Common Response 8.1
Economic Analysis and Other Considerations

Introduction

This introduction provides important context to this common response. A similar introduction is provided in each common response to ensure that the reader has the appropriate context when reviewing common responses. For ease of reference, a table of contents is included after this introduction to guide readers to specific subject areas.

Protecting the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) watershed and its many beneficial uses of water is one of the State Water Resources Control Board's (State Water Board) primary responsibilities and top priorities. In response to declines of several native aquatic species since the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Watershed (Bay-Delta Plan or Plan) was last comprehensively updated, the State Water Board commenced a process to update the Bay-Delta Plan for the Sacramento River and its tributaries, Delta eastside tributaries (including the Calaveras, Cosumnes, and Mokelumne Rivers), and Delta for the reasonable protection of fish and wildlife beneficial uses, referred to as the Sacramento/Delta Update to the Bay-Delta Plan. The Bay-Delta Plan identifies beneficial uses of water to be protected in the Bay-Delta watershed, water quality objectives and program of implementation to achieve the reasonable protection of those beneficial uses, monitoring, evaluation, and special study provisions. The State Water Board's proposed action to update the Bay-Delta Plan is supported by a Staff Report/Substitute Environmental Document (Staff Report), which provides an evaluation of the environmental impacts and economic effects in support of consideration of different alternatives to update the Bay-Delta Plan to achieve reasonable protection of fish and wildlife beneficial uses in the Sacramento/Delta. The Staff Report is functionally equivalent to an Environmental Impact Report under the California Environmental Quality Act (CEQA) but also provides the additional analyses that support the State Water Board's consideration of the action under the Clean Water Act and Porter-Cologne Water Quality Control Act (Porter-Cologne Act or Porter-Cologne).

Development of the final Staff Report and final draft Bay-Delta Plan were informed by several opportunities for public comment over multiple years. This common response may address issues that were raised during any of those public comment periods. In September 2023, the State Water Board released the 2023 draft Staff Report evaluating different alternatives for the Sacramento/Delta Update to the Bay-Delta Plan for public review and comment. Following release of the 2023 draft Staff Report, the State Water Board released draft amendments to the Bay-Delta Plan in October 2024 (2024 draft Plan) for public review and comment that incorporated alternatives identified in the 2023 draft Staff Report with revisions based on public comments. The State Water Board released revised draft Plan updates in July 2025 (July 2025 revised draft Plan), but delayed public comment on that version of the Plan pending further updates, though some parties did submit public comments on the July 2025 draft that are part of the State Water Board's response to comments. In December 2025, the State Water Board released Chapter 13, *Revised Proposed Plan Amendments*, as a limited recirculation of the 2023 draft Staff Report (2025 partially recirculated draft Staff Report) together with the December 2025 revised draft Plan for public review and comment. These documents reflect the updated proposed project, referred to as the revised proposed Plan amendments, which brings together in the Bay-Delta Plan program of implementation a voluntary agreement (VA) pathway that incorporates commitments identified in the Healthy Rivers and Landscapes (HRL) proposal and would apply to specified HRL water rights, and a regulatory pathway based on the proposed Plan amendments that would apply to other water rights and to any HRL water rights no longer covered under the VA pathway. In August 2026, the State Water Board released a final draft Bay-Delta Plan that included refinements to the revised proposed Plan amendments based on public comments received on the December 2025 revised draft Plan. At the same time, the State Water Board released this final Staff Report, including responses to comments previously received on the draft Staff Report. The final Staff Report informs the State Water Board's consideration of adoption of the Sacramento/Delta updates to the Bay-Delta Plan.

With respect to the CEQA impact conclusions, it is important that they be understood in the context of the overall nature of the proposed project, which is intended to be an environmental restoration action. CEQA only considers changes that could negatively impact the existing environment and does not recognize or offset negative changes with improvements that could result from an environmentally beneficial project. Here, the impacts that could potentially result from implementation of the restoration action occur in a system that has been highly altered, and the project would be expected to improve conditions for native fish and wildlife in the Sacramento/Delta watershed over time. However, the project will also result in changes in hydrology and changes in water supply that could result in some potentially significant adverse environmental impacts at certain times and locations that must be analyzed under CEQA. These potentially significant environmental impacts should be viewed in light of the overall purpose and goals of the Sacramento/Delta update to the Bay-Delta Plan.

The State Water Board, through the Bay-Delta Plan, must consider designated beneficial uses of water and set water quality objectives and a program of implementation that ensure the reasonable protection of all water uses. The Plan addresses "water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area" (Wat. Code, § 13050, subd. (h).) The Bay-Delta Plan establishes flow-based water quality objectives and implementation requirements for municipal and industrial beneficial uses as maximum chloride levels, for agricultural beneficial uses as maximum salinity levels or electrical conductivity (EC), and for fish and wildlife beneficial uses as maximum dissolved oxygen and EC levels and minimum flows (see Common Response 1.2, *Water Quality Control Planning Process*, for more information regarding the consideration of beneficial uses).

Under the Porter-Cologne Act (Wat. Code, § 13000 et seq.), the State Water Board is required to consider several factors, including economic considerations, when establishing water quality objectives for the reasonable protection of beneficial uses from water quality degradation (Wat. Code, §§ 13050, subd. (f), 13241). This common response is intended to describe the economic analysis used to inform the State Water Board's consideration of potential economic effects related to the Sacramento/Delta update to the Bay-Delta Plan. This common response also responds to commenters' concerns regarding potential economic effects.

The State Water Board's consideration of economic effects is inherently challenging because individuals or groups have strongly held opinions on how water uses should be prioritized and may view alternative perspectives as unacceptable. Such perceptions are partly due to longstanding economic disputes and the use of economics analysis tools that focus on measuring private-sector profits and employment effects without considering broader societal values and tradeoffs (Sukhdev

2010). The State Water Board's task, however, is to consider all relevant issues addressed in the Staff Report and adopt Plan amendments after considering the Porter-Cologne Act factors.

The State Water Board reviewed and considered all comments related to the Staff Report's economic analysis and developed this common response to address recurring comments and common themes. In particular, this common response addresses, but is not limited to, the following topics.

- Overview and adequacy of the economic analyses
- Agricultural economic effects and the Statewide Agricultural Production (SWAP) model
- Regional economic effects and the IMPLAN model
- Municipal water supply economic effects
- Potential sources of funding for municipal water conservation and alternative water supplies
- Water transfers
- Economic effects from reduced revenue from hydropower production and water sales
- Changes in hydropower revenues

This common response references related common responses as appropriate where recurring comments and common comment themes overlap with other subject matter areas. For responses to comments concerning water supply and other water management actions, please see Common Response 6.3, *Water Supply and Other Water Management Actions*. For responses to comments concerning impacts to agriculture, please see Common Response 7.4, *Agricultural Resources*. For responses to comments concerning municipal water supply impacts, please see Common Response 7.20, *Utilities and Service Systems*. For responses to comments concerning impacts to energy, please see Common Response 7.8, *Energy and Hydropower*.

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Overview and Adequacy of Economic Analysis

The State Water Board's amendments to the Bay-Delta Plan are prepared in accordance with the water quality planning provisions of the Porter-Cologne Act, Water Code section 13000 et seq., and other applicable laws. As described in Chapter 8, *Economic Analysis and Other Considerations*, the need for economic analysis associated with State Water Board actions is required by two sections of the California Water Code.

Under the Porter-Cologne Act, the State Water Board is required to consider several factors, including economic considerations, when establishing water quality objectives for the reasonable protection of beneficial uses (Wat. Code, § 13241). The need for economic analysis associated with State Water Board actions is also required by Water Code section 13141, which states: "prior to implementation of any agricultural water quality control program, an estimate of the total cost of such a program, together with an identification of potential sources of financing, shall be indicated in any regional water quality control plan" (Wat. Code, § 13141).

Section 13241 of the Porter-Cologne Act identifies certain factors that must be considered when establishing water quality objectives. These factors include: (1) past, present, and probable future beneficial uses of water; (2) environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto; (3) water quality conditions that could reasonably be achieved through the coordinated control of all factors that affect water quality in the area; (4) economic considerations; (5) the need for developing housing within the region; and (6) the need to develop and use recycled water. The Staff Report discusses these factors with respect to the Sacramento/Delta updates to the Bay-Delta Plan, including the proposed objectives and program of implementation under the revised proposed Plan amendments articulated in Chapter 13, *Revised Proposed Plan Amendments*, of the Staff Report, and other project alternatives. These factors are an inherent part of the State Water Board's analyses to understand the impacts not only on the environment but also effects on beneficial uses, economics, and other important considerations like the human right to water.

The State Water Board adopts water quality control plans as part of a certified regulatory program under CEQA. A certified regulatory program is one that includes the protection of the environment among its principle purposes and that the Secretary of the Resources Agency has certified incorporates specific authorities, rules, and regulations for its plan or other written documentation. Following certification, the program is exempt from certain CEQA requirements, and the plan or other written documentation containing the environmental analysis, often referred to as a substitute environmental document (SED), may be submitted in lieu of a CEQA environmental impact report. (Pub. Resources Code, § 21080.5, subd. (b)(2); Cal. Code Regs., tit. 23, § 3775 et seq.) The exclusive procedural requirements for the State Water Board's certified regulatory program are found in the California Code of Regulations (tit. 23, § 3775) but the certified regulator program is also "subject to the broad policy goals and substantive standards of CEQA." (City of Arcadia v. State Water Resources Control Bd. (2006) 135 Cal.App.4th 1392, 1422; Cal. Code Regs., tit. 23, § 3720, subd. (c)(2).)

In addition to the State Water Board's implementing regulations, the Staff Report cites the State CEQA Guidelines where appropriate and relevant to help guide or inform the analysis consistent with CEQA's goals and standards. Under CEQA, economic and social changes are not treated as significant effects on the environment. However, physical changes to the environment as a result of economic and social changes may be significant. Economic and social changes also may be used to determine the significance of physical changes caused by the economic or social change. (Cal. Code Regs., tit. 14, § 15064, subd. (e).) In addition, because the environmental analysis is under the State Water Board's certified regulatory program, it also must take into account a reasonable range of environmental, economic, and technical factors (Cal. Code Regs., tit. 23, § 3777, subd. (c)).

The Staff Report analysis takes into account a reasonable range of environmental, economic, and technical factors associated with the reasonably foreseeable methods of compliance and other actions. Due to the size and complexity of Sacramento/Delta water supply and use, the environmental analyses are necessarily broad to cover the wide range of foreseeable compliance measures and response actions. The State Water Board is responsible for adopting and updating the Bay-Delta Plan, which establishes water quality control measures and flow requirements needed to provide reasonable protection of beneficial uses in the watershed. The revised proposed Plan amendments were developed to improve flow and water quality conditions over a large geographic area, and particularly for fish and wildlife beneficial uses in the Sacramento River watershed, Delta eastside tributaries, and Delta regions (Sacramento/Delta). The revised proposed Plan amendments are expected to improve watershed functions and to provide associated benefits to the aquatic ecosystem and biological resources within the tributaries in the Sacramento/Delta watershed, the Delta, and San Francisco Bay. (See Common Response 1.2, *Water Quality Control Planning Process,* for a discussion of reasonable protection of fish and wildlife beneficial uses and consideration of other beneficial uses.)

To organize the analyses, the *plan area* includes the Sacramento/Delta and continues west as water flows through the Delta and downstream through Suisun Marsh and adjoining bays, marking the brackish transition from freshwater to saltwater and the Pacific Ocean. The plan area encompasses the areas where the Bay-Delta Plan's flow and water quality objectives and implementation measures apply, and the ecosystem that the Bay-Delta Plan is intended to protect. Water from the Sacramento/Delta is used within the watershed and is also delivered to and used in other areas of the state. Therefore, a larger *study area* is defined to ensure that environmental and economic impacts, including to water supply for municipal and agricultural uses, are evaluated in all areas where impacts may occur. Maps that depict the plan area and study area are provided in Chapter 1, *Executive Summary*.

The State Water Board recognizes that providing instream flows for the environment necessarily results in less water available for other uses. Currently, the California Department of Water Resources' (DWR) State Water Project (SWP) and the U.S. Bureau of Reclamation's (Reclamation) Central Valley Project (CVP) (collectively, Projects) have primary responsibility for meeting Bay-Delta Plan objectives that apply to the Sacramento/Delta watershed, including existing Sacramento River inflow, Delta outflow, salinity, Project operational constraints, and other requirements. Under State Water Board Water Right Decision 1641 (D-1641), the State Water Board accepted various agreements between DWR and Reclamation and other water users to assume responsibility for meeting specified Bay-Delta Plan objectives for a period of time through conditions on DWR's and Reclamation's water rights for the SWP and CVP, respectively. Under the proposed Plan amendments described in Chapter 5, *Proposed Changes to the Bay-Delta Plan for the Sacramento/Delta*, and revised proposed Plan amendments described in Chapter 13, *Revised Proposed Plan Amendments*, under the proposed program of implementation, all water users on these tributaries, except for *de minimis* water users, would bear responsibility for contributing to achievement of the Bay-Delta Plan's objectives.

Changes in water supply that could occur as a result of the project are evaluated extensively throughout the Staff Report. Chapter 6, *Changes in Hydrology and Water Supply*, describes the changes in hydrology and water supply that could occur as a result of the Plan amendments. Section 9.5, *Changes in Hydrology and Water Supply*, describes the changes in hydrology and water supply that could occur as a result of the proposed VAs. Section 13.4, *Changes in Hydrology and Water Supply*, describes changes in hydrology and water supply that could occur as a result of the revised proposed Plan amendments. Chapter 6, Section 9.5, and Section 13.4 present Sacramento Water Allocation Model (SacWAM) results for changes in hydrology and Sacramento/Delta surface water supply. Only a portion of the total water supply to each study area geographic region may be affected by the Sacramento/Delta update to the Bay-Delta Plan; this portion is termed *Sacramento/Delta supply*. The estimates of reduced Sacramento/Delta supplies described in Chapter 6, Section 9.5, and Section 13.4 do not factor in all of the flexibility that water users have or could develop to continue to meet water supply needs with reductions of Sacramento/Delta surface water supplies, including other water supply and conservation. Chapter 6 also describes other water management actions, including groundwater storage and recovery, water transfers, water recycling, and conservation measures. See Common Response 6.3, *Water Supply and Other Water Management Actions*, for further discussion of Staff Report's analysis of water supply and other water management actions.

The environmental analyses utilize a quantitative and qualitative approach to compare the potential impacts to baseline conditions. For example, Sections 7.4, 9.7.4, and 13.7.4, each titled *Agriculture and Forest Resources*, describe the environmental setting, potential impacts, and mitigation measures for agriculture and forest resources impacts that may result from changes in hydrology or changes in water supply. The focus is on *conversion*, which means the permanent change in land use from an agricultural use to a nonagricultural use. Sections 7.20, 9.7.20, and 13.7.20, each titled *Utilities and Service Systems*, describe the environmental setting, potential impacts, and mitigation measures for utilities and service systems that may result from changes in hydrology and changes in water supply. These analyses consider municipal supply, including whether and how communities that rely in whole or in part on Sacramento/Delta supply would be able to meet municipal demand using other water management actions in response to changes in supply. Sections 7.8, 9.7.8, and 13.7.8, each titled *Energy*, describe the environmental setting, potential impacts, and mitigation measures for energy impacts that may result from changes in hydrology and changes in water supply. See Common Response 7.4, *Agricultural Resources*, for more information and responses to comments regarding the Staff Report's analysis of impacts to agriculture, Common Response 7.20, *Utilities and Service Systems*, for more information and responses to comments regarding the Staff Report's analysis of impacts of changes in supply to municipal use, and Common Response 7.8, *Energy and Hydropower*, for more information and responses to comments regarding the Staff Report's analysis of impacts to energy.

Chapter 8, Section 9.8, and Section 13.8, each titled *Economic Analysis and Other Considerations*, evaluate economic effects, including economic effects of reduced Sacramento/Delta supply to agricultural and municipal use. Subsequent sections of this common response provide detailed information about the analysis of agricultural water supply economic effects and municipal water supply economic effects presented in Chapter 8, Section 9.8, and Section 13.8.

In response to comments, Chapter 8, *Economic Analysis and Other Considerations*, has been updated to include new content, including Section 8.6, *Fisheries Economic Analysis*, that addresses potential economic benefits from implementation of the flow scenarios and subsequent aquatic ecosystem improvements and benefits for native fish species. Chapter 8 has also been revised to include additional and updated information on potential funding sources to support agricultural and municipal water conservation. Additional minor edits, including editorial changes and clarifying edits, have also been applied.

Water is a shared natural resource and all water within California is the property of the people of the state (Cal. Const. art. X, § 5; Wat. Code §102). Water has many different "beneficial uses," which are defined differently in the water rights context as opposed to the water quality context. For example, an agricultural beneficial use in the water rights context refers to what the water is being used for (i.e., irrigation) whereas an agricultural beneficial use in the water quality context refers to the water being of a quality suitable for that use (e.g., not too salty). In addition, depending on their unique economic perspective and personal beliefs, people or organizations may ascribe more or less societal value to consumptive versus non-consumptive beneficial uses. For example, some may prioritize maintaining or increasing diversions for municipal or agricultural development, whereas others may prioritize preserving and restoring instream flows for fisheries and highly value water for cultural, spiritual, recreational uses.

As applied to water policy, natural resources economics is a transdisciplinary field of research within economics that considers the connections and interdependence between human actions and economies and aquatic ecosystems. Because most natural resources are scarce, economic analysis informs the decisions by which resources are (or might be) allocated to achieve competing objectives. In other words, from an economic perspective, choosing to use a resource one way usually means choosing not to use it another way. Potential benefits lost by the choice to use a resource in one way rather than another are referred to as opportunity costs, and every choice that is made "costs" something, even if the best choice is made. In modern economic theory, price signals the relative scarcity of resources because when supplies of a resource are limited, its value tends to increase.

Some commenters asserted that the Staff Report's economic analysis is insufficient because it does not evaluate potential economic effects on individual water users. Some commenters also conflated the State Water Board's obligations of meeting CEQA requirements with its obligations under the Porter-Cologne Act. The Staff Report's analysis of environmental impacts and economic effects is appropriate for the large scope of the project and wide range of possible response actions. Section 7.1, *Introduction, Project Description, and Approach to Environmental Analysis*, describes the approach to the CEQA analysis and describes reasonably foreseeable methods of compliance and response actions. The environmental and economic analyses often consider a range of potential outcomes, including the most conservative for evaluating potentially significant effects on the physical environment and costs associated with potential changes in supply. In many cases, there may be no impact or effect. For each resource area, the analysis assumes a worst-case scenario. Some impacts and effects are inversely proportional, and it is not possible for a worst-case scenario to occur for every environmental resource area.

Due to the scope and complexity of Sacramento/Delta water use, the environmental analyses of the Staff Report are necessarily broad. Discussing the implications of the impacts at the level of detail that addresses each water user is beyond the scope of the analytical granularity provided in the Staff Report and would not change the overall impact conclusions. While changes in hydrology and supply could result in some environmental impacts at certain times and locations that must be analyzed under CEQA, these potential environmental impacts are viewed in light of the overall purpose and goals of the Sacramento/Delta update to the Bay-Delta Plan. While some mitigation activities are within the State Water Board's jurisdiction, other mitigation measures are largely within the jurisdiction and control of other agencies or depend on the response actions of water users to the project. Accordingly, the State Water Board cannot guarantee that measures will always be adopted or applied fully to mitigate potentially significant impacts. Therefore, unless and until the mitigation is fully implemented, some impacts remain potentially significant.

The Staff Report fully satisfies the basic purposes of CEQA, which are to: (1) inform governmental decision makers and the public about the potential significant environmental effects of proposed activities; (2) identify ways that environmental damage can be avoided or significantly reduced; (3) prevent significant, avoidable damage to the environment by requiring changes in projects through the use of alternatives or mitigation measures when the governmental agency finds the changes to be feasible; and (4) disclose to the public why a governmental agency approved the project in the manner the agency chose if significant environmental effects are involved. (Cal. Code Regs., tit. 14, § 15002, subd. (a).) To fulfill these functions, an evaluation of the environmental effects need not be exhaustive, but the sufficiency of an environmental analysis is to be reviewed in light of what is reasonably feasible and CEQA documents need not be perfect. CEQA documents should be adequate, complete, and represent a good faith effort at full disclosure. (Id., § 15151.) Please see Common Response 7.1, *General CEQA and Approach to the Analysis,* for a discussion of the level and scope of analysis, and approach to CEQA requirements.

For similar reasons, additional specificity on the economic effects is not required or possible for the economic considerations under Porter-Cologne. The economic analysis is sufficiently robust and at the appropriate scale for the purposes of the Sacramento/Delta update to the Bay-Delta Plan. Water Code section 13241 does not specify any particular manner for evaluating economics and courts have found that the approach to economic consideration is subject to agency discretion. (See City of Arcadia v. State Water Res. Control Bd., (2006) 135 Cal. App. 4th 1392, 1415 [consideration of economic factors need not consider every conceivable compliance method].) Here, cost of compliance is estimated within a reasonable range, in addition to a reasonable range of costs associated with response actions. A traditional cost-benefit analysis or specific analysis of individual water users is not required, nor would it be possible given the scope and complexity of Sacramento/Delta water use.

In addition, the model results presented in the Staff Report represent one way that the Plan could be implemented. However, as discussed in Common Response 6.1, *Sacramento Water Allocation Model and Changes in Hydrology and Water Supply*, and Chapter 5, *Proposed Changes to the Bay-Delta Plan for the Sacramento/Delta*, and Chapter 13, *Revised Proposed Plan Amendments*, there are alternative ways that the Plan could be implemented, which could result in reduced water supply impacts to water users. The assumptions used in SacWAM described in Common Response 6.1 represent a conservative, worst case scenario of Plan implementation. Actual implementation of the Plan would likely involve fewer and less severe actual impacts because the Plan allows for flexible implementation for water users.

In addition, the project is revised as described in Common Response 1.3, *Revised Proposed Plan Amendments*. In addition to the proposed Plan amendments, which remain part of the project as the regulatory pathway, the revised proposed Plan amendments include water supply adjustments to carryover storage requirements for existing water right holders to reduce water supply effects and allow more water to be stored in reservoirs at the outset of Plan implementation.

The analysis provided in the Staff Report is appropriately detailed for the scope of the project. The Staff Report's economic analysis appropriately considers economic considerations as required under section 13241 of the Porter-Cologne Act, and under CEQA, to the extent that economic impacts could result in potential significant impacts on the physical environment. The Staff Report's analysis of the environmental impacts and economic effects of the Plan amendments is supported by facts, relevant information, and reasonable assumptions based on such facts and information. The State Water Board acknowledges that there is more than one way to approach modeling and analysis and that there are many data sources available. The State Water Board is not obligated to conduct an exhaustive analysis using every approach, modeling tool, and data set available. The State Water Board recognizes that there may be differing opinions as to how to approach an analysis for a given resource or which data sets should be used, but these differing opinions do not equate to inadequacy. A commenter's disagreement with that analysis does not make the Staff Report inadequate. As discussed in this common response, the record contains substantial evidence to support the scope of analyses, assumptions, methods, and conclusions of the economic analysis.

Agricultural Economic Effects and the SWAP Model

The Staff Report evaluates potential agricultural economic effects that could result from reductions in Sacramento/Delta surface water supply. The analysis provides a reasonable estimate of these economic effects by incorporating historical data and observed grower responses to past water supply reductions. The analysis uses historical data, local and regional trends, water supply from different sources, and standard agricultural management practices to characterize how water is managed on agricultural lands. The analysis does not account for site-specific actions that individual growers may choose to take, nor does it quantify economic effects for specific individuals or entities.

As discussed in Sections 7.4, 9.7.4, and 13.7.4, each titled *Agriculture and Forest Resources*, the Sacramento/Delta update to the Bay-Delta Plan could result in surface water and groundwater supply reductions to agricultural users in the study area. Such reductions could lead to changes in distribution of crop types and acreage and conversion of important farmland to non-agricultural use, which could also result in agricultural economic effects. Sections 7.4 and 9.7.4 present the estimated changes in crop acreage for average and dry hydrologic conditions, and Section 13.7.4 references these results as appropriate.

In Sections 8.4 and 9.8.2, each titled *Agricultural Water Supply Economic Effects,* changes in crop revenue in the Sacramento/Delta and San Joaquin Valley are estimated using the SWAP model, for average and dry hydrologic conditions. The SWAP model is an economic decision model that estimates growers' responses to changes in water supply by determining the cropping pattern that maximizes the net returns to agricultural production. The output that is generated for each of the model runs includes cropping acreage by category of crops, total revenue, net revenue (profit), and amount of irrigation water used by source of supply. The output details are generated for each production region which, when combined geographically, provide totals for: (1) the Sacramento/Delta watershed; and (2) the San Joaquin Valley region. Additional details about the SWAP model and methods can be found in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*.

In Section 8.4, *Agricultural Water Supply Economic Effects,* changes in crop revenue in the Bay Area, Central Coast, and Southern California regions are estimated using the California Sub-Regional Agricultural Analysis (CASRAA) model. The CASRAA model uses an approach similar to that used by the SWAP model to determine cropping patterns and water use for average and dry hydrologic conditions. Additional details about the CASRAA model and methods can be found in Appendix A1a, Attachment A1a1, *California Subregional Agricultural Analysis (CASRAA)*.

Commenters raised various concerns regarding the SWAP model and the approach used to evaluate potential agricultural economic effects. This section addresses these concerns and provides additional information to support the use of the SWAP model to inform the analysis of agricultural economic effects. This section also presents supplemental SWAP modeling results for: (1) critically dry water years; and (2) water year 1977, intended to represent the last year of a multi-year drought.

Given the inherent uncertainties involved in modeling agricultural economic effects, the Staff Report uses a reasonable and conservative approach to evaluating the potential agricultural economic effects of the flow scenarios. SWAP is currently the best available tool for modeling agricultural economic responses to water supply shortage. It has been peer-reviewed and applied to numerous policy analyses and impact assessments over the last two decades (Reclamation 2012; ^Medellín-Azuara et al. 2016). SWAP is frequently used to estimate changes in California agricultural production due to changes in water resource availability. Please see Chapter 8, *Economic Analysis and Other Considerations*, and Appendix A3, *Agricultural Economic Effects: SWAP Methodology and Modeling Results,* of the Staff Report for a more detailed description of the SWAP model and methods used to estimate agricultural economic effects.

SWAP Overview

SWAP is a regional economic model of agricultural production in California's Central Valley. It estimates the cropping pattern that maximizes the profits to agricultural production subject to resource constraints, technical production relationships, and market conditions (Reclamation 2012). It incorporates information on the availability of water supplies, such as SWP and CVP deliveries, local surface water supplies, and groundwater within a production region in its analysis. Surface water supply reductions could affect agricultural production primarily as a result of crop substitution, deficit irrigation, or permanent fallowing of cropland. As conditions change within a production region, the model optimizes production by adjusting the crop mix, water sources and quantities used, and other inputs. SWAP estimates that land will be fallowed when that is the most cost-effective response to changes in resource conditions. Farmers are assumed to face competitive markets in which no single farmer can influence crop prices. This competitive market is simulated by maximizing the sum of consumer and producer surplus subject to production costs, market conditions, and available resources (Reclamation 2012). Constraints can be imposed to simulate restrictions on how much adjustment is possible or how fast an adjustment can realistically occur. Constraints were applied to the SWAP model runs for this analysis and are detailed in Appendix A3, *Agricultural Economic Effects: SWAP Methodology and Modeling Results*.

The SWAP model applied in this study is made up of 27 production regions: 10 in the Sacramento/Delta (the Sacramento River valley floor, Delta eastside tributaries, and Delta regions), and 17 in the San Joaquin Valley. The production region boundaries correspond to single units or groups of DWR's Detailed Analysis Units (DAUs) (DWR n.d.) with similar climate and water supply (e.g., depth to groundwater) conditions. SWAP provides information on changes in gross revenues, agricultural production, irrigated acreage, crop mix, and water use, in addition to other parameters. Primary SWAP model outputs include estimated changes in gross and net revenues associated with the flow scenarios.

The cost and availability of groundwater have an important effect on how SWAP responds to changes in surface water deliveries. The SWAP model calculates the total costs of groundwater pumping for each production region. Pumping costs are calculated by region and are based on depth to groundwater and power rates.

The evaluation of agricultural economic effects involves using changes in Sacramento/Delta supply results from SacWAM as inputs to SWAP. Estimates of changes in Sacramento/Delta supply to growers within the Sacramento/Delta are provided by SacWAM in sufficient detail that the output can be directly mapped into the SWAP production regions. SacWAM also provides estimates of the amounts of Sacramento/Delta water exported to the other regions, including the San Joaquin Valley, in larger aggregations based on conveyance facilities. Information from water contracts and water management plans was used to disaggregate these estimates to individual SWP and CVP contractor levels and smaller subareas for analysis purposes. In this way, changes in agricultural water deliveries, the use of water, and the crop acreage and crop mix in the other regions can be analyzed.

In the analysis presented in Section 8.4 and Section 9.8.2, each titled *Agricultural Water Supply Economic Effects*, changes in crop revenue in the Sacramento/Delta and San Joaquin Valley are estimated using SWAP, for average and dry hydrologic conditions. The SWAP model results presented in Sections 8.4 and 9.8.2 are referenced in Section 13.8.2, also titled *Agricultural Water Supply Economic Effects*, where appropriate and to provide additional regional context. For detailed description of SWAP and the modeling results, please see Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*.

Assumptions about Groundwater Pumping in SWAP

The SWAP analysis considers that groundwater could be used to offset reductions in Sacramento/Delta supply. Because of the uncertainties about groundwater availability and water users' response to Sacramento/Delta supply regarding groundwater pumping, two bookends or bounds were evaluated using SWAP: *maximum replacement groundwater pumping* and *no replacement groundwater pumping*. Some commenters asserted that these two bookends are unrealistic and may not accurately reflect the level of groundwater pumping that could occur with implementation of the flow objectives. Some commenters suggested that the "no replacement" scenario may overstate agricultural economic effects because it assumes no additional groundwater pumping beyond baseline levels, which they asserted does not reflect likely responses to reduced surface water supply particularly during future droughts. Other commenters noted that the "maximum replacement" scenario may be infeasible due to physical infrastructure limitations and requirements under the Sustainable Groundwater Management Act (SGMA) that may limit the ability for growers to replace reduced Sacramento/Delta surface water supply with groundwater.

As described above, SWAP is currently the best available tool for modeling agricultural economic responses to water supply shortage. The "no replacement" and "maximum replacement" groundwater pumping scenarios used in the Staff Report's analysis are not directives or recommendations for groundwater management in any basin, and neither bookend provides a prediction of likely future conditions. Rather, the groundwater bookends represent the lower and upper limits of replacement groundwater pumping that could result from individual water users' personal and professional decisions in response to reduced Sacramento/Delta surface water supply. Actual conditions would likely fall between these bounds, with water users likely increasing groundwater pumping to offset some surface water reductions, but not enough to fully replace lost supplies. As a result, assuming no replacement pumping may overestimate reductions in irrigated crop acreage and crop revenue, while assuming maximum replacement pumping may underestimate reductions in irrigated crop acreage and crop revenue. As discussed in Sections 7.4, *Agriculture and Forest Resources*, and 8.4, *Agricultural Water Supply Economic Effects*, the actual change would likely fall between these bookends, and the agricultural economic effects due to changes in Sacramento/Delta water supply to the Sacramento/Delta watershed and San Joaquin Valley would be expected to be captured by the range of SWAP modeling estimates.

Please see Common Response 7.4, *Agricultural Resources*, for additional discussion on the groundwater bookends and impacts to agriculture. Also see Common Response 7.12.2, *Groundwater and Sustainable Groundwater Management* Act*,* for additional discussion regarding the groundwater bookends, groundwater impact analysis, SGMA, and potential effects on regional groundwater conditions.

Assumptions about Deficit Irrigation

The SWAP model can be modified for specialized studies to apply assumptions regarding deficit irrigation, which is an important setting to model farming operation in dry conditions. As discussed in Section 7.4.2, *Environmental Setting,* deficit irrigation is a short-term irrigation management measure that involves reducing application of irrigation water at strategic times in the growth cycle to reduce consumptive use of water. Deficit irrigation will stress the crop but allow its survival, at the expense of production yield. Typically, it is performed when water supplies are low, particularly during droughts. It can minimize impacts of reduced water supply on crop yield by carefully timing irrigation at certain growth stages to ensure that a crop receives water when it is most important (Goldhamer et al. 2005).

For the Staff Report analysis and subsequent SWAP analysis results presented below, deficit irrigation is disabled in the average year model run but enabled in the dry year model runs. SWAP will select the use of deficit irrigation for crop acres only if it represents a profit-maximizing response to a water supply shortage or to high water costs. Allowable deficit irrigation levels were specified in SWAP for certain crops based on a literature review of crop tolerance for deficit irrigation, as shown in Table A3-13, *Ability of Crop Groups Used in SWAP to Accommodate Deficit Irrigation and Literature Reviewed* and A3-14, *Maximum Allowed Irrigation Deficit by Crop,* in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results.*

Assumptions about Baseline Cropping Patterns

Some commenters suggested that the SWAP model results are flawed because the modeling relies baseline land use data from 2010. Commenters asserted that land use data from 2010 may not reflect current cropping patterns or recent agricultural trends in the Central Valley, which include a decline in alfalfa acreage and an increase in acreage of almonds and other tree crops since 2010. These commenters suggested that more recent cropping pattern data should be used to provide a more accurate baseline for the SWAP analysis.

The Staff Report uses SWAP version 6.1, which is the most recent peer-reviewed and publicly available model version. The SWAP model uses DWR 2010 land use survey data as the baseline cropping patterns. The Staff Report acknowledges that cropping patterns have changed over time when compared to 2010; however, the DWR 2010 land use survey data is the best publicly available and validated dataset to estimate baseline cropping patterns at the geographic scale required for the

SWAP model. See Common Response 7.4, *Agricultural Resources*, for additional information regarding the DWR land use survey data for 2010 and the SWAP modeling.

SWAP Modeling and Other Water Management Actions

Multiple commenters asserted that the SWAP analysis overestimates agricultural economic effects because the analysis does not explicitly consider adaptive measures that growers may employ when water supplies are limited, such as changing the type of crops grown, irrigation efficiency improvements, water conservation, water recycling, water transfers, and groundwater storage and recovery. Some commenters assert the analysis likely overestimates agricultural revenue losses because it ignores these factors and does not account for the ability of agricultural systems to adapt over time.

While the SWAP analysis does not explicitly incorporate adaptive measures and other water management actions, these actions are appropriately considered in the analysis of potential agricultural economic effects. As discussed in Section 8.4, *Agricultural Water Supply Economic Effects*, the SWAP model allows for some efficiency improvements and deficit irrigation, but does not capture the full set of other water management actions that farmers may pursue in response to reduced water supplies. It would be speculative to make assumptions regarding how individual water users would respond because it will depend on many individual and collective decisions including, but not limited to, the unique water supply portfolios, financial resources available to the water users, condition of existing infrastructure, and the discrete actions of other local water users in response to reductions in surface water. This combination of factors reflects that the SWAP model results should be considered an indicator rather than predictor of the change in crop acreage and agricultural economic effects that could occur under the Plan amendments. Actual outcomes on crop acreage and revenue may vary to some degree from the model results. Widespread adoption of alternative water management strategies could reduce agricultural economic effects compared to those estimated by SWAP and presented in the Staff Report.

The Staff Report assumes that any reduction in irrigated acreage could result in permanent conversion of farmland to non-agricultural uses. Commenters contended that this assumption is overly simplistic and misleading, and that some irrigated lands are marginal or unsustainable for long-term agriculture and could be restored for ecological benefits. These commenters asserted that the environmental impacts and economic effects of land conversion may therefore be overstated.

As discussed in Section 7.4, *Agriculture and Forest Resources*, the Staff Report uses a conservative threshold of significance related to land conversion by assuming any reduction in irrigated crop acreage would result in permanent conversion to nonagricultural use, resulting in a potentially significant impact. The section further states that actual conversion relies upon many factors that cannot be modeled, including individual decisions and preferences, local land use planning or zoning, and regional market demand for non-agricultural land uses. As such, the analysis likely overstates the amount of farmland converted to non-farming use. Please see Common Response 7.4, *Agricultural Resources*, for more information about agricultural land fallowing/idling and land conversion.

In addition, Section 8.4, *Agricultural Water Supply Economic Effects*, acknowledges that in response to reductions in Sacramento/Delta supply, individual water users may choose to increase groundwater pumping, where available and not locally restricted. Water users could also choose to plant lower-water-use crops, engage in deficit irrigation, or fallow land. Other water management actions could also be used to offset surface water supply reductions, such as water conservation, groundwater storage and recovery, water transfers, and use of recycled water. Where feasible, these other supply options could reduce the agricultural economic effects of changes in Sacramento/Delta water supplies.

One commenter was critical of the assumption in the Staff Report that all irrigated agriculture is important farmland, and noted that some lands have qualities (e.g., poor drainage, flood-prone, soil deficiencies) that make them less suitable for irrigation. In practice, when water supplies are limited, farmers typically remove the least productive or least profitable parcels from irrigation first, which is consistent with the SWAP modeling approach. Therefore, the Staff Report's analysis is consistent with commenter's concern, and changes to the Staff Report's analysis are not warranted.

Supplemental SWAP Modeling for Critically Dry Water Years and Multi-Year Drought

Several commenters asserted that the SWAP analysis presented in the Staff Report underestimates or misrepresents the potential agricultural economic effects of the flow scenarios because the SWAP analysis presented in Section 7.4, *Agriculture and Forest Resources*, and Chapter 8, *Economic Analysis and Other Considerations*, does not model specifically for critically dry water year types or multi-year drought conditions. Commenters asserted that Sacramento/Delta water supplies to agriculture would be more limited during critically dry water years and multi-year droughts than those assumed for the SWAP average and dry year model results presented in the Staff Report, and that the Staff Report therefore underestimates agricultural economic effects.

The Staff Report acknowledges that changes in Sacramento/Delta supply could result in agricultural water supply economic effects. The Staff Report notes that impacts to agricultural production and associated agricultural economic effects in any particular year may be greater or less than the SWAP average year or dry year model results. However, because several commenters requested additional information regarding effects during critically dry water years and multi-year drought conditions, this section presents the results of supplemental SWAP model analyses for: (1) critically dry water years; and (2) the driest water year (1977) intended to represent the last year of a multi-year drought. Results for changes in crop revenues are presented below, and results for the corresponding changes in crop acreages are presented in Common Response 7.4, *Agricultural Resources*. The modeling approach for these supplemental runs is the same as the approach used for the SWAP dry year model runs as described in detail in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*, except that Sacramento/Delta surface water deliveries were less, reflecting that Sacramento/Delta water supplies were more limited than those available under the SWAP dry year model run. Consistent with the SWAP analyses presented in the 2023 draft Staff Report, SacWAM version 2023.06.12 was used to obtain water deliveries for the supplemental model runs, ensuring comparability with other SWAP analyses for average and dry conditions. SWAP model version 6.1 was used for these supplemental model runs.

Both supplemental SWAP model analyses were completed for the no groundwater replacement pumping condition to capture the worst-case scenario for agricultural impacts and agricultural economic effects. For no replacement groundwater pumping, it was assumed that groundwater would not be available to replace reductions in surface water availability beyond current use under the baseline condition. This approach is appropriate given commenters' assertions that the SWAP model may underestimate reductions in crop acreage and crop revenue under the flow scenarios. However, it is uncertain how all water users may respond to reduced Sacramento/Delta supply regarding groundwater pumping. If groundwater replacement pumping by farmers and ranchers is assumed, more water would be available for agricultural uses which would reduce the associated effects on crop acreage and crop revenues. Therefore, reductions in crop acreage and crop revenues would be less than those presented below if it is assumed that growers could use groundwater in addition to local water supplies to offset some or all Sacramento/Delta supply reductions.

Both supplemental SWAP model analyses allow for deficit irrigation. By allowing deficit irrigation in those model runs, SWAP implicitly accounts for agricultural responses to very dry conditions such as critically dry years and multi-year drought. Under reduced surface water availability, farmers may choose to deficit-irrigate, shift to lower water-using crops, or fallow lower-profitability land. In some cases, deficit irrigation is more economical than increased groundwater pumping or additional land fallowing.

Overall, these supplemental SWAP results are provided for transparency and in response to commenters' requests for additional information regarding changes in agricultural production that could occur as a result of the flow scenarios during critically dry water years and during drought. However, the Staff Report already identifies potentially significant impacts to agriculture and identifies adverse agricultural economic effects. These additional analyses are consistent with the analyses already presented in the Staff Report, and do not change the Staff Report's conclusions that reductions in Sacramento/Delta supply to agriculture could result in agricultural water supply economic effects. This conclusion is unchanged by the supplemental analyses.

Supplemental SWAP Modeling for Critically Dry Water Year Type

This section presents the results of the supplemental SWAP analysis for critically dry water years. For these SWAP model runs, critically dry water year deliveries were estimated as the average deliveries for critically dry years only.

Table CR 8.1-1 presents the SWAP estimated agricultural crop revenues in the Sacramento/Delta for the baseline and each flow scenario for critically dry years, with no replacement groundwater pumping. Figure CR 8.1-1 presents the corresponding change in revenue compared to baseline by crop category. Similar to the SWAP model results presented in Chapter 8, *Economic Analysis and Other Considerations*, for the average year and dry year model runs, the results indicate that crop revenues would generally decrease with increasing flow scenarios. Based on the SWAP critically dry water year results, the estimated overall revenue for the Sacramento/Delta could be 6.3 percent lower than baseline under the 55 scenario. To contrast, the SWAP results presented in Chapter 8 for the 55 scenario estimate that the overall revenue for the Sacramento/Delta watershed could be 2.5 percent lower than baseline for the average year model run (see Table 8.4-4 in the Staff Report), or 4.7 percent lower than baseline for the dry year model run (see Table 8.4-6 in Staff Report). However, the SWAP results also show that the baseline crop revenue in the Sacramento/Delta watershed is lower for the critically dry year model run (approximately $9.2 billion) compared to the dry year model run (approximately $9.3 billion) and average year model run (approximately $9.4 billion), which indicates that water supplies limit crop production and revenue during critically dry water years under existing conditions, even absent the Plan amendments. The results presented below in Figure CR 8.1-1 for the critically dry year model runs also show that a large portion of the reduction in Sacramento/Delta crop revenues would be associated with a decline in the production of rice, followed by declines in production of alfalfa and pasture, and almonds and pistachios. Other crops could also experience a decrease in revenue, but to a lesser extent.

Table CR 8.1-2 presents the SWAP estimated agricultural crop revenues in the San Joaquin Valley for the baseline and each flow scenario for a critically dry water year, with no replacement groundwater pumping. Figure CR 8.1-2 presents the corresponding change in revenue compared to baseline by crop category. Similar to the SWAP model results presented in Chapter 8, *Economic Analysis and Other Considerations*, for the average year and dry year model runs, these results indicate that crop revenues would generally decrease with increasing flow scenarios. Based on SWAP critically dry water year results, the estimated overall revenue for the San Joaquin Valley could be 1.4 percent lower than baseline under the 55 scenario in critically dry years. To contrast, the SWAP results presented in Chapter 8 for the 55 scenario estimate that the overall revenue for the San Joaquin Valley could be 1.2 percent lower than baseline for the average year model run (see Table 8.4-9 in the Staff Report), or 1.9 percent lower than baseline for the dry year model run (see Table 8.4-11 in the Staff Report). However, the SWAP results also show that the baseline crop revenue in the San Joaquin Valley is lower for the critical year model run (approximately $24.4 billion) compared to the dry year model run (approximately $24.9 billion) and average year model run (approximately $25.4 billion), which indicates that water supplies limit crop production during critically dry water years under existing conditions, even absent the Plan amendments. The results presented below in Figure CR 8.1-2 for the critically dry year model runs show that for the lower flow scenarios, revenue reductions occur to several crops such as cotton, almonds and pistachios, alfalfa and pasture, and corn and other silage. At higher flow scenarios, larger revenue reductions also occur to additional crops such as cotton and processing tomatoes. Deficit irrigation also factors into the results, as the model indicates that reducing irrigation volume on some crops may be preferable, despite the yield and revenue decrement, to shifting to lower water-using crops or fallowing.

Overall, the SWAP results for the critically dry year model runs show that the percent reductions in crop revenue under the flow scenarios would be similar to those indicated by the SWAP dry year model runs, and the types of crops that would be most affected would be similar to those identified in Section 7.4, *Agriculture and Forest Resources*, and in Chapter 8, *Economic Analysis and Other Considerations*. However, SWAP also incorporates a baseline crop revenue that is lower under the critically dry year model runs compared to the dry and average year model runs, which reflects the limited availability of agricultural water supplies during critically dry years under existing conditions. Although Sacramento/Delta surface water supplies would be reduced under the flow scenarios, water users already experience limited agricultural water supplies during critically dry years that are not attributed to the flow scenarios.

Table CR 8.1-1. Critically Dry Year: Crop Revenue in the Sacramento/Delta, SWAP Model Analysis, No Replacement Groundwater Pumping ($)[a]

Crop Group	Baseline	35	45	55	65	75
Deciduous Orchards	3,616,937,500	3,592,667,100	3,585,912,700	3,575,204,600	3,564,154,300	3,554,439,200
Rice	1,464,607,000	1,260,976,200	1,217,797,900	1,137,591,300	1,045,936,000	824,328,800
Almonds & Pistachios	898,108,500	851,348,100	842,574,500	832,636,900	821,257,500	814,168,600
Vine	919,002,200	917,270,100	916,986,600	916,665,300	916,146,600	915,849,800
Vegetables	782,217,000	767,161,300	766,431,100	765,411,400	763,576,100	762,120,700
Alfalfa & Pasture	518,160,300	473,447,500	460,030,000	439,459,300	409,658,400	392,710,000
Corn and All Silage	433,256,300	420,482,500	419,292,200	417,375,400	413,567,600	406,999,700
Processing Tomatoes	372,124,500	349,538,500	348,351,700	346,862,300	343,129,800	339,475,600
Wheat & Field Crops	196,704,100	188,745,000	188,460,300	187,863,200	185,889,400	181,225,100
Cotton	10,521,500	10,202,000	10,166,800	10,125,700	10,091,800	10,068,600
TOTAL	9,211,638,700	8,831,838,100	8,756,003,800	8,629,195,400	8,473,407,500	8,201,386,300
Change from Baseline		-4.1%	-4.9%	-6.3%	-8.0%	-11.0%

[a] SWAP model crop revenue estimates for a critically dry year by crop group for baseline and each flow scenario under no replacement groundwater conditions.

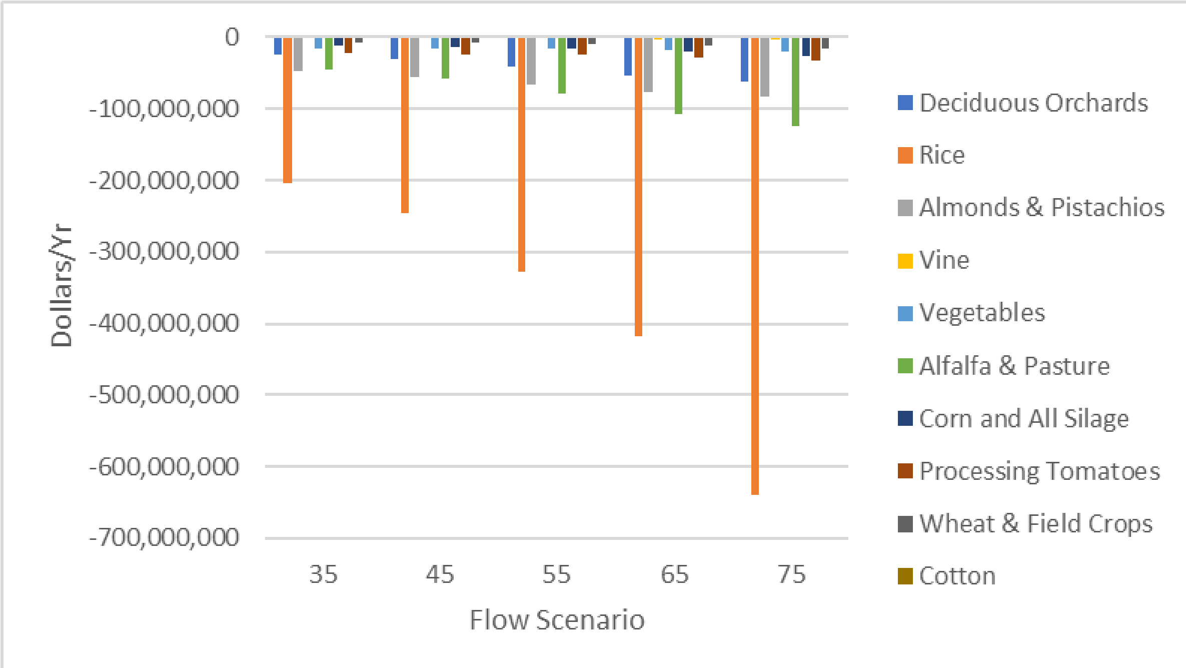

Figure CR 8.1-1. Changes in Crop Revenue, Sacramento/Delta, SWAP Model Analysis, Critically Dry Year, No Replacement Groundwater Pumping

Table CR 8.1-2. Critically Dry Year: Crop Revenue in the San Joaquin Valley, SWAP Model Analysis, No Replacement Groundwater Pumping ($)[a]

Crop Group	Baseline	35	45	55	65	75
Deciduous Orchards	7,757,180,600	7,756,122,700	7,748,099,200	7,733,907,200	7,713,679,900	7,690,678,700
Almonds & Pistachios	5,749,386,400	5,747,096,800	5,725,222,200	5,684,622,800	5,645,489,100	5,602,237,900
Vine	3,340,681,500	3,340,103,600	3,335,121,400	3,325,457,900	3,310,077,500	3,288,868,500
Vegetables	2,413,285,600	2,412,628,500	2,402,692,500	2,378,970,900	2,359,072,600	2,347,007,600
Corn and All Silage	1,765,024,800	1,764,573,500	1,760,689,800	1,752,467,800	1,738,141,300	1,713,002,700
Alfalfa & Pasture	1,361,306,400	1,360,600,200	1,354,908,300	1,343,025,700	1,321,965,200	1,298,451,800
Cotton	849,282,200	853,787,600	789,497,000	751,524,700	750,078,200	747,716,300
Processing Tomatoes	762,660,000	763,832,200	759,116,600	723,465,200	616,406,300	506,992,500
Wheat & Field Crops	370,298,100	370,553,100	367,417,800	337,294,400	286,874,000	284,788,900
Rice	25,521,300	25,521,200	25,516,400	25,497,100	25,451,600	25,421,700
TOTAL	24,394,627,000	24,394,819,300	24,268,281,100	24,056,233,700	23,767,235,800	23,505,166,600
Change from Baseline		0.0%	-0.5%	-1.4%	-2.6%	-3.6%

[a] SWAP model crop revenue estimates for a critically dry year by crop group for baseline and each flow scenario under no replacement groundwater conditions.

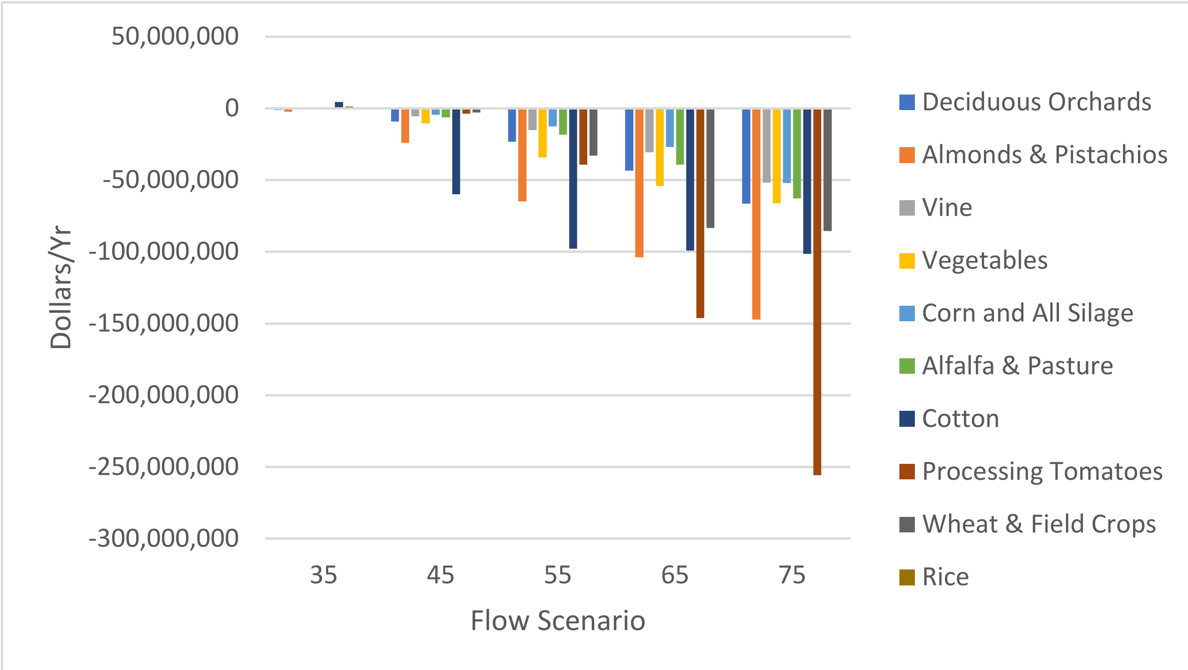

Figure CR 8.1-2. Changes in Crop Revenue, San Joaquin Valley, SWAP Model Analysis, Critically Dry Year, No Replacement Groundwater Pumping

Multi-Year Drought and Supplemental SWAP Modeling for Water Year 1977

Several commenters noted that historical drought sequences (e.g., 2020–2022, 2013–2015, 1987–1992) demonstrate that consecutive critically dry years can lead to extended land fallowing, groundwater depletion, and regional economic disruption. Some commenters contended that the Staff Report should include an assessment of the effects of the flow scenarios and prolonged drought on agricultural production.

SWAP is structured as an annual model that estimates the profit-maximizing response to changes in resource availability, crop market conditions, or other factors. As such, SWAP is not designed to evaluate the cumulative effects of multi-year conditions such as prolonged droughts on agricultural production. This is a limitation of available crop modeling tools that is not unique to SWAP. Commenters have not provided suggestions for an alternative model or specific recommendations on how SWAP could be used to assess agricultural economic effects under multi-year drought conditions.

While SWAP does not specifically model multi-year droughts, the SWAP analysis in the 2023 draft Staff Report does account for the effect of multi-year drought on surface water supply and delivery through the integrated use of output from SacWAM as input to SWAP. SacWAM simulates continuous hydrology over a 93-year period (1923–2015), which includes numerous multi-year drought sequences in the in the Sacramento/Delta. SacWAM output of water deliveries is used as input to SWAP, meaning that SWAP inherently reflects the effects of multi-year drought conditions through SacWAM's hydrologic sequences.

As discussed in Common Response 4.2, *Drought and Climate Change*, between 1923 and 2021, a "dry" and "critical" year sequence was experienced from 2020 to 2021, three very dry consecutive years were experienced between 2013-2015, and three other drought periods occurred from 1929-1934, 1976-1977, and 1987-1992. By including these periods in SacWAM, the Staff Report considers associated impacts from multi-year droughts within its analysis. This modeling approach allows stress on water supply to build across consecutive dry or critically dry years and revealing effects that single-year models cannot. By preserving hydrologic sequences, SacWAM also reflects delayed recovery in surface supply after drought, demonstrating that storage and allocations do not immediately rebound even when hydrologic conditions improve. As a result, the framework captures both the severity of individual drought years and the accumulated hydrologic and operational stresses from persistent drought conditions. See Common Response 4.2 for further discussion on SacWAM and multi-year droughts.

To further illustrate that the Staff Report has adequately accounted for the effects of multi-year drought, a supplemental SWAP analysis was conducted using SacWAM output for water year 1977. Water year 1977 was chosen for this supplemental SWAP analysis because it was the driest year in the SacWAM period and part of the severe 1976–1977 drought. In addition, because SacWAM accounts for prior-year hydrologic conditions, water deliveries in water year 1977 reflect cumulative stress on water supply from drought conditions in the preceding water year (1976). Results are first presented for the Sacramento/Delta watershed, followed by results for the San Joaquin Valley.

Table CR 8.1-3 presents the SWAP estimated agricultural crop revenues in the Sacramento/Delta for baseline and each flow scenario for water year 1977, with no replacement groundwater pumping. Figure CR 8.1-3 presents the corresponding change in revenue compared to baseline by crop category. Similar to the SWAP model results presented in Section 8.4, *Agricultural Water Supply Economic Effects*, for the average year and dry year model runs, the results indicate that crop revenues would generally decrease with increasing flow scenarios. For water year 1977, the estimated overall revenue for the Sacramento/Delta watershed would be 6.1 percent lower than baseline under the 55 scenario. To contrast, the SWAP results presented in Section 8.4 for the 55 scenario show that the overall revenue for the Sacramento/Delta watershed would be 2.5 percent lower than baseline for the average year model run (see Table 8.4-4 in the Staff Report), or 4.7 percent lower than baseline for the dry year model run (see Table 8.4-6 in Staff Report). However, the SWAP results also show that the baseline crop revenue in the Sacramento/Delta watershed is lower for the 1977 model run (approximately $8.9 billion) compared to the dry year model run (approximately $9.3 billion) and average year model run (approximately $9.4 billion), which indicates that water supplies limit crop production and revenue during very dry water years under existing conditions, even absent the Plan amendments. The results presented below in Figure CR 8.1-3 also show that a large portion of the reduction in crop revenues is associated with a decline in the production of rice. Other crops such as alfalfa and pasture and almonds and pistachios may also experience a decrease in revenue, but to a lesser extent.

Table CR 8.1-4 presents the SWAP estimated agricultural crop revenues in the San Joaquin Valley for the baseline and each flow scenario for water year 1977, with no replacement groundwater pumping. Figure CR 8.1-4 presents the corresponding change in revenue compared to baseline by crop category. Similar to the SWAP model results presented in Section 8.4, *Agricultural Water Supply Economic Effects*, for the average year and dry year model runs, the results indicate that crop revenues would generally decrease with increasing flow scenarios. However, the reduction in crop revenues would be much greater under the 65 and 75 scenarios compared to the 35, 45, and 55 scenarios for water year 1977. The estimated overall revenue for the San Joaquin Valley could be less than 0.1 percent lower than baseline under the 55 scenario. To contrast, the SWAP results presented in Section 8.4 for the 55 scenario show that the overall revenue for the San Joaquin Valley could be 1.2 percent lower than baseline for the average year model run (see Table 8.4-9 in the Staff Report), or 1.9 percent lower than baseline for the dry year model run (see Table 8.4-11 in the Staff Report). However, the SWAP results also show that the baseline crop revenue in the San Joaquin Valley is lower for water year 1977 (approximately $23.7 billion) compared to the dry year model run (approximately $24.9 billion) and average year model run (approximately $25.4 billion), which reflects that water supplies already limit crop production and revenue during very dry water years under existing conditions, even absent the Plan amendments. The results presented below in Figure CR 8.1-4 for water year 1977 model run show that revenue reductions could occur to several crops, and are estimated to be largest for processing tomatoes and almonds and pistachios, particularly under the highest flow scenarios.

Overall, the SWAP results for water year 1977 (the driest water year model run) show that the percent reduction in crop revenue under the flow scenarios would be similar to or less than those from the SWAP dry year model run, and the types of crops that would be most affected would be similar to those identified in Sections 7.4, *Agriculture and Forest Resources*, and 8.4, *Agricultural Water Supply Economic Effects*. These additional results do not change the Staff Report's conclusions on agricultural economic effects.

Table CR 8.1-3. Water Year 1977: Crop Revenue in the Sacramento/Delta, SWAP Model Analysis, No Replacement Groundwater Pumping ($)[a]

Crop Group	Baseline	35	45	55	65	75
Deciduous Orchards	3,578,808,300	3,556,678,800	3,554,219,100	3,552,535,900	3,548,449,000	3,545,541,500
Rice	1,320,385,300	1,029,103,600	1,023,724,800	962,810,900	961,108,400	946,347,500
Almonds & Pistachios	852,059,300	822,008,500	819,960,000	817,080,200	810,256,400	806,945,500
Vine	917,296,700	916,493,700	916,368,700	916,146,700	914,349,700	913,892,200
Vegetables	777,816,800	764,249,100	763,627,600	763,090,500	762,244,100	761,501,800
Alfalfa & Pasture	457,335,000	417,440,600	412,578,100	400,922,600	398,753,600	395,954,100
Corn and All Silage	427,082,500	411,882,700	410,882,500	409,254,800	407,765,200	405,984,300
Processing Tomatoes	361,585,100	344,603,200	342,889,800	341,938,500	340,182,900	338,098,600
Wheat & Field Crops	194,906,700	186,614,700	185,601,100	184,976,300	180,372,000	179,438,400
Cotton	10,349,200	10,090,400	10,090,900	10,081,300	10,069,400	10,066,800
TOTAL	8,897,624,900	8,459,165,300	8,439,942,600	8,358,837,900	8,333,550,800	8,303,770,700
Change from Baseline		-4.9%	-5.1%	-6.1%	-6.3%	-6.7%

[a] SWAP model crop revenue estimates for a critically dry year by crop group for baseline and each flow scenario under no replacement groundwater conditions.

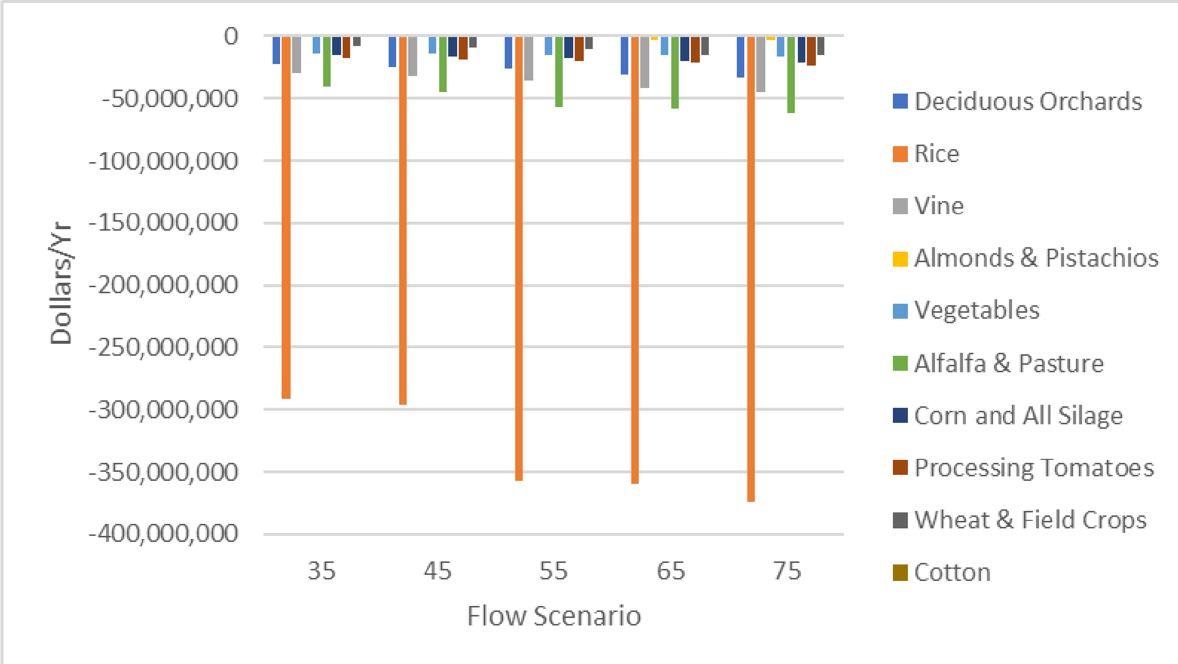

Figure CR 8.1-3. Changes in Crop Revenue, Sacramento/Delta, SWAP Model Analysis, Water Year 1977, No Replacement Groundwater Pumping

Table CR 8.1-4. Water Year 1977: Crop Revenue in the San Joaquin Valley, SWAP Model Analysis, No Replacement Groundwater Pumping ($)[a]

Crop Group	Baseline	35	45	55	65	75
Deciduous Orchards	7,692,277,100	7,688,580,200	7,691,733,100	7,691,458,400	7,687,418,000	7,675,343,900
Almonds & Pistachios	5,622,381,900	5,604,605,000	5,620,239,000	5,618,592,200	5,597,212,900	5,530,203,300
Vine	3,292,427,900	3,288,514,500	3,291,831,900	3,291,556,600	3,287,900,600	3,275,154,500
Vegetables	2,352,308,200	2,347,317,400	2,351,985,600	2,351,321,000	2,341,425,900	2,317,070,200
Corn and All Silage	1,702,764,600	1,701,901,100	1,702,605,200	1,702,691,100	1,696,762,200	1,672,822,300
Alfalfa & Pasture	1,275,955,300	1,280,052,100	1,278,217,200	1,279,586,000	1,267,106,200	1,239,801,000
Cotton	747,789,500	747,225,800	747,693,400	747,686,300	746,707,700	741,710,500
Processing Tomatoes	707,083,100	686,777,600	707,292,000	704,011,600	595,653,000	483,429,900
Wheat & Field Crops	281,574,500	281,531,500	281,561,400	281,592,800	280,033,000	273,986,800
Rice	24,966,400	24,989,400	24,970,200	24,976,700	24,718,200	17,623,000
TOTAL	23,699,528,500	23,651,494,700	23,698,129,100	23,693,472,900	23,524,937,500	23,227,145,400
Change from Baseline		-0.2%	0.0%	0.0%	-0.7%	-2.0%

[a] SWAP model crop revenue estimates for a critically dry year by crop group for baseline and each flow scenario under no replacement groundwater conditions.

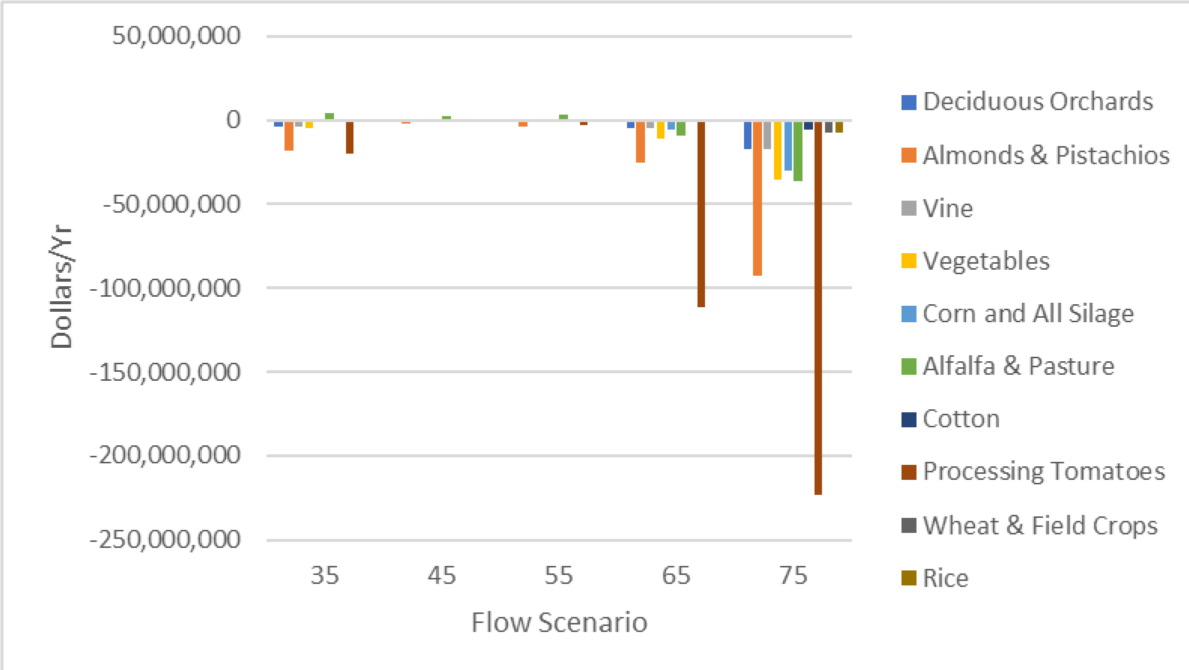

Figure CR 8.1-4. Changes in Crop Revenue, San Joaquin Valley, SWAP Model Analysis, Water Year 1977, No Replacement Groundwater Pumping

Summary of Supplemental SWAP Results

Table CR 8.1-5 and Table CR 8.1-6 show a comparison of agriculture revenue for the dry year, critical year and 1977 model runs under the 55 scenario with no replacement groundwater pumping in the Sacramento/Delta watershed and San Joaquin Valley. The results for the critical year and 1977 model runs are detailed in the previous sections. The percentage shown in the last three columns is the percentage reduction in revenue under the 55 scenario as compared to the baseline values in the respective model runs.

Table CR 8.1-5. Crop Revenue of Dry Year, Critically Dry Year, and Driest Water Year SWAP Model Runs for the 55 Scenario, No Replacement Groundwater, Sacramento/Delta

	Revenue ($)			% of Reduction from Baseline		
Crop Group	Dry Year	Critical Year	1977	Dry Year	Critical Year	1977
Deciduous Orchards	3,596,079,000	3,575,204,600	3,552,535,900	-1%	-1%	-0.7%
Rice	1,290,579,900	1,137,591,300	962,810,900	-13%	-22%	-27%
Almonds & Pistachios	851,894,400	832,636,900	817,080,200	-8%	-7%	-4%
Vine	919,049,200	916,665,300	916,146,700	-0.8%	-0.3%	-0.1%
Vegetables	767,693,200	765,411,400	763,090,500	-2%	-2%	-2%
Alfalfa & Pasture	478,787,100	439,459,300	400,922,600	-12%	-15%	-12%
Corn and All Silage	421,611,800	417,375,400	409,254,800	-3%	-4%	-4%
Processing Tomatoes	350,491,500	346,862,300	341,938,500	-7%	-7%	-5%
Wheat & Field Crops	189,629,700	187,863,200	184,976,300	-4%	-4%	-5%
Cotton	10,216,000	10,125,700	10,081,300	-3%	-4%	-3%
Total	8,876,031,800	8,629,195,400	8,358,837,900	-5%	-6%	-6%

Source: Tables 8.4-6, CR 8.1-1 and CR 8.1-3

Table CR 8.1-6. Crop Revenue of Dry Year, Critically Dry Year, and Driest Water Year SWAP Model Runs for the 55 Scenario, No Replacement Groundwater, San Joaquin Valley

	Revenue ($)			% of Reduction from Baseline		
Crop Group	Dry Year	Critical Year	1977	Dry Year	Critical Year	1977
Deciduous Orchards	7,788,267,100	7,733,907,200	7,691,458,400	-0.5%	-0.3%	-0.01%
Almonds & Pistachios	5,763,839,400	5,684,622,800	5,618,592,200	-2%	-1%	-0.07%
Vine	3,356,558,800	3,325,457,900	3,291,556,600	-0.8%	-0.5%	-0.03%
Vegetables	2,420,287,700	2,378,970,900	2,351,321,000	-2%	-1%	-0.04%
Corn and All Silage	1,794,423,000	1,752,467,800	1,702,691,100	-0.9%	-0.7%	-0.004%
Alfalfa & Pasture	1,386,174,300	1,343,025,700	1,279,586,000	-3%	-1%	0.3%
Cotton	804,742,700	751,524,700	747,686,300	-11%	-12%	-0.01%
Processing Tomatoes	760,616,300	723,465,200	704,011,600	-5%	-5%	-0.4%
Wheat & Field Crops	371,262,100	337,294,400	281,592,800	-9%	-9%	0.01%
Rice	25,570,700	25,497,100	24,976,700	-0.04%	-0.1%	0.04%
Total	24,471,741,900	24,056,233,700	23,693,472,900	-2%	-1%	-0.03%

Source: Tables 8.4-11, CR 8.1-2 and CR 8.1-4

Regional Economic Effects and the IMPLAN Model

This section provides an overview of the IMPLAN Input-Output modeling system and analysis of regional economic effects presented in the Staff Report and responds to commenters' concerns regarding the IMPLAN estimated regional economic effects from changes in agricultural production under the flow scenarios. Multiple commenters asserted that the Staff Report underestimates the regional economic effects of changes in agricultural production that would occur under the flow scenarios, particularly in the San Joaquin Valley. Several third-party reports were introduced to support the commenters' assertions, discussed further below.

IMPLAN Overview and Results

Changes in agricultural production could result in additional economic effects that affect total industry output (sales), income, and employment. The regional economic analysis presented in the Staff Report was conducted to estimate how changes in water supply and the resulting effects on agricultural economy could affect economic activity in the Sacramento/Delta watershed and statewide. The analysis uses the IMPLAN input–output modeling system, a widely-used, proprietary data and modeling platform, to evaluate how changes in crop production affect industry output (sales), income, and employment. SWAP model results for crop revenues and expenditures under each flow scenario serve as the primary inputs to the IMPLAN analysis. Appendix A4, *Regional Economic Analysis Modeling Procedure*, provides more information regarding IMPLAN and the approach and procedure used to evaluate regional economic effects as well as detailed results based on model output.

Two regional models were constructed to analyze regional economic effects in the following two areas.

- **Plan Area (Sacramento/Delta) Regional Model**—The model consists of 22 contiguous counties encompassing the geographic scope of the Sacramento River watershed, Delta eastside tributaries, and Delta regions; it includes the location of source waters directly affected by the proposed Plan amendments.
- **State of California Model**—The model includes all 58 counties in the state of California.

The purpose for having two models is to capture how the changes in Sacramento/Delta supply to agriculture would affect the regional economy in the respective areas. The plan area (Sacramento/Delta) regional model estimates regional economic effects in the areas where Sacramento/Delta supplies originate in or are diverted from. It provides useful information on the economic effects within the Sacramento/Delta watershed. However, there could be additional effects in the other geographic regions of the study area. The State of California model therefore allows for the capture of the extent of the ripple effects through all sectors of the economy throughout the state.

The Sacramento/Delta regional analysis relies upon SWAP model results for agricultural sectors' revenues and expenditures under the various flow scenarios for the Sacramento/Delta. The Sacramento/Delta regional analysis provides the direct economic effects of changes relative to baseline conditions in purchases of agricultural inputs, and payments to labor and net income, plus indirect and induced effects on 536 IMPLAN industry sectors, 9 household income categories, and state and local governments in the Sacramento/Delta watershed. For ease of presentation, the detailed IMPLAN model results are aggregated to 19 higher-level industry categories, which are presented in Appendix A4, *Regional Economic Analysis Modeling Procedure*.

A summary of the Sacramento/Delta regional analysis results for the flow scenarios is presented in Table 8.4-23 in the Staff Report. As shown in Table 8.4-23, results from the Sacramento/Delta regional analysis show that there would be effects on regional output (sales), income, and employment under all the flow scenarios. The effects would be largest under the 75 scenario, and smallest under the 35 scenario. For the 55 scenario, Table 8.4-23 shows that the IMPLAN-estimated regional economic effects would be reductions of approximately $416 million in economic output, $234 million in income, and 4,283 jobs.

A summary of the Sacramento/Delta regional analysis results for the proposed VAs is presented in Table 9.8-5. The results presented in Table 9.8-5 suggest reductions of approximately $55 million in economic output, $29 million in labor income, and 552 jobs (517 full time equivalent [FTE] jobs) in the Sacramento/Delta region compared with baseline. Most of the effects occur in the agriculture and agricultural support (i.e., Other Natural Resources & Mining) sectors. The IMPLAN results suggest that water purchase compensation could provide a positive economic effect on output, income, and jobs.

The State of California analysis relies upon SWAP model results for agricultural sectors' revenues and expenditures under the various flow scenarios for the Sacramento/Delta watershed and the San Joaquin Valley. These results are presented in the Staff Report and summarize the direct economic effects of changes in revenues and expenditures by the affected agricultural sectors plus indirect and induced effects on the 536 IMPLAN industry sectors relative to baseline in the 58 county IMPLAN California state model. This analysis captures the broader level recirculation of expenditures, including additional economic effects the extend beyond the Sacramento/Delta regional analysis. For ease of presentation, the detailed IMPLAN model results are aggregated to 19 higher-level industry categories, which are presented in Appendix A4, *Regional Economic Analysis Modeling Procedure*.

A summary of the State of California analysis results for the flow scenarios is presented in Table 8.4-25 in the Staff Report. As shown in Table 8.4-25, results from the State of California analysis show that output (sales), income, and employment would be affected by changes in Sacramento/Delta supply under all flow scenarios. The effects would be largest under the 75 scenario, and would be smallest under the 35 scenario. The modeled statewide effects are also larger than the modeled effects for the Sacramento/Delta watershed. For the 55 scenario, Table 8.4-25 shows that the IMPLAN-estimated regional economic effects would be reductions of approximately $996 million in economic output, $535 in income, and 8,490 jobs.

A summary of the State of California analysis results for the proposed VAs is presented in Table 9.8-6 in the Staff Report. As shown in Table 9.8-6, results indicate net decreases of approximately $54 million in economic output, $19 million in labor income, and 353 jobs (289 FTE jobs) in the State of California compared with baseline. Similar to the results for the Sacramento/Delta watershed, most of the effects occur in the agricultural and agricultural support (i.e., "Other Natural Resources & Mining") sectors. The IMPLAN results suggest that water purchase compensation could results in induced effects; that is, compensation for water purchases could provide a positive economic effect on economic output, income, and number of jobs.

Recent Transformations in Use of Labor by California Agriculture

Several commenters expressed concern that the flow scenarios would lead to substantial job losses in agriculture and related sectors. Commenters asserted that reductions in surface water supplies under the flow scenarios could result in widespread crop idling, fallowing, and, in some cases, permanent conversion of farmland. Some commenters asserted that these changes in farm operations would likely cause direct losses of farm jobs and additional employment impacts in other industries such as food processing, transportation, and agricultural services.

These concerns do not align with the current realities of California's agricultural labor market, which has experienced trends toward labor-saving mechanization in recent years that would be expected to continue in the future irrespective of the State Water Board's current efforts to update and implement the Bay-Delta Plan. For many years, the state's agriculture sector has faced persistent labor shortages, particularly for hand-harvest specialty crops. A statewide survey by the University of California, Davis and the California Farm Bureau Federation found that 58 percent of growers could not hire sufficient labor for their main crop at some point between 2014 and 2018, prompting widespread adjustments in wages, hiring practices, and technology adoption (Rutledge and Taylor 2019). In addition, California's agricultural sector relies heavily on a foreign-born (mainly from Mexico) workforce (JBS International 2022). However, this pool of available foreign-born farmworkers is shrinking due to changes in demographics, increased educational attainment among rural youth in Mexico, better nonfarm employment opportunities, and immigration policy uncertainty (Rutledge and Taylor 2019; Martin 2017; Jezdimirovic 2017). In response, growers have increasingly adopted labor-saving mechanization such as mechanical harvesters, thinners, weeders, specialized platforms, and automated irrigation, reflecting a structural shift from labor to capital (Rutledge and Taylor 2019).

When a market is characterized by vacancies and difficulty filling jobs, a marginal reduction in labor demand, if any, would most likely reduce unfilled vacancies rather than create new involuntary unemployment among workers. This logic is consistent with the observed growth in H 2A visa usage to backfill local shortages despite program cost and complexity, and with employer-reported recruitment challenges even absent policy changes (Martin 2017; Mayer 2021; Rutledge and Taylor 2019).

The structural transition toward mechanization and automation is driven primarily by demographic and economic forces, including declining farmworker immigration, rising labor costs, and modernization of farming technology. These changes are independent of the State Water Board's Bay-Delta Plan update and implementation processes and have been observed over many years. Therefore, attributing future job declines primarily to the proposed unimpaired flow objectives ignores the existing downward trend in manual labor demand that is happening without any change in Sacramento/Delta surface water supplies (Wang et al. 2022).

Processing-related employment is also unlikely to be significantly affected because many food processing processes, such as those for tomatoes and nuts, are already highly mechanized and depend more on crop volume and logistics than on large numbers of manual workers in plants. Any employment effects from the flow scenarios would most directly influence the production of labor-intensive crops, not the relatively automated food processing industry.

While the IMPLAN model results presented in Section 8.4.3, *Regional Economic Effects*, provide an estimate of potential agricultural job losses associated with the flow scenarios (Tables 8.4-24 and 8.4-26 in the Staff Report, and Tables A4-8 and A4-10 in Appendix A4, *Regional Economic Analysis*

Modeling Procedure), these modeled reductions appear relatively modest when viewed in the context of broader, long-term changes in California's agricultural labor market. For example, Appendix A4 shows that agricultural employment may decline by about 2.5 percent in the Sacramento/Delta (Table A4-8), or about 1.5 percent in California as a whole (Table A4-10) under the 55 scenario. Persistent labor shortages, mechanization, and demographic shifts have already been reducing labor demand across many crop sectors, and these structural trends are expected to continue into the future, independent of the Bay-Delta Plan update and implementation processes. Therefore, while the Plan amendments may contribute to some job reductions, the scale of these effects should be considered alongside the ongoing structural transformation of the industry.

Overall, water is not a limiting factor on agricultural employment. California agriculture is undergoing a long-term transformation with persistent labor shortages and accelerated mechanization (Win et al. 2025). In a market with insufficient worker supply, claims that the flow scenarios would cause widespread unemployment among farm laborers are not supported by recent trends in California's agricultural labor market. Any marginal reductions in labor demand would most likely reduce existing vacancies and accelerate ongoing mechanization, rather than displace an excess pool of workers that does not exist under current conditions.

Third-Party Reports and Regarding Regional Economic Effects

Some commenters suggested that the Staff Report underestimates the regional economic effects of changes in agricultural production that would occur under the flow scenarios. In particular, several commenters asserted that the flow scenarios would result in regional economic effects that would increase poverty in the San Joaquin Valley and that these effects are not evaluated in the Staff Report. Three third-party reports were cited as sources to support the commenters' assertions:

- "The Economic Impact of the Westlands Water District on the Local and Regional Economy: 2022 Update," prepared by Michael A. Shires, Ph.D (Shires 2022)
- "The Economic Impact of the Westlands Water District on the Local and Regional Economy: 2025 Update," prepared by Michael A. Shires, Ph.D and Matthew A. Jendian, Ph.D (Shires and Jendian 2025)
- "Blueprint Economic Impact Analysis: Phase One Results," prepared by David Sunding and David Roland-Holst (Sunding and Roland-Holst 2020)

Shires (2022) and Shires and Jendian (2025) are updated versions of an economic analysis originally published in 2016, titled "The Economic Impact of Westlands Water District on the Regional and Local Economy." These reports provide information about the role of agriculture in the Westlands Water District service area (located in portions of Fresno and Kings Counties) in the regional economy but do not specifically evaluate the economic effects of the Sacramento/Delta update to the Bay-Delta Plan. The reports describe Westlands Water District's water supplies as highly variable, and that surface water supplies from the CVP have fluctuated over the past several decades, with increases in groundwater use during years with low CVP allocations. These reports also discuss that there has been a shift in production from annual crops (e.g., grasses, cotton, beans) to permanent crops (e.g., almonds, pistachios, wine grapes) within the Westlands Water District over time.

The Shires (2022) and Shires and Jendian (2025) reports provide information on poverty rates for the State of California overall and in Fresno and Kings Counties specifically, and both reports note that poverty rates are higher in these counties relative to the State of California overall. Shires (2022) purports to demonstrate a relationship between poverty rates in Kings and Fresno Counties and CVP allocations during the period of 2010-2019 (see Figure 13 of Shires 2022 report) and asserts that "[…] the overall trend of these poverty levels moves concurrently with the reductions in water deliveries from the CVP to the Westlands Water District. While certainly not proof of causality, the visual correlation is quite high over the last decade, including significant declines in poverty rates in 2016 and 2017 when surface water was abundant in Westlands." Shires and Jendian (2025) purports to demonstrate a relationship between poverty rates in Kings and Fresno Counties and CVP allocations during the period of 2010-2023 (see Figure 26 of the Shires and Jendian 2025 report), and states that "The divergence between the state and Fresno and Kings Counties' poverty rates is persistent over time. Figure 26 replicates and updates the diagram from the prior analysis showing the rough visual correlation between lost access to surface water and poverty rates in the two counties. The trend lines for the past few years continue the rough trend identified then wherein poverty rises in households in these two counties in the years when water allocations fall short of contracted amounts."

Commenters referenced the Shires (2022) and Shires and Jendian (2025) reports to support the assertion that reduced Sacramento/Delta surface water supplies to the San Joaquin Valley would increase poverty rates, and suggested that the Staff Report's analysis is flawed because it does not evaluate this connection. This assertion is not substantiated by the information contained within the Shires (2022) and Shires and Jendian (2025) reports. Shires (2022) and Shires and Jendian (2025) suggest that there appears to be a rough, visual correlation between decreased CVP allocations to Westlands Water District and increased poverty levels in Fresno and Kings Counties in recent years. However, many growers have access to and may utilize other water supplies and other water management actions when CVP allocations are limited. Shires (2022) and Shires and Jendian (2025) appear to support the claim that CVP allocations to Westlands Water District are correlated with poverty rates in Fresno and Kings Counties based only on a visual data comparison, but neither study provides information to demonstrate if there is a mathematical correlation between these factors. Even if some relationship is present, information is not provided in either study to support the claim that reductions in CVP allocations to Westlands Water District causes increased poverty in Fresno and Kings Counties. Many correlations can be explained by other factors (compounding variables), and some correlations may even occur as a result of random chance. Many factors unrelated to CVP allocations may have affected poverty levels in Kings and Fresno Counties during 2010-2019 and 2010-2023, including broader economic conditions such as recovery from recession, changes in minimum wage laws, inflation, and other factors.

In addition, the information presented in Shires (2022) and Shires and Jendian (2025) is specific to particular time periods and to the Westlands Water District service area. Figure 13 presented in Shires (2022) focuses specifically on the 2010-2019 time period and Figure 26 in Shires and Jendian (2025) focuses specifically on the 2010-2023 time period, and information is not provided to demonstrate if CVP allocations to Westlands Water District appear to be correlated with poverty rates in Fresno and Kings Counties for any other years. Shires (2022) and Shires and Jendian (2025) also focus on the Westlands Water District service area specifically, and do not purport to determine if there is a causal relationship between reduced water supply allocations and increased poverty levels in other areas across the much larger San Joaquin Valley region.

Overall, the Shires (2022) and Shires and Jendian (2025) reports do not warrant changes to the Staff Report's analyses, and do not affect the conclusions of the environmental and economic analyses presented in the Staff Report.

Sunding and Roland-Holst (2020) summarizes the results of an economic analysis of possible reductions in water supply to agriculture in the San Joaquin Valley. The economic analysis presented in the Sunding and Roland-Holst (2020) report contains two scenarios for possible water supply reductions: (1) SGMA implementation, and (2) SGMA implementation plus reductions in surface water deliveries to agriculture in the San Joaquin Valley resulting from several state and federal regulatory processes, including the State Water Board's current processes to update and implement the Bay-Delta Plan, and from climate-induced sea level rise.

The Sunding and Roland-Holst (2020) report contains quantitative analyses to evaluate potential effects of reductions in water supply that are not comparable to the economic analyses in the Staff Report for several reasons:

1. SGMA is the focal point and source of 80 percent of crop acreage and 82 percent of the economic effects calculated by Sunding and Roland-Holst (2020). Therefore, about 80 percent of the economic effects are actually from SGMA, and not from reductions in surface water supplies. It is therefore difficult for a reader to isolate the report's estimated effects from reductions in surface supply from the overall results. In addition, because the economic analysis considers multiple state and federal concurrent regulatory processes, it is not possible to isolate the Sunding and Roland-Holst (2020) estimated economic effects of the Sacramento/Delta Update to the Bay-Delta Plan specifically.
2. The approach by the authors relies on reducing acreage geographically in proportion to existing production, rather than accounting for the fact that markets and crop profits drive production decisions which makes it more likely that lower-profit crops are reduced before higher-profit crops. In contrast, the SWAP model assumes that higher profit crops may shift locations in equilibrium if water limitations warrant it. As a result, the authors likely overestimate the economic effects of reductions in water supply.
3. For the second scenario, Sunding and Roland-Holst (2020) identify several measures related to reductions in surface water supplies, including "[…] assuming 45% Sacramento River Basin and Delta outflow unimpaired flow requirement and 40% unimpaired flow for San Joaquin River tributaries." It is not clear how the Sunding and Roland-Holst (2020) report estimated the changes in Sacramento/Delta surface water supplies that informed the economic analysis, since they preceded by several years the water supply modeling conducted in the 2023 draft Staff Report.
4. Sunding and Roland-Holst (2020) appear to assume that 40% unimpaired flow for San Joaquin River tributaries would be required on a year-round basis. In actuality, the 2018 Bay-Delta Plan would provide for 40% of unimpaired flow from February through June, with an allowed adaptive range between 30%-50%, inclusive, from each of the Stanislaus, Tuolumne, and Merced Rivers.

For these reasons, the Sunding and Roland-Holst (2020) analysis is not comparable to the Staff Report's agricultural economic analysis, and the information contained in this report does not change the conclusions of the Staff Report.

Overall, the Staff Report adequately evaluates agricultural impacts and agricultural economic effects that could occur under the flow scenarios, and provides estimates of changes in crop average and crop revenue and regional economic effects using the best available information, which includes the SWAP and IMPLAN models. These third-party studies referenced by commenters do not necessitate changes to the Staff Report.

Municipal Water Supply Economic Effects

The Sacramento/Delta update to the Bay-Delta Plan is expected to reduce Sacramento/Delta water supplies to municipal uses that could result in the need for some municipalities to obtain new water supplies. If the municipal water supply is reduced, service providers could respond in a variety of ways, if necessary. The response by individual municipalities will vary depending on the extent of their reliance on Sacramento/Delta surface water relative to other sources of water, and the balance between the existing and projected water supply and demand within their service area. Section 8.5, *Municipal Water Supply Economic Effects*, in the Staff Report analyzes the potential costs to affected municipal service providers of securing reliable water supplies for the flow scenarios, with the focus on: (1) cost of developing other water supplies to replace the reduced Sacramento/Delta water supply; (2) the opportunity cost of lost supply if no other supply sources are available; or (3) costs of using other water supplies within existing water portfolios to replace the reduced Sacramento/Delta water supply. Section 9.8.3, *Municipal Water Supply Economic Effects*, addresses the economic effects of the proposed VAs on municipal water providers. In addition, Section 13.8.3, *Municipal Water Supply Economic Effects*, describes the potential economic effects of the revised proposed Plan amendments and is informed by prior analysis presented in Section 8.5. Generally, economic effects under the revised proposed Plan amendments would be very similar to those described for the Low Flow Alternative (35 and 45 scenarios).

This section provides a summary of the approach to the municipal water supply economic analysis, and responds to various concerns raised by commenters regarding the analysis of municipal water supply economic effects.

Municipal Supply Analysis Approach

This section summarizes the approach to the analysis of municipal water supply economic effects presented in Section 8.5, *Municipal Water Supply Economic Effects*, of the Staff Report and responds to key issues raised by the commenters.

As discussed in Section 8.5, the relative economic costs of obtaining other water supplies is dependent on the amount of reduced Sacramento/Delta supply, the availability of other water supplies, the amount of water municipalities have in reserve, and the general costs for installing or implementing the other water supplies that are available. The economic analysis examines the marginal cost associated with shifting water sources within existing water portfolios or obtaining water from other sources.

The amount of reduced Sacramento/Delta supply was obtained from SacWAM results for the modeled flow scenarios. As a whole, Sacramento/Delta water supply to municipal uses decreases with increasing flow requirements and varies by water year type and by region (Tables 7.20-5 and 7.20-6 in the Staff Report). The analysis examines results for the average reduction by flow scenario and by region. In many cases Sacramento/Delta supply represents only a portion (or none) of providers' supply; therefore, the effects on the providers and the municipalities they serve can range from large to small, or to none at all. The response by individual municipalities to reduced Sacramento/Delta supply is expected to vary depending on the extent of reliance on those supplies, the balance between supplies and existing demand, the variety of water sources in their existing water portfolio, ability for water transfers or exchanges, and the extent of availability and access to groundwater. Municipal water conservation and efficiency measures are among management actions all service providers could implement to meet current and future water needs.

The types of measures to augment water supplies also vary by region. Sources of municipal water supply and reported demand were gathered for urban water providers in the Sacramento River watershed, Delta eastside tributaries, and Delta, as well as water wholesalers and water providers in other regions that receive exported Sacramento/Delta supply. In general, the focus is on what the providers themselves indicate as their most likely options for other water supplies, rather than the totality of opportunities that may be available.

Some water providers have reserve supplies, or supplies that exceed demand, that may be accessed during dry years and other times of shortage. This may include water supplies that could be provided under exchange agreements, storage in reservoirs, groundwater storage and recovery projects, or groundwater banking. There would be a lower monetary cost for these municipalities to use their reserve supplies first, without replenishing any reserves used. For some municipalities, there could be no additional monetary costs from switching to an alternative water source because the municipality has enough water in reserve to replace reduced Sacramento/Delta supply. Other municipalities might not have enough reserve supplies, or do not have any reserve supplies at all. The analysis uses the assumed costs of other water supplies, and the other water supplies that are likely to be used, to estimate the monetary costs for these municipalities to replace reduced Sacramento/Delta supply. A summary of the analysis details is provided in Appendix D, *Supplemental Municipal Supply Analysis Information*.

The costs are estimated as a range representing the extent to which municipal providers may rely on demand management and use reserve supplies, if available, versus the cost of acquiring additional water supplies to fully replace the reduction in the Sacramento/Delta water supply. Projecting the specific ways that all municipal users may respond to reduced surface supply would require undue speculation. Therefore, the analysis is general in nature and evaluates how reductions in Sacramento/Delta supply could affect municipal water supplies and associated costs. A water provider's actual cost most likely would fall between the lower and upper bound.

- Lower Bound—The lower bound represents the minimum annual cost to municipalities to replace the service of reduced Sacramento/Delta supply. Urban water conservation measures are evaluated in the lower bound analysis for all regions as these measures were explicitly identified as future water portfolio strategies in various urban water management plans (UWMPs). Generally, a reduction in municipal supply of up to 10 percent often would be managed through more intensive use of demand management measures (^DWR 2021a). The analysis assumes that urban water conservation measures represent the first source of replacement water and assumes no economic cost to the municipal provider.

  Any remaining water needed would then be met by other water supplies. For example, municipalities could choose to tap into their unused reserves (at no added cost) before acquiring additional water. Under existing conditions, wholesalers or municipalities may have sufficient reserve supply. With reduced Sacramento/Delta supply, municipalities may choose to use any or all reserve supply to replace the reduced supply, followed by acquisition of additional supply. Under this assumption, if a municipality has sufficient water supply reserves to replace reduction in Sacramento/Delta supply, additional water supplies would not be required. If reserves are large enough, effects on the water supply portfolio could result in an internal cost that would be absorbed by the provider or its customers. These internal costs are not reflected in the estimated costs shown.

- Upper Bound—The upper bound represents the maximum annual estimated cost for using reserve supplies to replace reduced Sacramento/Delta supply and the estimated cost for purchasing additional water supplies to completely replenish any reserves used to replace the reduced Sacramento/Delta supply, with no action to manage demand through demand management measures. The estimated costs account for new acquisitions of other supplies that would leave the water provider with the same reserve supply. Under this assumption, all reduction in surface water supply would be replaced on an equal basis, regardless of the municipality's reserve status, and the cost of obtaining new supplies would be counted. This represents a conservative estimate because the analysis assumes that demand management measures (e.g., water conservation) would not be implemented to maximize the use of existing water supplies. Additionally, the options were evaluated as an un-prioritized list, such that each additional water supply option is equally likely to be selected to replace reduced deliveries. This has the effect of possibly overestimating the cost of water replacement, because providers facing a reduction in one source of supply may prioritize replacement based on least cost first.

Table 8.5-1 in the Staff Report includes a summary of estimated water supply needs to replace reduction in Sacramento/Delta supplies for municipal use, and range of estimated costs for municipalities to replace reduction in Sacramento/Delta supply under the 55% unimpaired flow scenario. Section D.3, *Municipal Supply Economic Effects Analysis*, of Appendix D, *Supplemental Municipal Supply Analysis Information*, contains comparable information regarding partial replacement and full replacement volumes for the 35, 45, 65, and 75 scenarios. Regions that receive relatively small volumes of Sacramento/Delta supply for municipal use, such as the Delta eastside tributaries, Delta, Central Coast, and San Joaquin Valley regions show the smallest volume reductions in supply. In contrast, the Bay Area and Southern California regions receive large volumes of Sacramento/Delta supply for municipal use. Estimated costs to replace reduced Sacramento/Delta supply varies based on the portfolio of options for additional supply.

In order to provide some context to the magnitude of the estimated additional costs, the results are presented as a range of annual costs and as "cost as a share of economic output." This is estimated by dividing the lower and upper bound costs, as described above, by the total economic output (sales of all goods and services) generated in the respective region. The value of economic output for each region is discussed in Appendix A4, *Regional Economic Analysis Modeling Procedure*. Tables 8.5-2 through 8.5-8 in the Staff Report summarize the range of potential economic costs for municipalities to respond to reduced Sacramento/Delta supply within different regions (costs for the 55 scenario are summarized below as Table CR 8.1-7). The cost estimates reflect groundwater pumping, surface storage, water transfers (including in-basin transfers and transfers from other regions), recycled water, and desalination based on review of UWMPs and other planning documents (see Appendix D, *Supplemental Municipal Supply Analysis Information*).

Table CR 8.1-7. Range of Estimated Costs for Municipalities to Replace Reduced Supply by Region and Costs as a Share of Economic Output for the 55 Flow Scenario

Region	Cost ($)			Share of Economic Output (%)		
Sacramento River watershed	$213,000	to	$4,499,000	0.00010	to	0.00206
Delta Eastside Tributaries	$408,000	to	$2,544,000	0.00120	to	0.00750
Delta	$0	to	$423,000	0.00000	to	0.00073
San Francisco Bay Area	$32,206,000	to	$154,764,000	0.00272	to	0.01307
Central Coast	$9,152,000	to	$14,475,000	0.00741	to	0.01172
San Joaquin Valley	$0	to	$10,296,000	0.00000	to	0.00408
Southern California	$20,837,000	to	$529,798,000	0.00095	to	0.02419

Source: Tables 8.5-2 through 8.5-8, and Appendix D, *Supplemental Municipal Supply Analysis Information*.
Cost as a share of economic output is calculated as estimated cost (lower bound and upper bound) divided by the total value of the region's economic output, as estimated in Appendix A4, *Regional Economic Analysis Modeling Procedure*.

The analysis assumes that some water users could choose to increase groundwater pumping to offset reduced Sacramento/Delta supplies; however, the analysis does not consider that groundwater may be unavailable or locally restricted in some locations and does not evaluate additional costs that could be incurred to deepen groundwater wells as a response to possible groundwater level declines. As discussed in Section 7.12.2, *Groundwater*, increased groundwater pumping in response to reduced Sacramento/Delta supplies could lower groundwater levels in some locations. Water user response to reduced Sacramento/Delta supply could exacerbate groundwater overdraft in some locations. Communities that rely on groundwater for drinking water supplies in the San Joaquin Valley have been facing challenges from declining groundwater levels under baseline conditions, with critical shortages or dry wells occurring in some areas during prolonged drought periods. The frequency and severity of these challenges could increase as a result, even with no replacement groundwater pumping. Section 8.9.3, *Groundwater Wells and Groundwater Storage and Recovery*, in the final Staff Report provides additional information about the costs to deepen existing groundwater wells.

Scope and Level of Detail of Municipal Economic Analysis

Some commenters asserted that the analysis of municipal water supply economic effects is flawed because it does not contain an analysis specific to individual municipal water suppliers in the study area, and instead provides results for each study area geographic region.

As discussed above under *Overview and Adequacy of Economic Analysis*, the Staff Report's analysis of environmental impacts and economic effects is appropriate for the large scope of the project and wide range of possible response actions. The environmental and economic analyses often consider a range of potential outcomes, including the most conservative for evaluating potentially significant effects on the physical environment and costs associated with potential changes in supply. In many cases, there may be no impact or effect. For each resource area, the analysis assumes a worst-case scenario. Some impacts and effects are inversely proportional, and it is not possible for a worst-case scenario to occur for every environmental resource area.

Water users could take many possible actions in response to changes in Sacramento/Delta surface water supplies. The response by individual municipalities will vary depending on unique circumstances of each municipal water supplier, such as the extent of their reliance on

Sacramento/Delta water relative to other sources and the balance between supplies and demand. It would be speculative to make assumptions regarding how individual water users would respond because it will depend on many individual and collective decisions including, but not limited to, the unique water supply portfolios, financial resources available to the water users, condition of existing infrastructure, and the discrete actions of other local water users in response to reductions in surface water. This combination of factors reflects that the estimated economic effects should be considered an indicator rather than predictor of the change for individual water users that could occur under the Plan amendments. Flexibilities provided in the program of implementation could reduce municipal economic effects compared to those estimated in the Staff Report.

The amount of Sacramento/Delta supply was obtained from the SacWAM results for existing conditions and the modeled flow scenarios. SacWAM results are used to estimate changes in surface water availability by comparing baseline and scenario conditions. The level of detail of SacWAM is on par with the finest level of detail of any model that represents the entire Sacramento/Delta watershed. While individual models that represent only specific tributaries may be more detailed, they would not be applicable for a project of this scale, covering the entire Sacramento/Delta watershed. Every effort has been made to represent the detailed operations of Sacramento/Delta surface water supply projects; however, the results should not be interpreted at the water district or water right holder scale. Rather, the results should be interpreted at a larger scale appropriate for broader analyses, as presented in Chapter 6, *Changes in Hydrology and Water Supply*. This level of analysis appropriately supports the findings and conclusions in the Staff Report, and provides a suitable basis for the analysis of economic effects. See Common Response 6.1, *Sacramento Water Allocation Model and Changes in Hydrology and Water Supply*, for additional information on SacWAM scope, scale, and application.

Furthermore, the model results presented in the Staff Report represent one way that the Plan could be implemented. As discussed in Chapter 5, *Proposed Changes to the Bay-Delta Plan for the Sacramento/Delta*, of the Staff Report, there are alternative ways that the Plan could be implemented, which could result in smaller impacts to water users. The assumptions used in SacWAM represent a conservative implementation of the Plan. There would likely be fewer actual impacts because the Plan allows for flexible implementation for water users. In addition to provisions that allow for water supply adjustments for existing water rights, the program of implementation provides additional flexibilities that can help minimize water supply impacts. As a wide range of responses and associated environmental effects could occur as a result of the project due to the degree of flexibility included in the proposed Plan amendments and the scope and complexity of Sacramento/Delta water use, the analysis provided in the Staff Report is appropriately detailed for the scope of the project, and appropriately considers economic considerations as required under section 13241 of the Porter-Cologne Act.

Use of Averages and Estimated Range of Economic Effects

Some commenters asserted that the municipal water supply economic analysis should incorporate SacWAM results for changes in Sacramento/Delta surface water supplies during the driest hydrologic years and should not rely on SacWAM results for average changes in Sacramento/Delta surface water supplies. Commenters expressed concerns that reductions in Sacramento/Delta supplies to municipal water users and associated municipal water supply economic effects could be larger at times than the average annual changes in Sacramento/Delta surface water supplies used in the Staff Report's municipal water supply economic analysis.

The use of average conditions is appropriate and allowed in CEQA analyses, and the use of averages to characterize baseline conditions is a widespread and common practice when conducting most types of comparative analyses. While the Staff Report relies on averages to assess changes in resource-specific conditions compared to baseline conditions and to evaluate economic effects, appropriate statistical summaries of likely range of water supply changes are presented in Chapter 6, *Changes in Hydrology and Water Supply,* and Appendix A1, *Sacramento Water Allocation Model Methods and Results*. In addition to water year type averages, cumulative distributions are also provided to illustrate variations that may not be fully captured by averages alone. Taken together, the results presented in the Staff Report appropriately disclose the average change from the baseline conditions, a likely range of outcomes related to the potential changes in the Sacramento/Delta surface water supply for municipal uses, and the associated estimates of economic effects. Changes to the Staff Report's municipal water supply economic analysis are not warranted.

Additionally, as discussed in Section 8.5.1, *Approach to Analysis*, the amount of reduced Sacramento/Delta supply from SacWAM is a conservative representation of what water users could experience as model results do not account for flexibilities in the Plan for adaptive implementation and local cooperative solutions. In general, an economic analysis should reflect rational human behavior, including logical consideration of flexibilities in decision-making. Provisions for adaptive implementation of the numeric inflow requirements are provided to optimize flows to benefit native fish and wildlife while also minimizing water supply impacts, and for the numeric inflow requirements to be implemented in a coordinated fashion with the cold water habitat and inflow-based Delta outflow requirements. The State Water Board also plans to develop appropriate provisions to address human health and safety needs and other possible reasons for short-term and long-term exceptions to curtailments to allow continued diversions for minimum human health and safety water supplies where alternate supplies are not available. Failure to consider the flexibilities when interpreting the estimated effects can result in overstating the actual changes in supply that would result from Plan implementation. Given this, the use of average change in water supply is appropriate for this analysis. Municipal water supply economic effects would be expected to be greater than average during certain years and less than average during other years.

Some commenters asserted that the analysis of municipal water supply economic effects does not appropriately capture the range of potential municipal water supply economic effects that could occur as a result of the flow scenarios. In particular, commenters expressed concerns that the lower bound is unrealistically low because this lower bound does not consider the costs that would be incurred to implement new or additional water conservation.

The lower bound cost assumes no-cost water conservation of 10% and acts as a minimum annual cost to municipalities to replace the service of reduced Sacramento/Delta supply. The upper bound cost assumes no water conservation and calculates cost of full surface water replacements. However, the economic analyses presented in the Staff Report do not assume that municipal water suppliers will adopt any specific strategies, nor do those analyses purport that the lower bound used in the analysis represents the actual costs to municipal suppliers.

The upper bound estimate also reflects that municipalities may incur additional costs to implement new or additional water conservation measures. Because upper bound assumes the purchasing of additional water supplies to completely replenish any reserves used to fully replace the reduced Sacramento/Delta supply, the upper bound estimate covers a scenario where water conservation is either not feasible or costs more than purchasing a replacement supply. Additionally, the cost analysis assumes an un-prioritized list of water supply options: each water supply is equally likely to be selected to replace reduced deliveries. This has the effect of possibly overestimating the cost of water replacement, because providers facing a reduction in one source of supply may prioritize replacement based on least cost first. Given this, the full range of water conservation costs is included with the upper and lower bound cost estimates. A water provider's cost would likely fall between the lower and upper bound.

Alternative Water Supply Options and Weighting Factors for Source Categories

Multiple commenters expressed concerns related to assumptions about water users' alternative water supply portfolio options identified in Appendix D, *Supplemental Municipal Supply Analysis Information*. Some commenters asserted that the municipal supply economic analysis improperly identifies the types and availability of other water supplies or that the alternative water supplies used in the economic analysis are not feasible water replacements for municipal water suppliers. Some commenters claimed that it is not clear how the water portfolio options and weighting factors were determined for the municipal supply analysis. Among the commenters that disagreed with the water portfolio options and weighting factors used in the analysis, some stated that the approach underestimated economic effects, while others asserted that effects were overestimated. This section responds to these comments, and addresses the feasibility of replacement water supplies and weighting used in the analysis of municipal water supply economic effects.

Water users could take many possible actions in response to changes in Sacramento/Delta surface water supplies. As described in Section 8.5.1, *Approach to Analysis*, and detailed in Section D.3, *Municipal Supply Economic Effects Analysis*, of Appendix D, *Supplemental Municipal Supply Analysis Information*, sources of municipal water supply and demand were gathered for a sample of moderate-sized and larger municipalities in the study area. This information includes cities and urban water providers in the Sacramento River watershed, Delta eastside tributaries, and Delta, as well as water wholesalers and water providers in other regions that receive exported Sacramento/Delta supply. UWMPs, DWR's aggregated 2020 UWMP database, and other local planning documents, such as Integrated Regional Water Management Plans and water district planning documents, were reviewed to determine the types and availability of other water supplies that municipalities would be likely to implement. In general, the assumptions reflect what the providers themselves indicate as their most likely options for other water supplies, and the analysis may not reflect the totality of opportunities available. The options were also evaluated as an un-prioritized list, meaning that each other water supply is equally likely to be selected to replace reduced deliveries. This has the effect of possibly overestimating the cost of water replacement, because providers facing a reduction in one source of supply may prioritize replacement based on least cost first. However, projecting the specific ways that municipal users may respond to reduced surface supply would require undue speculation. Therefore, the environmental and economic analyses presented in the Staff Report do not assume that municipal water suppliers will adopt any specific strategies in response to the Sacramento/Delta update to the Bay-Delta Plan. For these reasons, the assumptions in the Staff Report are reasonable and properly identify the types and availability of other water supplies that water users would be likely to implement in response to reduced Sacramento/Delta supplies.

The Staff Report properly identifies the types and potential availability of replacement water supplies (water transfers, water conservation, water reuse and recycling, desalination, and groundwater storage and recovery) that municipal water users would be likely to implement in response to reduced Sacramento/Delta supplies. Additional discussion is provided below on replacement water supplies and weighting factors.

Groundwater Storage and Recovery. Groundwater supplies roughly 40–60 percent of statewide water use, and California's aquifer system has an estimated storage capacity exceeding 1,000 million acre-feet, compared to all the major above-ground reservoirs in California which can hold up to 44 million acre-feet (DWR 2026).

Groundwater storage and recovery (also known as managed groundwater recharge or groundwater banking) involves storage of water for later recovery by intentionally recharging groundwater basins when excess surface water or other water sources are available, for example, during years of above-average surface water supply or through storing recycled water or stormwater in groundwater basins for future use. Groundwater storage and recovery is also part of conjunctive management or use that involves coordinated management of surface water and groundwater resources to maximize the availability and reliability of water supplies in a region.

California hosts several large-scale groundwater banks, notably the Kern Water Bank (roughly 1.5 million acre-feet capacity) and the Semitropic Water Storage District (roughly 1.65 million acre-feet capacity), along with numerous smaller banks managed by local agencies. Although the total number of groundwater banks statewide is unknown, DWR identifies groundwater banking as a critical tool for meeting future water demands and adapting to climate change through continued investment, improved management, and enhanced data collection. (DWR 2026). Groundwater banking is most prevalent in the San Joaquin Valley, where historical overdraft has created available storage capacity. In contrast, many Sacramento Valley basins are less suitable due to limited storage space and strong surface-water connectivity. There are also examples in the San Francisco Bay Area. For example, Santa Clara Valley Water District (Valley Water) has a managed recharge program capturing local runoff in reservoirs and releasing it to groundwater recharge facilities or drinking water treatment plants. On average, about 50,000 AF/y (acre-feet per year) of runoff is recharged through existing recharge facilities (SCVWD 2021). Zone 7 Water Agency in the San Francisco Bay Area has been artificially recharging the Main Basin aquifer since the 1970s, supplying treated surface water to customers to augment groundwater supplies, and regulating municipal pumping by other users (Zone 7 Water Agency 2021).

Water Transfers. Water transfers were considered in the Staff Report analysis because numerous UWMPs indicated that such transfers had been or were being considered as part of the overall water supply planning efforts. Water transfers may not be able to fully mitigate reductions in Sacramento/Delta water supplies, but are expected to reduce the economic effects of changes in water supply by directing the available water supplies to their highest valued uses. This common response further addresses water transfers below, under *Water Transfers*.

Some municipal water suppliers extensively discuss water transfers in their UWMP. For example, East Bay Municipal Utility District (EBMUD) discusses the water transfer program as a feasible strategy and its current and future plans to secure dry-year water supplies to meet customer demands water through transfers in its 2020 UWMP. Sources of transfer water are primarily from senior water rights holders in the American and Sacramento River Watershed. EBMUD cites three examples of long-term water transfer Projects with other water suppliers: Placer County Water Agency (PCWA), Yuba Water Agency (YWA), and the Sycamore Mutual Water Company (EBMUD 2021a). EBMUD has relied on these agreements already, with a 20 thousand acre-feet (TAF) transfer from PCWA in 2022 after declaring a Stage 2 Critical Drought (EBMUD 2022). EBMUD has also planned to extend its Water Transfer Option Agreement with YWA through 2050 (YWA 2024b). As demonstrated in Table D-8 in Appendix D, *Supplemental Municipal Supply Analysis Information*, of the 2023 draft Staff Report, both YWA and PCWA have reserved water supplies that are minimally affected by the flow scenarios. This indicates that water supplies should be able to uphold transfer agreements as needed. Apart from long-term planning through water transfers, EBMUD also has developed short-term agreements, including the development of interties that improve water quality and supply reliability for the Bay Area (EMBUD 2021a).

Recycled Water. Water reuse was considered in the Staff Report analysis in instances where UWMPs indicated treatment and reuse as implemented or planned measures. Many municipal water suppliers discuss recycled water in their UWMPs, and identify recycled water as part of their long-term strategies. Commenters communicated impediments to plan and implement recycled water projects, including long time to implement and unfavorable costs.

The State Water Board promotes the use of recycled water through investing in infrastructure to support recycled water projects, implementing the Recycled Water Policy, streamlining permitting for recycled water projects, and identifying and funding the highest priority research needs to ensure the state's recycled water goals are achieved. A snapshot of existing capacity and planned future projects with projected additional recycled water production is provided in Table CR 8.1-8 below, identifying 95 planned projects statewide with the potential to increase recycled water use by approximately 313,000 acre-feet per year by 2030, and by an additional 428,000 acre-feet per year by 2040, compared to the 2022 reported deliveries of 749,000 acre-feet per year (SWRCB 2024).

Table CR 8.1-8. Summary of Planned Recycled Water Projects by Regional Water Board

Regional Water Board	2022 Recycled Water Use (AFY)	Sum of 2022- 2030 Volume Increase Projection (AFY)	Sum of 2030-2040 Volume Increase Projection (AFY)	No. of Planned Projects	No. of Planned Projects Identified as Potable Projects
North Coast	26,845	2,018	100	6	0
San Francisco Bay	54,359	4,701	16,723	10	2
Central Coast	27,827	11,456	4,211	12	10
Los Angeles	208,175	86,133	328,773	14	12
Central Valley	123,657	27,619	7,206	13	0
Lahontan	25,769	11,242	0	7	2
Colorado River	12,876	31,747	7,290	10	4
Santa Ana	206,361	69,942	4,000	11	6
San Diego	63,386	68,033	59,368	12	9
Total	**749,256**	**312,890**	**427,671**	**95**	**45**

Source: State Water Board, 2024

Given the planning and development across various water recycling projects, additional water supplies from water recycling facilities are considered as a feasible and a reasonably foreseeable alternative to supplement surface water. Large increases in planned recycled water volumes are expected particularly in the coastal regions, consistent with the goal of prioritizing reuse of treated wastewater that is currently discharged to the ocean.

Desalination. The Staff Report discusses desalination as a potential water supply source. Section 8.3.5, *Desalination*, in the Staff Report discusses that in California, desalinated water is not a common drinking water supply by volume. For many geographic areas within the state, desalination is impractical because of a lack of suitable saline source water and is not economically feasible because more cost-effective water supply alternatives are available. However, desalination technologies continue to improve; they are becoming more cost effective and are being used in the Central Coast and Southern California regions. Water agencies in the Bay Area are also continuing to look into desalination as a water option, and some have completed preliminary environmental feasibility studies for desalination projects[1]. Section 8.3.5 in the Staff Report acknowledges the costs and energy demands of desalination, but identifies that technologies have improved over time and are becoming more cost-effective, leading communities to reconsider previously deferred desalination plants.

Additionally, California has set water supply goals from brackish desalination, aiming to reach 28 TAF from desalinated water by 2030 and 84 TAF of desalinated water by 2040. To assist in funding these desalination projects, the state has awarded over $82 million in desalination grant funding, with $33 million of that total going toward addressing brackish desalination (DWR 2024a). Some of the Bay Area municipal water suppliers are taking action to pursue desalination as a potential water supply source. The Bay Area Regional Reliability (BARR) Partnership, which consists of eight Bay Area water agencies working to improve water supply reliability, is exploring desalination and other mitigation measures as well, such as regional drought mitigation measures and interties. A planned brackish desalination project with a planned capacity of 3 TAF per year is currently under construction in Antioch in the Bay Area (DWR 2024b).

Water Conservation. Municipal demand management measures are an important tool to minimize effects of reduced Sacramento/Delta supply to municipal uses. A recent study found that urban water conservation and efficiency are the most cost-effective ways to meet current and future water needs, as compared to developing alternative water supplies. Section 8.3.6.2, *Municipal Demand Management Measures*, discusses residential water efficiency measures that could be implemented to reduce the effects of reduced Sacramento/Delta supply to municipal users and result in cost savings for customers.

The Staff Report contains information that demonstrates that urban water users have taken action to reduce residential daily use in recent years. For example, Table 8.3-1 in Chapter 8, *Changes in Hydrology and Water Supply*, of the Staff Report shows that residential daily use during August, when water demand is typically the greatest, decreased during the period of 2013-2017 in all regions.

Some commenters alleged that because users have already lowered per-capita water use, additional water conservation would be difficult or infeasible. However, UWMPs provide general evidence supporting the feasibility of additional demand reduction measures. Based on information regarding long-term strategies contained within UWMPs, many municipal water suppliers are planning to implement additional water conservation measures, including those suppliers that have already implemented a variety of water conservation measures. For example, EBMUD has been one of the

[1] Santa Clara Valley Water District completed an environmental feasibility study in October of 2023 indicating that a desalination facility may be feasible if certain environmental issues are addressed. (Valley Water n.d.).

leaders in promoting efficiency and water conservation, and continues to identify additional opportunities for water conservation. EBMUD has incorporated water conservation as a central component of long-term water supply planning efforts aimed at ensuring the reliability of water supply now and in the future, leveraging information technology to help customers save water and continuing its leadership in the research and development of new technologies to conserve water (EBMUD 2021a). EBMUD's programs and projects include targeted outreach and education, financial incentives, technology installations such as automated metering infrastructure (EBMUD 2021a). Similarly, in their UWMPs, other agencies model water conservation (CCWD 2021). These and other examples indicate not only the municipal water providers' commitment to water conservation, but also their views on its feasibility as part of an effective water replacement portfolio in both the near- and long-term.

Recent technological improvements and new regulatory requirements suggest that additional water conservation is likely feasible, even where water users have already implemented water conservation actions. For example, toilet efficiency standards have continued to rise with California legislature adopting Assembly Bill 715 in 2007 to require manufactures to start offering high-efficiency toilets (HETs) with a flushing volume under 1.28 gallons per flush (gpf). The requirements of AB 715 were further solidified when its standards were incorporated into Title 20 regulations in 2015, making only HETs offered for sale in California starting in 2016 (California Urban Water Conservation Council 2016). Additionally, California adopted Appliance Efficiency Standards until Title 20, which were first introduced in 2015 under an executive order. This order mandated new plumbing efficiency standards across fixtures such as kitchen faucets, public lavatory faucets, toilets, urinal flush valves, and more. These standards went into effect on January 1st, 2016 (Delta Faucet 2019). Given this timeline on water conservation innovation, it is likely that municipal water suppliers like can achieve additional water conservation through HETs and other upgrades to modern water-use appliances.

Water conservation programs may come at a cost to water suppliers, although urban water conservation and efficiency are considered the most cost-effective ways to meet current and future water needs, as compared to developing alternative water supplies. In fact, many measures have a negative cost: they save the customer more money over their lifetime than they cost to implement (Cooley and Phurisamban 2016). As the upper bound used in the municipal water supply economic analysis assumes no water conservation and the purchasing of additional water supplies to completely replenish any reserves used to fully replace the reduced Sacramento/Delta supply, the upper bound estimate covers a scenario where water conservation is either not feasible or costs more than purchasing a replacement supply.

Weighting Factors. Some commenters expressed concern regarding the weighting factors used in the municipal water supply economic analysis, including how they were developed and applied.

Tables D-9, D-12, D-15, D-18, D-21, D-24, and D-27 in Section D.3, *Municipal Supply Economic Effects Analysis*, of Appendix D, *Supplemental Municipal Supply Analysis Information*, provide a series of water portfolio options and associated weighting factors along with representative unit costs (annual cost per AF) for municipal water suppliers. The weighting factors were developed based on review of the projected future water supply. The values of the weighting factors applied for each water supply category for an individual supplier were approximated based on the relative amount of projected water supply volume anticipated to be received from any one water supply category compared with the overall projected future water supply, and the relative emphasis placed on any one water supply category in the future water supply discussion of the documents reviewed. The relative weighting corresponds to the total portfolio of a supplier and is not normalized among suppliers; for example, for a supplier with multiple portfolio options a relative weight of "1" for a supply type could amount to a small percentage, while for a supplier with only one source a relative weight of "1" would represent 100 percent of its portfolio. Non-zero weighting factors are provided to indicate that a portfolio option may be considered as a replacement source of supply for that provider. The values indicate relative weighting, where a higher number indicates greater potential reliance on that option in terms of water supply volume, consistent with municipal suppliers' planning documents. Overall, the unprioritized weighting of alternative water supply options specified to each municipal water provider and based on each of their existing water portfolio and planning documentation is a good-faith approach to accurately if conservatively estimate the economic effects from the Plan amendments.

As shown in Tables D-9, D-12, D-15, D-18, D-21, D-24, and D-27 in Section D.3, *Municipal Supply Economic Effects Analysis*, of Appendix D, *Supplemental Municipal Supply Analysis Information*, the relative weightings may vary for each water supply source identified for a municipal water provider, based on the review of UWMPs and other information described above. For example, for EBMUD (identified in Table D-18 as "U_EBMUD_NU"), the alternative water supplies assumed in the analysis include: 1) SF Bay Area water transfers (weighted most heavily with a value of 10 out of 17), 2) large surface water, recycled non-potable water, brackish desalination (each weighted with a value of 2), and 3) Sac - groundwater banking (weighted least heavily with a value of 1 out of 17). The other water supply source types do not include a weighting value for EBMUD and were not assumed to be alternative water supply sources. For EBMUD, the greatest weight was placed on water transfers and the lowest weight placed on groundwater banking, consistent with information contained within EBMUD's UWMP that also places an emphasis on water transfers as a future source of water supply. In conclusion, the State Water Board used best available data and reasonable assumptions to estimate the cost range of replacing reduction in surface water supply as a result of the Plan amendments.

Some commenters were concerned about the reliance on UWMPs and other local planning documents to inform the municipal water supply economic analysis presented in Section 8.5, *Municipal Water Supply Economic Effects*, asserting that UWMPs may not have considered or planned for changes in Sacramento/Delta water supplies that could occur as a result of the Sacramento/Delta updates to the Bay-Delta Plan. Reducing reliance on the Delta is state policy, along with an associated mandate for improving regional self-reliance (Wat. Code, § 85021). Reduced reliance on the Delta can be achieved by diversifying water supply portfolios at the regional and local levels, which would provide greater overall supply reliability during periods when Sacramento/Delta supply is reduced. Many agencies have planning efforts to reduce reliance on the Delta and have made significant investments in developing their local and regional supplies, including groundwater banking, onstream and offstream surface water storage, increased use of recycled water, and desalinated supplies, while also achieving significant decreases in imported water demand through water conservation and water use efficiency efforts.

As explained in Section 7.20, *Utilities and Services Systems,* in developing UWMPs, municipal water providers are required to consider future conditions in their long-term water planning efforts. The Urban Water Management Planning Act requires municipal water suppliers serving more than 3,000 customers or supplying more than 3,000 acre-feet of water annually to prepare and update UWMPs every 5 years, demonstrating water supply reliability in normal, single dry, and multiple dry years. Per Water Code section 10635(a), the UWMP water service reliability requires combined assessment of supplier's water uses and supplies under varying hydrological and development conditions. The assessment represents projected variances that occur in both supply sources and customer use under changed conditions, which include both short-term and long-term hydrological, regulatory, and development variables. (^DWR 2021a). This approach accounts for an advance planning period generally required by providers to identify response actions, such as demand management and replacement sources of water; develop contracts and/or infrastructure as necessary; and potentially obtain municipal bonds or otherwise secure funding if needed. UWMPs are intended to provide a framework for long-term water planning and to ensure that adequate municipal water supplies exist to meet existing and future demands. Urban water suppliers are required to coordinate with local planning agencies to assess those needs based on projected development, population growth, and other factors. Furthermore, the 2020 UWMP Guidebook encourages urban water suppliers to include information demonstrating progress toward reduced reliance on water supplies from the Delta (^DWR 2021a).

In addition, the State Water Board identified the need to update the Bay-Delta Plan and its implementation many years ago. Chapter 12, *Public Participation*, of the Staff Report summarizes the public participation activities that occurred during the environmental review and water quality control planning processes for the Sacramento/Delta update to the Bay-Delta Plan. The State Water Board provided many opportunities for interested parties to provide input on the Sacramento/Delta updates to the Bay-Delta Plan, and that valuable input was carefully considered and informed the revised proposed Plan amendments and this Staff Report. Accordingly, it is reasonable to assume that municipal water supplies have considered and planned for possible future changes in Sacramento/Delta water supplies.

Replacement Water Supply Costs

Some commenters asserted that the Staff Report's estimated costs for replacement water supplies are inaccurate and may be unrealistically low, and that municipal water supply economic effects would be greater than those identified in the Staff Report. Some commenters make reference to costs associated with specific efforts or projects, such as Metropolitan's Pure Water Southern California Project, to support their assertions.

In response to reduced Sacramento/Delta surface water supplies, water users may choose to modify their water supply portfolios by increasing the use of other sources of water and maximizing the use of existing water supplies. The Staff Report's analysis of municipal water supply economic effects, including replacement water costs used in the analysis, is based on the cost information provided in Section 8.3, *Costs Associated with Other Water Management Actions*. The representative unit costs and cost ranges for source type (groundwater use, groundwater storage and recovery, water transfers, water recycling, desalination, and water conservation and water efficiency measures) identified in Section 8.3 were obtained from economic literature and are the best available source on representative costs for other water management actions. The referenced academic and peer-reviewed studies relied upon for the analysis were particularly focused on determining representative costs of developing and utilizing alternative water supply sources. The sources include Reclamation 2013 (groundwater pumping), McCann et al. 2018 (surface water storage), Perrone and Rhode 2016 (groundwater storage and recovery), WestWater Research 2017 (water transfers), and Cooley and Phurisamban 2016 (recycled water and desalination). These studies, discussed below, involved the review and synthesis of multiple, or in some cases dozens, of California projects for sizes, as-built construction and operating costs, and related characteristics. Each was oriented to determining a cost-per-unit (e.g., acre-foot) of delivered water. While costs to construct and operate an individual projects may vary to some degree from the information presented in Section 8.3 based on site-specific information, the values presented in Section 8.3 remain the best available information given the geographic scale of the project and a good faith effort to estimate municipal water supply economic effects. The State Water Board is not obligated to conduct an exhaustive analysis using every possible cost associated with other water management actions for individual water users or actions within the study area. The analysis accurately reflects relative values of different resource effects and as a share of economic output at a particular point in time and is sufficient to inform decision makers.

To calculate the costs for water replacement of municipal water suppliers, annualized cost per acre-foot (AF) was needed for each alternative supply. "Annualized costs" include capital repayment plus operating costs. Below is a discussion of the ranges found from the research provided in Chapter 8, *Economic Analysis and Other Considerations*, of the Staff Report as well as specific costs identified in Section 8.3, *Costs Associated with Other Water Management Actions*, and the prices used in Appendix D, *Supplemental Municipal Supply Analysis Information* (Table CR 8.1-9). All costs, unless specified, including capital infrastructure components, were converted to annual and levelized recurring costs in order to provide comparison among options. Costs were first adjusted to a common year (2022) using the Bureau of Labor Statistics, Consumer Price Index for All Urban Consumers (CPI-U) (Bureau of Labor Statistics 2023), or adjusted to approximate year 2022 dollar equivalence when the source data projected future costs or the source data themselves were approximated. Where source data could not be fully adjusted to a common dollar year (e.g., forward-looking estimates or values reported without sufficient detail for conversion), such values were retained as reported to preserve fidelity to the underlying sources. Any resulting differences in dollar year are not expected to materially affect the relative comparison of costs across supply options.

Groundwater Pumping: Groundwater pumping costs can vary depending upon the condition and size of the aquifer, the depth of the wells, pumping yield, and pump size. Recent studies indicate groundwater pumping operations and maintenance costs can vary from approximately $100 to $1,000 per AF, but are typically less than $200 per AF (McCann et al. 2018; Perrone and Rhode 2016). A study in Los Angeles County of the full cost of pumping, treatment, conveyance, and delivery found an estimated total cost to be $739 per AF (Porse et al. 2018, Table 3), although the cost of pumping alone from an existing groundwater well was estimated at $340 per AF (Porse et al. 2018, Table 2). The cost of drilling a new municipal well can vary considerably, with costs dependent upon size, well depth, pumping yield, and attendant infrastructure for storing pumped water. The analysis of municipal water supply options includes a range of groundwater pumping costs that generally reflect regional differences in regional depth to groundwater and electricity price, based upon representative costs derived from municipal and industrial (M&I) modeling conducted for Reclamation (Reclamation 2013).

For the analysis in Section 8.5, *Municipal Water Supply Economic Effects*, any projected increased use of groundwater was assumed to derive from existing wells, and the expense incurred would be reflected in additional energy use from pumping. The groundwater pumping costs assumed for Sacramento and American River in Section 8.5 were derived from a Reclamation study which projected costs to 2030 (Reclamation 2013). In those locations, the 2030 cost estimates were used as reported, resulting in a slightly conservative estimate with minimal effect on relative cost comparisons. The cost for pumping additional groundwater in the Central Coast and Southern California is assumed to come from existing groundwater wells and accounts for cost of pumping, and are based California Porse et al. (2018) estimates for Los Angeles, applied consistently with the broader cost framework used in this analysis. Groundwater pumping costs assumed in Section 8.5 are appropriate because they represent real-world and region-specific estimates, although the Staff Report acknowledges that actual costs could vary to some degree from the estimates presented. The assumed prices used to support the analysis of municipal water supply economic effects are appropriately conservative and represent a good faith attempt to estimate replacement costs for water suppliers and to inform the analysis of municipal water supply economic effects.

Surface Water: Costs to construct or modify on-stream and off-stream reservoirs can vary based on project-specific characteristics, such as the size and location of the reservoir. A recent infrastructure study contained a meta-review of the cost of developing surface water storage in California; it found that the average cost to construct storage ranged from $580 to $2,200 per AF, with an overall average of $1,224 per AF (Dayton et al. 2016). The surface water storage prices assumed in Section 8.5, *Municipal Water Supply Economic Effects*, were based on McCann et al. 2018, which calculated the cost and estimated yield of five proposed storage projects and expressed in 2015 dollars. Given the large degree of uncertainty in cost determination for storage projects based on size, site-specific conditions, materials, hydrology, and other factors, costs were applied consistent with the broader cost framework used in this analysis to support comparability across alternatives. The cost range was from a representative sample of projects and not absolute limits; the low end of the range was applied to reflect “large storage” cost per AF, and the high end was applied to reflect “small storage” cost per AF. Specific projects for any provider could be lower or higher in cost than what was used in the analysis. The assumed unit prices in the analysis of municipal water supply economic effects are appropriately conservative and represent a good faith attempt to estimate replacement costs for water suppliers and to inform the analysis of municipal water supply economic effects.

Groundwater Storage and Recovery: Costs are generally incurred to capture and store stormwater, as well as to extract that water from the aquifer and treat it to drinking water standards. Total cost of a stormwater capture system can vary based on required well depth and the quality of receiving water that must be treated. Recent estimates for a larger scale (over 6,000 AF) system are approximately $590 per AF (Cooley and Phurisamban 2016; Cooley et al. 2019), with estimates ranging from $500 to $1,500 per AF depending on scale (McCann et al. 2018). A separate study of groundwater recharge projects found a cost range of $90 to $1,100 per AF for most projects, with a median cost of $390 per AF (in 2014 dollars) (Choy et al. 2014). A recent study focused on stormwater capture found the median cost of urban projects to be $1,180 per AF (Diringer et al. 2020).

The prices assumed for groundwater storage and recovery in the analysis were derived from a study that reviewed 106 “managed aquifer recharge” project grant applications in California and were based on the median cost of projects where managed aquifer recharge was the primary goal (Perrone and Rhode 2016). Costs were generally lower for projects relying on surface water and blended sources while stormwater was the most expensive option for rechange. Median cost of $320 for projects where the managed aquifer recharge project was the primary goal (Perrone and Rhode 2016) was selected as a representative value from the available literature and applied consistently with the broader cost framework used in Section 8.5, *Municipal Water Supply Economic Effects*, to analyze municipal water supply economic effects. These assumptions are appropriate because they rely upon an array of best available information and represent a good faith attempt to estimate replacement costs for water suppliers and to inform the analysis of municipal water supply economic effects.

Water Transfers: An analysis of transactions demonstrates some regional differences in terms of observed market prices. In the Sacramento River watershed, historical prices (dating to 2007) averaged around $100/AF, but were over $500/AF in 2014 and 2015. In contrast, water prices for users south of the Delta were observed to be higher than prices observed within the Sacramento Valley. From 2007 through 2013, average prices ranged between $150/AF and $250/AF but were generally higher during drier years. For example, in 2014, prices rose to an average of $779/AF. In the Southern California region, average prices generally ranged between $200/AF and $300/AF, with fluctuations in years with single-year transfers. (WestWater Research 2017).

Forecasting future water prices is complex, requiring knowledge and information regarding supply alternatives, future demand and market conditions, and behavior of willing sellers and buyers in response to market prices. The analyses in Staff Report assume that there could be greater demand pressure in the water transfer market such that future prices may be higher than recent historical trends. For the purposes of the municipal water supply economic effects analysis, future transfer prices are assumed to be $500 per AF for transfers to the Bay Area, $500 per AF for transfers to the Central Coast, $500 per AF for transactions to and within the San Joaquin Valley region, and $750 per AF for transfers to the Southern California region. More information on development of water transfer pricing can be found in the *Water Transfers* section of this common response.

Recycled Water: Recycled water is used for both potable and non-potable (e.g., landscape and agricultural irrigation) uses. Non-potable recycling ranges in cost from $1,500 to $2,100 per AF, according to a recent study (Cooley and Phurisamban 2016). Approximately $950 per AF of this cost is associated with the installation of "purple pipe" systems to distribute the water. For this reason, expanding an existing reuse facility may result in a somewhat lower facility cost but only a modest savings overall if additional pipeline is needed. A large-scale indirect potable reuse project (more than 10,000 AF/yr) is similar in cost at $1,600 to $2,000 per AF, and a smaller-scale project can average about $2,300 per AF (Cooley and Phurisamban 2016). Although the treatment cost is higher for an indirect potable facility, the distribution pipeline cost is much less since a separate conveyance system is not required. A study in Los Angeles County estimated the total cost of a full indirect potable reuse system to range from $1,551 to $2,641 per AF. This includes sewage collection, disinfection, and tertiary treatment; conveyance; spreading and infiltration; pumping; treatment; and delivery (Porse et al. 2018).

The prices assumed for recycled water were based on the median cost for non-potable and indirect potable reuse, $1,540 and $2,360 in 2015 dollars, respectively. These costs were applied consistently with the broader cost framework used in Section 8.5, *Municipal Water Supply Economic Effects*, to analyze municipal water supply economic effects. These assumptions are appropriate because they used the best available data at the time of the analysis, which was a comprehensive analysis of alternative water supply options in California, and represent a good faith attempt to estimate replacement costs for water suppliers.

Desalination: In California, desalinated water is not a common drinking water supply by volume. For many geographic areas within the state, desalination is impractical because of a lack of suitable saline source water and is not economically feasible because more cost-effective water supply alternatives are available. However, desalination technologies continue to improve; they are becoming more cost effective and are being used in the Central Coast and Southern California regions. Seawater desalination, with a median cost of $2,100 per AF for large projects and $2,800 per AF for smaller projects, is currently among the most expensive water supply options. Brackish water desalination is less expensive, at median prices of $1,100 to $1,600 per AF, due to lower energy and treatment costs (Cooley and Phurisamban 2016). Brackish and seawater costs were applied consistent with the broader cost framework used in Section 8.5, *Municipal Water Supply Economic Effects*, to analyze municipal water supply economic effects.

Table CR 8.1-9 below summarizes the replacement water supply costs included in the municipal supply analysis. These costs are also shown in Tables D-9, D-12, D-15, D-18, D-21, D-24, and D-27 in Staff Report Appendix D, *Supplemental Municipal Supply Analysis Information*. As stated in Chapter 8, *Economic Analysis and Other Considerations*, and reiterated above, developing representative alternative water costs is complex and relies on many sources. The analysis was intended to capture a reasonable representative cost estimate. Overall, these costs represent good faith estimates and assumptions. Therefore, it can be concluded that these cost estimates are appropriate for the economic impact analysis and further the argument that the entire economic analysis is considered reasonable.

Table CR 8.1-9. Water Costs for Alternative Water Supplies as Shown in Appendix D

Appendix D Water Replacement Source	Cost ($ / AF)
Ground Water - Sac	75
Ground Water - AmR	50
Ground Water – S. Cal	400
Surface Water – Large	500
Surface Water – Small	2,000
Groundwater Storage and Recovery (GSR)	400
GSR Wastewater	1,020
Transfers – SF Bay Area	500
Transfers – SJV	500
Transfers – Central Coast	500
Transfers – So. Cal	750
Recycled Water – Non-potable	1,900
Recycled Water – Ind. Potable	2,910
Desalination – Brackish	1,990
Desalination - Seawater	3,460

Source: Appendix D, *Supplemental Municipal Supply Analysis Information*, Tables D-9, D-12, D-15, D-18, D-21, D-24, and D-27.

Costs and Constraints Associated with New and Modified Municipal Infrastructure

Some commenters asserted that the Staff Report does not adequately consider the time, infrastructure investments, or capital improvements that may be necessary for municipal water suppliers to develop alternative water supplies or implement demand management measures in response to reduced Sacramento/Delta surface water deliveries. However, the Staff Report appropriately considers actions that entities may take that would involve construction to modify or build new facilities and infrastructure to supplement or conserve surface water supplies and other construction projects that may result from implementation of the proposed Plan amendments in Section 7.22, *New or Modified Facilities*. Section 8.9 of the final Staff Report (Section 8.8 of the 2023 draft Staff Report), *Costs Associated with New or Modified Facilities*, directly addresses the capital infrastructure, cost ranges, feasibility constraints, and time considerations involved in developing alternative municipal water supplies and provides examples of realized projects.

The Staff Report identifies the types of infrastructure needed to develop alternative water supplies, such as new or modified dams/reservoirs and points of diversion; groundwater wells and groundwater storage and recovery projects; and new or modified drinking water treatment plants, including desalination plants and wastewater treatment plants. Section 8.9, *Costs Associated with New or Modified Facilities*, of the final Staff Report incorporates detailed cost information for new 52infrastructure. For instance, Section 8.9.3, *Groundwater Wells and Groundwater Storage and Recovery*, of the final Staff Report describes cost of new groundwater wells depending upon site characteristics, location, well depth, casing diameter, size of pump system required, and conveyance system to connect to an existing municipal system. Section 8.9.2.2, *New or Modified Wastewater Treatment Plants and Recycled Water*, of the final staff report provides cost ranges for other alternative supplies, explicitly including capital expenditures for non-potable recycling, large scale and a smaller scale indirect potable reuse projects. Section 8.9.2.1, *New or Modified Drinking Water Treatment Plants*, of the final Staff Report recognizes various components of a typical desalination project, such intake system, pretreatment facilities, post-treatment facilities, product water storage, pump stations, and product water transmission pipelines. In particular, seawater desalination is among the most expensive water supply options, while brackish water desalination is somewhat less expensive. Reservoir and surface storage projects are also assigned quantified cost ranges.

The Staff Report's analysis acknowledges that the feasibility of alternative water supplies is dependent on physical, hydrologic, institutional, and temporal constraints. For example, Section 8.3, *Costs Associated with Other Water Management Actions*, discusses regional variation in supply sources, with some regions primarily depending on groundwater, while other regions depend primarily on surface water supplies. The Staff Report also recognizes site-specific variation and discusses groundwater pumping costs depending upon the condition and size of the aquifer, the depth of the wells, pumping yield, and pump size, and provides information from recent studies on groundwater pumping operations and maintenance costs. The Staff Report recognizes that it may take time to develop alternative water supplies and that many measures are a part of long-term water supply planning efforts.

In summary, the Staff Report explicitly addresses the capital infrastructure, cost ranges, feasibility constraints, and time considerations involved in developing alternative municipal water supplies. Descriptive discussions, quantitative cost data, and real project examples included in the Staff Report demonstrate that the economic analysis incorporates the infrastructure and temporal factors contrary to what commenters allege. While the analysis does not model construction schedules for each agency, it clearly embeds the physical requirements, costs, and implementation considerations that underlie the development of alternative supplies.

Municipal Water Rates

Several commenters asserted that reductions in Sacramento/Delta surface water supply to municipal use would cause municipal water providers to increase water rates, resulting in water affordability challenges. However, water rates depend on a range of factors unique to each provider, and there is no direct relationship between reduced surface water supply and the water rates paid by customers.

Water rates are set based on expected revenue requirements to cover operating expenses, debt servicing, and capital project spending. Because there are many aspects of municipal water service that factor into determining the water rates that are charged to customers by municipal water providers, a change in water supply does not necessarily result in changes to the water rates. Municipal water providers are responsible for acquiring water supply, managing storage and conveyance systems, treating water, maintaining distribution infrastructure, budgeting for costs and revenues, and planning for future water needs. Water rates are determined by accounting for all of these activities. In this way, the water rates charged already account for the portfolio of water supplies, as well as the cost of conservation incentives and programs. Municipalities and urban water providers typically develop a water management plan, such as an UWMP, that provides details of the water infrastructure and facilities, their condition and maintenance requirements, projects in development, and future needs. The plan also includes budgeting information and requirements for capital improvements, such as expansion or new facilities.

Water suppliers are required to prepare UWMPs every 5 years, and to demonstrate that they have strategies and resources in place to address current and future water needs. UWMPs provide water suppliers with an opportunity to consider how changes in supply and demand potentially affect each water supplier and its ratepayers. Through UWMP effort, water suppliers can provide reliability while avoiding risk associated with dependence on one or a few sources of water. Many water providers may have already built into their financial planning and rate setting capital investment and the incorporation of future sources of supply and associated infrastructure to address ongoing and future needs. For example, reductions in Sacramento/Delta surface water supplies could cause municipal water suppliers to adjust their planning and require revisions to their water supply portfolios, including instituting new efforts to conserve water or develop or acquire additional sources of water. However, the planning mechanism is already in place to ensure replacement water can be transitioned into their operations. Although it is possible that some municipal water suppliers could incur additional costs related to acquiring new water supplies and utilizing other water management actions, significant increases in water rates are unlikely, particularly given that municipal water suppliers may have multiple options for developing and acquiring alternative water supplies and given available funding options. Additional discussion is provided below on potential sources of funding for municipal water conservation and alternative water supplies.

Multiple commenters asserted that increases in municipal water rates would be particularly challenging for economically disadvantaged communities (DACs). With respect to municipal water providers that serve DACs, many larger providers have flexibility or options in the way they charge their customers for water service so as to minimize the economic effects to the DACs in their service areas. While municipal water suppliers are already required to plan for future conditions and possible water shortages as discussed above, it is possible that some municipal water suppliers could incur some additional costs and could choose to absorb those costs wholly or in part through water rate increases to customers. Municipal water suppliers could implement adjustments to rate structures to reduce possible effects on water rates to DACs.

The rate structure used by the water provider can influence how DACs are affected, and rate structures can be designed to avoid disproportionately affecting lower-income households. Most water providers, such as EBMUD, apply a fixed fee plus a volumetric cost as an increasing block rate structure with lower prices for initial consumption blocks designed to cover basic needs, and higher prices for larger consumption volumes, often based on meter sizes, aiming to make water more affordable for low-income households.

Additionally, alternative pricing structures, such as adopting “budget-based rates” could be explored to further protect low-income households. Budget-based rates are effectively individualized increasing block rates in which a household’s “budget” is assigned a rate that is based on household and property characteristics and weather (Wichman 2025). Other rate-setting strategies involve a growing trend to use average winter consumption to create individualized rate structures tailored to revealed indoor use (Smith 2022). Water providers can also explore setting individualized fixed monthly service fees that vary by income (e.g., by setting service fees proportional to property values) (Wichman 2024).

One strategy to minimize effects on DACs involves non-price conservation measures such as outdoor watering restrictions, public education campaigns, and xeriscaping promotion, which tend to result in greater reductions for higher income households who tend to have larger properties and more extensive landscaping. This can lead to more substantial absolute reductions in water use on the level of municipal water supplier and less cost overall that needs to be absorbed by the supplier or passed on to consumers (Renwick and Green 2000).

Lastly, there are a number of funding sources available to assist municipalities in developing alternative water supply projects as well as financial and technical assistance programs available to assist public water systems serving DACs. These programs are designed to ensure access to safe, clean, and affordable water supplies and maintain compliance with all applicable water laws and regulations. The State Water Board is at the forefront of assisting DACs with obtaining clean, safe, and reliable water supplies. In doing so, the State Water Board is making its commitment to the human right to water through financial assistance, technical assistance, consolidations, SGMA oversight, and other means. Staff Report Chapter 10, *Economically Disadvantaged Communities*, discuses various financial and technical assistance programs available to assist public water systems serving DACs. Additional discussion is also provided below on potential sources of funding for municipal water conservation and alternative sources of water.

Proposition 218 and AB 1827

Some commenters asserted that Proposition 218 could exacerbate water affordability challenges for customers that could occur as a result of reduced Sacramento/Delta supply. Proposition 218, enacted by California voters in 1996, is the most recent amendment to the California Constitution designed to limit the ability of local governments to raise taxes. More specifically, it requires that property-related fees not exceed the proportional cost of providing services to the fee payer, and that local government fees not be used for other purposes such as enhancing general revenue. Some commenters asserted that Proposition 218 prevents municipal water providers from offering subsidized water rates to customers because it requires that fees reflect the cost of providing services.

Proposition 218 is not a blanket prohibition on tiered water rates. In *Capistrano Tax Payers v. City of San Juan*, a California Court of Appeals ruled the City’s water pricing violated the constitutional requirement that fees not exceed the proportional cost of the service attributable to the parcel because the City did not adequately calculate the cost attributed to each parcel. In fact, the City “admitted it effectively used revenues from the top tier [of its rates] to subsidize below-cost rates for the bottom tier.” (*Capistrano Tax Payers v. City of San Juan Capistrano* (2015) 235 Cal.App.4th 1493, 1499.) However, even in ruling against the City, the Court was emphatic that “there is nothing at all in subdivision (b)(3) or elsewhere in Proposition 218 that prevents water agencies from passing on the incrementally higher costs of expensive water to incrementally higher users. That would seem like a good idea. But subdivision (b)(3) does require they figure out the true cost of water, not simply draw lines based on budgets." (*Id.*, at p. 1510-1511).

Nevertheless, *Capistrano Tax Payers* and subsequent litigation have created confusion regarding tiered water rates. In 2024, the Legislature passed Assembly Bill 1827 to clarify that Proposition 218 does not prohibit tiered rates based on "the incrementally higher costs of water service associated with higher water usage demands, the maximum potential water use, or projected peak water use of parcels." (Government Code, § 53750.6.) A legal analysis by California Special Districts Association on Assembly Bill 1827 recognized that special districts may allocate such costs in any manner that reasonably assesses the cost of service, including based on meter size or peaking factors. The analysis went on to note that agencies "must continue to justify these incremental costs with evidence of higher usage and increased burden, and whether a special district's allocation of incremental costs violates Proposition 218 will hinge on whether it has sufficient evidence supporting its rates." (CSDA 2024).

Assembly Bill 1827 recognizes that Proposition 218 does not prohibit municipal water providers from adjusting their rates in a more targeted manner. For example, one study showed that high income households were able to curtail more water usage during drought, in part due the fact that high income households use more water overall when compared to low-income households (Rachunok and Fletcher 2022). Another study found that higher income households use more water compared to lower income households; specifically, the study found that for every $10,000 increase in median household income, per capita indoor water use increased by roughly 0.3 gallons per capita per day (GPCD) (DWR 2021). This means that municipal water providers have the flexibility to fairly adjust or raise rates to target households with higher per capita water use, which could provide sufficient revenue to providers without disproportionately impacting DACs who use less water.

Third-Party Economic Analysis

As a part of its comments, EBMUD's submittal included a third-party economic analysis titled *The Economic Impacts of Water Shortages in the EBMUD Service Area* (Sunding and Browne 2022), to support EBMUD's assertions that the analysis of municipal water supply economic effects presented in Section 8.5, *Municipal Water Supply Economic Effects*, greatly underestimates the potential costs to affected San Francisco Bay Area municipal service providers under the 45 and 55 scenarios. This section responds to these comments, and discusses the differing approaches taken in the Staff Report and in the Sunding and Browne report.

As described in Section 8.5.1, *Approach to Analysis*, the Staff Report estimates the marginal cost associated with shifting water sources within existing water portfolios or obtaining water from other sources. The costs of obtaining additional water supplies depends on the amount of reduced Sacramento/Delta supply, the availability of other water supplies, the amount of water municipalities have in reserve, and the general costs for installing or implementing other water supplies. Other water supplies, such as groundwater pumping, surface storage, water transfers, recycled water, and desalination, were identified as potential sources based on review of UWMPs and other planning documents. Table 8.5-5 in the Staff Report summarizes the range of potential economic costs for municipalities in the San Francisco Bay Area to respond to reduced Sacramento/Delta supply. For the 55 scenario, the Staff Report estimates costs ranging from $32.2 to $154.8 million per year for the San Francisco Bay Area.

In contrast, Sunding and Browne's economic analysis uses a different approach that does not attempt to calculate the marginal cost to respond to reduced Sacramento/Delta supply by replacing water supplies. Rather, Sunding and Browne estimate economic effects within EBMUD's service area by estimating the cost of not replacing the reduced supply. This is a water rationing-only approach, which limits water supply deliveries to all EBMUD customers without an attempt to manage water demand or obtain replacement supplies. The Sunding and Browne analysis is based on estimates of customer welfare losses, employment losses, business sales losses, and EBMUD revenue losses for 2020 and 2050 levels of demand presuming no replacement supply strategies to address water supply reductions. For the 55 scenario and assuming 2050 demand, Sunding and Browne estimates that welfare losses to EBMUD customers under a water rationing-only approach would be $181 million in an average year, and up to $1.9 billion in the worst drought year, and business sales losses would be $7.53 billion in an average year, and up to $56 billion in the worst drought year. These costs are much larger than those in the Staff Report.

The water rationing-only approach used in Sunding and Browne's analysis is conceptually different than the Staff Report's municipal water supply analysis approach, and it does not account for the range of adaptive demand-side strategies that EBMUD has already implemented or is positioned to expand in the future, such as water conservation, development of alternative water supplies, or infrastructure improvements as discussed further below. The water rationing-only is inconsistent with EBMUD's demonstrated history of proactive planning, infrastructure development, and financial investment in supply diversification as described in its UWMPs and other documents. Additionally, Sunding and Browne's analysis assumes that EBMUD will not pursue additional investments, partnerships, or policy changes in response to changing water supply conditions, which does not align with its demonstrated planning practices. Overall, Sunding and Browne's analysis is not comparable to the analysis described in the Staff Report, and does not change the conclusions of the Staff Report's economic analysis.

Assessment of Analysis

This section provides a more detailed assessment of Sunding and Browne's analysis.

Rationing-only Approach. Sunding and Browne's analysis assumes that EBMUD will not pursue additional investments, partnerships, or policy changes in response to changes in water supply. This assumption is not consistent with EBMUD's past practices and planning efforts, including those described in its UWMP. Because the water rationing-only approach used in Sunding and Browne's analysis fails to consider EBMUD's full suite of water management strategies, their analysis overestimates the effects of the flow scenarios on EBMUD, including effects on EBMUD's operations, customers, and long-term water supply reliability.

While the Staff Report's municipal water supply economic analysis considers the costs of obtaining additional water supplies, the water rationing-only approach used by Sunding and Browne presents unrealistic results that does not consider the water management strategies identified in EBMUD's UWMP or EBMUD's demonstrated planning practices. In its UWMP, EBMUD describes a diverse portfolio of water supply management strategies to achieve resiliency against drought, population growth, and climate change, such as fully utilizing existing sources, replacing water by obtaining water through transfers from other suppliers, or by developing new sources of water supply (^EBMUD 2016; EBMUD 2021a). In addition to imported Sacramento/Delta water supplies, EBMUD has developed local surface water supplies, interagency water transfers and exchanges, recycled water, water conservation programs, and ongoing infrastructure improvements (^EBMUD 2016;

EBMUD, 2021a). EBMUD's 2020 UWMP also describes continued planning for desalination and other regional initiatives to diversify its water supply portfolio. For example, EBMUD participates in the BARR Partnership, which includes agencies such as the San Francisco Public Utilities Commission (SFPUC), Contra Costa Water District, Santa Clara Valley Water District, and others to coordinate on drought response, emergency interties, and long-term infrastructure investments to improve collective water supply reliability. These strategies reflect broader Bay Area practices aimed at reducing reliance on any single source and improving long-term adaptability.

Demand Forecasting. Sunding and Browne's analysis includes estimates that rely on 2050 demand projections, which may not reasonably estimate future water needs within EBMUD's service area. EBMUD has historically overestimated its future water needs. For example, in its 2000 UWMP (Table 4-1), EBMUD overestimated its future (2020) water demand, forecasting that 2020 demand would be 229 million gallons per day (MGD) while the 2020 UWMP reported the 2020 demand was only 181 MGD (Table 3-1) (EBMUD 2001, EBMUD 2021a). In another example, Table 2 of Sunding and Browne (2022) shows institutional water demand increasing from 10.56 MGD in 2020 to 15.84 MGD in 2050. However, the historical trends show institutional water demand falling from its peak of approximately 12 MGD around 1976 to approximately 6 MGD in 2020, with total use remaining relatively constant (Figure 3-3 in EBMUD 2021a). Therefore, it is not clear why institutional water demand would be expected to increase in the future.

Additionally, EBMUD's 2050 water demand estimates rely on an assumption of steady population growth through 2050, which does not align with more recent population trends in the San Francisco Bay Area. The San Francisco Bay Area experienced a net population decline of more than 150,000 residents between April 2020 and July 2025. Within EBMUD's service area, Alameda County's population fell by about 45,000 people and Contra Costa County's population saw only a modest increase of 4,000 people (U.S. Census Bureau 2026). Given these more recent trends, assuming consistent population growth through 2050 may overestimate both the future population of the San Francisco Bay Area and future water demand within EBMUD's service area.

Use of Elasticity Values. Sunding and Browne's analysis uses elasticities[2] to parameterize (or isolate) causal links between water and various economic factors. The Sunding and Browne analysis appears to rely on elasticity values from a 1994 report titled "The Economic Impact of Water Delivery Reduction on the San Francisco Water Department's Commercial and Manufacturing Customers," by MHB Consultants (MHB Consultants 1994). However, it is not fully clear how the elasticity values from MHB Consultants (1994) were applied for Sunding and Browne's analysis.

In addition, the elasticity values from MHB Consultants (1994) are dated and, given the population, economic, and water supply changes that have occurred in the San Francisco Bay Area since the 1990s, it is unclear if the assumed elasticity values are reflective of current and future conditions within EBMUD's service area. For example, within the San Francisco Bay hydrologic region, per

[2] An economic variable is considered to be "elastic" with respect to another if it responds strongly to changes in that variable. If an economic variable is inelastic, it responds only weakly. Necessities are inelastic, while luxury goods are usually elastic. An elasticity ratio greater than one indicates a product demand is elastic and changes in price will significantly change demand. Common examples of elasticities include the price elasticity of demand, which shows how consumers respond to price changes; income elasticity of demand, which measures how demand changes with income; cross-price elasticity, which captures relationships between goods; and supply elasticity, which reflects how producers respond to price changes. These elasticities are important because they help determine the magnitude of economic impacts, such as who bears the burden of a tax, how markets adjust to policy changes, and how sensitive outcomes are to key assumptions in economic analysis.

capita water use has declined by 20 percent from 1967 (162 GPCD) to 2022 (130 GPCD) (Abraham and Cohen 2026). For urban water uses, this per-capita decline is primarily attributed to improved efficiencies, denser urban development, and shifts toward less water-intensive economic activities (Pacific Institute 2026). These trends reflect a decoupling of both population and economic growth from water use.

In addition, the MHB Consultants 1994 report analyzes the significant economic sectors for the San Francisco Water Department (SFWD)[3] service area in 1992, which was much more manufacturing-oriented than the EBMUD service area in 2024 that has a more service-oriented economy.[4] The responses to changes in water supply are much more pronounced for industrial or product manufacturing businesses, relative to commercial or service-oriented businesses and residential use (Worthington 2010; Bowman et al. 2018). This is true because firms treat water as an input to production and often seek or have options for substitution, including recycling or technology adjustments (Worthington 2010). For these reasons, reductions in water supply may have a lesser effect on job or business losses than assumed by the elasticity values used by Sunding and Browne.

Customer Welfare Losses from Urban Water Supply Disruptions. Sunding and Browne's analysis assumes that every surface water shortage translates to customer water demand rationing. Sunding and Browne define customer welfare loss as the effect resulting from forced reductions in water usage due to demand rationing, without action to incentivize water conservation or to recover revenue during extreme droughts. Considering EBMUD's resilient response to recent water shortage events (^EBMUD 2016, EBMUD 2021a) and plans for water shortage response actions (EBMUD 2021b), this appears to be an invalid assumption and likely leads to exaggerated customer welfare losses.

Sunding and Browne's estimated economic effects associated with water shortages in EBMUD's service area are based on the methodology used in Buck et al. (2016), which estimates an annual welfare loss for supply disruptions between 10 to 30 percent ($1,458 per acre-foot to $3,426 per acre-foot, respectively). The approach described by Buck et al. (2016) treats annual water usage as uniform without considering the adaptability of customers to periods of water shortages, which may lead to overstated welfare loss estimates. As documented in EBMUD's 2015 and 2020 UWMPs, customers have consistently adapted to periods of water shortage by reducing irrigation, fixing leaks, and prioritizing essential indoor uses, which are adaptations not captured in Buck et al. (2016).

Estimated Employment Losses. Sunding and Browne's forecasted job losses appear to be based on reduced water supply to commercial and industrial customers using elasticity values obtained from MHB Consultants (1994), but the methods used to estimate employment losses are not fully documented by Sunding and Browne. While not fully documented, it appears that Sunding and Browne use elasticity values to estimate employment losses within EBMUD's service area that were derived from a survey of businesses from the San Francisco Water District service area in 1994, as documented in MHB Consultants (1994), that may not be a suitable reference to estimate employment effects under current and future conditions. Substantial changes in the Bay Area

[3] At the time of the MHB, 1994 report, the San Francisco Water Department (SFWD) was a department under the jurisdiction of the San Francisco Public Utilities Commission (SFPUC). While SFPUC is more known in contemporary analyses, this section will use SFWD as that was the language used in the MHB analysis.

[4] The year 2024 was selected to represent contemporary economic conditions as it is the latest year for available data from the Bureau of Labor Statistics.

economy have occurred since 1994, with a noted shift away from manufacturing to service jobs as described above.

In addition, Sunding and Browne assumed linear employment growth until 2050, which introduces a high level of uncertainty about potential future conditions. The increasing employment projections are based on data from the Plan Bay Area 2040 (MTC & ABAG 2017). The Plan Bay Area 2040 was adopted in 2017, which doesn't account for the employment and population changes to the region such as those that occurred since 2020 due to the COVID-19 pandemic (Varian 2026).

Estimated Business Sales and Direct Revenue Losses. Sunding and Browne calculates EBMUD's revenue losses under the assumption that real water rates remain constant from 2020 to 2050 and that no drought surcharges or rate adjustments would be implemented. This assumption does not align with historical trends or EBMUD's stated policies. Sunding and Browne's projections assume that water supply shortages translate directly to unrecovered revenue, which ignores EBMUD's Water Shortage Contingency Plan (WSCP) and may inflate business sales and direct revenue losses. EBMUD's WSCP includes measures specifically designed to maintain financial stability during periods of reduced demand.

Potential Sources of Funding for Municipal Water Conservation and Alternative Water Supplies

Multiple commenters expressed concerns that reduced Sacramento/Delta water supplies could result in increased costs to municipal water providers. Some commenters asserted that municipal water suppliers would require financial assistance to develop alternative water supplies or implement water conservation programs upon Plan implementation, and suggested that some suppliers may require financial assistance to develop new water supplies or conservation programs. Some commenters suggested that funding may be a significant barrier to implementing water conservation. Some commenters also expressed concerns that these costs could disproportionately affect DACs.

The Staff Report provides information about potential sources of funding for municipal water supplies and water conservation in multiple chapters. Staff Report Chapter 10, *Economically Disadvantaged Communities*, discusses various financial and technical assistance programs available to assist public water systems serving DACs. These programs are designed to ensure access to safe, clean, and affordable water supplies and maintain compliance with all applicable water laws and regulations. In addition, Section 8.5.10, *Potential Sources of Funding for Municipal Water Conservation and Alternative Water Supplies,* summarizes potential sources of funding for municipal water supply and conservation. A variety of programs are available to provide funding for water conservation efforts in California. Municipal water providers are often eligible to secure funding from public and private sources for water conservation initiatives and measures. These sources include grants; single purpose appropriations from federal, state, and/or local legislative bodies; municipal bond indebtedness; and low-interest loans from government institutions. Federal agencies with funding for various forms of water conservation include the United States Environmental Protection Agency, United States Department of Agriculture's (USDA) Rural Utilities Service, USDA's Rural Business-Cooperative Service, U.S. Economic Development Administration, U.S. Department of Housing and Urban Development Office of Community Planning and

Development, and the U.S. Department of Health and Human Services. Several example funding sources are identified in Section 8.5.10.

This section provides updates related to the funding sources discussed in Section 8.5.10, *Potential Sources of Funding for Municipal Water Conservation and Alternative Water Supplies,* and discusses an additional new funding source, Proposition 4, that became available more recently. These and other funding sources could be utilized by municipal water providers to implement water conservation or develop alternative water supplies.

Some commenters asserted that water conservation measures will take time to implement, and are dependent on responses from customers. The pace of implementation of water conservation measures will vary depending on project feasibility, resource availably, and competing priorities. The Staff Report acknowledges that demand reduction actions, such as infrastructure improvements or installation of water-efficient appliances and fixtures would take time to fully implement, and that costs to implement water conservation programs can vary. However, water conservation is often considered the fastest, easiest, and most cost-effective way to extend existing supplies.

Proposition 1

As discussed in Chapter 8, *Economic Analysis and Other Considerations*, Proposition 1 of 2014 authorized $7.545 billion in general obligation bonds for water projects including surface and groundwater storage, ecosystem and watershed protection and restoration, and drinking water protection (SWRCB 2019). The State Water Board administers Proposition 1 funds for five programs: small community wastewater, water recycling, drinking water, stormwater, and groundwater (SWRCB 2019). The projects funded through Proposition 1 primarily focus on technical assistance and infrastructure (e.g., feasibility studies or providing wellhead treatment on a groundwater well). As of 2026, the State Water Board has committed approximately $7.52 billion in Proposition 1 funding for over 1946 projects (CNRA n.d.).

Drinking Water State Revolving Fund

As discussed in Chapter 8, *Economic Analysis and Other Considerations*, the American Recovery and Reinvestment Act of 2009 appropriated $2 billion to the Drinking Water State Revolving Fund (DWSRF) to help states finance infrastructure projects related safe drinking water. Installations of new water meters as well as upgrades of existing water meters are eligible for this funding. In California, the Drinking Water State Revolving Fund Program provides financing to publicly owned and privately owned community water systems as well as non-profit or publicly owned non-community systems.

The State Water Board's Division of Financial Assistance continues to administer the DWSRF, which assists public water systems in financing the cost of drinking water infrastructure projects needed to achieve or maintain compliance with Safe Drinking Water Act requirements. Many projects have been funded through the DWSRF in recent years. For example, as described in the State Water Board's Drinking Water State Revolving Fund Annual Report for State Fiscal Year 2023-2024 (SWRCB 2025), the State Water Board actively administered the DWSRF in fiscal year 2023-2024 to provide subsidized financing for a variety of small and large public water systems, which served both disadvantaged and non-disadvantaged communities, throughout California.

WaterSMART Program

As discussed in Chapter 8, *Economic Analysis and Other Considerations*, another source of funding for metering is the WaterSMART (Sustain and Manage America's Resources for Tomorrow) Program, established in 2010. WaterSMART enables all bureaus within the U.S. Department of the Interior to work with states, tribes, local governments, water agencies and non-governmental organizations to provide a sustainable water supply. An example of a metering project partially funded by WaterSMART is a 2017 project in San Bernardino County to upgrade 105 domestic and commercial water meters in Oro Grande. About half the cost of the $150,000 project is funded by a WaterSMART grant (Reclamation 2017).

As of Fiscal Year 2026, California has 11 active multi-year projects funded wholly or in-part by the WaterSMART program. These projects include efforts related to water savings, groundwater protection, infrastructure modernization, groundwater recharge, and supporting DACs (NRCS n.d.). As of November 2025, funding opportunities for the Small-Scale Water Efficiency Program, Applied Science Grants, Drought Response Program, and Large-Scale Water Recycling are currently under development (Reclamation 2026).

Proposition 4

Proposition 4, the Safe Drinking Water Wildfire Prevention, Drought Preparedness, and Clear Air Bond Act of 2024, authorized $10 billion in general obligation bonds for projects related to safe drinking water, wildlife prevention, drought preparedness, and clean air. This funding will be distributed over multiple years and allocated across multiple funding programs. The first year of implementation funding for Proposition 4 was authorized for fiscal year 2025-2026, and authorized the state to spend approximately $3.5 billion. Of this amount, approximately $1.2 billion in Proposition 4 funding was authorized for water-related activities, such as $232 million for DWR's Dam Safey and Climate Resilience Local Assistance Program, $183 million for water quality and safe drinking water administered by the State Water Board, and $153 million for water use and recycling administered by the State Water Board (Legislative Analyst's Office 2025).

Proposition 4 contains specific directives for funding relating to economically disadvantaged communities. In particular, Proposition 4 mandates that at least 40 percent of the total funds available are to support vulnerable populations, economically disadvantaged communities, and severely economically disadvantaged communities. At least 10 percent of the total funds available are to be allocated for projects that directly benefit severely disadvantaged communities (Government of California 2024).

Water Transfers

Water transfers, which include exchanges and purchases of water, are an important component of water resource management in California. The extensive network of water conveyance infrastructure developed through state, federal, and locally funded projects, most notably the CVP and SWP, is used to facilitate water transfers. Water can be transferred from a seller to a buyer through networks of rivers, canals, aqueducts, and pipelines. Although the SWP and CVP are the most extensive storage and conveyance projects involved in transfers, many major local and regional water suppliers are involved in transfers, especially in-basin transfers.

The Staff Report discusses other water management efforts that water users have or could develop to continue to meet water supply needs with reductions of Sacramento/Delta water supplies, including water transfers, in several chapters and sections. Section 6.6.1.2, *Water Transfers*, provides an overview of water transfers and provides a summary of water transfers in recent years. The environmental analysis presented in Chapter 7, *Environmental Analysis*, includes an evaluation of actions that may be taken in response to changes in water supply including other water management actions (including water transfers) that may be utilized to offset reductions in surface water (see Sections 7.3 through 7.20). Section 8.3, *Costs Associated with Other Water Management Actions*, describes the potential costs for implementation and operation and maintenance of other water management actions, including water transfers. Section 8.5, *Municipal Water Supply Economic Effects*, estimates the potential costs to affected municipal service providers of securing reliable water supplies, and considers water transfers as an alternate water supply option.

Multiple commenters expressed concern over the feasibility and costs of water transfers as an alternative water supply source under the flow scenarios. Multiple commenters asserted that the Staff Report underestimates the costs of water transfers and that the availability of water for transfer would decrease and the price of water would increase following implementation of the Sacramento/Delta update to the Bay-Delta Plan. Some commenters asserted that water transfers may not provide for a reliable alternate water supply source following implementation of the flow scenarios because the amount of water available for transfers would decrease with new flow requirements. Commenters also asserted that it is not realistic to assume that water transfers would be available and utilized to mitigate for the impacts of water supply reductions under the flow scenarios.

The Staff Report acknowledges that Sacramento/Delta surface water supplies would be reduced following implementation of the Sacramento/Delta update to the Bay-Delta Plan. As discussed in Section 6.6.1.2, *Water Transfers*, it is difficult to predict with certainty how reduced Sacramento/Delta surface water supplies will affect water transfers. With new instream flow and cold water habitat requirements, overall supplies of water from the Sacramento/Delta will decline. This may result in less water available for transfer. In addition, groundwater substitution and pumping transfers could be less feasible due to SGMA. However, it could incentivize transfers as the value of transfer water increases, leading to transfers from lower value temporary crops to higher value municipal uses and permanent crops.

Section 8.3.3, *Water Transfers*, in the Staff Report discusses that the market price for transferred water can vary widely and is affected by available seller supply and buyer need, supply reliability, transaction volume, duration of the transfer, location of both seller and buyer, and available transport infrastructure. A buyer’s end use is a key determinant of purchase price. Municipal purchasers generally pay higher prices than other users to acquire water. Refuge and agricultural buyers have generally acquired water at the lowest cost. However, during the severe drought in 2014–2015, agricultural buyers paid a premium above municipal buyers to prevent the loss of established tree crops. (WestWater Research 2017).

An analysis of transactions demonstrates some regional differences in terms of observed market prices. In the Sacramento River watershed, historical prices (dating to 2007) averaged around $100/AF, but were over $500/AF in 2014 and 2015. In contrast, water prices for users south of the Delta were observed to be higher than prices observed within the Sacramento Valley. From 2007 through 2013, average prices ranged between $150/AF and $250/AF but were generally higher during drier years. For example, in 2014, prices rose to an average of $779/AF. In the Southern

California region, average prices generally ranged between $200/AF and $300/AF, with fluctuations in years with single-year transfers. (WestWater Research 2017).

Forecasting future water prices is complex, requiring knowledge and information regarding supply alternatives, future demand and market conditions, and behavior of willing sellers and buyers in response to market prices. The analyses in the Staff Report assume that there could be greater demand pressure in the water transfer market such that future prices may be higher than recent historical trends. For the purposes of the municipal water supply economic effects analysis presented in Section 8.5, *Municipal Water Supply Economic Effects*, future transfer prices are assumed to be $500 per AF for transfers to the Bay Area, $500 per AF for transfers to the Central Coast, $500 per AF for transactions to and within the San Joaquin Valley region, and $750 per AF for transfers to the Southern California region.

The future water transfer prices assumed in Section 8.5, *Municipal Water Supply Economic Effects*, were estimated based on historical data and market trends, and are higher than historical averages for all water year types. These estimates were derived from market data assembled by WestWater Research. WestWater Research compiled information on historical water transfer prices to develop average estimated prices across all hydrologic conditions (WestWater Research 2017). These values were then adjusted to 2022 dollars, and an additional cost to account for the potential overall reduction in supply was added to the estimated price. Overall, the future transfer prices of $500/AF and $750/AF assumed in Section 8.5 are appropriate and are conservative estimates of average water transfer price across all hydrologic conditions. The assumed future transfer prices of $500/AF and $750/AF are considerably higher than the average observed market prices identified above ($100/AF in the Sacramento River watershed since 2007, and $150-$250/AF for users south of the Delta), although the Staff Report acknowledges that there could be greater demand pressure in the water transfer market such that future prices may be higher than recent historical trends. Overall, the assumed transfer prices used to support the analysis of municipal water supply economic effects are appropriately conservative and represent a good faith attempt to estimate replacement costs for water suppliers and to inform the analysis of municipal water supply economic effects.

Several commenters asserted that the amount of water available for transfer would decrease with implementation of the Plan amendments, and that water transfers will not provide a reliable future replacement water supply source. However, observations of historical water transfers presented in Section 6.6.1.2, *Water Transfers*, do not substantiate this claim. Data from WestWater Research on water transfers show that the water transfers occurred during all years from 2007-2016, even in dry and critical water years such as 2014 and 2015 (see Figure 6.6-1 of the Staff Report). In addition, information from the Public Policy Institute of California (PPIC) on both temporary and permanent transfers presented in Section 6.6.1.2 shows that water transfer volumes have grown in California in recent decades. While water transfers from north to south potentially would be more limited as a result of the Plan amendments, transfers between water users within a region could be an effective strategy for meeting local demands or responding to shortages associated with longer droughts or disruptions in deliveries.

Several commenters asserted that the Staff Report's analysis underestimates the actual costs of water transfers because the expense of water transfers to transferees is greater than the purchases price alone. Commenters asserted that there are multiple factors that increase the costs of water transfers beyond the purchase price alone, such as administrative costs, the loss of transfer water due to Bay-Delta carriage water losses and conveyance losses through canals, and applicable pumping, distribution, and water treatment expenses. However, the assumed per-acre foot water transfer costs identified in the Staff Report are appropriate and revisions to the Staff Report's assumed water transfer costs are not warranted. In particular, the per acre-foot cost of water transfers identified in the Staff Report are intended to include conveyance and carriage losses and administrative costs, which also apply to water transfers that occur under existing conditions. While it is possible that additional costs could apply for individual water transfers beyond costs that are incurred under existing conditions, such as additional water treatment costs, it would be highly speculative to assume what those additional costs might be.

Overall, water transfers may not be able to fully mitigate reductions in Sacramento/Delta water supplies, but are expected to reduce the economic effects of changes in water supply by directing the available water supplies to their highest valued uses. While the volume of water available for transfer would potentially diminish with reductions in water supply, water transfers will continue to be an important strategy for addressing future water supply shortages. Historical data (WestWater Research 2017) demonstrates that water transfers persist during dry and critical water year types, which provides a strong indication that they will continue at some level despite changes in water supply. The California water market has responded to past changes in regulations and water supply conditions, and it is expected that it will continue to do so in the future.

Economic Effects from Reduced Revenue of Hydropower Production and Water Sales

Several commenters, such as YWA and Nevada Irrigation District (NID) asserted that the Plan amendments would reduce water providers' revenues from hydropower production and water sales. Some commenters, such as YWA, asserted that these changes could jeopardize water providers' ability to fund water infrastructure projects, such as flood risk reduction and watershed improvement initiatives that benefit local communities. Some commenters, such as NID, asserted that reduced revenue would result in increased water rates for customers, which they suggested could make water unaffordable for the communities they serve.

The Staff Report acknowledges that the Sacramento/Delta update to the Bay-Delta Plan could result in agricultural and municipal economic effects. These changes are adequately evaluated in Chapter 8, Section 9.8, and Section 13.8, each titled *Economic Analysis and Other Considerations*. The Staff Report also acknowledges that changes in the timing of hydropower generation, including an increase of hydropower generation in the spring and a decrease in summer, could affect hydropower revenues; supplemental information on change in hydropower revenues, including quantitative estimates of the potential economic effects on hydropower generation, are provided below in the *Changes in Hydropower Revenues* section.

Based on a review of information concerning YWA and NID's current revenue sources described below, the Plan amendments would not be expected to limit YWA and NID's ability to fund public projects using revenue from hydropower generation and water sales. For responses specific to assertions regarding municipal water rates, please see the *Municipal Water Rates* section above.

Yuba Water Agency

YWA diverts water from the Yuba River for consumptive uses. YWA operates the Yuba River Development Project (Federal Energy Regulatory Commission [FERC] Project No. 2246) that provides multiple uses including hydropower, flood control, water supply, and environmental resources. Water diverted under YWA's water right permits is delivered to its eight member units (Browns Valley Water District, Cordua Irrigation District, Hallwood Irrigation Company, Ramirez Water District, Brophy Water District, South Yuba Water District, Wheatland Water District, and Dry Creek Mutual Water Company) (Yuba County Regional Water Management Group 2018). In 2008, the State Water Board approved a petition for long-term transfer of up to 200 TAF per year of water under YWA's water rights to allow implementation of the Yuba River Accord (Yuba Accord or Accord). In January 2026, the State Water Board extended the approval of YWA's long-term transfer program through December 31, 2050. YWA generates revenues from hydroelectric power generation, water sales to its seven member units, and water sales under the Yuba Accord long-term water transfer program. YWA asserted that the flow scenarios would substantially reduce these revenue sources, thereby limiting its ability to finance flood-risk reduction and watershed improvement projects that benefit local communities.

According to YWA's website, hydropower revenue accounts for about 85 percent of YWA's income (YWA n.d.). YWA generates electricity through three hydroelectric plants: the Colgate Powerhouse, and the Narrows 1 & Narrows 2 Powerhouses. Figure 7.8-14 of the Staff Report shows the estimated average change in hydropower generation under the 55 scenario at individual hydropower facilities, including the Colgate Powerhouse and the Narrows 1 & 2 Powerhouses. The figure shows a small increase for the Narrows 1 & 2 Powerhouses and a larger decrease for the Colgate Powerhouse under the 55 scenario (2023 draft Staff Report, Section 7.8, *Energy*, p. 7.8-26). This suggests that any changes in revenue from hydropower generation at the Narrows 1 & 2 Powerhouses would likely be small.

As simulated for the 2023 draft Staff Report and described in Section 7.8, *Energy*, larger reductions in annual hydropower generation were estimated to occur at Colegate Powerhouse. However, as discussed in Common Response 7.8, *Energy and Hydropower*, actual effects on hydropower generation could be less than what was calculated based on SacWAM results. Accordingly, changes in hydropower generation revenues could also be less than the model results may suggest. Please see Common Response 7.8 for additional information including responses to comments on evaluation of local effects.

YWA also generates revenue through water sales to its member units. As described in the SacWAM documentation (^SacWAM 2023), water budget areas (WBAs) 12&13, 14&15N, and 15S all contain lands serviced by YWA. As discussed in Common Response 6.1, *Sacramento Water Allocation Model and Changes in Hydrology and Water Supply*, under the 55 scenario, there is a total reduction of 24 TAF/yr to these WBAs, which is about a 4 percent reduction in water supply for the WBAs that encompass YWA's service area. Corresponding changes in revenue from water sales to YWA's member units would therefore be expected to be relatively small under the 55 scenario, and would be less under the starting point for the regulatory pathway (55 w/WSAs scenario).

YWA also generates revenue through Yuba Accord water transfers, including to SWP and CVP contractors south of the Delta and other water users. In 2008, the State Water Board approved a petition for long-term transfer of up to 200 TAF per year under YWA's Permit 15027 and made other changes to YWA's water rights to allow implementation of the Yuba River Accord. In January 2026, the State Water Board extended the approval of YWA's long-term transfer program through December 31, 2050. Based on YWA's fiscal year 2024-2025 budget, no revenue is projected from Yuba Accord sales in Fiscal Year 2025 or 2026, and only $115,000 was reported in 2024 (YWA

2024b). Water transfers, such as those under the Yuba Accord, can be a benefit of a water right; however, water right holders do not have any guarantee that water transfers can occur every year.

A review of YWA's publicly available financial information shows that YWA's revenues have exceeded its expenses in recent years. Over the period of fiscal year 2021-2022 through 2025-2026, YWA's revenues exceeded its expenses, based on YWA's publicly available financial information on YWA's expenses and revenues Fiscal Year 2021 through 2025 (YWA 2023, YWA 2024a, YWA 2026). Based on its financial documents for Fiscal Year 2021 through 2025, YWA's contributions to reserves (revenues – expenses) ranged from $25 million in FY 2021 to $143 million in FY 2025. Based on this information regarding YWA's revenues and expenses for Fiscal Years 2021 through 2025, it is likely that changes in hydrology and water supply would not result in substantial reduction or the elimination of major revenue sources for YWA based on YWA's overall revenues and expenses during this period. Accordingly, YWA would be expected to retain the ability to continue funding flood risk reduction projects following implementation of the Sacramento/Delta update to the Bay-Delta Plan.

In addition, YWA is not the sole source of funding for flood risk reduction projects and other watershed improvement initiatives in Yuba County. Please see Common Response 10.1, *Economically Disadvantaged Communities*, for additional discussion.

Nevada Irrigation District

NID owns and operates the Yuba-Bear Hydroelectric Project, and supplies water for municipal, domestic, and agricultural uses. NID provided many comments on the 2023 draft Staff Report based on analyses performed by their consultants, Western Hydrologics, interpreting the Plan update's possible effects within NID's service area. In its comments, NID asserted that changes in hydrology and changes in water supply would reduce its revenues from hydropower generation and water sales. NID also asserted that reductions in revenue would limit its ability to subsidize water rates and support watershed improvement projects, and would make water less affordable for its customers.

As explained in Common Response 6.1, *Sacramento Water Allocation Model and Changes in Hydrology and Water Supply*, NID's comments rely on support from the modeling presented in technical memoranda prepared by Western Hydrologics to defend various claims that the Plan would cause significant and irreversible impacts to NID's service area. However, NID draws these conclusions based on modeling and analyses that overstate the effects of the proposed Plan amendments on NID's operations. As a result, the NID comment letter presents modeling results that exaggerate the perceived impacts of the 55 scenario on water supply. As presented in Chapter 6, *Changes in Hydrology and Water Supply*, and Appendix A1, *Sacramento Water Allocation Model Methods and Results*, the SacWAM results for the flow scenarios show substantial reductions in interbasin diversions, which affect the water supply available to NID. However, SacWAM results also show that reductions in interbasin diversions from the Yuba River would likely only cause small changes in end-of-September storage and would not cause "irreversible impacts" to the NID service area. These findings support the conclusion that water supplies to NID would remain available under both the 55 scenario and the 55 w/WSAs scenario. Please see Common Response 6.1 for further discussion on Yuba River model representation and operations, and the limitations of Western Hydrologics' analysis.

According to its publicly available financial documents, NID receives revenues from the three business activities (water, electric, and recreation), supplemented by "nonoperating revenue" (property taxes, investment income, and other). When revenue exceeds expenses, the difference is accumulated as "Change in Net Position."[5] Water service includes approximately 5,027 irrigation customers and nearly 20,000 treated water connections (NID 2024). NID also provides raw water to the municipalities of Grass Valley, Nevada City, and the City of Lincoln. The electric business includes energy production from hydroelectric power plants with sales to Pacific Gas and Electric (PG&E) and Northern California Power Agency under various purchase agreements (NID 2024). NID also operates 15 recreation sites, much of it focused on its water storage facilities.

Based on its publicly available financial information, in 2024, NID's total revenue was $83.9 million, compared to expenses of $69.0 million, resulting in a Change in Net Position of $15 million (NID 2024). A review of publicly available financial summary information from NID from the period 2015 through 2024 shows that revenues, expenses, and change in net position have been relatively consistent from year to year (NID 2024). NID has added $10 to $20 million per year to net position (equity) each year since 2015, and has accumulated a total net position of $506 million by 2024, which was composed of $399 million investment in capital assets, $4 million restricted for capacity expansion/improvements/debt service, and $103 million of unrestricted funds (NID 2024).

Section 7.8, *Energy*, of the Staff Report, provides the results of a hydropower generation analysis of the 47 largest hydroelectric power facilities in the Sacramento River basin. This includes the three NID hydropower plants, Chicago Park, Dutch Flat 1&2, and Rollins power plants, which represent 86 percent of NID's capacity (NID 2024). Each of these plants could experience a small to moderate reduction in hydropower generation on an annual basis under the flow scenarios (see Figure 7.8-14). While NID's revenue from hydropower generation could be reduced at times under the Plan amendments, based on the magnitude of changes in hydropower generation and NID's total revenues and expenses, these reductions would not likely hinder NID's ability to continue to provide water that is affordable for its customers while still contributing to its net position.

The flow scenarios could also reduce NID's surface water supply. However, NID maintains extensive reservoir capacity, including a considerable volume for carryover storage with an end-of-September target of 130,000 acre-feet (NID 2021). As discussed in more detail in Common Response 6.1, *Sacramento Water Allocation Model and Changes in Hydrology and Water Supply*, SacWAM results show that reductions in interbasin diversions from the Yuba River would likely only cause small changes in end-of-September storage. While NID's revenue from water sales could be reduced at times under the Plan amendments, based on the magnitude of changes in water supply and NID's reservoir storage capacities and NID's total revenues and expenses, these reductions would not likely hinder NID's ability to continue to provide water that is affordable for its customers while still contributing to its net position. In addition, as discussed above under *Municipal Water Rates*, water rates depend on a range of factors unique to each provider, and there is no direct relationship between reduced surface water supply and the water rates paid by customers.

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[5] The term "Net Position" is an accounting term for non-profit or government entities that represents the difference between total assets and total liabilities, and is equivalent to equity in for-profit companies.

Changes in Hydropower Revenues

Section 7.8, *Energy*, of the Staff Report describes the potential energy impacts resulting from changes in hydrology and reduction of surface water supply under the flow scenarios. It concludes that these changes would lead to a decrease in hydropower generation in the summer, which could be significant for an individual project or community. Section 8.6.5, *Energy*, in the 2023 draft Staff Report (and Section 8.7.4, *Energy*, in the final Staff Report) likewise acknowledges that changes in the timing of hydropower generation, including an increase of hydropower generation in the spring and a decrease in the summer, could affect revenues from hydropower generation. Detailed description of the methods for estimating energy effects of changes in hydrology and changes in water supply associated with implementation of the Sacramento/Delta update to the Bay-Delta Plan, including hydropower generation in the Sacramento/Delta watershed, is provided in Appendix A5, *Hydropower, Energy Grid, and Export Energy Analyses,* and Section 7.8.

Several commenters asserted that the Plan amendments would reduce hydropower generation revenues, which they suggested could affect hydropower program budgets. Several commenters asserted that the Staff Report should quantify the potential changes in hydropower revenues under the Plan amendments. This subsection responds to those assertions by estimating the changes in hydropower revenues under the flow scenarios using a representative monthly hydropower price series. Overall, changes in hydropower revenue under the flow scenarios would be relatively small on an annual basis and would not be expected to substantially affect program budgets supported by hydropower generation revenues, as discussed further below. These estimates of changes in hydropower revenues are provided solely for transparency; they do not alter the conclusions of the Staff Report's economic analysis.

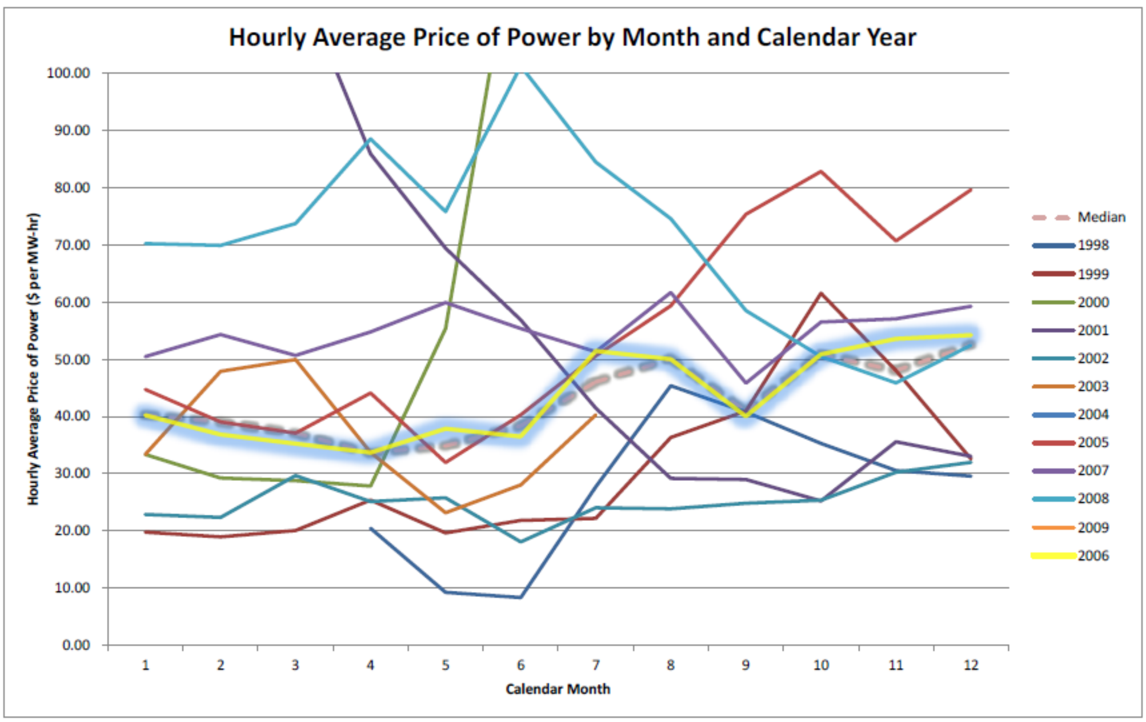
Some commenters asserted that the Staff Report should conduct an economic analysis of each sub-watershed to estimate the reduction in hydropower revenue. However, the economic analysis is sufficiently robust and at the appropriate scale for the purposes of the Sacramento/Delta update to the Bay-Delta Plan. Please see the *Overview and Adequacy of Economic Analysis* section in this common response for additional information about the scope of the analysis as required by the Porter-Cologne Act.

Approach

This analysis of change in hydropower revenues builds upon the hydropower analysis presented in Section 7.8, *Energy*, and Appendix A5, *Hydropower, Energy Grid, and Export Energy Analyses*. As discussed in Section 7.8, the main effect of the flow scenarios on hydropower is an increase in generation during the spring and a reduction in the summer, resulting primarily from changes in flow. Annually, hydropower effects would be relatively small because the total annual flow would not change, and reservoir storage would not be expected to be greatly reduced. As described in Appendix A5, monthly hydropower generation for the 47 largest facilities in the Sacramento/Delta was estimated for the entire 93-year SacWAM simulation period. The capacity of these facilities represents 79.4 percent of the total hydropower capacity in the Sacramento/Delta watershed.

To evaluate the effects of the flow scenarios on hydropower revenue, the estimated change in monthly power generated over the 93-year SacWAM simulation period was multiplied by the price of hydropower for the same month in a representative monthly series of hydropower prices. The products were then summed to annual values, and the results are presented below.

Because both water availability for hydropower generation and electricity demand vary throughout the year, hydropower prices vary seasonally. Higher prices typically occur when demand is greatest in summer and mid-winter, while lower prices occur when water supply is relatively abundant in spring. Therefore, a distinct hydropower price is needed for each month of the year to reflect these variations. The monthly prices of hydropower used in this analysis is the value of the 80th percentile of average hourly electricity prices (i.e., the value at which 80 percent of the average hourly prices were lower) available from the California Independent System Operators (CAISO) during the 2006 calendar year. Prices for 2006 were selected because, as shown in Figure CR 8.1-5, they most closely match the median prices of the period from 1998 to 2008, the period which price data are available (SWRCB 2018, Section 20.3.4). Each solid line in the figure represents the average hourly prices recorded by CAISO for the corresponding year. The dashed line represents 1998-2008 median. This fluctuating price series is more likely to capture larger potential effects than would a uniform price throughout the year. By using the 80th percentile of hourly prices, which are generally higher than historical averages, the results of this analysis provide a conservative assessment of the potential effect on hydropower revenue under the flow scenarios. This 2006 monthly prices were adjusted to 2023 dollars using the CAISO day-ahead market price (CAISO 2024).[6] Table CR 8.1-10 shows the resulting monthly price series that is used in this analysis.



Source: (SWRCB 2018, Section 20.3.4)

Figure CR 8.1-5. Monthly Average Price and Median Monthly Average Price for 1998-2008

[6] Day-ahead market price is a common measure in energy markets, where wholesale energy participants agree to a price one day ahead of actual energy production and delivery.

Table CR 8.1-10. 80th Percentile of Hourly Prices from 2006 and Adjusted to 2023 Dollars

Month	2006 ISO Power Price $/MWh ($2006)	ISO Power Price Adjusted to 2023 Dollars $/MWh ($2023)
1	56.46	64.44
2	47.86	54.62
3	43.81	50.00
4	47.48	54.19
5	51.83	59.15
6	54.31	61.98
7	61.49	70.18
8	61.22	69.87
9	51.25	58.49
10	58.63	66.91
11	63.76	72.77
12	64.31	73.40

Source: SWRCB 2018
Note:
The 2006 ISO power price is the 80th percentile of hourly prices within each month during the 2006 calendar year. The 2006 prices were adjusted to 2023 dollars using the CAISO day-ahead market price (CAISO 2024).
ISO = Independent System Operators
$/MWh ($2006) = dollars per megawatt hour in 2006 dollars
$/MWh ($2023) = dollars per megawatt hour in 2023 dollars

Results

The results of the economic analysis of annual hydropower revenues under the flow scenarios are shown below in Table CR 8.1-11. Each row displays the anticipated change in revenues for the driest (0 percent) to wettest (100 percent) years, and the average change in revenue for all years, for each of the flow scenarios (35 to 75 scenarios). The analysis is based on the full set of hydropower generation results as developed in Section 7.8*, Energy*, and shown in Table 7.8-3. It therefore accounts for the month-to-month variation in both prices and hydropower generation. The average value represents the overall effect on hydropower revenues.

Table CR 8.1-11. Cumulative Distribution of Annual Hydropower Revenues: Baseline Condition and Change from the Baseline Condition ($ thousands)

Percentile	Baseline	35	45	55	65	75
0%	254,282	14,203	16,120	10,421	8,154	-27,894
10%	497,490	-21,901	-29,271	-46,747	-60,990	-89,962
25%	622,859	-13,131	-30,622	-43,217	-52,147	-81,335
50%	842,762	-11,122	-16,894	-25,855	-54,712	-79,027
75%	1,147,376	-5,652	-8,657	-17,314	-42,305	-92,558
90%	1,519,682	-13,574	-21,581	-39,920	-46,712	-120,369
100%	2,010,605	-12,472	-14,394	-25,910	-52,060	-94,836
Average	924,194	-10,304	-18,658	-30,850	-49,383	-84,434
Average reduction as % of the baseline condition		-1.1%	-2.0%	-3.3%	-5.3%	-9.1%

Source: Derived from Table 7.8-3 and Appendix A5, *Hydropower, Energy Grid, and Export Energy Analyses*, Table A5-8

The averages for the scenarios provide a useful metric of the net economic effects from changes in hydropower generation. Overall, the results presented in Table CR 8.1-11 show that there would be a decrease in average annual hydropower revenues across all of the flow scenarios. On average, under the 45 to 65 scenarios, the estimated reductions in revenue range from approximately $18.7 million to $49.4 million. These changes in average annual hydropower revenue represent a relatively small portion of the total annual hydropower revenue in the Sacramento/Delta watershed; specifically, under the 45 to 65 scenarios these reductions in hydropower revenues represent approximately 2.0 to 5.3 percent of overall hydropower generation among the 47 facilities in the Sacramento/Delta included in this analysis. For the 55 scenario, the change in annual revenue is estimated to be a reduction of 3.3 percent.

The results indicate that the magnitude of change in monthly or annual power generation is unlikely to cause a substantial change in the total revenue of hydropower generators, even when accounting for seasonal variation in electricity prices. For example, the 55 scenario could result in annual average revenue reduction of 3.3 percent compared to baseline. This level of change is not likely to substantially affect program budgets supported by hydropower generation revenues. As noted in the beginning of this section, this analysis provides additional transparency regarding potential economic effects on hydropower generation. Overall, these results add quantitative information and additional context to support the discussion presented in Section 8.6.5, *Energy*, in the 2023 draft Staff Report (Section 8.7.4, *Energy*, in the final Staff Report). However, the Staff Report already identifies potentially significant impacts to energy and identifies that the Sacramento/Delta update to the Bay-Delta Plan could result in a decrease in annual hydropower generation revenues. The results presented in this section are consistent with the analyses already presented in the Staff Report, and do not change the Staff Report's conclusions related to changes in hydropower generation. This conclusion is unchanged by the additional analysis presented in this section.

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