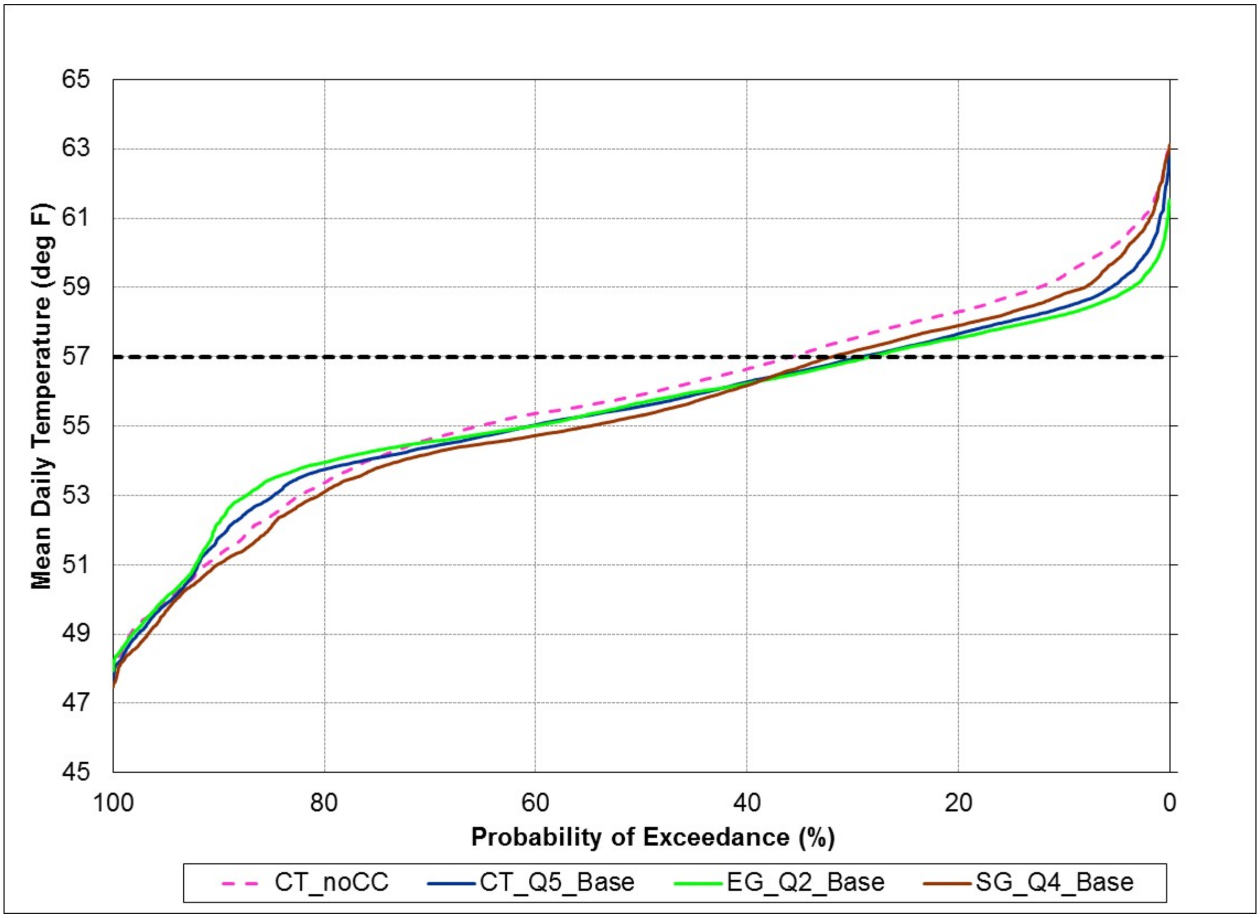
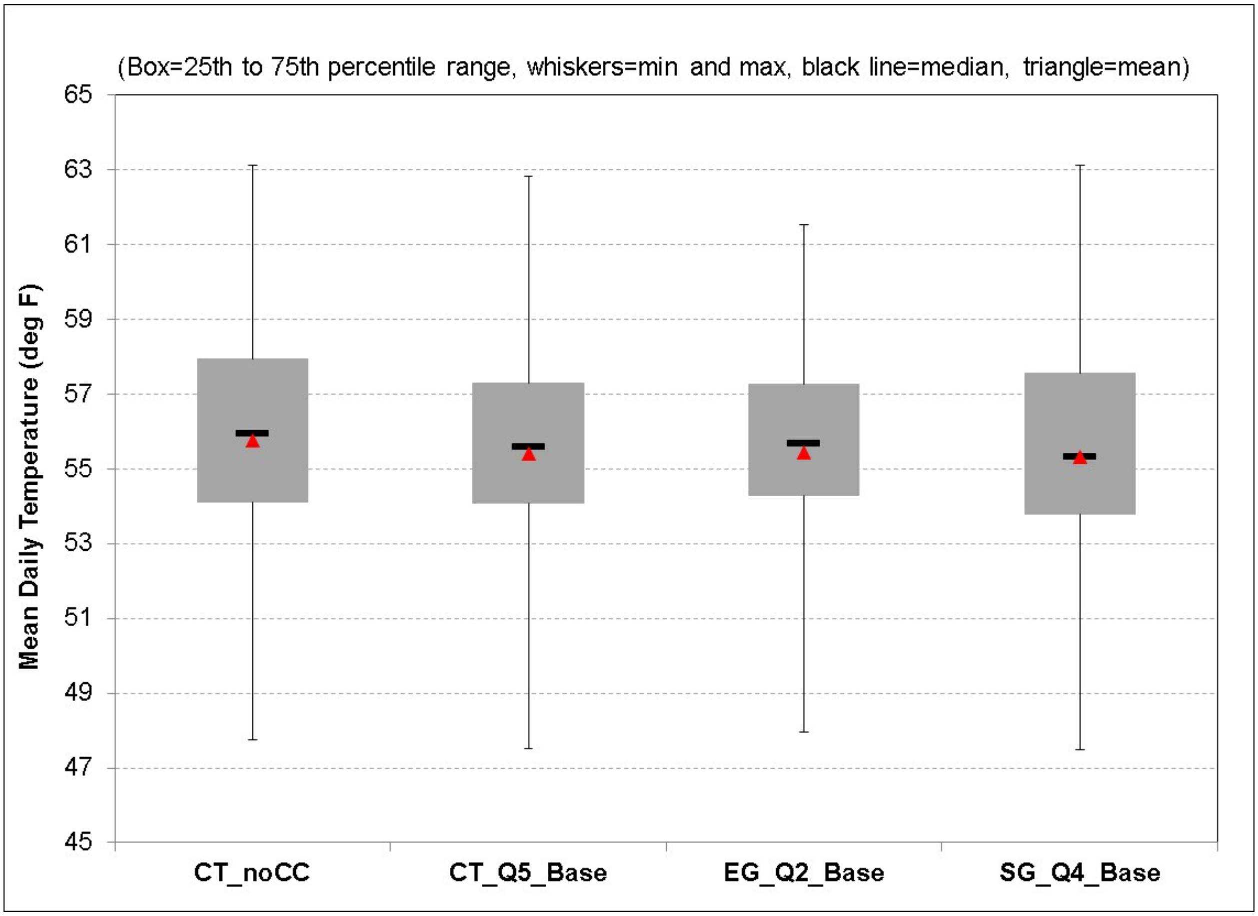


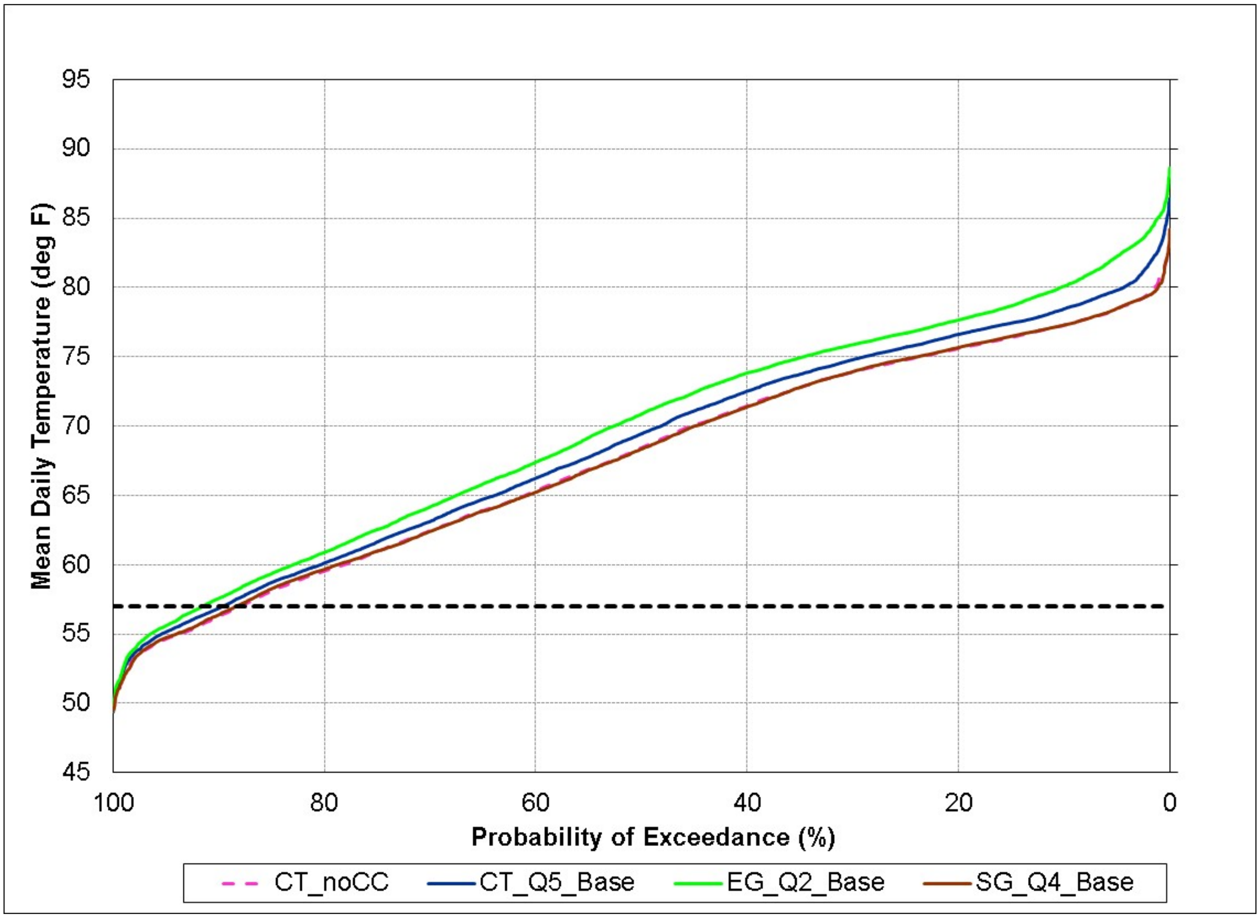
Key:
°F = Fahrenheit
CT_noCC = central tendency-no climate change

Figure 3-109. Exceedence of Average Daily Water Temperature (°F) on San Joaquin River at Lost Lake from August-to-November in each Scenario



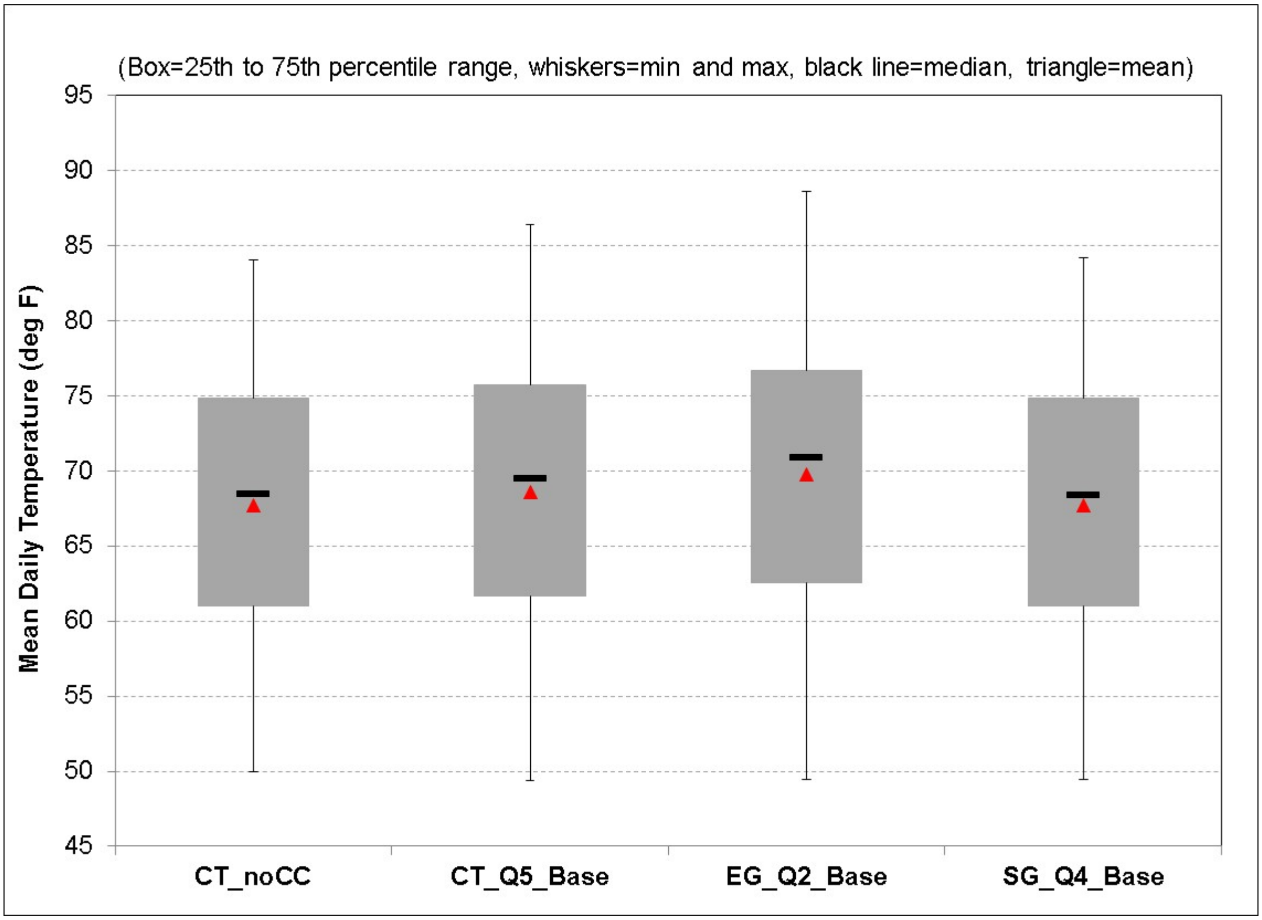
Key:
°F = Fahrenheit
CT_noCC = central tendency-no climate change

Figure 3-110. Box Plot of Average Daily Water Temperature (°F) on San Joaquin River at Lost Lake from August-to-November in each Scenario



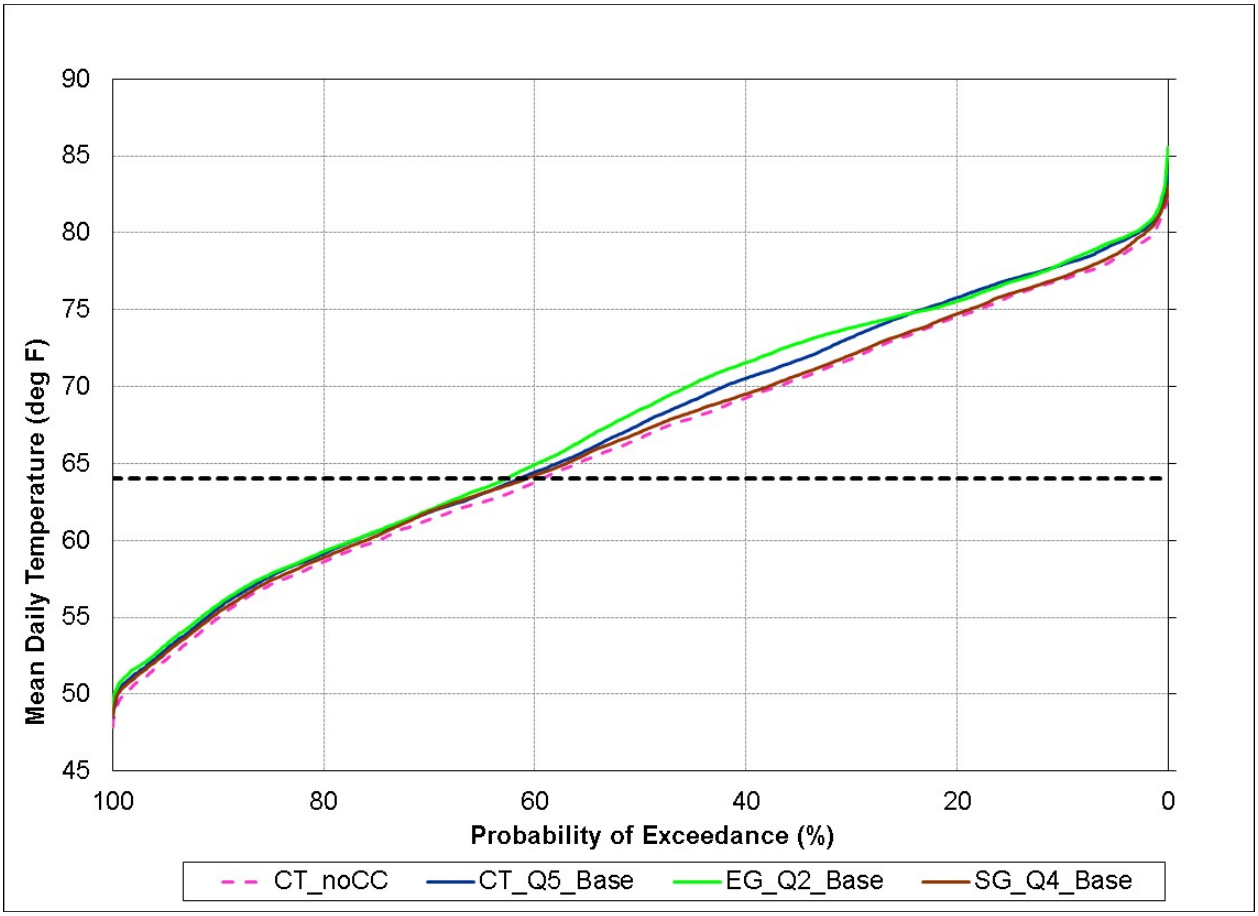
Key:
°F = Fahrenheit
CT_noCC = central tendency-no climate change

Figure 3-111. Exceedence of Average Daily Water Temperature (°F) on San Joaquin River at Gravelly Ford from August-to-November in each Scenario



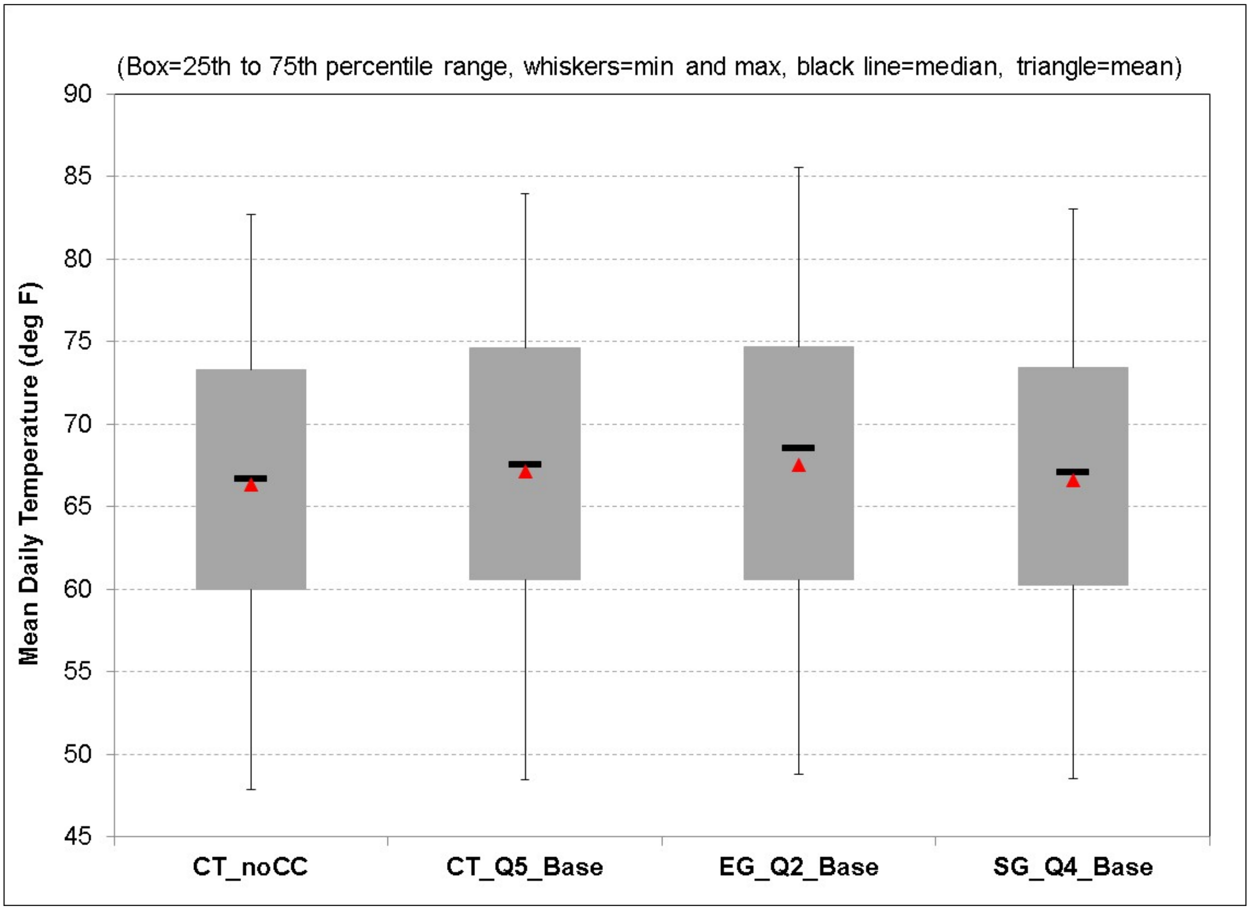
Key:
°F = Fahrenheit
CT_noCC = central tendency-no climate change

Figure 3-112. Exceedence of Average Daily Water Temperature (°F) on San Joaquin River at Gravelly Ford from August-to-November in each Scenario



Key:
°F = Fahrenheit
CT_noCC = central tendency-no climate change

Figure 3-113. Exceedence of Average Daily Water Temperature (°F) on San Joaquin River at Vernalis from August-to-November in each Scenario

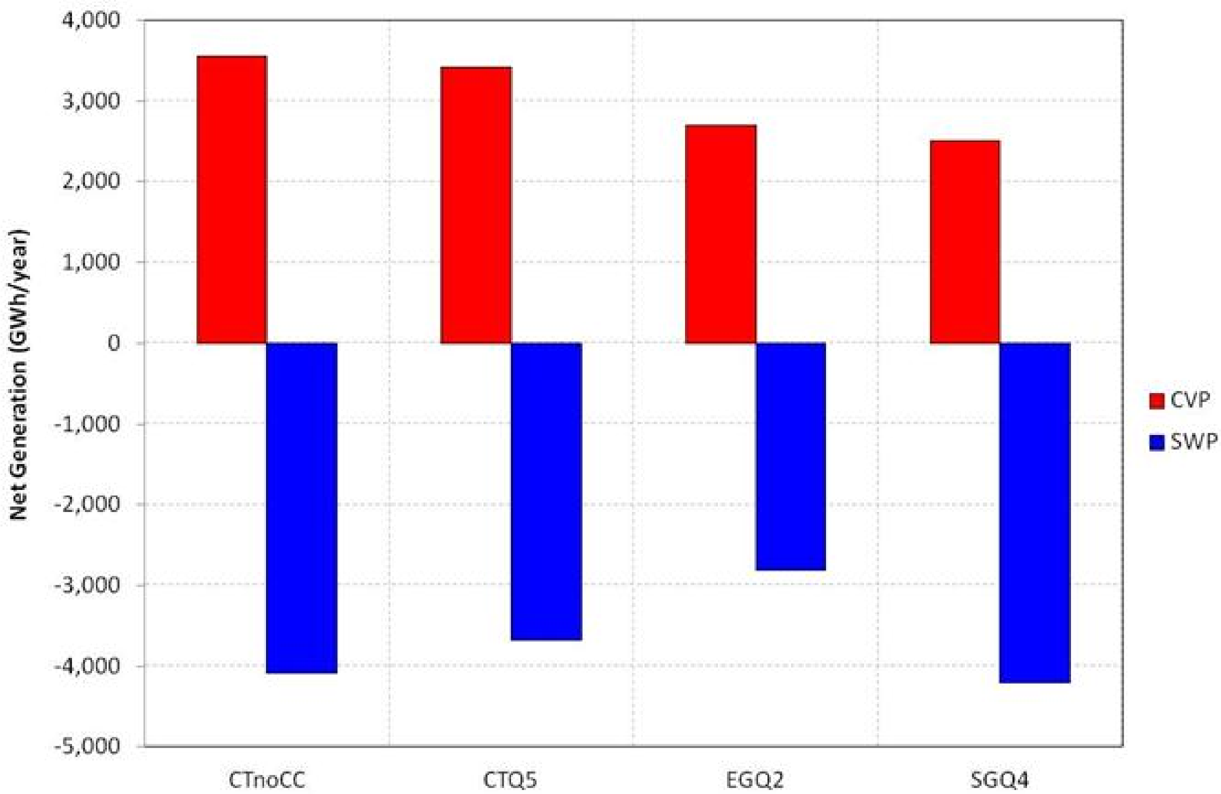


Key:
°F = Fahrenheit
CT_noCC = central tendency-no climate change

Figure 3-114. Box Plot of Average Daily Water Temperature (°F) on San Joaquin River at Vernalis from August-to-November in each Scenario

Hydropower and Greenhouse Emissions Figure 3-115 shows the average annual net energy generation expressed as gigawatts per year (GWh/year) for the CVP and SWP systems under the CT-NoCC, CT-Q5, EG-Q2 and SG-Q4 scenarios based on the results from LTGen for the CVP and SWP_Power for the SWP. Net energy generation is defined as the difference between hydropower power production and usage. Both CVP and SWP use hydropower for pumping and conveyance of water.

In all four socioeconomic-climate scenarios, the CVP system has more hydropower generation than energy use while the SWP system has more energy use than hydropower generation. The relative levels of net generation between the four scenarios are consistent with the CVP storage and the Banks pumping results for each scenario. The slightly drier conditions in the CT-Q5 relative to CT-NoCC result in slightly reduced net generation for the CVP and slightly less hydropower usage for the SWP. SG-Q4 has the highest storage levels in CVP reservoirs for generation but also higher usage for conveyance resulting lower net generation. Similarly, SWP Banks pumping and conveyance usage is greatest in the SG-Q4 resulting in its most negative net generation. Conversely, EG-Q2 has the lowest storage levels in CVP reservoirs resulting in less power production but also less water supply for exports. Banks pumping is also reduced therefore SWP has the least net generation in this drier than CT-NoCC scenario.

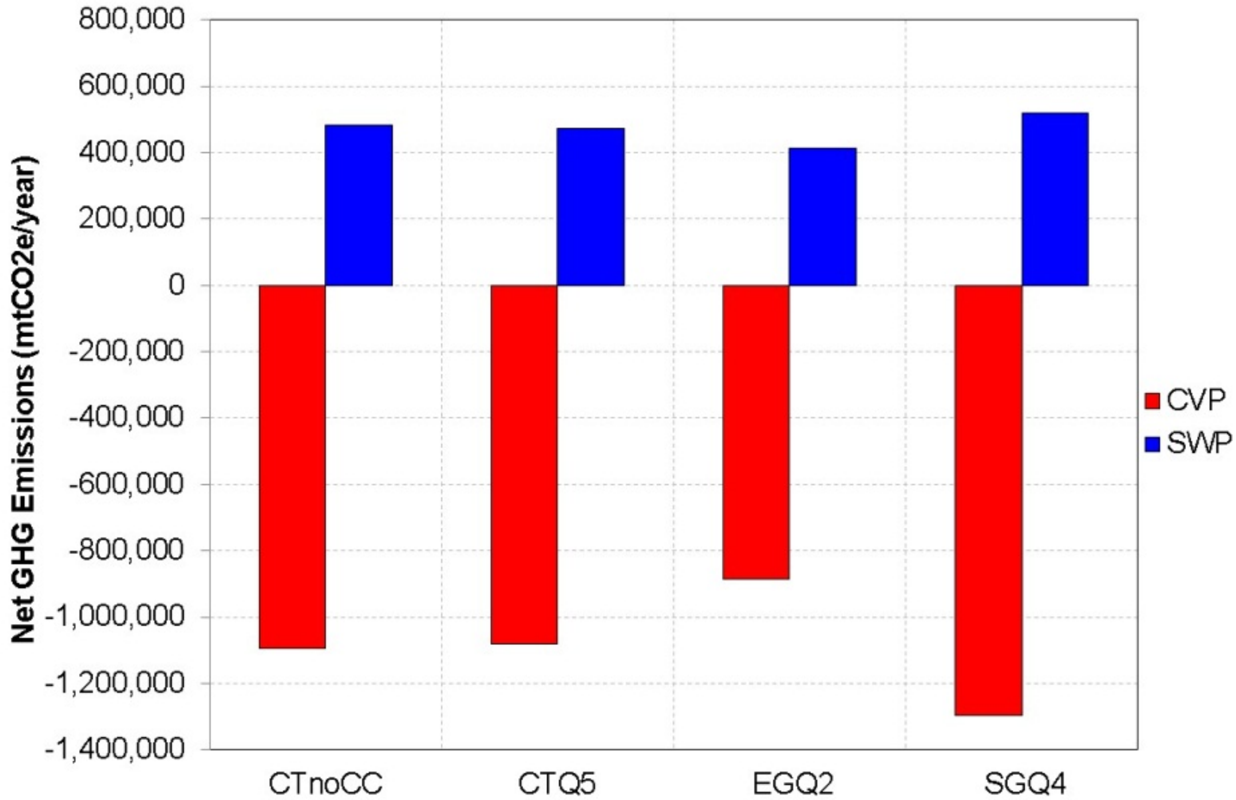


Key:
CTnoCC = central tendency-no climate change
CVP = Central Valley Project
GWh = gigawatt hour
SWP = State Water Project

Figure 3-115. Average Annual Net Energy Generation (GWh/year) for the CVP and SWP Systems

Figure 3-116 presents the average annual net GHG emissions expressed as metric tons of CO_2 equivalents per year

($mtCO_2e$/year) for the CVP and SWP systems under the CT-Q5, EG-Q2 and SG-Q4 scenarios. These results are consistent with the net generation results for the CVP and SWP in each scenario. The CVP system has negative net GHG emissions (i.e., potential GHG offsets) because it has positive net hydropower generation, while the SWP system has positive net GHG emissions because it has negative net hydropower generation. In addition, the net GHG emissions are greatest in SG-Q4 where the net generation results are greatest and lowest in EG-Q2 where the net generation results are lowest.



Key:
CTnoCC = central tendency-no climate change
CVP = Central Valley Project
mtCO2e = metric tons of carbon dioxide equivalents
SWP = State Water Project

Figure 3-116. Average Annual Net GHG Emissions ($mtCO_2e$/year) for the CVP and SWP Systems

Assessment of Potential Socioeconomic–Climate Uncertainties with Representative Alternative Conditions

Introduction

Temperance Flat RM 274 Reservoir (1,260 TAF) would be created through construction of a dam in the upstream portion of Millerton Lake at RM 274 (Figure 1-1). The dam site is located approximately 6.8 miles upstream from Friant Dam and 1 mile upstream from the confluence of Fine Gold Creek and Millerton Lake. Permanent features that would be constructed include a main dam with an uncontrolled spillway to pass flood flows, a powerhouse to generate electricity, and outlet works for other controlled releases. Some alternatives include a selective level intake structure (SLIS) for reservoir temperature management. Recreation facilities would be relocated upslope and a new boat ramp would be constructed.

At the top of active storage capacity (985 feet above mean sea level [elevation 985]), Temperance Flat RM 274 Reservoir would provide about 1,260 TAF of additional storage (1,331 TAF total storage, 75 TAF of which overlaps with Millerton Lake), and would have a surface area of about 5,700 acres. The reservoir would extend about 18.5 miles upstream from RM 274 to Kerckhoff Dam. Temperance Flat Dam would be single-center medium-thick roller-compacted concrete arch dam. The dam would be about 665 feet high, from base elevation 340 in the bottom of Millerton Lake (San Joaquin River channel) at the upstream face to the dam crest at elevation 1,005.

Because of the simplifications included in the CVP IRP CalLite simulations, the results presented here do not represent the full range of benefits possible with USJRBSI. More detailed analysis is currently being prepared for the USJRBSI Feasibility Report. However, the results presented here provide useful insights for understanding the potential impacts of socioeconomic and climate uncertainties on objectives addressed by USJRBSI.

Alternative Plans

Various alternative plans were evaluated in the feasibility phase of the Investigation. These plans all focused on the Temperance Flat RM 274 Reservoir with variations in operations scenarios and configuration of physical project features to define the features, operations and benefits of Temperance Flat RM 274 Reservoir. The analyses evaluated a range of potential reservoir operations, carryover storage, delivery routing and beneficiaries, cold water pool management, and other potential accomplishments that could be achieved.

The analyses resulted in the eight alternative plans. However as described below, the Temperance Flat reservoir operations simulated for purposes of the socioeconomic-climate change uncertainty analyses does NOT include some of details of these alternatives. The Alternatives considered vary according to the amount of Temperance Flat and Millerton Lake carryover storage, beneficiaries receiving new water supply, and the proportion and routing of new water supply. Features common to the alternatives include conveyance through the Friant-Kern Canal (FKC), Delta-Mendota Canal (DMC), and California Aqueduct that are necessary components for water exchanges. Unused capacity in the FKC, DMC, and California Aqueduct for operations of the alternative is assumed equivalent to current operations. The San Joaquin River from the Friant Dam to Mendota Pool is also used as a conveyance route in some alternative plans. Cross-valley conveyance for all alternative plans is limited to existing and foreseeable conveyance capacity.

Other features and operations common to all alternative plans include hydropower mitigation, recreation, cold water management, and operation of Millerton Lake. A new onsite powerhouse connected to the outlet works of Temperance Flat RM 274 reservoir is also included in project alternatives.

Representative Alternative Analysis

The Representative Alternative analysis was designed to quantitatively investigate the sensitivity of some of the potential benefits arising from new storage capacity in the Temperance Flat RM 274 Reservoir to uncertainties in future socioeconomic and hydroclimate conditions in the 21st century. The impact assessment is based on simulations performed using the CVP IRP CalLite model by using the same socioeconomic-climate scenarios employed in the Baseline conditions analyses. The results of these Representative Alternative simulations can then be compared to corresponding Baseline conditions results.

In the CVP IRP CalLite model implementation, the Temperance Flat reservoir alternative is implemented with a maximum storage capacity of 1331 TAF and the maximum Millerton Lake storage reduced by 71 TAF to account for previous storage which would be within the Temperance Flat reservoir footprint. This is assumed for all simulations in which Temperance Flat is implemented.

In addition, two options are available in the model for San Joaquin River Restoration Program (SJRRP) flows:

- Full restoration flows from SJRRP Preferred Alternative
- SJRRP water year 2010 interim flows

Full SJRRP restoration flows are assumed for all simulations performed in the analyses described in this section.

Schematic Representation

The Temperance Flat reservoir alternative is simulated in CVP IRP CalLite model as a new reservoir located upstream from Millerton Lake on the San Joaquin River. Releases from Temperance Flat flow into Millerton Lake. The schematic representation of the Upper San Joaquin River used in the model is shown in Figure 3-117.

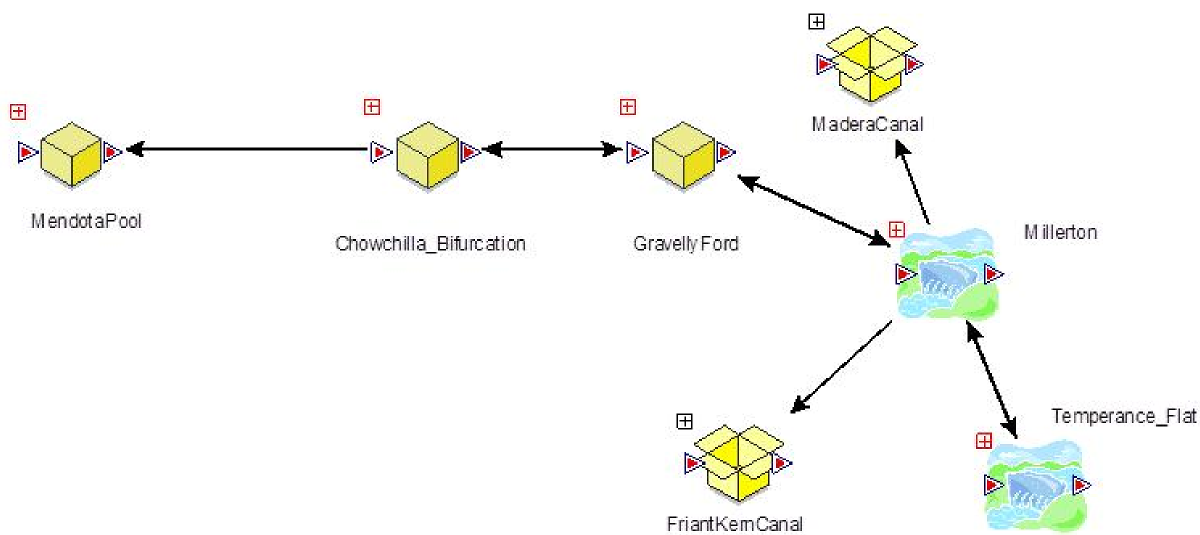


Figure 3-117. Schematic Representation of the Representative Alternative Features

Facility Operations

The Temperance Flat reservoir operations implemented in the CVP IRP CalLite model are a simplified representation of the Investigation alternatives. These operations and their differences from the more detailed CalSIM II operations are described below.

Integration with CVP/SWP System

The CVP IRP CalLite model does not fully reflect the level of detail of CVP/SWP operations that are included in the CalSIM II model. However, the CVP IRP model was calibrated by comparing its system wide performance characteristics with those of the more detailed CalSIM II model representation of the CVP/SWP system used in evaluation of the Investigation alternatives.

User Input and Output Requirements

The CVP IRP CalLite model provides users with a check box to optionally turn on or off simulation of the Temperance Flat RM 274 reservoir operations. A second check box allows the user to select full or interim San Joaquin River Restoration Program flows.

Limitations

Limitations of the Representative Alternative implementation in CVP IRP CalLite include the following:

- Simplified model schematic and CVP/SWP operations compared to CALSIM II
- CVP IRP CalLite does not provide for the full representation of the range of potential benefits
- Only a single simplified representation of Temperance Flat reservoir operations is simulated.
- Exclusion of Central Valley Project Improvement Act (b)(2) requirements
- No explicit delivery of water to Mendota Pool for exchange with other CVP water is simulated

The CVP IRP CalLite model representation and operation differs from the CALSIM II model representation. The primary difference between the CVP IRP CalLite and CALSIM II representations is that CVP IRP CalLite does not release water for delivery to SWP and CVP contractors at Mendota Pool. Instead it provides all water delivery benefits from Temperance Flat by diversions through Friant-Kern and Madera Canals. Thus, there is no explicit representation of the various alternatives simulated by the CalSIM II model. In addition, because the CALSIM II model has a more detailed representation of Temperance Flat and Millerton Lake operations, CALSIM II results are considered to be quantitatively more accurate. However, for the purpose of evaluating the sensitivity of Temperance Flat reservoir to potential future socioeconomic-climate uncertainties, the CVP IRP CalLite model representation provides results that are useful for comparison with the Baseline impact analyses.

A graphical user interface was developed for CVP IRP CalLite model to allow users to control which options to include in the simulations. By selecting various combinations of actions from a “dashboard” menu of available actions, users can specify the details of the parameters for particular water management actions. Example dashboards are shown in Figure 3-118 and Figure 3-119.

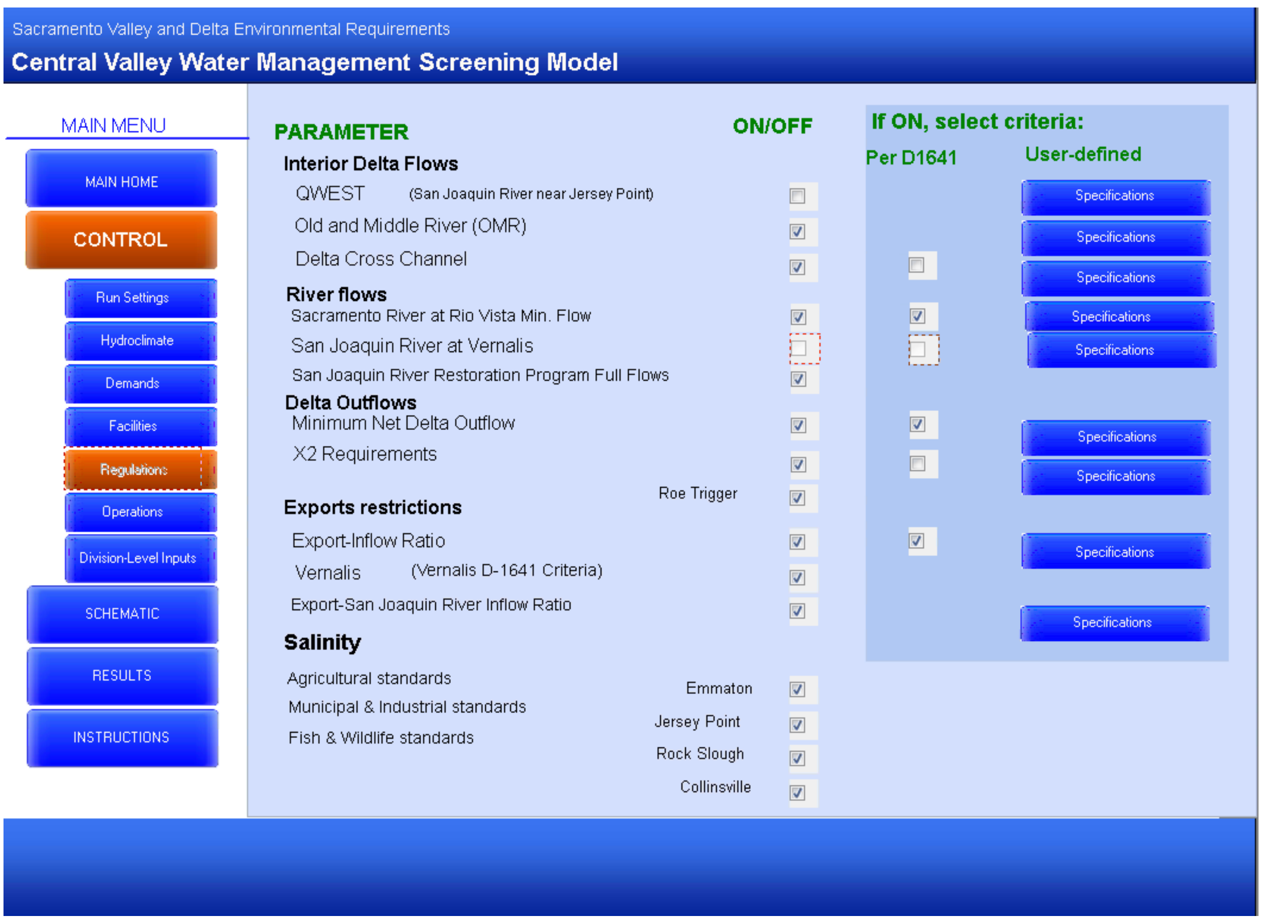


Figure 3-118. Example CalLite Dashboard for Specifying San Joaquin River Restoration Flows

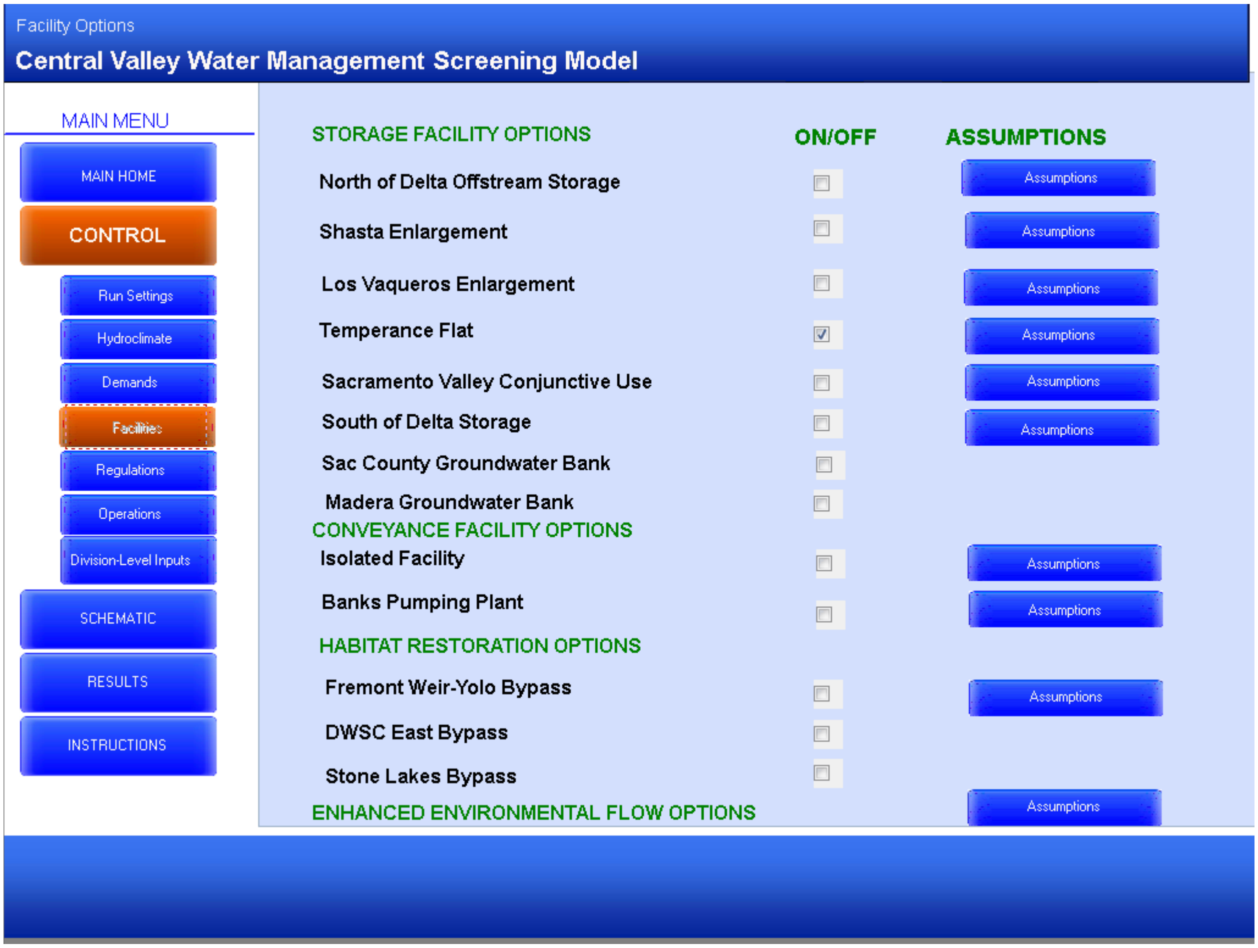


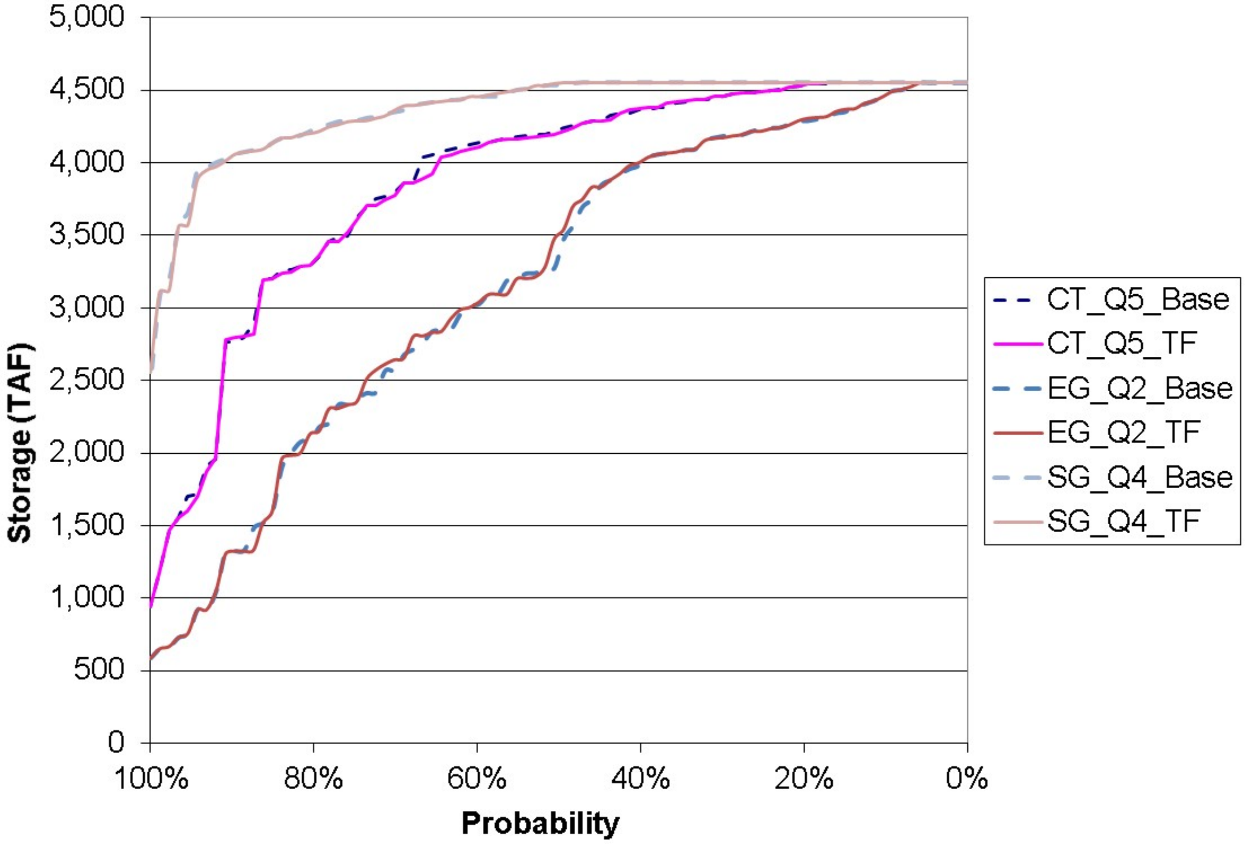
Figure 3-119. Example CalLite Dashboard for Triggering Temperance Flat RM 274 Facilities

CVP and SWP Project Storage Figures 3-120 through 3-133 show exceedence plots of reservoir storage over the 21st century in the Baseline (without USJRBSI) and with the USJRBSI alternative simulations at the end of May, representing storage available for water supply, and at the end of September, representing carryover storage conditions, in Shasta, Folsom, Oroville, New Melones, Millerton Lake, CVP San Luis, and SWP San Luis reservoirs under scenarios CT-Q5, EG-Q2 and SG-Q4. As in the Baseline, the highest storage levels occurred in SG-Q4 (wetter), and the lowest storage levels occurred in the EG-Q2 (drier) scenario. With the exception of Millerton Lake, there are essentially no effects of USJRBSI Temperance Flat alternative on any of the other reservoirs. The only significant changes in reservoir storage are in Millerton Lake. These changes are primarily are result of how Temperance Flat reservoir is operated to keep Millerton

Lake at an essentially constant level. As can be seen on Figure 3-130 and Figure 3-131, storage in Millerton Reservoir is relatively constant except in years of exceptionally high precipitation when the reservoir level reaches the flood storage pool and additional releases are made.

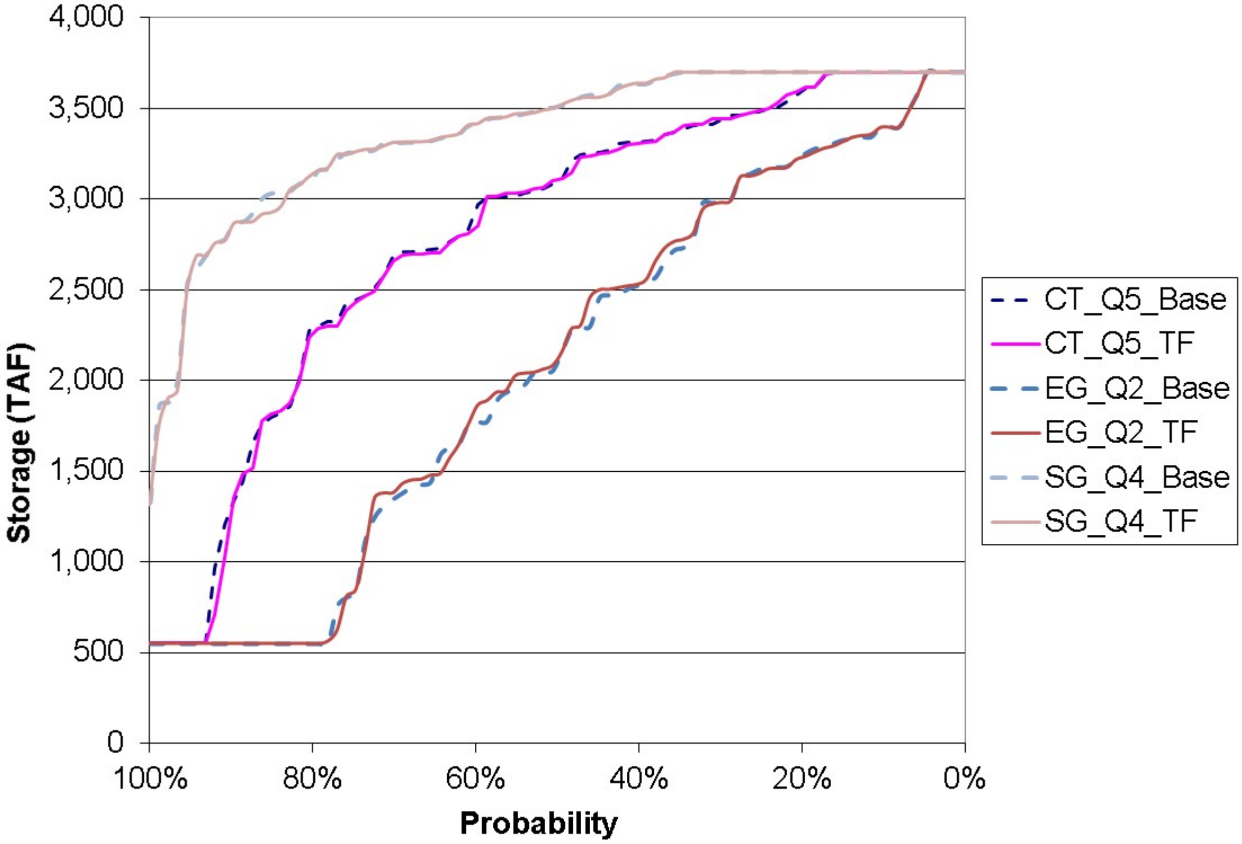
Figure 3-134 and Figure 3-135 show exceedence plots of Temperance Flat Reservoir alternative for storage in the end-of-May and end-of-September storages over range of all 18 socioeconomic-climate projection scenarios. On these figures, only the lines for the Slow Growth socioeconomic scenario are visible because there is no difference in Millerton Lake, Madera Canal, Friant Kern Canal operations between different socioeconomic scenarios with each climate scenario. This result occurs because it was assumed that Madera Canal and Friant Kern Canal deliveries are not constrained by consumptive use demands. In those years when excess water supplies existed, additional deliveries were made to recharge groundwater in the Friant Division.

As shown on figures, end-of-month storage levels primary reflect differences in the climate projections. At the end of May, the wetter projections (Q3 and Q4) have the largest storage volumes while the drier projections (Q1 and Q2) have storage similar to the NoCC projections. The central tendency Q5 projections are intermediate in volume with an average end-of-May storage of approximately 750 TAF. As shown on Figure 3-135, end-of-September storages in Temperance Flat reservoir. All of the climate projections with the exception of the wetter, less warming projections (Q4) have less carryover storage than the NoCC projections. The drier projections (Q1 and Q2) have the lowest storage levels, reflecting the lowest levels of carryover storage in these scenarios.



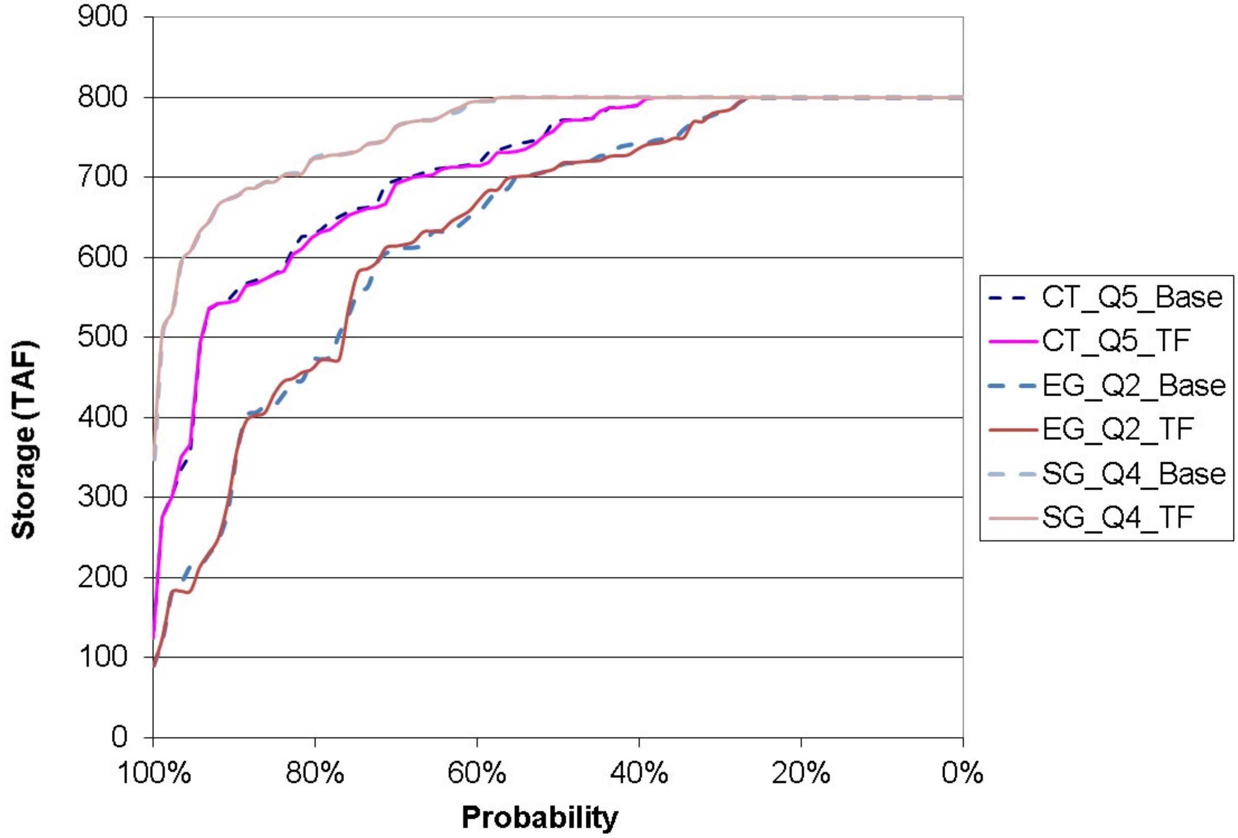
Key:
TAF = thousand acre-feet

Figure 3-120. Exceedence of Shasta Lake End-of-May Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



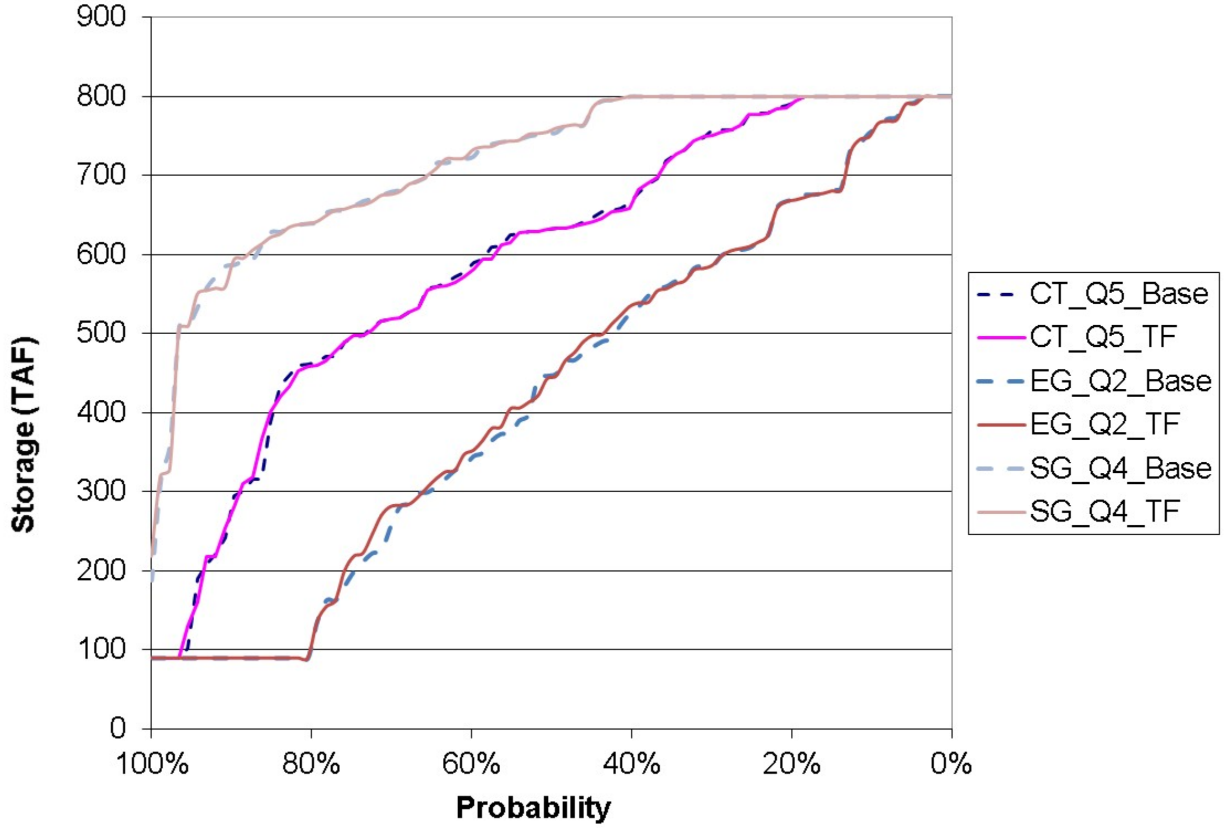
Key:
TAF = thousand acre-feet

Figure 3-121. Exceedence of Shasta Lake End-of-September Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



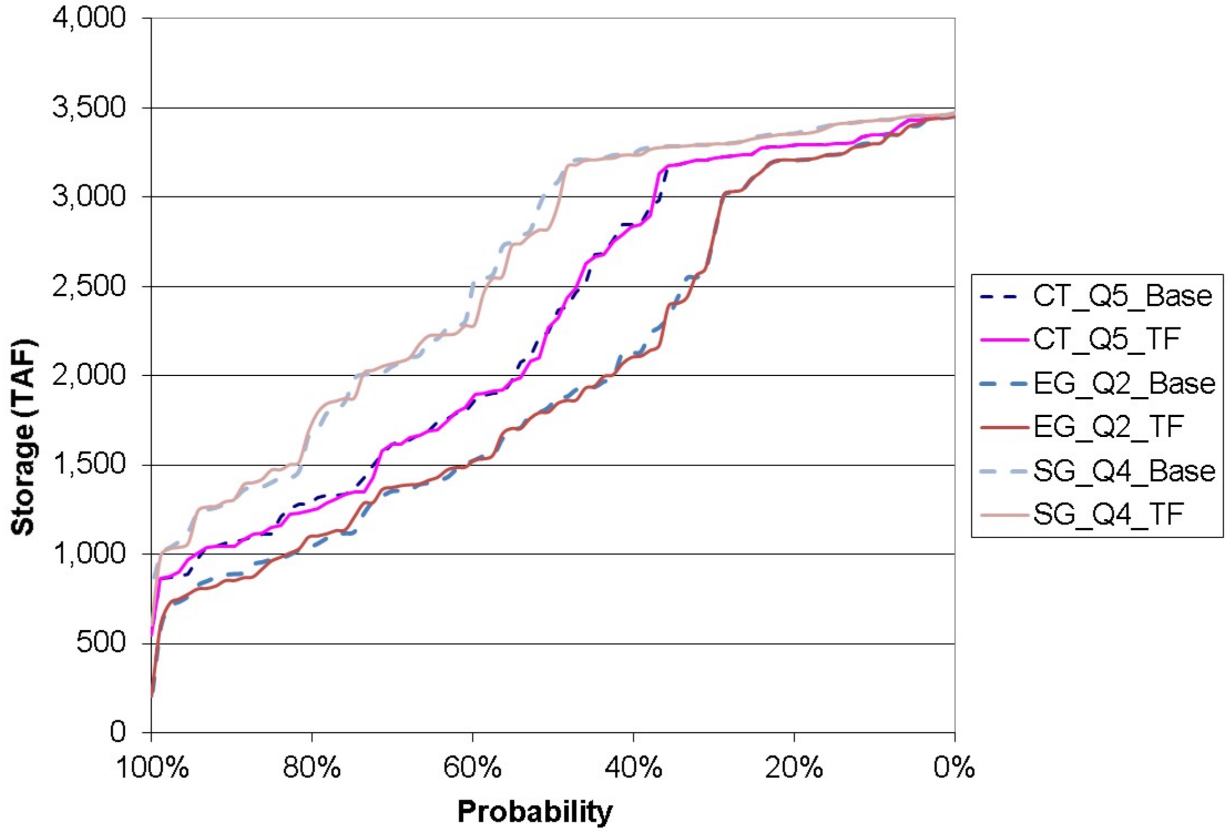
Key:
TAF = thousand acre-feet

Figure 3-122. Exceedence of Folsom Lake End-of-May Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



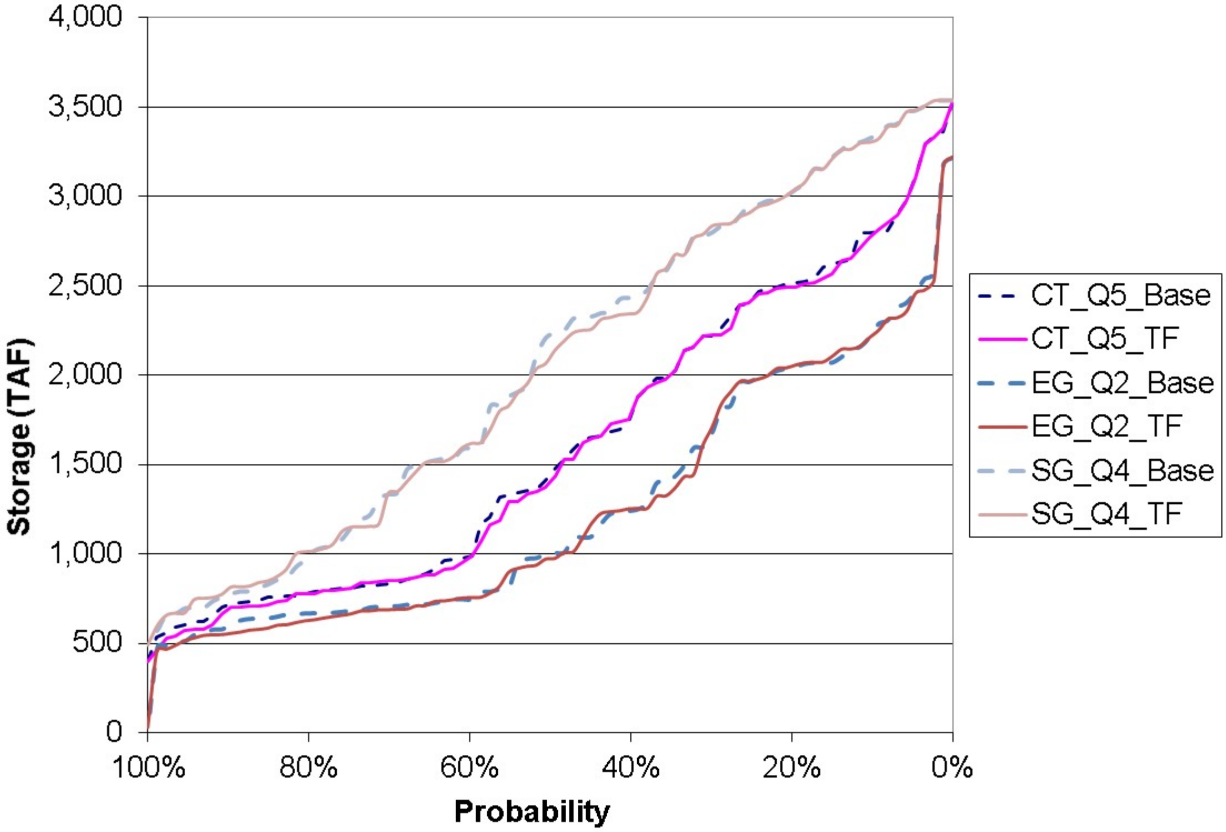
Key:
TAF = thousand acre-feet

Figure 3-123. Exceedence of Folsom Lake End-of-September Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



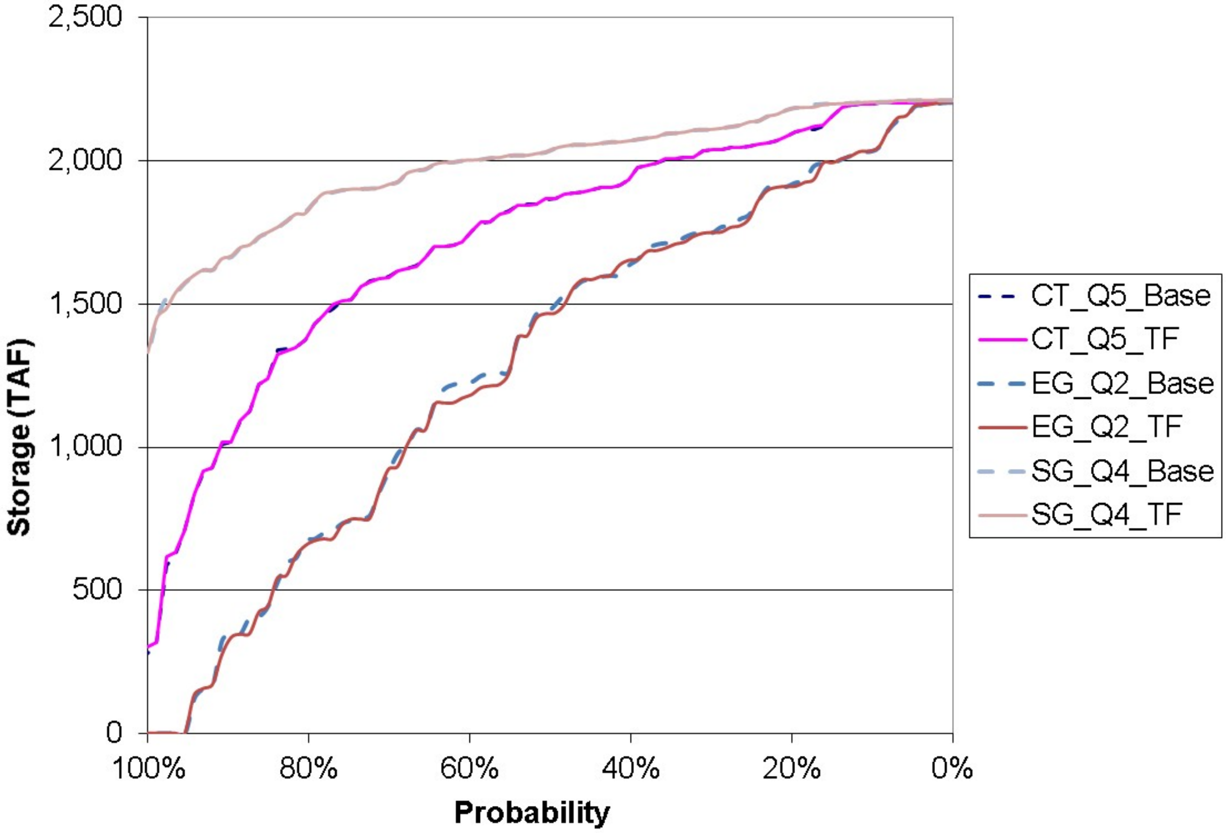
Key:
TAF = thousand acre-feet

Figure 3-124. Exceedence of Lake Oroville End-of-May Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



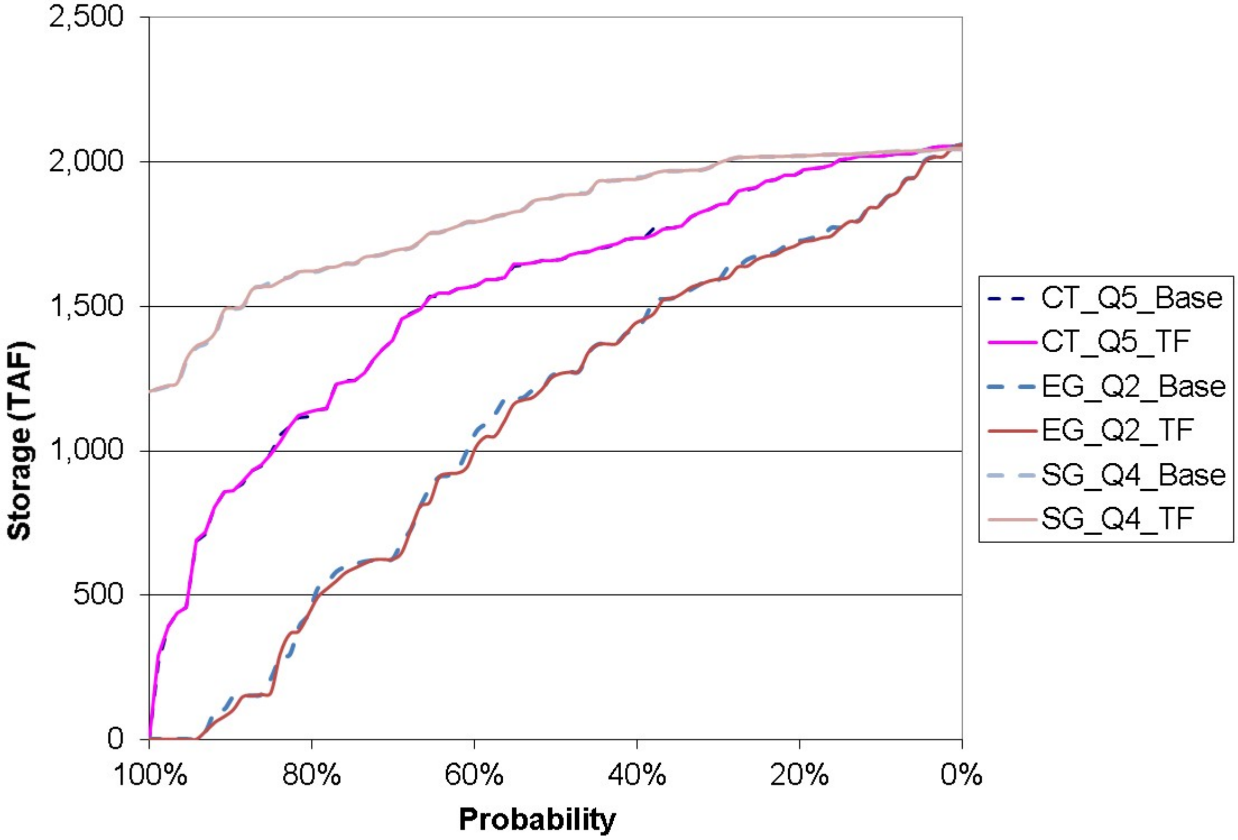
Key:
TAF = thousand acre-feet

Figure 3-125. Exceedence of Lake Oroville End-of-September Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



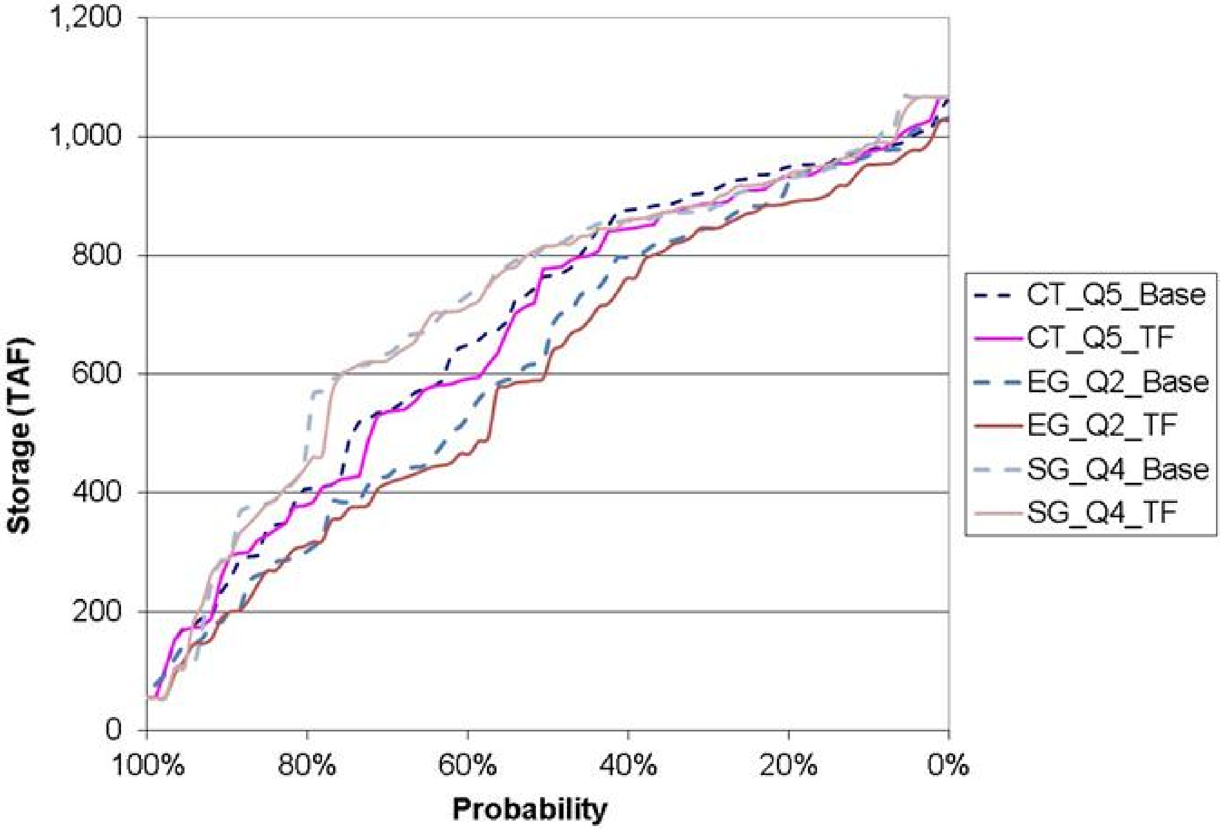
Key:
TAF = thousand acre-feet

Figure 3-126. Exceedence of New Melones Lake End-of-May Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



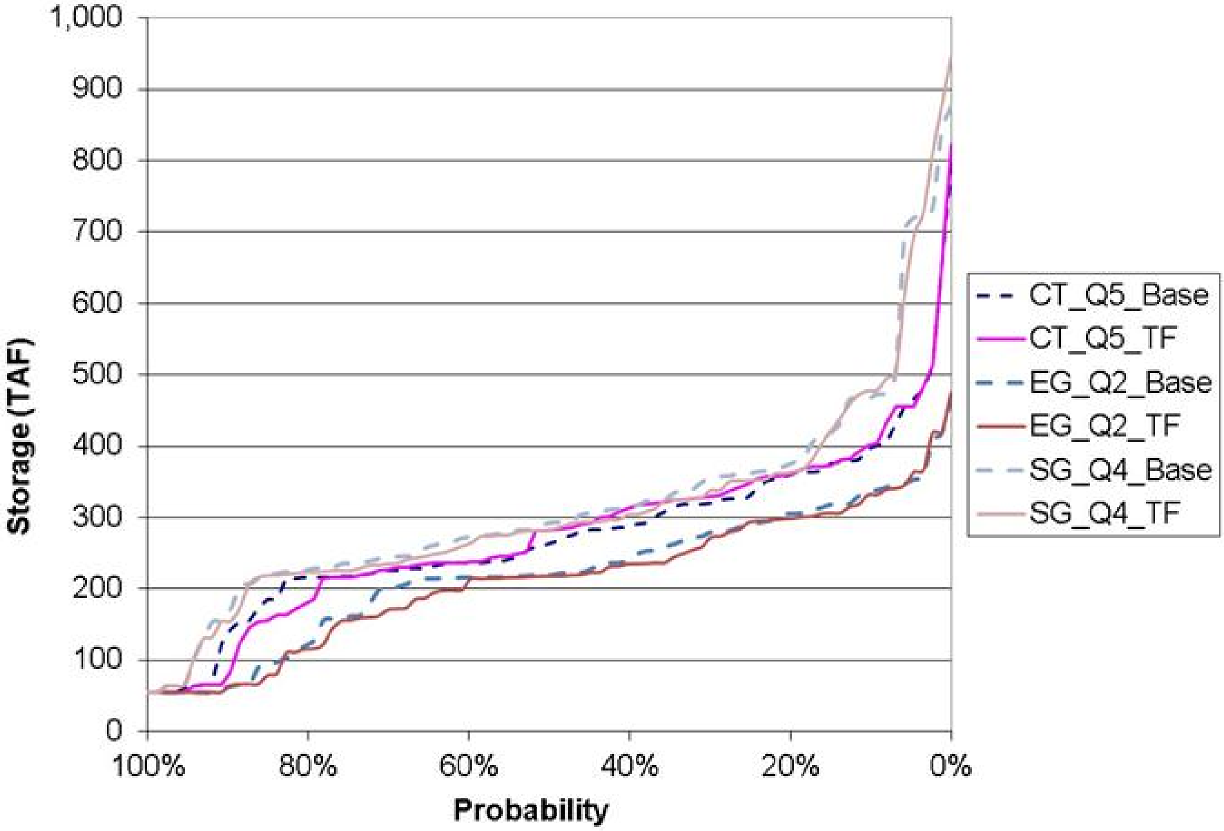
Key:
TAF = thousand acre-feet

Figure 3-127. Exceedence of New Melones Lake End-of-September Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



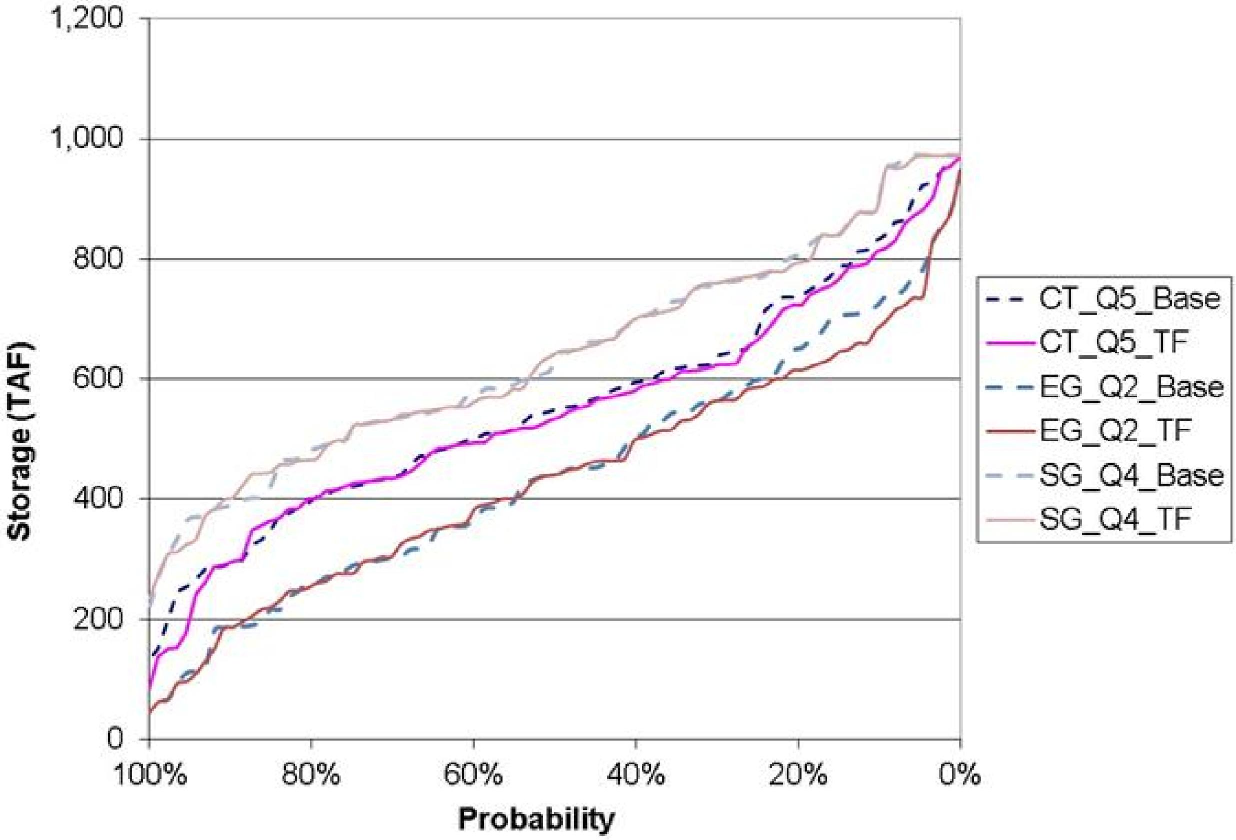
Key:
SWP = State Water Project
TAF = thousand acre-feet

Figure 3-128. Exceedence of SWP San Luis End-of-May Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



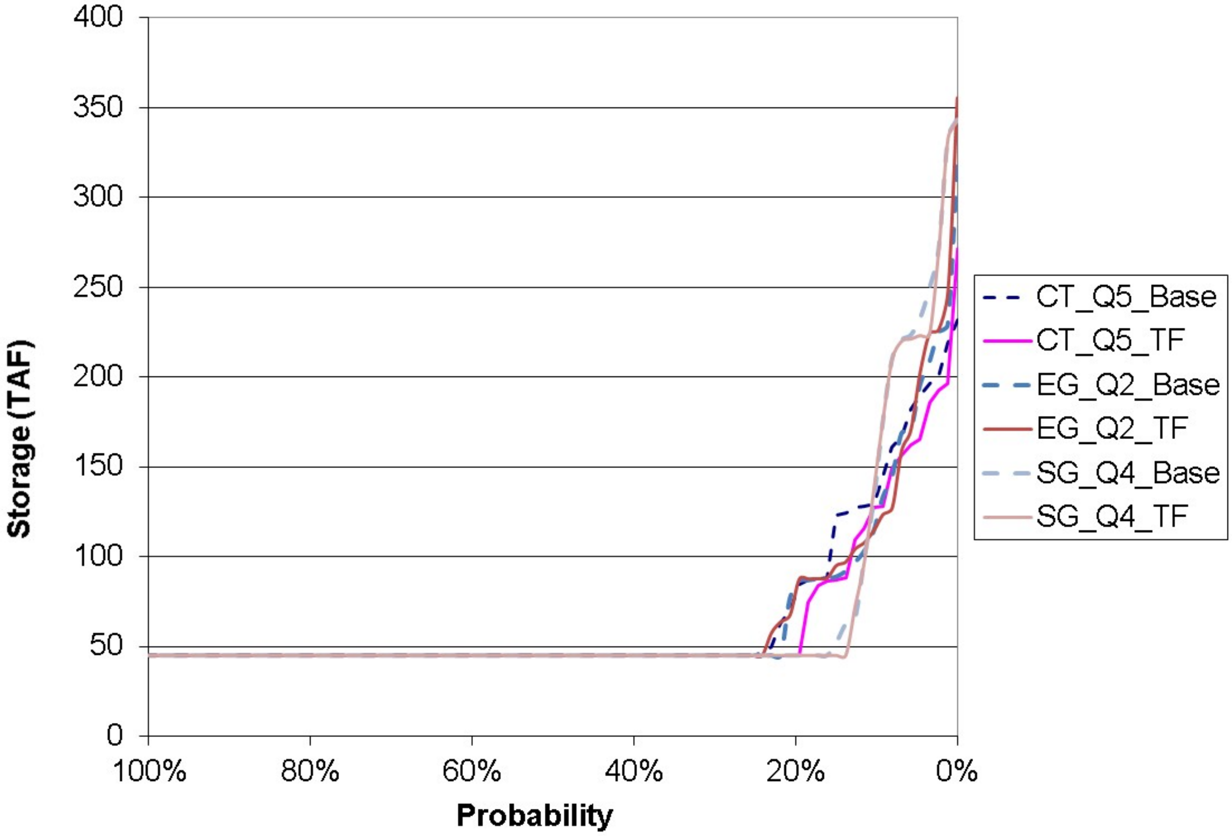
Key:
SWP = State Water Project
TAF = thousand acre-feet

Figure 3-129. Exceedence of SWP San Luis End-of-September Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



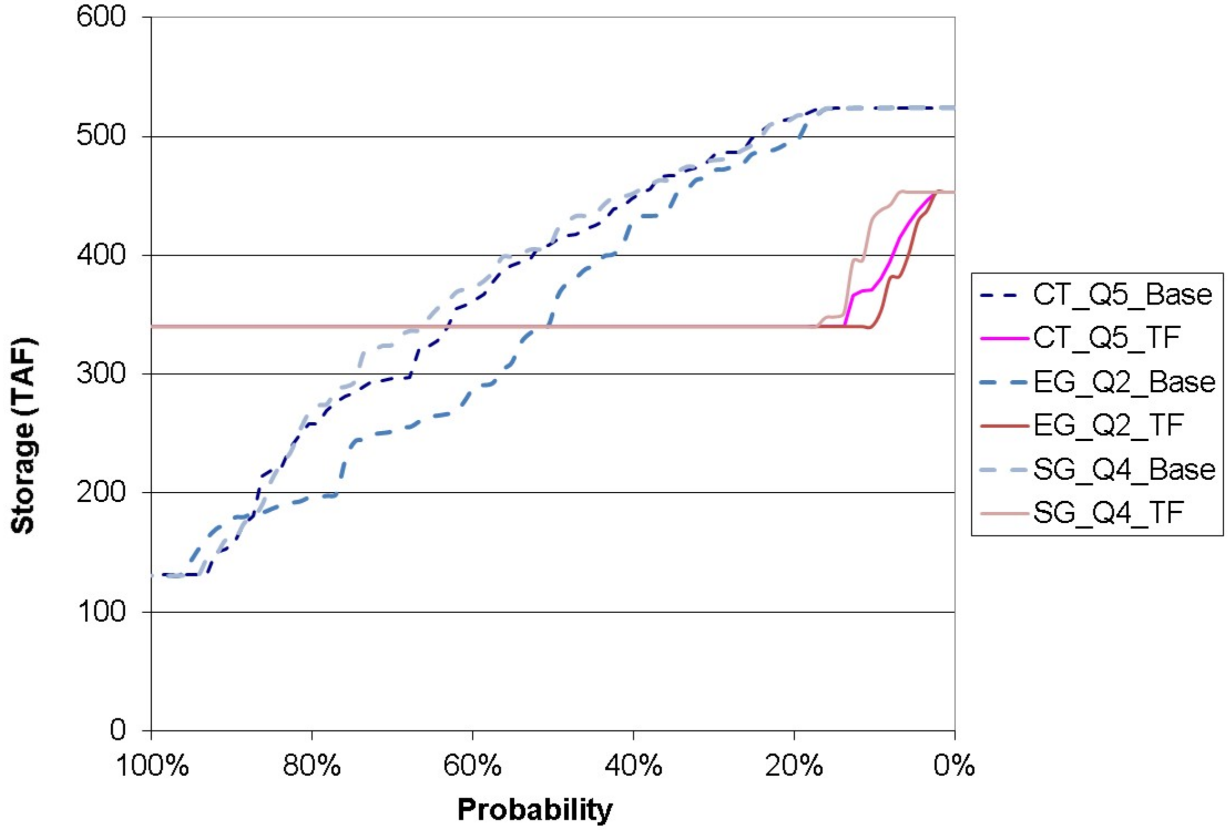
Key:
CVP = Central Valley Project
TAF = thousand acre-feet

Figure 3-130. Exceedence of CVP San Luis End-of-May Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



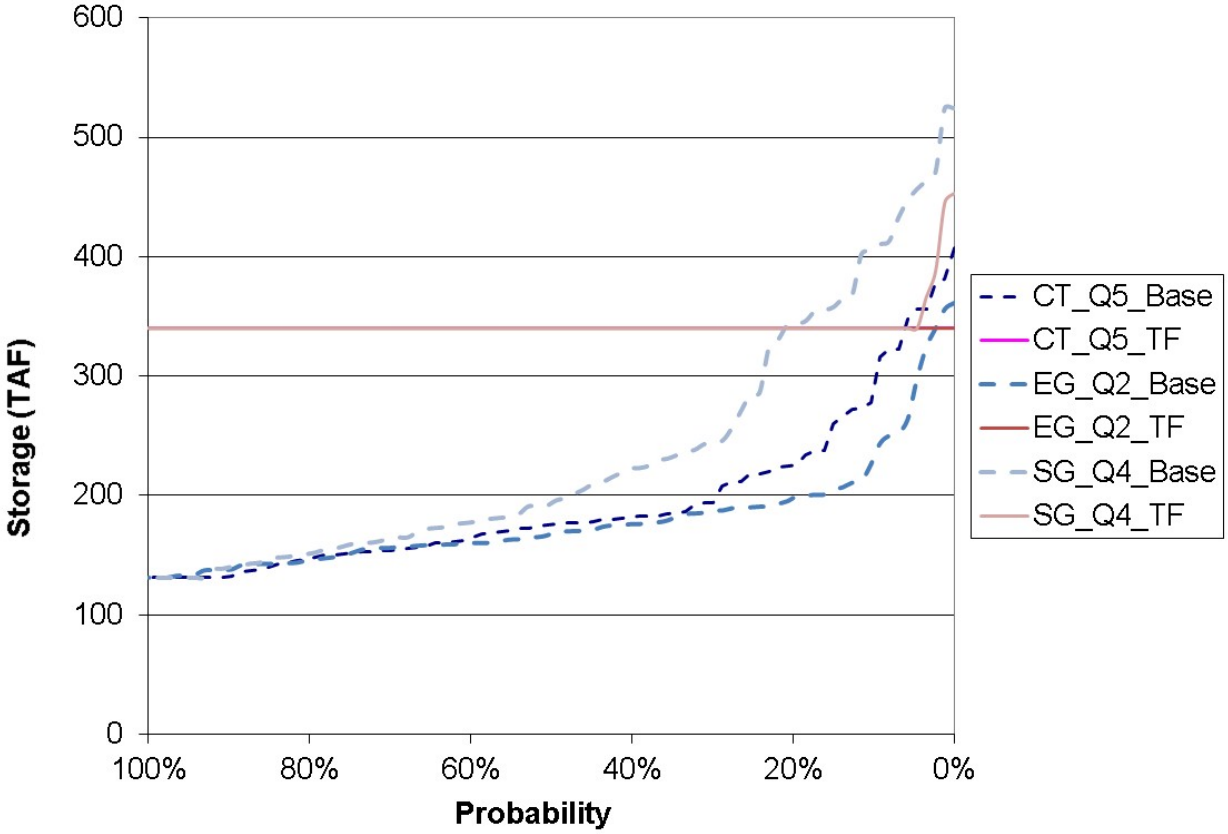
Key:
CVP = Central Valley Project
TAF = thousand acre-feet

Figure 3-131. Exceedence of CVP San Luis End-of-September Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



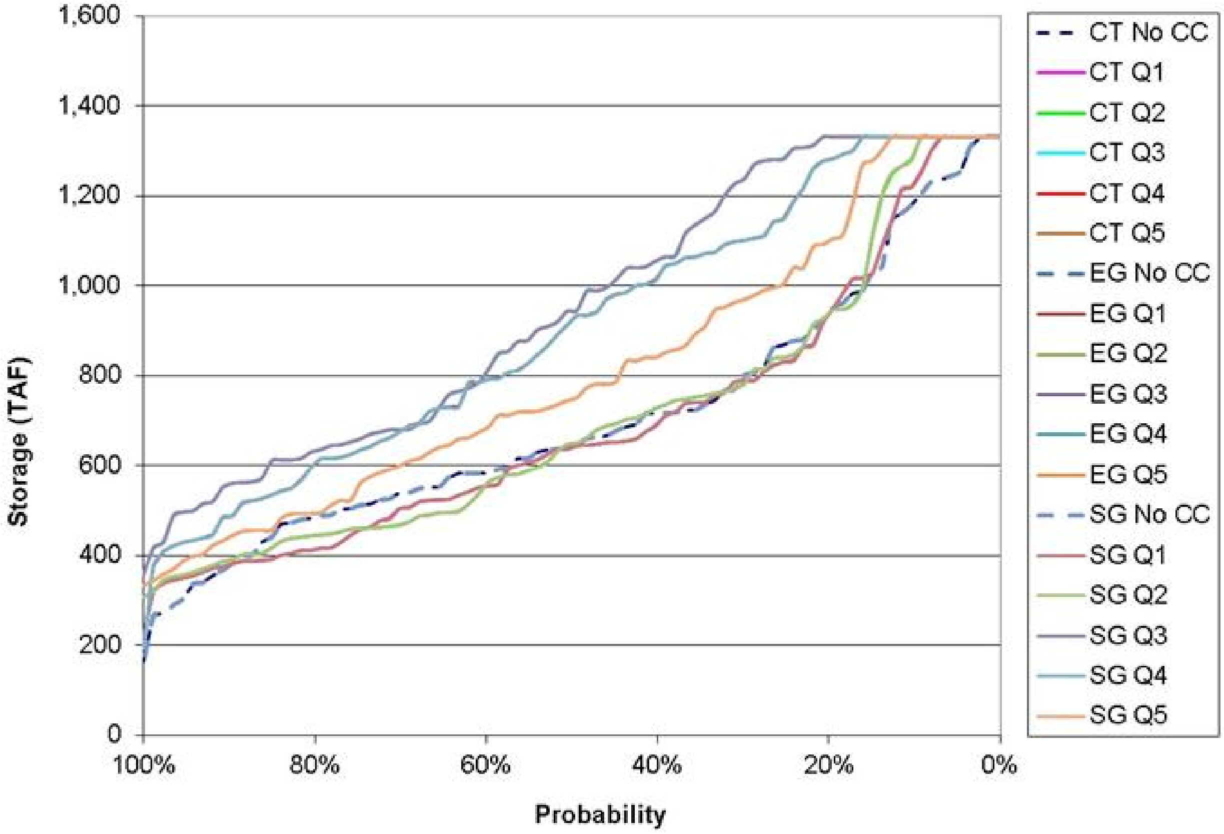
Key:
TAF = thousand acre-feet

Figure 3-132. Exceedence of Millerton Lake End-of-May Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



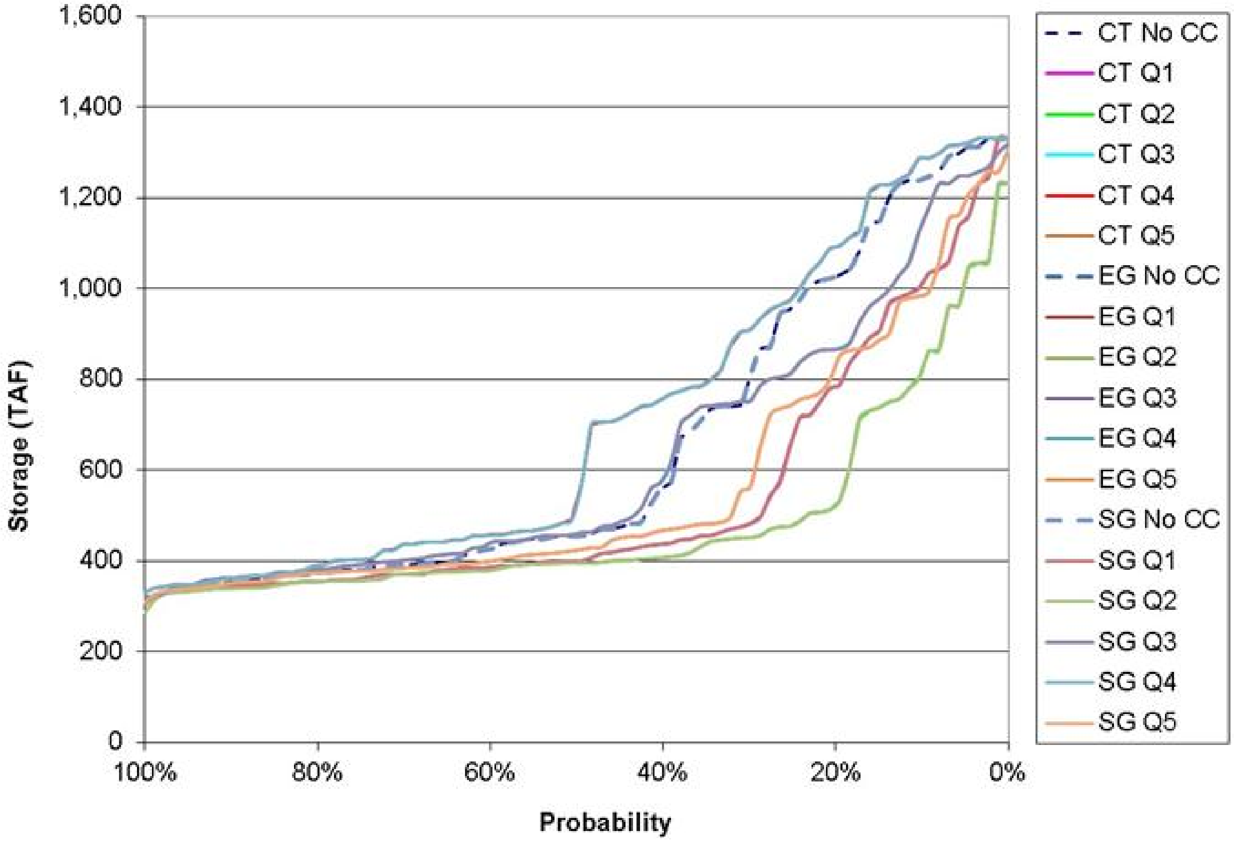
Key:
TAF = thousand acre-feet

Figure 3-133. Exceedence of Millerton Lake End-of-September Storage (TAF) with Baseline (dashed) and Temperance Flat (solid line)



Key:
TAF = thousand acre-feet

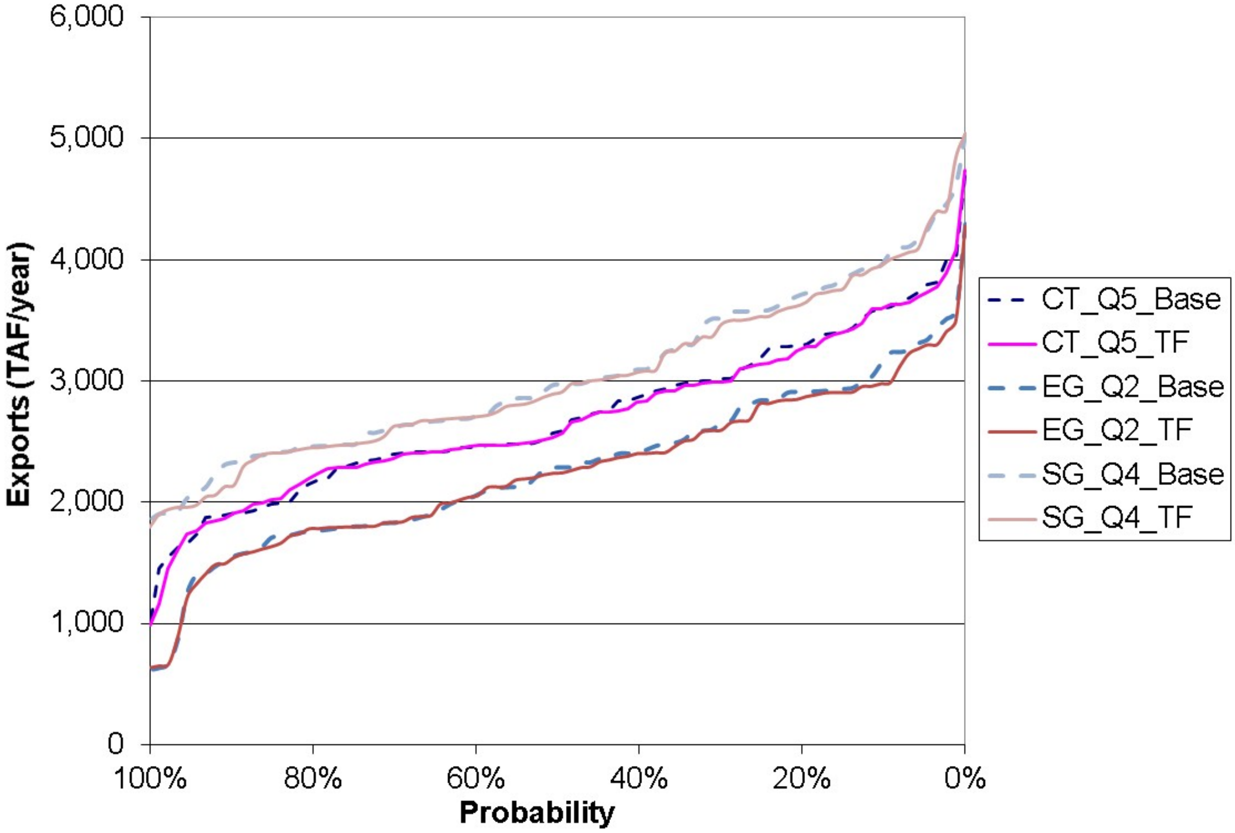
Figure 3-134. Temperance Flat End of May Monthly Exceedence with Baseline (dashed) and Temperance Flat (solid)



Key:
TAF = thousand acre-feet

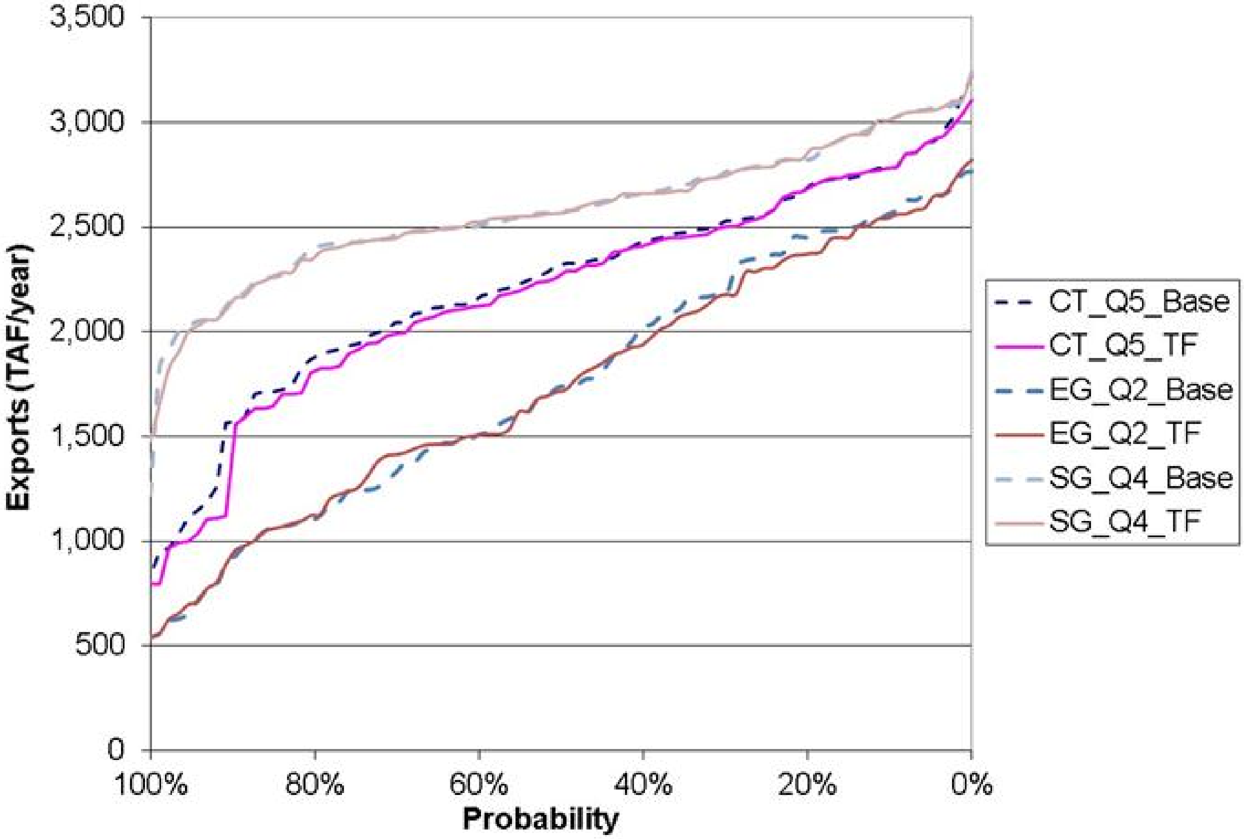
Figure 3-135. Temperance Flat End of September Monthly Exceedence with Baseline (dashed) and Temperance Flat (solid)

Delta Exports and Delta Outflow Figures 3-136 and 3-137 are annual exceedence plots of Delta exports from the H.O. Banks and C.W. Jones pumping plants comparing the with Temperance Flat reservoir to the no project baselines for the current trends-central tendency (CT_Q5), expansive growth-warmer, drier (EG_Q2) and slow growth-less warming, wetter socioeconomic-climate scenarios. As shown on these figures, Delta export pumping at both Jones and Banks is only slightly affected by the operations of Temperance Flat reservoir. The changes in total Delta exports range from a minimum decrease of 10 TAF/year to maximum decrease of 55 TAF/year.



Key:
TAF = thousand acre-feet

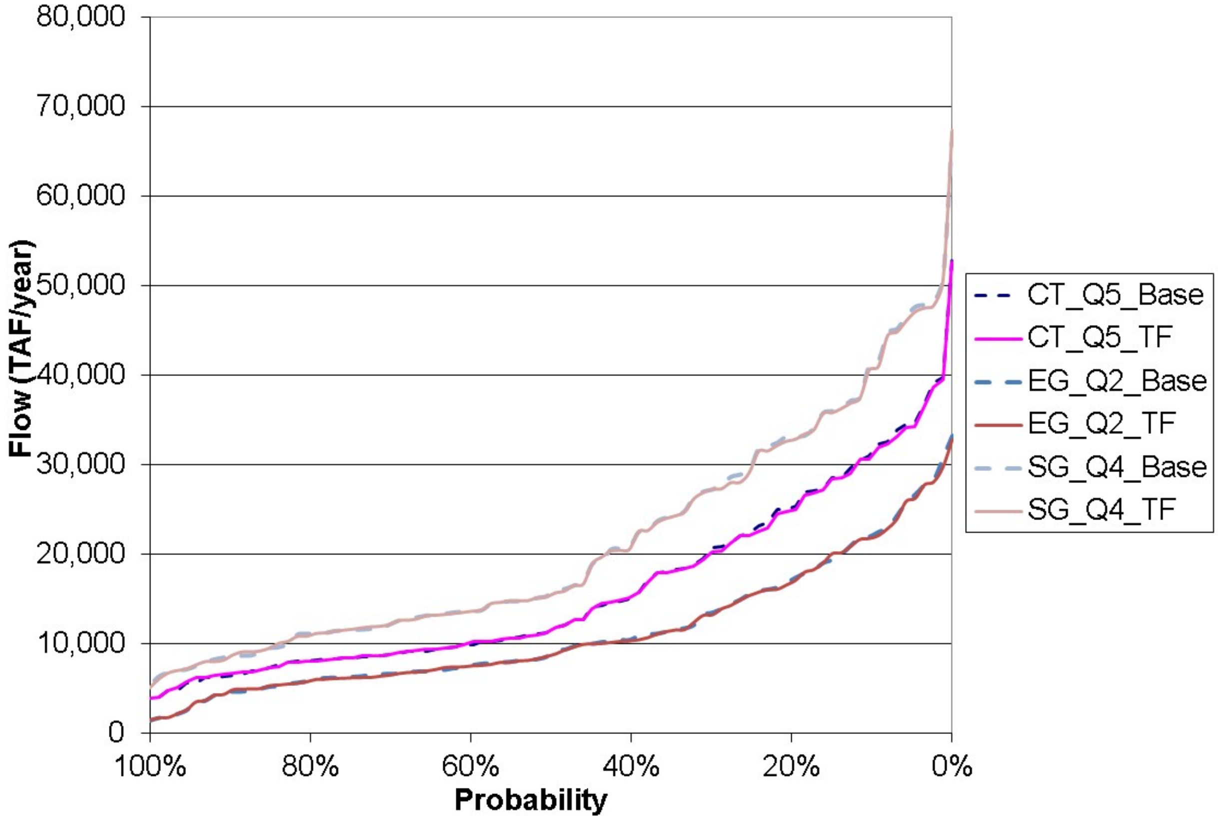
Figure 3-136. Exceedence of Annual Banks Pumping (TAF/year) showing Baseline (dashed) and Temperance Flat (solid line)



Key:
TAF = thousand acre-feet

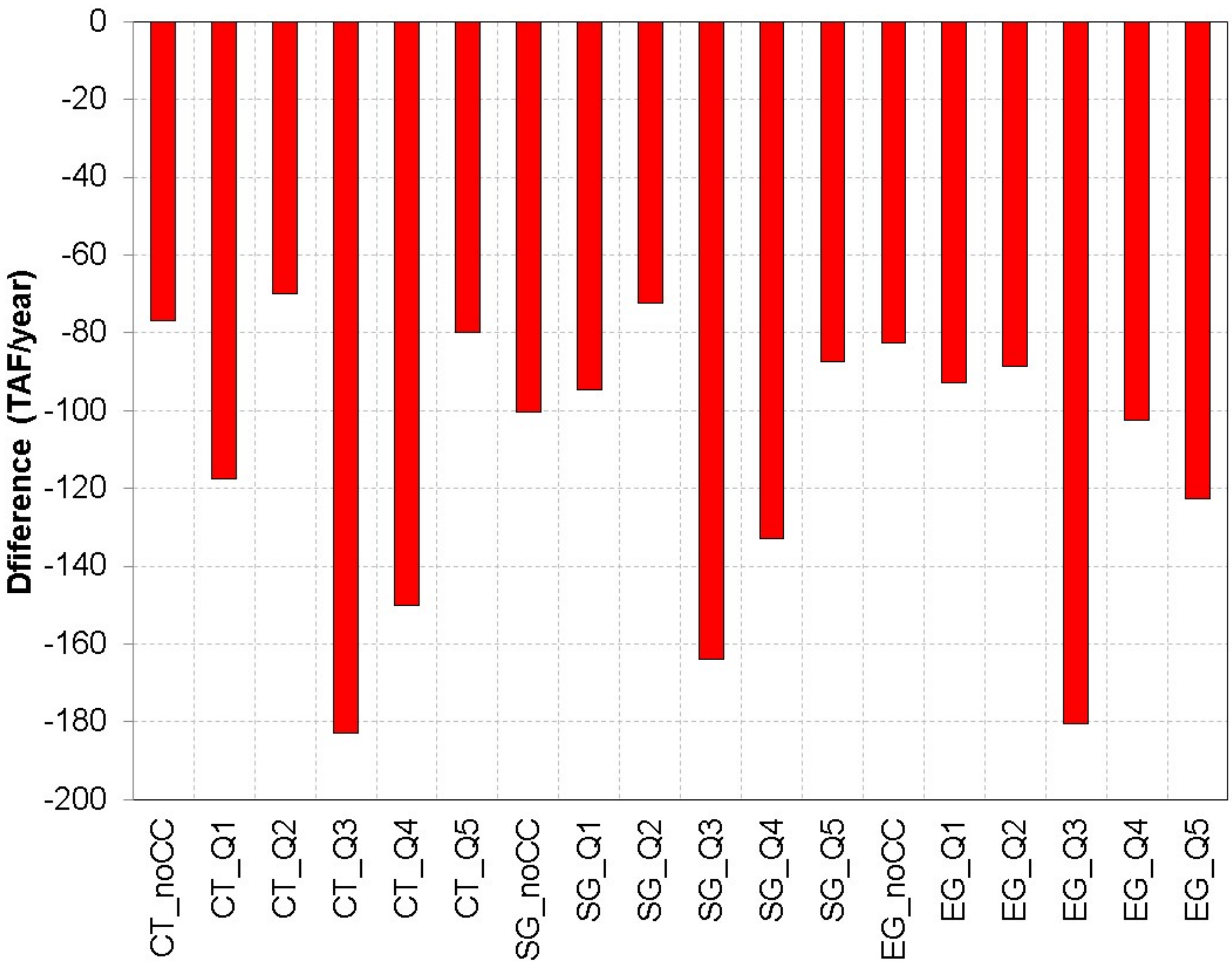
Figure 3-137. Annual Exceedence of Jones Pumping (TAF/year) showing Baseline (dashed) and Temperance Flat (solid line)

Figure 3-138 is a similar exceedence plot of annual Delta outflows. As can be observed, Temperance Flat reservoir has only slight effects on Delta outflows. Figure 139 shows the magnitude of changes in Delta outflows for all 18 of the socioeconomic-climate scenarios. The decreases range from a minimum of 70 to a maximum of 180 TAF/year with the central tendency Q5 projections showing average decreases ranging from approximately 80 to 120 TAF/year.



Key:
TAF = thousand acre-feet

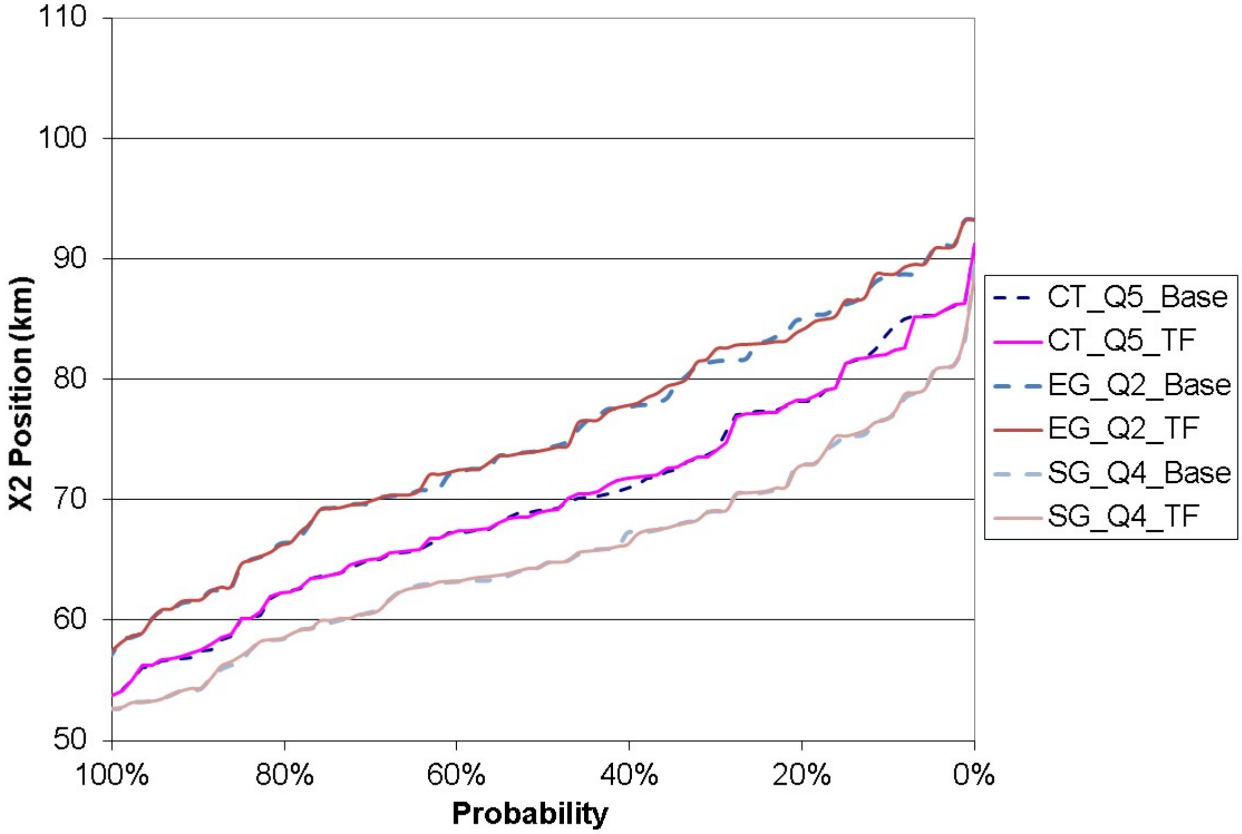
Figure 3-138. Annual Exceedence of Delta Outflow (TAF/year) showing Baseline (dashed) and Temperance Flat reservoir results (solid line)



Key:
TAF = thousand acre-feet

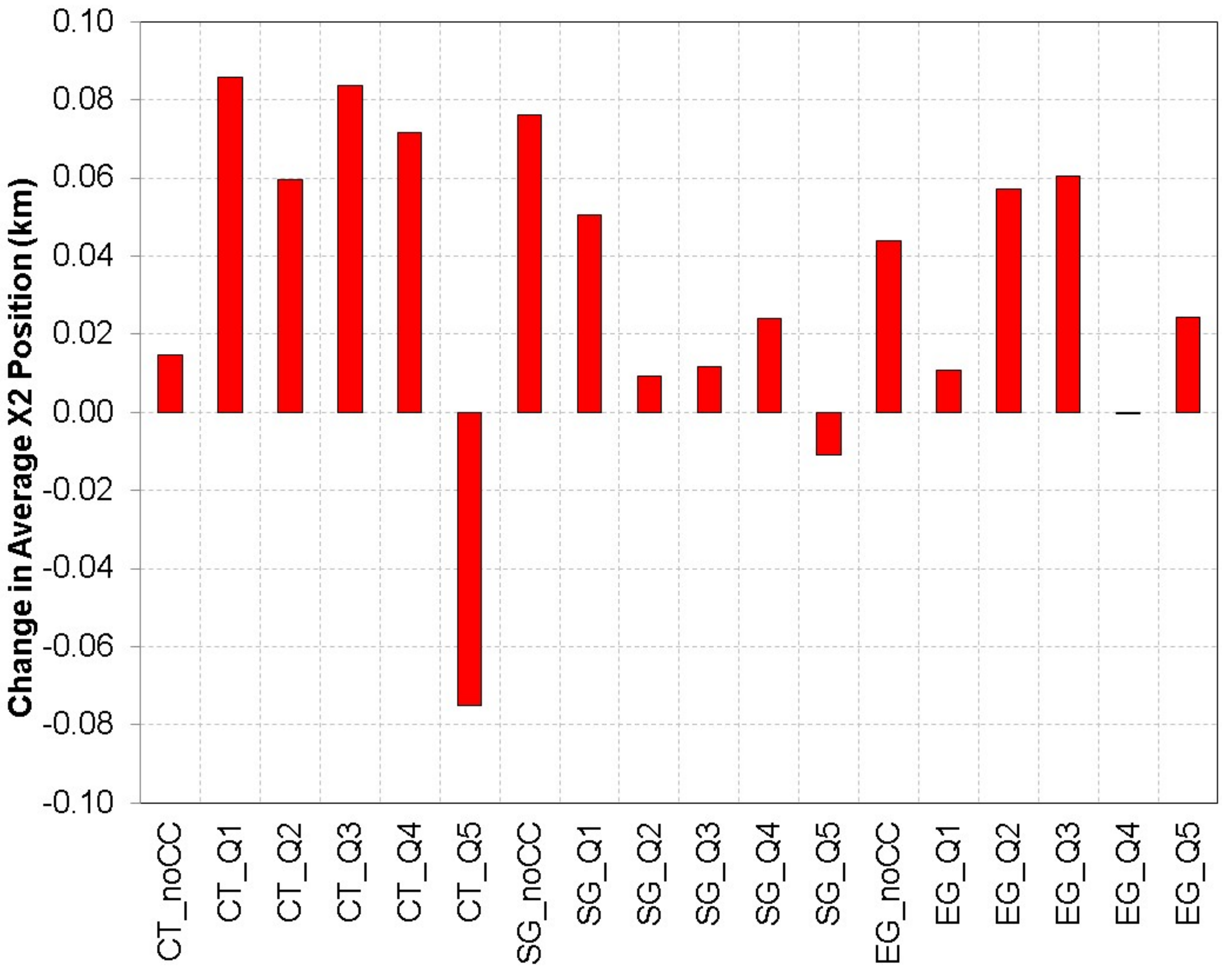
Figure 3-139. Average Annual Change in Delta Outflow for (TAF/year) comparing the Baseline to Temperance Flat in each Scenario

Delta Salinity Figure 3-140 shows the exceedence plots of average X2 position during the 21st century from February through June under socioeconomic-climate scenarios CT-Q5, EG-Q2 and SG-Q4. Figure 3-142 shows the change in the average X2 position for all 18 socioeconomic-climate scenarios for the months of February through June comparing Temperance Flat reservoir to the Baseline simulations. As can be observed from the figure, the operations of the Temperance Flat reservoir has very little effect on the X2 location. The maximum changes are less than 0.1 km either to the east or west.



Key:
km = kilometer

Figure 3-140. Exceedence of Average February-to-June X2 Position (km) Comparing Baseline (dashed) with Temperance Flat (solid)



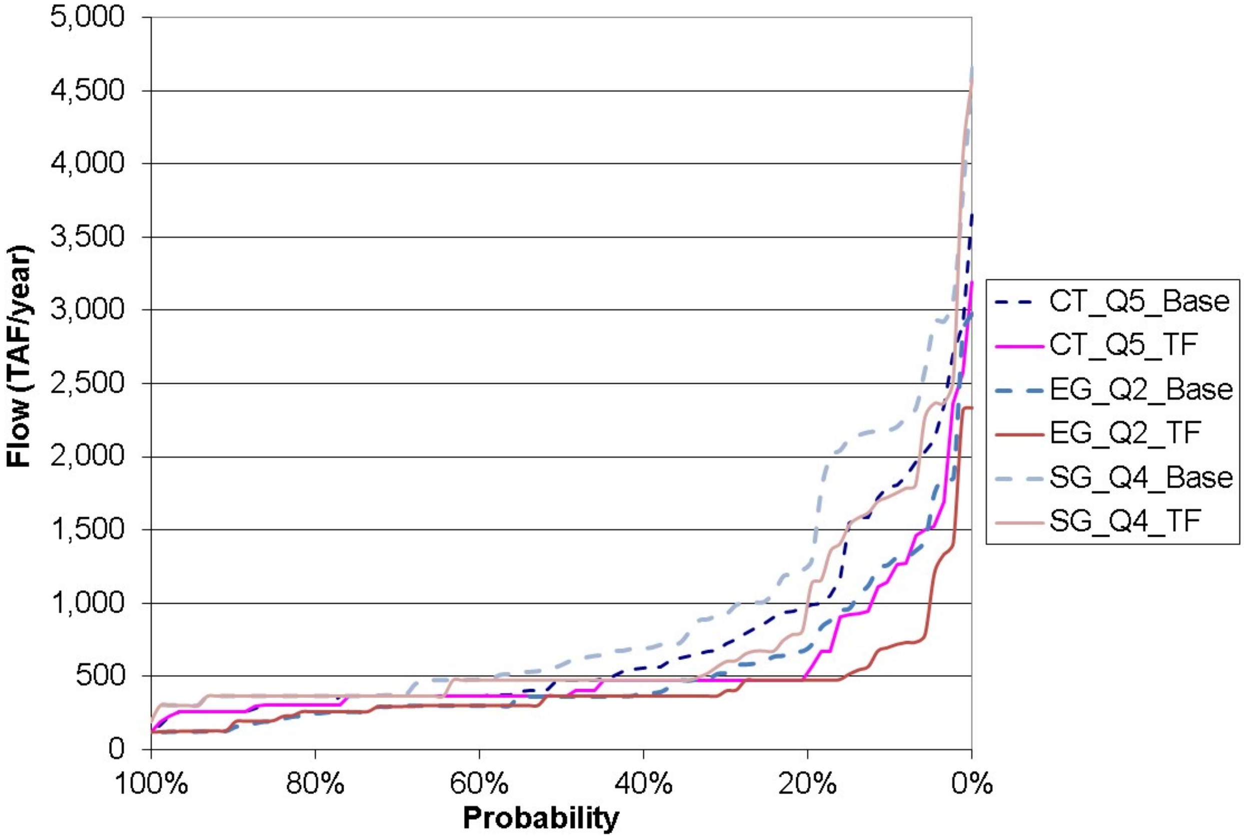
Key:
km = kilometer

Figure 3-141. Change in Average February-to-June X2 Position (km) comparing the Baseline to Temperance Flat in each Scenario

Water Supplies and Demands Figure 3-143 is an exceedence plot of annual releases from Millerton Lake into the San Joaquin River. As can be seen on the figure, Millerton Lake releases with Temperance Flat reservoir are reduced in the highest flow years reflecting the ability of Temperance Flat to capture watershed runoff which otherwise would have to be released from Millerton Lake for flood control purposes. Figure 3-144 shows the magnitude of these changes for each of the 18 socioeconomic-climate scenarios. Only small differences between the socioeconomic scenarios occur. The largest reductions in releases occur in the wetter Q3 and Q4 projections where they range from a minimum of approximately 165 TAF to a maximum of 210 TAF. The central tendency Q5 projections result in a reduction of releases of about 155 TAF.

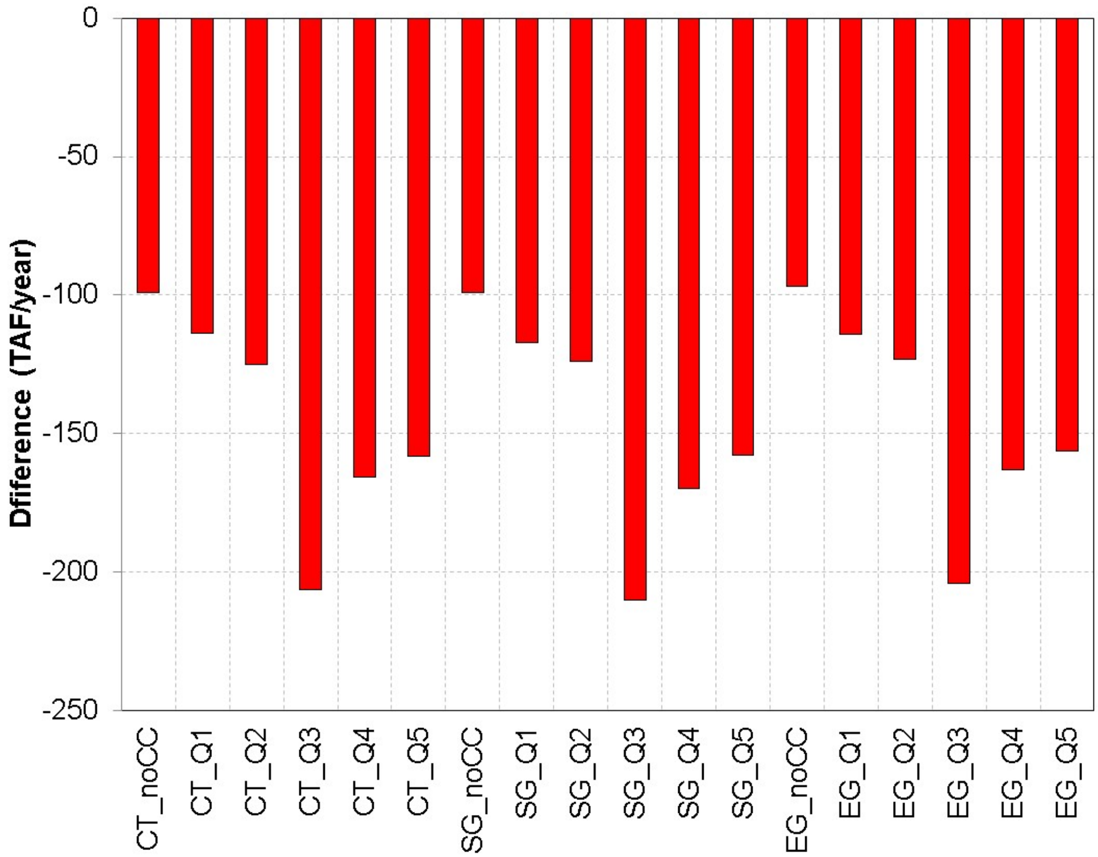
Figures 3-145 through Figure 148 show changes in annual exceedences and deliveries from Friant-Kern and Madera canals relative to the baseline conditions. Overall the simulations show that the presence of Temperance Flat reservoir has significant impacts on deliveries. As shown on Figures 3-145 and 3-147, in the wettest years, deliveries are slightly reduced due to Temperance Flat reservoir being used to capture excess runoff for carryover storage whereas in the drier years, canal deliveries with Temperance Flat reservoir are similar to the baseline results. However, as shown on Figures 3-146 and 3-148, over the 21st century, the operation of Temperance Flat reservoir results in an average increase in deliveries across the range of all 18 socioeconomic-climate scenarios considered. For the Friant-Kern Canal, increases in deliveries range from a minimum of 60 TAF/year in the drier Q2 scenarios to a maximum of 140 TAF/year in wetter Q3 scenarios. The central tendency Q5 deliveries increase by approximately 100 TAF/year. For the Madera Canal, increases in deliveries range from a minimum of 30 TAF/year in the drier Q2 scenarios to a maximum of 60 TAF/year in wetter Q3 scenarios. The central tendency Q5 deliveries increase by approximately 40 TAF/year.

Figure 3-149 shows the change in average annual unmet demands in the CVP Service Area with the operation of Temperance Flat reservoir. Overall with the Temperance Flat, reductions in unmet demands range from a minimum of approximately 50 TAF/year to a maximum of 120 TAF/year. The central tendency Q5 unmet demands decrease in range of about 70 to 80 TAF/year for the 3 socioeconomic scenarios considered in the analyses.



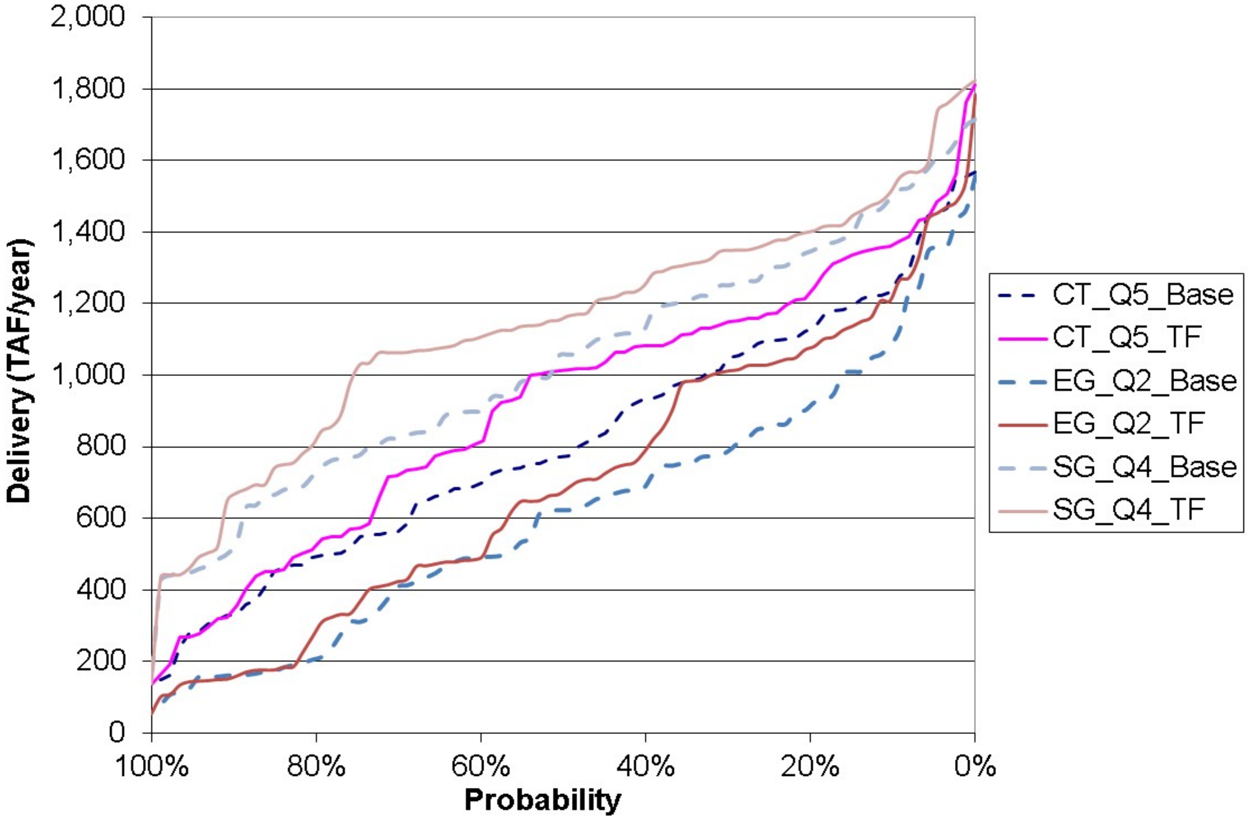
Key:
TAF = thousand acre-feet

Figure 3-143. Exceedence Annual Releases from Millerton Lake (TAF/year) Comparing Baseline (dashed) and Temperance Flat Results (solid line)



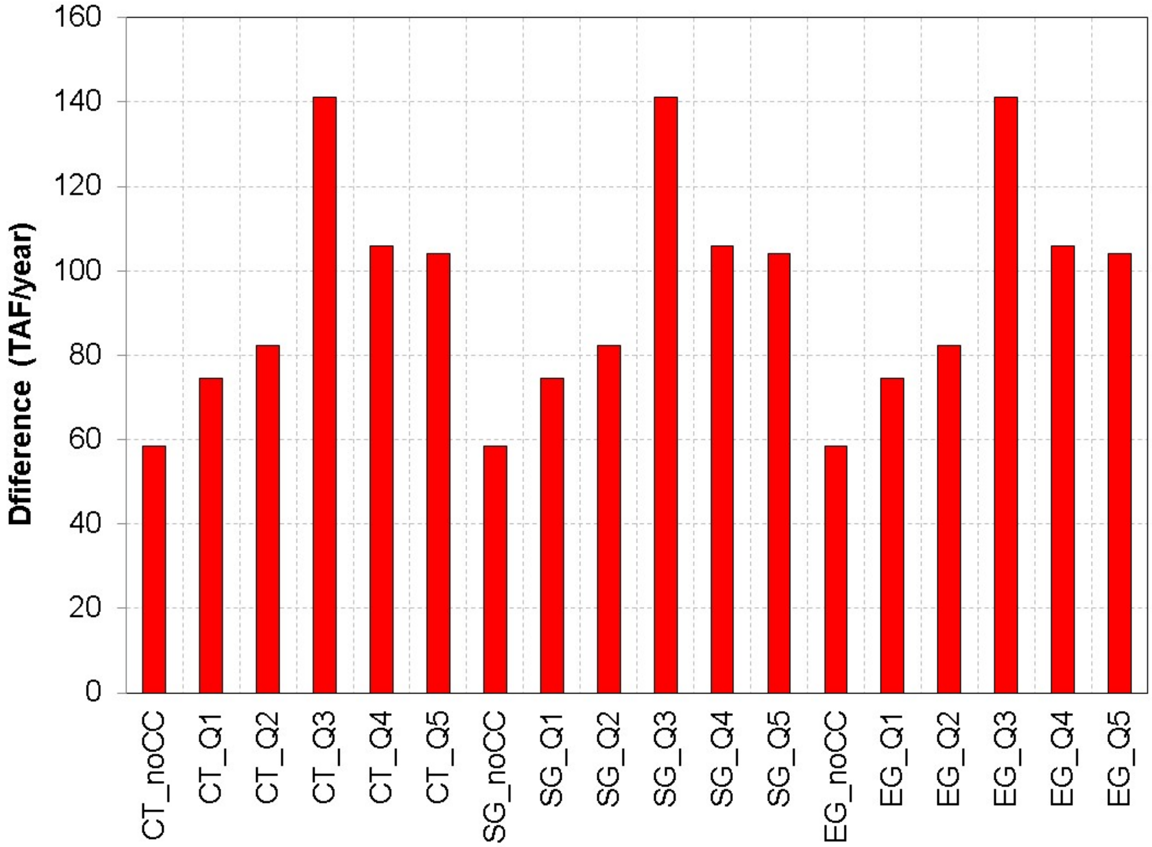
Key:
TAF = thousand acre-feet

Figure 3-144. Average Annual Change in Millerton Releases for (TAF/year) Comparing the Baseline to Temperance Flat in each Scenario



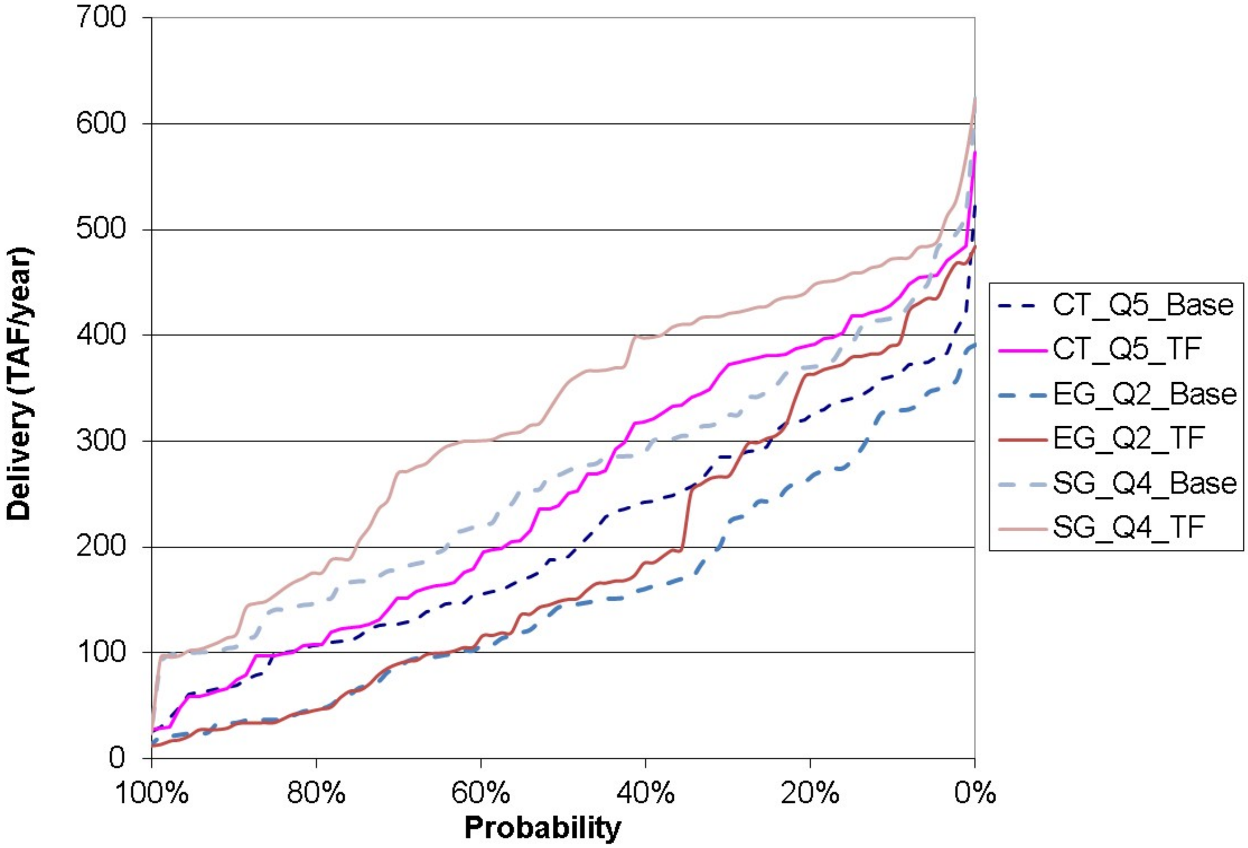
Key:
TAF = thousand acre-feet

Figure 3-145. Exceedence of Annual Friant-Kern Canal Deliveries (TAF/year) Comparing Baseline (dashed) and Temperance Flat Results (solid line)



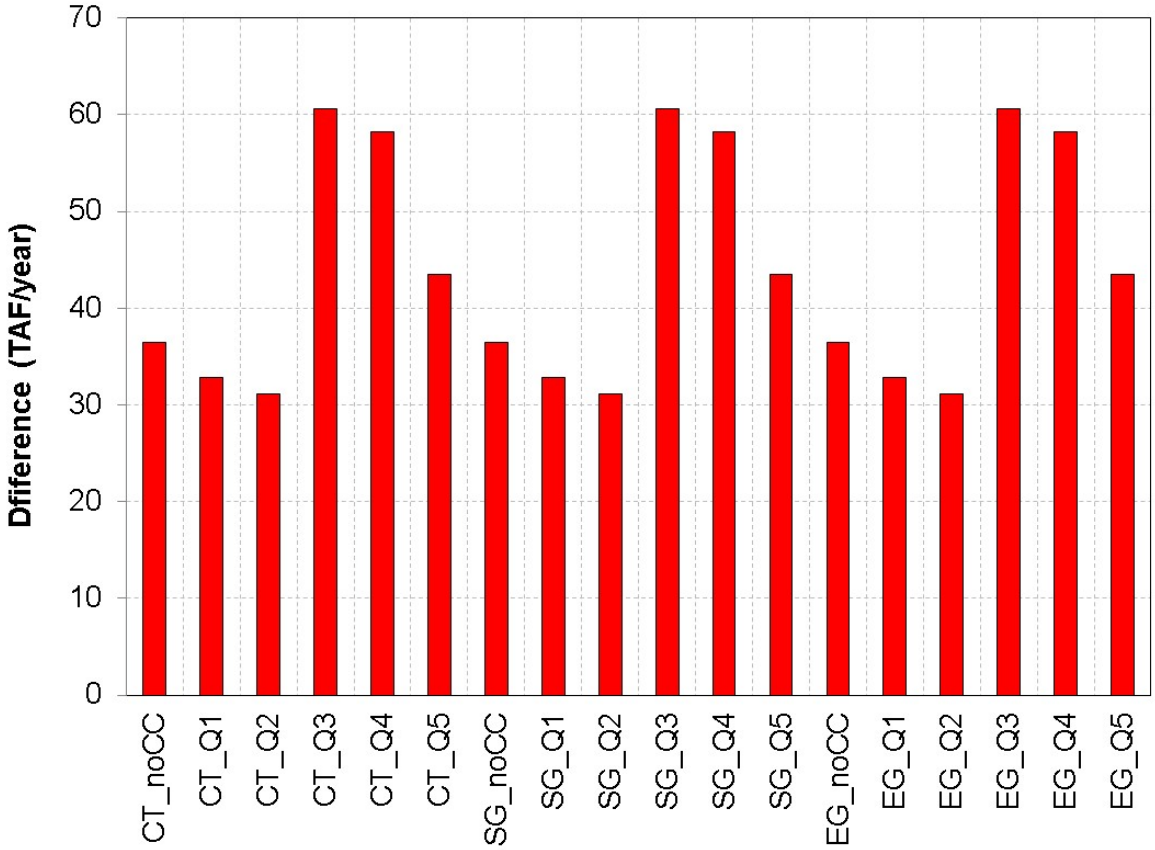
Key:
TAF = thousand acre-feet

Figure 3-146. Average Annual Change in Friant-Kern Canal Deliveries for (TAF/year) Comparing the Baseline to Temperance Flat in each Scenario



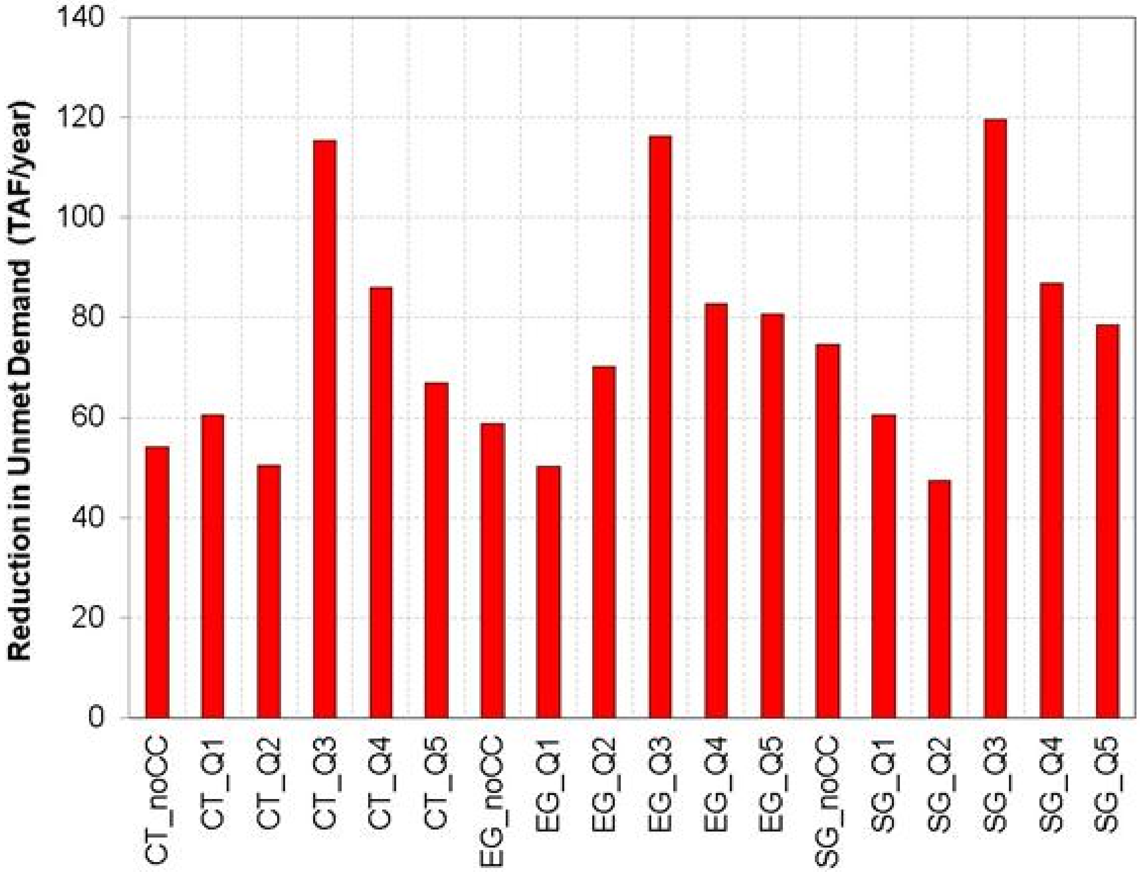
Key:
TAF = thousand acre-feet

Figure 3-147. Exceedence of Annual Madera Canal Delivery (TAF/year) Comparing Baseline (dashed) and Temperance Flat Results (solid line)



Key:
TAF = thousand acre-feet

Figure 3-148. Average Annual Change in Madera Canal Delivery for (TAF/year) Comparing the Baseline to Temperance Flat in each Scenario



Key:
CVP = Central Valley Project
TAF = thousand acre-feet

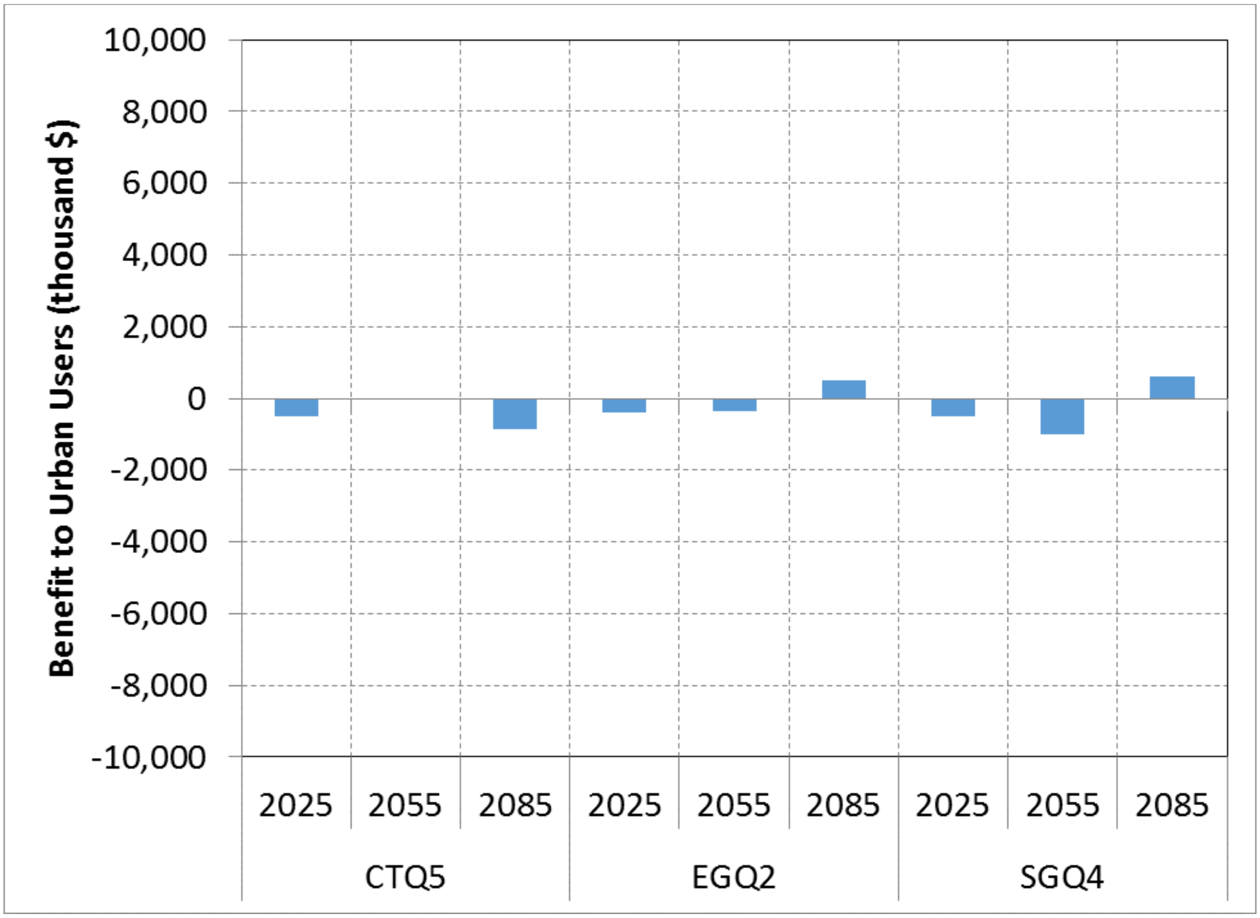
Figure 3-149. Average Annual Reduction in Unmet Demand (TAF/year) in the CVP Service Area Comparing the Baseline to Temperance Flat in each Scenario

Results of Other Performance-Assessment Tools

Economics Figure 3-152 through Figure 3-155 show the net change in water supply system costs from the urban economic models LCPSIM and OMWEM, the net change in avoided cost from the water quality economic model SBWQM and the change in agricultural net revenue from SWAP for the Representative Alternative in the CT-Q5, EG-Q2 and SG-Q4 scenarios at the 2025, 2055, and 2085 LODs.

Figure 3-152 shows the change in cost of meeting urban water demand in the South Bay area with Temperance Flat compared to without Temperance Flat (Baseline). Positive values indicate that Temperance Flat provides a cost savings (a benefit) relative to the baseline. Negative values indicate that Temperance Flat results in a cost increase relative to baseline.

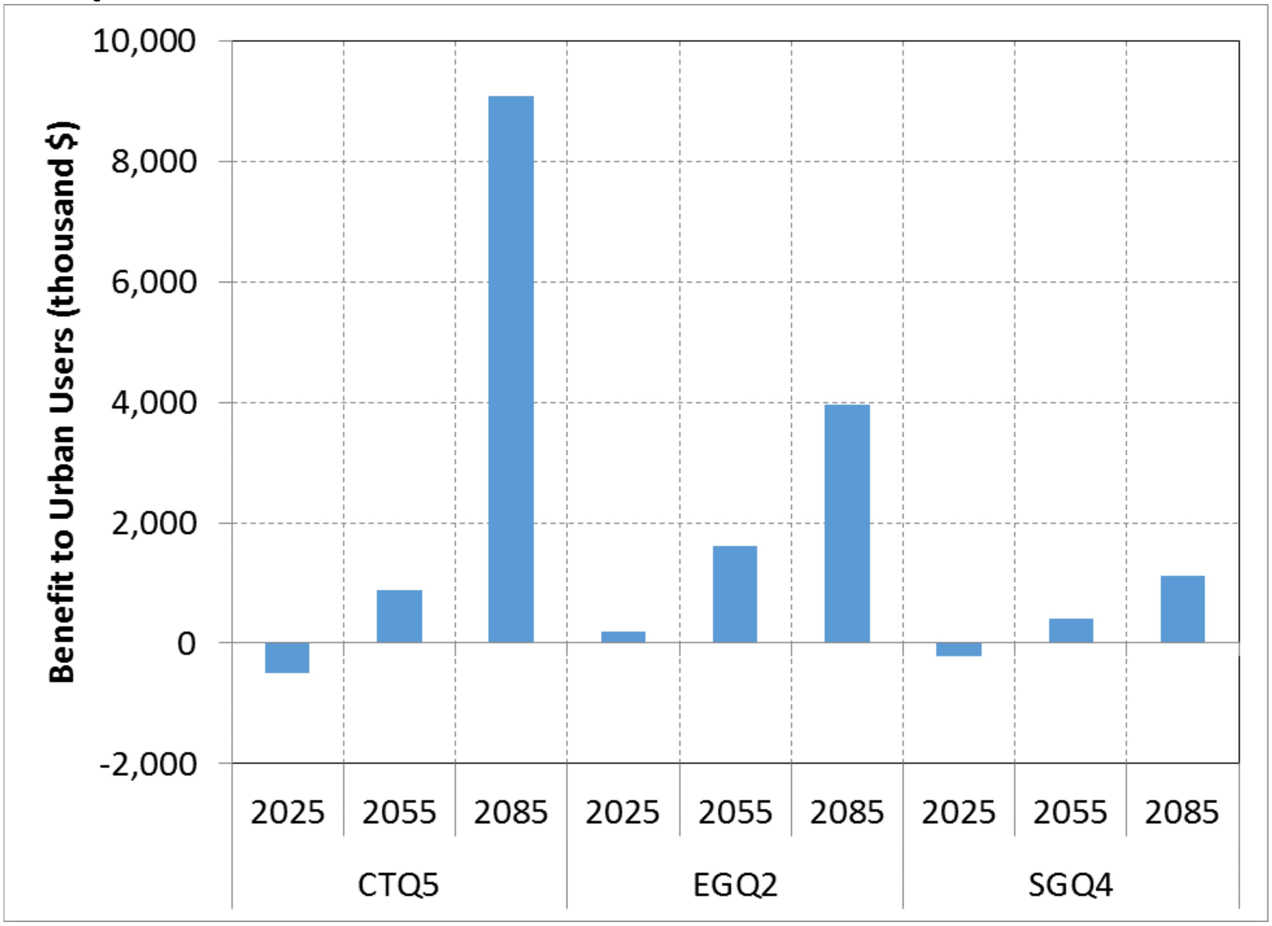
None of the scenarios show an increase or decrease in costs greater than $1 million in any year, and most are much less. The differences are so small that the model shows no significant change in the costs of meeting urban water demand in the South Bay Area.



Key:
LCPSIM = Least Cost Planning Simulation Model

Figure 3-152. Improvement in Average Annual Urban Net Water Supply System Costs in South Bay Region from LCPSIM with Temperance Flat Relative to the Baseline in each Scenario

Figure 3-153 shows the cost of meeting urban water demand in CVP and SWP M&I contractors in the Central Valley, Central Coast, and American River Region with Temperance Flat compared to without Temperance Flat (Baseline). Positive values indicate that Temperance Flat provides a cost savings (a benefit) relative to the baseline. Negative values indicate that Temperance Flat results in a cost increase relative to baseline. For Friant M&I contractors receiving additional CVP delivery, the benefit is the avoided cost of groundwater pumping. All three scenarios show benefits from avoided groundwater pumping costs in 2055 and 2085, with the greatest cost savings in CTQ5 in 2085.

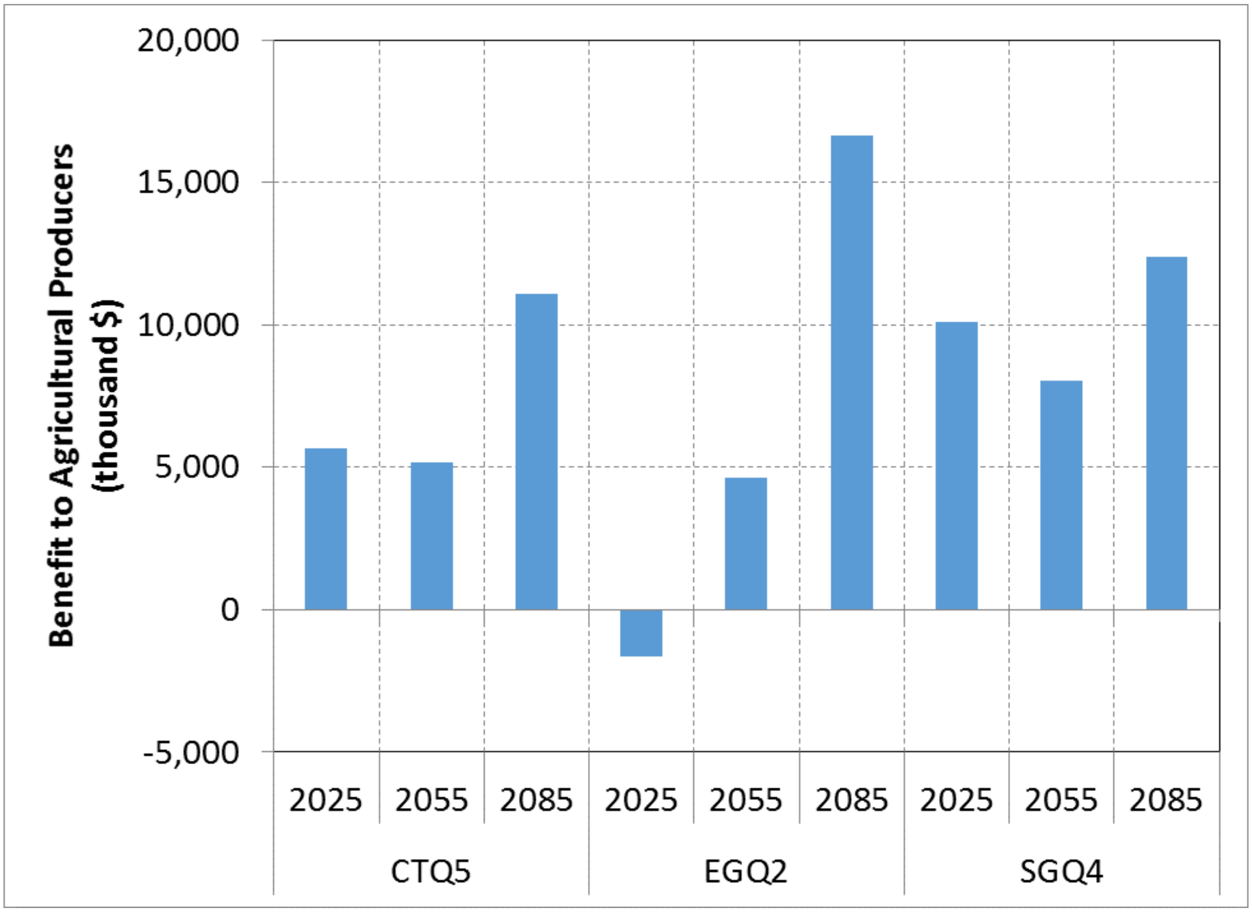


Key:
OMWEM = Other Municipal Water Economics Model

Figure 3-153. Improvement in Average Annual Urban Net Water Supply System Costs in Central Valley from OMWEM with Temperance Flat Relative to the Baseline in each Scenario

Figure 3-154 shows the change in agricultural net revenues in the Central Valley with Temperance Flat compared to without Temperance Flat (Baseline). Positive values on the figure indicate higher net revenues with Temperance Flat than without Temperance Flat. The values displayed are measured by subtracting average annual net revenue without Temperance Flat from the average annual net revenue with Temperance Flat. In scenarios CTQ5 2025/2055/2085, EGQ2 2025/2055/2085, and SGQ4 2055/2085 (all of the scenario/year combinations but one), Temperance Flat provides an improvement in average annual agricultural net revenues in the

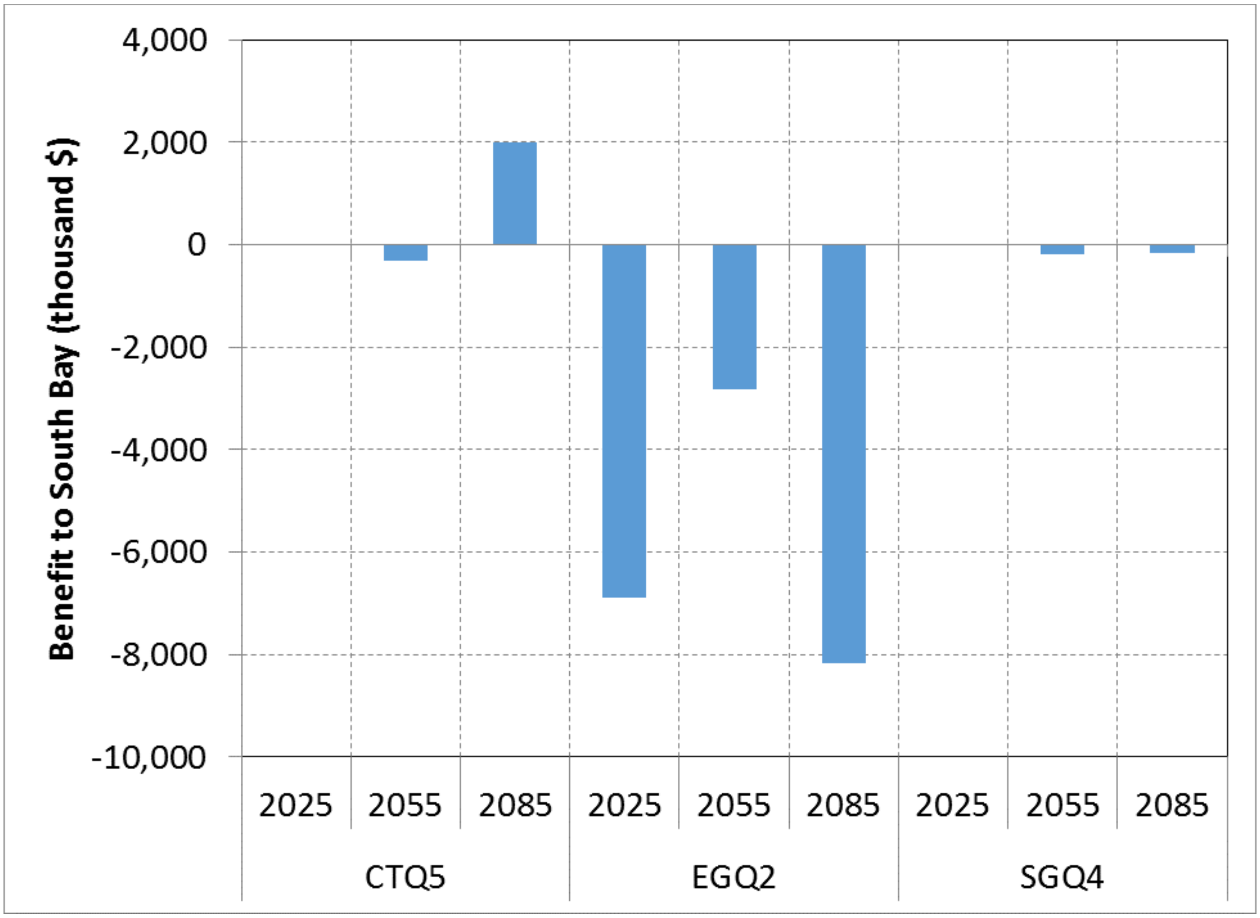
Central Valley. As the figure shows, EGQ2 2085 shows the largest increase, with $60 million in average annual net revenues to agriculture in the Central Valley.



Key:
SWAP = Statewide Agricultural Production Model

Figure 3-154. Improvement in Average Annual Agricultural Net Revenue in Central Valley from SWAP with Temperance Flat Relative to the Baseline in each Scenario

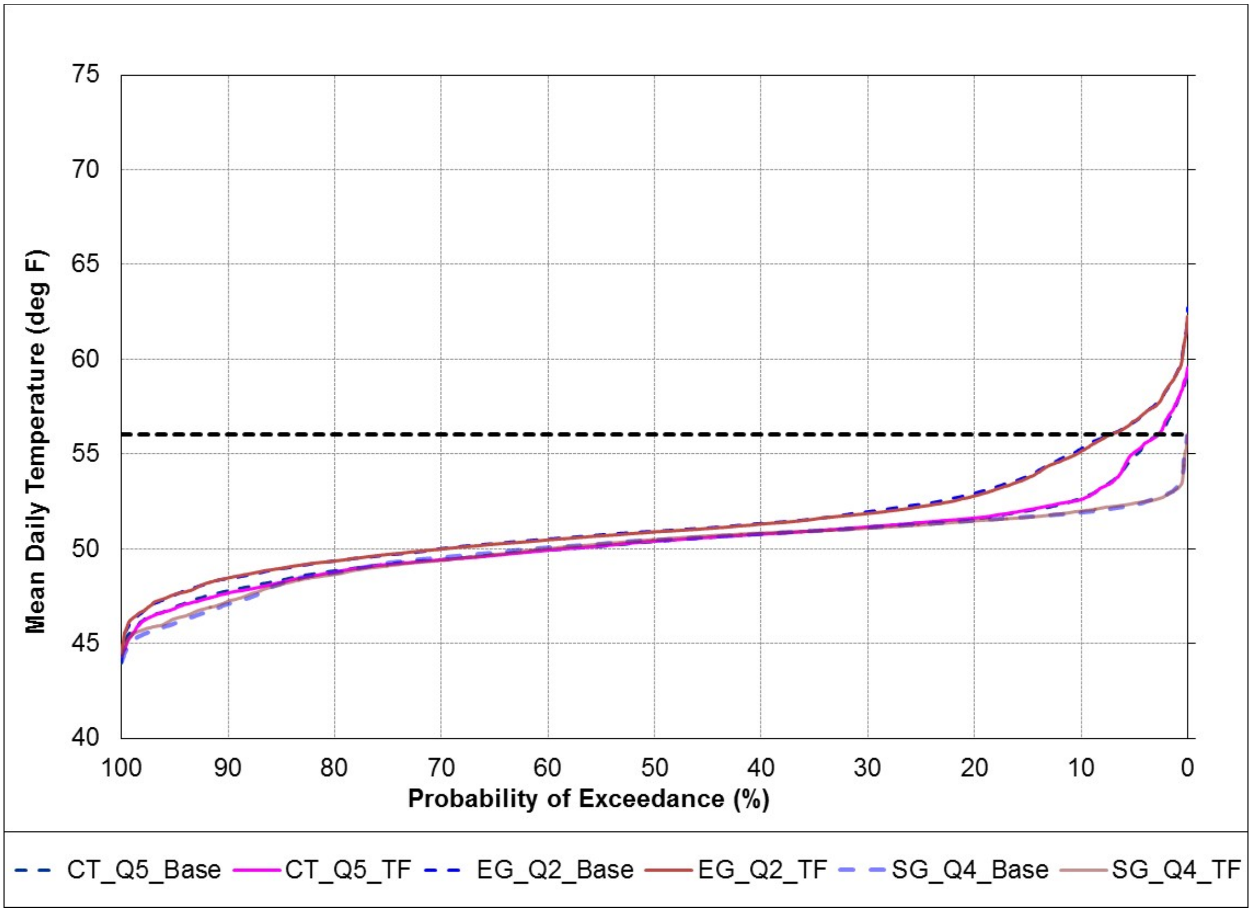
Figure 3-155. This figure shows the change in water quality-related costs for Contra Costa Water District and South Bay area. In EGQ2, there is an increase in costs of $2 million to $8 million/year in all three periods due to higher salinity in the Delta export areas with Temperance Flat compared to without Temperance Flat. This is caused by reductions in San Joaquin River inflow into the Delta with Temperance Flat. By contrast, CTQ5 has a cost reduction benefit of about $2 million/year due to a modest improvement in Delta water quality.



Key:
SBWQM = Sacramento River Water Quality Model

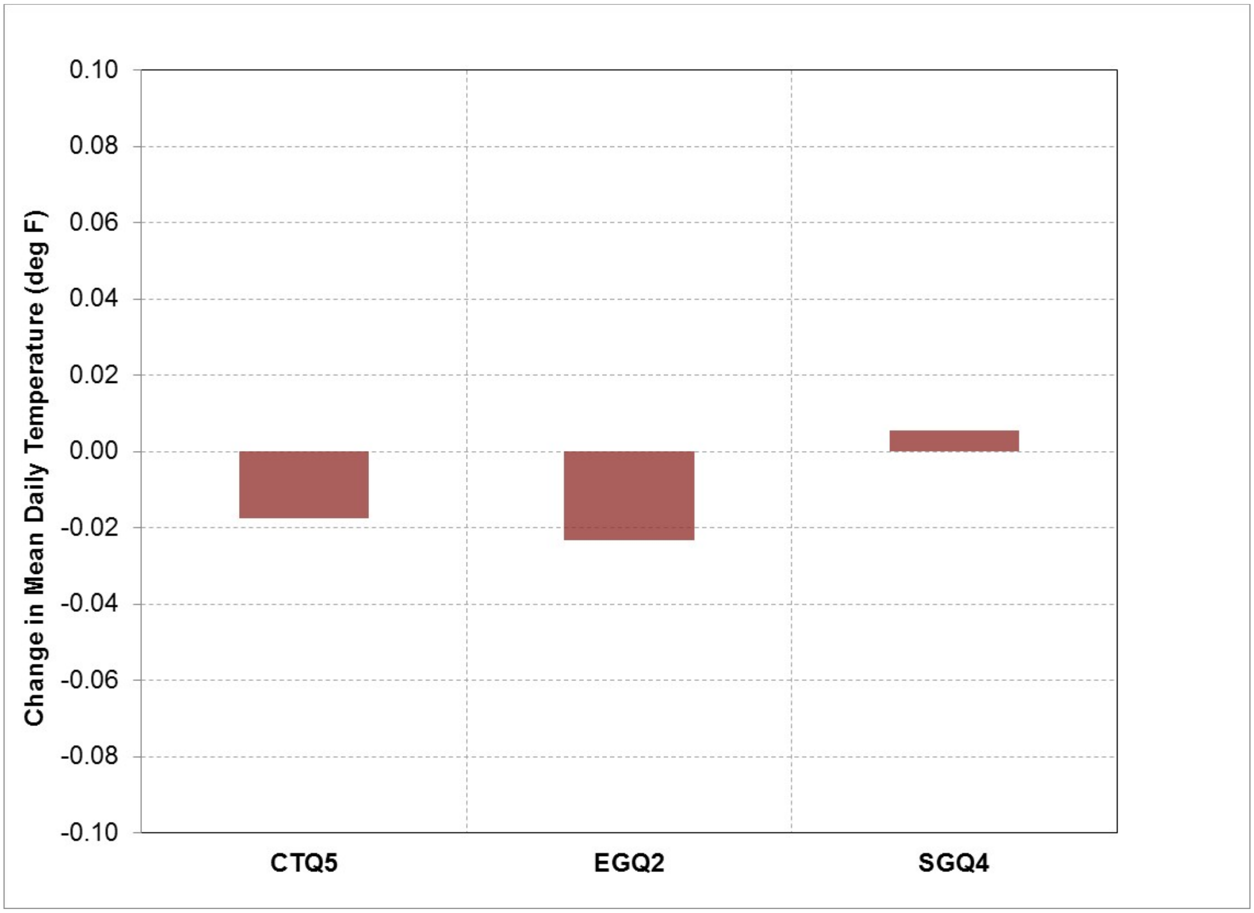
Figure 3-155. Improvement in Average Annual Avoided Water Quality Costs in South Bay Region from SBWQM with Temperance Flat Relative to the Baseline in each Scenario

Water Temperature Figure 3-156 through 3-159 show exceedence plots of mean daily water temperature and average changes for the Representative Alternative relative to the corresponding Baseline in the Sacramento River at Keswick Dam and Jellys Ferry. As can be observed from the figures, changes in exceedence of the 56°F threshold with the Representative Alternative at these distant locations are insignificant. Similarly, the magnitude of changes are less than 0.1°F.



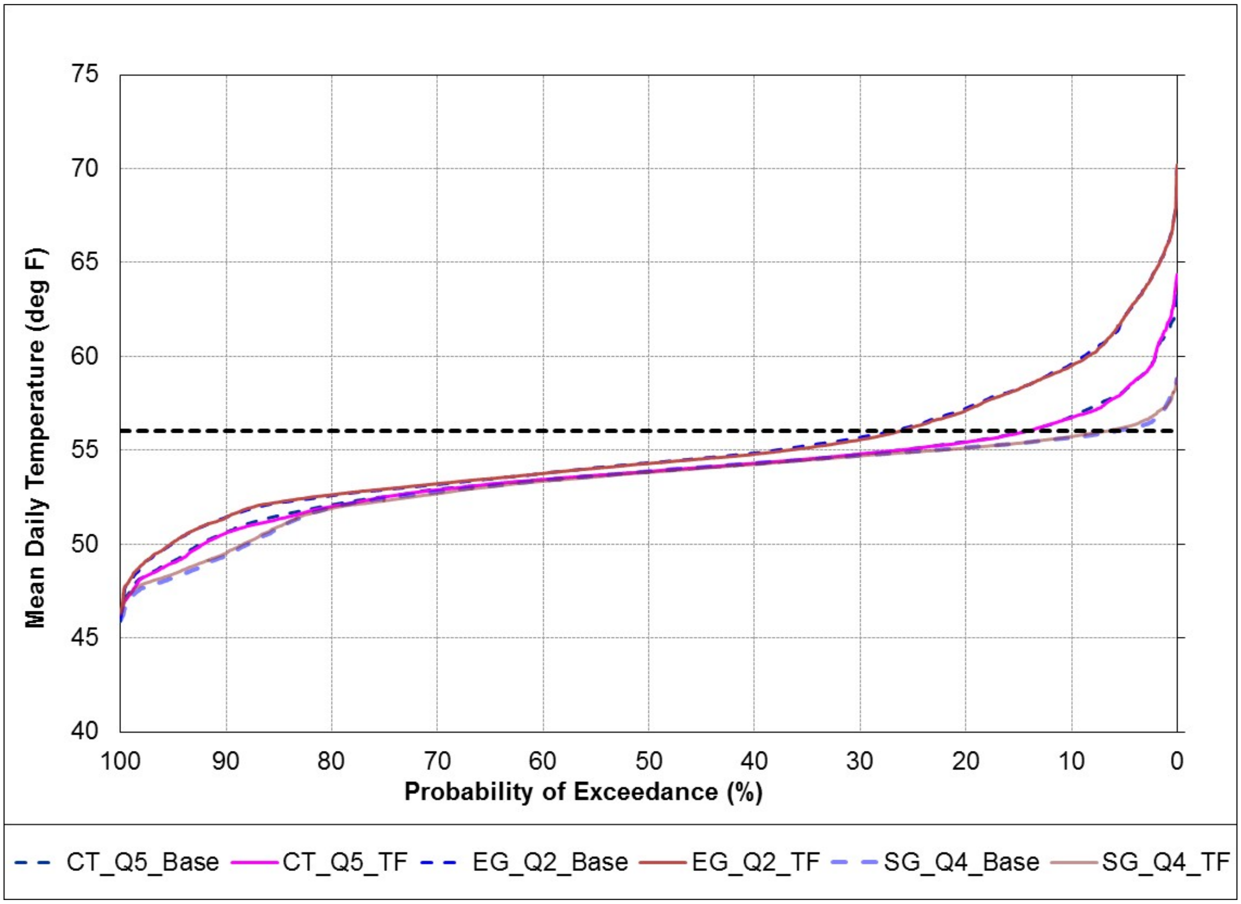
Key:
°F = degrees Fahrenheit

Figure 3-156. Exceedence of Mean Daily Temperature (°F) on Sacramento River at Keswick from July-to-September with Baseline (dashed) and Representative Alternative (solid line)



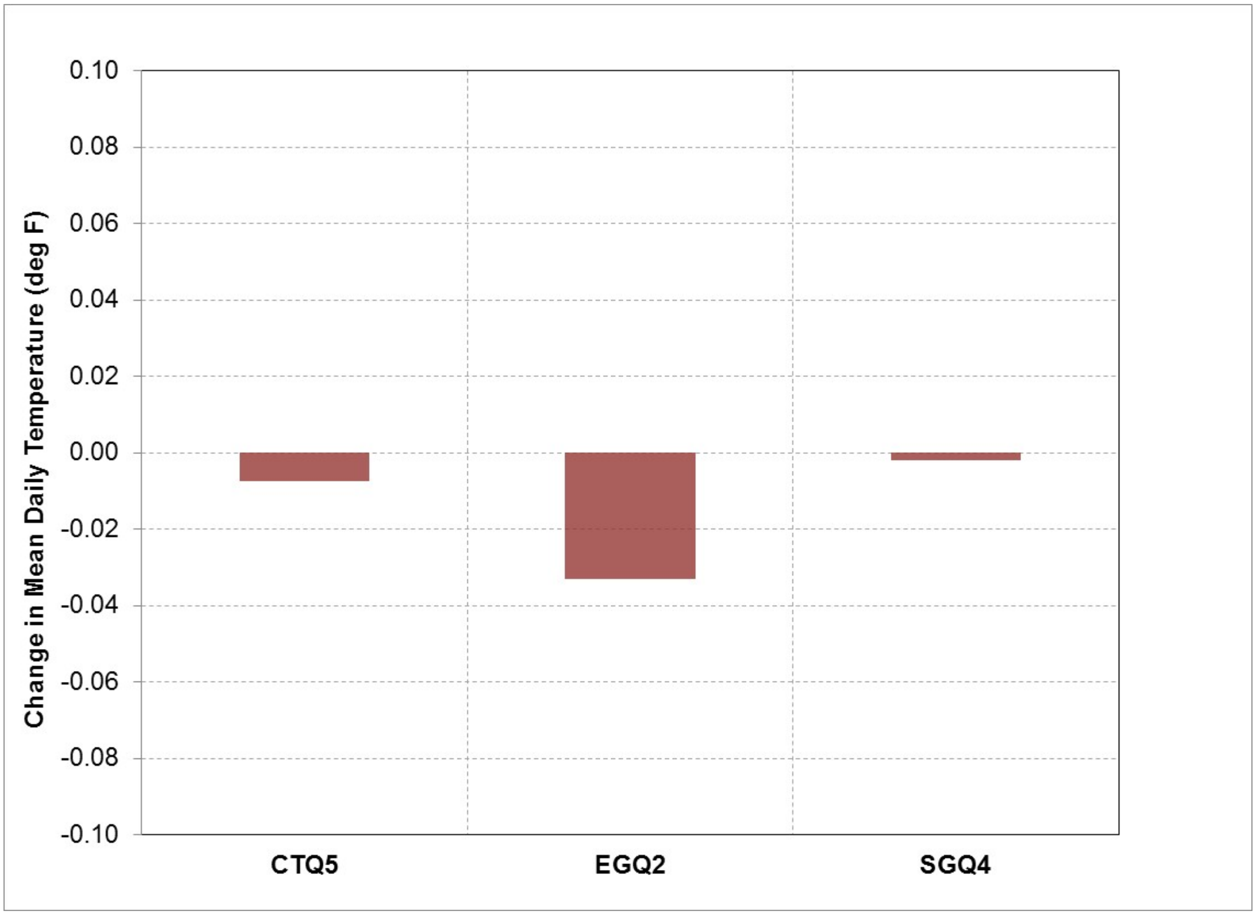
Key:
°F = degrees Fahrenheit

Figure 3-157. Change in Mean Daily Temperature (°F) on Sacramento River at Keswick from July-to-September with Representative Alternative Relative to the Baseline in each Scenario



Key:
°F = degrees Fahrenheit

Figure 3-158. Exceedence of Mean Daily Temperature (°F) on Sacramento River at Jellys Ferry from July-to-September with Baseline (dashed) and Representative Alternative (solid line)

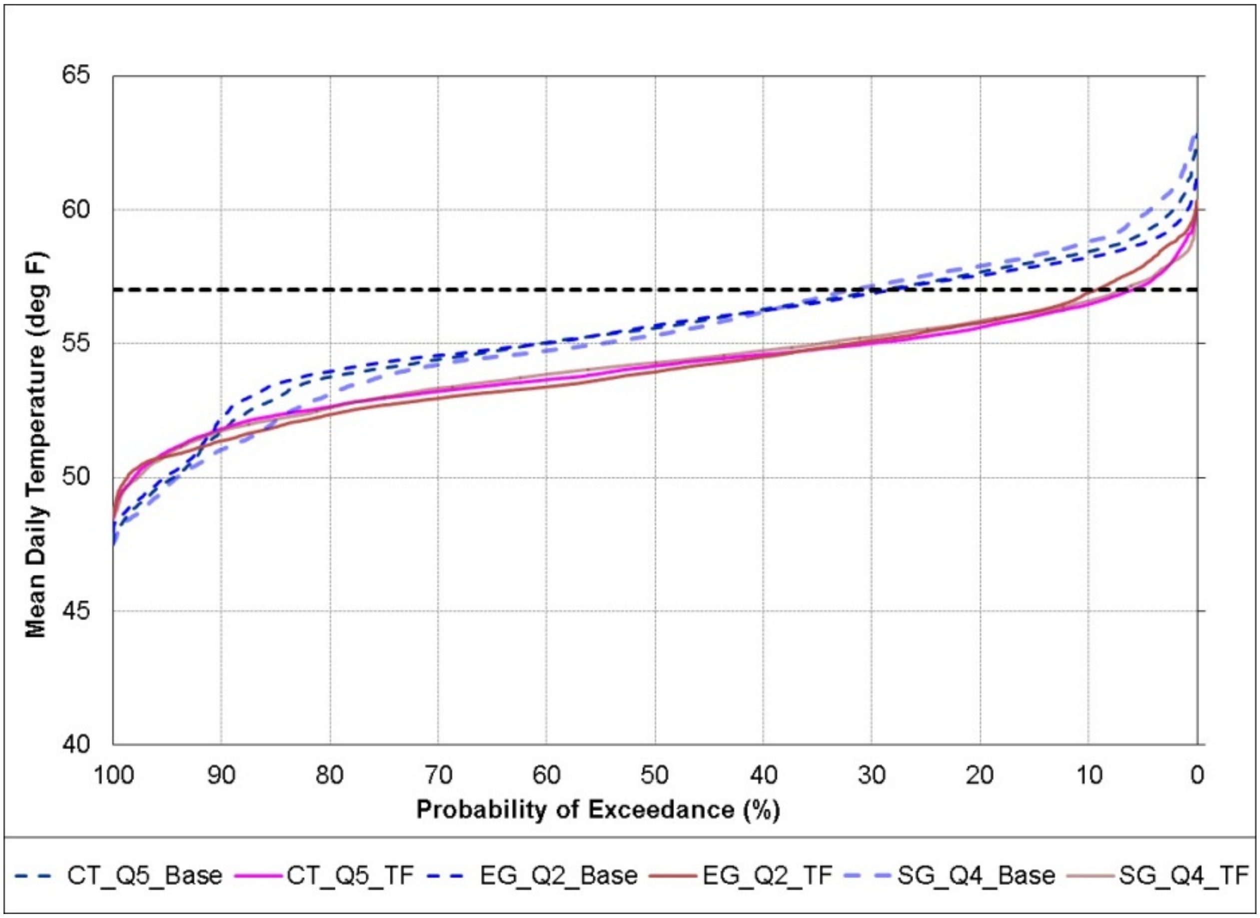


Key:
°F = degrees Fahrenheit

Figure 3-159. Change in Mean Daily Temperature (°F) on Sacramento River at Jellys Ferry from July-to-September with Representative Alternative Relative to the Baseline in each Scenario

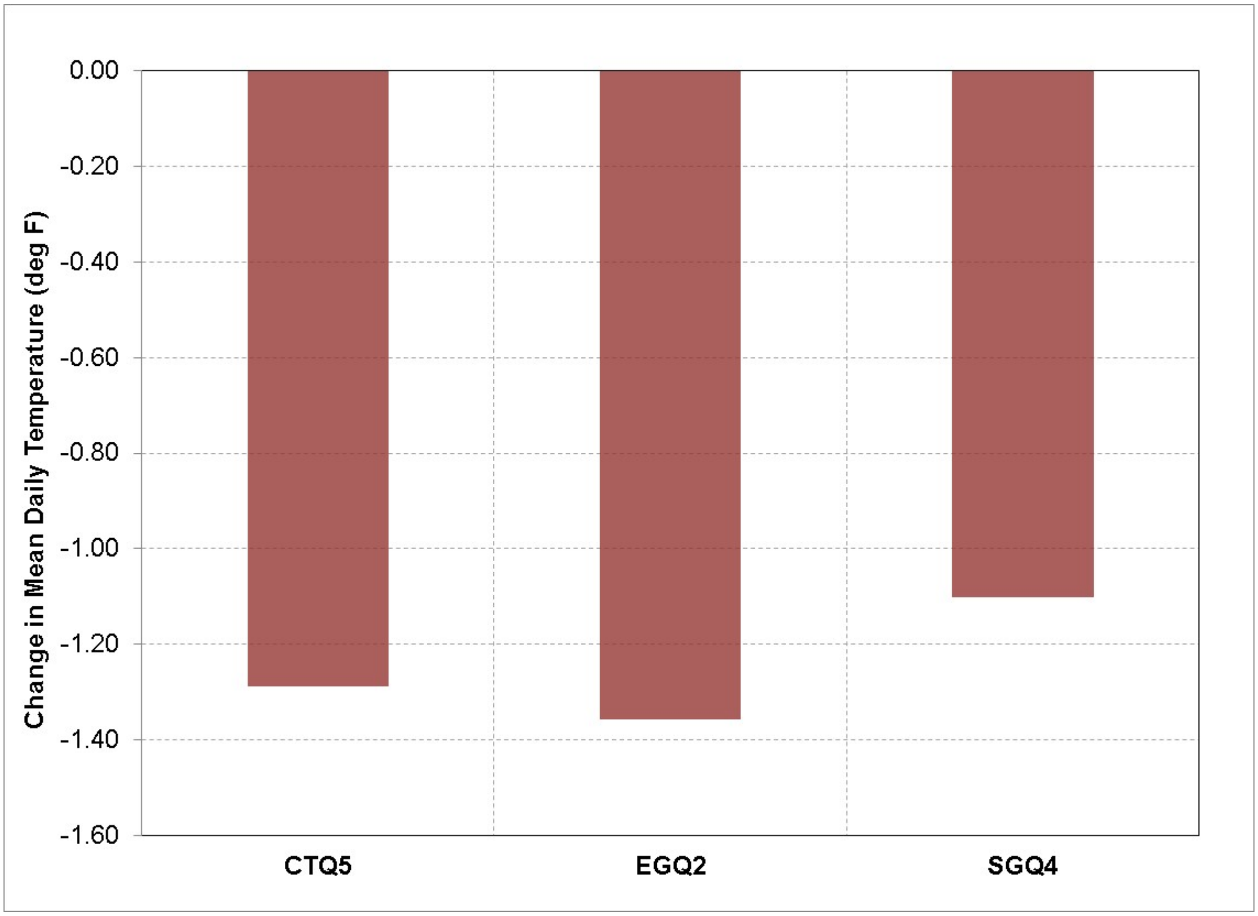
Figure 3-160 through Figure 3-165 show exceedence plots and average changes relative to the Baseline in mean daily temperatures for the CT-Q5, EG-Q2 and SG-Q4 scenarios at the 2025, 2055, and 2085 LODs in the San Joaquin River at Lost Lake, at Gravelly Ford and at Vernalis.

As can be observed from the figures, the Representative Alternative provides considerable reductions in water temperatures at Lost Lake relative to the without project climate scenarios. The probability of exceeding the 56°F threshold decreases from about 30 percent to 10 percent with an average reduction of more than 1°F in all the scenarios.



Key:
°F = degrees Fahrenheit

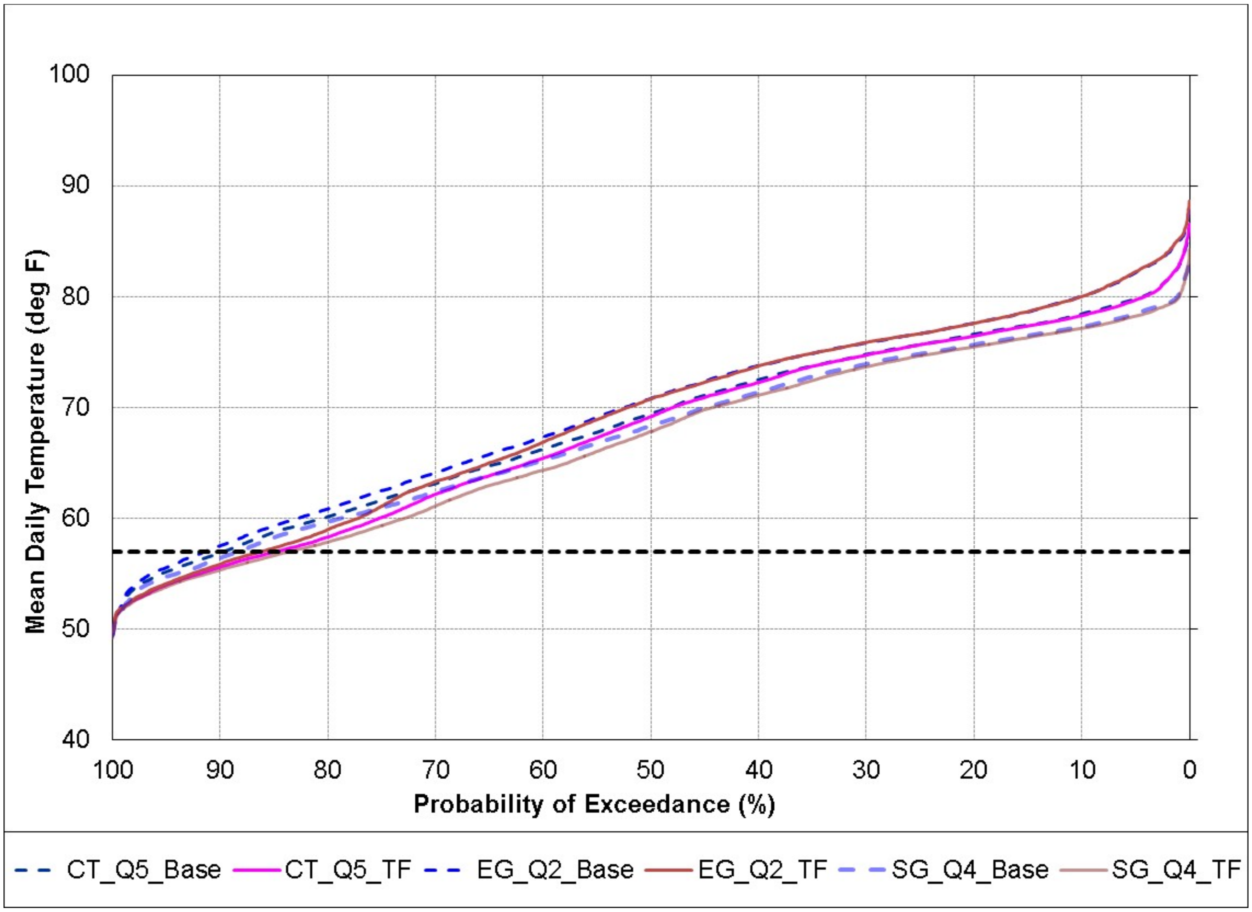
Figure 3-160. Exceedence of Mean Daily Temperature (°F) on San Joaquin River at Lost Lake from August-to-November with the Baseline (dashed line) and Representative Alternative (solid line)



Key:
°F = degrees Fahrenheit

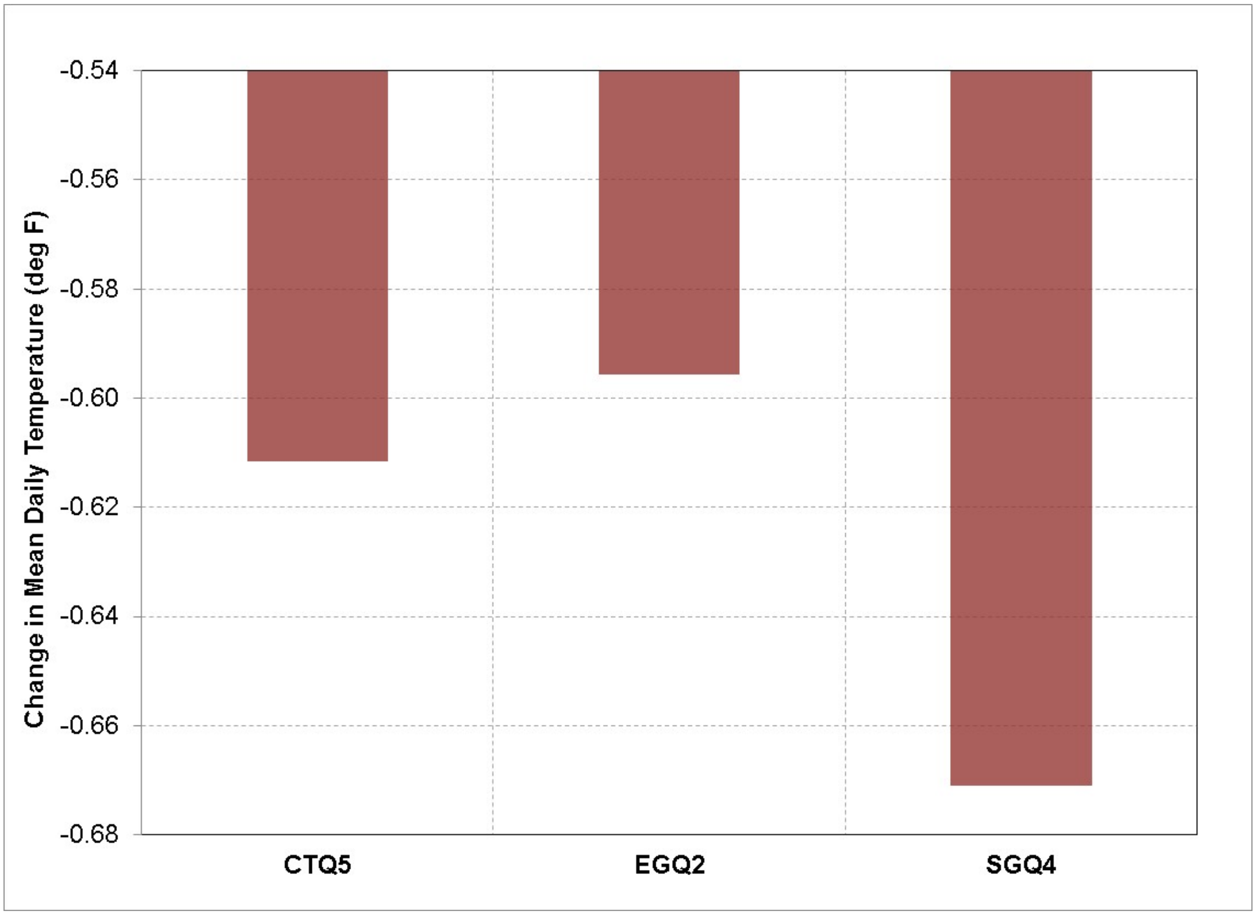
Figure 3-161. Change in Mean Daily Temperature (°F) on San Joaquin River at Lost Lake from August-to-November with the Representative Alternative relative to the Baseline

At Gravelly Ford, the results are similar to Lost Lake but the changes in exceedance of the 56°F threshold (dashed horizontal line) occurring with much higher probability (85 to 90 percent) and with much smaller but still potentially significant changes in water temperature (-0.59 to -0.67°F) relative to Baseline conditions.



Key:
°F = degrees Fahrenheit

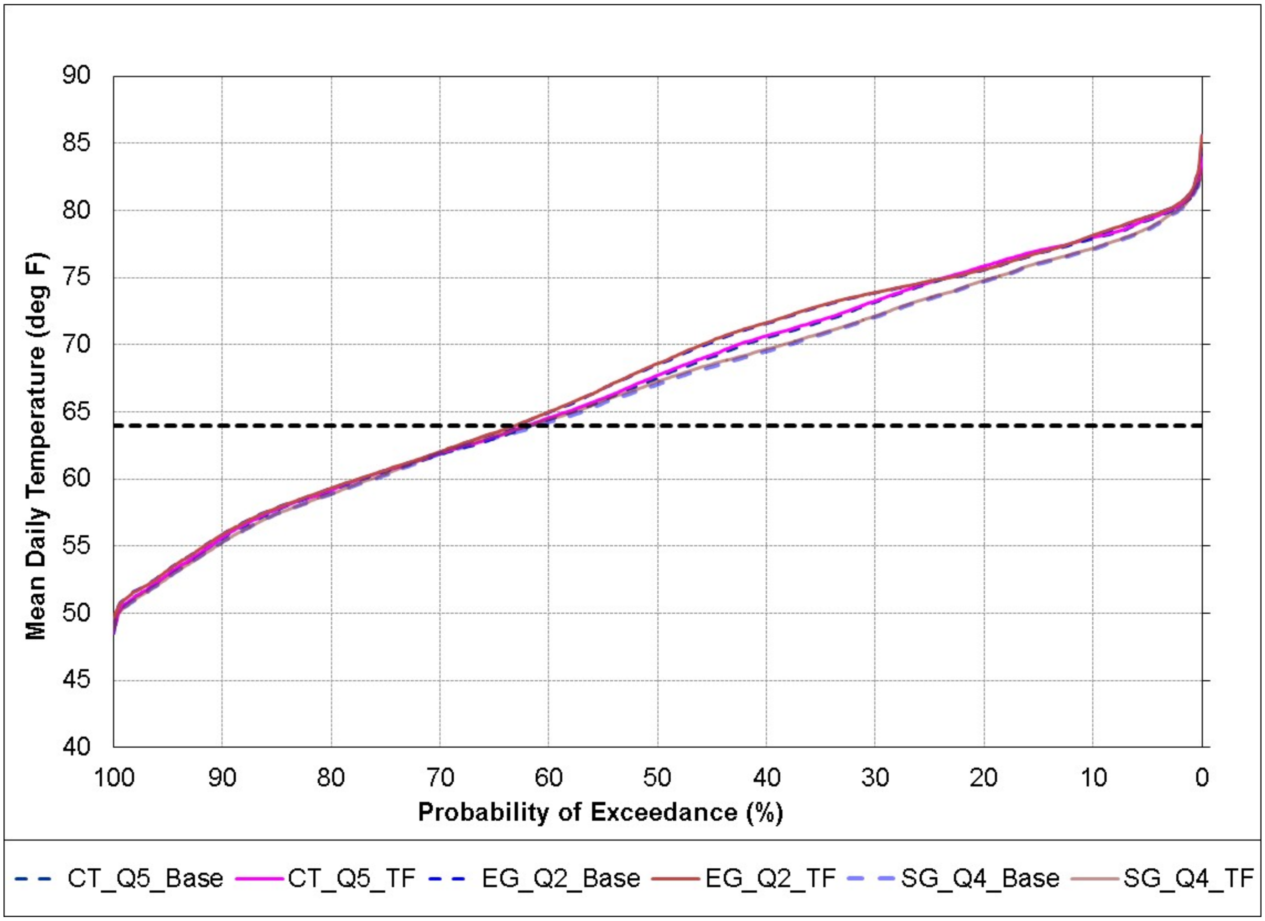
Figure 3-162. Exceedence of Mean Daily Temperature (°F) on San Joaquin River at Gravelly Ford from August-to-November with the Baseline (dashed line) and Representative Alternative (solid line)



Key:
°F = degrees Fahrenheit

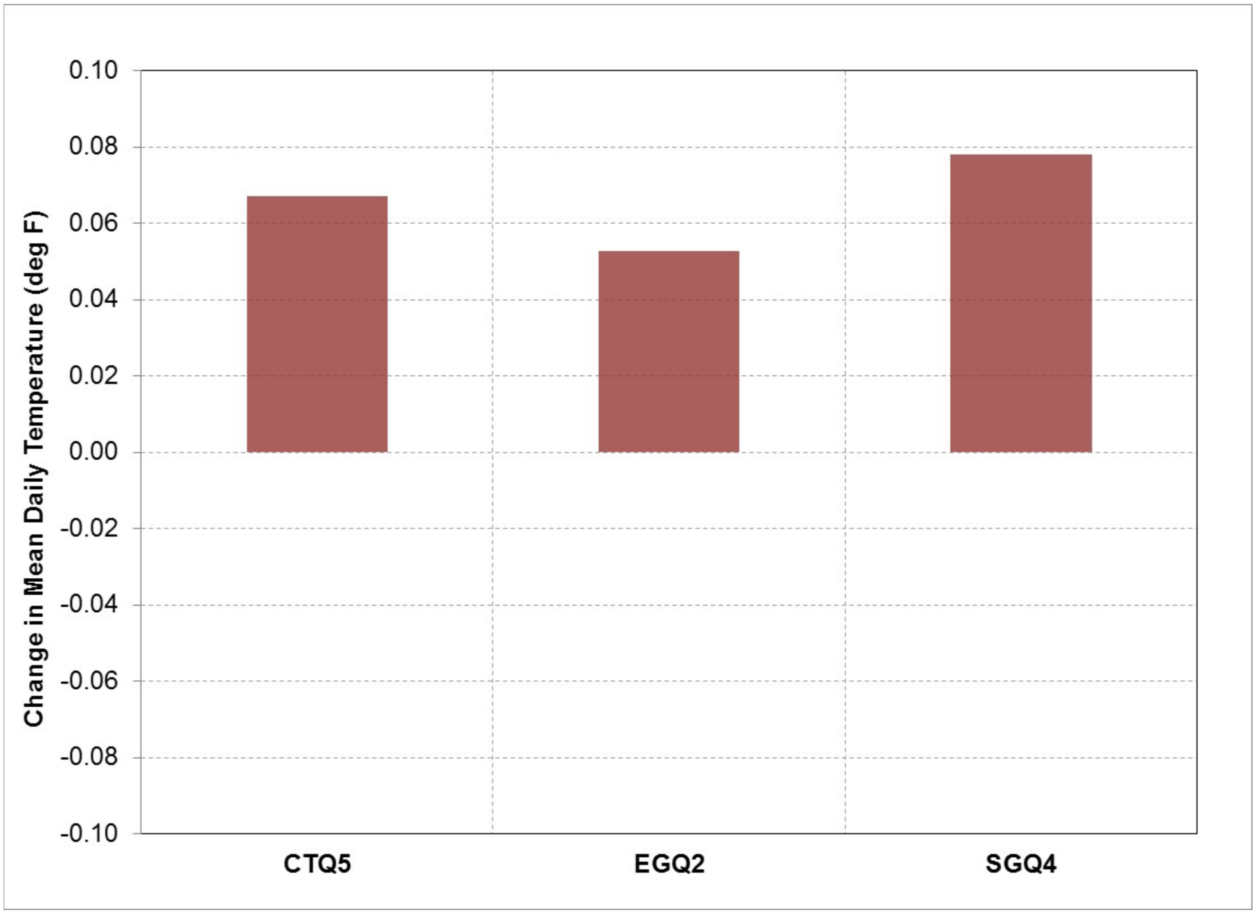
Figure 3-163. Change in Mean Daily Temperature (°F) on San Joaquin River at Gravelly Ford from August-to-November with the Representative Alternative relative to the Baseline

In the San Joaquin River at Vernalis, the effects of Representative Alternative on water temperatures are insignificant because air temperature dominates the equilibrium water temperatures.



Key:
°F = degrees Fahrenheit

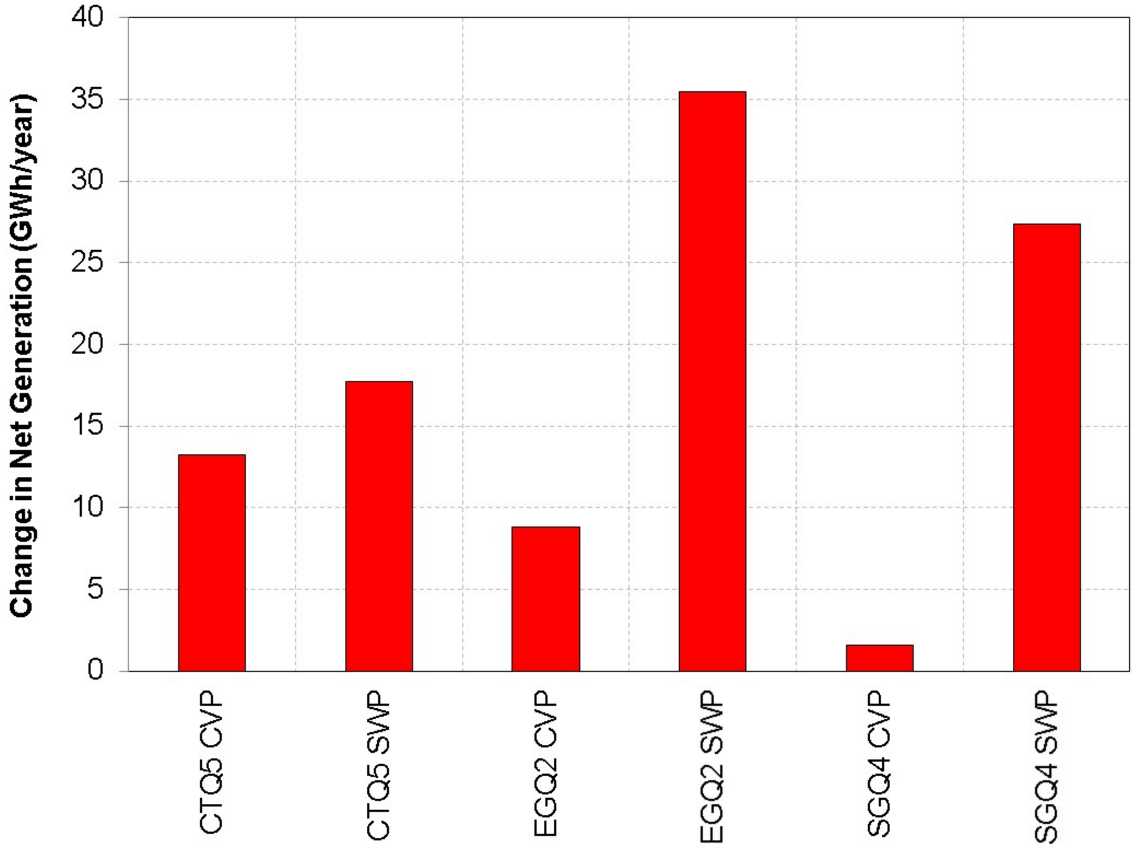
Figure 3-164. Exceedence of Mean Daily Temperature (°F) on San Joaquin River at Vernalis from August-to-November with the Baseline (dashed line) and Representative Alternative (solid line)



Key:
°F = degrees Fahrenheit

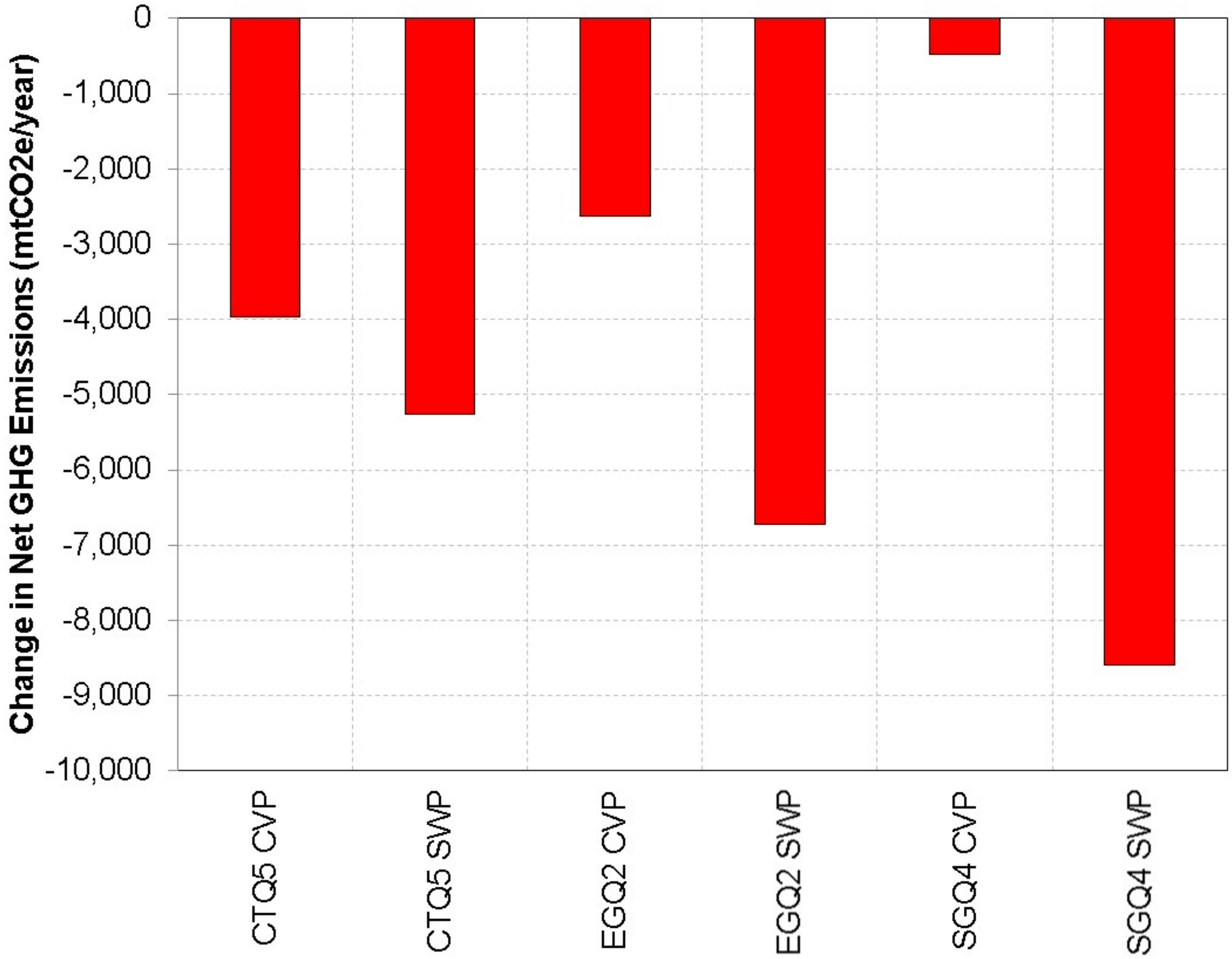
Figure 3-165. Change in Mean Daily Temperature (°F) on San Joaquin River at Vernalis from August-to-November with Representative Alternative relative to the Baseline

Hydropower and GHG Emissions Figure 3-167 and Figure 3-168 show the changes in net generation and net GHG emissions in the CVP and SWP systems with the Representative Alternative relative to the Baseline. Across the range of socioeconomic-climate change scenarios, the Representation Alternative increases net generation for both the CVP and SWP systems. As the net generation increases, the GHG emissions for both the CVP and SWP systems decrease.



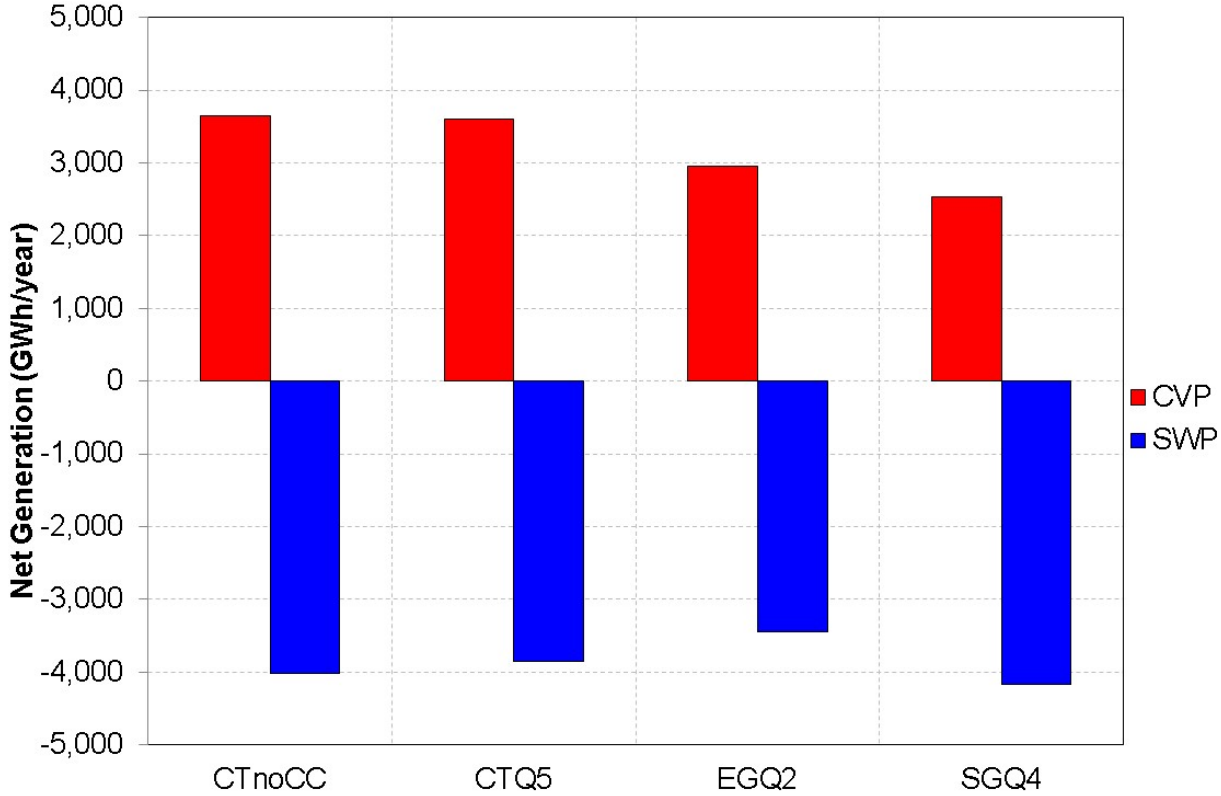
Key:
CVP = Central Valley Project
GWh = gigawatt hour
SWP = State Water Project

Figure 3-167. Change in Average Annual Net Energy Generation (GWh/year) for the CVP and SWP Systems with Representative Alternative



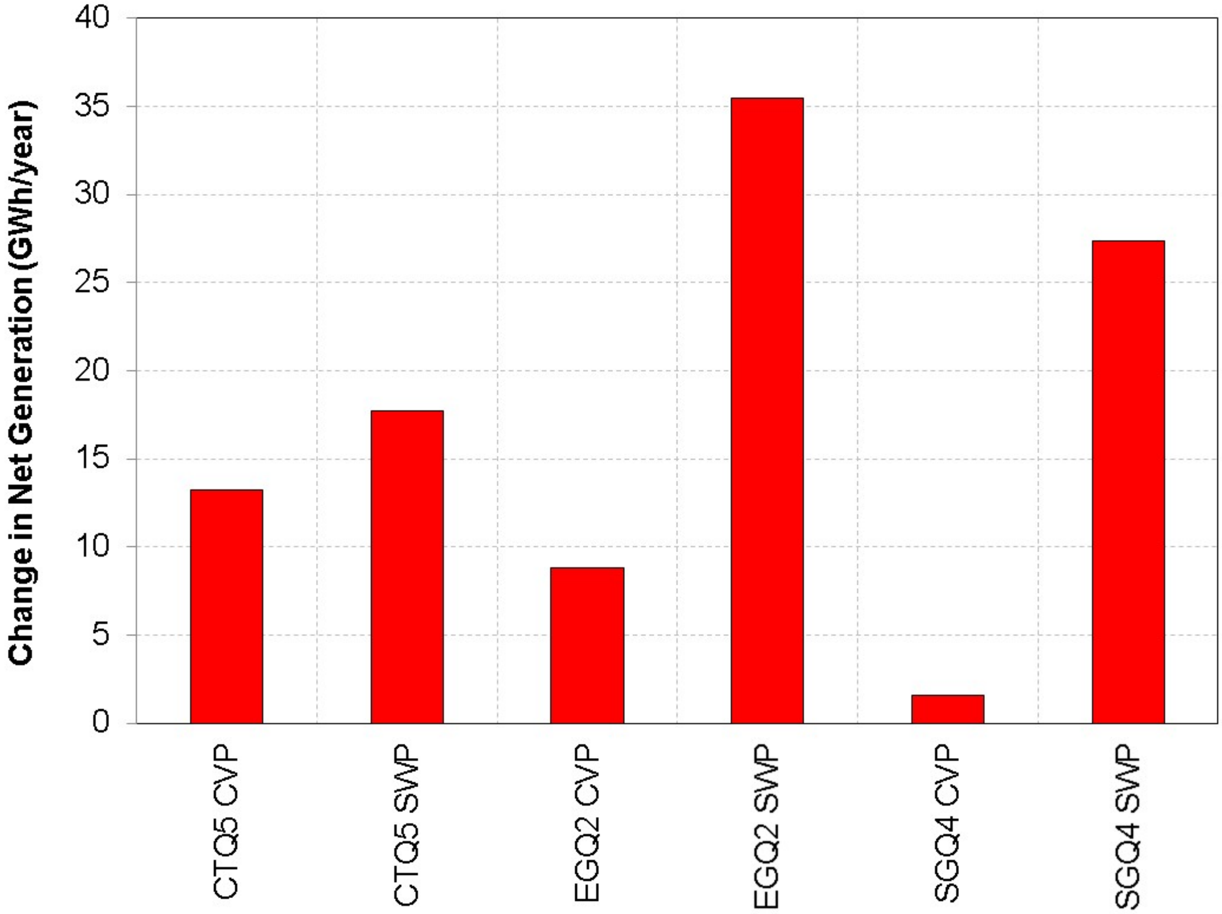
Key:
CVP = Central Valley Project
GHG = greenhouse gas
$mTCO_2e$ = metric tons of carbon dioxide equivalents
SWP = State Water Project

Figure 3-168. Change in Average Annual Net GHG Emissions ($mTCO_2e$/year) for the CVP and SWP Systems with Representative Alternative



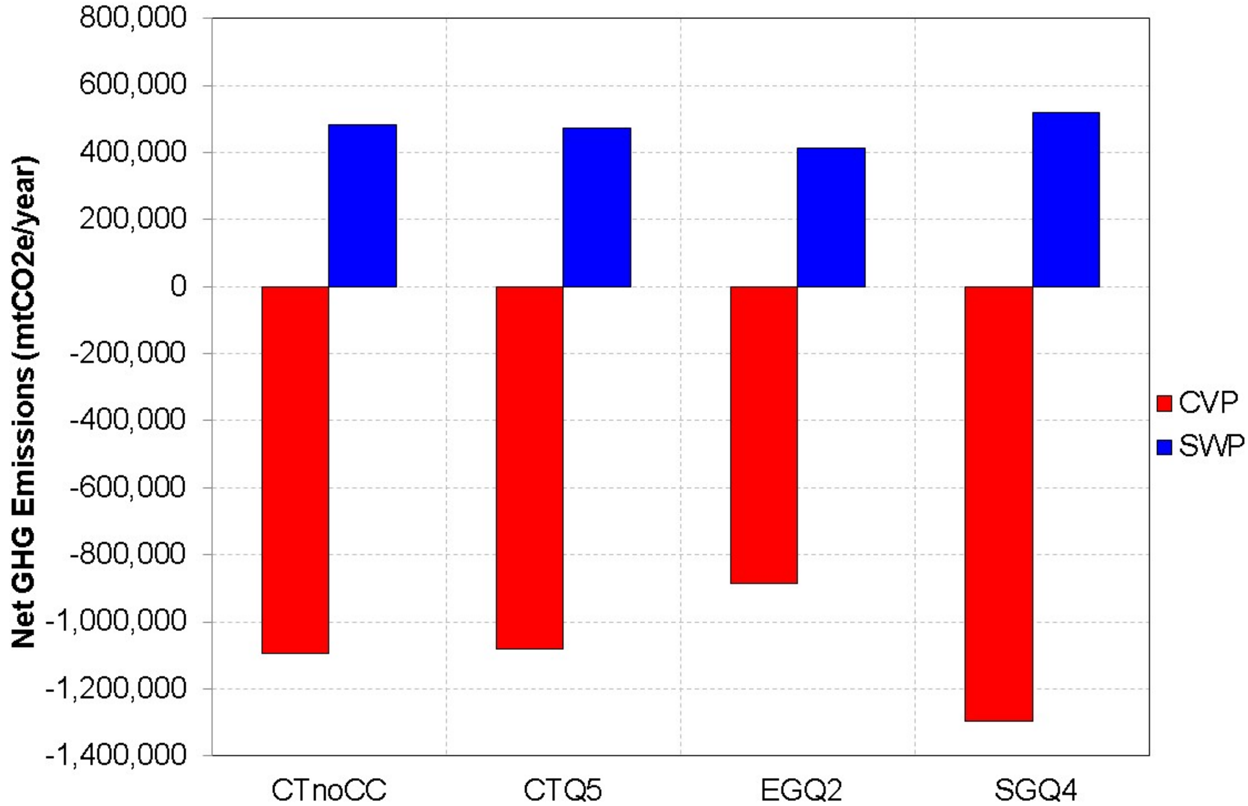
Key:
CTnoCC = central tendency-no climate change
CVP = Central Valley Project
GWh = gigawatt hour
SWP = State Water Project

Figure 3-166. Average Annual Net Energy Generation (GWh/year) for the CVP and SWP Systems Baseline



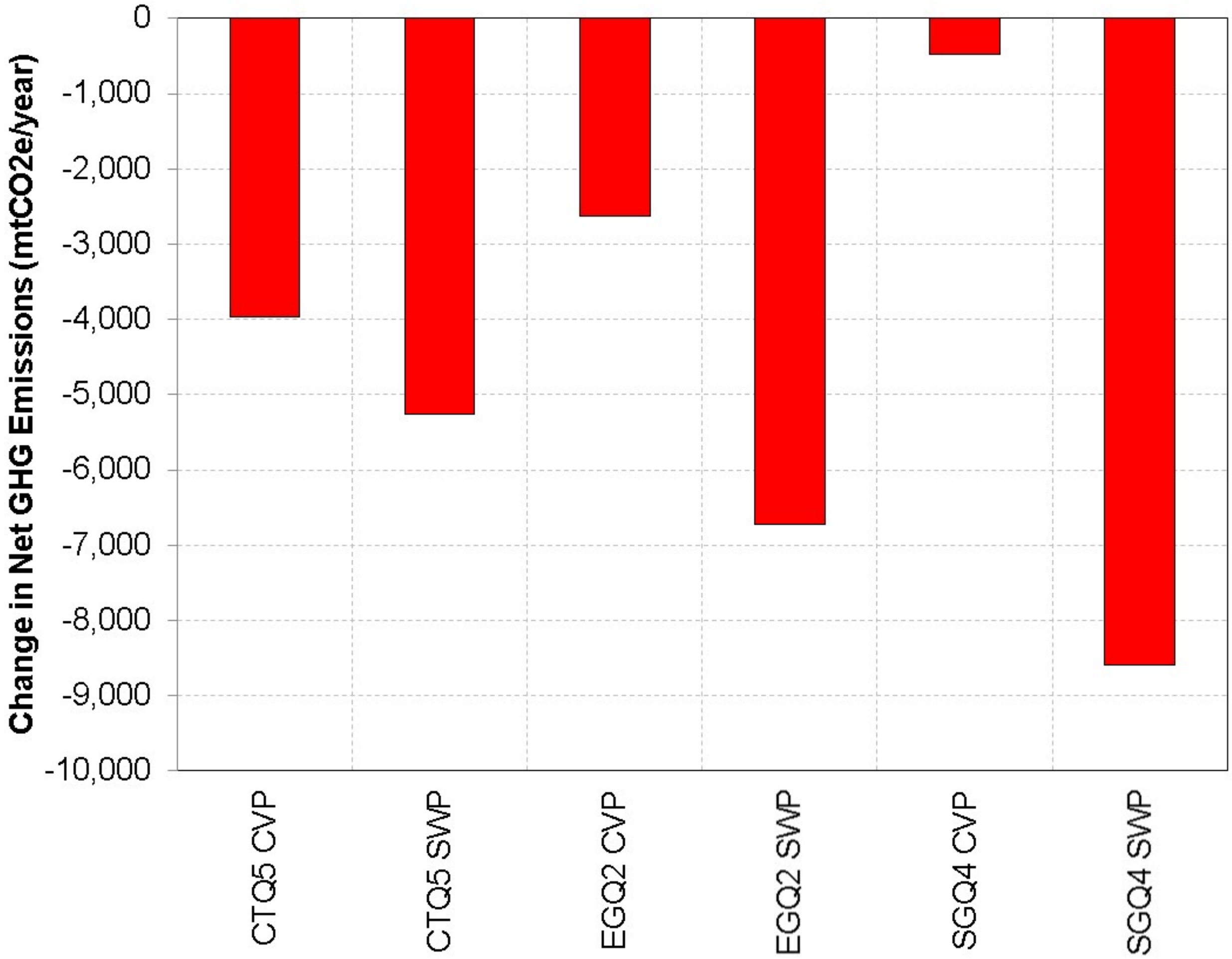
Key:
CVP = Central Valley Project
GWh = gigawatt hour
SWP = State Water Project
USJRBSI = Upper San Joaquin River Basin Storage Investigation

Figure 3-167. Change in Average Annual Net Energy Generation (GWh/year) for the CVP and SWP Systems with USJRBSI



Key:
CTnoCC = central tendency-no climate change
CVP = Central Valley Project
GHG = greenhouse gas
$mTCO_2e$ = metric tons of carbon dioxide equivalents
SWP = State Water Project

Figure 3-168. Average Annual Net GHG Emissions ($mTCO_2e$/year) for the CVP and SWP Systems Baseline



Key:
CVP = Central Valley Project
GHG = greenhouse gas
$mTCO_2e$ = metric tons of carbon dioxide equivalents
SWP = State Water Project
USJRBSI = Upper San Joaquin River Basin Storage Investigation

Figure 3-169. Change in Average Annual Net GHG Emissions ($mTCO_2e$/year) for the CVP and SWP Systems with USJRBSI

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Chapter 4
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