-19%	-40%	4%	-23%	Sep	LTS - B
San Joaquin River at Jersey Point	14	-770	-1880	-260	-780	-58%	-69%	-19%	-29%	Dec	B
San Joaquin River at Antioch	15	-1140	-1510	-100	240	-35%	-28%	-3%	4%	Oct	LTS - B
Suisun Bay at Port Chicago	5	-1110	-2590	510	-1450	-7%	-13%	3%	-7%	Sep	LTS - B
Carquinez Strait at Martinez	6	-970	-2040	630	-1130	-5%	-8%	3%	-4%	Sep	LTS

Notes:

* Indicates diversion points for municipal and industrial use.

B = Beneficial.
CCWD = Contra Costa Water District.
EC = Electrical conductivity.
LTS = Less than significant.
µmhos/cm = Micromhos per centimeter.
PS = Potentially significant.
SR = State Route.

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.

The following projects would result in negligible effects on water quality in the Bay-Delta system: the components of the CVPIA that are not included in the No Action Alternative, CCWD Multi-Purpose Pipeline Project, Hamilton City Pumping Plant Fish Screen Improvement Project, Montezuma Wetlands Project, Red Bluff Diversion Dam Fish Passage Program, Sacramento River Flood Control System Evaluation, West Delta Watershed Program, and the Sacramento River Conservation Area Program. The Trinity River Restoration Project and Interim South Delta Program (ISDP) cause water quality effects that were considered in the environmental impact analysis presented in Sections 5.3.7 and 5.3.8 of this chapter, and, therefore, would not cause additional cumulative effects. Consequently, these projects would not contribute to cumulative impacts on water quality and are not considered further in this cumulative impact analysis.

The American River Water Resources Investigation, American River Watershed Project, Delta Wetlands Project, Pardee Reservoir Enlargement Project, Sacramento Water Forum Process, EBMUD Supplemental Water Supply Project, Sacramento County Municipal and Industrial Water Supply Contracts and urbanization could cause environmental consequences that, when combined with Program actions, would result in cumulative impacts.

The water management projects listed in Attachment A and Program actions could lead to or involve increased storage and diversion of water. These projects cumulatively would reduce flows in tributary rivers and the Delta during high-flow periods and may increase flows in river reaches and Delta channels upstream of diversions during low-flow periods. The flow changes could result in cumulative effects on water quality. Changes in salinity due to lower flows and increased exports would result in a potentially significant cumulative impact in the Bay Region. Salinity increases in the Delta and lower Sacramento River could result in potentially significant adverse cumulative impacts on water quality of in-stream and consumptive use water resources. Mitigation measures have been identified that would reduce the impacts for Program actions and the projects included in Attachment A. Nevertheless, these cumulative effects in the Bay, Delta, and Other SWP and CVP Service Area Regions are considered potentially significant.

Changes in salinity due to lower flows and increased exports would result in a potentially significant cumulative impact in the Bay Region.

Projects listed in Attachment A and Program actions that involve construction, dredging, or drainage of flooded lands have the potential to release inorganic and organic suspended solids; and the potential for releases of toxic substances, such as pesticide, selenium, and heavy metal residues into the water column. These releases could result in potentially significant adverse cumulative impacts on the water quality of in-stream and consumptive use water resources. Mitigation measures have been identified that would reduce the impacts for Program actions and the projects included in Attachment A. Nevertheless, these cumulative effects are considered potentially significant in all Program regions.

To the extent that Program actions and projects listed in Attachment A lead to potential growth increases, this growth in combination with urbanization would result in a cumulative increase in discharge of nonpoint source pollutants to water bodies, with a consequent adverse effect on water quality of in-stream and consumptive use water resources. Nonpoint sources largely are unregulated, and mitigation depends on local voluntary efforts. This cumulative impact is considered potentially significant in all Program regions.

Cumulative impacts regarding bromide concentration increases are considered potentially significant.

Projects listed in Attachment A and Program actions could lead to increased bromide concentrations in certain Delta water areas. Program impacts are considered potentially significant adverse impacts regarding bromide concentration increases. The additional increases due to projects included in Attachment A would result in potentially significant adverse cumulative impacts on the water quality of in-stream and consumptive use water resources. Mitigation measures have been identified that would reduce the impacts for Program actions and for projects included in Attachment A. Nevertheless, these cumulative effects are considered potentially significant in the Delta Region and in the Other SWP and CVP Service Areas.

Projects listed in Attachment A and Program actions could lead to increased TDS content in certain Delta channels. The Program actions are considered potentially significant unavoidable impacts on the suitability of the water as a source for agricultural irrigation. The additional increases due to projects in Attachment A would result in potentially significant adverse cumulative impacts. Mitigation measures have been identified that would reduce the impacts for Program actions and the projects included in Attachment A. Nevertheless, these cumulative effects are considered potentially significant in the Delta Region.

Projects listed in Attachment A and Program actions could lead to increased TOC in river and Delta water areas. The Program actions are considered potentially significant adverse impacts regarding TOC increases. The additional increases due to projects in Attachment A would result in potentially significant adverse cumulative impact on the water quality of in-stream and consumptive use water resources. Mitigation measures have been identified that would reduce the impacts for Program actions and for projects included in Attachment A. Nevertheless, these cumulative effects are considered potentially significant in the Delta Region and in the Other SWP and CVP Service Areas.

Projects listed in Attachment A and Program actions could lead to increased water temperatures and resultant decreased dissolved oxygen concentrations due to the increased residence time of water in channels that are widened or restored to meandering patterns.

Projects listed in Attachment A and Program actions could lead to increased water temperatures and resultant decreased dissolved oxygen concentrations due to the increased residence time of water in channels that are widened or restored to meandering patterns. The Program actions are considered potentially significant adverse impacts regarding temperature increases and decreases in dissolved oxygen. The additional increases due to projects in Attachment A would result in cumulative impacts. Mitigation measures have been identified that would reduce the impacts for Program actions and for projects included in Attachment A. Nevertheless, these cumulative effects are considered potentially significant in all Program regions except in the Other SWP and CVP Service Areas.

Mitigation strategies have been identified that would reduce the impacts for Program actions and for projects included in Attachment A. Project-specific mitigation strategies that could be used are presented in Section 5.3.12. Other strategies could include operating the projects to minimize adverse effects on water quality. Effects on water quality will be addressed during project authorization or establishment of water rights. Nevertheless, the cumulative effects on water quality are considered potentially significant.

Cumulative effects on water quality are considered potentially significant.

Growth-Inducing Impacts. The Preferred Program Alternative would increase the reliability of water for municipal and agricultural use in the San Joaquin Valley, in central and southern coastal regions, and in southern California. Growth-inducing impacts could be caused by beneficial impacts on water quality associated with the Preferred Program Alternative. These impacts could include economic or population growth, or the construction of new housing stimulated by increased reliability of water supply. The degree of growth-inducing impact would depend on the locations of these activities and other factors dependent on the location. The significance of the growth-inducing impact cannot be determined at the programmatic level.

The potential growth induced by the Preferred Program Alternative would result in indirect adverse impacts on water quality. Undeveloped lands converted to urban and agricultural uses could become a source of nonpoint pollutants. These pollutants, which would include TSS, pesticides, nutrients and toxic metals, would be delivered to waterways from urban and agricultural runoff. The volume of municipal wastewater and irrigation tailwater discharged to water bodies would increase, and in-stream water quality would be degraded.

The growth induced by the Preferred Program Alternative would result in indirect adverse impacts on water quality.

Alternative 1 would induce less growth than the Preferred Program Alternative. Alternative 3 would induce more growth than the Preferred Program Alternative. The effects of Alternative 2 on growth would be similar to those described for the Preferred Program Alternative.

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

The Preferred Program Alternative would result in short-term adverse effects on water quality during the construction of facilities that are included in each alternative. The contaminant of concern most affected would be TSS. TSS concentrations are likely to be increased in the immediate vicinity of construction activities. Where possible, avoidance and mitigation measures would be implemented as a standard course of action to lessen impacts on these resources. The short-term impacts of the Preferred Program Alternative on water quality would be greater than, but similar to, those of Alternative 1, and less than those of Alternatives 2 and 3.

The short-term impacts on water quality of the Preferred Program Alternative would be offset by long-term improvements. The Ecosystem Restoration, Water Quality, and Watershed Program elements would result in long-term positive impacts on water quality for aquatic life and municipal and agricultural supply. The Levee System Integrity

The reduction in total Delta outflow to San Francisco Bay could adversely affect water quality in the Bay.

Program and the Storage and Conveyance elements of all Program alternatives would result in little effect on water quality for aquatic life but would improve the quality of water diverted from the Delta for municipal and agricultural use at some locations, with one exception. The reduction in total Delta outflow to San Francisco Bay could adversely affect water quality in the Bay.

Irreversible and Irretrievable Commitments. The irreversible and irretrievable commitments of resources associated with the Preferred Program Alternative would not affect water quality.

Specific mitigation measures will be adopted consistent with the Program goals and objectives and the purposes of site-specific projects.

5.3.11 MITIGATION STRATEGIES

These 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.

TOC increases may be mitigated by locating created wetlands away from drinking water intakes, by treating wetland discharges, or by treating water to remove TOC before it is disinfected and supplied to water system customers.

Ecosystem Restoration Program. The Ecosystem Restoration Program element could increase the TOC content of Delta waters. If tests show that TOC increases would occur, wetland creation projects could be located away from the municipal water supply intakes or the diverted water could be treated to remove TOC. The Water Use Efficiency and Water Transfer Program elements of the alternatives, would result in some localized adverse impacts on water quality which could be mitigated, in most cases, by release of greater volumes of fresh water from upstream reservoirs.

TOC increases may be mitigated by locating created wetlands away from drinking water intakes, by treating wetland discharges, or by treating water to remove TOC before it is disinfected and supplied to water system customers. Mitigation may not be available to reduce impacts to less-than-significant levels.

Construction activities for the Levee System Integrity Program would be similar to and integrated with those described for the Ecosystem Restoration Program.

Levee System Integrity Program. Construction activities for the Levee System Integrity Program would be similar to and integrated with those described for the Ecosystem Restoration Program. Existing levees would be demolished, and new levees would be constructed—either at or close to the site of the original levees or set back some distance from the original levees if a channel is to be widened or a wetland created. Short-term effects on water quality would be similar to those described for the Ecosystem Restoration Program but would occur only in the Delta Region. Local increases in the TSS content of waters in Delta channels are expected. Some increase in nutrient and TOC concentrations also may occur. Toxic substances contained in old levees or in channel sediments could be released during demolition or dredging.

It is expected that short-term construction impacts can be reduced to a less-than-significant level by employing construction methods that minimize in-water construction and by applying appropriate mitigation measures.

It is expected that short-term construction impacts can be reduced to a less-than-significant level by employing construction methods that minimize in-water construction and by applying appropriate mitigation measures. Soils in the levees and channel sediments would be tested prior to commencement of construction so that the need for special mitigation measures can be determined.

Water Use Efficiency Program. Increased water use efficiency would adversely affect water quality when the volume of municipal wastewater or agricultural tailwater discharged to a stream is reduced but the mass load of salts and other contaminants in the discharge remains the same. The adverse effect would be most pronounced in streams where municipal or agricultural discharges represent a substantial proportion of streamflow. Adverse effects would occur most acutely in small streams in the Sacramento River and San Joaquin River Regions, downstream of municipal and agricultural wastewater discharges.

It is expected that, in most cases the localized adverse water quality impacts of the program can be mitigated to less-than-significant levels by increasing treatment of wastewater before it is discharged to waterways or increasing fresh-water releases from reservoirs to provide more dilution water.

Water Transfer Program. Reduced streamflows in the Delta and in the Sacramento River and San Joaquin River Regions would adversely affect water quality. Contaminant concentrations in streams would increase as the volume of dilution water decreased, and water temperatures may be elevated. The adverse effects of water transfers would be greatest if water is diverted at an upstream location in the Bay-Delta system and transferred in a pipeline or canal to the area of use.

Reduced streamflows in the Delta and in the Sacramento River and San Joaquin River Regions would adversely affect water quality.

The adverse impacts of water transfers on water quality could be lessened by requiring transferred water to be conveyed through natural channels to the area of use where feasible.

Storage. Most of the long-term adverse effects of surface and groundwater storage on water quality could be reduced to a less-than-significant level by various mitigation measures. Surface water reservoirs could be sited to avoid areas where rocks contain mercury or other potentially hazardous substances. If avoidance is impossible, rock outcrops could be covered with inert materials and vegetation cleared from the site to minimize the development of anaerobic conditions at the bottom of reservoirs. Outlet works at the reservoirs could be designed with multiple outlet portals to minimize depression of dissolved oxygen concentrations, to minimize the elevation of dissolved nitrogen concentrations, and to better control the temperature of released water. Water could be released from surface storage reservoirs to simulate natural flows in the small stream on which they are built. The potentially significant impacts of a reduction in the magnitude and frequency of high Delta outflows on water quality in San Francisco Bay would be unavoidable.

Most of the long-term adverse effects of surface and ground-water storage on water quality could be reduced to a less-than-significant level by various mitigation measures.

Point and Nonpoint Source Loads Attributable to Growth. Growth induced by the Preferred Program Alternative in conjunction with other non-CALFED actions with growth-inducing impacts would result in indirect adverse effects on water quality. Water quality would be degraded by increased discharge of contaminants in municipal wastewater and urban runoff. Degradation of water quality from point sources of pollutants could be

Water quality would be degraded by increased discharge of contaminants in municipal wastewater and urban runoff.

mitigated by increases in treatment. Degradation of water quality by nonpoint sources is more difficult to mitigate. The available mitigation strategies for nonpoint sources include implementing various BMPs but they are expected to largely fall short of fully offsetting the overall increase in nonpoint source loads attributable to growth.

The following mitigation strategies related to nonpoint source loads:

- Improving treatment levels provided at municipal wastewater treatment plants to upgrade the quality of the constituents (other than dissolved inorganic solids) discharged to receiving waters in order to compensate for the reduction in dilution caused by improved water use efficiency or water transfers.

- Releasing additional water from enlarged or additional off-stream surface storage, or from additional groundwater storage.

- Releasing additional water from storage in existing reservoirs or groundwater basins.

- Improving water treatment facilities, either at the point of consumption or at the source, to remove TOC. Using a mix of alternative source waters to reduce the influent bromide concentration.

- Using innovative, cost-effective disinfection processes (for example, ultra-filtration, UV irradiation, and ozonation—in combination with other agents) that form fewer or less harmful DBPs.

- Using existing river channels for water transfers and timing the transfers to avoid adverse water quality impacts.

- Using best construction and drainage management practices to avoid transport of soils and sediments into waterways.

- Using cofferdams to construct levees and channel modifications in isolation from existing waterways.

- Using sediment curtains to contain turbidity plumes during dredging.

- Relocating water supply intakes away from discharges of agricultural and urban runoff.

- Applying agricultural and urban BMPs, and treating drainage from lands to reduce contaminants (for example, treating drainage from agricultural lands underlain by peat soils to remove TOC).

- Relocating diversion intakes to locations with better source water quality.

- Restoring additional riparian vegetation to increase shading of channels.

5.3.12 POTENTIALLY SIGNIFICANT UNAVOIDABLE IMPACTS

Certain potentially significant adverse impacts on water quality that are associated with the Preferred Program Alternative cannot be reduced to a less-than-significant level by mitigation. These impacts are an unavoidable consequence of implementing the Preferred Program Alternative.

Although the Preferred Program Alternative would improve water quality at many locations in the Delta, it would cause water quality to deteriorate in others. The increased TDS content of water in certain Delta channels would result in a potentially significant and unavoidable impact on the suitability of the water as a source for agricultural irrigation.

The Preferred Program Alternative could result in an increase in the total amount of water that could be diverted from the south Delta, with a concomitant reduction in the total volume of fresh water outflow from the Delta to San Francisco Bay. The resultant changes in salinity of Bay waters would be potentially significant and unavoidable.

The Preferred Program Alternative would allow an increase in the total amount of water that could be diverted from the south Delta, with a concomitant reduction in the total volume of fresh water outflow from the Delta to San Francisco Bay.

Potential growth induced by the Preferred Program Alternative would result in increased discharges of nonpoint source pollutants to water bodies, with a consequent potentially significant impact on in-stream water quality. Nonpoint sources are largely unregulated, and mitigation depends on local voluntary efforts. The potentially significant adverse impacts of increased discharges of nonpoint source pollutants from growth induced by the Preferred Program Alternative are unavoidable.