7.4 Agriculture and Forest Resources

California leads all states in agricultural production, with top producing commodities such as dairy, grapes, almonds, and strawberries. California is also the leading state in crop cash receipts, with over $50 billion generated in 2017 (CDFA 2019). Agricultural exports totaled over $20 billion in 2016, with prominent commodities including almonds, wine, dairy, walnuts, and pistachios (CDFA 2018a).

California's agricultural success would not be possible without irrigation. In most years, water supply is adequate to serve the irrigation needs of crops currently in production (CDFA 2009; CDFA 2018a). However, in drier years when less surface water is available, farmers typically rely on more groundwater. In many of the state's overdrafted basins, the availability of groundwater for agricultural use may decrease in response to the Sustainable Groundwater Management Act (SGMA). In addition, some of the most suitable agricultural land has been lost due to urbanization (American Farmland Trust 2009; DOC 2015), and this trend continues in light of development pressure and water scarcity.

This section describes 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. The proposed Plan amendments could result in conversion of farmland as a result of reduced Sacramento/Delta water supplies and lowered groundwater levels, which could affect flexibility for water districts that rely on conjunctive use to manage their supplies. Conversion also could occur from increased water transfers, particularly in rapidly developing areas where land prices are competitive. In addition, lower flows on some streams during summer and fall could affect some agricultural water diverters if their diversion structure intakes can no longer access the waterbody, and increased floodplain inundation could increase interference with agricultural activities.

Section 7.1, *Introduction, Project Description, and Approach to Environmental Analysis*, describes reasonably foreseeable methods of compliance and response actions, including actions that would require construction. These actions are analyzed for potential environmental effects in Section 7.21, *Habitat Restoration and Other Ecosystem Projects*, and Section 7.22, *New or Modified Facilities*.

7.4.1 Environmental Checklist

II. Agricultural and Forestry Resources	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less-than-Significant Impact	No Impact
In determining whether impacts on agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (DOC 1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts on forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment Project, and forest carbon measurement methodology provided in the Forest Protocols adopted by the California Air Resources Board. Would the project:				
a. Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☒	☐	☐	☐
b. Conflict with existing zoning for agricultural use or conflict with a Williamson Act contract?	☐	☐	☐	☒
c. Conflict with existing zoning for, or cause rezoning of forest land (as defined in Public Resources Code Section 12220(g)), timberland (as defined by Public Resources Code Section 4526), or timberland zoned Timberland Production (as defined by Government Code Section 51104(g))?	☐	☐	☐	☒
d. Result in the loss of forest land or conversion of forest land to non-forest use?	☐	☐	☐	☒
e. Involve other changes in the existing environment that, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use?	☒	☐	☐	☐

7.4.2 Environmental Setting

This section describes the agriculture and forest resources setting to inform the impact discussion presented in this section and in Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; Section 7.22, *New or Modified Facilities*; and Chapter 9, *Proposed Voluntary Agreements*.

For descriptions of hydrology and water supply, see Chapter 2, *Hydrology and Water Supply*; Chapter 6, *Changes in Hydrology and Water Supply*; and Section 7.12, *Hydrology and Water Quality*. See Chapter 8, *Economic Analysis and Other Considerations,* for details on population projections, primary crops by region, and additional economic information and analysis on livestock industries, including dairies and beef cattle.

7.4.2.1 Important Farmland and Farmland Types

The Natural Resources Conservation Service classifies the suitability of soils to support agricultural enterprises based on the soil type, drainage characteristics, and availability of water supply for irrigation. The California Department of Conservation (DOC) uses this information to map important farmland within California counties every 2 years (DOC 2017). This mapping is done in accordance with the federal Farmland Protection Policy Act, which provides definitions for important farmland types. Farmland use is tracked through the state Farmland Mapping and Monitoring Program (FMMP), which is administered by the DOC Division of Land Protection. FMMP data illustrate existing and historical areas of active agriculture and can be used to analyze the potential for agricultural production. DOC designates important farmland based on certain positive qualities, such as good soil characteristics like drainage; and the availability, amount, and frequency of moisture, such as through irrigation. *Important farmland* includes the following FMMP categories (DOC 2016a).

- Prime Farmland—Land that has the best combination of features for producing agricultural crops. Prime Farmland must have been used for production of irrigated crops at some time during the 4 years prior to the FMMP's mapping date. Soil salinity must be below 4 deciSiemens/meter (a measure of electrical conductivity) for part of the year.[1]
- Farmland of Statewide Importance—Land, other than Prime Farmland, with a good combination of physical and chemical characteristics for producing crops. Farmland of Statewide Importance must have been used for production of irrigated crops at some time during the 4 years prior to the mapping date. Soil salinity must be below 16 deciSiemens/meter for part of the year.
- Unique Farmland—Land that has been used to produce specific crops with high economic value but does not meet the criteria for Prime Farmland or Farmland of Statewide Importance. Irrigation is not a requirement for designation as Unique Farmland, and this category includes non-irrigated orchards or vineyards in some climatic zones. However, these lands may be irrigated. Unique Farmland must have been used for crops at some time during the 4 years prior to the mapping date.

Figures 7.4-1a and 7.4-1b show the areas of important farmland and grazing lands in the study area. Generally, important farmland is concentrated in the Central Valley, and grazing lands surround the important farmland and extend out in all directions.

The California Department of Water Resources (DWR) regularly conducts agricultural land use and water use surveys (DWR 2017). In addition, California law requires county agricultural commissioners to submit crop reports for their counties and, since December 31, 2012, requires agricultural water suppliers with more than 25,000 irrigated acres to submit agricultural water management plans (AWMP) and update them every 5 years. In some cases, the data from these reports may conflict or overlap because information is gathered over varying years or for differing scales, but collectively, the reports provide a general picture of agricultural activities.

[1] Soil salinity is a measure of the electrical conductivity of the extract of a water-saturated paste of soil, as opposed to the soil diluted in water.

Most important farmland relies on irrigation provided by surface water diversions and groundwater (i.e., Prime Farmland and Farmland of Statewide Importance); however, Unique Farmland does not require irrigation to be so designated. Examples include orchards and vineyards in some climatic zones in California where adequate precipitation falls (DOC 2015). Cultural crop practices also include dryland farming, with some lands subject to short-term variations in the intensity of agricultural use where crop rotation and fallowing are practiced. Dryland farming, fallowing, dairy, and livestock grazing are non-irrigated agricultural uses. Because dryland farming and fallowed land are not mapped individually, there are no DOC statistics on the existing acreage of these types of agriculture.

Cropping can be characterized as annual crops (e.g., such as cotton, wheat, vegetables) and permanent crops (e.g., almonds, citrus, grape vines). Both irrigated pasture and alfalfa also can be considered permanent crops because, once planted, they are often kept in production for multiple years. From an irrigation perspective, the difference between annual and permanent crops is that permanent crops require water every year, whereas annual cropland can be fallowed if there is insufficient irrigation water supply. Vines planted for high-quality wine grapes are typically deficit irrigated to increase the crop's quality; however, they usually require at least some irrigation for production.

Between 2007 and 2016, almond, pistachio, and other permanent crop acreage steadily increased (Goodhue et al. n.d.) whereas cotton acreage fluctuated (USDA 2017; Geisseler and Horwath 2016). Reduced surface water irrigation supply and an increase in the cost of water are pushing farmland away from annual crops and pasture toward high-value orchards and vineyards, including almonds and wine grapes (Knauf 2015). During this same period, irrigated pasture and grazing land experienced the largest area reductions (Klonsky 2012). Because tree and vine crops are permanent, they adapt poorly to dry years; their demand for water is relatively steady, or hardened.

Deep-well development has enabled groundwater-dependent agriculture to exist or expand in areas that are outside of organized agricultural water district service areas and removed from riparian water sources. DWR conducted a reconnaissance-level analysis of cropping patterns in and outside of irrigation and water district service areas using publicly available shape files (^2013 Water Plan, V1, DWR 2015) for 2014 cropping patterns and water district boundaries. The results show large areas of permanent crop acreage outside of organized water district service areas. An assessment of trends in agricultural land and lease values similarly identifies that large blocks of new almond orchards continue to be developed outside of water district boundaries (ASFMRA 2015). Because there is less water resource governance of areas outside of water districts, groundwater pumping may proceed without oversight or abatement of potential impacts on groundwater and its users within district boundaries. In coming years, SGMA and its related statutes will provide increased oversight and regulation of groundwater use in California. See also Section 7.12.2, *Groundwater*, for additional discussion of SGMA, including explanation of the SGMA 2019 Basin Prioritization process that identifies levels of priority and whether the basin is in critically overdraft condition, to aid in implementing management actions.

Livestock

Livestock production is another significant agricultural activity in the study area, particularly dairy and beef cattle production. Other livestock includes poultry for eggs and meat and honeybees.

This section, focusing on the conversion of agricultural land to nonagricultural uses, considers the potential for conversion of land devoted to crops that support animal husbandry, including alfalfa,

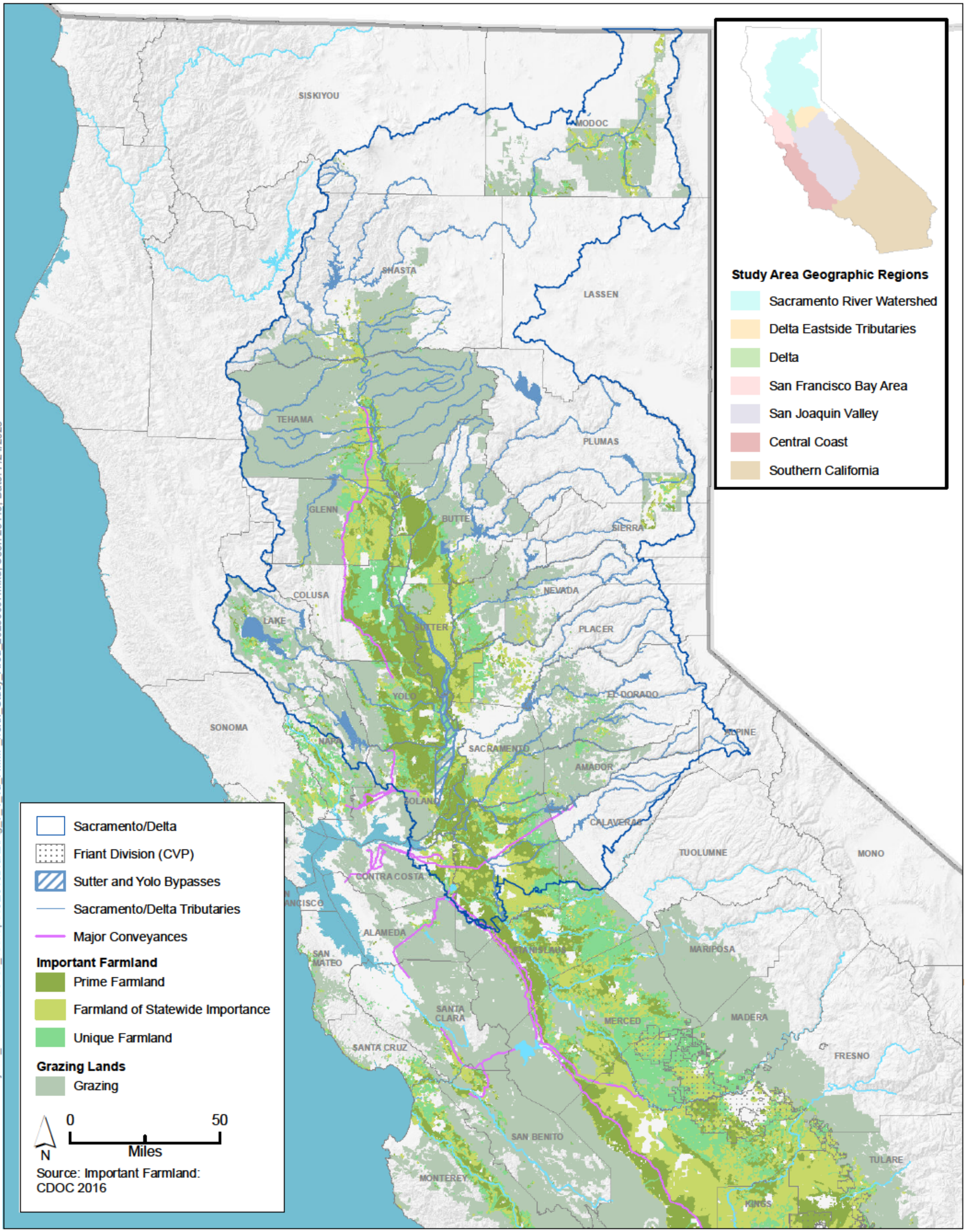

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Figure 7.4-1a
Important Farmland in the Study Area (northern)

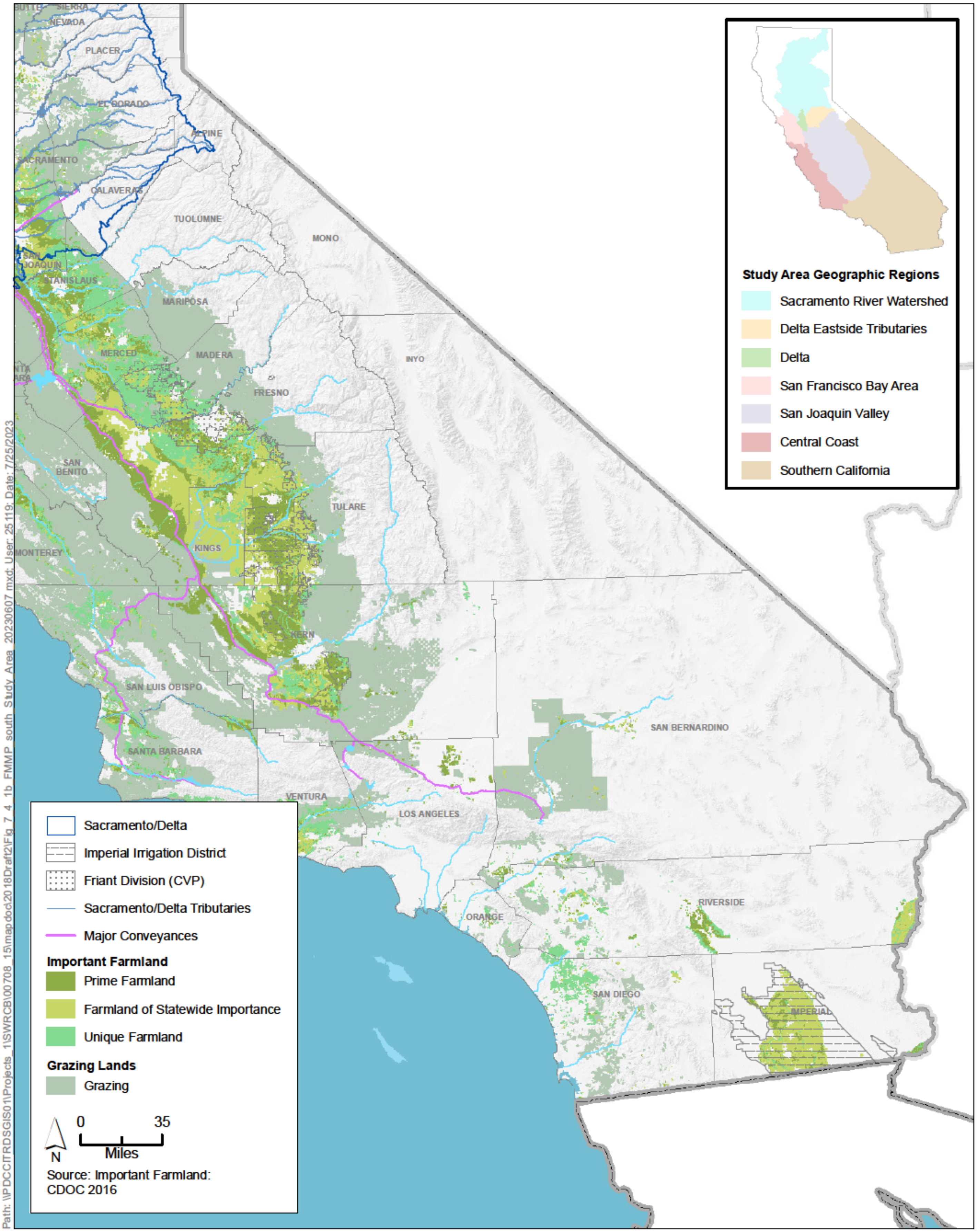

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Figure 7.4-1b
Important Farmland in the Study Area (southern)

corn for silage,[2] and pasture. Conversion of such cropland could affect the economic viability of livestock and dairy operations that depend on its products. Chapter 8, *Economic Analysis and Other Considerations,* analyzes economic effects related to livestock.

7.4.2.2 Williamson Act and Farmland Security Zone Contracts

The Land Conservation Act of 1965, commonly referred to as the *Williamson Act*, provides a statutory framework for local implementation of farm and ranch land preservation, protecting over 16.4 million acres (or nearly one-third) of all privately owned land in California. The Williamson Act discourages premature and unnecessary conversion of agricultural land to urban uses through an interrelated set of property tax, land use, and conservation measures. Under the Williamson Act, a landowner enters into a contract with the local government wherein he or she foregoes the possibility of development or converting his or her property into nonagricultural or non-open space use during the term of the contract. In return, the landowner receives lower property taxes. Land Conservation Act contracts are for rolling 10-year terms, meaning the contract automatically renews each year for another 10-year term. There is also a rolling 20-year contract option called a Farmland Security Zone contract.

There are three ways to terminate a Williamson Act contract: nonrenewal, cancellation, and rescission. The preferred method for termination is nonrenewal. Under nonrenewal, the landowner files a notice of nonrenewal. After the next contract anniversary date, the tax rate will adjust over the contract term (generally 9 years). Cancellation is allowed under certain circumstances specified by statute (Gov. Code, § 51280 et seq.). Under cancellation, the landowner must provide a proposal for a specified alternative use for the property and provide a list of all agencies with permit authority over the proposed alternative use. The county board of supervisors or city council must approve the request for cancellation.

Figures 7.4-2a and 7.4-2b show areas under Williamson Act contracts, Farmland Security Zones, and where data about these contracts is unavailable in the study area. Williamson Act lands extend from Shasta County at the northern end of the study area, throughout the Central Valley, south to Kern County. Farmland Security Zones mostly exist in the Central Valley.

7.4.2.3 Agricultural Zoning

Local jurisdictions have the authority to establish zoning ordinances that regulate the use of land for agricultural purposes and specify the location, height, bulk, number of stories, and size of buildings and structures; the size and use of lots and other open spaces; the percentage of a lot that may be occupied by a structure; and the intensity of land use (OPR 2010).

Jurisdictions with extensive agriculture may have multiple zones for agriculture. For instance, the following are agricultural zones used in Sacramento and San Joaquin Counties.

- Sacramento County (Sacramento County 2015)
  - Agricultural Land Use Zoning Districts
    - AG-160 (agriculture uses on minimum 160 acres)

[2] S*ilage* includes that made from barley, oats, triticale, and wheat. Depending on the individual county reports, silage also may include sorghum or green chop, or those crops may be counted separately. Silage made from corn is typically tallied separately from silage in the Agricultural Commissioners' reports.

        - AG-80 (agriculture uses on minimum 80 acres)
        - AG-40 (agriculture uses on minimum 40 acres)
        - AG-20 (agriculture uses on minimum 20 acres)
        - Urban Reserve (agriculture uses on minimum 20 acres; land is reserved for urban development at a future date)
        - Interim Agricultural Reserve (agriculture uses on minimum 20 acres; land is reserved for industrial development at a future date)
    - Agricultural-Residential Land Use Zoning Districts
        - AR-10 (minimum parcel size 10 acres; allows some agricultural uses)
        - AR-5 (minimum parcel size 5 acres; allows some agricultural uses)
        - AR-2 (minimum parcel size 2 acres; allows some agricultural uses)
        - AR-1 (minimum parcel size 1 acres; allows some agricultural uses)
- San Joaquin County (San Joaquin County 2017)
    - A/G Zone (General Agriculture), which is established to preserve agricultural lands for the continuation of commercial agricultural enterprises. Minimum parcel sizes within the A/G Zone are 20, 40, 80, or 160 acres, depending on the precise zoning.
    - A/L Zone (Limited Agriculture), which is intended to recognize and preserve areas that contain existing concentrations of small-scale agricultural operations and dwellings. Minimum parcel sizes within the A/L Zone are 5 or 10 acres, depending on the precise zoning.
    - A/UR (Agriculture—Urban Reserve), which is intended to retain in agriculture those areas planned for future urban development in order to facilitate compact, orderly growth and to assure the proper timing and economical provision of services and utilities. The minimum parcel size within the A/UR Zone is 20 acres.

Land uses within each of these zoning designations are generally restricted to the uses specified in the zoning ordinance. In this way, agricultural zoning provides protection for land in agricultural use; only agricultural uses (and, usually, compatible uses) are allowed on it. However, a local jurisdiction can choose to change the zoning, such as by changing an area zoned for agriculture to residential to accommodate housing. Such a change is accompanied by environmental analysis and public review.

7.4.2.4 Forest Resources

Forest land and timberland resources are managed as valuable natural resources that provide a range of public, economic, and environmental benefits for the state. The Public Resources Code identifies forest land as land that can support 10 percent native tree cover of any species, including hardwoods, under natural conditions and that allows for management of one or more forest resources, including timber, aesthetics, fish and wildlife, biodiversity, water quality, recreation, and other public benefits (Pub. Resources Code, § 12220, subd. (g)).

There are 33 million acres of forest land in California. Federal agencies own and manage 19 million acres, or 57 percent, of the forest land. State lands, managed by multiple state and local agencies,

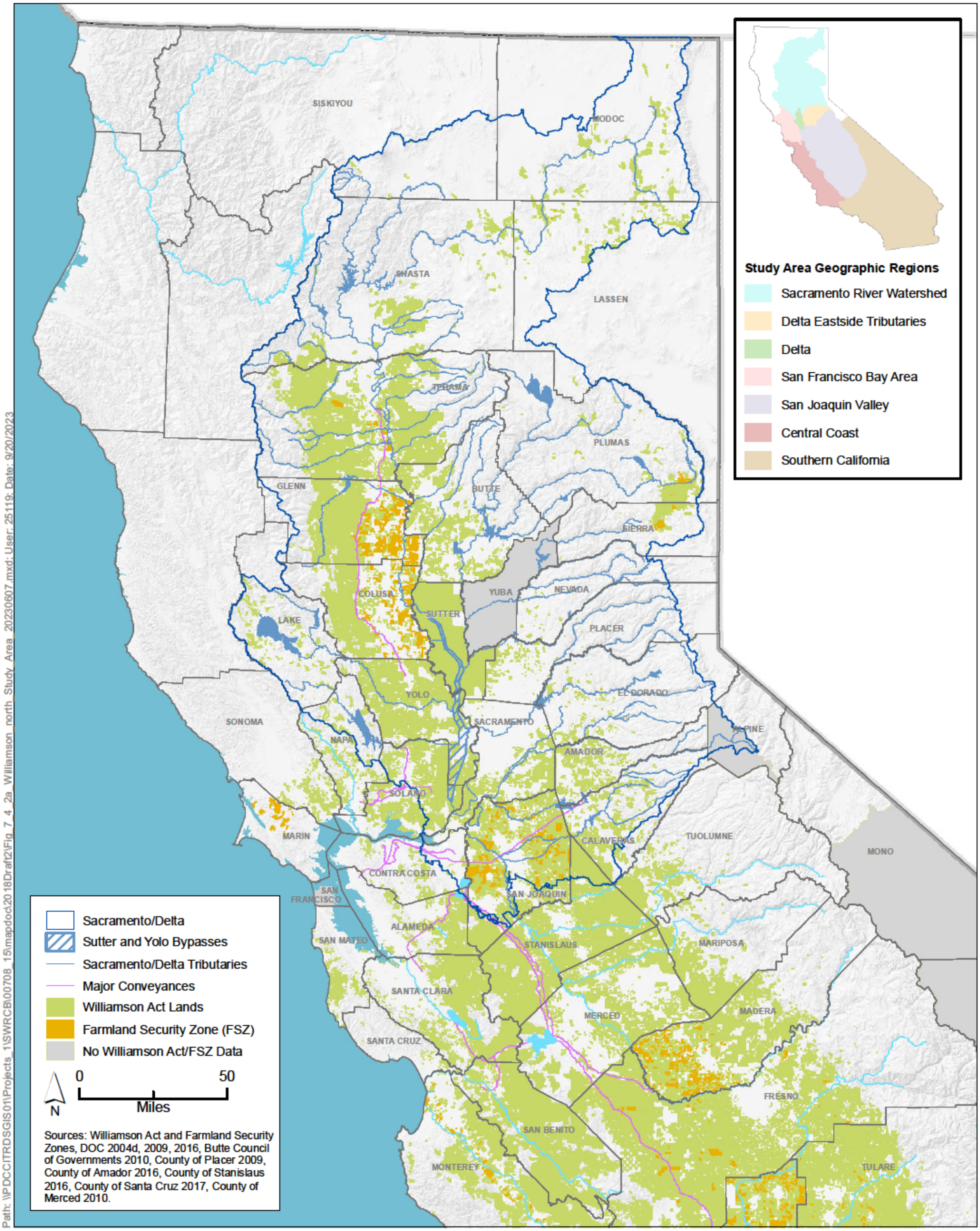

Figure 7.4-2a
Williamson Act and Farmland Security Zones in the Study Area (northern)

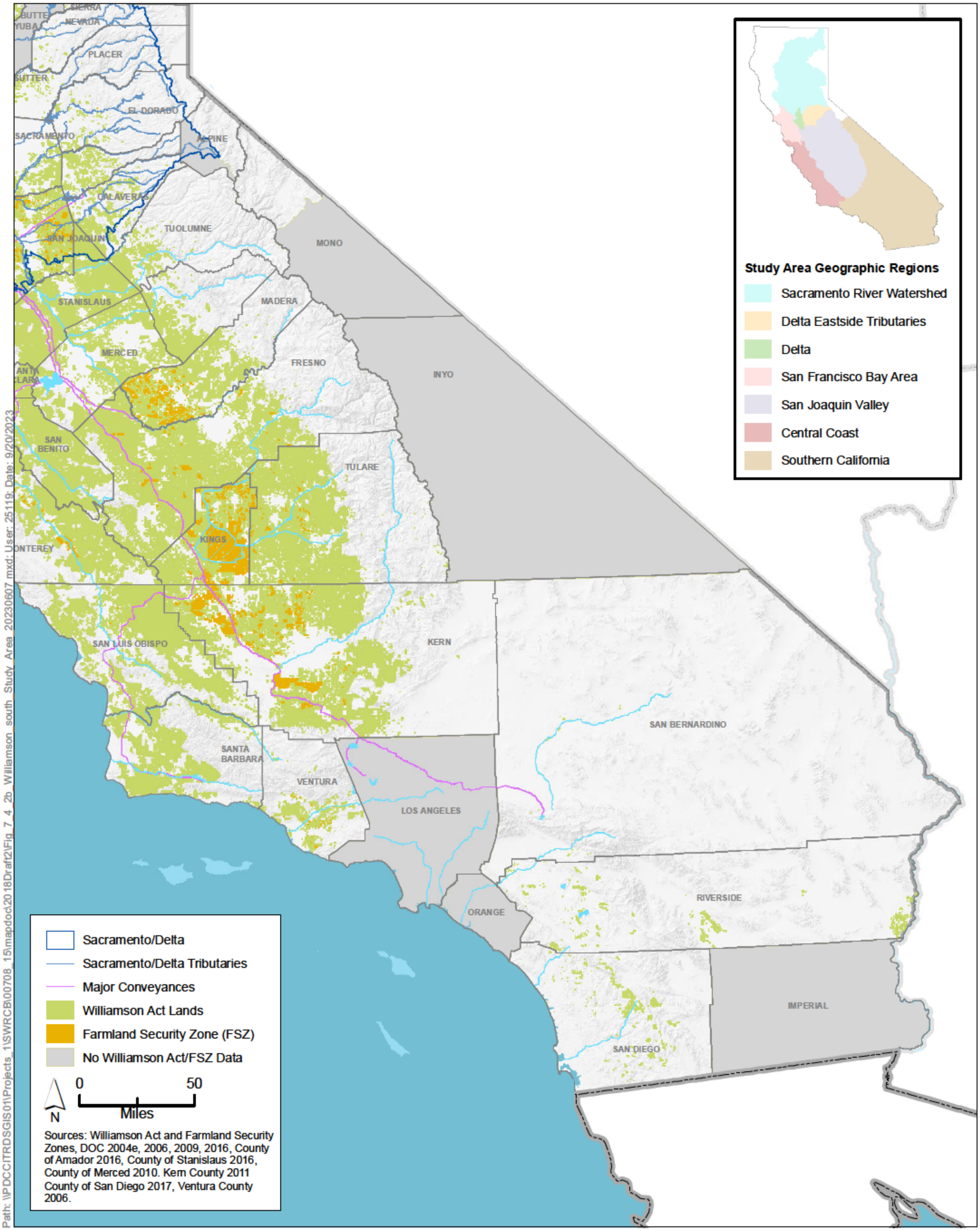

Figure 7.4-2b
Williamson Act and Farmland Security Zones in the Study Area (southern)

total 3 percent or 730,000 acres of forest land (UC-ANR 2018). Privately owned forest land managed by families, companies, and Native American tribes accounts for 40 percent of the total forest land throughout the state, with 99 percent on parcels of less than 500 acres. Corporations own around 14 percent, or 5 million acres, of forest land (USDA 2016).

Approximately 17 million acres of the total 33 million acres of forest land in California can be considered timberland; however, 6 million acres, or 18 percent, of this land is unavailable for timber production under federal reservation regulations.[3] Of the remaining 11 million acres available for timber production, 56 percent of the timberland areas in California are publicly owned and primarily comprise older forests located at higher elevations (USFS 2016a).

The study area contains approximately 15 million acres of forest land, of which approximately 9.5 million acres lie within the plan area. In California, neither planted nor natural timberlands are irrigated but instead receive their water through precipitation. Figures 7.4-3a and 7.4-3b show that most forest land exists in the eastern and western foothills and mountain regions of the study area.

The California Department of Forestry and Fire Protection (CAL FIRE) is responsible for administering timber harvesting and timberland conversion regulations on all non-federal timberland pursuant to the 1973 Forest Practice Act. Any timber operations (as defined by Pub. Resources Code, § 4527) must be approved by CAL FIRE prior to undertaking operations. A timber harvesting plan (THP) must be prepared by a registered professional forester detailing what timber the property owner wants to harvest, the amount of harvest, how the timber will be harvested, on what schedule the timber will be harvested, and the steps that will be taken to prevent damage to the environment (CAL FIRE 2012). THPs are considered functionally equivalent to environmental impact reports under CEQA and require the detailed evaluation of forestry, soil, water, plant, fish, and wildlife resources (Abbott and Kindermann 2008).

Instead of a THP, a non-industrial timber management plan (NTMP) can be filed with CAL FIRE. NTMPs allow non-industrial private foresters with smaller operations to prepare a long-term forest management and harvesting plan, saving these individuals expenses and regulatory review time that typically is associated with carrying out the lengthier THPs (CAL FIRE 2003). In exchange for filing and executing an NTMP, the individuals must agree to manage their forests through long-term sustained yield.

Timberland conversion occurs when timberland is converted to any non-timber growing use, such as residential or other land development. The conversion of timberland requires either a timberland conversion permit or a permit exemption from CAL FIRE (less than 3 acres). Approval is granted in the form of a Timberland Conversion Permit from CAL FIRE if the conversion would be in the public interest; would not have a substantial and unmitigated adverse effect on the continued timber-growing use or open-space use of other land zoned as timberland preserve; and the soils, slopes, and watershed conditions would be suitable for the uses proposed if the conversion were approved. (Pub. Resources Code, §§ 4621–4628.)

[3] According to the Forest Inventory and Analysis program, reserved forest land is land that is permanently removed from wood product utilization, either through administrative designation or statute (USFS 2016b). National forests, wilderness areas, national parks, and national monuments are often reserved forest land.

7.4.2.5 Water Supply and Irrigation

Agricultural water users in California generally rely upon two major sources of water: (1) surface water supply, which is pumped by farmers directly from streams or rivers or distributed by water districts, water conservation districts, water management districts, or irrigation districts—collectively referred to as *water suppliers*; and (2) groundwater, which is available from either private wells or wells operated by water suppliers and distributed to fields of district members. Water suppliers for agricultural water can be formed under the authority of the California Water Code as state water districts (Wat. Code, § 34153), county water districts (Wat. Code, § 30200), flood control districts (Wat. Code, §§ 8110, 8500, 8550), irrigation districts (Wat. Code, § 20700), reclamation districts (Wat. Code, § 50110), municipal water districts (Wat. Code, § 71060), water conservation districts (Wat. Code, § 74031), or through a special act of the California Legislature. These water suppliers are public agencies, governed either directly by a city or county or by a governing body elected by the voters or appointed, often by a board of supervisors (Legislative Analyst's Office 2002). They pay for their activities and products through a mix of direct user fees, sales and property taxes, and other sources (Legislative Analyst's Office 2002). For example, Glenn-Colusa Irrigation District revenue streams are water sales (irrigation, refuge wheeling, and standby charges), third-party water sales, taxes, and assessments (Glenn-Colusa Irrigation District 2018). Yolo County Flood Control and Water Conservation District revenue streams are water sales, hydropower sales, recreation fees, property taxes, and federal and state grants (Yolo County Flood Control and Water Conservation District 2017).

Fees—the price of water to the user—can vary substantially between districts that provide roughly the same service. These differences are attributable both to the cost of the water to the supplier, which varies among sources, and to policy decisions by the supplier. For example, SWP water is more expensive than CVP water, so suppliers using SWP water generally charge higher fees to users.

Surface water is delivered directly from rivers and streams or through canals that divert water from watercourses. Much of California's irrigation water is stored in reservoirs that receive snowmelt and rainwater runoff in winter and spring. Reservoir operators release this water into rivers and canals in late spring through early fall based on crop irrigation needs. Reservoir operators, water suppliers, and individual diverters typically monitor releases and diversions through appropriate devices such as stream gages, flow meters, or other structures. Diversion points may include gravity-fed or pumped structures. Once diverted, the water supply is routed through conveyance facilities to growers. Each canal in the water supply network requires an intake structure to divert water into the canal; these structures often depend on the water being at a high enough elevation to flow into the intake. Additional infrastructure may include regulating reservoirs, interceptor canals, production and recovery wells, and runoff and drainage facilities. In addition to irrigation systems, growers may have regulating reservoirs, tailwater ponds, tile drainage, and groundwater wells. Not all end users rely on water district water; some water users rely strictly on riparian diversions, and some on groundwater.

Water that may be affected by the proposed Plan amendments originates in or is diverted from surface waterbodies in the Sacramento River watershed, Delta eastside tributaries, and Delta regions (this area is referred to as the *Sacramento/Delta*) (Figure 1-1a). Water from the Sacramento/Delta is used within these three regions; additional Sacramento/Delta water is delivered to and used in portions of the San Francisco Bay Area (Bay Area), San Joaquin Valley, Central Coast, and Southern California regions. Only a portion of the water supply used in each of the regions is derived from surface water supplied from the Sacramento/Delta. The larger *study area* is

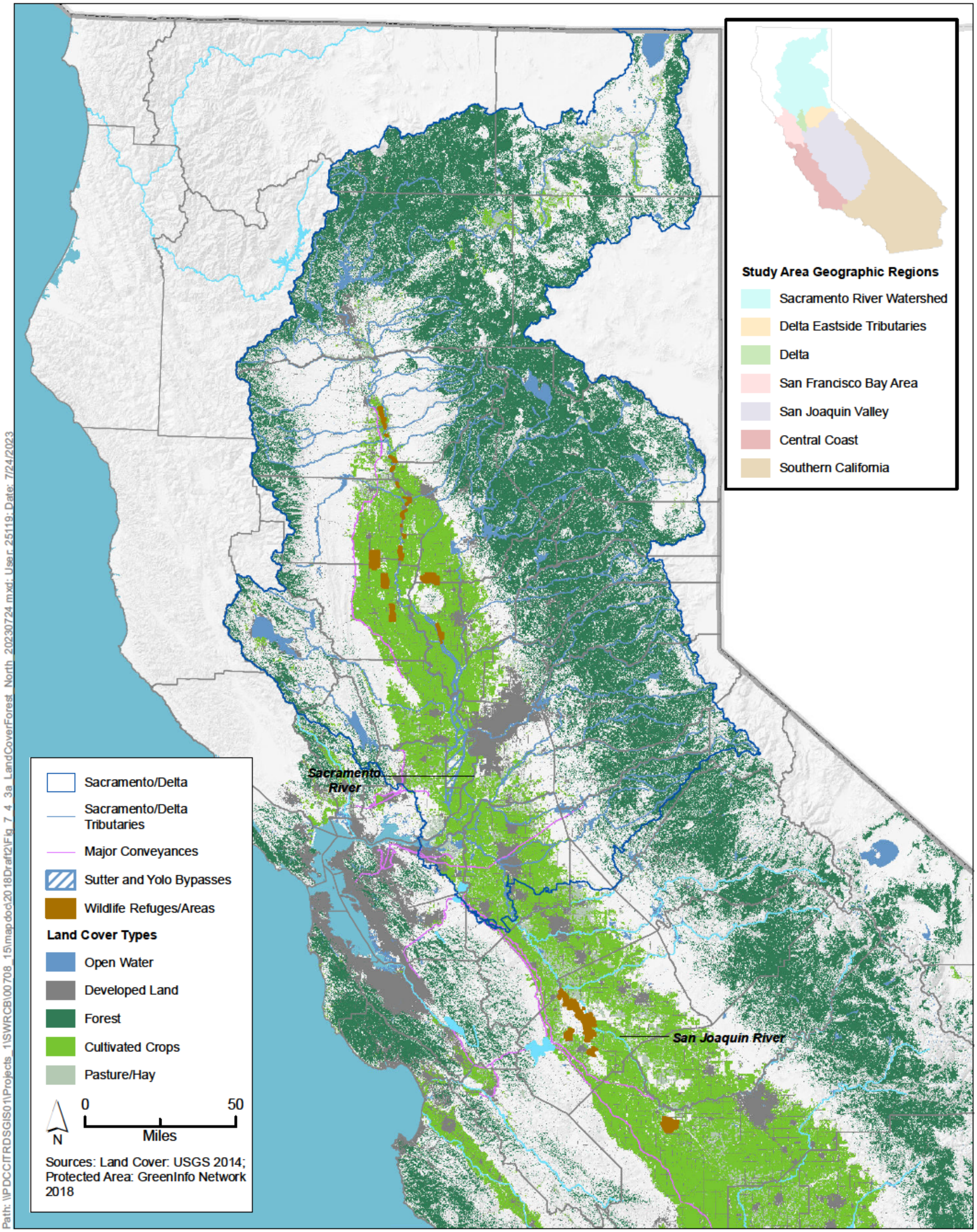

Figure 7.4-3a
Land Cover and Forest in the Study Area (northern)

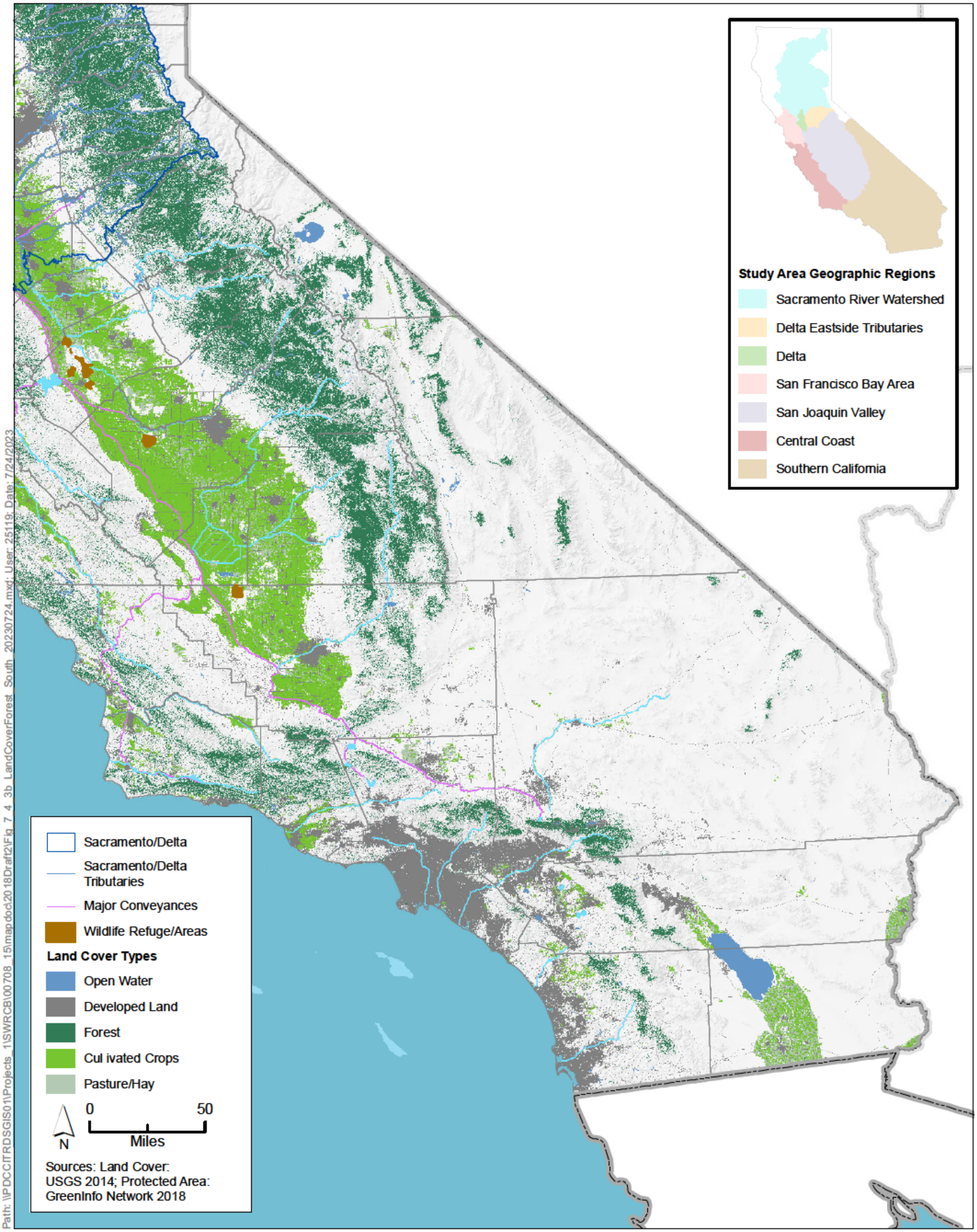

Figure 7.4-3b
Land Cover and Forest in the Study Area (southern)

defined to provide context for total water supplies and includes areas beyond the Sacramento/Delta where the proposed Plan amendments may cause environmental impacts. The study area is divided into seven regions based on geography and water supply (Figure 1-1c). The study area geographic regions generally correspond to the hydrologic regions defined in the California Water Plan (^2013 Water Plan, V1) or are aggregations of hydrologic regions, differing where appropriate. (See Section 2.8, *Existing Water Supply*.)

Table 7.4-1 summarizes the 2005 to 2015 average annual total water supply (surface water and groundwater) by geographic region and sector based on historical water deliveries data (Section 2.8, *Existing Water Supply*. Of the average annual total water supply of approximately 41 million acre-feet (MAF) from 2005 to 2015 in all regions combined, approximately 32 MAF was used for agriculture, which is over 75 percent of the total water supply.

Table 7.4-1. Average Annual Total Water Supply (Surface Water and Groundwater) by Geographic Region and Sector, 2005–2015 (thousand acre-feet)

Geographic Region	Agriculture	Municipal	Managed Wetlands	Total
Sacramento River watershed	6,773	826	451	8,050
Delta eastside tributaries	824	154	8	986
Delta	1,185	136	48	1,368
San Francisco Bay Area	137	1,089	26	1,251
San Joaquin Valley	16,803	1,053	581	18,437
Central Coast	1,055	279	0	1,334
Southern California	4,863	4,518	68	9,449
Total	31,639	8,054	1,181	40,875

Source: Sum of values in Tables 2.8-1 and 2.8-2 in Chapter 2, *Hydrology and Water Supply*.

Table 7.4-2 summarizes the 2005 to 2015 average annual groundwater supply by geographic region and sector based on historical water deliveries data (Section 2.8, *Existing Water Supply*). Of the total average annual groundwater supply of approximately 17.3 MAF from 2005 to 2015 in all regions combined, approximately 13.7 MAF was used for agriculture (over 75 percent of the total groundwater use).

Table 7.4-2. Average Annual Groundwater Supply by Geographic Region and Sector, 2005–2015 (thousand acre-feet)

Geographic Region	Agriculture	Municipal	Managed Wetlands	Total
Sacramento River watershed	2,272	387	20	2,679
Delta eastside tributaries	545	53	<1	597
Delta	34	40	0	74
San Francisco Bay Area	80	184	0	264
San Joaquin Valley	9,034	823	251	10,107
Central Coast	968	196	0	1,164
Southern California	792	1,590	<1	2,382
Total	13,725	3,272	271	17,268

Source: Table 2.8-2 in Chapter 2, *Hydrology and Water Supply*.

Table 7.4-3 summarizes the average annual Sacramento/Delta supply to each geographic region based on the Sacramento Water Allocation Model (SacWAM) results for the baseline condition. SacWAM results show that annual Sacramento/Delta surface water supply ranges from approximately 7.3 to 14.8 MAF depending on hydrology, with an average of about 12.0 MAF (see Section 2.8, *Existing Water Supply*). Of the average 12.0 MAF of Sacramento/Delta supply, 8.4 MAF is used for agriculture.

Table 7.4-3. Simulated Average Annual Sacramento/Delta Surface Water Supply by Geographic Region and Sector (thousand acre-feet)

Geographic Region	Agriculture	Municipal	Refuge	Total
Sacramento River watershed	4,641	480	199	5,320
Delta eastside tributaries	124	81	0	205
Delta	1,136	18	0	1,154
San Francisco Bay Area	27	670	0	698
Central Coast	37	49	0	86
San Joaquin Valley	2,422	99	298	2,819
Southern California	14	1,661	0	1,675
Total	8,401	3,058	497	11,957

Source: Table 2.8-3 in Chapter 2, *Hydrology and Water Supply*.

The water supply summaries in Table 7.4-1, Table 7.4-2, and Table 7.4-3 demonstrate regional differences in water supply portfolios and water uses. Most of the agricultural water use in the study area is within the Sacramento River watershed and the San Joaquin Valley regions. Some regions, such as the San Joaquin Valley, use water primarily for agricultural purposes, while other regions, such as the Bay Area, use water primarily for municipal uses. Some regions, such as the Central Coast, depend primarily on groundwater, while other regions, such as the Bay Area, depend primarily on surface water supplies. Regional water supply portfolios and water uses are described in Section 2.8, *Existing Water Supply.*

Responses to Water Supply Shortages

Both water suppliers and growers (irrigators) may take actions to respond to water supply shortages, such as drought. Water suppliers can implement policy and infrastructure changes. Water use efficiency strategies can increase the amount of water used for consumptive use of irrigation (evapotranspiration) while reducing non-consumptive uses, such as deep percolation and runoff. Water use efficiency strategies can involve both the water supplier and the irrigator and may include the following measures.

- Increasing the use of hired irrigation management services to better determine how much water is needed by a crop and when to apply it.
- Converting less efficient irrigation systems (e.g., flood irrigation) to more efficient ones (e.g., micro-irrigation).
- Increasing the capability of irrigation water suppliers to provide delivery flexibility, such as the use of irrigation district regulating reservoirs, to allow flexible delivery durations, scheduling, and flow rates.

The actual effects of water use efficiency measures on growers' profitability cannot be fully described or quantified because many factors could influence a grower's decision to implement such measures. These decisions would be based on considerations such as crop mix, acres grown, market conditions, actual applied-water needs, and actual water supply. The water demand management methods of crop substitution, dry land farming, deficit irrigation, irrigation efficiencies, and management of permanent crops are discussed in the following subsections. Also discussed are other responses to water shortages, including fallowing or land idling, or other water management actions, such as groundwater storage and recovery/conjunctive use, water transfers, and water recycling.

Crop Substitution

Crop substitution involves shifting to less water-intensive crops; it is a water supply shortage response that allows agricultural production to continue and to be profitable while reducing the overall use of water. In the Sacramento River watershed and San Joaquin Valley regions, alfalfa hay is a crop frequently targeted for crop substitution and has, for example, been replaced in many places by nut orchards or grapes.

Dryland Farming

Dryland farming involves the use of stored soil water and rainfall to produce a crop without irrigation, typically a winter grain such as wheat or oats. Dryland farming maintains agricultural production.

Neither the FMMP nor irrigation districts' AWMPs differentiate dryland farming acreage from agricultural land in general; as a result, the full extent of the practice and resultant crops is unknown.

Deficit Irrigation

Deficit irrigation is a practical, 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 survival, even for permanent crops, at the expense of production yield. Typically, deficit irrigation is performed when water supplies are low, particularly during droughts. Due to irrigation methods or cultural practices, not all crops are amenable to deficit irrigation.

Deficit irrigation 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 example, spring cuttings of alfalfa are higher in yield and nutrient quality compared with summer cuttings, so it may be preferable to deficit irrigate in summer when yield and quality are already lower. In addition, consumptive water use during spring for alfalfa is lower than in summer. Alfalfa growers facing a limited water supply could allocate more of their surface water supply for early-season irrigation and cut back on summer watering (^Orloff et al. 2015b). Permanent crops such as orchards can tolerate water stress relatively well compared to some annual crops; however, consecutive years under deficit irrigation can weaken the plants and, even if water supplies return to normal, it may take a few years for the plants to fully recover. Studies have shown that strategic deficit irrigation of almonds, where consumptive water use was reduced by 34 percent, resulted in 85 to 93 percent of full yield (Prichard et al. 1994). However, achieving the 85 to 93 percent of full yield required growers to carefully monitor plant water status (Sanden 2007).

Irrigation Efficiencies

At the field scale, applied irrigation water is divided into recoverable and irrecoverable flows (DWR 2011). Recoverable flows include deep percolation and surface runoff. Irrecoverable flows include evapotranspiration and flows to saline sinks. At the field scale, increasing irrigation efficiency requires a reduction of applied water flowing to deep percolation, surface runoff, or to non-beneficial evapotranspiration. In addition, many on-farm irrigation efficiency improvements require water supplier improvements so that irrigators can get the proper flow rate for the duration needed at the required frequency (DWR 2016).

Irrigation systems include gravity or surface, pressurized, and subirrigation (Irrigation Association n.d.). Common surface irrigation systems in California include furrow, border strips, and level basins. Pressurized irrigation systems include sprinkler and drip and are widespread throughout the state. Subirrigation is a method of irrigation using underground porous pipes to wet the soil near the root zone; its use is primarily limited to the Delta region.

At the field scale, improving irrigation efficiency can be achieved through some combination of management and infrastructure changes. For example, by using the California Irrigation Management Information System network, irrigators can better forecast crop water needs for use in scheduling irrigation (DWR 2023). Shifting from surface irrigation to pressurized systems allows growers to better manage the depth of applied water, which, if properly managed, can lead to reduced deep percolation. Implementation of a tailwater recovery system can turn an inefficient furrow or border strip system into a very efficient system. Growers can use funding from state and federal grant and loan programs to fund water-use efficiency measures. The state's most recent program, Proposition 1 (Assembly Bill 1471, [Rendon], Statutes of 2014, added sections 5096.968 and 75089 to the Pub. Resources Code), authorized $30 million to finance water supplier modernization, automation, and capital outlay projects, as well as research and development and technical assistance that support growers' implementation of on-farm water-use efficiency measures (Reclamation 2019a). The State Water Efficiency and Enhancement Program awards funding for projects such as irrigation efficiency upgrades and soil water monitoring. The federal government provides grant funding through the U.S. Bureau of Reclamation's (Reclamation) Water Smart Program, which supports water supplier water conservation and water-use efficiency projects (Reclamation 2017a; Reclamation 2019a).

Management of Permanent Crops

The day-to-day management of permanent crops is complex due to an individual grower's objectives, crop mix, resources, and other factors. Permanent crops may be more vulnerable to decreased yields during consecutive dry years than other crops because maintaining agronomic productivity and ensuring profitability requires a steady amount of applied water.

Generally, growers avoid replacing all of their trees in an orchard at the same time in order to keep crop production levels relatively stable. For example, newly planted almond trees take about 3 years to start producing (Duncan et al. 2016); peaches reach maturity in 5 to 7 years (Hasey et al. 2017). Therefore, growers often stagger replacement of the permanent crop acres so that only a small percentage of the crop is coming out of production each year and an equal percentage is coming into production (Doll and Shackel 2015). However, during dry periods, growers may choose to retire some acres earlier than planned. This helps save water because the applied water requirements for the first several years of newly established plantings are less than those of more mature plantings (Schwankl and Prichard n.d.). In contrast, during a robust market, growers may defer removing low-producing trees because, even at lower yields, profits may be high.

Growers also have effective water management strategies to preserve permanent crops during water shortages (Fulton 2007). Growers with less efficient irrigation systems can switch to more efficient systems or implement deficit irrigation (see *Deficit Irrigation*), although it may affect yield.

Fallowing, Land Idling, and Conversion

Fallowing, or non-crop production, is an important practice to manage agricultural systems (National Research Council 2010). Fallowing involves growing no crop on a piece of land for a season or more. Fallowing can include planting cover crops to prevent erosion and provide nutrients; these can include diverse plants to maintain biodiversity and enhance biological control of pests, weeds, and diseases. Fallowing may be practiced for agricultural reasons or for economic reasons.

Land idling results when conditions become unfavorable for productive farming, such as lack of adequate water supply during drought (Howitt et al. 2015) or other water supply availability changes, disease, or market conditions. Unlike fallowing, idling is a long-term change in the land use. It is thus a form of conversion.

Conversion is the permanent change in land use from agriculture to another use. Conversion may be the result of extended land idling. When farmland is unirrigated for more than 4 consecutive years, it no longer qualifies as Prime Farmland or Farmland of Statewide Importance under the FMMP, and when farmland has not been used for crops at some time during the preceding 4 years of mapping, it no longer qualifies as Unique Farmland under the FMMP (DOC 2017). This nonuse is not in itself conversion but may be an indicator that conversion has occurred or is about to occur. Conversion could also be a direct change in the land use, as when agricultural land is developed for residential or other urban uses. If reduced water availability decreases agriculture’s profitability by increasing the price of water, reducing the land’s productivity, or both, the economic incentive to convert to urban use could grow. Especially in areas where ongoing urban growth increases the development value of agricultural lands, such conversion can be a rational response to water supply reductions.

Groundwater Storage and Recovery/Conjunctive Use

Groundwater storage and recovery involves storage of water for later recovery by intentionally recharging groundwater basins for future use. Recharge can come from excess surface water supply, as in years of above-average surface supply, or from recycled water. When it is practiced actively, a water district stores surface water in a groundwater basin during wet years and withdraws it during dry years; this is referred to as *groundwater banking*.

Several groundwater storage and recovery programs exist in the San Joaquin Valley, such as the Kern Water Bank. The Kern Water Bank, located in a naturally occurring aquifer in the southern San Joaquin Valley, contains 7,000 acres of recharge ponds that can recharge 30 to 70 thousand acre-feet (TAF) per month with the capacity to store 1.5 MAF of readily accessible water (Kern Water Bank Authority n.d.). Several local irrigation districts are working on their own groundwater storage and recovery projects. Surface spreading sometimes includes diverting water onto agricultural land during the wet season. The factors essential for successful groundwater recharge are deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition (California Soil Resource Lab and UC-ANR n.d.). Some agencies have experimented with diverting water onto active growing fields for recharge, specifically low-value, low-nutrient crops that would not leach nutrients into the groundwater, showing that some crops, such as alfalfa, can be used successfully during the winter growing season for recharge (e.g., Dahlke et al. 2018).

Water Transfers

Water transfers can be utilized both long term and short term. Transfers may take place between parties within the same geographic region (within-region transfers), and between parties that are not in the same geographic region (out-of-region transfers). (SWRCB 2013.) For example, many transfers take place through the Delta using SWP or CVP facilities (DWR and SWRCB 2015). The most common through-Delta transfers are short-term transfers from agricultural users in the Sacramento Valley to agricultural and urban users south-of-the Delta in dry years (DWR and SWRCB 2015). Agriculture is by far the largest-volume source of water for transfer. This is understandable, given that agriculture uses approximately 80 percent of the state's water diversions (PPIC 2016). The number, type, and transaction volume of water transfers are highly correlated with the hydrologic water year type, with increased transfer activity during dry or critically dry water years. (See the *Water Transfers* subsection of Section 7.1.5.3, *Reasonably Foreseeable Methods of Compliance and Response Actions,* and Section 6.6.1.2, *Water Transfers*.)

Water Recycling

Water recycling redistributes treated wastewater for beneficial use. The required level of treatment corresponds to the proposed use of the recycled water. Use of recycled water is part of the state's larger strategy to develop more resilient water supply and increase regional self-reliance. The largest use of recycled water statewide has been agricultural irrigation (31 percent), followed by landscape irrigation (18 percent), and active groundwater recharge (16 percent) (Pezzetti and Balgobin 2017). The largest increase in recycled water use since 2009 was in active groundwater recharge.

The California Water Recycling Criteria, encoded in title 17 and title 22 of the California Code of Regulations, governs use of recycled water for agricultural purposes, including the conditions of use and the requirements to protect the health of workers and the public (Pacific Institute 2010). Different degrees of water treatment are required for food crops where recycled water contacts the edible portion of the crop, including root crops; food crops where the edible portion is produced above ground and does not contact recycled water; orchards with no contact between edible portion and recycled water; fodder (e.g., alfalfa) and fiber (e.g., cotton) crops; and other crop categories, ranging from a requirement for disinfected tertiary recycled water to undisinfected secondary recycled water (Pacific Institute 2010). Water suppliers further specify regulations for recycled water use within their districts.

In California in 2015, recycled water use for agricultural purposes accounted for 220 TAF, or 31 percent of all recycled water use in the state (Pezzetti and Balgobin 2017). The Central Valley accounted for the largest use of recycled water, followed by southern California and the central Coast.

7.4.2.6 Sacramento River Watershed

The Sacramento River watershed covers approximately 17.1 million acres. In 2018, the Sacramento River watershed supported approximately 1.8 million acres of irrigated agriculture, mostly on the valley floor (^Land IQ 2021). Figure 7.4-4a shows that irrigated agriculture (crops) in this region mostly exist on the Sacramento River valley floor. Based on historical water deliveries data (Table 7.4-1), the region's 2005 to 2015 average annual agricultural surface water supply was approximately 6.8 MAF, or over 80 percent of the region's average annual total surface water supply. During the same period, historical water deliveries data estimate that the average annual agricultural groundwater supply was approximately 2.3 MAF, or over 80 percent of the region's average annual total groundwater supply (Table 7.4-2). SacWAM estimates that the average annual Sacramento/Delta surface water supply to the region is about 5,320 TAF, with 4,641 TAF used for agriculture (Table 7.4-3).

The Sacramento River watershed produces a diversity of crops. However, a few of these crops dominate the majority of the agricultural acreage; rice is the leading crop in terms of acreage and is strongly associated with the Sacramento River watershed. Irrigated pasture also represents a large area of agricultural land in this region. Table 7.4-4 provides a list of the most dominant crops in terms of acreage as an average of 2011 through 2016 production.

Table 7.4-4. Top-Producing Crops, by Acreage, Sacramento River Watershed (2011–2016 average)

Crop	Acres
Rice, milling	500,000
Pasture, irrigated	368,000
Alfalfa	198,000
Almonds	156,000
Walnuts	154,000
Wheat	116,000
Grapes, wine	74,000
Tomatoes, processing	61,000
Corn, grain	58,000
Plums, dried	50,000

Sources: CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a.

There are portions of the Sacramento River watershed and Delta eastside tributaries regions (upper watersheds) that are not modeled in the Statewide Agricultural Production (SWAP) model. In general, these are areas above the valley floor, as is shown on Figure 7.4-5.

The upper watersheds are subdivided into six subareas. Each subarea includes varying levels of intensity of irrigated agriculture, cropping patterns, and relative reliance on surface water or groundwater for irrigation. Existing irrigated acreage and cropping patterns for the subareas are shown in Table 7.4-5. As indicated in the table, the largest amount of irrigated land is in the Above Shasta Lake and the Feather-Yuba-American subareas; alfalfa and pasture are predominant in both locations. In contrast, the Cache-Putah and Upper Delta Eastside Tributaries subareas contain relatively large proportions of vine (wine grape) crops and some deciduous orchards, both crop categories with high revenue values per acre. Finally, the West Upper Sac and East Upper Sac subareas contain relatively small amounts of irrigated acreage.

Table 7.4-5. Baseline Irrigated Crop Acreage in Upper Watersheds (acres)

Subarea	Predominant Crop Type	Acres	Other Crop Types	Acres
Cache-Putah	Vine	14,000	Alfalfa and Pasture, Deciduous Orchards, Miscellaneous	8,000
West Upper Sac	Alfalfa and Pasture	2,000	Miscellaneous	1,000
Above Shasta Lake	Alfalfa and Pasture	99,000	Wheat and Field Crops, Rice, Vegetables, Miscellaneous	32,000
East Upper Sac	Alfalfa and Pasture	10,000	Miscellaneous	1,000
Feather-Yuba-American	Alfalfa and Pasture	58,000	Wheat and Field Crops, Vine, Deciduous Orchards, and Miscellaneous	12,000
Upper Delta Eastside Tributaries	Vine	6,000	Alfalfa and Pasture, Wheat and Field Crops, Deciduous Orchards, and Miscellaneous	8,000

Source: DWR Agricultural Land and Water Use Estimates, 2010 Detailed Analysis Unit Data (DWR 2020a).

Rice is the predominant crop in the southern Sacramento Valley, where it first became established in Butte County in the early 1900s. The heavy soils and long growing season in that portion of the Sacramento River watershed made it particularly suitable for growing the japonica type of rice (^UC AIC 1994). As rice acreage expanded in the 1910s and 1920s, irrigation districts formed to supply Sacramento River and Feather River water to rice growers. By the 1950s, additional districts formed on the west side of the valley, served by water from the CVP Tehama-Colusa Canal (^UC AIC 1994). California is the second largest producer of rice in the U.S., but first in production of medium-grain rice, which is now a major export crop to Asian countries (USDA 2023).

Irrigated pasture in support of beef cattle production in the Sacramento Valley and alfalfa production used by dairies and beef cattle throughout the Central Valley are also prominent agricultural land uses in the Sacramento River watershed. These practices are consistent with the historical growth pattern in the dairy and beef cattle industries in the Central Valley (and California as a whole) that occurred from 1940 to the present, especially through the advent of large-scale commercial feed-lot operations pioneered in California and Arizona (Olmstead and Rhode 2017).

Farm acreage and crops grown can and do vary from year to year. Figure 7.4-6 displays changes in the top nine crops in the Sacramento/Delta over the period 2010 through 2015. The acreage over time demonstrates that cropping patterns are not static, as growers respond to commodity markets and prices, long-term market trends, and hydrologic conditions (i.e., droughts or water supply). In the Sacramento/Delta, rice and field crop acreage decreased substantially in 2014 and 2015 as the drought persisted, but alfalfa and irrigated pasture remained relatively constant. At the same time, almond and walnut acreage *increased* each year from the previous one.

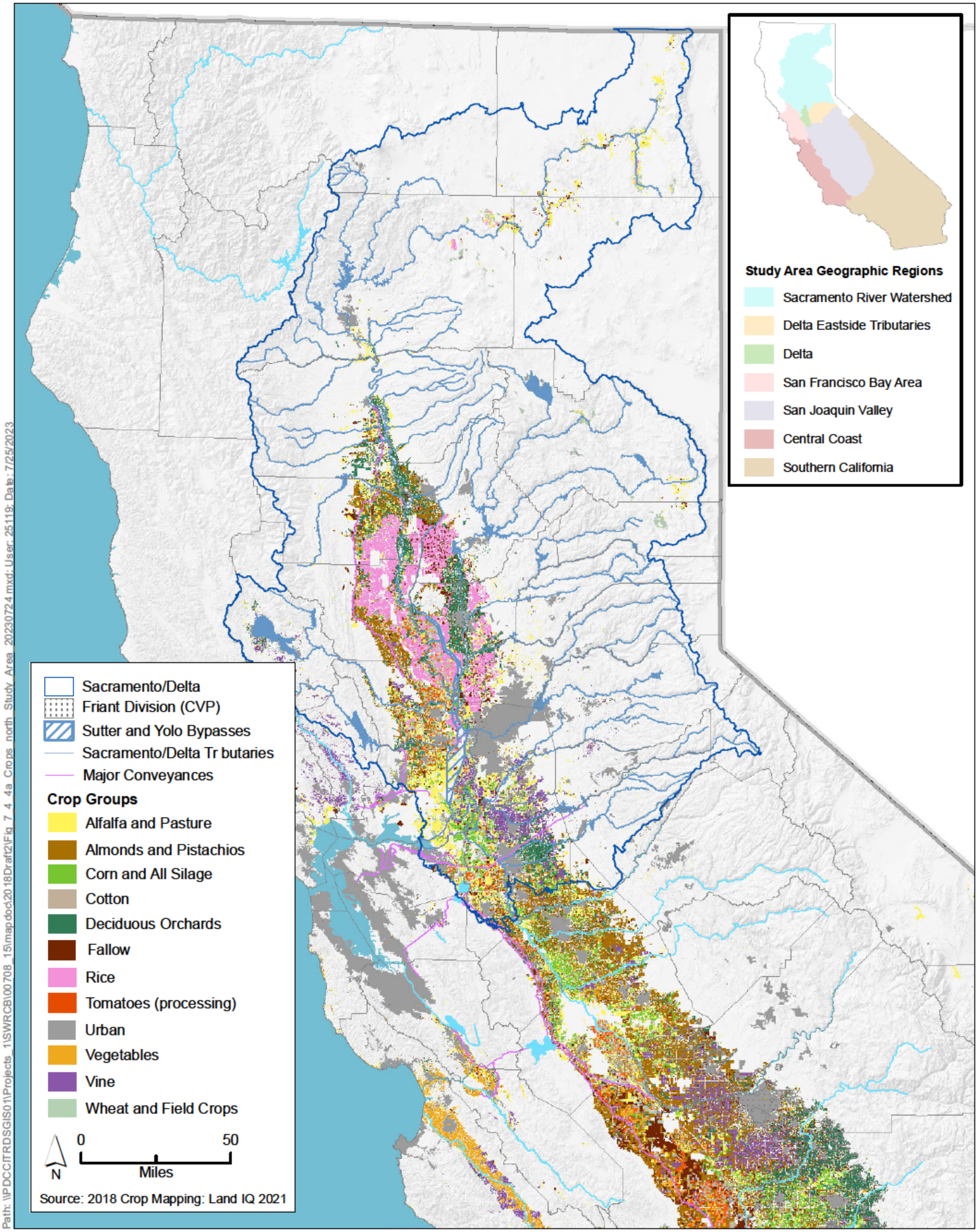

Figure 7.4-4a
Crops in the Study Area (northern)

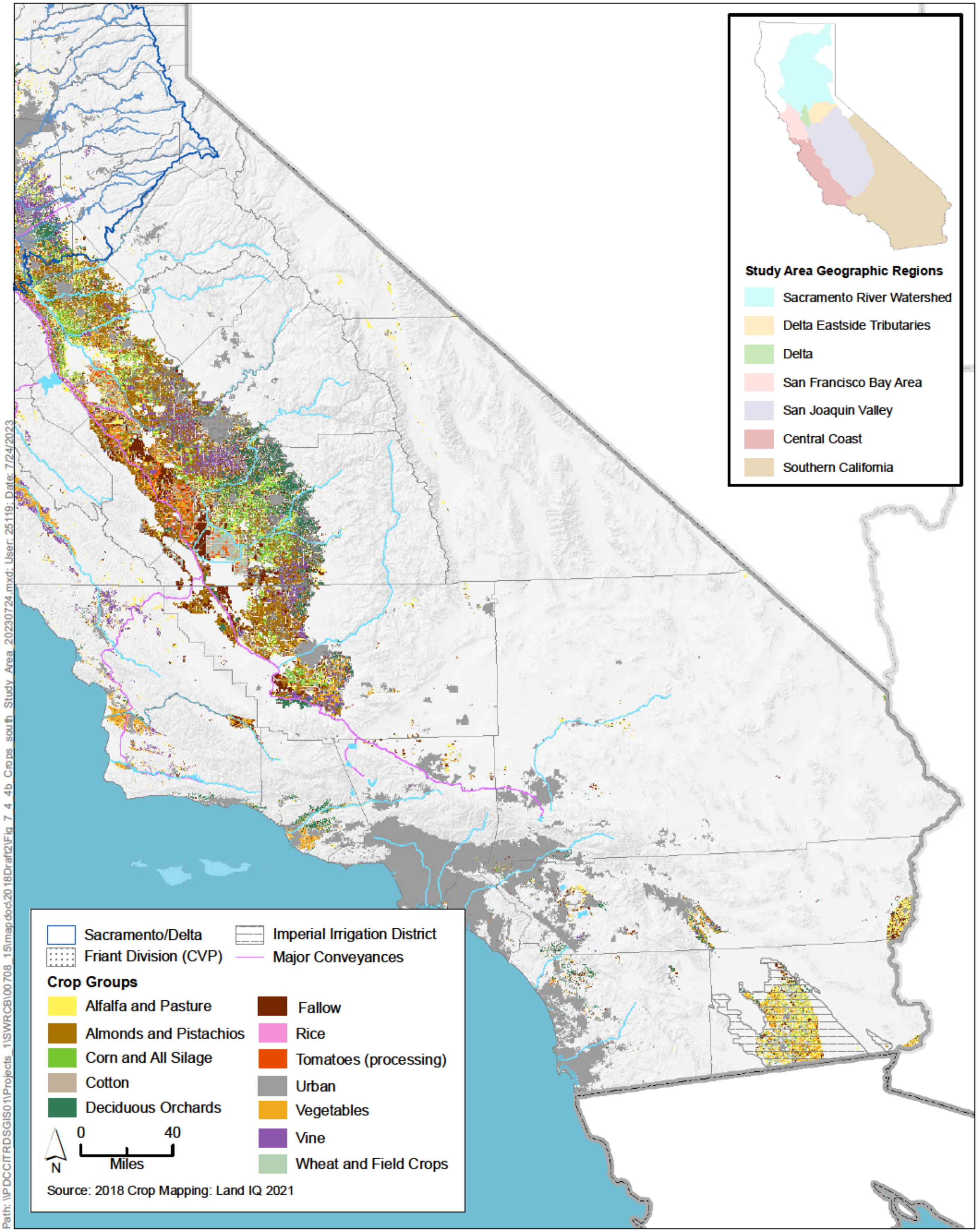

Figure 7.4-4b
Crops in the Study Area (southern)

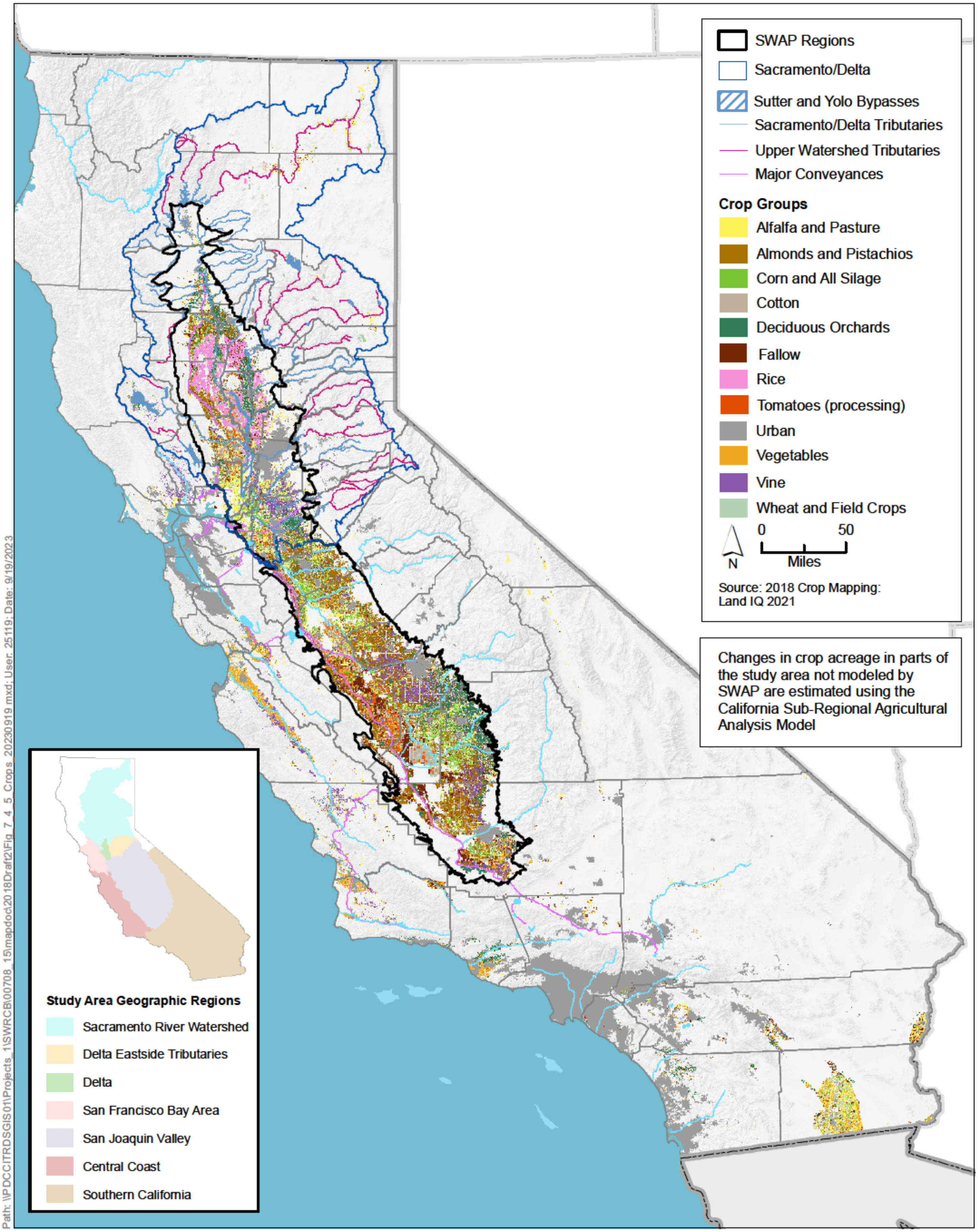

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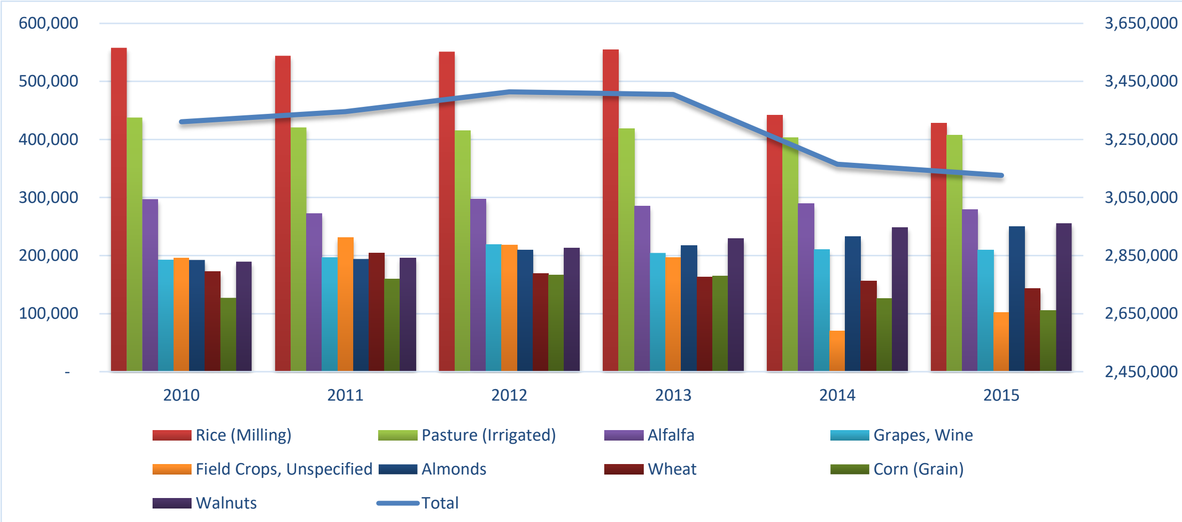
Figure 7.4-5
Crops and Statewide Agricultural Production (SWAP) Region in the Study Area



Sources: CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a.

Figure 7.4-6. Top-Producing Crops and Total of All Crops, by Acreage in the Sacramento/Delta (2010–2015)

Sacramento County and Placer County were among California's top 10 counties for conversion of important farmland to nonagricultural use from 2010 to 2012 (DOC 2015). Irrigated agricultural acreage has declined since its peak during the 1980s, mostly due to urban development (DOC 2015). During the 2012–2016 drought, idling and reversion to dryland farming accounted for further decline in irrigated agriculture, with all counties in the Sacramento River watershed showing overall reductions (DOC 2015). The California Water Plan projects that conversion of agricultural land between 2006 and 2050 in the Sacramento River watershed would range from 6 to 16 percent, depending on population growth and development density (^2013 Water Plan, V2, Sacramento River).[4]

A portion of the farmland in the region is enrolled in Williamson Act and Farmland Security Zone programs (Figure 7.4-2a). In 2016, approximately 18 percent was under Williamson Act contract and 1 percent was under Farmland Security Zone contract.

Timing of water delivery for some crops, such as rice, is important. Water is delivered to rice crops initially in spring to flood the fields, around April after the fields have been prepared for planting, throughout the season as needed for maintenance for an approximately 120-day flooding season, and again during fall after rice has been harvested (Hill et al. 2006; California Rice Commission 2017). Rice fields are flooded during fall so that the rice straw can decompose. The flooding and decomposition have the dual benefit of preparing the field for subsequent planting and providing habitat for wildlife species, including waterfowl migrating through the Pacific Flyway, such as ducks and geese (NCWA n.d.; California Rice Commission 2017).

A prominent hydrologic feature in the Sacramento River watershed is the Yolo Bypass, an approximate 60,000-acre leveed floodway providing flood conveyance, agricultural land, riparian and managed wetland habitat, and some upland and grassland habitat (CDFW n.d.) (Figure 7.4-3a).

[4] The *California Water Plan* projects conversions related to all types of agriculture, including important farmland, farmland of local importance, grazing land, and where defined as a separate farmland type, confined animal agriculture.

The Yolo Bypass can convey up to 80 percent of the flow of the Sacramento River during high flows (^Sommer et al. 2001). All land within the bypass, both public and private, is restricted by easements, which are held by the Reclamation Board. These easements grant the state the right to inundate the land with floodwaters and preclude landowners from building structures or berms or growing vegetation that would significantly obstruct flood flows. When inundated, the Yolo Bypass provides fish, migratory waterfowl, and other wildlife habitat (^Sommer et al. 2001; Schmitt 2011). Approximately two-thirds of the Yolo Bypass is used for agriculture in the dry growing season (Schmitt 2011). Agricultural activity mainly occurs during late spring and summer when flooding is less common. The remaining one-third of the Yolo Bypass is a mosaic of wetlands, riparian, upland, and pond habitat (^Sommer et al. 2001). The northern section of the Yolo Bypass (north of Interstate 80) is primarily owned by a small number of private landowners. The California Department of Fish and Wildlife (CDFW) Fremont Weir Wildlife Area is located in this section of the Yolo Bypass. The southern section of the Yolo Bypass (south of Interstate 80) is a mosaic of private and public lands; this area includes numerous small privately owned parcels, as well as the 16,000-acre Yolo Bypass Wildlife Area (CDFW n.d.). Several crops, such as sugar beets, rice, wild rice, safflower, corn, other grains, and tomatoes are grown on important farmland in the Yolo Bypass (^Sommer et al. 2001). Large areas are identified as pasture and several areas are identified as wetlands (Reclamation 2017b).

Yolo Bypass inundation occurs in many years, typically during the wet season months. Some portion of the Yolo Bypass typically floods in about 60 percent of years, with peak inundation occurring between January and March (DWR 2012; ^Feyrer et al. 2006b; ^Sommer et al. 2001). However, the flood season can extend to other months; for example, in 1998, water entered the Yolo Bypass in June (Reclamation 2017b). Late spring flooding in the Yolo Bypass can negatively affect farming operations. Floods affect crops in a variety of ways. Floods in April through June can damage or destroy crops planted during dry periods in March through May. When this flooding happens, it is usually too late to replant those fields with a different crop. Floods also can erode planting beds and furrows. If the ground remains too wet to work until May or June, the shortened season results in limited crop options and decreased yields.

Multiple surface water sources can contribute to inundation of the Yolo Bypass under high-flow conditions. The major inflows to the Yolo Bypass are from the Sacramento River at the Fremont and Sacramento Weirs. Surface waters enter the Yolo Bypass from the north over Fremont Weir when Sacramento River flows at Verona exceed 55,000 cubic feet per second (cfs). Waters also can enter the Yolo Bypass from the east via the Sacramento Weir, an operable weir that discharges into the Yolo Bypass with a design capacity of 112,000 cfs (see Chapter 2, *Hydrology and Water Supply*, for additional discussion). Other local tributaries that contribute flows to the Yolo Bypass include the Colusa Basin Drain (via the Knights Landing Ridge Cut), Cache Creek, Willow Slough, and Putah Creek. All these sources join the Tule Canal/Toe Drain, a perennial channel on the east side of the Yolo Bypass that discharges to Cache Slough and the Delta several miles above Rio Vista. In general, the Toe Drain spills onto the floodplain when flows exceed approximately 3,500 cfs at Lisbon Weir (^Feyrer et al. 2006a). However, inundation modeling shows some Yolo Bypass floodplain inundation at flows below 2,000 cfs (DWR and Reclamation 2016).

Cache Creek and Putah Creek represent the largest contributions of flows to Yolo Bypass from local tributaries. Cache Creek flows enter the Yolo Bypass from the Cache Creek Settling Basin, which was constructed to capture sediment from Cache Creek upstream of the Yolo Bypass. The Cache Creek Settling Basin is a 3,600-acre basin located east of the city of Woodland that contains an outlet weir and a low-flow outlet to the Yolo Bypass; the low-flow outlet may pass up to 580 cfs, while the outlet weir is designed to pass flood flows up to 30,000 cfs (Carr et al. 2011). During periods of low flow, Cache Creek may dry up upstream of the Cache Creek Settling Basin. Lower Putah Creek flows enter the Yolo Bypass south of the city of Davis and flow to the Toe Drain in the Yolo Bypass. Flood control modifications in the lower Putah Creek watershed have forced Putah Creek to flow through a bypass channel with constructed levees from Davis to the Yolo Bypass. The Lower Putah Creek Realignment Project, which is currently in planning stages, intends to create a realigned channel within the Yolo Bypass to restore ecological functions and enhance fish passage. The project would restore approximately 510 acres of floodplain and tidal wetland habitat and improve anadromous salmonid access to approximately 25 miles of lower Putah Creek (CNRA n.d.).

The Yolo Bypass and Cache Slough Partnership was formed in 2015 to improve interagency coordination for Yolo Bypass activities (Reclamation et al. 2016). The Partnership consists of 15 federal, state, and local agencies, including Reclamation, U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Army Corps of Engineers (USACE), the California Natural Resources Agency, DWR, CDFW, the Central Valley Flood Protection Board, State Water Board, Central Valley Water Board, Yolo County, Solano County, Sacramento Area Flood Control Agency, Solano County Water Agency, and Reclamation District No. 2068. In 2016, the parties signed a memorandum of understanding to improve collaboration, synchronize efforts, and enhance outcomes of planning efforts related to flood conveyance, fish and wildlife habitat, water supply and water quality, agricultural land preservation, economic development, and recreation.

North of the Yolo Bypass, the Sutter Bypass is a flood bypass in Sutter County that diverts water from the Sacramento River between two large levees during high-flow periods. The Sutter Bypass consists primarily of agricultural land uses (Figure 7.4-4a). Rice is the most cultivated crop within the Sutter Bypass in terms of acreage. Other crop types in the Sutter Bypass include walnuts, corn, tomatoes, dry beans, safflower, alfalfa and other hay, melons, and grass/pasture. In addition, there are nonagricultural areas within the Sutter Bypass, such as wetlands within the Sutter National Wildlife Refuge (USFWS n.d.) and other open spaces (Figure 7.4-3a). Inundation of the Sutter Bypass occurs in at least 80 percent of historical water years (Reclamation and DWR 2005).

Groundwater levels in the Sacramento River watershed tend to vary based on hydrologic conditions and demand and generally are declining in several localized areas. There are 7 high-priority and 10 medium-priority basins and subbasins for which the majority of the basin underlies the Sacramento River watershed (Table 7.12.2-2, Figure 7.12.2-1a); there are no critically overdrafted groundwater basins in the region (^CNRA 2022).The Sacramento Valley basin contains the majority of these high-priority and medium-priority subbasins. Some of the challenges facing these areas include expansion of groundwater-dependent agriculture into new areas, replacement of annual crops with permanent crops, and groundwater pumping for agriculture outside of organized water district boundaries.

There are approximately 7 million acres of forest lands in the region that are used in part to manage and harvest timber. Approximately 1.7 million acres are used for timber harvesting and 61,000 acres for non-industrial timber management (CAL FIRE 2018a, 2018b).

7.4.2.7 Delta Eastside Tributaries

The Delta eastside tributaries region covers approximately 2 million acres. In 2018, the Delta eastside tributaries region supported approximately 304,500 acres of irrigated agriculture (^Land IQ 2021) (Figure 7.4-4a). Based on historical water deliveries data (Table 7.4-1), the region's 2005 to 2015 average annual total agricultural water supply was approximately 824 TAF, which constitutes over 80 percent of the region's average annual total water supply of 986 TAF. Agricultural water supply constitutes the majority of the region's total average annual groundwater supply; historical water deliveries data estimates that the region's 2005 to 2015 average annual agricultural groundwater supply was approximately 545 TAF, or approximately 90 percent of the region's total groundwater supply (Table 7.4-2). SacWAM estimates that the average annual Sacramento/Delta surface water supply to the region is about 205 TAF, with 124 TAF used for agriculture (Table 7.4-3).

A variety of crops are grown within the region. Table 7.4-6 displays a list of the most dominant crops in terms of acreage as an average of 2011 through 2016 production. Wine grapes cover the most acreage, followed by silage.

Table 7.4-6. Top-Producing Crops, by Acreage, Delta Eastside Tributaries (2011–2016 average)

Crop	Acres
Grapes, wine	60,000
Silage, other	50,000
Almonds	36,000
Corn, grain	33,000
Alfalfa	33,000
Silage, corn	31,000
Walnuts	30,000
Pasture, irrigated	20,000
Tomatoes, processing	16,000
Wheat	16,000

Sources: CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a.

San Joaquin County was one of the top 10 counties for conversion of important farmland to nonagricultural use from 2010 to 2012 (DOC 2015). Irrigated farmland in the region decreased slightly between 2004 and 2014, but large conversions in Prime Farmland and Farmland of Statewide Importance were counterbalanced with gains in Unique Farmland in San Joaquin County (DOC 2008a, DOC 2015), primarily expansion of nut orchards, vineyards, and crops on soils of lesser quality (DOC 2004a, 2006a, 2008b, 2010a, 2012a, 2014a, 2015). The California Water Plan projects that conversion of agricultural land between 2006 and 2050 would range from 2 to 8 percent, depending on population growth and development density in the San Joaquin Valley, which geographically includes the Delta eastside tributaries region (^2013 Water Plan).

A portion of the farmland in the region is enrolled in Williamson Act and Farmland Security Zone programs (Figure 7.4-2a). In 2016, approximately 30 percent was under Williamson Act contract, and approximately 0.1 percent was under Farmland Security Zone contract.

Groundwater levels in the Delta eastside tributaries region vary based on hydrologic conditions and demand. Two groundwater subbasins are located entirely or partially in the region: The Eastern San Joaquin and Cosumnes subbasins. The region relies heavily on groundwater. The Eastern San Joaquin subbasin is identified by SGMA as a high-priority subbasin, and the Cosumnes subbasin is identified as a medium-priority subbasin; the Eastern San Joaquin subbasin is critically overdrafted

(Table 7.12.2-3, Figure 7.12.2-1a) (CNRA 2022) Because of the status of the two subbasins, both are subject to management under SGMA (see Section 7.12.2, *Groundwater*).

There are approximately 671,000 acres of forest lands in the region that are used, in part, to manage and harvest timber (Figure 7.4-3a). Approximately 118,000 acres are used for timber harvesting and 11,000 acres for non-industrial timber management (CAL FIRE 2018a, 2018b).

7.4.2.8 Delta

The Delta region spans approximately 1,115 square miles (more than 700,000 acres) of tidally influenced land near the confluence of the Sacramento and San Joaquin Rivers. This region primarily contains agricultural uses. In 2018, the Delta supported approximately 373,000 acres of irrigated agriculture (^Land IQ 2021) (Figure 7.4-4a). Although Suisun Marsh and the surrounding areas are in the Bay Area region, most of the agricultural land is in the Delta proper. Based on historical water deliveries data (Table 7.4-1), the region's 2005 to 2015 average annual agricultural water supply was approximately 1.2 MAF, or over 85 percent of the region's total water supply. Nearly all water use in the Delta is from surface water supplies. Historical water deliveries data estimate that the region's 2005 to 2015 average annual total groundwater supply was 74 TAF, with 34 TAF used for agriculture (Table 7.4-2). SacWAM estimates that the average annual Sacramento/Delta surface water supply to the region is about 1,154 TAF, with 1,136 TAF used for agriculture (Table 7.4-3).

A similar variety of crops is grown within the Delta region as in the Sacramento River watershed and Delta eastside tributaries regions. Table 7.4-7 displays a list of the dominant crops in terms of acreage as an average of 2011 through 2016 production. Wine grapes cover the most acreage, followed by field crops (silage, grain corn, processing tomatoes, and wheat) and hay. Walnut and almond acreage also have a presence in the Delta.

Table 7.4-7. Top-Producing Crops, by Acreage, Delta Region (2011–2016 average)

Crop	Acres
Grapes, wine	42,000
Silage, other	36,000
Alfalfa	32,000
Corn, grain	28,000
Walnuts	24,000
Almonds	22,000
Wheat	19,000
Silage, Corn	19,000
Tomatoes, processing	18,000
Pasture, irrigated	15,000

Sources: CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a.

Much of the Delta consists of land with physical and chemical characteristics (such as the fertile organic soils) favorable to agriculture and a reliable irrigation water supply that allows for crop production (DSC 2011a). Because the Delta region is recognized as an agricultural and open space region of great value to the state and nation, and retention and continued cultivation and production of its fertile peatlands and prime soils are of significant value, the California Legislature passed the

Johnston-Baker-Andal-Boatwright Delta Protection Act of 1992 (Pub. Resources Code, § 29700 et seq.). The act created the Delta Protection Commission and required the commission to adopt a resource management plan for the Delta by October 1, 1994. This resource management plan addresses, among its mandatory requirements, how to protect the Delta from any development that results in significant loss of habitat or agricultural land (Pub. Resources Code, § 29760). In 2009, in response to the ongoing ecosystem and water infrastructure crisis in the Delta, the California Legislature passed the Delta Reform Act (Wat. Code, § 85000 et seq.), revised the Delta Protection Act, and created the Delta Conservancy. The Delta Reform Act includes among its ecosystem and water supply goals a directive to protect and enhance the unique cultural, recreational, and agricultural values of the Delta as an evolving place. Despite specific legal protections, agricultural land area historically has decreased, largely because of conversion to urban land uses.

Contra Costa and San Joaquin Counties were among the top 10 counties for conversion of important farmland to nonagricultural use from 2010 to 2012 (DOC 2015). Irrigated agricultural acreage declined between 2004 and 2014 (DOC 2008a; DOC 2015).

Nearly half of the farmland in the Delta region is enrolled in Williamson Act and Farmland Security Zone programs (Figure 7.4-2a). In 2016, approximately 42 percent was under Williamson Act contract, and approximately 4 percent was under Farmland Security Zone contract.

Groundwater levels vary seasonally in the Delta region; they are influenced by precipitation, drainage, soil texture, and proximity to and levels of adjoining surface waters (^2013 Water Plan, V2, Sacramento-San Joaquin Delta). In the central Delta, groundwater levels are shallow and close to the surface on several Delta islands as a result of land subsidence because of land reclamation and farming. In areas where shallow groundwater levels encroach on crop root zones, groundwater is pumped to drain waterlogged agricultural fields (DSC 2011b). Groundwater levels also are influenced by tidal flows. While some groundwater is used for agriculture, the ease of diverting surface water from adjacent water sources makes the use of groundwater much less than in other regions (^2013 Water Plan, V2, Sacramento-San Joaquin Delta).

The Delta region includes 199 acres of forest lands. None of these forest lands are used to manage or harvest timber (CAL FIRE 2018a, 2018b).

7.4.2.9 San Francisco Bay Area

The Bay Area region covers approximately 3.0 million acres. In 2018, the Bay Area region supported approximately 115,000 acres of irrigated agriculture (^Land IQ 2021) (Figure 7.4-4a). Based on historical water deliveries data, municipal water use of approximately 1.1 MAF constitutes over 90 percent of the region's average annual total water supply; however, the region's 2005 to 2015 average annual total agricultural water supply was approximately 137 TAF (Table 7.4-1). Historical water deliveries data show that groundwater accounts for the majority of the region's total agricultural water supply; the region's 2005 to 2015 average annual agricultural groundwater supply was estimated at 80 TAF (Table 7.4-2). Although the region is heavily dependent upon surface water (both local and imported sources), agricultural irrigators predominantly rely upon groundwater. In Napa County, groundwater constitutes approximately 80 percent of the agricultural water supply (West Yost & Associates 2005). Sacramento/Delta supplies delivered to the region are represented in SacWAM by the North Bay Aqueduct, South Bay Aqueduct, and Mokelumne Aqueduct. The analysis approach in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*, uses SacWAM results and water management plan information to estimate that the average annual Sacramento/Delta supply to the region is approximately 698 TAF, with 27 TAF used for agriculture (Table 7.4-3).

Bay Area agriculture is dominated by wine grape production. As shown in Table 7.4-8, after wine grapes, there are few crops with a large presence in terms of acreage, based on an average of 2011 through 2016 production. Hay (alfalfa and other), pasture, general field crops, grain corn, and silage, occupy much of the remaining irrigated land.

Table 7.4-8. Top-Producing Crops, by Acreage, San Francisco Bay Area Region (2011–2016 average)

Crop	Acres
Grapes, wine	106,000
Hay, excluding alfalfa	14,000
Pasture, irrigated	13,000
Corn, grain	7,000
Silage	7,000
Field crops, unspecified	6,000
Alfalfa	4,000
Corn, sweet	4,000
Tomatoes, processing	3,000
Vegetables, unspecified	2,000

Sources: CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a.

Although a variety of crops are grown in the Bay Area region, irrigated acreage has decreased in this region over the past several decades. Urbanization has reduced agricultural acreage in the Santa Clara Valley from more than 125,000 acres originally to fewer than 18,000 acres in 2017, and Marin County has only about 3,700 irrigated acres remaining (SCCACO 2014; ^SCCDA 1949; ^SCCDA 1960; ^Marin County Department of Agriculture 2016; USDA 2017). In Napa and Sonoma Counties, agricultural acreage has increased because vineyard acreage has expanded (DOC 2015, p. 4; Napa County Department of Agriculture and Weights and Measures 2018, p. 6; Sonoma County Department of Agriculture/Weights and Measures 2016; Sonoma County Department of Agriculture/Weights and Measures 2017). The adoption of drip irrigation has allowed planting on lands too steep for furrow or sprinkler irrigation practices.

Counties in the region did not rank in the top 10 counties in agricultural conversion to urban uses because much of the Bay Area's agricultural land already has been converted (DOC 2015). However, regionally, the Bay Area ranks fourth of seven regions in urbanization for the period 2010 through 2012 (DOC 2015). The California Water Plan projects that conversion of agricultural land between 2006 and 2050 would range from 6 to 25 percent, depending on population growth and development density (^2013 Water Plan, V2, San Francisco Bay).

A little less than one-quarter of the farmland in the region is enrolled in Williamson Act programs (Figure 7.4-2a). In 2016, 21 percent was under Williamson Act contract, and approximately 0.6 percent was enrolled in Farmland Security Zone programs.

Groundwater conditions in the Bay Area region are varied. At the south end of the San Francisco peninsula, Santa Clara Valley Water District (Valley Water) manages the Santa Clara subbasin, which is a high-priority groundwater subbasin but is not identified as critically overdrafted (Table 7.12.2-5)(^CNRA 2022). Surface water and precipitation in the Santa Clara Valley are used to recharge the aquifer through groundwater infiltration basins. Sacramento/Delta supplies also are used to recharge aquifers in this area. In recent decades, groundwater levels have recovered from overdraft and tend to follow the hydrologic cycle, with increasing groundwater storage and levels during wet periods and declining storage and levels during dry periods.

The Bay Area region includes approximately 671,000 acres of forest lands. Approximately 15,000 acres are used for timber harvesting and 4,000 acres for non-industrial timber management (CAL FIRE 2018a; CAL FIRE 2018b).

7.4.2.10 San Joaquin Valley

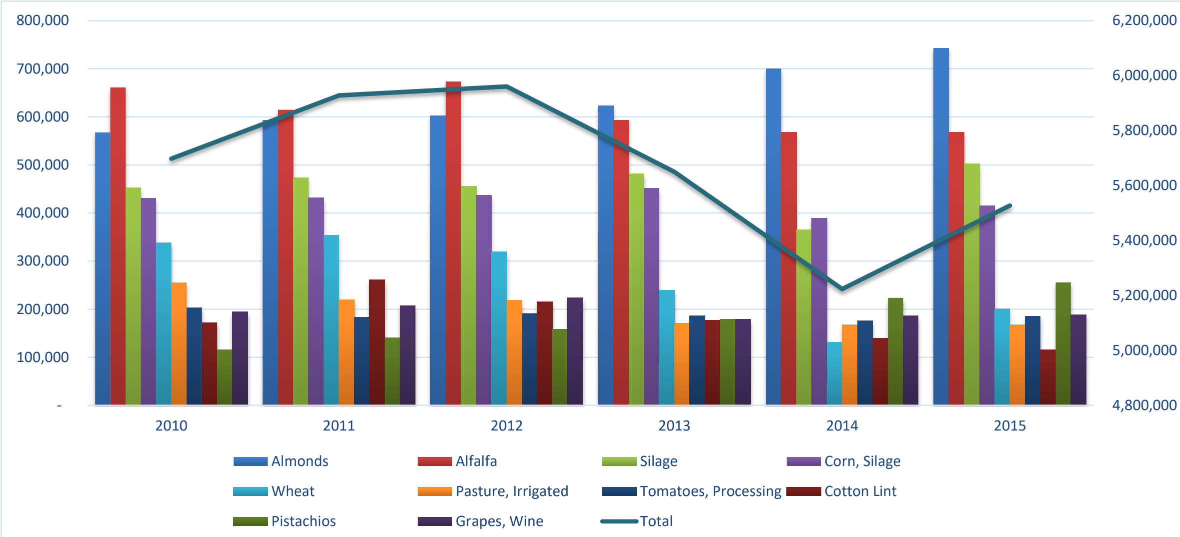
The San Joaquin Valley region covers approximately 18 million acres. The San Joaquin Valley is the largest agricultural region in California. In 2018, the San Joaquin Valley supported approximately 4 million acres of irrigated cropland (^Land IQ 2021) (Figure 7.4-4b). Based on historical water deliveries data, the region's 2005 to 2015 average annual total agricultural water supply was approximately 16.8 MAF, over 90 percent of the region's total water supply (Table 7.4-1). Historical water deliveries data estimate that the region's 2005 to 2015 average annual agricultural groundwater supply was approximately 9.0 MAF, or about 90 percent of the average annual total groundwater supply for the region (Table 7.4-2). Sacramento/Delta supplies provided to the region are represented in SacWAM by CVP and SWP deliveries via the Delta-Mendota Canal (DMC) and the California Aqueduct. The analysis approach in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*, uses SacWAM results and water management plan information to estimate that the average annual Sacramento/Delta supply to the region is approximately 2.8 MAF, with the majority for agricultural use (2.4 MAF) (Table 7.4-3).

The San Joaquin Valley region produces a diversity of crops. Table 7.4-9 provides a list of the top 10 crops in terms of acreage as an average of 2011 through 2016 production, and Figure 7.4-7 displays changes in producing acreage of these crops from 2010 through 2015. The largest crop acreage is devoted to almonds, followed by alfalfa, silage, and corn silage. Producing almond acreage has grown steadily from 2010 through 2015. Alfalfa was the highest acreage crop from 2010 through 2012, but a decline in 2015 moved it to second highest, with almonds covering more acres. Silage and corn silage have remained relatively constant over the 2010 through 2015 timeframe, as have processing tomatoes. During this period, pistachio orchards have more than doubled and wine grapes varied just slightly over the period.

Table 7.4-9. Top-Producing Crops, by Acreage, San Joaquin Valley Region (2011–2016 average)

Crop	Acres
Almonds	638,000
Alfalfa	613,000
Silage	455,000
Corn, silage	426,000
Wheat	264,000
Pasture, irrigated	200,000
Grapes, wine	197,000
Tomatoes, processing	188,000
Cotton lint	180,000
Pistachios	179,000

Sources: CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a.



Sources: CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a.

Figure 7.4-7. Top-Producing Crops and Total of All Crops, by Acreage, San Joaquin Valley Region (2010–2015)

Kings, Kern, and Tulare Counties were among the top 10 counties for conversion of important farmland to urban use from 2010 to 2012 (DOC 2015).

Between 2004 and 2014, important farmland in the region decreased due to conversions in most counties (DOC 2008a; DOC 2015). However, Stanislaus County saw gains in Unique Farmland, including nut orchards, vineyards, and nursery products (DOC 2004b, 2006b, 2008c, 2010b, 2012b, 2014b, 2015). Between 2010 and 2012, Fresno, Kern, Madera, and San Joaquin Counties were among the top 10 counties for conversion of agricultural lands to urban use (DOC 2015). The California Water Plan projects that conversion of agricultural land between 2006 and 2050 would range from 2 to 8 percent, depending on population growth and development density (^2013 Water Plan, V2, Tulare Lake).

A little over a third of the farmland in the region is enrolled in Williamson Act and Farmland Security Zone programs (Figures 7.4-2a and 7.4-2b). In 2016, 37 percent was under Williamson Act contract, and 3 percent was under Farmland Security Zone contract.

The San Joaquin Valley has a history of high groundwater use, which has resulted in overdraft. Prior to the 1960s, groundwater discharged to streams in much of the San Joaquin River watershed; however, with increased groundwater pumping over the years, the hydraulic gradient between surface water and groundwater systems reversed such that surface water recharges the underlying aquifer (DSC 2011b). Long-term groundwater pumping has lowered groundwater levels, and most streams lose water to the underlying aquifers. Groundwater generally moves from high ground down toward the San Joaquin River and Delta. However, groundwater may also move into areas of substantial drawdown, such as toward the cone of depression in the eastern half of the Turlock groundwater subbasin or the high groundwater pumping areas west of the San Joaquin River (^USGS 2015).

The San Joaquin Valley region includes approximately 3.7 million acres of forest lands. Approximately 110,000 acres are used for timber harvesting and 16,000 acres for non-industrial timber management (CAL FIRE 2018a, 2018b).

Sacramento/Delta supply is delivered to the western and southern areas of the San Joaquin Valley and influences water availability in the CVP Friant Division service area. Agriculture in these areas of the San Joaquin Valley region is discussed under *Western San Joaquin Valley, Southern San Joaquin Valley,* and *Friant Division*.

Western San Joaquin Valley

Sacramento/Delta supply is delivered by the CVP and SWP for agricultural uses in the western San Joaquin Valley. The CVP provides Sacramento/Delta supply to the San Joaquin River exchange contractors through the DMC. The portion of water stored by the CVP in San Luis Reservoir is delivered to several south-of-Delta service areas via the San Luis Canal to serve south-of-Delta contractors, including Westlands Water District. Water is also delivered via the DMC and the California Aqueduct to serve other CVP and SWP contractors on the west side of the San Joaquin Valley, such as Oak Flat Water District and Del Puerto Water District.

The San Joaquin River exchange contractors comprise four water districts: Central California Irrigation District, San Luis Canal Company, Firebaugh Canal Water District, and Columbia Canal Company. These water districts possess water rights that existed before construction of the CVP and historically diverted water from the San Joaquin River. In 1939, they entered contracts with Reclamation to exchange their San Joaquin River water for Sacramento/Delta water delivered from the DMC. The execution of these contracts allowed for construction of Friant Dam (SJRECWA 2021). Per their agreement with Reclamation, the exchange contractors receive 100 percent of their contract amount in all years except critically dry water years, as defined by the Shasta Hydrological Index. In Shasta critical years (i.e., when the total inflow to Shasta Reservoir is below 3.2 MAF), exchange contractors receive 75 percent of their contract amounts (SWRCB 2019). The exchange contractors deliver water to 240,000 acres of irrigated land, in the San Joaquin Valley, along the San Joaquin River.

CVP south-of-Delta agricultural water service contractors receive a lower priority allocation of CVP supplies than exchange contractors, which typically results in deliveries that are lower than their maximum contract quantities. For example, in 2011, a wet water year, CVP south-of-Delta water service contractors such as Westlands Water District received 80 percent of their contract amounts, while CVP south-of-Delta settlement/water rights contractors received 100 percent (Reclamation 2021). Westlands Water District has CVP contracts for approximately 1.2 MAF/yr (Westlands Water District n.d.). SacWAM representation of Sacramento/Delta water deliveries to Westlands Water District is included with deliveries to other CVP contractors via the San Luis Canal and Mendota Pool demand sites. The analysis approach in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*, uses SacWAM results and water management plan information to estimate that average CVP deliveries to Westlands Water District are approximately 560 TAF/yr under baseline conditions.

Westlands Water District encompasses approximately 1,000 square miles in western San Joaquin Valley (^Westlands Water District 2013), much of this area is important farmland. Major crop types grown within the Westlands Water District have changed over the past several decades. Prior to the initiation of CVP water deliveries in 1968, Westlands Water District farmers primarily grew cotton and grain crops, such as wheat and barley, and some vegetables. Between 1980 and 1996, the acreage devoted to vegetables increased to more than 220,000 acres, while acres of grain crops declined by approximately 100,000 acres (^Westlands Water District 2013). Nut trees now represent a major crop type within the Westlands Water District. Of the approximately 570,000 acres included in Westlands Water District's 2018 Crop Acreage Report, the crops with the largest acreage in 2018 were almonds (approximately 88,000 acres), processing tomatoes (approximately 65,000 acres), and pistachios (approximately 51,000 acres). Other major crops identified in the 2018 Crop Acreage Report include cantaloupes, cotton, garlic, hay, wine grapes, wheat, and other trees and vines. Westlands Water District also reported that over 140,000 acres were fallowed in 2018. (Westlands Water District 2018.)

Groundwater quality in parts of the west side of the San Joaquin Valley is not uniform. In a portion of the CVP's San Luis Unit including the Westlands Water District, an impermeable layer separates a shallow aquifer (the upper 20 to 200 feet of the saturated groundwater zone) from a deep aquifer. Water in the shallow aquifer is generally not adequate for agriculture (Reclamation 2006 because of high salt concentrations due in part to ongoing agricultural practices.

Much of the area thus requires drainage to remove salt-laden high groundwater from the shallow aquifer (^Westlands Water District n.d.[a]). The 2003 Westside Regional Drainage Plan includes land retirement of up to 200,000 acres and other measures, such as adaptive management for drainage, groundwater management, regional reuse, and salt disposal. As of 2017, Westlands had retired approximately 40,000 acres of farmland because the soil had become too saline for growing crops. Another 50,000 acres of land are no longer irrigated but can be farmed with dryland farming methods (^Benson 2017). Westlands growers manage salinity through irrigation management, crop rotation, and salinity testing (^Westlands Water District n.d.[b]).

In contrast to the salty shallow aquifer, the deep aquifer in the Westlands area, protected from salts by the impermeable soil layer, contains high-quality water for irrigation. However, drilling a well to a depth necessary to access the deep aquifer is expensive, in some cases prohibitively so.

The service areas of Westlands, Broadview, Panoche, and Pacheco Water Districts and the southern portion of the San Luis Water District lie within the geographic boundaries of the CVP's San Luis Unit (Reclamation 2007). The presence of poor-quality groundwater in the shallow aquifer underlying the San Luis Unit has had the greatest effect on Westlands Water District, although groundwater quality in the shallow aquifer underlying the Broadview, Panoche, and Pacheco Water Districts is also impaired to a certain degree (Reclamation 2006).

Southern San Joaquin Valley

Most of the Sacramento/Delta supply to this area is delivered via the California Aqueduct and Cross Valley Canal to SWP and CVP contractors in the southern San Joaquin Valley. These users are primarily agricultural contractors in the Tulare Lake hydrologic region. From O'Neill Forebay, the San Luis Canal/California Aqueduct extends south to the Kettleman City area. Dos Amigos and Buena Vista Pumping Plants provide the lift necessary for the aqueduct to continue conveying water south to the Tulare Lake basin, where it serves many of the agricultural users in the southern San Joaquin Valley. Sacramento/Delta supplies to the southern San Joaquin Valley are represented in SacWAM by deliveries from the California Aqueduct to SWP contractors and CVP Cross Valley Canal contractors in the region. The analysis approach in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*, uses SacWAM results and water management plan information to estimate that Sacramento/Delta supply constitutes about 721 TAF/yr on average to the southern San Joaquin Valley. Although this represents most of the Sacramento/Delta supply to the area, it is a small portion of the overall water use for agriculture. Historical water deliveries data estimate the average annual total water use for irrigated agriculture in the Tulare Lake hydrologic region to be approximately 10.9 MAF for the 2005 to 2010 period, which consists primarily of local surface water and groundwater. The greater Tulare Lake area is one of the nation's leading agricultural production areas, growing a wide variety of crops on approximately 3 million irrigated acres (^2013 Water Plan), much of it important farmland. In 2005, cotton had the most acreage planted with approximately 540,000 acres, followed by alfalfa and vineyards with about 350,000 and 340,000 acres, respectively (^2013 Water Plan). From 2005 to 2010, many farmers in the region replaced some of their cotton fields with almonds and/or pistachios, leading to a 53-percent increase in nut tree crop acreage from 2005 to 2010 (^2013 Water Plan). In 2010, almonds and pistachios had the highest crop acreage with approximately 500,000 acres, followed by vineyards and corn with about 350,000 and 340,000 acres, respectively (^2013 Water Plan).

Several SWP contractors are in the southern San Joaquin Valley, including County of Kings, Dudley Ridge Water District, Empire West Side Irrigation District, Kern County Water Agency, and Tulare Lake Basin Water Storage District. Kern County Water Agency has the largest SWP contract in the southern San Joaquin Valley area, with a maximum DWR contract allocation of approximately 980 TAF/yr. Kern County Water Agency has long-term contracts to provide SWP water to several member water districts (Kern County Water Agency 2018). For some member water districts, SWP water supplements water supply from other water sources (Buena Vista WSD 2016; Cawelo WD 2015).

The Cross Valley Canal contractors consist of seven agencies (Lower Tule River Irrigation District, Pixley Irrigation District, Kern-Tulare Water District, Hills Valley Irrigation District, TriValley Water District, County of Tulare, and County of Fresno) that are located on the eastside of the San Joaquin Valley. The Cross Valley Canal contractors receive Sacramento/Delta supply for agricultural use via the Cross Valley Canal. Water that is conveyed to the Delta by the CVP is transported by DWR to the Cross Valley Canal via the California Aqueduct. The Cross Valley Canal contractors have an annual CVP water supply of 128,300 acre-feet (AF). Because of water availability, pumping constraints, available transfers/exchanges, and timing of deliveries, the typical CVP delivery to the Cross Valley Canal contractors is substantially less than the contract amount. Crops grown in the area include row crops, orchards, vineyards, and irrigated pasture (Lower Tule River Irrigation District 2016).

Because most groundwater subbasins in this area are overdrafted, the aquifers have a substantial amount of storage space to capture recharge water. Groundwater banking projects in the area, such as the Kern Water Bank and Semitropic Groundwater Bank, store excess water when it is available and extract the water for later use. Multiple water sources, including local water supplies and Sacramento/Delta water, can be stored in these water banks. Participating water users, including districts, agencies, and mutual water companies, have complex water portfolios and publish little data on the volumes or sources of water entering the banks. SWP and CVP infrastructure, such as the California Aqueduct, are used to move water acquired through settlements, rights, claims, transfers, exchanges, and purchases to local canals or conveyances that move the water to the recharge areas. Local surface waters are also used for recharge. The same canals that transfer water from the California Aqueduct to the water banks during wet periods are used to transfer water from the banks back to the California Aqueduct during dry periods when the water is made available to banking partners.

As discussed in the *Groundwater Storage and Recovery/Conjunctive Use* subsection of Section 7.4.2.5, *Water Supply and Irrigation,* Kern Water Bank Authority owns and operates the Kern Water Bank, a groundwater banking project located on approximately 20,000 acres in Kern County, which stores SWP deliveries to the Kern County area as well as smaller quantities of Kern River flows and CVP deliveries. The southern San Joaquin Valley area is the location of other groundwater banks receiving water from multiple sources, including SWP and CVP contractors. Groundwater banks store water for entities that are both geographically proximate and those that are farther away. Groundwater banks in the southern San Joaquin Valley area that store water for other districts include, among others, Semitropic Water Storage District (Semitropic Water Storage District 2015) and Cawelo Water District (Cawelo Water District 2015). Semitropic Water Storage District's and Cawelo Water District's primary remote water banking partner that would use banked water for agricultural purposes is Alameda County Flood Control and Water District (also known as Zone 7 Water Agency [Zone 7]) in the Bay Area region (Cawelo Water District 2015; Semitropic Water Storage District 2015). Semitropic Water Storage District and Cawelo Water District both operate primarily an in-lieu water banking program,[5] although both have some water recharge basins (Semitropic Water Storage District 2015; Cawelo Water District 2015).

Friant Division

The Friant Division is a unit of the CVP that transports water from Friant Dam at Millerton Lake. Water is delivered through the Madera Canal, which extends northward 36 miles to the Chowchilla River, and the Friant-Kern Canal, which extends southward 153 miles to the Kern River. The Friant Division encompasses parts of Fresno, Kern, Kings, Madera, Merced, and Tulare Counties (Figure 7.4-1b). In most years, the Friant Division diverts nearly the entire flow of the San Joaquin River (Reclamation 2019b).

As mentioned under *Western San Joaquin Valley*, a 1939 agreement between Reclamation and the San Joaquin River exchange contractors enabled construction of the Friant Dam to bring San Joaquin River water to the east side of the San Joaquin Valley and the Friant Division. The agreement provides the exchange contractors with Sacramento/Delta water, delivered through the Delta via the CVP's DMC in exchange for allowing the Friant Division to use San Joaquin River water. If Reclamation is not able to deliver the contractual allotment, the exchange contractors can "call" their water rights from the San Joaquin River delivered from Millerton Lake. This can reduce or eliminate San Joaquin River water availability for the Friant Division water contractors (Friant Water Authority 2014). In 2014 and 2015, the Friant Division contractors received a zero allocation of surface water from the San Joaquin River (Friant Water Authority 2018) because the available water went to meet San Joaquin River exchange contractors' demand. In recent years when calls on Friant water have been made by the exchange contractors, Reclamation continued to release water from Millerton Lake that otherwise would have been used by Friant Division contractors, although a portion of the contract had been delivered from the Delta.

[5] Groundwater banks can store water underground directly, bank the water indirectly through in-lieu agreements, or both. In direct storage, the water bank pumps the water back from its storage groundwater basin to a water conveyance system, which conveys it to the water banking partner. In indirect in-lieu storage, the water bank provides water to the banking partner from its allotment of surface water from a source such as SWP or CVP and uses the banked water for local use.

The Friant Division service area includes more than 1 million acres of irrigable farmland, much of which is planted in permanent crops from approximately Chowchilla in the north to the Tehachapi Mountains in the south (Friant Water Authority 2019). The major crops in the Friant Division are grape (both table and wine), almonds, pistachios, oranges, lemons and limes, olives, alfalfa, and cotton (CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a).

In addition to San Joaquin River water, growers in the Friant Division service area utilize a range of other water supplies, including Sacramento/Delta water via the Cross Valley Canal; local surface water such as the Kings River, Tule River, and Kern River; and groundwater. Several groundwater basins in the Friant Division service area are critically overdrafted and are ranked as high priority by SGMA (^CNRA 2022) (Figure 7.12.2-1b, Table 7.12.2-6).

7.4.2.11 Central Coast

The Central Coast region covers approximately 7.2 million acres. In 2018, the Central Coast region supported approximately 526,000 irrigated acres (^Land IQ 2021) (Figures 7.4-4a and 7.4-4b). Based on historical water deliveries data, the region's 2005 to 2015 average annual total water supply was approximately 1.3 MAF, of which approximately 1.1 MAF was used for agricultural purposes (Table 7.4-1). The Central Coast is the region most reliant on groundwater for its water supply. For the same period, historical water deliveries data estimate that groundwater supplies accounted for approximately 1.2 MAF (over 85 percent) of the region's total water supply, of which approximately 968 TAF was used for agricultural purposes (Table 7.4-2). Sacramento/Delta supplies to the Central Coast region are represented in SacWAM by CVP San Felipe Division deliveries to the northern Central Coast and SWP Central Coast Aqueduct deliveries to the southern Central Coast. The analysis approach in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*, uses SacWAM results and water management plan information to estimate that Sacramento/Delta water supply constitutes a small amount of the region's total water supply, with an annual average of 86 TAF, of which approximately 37 TAF was used for agricultural purposes, as estimated by SacWAM (Table 7.4-3).

Irrigated agriculture is found in every county of the Central Coast region but is concentrated in several valleys in the north (Santa Clara and San Benito Counties), the Salinas Valley, portions of San Luis Obispo County, and in the Santa Maria and lower Santa Ynez Valleys in the south part of the region. Some agricultural activity also takes place near the south coastal and Cuyama areas in this region (SWRCB 1999). The vast majority of irrigation in the region is from groundwater, with local surface water sources providing most of the balance. Recycled water for irrigation is becoming more prevalent in the region.

Central Coast crop acreage includes some crops that are grown for a national market and at a production scale in terms of acreage that is unique to this area, due to its temperate climate year-round. Table 7.4-10 displays the leading crops in terms of acreage in the period 2011 through 2016. Lettuce, including spinach and mixed greens, represents the largest area in production. Wine grapes are second. Other cool-season vegetables, including broccoli, cauliflower, celery, and cabbage, have significant production areas in the Central Coast. Flowers and nursery products are also important agricultural crops in terms of economic value but do not occupy as large an area compared with the crops listed in Table 7.4-10.

Table 7.4-10. Top-Producing Crops, by Acreage, Central Coast Region (2011–2016 average)

Crop	Acres
Lettuce, including spinach and greens	176,000
Grapes, wine	109,000
Broccoli	97,000
Vegetables, unspecified	63,000
Hay, grain	30,000
Cauliflower	29,000
Strawberries	25,000
Celery	17,000
Avocados	12,000
Cabbage	10,000

Sources: CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a.

Important farmland in the region decreased between 2004 and 2014 due to conversions in all crop types in most counties (DOC 2008a, 2015). However, San Luis Obispo County saw gains in Unique Farmland in the form of additions of grapes and orchards (DOC 2004c, 2006c, 2008d, 2010c, 2012c, 2014c). The California Water Plan projects that conversion of agricultural land between 2006 and 2050 would range from 4 to 27 percent, depending on population growth and development density (^2013 Water Plan).

A little less than half of the farmland in the region is enrolled in Williamson Act and Farmland Security Zone programs (Figures 7.4-2a and 7.4-2b). In 2016, 41 percent was under Williamson Act contract and approximately 0.4 percent was under Farmland Security Zone contract.

There are 7 medium-priority and 10 high-priority groundwater basins and subbasins for which the majority of the basin underlies the Central Coast region; 5 of the high-priority basins are identified as critically overdrafted (Table 7.12.2-7, Figure 7.12.2-2) (CNRA 2022). These designations demonstrate that, in these areas, current levels of groundwater pumping are not sustainable. In years with below-normal precipitation, creek flows are intermittent, flow is insufficient for agricultural uses, wells become dry, and seawater intrudes into some coastal groundwater basins. In San Benito County, accumulated salts from seawater intrusion are high enough to constrain agricultural use (SBCWD 2015).

The Central Coast region includes approximately 1.5 million acres of forest lands. Approximately 22,000 acres are used for timber harvesting and 10,000 acres for non-industrial timber management (CAL FIRE 2018a, 2018b).

7.4.2.12 Southern California

The Southern California region covers approximately 36.8 million acres. In 2018, Southern California supported approximately 728,000 acres of irrigated agriculture (^Land IQ 2021). Figure 7.4-4b shows most irrigated agriculture occurs on the valley floor. Southern California is an important agricultural region in producing winter vegetables when other areas of the country cannot produce them, year-round hay for the dairy industry and specialty crops not widely grown elsewhere. The Imperial Valley is the most productive agricultural area in the region and contains a large portion of the region’s total crop acreage, with more than 377,000 acres of farmland in 2018 (^Land IQ 2021). Major crop types in the Imperial Valley include livestock forage and field crops, such as alfalfa and lettuce. Coachella Valley is also an important local agricultural region where orchards, particularly citrus, are the predominant crop type (^2013 Water Plan).

Southern California also includes crop acreage in the western temperate zone of Ventura, Orange, and San Diego Counties, where strawberries, avocados, citrus crops, cut flowers, and nursery crops are the most prominent. These areas rely upon groundwater, recycled water, and local surface water sources for irrigation but also receive a portion of their supply from Sacramento/Delta sources through the SWP.

Based on historical water deliveries data, the region's 2005 to 2015 average annual total water supply was approximately 9.4 MAF with approximately 4.9 MAF for agricultural uses (Table 7.4-1). For the same period, historical water deliveries data estimate that approximately 2.4 MAF of the region's average annual total water supply was from groundwater sources, of which approximately 792 TAF was used for agriculture (Table 7.4-2). Groundwater supplies account for approximately 25 percent of the region's total water use (Table 7.4-1 andTable 7.4-2). Although non-groundwater supplies account for the majority of the region's total water supply, groundwater makes up most of the agricultural water supply in the Owens-Mono, Antelope Valley, and Mojave River areas. Some Southern California groundwater basins are in overdraft conditions due to decades of pumping, especially in the eastern portion of Southern California (DWR 2014). Sacramento/Delta supply to Southern California is represented in SacWAM by SWP deliveries to the South Coast hydrologic region via the California Aqueduct. The analysis approach in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*, uses SacWAM results and water management plan information to estimate that the average annual Sacramento/Delta water supply to Southern California is 1,675 TAF, of which a small amount, approximately 14 TAF was used for agricultural purposes, as estimated by SacWAM (Table 7.4-3).

The Colorado River provides another substantial source of imported surface water to the Southern California region. Colorado River water is delivered to Southern California via the Colorado River Aqueduct and the All-American Canal. Southern California water users receive approximately 4.4 MAF/yr of imports from the Colorado River (^2013 Water Plan, V2, South Coast), including conserved water from Imperial Irrigation District (IID) under the Quantification Settlement Agreement (IID 2019a).

Riverside, San Bernardino, and San Diego Counties were among the top 10 counties for conversion of important farmland to urban use from 2010 to 2012 (DOC 2015).

Since the 1940s, the coastal portion of this region has changed from largely rural counties with an agricultural economy to a highly urban-industrial society. The inland portion of this region includes orchards, pastures, and ranches to the north and the Imperial Valley to the south.

Important farmland in the region decreased from 2004 to 2014 due to conversions in all important farmland types in most counties (DOC 2008a, 2015). The California Water Plan projects that conversion of agricultural land between 2006 and 2050 would range from 6 to 59 percent, depending on population growth and development density (^2013 Water Plan).

A small portion of the farmland in the region is enrolled in Williamson Act and Farmland Security Zone programs (Figure 7.4-2b). In 2016, 1 percent was under Williamson Act contract, and less than 0.1 percent was under Farmland Security Zone contract.

The region supports a variety of crops, including higher-profit crops such as floriculture and fruit, and lower profit crops such as alfalfa, hay, and wheat (CDFA 2018b). The coastal counties grow a number of higher-profit crops on small, irrigated parcels that can support use of higher-cost water (see Chapter 8, *Economic Analysis and Other Considerations*), with nursery and floriculture production being among the most valuable. Additionally, fruit crops are key contributors to the value of agriculture along the coast and include strawberries, avocados, grapes, and lemons. Vegetables such as lettuce, celery, and broccoli are also grown in the coastal counties. Field crops are principally produced in the inland counties of the region. Because of the differences in commodity production, the coastal areas see a higher profit per acre than the inland areas (UC AIC 2012). The major crops in terms of acreage from 2011 through 2016 are shown in Table 7.4-11. They include hay (all forms), irrigated pasture, grass seeds, and wheat; these are found within interior lands. Lettuce, avocados, lemons, and broccoli are the most prominent food crops. Avocados, lemons, and strawberries (not shown in Table 7.4-11) are located near the coast.

Table 7.4-11. Top-Producing Crops, by Acreage, Southern California Region (2011–2016 average)

Crop	Acres
Hay, alfalfa	203,000
Hay, excluding alfalfa	155,000
Wheat	73,000
Pasture, irrigated	65,000
Lettuce, including spinach and greens	57,000
Seed, alfalfa and bermuda	51,000
Avocados	44,000
Lemons	29,000
Sugar beets	25,000
Broccoli	17,000

Sources: CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a.

Sacramento/Delta water supplied by the SWP is used for surface irrigation in the northern and western portions of the region. Crops grown with SWP water include avocado trees, citrus and other subtropical trees, fruit and nut trees, grapes, vegetables, flowers, and berries (e.g., San Diego County Farm Bureau 2016; Rancho California Water District 2016). Because of the higher cost of SWP water and the limited availability of this source for agricultural production, very little SWP water is used for agriculture.

Alluvial groundwater basins underlie 55 percent of the Southern California region, and dozens of groundwater basins are used for water supplies throughout the region. Groundwater conditions in much of the Southern California region are driven by high population density, low precipitation, and reliance on imported water. Some groundwater wells are pumped faster than they can recharge. Due to this fact, there are 20 adjudicated groundwater basins in the region (Table 7.12.2-1, Figure 7.12.2-2), and 4 of the high-priority basins are identified as critically overdrafted (Table 7.12.2-8, Figure 7.12.2-1b).

To help alleviate groundwater overdraft conditions, groundwater storage and recovery projects in the Southern California region use imported water to reduce seawater intrusion, maintain groundwater levels, and augment the overall water supply. The region also uses recycled water to augment groundwater aquifers and to replace other potable sources.

The Southern California region includes approximately 1.6 million acres of forest lands. Approximately 3,000 acres are used for timber harvesting (USGS 2014).

7.4.3 Impact Analysis

This impact analysis considers how and to what extent actions under the proposed Plan amendments could lead to reductions in irrigated acreage that could result in conversions of important farmland to nonagricultural uses or could affect parcels under existing contracts protecting agricultural land. This evaluation focuses on the potential conversion of irrigated farmland to nonagricultural uses as a result of changes in hydrology and changes in water supply. Change in water supply is the primary impact mechanism and is evaluated first, followed by a discussion of potential impacts from changes in hydrology, including floodplain inundation and river-level changes that could affect diversion structures.

Forest land and timberland are essential to the health of the watersheds. Forests shield streams and reservoirs from erosion and siltation and are a natural filter protecting water quality. Forests get their water from precipitation rather than irrigation. The proposed Plan amendments would not change the amount of water available to forest land and timberland. The amendments, therefore, rely upon, but do not affect, these resources. There would be no impact; therefore, forest land and timberland resources (Impact AG-c and Impact AG-d) are not discussed further in this section. Potential impacts related to wildland fire and the availability of water for firefighting are discussed in Section 7.11, *Hazards and Hazardous Materials*.

Section 7.21, *Habitat Restoration and Other Ecosystem Projects*, and Section 7.22, *New or Modified Facilities*, describe and analyze potential impacts on agriculture and forest resources from various actions that involve construction.

Impact AG-a: Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Important Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to nonagricultural use

Impact AG-e: Involve other changes in the existing environment that, due to their location or nature, could result in conversion of important farmland to nonagricultural use

The analyses of conversion of important farmland under Impact AG-a and Impact AG-e are closely related and therefore are combined and addressed together.

Changes in Water Supply

Approach to Analysis

Most of the irrigated agriculture in the study area is located on the valley floor portion of the Sacramento/Delta and the San Joaquin Valley. For these areas, growers' responses to changes in water supply were estimated using the SWAP model. The SWAP model is a regional agricultural and economic optimization model, originally developed at the University of California, Davis, that estimates growers' responses to changes in water supply by determining the cropping pattern that maximizes the net returns to agricultural production for 28 production regions: Regions 1 through 9 are in the Sacramento/Delta, and Regions 10 through 21C are in the San Joaquin Valley. Figure 7.4-5 depicts the geographic extent of the SWAP model production region boundaries.

The SWAP model estimates the cropping pattern that maximizes the net returns to agricultural production. It incorporates information on the availability of water supplies within a SWAP region, such as SWP and CVP deliveries, local surface water supplies, and groundwater, into its analysis. As conditions change within a SWAP-modeled region (e.g., the quantity of available SWP and CVP water supply decreases or the cost of groundwater pumping increases), the model optimizes production by adjusting the crop mix, water sources and quantities used, and other inputs. Land will be fallowed when that is the most cost-effective response to resource conditions. Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*, provides more details on the SWAP model, including the modeling methodology, model inputs, adjusted modeling parameters, and detailed model results.

Changes in crop acreage in other parts of the study area that are not modeled in SWAP (i.e., areas outside of the Central Valley) are estimated using an analytical approach, the California Sub-Regional Agricultural Analysis (CASRAA) model, that emulates the same optimization process that is used in the SWAP model. The details of the analyses are described in Chapter 8, *Economic Analysis and Other Considerations*, as part of the methodology for estimating the potential economic effects of the proposed Plan amendments on agriculture. Estimated changes in crop acreage derived in Chapter 8 for these regions are summarized in the following respective regional discussions, with qualified descriptions of the potential effects on example growers in those areas.

The evaluation of impacts on agriculture involves using surface water delivery estimates from SacWAM as inputs. Estimates of surface water deliveries 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 in larger aggregations based on conveyance facilities. Information from water contracts and water management plans were used to disaggregate these estimates to individual SWP and CVP contractor levels and smaller subareas for analysis purposes. Further details are provided in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*. 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.

The format of the SacWAM output is described in Chapter 6, *Changes in Hydrology and Water Supply.* In summary, the output is monthly quantities of water delivered for agricultural, municipal, and wildlife refuge uses, for the entire span of the simulated hydrologic period (1923 through 2015). Monthly output values for the time series are combined into annual averages for use in the agricultural analyses. Estimated reductions in Sacramento/Delta supply are represented by SacWAM results that are based on potential instream flow requirements in increments of 10 percent, from 35 percent unimpaired flow up to 75 percent unimpaired flow (referred to as numbered flow scenarios such as *35 scenario*, *45 scenario*). The proposed program of implementation for the Plan amendments provides for a range of flow scenarios from 45 to 65, with default implementation starting at the 55 scenario. Changes in crop mix and irrigated acreage for the flow scenarios are compared with baseline conditions. The 35 and 75 flow scenarios are also shown in charts and tables presented in this section to inform the analyses of low and high flow alternatives in Section 7.24, *Alternatives Analysis*.

The SacWAM hydrologic period can be organized into five water year types as classified by the Sacramento Valley 40-30-30 Water Year Hydrologic Classification Index: wet, above normal, below normal, dry, and critical. For the agricultural analyses, both average and dry year water supply conditions are considered, and the modeling outcomes for each are discussed. The average year surface water supply condition (average year) was developed by calculating the straight average for all water year types. The dry year surface water supply condition (dry year) was calculated using the weighted average for water year types classified as dry and critical.

The average year model runs reflect long-term cropping decisions. For the average year SWAP model runs, a deficit-irrigation strategy was not applied. Instead, the average year SWAP model runs implement a strategy in which growers would plant only land that can be fully irrigated in normal or average water year types. The dry year model runs represent short-term responses to drought conditions, and deficit irrigation is allowed to occur. In deficit irrigation, growers can apply crop stress management techniques in which they reduce applied water for that year, acknowledging reduced yields but keeping the land in irrigated production and keeping permanent crops alive for another year (at least for permanent crops). In some cases, deficit irrigation can be a more economical response to reduced water supply than increased groundwater pumping. This leads to the counterintuitive result that SWAP model output shows greater reductions in irrigated acreage in response to the proposed Plan amendments in average years as compared to dry years.

A conservative threshold of significance for conversion is used that captures the importance of agriculture as a resource in California. All irrigated agriculture is used as a proxy for important farmland. In addition, this analysis assumes that any reduction in irrigated crop acreage is important farmland converted to nonagricultural use. This conversion to nonagricultural use would be a significant impact.

Quantitative estimates of growers' responses to changes in water supply is part of the input to the regional economic analysis that is performed using the IMPLAN model, which estimates regional economic effects on total industry output (sales) and employment based on changes in crop acreage for the different flow scenarios. The economic analysis is described in Chapter 8, *Economic Analysis and Other Considerations*.

The analyses do not account for all factors that could affect the range of the proposed Plan amendments' potential impacts. The results and their potential significance must be considered in light of several qualifying factors.

- The SWAP model is an agricultural production model developed specifically for large-scale analysis of agricultural water supply and cost changes. The SWAP model simulates decisions that California growers would make regarding crops, water supplies, and other inputs that would maximize profit, subject to resource constraints, agronomic production relationships, and market conditions. As with many planning-level models, the SWAP model is not intended to precisely predict the potential future cropping decision of every single grower in an area but rather to aid in planning by presenting how irrigated agriculture could respond to estimated reductions in Sacramento/Delta supply, based on reasonable assumptions of grower behavior. Actual decisions made by growers may differ from a modeled result because of unique beliefs or circumstances. For example, the assumption that growers maximize their profit might not apply to every grower, as some will make cropping decisions based on familiarity with a particular crop or based on personal preference.

- Growers and/or water suppliers may replace some of the reduced Sacramento/Delta supplies with groundwater; however, there is uncertainty about how much groundwater is available. The proposed Plan amendments also have the potential to affect groundwater levels (and thus groundwater supply). There is uncertainty regarding groundwater recharge rates, stream-aquifer interactions, and groundwater pumping in the study area. Precisely how these physical processes may change and how water users may respond to reduced Sacramento/Delta surface water supplies are difficult to determine. In some areas, groundwater pumping may be subject to other regulatory requirements (e.g., water quality, groundwater adjudications, SGMA).
- Because of the uncertainties about groundwater availability and water users' response to reduced Sacramento/Delta supply regarding groundwater pumping, a range between two *bookends* or bounds are evaluated: *maximum replacement groundwater pumping* and *no replacement groundwater pumping*. Under maximum replacement groundwater pumping, it was assumed that growers could use groundwater in addition to local water supplies to offset some or all Sacramento/Delta supply reductions. Importantly, this is not a directive that farmers and ranchers should or would replace Sacramento/Delta reductions with groundwater pumping, especially in light of requirements to achieve sustainability in basins subject to SGMA, but a good faith attempt to capture the potential maximum impacts on the groundwater basin from replacement pumping. 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. Similarly, this is not an assumption about groundwater demand management in any particular basin, for example under SGMA, but a good faith attempt to model the potential lower limit of groundwater pumping. In this way, the analysis captures the breadth of likely responses, which would be somewhere in between—meaning that water users likely would increase groundwater pumping to replace some amount of the reduced surface water supplies, but not at volumes sufficient to replace all of the reduced surface water supplies. The amount of groundwater pumping assumed under the no replacement groundwater pumping bookend was limited to the existing groundwater pumping levels within each SWAP region during an average year; this represents a situation in which growers and/or water suppliers do not draw any new groundwater to replace reduced Sacramento/Delta surface water supply. The maximum amount of groundwater pumping allowed for the maximum replacement groundwater bookend was capped at the highest annual pumping levels within each SWAP region as estimated by SacWAM over the 1923 through 2015 SacWAM hydrologic period, or for areas not covered by SacWAM, the 2014 estimated groundwater pumping capacity in the SWAP model. This approximates the maximum amount of replacement groundwater available without new groundwater development. Further discussion on the assumptions for groundwater available under the SWAP model scenarios is presented in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*.

Crop Categories, Water Requirements, and Revenue

Agricultural water requirements vary by type of crop and geographic location. Even for the same crop, several factors can affect irrigation water needs, including irrigation methods, elevation and climate, available water moisture, and weather conditions during the growing season. Differences in crop water needs among all crops and for the same crop in different locations within the study area are listed in Table 7.4-12. Table 7.4-12 displays the range of applied water requirements (in acre-feet per acre) by crop category used in the SWAP model analysis.

Table 7.4-12. Range of Applied Water Requirements by Crop Category used in the SWAP Model Analysis, Sacramento/Delta and San Joaquin Valley (acre-feet per acre per year)

Crop Category	Minimum	Maximum
Alfalfa	3.48	5.51
Almonds and Pistachios	3.19	4.94
Corn	2.44	3.60
Cotton	2.45	3.31
Corn Silage	2.44	3.60
Cucurbits	1.54	2.27
Dry Beans	1.96	3.36
Fresh Tomatoes	1.57	3.02
Grain	0.12	2.15
Onions and Garlic	1.87	4.27
Other Deciduous	3.48	4.67
Other Field	2.06	3.14
Other Truck	1.11	2.42
Pasture	3.27	5.48
Potatoes	1.25	3.23
Processing Tomatoes	2.08	3.25
Rice	4.03	5.59
Safflower	1.03	2.61
Sugar Beet	1.57	4.32
Subtropical	2.67	4.48
Vine	1.28	2.98

Methodology and sources are described in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results.*

As indicated in Table 7.4-12, the crops with the highest water use tend to be rice, alfalfa, and pasture, with orchard crops (almonds and pistachios, other deciduous trees, and subtropical trees such as oranges) also with higher water use compared to most annual crops. Among crops with lower water use are grains, safflower, other truck crops, and cucurbits (summer squash, melons, cucumbers, and pumpkins).

In addition to soils, climate, water supply, biophysical requirements, and anticipated crop revenues also factor into planting decisions by growers. Crop revenues per acre can vary significantly among the wide range of crops that are grown in the study area. Even the same crop (for example, wine grapes) can generate revenues that vary by location and attributes of the commodity. Table 7.4-13 provides a comparison of representative levels of revenue generated per acre of production for a selection of crops grown in the study area, based on cost of production budgets prepared at the University of California, Davis. As Table 7.4-13 indicates, the amount of revenue that is generated for berries, grapes, fruit and nut orchards, and vegetables can be several times greater than for field crops, grain, pasture, and hay. In addition, in California, crops with high water requirements may not correlate to crops receiving the highest crop prices.

Table 7.4-13. Representative Revenue Generated per Acre of Crop Production

Crop	Representative Revenue per Acre	Associated Geographic Area	Source
Strawberries	$70,000	Central Coast	Bolda et al. 2016
Grapes, table	$22,100	San Joaquin Valley South	Fidelibus et al. 2018
Vegetables	$15,131	Sacramento and San Joaquin Valley	Reclamation 2012
Grapes, wine	$13,480	Russian River Valley	Smith et al. 2017
Avocados	$13,268	Santa Barbara County	Takele et al. 2011
Peaches	$9,265	Sacramento and San Joaquin Valley	Hasey et al. 2017
Pistachios	$7,224	San Joaquin Valley South	Brar et al. 2015
Walnuts	$7,200	San Joaquin Valley	Grant et al. 2017
Oranges	$6,600	San Joaquin Valley South	O'Connell et al. 2015
Grapes, wine	$6,600	Santa Barbara/Santa Maria	Takele and Bianchi 1996
Almonds	$5,500	San Joaquin Valley North	Duncan et al. 2019
Grapes, wine	$4,928	San Joaquin Valley South	Zhuang et al. 2019
Processing Tomatoes	$4,089	San Joaquin Valley South	Turini et al. 2018
Alfalfa Hay	$1,995	Sacramento Valley	Long et al. 2015
Rice	$1,760	Sacramento Valley	Espino et al. 2016
Cotton	$1,625	San Joaquin Valley South	Hutmacher et al. 2012
Corn Silage	$1,536	San Joaquin Valley	Mitchell et al. 2015
Other field crops	$1,303	Sacramento and San Joaquin Valley	Reclamation 2012
Beans, dry	$1,080	Sacramento Valley	Long et al. 2014
Corn for grain	$1,020	Sacramento Valley	Brittan et al. 2008
Wheat	$675	Sacramento Valley	Mathesius et al. 2016
Pasture	$638	Sacramento Valley	Forero et al. 2015

The SWAP model provides annual estimates of crop production acreage, water use, and revenue by 21 crop categories or groups. Each crop group represents a number of individual crops, but many are dominated by a single crop. Irrigated acres represent acreage of all crops within the group, and production costs and returns are represented by a single proxy crop for each group. To help with representation of results, tables and graphs in this section aggregate the results into 10 crop groups, although the narrative may describe trends in one of the 21 crop groups where appropriate. Table 7.4-14 identifies the crop groups, SWAP model definition, proxy crop, and other associated crops, if any.

Table 7.4-14. Crop Groups for Display of Results and Analysis

Crop Groupings	SWAP Model Definition	Proxy Crop [a]	Other Associated Crops
Alfalfa and Pasture	Alfalfa	Alfalfa Hay	-
Alfalfa and Pasture	Pasture	Irrigated Pasture	-
Almonds and Pistachios	Almonds and Pistachios	Almonds	Pistachios
Corn and All Silage	Corn	Grain Corn	-

Crop Groupings	SWAP Model Definition	Proxy Crop [a]	Other Associated Crops
Corn and All Silage	Corn Silage	Corn Silage	-
Corn and All Silage	Other Field	Sudan Grass Hay	Other Silage
Cotton	Cotton	Pima Cotton	Upland Cotton
Deciduous Orchards	Other Deciduous	Walnuts	Peaches, Plums, Apples
Deciduous Orchards	Subtropical	Oranges	Lemons, Misc. Citrus, Olives
Processing Tomatoes	Processing Tomatoes	Processing Tomatoes	-
Rice	Rice	Rice	-
Vegetables	Cucurbits	Summer Squash	Melons, Cucumbers, Pumpkins
Vegetables	Fresh Tomatoes	Fresh Tomatoes	-
Vegetables	Onions and Garlic	Dry Onions	Fresh Onions, Garlic
Vegetables	Other Truck	Broccoli	Carrots, Peppers, Lettuce, Other Vegetables
Vegetables	Potatoes	White Potatoes	-
Vine	Vine	Wine Grapes	Table Grapes, Raisins
Wheat and Field Crops	Dry Beans	Dry Beans	Lima Beans
Wheat and Field Crops	Grain	Wheat	Oats, Sorghum, Barley
Wheat and Field Crops	Safflower	Safflower	-
Wheat and Field Crops	Sugar Beet	Sugar Beets	-

Source: Reclamation 2012, for SWAP definition, proxy crop, and other associated crops.
[a] The proxy crop is the specific crop that was used to establish the crop production input requirements and output for each SWAP model crop group.

Although the SWAP model provides results in less aggregated crop groupings as shown under the Table 7.4-14 column, “SWAP Model Definition,” the combined crop groupings were developed to present a clear and concise discussion of the potential agricultural impacts. The groups were organized according to similarities in crop type, attributes, growing characteristics, production, and harvest requirements in terms of equipment and labor, and economic revenue. Descriptions of the crop groups follow.

Alfalfa and Pasture. Alfalfa, other hay, and irrigated pasture are included in this group. These forage crops are planted as seeds and grow for several years, respond well to application of irrigation water for high yields, and are harvested multiple times during the growing season. These crops require less labor per acre than most other crops. Although they require proportionally greater amounts of water than other crops, hay and pasture can also tolerate and recover from deficit irrigation better than most. Revenue per acre is among the lowest in the crop categories.

Almonds and Pistachios. These tree nuts are grown as orchards that require long-term planning and investment by growers. Young orchards start producing in the third year (almonds) to sixth year (pistachios) after planting and may not reach peak yield until the sixth year for almonds or twelfth year for pistachios. Average life span is 25 to 40 years (Duncan et al. 2019; Brar et al. 2015). Almonds and pistachios have typically higher costs of production and higher revenues relative to other crops.

Corn and All Silage. Corn grown for grain or silage is included in this category. Corn is an annual crop planted in spring, and both forms are harvested in summer or fall. The vast majority of the product is fed to livestock. (Sweet corn is in the vegetable crop category.) Nearly all the corn grown in the Sacramento Valley is harvested as grain, sent to mills, and shipped elsewhere. In the San Joaquin Valley, most corn is grown as silage and fed locally (within approximately 20 miles) to dairy cows. Silage grown from other grains also is included in this category.

Cotton. This field-grown annual crop is its own category and includes both the more common Pima variety and less common upland form.

Deciduous Orchards. Fruit trees (e.g., peaches, plums, cherries, apples), walnuts, and subtropicals (e.g., oranges, lemons, limes) are included in this crop category. Production methods have many similarities in the category, with an initial establishment period of several to many years before any crop can be harvested, an orchard life span of 25 to 40 years or more, and tending to require a considerable amount of harvesting labor. As a result, there are higher production costs and higher revenues per acre than most other crop categories.

Processing Tomatoes. Tomatoes grown for processing is a large-acreage crop that is a category of its own. They are field grown in both the Sacramento Valley and San Joaquin Valley (with smaller amounts elsewhere), mechanically harvested, and hauled in trucks to processing plants. Tomatoes grown for the fresh market are included in the vegetable crop category.

Rice. The production of rice requires specific soil types such as that found in the Sacramento Valley that provide proper growing conditions. Rice is an annual crop that is among the highest water users per acre. Production methods typically require ponding at specific periods of the year for the highest yields from year to year.

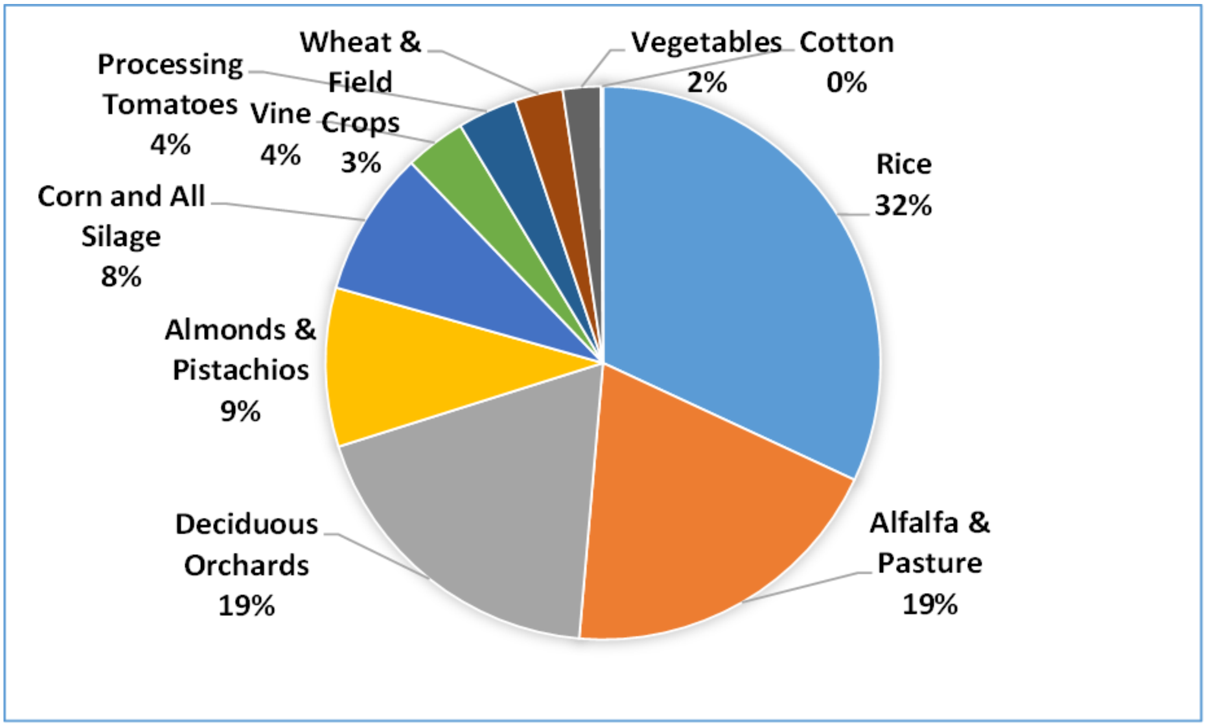
Vegetables. This broad category includes a large mix of truck crops (vegetables grown and packed in boxes for distribution), cucurbits (summer squash, melons, cucumbers, and pumpkins), fresh tomatoes, onions, and potatoes. The crops all tend to require large investments in precision equipment, considerable amount of labor throughout the growing season, and effective logistics with transportation and processors. Strawberries are also included in this category, although they are produced mainly in the Central Coast and Southern California regions.

Vine. Grapes grown for wine, raisins, and fresh (table grapes) are included in this category. Grapes are a perennial crop, with an initial period of 3 to 5 years with no or little crop yield before full production. They may be harvested mechanically or using hand labor. Grapes can require high investment, and revenues can be moderate to high, depending upon the commodity and growing conditions. Vine crops also use less water per acre than most other crop categories.

Wheat and Field Crops. This category includes small grains such as wheat, barley, and oats, plus other field crops such as safflower and dry beans. These annual crops typically rely on mostly mechanized equipment and relatively little labor. Water requirements per acre are also less than most other crop categories. Wheat is often grown using “winter” varieties, that are planted in late fall, irrigated lightly to get the seeds to germinate, overwinter with seasonal rains, and harvested in late spring.

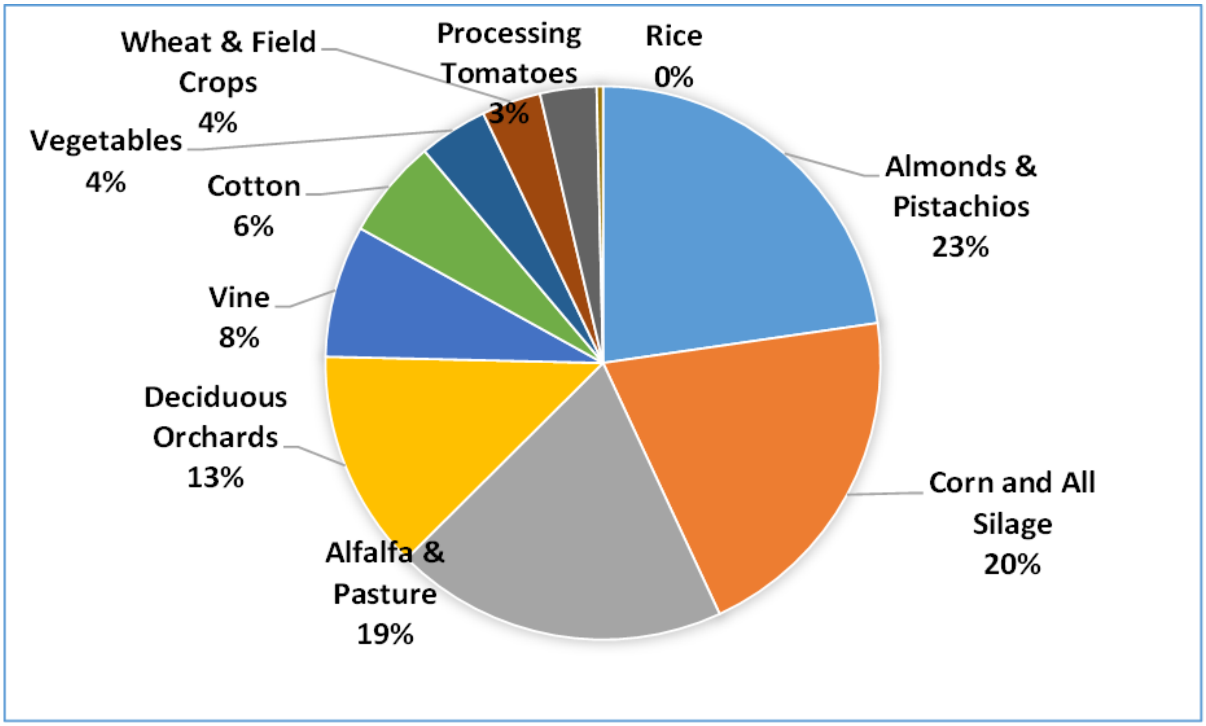
Factors Influencing Crop Acreage Reductions

Water requirements alone are not good indicators for where crop acreage reductions could occur. Economic revenues and profit among the crops, as well as geographic distribution of crop production, and where Sacramento/Delta deliveries take place within the San Joaquin Valley, are all factors that combine with water need to determine which crop groups are likely to be affected and by how much. Crop water use can be estimated using the applied water requirements information from Table 7.4-12 and DWR (2020a) land use information. Figures 7.4-8 and 7.4-9 show the relative proportion of annual water use by crops grown in the Sacramento/Delta and San Joaquin Valley, respectively, under existing conditions. Within the Sacramento/Delta, rice is the largest water user at 32 percent of the total agricultural water use for the region. Alfalfa and pasture and deciduous orchards each consume 19 percent of the total agricultural water use. Within the San Joaquin Valley, almonds and pistachios consume the largest proportion of the total agricultural water supply at 23 percent, followed by corn and all silage at 20 percent, and alfalfa and pasture at 19 percent.



Sources: 2010 agricultural land and water use information (DWR 2020a) and SacWAM crop applied water requirements.

Figure 7.4-8. Proportion of Average Annual Agricultural Water Use by Crop Category, Sacramento/Delta



Sources: 2010 agricultural land and water use information (DWR 2020a) and SWAP model crop applied water requirements.

Figure 7.4-9. Proportion of Average Annual Agricultural Water Use by Crop Category, San Joaquin Valley Region

Sacramento River Watershed, Delta Eastside Tributaries, and Delta

Agriculture in the Sacramento River watershed, Delta eastside tributaries, and Delta regions (Sacramento/Delta) rely on relatively abundant and reliable surface water from local sources supplied by local water districts, the CVP and SWP, and groundwater. For the three regions combined, approximately 10.4 MAF of total annual average water supplies are used for all purposes (Table 7.4-1); Sacramento/Delta surface water supplies account for approximately 7.1 MAF, including 5.9 MAF (84 percent) for agricultural uses (Table 7.4-3).

The annual Sacramento/Delta supply to the Sacramento River watershed, Delta eastside tributaries, and Delta regions (Sacramento/Delta) would be reduced under the proposed Plan amendments (45 to 65 scenarios) (Table 7.4-15). Under the 45 scenario, the reductions would be less than 300 TAF on average of all water year types. Under the 55 scenario, larger reductions would range on average from 183 TAF in wet years to 1,235 TAF in critical years. Under the 65 scenario, reductions in Sacramento/Delta supply would range on average from 522 TAF in wet years to 1,611 TAF in critical years. The reductions in total supply amount to 5 percent and 9 percent in the 45 and 55 scenarios, respectively.

Table 7.4-15. Sacramento/Delta Supply to Agriculture in the Sacramento River Watershed, Delta Eastside Tributaries, and Delta Regions by Water Year Type Average: Change from Baseline (thousand acre-feet per year)

Water Year Type	Baseline	35	45	55	65	75
Critical	5,493	-754	-934	-1,235	-1,611	-2,233
Dry	5,938	-144	-335	-810	-1,335	-1,967
Below normal	6,038	-97	-196	-433	-1,058	-1,981
Above normal	5,983	-36	-108	-204	-603	-1,589
Wet	5,973	-33	-69	-183	-522	-984
All	5,901	-187	-297	-544	-990	-1,668

Sources: Sum of values in Table 6.4-5 (Sacramento River watershed), Table 6.4-9 (Delta eastside tributaries), and Table 6.4-12 (Delta) in Chapter 6, *Changes in Hydrology and Water Supply*.

Reductions in Sacramento/Delta surface water supplies could lead to changes in distribution of crop types and acreage and conversion of important farmland to nonagricultural use in the Sacramento/Delta. For the SWAP model analysis, SacWAM results are postprocessed to obtain the amount of water available for crop irrigation at farm locations by adjusting for conveyance losses and winter flooding of rice fields. Total surface water supplies available for crop irrigation are represented in SWAP as SWP, CVP, and local surface water supplies. For the analysis in the Sacramento/Delta, the postprocessed Sacramento/Delta supplies represent the total available surface water supplies for irrigation. Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*, provides more details on the approach used. Table 7.4-16 shows the total surface water supply inputs used in the average year and dry year SWAP model runs for baseline and the flow scenarios.

Table 7.4-16. Total Surface Water Supply for Agriculture in the SWAP Zones of the Sacramento River Watershed, Delta Eastside Tributaries, and Delta Regions, Average and Dry Water Year Types, SWAP Model Inputs for Baseline and Flow Scenario Runs (thousand acre-feet per year)

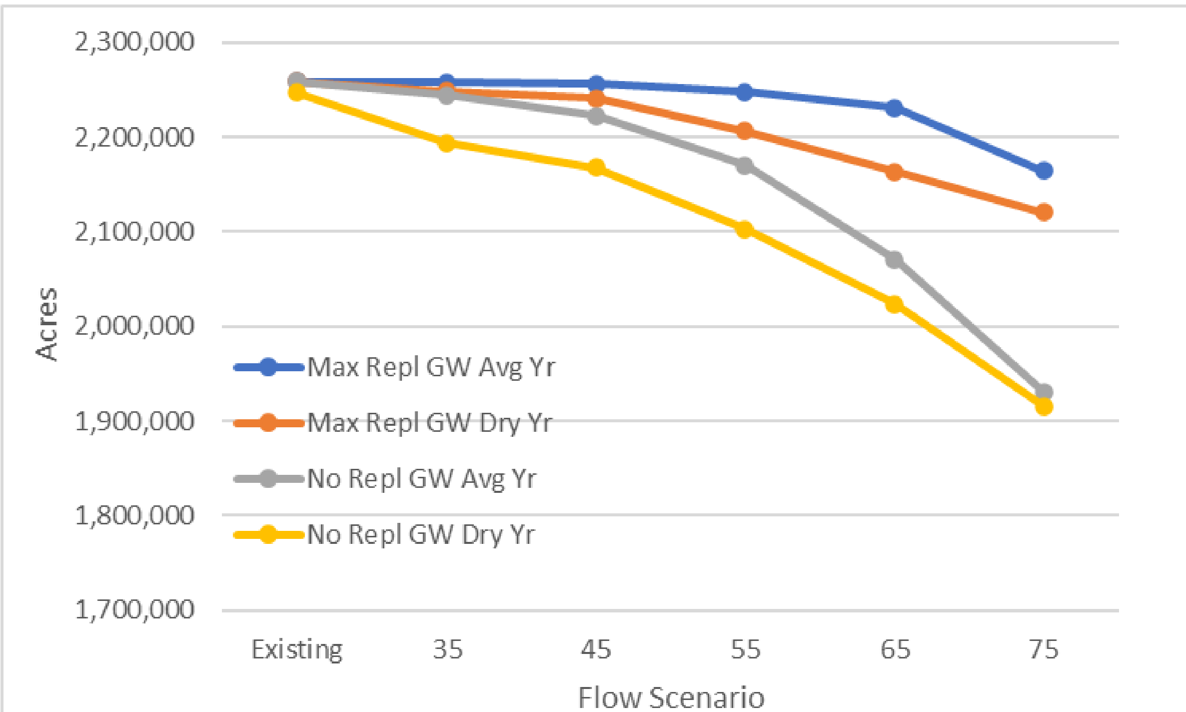
SWAP Water Year Type	Baseline	35	45	55	65	75
Average year	4,858	4,690	4,598	4,389	4,008	3,448
Dry year	4,649	4,289	4,129	3,788	3,403	2,917

Source: Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results.*

Figure 7.4-10 shows the SWAP model output of potential changes in crop acreage in the Sacramento/Delta for no replacement groundwater and maximum replacement groundwater pumping. The estimated reduction in crop acres is relatively small when groundwater is available to offset reduced Sacramento/Delta supply but is greater (i.e., larger reduction in crop acres) when groundwater is not used to replace lost Sacramento/Delta supply.

As discussed in Section 7.12.2, *Groundwater,* there are no critically overdrafted groundwater basins in the Sacramento River watershed. However, in the Delta eastside tributaries region, there is one high-priority and critically overdrafted basin (Table 7.12.2-3); the majority of this basin underlies the Delta eastside tributaries region. There are three additional medium-priority groundwater subbasins for which the majority of the basin underlies either the Delta eastside tributaries or Delta region (Tables 7.12.2-3 and 7.12.2-4, respectively; Figure 7.12.2-1a). In overdrafted areas, assuming maximum replacement of groundwater may underestimate the irrigated acreage that could be lost because that assumption does not account for how much groundwater would be accessible. However, maximum replacement groundwater pumping is one end of a continuum, the other end of which would be no replacement groundwater pumping. Actual irrigated acreage reductions would likely correspond to groundwater availability that lies somewhere between these bookends.

When groundwater is not used to offset Sacramento/Delta surface water supply reductions, crop acreage reductions are evident at the lower end of the range (45 scenario), increase in magnitude starting at the 55 scenario, and incrementally increase through the higher end of the range (65 scenario). The irrigated crop acreage changes would not be uniform across the entire region because changes in crop acreage would depend on several different economic and other factors, including the priority of individual water right diversions, availability of local supplies, and other factors. Additional details about potential changes in crop acreage as a result of implementation of the proposed Plan amendments within the Sacramento/Delta are provided in this discussion and in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*.



Source: SWAP model results.

Figure 7.4-10. Irrigated Crop Acreage by Flow Scenario, Sacramento/Delta, SWAP Model Analysis

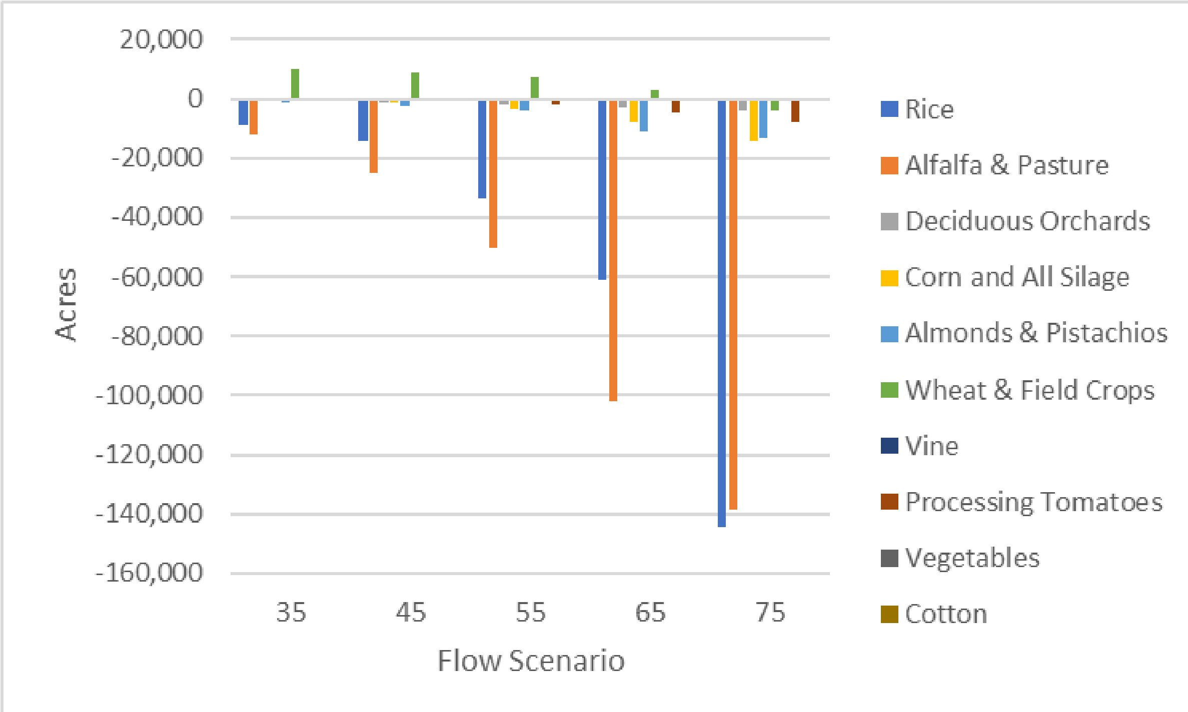
Table 7.4-17 shows the estimated changes in crop acreage by crop group for an average year if groundwater is not used to offset Sacramento/Delta surface water supply reductions. Under the proposed Plan amendments, irrigated crop acreage could range from approximately 2,222,400 to 2,071,100 acres (45 to 65 scenarios). Under the 55 scenario, approximately 2,170,000 irrigated crop acres would be maintained; this represents a decline of 3.9 percent from baseline. This result indicates that up to 88,900 irrigated crop acres could be fallowed.

As shown in Table 7.4-17 and Figure 7.4-11, during an average year, if groundwater is not used to offset Sacramento/Delta surface water supply reductions, crop acres primarily decline in alfalfa and pasture and rice. By relative acres, alfalfa and pasture could decrease the most, as the 55 scenario shows a 13.2-percent change from baseline. Rice acres in the 55 scenario could be reduced by 6.0 percent from baseline. While most other crop categories show little or no change in crop acreage, the model results indicate that wheat and field crop acreage could increase. This result reflects an economic decision to substitute alfalfa and pasture, rice, and other crops acreage to wheat and field crops acreage that have relatively low applied water requirements and modest profit levels. Nevertheless, the substitution of crops with lower applied water requirements would not be enough to completely offset decreases in acreage that could occur in other crops, and it is likely that fallowing would occur.

Table 7.4-17. Average Year: Irrigated Crop Acreage in the Sacramento/Delta, SWAP Model Analysis, No Replacement Groundwater (acres)

Crop Group	Existing	35	45	55	65	75
Rice	567,700	558,600	553,400	533,900	506,600	423,300
Alfalfa & Pasture	382,600	370,300	357,400	332,100	280,700	244,000
Deciduous Orchards	369,300	368,500	368,000	367,200	366,200	365,100
Corn and All Silage	258,500	258,300	257,300	255,100	250,600	244,200
Almonds & Pistachios	168,300	166,800	165,800	164,400	157,400	155,000
Wheat & Field Crops	194,100	203,700	203,000	201,300	196,800	190,200
Vine	134,700	134,800	134,800	134,700	134,300	134,100
Processing Tomatoes	101,600	101,100	100,600	99,500	97,200	93,900
Vegetables	78,800	79,000	78,800	78,600	78,100	77,700
Cotton	3,300	3,300	3,300	3,200	3,200	3,100
TOTAL	2,258,800	2,244,300	2,222,400	2,170,000	2,071,100	1,930,700

Source: Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results.*



Source: SWAP model results.

Figure 7.4-11. Average Year: Changes in Crop Acreage, Sacramento/Delta, SWAP Model Analysis, No Replacement Groundwater

Table 7.4-18 shows the estimated changes in irrigated crop acreage for a dry year if groundwater is not used to offset surface water supply reductions. In the 55 scenario, approximately 2,103,200 crop acres would be maintained, a decline of 6.4 percent from baseline. This result indicates that up to 144,000 crop acres could be fallowed.

The total change in crop acreage is larger in the dry year scenarios than the average year scenarios, but the effects on individual crop acreage do not follow the same pattern. This difference reflects the allowance of deficit irrigation during dry years for those crops that can be shorted their full water requirement and still produce a crop, albeit with a lower yield. Deficit irrigation is a short-term strategy for managing during a drought year (or multiple years). Analytically, when deficit irrigation is applied, the SWAP model compares the profitability of a reduced yield versus crop substitution and fallowing. The dry year modeling shows there could be less fallowing of some crops, including corn, all silage, wheat, and field crops, than during average years.

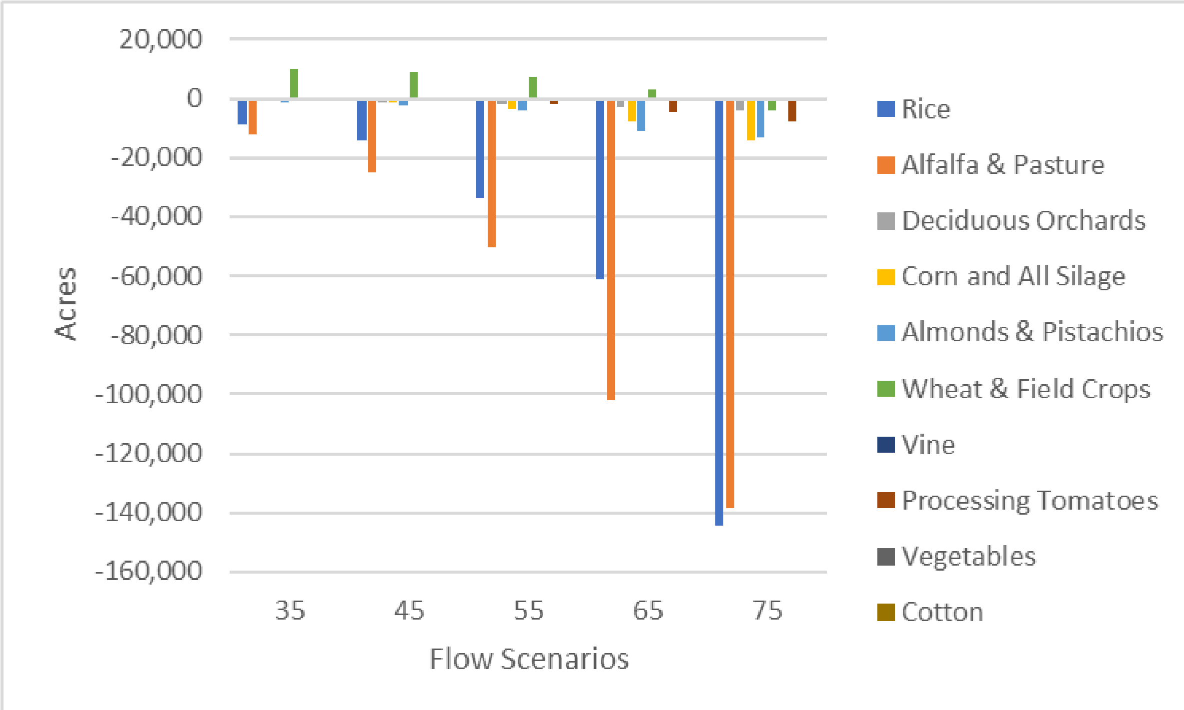
For other crops, the dry year with no replacement groundwater pumping shows larger reductions than the average year. Rice occupies a large proportion of the agricultural acreage in the Sacramento/Delta—25 percent (see *SWAP Crop Acres* in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*). As described in Appendix A3, rice has a low tolerance for deficit irrigation. Because this crop is a comparatively lower revenue crop, does not tolerate deficit irrigation, and occupies a large proportion of the crop category acreage, changes in water supply would likely affect a larger proportion of the rice acreage. Table 7.4-18 and Figure 7.4-12 show that, during a dry year, if groundwater is not used to offset surface water supply reductions, rice acres in the 55 scenario could be reduced by 13.2 percent from baseline. This crop acreage reduction is approximately 7 percent more than the crop reduction that could occur during average years. Effects on crop acreage would be less with maximum replacement groundwater pumping.

Another crop category, alfalfa and pasture, has notable effects in the dry year conditions. As shown in Table 7.4-18 and Figure 7.4-12, during a dry year, if groundwater is not used to offset surface water supply reductions, alfalfa and pasture acres in the 55 scenario could experience a 13.5-percent change from baseline. This crop acreage reduction is about the same as the crop reduction that could occur for alfalfa and pasture during average years due to application of deficit irrigation.

Table 7.4-18. Dry Year: Irrigated Crop Acreage in the Sacramento/Delta, SWAP Model Analysis, No Replacement Groundwater (acres)

Crop Group	Existing	35	45	55	65	75
Rice	564,000	540,400	527,700	489,600	443,500	371,300
Alfalfa & Pasture	372,900	349,100	340,200	322,600	294,900	267,200
Deciduous Orchards	368,800	368,200	368,000	367,400	366,800	366,200
Corn and All Silage	257,600	254,800	253,400	250,600	248,500	245,600
Almonds & Pistachios	166,800	165,400	164,300	162,300	160,800	160,000
Wheat & Field Crops	199,300	200,400	199,500	197,400	196,400	194,100
Vine	134,500	134,300	134,300	134,200	134,100	134,000
Processing Tomatoes	101,100	99,500	98,800	97,700	97,000	96,200
Vegetables	78,800	78,600	78,400	78,300	78,100	78,000
Cotton	3,300	3,200	3,200	3,200	3,200	3,100
TOTAL	2,247,000	2,193,900	2,167,700	2,103,200	2,023,400	1,915,700

Source: Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results.*



Source: SWAP model results.

Figure 7.4-12. Dry Year: Changes in Crop Acreage, Sacramento/Delta, SWAP Model Analysis, No Replacement Groundwater

The SWAP model considers decisions growers can make to maximize farm profits, including choosing to pump more groundwater if available, shifting to less water-intensive crops, applying deficit irrigation to crops where yields are not affected, or fallowing land. Growers could also decide to purchase other water supplies if it is profitable to do so, a decision that is not modeled in SWAP. In general, alfalfa, corn, pasture, and rice have low revenue per unit of applied water. A large fraction of the affected crop acreage is in rice, alfalfa, and pasture. These are crops with lower revenue per unit of applied water. To maximize farm profits, growers with limited access to groundwater may choose to fallow land rather than purchase other water supplies to continue growing them. Fallowing of land could be combined with selling of unused water supplies through water transfers to within-region or out-of-region buyers.

Effects on agriculture in the Delta are included in Table 7.4-17 and Table 7.4-18 and Figures 7.4-10, 7.4-11, and 7.4-12. According to the SWAP model results, crop acreage declines in the Delta primarily occur in pasture, alfalfa, and rice. There is less change in acreage for other crops compared with baseline conditions. In the SWAP modeling, local surface water supplies were assumed to not change with increasing flow scenario. This approach is used because the amounts of local supplies available and consumptive use within the Delta region are not known with any certainty due to lack of information on the magnitudes of in-channel Delta accretions and depletions. However, water users in the Delta region would be subject to the proposed inflow-based Delta outflow objective, and it is possible that water supplies in the Delta would be reduced (including riparian use in excess of natural and abandoned flows) to some extent, depending on the availability of natural and abandoned flows, water right priorities, and other factors. With reduced water supplies, there also could be reduced crop acreage in the Delta not specifically reflected in the SWAP model results.

Upper Watersheds

The Above Shasta Lake subarea includes irrigated agriculture in Modoc, Shasta, and Siskiyou Counties. The historical inflow to Shasta Reservoir is very close to unimpaired, at 99 percent (see Chapter 2, *Hydrology and Water Supply*). This demonstrates that diversions for agriculture above Shasta Reservoir are very small compared to the inflow. Nevertheless, changes in water supply under the proposed Plan amendments could affect agriculture in the watersheds that drain into Shasta Reservoir, depending upon water rights priority. While actual inflow into the reservoir is close to unimpaired flow, flow requirements may necessitate reduced diversions from these streams.

Although the majority of the crops grown in the upper watersheds is pasture and alfalfa, on the west side in the Upper Cache Creek and Putah Creek basins, over 81 percent of irrigated land is grape vineyards or deciduous orchards. In this area, it is possible that some grape acreage could be fallowed.

Agriculture in the upper Feather River watershed, such as in Plumas and Sierra Counties, could be affected by changes in surface water supply. Alfalfa and pasture are the most predominant crops (Upper Feather River Regional Water Management Group 2016). Although groundwater pumping is part of the water supply portfolio in the upper Feather River basin, the area is experiencing lowered groundwater recharge and lowering of groundwater tables (Upper Feather River Regional Water Management Group 2016). Changes in supply could result in reductions in crop acreage and increased fallowing.

Reduced flows in some streams in the upper watersheds that are interconnected by interbasin diversions could occur in the Upper Yuba and Bear Rivers. Crops grown in these areas include alfalfa and pasture, vine crops, rice, and deciduous orchards (NID 2016). Groundwater is not extensively utilized in these areas because of the presence of a fractured rock aquifer system. Changes in supply could result in reductions in crop acreage and increased fallowing.

Like the analysis in the SWAP regions, it was assumed that fallowed lands would be converted to nonagricultural use. Crop acreage in these upper watersheds comprise a small fraction of the total irrigated crop acreage in the entire Sacramento River watershed and Delta eastside tributaries regions. As a result, this conversion would represent a very small (<1 percent) addition to the total reduction in irrigated acreage for the Sacramento/Delta as a whole.

Conclusion—Sacramento/Delta

Changes in water supply could lead to removing important farmland from irrigation in the Sacramento/Delta. This analysis assumes that all such lands would be converted to nonagricultural uses. This impact would be potentially significant.

The analysis presents a range of possible outcomes based on the most conservative assumptions and the least conservative assumptions as they relate to impacts on agriculture. Under the most conservative assumptions, the analysis likely overstates conversion for a number of reasons. At the higher end of the proposed Plan amendments flow range (65 scenario), in dry years and with no replacement groundwater, the SWAP model results indicate that a larger amount of land would no longer be irrigated than when using the least conservative assumptions (lower end of the flow range [45 scenario], average or wet years, maximum replacement groundwater pumping). Under baseline, rice utilizes nearly one-third of applied water for agriculture in the Sacramento/Delta (see Figure 7.4-8); yet rice may not be the crop most affected by reduced Sacramento/Delta supply at the low end of the flow range. Instead, alfalfa and pasture acreage may be reduced more than rice acreage because these forage crops are typically less profitable for growers.

In addition, equating reductions in irrigated acreage to cropland conversions likely overestimates potential acreage reduction; not all land acreage estimated to be removed from irrigation would be permanently converted to nonagricultural uses. Conversions of land to nonagricultural uses are governed by many factors, including the proximity of land to a developable area and the decision of a landowner whether to remain in agriculture.

Also, the management decisions of individual agricultural producers are more sophisticated and driven by more variables than can be accounted for in modeling. For example, land with less access to irrigation could still remain in agricultural production due to one or more factors, including water conservation efficiency improvements that reduce water demand, crop category, or agricultural use changes to less water-intensive applications, dryland farming, or increased crop rotation.

Some factors influence conversion in the other direction—pressuring conversion rates toward the higher end of the model results. Several of the groundwater basins that could provide replacement water are, if not already in overdraft, under stress. This condition on its own may limit the ability to achieve maximum groundwater replacement. Implementation of SGMA also may reduce users' abilities to fully replace lost Sacramento/Delta surface water with groundwater in some locations. Also, expansion of groundwater use, as through the continued shift toward tree crops, in areas that depend on groundwater rather than surface water, could reduce the availability of local groundwater.

The groundwater analyses in Section 7.12.2, *Groundwater*, show that, under the proposed Plan amendments, increased groundwater pumping and reductions in incidental groundwater recharge from applied irrigation could contribute to groundwater overdraft, particularly in areas where groundwater storage volumes are already in decline. If such reductions became severe, either through absolute shortages (i.e., failed wells) or through increased costs of drilling and operating deep wells, farmers could choose to convert groundwater-irrigated land to nonagricultural use. These reductions could particularly affect growers who rely on groundwater in areas where groundwater levels are currently already in decline. In addition, the availability of Sacramento/Delta surface water supply for managed groundwater recharge could decrease. Irrigation or water districts that rely on conjunctive use could, over time, have less water available for agricultural purposes both from surface water and from groundwater. Lower groundwater levels could lead to less flexibility for water management because of an inability to get groundwater supply when or where it is needed, leading to potential conversion of agricultural land to nonagricultural uses.

Given the uncertainty and individual decisions involved, any attempt to precisely predict conversion within the stated flow scenarios would require inappropriate speculation. In regions where groundwater faces preexisting limitations, those limitations and SGMA-based measures are likely to predominate, suggesting that the actual amount of conversion may be toward the higher end of the modeled flow scenarios, as described. In other areas, where groundwater is more abundant, factors such as growers' ability to adapt to changes in water supply through agricultural methods and substitute sources would likely shift actual conversion to the lower end of the modeled flow scenarios.

The SWAP model runs capture a range of possible conditions, including the worst case for agricultural impacts. In practice, conditions are likely to vary in any given year, and the acreage actually removed from irrigation would be somewhere between the model results.

A series of intermediate decisions lie between imposition of the proposed Plan amendments' flow requirements and conversion of farmland to nonagricultural uses. Individual irrigation districts will make decisions about how to allocate the available surface water in accordance with established rules and regulations. Individual farmers will make cropping decisions, including the decision whether to fallow, idle, or permanently convert land. If a farmer decides to convert the land, others in the market may decide whether to buy it and how it is to be used. Local general plan and zoning patterns make it probable that a new, nonagricultural use would require discretionary decisions by local agencies, such as general plan amendments, rezoning, subdivisions, or conditional use permits. The State Water Board does not control any of these decisions and does not have the authority to place conditions on local agencies to implement measures that would reduce or avoid the potentially significant impacts identified in this analysis.

Implementation of Mitigation Measures MM-AG-a,e: 1 through 6 will avoid or reduce the amount of agricultural conversion as a result of the proposed Plan amendments. The proposed program of implementation of the Bay-Delta Plan promotes voluntary implementation plans that could amplify the ecological benefit of new and existing flows with physical habitat restoration and other complementary ecosystem measures. The voluntary implementation plans also may reduce the volume of water that needs to be dedicated for instream purposes, resulting in smaller Sacramento/Delta water supply reductions for agriculture. In addition, water users can and should diversify their water supply portfolios to the extent possible, in an environmentally responsible manner and in accordance with the law. Diversification includes sustainable conjunctive use of groundwater and surface water, water recycling, water transfers, and water conservation and efficiency upgrades. Farmers are likely to implement efficiency and conservation measures on their own initiative in response to reduced supply. The State Water Board will continue to work with farmers and districts to develop and implement programs to increase water use efficiency and conservation in order to maximize the beneficial use of Sacramento/Delta supplies, including through conditions on discretionary approvals for funding and other approvals as appropriate. In addition, local agencies can and should impose conditions on such approvals to provide the permanent protection of an area of farmland equal to the converted area. Finally, implementation of groundwater mitigation would reduce agricultural impacts associated with lower groundwater levels.

While the State Water Board can ensure that mitigation is implemented for actions within its authority, other mitigation measures are largely within the jurisdiction and control of other agencies or depend on how water users respond to the proposed Plan amendments. Accordingly, the State Water Board cannot guarantee that measures will always be adopted or applied to fully mitigate potential agricultural impacts. Therefore, unless and until the mitigation is fully implemented, the impacts remain potentially significant.

San Joaquin Valley

The San Joaquin Valley region has many local surface water supplies and relies heavily on groundwater. As indicated in Table 7.4-1, agriculture is the primary water supply use in the region. Of the 18.4 MAF of total annual average water supplied to the San Joaquin Valley region (Table 7.4-1), Sacramento/Delta surface water supplies account for approximately 2.8 MAF, including 2.4 MAF, or 86 percent for agricultural uses (Table 7.4-3).

The annual Sacramento/Delta supply to the San Joaquin Valley region would be reduced under the proposed Plan amendments (45 to 65 scenarios) (Table 7.4-19). Under the 45 scenario, the reductions would be less than 300 TAF on average of all water year types. Under the 55 scenario, there would be larger reductions that range on average from 87 TAF in wet years to 658 TAF in dry years. Sacramento/Delta supplies would not be reduced as much in critical years as in below normal or dry years in the higher flow scenarios because the baseline Sacramento/Delta supply is already much reduced in these years. Under the 65 scenario, reductions in Sacramento/Delta supply would range on average from 626 TAF in critical years to 1,048 TAF in dry years.

While the reductions in Sacramento/Delta surface water supply represent a substantial amount of water, when compared with the total San Joaquin Valley region average annual supply of over 18.4 MAF as estimated by historical water deliveries data, the reductions are proportionally smaller. The reductions in total supply amount to 1 percent and 2 percent in the 45 and 55 scenarios, respectively (see Table 6.4-1).

Table 7.4-19. Sacramento/Delta Supply to San Joaquin Valley Region Agriculture, Water Year Type Average: Change from Baseline Conditions (thousand acre-feet)

Water Year Type	Baseline	35	45	55	65	75
Critical	1,404	-4	-139	-365	-626	-859
Dry	2,237	-103	-299	-658	-1,048	-1,516
Below normal	2,406	-41	-162	-476	-903	-1,462
Above normal	2,530	3	-65	-250	-843	-1,319
Wet	3,069	-11	-21	-87	-661	-968
All	2,422	-34	-134	-353	-811	-1,210

Source: Table 6.4-21 in Chapter 6, *Changes in Hydrology and Water Supply*.

Reductions in Sacramento/Delta surface water supplies could lead to changes in distribution of crop types and acreage and conversion of important farmland to nonagricultural use in the San Joaquin Valley. For the SWAP model analysis, SacWAM results are postprocessed to obtain the amount of water available for crop irrigation at farm locations by adjusting for conveyance losses and winter flooding of rice fields. Total surface water supplies available for crop irrigation are represented in the SWAP model as SWP, CVP, and local surface water supplies. For the analysis in the San Joaquin Valley areas that receive Sacramento/Delta supply, the postprocessed Sacramento/Delta supplies represent SWP and CVP supplies, while SWAP model default values are used to represent local supplies. Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*, provides more details on the approach used. Table 7.4-20 shows the total surface water supply inputs used in the average year and dry year SWAP model runs for the baseline and flow scenarios.

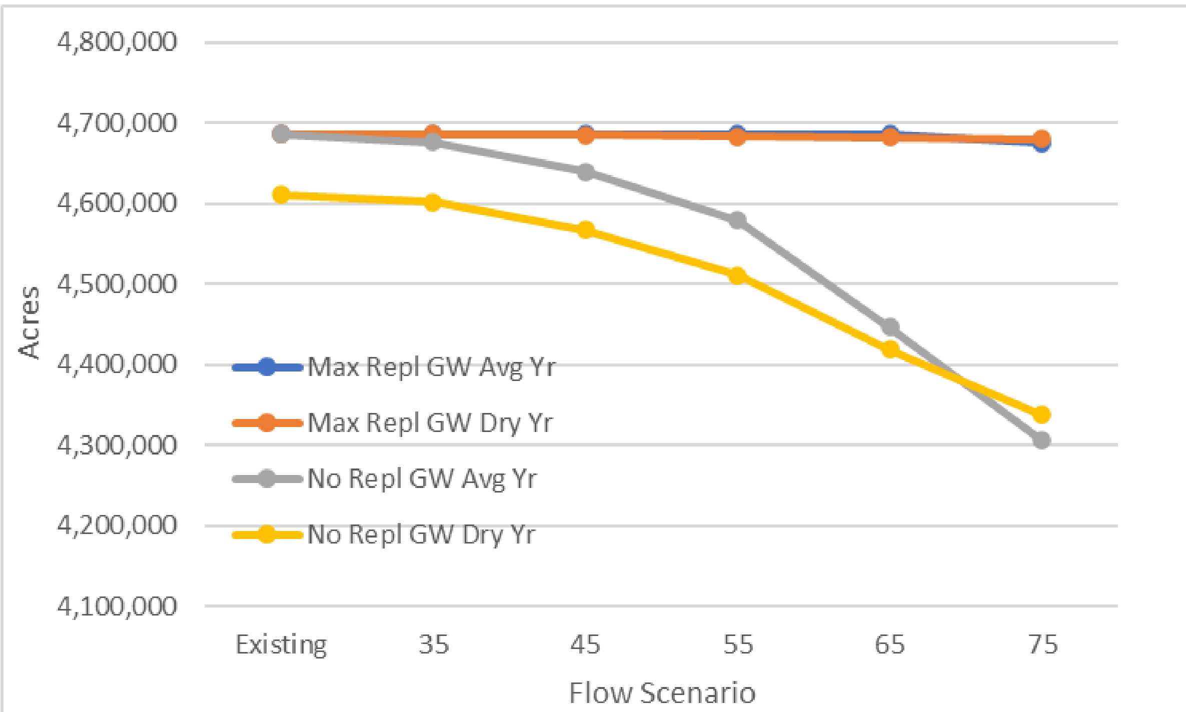
Table 7.4-20. Total Surface Water Supply for Agriculture in the SWAP Zones of the San Joaquin Valley Region, Average and Dry Water Year Types, SWAP Model Inputs for Baseline and Flow Scenario Runs (thousand acre-feet per year)

SWAP Water Year Type	Baseline	35	45	55	65	75
Average year	8,466	8,421	8,302	8,083	7,638	7,267
Dry year	7,596	7,528	7,348	7,061	6,736	6,373

Source: Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results.*

Figure 7.4-13 shows the analysis of potential changes in crop acreage in the San Joaquin Valley for no replacement groundwater and maximum replacement groundwater pumping. Meaningful changes in crop acreage are estimated by the SWAP model when groundwater is not used to replace lost surface water supply. Changes in crop acreage when groundwater is available to offset reduced surface water supply are small. The actual amount of crop acreage reduction that would occur will likely fall somewhere within the ranges depicted.

When groundwater is not used to offset surface water supply reductions, crop acreage reductions incrementally increase through the range of scenarios for both average and dry years. When groundwater is assumed to offset Sacramento/Delta surface water supply reductions, there would be no change in crop acres for the 45 and 55 scenarios because increased groundwater pumping would be able to offset the reduction in surface water supplies. Declines in crop acreage would occur under the 65 scenario because increased groundwater pumping would reach maximum groundwater replacement limits for some SWAP model regions (e.g., SWAP model Regions 10, 17, 19A).



Source: SWAP model results.

Figure 7.4-13. Irrigated Crop Acreage by Flow Scenario, San Joaquin Valley, SWAP Model Analysis

Table 7.4-21 shows the estimated changes in crop acreage by crop group for an average year if groundwater is not used to offset Sacramento/Delta surface water supply reductions. Under the proposed Plan amendments, irrigated crop acreage could range from approximately 4,639,700 to 4,446,600 acres (45 to 65 scenarios). Under the 55 scenario, approximately 4,578,800 crop acres would be maintained; this represents a decline of 2.3 percent from baseline. This result indicates that as many as 107,000 crop acres could be fallowed.

As shown in Table 7.4-21 and Figure 7.4-14, during an average year, if groundwater is not used to offset surface water supply reductions, the numbers of crop groups affected increase with increasing flow scenario. Under the 45 scenario, the model indicates that wheat and other field crops, corn and other silage, alfalfa and pasture, and almonds and pistachios are most likely to be affected. Under the higher flow scenario (e.g., the 65 scenario), impacts may extend to cotton and processing tomatoes. In the 55 scenario, the model results indicate that the largest reductions in terms of percentage are seen in wheat and field crop acres (9-percent reduction from baseline), alfalfa and pasture (4-percent reduction), and corn and other silage (3-percent reduction). In contrast to the Sacramento/Delta, the model results do not suggest a shift in crops in the San Joaquin Valley region that would lead to an increase in acreage for any particular crop category.

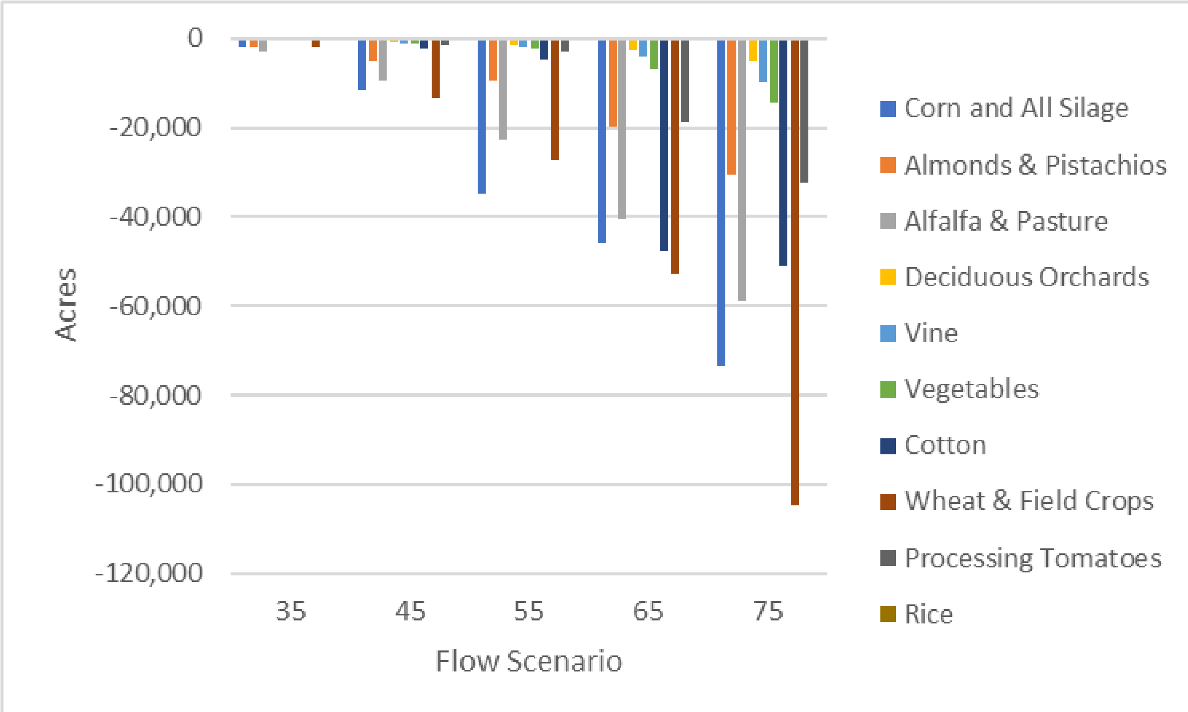
When groundwater is assumed to replace Sacramento/Delta surface water supply reductions, in an average year there are only minor changes in the cropping pattern and total crop acres. For example, under the 55 scenario, SWAP model results indicate no reduction in total crop acres from baseline conditions during an average year. Results for the SWAP model runs using the maximum replacement groundwater assumption are provided in Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results*.

Similar to the Sacramento/Delta, crop acreage changes would not be uniform across the entire region, as they will depend on a number of different economic and other factors, including the priority of individual water right diversions, availability of local supplies, and other factors. Crop acreage reductions as modeled in SWAP for some subregions are more pronounced than for other subregions in the San Joaquin Valley region.

Table 7.4-21. Average Year: Irrigated Crop Acreage in the San Joaquin Valley Region, No Replacement Groundwater (acres)

Crop Group	Existing	35	45	55	65	75
Corn and All Silage	1,075,500	1,073,600	1,064,100	1,040,700	1,029,400	1,002,000
Almonds & Pistachios	907,700	905,800	902,500	898,100	887,900	877,200
Alfalfa & Pasture	601,600	598,800	592,200	579,000	560,800	542,700
Deciduous Orchards	539,800	539,600	539,000	538,500	537,200	534,900
Vine	449,100	448,800	448,100	447,400	445,200	439,400
Vegetables	308,400	308,100	307,200	306,100	301,400	294,000
Cotton	282,700	282,200	280,500	278,100	235,000	231,900
Wheat & Field Crops	312,400	310,600	299,000	285,100	259,800	207,500
Processing Tomatoes	198,600	198,500	197,100	195,800	179,900	166,200
Rice	10,100	10,100	10,000	10,000	10,000	10,000
TOTAL	4,685,800	4,676,200	4,639,700	4,578,800	4,446,600	4,305,700

Source: Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results.*



Source: SWAP model results.

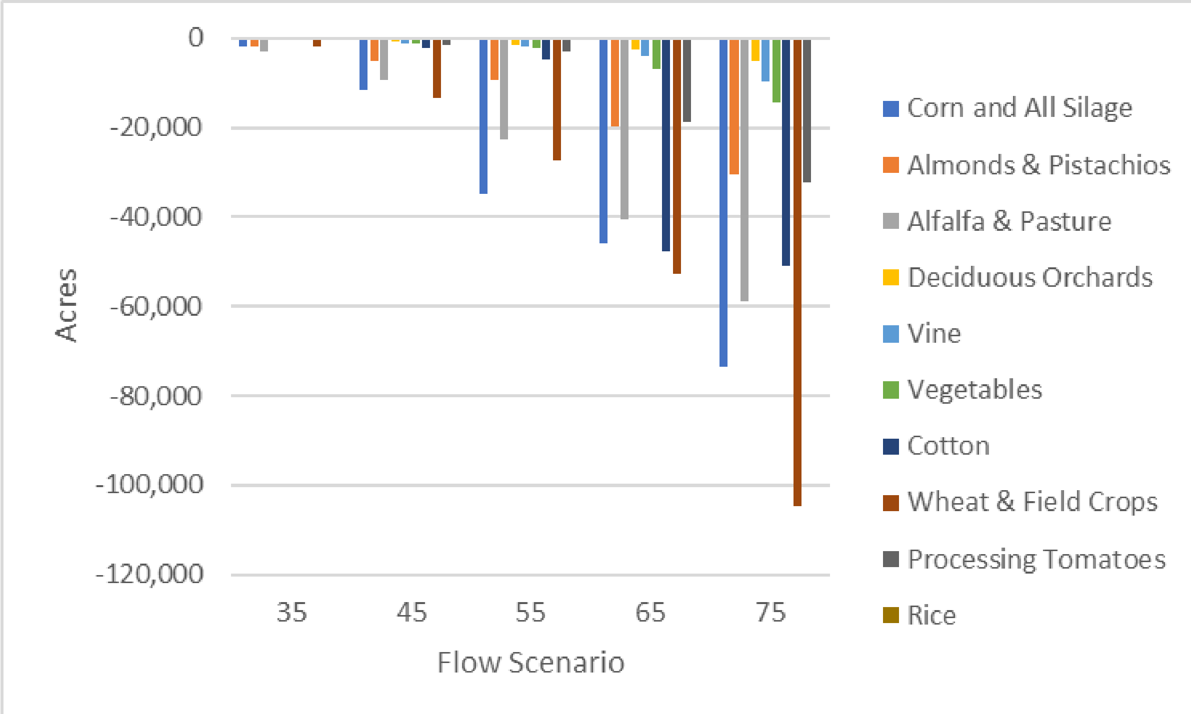
Figure 7.4-14. Average Year: Changes in Crop Acreage, San Joaquin Valley, SWAP Model Analysis, No Replacement Groundwater

During dry years with no replacement groundwater pumping, the same crop groups are affected as for average years, but fewer total crop acres would be fallowed because deficit irrigation would reduce the amount of crop fallowing needed to balance crop water demand with available water supplies. Table 7.4-22 and Figure 7.4-15 show the estimated changes in crop acreage by crop group for a dry year if groundwater is not used to offset Sacramento/Delta surface water supply reductions. Under the proposed Plan amendments, irrigated crop acreage could range from approximately 4,566,800 to 4,418,700 acres (45 to 65 scenarios). Under the 55 scenario, approximately 4,510,700 irrigated crop acres would be maintained, a decline of 2.2 percent from baseline. This result indicates that as many as 100,000 crop acres could be fallowed. The SWAP model results suggest that the largest reductions in crop acreage are in cotton acres (11-percent reduction from baseline), and wheat and field crop acres (9-percent reduction from baseline). Other categories with lesser reductions in crop acreage include alfalfa and pasture and processing tomatoes. In contrast, only small reductions in acreage would be associated with corn and other silage, deciduous orchards, vines, and vegetables.

Table 7.4-22. Dry Year: Irrigated Crop Acreage in the San Joaquin Valley Region, No Replacement Groundwater (acres)

Crop Group	Existing	35	45	55	65	75
Corn and All Silage	1,042,700	1,041,600	1,039,700	1,036,100	1,028,200	1,015,300
Almonds & Pistachios	903,100	902,200	899,800	896,100	893,400	888,600
Alfalfa & Pasture	588,100	584,400	577,500	574,600	572,700	567,400
Deciduous Orchards	538,700	538,500	538,200	537,600	537,000	535,900
Vine	447,400	447,200	446,600	445,700	444,800	442,800
Vegetables	306,400	306,100	304,800	302,800	301,000	295,900
Cotton	279,600	279,200	276,100	249,700	233,800	232,900
Wheat & Field Crops	299,300	297,200	281,300	271,000	220,600	210,300
Processing Tomatoes	195,700	195,600	192,800	187,000	177,100	138,200
Rice	10,000	10,000	10,000	10,000	10,000	10,000
TOTAL	4,611,000	4,602,100	4,566,800	4,510,700	4,418,700	4,337,500

Source: Appendix A3, *Agricultural Economic Analysis: SWAP Methodology and Modeling Results.*



Source: SWAP model results.

Figure 7.4-15. Dry Year: Changes in Crop Acreage, San Joaquin Valley, SWAP Model Analysis, No Replacement Groundwater

As discussed in Section 7.12.2, *Groundwater*, most groundwater subbasins for which the majority of the basin underlies the San Joaquin Valley region are ranked as high-priority; all but one of these are also critically overdrafted (Table 7.12.2-6, Figures 7.12.2-1a and 7.12.2-1b) (^CNRA 2022). In these areas, assuming maximum replacement groundwater pumping underestimates the irrigated acreage that could be lost because it does not account for groundwater availability. In addition to existing stress on groundwater supplies, the proposed Plan amendments may reduce groundwater availability further by increasing groundwater use as replacement for Sacramento/Delta surface supplies and reducing incidental recharge from applied irrigation. Maximum replacement groundwater pumping is one end of a continuum, the other end of which is no replacement groundwater pumping. Irrigated acreage reductions would likely correspond to groundwater availability that falls somewhere between these two conditions.

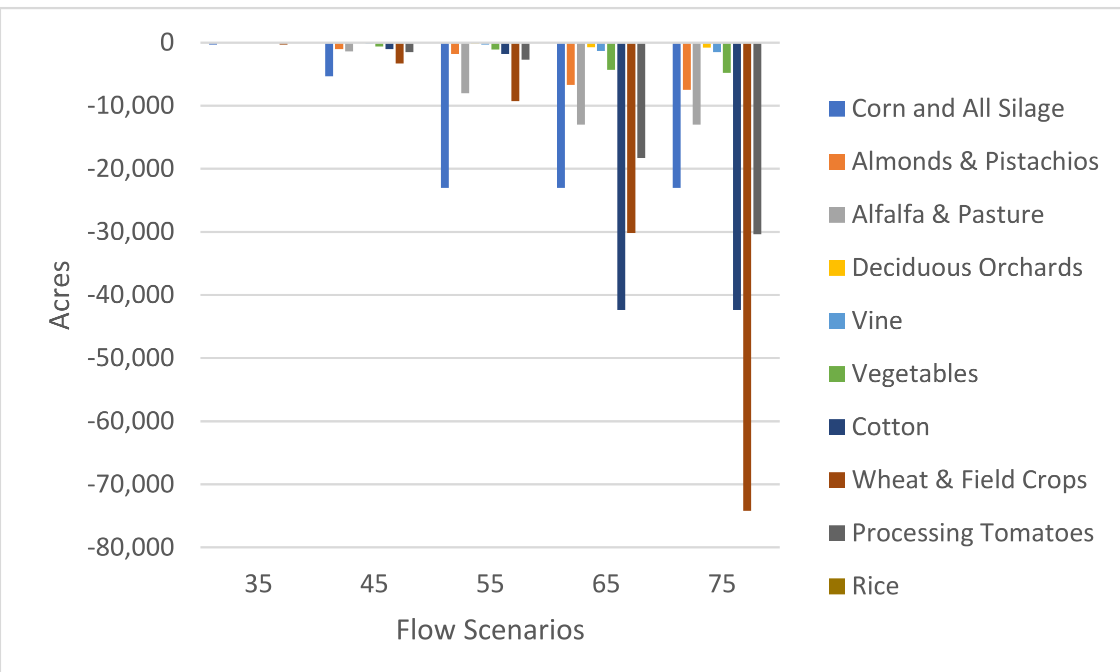
The analysis characterizes the anticipated range of potential effects on irrigated agriculture within the San Joaquin Valley region as a whole. Examples of localized effects in the study region are summarized here followed by detailed analysis.

- The analysis examines the range of effects on crop acreage that could occur within the groundwater replacement bookends. However, groundwater quality in the western San Joaquin Valley is impaired for nitrates and salts. Higher groundwater salinities pose risks to agriculture, including lowering of crop yields and increases in production crops. The potential effects of reduced groundwater quality on the ability of farmers in the western San Joaquin Valley to pump additional groundwater in response to reduced Sacramento/Delta supplies are described.

- A large amount of groundwater banking activity occurs at several water banks in Kern County. Continued development of groundwater banking is one way to plan for future water needs. A discussion of how reduced Sacramento/Delta supply could affect the amount of water available for future storage in groundwater banks is provided.
- If the exchange contractors make a call for their historical rights for San Joaquin River water, water supply availability for the CVP Friant Division and its members could be affected. Although these effects are included in the amounts of crop acreage reduction that could occur throughout the entire San Joaquin Valley region, a localized analysis describes the potential effects on agriculture in the Friant Division due to the shifting of the effects of reduced Sacramento/Delta supply from the exchange contractors to the Friant Division.

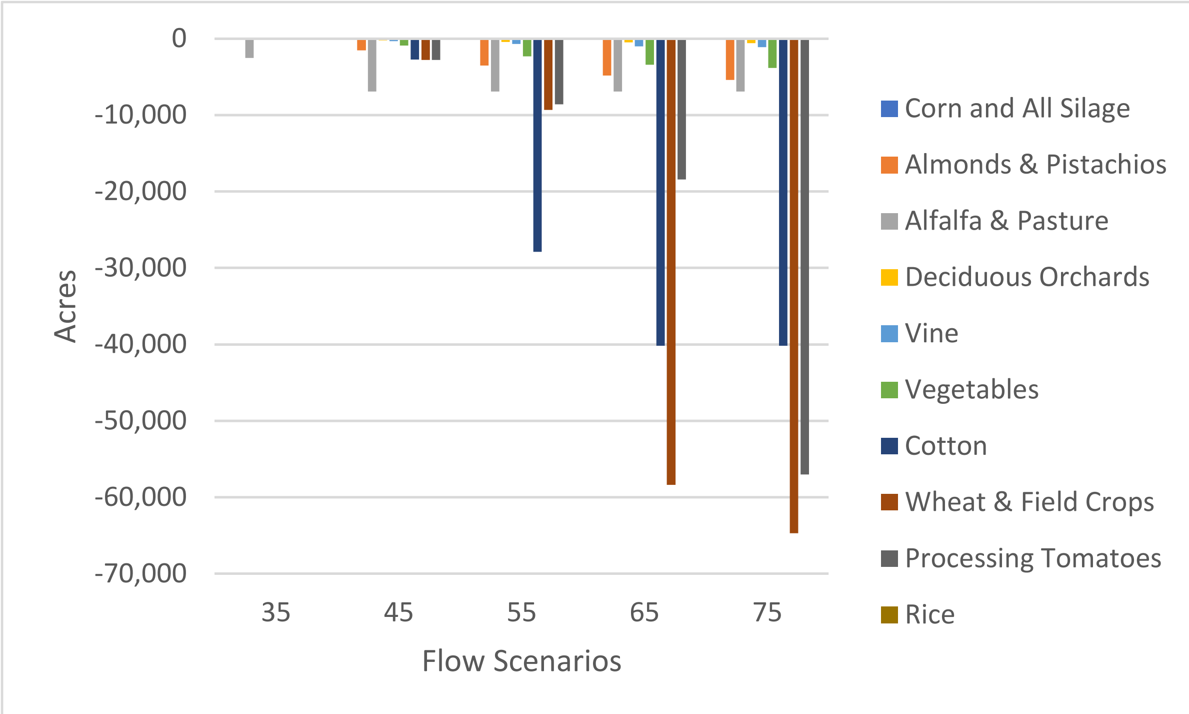
Western San Joaquin Valley

Agriculture in parts of the western portion of the San Joaquin Valley region, notably the Westlands Water District area, is potentially more sensitive to reductions in Sacramento/Delta surface water supplies because of its relatively poor groundwater quality in the shallow aquifer and the high cost of developing supplies from the deep aquifer. Additionally, most of the groundwater subbasins underlying this area are in overdraft. Figures 7.4-16 and 7.4-17 provide summaries of the modeled changes in crop acreages from the baseline condition for growers in the region, including CVP water users in the Westlands Water District, for average and dry years, respectively. Under the 55 scenario and no replacement groundwater pumping, average year crop reductions suggested by the SWAP model results occur primarily in corn and other silage, wheat and field crops, and alfalfa and pasture. Dry year reductions primarily occur in cotton, wheat and field crops, processing tomatoes, and alfalfa and pasture.



Source: SWAP model results.

Figure 7.4-16. Average Year: Changes in Crop Acreage by Scenario, Westlands Water District, SWAP Model Analysis, No Replacement Groundwater



Source: SWAP model results.

Figure 7.4-17. Dry Year: Changes in Crop Acreage by Scenario, Westlands Water District, SWAP Model Analysis, No Replacement Groundwater

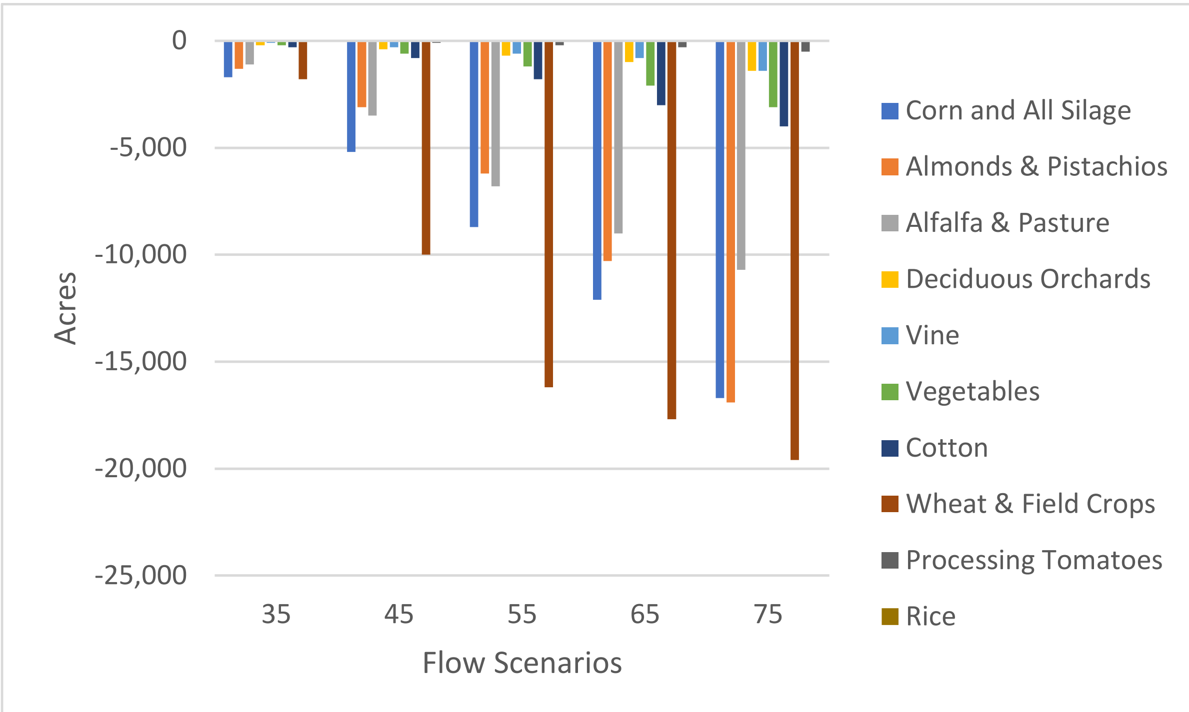
Results indicate that, with maximum replacement groundwater pumping, there would be no or very little change in irrigated acreage. However, the Westside subbasin, which underlies the Westlands Water District, is ranked as high priority and identified as critically overdrafted (Table 7.12.2-6, Figure 7.12.2-1b). These conditions could indicate that current levels of groundwater pumping are not sustainable. In this area, a combination of salty irrigation water, native salty soils, and an impermeable barrier have led to poor-quality groundwater in the shallow aquifer, while higher-quality water that is available in the deep aquifer is more expensive to obtain. Here, the changes in water supply could require farmers to make a choice: they could plant crops that can be irrigated with poor-quality but relatively inexpensive groundwater, which would be lower-profit crop categories; they could use higher-quality groundwater from the deep aquifer, raising their costs and reducing profit; or they could use less irrigation water. Any one of these options, but particularly using less water, could eventually lead farmers to convert land to nonagricultural use.

The SWAP model does not account for the possibility that groundwater pumping at the historical rates under the maximum replacement groundwater pumping assumption could yield only poor-quality water with limited ability to replace Sacramento/Delta surface supplies. It may be more likely that actual outcomes would be closer to the no replacement groundwater pumping assumption. Accordingly, reduced irrigated acres in western San Joaquin Valley are likely to be closer to those modeled for no replacement groundwater pumping. Conversion would likely be toward the higher end of the modeled range. However, some of the acres converted could have been removed from irrigation under the land retirement program discussed in Section 7.4.2.10, *San Joaquin Valley,* even without the proposed Plan amendments.

Southern San Joaquin Valley

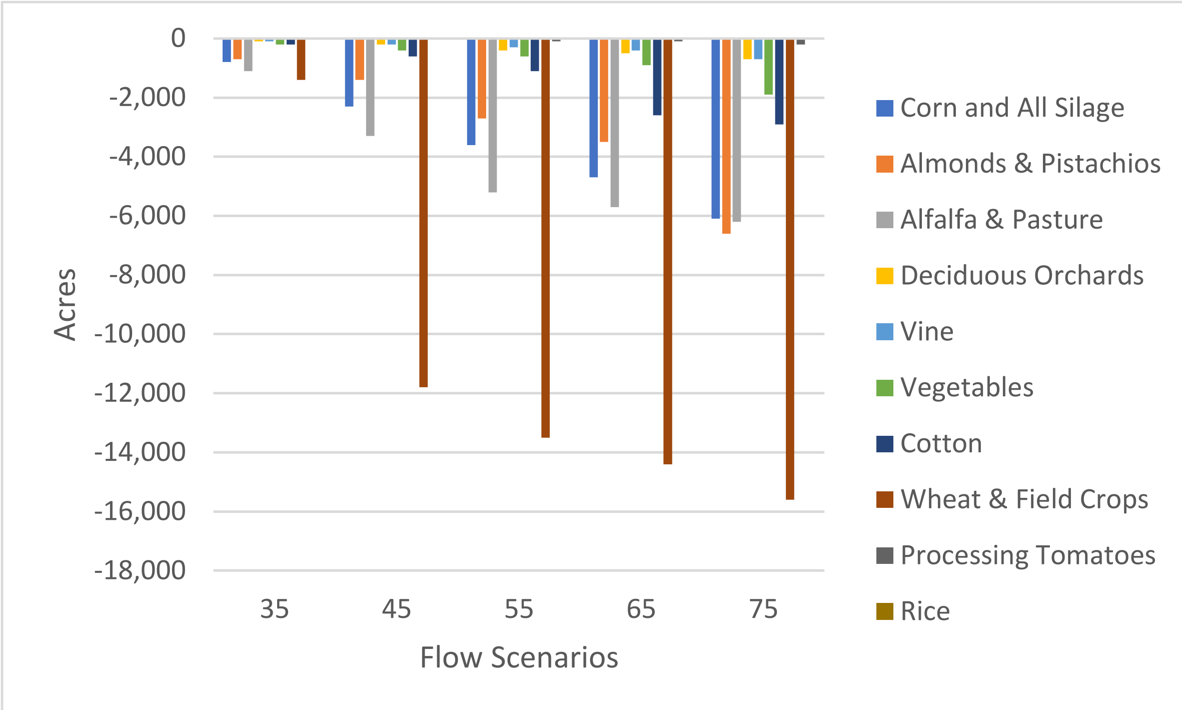
Several growers in the southern portion of the San Joaquin Valley region (e.g., Kern County area) receive Sacramento/Delta water supplies for agricultural use that could be reduced under the proposed Plan amendments.

Figures 7.4-18 and 7.4-19 summarize the estimated changes in crop acreages from baseline conditions for growers in the southern San Joaquin Valley, for average and dry years, respectively. The model results suggest that under the 55 scenario and no replacement groundwater pumping, average year crop reductions primarily occur in wheat and field crops, corn and other silage, alfalfa and pasture, and almonds and pistachios. Dry year reductions primarily occur in wheat and field crops, and alfalfa and pasture.



Source: SWAP model results.

Figure 7.4-18. Average Year: Changes in Crop Acreage by Scenario, Southern San Joaquin Valley, SWAP Model Analysis, No Replacement Groundwater



Source: SWAP model results.

Figure 7.4-19. Dry Year: Changes in Crop Acreage by Scenario, Southern San Joaquin Valley, SWAP Model Analysis, No Replacement Groundwater

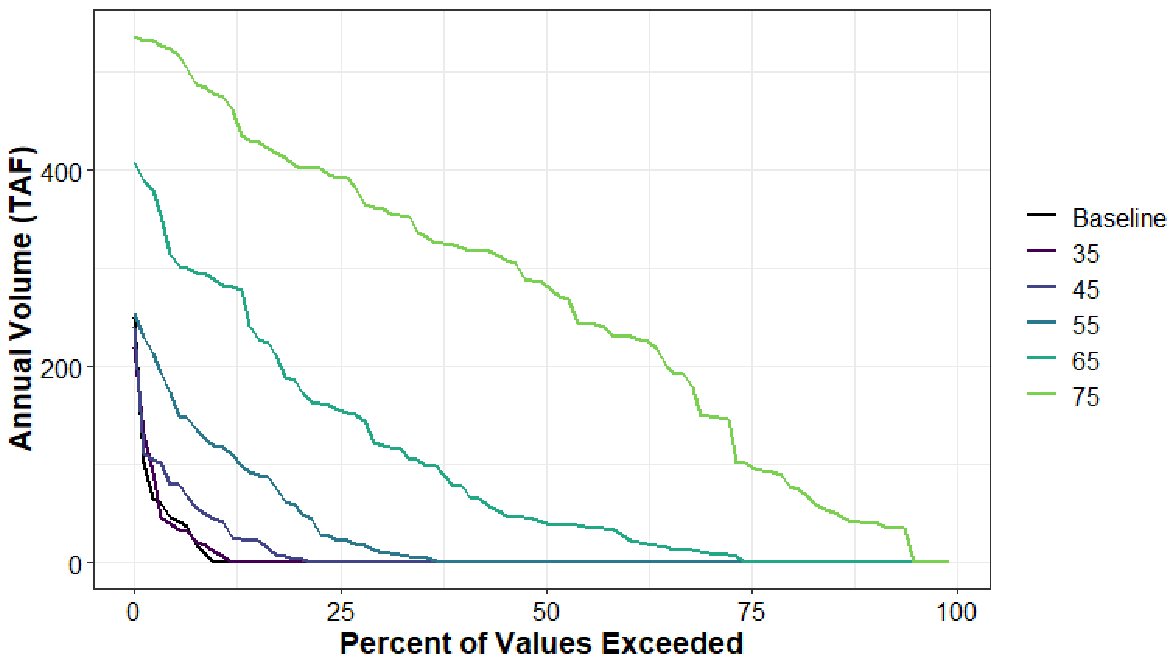
There are groundwater storage banks in the San Joaquin Valley (e.g., Kern Water Bank, Semitropic Water Storage District, Cawelo Water District) with capacities up to 1.5 MAF for the Kern Water Bank (Kern Water Bank Authority n.d.), exceeding 900,000 AF for the Semitropic Groundwater Banking Project (Semitropic Water Storage District 2012), and 400 AF for Cawelo Water District's Famoso Groundwater Banking Project (Cawelo Water District 2015). It is possible that conversions of agricultural land to nonagricultural as a result of the proposed Plan amendments could be reduced because of the proximity to multiple sources of supply capable of being stored in these banks and the proximity to the banks and interconnected infrastructure. However, while within-region member agencies can contribute water to the groundwater banks from several sources of supply, these sources can include Sacramento/Delta supply, which could be reduced under the proposed Plan amendments. This could reduce the amount of banked water available for return for agricultural use and lead to conversion.

Because groundwater banks in the southern San Joaquin area also bank water for customers in other regions (Semitropic Water Storage District 2015; Cawelo Water District 2015), in cases of successive dry years, groundwater banks may be unable to fulfill obligations to provide banked water not only to local customers but also to customers outside the local area who would use the water for agricultural purposes (e.g., Zone 7 in the Bay Area; Valley Water, Goleta Water District, Carpinteria Valley Water District in the Central Coast; MWD in Southern California). This could result in some additional converted acreage outside the San Joaquin Valley.

Friant Division

Implementation of the proposed Plan amendments could result in reduced Sacramento/Delta supply to the San Joaquin River exchange contractors. As discussed in Section 7.4.2.10, *San Joaquin Valley*, when exchange contractors receive less supply than their allocation, they can make a "call" on the water from the San Joaquin River. This results in less water being available from the San Joaquin River to Friant contractors. This section discusses the potential changes in supply to exchange contractors from the Sacramento/Delta and the resulting changes in supply to Friant contractors.

SacWAM results show that the frequency and magnitude of instances when Sacramento/Delta supplies are insufficient to meet the allocation obligations to the San Joaquin River exchange contractors would increase to various degrees depending upon the flow scenario and water year conditions. Figure 7.4-20 shows how frequently shortages could occur on an annual basis and the estimated magnitudes of the shortages for each flow scenario. In the existing condition, some level of shortage of Sacramento/Delta supplies occur in 9 of the 93 years of simulation, with a maximum shortage of about 250 TAF (Table 7.4-23). The magnitudes and frequency of occurrence of the shortages would vary but tend to be progressively larger and more frequent under the higher flow scenarios.



Source: SacWAM results.
TAF = thousand acre-feet

Figure 7.4-20. Annual Total Exchange Contractor Shortages Percent Exceedance by Scenario

The actual number of calls made may be different than these results suggest for a number of reasons, including the fact that the model does not account for real-time operational decisions that could affect the actual supply availability during dry periods, such as transfers, and temporary urgency change petitions.

Table 7.4-23. Exchange Contractor Shortage (thousand acre-feet) Percent Exceedance by Scenario

Percent Exceedance	Existing	35	45	55	65	75
0%	0	0	0	0	0	0
10%	0	0	0	0	0	37
25%	0	0	0	0	2	102
50%	0	0	0	0	49	296
75%	0	0	0	28	164	392
90%	0	0	48	119	280	465
100%	250	204	211	279	406	541

Source: Based on SacWAM results.

When Reclamation and the exchange contractors determine during any given year that agricultural production could be affected by reduced Sacramento/Delta supply, the exchange contractors could call on Millerton Lake water. Such calls on Friant water from the San Joaquin River and Millerton Lake would effectively shift water supply impacts on agriculture from the San Joaquin exchange contractors to the Friant Division, which uses Millerton Lake water for agricultural and municipal use. This could lead to reduced irrigated acreage and conversion to nonagricultural uses in the Friant Division.

Table 7.4-24 provides average year and dry year estimates of the amounts of Millerton Lake water that would be redirected to the San Joaquin exchange contractors for each flow scenario, assuming the exchange contractors would rely solely on upper San Joaquin River and Millerton Lake supplies to replace the reductions in Sacramento/Delta supply. These amounts represent the estimated Millerton Lake surface water supply reductions that could be experienced by the Friant Division if calls on Friant are made. These water supply assumptions are implemented in the CVP water supply inputs to the SWAP model for the applicable SWAP-modeled regions.

Table 7.4-24. Estimated Annual Volume of Millerton Lake Supply Redirected to Exchange Contractors Due to Calls on Friant, Average and Dry Water Year (thousand acre-feet)

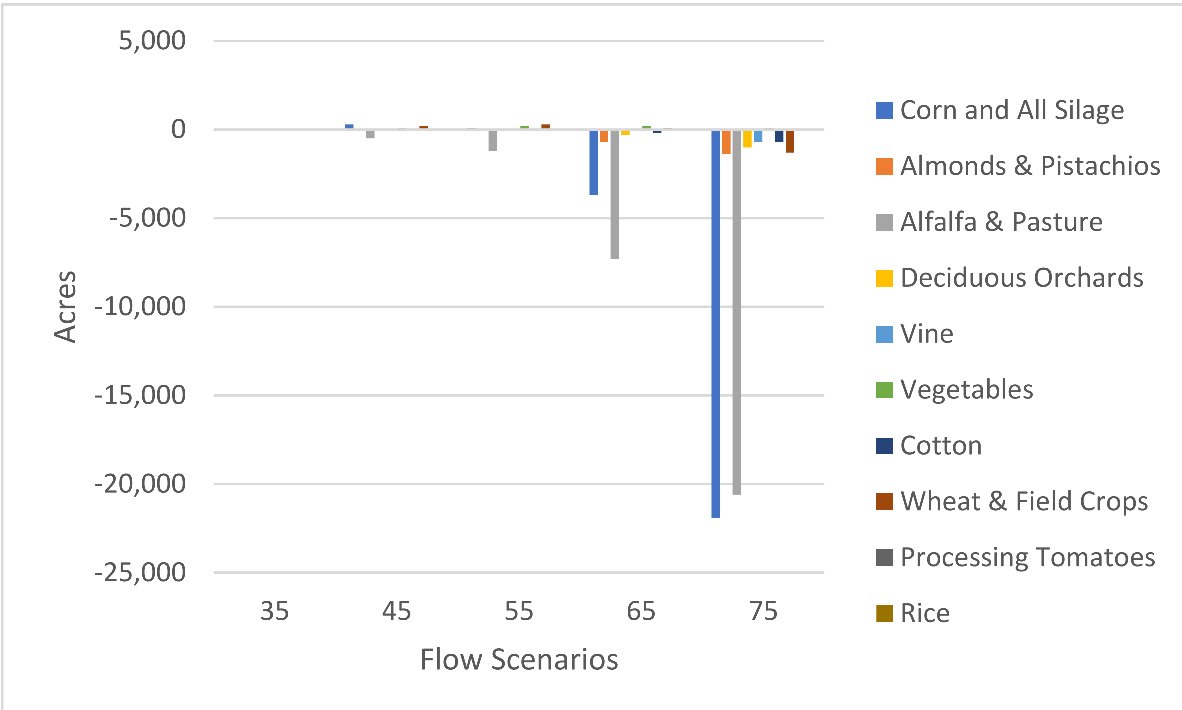
Condition	Existing	35	45	55	65	75
Average year	6.7	6.9	11.7	30.0	93.7	259.9
Dry year	16.5	18.0	27.7	70.6	176.4	368.8

Source: Based on SacWAM results.

Although the effects of redirection of Millerton Lake supply were modeled in SWAP, only qualitative effects on Friant growers can be described because of the comingling of Friant and non-Friant growers within the SWAP production regions. The effects described are derived from SWAP modeling results in which each region is run by a single representative grower who decides how best to allocate water supplies, which may not represent real-life water and crop management. In real-time, individual Friant Division growers could experience more effects on crop production depending on the extent of groundwater overdraft and whether agreements for local surface water supply are in place.

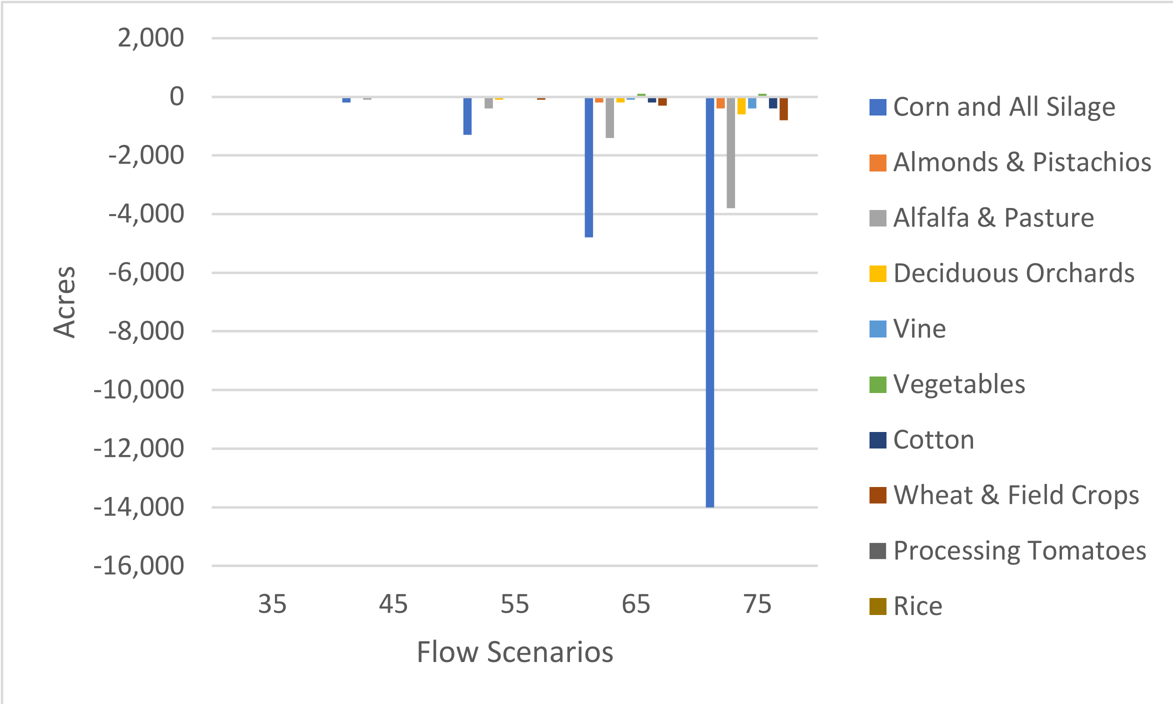
For growers in Madera, Fresno, and Kings Counties (see Figure 7.4-21), average year modeling shows little reduction in total crop acreage (fallowing) under the 55 scenario compared with baseline conditions; more substantial reductions in acreage begin to occur under the 65 scenario.

Crop acreage declines primarily occur in alfalfa and pasture lands. Other crops do not see much change in crop acreage compared with baseline conditions. CVP supplies comprise a small fraction of the overall water supply in these regions, as modeled, and could be a major reason for these outcomes. Dry year modeling shows little additional fallowing under the 55 scenario compared with baseline conditions (Figure 7.4-22). However, some crop acreage declines may occur in corn and other silage and in alfalfa and pasture under the 65 scenario. These outcomes may be due to the small fraction of CVP supplies used in the region and the use of deficit irrigation in the dry year modeling scenarios.



Source: SWAP model results.

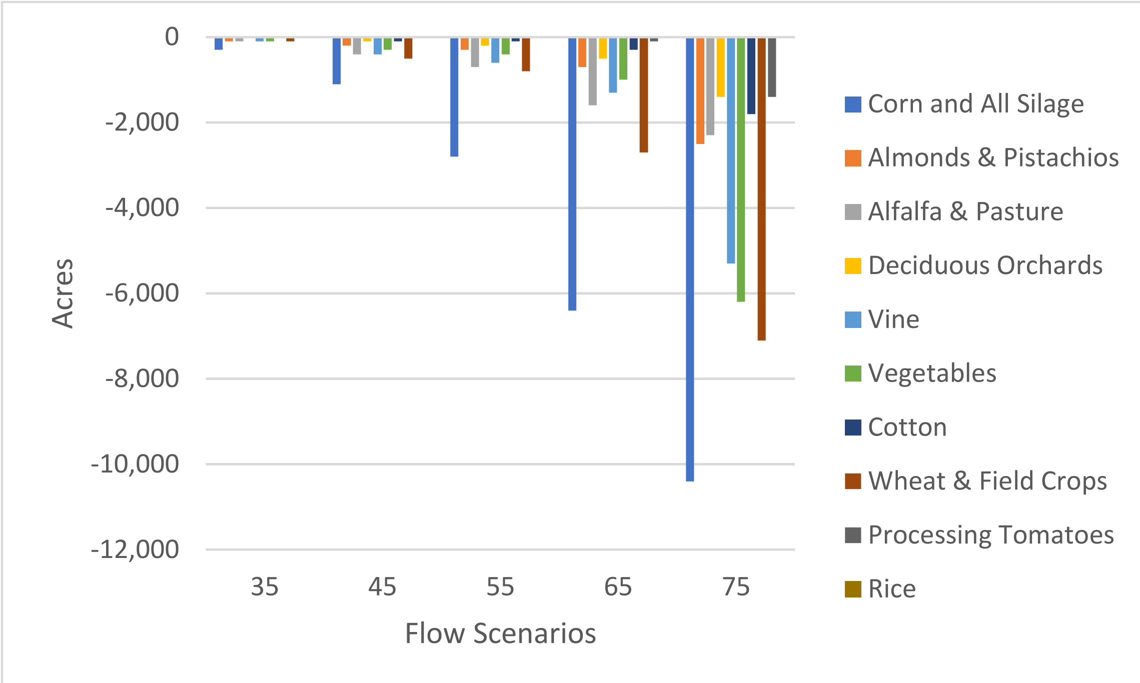
Figure 7.4-21. Average Year: Changes in Crop Acreage by Scenario, Friant Division (northern), SWAP Model Analysis, No Replacement Groundwater



Source: SWAP model results.

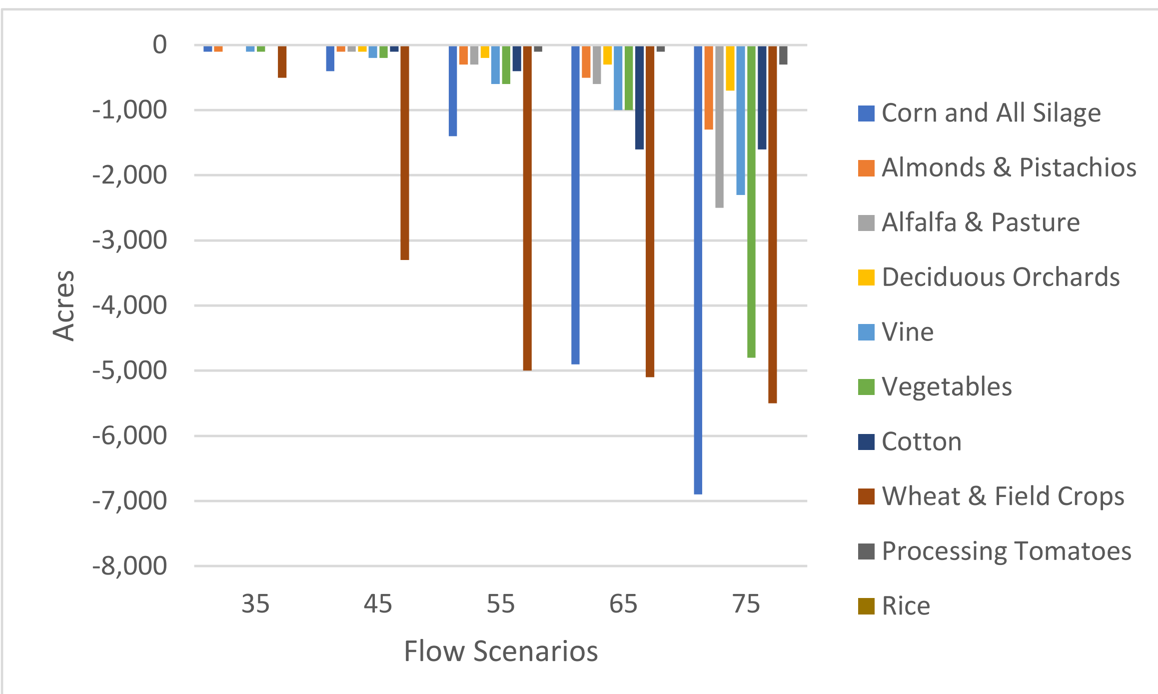
Figure 7.4-22. Dry Year: Changes in Crop Acreage by Scenario, Friant Division (northern), SWAP Model Analysis, No Replacement Groundwater

Average year modeling for growers in Tulare and Kern Counties (see Figure 7.4-23) shows larger reductions in total crop acreage (fallowing) than for Madera, Fresno, and Kings Counties. Reductions in acreage begin to occur under the 45 scenario and incrementally increase through the 65 scenario. Crop acreage declines are distributed among most crop groups but are particularly seen in corn and other silage. Crop acreage reductions incrementally increase through the higher flow scenarios. Dry year modeling shows there would be some additional fallowing compared with baseline conditions, with wheat and field crops having the bulk of the reduction (Figure 7.4-24). Crop acreage declines would affect many crop types, but the magnitudes of the reductions are smaller in the dry year than observed in the average year modeling, due to the use of deficit irrigation. Growers in Tulare and Kern Counties experience more additional fallowing than growers in Madera, Fresno, and Kings Counties because, as modeled, CVP supplies represent a larger fraction of the total water supplies in the southern area of the Friant Division, and fewer local surface water supply options are available.



Source: SWAP model results.

Figure 7.4-23. Average Year: Changes in Crop Acreage by Scenario, Friant Division (southern), SWAP Model Analysis, No Replacement Groundwater



Source: SWAP model results.

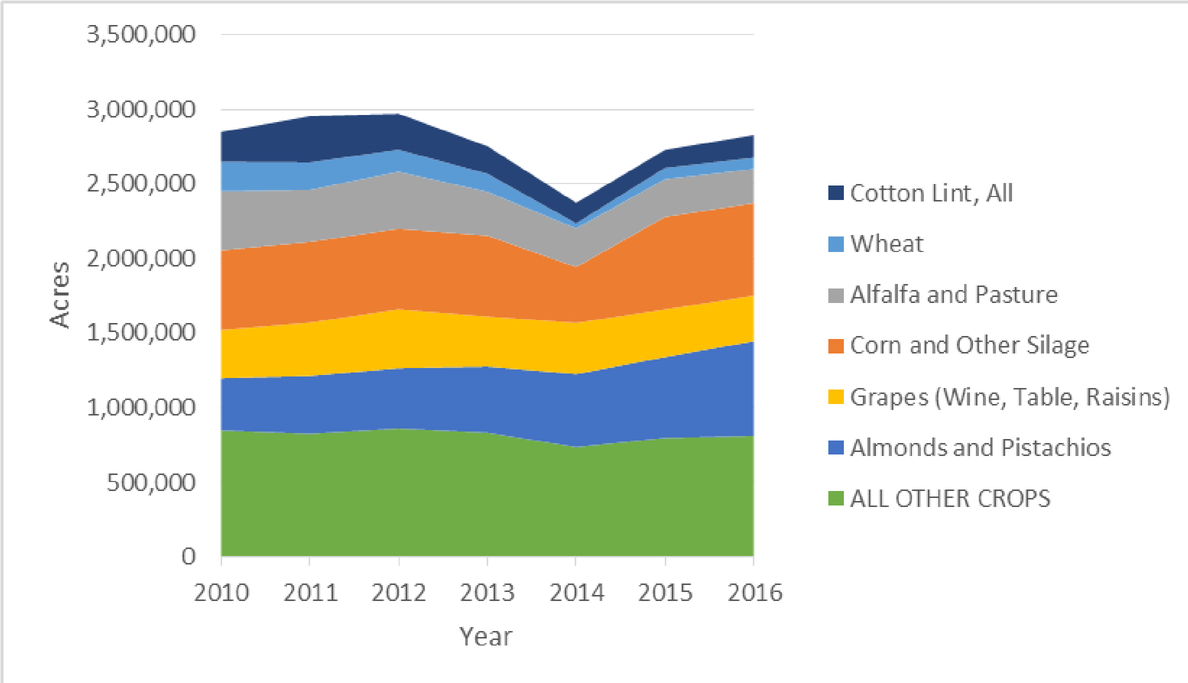
Figure 7.4-24. Dry Year: Changes in Crop Acreage by Scenario, Friant Division (southern), SWAP Model Analysis, No Replacement Groundwater

While the frequency of calls in the past is low, a review of historical empirical data allows examination of possible effects. Since the 1939 agreement with Reclamation (SJRECWA 2021), the San Joaquin exchange contractors exercised their senior rights for San Joaquin River water in 2014, 2015, 2021, and 2022. For these years, Friant Division contractors received zero CVP allocations from Millerton Lake because Millerton Lake water supply was redistributed to the San Joaquin exchange contractors.

Although the Friant Division received no CVP allocation in 2014 and 2015, the extent to which Friant Division growers were negatively affected economically is not clear. Friant Division contractors are distributed among several counties in the eastern Tulare Basin of the San Joaquin Valley region, including Madera, Fresno, Tulare, and Kings Counties, with additional land in Kern and Merced Counties. Other agricultural producers that are not part of the Friant Division also exist in these counties. Published crop acreage data from the California Department of Food and Agriculture are available on a county-level basis and represent a mix of both Friant Division and non-Friant producers within each county.

Although it is not possible from available information to differentiate the effects on the Friant Division growers from non-Friant growers, an examination of data from counties in which the Friant Division is predominant can provide some insight into the effects of the call on Friant water. Available crop acreage and economic information for a four-county region (Fresno, Kings, Madera, and Tulare) shows the following trends for the 2010 through 2016 period: overall irrigated acreage declined during 2014 and 2015, but acreage for certain high-value crops increased; average water costs for growers were higher due to a higher reliance on more expensive groundwater and water transfers, but total revenue (value of production) earned by growers was greatest in 2014, despite the drought conditions.

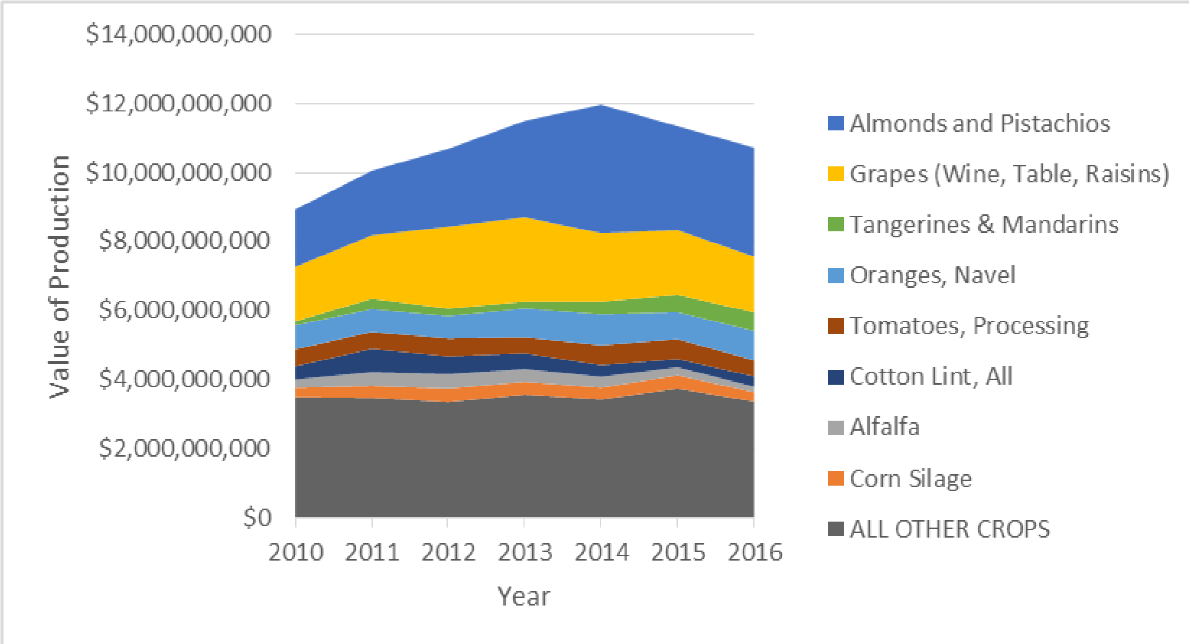
Figure 7.4-25 shows that although the total crop acres in the four-county region declined during 2014 and 2015 compared with prior years, crop acres for some major crops—almonds, pistachios, and walnuts—increased over the same period. The yearly increase in almond and pistachio acreage reflects a multi-year transition in cropping patterns in the four-county region from hay and grains to nut orchards, a trend that was little affected by the 2012–2016 drought.



Sources: CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a.

Figure 7.4-25. Trends in Crop Acres Production, Four-County Region (Fresno, Kings, Madera, and Tulare), 2010–2016

Figure 7.4-26 shows that total crop value, or the revenue earned by farmers, was highest during 2014, despite the presence of drought and associated decline in irrigated acreage. This occurred due to a unique circumstance of market conditions: new nut producing orchards were emerging on the market at the same time as the market was experiencing high demand and high prices for almonds and pistachios. This created economic gains that more than made up for the losses experienced by other crop categories (e.g., alfalfa and wheat), including fallowed land.



Sources: CDFA n.d., 2012, 2015a, 2015b, 2016, 2018a.

Figure 7.4-26. Trends in Crop Production Value, Four-County Area (Fresno, Kings, Madera, and Tulare), 2010–2016

Gains in crop value did not completely offset increased costs for other water supplies. Increased groundwater pumping was the primary response to surface water shortage during the drought, with decreases in groundwater pumping capabilities and increasing costs due to declining water levels. (Howitt et al. 2014). Increased groundwater pumping lowers groundwater levels, reduces groundwater quality, and increases land subsidence. As groundwater levels drop, the costs to extract groundwater increased in consecutive years of drought (Howitt et al. 2014; Howitt et al. 2015).

Water districts and individual growers also participated in water markets and transfers during this period. As noted in Section 8.3.3, *Water Transfers*, in 2014, [water purchase] prices soared to an average of $779/AF with individual transactions executed at prices as high as $2,200/AF due to severe drought conditions and historically low SWP and CVP allocations (WestWater Research, unpublished data).

Conclusion—San Joaquin Valley

Changes in water supply could lead to removing important farmland from irrigation in the San Joaquin Valley region and, as a result, to conversion of agricultural land to nonagricultural uses. The impact would be potentially significant.

As indicated in Figure 7.4-9, within the San Joaquin Valley, almonds and pistachios use the largest proportion of the region's total agricultural water supply, followed by corn and other silage, and alfalfa and pasture. Nevertheless, the impact analysis suggests that other crop groups, such as wheat and field crops, could be highly affected by reduced Sacramento/Delta surface water supply. These effects may occur because of the lower profitability of these crops relative to other crop groups that utilize more water.

Other than the western San Joaquin Valley analysis, results may overstate conversion for the reasons previously described, land taken out of irrigation is not necessarily converted to nonagricultural use. Moreover, conditions in most years are likely to differ from the most conservative assumptions that lead to this conclusion: most years will not be dry years; flow likely would not be required in the 65 scenario in tributaries with high water demand; and some groundwater substitution above the no replacement groundwater pumping levels would be available, including in basins subject to SGMA where that is consistent with local management under SGMA. On the west side of the valley, growers' ability to substitute with groundwater would be more constrained, but these other factors could similarly work to produce actual conversion rates lower than the modeling predicts.

Expansion of groundwater use, as through the continued growth in tree crops, in areas that depend on groundwater rather than surface water could reduce the availability of groundwater. This could reduce the availability of groundwater to use as a substitute for reduced Sacramento/Delta surface water deliveries and lead to greater conversion than estimated assuming maximum replacement groundwater pumping. Implementation of SGMA also may reduce water users' ability to fully replace lost Sacramento/Delta surface water with groundwater. These factors would contribute to conditions represented by no replacement groundwater pumping and a greater potential for conversion.

Additionally, the reduction in irrigation could reduce incidental recharge, which could, in turn, reduce the availability of groundwater. The groundwater analyses in Section 7.12.2, *Groundwater*, show that, under the proposed Plan amendments, increased groundwater pumping and reductions in incidental groundwater recharge could contribute to lower groundwater levels, particularly in groundwater basins where groundwater storage volumes are already in decline. If such reductions became severe, either through absolute shortages (i.e., failed wells) or through increased costs of drilling and operating deep wells, farmers could choose to convert groundwater-irrigated land to nonagricultural use. In addition, the availability of Sacramento/Delta surface water supply for managed groundwater recharge could decrease. Districts that rely on conjunctive use could, over time, have less water available for agricultural purposes both from surface water and from groundwater. Lower groundwater levels could lead to less flexibility for water management because of an inability to get groundwater supply when or where it is needed. As in the Sacramento/Delta, this outcome could add additional converted acreage.

Given the uncertainty and individual decisions involved, any attempt to precisely predict conversion within the stated ranges would require inappropriate speculation. The San Joaquin Valley is a region where groundwater faces preexisting limitations. Those limitations and SGMA-based measures are likely to predominate, suggesting that the actual amount of conversion may be toward the higher end of the modeled flow scenarios.

A series of intermediate decisions lie between imposition of the proposed Plan amendments unimpaired flow requirements and the conversion of farmland to nonagricultural uses. Individual irrigation districts will make decisions about how to allocate the available surface water in accordance with established rules and regulations. Individual farmers will make cropping decisions, including the decision whether to fallow, idle, or permanently convert land. If a farmer decides to convert the land, others in the market may decide whether to buy it and how it is to be used. Local general plan and zoning patterns make it probable that a new, nonagricultural use would require discretionary decisions by local agencies, such as general plan amendments, rezoning, subdivisions, or conditional use permits. The State Water Board does not control any of these decisions and does not have the authority to place conditions on local agencies to implement measures that would reduce or avoid the potentially significant impacts identified in the analysis.

Implementation of Mitigation Measures MM-AG-a,e: 1 through 6 will avoid or reduce the amount of agricultural conversion as a result of the proposed Plan amendments. The proposed program of implementation promotes voluntary implementation plans that could amplify the ecological benefit of new and existing flows with physical habitat restoration and other complementary ecosystem measures. The voluntary implementation plans also may reduce the volume of water that needs to be dedicated for instream purposes, resulting in smaller Sacramento/Delta water supply reductions for agriculture. In addition, water users can and should diversify their water supply portfolios to the extent possible, in an environmentally responsible manner and in accordance with the law. Diversification includes sustainable conjunctive use of groundwater and surface water, water recycling, water transfers, and water conservation and efficiency upgrades. Farmers are likely to implement efficiency and conservation measures on their own initiative in response to reduced supply. The State Water Board will continue to work with farmers and districts to develop and implement programs to increase water use efficiency and conservation to maximize the beneficial use of Sacramento/Delta supplies, including through conditions on discretionary approvals for funding and other approvals as appropriate. In addition, local agencies can and should impose conditions on such approvals to provide the permanent protection of an area of farmland equal to the converted area. Finally, implementation of groundwater mitigation would reduce agricultural impacts associated with lower groundwater levels.

While the State Water Board can ensure that mitigation is implemented for actions within its authority, other mitigation measures are largely within the jurisdiction and control of other agencies or depend on how water users respond to the proposed Plan amendments. Accordingly, the State Water Board cannot guarantee that measures will always be adopted or applied to fully mitigate potential impacts. Therefore, unless and until the mitigation is fully implemented, the impacts remain potentially significant.

San Francisco Bay Area, Central Coast, and Southern California

Sacramento/Delta supplies are exported to each of the Bay Area, Central Coast, and Southern California regions; although the water predominately serves municipal purposes, some Sacramento/Delta water is also used for agricultural purposes in these regions. Because of the limited use of Sacramento/Delta supplies for agricultural irrigation, impacts on agriculture likely would be small and localized but nevertheless potentially significant.

Changes in crop acreage in these regions were estimated using the CASRAA methodology that emulates the agricultural and economic optimization process used in the SWAP model. The details of the analysis for these study regions are provided in Chapter 8, *Economic Analysis and Other Considerations,* as part of the methodology for estimating the potential economic effects of the proposed Plan amendments on agriculture. Estimated changes in crop acreage derived in Chapter 8 are summarized in the following respective regional discussions, with qualified descriptions of the potential effects on example growers in those areas. The analysis considers water portfolios that are currently being implemented as examples to assess whether sufficient water supplies are available. Extended dry years or drought conditions would exacerbate shortages for some agricultural uses. The analysis assumes that impacts would occur (i.e., conversion if suppliers could not meet existing demand with a combination of reduced Sacramento/Delta supply and existing other supplies identified in current planning documents, including the use of other water management actions).

San Francisco Bay Area

The vast majority of Sacramento/Delta water supply to the Bay Area region serves municipal and industrial demands. As described in Chapter 2, *Hydrology and Water Supply*, of the total 137 TAF of water used by agriculture for irrigation in the region, only 27 TAF is Sacramento/Delta water (Table 7.4-3). Solano County Water Agency, Zone 7 in eastern Alameda County, and the Napa County Flood Control and Water Conservation District have agricultural customers. East Bay Municipal Utility District and Contra Costa Water District also receive Sacramento/Delta water but do not have agricultural customers.

As shown in Table 7.4-25, potential reductions in Sacramento/Delta supply to Bay Area agriculture would be 14 TAF/yr on average under the 55 scenario, with a range from an average of 10 TAF/yr to 17 TAF/yr under the 45 to 65 scenarios, respectively. These reductions in supply could lead to conversions of agricultural land to nonagricultural use.

Table 7.4-25. Sacramento/Delta Supply to Bay Area Region Agriculture Water Year Type Average Change from Baseline (thousand acre-feet)

Water Year Type	Baseline	35	45	55	65	75
Critical	23	-9	-13	-14	-18	-20
Dry	27	-9	-13	-16	-20	-22
Below normal	28	-9	-13	-16	-20	-23
Above normal	28	-5	-10	-14	-19	-21
Wet	29	-2	-3	-12	-13	-15
All	27	-6	-10	-14	-17	-20

Sources: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis* and SacWAM results.

For SWAP modeling purposes, the resulting Sacramento/Delta surface water supply available for agricultural irrigators in the Bay Area region under baseline and flow scenarios is shown in Table 7.4-26 for average year and dry water year types.

Table 7.4-26. Surface Water Supply for Agriculture in the San Francisco Bay Area Region, Average and Dry Water Year Types, Baseline and Flow Scenarios (thousand acre-feet per year)

Water Year Type	Baseline	35	45	55	65	75
Average year	27	21	18	13	10	7
Dry year	25	16	12	10	6	4

Source: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis.*

In addition, groundwater levels may be lowered in localized areas if diverters increase groundwater use as a result of reduced Sacramento/Delta supplies and because less Sacramento/Delta water would be available for managed groundwater recharge. Lower groundwater levels could also lead to conversion of land to nonagricultural use for growers who rely in whole or in part on groundwater.

A portion of Solano Irrigation District near Fairfield is located within the Bay Area region, but the majority of the District's service area is within the Sacramento River watershed. Potential effects on agriculture from reductions in Sacramento/Delta supply to Solano Irrigation District through the Putah South Canal are included in the results of this subsection.

The City of Napa is an SWP contractor, and its allocation is comingled with other local sources. While nearly all of its customers are nonagricultural, the City provides interruptible (low-priority) water to a number of vineyards. Although the agricultural service is anticipated to increase to 300 AF by 2030, the City's water supply reserves from its portfolio of sources far exceed municipal and agriculture demand (City of Napa 2017). Therefore, any decrease in SWP deliveries resulting from implementation of the proposed Plan amendments may not reduce deliveries to the irrigators. The City of Napa also exports water to American Canyon, which further provides water to several agricultural users. However, the City of American Canyon plans to convert all those users to recycled water after 2020 (City of American Canyon 2016).

Zone 7 delivers approximately 5.6 TAF to agricultural producers in the Livermore area. Zone 7 receives an average of about 50 TAF of SWP water through the South Bay Aqueduct (Zone 7 2016). It also relies on local surface water sources, groundwater, a water transfer contract with Byron Bethany Irrigation District, and a contract to purchase water under the Yuba Accord. Zone 7 also has two groundwater banking contracts with the Semitropic Water Storage District and Cawelo Water District (Zone 7 2016). The majority of the water demand within the agency's service area is municipal. However, Zone 7 also provides SWP water to approximately 3,500 acres of mostly high-value crops such as vineyards, olives, and pistachios in the Livermore Valley (Zone 7 2016). The water demand for the irrigated land in 2015 was about 5,600 AF (Zone 7 2015) and is projected to increase to 7,800 AF by 2030 (Zone 7 2016), or approximately 8.3 percent of the agency's total 2030 water demand.

The analysis of the effects of reduced Sacramento/Delta supply on crop acreage in the Bay Area region is derived from the CASRAA model, detailed in Chapter 8, *Economic Analysis and Other Considerations;* the analysis is summarized in Table 7.4-27 and Table 7.4-28 and in Figures 7.4-27 and 7.4-28. This analysis focuses on potential impacts on agriculture in areas receiving Sacramento/Delta supply from the Solano Irrigation District served by the Putah South Canal and from Zone 7. The reduction in Sacramento/Delta supply most likely would affect pasture and alfalfa crops in the Solano Irrigation District; it was assumed that land would be fallowed.

Based upon Zone 7's broad portfolio of supplies, including its use of groundwater banking and water transfers (some of which are CVP or SWP contractors subject to reductions as well), it is anticipated that replacement water would be utilized for reductions in SWP deliveries resulting from implementation of the proposed Plan amendments. In the event that replacement water is not available, and no replacement groundwater is developed, then under the 55 scenario, loss of Sacramento/Delta supply could result in the fallowing of up to 900 acres in each of average years and dry years, respectively (see Table 7.4-27 and Table 7.4-28). The fallowed acreage could include vineyards and deciduous orchards. Similar to the analysis in the SWAP modeled regions, it was assumed that fallowed lands would be converted to nonagricultural use.

Table 7.4-27. Average Year: Irrigated Crop Acreage in the San Francisco Bay Area Region (acres)

Crop Group	Existing	35	45	55	65	75
Vegetables	6,600	6,600	6,600	6,600	6,600	6,600
Deciduous Orchards	3,200	3,100	3,100	3,100	3,100	3,100
Processing Tomatoes	2,700	2,700	2,700	2,700	2,700	2,700
Vine	107,800	107,700	107,400	107,000	106,900	106,800
Alfalfa and Pasture	30,400	28,400	27,500	26,200	25,300	24,100
Corn and All Silage	13,500	13,500	13,500	13,500	13,500	13,500
Wheat and Field Crops	8,500	8,500	8,500	8,500	8,500	8,500
Almonds and Pistachios	0	0	0	0	0	0
Cotton	0	0	0	0	0	0
Rice	0	0	0	0	0	0
TOTAL	179,800	177,600	176,400	174,800	173,700	172,400

Source: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis.*

Table 7.4-28. Dry Year: Irrigated Crop Acreage in the San Francisco Bay Area Region (acres)

Crop Group	Existing	35	45	55	65	75
Vegetables	6,600	6,600	6,600	6,600	6,600	6,600
Deciduous Orchards	3,200	3,100	3,100	3,100	3,100	3,100
Processing Tomatoes	2,700	2,700	2,700	2,700	2,700	2,700
Vine	107,800	107,700	107,200	107,000	106,800	106,800
Alfalfa and Pasture	30,400	27,400	26,500	26,000	24,800	23,800
Corn and All Silage	13,500	13,500	13,500	13,500	13,500	13,500
Wheat and Field Crops	8,500	8,500	8,500	8,500	8,500	8,500
Almonds and Pistachios	0	0	0	0	0	0
Cotton	0	0	0	0	0	0
Rice	0	0	0	0	0	0
TOTAL	179,800	176,600	175,300	174,400	173,100	172,000

Source: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis.*

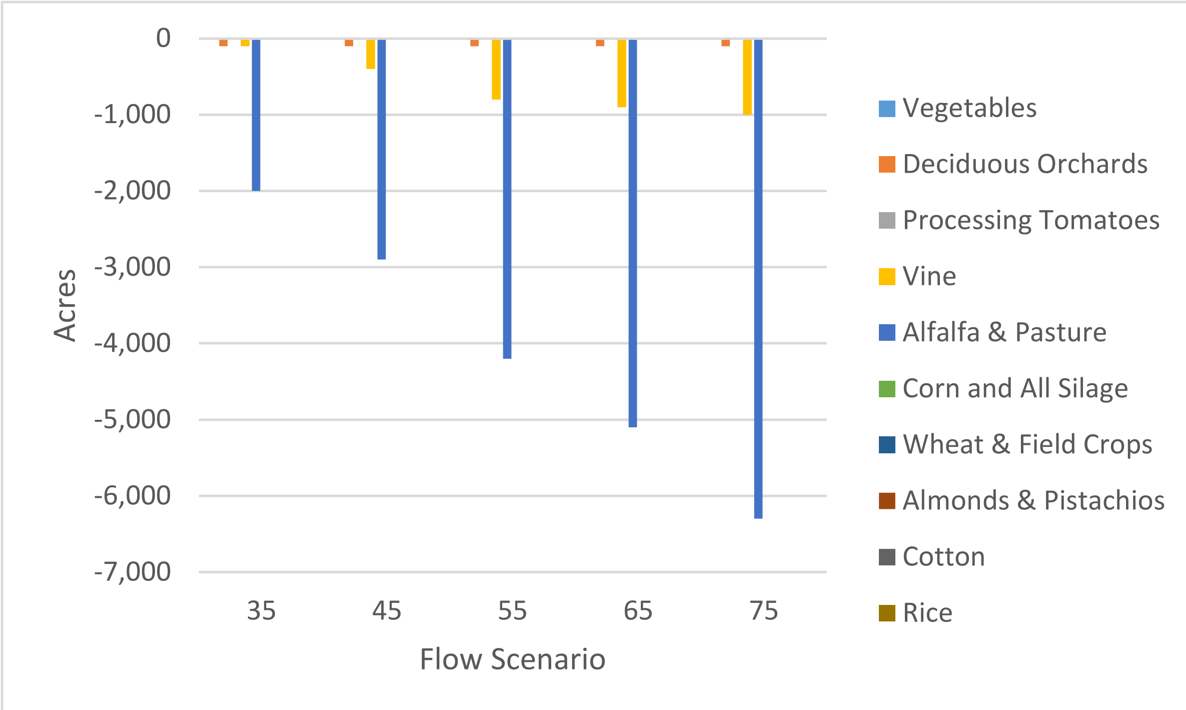


Figure 7.4-27. Average Year: Changes in Crop Acreage by Scenario, San Francisco Bay Area

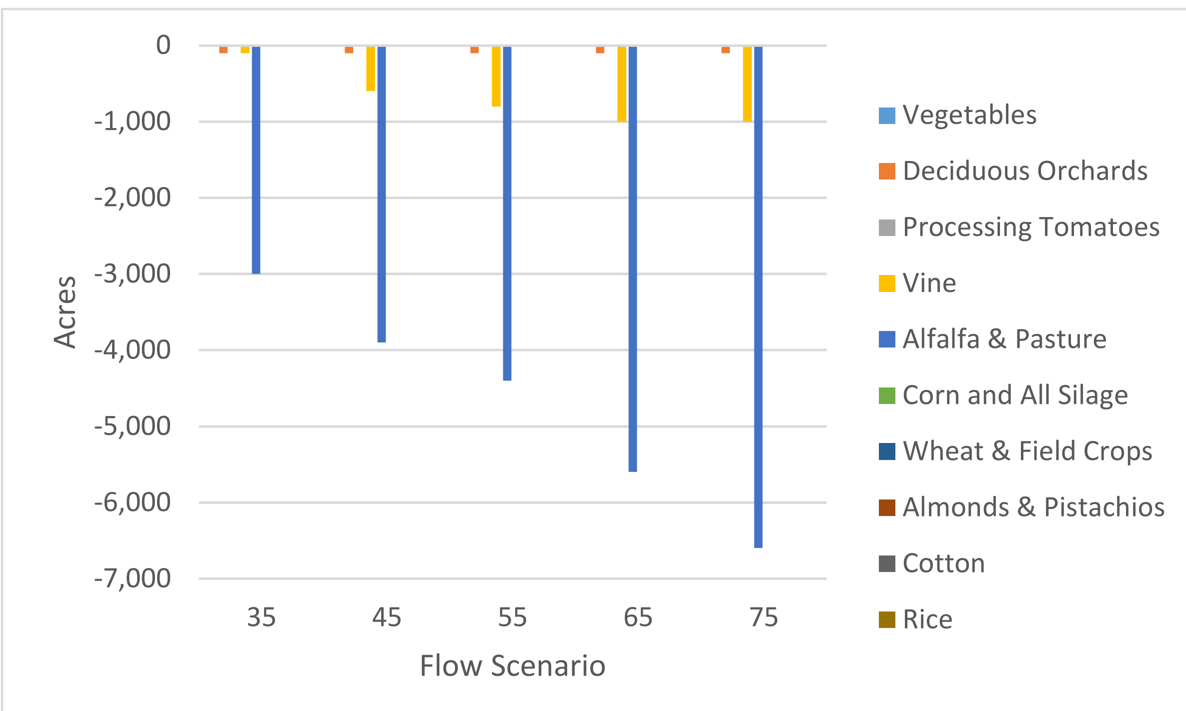


Figure 7.4-28. Dry Year: Changes in Crop Acreage by Scenario, San Francisco Bay Area

Zone 7 has been able to maintain significant amounts of stored water in local groundwater basins, out-of-region banking programs, surface reservoirs, and carryover storage within the SWP service areas. In 2014, the fourth consecutive drought year, Zone 7's available year-end storage totaled

173,700 AF (Zone 7 2015), well above its annual demand. Due to Zone 7's stored water management efforts, reductions in Sacramento/Delta supply would not immediately affect Zone 7's ability to provide water for agricultural use. However, much of this storage derives from surface water, so continued reductions of Sacramento/Delta supply over time may affect reserves and affect water available for agricultural use if water conservation efforts do not continue or improve, or if there is no development of other water supply sources. The high value of the crops grown in Zone 7 would create incentives for development of other water supply sources. However, the district's base supply derives from surface water, which would be reduced under the proposed Plan amendments. Reduced supply could lead to conversion of land to nonagricultural use.

Central Coast

Agricultural irrigation water in the Central Coast region is supplied by local and regional water districts and groundwater. Surface water for agriculture is largely from local sources but some Sacramento/Delta water is used.

In an agricultural production area near Gilroy and Hollister, the San Felipe Project of the CVP provides Sacramento/Delta supplemental irrigation water to agricultural producers, including Valley Water and San Benito County Water District. The CVP contracts for the San Felipe Division allow the supplied water to be used for municipal or agricultural use. The CVP water shortage policy applies to these contracts and specifies that municipal water use is to be prioritized during times of water shortage.

Sacramento/Delta water is provided to the southern portion of the Central Coast region through the Coastal Aqueduct of the SWP. Only a small percentage of the Sacramento/Delta water supplied through the Coastal Branch Aqueduct is used for agriculture. There are two Coastal Aqueduct SWP contractors: San Luis Obispo Flood Control and Water Conservation District and the Santa Barbara Flood Control and Water Conservation District. Within San Luis Obispo County, the majority of agricultural water supply is obtained from groundwater sources, and a small volume is supplied from local surface water sources (San Luis Obispo County Flood Control and Water Conservation District 2012). No SWP supplies are used for agricultural purposes within the county (Hutchinson pers. comm.). Santa Barbara County Flood Control and Water Conservation District relies upon a variety of water sources to meet municipal and agricultural water demands. The District has an SWP Table A allocation of 39 TAF, but local water supplies, including groundwater and the Cachuma Project, provide the majority of the municipal and irrigation water. (^County of Santa Barbara 2013)

As shown in Table 7.4-29, SacWAM estimated reductions in Sacramento/Delta supplies to this area's agriculture would be 7 TAF on average in the 55 scenario, with annual average range from 2 TAF/yr to 20 TAF/yr under the 45 to 65 scenario, respectively. These reductions in supply could lead to conversions of land to nonagricultural use.

Table 7.4-29. Change in Sacramento/Delta Supply to Central Coast Agriculture, Water Year Type Annual Change from Baseline (thousand acre-feet)

Water Year Type	Baseline	35	45	55	65	75
Critical	18	0	-3	-8	-13	-17
Dry	32	-1	-5	-13	-22	-27
Below normal	36	0	-3	-9	-20	-27
Above normal	37	-1	-1	-5	-19	-29

Water Year Type	Baseline	35	45	55	65	75
Wet	52	0	-1	-2	-23	-22
All	37	-1	-2	-7	-20	-24

Source: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis* and SacWAM results.

For modeling purposes, the resulting surface water supply available for agricultural irrigators in the Central Coast region under baseline and flow scenarios is shown in Table 7.4-30 for average year and dry year types.

Table 7.4-30. Surface Water Supply for Agriculture in the Central Coast Region, Average and Dry Water Year Types, Baseline and Scenarios (thousand acre-feet per year)

Water Year Type	Baseline	35	45	55	65	75
Average year	37	37	35	30	17	13
Dry year	26	26	22	15	8	3

Source: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis.*

The analysis of the effects of reduced Sacramento/Delta supply on crop acreage in the Central Coast is based on the CASRAA model detailed in Chapter 8, *Economic Analysis and Other Considerations*; the analysis is summarized in Table 7.4-31 and Table 7.4-32 and in Figures 7.4-29 and 7.4-30. The analysis considered changes in crop acreage due to reduced Sacramento/Delta supply delivered to both the San Felipe Division and affected areas of Santa Barbara County. Under the 55 scenario, approximately 6,500 acres (less than 1 percent) of an estimated 685,000 acres of irrigated land in the Central Coast region could be affected during average years, and 9,900 (slightly more than 1 percent) acres could be affected during dry years. This represents worst-case results because the analysis assumes that no replacement groundwater would be developed. Although crops grown in this region tend to generate higher profit per acre relative to the cost of purchased water, the usual sources of other water supplies for this region have been from other CVP and SWP contractors or water banks, all of which could experience reductions in Sacramento/Delta supply from implementation of the proposed Plan amendments. If growers in this region that use Sacramento/Delta supply are not able to obtain enough replacement water from these or other water sources, crop fallowing up to the amounts indicated in Table 7.4-31 and Table 7.4-32 could occur. Similar to the analysis in the SWAP modeled regions, it was assumed that fallowed lands would be converted to nonagricultural use.

Table 7.4-31. Average Year: Irrigated Crop Acreage in the Central Coast Region (acres)

Crop Group	Existing	35	45	55	65	75
Vegetables	418,200	417,900	417,200	415,200	410,000	408,400
Deciduous Orchards	28,600	28,600	28,500	28,300	27,900	27,800
Processing Tomatoes	3,800	3,700	3,500	2,900	1,100	600
Vine	109,000	108,800	108,200	106,600	102,400	101,000
Alfalfa and Pasture	36,600	36,600	36,600	36,600	36,600	36,600
Corn and All Silage	0	0	0	0	0	0
Wheat and Field Crops	27,300	27,300	27,300	27,300	27,300	27,300
Almonds and Pistachios	0	0	0	0	0	0
Cotton	0	0	0	0	0	0
Rice	0	0	0	0	0	0
TOTAL	685,100	684,600	682,900	678,600	666,900	663,300

Source: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis.*

Table 7.4-32. Dry Year: Irrigated Crop Acreage in the Central Coast Region (acres)

Crop Group	Existing	35	45	55	65	75
Vegetables	418,200	417,900	416,600	413,700	410,600	408,900
Deciduous Orchards	28,600	28,600	28,400	28,200	28,000	27,800
Processing Tomatoes	3,800	3,700	3,300	2,400	1,400	800
Vine	109,000	108,800	107,700	105,400	102,900	101,400
Alfalfa and Pasture	36,600	36,600	36,600	36,600	36,600	36,600
Corn and All Silage	0	0	0	0	0	0
Wheat and Field Crops	27,300	27,300	27,300	27,300	27,300	27,300
Almonds and Pistachios	0	0	0	0	0	0
Cotton	0	0	0	0	0	0
Rice	0	0	0	0	0	0
TOTAL	685,100	684,500	681,500	675,200	668,400	664,400

Source: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis.*

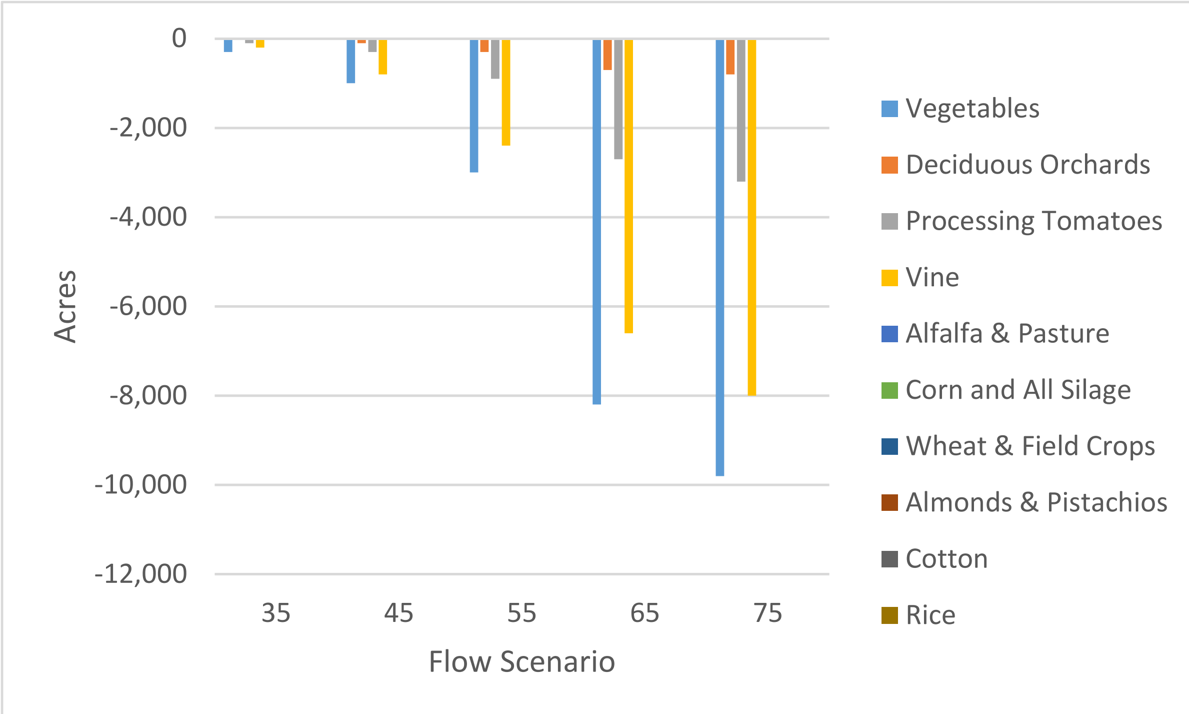


Figure 7.4-29. Average Year: Changes in Crop Acreage by Scenario, Central Coast

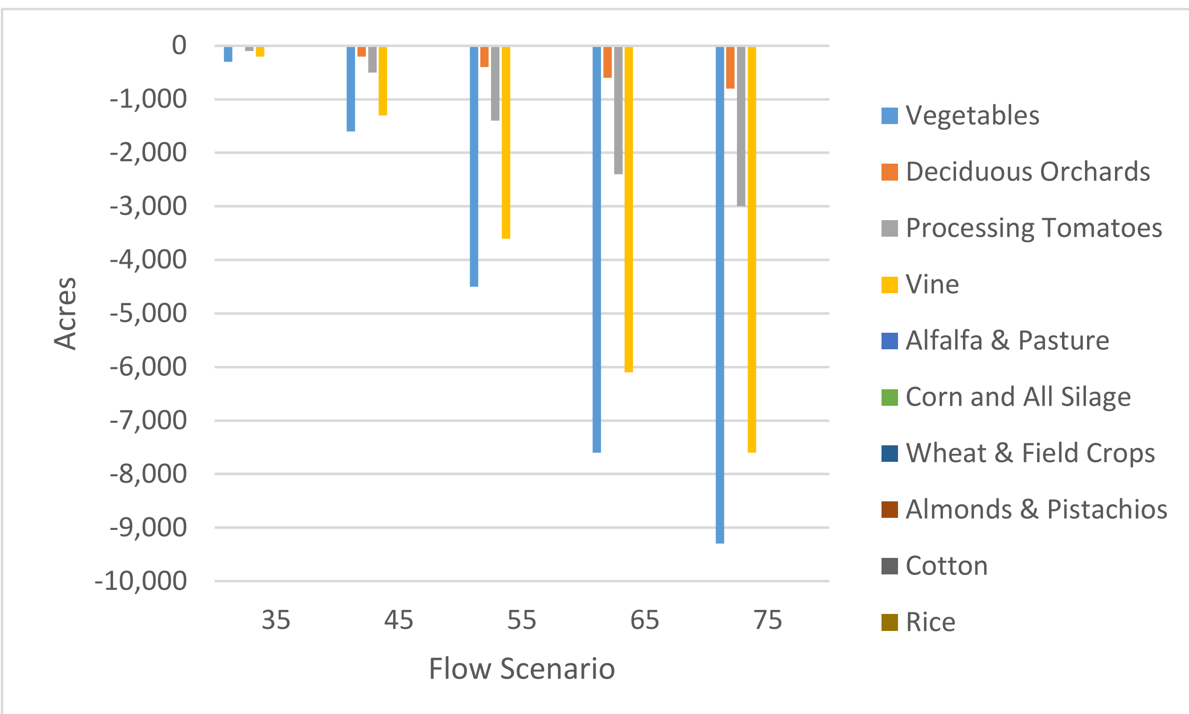


Figure 7.4-30. Dry Year: Changes in Crop Acreage by Scenario, Central Coast

Southern California

Water for agricultural irrigation in the Southern California region is supplied by local and regional water districts, the Colorado River, groundwater, and recycled water. Surface water for agriculture is nearly all from local sources and the Colorado River, but a small amount of Sacramento/Delta supply is used by agricultural producers. MWD, as a large wholesaler and SWP contractor, provides water from its portfolio of sources to 14 member cities and 12 member districts. Five of these member districts sell to agricultural customers.

Agricultural producers in Southern California that rely upon SWP water supplies grow higher revenue crops that are better able to withstand high water costs. In 2015, a critical water year, Sacramento/Delta supplies comprised 16 percent and Colorado River water comprised 34 percent of MWD's total water supply. During 2011, a wet year, Sacramento/Delta supplies comprised 35.7 percent and Colorado River water comprised 11.5 percent of MWD's total water supply. Member agencies also provide their own supplies, including local groundwater, local surface water, and Owens Valley water delivered through the Los Angeles Aqueduct. About 50 percent of the water supply in MWD's service area comes from resources controlled or operated by local agencies. SacWAM estimates that only 14 TAF/yr of Sacramento/Delta supplies go to agriculture in Southern California on average. Reductions from the proposed Plan amendments range from 2 TAF/yr to 6 TAF/yr on average in the 45 and 65 scenarios, respectively (Table 7.4-33).

Table 7.4-33. Sacramento/Delta Supply to Southern California Agricultural, Water Year Type Annual Change from Baseline (thousand acre-feet)

Water Year Type	Baseline	35	45	55	65	75
Critical	6	0	-1	-2	-3	-4
Dry	13	-2	-4	-6	-7	-9
Below normal	15	-1	-3	-6	-8	-10
Above normal	16	0	-1	-5	-8	-9
Wet	20	0	-1	-2	-4	-8
All	14	-1	-2	-4	-6	-8

Source: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis* and SacWAM results.

For modeling purposes, the resulting surface water supply available for agricultural irrigators in the Southern California region under baseline and flow scenarios is shown in Table 7.4-34 for average year and dry year types.

Table 7.4-34. Surface Water Supply for Agriculture in the Southern California Region, Average and Dry Water Year Types, Baseline and Scenarios (thousand acre-feet per year)

Water Year Type	Baseline	35	45	55	65	75
Average year	14	14	12	11	9	7
Dry year	10	9	7	6	5	3

Source: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis*.

The analysis of the effects of reduced Sacramento/Delta supply on crop acreage in this region is based on the CASRAA model detailed in Chapter 8, *Economic Analysis and Other Considerations,* and is summarized in Table 7.4-35 and Table 7.4-36, and Figures 7.4-31 and 7.4-32. The analysis assumes that MWD's member districts would share proportionally in any reduction in SWP deliveries to MWD. The member districts who supply water to agricultural producers rely on comingled supplies from local surface water sources, groundwater, imported water from the Imperial Valley and Colorado River, and imported Sacramento/Delta supplies through their contracts with MWD. Under the 55 scenario, of an estimated 991,400 acres of irrigated land in Southern California, approximately 1,200 (less than 0.2 percent) crop acres could be affected during average years, and 1,300 acres (less than 0.2 percent) could be affected during dry years. This represents worst-case results as the analysis assumes no replacement groundwater pumping. The analysis also does not account for the prevalent use of recycled water. Although crops grown in the affected portion of this region tend to be of higher value relative to the cost of purchased water, as discussed in Chapter 8, the usual sources of other water supplies for this region have been from other CVP and SWP contractors or water banks, all of which could experience reductions in Sacramento/Delta supply under the proposed Plan amendments. If growers in this region that use Sacramento/Delta supply are not able to obtain enough replacement water from these or other water sources, crop fallowing up to the amounts indicated could occur. Similar to the analysis in the SWAP-modeled regions, it was assumed that fallowed lands would be converted to nonagricultural use.

The analysis assumes that MWD would share reductions proportionally among its member districts, and that those member districts that serve agricultural customers would also share reductions proportionally among all its customers. However, MWD or its member districts could implement policies that could result in disproportionally greater impacts on agriculture than municipal customers. For example, MWD's Water Shortage Contingency Plan (MWD 2021) includes a drought management plan calling for reduced deliveries to agriculture under "severe shortage" conditions (MWD 2021). In MWD's plan, *severe shortage* conditions could result in supply reductions for participants in the Interim Agricultural Water Program. Other customers would face supply reductions only if water shortage conditions worsen. It is emphasized here that MWD's Water Shortage Contingency Plan is intended to address short-term shortages, rather than implementation of the proposed Plan amendments. MWD has not yet proposed policies or supply reduction plans in response to the proposed Plan amendments.

Table 7.4-35. Average Year: Irrigated Crop Acreage in the Southern California Region (acres)

Crop Group	Existing	35	45	55	65	75
Vegetables	216,700	216,700	216,700	216,700	216,700	216,700
Deciduous Orchards	107,200	107,000	106,500	106,000	105,400	104,600
Processing Tomatoes	0	0	0	0	0	0
Vine	11,600	11,600	11,600	11,600	11,600	11,600
Alfalfa and Pasture	423,000	423,000	423,000	423,000	423,000	423,000
Corn and All Silage	4,700	4,700	4,700	4,700	4,700	4,700
Wheat and Field Crops	157,900	157,900	157,900	157,900	157,900	157,900
Almonds and Pistachios	0	0	0	0	0	0
Cotton	14,100	14,100	14,100	14,100	14,100	14,100
Rice	0	0	0	0	0	0
TOTAL	991,400	991,200	990,700	990,200	989,600	988,800

Source: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis.*

Table 7.4-36. Dry Year: Irrigated Crop Acreage in the Southern California Region (acres)

Crop Group	Existing	35	45	55	65	75
Vegetables	216,700	216,700	216,700	216,700	216,700	216,700
Deciduous Orchards	107,200	106,900	106,400	105,900	105,500	105,000
Processing Tomatoes	0	0	0	0	0	0
Vine	11,600	11,600	11,600	11,600	11,600	11,600
Alfalfa and Pasture	423,000	423,000	423,000	423,000	423,000	423,000
Corn and All Silage	4,700	4,700	4,700	4,700	4,700	4,700
Wheat and Field Crops	157,900	157,900	157,900	157,900	157,900	157,900
Almonds and Pistachios	0	0	0	0	0	0
Cotton	14,100	14,100	14,100	14,100	14,100	14,100
Rice	0	0	0	0	0	0
TOTAL	991,400	991,100	990,600	990,100	989,700	989,200

Source: Appendix A1a, Attachment 1, *California Sub-Regional Agricultural Analysis.*

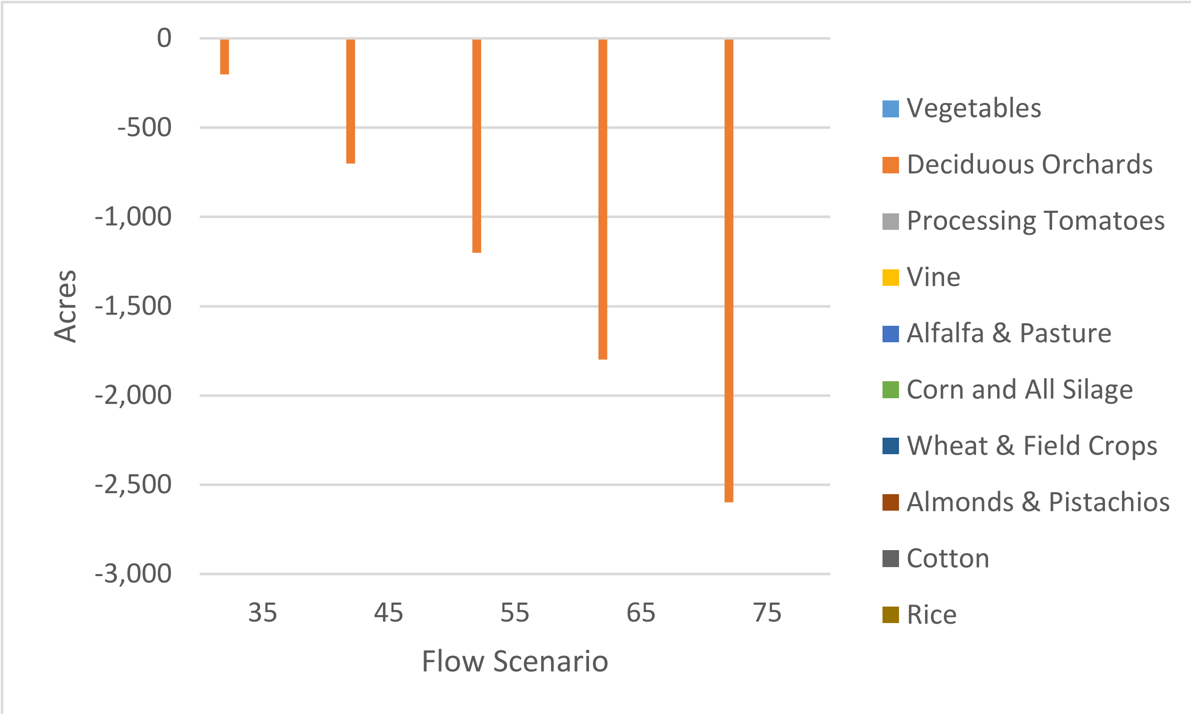


Figure 7.4-31. Average Year: Changes in Crop Acreage by Scenario, Southern California

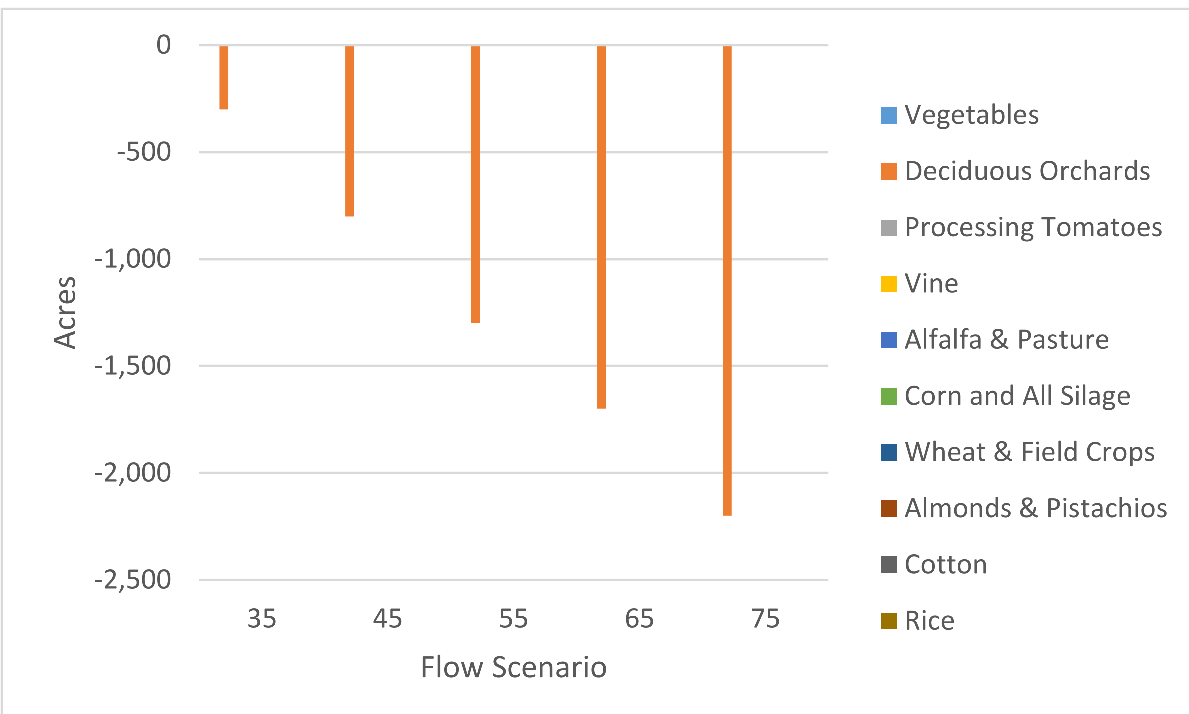


Figure 7.4-32. Dry Year: Changes in Crop Acreage by Scenario, Southern California

Water that is imported to Southern California is primarily provided to MWD, both the largest SWP contractor and a water wholesaler that provides Sacramento/Delta supply and Colorado River water to 26 member agencies in Southern California. Each member agency distributes water to customers (and sometimes other agencies) within its service area, generally at a high cost.

In 2015, about 97 percent of MWD's retail demands were used for municipal purposes, and just 3 percent for agricultural purposes. Since 1970, the relative share of agricultural water use has declined due to urbanization and market factors, including the price of water. Agricultural water use accounted for 19 percent of total regional water demand in 1970, 12 percent in 1980, 10 percent in 1990, and 3.5 percent in 2010 (MWD 2016).

While very little MWD water is used for agriculture, many among its agriculture-focused member agencies and water users have limited or no alternatives to MWD supply. Reductions in Sacramento/Delta supplies would lead to reduced MWD deliveries. In areas served by agencies without substantial alternatives, conversion of agricultural land could result, causing a potentially significant impact within these local areas.

For example, San Diego County Water Authority (SDCWA) serves 24 member agencies. SDCWA's imported water supplies consist of water purchases from MWD, water transfers associated with the 1988 IID/MWD agreement, water conserved from the All-American Canal and Coachella Canal lining projects, and water transfers pursued on an as-needed basis to offset reductions in supplies from MWD. SDCWA also provides desalinated water through the Lewis Carlsbad Desalination Project.

Agricultural water use within the SDCWA service area is concentrated mainly in northern San Diego County and includes member agencies such as the Rainbow Municipal Water District, Valley Center Municipal Water District, Ramona Municipal Water District, and Yuima Municipal Water District; the Fallbrook Public Utility District; and the City of Escondido (SDCWA 2016). For these member agencies, agricultural use is sometimes larger than municipal use, and use of local water supplies is minimal or nonexistent.

Another example is Valley Center Municipal Water District, where agriculture is the predominant water use. Valley Center does not use groundwater or other local supplies and relies almost entirely on imported water from SDCWA (San Diego County Farm Bureau 2016). Other SDCWA agencies supplement imported water with recycled water and groundwater, such as Ramona Municipal Water District and Yuima Municipal Water District.

Southern California agricultural water suppliers outside of the MWD service area generally use Sacramento/Delta water as a supplemental supply. For example, Mojave Water Agency in San Bernardino County provides essentially all of its supply from local groundwater basins, but also receives SWP water from the East Branch of the California Aqueduct to replenish those basins. (MWA 2016).

Reductions in Sacramento/Delta supply would reduce Mojave Water Agency's ability to recharge groundwater basins that are used for agricultural and municipal supply. Reduced groundwater replenishment could result in drawdown in those basins, less groundwater available for agriculture, and potential conversion of land to nonagricultural use. Existing regulations, such as basin adjudications and SGMA, would likely reduce that impact by requiring management and replenishment of the basins to prevent such drawdown.

Conclusion—San Francisco Bay Area, Central Coast, Southern California

In the Bay Area, Central Coast, and Southern California regions, agricultural water supply portfolios vary widely. Some suppliers would be little affected by Sacramento/Delta reductions because such water is a small part of their overall supply or they have alternative supplies that would experience little or no effect from the proposed Plan amendments, such as groundwater. However, the groundwater analyses in Section 7.12.2, *Groundwater*, show potential localized reductions in groundwater levels from substitute groundwater pumping. The analyses also show potential impacts on groundwater storage that depends in part on Sacramento/Delta surface water supplies. Lower groundwater levels could lead to less flexibility for water management because of an inability to get groundwater supply when or where it is needed. Moreover, conversion pressure may be higher for agricultural use near the urban areas of these regions. Notwithstanding other supplies potentially available to replace reduced Sacramento/Delta supplies, conversion of important farmland to nonagricultural use may occur in localized areas. This impact would be potentially significant.

A series of Intermediate decisions lie between imposition of the proposed Plan amendments unimpaired flow requirements and conversion of farmland to nonagricultural uses. Individual irrigation districts will make decisions about to how allocate the available surface water in accordance with established rules and regulations. Individual farmers will make cropping decisions, including the decision whether to fallow, idle, or permanently convert land. If a farmer decides to convert the land, others in the market may decide whether to buy it and how it is to be used. Local general plan and zoning patterns make it probable that a new, nonagricultural use would require discretionary decisions by local agencies, such as general plan amendments, rezoning, subdivisions, or conditional use permits. The State Water Board does not control any of these decisions and does not have the authority to place conditions on them to implement measures that would reduce or avoid the potentially significant impacts identified in the analysis.

Implementation of Mitigation Measures MM-AG-a,e: 1 through 6 could avoid or reduce the amount of agricultural conversion as a result of the proposed Plan amendments. Impacts on groundwater can be mitigated through implementation of sustainable groundwater management through SGMA and other management efforts, groundwater storage and recovery, and conjunctive use. These efforts are expected to help reduce impacts on groundwater supplies. However, unless and until the mitigation is fully implemented, the impacts remain potentially significant.

Other Water Management Actions

Water users often rely on a variety of water sources and management (water portfolios), including groundwater, water transfers, and recycled water (see the *Other Water Management Actions* subsection of Section 7.1, *Introduction, Project Description, and Approach to Environmental Analysis*). Significant decreases in water demand can be achieved through water conservation and water use efficiency efforts. Reducing reliance on the Delta is state policy, along with an associated mandate for improving regional self-reliance (Wat. Code, § 85021). In response to reduced Sacramento/Delta supplies attributable to the proposed Plan amendments, water users may further expand and modify their water portfolios by implementing groundwater storage and recovery; water transfers; water recycling; and water conservation. The use of other water management actions can reduce the magnitude of agriculture impacts associated with changes in surface water supply but could also result in environmental impacts that must be evaluated.

In many areas, groundwater storage and recovery strategies could offset the impacts of a reduced surface water supply or even increase the groundwater supply. By capturing local precipitation, stormwater, and flood flows and routing that water to locations suitable for recharging the local aquifers, natural processes can be augmented, and water can be efficiently stored and extracted through existing wells for local use.

Additional storage and recharge would be expected to have no impact on important farmland conversion. New injection recharge would use existing small wells (projects involving expansion or new construction are discussed in Section 7.22, *New or Modified Facilities*). Groundwater recharge through distribution of irrigation water on fields would involve adding available surface water to canals or otherwise putting water on agricultural lands during winter months when crops typically are not growing. This would not modify the lands' agricultural purpose. Fields used for row crops are typically well suited to recharge because the fields are bare during the recharge season. Perennial crops, such as fruits and nuts, could be damaged if groundwater recharge causes root rot in orchards. Farmers are likely to take care that such damage does not occur. If crops were damaged in this manner, fields would likely be returned to agricultural use and not be converted. Because no agricultural land conversion is anticipated, there would be no impact. Increased groundwater storage and recovery would, rather, benefit agriculture and limit conversion because the recharged groundwater could later be used in irrigation.

Water recycling has been used for agricultural irrigation at an increasing number of sites in increasing volume since 1910 (Pacific Institute 2014). According to results of the 2015 water recycling survey (SWRCB 2017), agriculture represents the greatest use of recycled water among recycled water uses at 31 percent (219 TAF/yr of a total of 714 TAF/yr). Other agriculture-related uses of recycled water include groundwater recharge (16 percent or 115 TAF/yr) and seawater intrusion barrier (8 percent or 54 TAF/yr). While recycled water is used in nearly every California county, use is concentrated in southern California, with approximately 60 percent of statewide recycled water used south of the Tehachapi Mountains (Pacific Institute 2014).

Use of recycled water is expanding, driven by drought and by efforts to develop a more reliable water supply (Pacific Institute 2014). Agriculture consumes the largest portion of California's recycled water, approximately 48 percent (DWR 2003). California's Recycled Water Task Force estimated potential ranges of recycled water use in California; the upper estimate indicates that, by 2030, use of recycled water in California could increase by as much as 1,670 TAF/yr over the 2002 level of approximately 580 TAF/yr, for a total recycled water usage of approximately 2,250 TAF/yr in 2030 (DWR 2003). These projections have thus far held true: recycled water use had increased at the projected rate by 2015 (SWRCB 2017).

In response to changes in water supply, agricultural water users may increase use of recycled water from existing wastewater treatment plants or use it as a source for groundwater recharge. If recycled water use continues to expand, more acres could remain in irrigation than otherwise. The increased use of recycled water would not result in conversion of important farmland to nonagricultural use, and there would be no impact.

Water transfers can cause impacts or provide benefits to agriculture, depending on the volume of water being transferred, the timing and duration of the transfer, and the changes in place and use of the water being transferred.

Potential changes to water transfers in response to reduced surface water supply would take place in the context of increasing value of water as regulation tightens the availability of surface water and groundwater supplies. As the value of water increases, surface water rights holders, including those that use water for agricultural purposes, are being presented with opportunities to transfer water at higher prices. Growers tend to be the primary source of water transfers, and the recipients of the water transfers are primarily municipal water holders, San Joaquin Valley growers, and environmental water, with municipal water users generally receiving the largest proportion of the transferred water (PPIC 2012) (see also Section 6.6.1.2, *Water Transfers*). The large volume of water transfers from agricultural use to municipal use and environmental water means that growers are facing a more expensive and competitive market to access surface water supplies through transfers.

Transfers can occur among agricultural water users, including from the Sacramento River watershed and Delta to San Joaquin Valley, but also among growers within the San Joaquin Valley; this often occurs between growers of lower revenue crops to higher revenue or permanent crops. These types of transfers can be mutually beneficial among willing sellers and buyers. Transfers can also take place from willing agricultural to municipal uses, including from agricultural water users in the Sacramento River watershed, Delta, and San Joaquin Valley. Municipal providers in the Bay Area, Central Coast, and Southern California regions are the most likely lessees or purchasers. If the transfer is permanent (a purchase), it can lead to the conversion of agricultural land to nonagricultural uses in the source locations.

Increased use of water transfers, both sales and leases, can lead to shifts in cropping patterns, and in some circumstances, to greater conversion of agricultural land to nonagricultural uses. This effect would be more likely under the higher end of the proposed flow requirements range (65 scenario) than under the lower end of the range (45 scenario), because diversions would be decreased more under the 65 scenario and thus increase demand for transfers. Depending on location, selling idled cropland for development (and thus conversion to nonagricultural uses) could become an attractive option for landowners whose cropland is not economically productive. For example, IID transfers water to MWD and SDCWA (IID 2019b). The transfers are intended to reduce California's overall dependence on Colorado River water while providing for reliable water supply to San Diego. Under the transfer agreements, water that is conserved in IID is made available for transfer to these two water agencies. IID has multiple conservation programs, including the All-American Canal Lining Project (IID 2019c). One of the features of the agreements is a fallowing program that was in place through 2017. In this program, water that otherwise would have been used to produce crops on the fallowed fields was considered conserved and was delivered to SDCWA. This fallowing represented increased economic pressure on agriculture. In addition, increased conservation, for example through the All-American Canal Lining Project, has potential to reduce groundwater recharge and result in reduced groundwater levels. Reduced groundwater levels also have potential to result in additional pressure on agriculture.

The magnitude of the effect of water transfers on source area agricultural land conversions is unknown, but some conversion would be likely. This impact would be potentially significant.

Impacts on agriculture related to water transfers could be reduced through implementation of Mitigation Measures MM-AG-a,e: 4 and 6. The California Water Code and the common law's "no injury" rule prevents transfers of water that would cause injury to other legal users of water. Legal users of water include those possessing riparian/overlying and perfected appropriative rights. The no injury rule generally does not consider impacts on third-party beneficiaries, such as effects on local agricultural economies. However, if a transfer involves wheeling water through a state or local water conveyance system, Water Code section 1810 prohibits the use of such facilities if the transfer would unreasonably affect the overall economy or the environment of the county from which the water is being transferred (Water Transfer Workgroup 2002). CEQA requires that a public agency consider the reasonably foreseeable direct and indirect environmental consequences of transfers when a public agency is involved in the transfer, such as in the case of a change order from the State Water Board.

Local land use agencies would require compensatory preservation of agricultural land to mitigate the impacts of projects that convert agricultural land. Many jurisdictions in the most affected areas are likely to do so, as protection of agriculture is an important policy goal. If they do so, Mitigation Measure MM-AG-a,e: 4 could reduce this impact to a less-than-significant level. However, those agencies, and not the State Water Board, would be responsible for implementing the measure. Transfers approved by the State Water Board and conveyed by facilities operated by DWR and/or Reclamation generally require environmental review and approval by different agencies that would be expected to analyze and address impacts on agriculture. While this process requires consideration of agricultural impacts, the process cannot ensure protection against agricultural impacts in all cases, and it is possible that transfers could occur outside of the permitting processes. Unless and until mitigation is implemented, impacts on agriculture from water transfers would remain potentially significant.

Implementation of agricultural water use efficiency measures is another strategy to reduce overall water demand. Conveyance facility improvements, including lining canals, can reduce the volume of water lost to evaporation, spills, and seepage. On a basin scale, the result would be more surface water available for agricultural use. However, an agricultural operation that relies on infiltration from a local irrigation canal to groundwater underlying it could potentially lose a source of groundwater recharge and thus a source of irrigation water. In response to changes in water supply, lower groundwater levels could lead to less irrigation supply for users who rely solely or in part on groundwater. Impacts on agriculture from lower groundwater levels would be potentially significant, and less recharge from agricultural conservation measures could contribute to lower groundwater levels.

Impacts on agriculture from lower groundwater levels could be reduced through implementation of Mitigation Measure MM-AG-a,e: 5, which incorporates groundwater mitigation measures to reduce lowering of groundwater levels. Unless and until the mitigation is fully implemented, impacts of reduced groundwater levels on agriculture remain potentially significant.

Changes in Hydrology

Stream and Reservoir Elevation at Diversions

Changes in flows associated with new instream flow and cold water habitat requirements could affect the ability of existing diversion points to access water in streams where the flow requirements apply. Although instream flows would generally be maintained or would increase compared with the baseline condition, it is possible that, at some times in some streams, water levels could be lowered to the extent that existing diversion structures would be affected and could not access water. This is particularly true on regulated tributaries during summer in drier years at the higher end of the proposed flow requirements (65 scenario) because flows on regulated streams are generally stored during winter and spring and released in summer and fall for water supply purposes. Under the baseline condition, flows can be higher during summer and fall than the flow levels that would be required under the proposed Plan amendments.

Higher flow requirements in winter and spring and higher reservoir carryover storage levels in drier conditions for cold water pool could result in less water available for release for water supply purposes in summer and fall. This shift could reduce water levels. This is especially true if water users in a watershed are not coordinating their diversions and many diverters begin diversion activities at the same time, as is common during heat spells, flood-up operations, or other conditions leading to increased water use. As a result, diverters would need to coordinate their diversions within streams to ensure that water is available for their collective diversions, as well as to ensure that those diversions comply with applicable narrative and numeric instream flow and cold water habitat requirements. In the absence of coordination among diverters, water levels could remain below diversion intakes, resulting in inadequate access to water supply for agriculture.

One location where coordination among water users may be needed is on the Sacramento River. To ensure that water supplies are available for Sacramento River diverters, Reclamation monitors flow conditions on the Sacramento River at Wilkins Slough and adjusts releases from Shasta Reservoir to ensure that adequate flows (approximately 4,000 cfs during the diversion season) are present on the Sacramento River to maintain diversions. During the 2012–2016 drought, flow releases from Shasta Reservoir into the Sacramento River were constrained to preserve cold water resources throughout the temperature control season, which affected flows at Wilkins Slough. To address this issue in part, Reclamation worked with Sacramento River diverters to coordinate the timing of their water diversions to avoid diversion spikes and associated significant dips in flows in the river. The need for such coordinated operations would likely increase.

In addition to coordination among diverters, some diversion points may require physical modifications to maintain diversions where flows may be reduced during low-flow, high-demand periods. Specifically, diverters may need to extend diversion works into the channel, change from gravity diversion works to powered diversion works, or make other types of modifications, or cease diversions at times. Until new diversion works are operable, water access could be reduced, and some agricultural areas may receive less water. In such areas, some agricultural areas may be converted to nonagricultural uses until new intakes are developed.

In addition, reservoir elevation changes could affect diversions in areas that receive Sacramento/Delta supplies, such as San Luis Reservoir. There, diversions to the San Felipe Unit become constrained when the total reservoir storage drops below 369 TAF (Reclamation 2019c). Under the proposed Plan amendments, storage levels would drop below this threshold more frequently. Higher frequencies of lower reservoir elevations may result in additional suspended solids in irrigation water, which could add to the maintenance needs for irrigation systems. This could be burdensome but would be unlikely to lead to the conversion of important farmland to nonagricultural use. If the elevation of San Luis Reservoir were to frequently drop below the intake, modifications would be required to ensure a consistent supply to users. Impacts associated with construction projects are evaluated in Section 7.22, *New or Modified Facilities*.

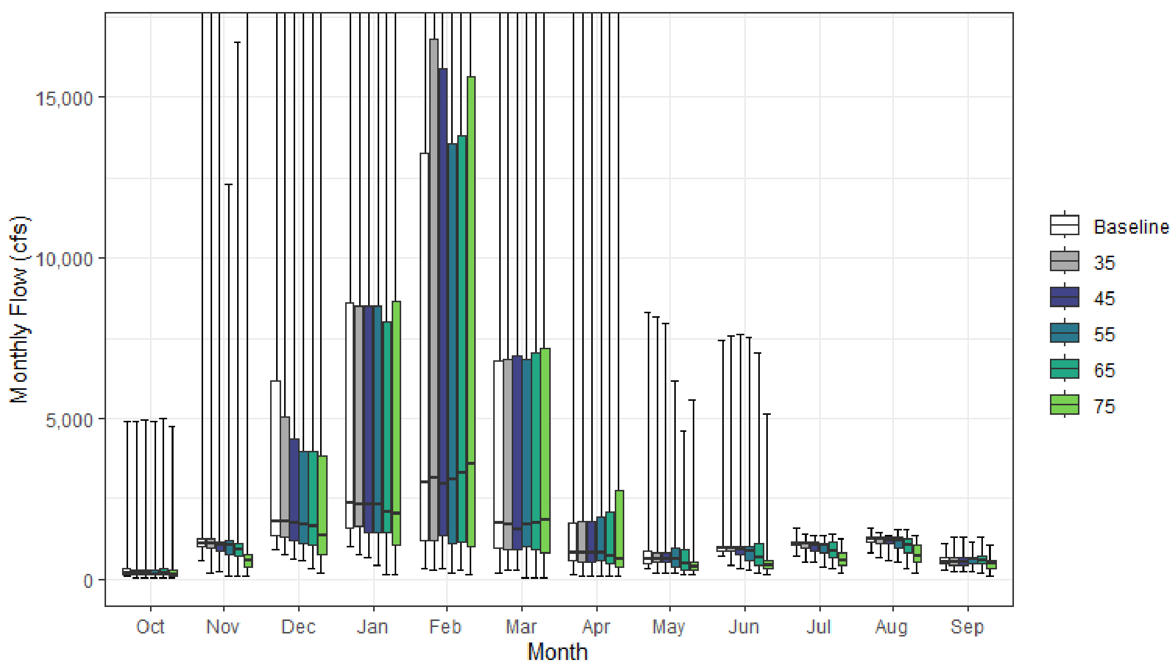
In the absence of coordination among diverters and, potentially, modifications to diversion intakes at some locations, reduced water volumes in streams during the irrigation season could bring water levels below intakes, limiting diversions and potentially leading to farmland conversion. This impact would be potentially significant. Mitigation Measure MM-AG-a,e: 7 identifies actions to help ensure the effectiveness of diversion intakes, including monitoring and coordination activities among water users and modifying intakes. Private individuals and irrigation districts are strongly encouraged to implement these actions. The proposed Plan amendments do not include any State Water Board action that would require them to do so. Unless and until these mitigation measures are implemented, the impact would remain potentially significant.

Sutter and Yolo Bypasses

The Sutter and Yolo Bypasses of the Sacramento Valley contain agricultural lands, including important farmland (Figure 7.4-3a). Typically, floods occur in winter months that do not affect planting or growing of rice or other crops. When floods in the bypasses occur in later spring, it can delay planting and cause a reduction in agricultural productivity.

As described in a report sponsored by Yolo County, after flow over Fremont Weir stops, there is a lag of 6 to 8 weeks before planting can occur due to time required for field drainage and preparation (Howitt et al. 2013). When inflow to the Yolo Bypass stops before early April, the effect on agriculture is much smaller than when inflow stops after early April (Howitt et al. 2013). It is likely that agriculture in the Sutter Bypass is similarly affected. Changes in bypass flow from April through June were evaluated to assess the effect of bypass inundation on agriculture.

Changes in streamflows due to the proposed Plan amendments are not expected to result in large changes in the frequency or extent of inundation in the Sutter Bypass that would affect agriculture. SacWAM results show small changes in the distribution of flows through the Sutter Bypass during April and later months in association with the proposed Plan amendments (Figure 7.4-33). The most notable change is an increase of about 1,000 cfs in the higher end of flows (75th percentile values) under the 65 scenario in April. Although increases in April flows would not be large, they could result in some farmland conversion to nonagricultural uses.



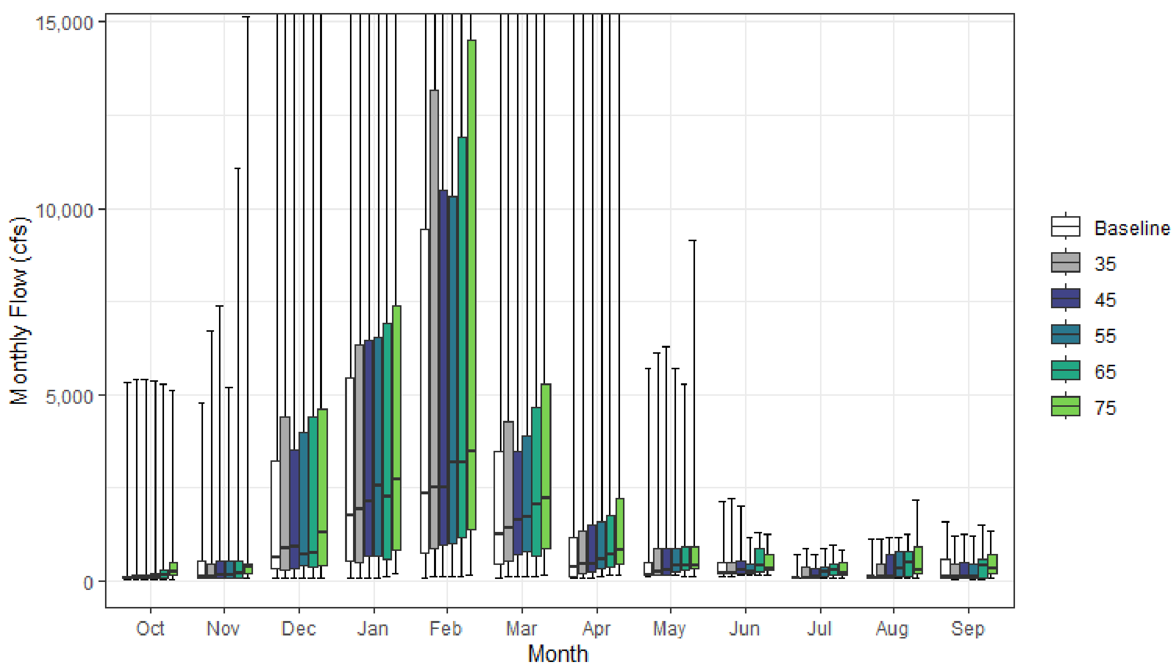
Source: Based on SacWAM results.
cfs = cubic feet per second
The black lines represent the median, the box represents the 25th through 75th percentiles, and the whiskers represent the extreme values.

Figure 7.4-33. Bypass at Sacramento Slough, Changes in Flows across the Scenarios for Sutter Bypass

Changes in streamflows on the lower Sacramento River, Cache Creek, and Putah Creek would likely cause an increase in inundation in the Yolo Bypass, which could affect agriculture. As described in Chapter 6, *Changes in Hydrology and Water Supply*, there would be small changes in average monthly flows at Fremont Weir (where the Sacramento River flows into the Yolo Bypass at times of high flow) but larger changes, mainly in winter months, would occur farther downstream in the Yolo Bypass. Increased flows over the Fremont Weir, in Cache Creek, over the Sacramento Weir, and in Putah Creek would all compound to increase the flows and inundated acreage in the lower half of the Yolo Bypass below Putah Creek (the farthest downstream of these contributors).

There would be small increases in flow under the proposed Plan amendments in April through June. The most frequent, large increases would occur in December through March (before the planting season), especially at the higher end of the proposed flow requirements (Figure 7.4-34).

Although agricultural land in the Yolo Bypass is already subject to inundation in many years under existing conditions (Figure 7.4-34), increased inundation could take some land out of agricultural production if it caused more interference with agricultural activities than current inundation patterns. Analysis of the 55 to 65 scenarios suggests that median flows in the Yolo Bypass downstream of Putah Creek may increase by about 239 and 365 cfs in April, respectively. Most, but not all, of these increases are likely to be constrained within the Tule Canal/Toe Drain.



Source: Based on SacWAM results.
cfs = cubic feet per second
The black lines represent the median, the box represents the 25th through 75th percentiles, and the whiskers represent the extreme values.

Figure 7.4-34. Changes in Flows Across the Scenarios for Yolo Bypass below Putah Creek Inflow

The proposed Plan amendments could result in increased inundation of the Sutter and Yolo Bypasses during the planting season, prompting some farmers in the area to convert land to nonagricultural uses. Because land in the bypasses is restricted by easements that preclude landowners from building structures that would significantly obstruct floodflows, any potential conversion likely would be to natural habitat and not development. Although affected acreage would likely be small, this impact could be potentially significant.

Implementation of Mitigation Measures MM-AG-a,e: 4 and 8 could reduce or avoid disruptions to agricultural operations and associated potential land use conversions from increased inundation in the Sutter and Yolo Bypasses as a result of the proposed Plan amendments. Another measure is to communicate and collaborate with farmers to maintain the economic feasibility of continued use of land for agricultural purposes in the bypasses. An interagency coordination group such as the Yolo Bypass and Cache Slough Partnership could serve as a forum for expanding existing efforts and developing additional planning and implementation measures to reduce the impacts on agricultural operations associated with increased floodplain inundation during the planting season. These measures could be implemented in conjunction with planned habitat restoration and other efforts, which could promote multiple beneficial uses within the Yolo Bypass. However, the State Water Board cannot guarantee such implementation. Unless and until mitigation is implemented, the impact would remain potentially significant.

Impact AG-b: Conflict with existing zoning for agricultural use or conflict with a Williamson Act contract

Lands under Williamson Act and Farmland Security Zone contracts are restricted to compatible open space or agricultural uses, generally for rolling 10-year or 20-year terms.

The proposed Plan amendments would not alter Williamson Act and Farmland Security Zone contract restrictions. Therefore, any change in hydrology or water supply under the proposed Plan amendments would not conflict with Williamson Act provisions because the existing agricultural lands can and must be maintained in compatible open space and agricultural uses, which can include non-irrigated agricultural uses.

The Williamson Act holds that a reduction in the economic character of existing agricultural land is not a sufficient reason for cancellation of a contract. There is enough annual crop acreage for rotation if plantings of annual crops are rotated in years with reduced irrigation supply such that all lands would be irrigated on a staggered schedule or dryland farmed or fallowed in other years. For example, in the Sacramento River watershed, there would be sufficient irrigation water supply to irrigate 85 percent of the annual cropped acreage under the most conservative SWAP model scenario, which would be a dry year with no replacement groundwater pumping. The water supply used to irrigate this amount of land (85 percent of annual acreage) could be rotated such that annual cropped land is non-irrigated in 1 out of 7 years. Lands that are not irrigated can be dryland farmed for crops such as grain (Luebs 1970). In addition, there is potential for alfalfa and pasture to survive without receiving their full water requirements during an irrigation season (i.e., deficit irrigation), even though they are permanent-type crops (^Orloff et al. 2015a, 2015b). These practices are all considered agricultural uses even though the economic character of the land may change. Further, under the Williamson Act, open space is an allowable use, so the land does not have to remain in agricultural use to be consistent with requirements of the Williamson Act and contracts under the act.

While cities or counties may designate boundaries for agricultural preserves, create farmland security zones, enter into conservation easements, or enter into Williamson Act contracts, they do not have the authority to require landowners to participate in such measures. However, once a landowner has entered into a Williamson Act contract, he or she must abide by the contract provisions until he or she chooses to non-renew, cancel, or otherwise withdraw. Cities and counties administering agricultural preserves may enforce existing Williamson Act contracts, but it is speculative and unknown to what extent, if any, contracts covering such lands would be subject to nonrenewal, cancellation, or enforcement. Importantly, there are serious financial disincentives to landowners for each of those outcomes: nonrenewal carries with it significant tax disadvantages; cancellation is at the option of the city or county administering the preserve and can include cancellation fees; and, enforcement can result in financial penalties. Therefore, the proposed Plan amendments would not conflict with the existing Williamson Act, and there would be no impact.

The proposed Plan amendments would not conflict with existing zoning for agricultural use. Only cities and counties enact zone change. The proposed Plan amendments would not change zoning and would not require a discretionary action that conflicts with a land zoned for agriculture. It could result in reduced irrigation available to designated important farmland as described under Impact AG-a and Impact AG-e; however, if the lands do not receive irrigation, they could be dryland farmed, rotated, deficit irrigated, or fallowed, all of which would be consistent with agricultural zoning. Therefore, a conflict would not occur as a result of the proposed Plan amendments, and agricultural land would continue to maintain existing zoning. There would be no impact.

7.4.4 Mitigation Measures

Mitigation Measure MM-AG-a,e: Mitigate impacts related to the conversion of Prime and Unique Farmland and Farmland of Statewide Importance (important farmland) to nonagricultural use

1. **Voluntary Implementation Plans:** The State Water Board's proposed program of implementation for the Bay-Delta Plan promotes voluntary implementation plans that could amplify the ecological benefit of new and existing flows with physical habitat restoration and other complementary ecosystem measures that may also reduce the volume of water that needs to be dedicated for instream purposes, resulting in less water supply reductions for agriculture. Water users are encouraged to work together to tailor approaches to meet the proposed Plan amendments in a manner that minimizes disruptions to consumptive uses to the extent possible.

2. **Diversify Water Portfolios:** Water users can and should diversify their water supply portfolios to the extent possible, in an environmentally responsible manner and in accordance with the law. This includes sustainable conjunctive use of groundwater and surface water, water recycling, water conservation and efficiency upgrades, and water transfers.

   i. **Groundwater Storage and Recovery:** The State Water Board will continue efforts to encourage and promote environmentally sound recharge projects that use surplus surface water, including prioritizing the processing of temporary and long-term water right permits for projects that enhance the ability of a local or state agency to capture high runoff events for local storage or recharge.

   ii. **Water Recycling:** The State Water Board will continue efforts to encourage and promote water recycling projects, including projects that involve use of recycled water for groundwater recharge, through expediting permit processes and funding efforts.

iii. **Water Conservation:** Water conservation reduces runoff of wastewater, which, in turn, reduces the overall amount of irrigation water needed because the water applied to the crops would have fewer losses to deep percolation and surface runoff. The conserved water would then be available for application to additional acreage, thus reducing the likelihood of conversion to nonagricultural use.

- Pursuant to Water Code section 10826 et seq., agricultural suppliers that provide water to 10,000 acres or more are required to develop and implement AWMPs that describe agricultural efficient water management practices that should result in reduced water supply demands. Efficient water management practices include, but are not limited to, improvements to on-farm irrigation systems and water supplier delivery systems, such as installation of integrated supervisory control and data acquisition (SCADA) systems and canal automation; increased use of pressurized, drip, or micro-spray irrigation methods; and lining canals.
- Grant programs, such as the Agricultural Water Use Efficiency Program and State Water Efficiency and Enhancement Program (^DWR 2018; ^CDFA 2018) could help to provide for the enhancement of agricultural water use efficiency and water conservation efforts that should reduce water supply demands. These programs provide grants for on-farm improvements to address: (1) agricultural water use efficiency, conservation, and reduced demands; (2) greenhouse gas emission reductions; (3) groundwater protection; and (4) sustainability of agricultural operations and food production. Where appropriate in funding water conservation-related activities, including for agriculture, the State Water Board will consider, and other agencies should consider, measures that would dedicate a portion of the conserved water to instream flows.

3. **Increase Efficiency of Agricultural Water Use:**

i. **State Jurisdiction:** The State Water Board will continue to pursue various efforts that increase water use efficiency and conservation to maximize the beneficial use of Sacramento/Delta supplies. The following water efficiency measures will reduce agricultural impacts from reduced water supplies.

- All agricultural water users have an obligation to maximize water efficiency and utilize conservation to the extent possible in conformance with the prohibition against waste and unreasonable use in the California Constitution. As directed by the Governor's Executive Order B-40-17 (April 7, 2017), the State Water Board is currently conducting a rulemaking process to prohibit wasteful water use practices. The State Water Board may implement the prohibition on waste and unreasonable use in exercising its discretionary authorities in its water right and water quality decision-making processes.
- The State Water Board, DWR, Public Utilities Commission, Department of Food and Agriculture, and the Energy Commission will continue to implement their April 2017 response plan to the Governor's Executive Orders B-37-16 (May 9, 2016) and B-40-17 (April 7, 2017). The response plan includes actions and an implementation timeline to (1) use water more wisely; (2) eliminate water waste; (3) strengthen local drought resistance; and (4) improve agricultural water use efficiency and drought planning.

- As appropriate, the State Water Board will include provisions for water use efficiency and conservation when providing funding for water supply–related projects.

ii. **Local Jurisdiction:** Local water suppliers, regional groundwater management agencies, and irrigation districts can and should reduce potential conversion of agricultural land due to reduced surface water availability by requiring existing agricultural practices to be modified to increase irrigation efficiency in conformance with state law (see 3.i). Increasing irrigation efficiency could be accomplished with the following methods.

- Increase the use of irrigation management services, including audits of efficiency and soil surveys, to better determine how much water is needed by a crop in the present soil type and when to apply it.
- Convert less efficient irrigation systems (e.g., surface irrigation) to more efficient ones (e.g., drip or micro-irrigation) or combine the use of different systems at different plant lifecycle stages. Manage systems appropriately to realize efficiency gains.
- Increase the capability of irrigation water suppliers to provide delivery flexibility, such as the use of irrigation district regulating reservoirs, to allow flexible delivery durations, scheduling, and flow rates to better match each individual farm's needs.

4. **Impose Conditions on Land Use Changes or Other Discretionary Approvals:** Agencies that grant use approvals that would convert agricultural land to nonagricultural uses can and should impose conditions on such approvals to provide the permanent protection of an area of farmland equal to the converted area. Such conditions could include the following.

i. The grant or purchase of a conservation easement protecting farmland that is not protected at the time of approval.

ii. The payment of in-lieu fees sufficient to purchase an easement or land, into a fund committed to such purchases.

5. **Reduce Impacts on Groundwater:** Implementation of Mitigation Measure MM-GW-b will reduce potential impacts of lowered groundwater levels on agriculture.

6. **Oversight and Approval of Water Transfers**:

i. When processing petitions for transfers, the State Water Board will ensure, to the extent possible, that the transfer would not result in conversion of farmland to nonagricultural uses.

ii. When processing transfers, DWR, Reclamation, and other agencies involved in approving transfers should require transferors to show that the transfer would not result in conversion of farmland to nonagricultural uses.

7. **Ensure Effectiveness of Diversion Intakes:** Entities can ensure that river and stream elevations are sufficient for diversion at intake structures by taking one or more of the following actions.

i. Monitor flow conditions on relevant rivers and streams.

ii. Adjust water releases from reservoirs to ensure that adequate flows are present on the watercourse to maintain diversions.

iii. Coordinate the timing of diversions to avoid diversion spikes and associated significant dips in flows in the river.

iv. Modify intake structures when necessary.

8. **Minimize Disruptions to Agriculture in the Sutter and Yolo Bypasses from Increased Floodplain Inundation:** Federal, state, and local agencies, landowners, and water users should continue and expand collaborative efforts to achieve flood protection, agricultural sustainability, ecosystem protection, and other benefits in the Sutter and Yolo Bypasses. To reduce or avoid disruptions to agricultural operations and associated land use conversions associated with floodplain inundation, these entities should continue and expand efforts related to monitoring, planning, and implementing projects in the Sutter and Yolo Bypasses. These efforts should include the following.

   i. Monitoring flow conditions and collaborating on other planning efforts to predict floodplain inundation to inform crop planting and other land management decisions in advance.

   ii. Coordinating restoration projects and other implementation activities to maximize fish and wildlife beneficial uses while minimizing disruptions to agricultural operations associated with floodplain inundation to the extent feasible.

7.4.5 References Cited

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7.4.5.3 Personal Communications

Hutchinson, Mark. Public Works Director. San Luis Obispo County. February 1, 2018—Phone conversation with Harry Seely, Director, WestWater Research LLC, Brush Prairie, WA.