Chapter 11
Agricultural Resources

11.1 Introduction

This chapter describes the environmental setting for agricultural resources and the regulatory background associated with these resources. It also evaluates environmental impacts on agricultural resources that could result from the Lower San Joaquin River (LSJR) alternatives and, if applicable, offers mitigation measures that would reduce significant impacts.

LSJR Alternatives 2, 3, and 4 require sufficient flows for the reasonable protection of fish and wildlife beneficial uses. This chapter analyzes those alternatives and assumes that any increases in unimpaired flows[1] would reduce surface water supplies that are available for irrigation purposes. For Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, the analysis then assumes that reduced surface water supplies could potentially lead to reductions in crop acreages, and, where applicable, equates those changes to possible conversions of those lands to nonagricultural uses. It should be noted that this likely presents a more conservative (i.e., "worst case") estimate of potential acreage reduction than may actually occur. 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. Moreover, the management decisions of individual agricultural producers (farmers) are more sophisticated and driven by more variables than can be accounted for in modeling. For example, land with less irrigation could still remain in agricultural production due to one or more factors, including: efficiency improvements that reduce water demand, crop type or agricultural use changes to less water-intensive applications, dry land farming, or, increased crop rotation among plots of acreage. However, these actions are too speculative to be modeled as they are within the control of the individual farmer, not the State Water Resources Control Board (State Water Board).

This chapter includes assumptions based on past levels of groundwater pumping. Potential impacts on the groundwater subbasins, as a resource, resulting from the LSJR alternatives are addressed in Chapter 9, *Groundwater Resources*. Potential groundwater impacts related to municipal and domestic needs are addressed in Chapter 13, *Service Providers*, and Chapter 22, *Evaluation of Groundwater and Drinking Water Supply of Municipal and Domestic Needs*. Those chapters also reference the recently-passed Sustainable Groundwater Management Act (SGMA), which requires that groundwater basins be locally-managed to ensure reliable levels of groundwater supplies and to prevent continued chronic overdrafting of groundwater basins and other undesirable results.

The LSJR area of potential effects for agricultural resources includes Merced, Stanislaus, and part of San Joaquin Counties. Figure 11-1 identifies the location and type of farmland within the LSJR area

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[1] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

of potential effects. The area of potential effects is based on California Department of Water Resources (DWR) Detailed Analysis Units (DAUs) used in the Statewide Agricultural Production (SWAP) model[2] and is comprised of six geographic areas. These six geographic areas include Stockton East Water District/Central San Joaquin Water Conservation District (SEWD/CSJWCD), South San Joaquin Irrigation District (SSJID), Oakdale Irrigation District (OID), Modesto Irrigation District (MID), Turlock Irrigation District (TID), and Merced Irrigation District (Merced ID).

As described in Chapter 1, *Introduction*, the extended plan area generally includes the area upstream of the rim dams.[3] Unless otherwise noted, all discussion in this chapter refers to the plan area. Where appropriate, the extended plan area is specifically identified.

The SWAP model is a regional economic model for irrigated agricultural production that simulates the decisions of farmers in California. The model assumes that farmers maximize profit subject to resource, technical, and market constraints and that farmers sell and buy in competitive markets in which no one farmer can affect or control the price of any commodity. The SWAP model incorporates project water supplies (State Water Project [SWP] and Central Valley Project [CVP]), other local water supplies, and groundwater in its analysis. SWAP is the best available model for estimating the regional agricultural response to a change in water availability in the LSJR area of potential effects.

However, it should be noted that the SWAP model has limitations. The SWAP model uses a simplified assumption that water use will shift from lower net revenue crops to high-value crops. This means that under the modeling scenarios, irrigation shifts almost completely from Alfalfa and Pasture to higher net revenue crop types. As noted previously, this likely presents a more conservative estimate than may actually occur. The model also calculates the value of the Alfalfa or Pasture as a commodity and cannot factor in its proximity to an affiliated agricultural enterprise such as dairy or beef cattle, which could increase the crop value to an individual producer because of the reduced transportation costs or other factors.

Southern Delta water quality (SDWQ) alternatives are also analyzed throughout this chapter. However, no reduction or conversion of agricultural acreage under the SDWQ alternatives is likely for several reasons. The principle factor influencing water quality in the southern Delta is the salinity level of water coming from the San Joaquin River (SJR) Watershed. However, the program of implementation requires the U.S. Bureau of Reclamation (USBR) to meet and maintain the same salinity requirements that are currently measured at Vernalis on the SJR. Therefore, water quality within the southern Delta is expected to remain unchanged. In addition, as explained in this chapter and Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta,* under SDWQ Alternatives 2 and 3, even salt-sensitive crops would not be considered significantly impacted. The SDWQ area of potential effects is comprised of agricultural resources in the southern Delta, which are primarily within the boundaries of the Southern Delta Water Agency (SDWA). Figure 11-2 shows the location of the SDWQ area of potential effects and the SDWA boundary with respect to San Joaquin County and the legal boundary of the Delta.

[2] The LSJR alternatives area of potential effects includes: DAUs 182, 205, 206, 208, and 210.

[3] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

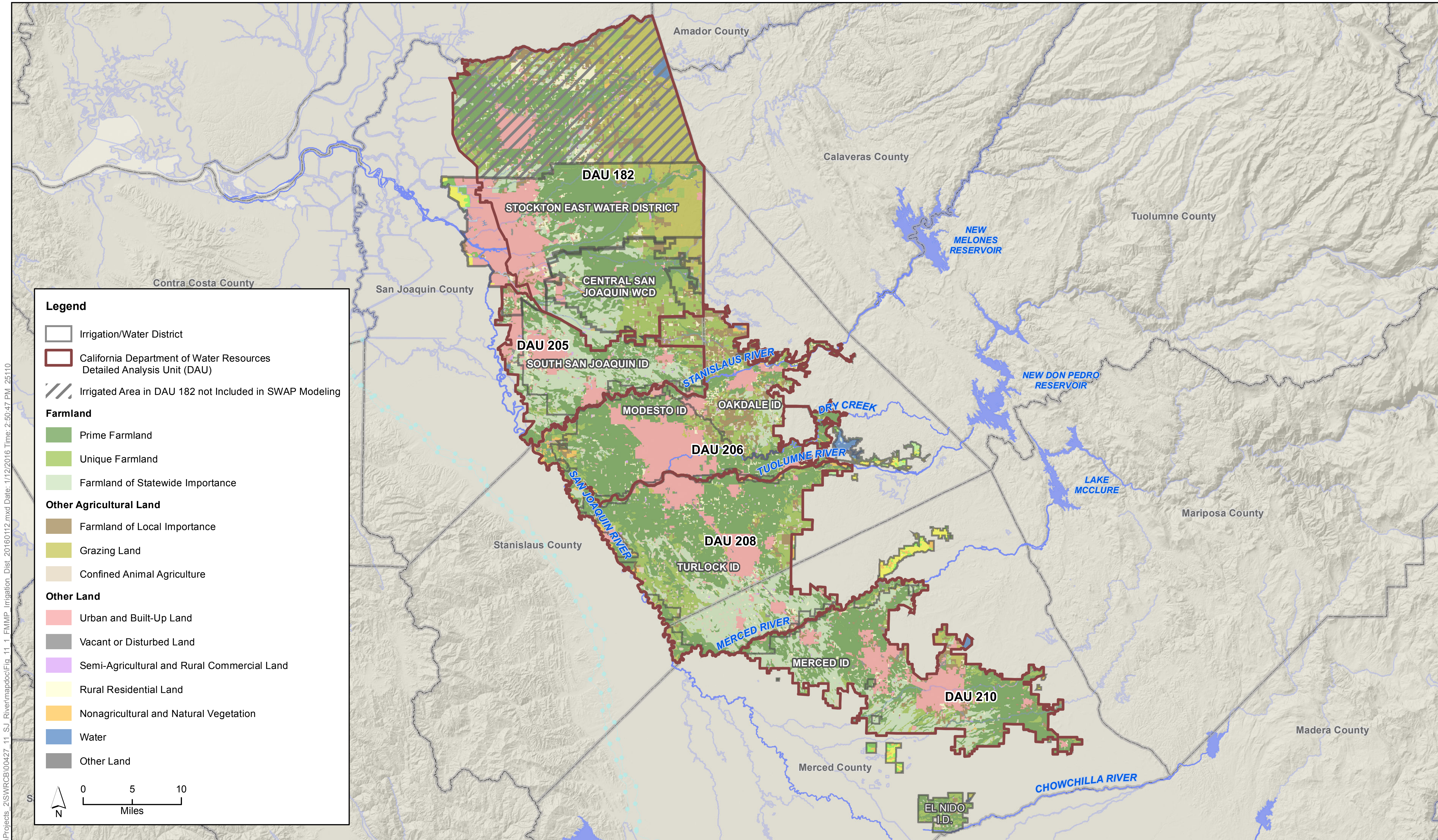

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Figure 11-1
Farmland Mapping and Monitoring Program Designations within the LSJR Area of Potential Effects

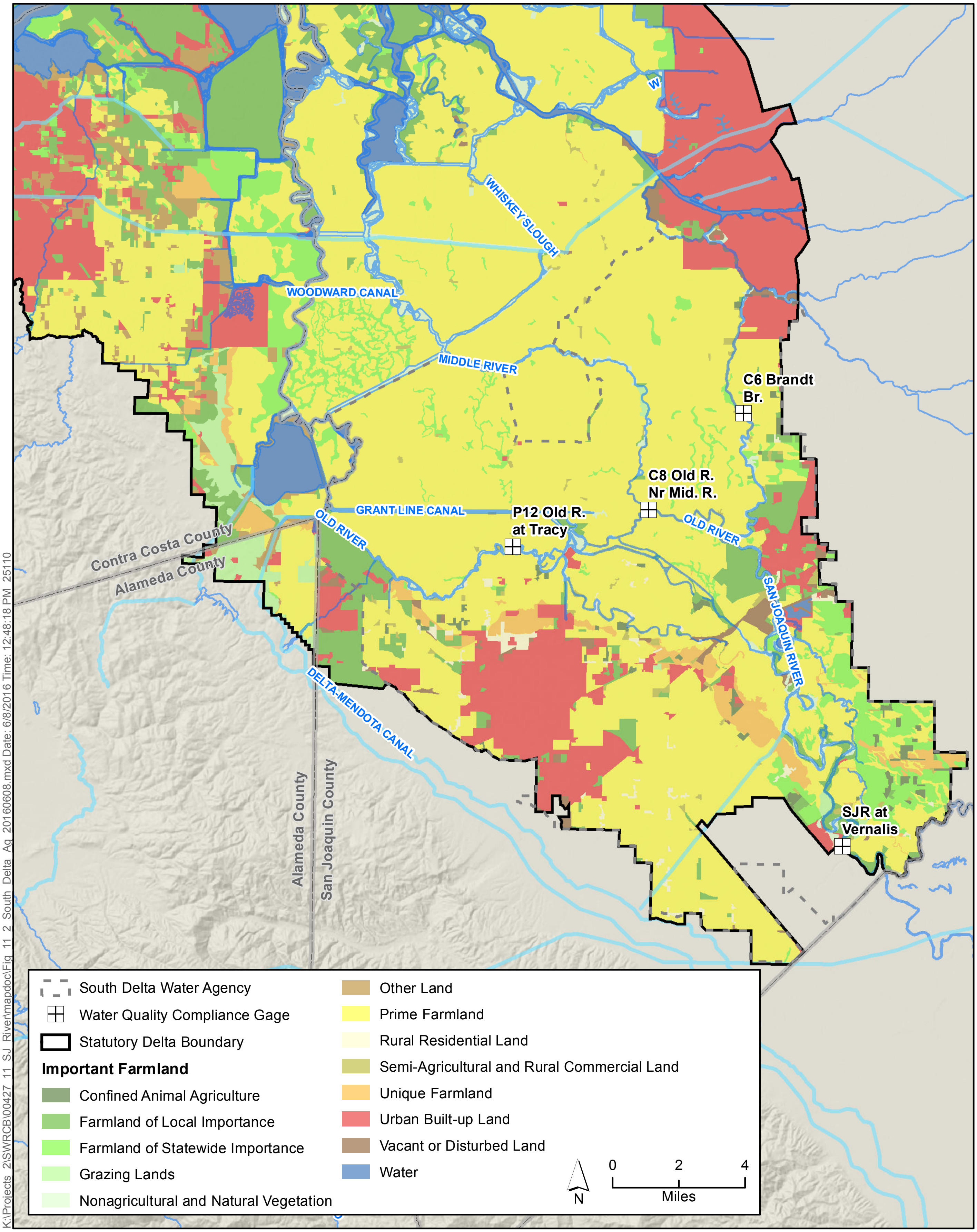

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Figure 11-2
Agriculture within the SDWQ Area of Potential Effects

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Board determined whether the plan amendments would cause any adverse impact for each environmental category in the checklist and provided a brief explanation for its determination. Impacts on agricultural resources that are listed as "Potentially Significant Impacts" are discussed in detail in this chapter. Appendix B, Section II, identified potentially significant impacts of the LSJR and SDWQ alternatives on agricultural resources as: (1) those that result in the conversion of Prime Farmland, Unique Farmland, and Farmland of Statewide Importance (e.g., irrigated farmland); (2) changes in the existing environment which, due to their location or nature, could result in the conversion of farmland to nonagricultural uses; or (3) those that conflict with existing zoning for agricultural uses or Williamson Act contracts. In addition, Appendix B, Section X identified potentially significant impacts of the LSJR and SDWQ alternatives as those that conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over a project adopted for the purpose of avoiding or mitigating an environmental effect.[4]

As noted previously, this evaluation generally focuses on the potential conversion of irrigated farmland to nonagricultural uses as a result of a reduction in surface water supplies (LSJR alternatives) or a change in water quality (SDWQ alternatives). Impacts associated with the LSJR alternatives were assessed using the State Water Board's Water Supply Effects (WSE) model and the SWAP model to determine whether reduction in surface water diversions for crop production in the LSJR area of potential effects or a change in water quality could result in a change in the distribution of crops or crop production. The analysis uses this information to qualitatively discuss the potential conversion of designated agricultural lands to nonagricultural land. The qualitative assessment of impacts associated with the SDWQ alternatives on agricultural resources was based on the expected water quality in the southern Delta under the different alternatives, in conjunction with the LSJR alternatives, and the tolerance of salt-sensitive crops in the southern Delta.

A summary of the potential impacts of the LSJR and SDWQ alternatives on agricultural resources is provided in Table 11-1. As described in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3, and 4 each include four methods of adaptive implementation. This recirculated substitute environmental document (SED) provides an analysis with and without adaptive implementation because the frequency, duration, and extent to which each adaptive implementation method would be used, if at all, within a year or between years under each LSJR alternative is unknown. The analysis, therefore, discloses the full range of impacts that could occur under a LSJR alternative, from no adaptive implementation to full adaptive implementation. As such, Table 11-1 summarizes impact determinations with and without adaptive implementation.

Impacts related to the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*. Chapter 16, *Evaluation of Other Indirect and Additional Actions,* includes discussion of impacts related to compliance and methods of compliance.

[4] This language is applicable when put in an agricultural context.

Table 11-1. Summary of Agricultural Resources Impact Determinations

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact AG-1: Potentially convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Significant	NA
LSJR Alternative 2	Potential environmental impacts from the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use are less than significant under LSJR Alternative 2 without adaptive implementation because potential reductions in surface water diversions could result in a less than 4% average reduction in irrigated acreage for the irrigation districts in the LSJR area of potential effects. However, if adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 20% up to 30%), environmental impacts would be potentially significant and unavoidable as it is estimated that OID could experience a 4.4% average reduction in irrigated crops, which equates to 2,356 acres receiving reduced irrigation, and MID could experience a 4.5% average reduction in irrigated crops, which equates to 2,589 acres receiving reduced irrigation. It is reasonable to assume that a portion of the reduced irrigated acreage is Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, and that some portion of acreage with reduced irrigation could potentially be converted to nonagricultural uses even though there are many factors affecting whether land is converted. Conversely, land can be maintained in agricultural use through crop substitution, crop rotation, fallowing, and dry land farming.	Less than significant	Significant and unavoidable

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternative 3	Environmental impacts from the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses are considered potentially significant and unavoidable because approximately 22,879 acres, on average, of Prime or Unique farmland or Farmland of Statewide Importance requiring irrigation could have reduced surface water diversions, and it is reasonable to assume that a portion could potentially be converted to nonagricultural uses, even though there are many factors affecting whether land is converted. Conversely, land can be maintained in agricultural use through crop substitution, crop rotation, and dry land farming. Specifically, reductions in surface water diversions could result in reduced acres of irrigated land for Alfalfa for SSJID, MID, and TID; Grain in MID; Field Crops in SSJID, MID and TID; Pasture in SSJID, OID, MID, and TID; Rice in SSJID and MID; and Dry Beans and Processing Tomatoes in SSJID. Those potential average reductions in irrigated acreage range from 0.8% for Merced ID to 9.9% for MID.	Significant and unavoidable	Significant and unavoidable
LSJR Alternative 4	Environmental impacts from the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses are potentially significant and unavoidable because approximately 70,640 acres, on average, of Prime or Unique Farmland or Farmland of Statewide Importance requiring irrigation could have reduced surface water diversions, and it is reasonable to assume that a portion could potentially be converted to nonagricultural uses, even though there are many factors affecting whether land is converted. Conversely, land could be maintained in agricultural use through the crop substitution, crop rotation, and dry land farming. Specifically, reductions in surface water diversions could result in reduced acres of irrigated land for Alfalfa, Pasture, Corn, Grain, and Field in SSJID, OID, MID, and Merced ID; Rice and Safflower in SSJID, OID, and MID; Dry Bean and Cucurbits in	Significant and unavoidable	Significant and unavoidable

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
	SSJID, OID, MID, and Merced ID; Processing and Fresh Tomato and Truck in SSJID, and Truck in SSJID, MID, and TID. Those potential average reductions in irrigated acreage range from 2.6% for Merced ID to 27.5% for MID.		
SDWQ Alternatives 2 and 3	No reduction or conversion of agricultural acreage is likely because water quality within the southern Delta is expected to remain unchanged as USBR would be responsible for complying with the same salinity requirements that currently exist at Vernalis.	Less than significant	NA
Impact AG-2: Involve other changes[c] in the existing environment which, due to their location or nature, could result in a conversion of farmland to nonagricultural use			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA
LSJR Alternative 2	Impacts on irrigated agriculture from a high water table resulting from increased river flows on the Stanislaus River are expected on less than 0.1% of irrigated acreage; therefore, crop production would not be substantially reduced.	Less than significant	Less than significant
LSJR Alternative 3	Impacts on irrigated agriculture from a high water table resulting from increased river flows on the Stanislaus River are expected on less than 0.1% of irrigated acreage; therefore, crop production would not be substantially reduced. Given cost of feed input compared to other dairy inputs and the availability of the feed input, the value of dairy production in the LSJR area of potential effects, and the potential use of equitable distribution of local water suppliers, it is unlikely dairies, as an agricultural use, would be converted to nonagricultural uses.	Less than significant	Less than significant
LSJR Alternative 4	Impacts on irrigated agriculture from a high water table resulting from increased river flows on the Stanislaus River are expected on less than 0.1% of irrigated acreage; therefore, crop production would not be substantially reduced. Given cost of feed input compared to other dairy inputs and the availability of the feed input, the value of dairy production in the LSJR area of potential effects, and the potential use of	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
	equitable distribution of local water suppliers, it is unlikely dairies, as an agricultural use, would be converted to nonagricultural uses		
SDWQ Alternatives 2 and 3	Conversion of farmland to nonagricultural use is not expected because water quality within the southern Delta is expected to remain unchanged as USBR would be responsible for complying with the same salinity requirements that currently exist at Vernalis.	Less than significant	NA
Impact AG-3: Conflict with existing zoning for agricultural use or a Williamson Act contract			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA
LSJR Alternatives 2, 3, and 4	The LSJR alternatives would not conflict with existing zoning for agricultural use or Williamson Act contracts because the LSJR alternatives would not change zoning and lands that are under Williamson Act contracts must be maintained in the compatible uses specified in those contracts until non-renewed, canceled or otherwise withdrawn from contract. Lands that experience a reduction in surface water supply could be dryfarmed, rotated, or fallowed, all of which would be agricultural activities that are consistent with agricultural zoning and Williamson Act contracts.	Less than significant	Less than significant
SDWQ Alternatives 2 and 3	The SDWQ alternatives would not conflict with existing zoning for agricultural use or Williamson Act contracts because the SDWQ alternatives would not change zoning, and agricultural lands would continue to divert water from existing waterways and rely on suitable water quality to irrigate crops.	Less than significant	NA
Impact AG-4: Conflict with any applicable land use plan, policy, or regulation related to agriculture of an agency with jurisdiction over a project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternatives 2, 3, and 4	The LSJR alternatives would not conflict with applicable land use plans, policies, or regulations because the LSJR alternatives are not proposing amendments to existing land use plans, policies, or regulations. While some agricultural land could be taken out of irrigated agricultural use as a result of the LSJR alternatives (particularly LSJR Alternatives 3 and 4), many of these lands could remain in agricultural use, even if they are not irrigated and must remain in uses that are compatible with applicable local land use plans, policies or regulations.	Less than significant	Less than significant
SDWQ Alternatives 2 and 3	The SDWQ alternatives would not conflict with applicable land use plans, policies, or regulations because the SDWQ alternatives would not change zoning, and agricultural lands would continue to divert water from existing waterways and rely on suitable water quality to irrigate crops.	No impact	NA

CSJWCD = Central San Joaquin Water Conservation District
LSJR = Lower San Joaquin River
Merced ID = Merced Irrigation District
MID = Modesto Irrigation District
NA = not applicable
OID = Oakdale Irrigation District
SDWQ = southern Delta water quality
SEWD = Stockton East Water District
SSJID = South San Joaquin Irrigation District
TID = Turlock Irrigation District
USBR = U.S. Bureau of Reclamation

[a] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description*, and summarized in Section 11.4.2, *Methods and Approach*, of this chapter. There is no adaptive implementation or adaptive implementation methods for the SDWQ alternatives.

[b] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in the continued implementation of flow objectives and salinity objectives established in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project Alternative technical analysis.

[c] The "other changes" to the existing environment included in the Impact AG-2 analysis are high water tables that could potentially affect fields due to seepage and potential reductions in farmland upon which other agricultural production relies.

11.2 Environmental Setting

This section characterizes the agricultural resources in the LSJR area of potential effects and SDWQ area of potential effects (or SDWA). The description of agricultural resources includes soils, farmland, crop mix, methods of irrigation, drainage, and water supply and describes the connection between crop production and water quality. General information regarding soil and water quality is first discussed to provide context for crop production in the LSJR area of potential effects and SDWQ area of potential effects. Information on soils and farmland is from the Natural Resources Conservation Service (NRCS) and the California Department of Conservation (DOC); crop production and cropping trends are from DWR land use surveys; water supply and quality information is from previous chapters in this document. Additionally, the current state of knowledge for salinity and its applicability to the LSJR area of potential effects and SDWQ area of potential effects is fully discussed in Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*.

11.2.1 Soil and Water Quality

Soils are intrinsic features of a landscape. They develop over time through physical, chemical, and biological processes. In the LSJR area of potential effects and SDWQ area of potential effects, the suitability of soils to support agricultural enterprises is classified by NRCS and is based on the soil type, adequate drainage, and the availability of water supply for irrigation. The State of California uses this information to develop maps that identify Prime Farmland, Farmland of Statewide Importance, and Unique Farmland. In addition, counties may identify Farmland of Local Importance. The definitions for each of the land use categories are provided in Section 11.3.1, *State [Regulatory Background]*.

All waters contain soluble salts, collectively referred to as *salinity*. The major components of either water or soil salinity include cations (calcium, sodium, and magnesium) and anions (bicarbonate, chloride, and sulfate) (Ayers and Westcott 1985). With regards to soil, salinity refers to the soluble plus readily dissolvable salts in the soil or in an extract of a soil sample. Salinity is quantified in terms of the total concentration of soluble salts. In practical terms, salinity is measured as electrical conductivity (EC)[5] of the solution (USDA 1954).

Salts in soil are generally at higher concentrations than those found in water. The extent to which salts accumulate in the soil depends on the irrigation water quality, irrigation management, and the adequacy of drainage. Crop water use (evapotranspiration) of irrigation water results in a salt load to the soil because crop evapotranspiration removes water from the soil profile but leaves the salt. Although crops uptake salt, the amount is insignificant. If salts in the soil become excessive, crop yield could be reduced. Certain crops may also have specific ion toxicities, where even relatively low concentrations of the ion could lead to yield reductions. Factors to consider when establishing a salinity standard for irrigated agriculture include plant response to soil salinity, effective rainfall, and irrigation management and method. Another important factor is that a plant's sensitivity to soil

[5] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

salinity changes during plant development. Many crops are most sensitive to soil salinity during emergence and early seedling development (Ayers and Westcott 1985; USSL 2011).

The method of irrigation and water management affects how a plant tolerates water or soil salinity. The main methods of irrigation in the LSJR Watershed and southern Delta include surface (border strip, furrow, and basin), sprinkler, and micro-irrigation (Edinger-Marshall and Letey 1997). In some areas of the southern Delta, subirrigation is also practiced. Poorly managed border and furrow irrigation can cause salt to build up in the soil profile in areas that do not receive adequate irrigation water of sufficient quality. Salt buildup can occur with micro-irrigation if the systems are not properly managed to push salts away from the rootzone. Subirrigation causes salt to build up in the top portion of the soil profile, unless this is flushed with surface irrigation or precipitation (Grattan 2002).

To reduce salinity impacts on crops, a leaching fraction is added to the crop's irrigation water requirement. The amount of water used for leaching is considered a beneficial use and is based on a plant's salinity tolerance and the salinity of the irrigation water. However, depending on the efficiency of the irrigation system being used and the effectiveness of rainfall, the leaching requirement may be inherently satisfied through irrigation inefficiency.

11.2.2 Lower San Joaquin River Watershed and Eastside Tributaries

This section summarizes the types of farmland and recent changes in farmland acreage, land subject to Williamson Act contracts, crop production, and water supply in the LSJR area of potential effects.

Types of Farmland

The LSJR area of potential effects covers more than 1 million acres of agricultural lands in California's San Joaquin Valley. The majority (55 percent) of farms in the San Joaquin Valley are less than 100 acres, while approximately 20 percent of farms are between 100 and 250 acres (Agricultural Water Management Council 2010). Statewide, the average farm size is 312 acres (DFA 2010).

The majority of land (65 percent) in the LSJR area of potential effects is designated as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Table 11-2). These lands are designated as such because of certain positive qualities, such as good soil characteristics like drainage, and the availability, amount, and frequency of irrigation. The lands must be irrigated 8 out of every 10 years and there must be adequate depth to the water table to support commonly cultivated crops.

Table 11-2 identifies the total acres of the various farmland categories within the LSJR area of potential effects organized by the six geographic areas that receive surface water supplies from the Stanislaus, Tuolumne, and Merced Rivers: SEWD/CSJWCD, SSJID, OID, MID, TID, and Merced ID. Figure 11-1 identifies the location and type of farmland within the LSJR area of potential effects. Although Table 11-2 shows total acres, including nonagricultural land, for the six geographic regions, typically the respective water districts supply only the farmland portion of each region with irrigation water.

Table 11-2. California Department of Conservation's Land Use Classification Acreages in the LSJR Area of Potential Effects

Land Use Category	SEWD and CSJWCD	SSJID	OID	MID	TID	Merced ID	Total Acres
Prime Farmland	79,648	20,021	11,370	50,186	82,466	67,566	311,257
Unique Farmland	23,754	4,190	18,625	5,871	22,142	10,219	84,802
Farmland of Statewide Importance	20,647	29,408	6,905	2,057	36,788	35,930	131,734
Total Designated Farmland[a]	124,049	53,619	36,900	58,114	141,396	113,715	527,793
Farmland of Local Importance	11,532	3,004	16,984	2,784	3,956	8,390	46,650
Semi-Agricultural and Rural Commercial Land	736	466	540	481	794	687	3,702
Urban and Built-Up Land	47,730	12,674	6,163	28,743	23,725	23,154	142,190
Rural Residential Land	4,514	1,578	3,875	1,864	3,813	2,091	17,735
Grazing Lands	22,490	0	3,975	3,674	1,835	2,129	34,103
Confined Animal Agriculture	1,868	728	2,458	1,362	8,395	2,863	17,675
Nonagricultural and Natural Vegetation	1,263	205	1,357	2,192	1,203	403	6,623
Vacant or Disturbed Land	2,167	312	594	690	1,440	1,420	6,623
Water	726	0	286	2,011	0	429	3,453
Total Land	217,075	72,586	73,133	101,915	186,558	155,280	806,547
Percent Total Designated Farmland of Total Land	57%	74%	50%	57%	76%	73%	65%

Source: DOC 2012.

SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Control District
SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District

[a] The sum of Prime Farmland, Unique Farmland, and Farmland of Statewide Importance.

The LSJR area of potential effects, like other parts of the Central Valley and California, has generally experienced a decline in agricultural lands in the past 20 years. Table 11-3 identifies the change in the acreages of Prime Farmland, Unique Farmland, Farmland of Statewide Importance, and Farmland of Local Importance in San Joaquin, Stanislaus, and Merced Counties. San Joaquin County had a relatively large reduction of Prime Farmland from 1990 to 2012, resulting in a correspondingly large net loss of farmland overall. Total farmland area in Merced County remained mostly unchanged from 1992 to 2012, but there was still a large reduction of Prime Farmland. On the other hand, from 2004 to 2012, Stanislaus County had a net gain in total farmland area, primarily because lost Prime Farmland was offset by a large increase of Unique Farmland.

Table 11-3. Changes in Prime Farmland, Unique Farmland, and Farmland of Statewide and Local Importance (Acres)

Land Use Category	San Joaquin County (1990–2012)	Stanislaus County (2004–2012)	Merced County (1992–2012)
Prime Farmland	-55,744	-10,321	-17,105
Farmland of Statewide Importance	-18,116	2,017	-8,687
Unique Farmland	25,194	25,053	15,606
Farmland of Local Importance	23,261	-3,719	10,142
Total	-25,405	13,030	-44

Source: DOC 2015a.

Note: Data include the entire counties, and therefore it is assumed that changes in the LSJR area of potential effects are proportional in the LSJR area of potential effects portion of the respective county.

Farmland Conversion

Like many of California's inland areas, the San Joaquin Valley is likely to experience urbanization on an unprecedented scale. As California grows, much of its growth will be accommodated in crowded metropolitan coastal areas and in Southern California's Inland Empire (PPIC 2005). But spillover from the Bay Area is causing growth stress in the San Joaquin Valley as commuters seek affordable housing. Over the past 35 years, the northern San Joaquin Valley, including San Joaquin, Stanislaus and Merced Counties, has experienced explosive growth in the numbers of workers who commute north and west out of the valley each day. By 2010, that was estimated to be about 24 percent of workers working outside their county of residence with about 46,000 heading towards the Bay Area (Stevens 2014). In addition to the Bay Are growth shift, the San Joaquin Valley is experiencing major growth in its own right—doubling in population approximately every 30 years since 1900.

To accommodate that growth, the Public Policy Institute of California estimated that an additional 1 million acres or more of land would be converted by 2040, which would triple the current amount of urbanized land to accommodate new development and reduce farmland by at least 15 percent overall (PPIC 2005). Under DWR projections, irrigated acreage in the San Joaquin Valley declines on average from a low of 117,000 acres by year 2050 to a high of approximately 272,000 acres relative to a 2006 base-year footprint of approximately 1.9 million acres. In other words, declines of between 6 percent and 14 percent of the irrigated acreage (DWR 2014).

Historically, in the San Joaquin Valley, more than 60 percent of all land developed is high quality farmland (Prime, Unique, or Farmland of Statewide Importance), even though that land is only 40 percent of all land in the region. In the LSJR area of potential effects for agricultural resources, the impacts are even higher with development in San Joaquin, Stanislaus, and Merced Counties occurring on high-quality farmland at rates of 76 percent, 83 percent, and 63 percent, respectively, of all land urbanized between 1990 and 2004. The disproportionate impact of urbanization on the best farmland is because most California cities were located in areas with good soils and abundant water, and most development occurs in the immediate urban fringe. In addition, while statewide growth has consumed an acre of land for every 9.4 people (and even less in places like Sacramento where it is about 20 people per acre), the San Joaquin Valley has consumed land at the rate of an acre for every 8 people and, if rural residential ranchettes are included, the development efficiency figure drops even lower. This makes rapid city-centered growth and inefficient land use the underlying causes of most farmland conversion (AFT 2007).

While urbanization isn't the only pressure causing conversions to nonagricultural use in the San Joaquin Valley, it is the greatest pressure in the potential area of effects for agricultural resources. Other large scale pressures, such as salt buildup, are occurring outside the potential area of effects. For example, the San Joaquin Valley Drainage Relief Act identifies 75,000 acres of irrigated agricultural lands on the west side of the San Joaquin Valley that should be retired by the year 2040 primarily due to characteristics of low productivity, poor drainability, and high levels of selenium in shallow groundwater. (Wat. Code, § 14900 et seq.)

Williamson Act 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 he or she receives lower property taxes. A 1989 analysis of the program showed an average tax savings of 44 percent for tree and vine land up to 70 percent for grazing land (DOC 1989). In a 2012 study, 91 percent of the ranchers polled stated Williamson Act tax reductions were either "very important" or "extremely important" for the "long term viability of their cattle and rangeland operations" and that for 71 percent of the Williamson Act-enrolled ranchers, their net annual profit was equal or less than their Williamson Act property tax savings in 2009 (Wetzel 2012). Although local governments forego a portion of property taxes due to Williamson Act valuations, in return they receive planning advantages and values implicit in retaining or open space.

Land Conservation Act contracts are for rolling 10-years terms, meaning they renew automatically each year for another 10 year term. There is also a rolling 20-year contract option called a Farmland Security Zone contract, also known as a "Super Williamson Act" contract. Until 2010, the state made Open Space Subvention payments from the state general fund to local governments to offset a portion of Williamson Act-related reduced revenues. Those payments totaled $863 million between 1971 and 2010, or almost $1.5 billion when adjusted for inflation. Starting fiscal year 2010–11 Open Space Subvention payments were effectively eliminated. In response, the legislature passed Assembly Bill (AB) 1265, which allows participating counties to recapture a portion of foregone property tax revenue by decreasing the duration of contracts to 9 years for regular Land Conservation Act contracts or 18 years for Farmland Security Zone contracts. Also in 2011, the legislature passed Senate Bill (SB) 618, providing an option to rescind Land Conservation Act contracts on land that has been compromised due to chemical, physical, or water-related limitations and replace the contracts with Solar-Use Easements. Within the past decade, the nonrenewal of Williamson Act contracts, often viewed as a precursor to converting farmland to other uses, occurred in response to economic trends with nonrenewal peaking in 2007 at 157,805 acres. Following that period, as the recession slowed the demand for urban expansion, nonrenewal initiation acreages fell sharply to 19,967 acres in 2010. In 2011, the elimination of Open Space Subvention payments led Imperial County to initiate nonrenewal on all 117,246 acres remaining under contract (DOC 2015b).

There are approximately 377,999 acres under Williamson Act contracts in the LSJR area of potential effects (DOC 2009, 2010a) with Merced and Stanislaus Counties participating in the AB 1265 option for reduced contract terms. Table 11-4 identifies the acreages under Williamson Act contracts within each of the six geographic areas.

Table 11-4. Acreages under Williamson Act Contract in the LSJR and SDWQ Areas of Potential Effects

Areas of Potential Effects	Williamson Act Land
LSJR Area of Potential Effects	
SEWD/ CSJWCD	121,439
SSJID	26,172
OID	46,503
TID	103,834
MID	43,984
Merced ID	36,065
Total	377,999
SDWQ Area of Potential Effects	
Total	83,614

Source: DOC 2009, 2010a.

LSJR = Lower San Joaquin River
SDWQ = southern Delta water quality
SEWD/CSJWCD = Stockton East Water District/Central San Joaquin Water Conservation District
SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District

Crop Production

Farmland in the LSJR area of potential effects is irrigated by surface water diversions from the three eastside tributaries[6] and from groundwater.

Dryland farming, which relies on stored water in the soil, is feasible for some annual crops in the LSJR area of potential effects (Luers 1970). Dryland farming acreage information is not collected by the Farmland Mapping Program (DOC 2009, 2010a) or reported in the agricultural water management plans for the irrigation districts in the LSJR area of potential effects; as a result, the full extent of the practice is unknown. The acreage reported for planted and harvested winter wheat can be used to estimate dryland farming because this type of crop can be dryland farmed in the LSJR area of potential effects. In 2011, Merced County harvested 20,800 acres of 36,000 acres of winter wheat that were planted, San Joaquin County harvested 26,000 acres of the 36,500 acres of winter wheat that were planted, and Stanislaus County harvested 3,200 acres of the 12,000 acres of winter wheat that were planted (USDA 2012). No acreage was planted in any county in 2013 (USDA 2013). While winter wheat acreage is useful to characterize the practice of dryland farming, there is the potential that winter wheat may be irrigated. In such cases, these estimates would potentially overestimate the amount of dryland acres.

On a periodic basis, DWR surveys and catalogs irrigated acreage into 19 crop categories and provides this data organized by DAU. Irrigated crop production within the LSJR area of potential effects is diverse, with a wide variety of crops grown on 516,727 acres (Table 11-5). Table 11-6 shows the percentage of each of the 19 crop categories within each irrigation district and illustrates how cropping patterns differ between districts.

Cultural crop practices in the LSJR area of potential effects include crop rotation and fallowing (Marsh and Jackson 2006). However, the extent of fallowed land and crop rotation cannot be quantified because this type of data is not readily available and is not reported in the irrigation districts' agricultural water management plans. Crop rotation involves the use of the same piece of land cultivated for various crops, such as corn followed by winter wheat. Land fallowing, or removing land from agricultural production for a period of time, is the deliberate idling of land for a cultural crop practice, such as disease control. Fallowed land is typically managed to keep down weed growth (Marsh and Jackson 2006).

Other Agricultural Production

In addition to crop production, the other significant agricultural activity in the LSJR area of potential effects is dairy. In California there are approximately 1,563 dairies, of which 578 are located in Merced, Stanislaus, and San Joaquin Counties. This is approximately 36 percent of the state's total dairy operations (USDA 2015). Confined animal agriculture acreage is approximately 17,675 acres in the LSJR area of potential effects (Table 11-2); however, the breakdown of this acreage into dairy and other feed operations is unknown because the data is collected based on the definition of confined animal agriculture and does not distinguish between dairies and other confined animal operations. The total value of dairy in the LSJR area of potential effects in 2013 was $2.2 billion (USDA 2015).

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[6] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

Dairies in the LSJR area of potential effects use water for herd and facility management and for waste disposal. Local crop production allows for both feed and waste disposal for dairies within the LSJR area of potential effects. Dairy relies on Alfalfa and Corn for feed and, to some extent, pasture for grazing. Waste disposal is typically on cropland that is adjacent to dairy facilities. Cropland that is used for disposal may be used for production of feed crops such as Corn, Grain, or Pasture. Water used for waste disposal is to help manage the salt and nitrate loading to lands and local groundwater. Dairy operations in the LSJR area of potential effects operate under waste discharge permits issued by the Central Valley Regional Water Quality Control Board (Cady and Francesconi 2010). In 2015, a critically dry year, irrigation water cost for dairy feed in the San Joaquin Valley represent about 9 percent of the cost of farm milk production (Sumner 2016). Although this is a major cost, it is not itself dominant when considering other costs associated with dairies (Sumner 2016).

Beef cattle operations are also located in the LSJR area of potential effects, representing about 11 percent of the state's total beef cattle inventory of 600,000. There are three segments to beef cattle operations: cow-calf, feeder cattle, and feedlot operations. Cow-calf and feeder cattle operations typically rely on winter pasture and some irrigated pasture for grazing in the summer. In contrast, feedlots rely on grains and oilseed from out of state and, therefore, do not rely on feed directly produced in the LSJR area of potential effects (Medellin-Azuara et al. 2016).

Table 11-5. Crop Production in the LSJR Area of Potential Effects by DAU (Acres)

	SEWD and CSJWCD (DAU 182)	SSJID (DAU 205)	OID (DAU 206)	MID (DAU 206)	TID (DAU 208)	Merced ID (DAU 210)
Crop Category	Acres					
Alfalfa	6,893	3,175	2,131	2,674	14,371	5,810
Almonds and Pistachios	17	27,032	10,513	13,157	33,776	30,615
Corn	16,098	8,332	9,758	10,525	43,350	19,088
Cotton	0	0	0	0	0	2,490
Cucurbits	819	490	101	127	469	646
Dry Bean	770	175	214	255	1,073	0
Field Crops	0	210	7,806	9,422	29,078	7,193
Fresh Tomato	8,066	70	0	0	379	1,844
Grain	8,310	1,670	376	212	455	3,135
Onion and Garlic	179	602	0	0	0	0
Orchards	43,161	6,854	6,504	8,149	8,238	4,887
Pasture	4,057	1,664	8,839	8,743	4,784	5,994
Rice	0	84	4,250	679	0	1,199
Safflower	0	162	0	0	0	0
Subtropical Crops	0	1,747	137	42	63	0
Sugarbeet	0	0	0	0	0	277
Tomato (Processing)	0	454	0	0	0	1,383
Truck Crops	1,124	437	2,807	3,523	7,977	11,803
Vine	9,485	5,393	879	1,103	2,016	3,873
Total by District	98,979	58,551	54,315	58,611	146,029	100,237
Total All Districts						516,722

Source: Table G.4-3, Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

Notes: The total district irrigated acres is from the districts' agricultural water management plans, while the distribution of crops is based on DWR DAU crop data. See Appendix G, Section G.4.2, *Crop Distribution and Applied Water Inputs for SWAP*, for more details.

DAUs are typically river basin- and irrigation district-specific.

Each crop category is a consolidation of several different crop types. For example, Grain includes barley, wheat, and oats.

SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Control District
SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District
DAU = California Department of Water Resources Detailed Analysis Units

Table 11-6. Crop Production in the LSJR Area of Potential Effects by DAU (Percent)

Crop Category	SEWD and CSJWCD (DAU 182)	SSJID (DAU 205)	OID (DAU 206)	MID (DAU 206)	TID (DAU 208)	Merced ID (DAU 210)
	% of Irrigated Cropland					
Alfalfa	7.0	5.4	3.9	4.6	9.8	5.8
Almonds and Pistachios	0.0	46.2	19.4	22.4	23.1	30.5
Corn	16.3	14.2	18.0	18.0	29.7	19.0
Cotton	0	0	0	0	0	2.5
Cucurbits	0.8	0.8	0.2	0.2	0.3	0.6
Dry Bean	0.8	0.3	0.4	0.4	0.7	0
Field Crops	0.0	0.4	14.4	16.1	19.9	7.2
Fresh Tomato	8.1	0.1	0	0	0.3	1.8
Grain	8.4	2.9	0.7	0.4	0.3	3.1
Onion and Garlic	0.2	1.0	0	0	0	0
Orchards	43.6	11.7	12.0	13.9	5.6	4.9
Pasture	4.1	2.8	16.3	14.9	3.3	6.0
Rice	0	0.1	7.8	1.2	0	1.2
Safflower	0	0.3	0	0	0	0
Subtropical Crops	0	3.0	0.3	0.1	0	0
Sugarbeet	0	0	0	0	0	0.3
Tomato (Processing)	0	0.8	0	0	0	1.4
Truck Crops	1.1	0.7	5.2	6.0	5.5	11.8
Vine	9.6	9.2	1.6	1.9	1.4	3.9
Total	100	100	100	100	100	100

Source: Adapted from Table G.4-3, Appendix G, *Agricultural Economic Effects of the lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

DAU = California Department of Water Resources Detailed Analysis Units
SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Control District
SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District

Water Supply, Irrigation, and Water Quality

Surface water supply for irrigation in the LSJR area of potential effects is provided to agricultural users by organized irrigation and water (conservation) districts (collectively referred to as the *irrigation districts* throughout the rest of this chapter). These irrigation districts regularly receive surface water from the Stanislaus, Tuolumne, and Merced Rivers. In addition to surface water supply provided by irrigation districts, many growers have access to groundwater. Details on surface water supply availability and groundwater supply to irrigation and water districts are discussed in Chapter 2, *Water Resources,* Chapter 9, *Groundwater Resources*, and Chapter 13, *Service Providers*.

Irrigation district operations are generally based on diverting river flow into open channels that provide service to parcels of various sizes (Merced ID 2013; MID 2012; OID 2012; TID 2012). Typically, surface water irrigation deliveries begin in April and continue through September, with peak delivery in the summer months. Water can be delivered to a farm on various terms – for example, it can be delivered on a rotating schedule with a fixed flow rate and duration or a user-requested schedule with a variable flow rate and duration. In addition, some irrigation districts operate canals and make deliveries in the off-season for groundwater recharge.

In general, irrigation districts state that they emphasize equity and fairness in the distribution of surface water supplies during normal and dry periods (Merced ID 2013; OID 2012, TID 2012). Irrigation districts acknowledge an increase in groundwater pumping by growers during normal and dry periods, as well as some level of groundwater overdraft, to meet on-farm flexibility needs when surface water supplies are not enough (Merced ID 2013; MID 2012; OID 2012; TID 2012). Merced ID reported in its 2012 Agricultural Water Management Plan that it meets shortages in surface water through increased groundwater pumping (Merced ID 2013). TID allows for internal water transfers but does not distinguish between crop types when making surface water supply allocations (TID 2012).

On-farm irrigation methods in the LSJR area of potential effects include surface, sprinkler, drip, and micro-irrigation (Table 11-7) (DWR 2010). Sometimes other methods of irrigation are used, such as subirrigation, in which the water table is controlled (Table 11-7) (DWR 2010). For the most part, higher net value crops, such as Trees and Vines, are irrigated with pressurized systems, such as hand-moved sprinklers or micro-sprayers. Generally, crops that produce lower net revenue per acre, such as Grains and Pasture, are irrigated with surface methods.

Table 11-7. Irrigation Method Types in Merced, San Joaquin, and Stanislaus Counties (Percent)

County	Surface	Sprinkler	Drip and Micro	Other
Merced	57.2	6.2	34.0	2.7
San Joaquin	36.0	14.2	36.6	13.2
Stanislaus	44.1	9.5	44.8	1.6

Source: DWR 2010.

Surface water quality is very good in the three eastside tributaries, with an average salinity (ECw) value of less than 0.1 deciSiemens per meter (dS/m), as discussed in Chapter 5, *Surface Hydrology and Water Quality*. Groundwater quality in the LSJR area of potential effects varies depending on the groundwater basin, hydrogeology, and depth to groundwater, as discussed in Chapter 9, *Groundwater Resources*. In general, groundwater is known to have elevated salt and nitrate concentrations in the LSJR area of potential effects. However, groundwater within the three eastside tributary watersheds is considered to be of higher quality than for other locations because it is recharged by snowmelt from the Sierra Nevada, which has a low concentration of dissolved constituents.

11.2.3 Extended Plan Area

There are limited agricultural resources in the extended plan area and no designated Prime, Unique, or Farmland of Statewide Importance (California Farmland Mapping and Monitoring Program n.d.). Much of the extended plan area is designated as nonagricultural, but there is some acreage in grazing in Mariposa County near Lake McClure (California Farmland Mapping and Monitoring Program webpage). There are individual small water rights used for irrigated pastures, orchards, and occasional vineyards.

11.2.4 Southern Delta

This section summarizes the agricultural features within the SDWQ area of potential effects, including the farmland classification and acreage, the Williamson Act contract acreage, and the total crop production for different crop types. This section also summarizes water supply, irrigation methods, and water quality in the SDWQ area of potential effects within the boundary of the SDWA. Figure 11-2 shows the location of the SDWQ area of potential effects and the SDWA boundary with respect to San Joaquin County and the legal boundary of the Delta.

Prior to development, lands in the SDWQ area of potential effects existed in a natural state with both organic and mineral soils (NRCS 1999). Over many millennia, histosols, commonly known as organic soils, peats, or mucks, developed in the Delta as plants grew and died. Delta reclamation took place between 1900 and 1920 on lands in the Delta's interior. When adequate drainage was provided to these lands, microbial oxidation of the organic material began, resulting in loss of soil volume (subsidence) over time. Soil subsidence is compounded by wind erosion. Depending on the location, subsidence and erosion rates of 0.5–1.5 inches per year can be common in certain areas. Since the early 1900s, as much as half of the original accumulated soil volume has been lost. The result of the reclamation efforts is largely what is seen as the Delta today—approximately 700 miles of waterways and 1,100 miles of levees that protect over 538,000 acres of farmland, homes, and other structures (DWR 2009).

Types of Farmland

As depicted on Figure 11-2 and described in Table 11-8, the majority of agricultural land in the SDWQ area of potential effects is classified as Prime Farmland (DOC 2012).

Table 11-8. California Farmland Mapping Program Land Use Classification for the SDWA (2010)

Land Use Classification	Acres
Prime Farmland	98,563
Unique Farmland	4,890
Farmland of Statewide Importance	8,079
Farmland of Local Importance	9,071
Semi-Agricultural and Rural Commercial Land	1,255
Urban and Built-Up Land	16,186
Rural Residential Land	1,592
Grazing Lands	447
Confined Animal Agriculture	1,213
Nonagricultural and Natural Vegetation	3,942
Vacant or Disturbed Land	1,930
Water	227
Total	147,396

Source: DOC 2012.

SDWA = Southern Delta Water Agency

Some Prime Farmland in San Joaquin County (Table 11-3) has undergone conversion to urban and other lands (California Department of Conservation 2015).

Farmland Conversion

For over 20 years, the Delta has been recognized as an agricultural region and open-space region of great value to the state and nation and that retention and continued cultivation and production of its fertile peatlands and prime soils are of significant value. In response, the 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, as updated in 2009, required the commission to adopt a resources management plan for the Delta region by October 1, 1994 that addressed, 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.) The Delta Protection Act is discussed in more detail below under Section 11.3.1, *State [Regulatory Background]*. However, as no reduction or conversion of agricultural acreage under the SDWQ alternatives is likely, potential farmland conversion pressures in the Delta are not discussed further here.

Williamson Act Contracts

There are approximately 83,614 acres under Williamson Act contracts in the SDWQ area of potential effects (Table 11-4), representing about 84 percent of the total agricultural acreage. Further discussion of the Williamson Act can be found in Section 11.3.1, *State [Regulatory Background]*.

Crop Production

A wide variety of crops are grown on over 100,000 acres in the SDWQ area of potential effects (Table 11-9) (DWR 2005). Agricultural uses in the southern Delta currently divert water from existing waterways, expecting it to be of suitable water quality to irrigate various different crops. About 60 percent of the land is cultivated as annual crops (Truck & Berry, Field Crops, and Grain & Hay). Alfalfa is cultivated on roughly 30 percent of the land. There has been about a 15 percent drop in total cultivated acreage since 1996, as the acreage planted with dry beans and safflower has declined (Field Crops) (Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*).

Table 11-9. Crop Production in the SDWQ Area of Potential Effects for 2005

Crop Category & Crop	Acres
Fruits & Nuts	
Apples	18
Apricots	204
Olives	77
Peaches & Nectarines	0
Pears	0
Plums	5
Almonds	3,107
Walnuts	2,051
Pistachios	18
Fruit or Nut < 10 acres	56
Subtotal	5,536
Field Crops	
Cotton	34
Safflower	2,684
Sugar Beets	135
Corn	15,481
Grain Sorghum	0
Sudan	1,286
Castor	0
Dry Beans	4,417
Sunflowers	0
Hybrid sorghum/sudan	71
Subtotal	24,108
Grain & Hay	
Wheat & Oat	7,297
Pasture	
Alfalfa	31,342
Clover	0
Turf Farm	324
Pasture	3,148
Subtotal	34,814

Crop Category & Crop	Acres
Truck & Berry	
Asparagus	3,651
Green Beans	24
Cole	257
Carrots	197
Celery	105
Cucurbits	2,628
Onion & Garlic	165
Tomatoes	16,444
Strawberries	4
Peppers	253
Misc.	555
Subtotal	24,283
Vineyards	2,902
Idle	2,114
Total	101,054

Note: Data was adapted from Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*.

Water Supply, Irrigation, and Water Quality

Although growers have access to groundwater, it is not commonly used as a source of irrigation water. The majority of growers claim riparian or appropriative water rights and obtain their water supply through direct diversion of surface water from the Delta waterways (San Joaquin County 2009). Diversions are performed using pumps, siphons, or subirrigation. The operation of diversion pumps and siphons is dependent upon sufficient water depth and quality. When the depth of water in conveyance canals is too shallow, pumps and siphons cannot operate.

The salinity in the southern Delta is strongly influenced by the concentrations in the SJR at Vernalis. If the salinity of Delta water exceeds a crop's salinity tolerance, it cannot be used to irrigate that crop. Historically, salinity in the southern Delta has generally ranged between 0.2 dS/m and 1.2 dS/m and is suitable for irrigating a wide variety of agricultural crops (Chapter 5, *Surface Hydrology and Water Quality*). Chapter 5 and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta,* provide additional information regarding water quality and historical and existing salinity concentrations in the southern Delta.

The primary on-farm irrigation methods include surface methods, sprinklers, and drip or micro-irrigation methods (Table 11-10). For the most part, higher net value crops, such as Trees and Vines, are irrigated with pressurized systems, such as hand-moved sprinklers or micro-sprayers (Edinger-Marshall and Letey 1997). Generally crops with lower net revenue, such as Grains and Pasture, are irrigated with surface methods. There is significant subirrigation in the area, which provides irrigation water by controlling the water table. Dryland cropping is possible on some annual acreage in the SDWQ area of potential effects; however, the vast majority of the crops rely on a supply of irrigation water.

Table 11-10. Irrigation Method Types in San Joaquin County

Surface (%)	Sprinkler (%)	Drip and Micro (%)	Other (%)
36.0	14.2	36.6	13.2
Source: DWR 2010.			

Soil salinity for crop lands is managed through the use of a leaching fraction, which is the portion of applied irrigation water that infiltrates past the root zone. The amount of water required for leaching is dependent on the crop being grown and the salinity of the water used for irrigation. Maintaining the leaching fraction is an important management tool in the southern Delta. Over time, the use of irrigation water and water management techniques, particularly leaching, brings soil salinity to equilibrium. In other words, salt introduced in the irrigation water is removed from the rootzone through the additional water supplied for leaching. There are 7,041 acres of saline soils in the SDWQ area of potential effects, or about 5 percent of the total acreage. Several leaching fraction studies examining salt are based on an irrigation water quality of 0.7 dS/m. Among the studies, the leaching fractions averaged between 21 and 27 percent, with a low of 11 percent and a high of 44 percent. Bean and Alfalfa, two crops with significant acreage (Table 11-9) in the SDWQ area of potential effects, have the highest sensitivity to salinity. These crops are successfully grown on lands with low infiltration rates, but maintain leaching fractions that average between 21 percent and 27 percent (Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*). Further information on soil salinity and leaching fractions within the boundary of the SDWA is provided in Appendix E.

11.3 Regulatory Background

11.3.1 State

Relevant state programs, policies, plans, or regulations related to agricultural resources are described below.

Farmland Mapping and Monitoring Program

Through the DOC, California administers the Farmland Mapping and Monitoring Program (FMMP). This program maps farmland throughout the state (California Department of Conservation 2007). The farmland categories listed under the FMMP are the basis of certain significance thresholds in the State CEQA Guidelines, discussed in Section 11.4.1, *Thresholds of Significance*. The categories are defined based on the U.S. Department of Agriculture's (USDA) land inventory and monitoring criteria and modified for California.

Prime Farmland is land with the best combination of physical and chemical characteristics for the production of crops. It has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops when treated and managed in accordance with accepted farming methods. In addition, the land must have been used for irrigated agricultural production in the last 4 years to qualify as Prime Farmland. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use. Prime Farmland must meet several criteria, some of which are listed below (DOC 2013a).

(a) Water —The soils have xeric, ustic, or aridic (torric) moisture regimes in which the available water capacity is at least 4.0 inches (10 centimeters) per 40 to 60 inches (1.02 to 1.52 meters) of soil, and a developed irrigation water supply that is dependable and of adequate quality. A dependable water supply is one which is available for the production of the commonly grown crops in 8 out of 10 years.

(d) Water Table—The soils have no water table or have a water table that is maintained at a sufficient depth during the cropping season to allow cultivated crops common to the area to be grown.

(f) Flooding—Flooding of the soil (uncontrolled runoff from natural precipitation) during the growing season occurs infrequently, taking place less often than once every 2 years.

Farmland of Statewide Importance is land other than Prime Farmland that has a good combination of physical and chemical characteristics for the production of crops. It must have been used for the production of irrigated crops at some time during the two update cycles (4 years) prior to the mapping date, and it does not include publicly owned lands for which there is an adopted policy preventing agricultural use (DOC 2013b).

Unique Farmland is land that does not meet the criteria for Prime Farmland or Farmland of Statewide Importance and that has been used for the production of specific high–economic value crops at some time during the two update cycles (4 years) prior to the mapping date (DOC 2013b). This land is usually irrigated, but may include nonirrigated orchards or vineyards. It has the special combination of soil quality, location, growing season, and moisture supply needed to produce sustained high quality or high yields of a specific crop when treated and managed according to current farming methods. Examples of such crops may include oranges, olives, avocados, rice, grapes, and cut flowers. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use.

Williamson Act and Farmland Security Zone Contracts

As discussed above, the Williamson Act recognizes the importance of protecting agricultural land from premature development and provides a tax incentive for the voluntary enrollment of agricultural and open space lands in contracts between local government and landowners. (DOC 2010b; Gov. Code, § 51200 et seq.) Establishment of an agricultural preserve by a city or county is a prerequisite for a landowner to enter into Williamson Act contract, and only land located within the agricultural preserve is eligible. The city or county establishing the agricultural preserve also adopts rules that provide the standards for property eligibility, including minimum parcel sizes, and that determine the land use restrictions within the preserve. Once a landowner enters into a Williamson Act contract, the land is reassessed for tax purposes based upon the restrictions. This assures the landowner that property valuations and taxes will remain at lower stable levels notwithstanding location relative to urban or other developing areas. In exchange for the tax benefits of the program, the landowner agrees to keep the land in agricultural or open space use and in parcel sizes related to the quality of the land or existing use (Merced County 2015).

As was previously noted, the Williamson Act also provides for the establishment of Farmland Security Zone contracts. (Gov. Code, § 51296 et seq.) A Farmland Security Zone is an area created within an agricultural preserve by a board of supervisors upon the request of a landowner or group of landowners. Farmland Security Zone contracts offer landowners greater property tax reduction and have a minimum initial term of 20 years.

Central Valley Water Board Basin Plan Amendment for Control of Salt and Boron Discharges in the Lower San Joaquin River

The Central Valley Regional Water Quality Control Board (Central Valley Water Board) has adopted the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan). In 2004, it adopted a total maximum daily load (TMDL) and Basin Plan amendment that establishes a control program for salt and boron discharges into the LSJR to Vernalis (Central Valley Water Board 2004).

The Delta Protection Act and Delta Reform Act

The California legislature, through various statutes, has established a policy of recognizing, protecting, and preserving Delta resources, including agriculture, in various statutes. These statutes include the Delta Protection Act, referenced under Section 11.2.4, *Southern Delta (Farmland Conversion)* above, and the Delta Reform Act.

The Delta Protection Act created the Delta Protection Commission and required that the commission prepare and adopt a comprehensive long-term resource management plan for land uses within the primary zone of the Delta. The *Land Use and Resource Management Plan for the Primary Zone of the Delta* was prepared and adopted by the Delta Protection Commission in 1995 and revised in 2002. Regarding agriculture, the plan is required to conserve and protect the quality of renewable resources, preserve and protect agricultural viability, preserve and protect the water quality of the Delta, and protect the Delta from any development that results in a significant loss of habitat or agricultural land. This plan identifies nine general policies in support of Delta agriculture. Among these policies are prioritizing lower net revenue lands for conversion to nonagricultural uses, encouraging the acquisition of agricultural conservation easements, managing agricultural lands to maximize wildlife habitat, and supporting efforts to maintain a viable agricultural economy, such as educational programs, ag-tourism, and value-added production activities.

SB 1 passed during the Seventh Extraordinary Session of the Legislature in November 2009, declared that the two coequal goals for the state regarding the Delta are to achieve “a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem.” In addition, the coequal goals are to “be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.” (Pub. Resources Code, § 29702.) SBX7-1 also revised the membership of the Delta Protection Commission (Pub. Resources Code, § 29735) and included the Sacramento-San Joaquin Delta Reform Act of 2009. (Wat. Code, § 85000 et seq.) The Delta Reform Act established a new legal framework for Delta management, emphasizing the coequal goals as a foundation for state decisions about Delta management and creating the Delta Stewardship Council, which was required to develop and adopt a long-term and enforceable management plan for the Delta. The Delta Stewardship Council unanimously adopted the Delta Plan in 2013. The Delta Plan acknowledges that agriculture dominates the Delta landscape and that “agriculture is among the qualities that define the Delta as a place.” The Delta Plan identifies many challenges for Delta agriculture, including increasing urbanization (DSC 2013). Finally, SBX7-1 also created a new Sacramento–San Joaquin Delta Conservancy to support efforts that advance environmental protection and the economic well-being of Delta residents. (Pub. Resources Code, § 32320, et seq.)

Water Conservation Bill of 2009

The Water Conservation Bill, SB 7 (Steinberg), was also enacted during the Seventh Extraordinary Session in November 2009. SBX7-7 requires all water suppliers to increase efficiency in water use and evaluate additional practices that may conserve water. SBX7-7 requires that agricultural water suppliers providing water to 25,000 irrigated acres or more (excluding acres that receive only recycled water) measure the volume of water delivered to their customers; implement efficient water management practices; submit documentation for agricultural water measurement regulation compliance by preparing and adopting an agricultural water management plan (AWMP); and submit an aggregated farm-gate delivery report. AWMPs that were submitted in 2012 must be updated by December 31, 2015 and every 5 years thereafter.

In response to a continued drought State of Emergency, Governor Brown issued Executive Order B-29-15 on April 1, 2015, requiring agricultural water suppliers that supply water for between 10,000 and 25,000 acres of irrigated land to also develop AWMPs and to submit them to DWR by July 1, 2016. The executive order required plans to include "a detailed drought management plan and quantification of water supplies and demands in 2013, 2014, and 2015, to the extent that data is available." On, May 9, 2016 the governor issued Executive Order B-37-16, *Making Water Conservation a Way of Life*. Executive Order B-37-16 permanently requires the completion of AWMPs by water suppliers with over 10,000 acres of irrigated land. A general description of AWMPs within the LSJR area of potential effects is provided in Section 11.3.2, *Regional or Local [Regulatory Background]*.

11.3.2 Regional or Local

Regional or local programs, policies, plans, and regulations related to agricultural resources are described in this section. Although local policies, plans, and regulations are not binding on the State of California, below is a description of those that are relevant in the LSJR area of potential effects.

General Plans

Local agencies in California have primary responsibility for land use control and regulation within their areas of jurisdiction and, to a lesser extent, for areas within their spheres of influence. State planning and zoning law requires all California counties and incorporated cities to prepare, adopt, and implement a comprehensive general plan to guide the community's growth and development. A general plan may also include optional elements at the discretion of the local agency, such as an agricultural element or a recreation element. The counties and cities in the LSJR area of potential effects have general plans stipulating goals, objectives and policies associated with agricultural land, as described in this section.

Merced County

The *Agricultural Element* of the *2030 Merced County General Plan* (Merced County 2013) provides goals and policies related to the agricultural economy, preservation of agricultural lands, agricultural and urban area compatibility, agricultural research and education, and agricultural recreation.

- Goal AG-2: Ensure the long-term preservation and conservation of land used for productive agriculture, potentially-productive agricultural land, and agricultural-support facilities.

- Policy AG-2.1: Protect agriculturally-designated areas and direct urban growth away from productive agricultural lands into cities, Urban Communities, and New Towns.
- Policy AG-2.2: Protect productive agricultural areas from conversion to nonagricultural residential uses by establishing and implementing an agricultural mitigation program that matches farmland acres to be converted with farmland acres of a similar quality to be preserved at a 1:1 ratio. The plan also requires coordination with the six cities in Merced County and the Merced Local Agency Formation Commission (LAFCo), consistent with LAFCo's statutory mission to preserve agricultural land and open space, to establish consistent standards and mitigation for the loss of farmland. In addition, the Land Evaluation and Site Assessment Model (LESA Model) may be used to determine whether the conservation land is of equal or greater value than the land being converted.
- Policy AG-2.17: Where requested by the water purveyor, when agricultural parcels are subdivided and the original parcel (prior to subdivision) has access to surface water (such as from an irrigation or water district facility), it is required that an easement be provided over the parcel(s) that has/have access to the surface water source to the remaining parcel(s) that will not be adjacent to or near the surface water source. The easement should specify the purpose of the easement and whose responsibility it is to maintain private water conveyance facilities within said easement.

San Joaquin County

The *Resources* chapter of the *San Joaquin County General Plan* (San Joaquin County 2010) describes policies for the protection of the county's natural resources, including agricultural lands. San Joaquin County is in the process of updating its general plan.

- Objective 1: To protect agricultural lands needed for the continuation of commercial agricultural enterprises, small-scale farming operations and the preservation of open space.
- Objective 3: To minimize the impact on agriculture in the transition of agricultural areas to urban development.
- Policy 5: Agricultural areas shall be used principally for crop production, ranching, and grazing.
- Policy 6: All lands designated for agricultural uses and those lands designated for nonagricultural use but not needed for development for 10 years shall be placed in an agricultural preserve and shall be eligible for Williamson Act contracts. Parcels eligible for Williamson Act contracts shall be 20 or more acres in size in the case of prime land, or 40 or more acres in the case of non-prime land.

Stanislaus County

The *Agricultural Element* of the *Stanislaus County General Plan* (Stanislaus County 2012) describes goals, objectives, policies, and implementation measures focused on the protection of the economy of the county by minimizing conflicts between the environment, agriculture, and urban development. Stanislaus County is currently updating its general plan and incorporating a 20-year planning horizon to 2035.

- Goal 1: Strengthen the agricultural sector of the economy.
- Goal 2: Conserve our agricultural lands for agricultural uses.

- Policy 1: Established agricultural land use categories that promote a range of agricultural activities and preserve open space (e.g., general agriculture, limited agriculture, and agriculture-urban reserve).

City of Tracy

The *City of Tracy General Plan's Open Space and Conservation Element* contains an objective (OSC-2.2) and policy (P1) focused on minimizing conflicts between agricultural and urban uses, and the policy establishes buffer zones around development projects to protect agriculture operations from the impacts of incompatible development (City of Tracy 2011).

City of Stockton

The *Land Use Element* of the *2035 Stockton General Plan Goals and Policies Report* discusses the City's goal to promote the protection of agricultural lands outside of the urban service area and to discourage the premature conversion of agricultural lands within the urban service area. Related policies limit urban uses in agricultural land and establish permanent agricultural/open space buffers along the "ultimate edge" of the Urban Service Area (Policies LU-2.1 and LU-2.2, respectively). In addition, The *Natural and Cultural Resources Element* describes the goal and related policies to foster a viable agricultural industry in the city through promoting the continuation of existing agricultural operations; insuring the compatibility of Stockton's Right to Farm ordinance with San Joaquin County's ordinance; supporting an Agricultural Conservation Program; and supporting policies adopted by San Joaquin County to promote agricultural viability (City of Stockton 2007).

City of Modesto

The *Environmental Resources and Open Spaces* element of the City of Modesto's *Final Urban Area General Plan* identifies agricultural resources policies focused on minimizing the loss of agricultural land by maintaining future development such that it is relatively compact and of "reasonable high density." Where necessary to promote planned growth, the City encourages the development of agricultural lands that are already compromised by adjacent urban development (City of Modesto 2008).

City of Merced

Agriculture is a major contributor to the economic viability of the City of Merced. As such, Merced's general plan identifies goals and policies intended to foster the protection of agriculture and the preservation of agriculturally significant areas by directing development away from significant concentrations of Prime agricultural soils, giving priority to the conversion of non-prime agricultural land, and limiting development impacts on agricultural lands along the city's urban fringe (City of Merced 2015).

City of Turlock

In its general plan, the City of Turlock states that one of the eight "General Plan Themes" is the establishment of limits to urban growth to maintain Turlock as a "freestanding city surrounded by agricultural land" (City of Turlock 2012). To that end, policies related to agricultural resources in the *Turlock General Plan* promote continued agricultural activity on lands surrounding the urban areas of the city; encourage infill to protect farmland; minimize conflict between urban and agricultural uses; require participation in county-wide agricultural mitigation; and support participation in the Williamson Act Program (City of Turlock 2012).

City of Riverbank

The *Conservation and Open Space* element of the *City of Riverbank General Plan 2005–2025* addresses the importance of agriculture in the city of Riverbank through policies that focus on sustaining agriculture and resources associated with farming. These policies include developing a sustainable agricultural strategy to conserve agricultural production in the Stanislaus River Watershed and establishing buffers to protecting ongoing agricultural practices in the western portion of the Riverbank planning area from urban encroachment (City of Riverbank 2009).

City of Oakdale

The *Land Use* and *Natural Resources* elements of the *City of Oakdale 2030 General Plan* identify goals and policies related to the preservation of agricultural lands and agricultural operations within and outside of the City of Oakdale's planning area. Policies include supporting the production of existing agricultural properties; preparing and adopting a plan for agricultural preservation; and maintaining agricultural and rural lands outside of urbanized areas (City of Oakdale 2013).

City of Ripon

The *Open Space and Conservation* element of the *City of Ripon General Plan 2040* establishes goals and policies to protect recreational, cultural, and natural resources, including agricultural resources. The general plan identifies policies intended to discourage premature conversion of agricultural lands, reduce the intrusion of urban development in agricultural areas, and prohibit the conversion of agricultural land to urban uses unless the property is contiguous to existing or approved urban uses (City of Ripon 2006).

City of Manteca

The *Resource Conservation Element* of the *City of Manteca General Plan 2023 Policy Document* outlines a goal and related policies to "promote the continuation of agricultural uses in the Manteca area and discourage the premature conversion of agricultural land to nonagricultural uses, while providing for the urban development needs of Manteca" (City of Manteca 2011).

City of Lathrop

The *Comprehensive General Plan for the City of Lathrop* (City of Lathrop 2004) stresses the importance of minimizing the amount of agricultural land converted for urban use and avoiding premature conversion of agricultural land. Agricultural land policies are focused on avoiding urban-agricultural conflicts at the margin of urban areas.

City of Escalon

Select goals and policies identified in the *Urban Boundary Element* and the *Open Space, Conservation and Recreation Element* of the City of Escalon's general plan stress the need to preserve and protect agricultural use on lands in and around the Escalon planning area for open space, and to prohibit the premature conversion of agricultural lands where agricultural preserves are present (City of Escalon 2010).

Zoning

The general plan for counties and cities is commonly implemented through zoning and other local land use and development ordinances that must be consistent with the general plan. City and county zoning ordinances in the LSJR area of potential effects generally allow a variety of agricultural and related uses. In reviewing and making decisions on applications for various land use entitlements and development projects, the local agency must typically make findings that the proposed activity (e.g., a conditional use permit or a subdivision of real property) is consistent with the applicable general plan. If the decision is discretionary and a project could have a potentially significant adverse effect on the physical environment, then the county or city is also obligated to comply with the procedural and documentation requirements of CEQA. Table 11-11 identifies the approximate acres zoned for agriculture or related use (e.g., agricultural residential) in the LSJR area of potential effects according to the six geographic areas, as well as in the SDWQ area of potential effects.

Table 11-11. Acreages Zoned for Agricultural Use in the LSJR and SDWQ Areas of Potential Effects

Areas of Potential Effects	Zoned Agricultural Land [a, b]
LSJR Area of Potential Effects	
SEWD/ CSJWCD	119,000
SSJID	55,000
OID	65,000
TID	161,000
MID	69,000
Merced ID	129,000
Total	598,000 [c]
SDWQ Area of Potential Effects	
Total	113,000 [d]

LSJR = Lower San Joaquin River
SDWQ = southern Delta water quality
SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Conservation District
SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District

[a] Acreage values are rounded to the nearest thousand and are based on available GIS zoning data for the cities and counties within the areas of potential effects.

[b] *Zoned agricultural land* includes land designations made by the applicable local jurisdictions (i.e., Merced, Stanislaus, and San Joaquin Counties) that are intended to protect farmland and farming activities from incompatible uses.

[c] Approximately 73,000 additional acres lie within the LSJR area of potential effects that could not be identified according to county or city zoning because GIS zoning data was not available.

[d] Approximately 4,000 additional acres lie within the SDWQ area of potential effects that could not be identified according to county or city zoning because GIS zoning data was not available.

Agricultural Water Management Plans or Water Management Plans

Pursuant to the Water Conservation Bill of 2009 (SBX7-7), OID, Merced ID, MID, SSJID, SEWD, and TID have prepared AWMPs. Table 13-10 in Chapter 13, *Service Providers*, describes methods that are common throughout all of the irrigation district AWMPs for addressing surface water shortages. Below is a brief summary of information contained in each district's AWMP regarding water shortage allocation polices and water management.

Oakdale Irrigation District

OID supplies irrigation water and domestic drinking water for subdivisions outside of the City of Oakdale service area.[7] The district's primary water supply comes from surface water diversions on the Stanislaus River at Goodwin Dam. OID's surface water shortage policy "includes suspension of surface water deliveries once available supplies are exhausted, but allows for intra-district water transfers and the use of available groundwater from OID wells" (OID 2012). OID's *Rules and Regulations Governing the Operation and Distribution of Irrigation Water within the Oakdale Irrigation District Service Area* (Rules and Regulations) are occasionally reviewed and revised as needed to address changing conditions and to account for dry periods, most recently in 2005. The rules and regulations prescribe conditions that ensure distribution of irrigation water to users in an orderly, efficient and equitable manner. Depending on the severity of the water shortage the district may suspend out of district agreements, provide irrigation water for agricultural purposes only, and implement a zero discharge policy, with fines for violators. OID's AWMP identifies implemented and planned efficient water management practices (EWMPs), including providing technical assistance for growers implementing on-farm improvements through the Natural Resources Conservation Service Environmental Quality Incentives program; continuing a testing and evaluation program for existing pumps; and implementing OID's water resources plan flow control and measurement structure projects (OID 2012).

Merced Irrigation District

The Merced River is the main source of Merced ID's water supply. During an average wet year, 99 percent of Merced ID's water supply comes from surface water. The remainder of the supply comes from groundwater. Merced ID identifies a conjunctive water management strategy in their AWMP as part of its drought water management approach. This strategy is intended to manage groundwater conditions so that during surface water supply shortages, there will be sufficient water supplies available to meet the district's needs. Furthermore, during years of surface water shortage, Merced ID reduces the allocation to its growers proportioned to its Class I and Class II users. The Merced ID AWMP identifies several EWMPs, such as facilitating financial assistance to support on-farm improvements needed to take surface water from Merced ID during years of available surface water and utilize groundwater wells during years of surface water shortages. Other Merced ID EWMPs include implementing an incentive pricing structure to encourage more efficient water use at the farm level; constructing/operating tailwater and spill recovery systems; and promoting and performing pump testing (Merced ID 2013).

[7] OID surface water is provided for agriculture, and OID owns and operates a rural water system that provides groundwater for domestic use.

Modesto Irrigation District

MID supplies groundwater and surface water from the Tuolumne River to agricultural, residential, and municipal customers. Tuolumne River water supplies vary depending on precipitation, snow melt runoff, and the previous year's carryover storage in Don Pedro Reservoir. During dry years, the MID Board of Directors reduces water allocation and may shorten the irrigation season. In addition, MID will also conjunctively use groundwater to supplement surface water and water users may use private irrigation wells to supplement water supplied by the irrigation district. MID has an irrigation water allocation policy, which establishes the allocation and cost of water to landowners. It is adopted by the Board of Directors annually. The allocation is based on factors including the volume of water carried over in storage in Don Pedro Reservoir and the projected runoff from the watershed. The allocation is not finalized and adopted until after the rainy season when runoff information has been made available. Identified in MID's AWMP are several ongoing and planned EWMPs, such as facilitating alternative land uses for lands with high water duties or irrigation problems, including drainage issues; providing financial assistance to water users to replace private ditches and pipelines; and lining approximately 86 percent of the district's delivery canals with concrete (MID 2012).

South San Joaquin Irrigation District

SSJID diverts water from the Stanislaus River at Goodwin Dam into the Joint Main Canal, which is jointly owned and operated by SSJID and OID, with 72 percent of the capacity intended for SSJID. SSJID provides water predominately for irrigation, but also provides treated surface water to the cities of Manteca, Lathrop, and Tracy for domestic use (SSJID 2012). SSJID's surface water shortage contingency actions entail eight operational measures including postponing the start date of the irrigation season; implementing a variable water delivery rotation schedule and maximum time limits for flood irrigation; allowing for inter-parcel transfers/fallowing; and implementing irrigation quantity limits for pressurized systems (SSJID 2012). The SSJID AWMP identifies several ongoing EWMPs and the activities implemented and planned to achieve those EWMPs. Some planned activities include continuing their On-Farm Conservation Program, which provides financial incentives to improve the existing distribution system and enhance farm irrigation practices (SSJID 2013); refining conjunctive management by further evaluating the underlying groundwater system; and continuing and expanding spill site monitoring to reduce spillage and develop representative data (SSJID 2012). SSJID functions in an economical manner to distribute the water equitably and in as satisfactory a manner as possible for all water users.as near as may be satisfactory to all water users. No two individuals have exactly the same requirements, and while these individual requirements will be met as far as possible, there must be general rules and general practices to secure the greatest good to the greatest number.

Stockton East Water District

SEWD serves both urban and agricultural water users. SEWD receives surface water from both the Stanislaus River (within the LSJR area of potential effects) and Calaveras River (outside of the LSJR area of potential effects). SEWD also has a contract to provide water to CSJWCD (within the LSJR area of potential effects) on an annual basis (SEWD 2014). The *Stockton East Water Management Plan* (SEWD 2014) includes information that addresses the AWMP requirements, including the agricultural water allocation policy, as well as an EWMP report and best management practices (BMPs) for agricultural contractors. According to the agricultural water allocation policy, SEWD has sufficient water to withstand 2 to 3 dry years. When a water year has been identified as a dry year, SEWD requests voluntary water use reductions from its agricultural customers. In a subsequent dry year, these voluntary reductions are identified as critical, and in a third subsequent dry year, these reductions may be mandatory (SEWD 2014). In all water years, SEWD customers are asked to call in advance of diverting water so that the district may adjust water releases; this advance notice is mandatory in dry years. SEWD's water management plan identifies several BMPs that the district implements in the context of efficient water management, such as providing evaluation of irrigation practices to its customers; implementing agricultural water management educational programs for farmers and the public; and optimizing conjunctive management of surface and groundwater (SEWD 2014).

Turlock Irrigation District

TID receives its principal water supply from the Tuolumne River. TID supplements surface water releases with drainage wells and rented wells, and also uses supplemental groundwater pumping to help conserve water by reducing canal spillage. TID primarily supplies irrigation water for agriculture in its service area, but also provides drinking water to the community of La Grange, in conjunction with MID. TID's surface water shortage policies include increasing groundwater pumping, implementing a "dry year" rate schedule, and internal transfers (TID 2012). Historically a three-tiered, increasing block rate schedule based on three classes of water deliveries has been used. The first block is the annual allotment that was available equally to each acre of land. The volume of the allotment varied depending upon the available surface water supply. The actual allotment, as well as any additional water available above the allotment, is set each year based on projected runoff including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River and the availability of rented pumps. TID's AWMP also identifies currently implemented and planned EWMPs, such as operating spill and tailwater recovery systems; facilitating the use of available recycled water; implementing a pricing structure that promotes various goals to improve water use efficiency; and converting 90 percent of its conveyance and distribution system to pipeline or concrete lined canals (TID 2012).

11.4 Impact Analysis

This section identifies the thresholds or significance criteria used to evaluate the potential impacts on agricultural resources. It further describes the methods of analysis used to determine significance. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany the impact discussion, if any significant impacts are identified.

11.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based on the State Water Board's Environmental Checklist in Appendix A of the Board's CEQA regulations. (Cal. Code Regs., tit. 23, §§ 3720–3781.) The thresholds derived from the checklist have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) Agricultural resource impacts were determined to be potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Board's Environmental Checklist*) and, therefore, are discussed in this analysis as to whether the alternatives could result in the following.

- Potentially convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland) to nonagricultural use.
- Involve other changes in the environment which, due to their location or nature, could result in conversion of farmland to nonagricultural use.
- Conflict with existing zoning for agricultural use or a Williamson Act contract.
- Conflict with any applicable land use plan, policy, or regulation related to agriculture of an agency with jurisdiction over a project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect.

Where appropriate, specific quantitative or qualitative criteria are described in Section 11.4.2, *Methods and Approach*, for evaluating these thresholds.

As described in Appendix B, *State Water Board's Environmental Checklist*, the alternatives would result in either no impact or less-than-significant impacts with regards to the following conditions, and therefore are not discussed further in this chapter.

- Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Pub. Resources Code, § 12220(g)), timberland (as defined by Pub. Resources Code, § 4526), or timberland zoned Timberland Production (as defined by Gov. Code, § 51104(g).)
- Result in the loss of forest land or conversion of forest land to nonforest use.

11.4.2 Methods and Approach

Under the LSJR and SDWQ alternatives, two basic changes could result in significant impacts on agricultural resources: reduction in surface water diversions for crop production in the LSJR area of potential effects or a change in water quality that could result in crop yield reductions in the SWDA. Both of these changes have the potential to affect crop production and lead to conversion of irrigated lands to nonagricultural uses in either the LSJR area of potential effects or the SDWQ area of potential effects.

The methods for analyzing impacts under the LSJR and SDWQ alternatives are described below.

LSJR Alternatives

This chapter evaluates the potential groundwater impacts associated with the LSJR alternatives. Each LSJR alternative includes a February–June unimpaired flow requirement (i.e., 20, 40, or 60 percent) and different methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. The sections below describe steps for processing the WSE model results for the groundwater analysis, methods of analysis for adaptive implementation in this chapter, and baseline results to which the LSJR alternatives are compared to determine the significance of impacts on groundwater. The LSJR alternatives could result in a reduction of surface water diversions currently used to irrigate existing agricultural lands. The WSE and SWAP models are the primary tools used to assess how decreased surface water supplies under the LSJR alternatives could impact irrigated crop land.

Four separate models were used to analyze agricultural impacts. Brief definitions of each model and the manner in which they are used and applied to the analysis are given below. For full descriptions of the models refer to the appendices listed by each model below.

- Water Supply Effects (WSE) Model – Appendix F.1, *Hydrologic and Water Quality Modeling*.
- Statewide Agricultural Production (SWAP) Model – Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results.*
- Impact Analysis for Planning (IMPLAN) – Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results.*
- Salinity Related Impacts – Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta.*

Water Supply Effects Model

Results from the WSE model were used in the SWAP model to generate annual crop production under each LSJR alternative. The WSE model generated monthly surface water diversion volumes and estimated the availability of water delivery for crop production expected under each LSJR alternative. In addition to surface water, groundwater was assumed to be available (see Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results,* and Chapter 9, *Groundwater Resources,* for more information regarding groundwater) and was included in the monthly water amounts available for irrigation. Monthly surface and groundwater values were aggregated to cropping season requirements. Annual crop production under each LSJR alternative is represented as acreage of a given crop category by year for 1922–2003.

Estimates of the total amount of water applied to the irrigated lands of the irrigation districts (applied water) are required for the SWAP analysis. Applied water rates are unique to each crop category and to each geographic area. Applied water demands may be satisfied by surface water and groundwater, or a combination of the two. After the water is applied to the irrigated land, it will either be consumptively used by the crops, return to the river as surface runoff, or percolate into the ground below the fields. However, for the WSE modeling surface runoff from the fields is accounted for separately from applied water, as part of the "spills and returns" of each irrigation district. For more information on applied water see Appendix G, Section G.4.2, *Crop Distribution and Applied Water Inputs for SWAP*.

Some post-processing of the WSE model results is required to generate the applied water input for the SWAP analysis. As part of post-processing, the diversions for each river are partitioned between different types of deliveries and losses. Volumes of water assumed not to be subject to a water shortage (e.g., municipal and industrial water supply, riparian rights) are subtracted from the total diversions for each river to calculate the remaining water. Any water left over is then delivered to the irrigation districts to be used for applied water demands and to account for the operational spills and river returns from the district. In the modeling, operational spills and river returns are assumed to be fully accounted for, even in times of water shortage. In addition, some fraction of the water delivered to the districts will also be lost as seepage or evaporation from the conveyance system. When diversions are less than what is needed to meet full demands (including all categories of deliveries and losses), only the applied water deliveries are assumed to be reduced (which, in turn, will also reduce the conveyance losses). This allows for a conservative estimate of agricultural impacts (i.e., agricultural impacts may be slightly overestimated rather than underestimated).

In the WSE model, SEWD and CSJWCD diversions from the Stanislaus River are calculated separately from the SSJID and OID diversions because they are CVP contractors and only receive water after SSJID and OID water rights have been met. The division of Stanislaus River water between SSJID and OID and Tuolumne River water between MID and TID is calculated as part of post processing. This is based on the assumption that each district receives the same percent of surface water demand for consumptive use, as described in Appendix G.

The capacity of each irrigation district to pump groundwater varies and depends on existing infrastructure (Chapter 9, *Groundwater Resources*, Table 9-6, and Appendix G). Within the districts, there is a minimum amount of groundwater pumping that occurs every year. If the amount of available surface water and minimum groundwater pumping is insufficient to meet the irrigation district's applied water demands, then additional groundwater pumping would occur. In this situation, groundwater pumping would increase either to meet the shortage or until it reaches the maximum amount that the districts could pump. The maximum groundwater pumping capacities are estimated based on best available data as described in Chapter 9 and Appendix G. Agriculture is potentially affected when the additional groundwater pumping is unable to fully meet the shortfall in the applied surface water.

Because baseline is representative of 2009 groundwater infrastructure, the primary agricultural analysis utilizes estimates of maximum groundwater pumping that were possible in 2009. However, as a result of recent drought conditions, more wells have been drilled and, therefore, an assessment using estimates of maximum groundwater pumping for 2014 is also discussed in Section 11.4.3, *Impacts and Mitigation Measures*. All of the 2014 maximum groundwater pumping estimates are greater than the 2009 maximum groundwater estimates, with the exception of Merced ID, for which the two estimates are the same. This is reasonable because Merced ID's 2009 capacity for increased groundwater pumping was almost sufficient to meet full demand in drought years.

Adaptive Implementation

Each LSJR alternative includes a February–June unimpaired flow requirement (i.e., 20, 40, or 60 percent) and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. In addition, a minimum base flow is required at Vernalis at all times during this period. The base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses.

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. The STM Working Group may recommend adjusting the flow requirements through adaptive implementation if scientific information supports such changes to reasonably protect fish and wildlife beneficial uses. Scientific research may also be conducted within the adaptive range to improve scientific understanding of measures needed to protect fish and wildlife and reduce scientific uncertainty through monitoring and evaluation. Further details describing the methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K.

Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of no more than 7 days. The four methods of adaptive implementation are described briefly below.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.

2. Based on best available scientific information indicating a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.

3. Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature, which would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Chapter 3 and Appendix K for further details.

4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cubic feet per second (cfs) may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (e.g., monthly or annually) or longer-term basis. Adaptive implementation is intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. While the measures and processes used to decide upon adaptive implementation actions must achieve the narrative objective for the reasonable protection of fish and wildlife beneficial uses, adaptive implementation could result in flows that would benefit or reduce impacts on other beneficial uses that rely on water.

The quantitative results included in the figures, tables, and text of this chapter present WSE modeling results of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). However, the modeling does allow some inflows to be retained in the reservoirs after June, as could occur under adaptive implementation method 3, to prevent adverse temperature effects and this is included in the results presented in this chapter. If the percent of unimpaired flow is not specified in this chapter, these are the percentages of unimpaired flow evaluated in the impact analysis. However, as part of adaptive implementation method 1, the required percent of unimpaired flow could change by up to 10 percent if the STM Working Group agrees to adjust it. The highest possible percent of unimpaired flow associated with an LSJR alternative is also evaluated in the impact analysis if long-term implementation of method 1 has the potential to affect a determination of significance. For example, if the determination for LSJR Alternative 2 at 20 percent unimpaired flow is less than significant, but the determination for LSJR Alternative 3 at 40 percent unimpaired flow is significant, then LSJR Alternative 2 is also evaluated at the 30 percent unimpaired flow. This use of modeling provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1, *Hydrologic and Water Quality Modeling*.

SWAP Model

After the post processing of the WSE model results, as described above, the SWAP model simulates the decisions of growers at a regional level based on the principles of economic optimization. The model assumes that farmers maximize profit subject to resources and market constraints, shifting crop production to favor crop categories that maximize profit subject to given constraints. The model accounts for land and water availability and production prices, while calibrating to observed yearly values of land, labor, and water supplies. The basic model outputs are annual estimates of crop production acreage, water use, and revenue by the 19 crop categories in the DAU survey (Table 11-4) for the LSJR alternatives.

Impact AG-1 uses the quantitative results of the SWAP model to first evaluate if significant reductions in agricultural acreage or significant reductions in crop mix would occur under the LSJR alternatives. This analysis uses cumulative distribution tables since the cumulative distribution of a particular variable (e.g., irrigated acreage) provides a basic summary of the distribution of values. The percentile (percent cumulative distribution) associated with each value indicates the percent of time that the values were less than the specified value. For example, as depicted in Figure 11-3b, for SSJID under baseline conditions, approximately 1,656 acres of Pasture receive irrigation water at the 80th percentile, while approximately 473 acres of Pasture are irrigated at the 90th percentile; and, in all water years (i.e., 100th percentile) there is sufficient supply to irrigate only about 50 acres of Pasture. In other words, the acreage value at the 100th percentile provides an estimate of irrigated acreage that is likely to be exceeded 100 percent of the time, meaning that this fraction of irrigated pasture under baseline conditions would be expected to always be irrigated in SSJID, even under the driest possible conditions. The acreage value at the 0 percentile is an amount of irrigated acreage that would never likely be exceeded, even under the wettest conditions.

The amount of irrigated acreage is central to the analysis of Impact AG-1 because, by definition, Prime Farmland and Farmland of Statewide Importance, as described by the 2006 FMMP, requires a dependable water supply in 8 out of 10 years (DOC 2007). Stated another way, if there is more than a 20 percent reduction in overall irrigated acreage, then the water supply for that crop will be assumed to be inadequate to maintain the Prime Farmland and Farmland of Statewide Importance criteria. For this analysis, annual changes in the amount of irrigated acreage over the 82-year modeling period were averaged by irrigation district,.

The SWAP-generated baseline was the basis for comparison and determination of potential impacts on irrigated cropland for Impact AG-1. However, the SWAP model cannot quantify whether actual conversation of Prime, Farmland of Statewide Importance, and Unique Farmland to nonagricultural uses would result, given numerous factors, including the individual decisions of agricultural producers that influence potential conversion. However, as the amount of irrigated lands that are converted to non-irrigated agriculture increases, the likelihood that *some* of these lands may result in being converted to nonagricultural uses, including urbanization, would be expected to increase.

The 2013 California Water Plan Update for the San Joaquin River Hydrologic Region (DWR 2014) projects that by 2050 urbanization will result in the permanent conversion of between 6 percent and 14 percent of irrigated acreage in the San Joaquin Valley annually. This conversion is dependent on many development pressure factors, such as population growth and the density of development of surrounding lands. Although predicting which irrigation districts would be more likely to be affected by urbanization in the San Joaquin Valley is not possible because it would depend on local land use decisions, a reduction of irrigated lands would be expected to influence where conversions occur. For example, all the irrigation districts presently contain urban and built-up lands, much of it along the Highway 99 corridor, and most conversions of agricultural lands to urban uses happen in the urban fringe area. Therefore, it is reasonable to assume that the amount of land that may actually convert to nonagricultural use in the San Joaquin Valley would include some fraction of the percentage of land that does not receive irrigation in the LSJR area of potential effects for agricultural resources. It is also reasonable to assume that some percentage of the farmland that would be converted to nonagricultural uses has been included as part of recent projections (6–14 percent annually) for urban conversion (although reductions in the availability of irrigation water may have more influence on the ultimate location of development as opposed to the extent of development). Importantly, a presumably large proportion of the farm lands affected by potential reductions of irrigation water supply, as estimated by the SWAP model, is likely to remain either temporarily or permanently in nonirrigated agricultural use (e.g., dryland farming, grazing, and fallowing). Based on consideration of these factors, a predicted reduction of 4 percent or more of irrigated acreage in any one district was adopted as a conservative threshold for determining significance for Impact AG-1.

For Impact AG-2, other changes in the existing environment, as possibly predicted by the SWAP model, are addressed, including seepage effects on agricultural lands and indirect effects of reduced Pasture and Alfalfa on dairies. Information from Chapter 5, *Surface Hydrology and Water Quality*, and Chapter 6, *Flooding, Sediment, and Erosion,* is incorporated to identify Stanislaus River flow levels that may result in elevated seepage in areas previously identified as being affected by Stanislaus River flows. Information from the SWAP model and irrigation district water use are used to qualitatively discuss indirect effects on dairies. To observe impacts that may affect the dairy industry acreage for Alfalfa and Pasture or Corn and Grain from the SWAP model can be combined. The SWAP model has limitations in modeling performance of feed crops as these crop groups usually have lower net returns to land and management. The issue is overcome for dairies by employing minimum silage constraints as silage typically must be produced closed to the dairies. Given the SWAP model uses a simplified assumption that water use would shift from lower net revenue crops to high-value crops, it likely over predicts the shift for other feed crops.

Impacts AG-3 and AG-4 were qualitatively evaluated based on whether the reduced crop production conflict with Williamson Act or zoning policies. The evaluation incorporates the existing setting information identified in Sections 11.2.2, *Lower San Joaquin River Watershed and Eastside Tributaries*, and 11.3, *Regulatory Background*, and the authority of the State Water Board as a state agency under each of the LSJR alternatives.

SWAP Modeled Baseline

Based on the WSE model estimates of allowable surface water diversions and available groundwater for the 1922–2003 period, SWAP model output show the distribution of crop acreage by crop categories for each irrigation district in the area of potential effects (Table 11-12 and Figures 11-3a and 11-3b through Figure 11-8). Crop category groupings are based on similar type crops. These combinations were selected because of similar net revenue by crop category, the ability to observe impacts on specific industries such as dairy and cattle, and where appropriate to reduce the overall number of impact curves. These figures provide examples of how the acreage of different crop types can change in response to water availability. Figure 11-3, for example, shows that the acreage of permanent crops (Almonds, Orchards, Pistachio, Subtropical, and Vine) changes very little. There is only a very small reduction that occurs in less than 10 percent of years, when acreage drops from approximately 41,000 acre to approximately 39,000 acres. The acreage of pasture stays the same, about 2,300 acres, most of the time under baseline. However, unlike for permanent crops, acreage decreases in about 15 percent of years to acreages approaching zero under baseline. This is generally reflective of the response of irrigated agriculture to reduced water availability—limited water supplies are typically directed towards permanent crops and crops with higher net revenue.

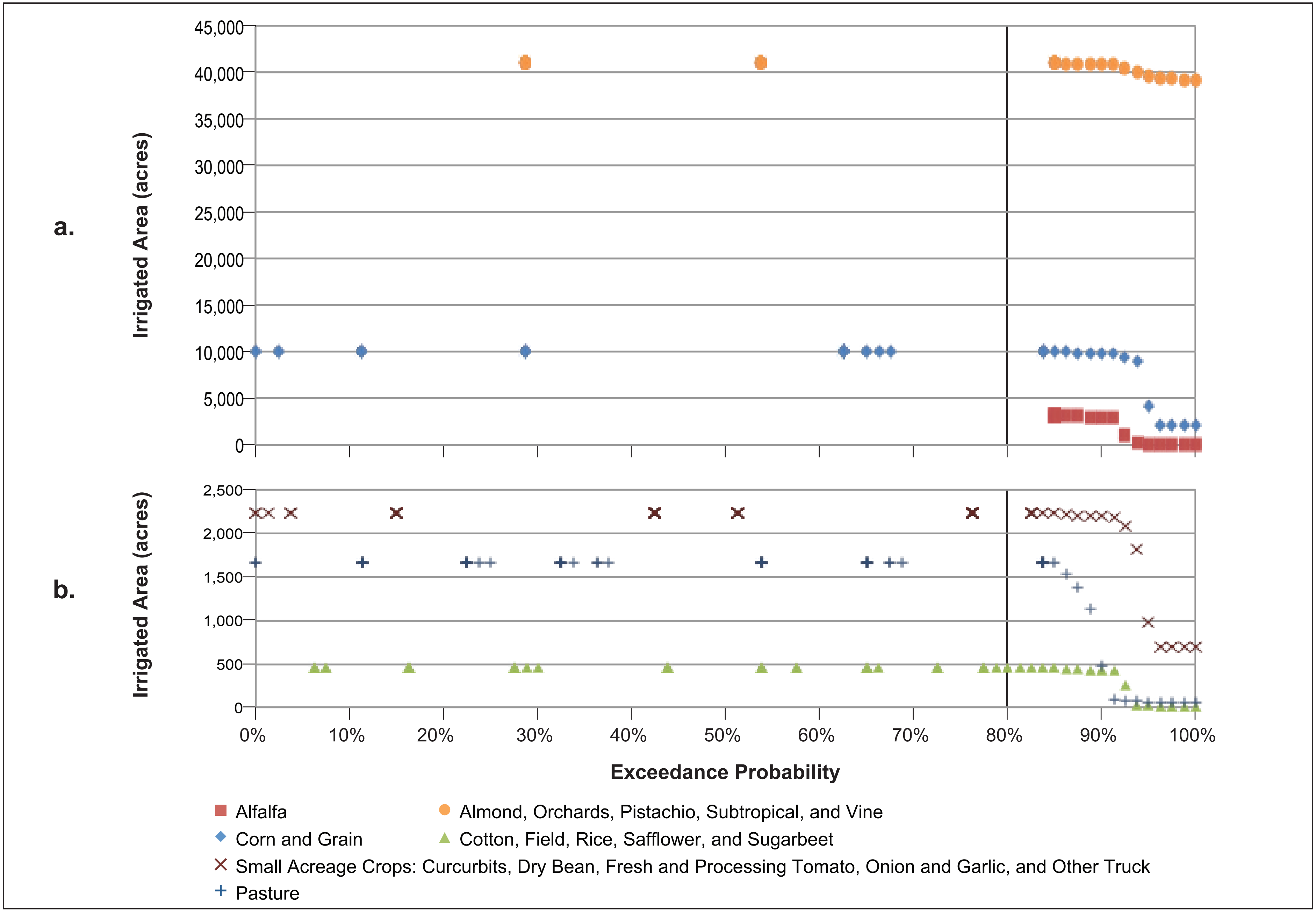
Salinity Impacts of LSJR Alternatives

The effects of the LSJR Alternatives on salinity concentrations in the SJR at Vernalis and the southern Delta are evaluated using the WSE model as presented in Appendix F.1, *Hydrologic and Water Quality Modeling*. The impacts of these salinity concentrations relative to baseline are analyzed in Chapter 5, *Surface Hydrology and Water Quality* (Impacts WQ-1 and WQ-2) and determined to be less than significant for all LSJR alternatives. Therefore, the associated salinity impacts on agricultural resources are also considered to be less than significant and are not discussed further in this chapter.

Table 11-12. Average Annual SWAP Baseline Acreage and Percent by Crop Category for Each Irrigation District

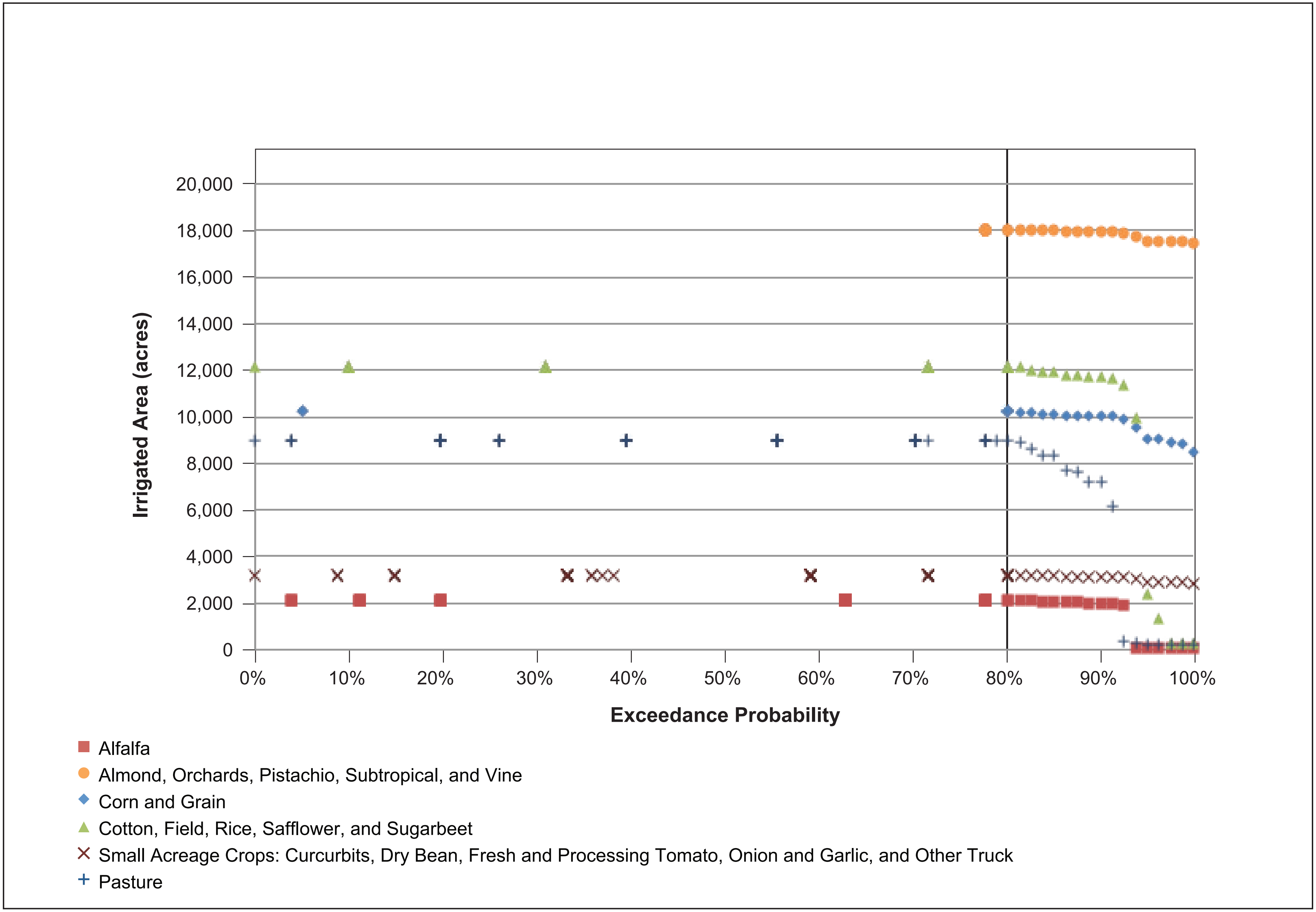
	SSJID		OID		SEWD & CSJWCD		MID		TID		Merced ID	
	Acres	% of Total	Acres	% of Total	Acres	% of Total	Acres	% of Total	Acres	% of Total	Acres	% of Total
Alfalfa	3,080	5.3	2,098	3.9	6,870	6.9	2,513	4.4	13,115	9.1	5,634	5.6
Almonds and Pistachios	27,022	46.4	10,519	19.4	17	0.0	13,139	22.9	33,741	23.5	30,616	30.7
Corn	8,248	14.2	9,810	18.1	16,096	16.3	10,506	18.3	43,283	30.1	19,109	19.2
Cotton	NC		NC		NC		NC		NC		2,482	2.5
Cucurbits	486	0.8	103	0.2	818	0.8	128	0.2	469	0.3	649	0.7
Dry Bean	172	0.3	216	0.4	768	0.8	254	0.4	1,065	0.7	NC	
Grain	1,666	2.9	387	0.7	8,320	8.4	215	0.4	460	0.3	3,177	3.2
Onion and Garlic	602	1.0	NC		179	0.2	NC		NC		NC	
Orchards	6,847	11.8	6,508	12.0	43,174	43.6	8,138	14.2	8,221	5.7	4,884	4.9
Other Field Crops	203	0.3	7,865	14.5	NC		9,376	16.3	28,848	20.1	7,145	7.2
Other Truck Crops	431	0.7	2,854	5.3	1,119	1.1	3,548	6.2	8,020	5.6	11,912	11.9
Pasture	1,582	2.7	8,597	15.9	4,019	4.1	7,754	13.5	4,106	2.9	5,622	5.6
Rice	82	0.1	4,188	7.7	NC		639	1.1	NC		1,158	1.2
Safflower	158	0.3	NC		NC		NC		NC		NC	
Subtropical	1,743	3.0	137	0.3	NC		42	0.1	63	0.0	NC	
Sugarbeet	NC		NC		NC		NC		NC		277	0.3
Tomato (Fresh)	70	0.1	NC		8,064	8.2	NC		379	0.3	1,847	1.9
Tomato (Processing)	446	0.8	NC		NC		NC		NC		1,383	1.4
Vine	5,391	9.3	881	1.6	9,487	9.6	1,103	1.9	2,014	1.4	3,874	3.9
Total	58,229		54,162		98,931		57,354		143,783		99,769	

SEWD/CSJWCD = Stockton East Water District/Central San Joaquin Water Conservation District
SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District



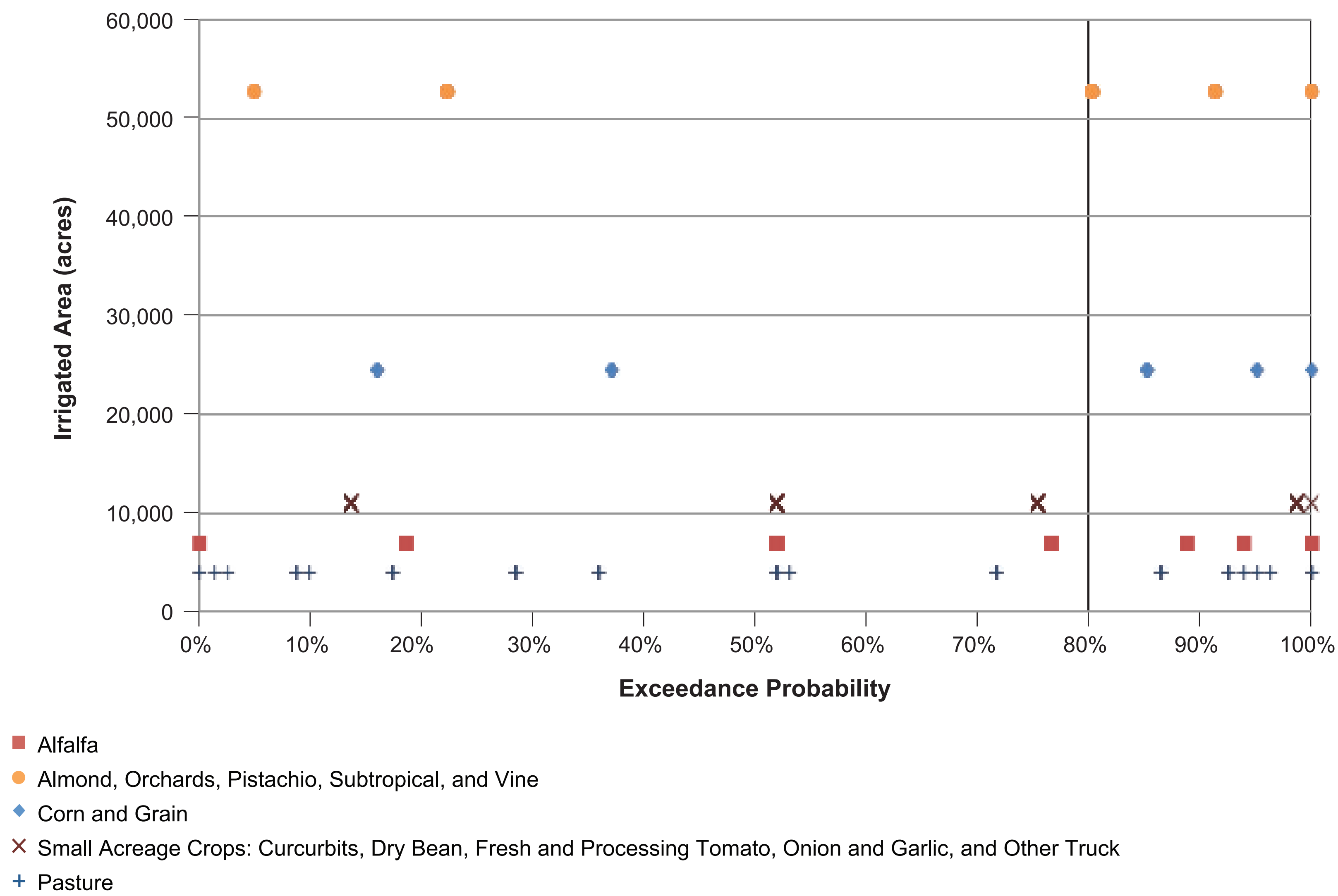
Graphics...00427.11 (1-6-2016)

Figure 11-3
Irrigated Acreage in SSJID for Baseline



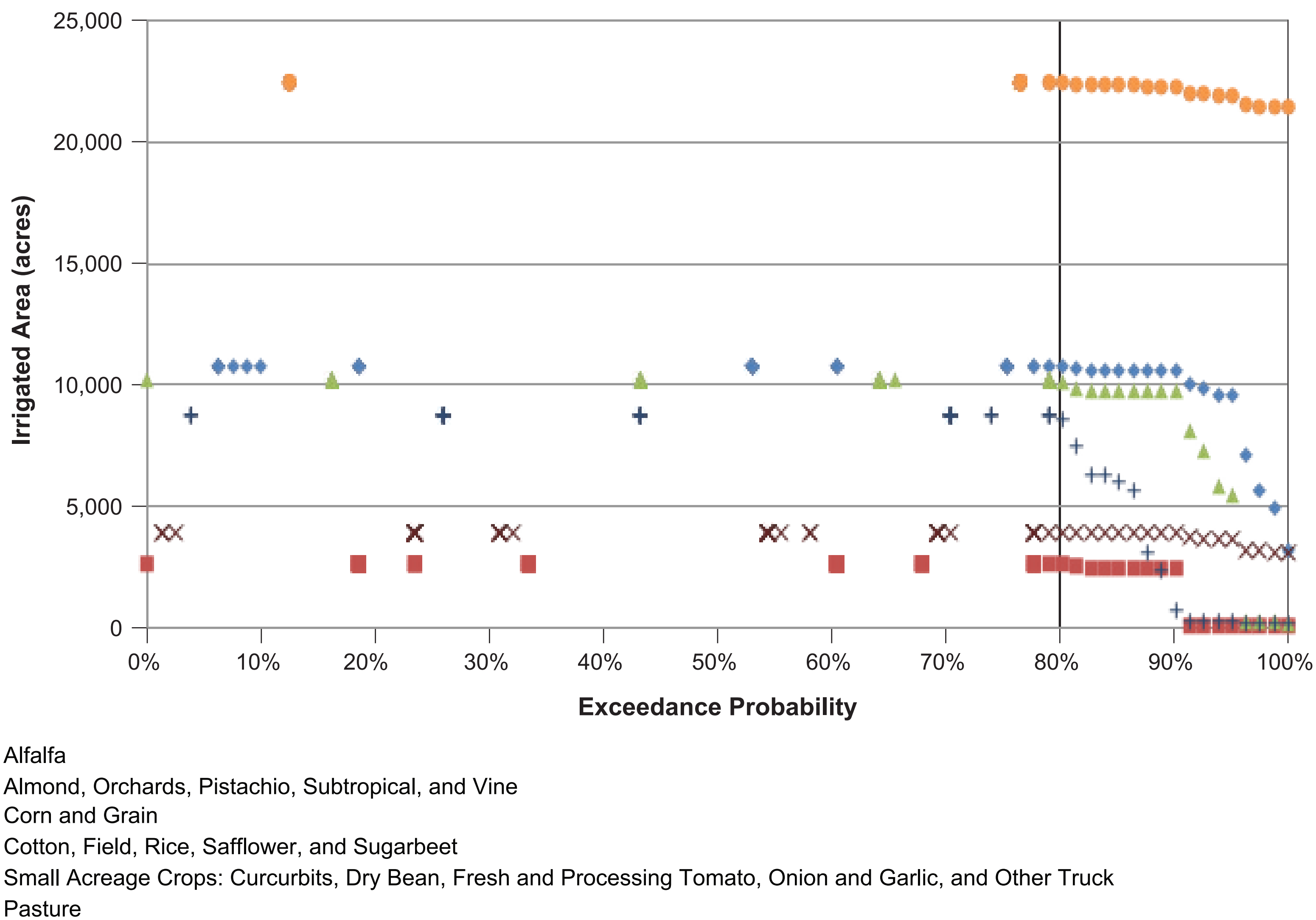
Graphics...00427.11 (1-6-2016)

Figure 11-4
Irrigated Acreage in OID for Baseline



Graphics…00427.11 (1-6-2016)

Figure 11-5
Irrigated Acreage in SEWD and CSJWCD for Baseline



Graphics...00427.11 (1-6-2016)

Figure 11-6
Irrigated Acreage in MID for Baseline

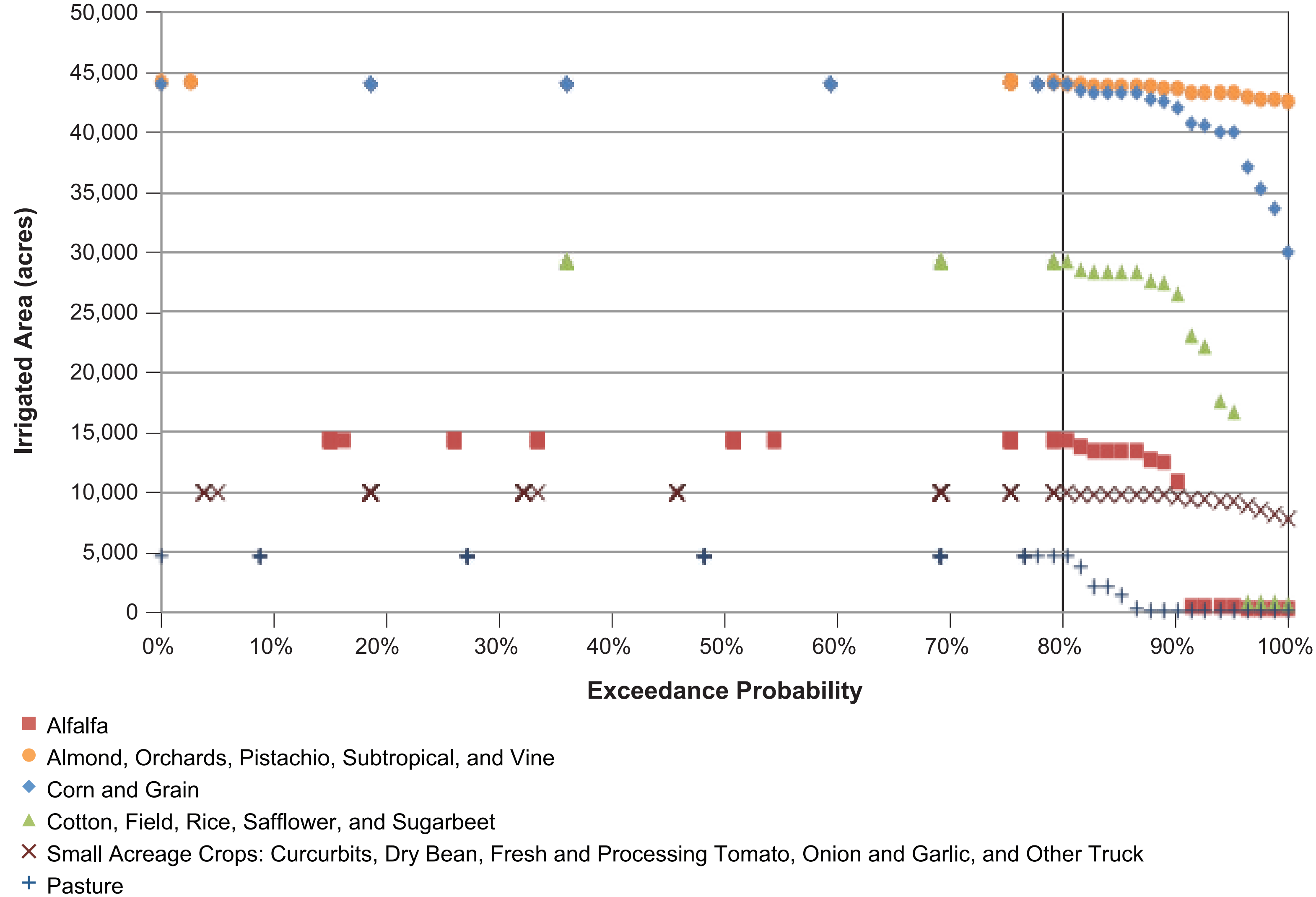


Figure 11-7
Irrigated Acreage in TID for Baseline

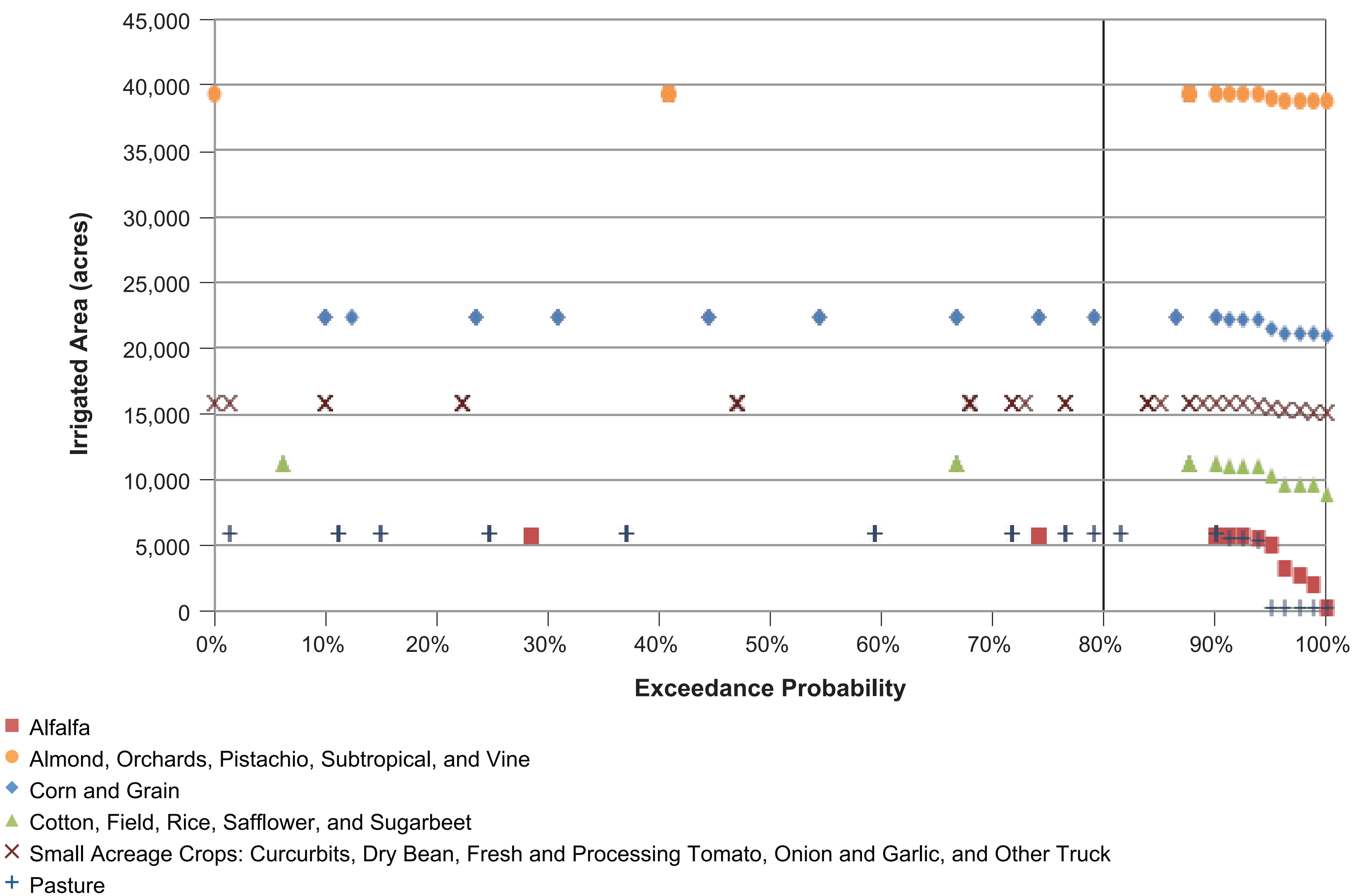


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Figure 11-8
Irrigated Acreage in Merced ID for Baseline

Extended Plan Area

The analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

SDWQ Alternatives

The program of implementation for the numeric salinity objectives contained in SDWQ Alternatives 2 and 3 includes continued USBR compliance with the Vernalis salinity requirement currently established in the 2006 *Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan) and implemented through the State Water Board's Water Right Decision 1641 (D-1641). Accordingly, it is expected that salinity conditions in the southern Delta would not be degraded and would not result in significant impacts.

SDWQ Alternatives 2 and 3 include numeric salinity objectives of 1.0 dS/m and 1.4 dS/m, respectively, applicable in all months. The program of implementation for these two alternatives would maintain the EC at Vernalis at or below 0.7 dS/m April–August and 1.0 dS/m September-March, as it is under the current objectives. This would provide some assimilative capacity downstream of Vernalis and protect beneficial agricultural uses. The existing salinity objectives are 0.7 dS/m for April-August and 1.0 dS/m for September-March and, as described in Chapter 5, *Surface Hydrology and Water Quality,* and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, baseline salinity conditions have historically ranged from approximately 0.2 dS/m to 1.2 dS/m. The potential agricultural acreage impact (Impact AG-1 and Impact AG-2 for the SDWQ alternatives) is estimated by assuming year-round irrigation salinity concentrations of 1.0 dS/m and 1.4 dS/m for SDWQ Alternatives 2 and 3, respectively. The analysis compares the associated crop yield impacts for this salinity concentration against crop yields under baseline. Based on the conclusions of Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta,* baseline salinity conditions are suitable for all agricultural crops, so the crop yield and agricultural acreage impacts of Alternatives 2 and 3 would simply be those associated respectively with 1.0 dS/m and 1.4 dS/m irrigation water salinity concentrations.

The potential for salinity-related impacts was evaluated using the information and modeling approaches contained in Appendix E. It is first determined if significant reductions in agricultural acreage or significant reductions in crop mix or crop production would take place under the SDWQ alternatives using the quantitative and qualitative results presented in Appendix E. These results are then qualitatively discussed as to the expected impacts under each SDWQ alternative with respect to conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses or conversion of farmland to nonfarmland.

Appendix E describes the models that are commonly used when assessing the suitability of a particular water quality (ECw) for crop production. A summary is provided here. Such models estimate the soil water salinity (ECe) that would result from using a certain quality of ECw under specified irrigation management practices (i.e., leaching fraction) and then uses the relationship between salinity and crop yield to develop an estimate of an associated impact. As recommended in Appendix E, the exponential steady-state model results presented in Appendix E are used in this analysis to determine ECe. ECe threshold levels, and the rates at which increasing levels affect crop production, are unique for each crop, a crop's growth stage, and potentially for a cultivar (Ayers and Westcott 1985).

Maas and Hoffman (1977) developed a relationship (Eqn. 11-1) between rootzone salinity and yield decline using the salinity tolerance of crops. This relationship states that at rootzone salinity (ECe) levels greater than a threshold (salinity tolerance of a crop), yield decline begins and increases based on the percent decline for the given increase in salinity (ECe).

$$Yield = 100\% - slope\ (\%) * (measured\ rootzone\ ECe - threshold\ ECe) \qquad (Eqn.\ 11\text{-}1)$$

This equation (Eqn. 11-1) uses quantitative salinity tolerance information available for many of the crops grown in the SDWQ area of potential effects, presented in Table 11-13. Relative salt tolerance, on an annual basis, for each crop group is ranked from *sensitive* (S), *moderately sensitive* (MS), *moderately tolerant* (MT), to *tolerant* (T). Qualitative salinity tolerance information, presented in Table 11-14 is available for crops without quantitative data.

As an example, using Eqn. 11-1 above and information from Table 11-13, the decrease in apricot yield can be calculated. Apricots have an ECe tolerance of 1.6 dS/m with a decline of 24 percent for each unit increase in rootzone salinity (ECe). Therefore, using Eqn. 11-1, if the rootzone salinity (ECe) was 2.6 dS/m, then the yield would be expected to decrease by 24 percent, and the total apricot yield would be 76 percent, as presented below in Eqn. 11-2.

$$Apricot\ yield = 100\% - 0.24 * (2.6 - 1.6) = 76\% \qquad (Eqn.\ 11\text{-}2)$$

The methodology uses the results presented in Appendix E for three crops: alfalfa, almonds, and dry beans. All of these crops are grown on significant acreage in the southern Delta (Table 11-9) and have relatively low thresholds to soil salinity (ECe) (Table 11-13). Crops without specific tolerance are listed in Table 11-14. This information can be compared against crops with quantitative data. For example, there is no specific information on apples, but when comparing apples to another sensitive crop (S), yield decline should not occur unless the salinity of the soil extract (ECe) becomes greater than 1 to about 1.5 dS/m. Appendix E presents estimates of soil water salinity and yield impact estimates for dry beans, alfalfa, and almonds across a range of different irrigation water salinity levels and leaching fractions. The analysis considers both a minimum and median level of precipitation, as precipitation influences the level of salinity in the soil, and higher precipitation can result in lower salinity levels. For the purpose of this analysis, a significant impact would result if the impact on crop yield for salt-sensitive crops is greater than 10 percent. Above this level, it would become more difficult for farmers to mitigate impacts with modified irrigation practices (e.g., increased leaching) and would start to substantially reduce the acreage of these types of crops in the southern Delta.

Central Valley Water Board's TMDLs for salt and boron determined that EC objectives protective of beneficial uses in this part of the watershed also protect those uses from the potential impacts from boron. Therefore, boron toxicity to agricultural resources is not considered in this analysis.

Table 11-13. Available Soil Salinity Threshold, Slope Information, and Relative Salinity Tolerance for Crops Grown in within the SDWQ Area of Potential Effects

Crop Category & Crop	Threshold ECe (dS/m)	Slope %/dS/m	Relative Salt Tolerance
Fruits & Nuts			
Apricots	1.6	24	S
Almonds	1.5	19	S
Field Crops			
Cotton	7.7	5.2	T
Sugar Beets	7	5.9	T
Corn	1.7	12	MS
Sudan	2.8	4.3	MT
Dry Beans	1	19	S
Sorghum	6.8	16	MT
Grain & Hay (Wheat)	5.9	3.8	MT
Pasture			
Pasture (clover)	1.5	12	MS
Alfalfa	2	7.3	MS
Truck & Berry			
Asparagus	4.1	2	T
Cole (broccoli)	2.8	9.2	MS
Carrots	1	14	S
Celery	1.8	6.2	S
Cucurbits	2.5	13	MS
Onion & Garlic	1.2	16	S
Tomatoes	2.5	9.9	S
Peppers	1.5	14	MS
Vineyards	1.5	9.6	MS

Source: United States Salinity Lab 2012.

Notes:

1 dS/m = 1000 microSiemens per centimeter (1000 µS/cm).

Because Pasture typically contains a mixture of grasses and legumes, the crop with the lowest tolerance to salinity (clover) was selected to represent all Pasture. United States Salinity Lab quantifies the impact of salinity on crop production and catalogs crops into salt tolerance categories.

SDWQ = southern Delta water quality

ECe = soil salinity

dS/m = deciSiemens per meter

S = sensitive

MS = moderately sensitive

MT = moderately tolerant

T = tolerant

Table 11-14. Relative Salinity Tolerance for Crops Grown within the SDWQ Area of Potential Effects that do not have Quantitative Threshold Information

Crop Category & Crop	Relative Salt Tolerance
Fruits & Nuts	
Apples	S
Olives	T
Walnuts	S
Pistachios	MS
Field Crops	
Safflower	MT
Pasture	
Turf Farm	MT
Truck & Berry	
Green Beans	S

Source: Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*.

Notes:

1 dS/m = 1000 microSiemens per centimeter (1000 µS/cm).

There is no quantitative data for the crops with only the relative salt tolerance information; however, these crops can be compared against crops with quantitative data. For example, there is no specific information on apples, but when comparing apples to another sensitive crop (S), yield decline should not occur unless the salinity of the soil extract (ECe) becomes greater than 1 to about 1.5 dS/m.ECe = soil salinity

SDWQ = southern Delta water quality

dS/m = deciSiemens per meter

S = Sensitive

MS = Moderately sensitive

MT = Moderately tolerant

T = Tolerant

11.5 Impacts and Mitigation Measures

Impact AG-1: Potentially convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)* for the No Project Alternative technical analysis.

LSJR Alternatives

The LSJR alternatives would require flows for fish and wildlife beneficial uses in the rivers. As a result, modifications to reservoir operations and reductions in the available surface water supply could result in irrigation diversions. A reduction in water supply availability for irrigation purposes could potentially lead to a reduction in crop acreage and a potential conversion to nonagricultural uses. The precise amount of lands that are designated as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance that could be converted to nonagricultural uses cannot be precisely quantified. However, potential impacts, based on the crop reduction modeling results, can be qualitatively discussed to determine possible conversion to nonagricultural uses. In other words, the analysis uses decreased crop production as a proxy for potential conversion to nonagricultural uses. Although the reduction in water supply is used as a proxy for the conversion of irrigated land to nonagricultural lands, lands that are not irrigated could remain in agricultural use (as discussed in Impact AG-3). Non-irrigated uses that are still considered agricultural use include dry land farming, fallowing, grazing, dairy, and animal husbandry. Figures 11-9 through 11-14 summarize the results of the SWAP analysis for all crops for each LSJR Alternative compared to the baseline in each of the six geographic areas.

These figures show how irrigated acreage in each water district changes in response to changed water availability under baseline and for each of the LSJR alternatives. Figure 11-9, for example shows that irrigated acreage in SSJID stays the same, at approximately 58,500 acres in most years under baseline. Irrigated acreage, however, starts dropping at the 95 percent exceedance probability—this means that irrigated acreage drops below 58,500 acres about once in every 20 years and can be as low as approximately 44,000 acres. Figure 11-9 also shows that reduction in irrigated acreage is bigger and occurs more frequently under the LSJR alternatives. Under LSJR Alternative 3, there would be no reduction in crop acreage about 62 percent of the time, and 80 percent of the time crop acreage would still be approximately 55,000 acres. Although the lowest irrigated acreage under LSJR Alternative 3 is only slightly lower than under baseline (42,000 acres under LSJR Alternative 3 versus 44,000 acres under baseline), crop acreage would be lower than under baseline in about 38 percent of all years.

LSJR Alternative 2 (Less than significant/Significant and unavoidable with adaptive implementation)

Irrigated crop acreage under LSJR Alternative 2 as estimated by the SWAP model for the 1922–2003 period shows minimal reductions when compared to baseline (Figures 11-9 through 11-14). Average crop acreage and acreage reductions are summarized in Table 11-15. Two of the six districts had none or minimal (Merced ID) acreage reductions. Reductions in the remaining districts ranges from 1.5 to 2.6 percent. The impact is less than significant.

Adaptive Implementation

Based on best available scientific information indicating that a change in the percent of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation of method 1 would allow an increase of up to 10 percent over the 20-percent February–June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. However, an increase of up to 30 percent of unimpaired flow would potentially result in different effects as compared to 20-percent unimpaired flow, depending upon flow conditions and frequency of the adjustment.

Table 11-15. Average Cropped Acreage and Acreage Reduction under LSJR Alternative 2

	Baseline	LSJR Alternative 2		
District	Average Acres		Acre Change	% Reduction
SSJID	58,229	57,372	-857	1.5
OID	54,162	52,767	-1,395	2.6
SEWD + CSJWCD	98,931	98,931	0	0.0
MID	57,354	56,143	-1,211	2.1
TID	143,783	141,183	-2,600	1.8
Merced ID	99,769	99,747	-22	0.0
Total	512,229	506,144	-6,086	1.2

SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Conservation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District

If the adjustment occurs frequently or for extended durations, impacts under LSJR Alternative 2 could become more like the impacts under LSJR Alternative 3. At 30 percent unimpaired flow, the average acreage reduction for all irrigation districts increases from 1.2 percent (Table 11-15) to 2.3 percent (Table 11-16). Reductions in average acreage at the district level ranges from none for SEWD & CSJWCD to 4.5 percent for MID (Table 11-16). When the maximum groundwater pumping capacity for 2014 is used in the analysis instead of the estimates for 2009, the acreage is less affected because increased groundwater pumping can meet the shortfall in the applied surface water needed to meet crop demand.

Table 11-16 Average Baseline and Crop Production 2009 and 2014 Groundwater Pumping under LSJR Alternative 2 with Adaptive Implementation

	2009 Groundwater Pumping			2014 Groundwater Pumping[a]		
	Baseline	30 PCT		Baseline	30 PCT	
District	Acres		% Reduction		Acres	% Reduction
SSJID	58,229	56,806	2.4	58,385	57,367	1.7
OID	54,162	51,806	4.4	54,414	52,865	2.8
SEWD & CSJWSD	98,931	98,931	0.0	98,931	98,931	0.0
MID	57,354	54,765	4.5	58,833	58,584	0.4
Turlock ID	143,783	138,550	3.6	146,006	144,129	1.3
Merced ID	99,769	99,544	0.02	99,769	99,544	0.2
	512,229	500,401	2.3	516,339	511,420	1.0

SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Conservation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District
[a] TID baseline increased by 182 acres with 2014 groundwater pumping.

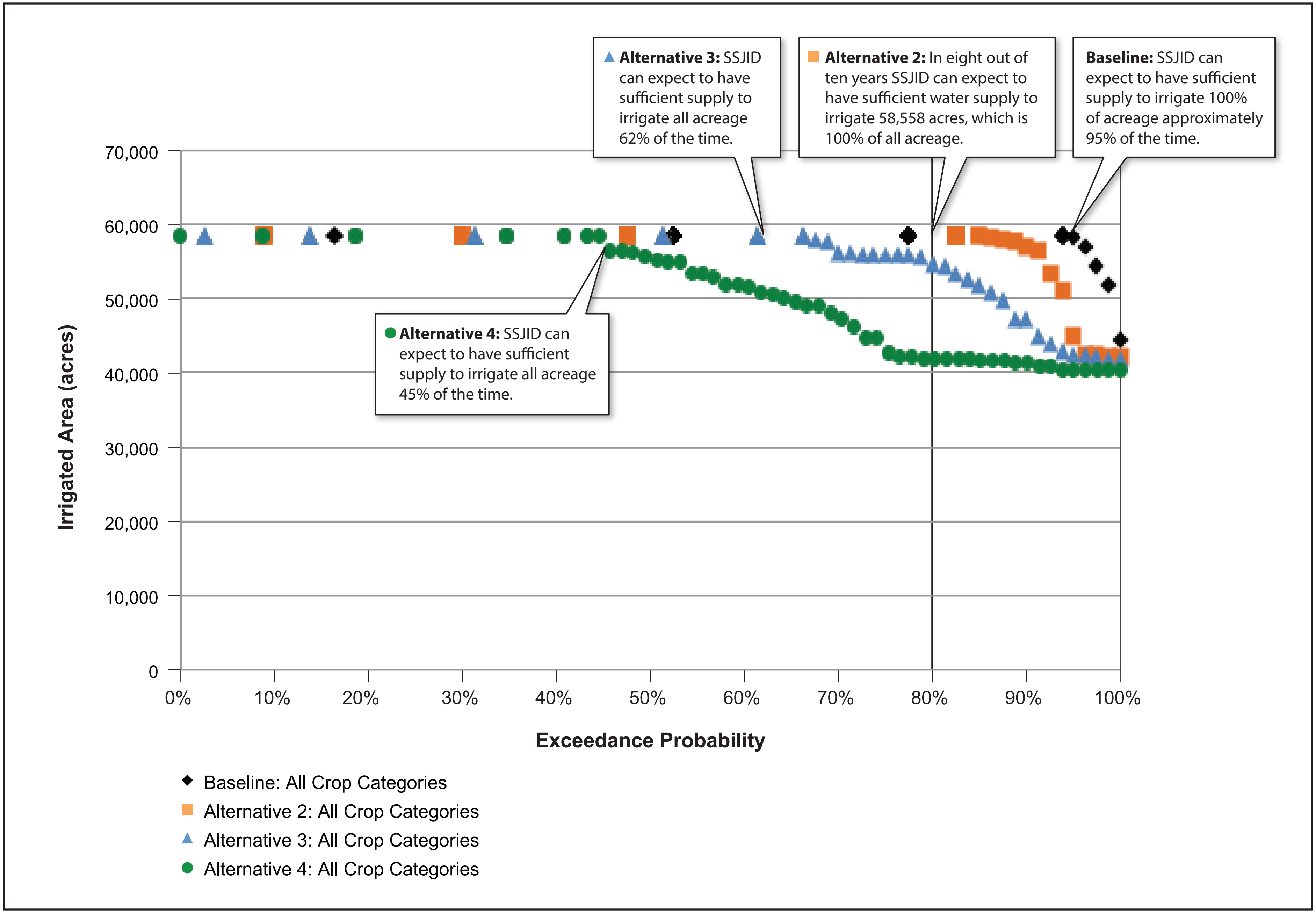

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Figure 11-9
Irrigated Acreage in SSJID for All Crops, All Alternatives, and Baseline

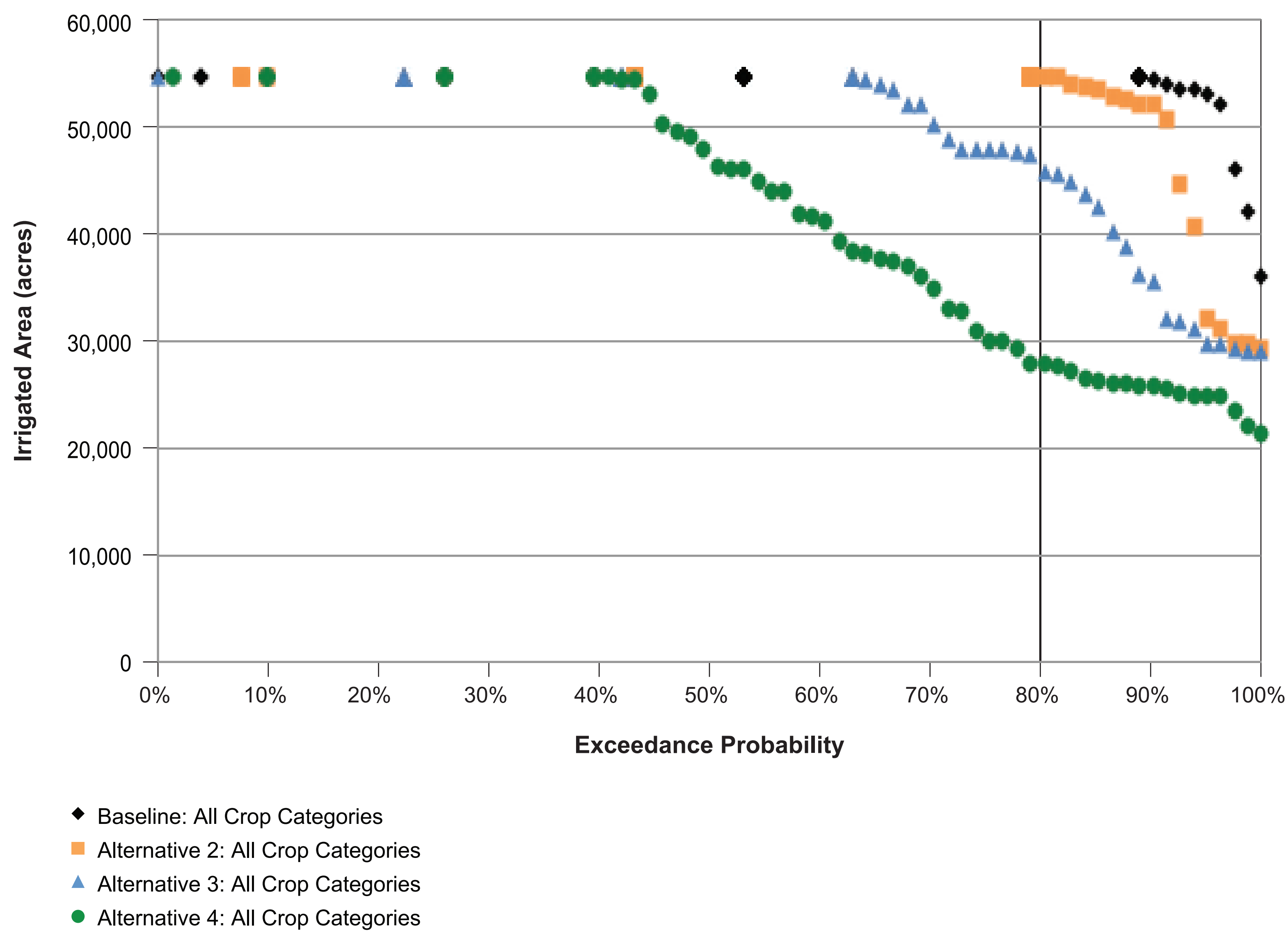

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Figure 11-10
Irrigated Acreage in OID for All Crops, All Alternatives, and Baseline

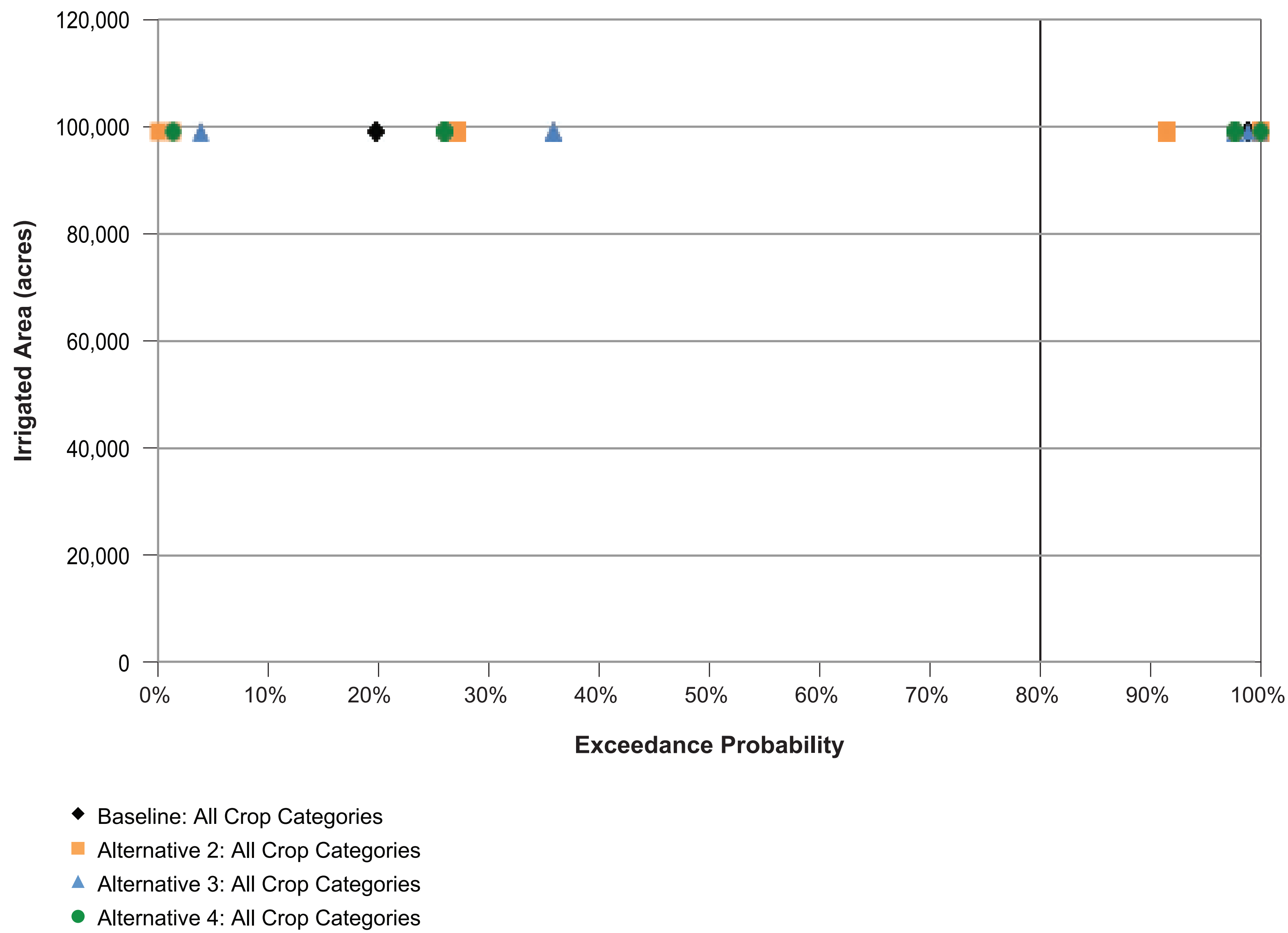

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Figure 11-11
Irrigated Acreage in SEWD and CSJWCD for All Crops, All Alternatives, and Baseline

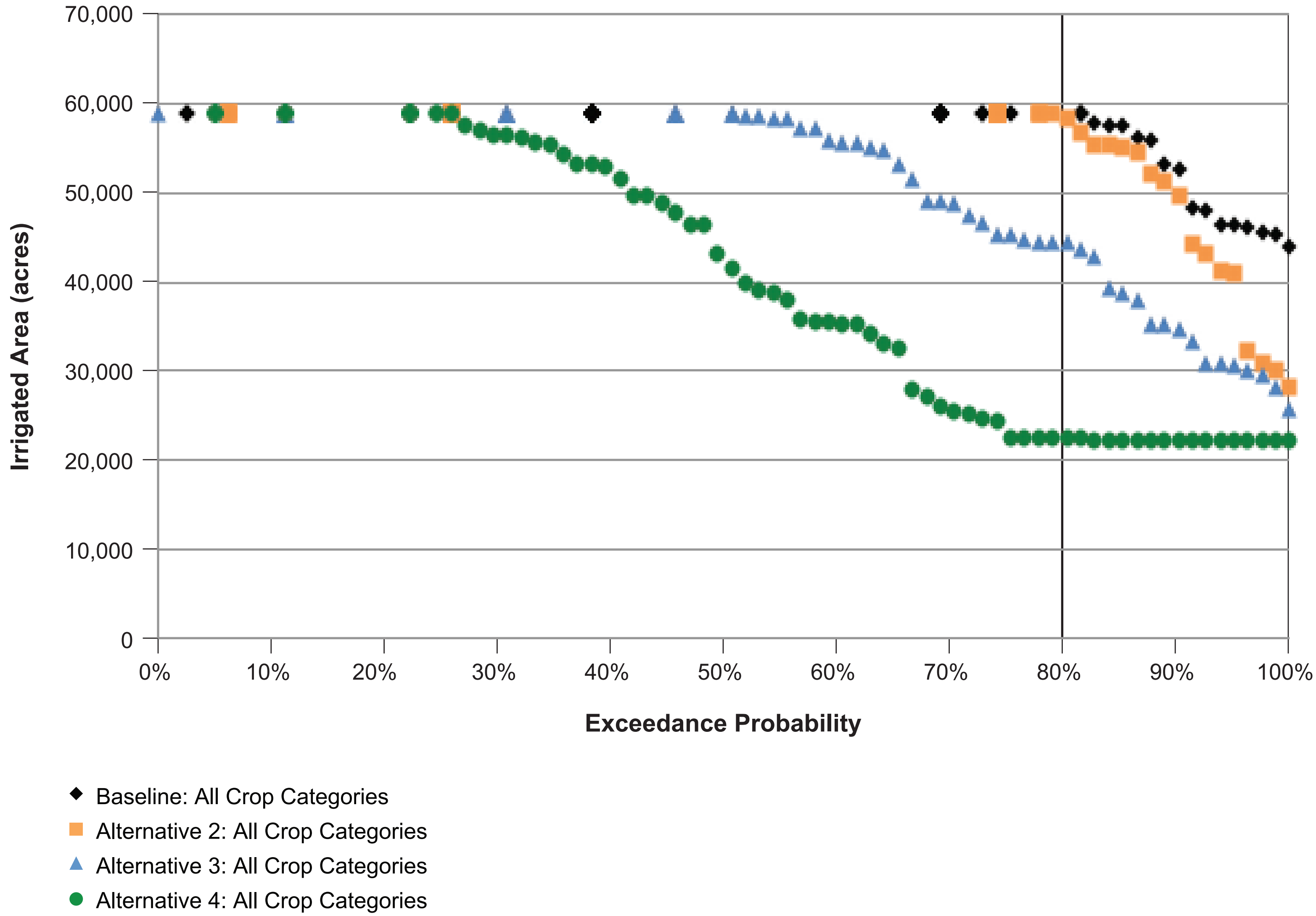

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Figure 11-12
Irrigated Acreage in MID for All Crops, All Alternatives, and Baseline

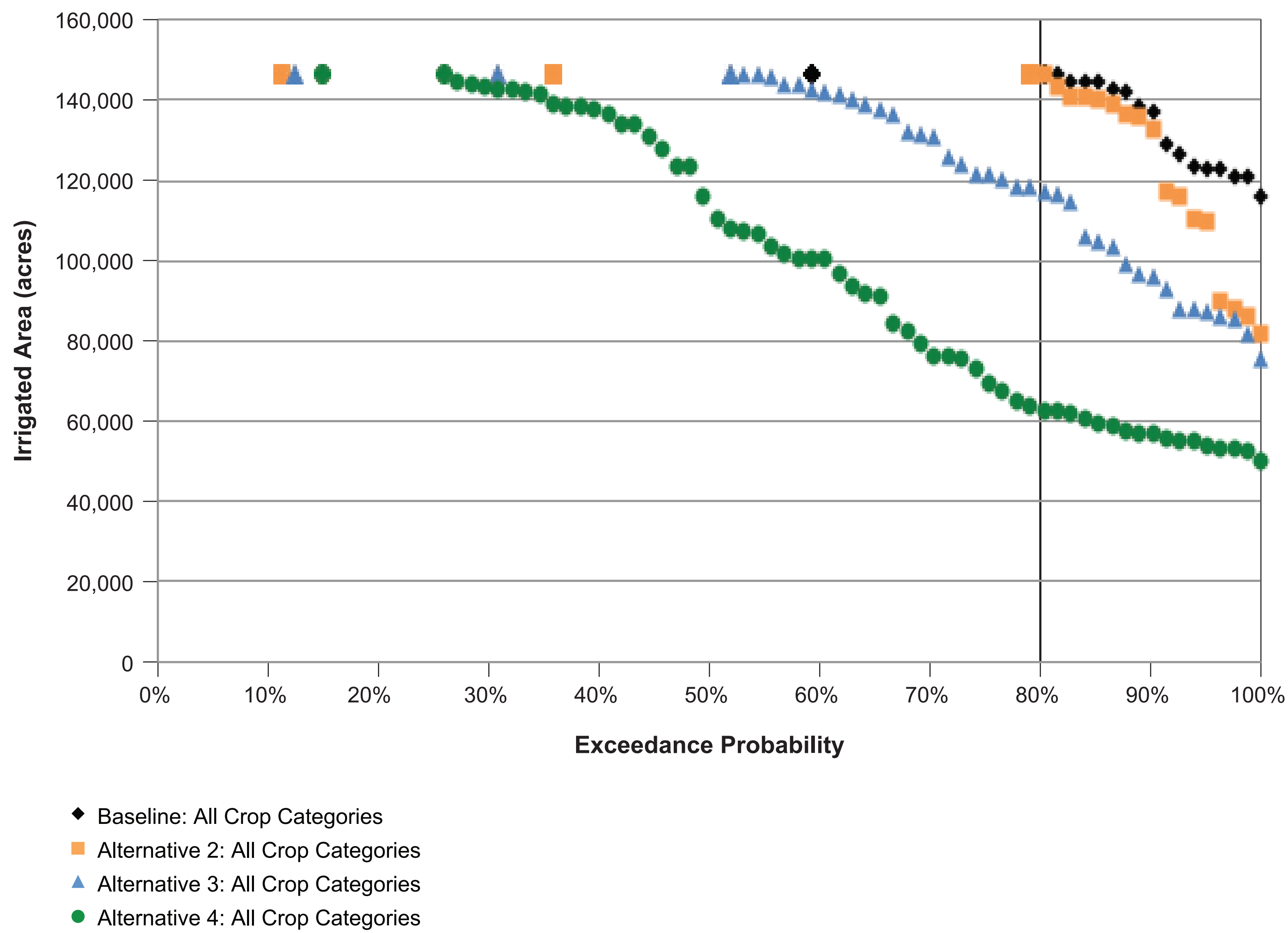

Figure 11-13
Irrigated Acreage in TID for All Crops, All Alternatives, and Baseline

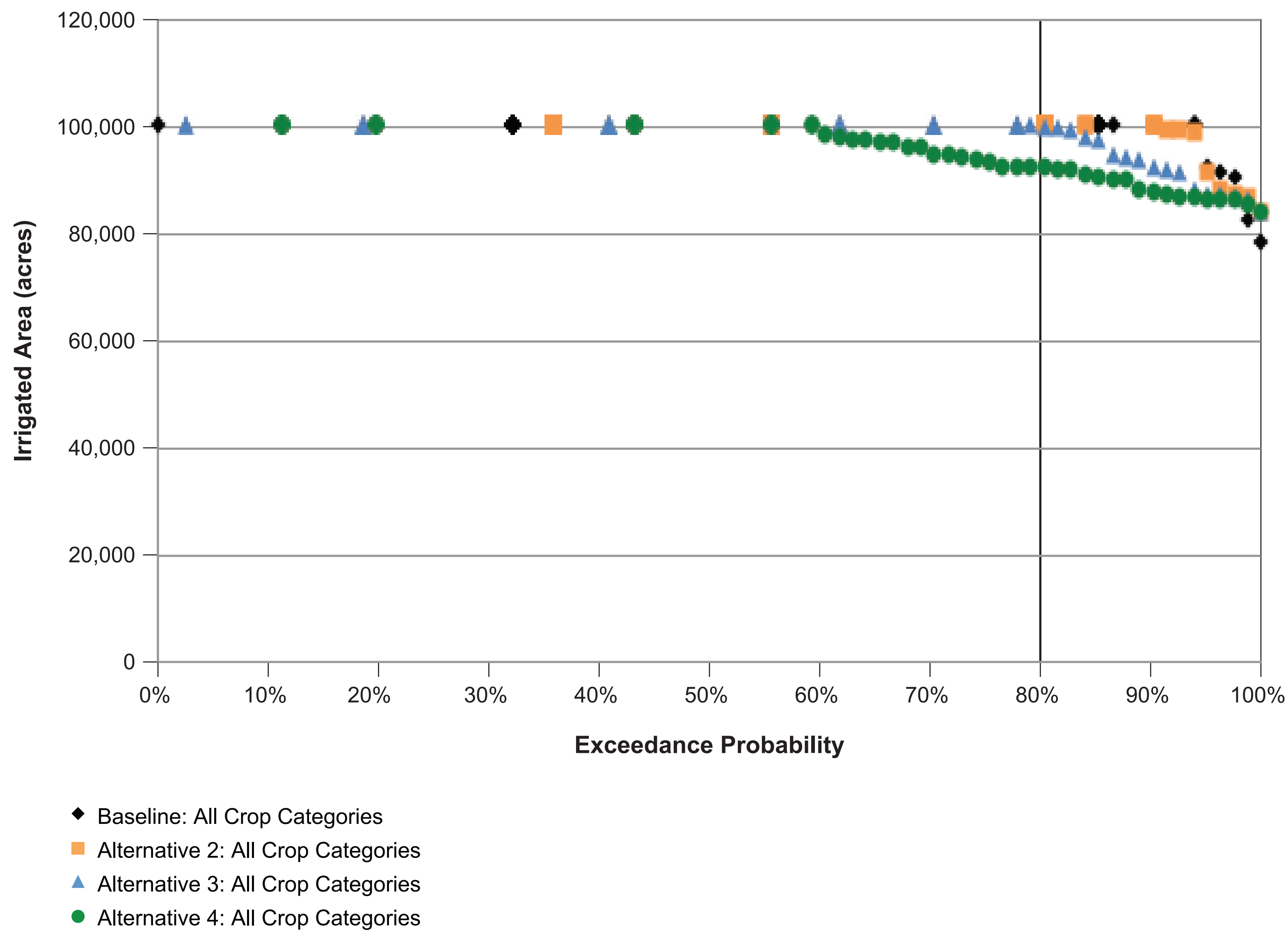

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Figure 11-14
Irrigated Acreage in Merced ID for All Crops, All Alternatives, and Baseline

Based on best available scientific information indicating that a change in the timing or rate of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February-June timeframe. While the total volume of water released February-June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate. Method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. It is unlikely that alteration of the timing of the river flows under method 2 would result in substantial modification to the April–September (e.g., irrigation season) diversions. Although method 2 could result in a change in flow during April through June, the total volume of water required for river flow would be the same and, therefore, there would be little change in the volume of water available for agriculture. Method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent. Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June flow requirement. The WSE model results indicate changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR, and thus would not affect agricultural resources. Accordingly, LSJR Alternative 2, with the incorporation of adaptive implementation methods 2, 3, and 4, would not affect agricultural resources, and impacts would be less than significant.

Although adaptive implementation methods 2, 3, and 4 would not cause significant impacts, this impact is still considered to be significant as a result of adaptive implementation method 1. If method 1 is used to increase the required percent of unimpaired flow to 30 percent unimpaired flow on a long-term basis, it is estimated that OID would experience an average decrease in irrigated acreage of 4.4 percent and MID would experience an average reduction in irrigated acres of 4.5 percent under 2009 conditions (Table 11-16). Therefore, impacts would be significant.

Mitigation Measures

A SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777(b)(3).) Local land use agencies can mitigate for the loss of farmland to urban development through development conditions such as in lieu fees for, or direct purchases of, agricultural conservation easements. In addition, local water suppliers, regional groundwater management agencies, and irrigation districts could reduce potential conversion of agricultural land due to reduced surface water availability by requiring modifications to existing agricultural practices that increase irrigation efficiency. To some extent, irrigation efficiencies have already resulted from the implementation of SBX7-7 requirements (see Section 11.3, *Regulatory Background*). Implementing irrigation efficiency measures could reduce 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. Increasing the irrigation efficiency could be accomplished with the following methods.

- Increase the use of irrigation management services to better determine how much water is needed by a crop and when to apply it.
- Convert less efficient irrigation systems (e.g., surface irrigation) to more efficient ones (e.g., microirrigation).

- 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.

The measures identified above, such as agricultural conservation easements, could be adopted as project-level measures for project-specific development. Individual projects will be subject to the appropriate level of environmental review at the time they are proposed, and mitigation would have to be identified to avoid or reduce significant effects, prior to any project-level action. Some potential actions, however, may not require discretionary approvals and may not be subject to project-level CEQA review. Nevertheless, local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or under other local authorities, adopt the relevant mitigation measures identified above.

The State Water Board has authority to take action to prevent waste, unreasonable use, unreasonable method of use, and unreasonable method of diversion of water. The State Water Board may exercise this authority through quasi-adjudicative or quasi-legislative proceedings. However, such proceedings are not part of this project. It is also infeasible for the State Water Board to impose mitigation measures at this time because it is undertaking a programmatic analysis of the potential agricultural resource impacts, does not now have specific facts associated with an individual project to legally and technically impose requirements related to waste and unreasonable use, and it is speculative whether these actions would reduce conversions of agricultural lands. In addition, while the State Water Board may impose water conservation or efficiency requirements through the adoption of regulations, the amount of time, high cost, and commitment of staff resources associated with such rule-making proceedings also renders adopting the mitigation measures now infeasible. Adopting regulations right now would require considerable staff time to research, formulate and develop, require extensive stakeholder outreach, and require numerous public meetings before the regulations would take effect. The State Water Board currently has limited resources to pursue adoption of such regulations as most of its budget for the water right program is supported by fees imposed on water right permit and license holders, and is used for program activities related to the diversion and use of water subject to the permit and license system. Only a small amount of funding is available for other regulatory activities and it is speculative to anticipate that additional funding will be made available. Therefore, at this time the imposition of the above mitigation measures is infeasible and impacts under LSJR Alternative 2 with adaptive implementation would remain significant and unavoidable.

While it is possible that some of the water-diversion and use measures, including irrigation efficiency, may have some applicability to reducing impacts or could be implemented as part of the individualized water right proceedings that are expected to take place to implement the flow objectives, any application of these measures at this point by the State Water Board is infeasible for the reasons stated above. Furthermore, it is unknown whether these activities would reduce the significant impacts to less-than-significant levels. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies can and should adopt irrigation efficiencies and local land use authorities can and should impose development conditions and require conservation easements where allowed to mitigate for the loss of agricultural lands to urbanization; however, given the uncertainty of the extent to which these mitigation measures would occur and because they may not fully mitigate impacts, impacts would remain significant. As such, according to the number of acres that would no longer be considered Prime Farmland, Unique Farmland, or Farmland of Statewide Importance as predicted by the SWAP model and the possibility of conversion of these acres to nonagricultural land uses, impacts on agricultural resources under LSJR Alternative 2 with adaptive implementation would remain significant and unavoidable.

LSJR Alternative 3 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

Under LSJR Alternative 3, the average annual reduction in acreage ranges from a low of 0.0 percent for SEWD and CSJWCD to just under 10 percent for MID (Table 11-17). While the SWAP results indicated there would be little to no change in crop acreage for either SEWD/CSJWCD or Merced ID, the remaining irrigation districts could experience change in crop acreage of various crop categories.

Crops categories that would experience greater than 1 percent average acreage reduction are shown in Figures 11-15 through 11-18 for SSJID, OID, MID, and TID, respectively for illustration purposes. These figures illustrate how the acreage of select crops change in response to reduced water availability, under both baseline and Alternative 3. Figure 11-15a, for example, shows the irrigated acreage in SSJID for alfalfa. Under baseline, acreage remains stable, at approximately 3,200 acres, in a little over 95 percent of all years, and then is reduced to less than 200 acres. This is reflective of the response to reduced water availability that occurs about once in every 20 years under baseline. Acreage also remains stable under Alternative 3 in approximately 65 percent of years, but then drops a little in about 10 percent of years, followed by a dramatic drop in acreage to 200 acres or less in approximately 17 percent of years. These figures show how the average reductions in crop acreages are concentrated in years with reduced water availability, and vary depending on crop type. Figures are not shown for crops that are not much affected by reduced water supplies, such as orchards, vines, and truck crops (see Appendix G tables G.4-6a through G.4-6f).

Table 11-17. Average Cropped Acreage and Acreage Reduction under LSJR Alternative 3, by District, Compared to Baseline

	Baseline	LSJR Alternative 3		
District	Average Acres		Acre Change	% Reduction
SSJID	58,229	55,951	-2,277	3.9
OID	54,162	50,184	-3,978	7.3
SEWD + CSJWCD	98,931	98,931	0	0.0
MID	57,354	51,685	-5,670	9.9
TID	143,783	132,830	-10,954	7.6
Merced ID	99,769	98,970	-800	0.8
Total	512,229	488,551	-23,679	4.6

Since the crop categories within the six geographic areas need irrigation in 8 out of 10 years to qualify as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, implementing LSJR Alternative 3 could potentially reduce the total lands classified as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance. When the maximum groundwater pumping capacity scenario for 2014 is used in the analysis instead of the estimates for 2009, the acreage is less affected because there was more groundwater pumping in 2014 to meet the shortfall in the applied surface water needed to meet crop demands. The results show an overall decrease in the reduction of average annual crop acreage for all irrigation districts, but particularly MID (Table 11-18). If the groundwater pumping capabilities of the irrigation districts are closer to the 2014 values, then the crop acreage reductions estimated under 2009 conditions would be smaller; however, it is unlikely this is a sustainable practice given groundwater conditions (Chapter 9, *Groundwater Resources*).

Table 11-18. Percent Average Acreage Reduction from Baseline for Irrigation Districts Impacted under LSJR Alternative 3 for 2009 and 2014 Groundwater Pumping Levels

	Groundwater Pumping Level	
	2009	2014
District	% Reduction	
SSJID	4	3
OID	7	5
MID	9	1
TID	8	3

SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District

It is unknown whether the reduction in irrigation water would result in a direct conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use, but it is conservative to assume that if irrigation water is unavailable to sustain these specific crop categories identified in Table 11-17, then some of the 22,879 acres affected, on average, in SSJID, OID, MID, and TID (7.3 percent of the total Prime Farmland, Unique Farmland, and Farmland of Statewide Importance within the affected districts) would be converted to nonagricultural uses. While it would be speculative to quantify the amount of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance that might be converted, the substantial reduction in these types of existing irrigated agricultural lands, as a result of LSJR Alternative 3, could result in their conversion to nonagricultural uses, in which case impacts would be significant.

Similar to the availability of feasible mitigation above under LSJR Alternative 2 (20 percent unimpaired flow), while it is possible that some of the water-diversion and use measures, including irrigation efficiency, may have some applicability to reducing impacts or could be implemented as part of the individualized water right proceedings that are expected to take place to implement the flow objectives, any application of these measures at this point by the State Water Board is infeasible as explained in LSJR Alternative 2. Furthermore, it is unknown whether these activities would reduce the significant impacts to less-than-significant levels. Local water districts and suppliers,

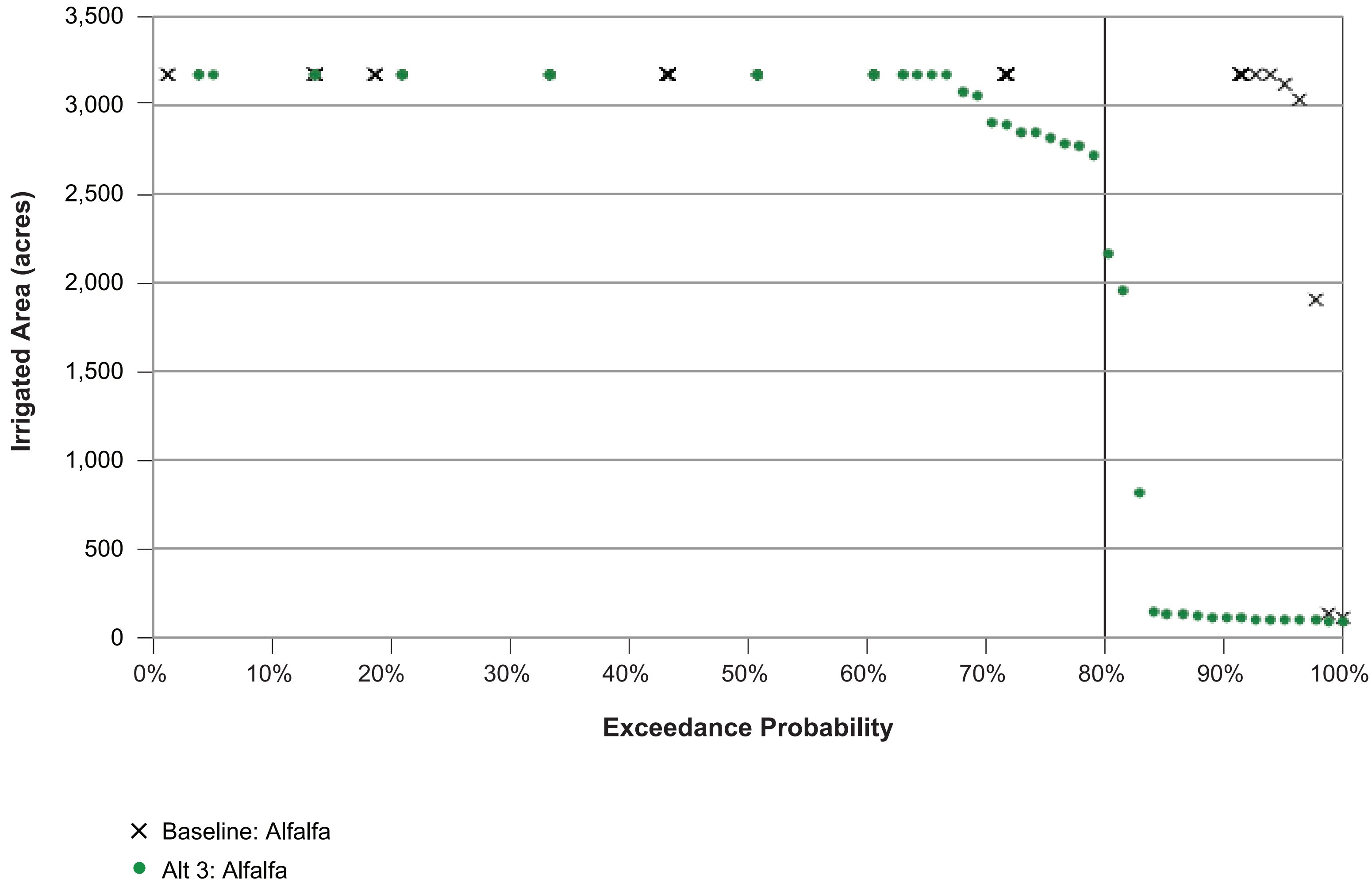

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Figure 11-15a
Irrigated Acreage in SSJID for Alfalfa under Alternative 3

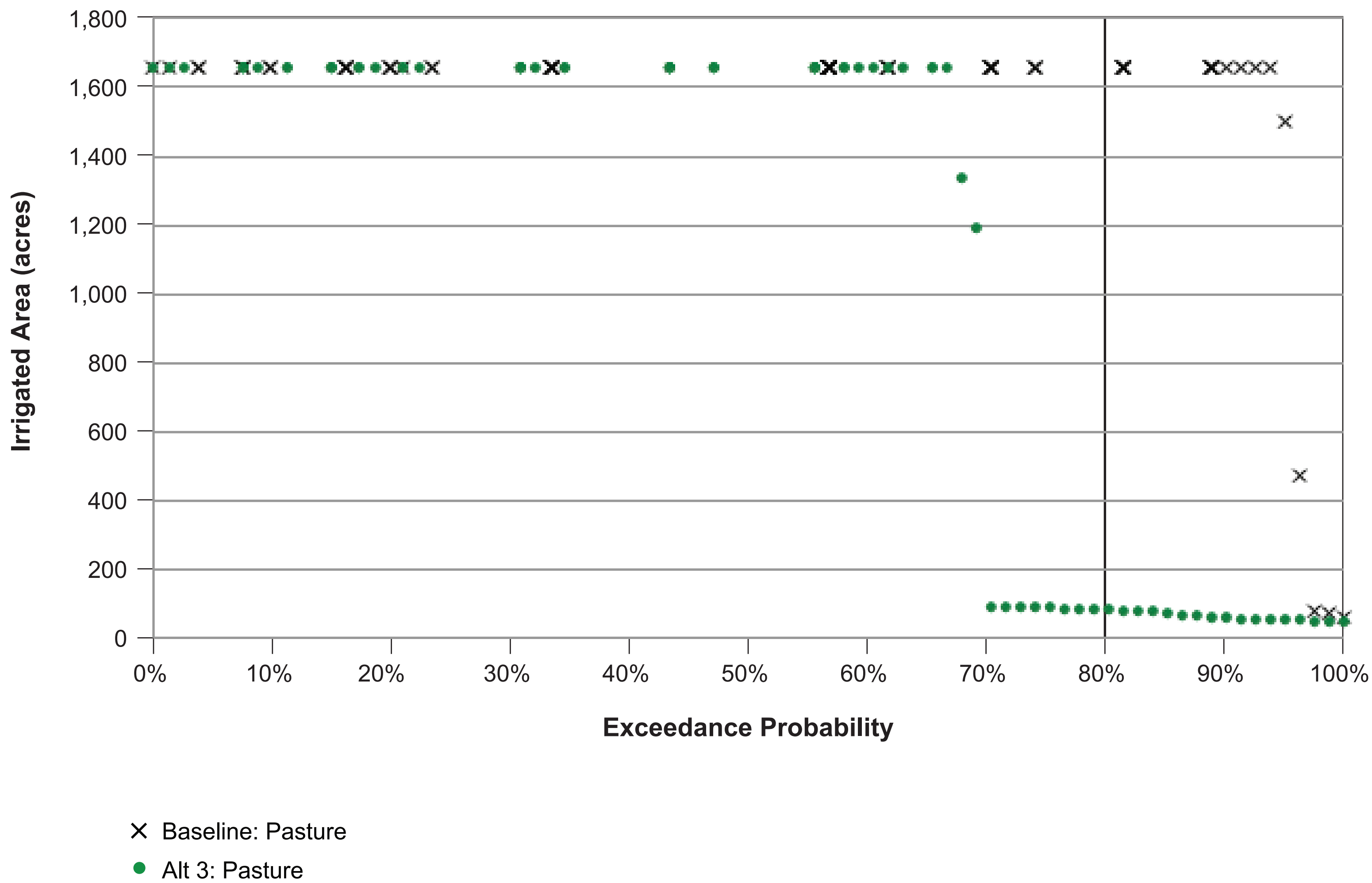

Figure 11-15b
Irrigated Acreage in SSJID for Pasture under Alternative 3

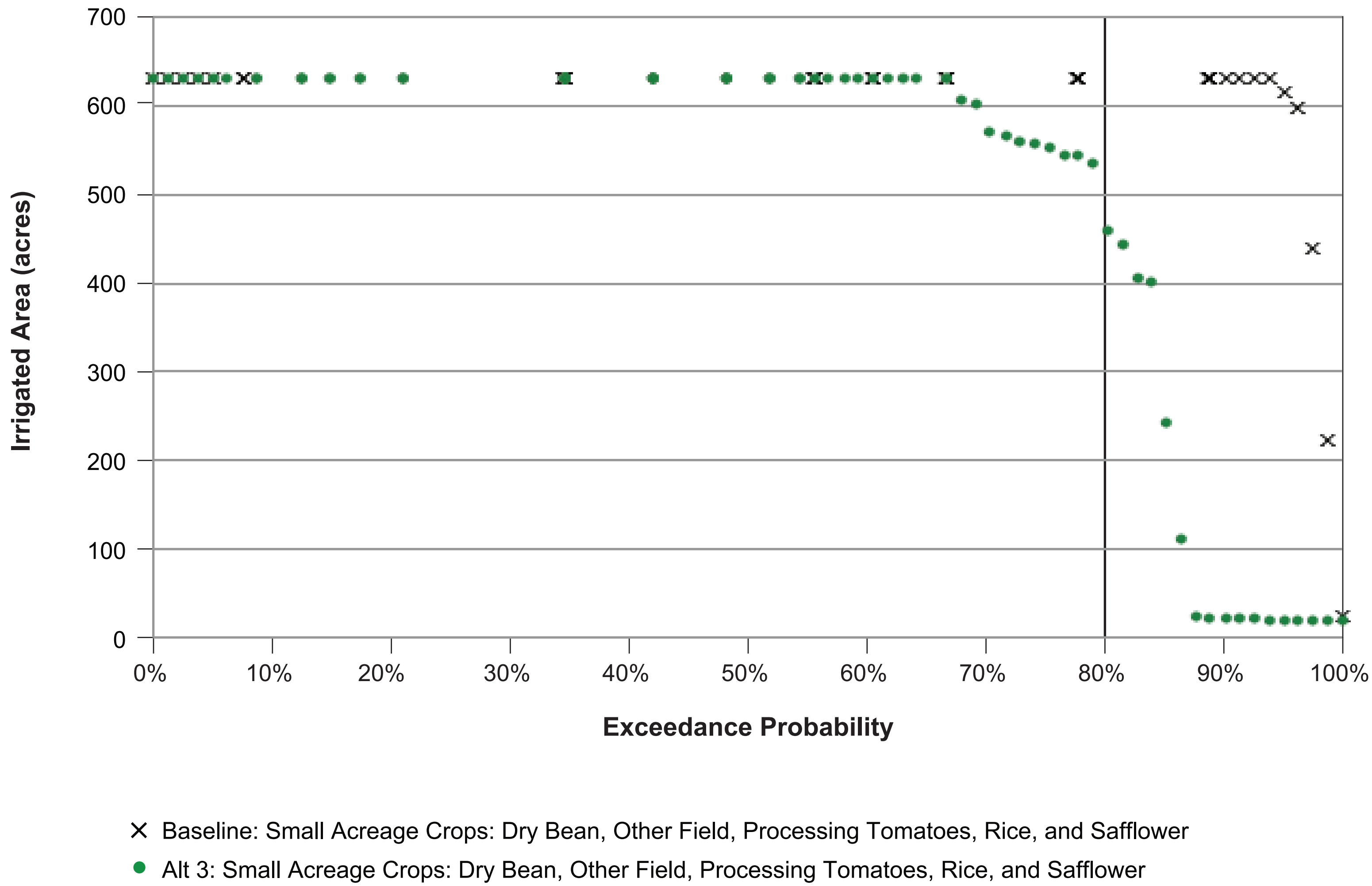

Figure 11-15c
Irrigated Acreage in SSJID for Small Acreage Crops under Alternative 3

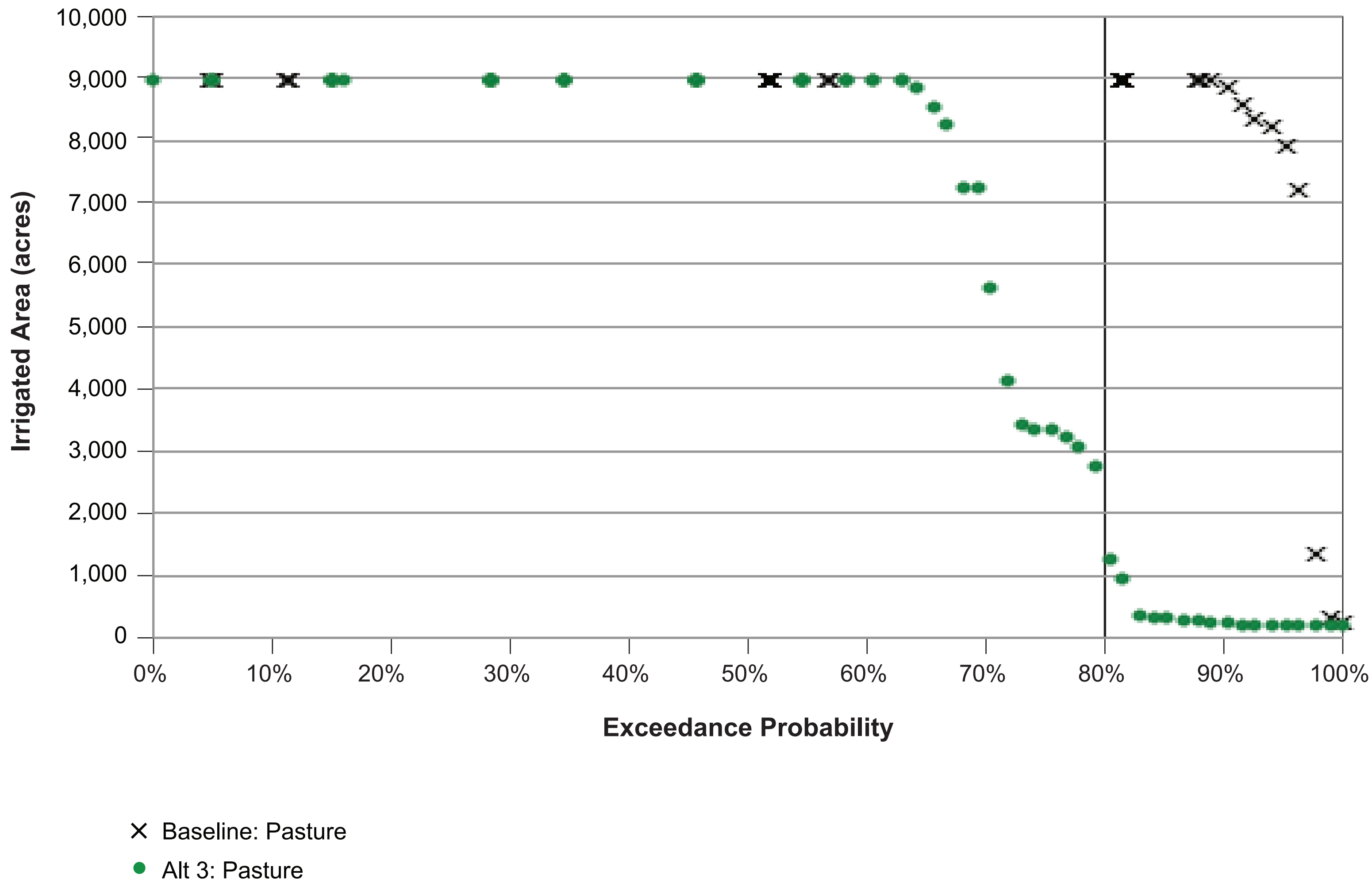

Figure 11-16
Irrigated Acreage in OID for Pasture under Alternative 3

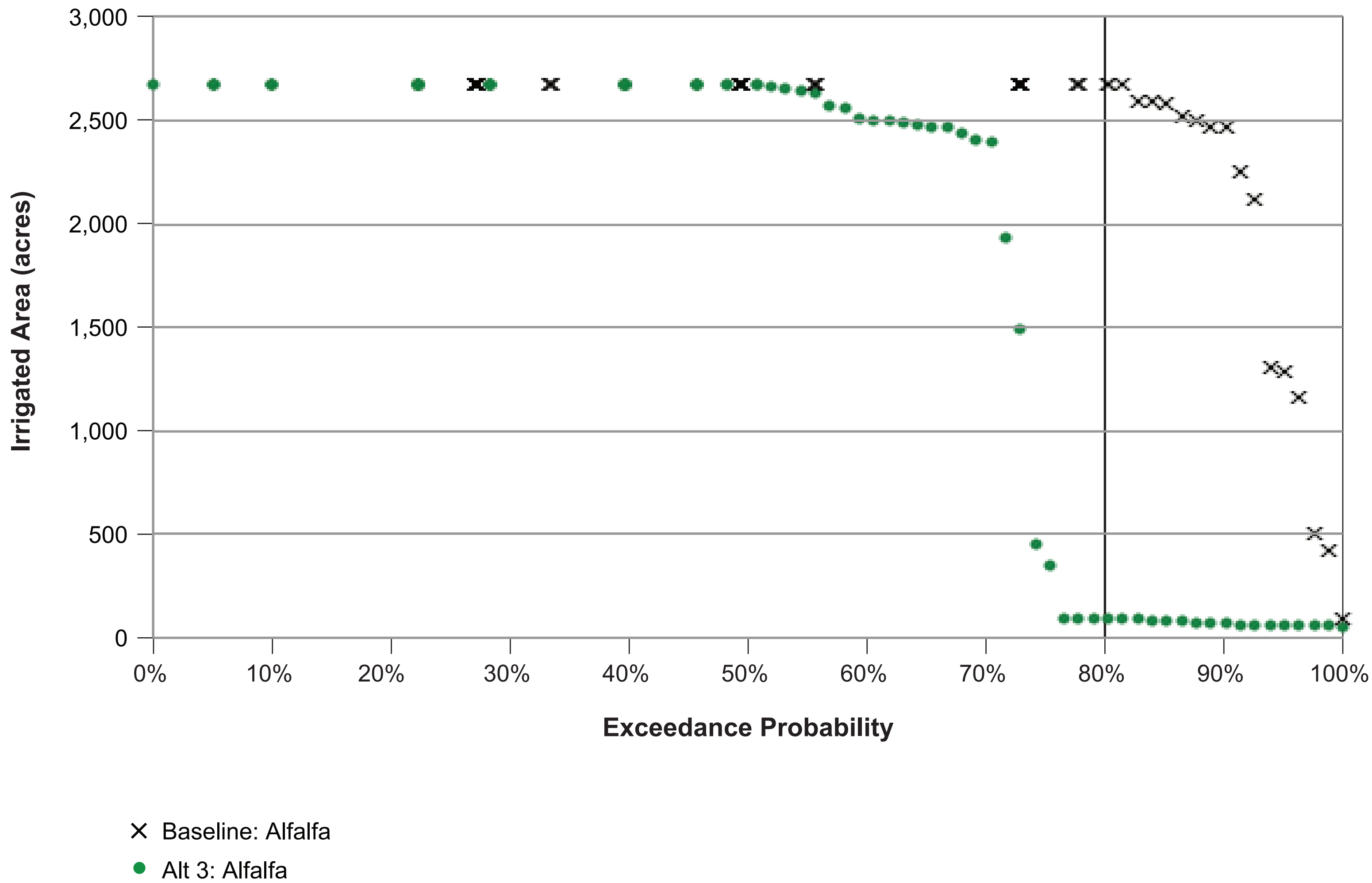

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Figure 11-17a
Irrigated Acreage in MID for Alfalfa under Alternative 3

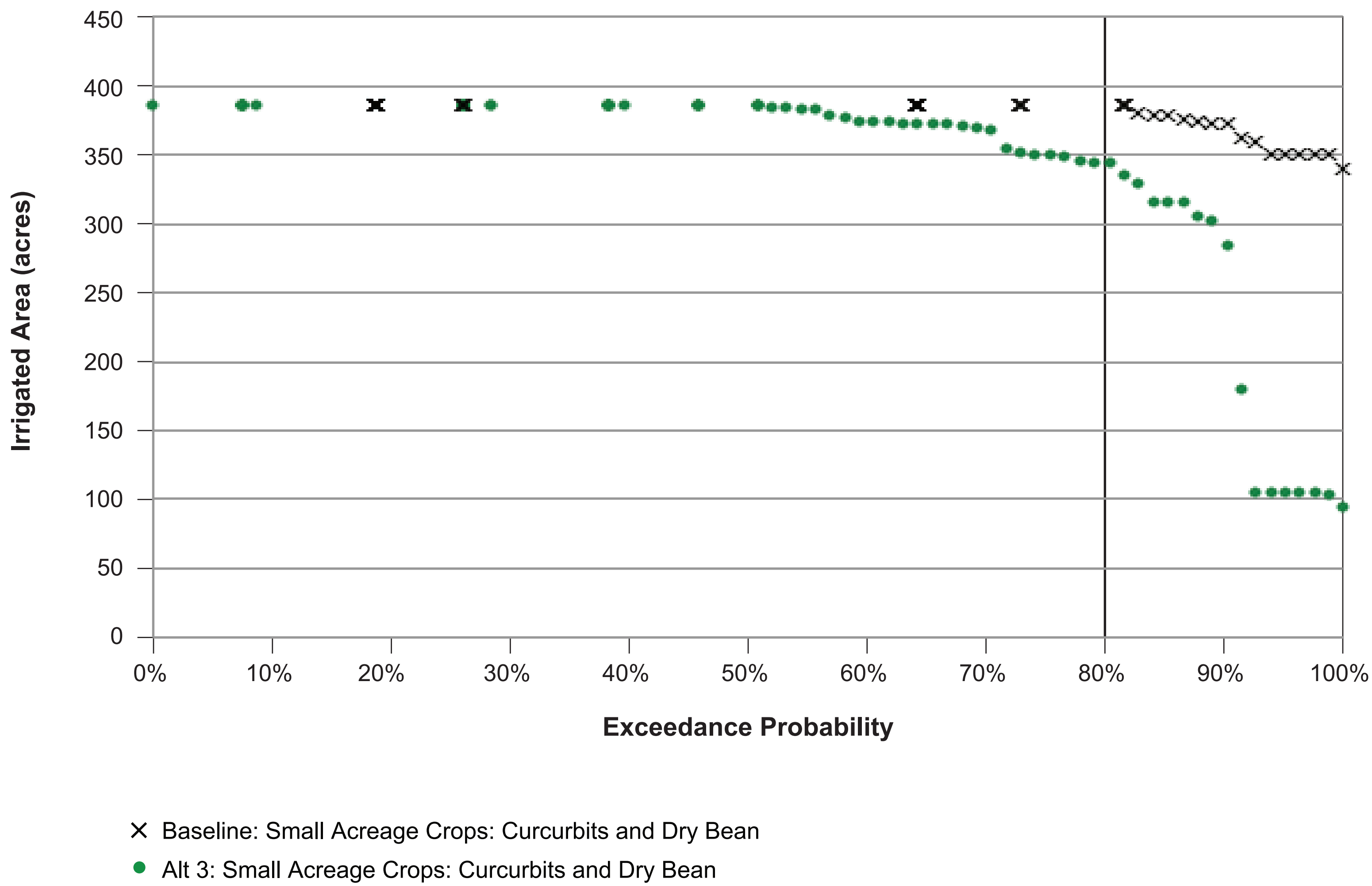

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Figure 11-17b
Irrigated Acreage in MID for Small Acreage Crops under Alternative 3

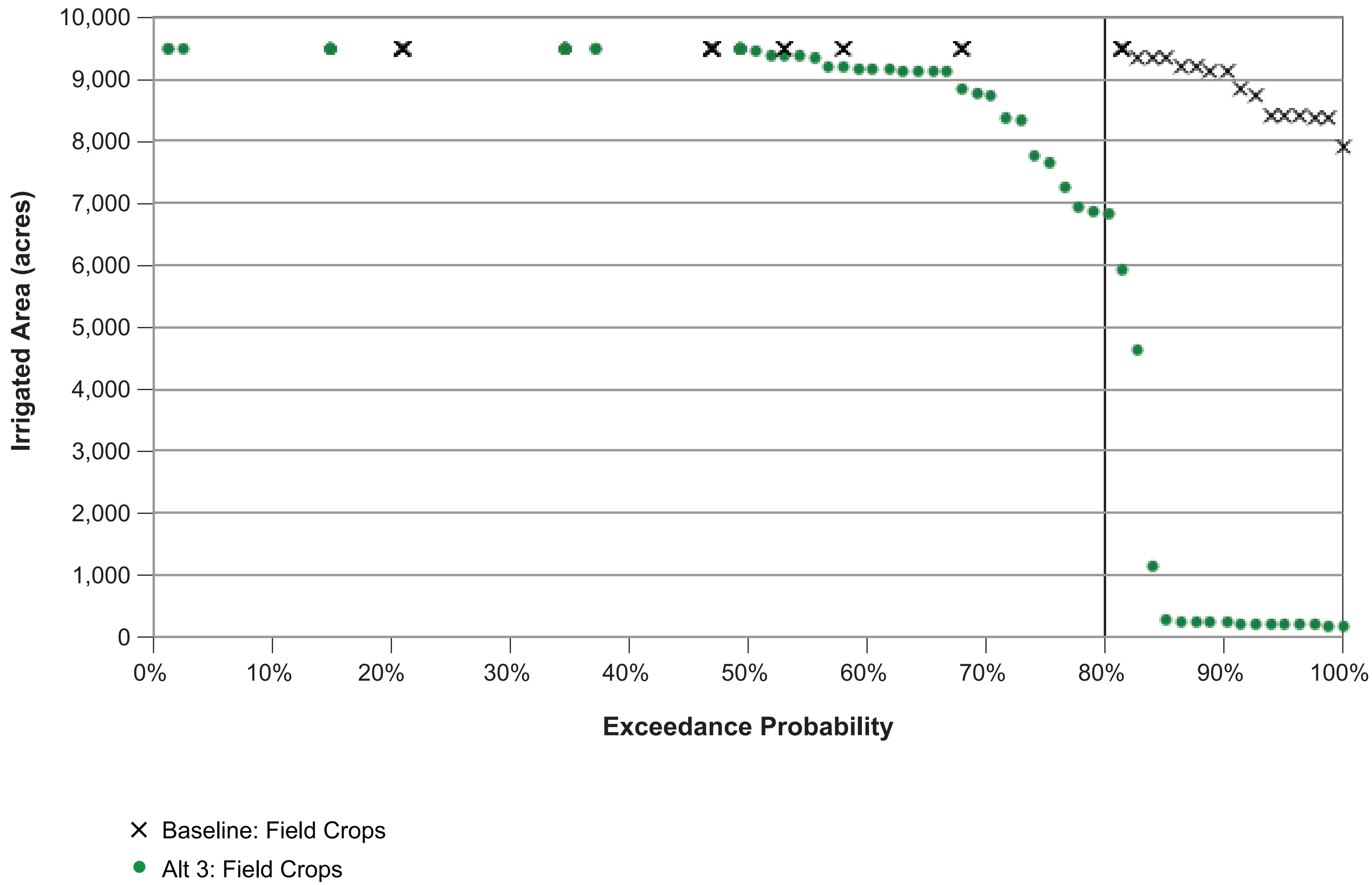

Figure 11-17c
Irrigated Acreage in MID for Field Crops under Alternative 3

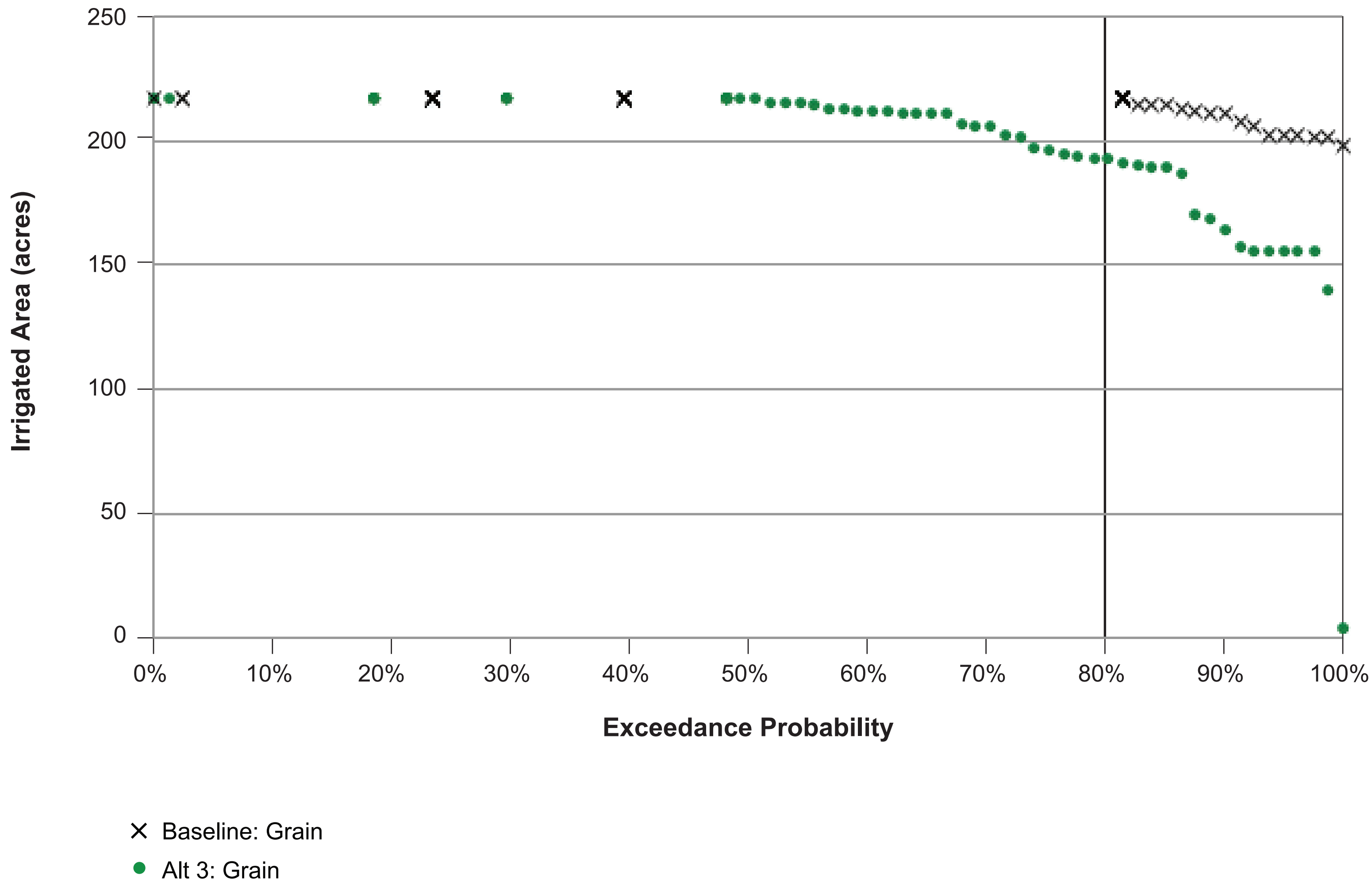

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Figure 11-17d
Irrigated Acreage in MID for Grain under Alternative 3

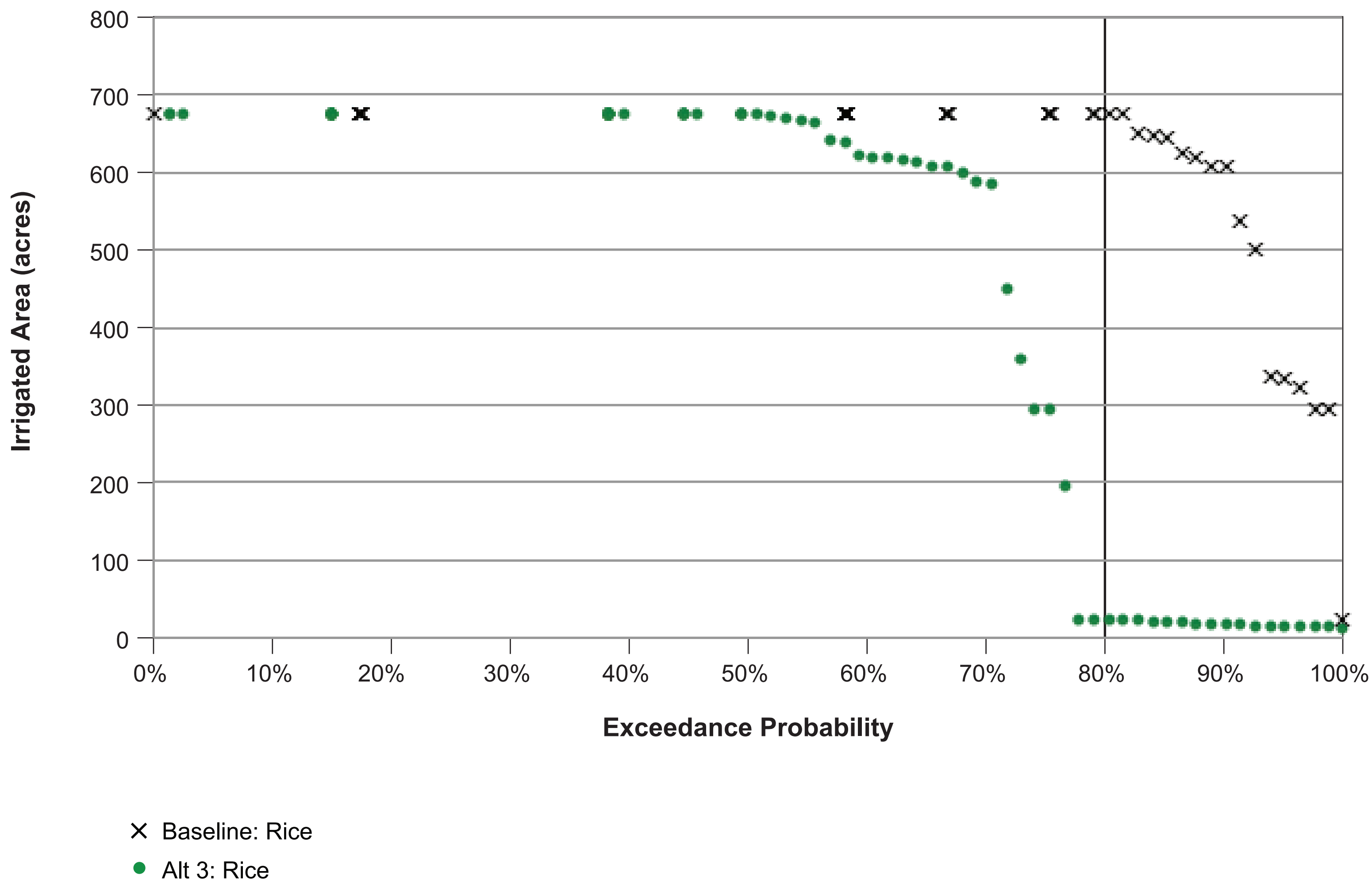

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Figure 11-17e
Irrigated Acreage in MID for Rice under Alternative 3

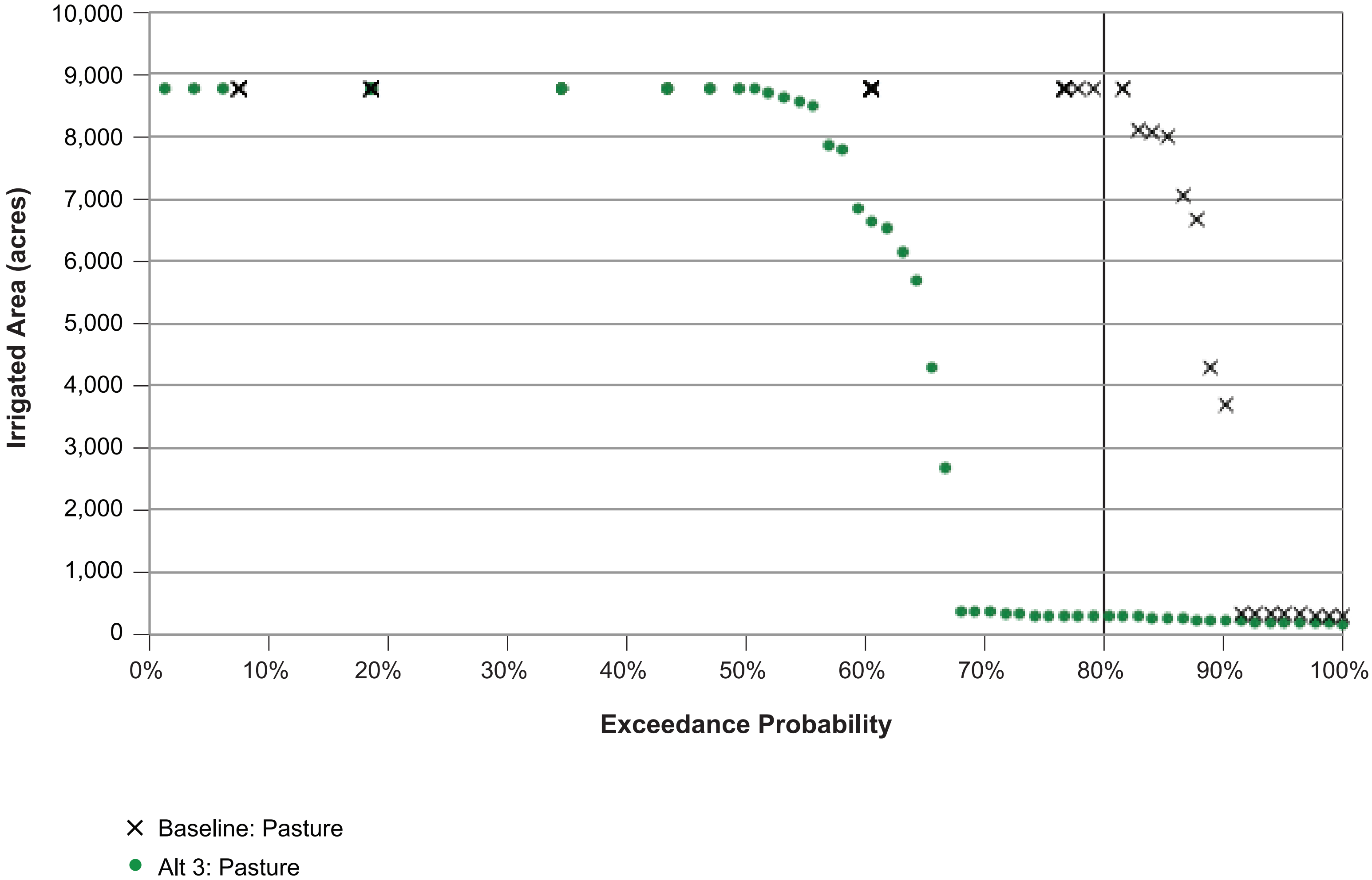

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Figure 11-17f
Irrigated Acreage in MID for Pasture under Alternative 3

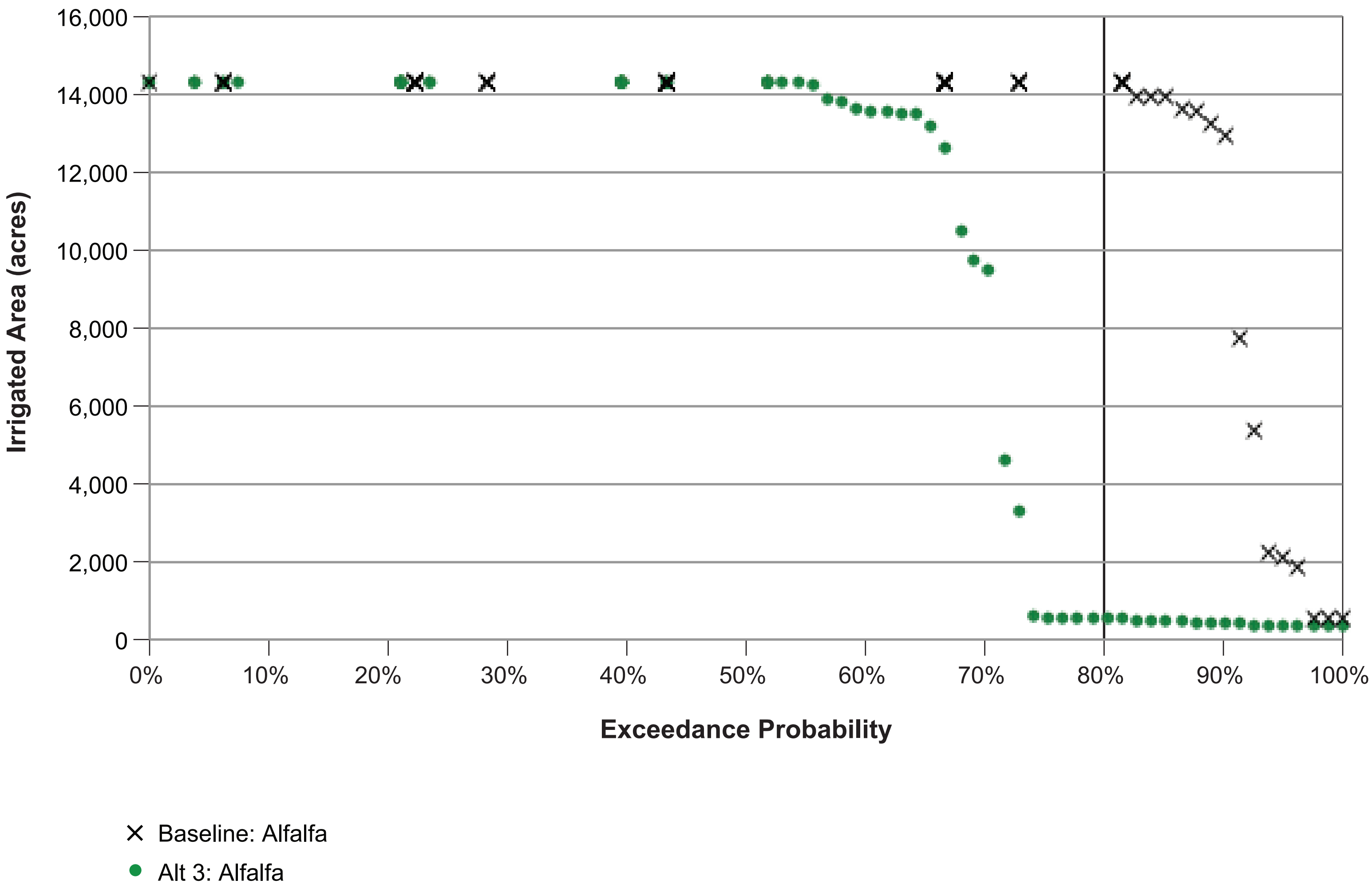

Figure 11-18a
Irrigated Acreage in TID for Alfalfa under Alternative 3

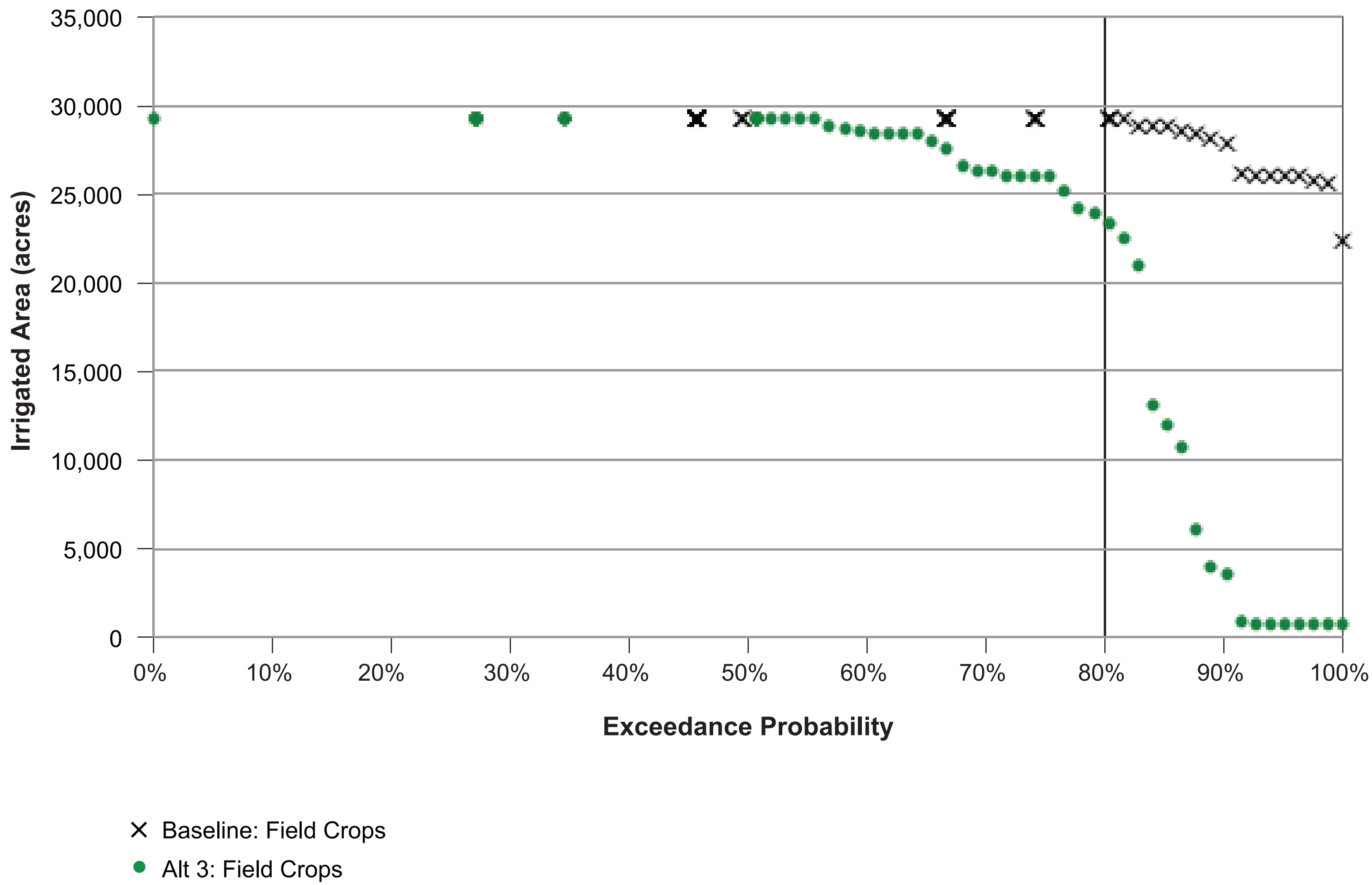

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Figure 11-18b
Irrigated Acreage in TID for Field Crops under Alternative 3

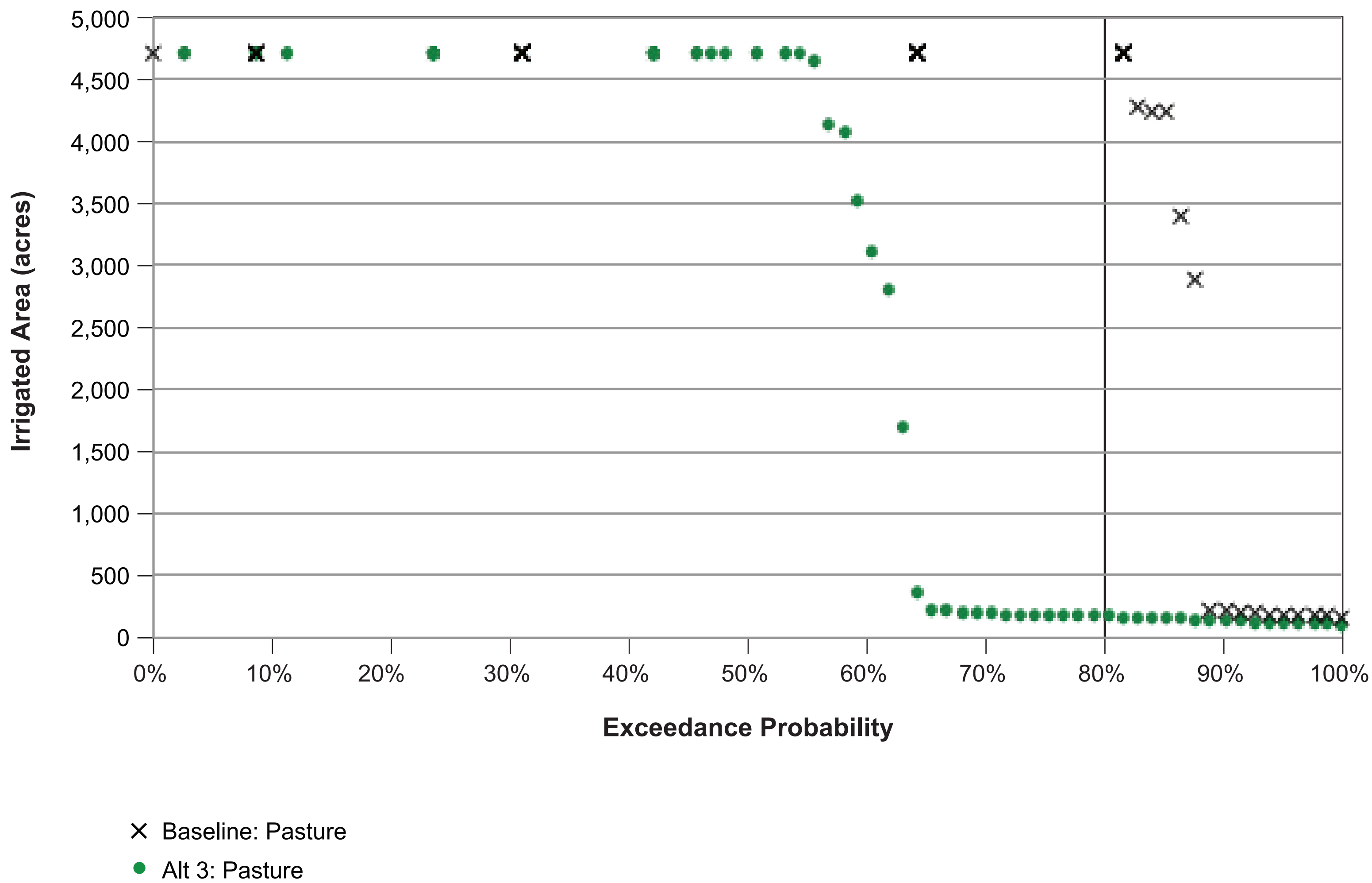

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Figure 11-18c
Irrigated Acreage in TID for Pasture under Alternative 3

regional groundwater agencies, irrigation districts, and local agencies can and should adopt irrigation efficiencies described in LSJR Alternative 2 and local land use authorities can and should impose development conditions and require conservation easements where allowed to mitigate for the loss of agricultural land; however, given the uncertainty of the extent to which these mitigation measures would occur and because they may not fully mitigate impacts, impact would remain significant. While adaptive implementation method 1 could reduce the percent of unimpaired flow to 30 percent and potentially reduce impacts on agricultural resources, it cannot be independently applied as an alternative because it is part of LSJR Alternative 3 and because the purpose of adaptive implementation is to benefit fish. Therefore, according to the number of acres that would no longer be considered Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, as predicted by the SWAP model, and the possibility of conversion of these acres to nonagricultural land uses, impacts on agricultural resources would remain significant and unavoidable.

Adaptive Implementation

As discussed under LSJR Alternative 2, adaptive implementation methods 2 and 4 are not expected to result in impacts on agricultural resources. Adaptive implementation method 3 would result in a shift in the volume of February–June water available to other parts of the year, and one potential way to implement this method is included in the modeling results presented for LSJR Alternative 3 in Table 11-17. Because this method would have minimal effect on diversions and the total annual volume of river flow, this method would not affect agricultural resources and it would result in similar impacts to those described above. Adaptive implementation method 1 would allow an increase or decrease of up to 10 percent in the February–June, 40-percent unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 40 percent to 30 percent or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternatives 2 or 4, respectively.

If the adjustment occurs frequently or for extended durations, based on the modeling results for LSJR Alternative 4 and with adaptive implementation method 1 incorporated (i.e., 50 percent unimpaired flow), impacts would still be significant. If the adjustment occurs frequently or for extended durations, based on the modeling results for LSJR Alternative 2 and with adaptive implementation method 1 incorporated (i.e., 30 percent unimpaired flow), impacts on agricultural resources would be less than significant for all districts except for OID, which would experience an average decrease in irrigated acreage of 4.4 percent; and, MID, which would experience an average reduction in irrigated acres of 4.5 percent (Table 11-16) from baseline.

LSJR Alternative 4 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

Under Alternative 4, the average annual reduction in acreage ranges from a low of 0 percent for SEWD and CSJWCD to 27.5 percent for MID (Table 11-19). Figures 11-19 through 11-22 show SWAP-modeled crop changes for all crops as a result of LSJR Alternative 4 compared to baseline for the six geographic areas. While the SWAP results indicated there would be little to no change in crop acreage for either SEWD/CSJWCD or Merced ID, the remaining irrigation districts are predicted to experience change in crop acreage for various crop categories. Crops categories that would experience an average acreage reduction of greater than 4 percent are shown in Figures 11-19 through 11-22 for SSJID, OID, MID, and TID respectively. These figures show how the acreage of select crops change in response to reduced water availability under both baseline and LSJR Alternative 4. Figure 11-19a, for example, shows the irrigated acreage in SSJID for Alfalfa. Under baseline, acreage remains stable, at approximately 3,200 acres, in a little over 95 percent of all years, and then is reduced to less than 200 acres. This is reflective of the response to reduced water availability that occurs about once in every 20 years under baseline. Acreage also remains stable under LSJR Alternative 4 in approximately 45 percent of years, but then is reduced to about 200 acres or less in approximately 42 percent of years. These figures show how the average reductions in crop acreages are concentrated in years with reduced water availability, and vary depending on crop type. Figures are not shown for crops that are not much affected by reduced water supplies, such as Orchards, Vines, and Truck crops (see Appendix G, Tables G.4-6a through G.4-6f).

Table 11-19. Average Cropped Acreage and Acreage Reduction under LSJR Alternative 4, by District, Compared to Baseline

	Baseline	LSJR Alternative 4		
District	Average Acres		Acre Change	% Reduction
SSJID	58,229	52,048	-6,181	10.6
OID	54,162	43,414	-10,748	19.8
SEWD + CSJWCD	98,931	98,931	0	0.0
MID	57,354	41,580	-15,774	27.5
TID	143,783	108,490	-35,294	24.5
Merced ID	99,769	97,126	-2,644	2.6
Total	512,229	441,589	-70,640	13.8

Since the land within the six geographic areas would need irrigation 8 out of 10 years to qualify as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance it is expected the total lands classified as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance would be reduced as a result of LSJR Alternative 4 (Table 11-19). It is unknown whether the reduction in irrigation water would result in a direct conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use, but it is conservative to assume that if irrigation water is unavailable to sustain these acreages identified in Table 11-19, then some of the 70,640 acres affected in SSJID, OID, MID, and TID (17 percent of the total Prime Farmland, Unique Farmland, and Farmland of Statewide Importance within the affected districts) would be converted to nonagricultural uses

When the maximum groundwater pumping capacity for 2014 is used in the analysis instead of the estimates for 2009, the acreage is less affected because there was more groundwater pumping in 2014 to meet the shortfall in the applied surface water needed to meet crop demand. The results show an overall decrease in the reduction of average annual crop acreage for all irrigation districts, but particularly MID (Table 11-20). If the groundwater pumping capabilities of the irrigation districts are closer to the 2014 values, then the crop acreage reductions estimated under 2009 conditions would be smaller; however, it is unlikely this is a sustainable practice given groundwater conditions (Chapter 9, *Groundwater Resources)*.

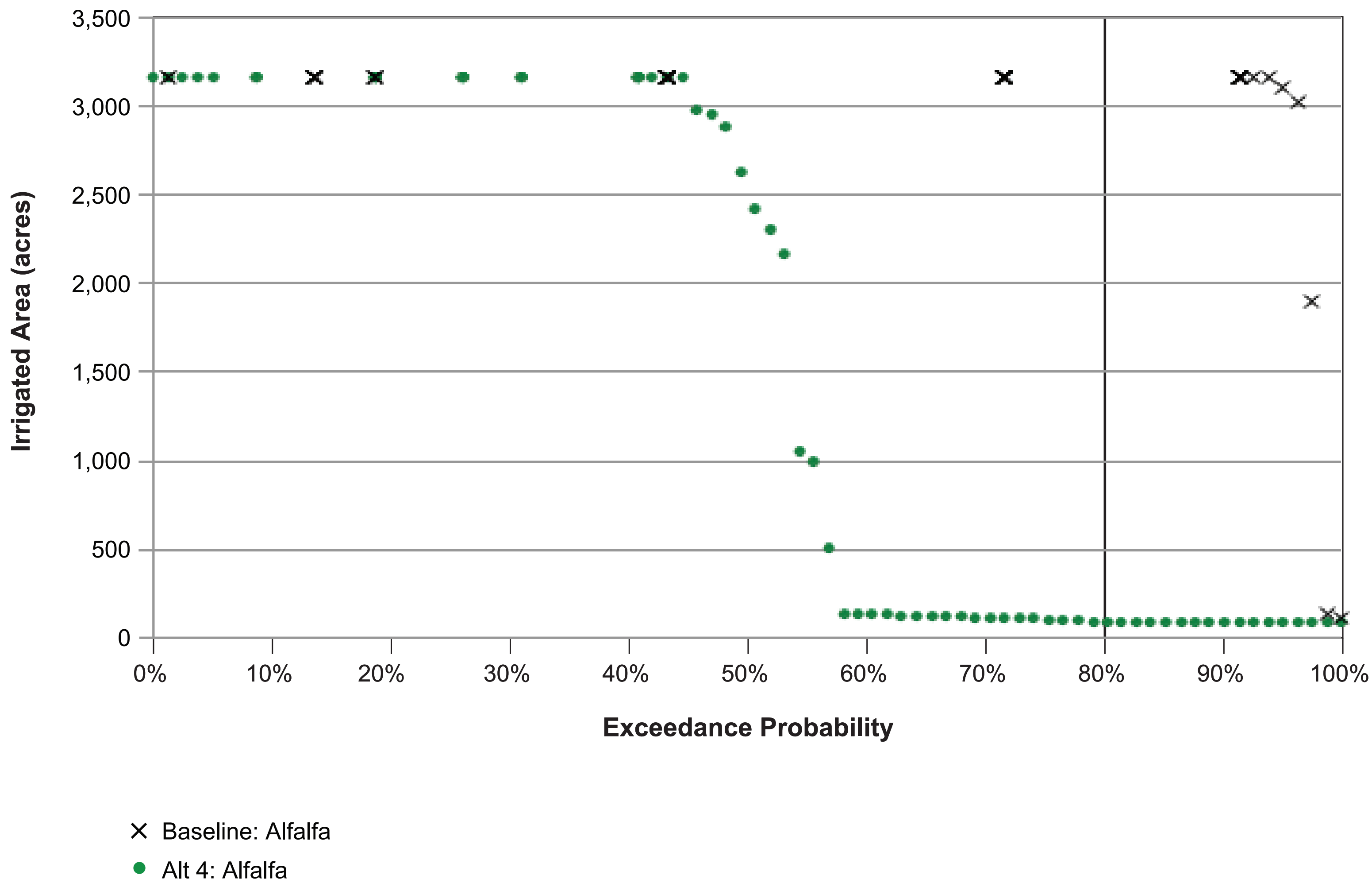


Figure 11-19a
Irrigated Acreage in SSJID for Alfalfa under Alternative 4

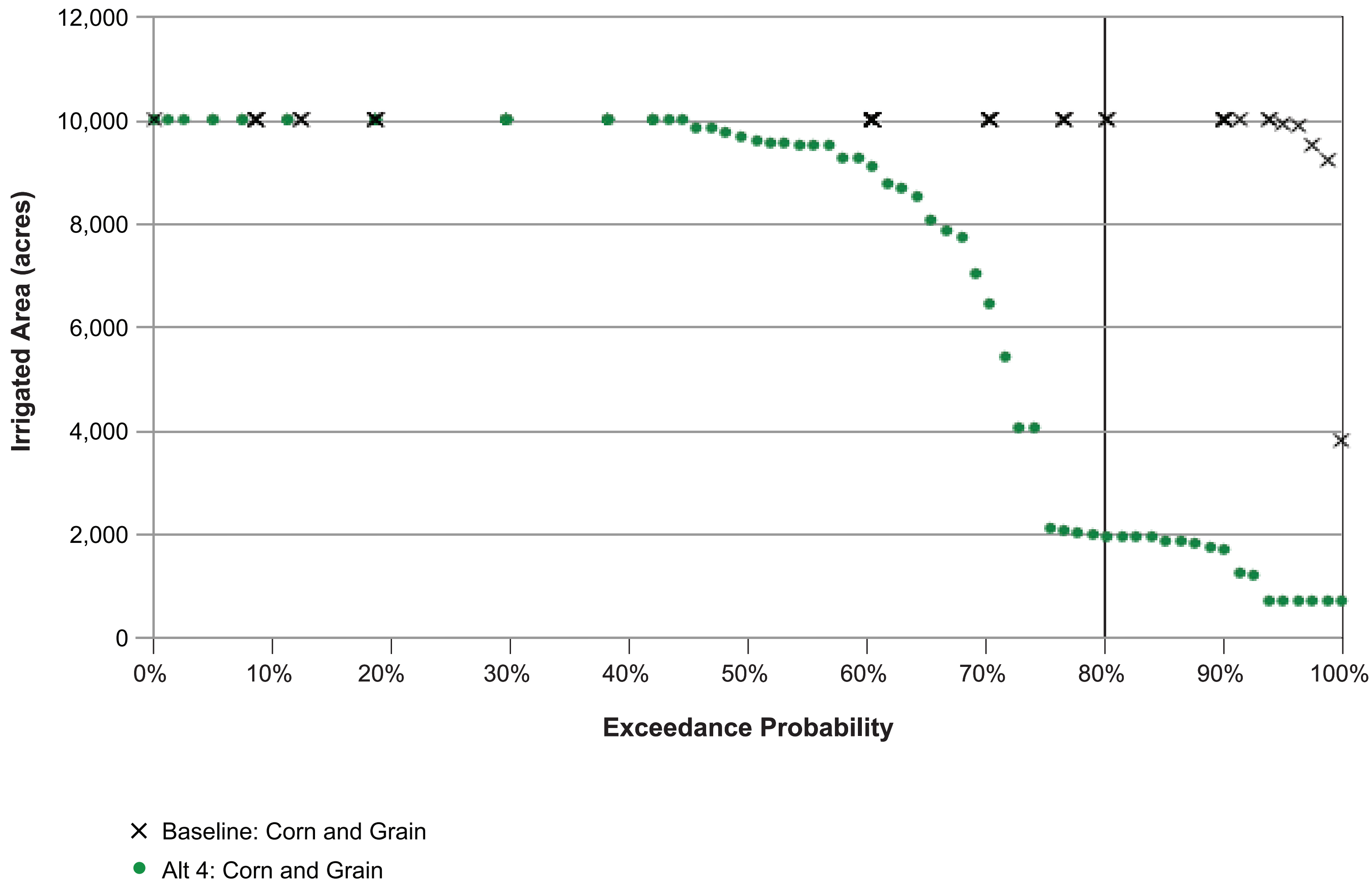
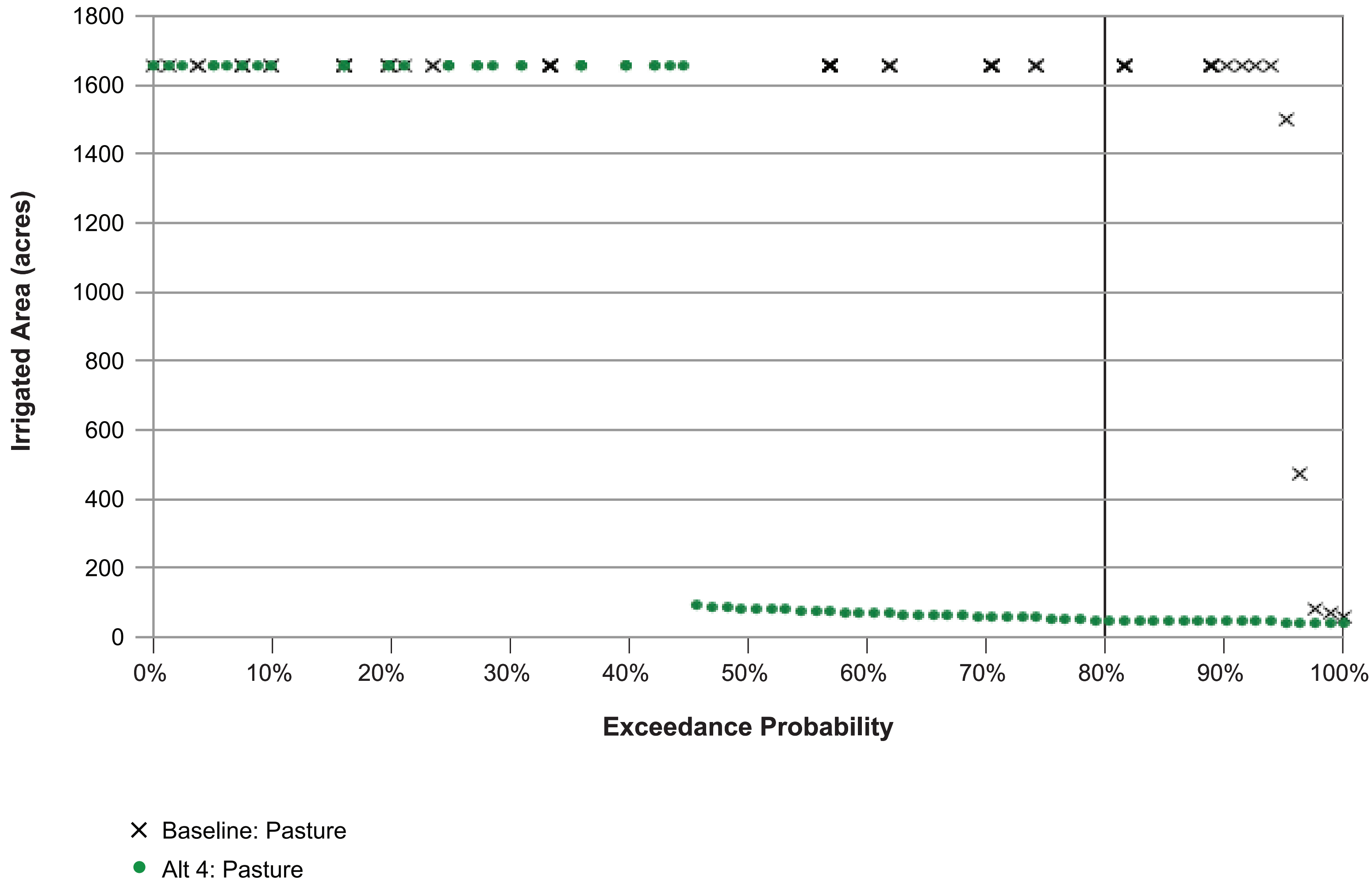
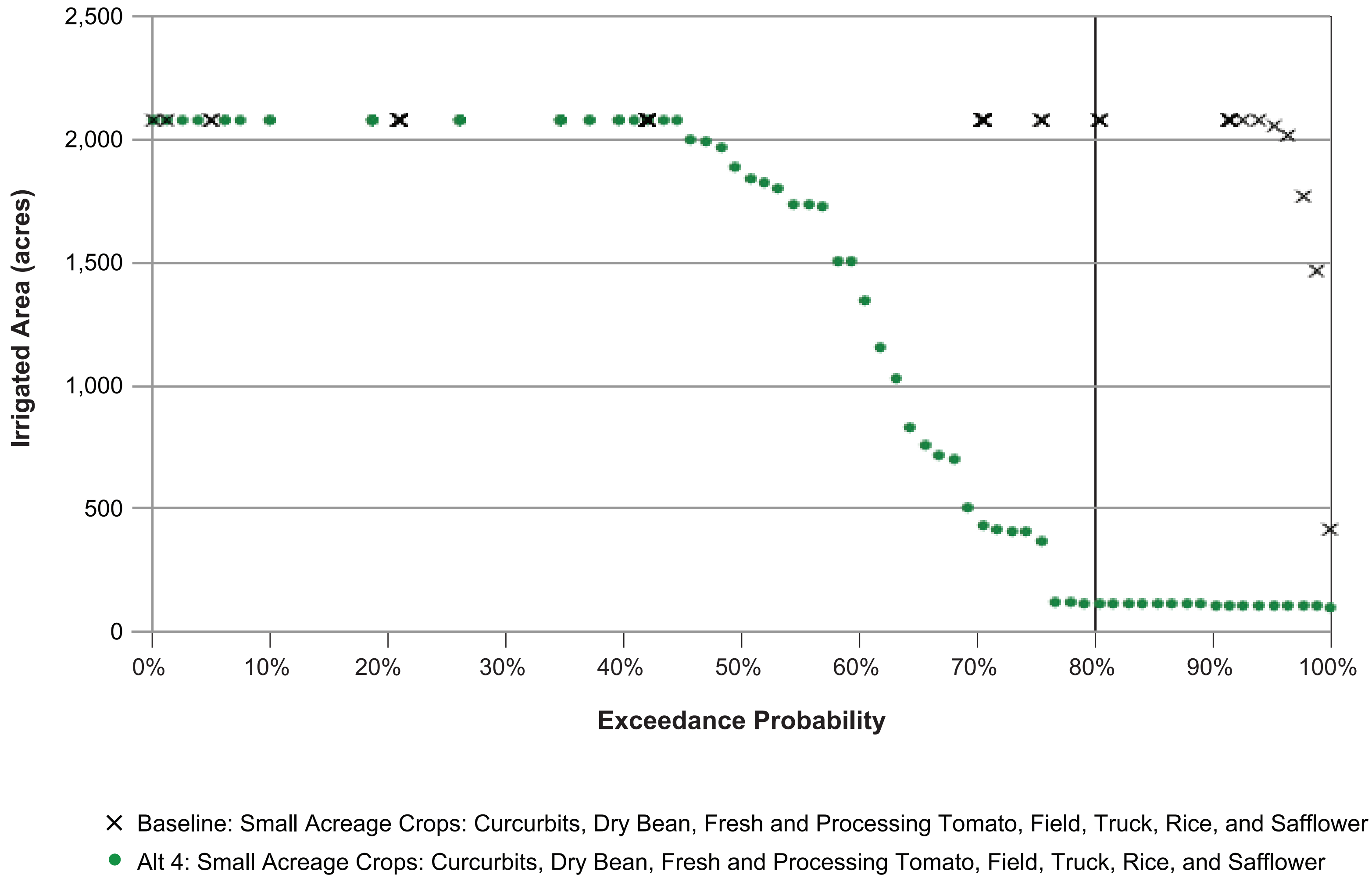


Figure 11-19b
Irrigated Acreage in SSJID for Corn and Grain under Alternative 4



Graphics…00427.11 (1-8-2016)

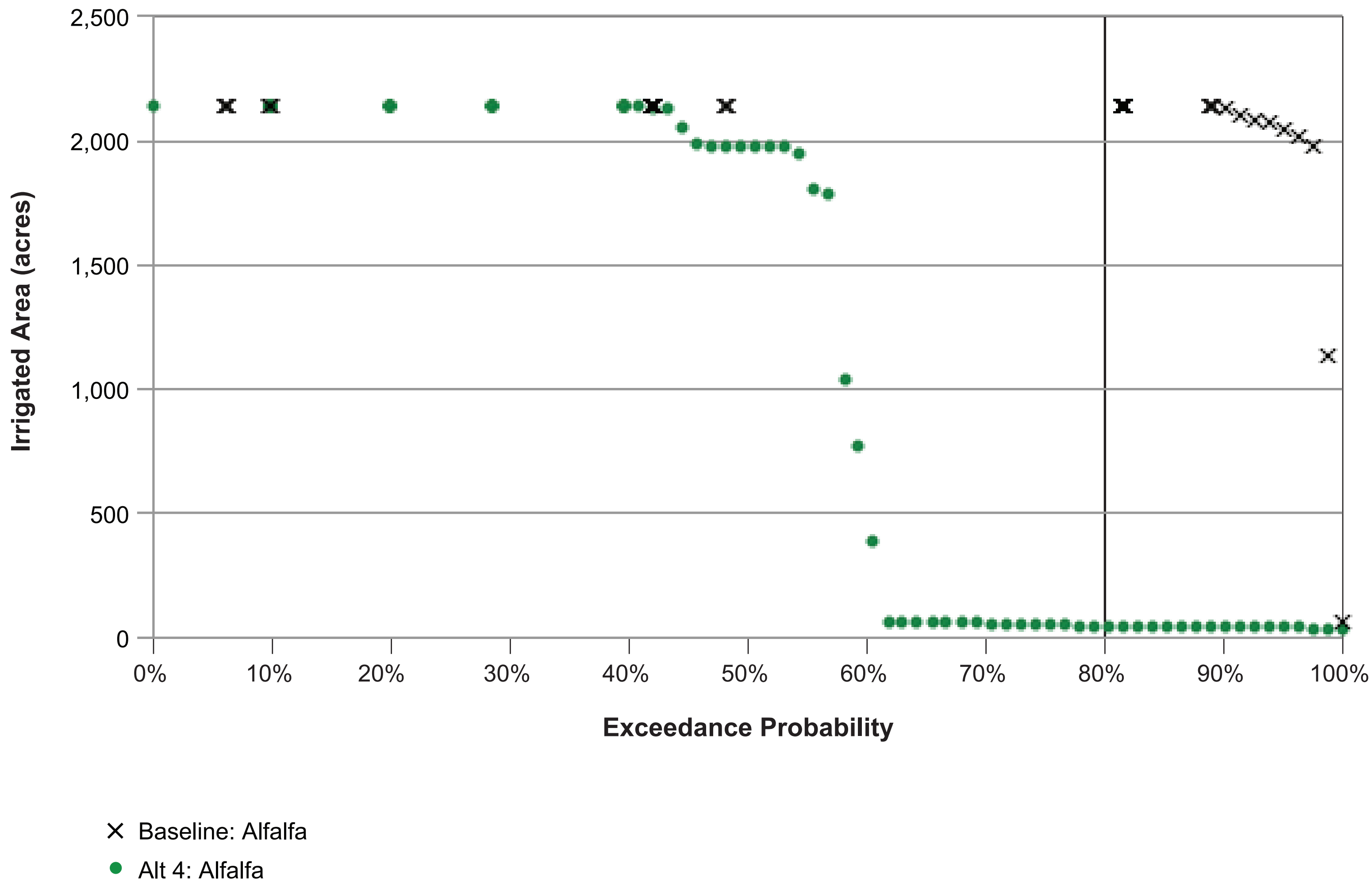
Figure 11-19c
Irrigated Acreage in SSJID for Pasture under Alternative 4



Graphics...00427.11 (1-8-2016)

ICF INTERNATIONAL

Figure 11-19d
Irrigated Acreage in SSJID for Small Acreage Crops under Alternative 4



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ICF INTERNATIONAL

Figure 11-20a
Irrigated Acreage in OID for Alfalfa under Alternative 4

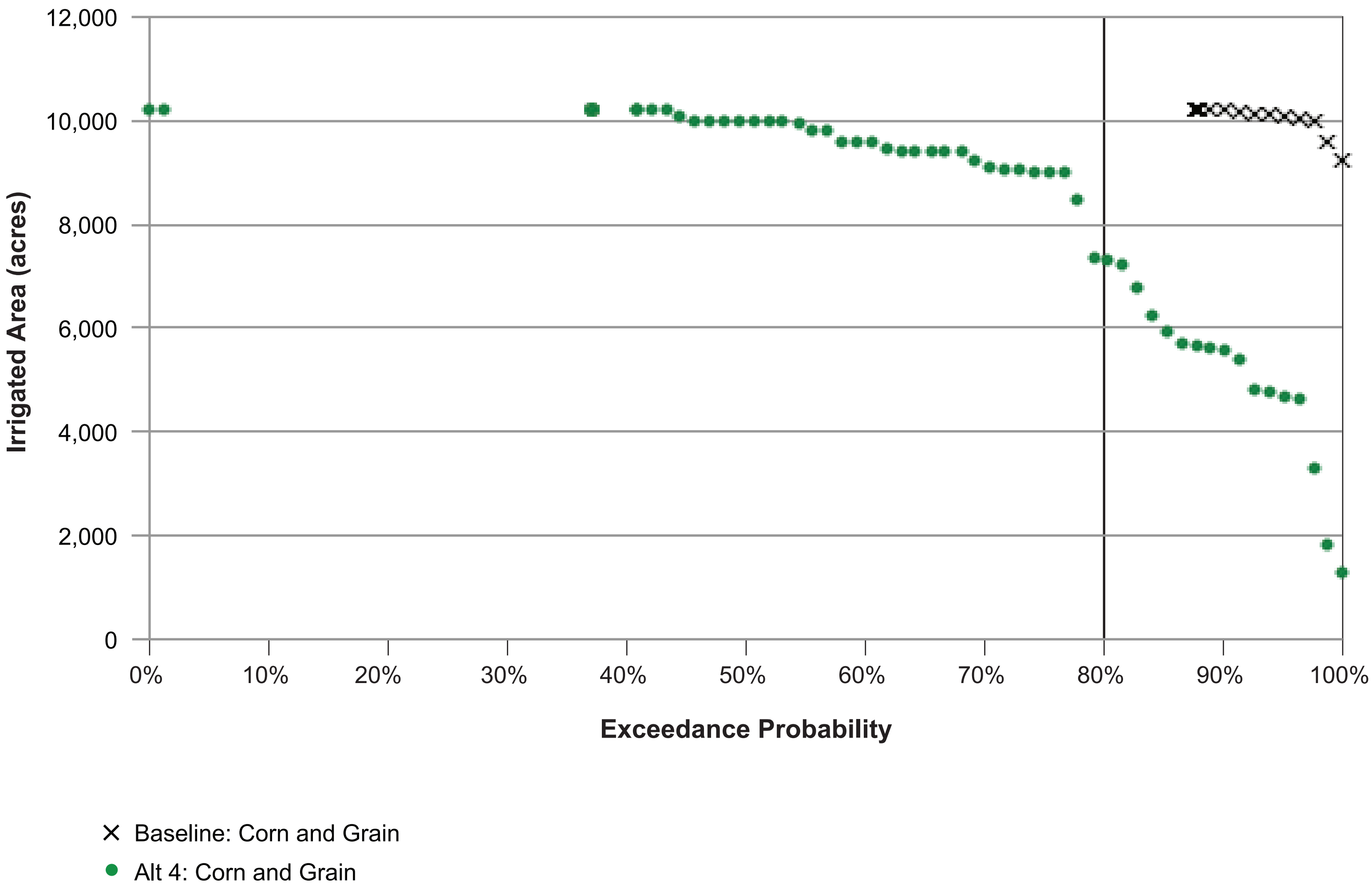

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Figure 11-20b
Irrigated Acreage in OID for Corn and Grain under Alternative 4

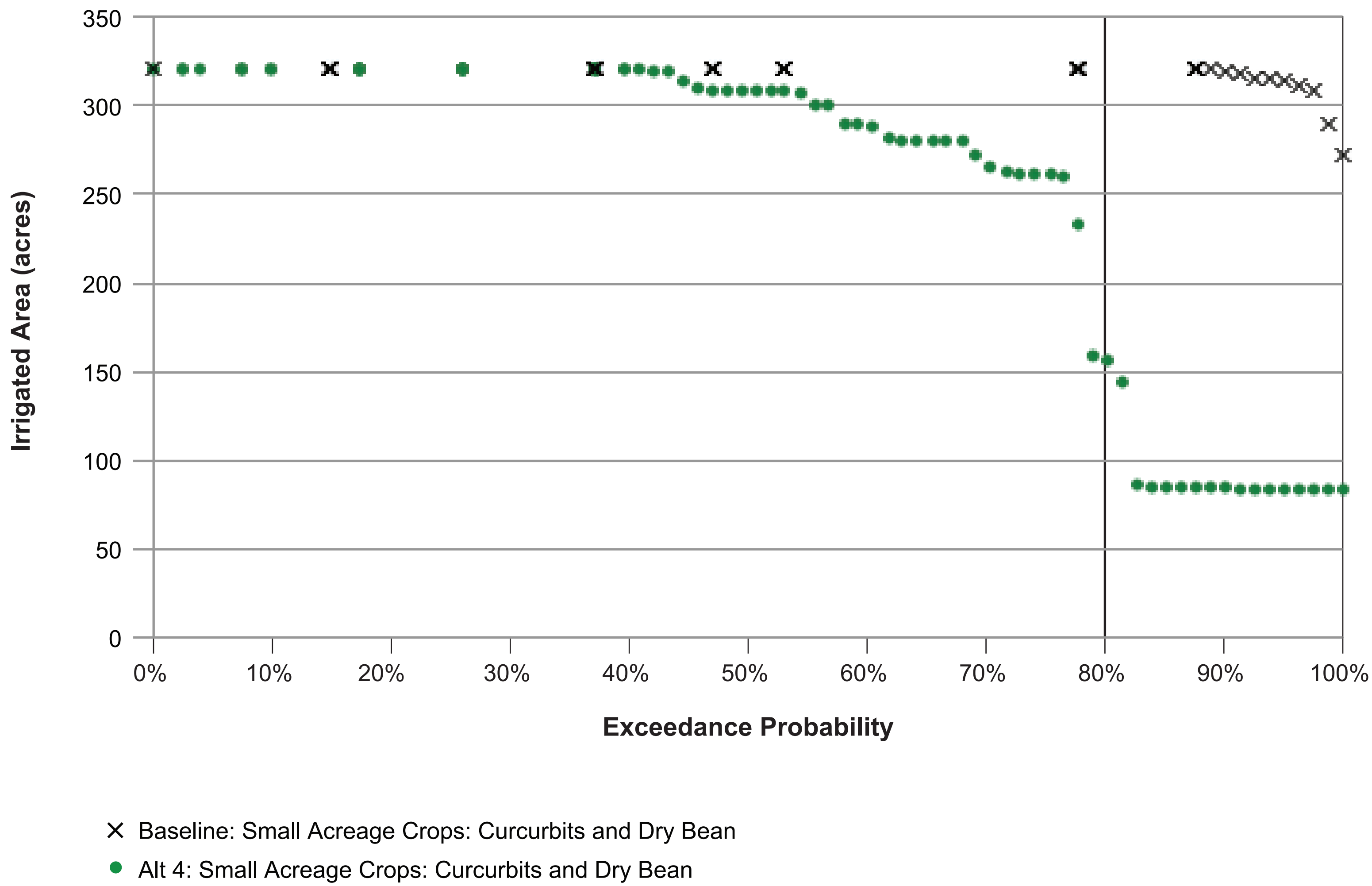
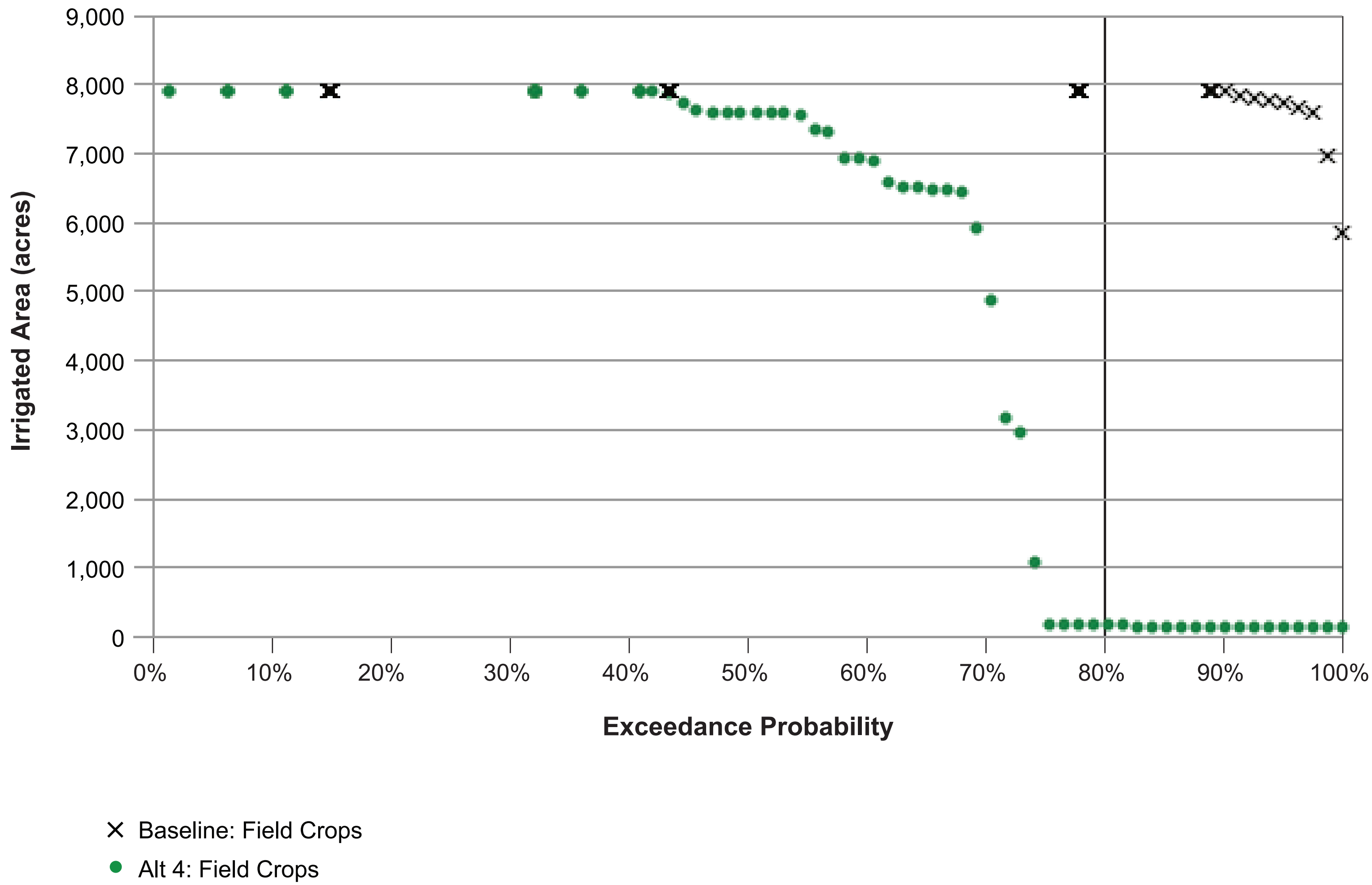


Figure 11-20c
Irrigated Acreage in OID for Small Acreage Crops under Alternative 4



Graphics...00427.11 (1-8-2016)

Figure 11-20d
Irrigated Acreage in OID for Field Crops under Alternative 4

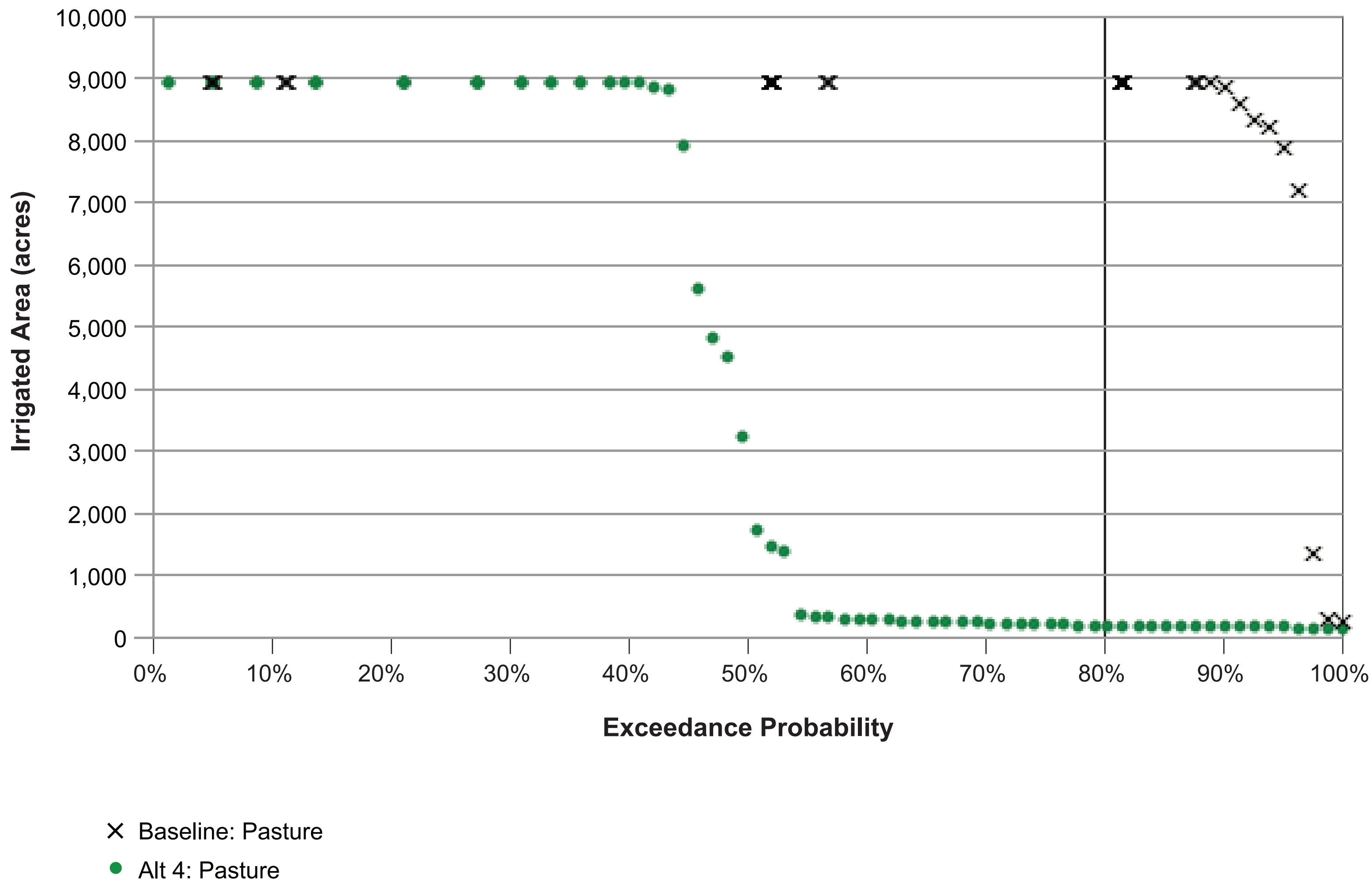


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Figure 11-20e
Irrigated Acreage in OID for Pasture under Alternative 4

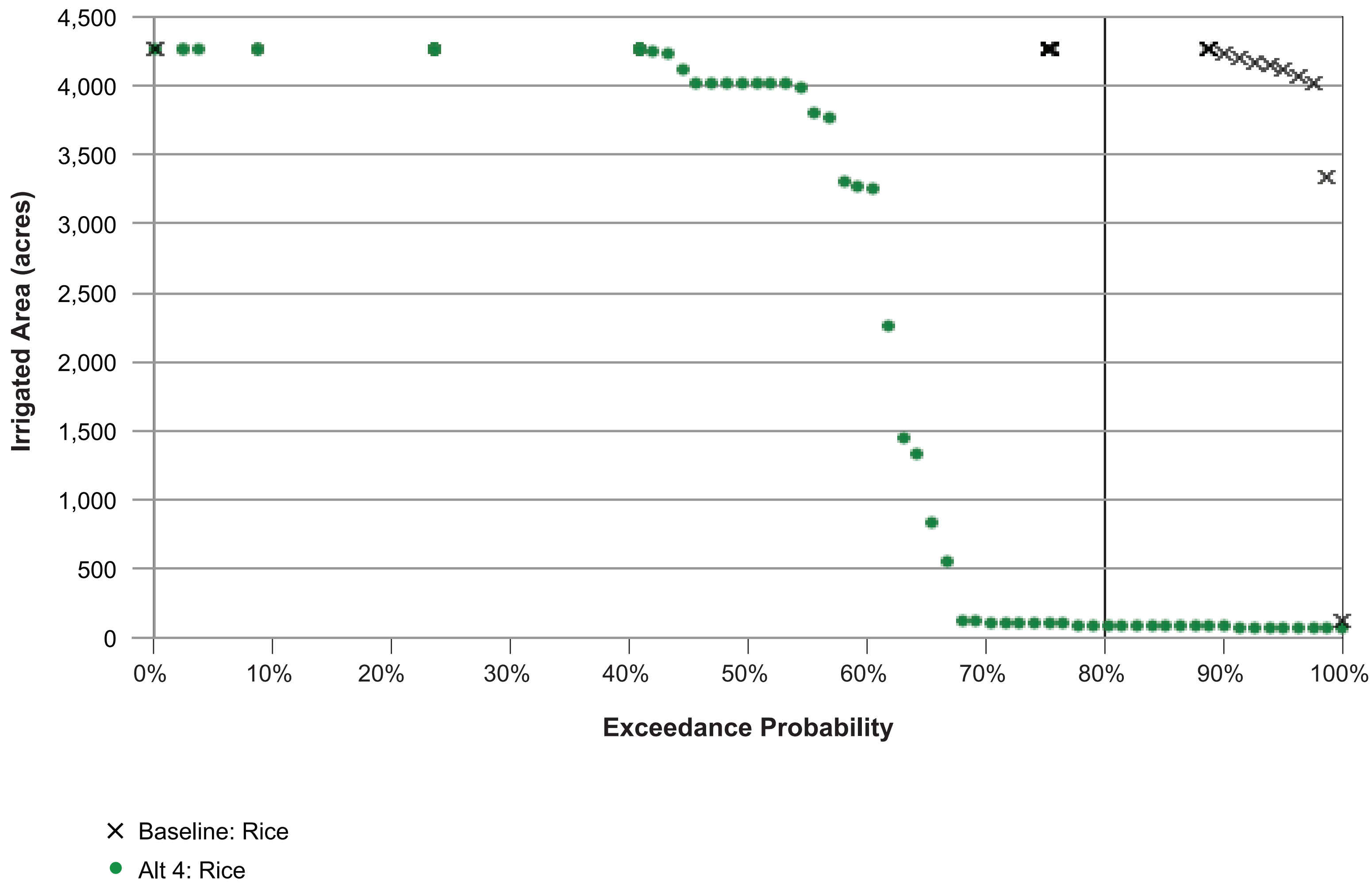

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Figure 11-20f
Irrigated Acreage in OID for Rice under Alternative 4

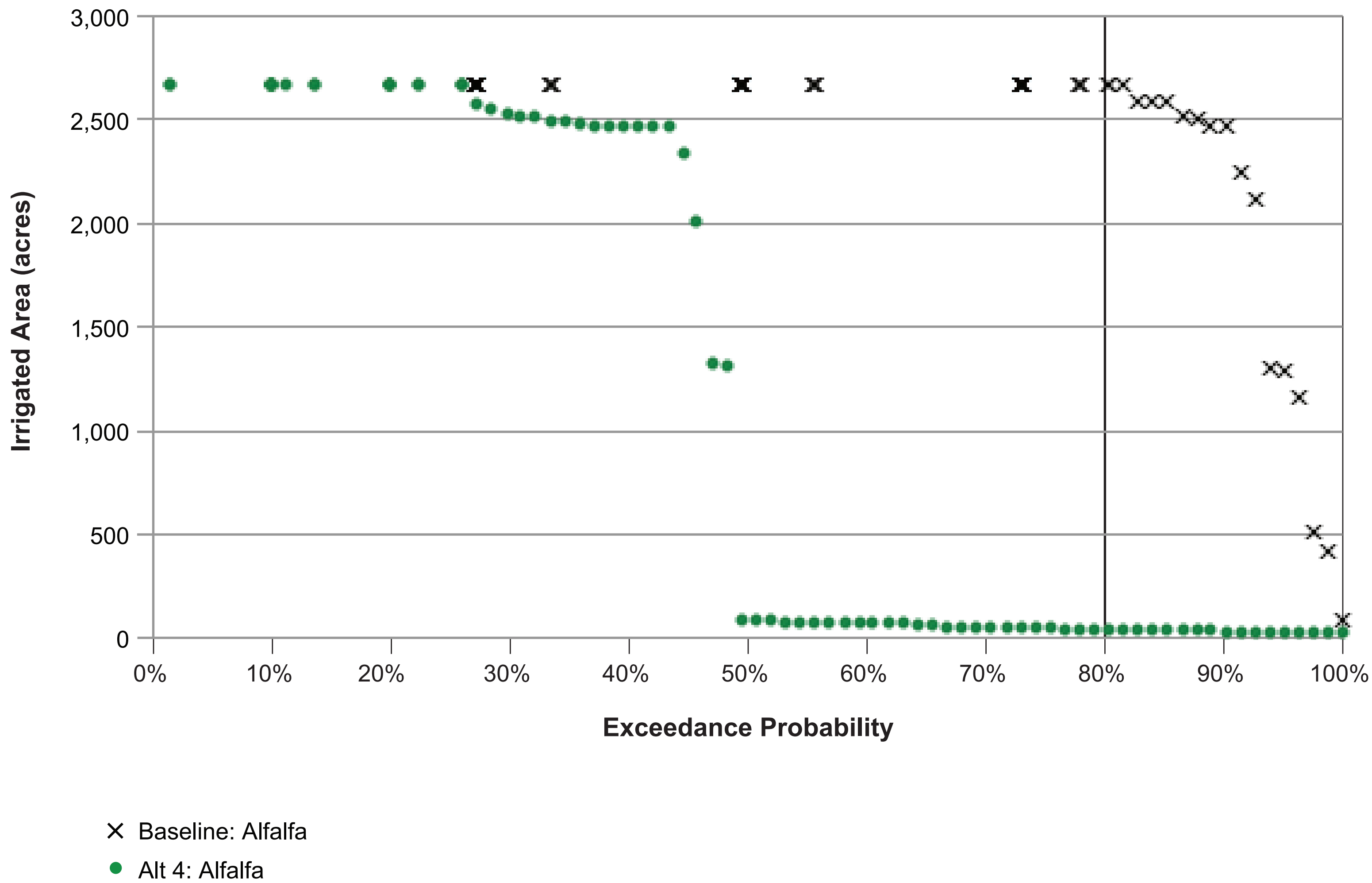

Figure 11-21a
Irrigated Acreage in MID for Alfalfa under Alternative 4

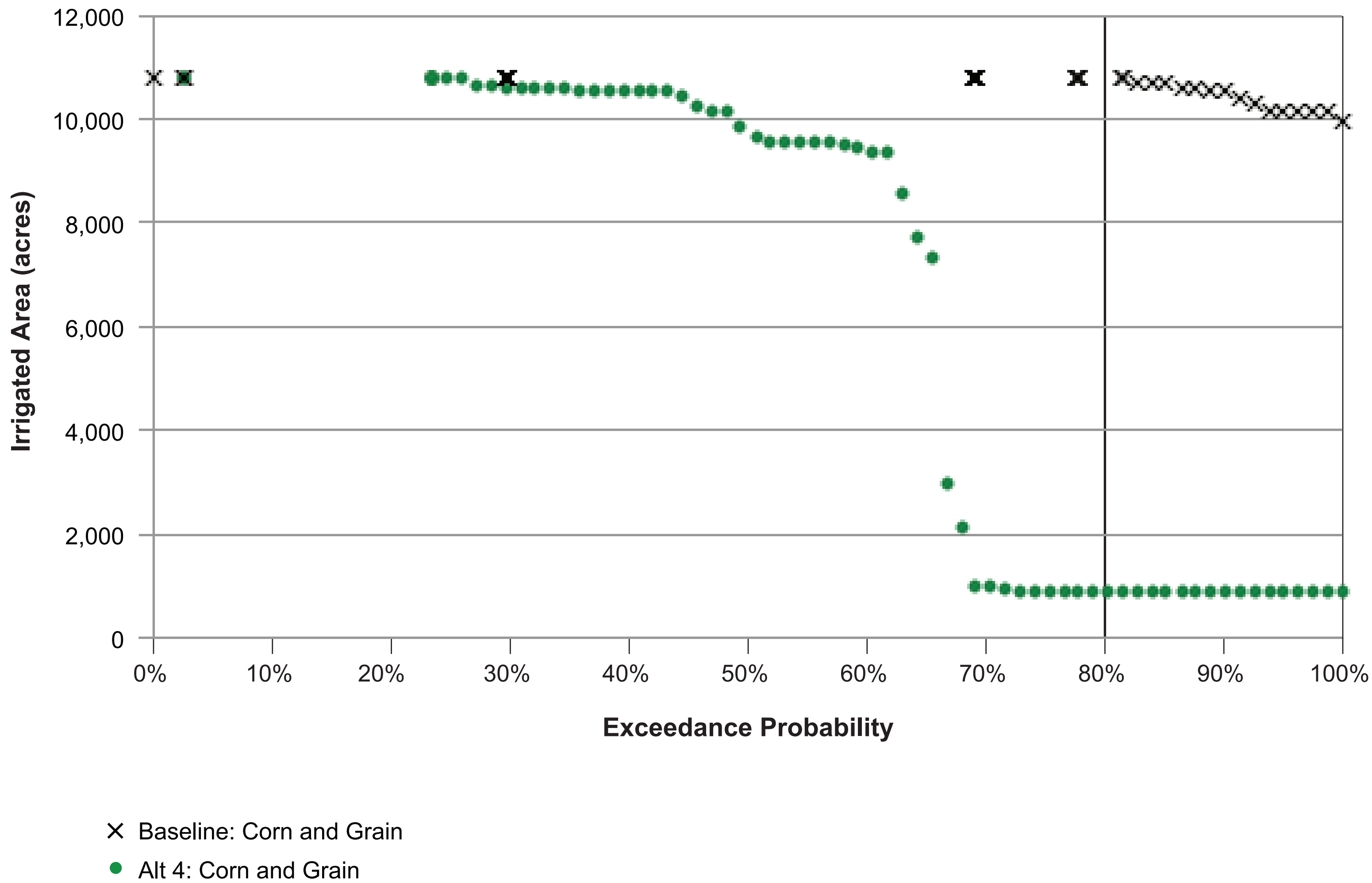

Figure 11-21b
Irrigated Acreage in MID for Corn and Grain under Alternative 4

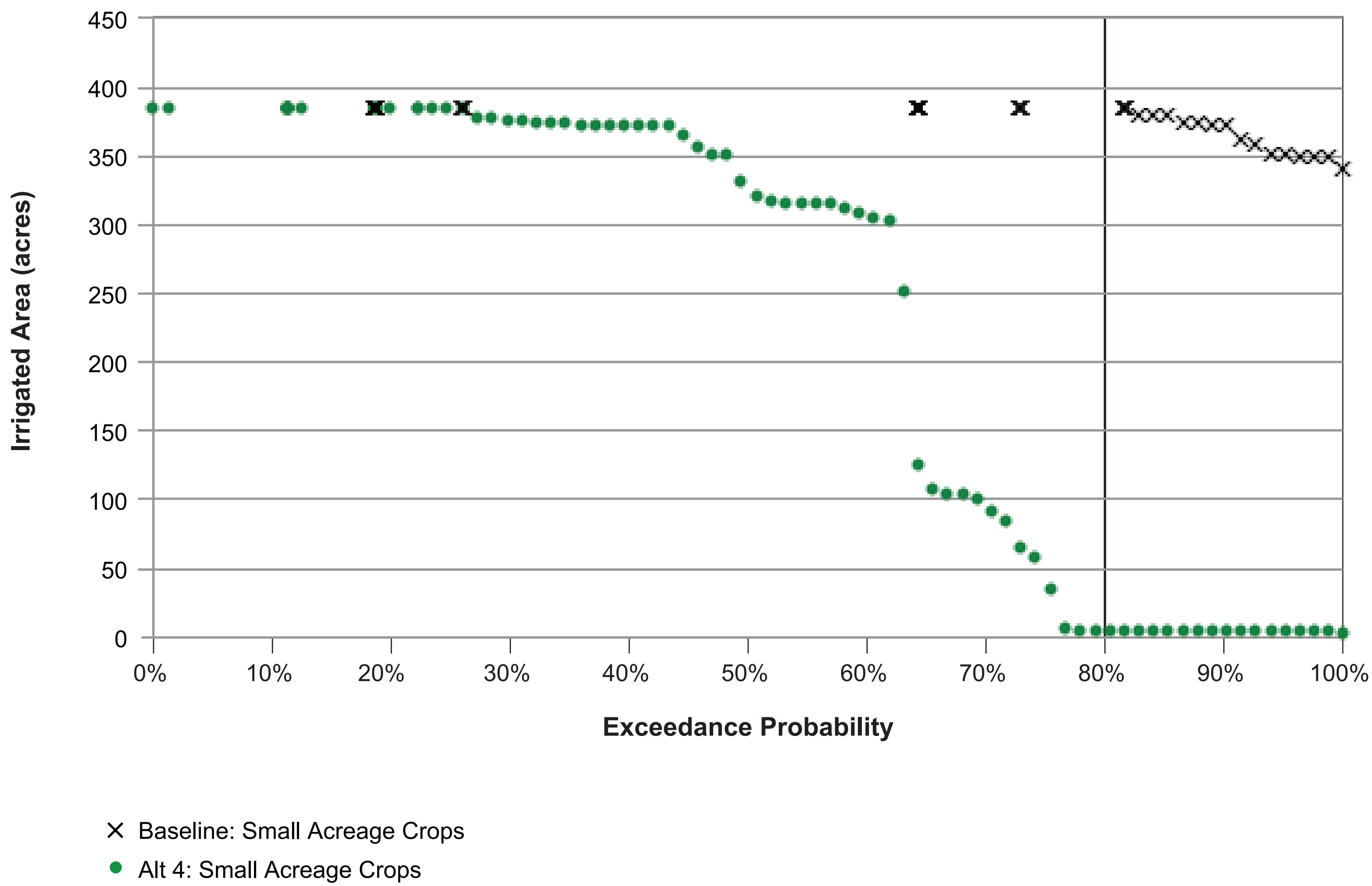

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Figure 11-21c
Irrigated Acreage in MID for Small Acreage Crops under Alternative 4

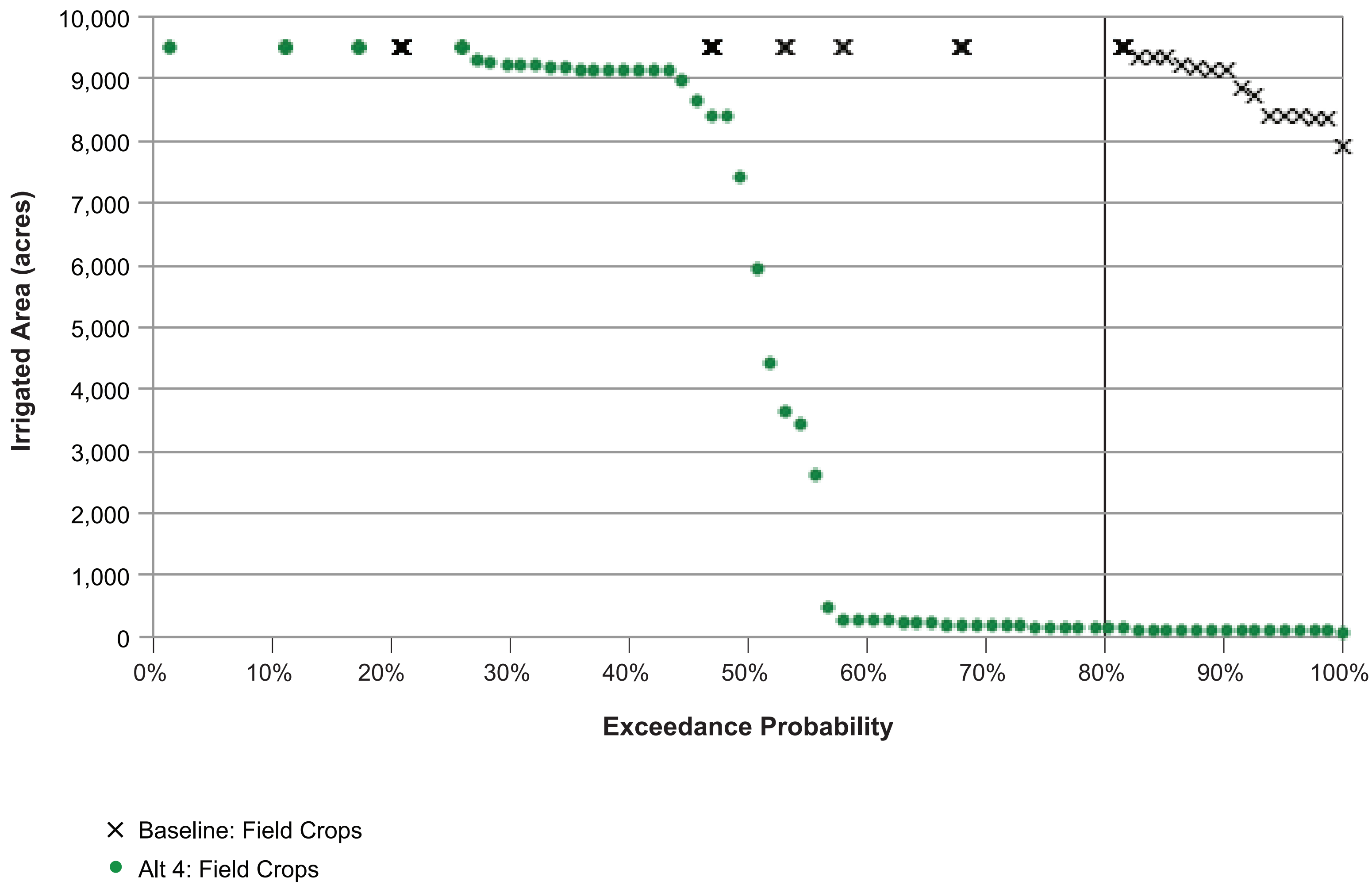

Figure 11-21d
Irrigated Acreage in MID for Field Crops under Alternative 4

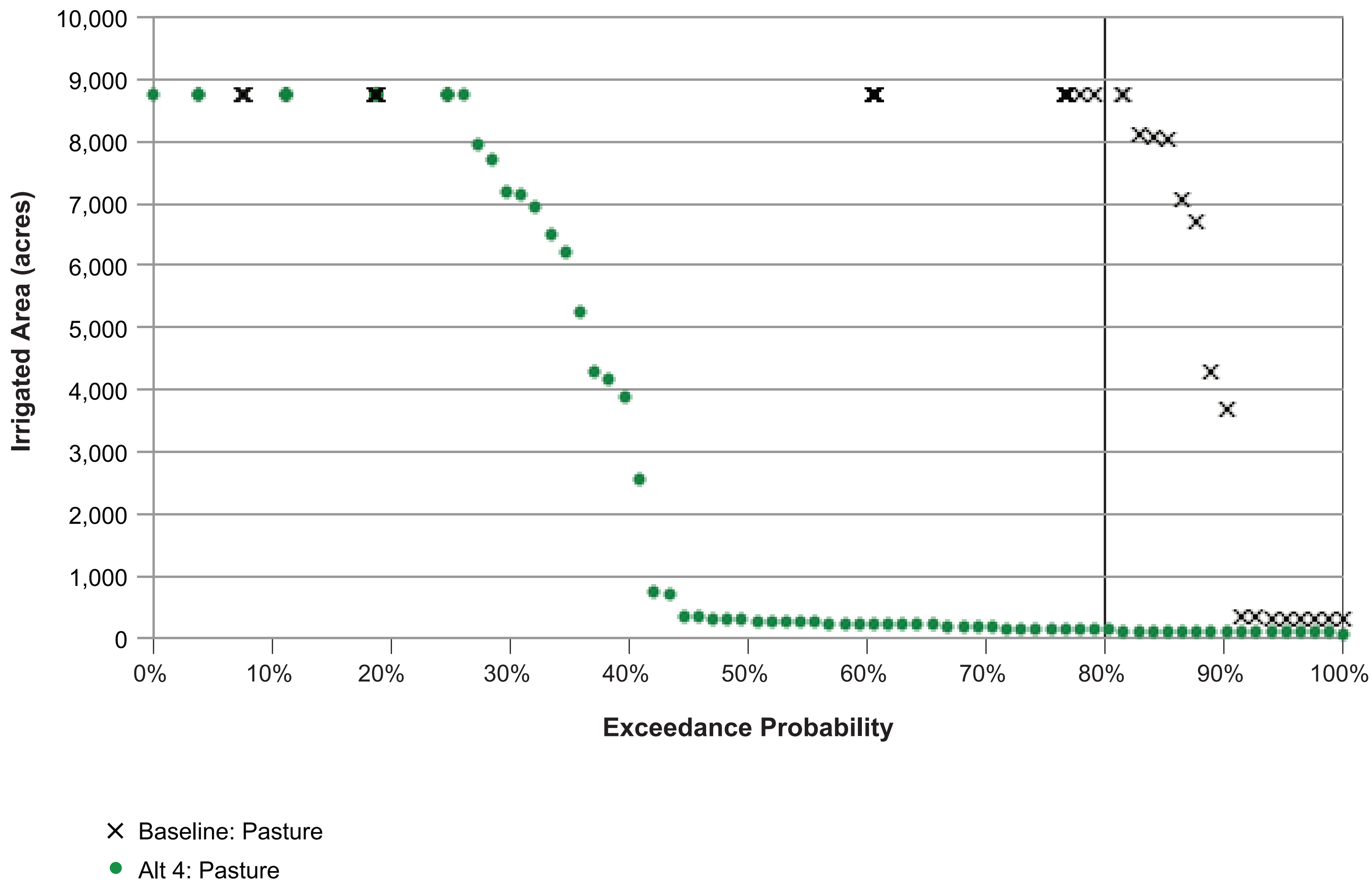

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Figure 11-21e
Irrigated Acreage in MID for Pasture under Alternative 4

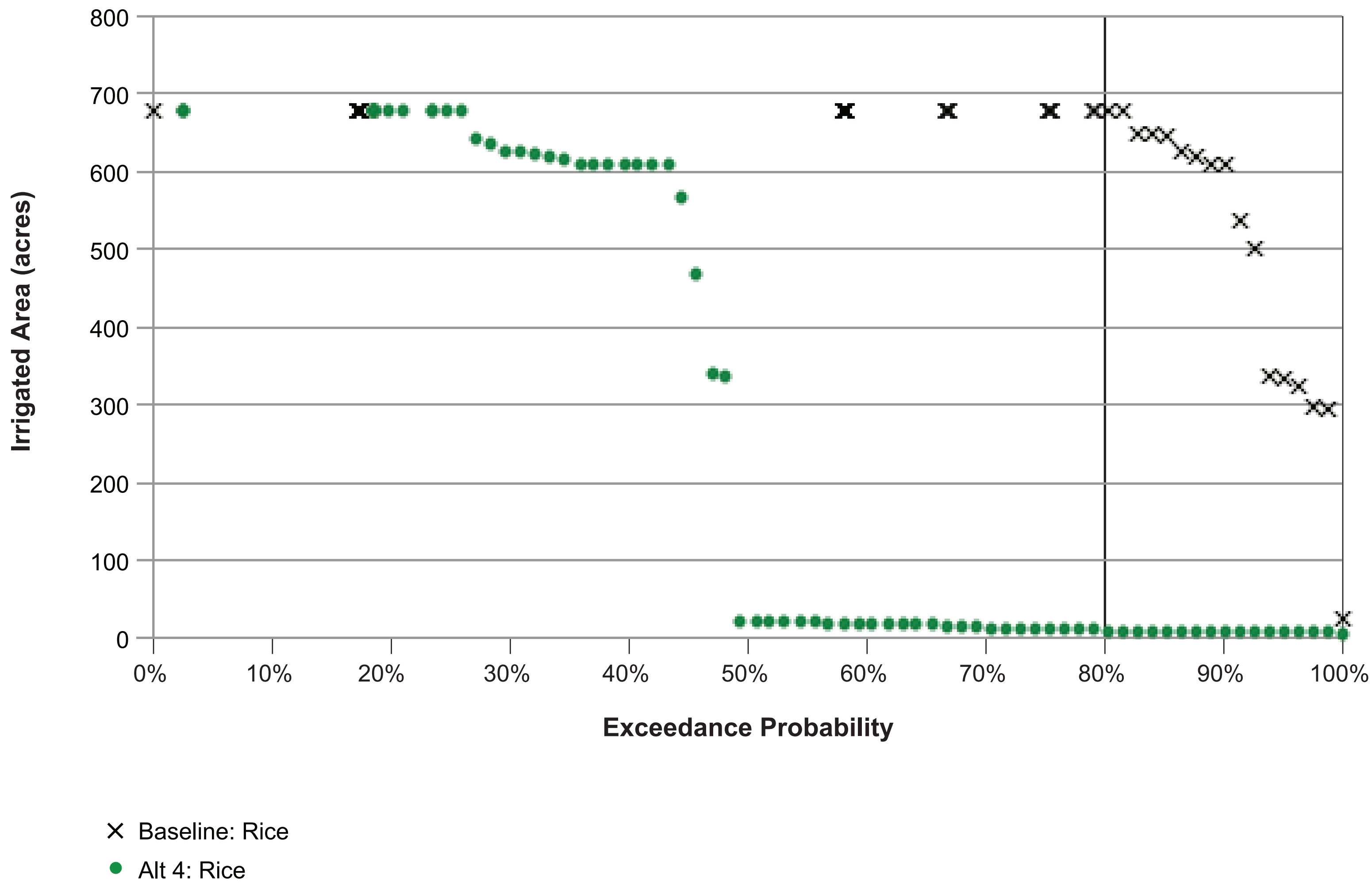

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Figure 11-21f
Irrigated Acreage in MID for Rice under Alternative 4

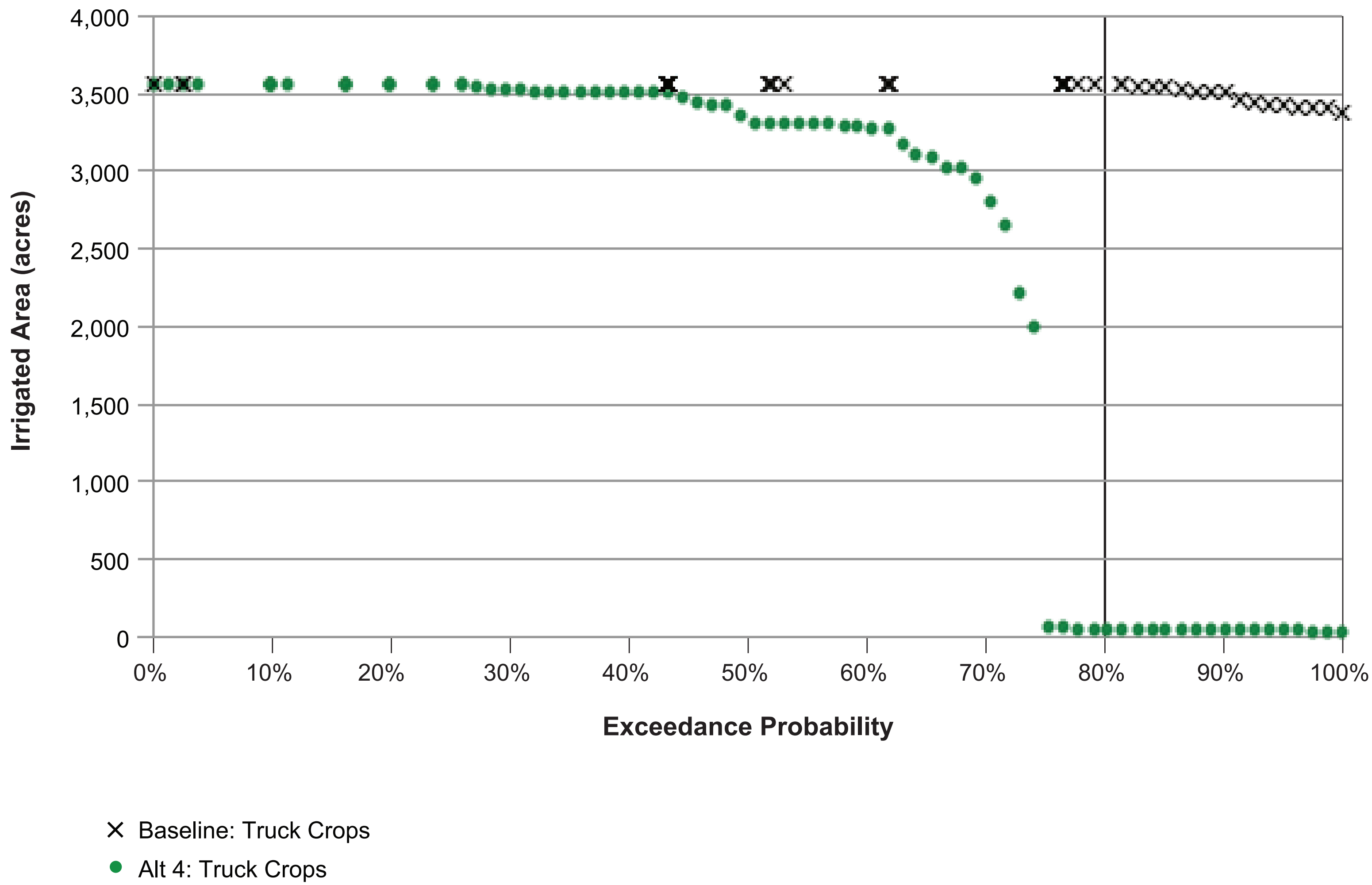

Figure 11-21g
Irrigated Acreage in MID for Truck Crops under Alternative 4

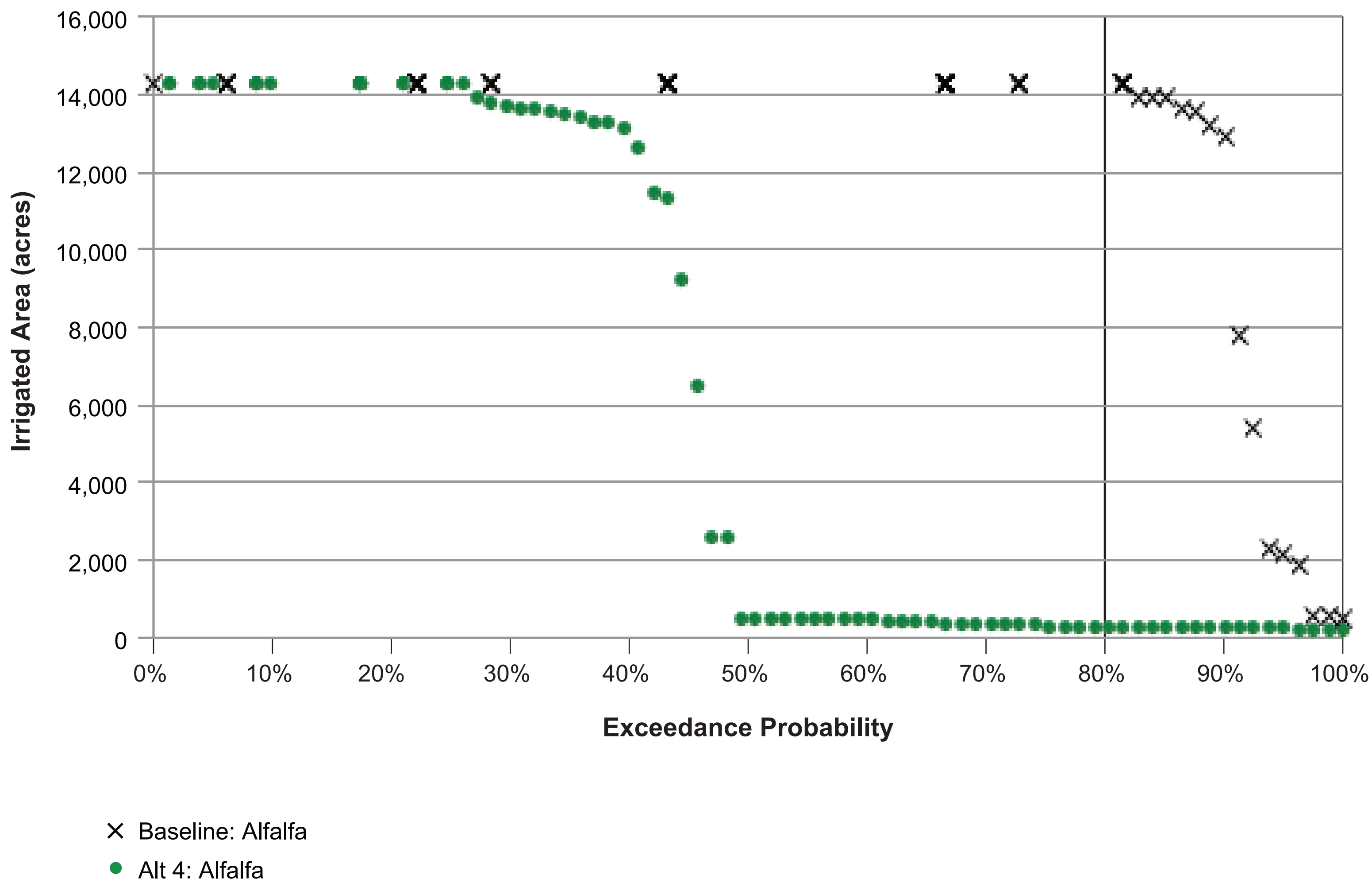

Figure 11-22a
Irrigated Acreage in TID for Alfalfa under Alternative 4

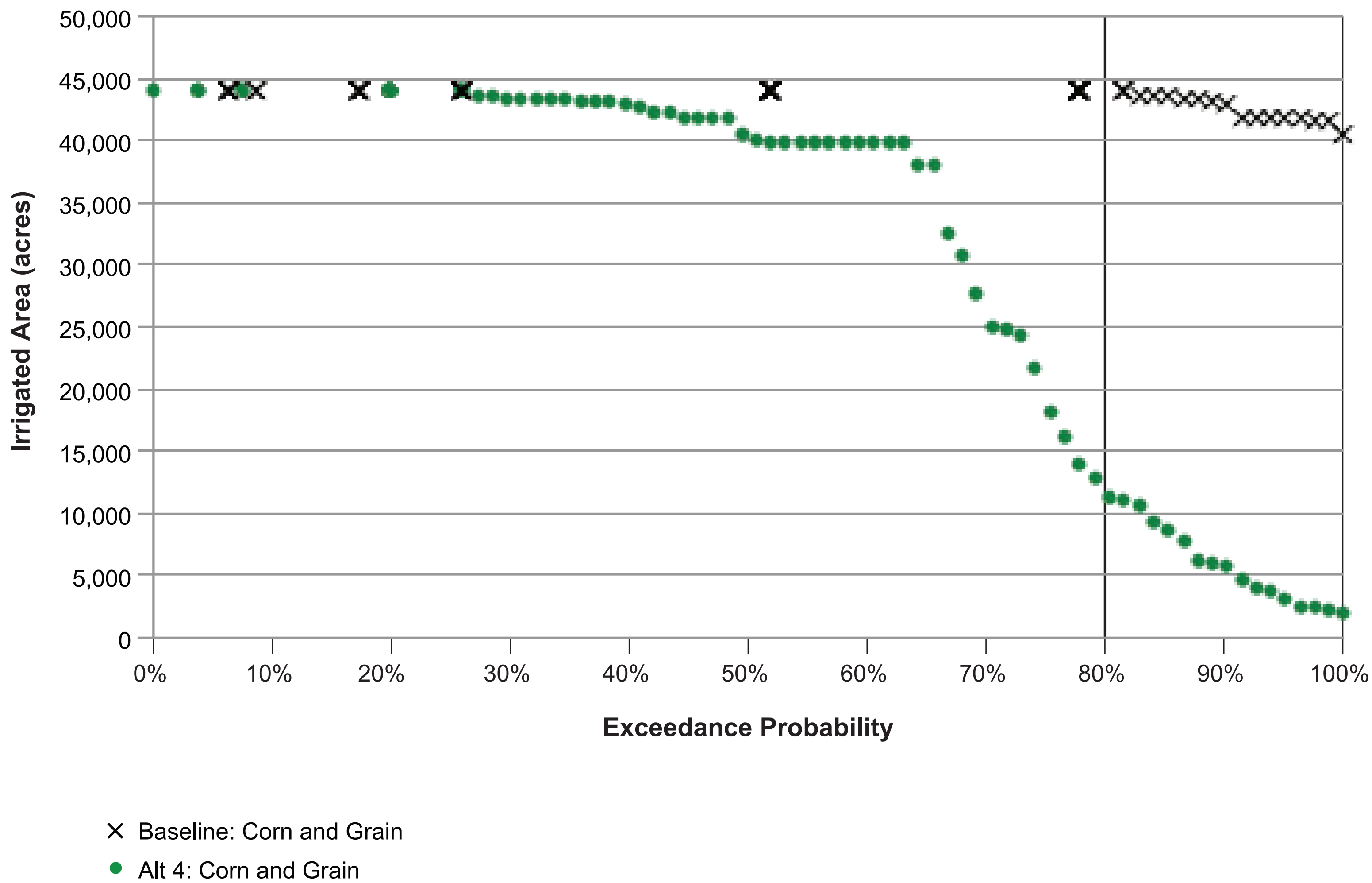

Figure 11-22b
Irrigated Acreage in TID for Corn and Grain under Alternative 4

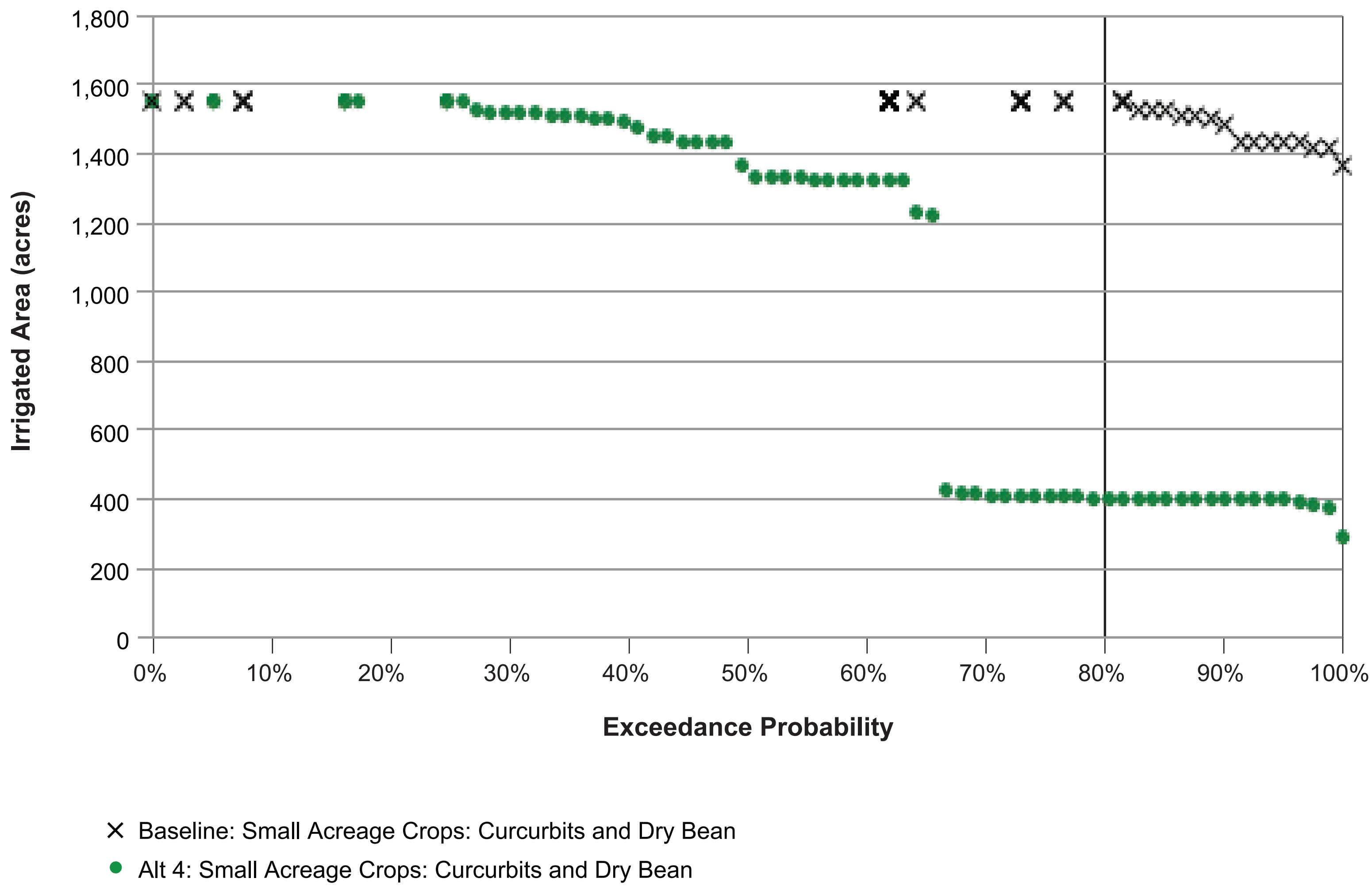

Figure 11-22c
Irrigated Acreage in TID for Small Acreage Crops under Alternative 4

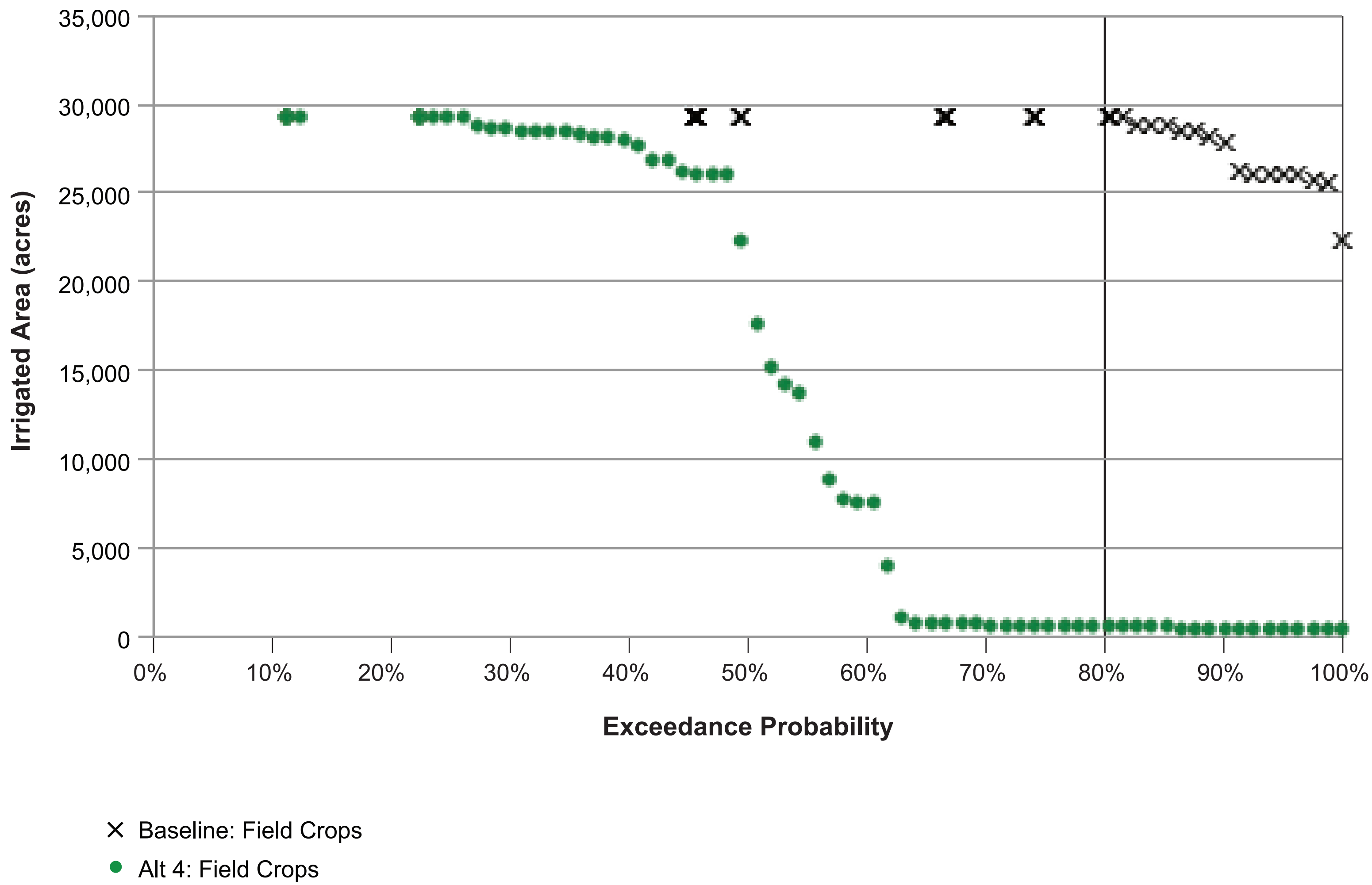

Figure 11-22d
Irrigated Acreage in TID for Field Crops under Alternative 4

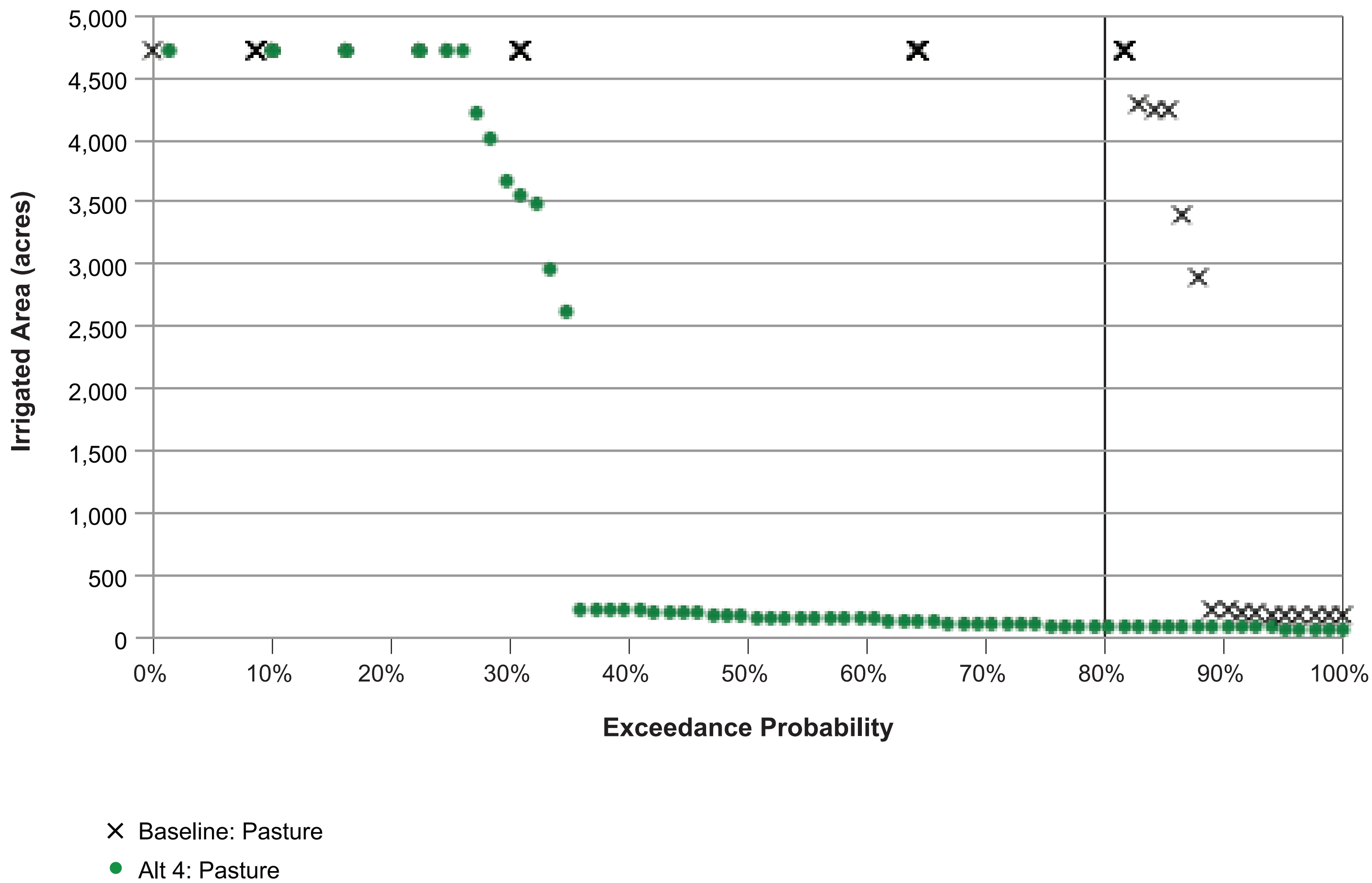

Figure 11-22e
Irrigated Acreage in TID for Pasture under Alternative 4

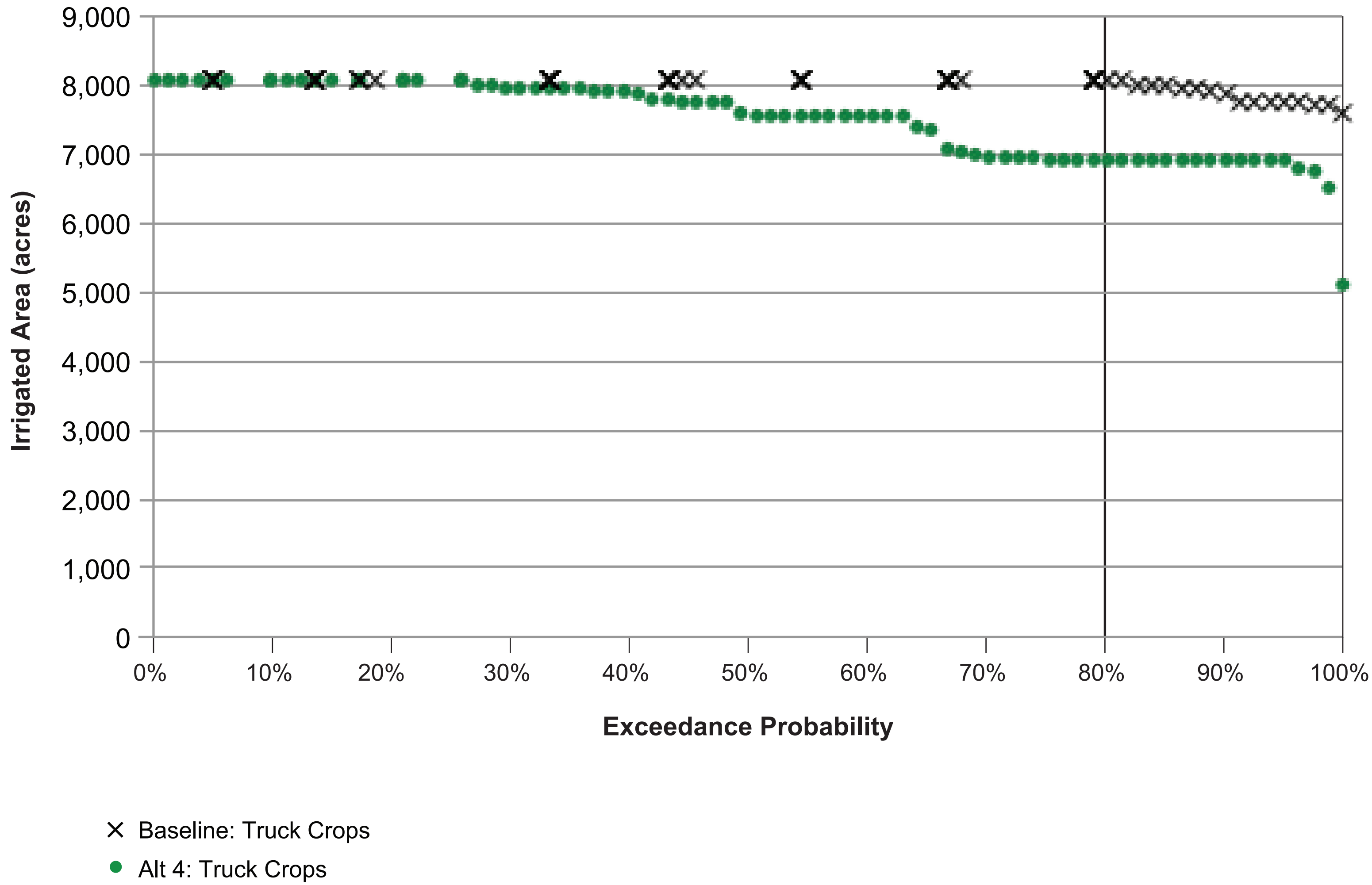

Figure 11-22f
Irrigated Acreage in TID for Truck Crops under Alternative 4

Table 11-20. Percent Average Acreage Reduction from Baseline for Irrigation Districts Impacted under LSJR Alternative 4 for 2009 and 2014 Groundwater Pumping Levels

	Groundwater Pumping Level	
	2009	2014
District	% Crop Reduction	
SSJID	11	8
OID	20	14
MID	28	5
TID	25	11

SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District

Similar to the availability of feasible mitigation above under LSJR Alternative 2 (20 percent unimpaired flow), while it is possible that some of the water-diversion and use measures, including irrigation efficiency, may have some applicability to reducing impacts or could be implemented as part of the individualized water right proceedings that are expected to take place to implement the flow objectives, any application of these measures at this point by the State Water Board is infeasible, as explained in LSJR Alternative 2. Furthermore, it is unknown whether these activities would reduce the significant impacts to less-than-significant levels. Irrigation efficiency measures could be implemented by local water purveyors, irrigation districts, or groundwater management districts to reduce the amount of water applied to crops while still meeting crop water demands. Irrigation efficiency would serve to keep as much agricultural acreage in production as possible. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies can and should adopt irrigation efficiencies described in LSJR Alternative 2 and local land use authorities can and should impose development conditions and require conservation easements where allowed to mitigate for the loss of agricultural lands; however, given the uncertainty of the extent to which these mitigation measures would occur and because they may not fully mitigate impacts, impacts would remain significant. While adaptive implementation method 1, could reduce the percent of unimpaired flow to 50 percent and potentially reduce impacts on agricultural resources (discussed below), it cannot be independently applied as an alternative because it is part of LSJR Alternative 4 and because the purpose of adaptive implementation is to benefit fish. Therefore, according to the number of acres that would no longer be considered Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, as predicted by the SWAP model, and the possibility of conversion of these acres to nonagricultural land uses, impacts on agricultural resources would remain significant and unavoidable.

Adaptive Implementation

As discussed under LSJR Alternative 2, adaptive implementation methods 2 and 4 are not expected to result in impacts on agriculture. For reasons discussed under LSJR Alternative 3, adaptive implementation method 3 would not affect agricultural impacts associated with LSJR Alternative 4. Adaptive implementation method 1 would allow a decrease of up to 10 percent in the February-June, 60-percent unimpaired flow requirement (to 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 60 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternative 3 (i.e., less severe for agricultural resources, but still significant).

Irrigation efficiency measures and adaptive implementation method 1 could potentially reduce impacts, but likely not to a less-than-significant level. Applying adaptive implementation method 1 independent of LSJR Alternative 4 is infeasible given adaptive implementation is for the benefit of fish. Therefore, the significant impacts on agricultural resources are based on the number of acres of crop loss predicted by the model and the unknown ability of pumping groundwater or irrigation efficiencies to offset the loss of crop acreage. Impacts would remain significant and unavoidable.

SDWQ Alternatives

While the SDWQ alternatives are expected to maintain historical salinity concentrations in the southern Delta, the potential crop yield under the SDWQ alternatives is estimated by assuming year-round irrigation salinity concentrations of 1.0 dS/m and 1.4 dS/m for SDWQ Alternatives 2 and 3, respectively. The crop yield estimated under each of the alternatives is then compared with baseline results to determine the associated crop yield impacts of the alternatives. This information is used to qualitatively discuss if conversion to nonagricultural uses would take place.

SDWQ Alternative 2: (Less than significant)

Using the modeling approach described in Section 11.4.2, *Methods and Approach*, with a 20 percent leaching fraction, under either a median or minimum amount of precipitation, there was no yield reduction for dry beans irrigated with water containing a salinity level (ECw) of 1.0 dS/m. In addition, Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta,* reports that studies in the LSJR area of potential effects have shown that the highest soil salinities (ECe) and lowest apparent leaching fractions occurred at locations where water quality was the best and that higher leaching fractions and lower salt accumulations (ECe) were found at the locations where more saline irrigation water was used (1.1 dS/m or more). For this reason, it is reasonable to assume that salt-sensitive crops would not be affected. Since dry bean is the southern Delta crop most sensitive to salinity (Table 11-12), and given that the yield for dry beans is not affected, then the yield of crops with higher salt tolerance would not be affected. Crop production would not be substantially reduced, and Prime Farmland, Unique Farmland or Farmland of Statewide Importance would not be converted to nonagricultural uses. Impacts on agricultural resources would be less than significant.

SDWQ Alternative 3: (Less than significant)

Using the modeling approach described in Section 11.4.2, *Methods and Approach*, there is a 5 percent yield reduction for dry bean irrigated with 1.4 dS/m water, with a minimum amount of precipitation and a leaching fraction of 20 percent. When the median level of precipitation is used, the yield decline is less than 1 percent. For almonds, the yield decline is 3 percent with a leaching fraction of 15 percent and minimal precipitation; with the median level of precipitation the yield decline is less than 1 percent. For alfalfa there was no yield decline under the 15 percent leaching fraction with minimal precipitation. In addition, Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–*

San Joaquin Delta, reports that southern Delta studies have shown that the highest soil salinities (ECe) and lowest apparent leaching fractions occurred at locations where water quality was the best and that higher leaching fractions and lower salt accumulations (ECe) were found at the locations where more saline irrigation water was used (1.1 dS/m or more). Because dry bean is the southern Delta crop most sensitive to salinity (Table 11-12) and given that the reduction in yield for dry beans is less than 10 percent, there is little potential for any yield impacts on crops with higher salt tolerance. Accordingly, a 10 percent yield decline is not expected, and it is reasonable to assume that Prime Farmland, Unique Farmland, or Farmland of Statewide Importance would not be converted to nonagricultural uses. Impacts would be less than significant.

Impact AG-2: Involve other changes in the existing environment which, due to their location or nature, could result in a conversion of farmland to nonagricultural use

Other changes to the existing environment that could result from the LSJR and SDWQ alternatives include changes to the timing and magnitude of flows in the tributaries, the loss of farmland upon which other agricultural production relies, and the amount of farmland in production that could be reduced as a result of these changes.

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Agricultural lands along the Stanislaus River include orchard, field, and vegetable crops. An investigation by the U.S. Attorney in Sacramento, California (USDOI 1982) found that when the river is over 1,250 cfs at Ripon, the high water table (i.e., seepage) can affect fields, specifically a 60-acre sugar beet field on the Collier Ranch, and that at flows above 1,500 cfs, the water tables rises sufficiently to damage almond and walnut orchards adjacent to the river. To monitor the water table, auger holes were dug on six properties that were thought to be susceptible under high river flow conditions.

Flows greater than 1,500 cfs currently exist on the Stanislaus River. Such flows typically occur more than 30 percent of the time in March, April, and May and less than 20 percent of the time the remainder of the year (Tables 6-13 and 6-14 in Chapter 6, *Flooding, Sediment, and Erosion).* Flows greater than 1,500 cfs on the Stanislaus River are not considered to increase in frequency under LSJR Alternative 2 when compared to baseline (Table 6-14 in Chapter 6, *Flooding, Sediment, and Erosion*).

For this analysis, it is assumed that regardless of what crop is grown on the land, a high water table could still impact agricultural production. However, if this land is in sugar beet production, it would represent less than 3 percent of the total sugar beet production in the LSJR area of potential effects and approximately 0.1 percent of the total agricultural production in the LSJR area of potential effects (Table 11-5). Therefore, this would be a localized effect that would have a less-than-significant impact on the overall production of sugar beets in the area and would not substantially reduce crop production.

Six properties of walnut and almond orchards adjacent to the Stanislaus River were also reported as being susceptible to damage at flows above 1,500 cfs (USDOI 1982). As of 2010, there were approximately 2,605 acres of almonds and 1,288 acres of walnuts within the Stanislaus River 100-year floodplain (based on GIS analysis using 2010 CropScape Data published by the USDA (2016), and floodplain area data published by the Federal Emergency Management Agency (2016). The 100-year floodplain is inundated at volumes much greater than 1,500 cfs. For this area, in 2010 the gross annual revenue of orchards ranged from $1,500 to $2,000 per a (from the SWAP model, as described in Medellín-Azuara 2015). If 100 percent of this acreage was affected by seepage the revenue lost could range from $5.8 million to $7.8 million in value. This acreage represents only about 3 percent of baseline Almond and Pistachio (the crop category that most resembles walnuts and almonds) acreage and less than 1 percent of all agricultural production in the LSJR area of potential effects (Table 11-5). There would be no change in the frequency of flows at 1,500 cfs relative to baseline conditions and LSJR Alternative 2 would not increase the likelihood of a 100-year flood (Chapter 6, *Flooding, Sediment, and Erosion*). As such, it is reasonable to assume that a substantial reduction in agricultural production would not occur in the LSJR area of potential effects as a result of seepage when compared to baseline. Because there is no substantial reduction in crop production, acreage impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

Flows greater than 1,500 cfs on the Stanislaus River would slightly increase in frequency under LSJR Alternative 3 when compared to baseline. The overall frequency of monthly flows greater than 1,500 cfs would increase from 14 percent to 16 percent at Ripon (Table 6-14 in Chapter 6). However, as described under LSJR Alternative 2, LSJR Alternative 3 would not increase the likelihood of a 100-year flood and effects would occur to less than 1 percent of the total agricultural production in the LSJR area of potential effects. Therefore, it is reasonable to assume that a substantial reduction in agricultural production, and thus acreage, would not occur in the LSJR area of potential effects as a result of seepage when compared to baseline. Impacts would be less than significant.

For economic viability, dairies rely, in part, on the proximity of cropland for feed and waste disposal. If cropland is in close proximity to a dairy or used by a dairy it may be considered a higher net revenue crop when compared to other cropland in the LSJR area of potential effects. Reduction in acreage for feed, particularly Alfalfa, can be offset through purchases of feed from production areas outside of the LSJR area of potential effects. Due to additional transportation costs, feed costs could go up; however, the increase in the cost of feed is not known because it depends on where dairies source feed from and the competition for the feed from other users. As an example of the uncertainty in feed costs, statewide feed costs decreased in 2015 ($10.41/hundredweight [112 pounds]) from 2014 ($11.05/hundredweight) prices (Sumner 2016).

During water-short years, dairy and cattle operations relying on Alfalfa (SSJID, MID, and TID), Grain (MID), and Pasture (SSJID, OID, MID, and TID) production could experience some input cost increases if reductions to these crop types occur. Although SWAP results predict a reduction of lower net revenue crops, such as Alfalfa, under LSJR Alternatives 3, SWAP could be over predicting fallowing from feed crops in particular Alfalfa and Pasture. Considering that Alfalfa and Pasture crops could be associated with dairies (i.e., have higher net revenue), potentially less acreage could actually go out of production. In addition, Alfalfa and Pasture are able to survive without receiving their full water requirements during an irrigation season; however, there could be a decline in yield for these crops or a reduction in the full use of Pasture if the full water requirements were continually restricted (Putnam et al. 2015a, 2015b). Silage corn can only be grown locally for cost effectiveness. Limited substitution of silage corn in dairy cows is considered in SWAP because of the minimum silage constraints in the model and hence less fallow land in silage crops is predicted because of the minimum silage constraints in the model. This is exemplified in the recent drought, as dairy operators obtained water supplies from willing sellers within an irrigation district in order to manage waste disposal and meet minimum dietary requirements of silage corn particularly.

A review of agricultural commodity data shows that dairies either exceed or are competitive with other agricultural commodities in the LSJR area of potential effects (Table 11-21). As such, some commodities, such as field and grain and even higher net value crops in the spectrum, may decrease in production if dairies obtain needed water supplies during drier conditions. Given the gross revenues of different agricultural commodities, it is likely that dairies would be competitive for water supplies (Table 11-21), as they have in the past. For example, irrigation water cost for dairy feed in the San Joaquin Valley represent about 9 percent of the cost of farm milk production in 2015, and is not considered the dominant cost when evaluating all other costs associated with dairies (Sumner 2016).

Table 11-21. Gross Revenue of Agricultural Commodities

Agricultural Commodity	Gross Value ($)
Dairy	2,211,377,149
Hay Alfalfa	50,337,017
Oranges	8,074,381
Almonds	883,756,849
Vegetables (Truck in SWAP)	121,637,329

Source: USDA 2015.

The three sectors of beef cattle operations may adjust differently under LSJR Alternative 3 conditions. Beef cattle feedlot operations rely on grains and oilseeds from out of the state are imported (Medellin-Azuara et al. 2016). As such, the beef cattle feedlot segment is more vulnerable to fluctuations in output commodity prices (e.g., feed and where it is coming from) than water supply conditions and would be unlikely to be affected by reduced surface water conditions (Medellin-Azuara et al. 2016). The cow-calf and feeder cattle segments of the beef cattle industry may be more vulnerable. These two segments rely on pasture and other forages prior to weaning calves and before transitioning to feedlots. Under reduced surface water conditions, summer Pasture (typically irrigated) can become scarce and may limit grazing opportunities. If this is combined with poor winter grass conditions, the size of these operations could be reduced (Medellin-Azuara et al. 2016). Pasture is typically grown on land with soils, slopes or other characteristics support pasture rather than other crops (Cattlemen's Beef Board and Cattlemen's National Beef Association 2009). As such, it is likely these areas would be maintained as Pasture. In addition, these lands can provide Pasture for 4 or 5 months per year during the wet season and so the timing could offset potential effects. Further, cow-calf operations are able to substitute fodder and other food sources for irrigated pasture land, if needed (The Pennsylvania State University

2013). Finally, as discussed above, SWAP is potentially over predicting effects on Pasture and as such, not all of the lands would be reduced under LSJR Alternative 3.

Given cost of feed input compared to other dairy and beef cattle inputs and the availability of the feed input for both dairy and beef cattle, the value of dairy production in the LSJR area of potential effects, and the potential use of equitable distribution of local water suppliers, it is unlikely dairies and beef cattle operations would be converted to nonagricultural uses. Impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

Flows greater than 1,500 cfs on the Stanislaus River would increase in frequency under LSJR Alternative 4 when compared to baseline. The overall frequency of monthly flows greater than 1,500 cfs would increase from 14 percent to 22 percent at Ripon (Table 6-14 in Chapter 6). However, as described under LSJR Alternative 2, LSJR Alternative 4 would not increase the likelihood of a 100-year flood and effects would occur to less than 1 percent of the total agricultural production in the LSJR area of potential effects. Therefore, it is reasonable to assume that a substantial reduction in agricultural production, and thus acreage, would not occur in the LSJR area of potential effects as a result of seepage when compared to baseline. Impacts would be less than significant.

Similar to the discussion above under LSJR Alternative 3, dairy and cattle operations that rely on Alfalfa, Corn, Grain, and Pasture production from SSJID, OID, MID, and TID could experience some input cost increases during water-short years. Dry forms of feed crops such as alfalfa can be imported to replace the reduction in locally grown feed crops that may occur when the regional markets for these crops exist. A review of data shows that dairy value either exceeds or is competitive with other crops in the LSJR area of potential effects (Table 11-21). As such, some crops, such as Field and Grain and even higher net value crops in the spectrum, may decrease in production if dairies obtain water supplies. Given the gross revenues of different agricultural commodities, it is likely that dairies would be competitive for water supplies (Table 11-21). Furthermore, because of the equitable distribution policies of local water suppliers described in Section 11.3, *Regulatory Background*, it is anticipated dairy operators could receive water within irrigation districts that apply reductions equally across agricultural uses. Given cost of feed input compared to other dairy and beef cattle inputs and the availability of the feed input for both dairy and beef cattle, the value of dairy production in the LSJR area of potential effects, and the potential use of equitable distribution of local water suppliers, it is unlikely dairies and beef cattle operations would be converted to nonagricultural uses. Impacts would be less than significant. Impacts would be less than significant.

SDWQ Alternatives

SDWQ Alternatives 2 and 3: (Less than significant)

As discussed under Impact AG-1 for SDWQ Alternatives 2 and 3, reductions in crop acreage in the SDWQ area of potential effects are not expected beyond what may typically occur in the area as a result of normal farming practices. Therefore, it is reasonable to assume that a conversion of farmland to nonagricultural uses would not occur in the SDWQ area of potential effects. Impacts would be less than significant.

Impact AG- 3: Conflict with existing zoning for agricultural use or a Williamson Act contract

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternatives 2, 3, and 4 (Less than significant/Less than significant with adaptive implementation)

Lands under Williamson Act contracts are enforceably restricted to compatible open space or agricultural uses, generally for rolling 10-year or 20-year terms, and the LSJR alternatives do not alter those restrictions. Therefore, any reduction in surface water supplies expected under LSJR Alternatives 2, 3, and 4 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. Specifically, 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 the plantings of annual crops such as Corn and Grain were rotated in years with reduced irrigation supply such that all the lands would be irrigated at least once every other year or fallowed in other years. There is enough annual crop acreage for rotation if the plantings of Grain were rotated in years with reduced irrigation supply such that all lands would be irrigated at least once every other year or dryland farmed or fallowed in other years. These practices are all considered agricultural uses. 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 (Putnam et al. 2015a, 2015b). Deficit irrigation would keep this acreage in agricultural use. 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 sparticipate in such measures in the first instance. However, once a land owner 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, LSJR Alternatives 2, 3, and 4 would not conflict with the existing Williamson Act, and impacts would be less than significant.

LSJR Alternatives 2, 3, and 4 would not conflict with existing zoning for agricultural use. Only cities and counties enact zone change. The LSJR alternatives would not change zoning and would not require a discretionary action that conflicts with a land zoned for agriculture. LSJR Alternatives 3 and 4 could result in reduced irrigation available to designated prime, unique, and farmland of statewide importance as described above under Impact AG-1; 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 LSJR Alternatives 2, 3, and 4, and agricultural land would continue to maintain existing zoning. Impacts would be less than significant.

SDWQ Alternatives

SDWQ Alternatives 2 and 3: (Less than significant)

Williamson Act contracts for lands in the SDWQ area of potential effects total 83,614. While Williamson Act lands do not need to be irrigated to be maintained within Williamson Act contracts, agricultural uses in the southern Delta currently divert surface water from existing waterways, expecting it to be of suitable water quality to irrigate existing crops. SDWQ Alternatives 2 and 3 would not conflict with existing Williamson Act contracts or zoning for agricultural use because they would not result in an action that would change existing zoning or activities consistent with agricultural zoning, and Williamson Act contracts would continue in the southern Delta. Therefore, impacts would be less than significant.

Impact AG- 4: Conflict with any applicable land use plan, policy, or regulation related to agriculture of an agency with jurisdiction over a project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternative 2, 3, and 4 (Less than significant/Less than significant with adaptive implementation)

Implementation of the LSJR alternatives do not involve general plan amendments to convert currently designated agricultural land to other uses. LSJR Alternatives 2, 3, or 4 would result in a change in the volume of water within existing reservoirs or rivers. This change would not conflict with applicable land use plans, policies, or regulations in the LSJR area of potential effects. LSJR Alternatives 3 or 4 could result in physical environmental effects associated with reducing surface water diversions that primarily serve agricultural lands, as described under Impact AG-1. Some agricultural land could be taken out of use as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, given reductions in the availability of irrigation water due to reductions in surface water diversions under LSJR Alternatives 3 and 4. However, some of these lands could remain in agricultural use even if they are not irrigated, as described under Impact AG-3. Thus, the reduction in surface water diversions due to implementation of LSJR Alternatives 3 or 4 would not conflict with existing land use plans or policies that protect or preserve agricultural lands. Although LSJR Alternatives 3 and 4 could result in constraints on agricultural use and may limit it in some cases, LSJR Alternatives 2, 3, and 4 would not conflict with any land use plan or policy. Therefore, impacts would be less than significant.

SDWQ Alternatives

SDWQ Alternatives 2 and 3: (No impact)

The SDWQ alternatives do not include general plan amendments or zone changes and would not result in changes to existing land designations or zoning. Furthermore, the agricultural lands would continue to divert water from existing waterways and rely on suitable water quality to irrigate crops. Therefore, there would be no impact.

11.6 Impacts and Mitigation Measures: Extended Plan Area

Bypassing flows, as described in Chapter 5, *Surface Hydrology and Water Quality*, would not cause potentially significant impacts on agricultural resources in the extended plan area. There are limited agricultural resources in the extended plan area and no designated Prime, Unique, or Farmland of Statewide Importance (California Farmland Mapping and Monitoring Program webpage). Much of the extended plan area is designated as nonagricultural with some acreage in grazing in Mariposa County near Lake McClure (California Farmland Mapping and Monitoring Program n.d.) and individual small water rights used for irrigated pastures, orchards, and occasional vineyards. However, these are a small volume with limited or no storage volume that could be affected by bypass flow requirements (State Water Board 2016). Any reduction in surface water supplies that are available for irrigation in the extended plan area would be similar to that described for the plan area, but smaller in magnitude. Therefore, impacts would be less than significant.

11.7 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

11.8 References Cited

Agricultural Water Management Council. 2010*. Irrigation Practices and Influencers Survey Findings San Joaquin Valley.* Available: http://www.agwatercouncil.org/08312010.pdf. Accessed: May 11, 2012.

American Farmland Trust (AFT). 2007. *Paving Paradise: A New Perspective on California Farmland Conversion.* Available: http://www.thegreenhorns.net/wp-content/files_mf/1345131218pavingparadise.pdf. Accessed: July 15, 2016.

Ayers, R. S., and D. W. Westcot. 1985*. Water Quality for Agriculture*. Food and Agricultural Organization of the United Nations. FAO Irrigation and Drainage Paper 29. Available: http://www.fao.org/docrep/003/T0234E/T0234E00.HTM. Accessed: September 25, 2012.

Cady, C. W., and M. Francesconi. 2010. *Water quality regulations for dairy operators in California's Central Valley – overview and compliance cost analysis.* Central Valley Regional Water Quality Control Board. Available: https://www.cdfa.ca.gov/dairy/pdf/notices/WDR-CostOfCompliance.pdf. Accessed May 12, 2016.

California Department of Conservation (DOC). 1989. *Report of the Williamson Act Study Group: Executive Summary*. Prepared by H. O. Carter, A. D. Sokolow. G. Goldman, R. Maus, T. Sexton, J. Spezia, and D. Strong. California.

———. 2007. *Important Farmland Map Categories*. Available: http://www.consrv.ca.gov/DLRP/fmmp/mccu/map_categories.htm. Accessed: December 2011.

———. 2009. *San Joaquin Williamson Act; Stanislaus Williamson Act*. File Geodatabase Feature Class.

———. 2010a. *Merced Williamson Act*. File Geodatabase Feature Class.

———. 2010b. *Williamson Act Program—Reports and Statistics*. Biennial Land Conservation (Williamson) Act Status Reports, November 2010. Available: http://www.consrv.ca.gov/dlrp/lca/stats_reports/Pages/Index.aspx. Accessed: December 2011.

———. 2012. *Farmland Mapping and Monitoring Program GIS Shapefiles*. Available: http://redirect.conservation.ca.gov/DLRP/fmmp/product_page.asp. Accessed: August 2016.

———. 2013a. *Prime Farmland as Mapped by FMMP*. Available: http://www.conservation.ca.gov/dlrp/fmmp/overview/Pages/prime_farmland_fmmp.aspx. Accessed: July 8, 2015.

———. 2013b. *Important Farmland Categories*. Available: http://www.conservation.ca.gov/dlrp/fmmp/mccu/Pages/map_categories.aspx. Accessed: July 8, 2015.

———. 2015a. *Important Farmland Data Availability*. File Geodatabase Feature Class.

———. 2015b. *The California Land Conservation Act 2014 Status Report — The Williamson Act*. Available: http://www.conservation.ca.gov/dlrp/lca/stats_reports/Documents/2014%20LCA%20Status%20Report_March_2015.pdf. Accessed: May 13, 2016.

California Department of Food and Agriculture (DFA). 2010. *California Agricultural Highlights*. Available: http://www.cdfa.ca.gov/statistics/. Accessed: December 2011.

California Department of Water Resources (DWR). 2005. *California Water Plan Update 2005.* Available: http://www.waterplan.water.ca.gov/previous/cwpu2005/index.cfm. Accessed: October 4, 2012.

———. 2009. *Technical Memoranda*. Available: http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp/techmemos.cfm. Accessed: August 2016.

———. 2010*. Statewide Irrigation Methods Survey*. Available: http://www.water.ca.gov/landwateruse/surveys.cfm. Accessed: December 2011.

———. 2014. *California Water Plan Update 2013: Investing in Innovation and Infrastructure*. San Joaquin River Hydrologic Region. Volume 2 Regional Reports. Available: http://www.water.ca.gov/waterplan/cwpu2013/final/index.cfm. Accessed: June 2016.

California Farmland Mapping and Monitoring Program. n.d. *FTP Directory.* Available: ftp://ftp.consrv.ca.gov/pub/dlrp/FMMP/pdf and ftp://ftp.consrv.ca.gov/pub/dlrp/FMMP/pdf/2014/. Accessed: June 2016.

Cattlemen's Beef Board and Cattlemen's National Beef Association. 2009. *Modern Beef Production*.

Central Valley Regional Water Quality Control Board (Central Valley Water Board). 2004. *Draft Final Basin Plan Amendment.* Available: http://www.waterboards.ca.gov/rwqcb5/water_issues/tmdl/central_valley_projects/vernalis_salt_boron/#July2004DraftFinal. Accessed: April 2012.

City of Escalon. 2010. *City of Escalon General Plan*. Last revised: October 18. Available: http://worldcat.org/arcviewer/5/CBG/2011/12/06/H1323198588278/viewer/file2.pdf. Accessed: September 29, 2015.

City of Lathrop. 2004. *Comprehensive General Plan for the City of Lathrop, California*. Last revised: November. Available: http://www.ci.lathrop.ca.us/cdd/documents/pdf/03-02-2011_16-59-23-758_758.pdf. Accessed: September 29, 2015.

City of Manteca. 2011. *City of Manteca General Plan* 2023 Policy Document. Last revised: April. Available: file:///C:/Users/19140/Desktop/SWRCB%20Ph%201%20GPs/City%20of%20Manteca%20General%20Plan_policy%20document_2003.pdf. Accessed: September 29, 2015.

City of Merced. 2015. *Merced Vision 2030 General Plan*. Chapter 2, Urban Expansion. Available: https://www.cityofmerced.org/civicax/filebank/blobdload.aspx?BlobID=11475. Accessed: September 29.

City of Modesto. 2008. *City of Modesto Urban Area General Plan*. October. Available: https://www.modestogov.com/ced/pdf/planning/documents/general-plan/technical/urban%20area%20general%20plan.pdf. Accessed: September 29, 2015.

City of Oakdale. 2013*. Oakdale 2030 General Plan*. August 8. Available: http://www.stanislauslafco.org/info/PDF/CraneCrossing/AdoptedOak2030GP.pdf. Accessed: September 29, 2015.

City of Ripon. 2006. *City of Ripon General Plan 2040*. Open Space and Conservation Element. September 19. Available: http://www.cityofripon.org/Government/GeneralPlan2040/V1Chap5.pdf. Accessed: September 29, 2015.

City of Riverbank. 2009. *City of Riverbank General Plan 2005-2025*. Available: http://www.riverbank.org/DocumentCenter/Home/View/236. Accessed: September 29, 2015.

City of Stockton. 2007. *Stockton General Plan 2035*. Goals and Policies Report. Available: http://www.stocktongov.com/files/GoalPolicyReport.pdf. Accessed: September 29, 2015.

City of Turlock. 2012. *Turlock General Plan*. September. Prepared by Dyett & Bhatia. Available: http://www.cityofturlock.org/pdf/documents/developmentservices/planning/generalplancomplete.pdf. Accessed: September 29, 2015.

City of Tracy. 2011. *City of Tracy General Plan*. Open Space and Conservation Element. Available: http://www.ci.tracy.ca.us/documents/2011_General_Plan.pdf. Accessed: September 29, 2015.

Delta Protection Act. 1992. *Delta Protection Act of 1992*. Available: http://www.delta.ca.gov/protection_act.htm. Accessed: December 2011.

Delta Stewardship Council (DSC). 2013. *The Delta Plan: Ensuring a reliable water supply for California, a healthy Delta ecosystem, and a place of enduring value*. Available: http://deltacouncil.ca.gov/sites/default/files/documents/files/DeltaPlan_2013_CHAPTERS_COMBINED.pdf. Accessed: May 17, 2016.

Edinger-Marshall, S., and J. Letey. 1997. *Irrigation Shifts Toward Sprinklers, Drip and Microsprinklers*. University of California Agricultural and Natural Resources. *California Agriculture* 51(3):38–40.

Federal Emergency Management Agency (FEMA). 2016. *FEMA Flood Map Service Center*. Available: <https://msc.fema.gov/portal/advanceSearch#searchresultsanchor>. Accessed May 14, 2016.

Grattan, S. R. 2002. *Irrigation Water Salinity and Crop Production*. University of California Agriculture and Natural Resources. Publication 8066. Available: http://ucanr.org/freepubs/docs/8066.pdf. Accessed: December 2011.

Luers, R. R. 1970. *Dryland Agriculture in California, Grain Cropping with winter rainfall*. California Agriculture. Available: https://ucanr.edu/repositoryfiles/ca2412p12-63814.pdf. Accessed: January 11, 2016.

Maas E. V., and G. J. Hoffman. 1977. *Crop Salt Tolerance: Current Assessment*. Available: http://www.waterrights.ca.gov/baydelta/docs/southerndeltasalinity/hist_exhibits/1977bdh_p2ex2.pdf. Accessed: September 25, 2012.

Marsh B. and L. Jackson. 2006. *Small grains in crop production. Small grains production manual part 12*. University of California Cooperative Extension. Publication 8175. Available: http://anrcatalog.ucdavis.edu. Accessed: February 2, 2016.

Medellín-Azuara, J., D. MacEwan; R. E. Howitt; G. Koruakos; E. C. Dogrul; C. F. Brush; T. N. Kadir; T. Harter; F. Melton, and J. R. Lund. 2015. Hydro-Economic Analysis of Groundwater Pumping for Irrigated Agriculture in California's Central Valley, USA. *Hydrogeology Journal* 23(6): 1205–16.

Medellin-Azuara, J., MacEwan, D., Howitt, Richard E., Medellín-Azuara, Sumner, D.A. Lund, J.R. 2016. *Economic Analysis of the 2016 California Drought on Agriculture*. Center for Watershed Sciences, UC Davis. Davis, CA, 17 pp.

Merced County. 2013. *2030 Merced County General Plan*. Final Program Environmental Impact Report. State Clearinghouse #2011041067. October. Available: http://www.co.merced.ca.us/index.aspx?NID=2009. Accessed: September 30, 2015.

———. 2015. *Rules of Procedure to Implement the California Land Conservation Act of 1965*. Last revised: July 7. Available: http://www.co.merced.ca.us/DocumentCenter/Home/View/3035. Accessed: May 13, 2016.

Merced Irrigation District (Merced ID). 2013. *Merced Irrigation District Agricultural Water Management Plan*. Prepared for the Department of Water Resources. September 3. Available: http://www.mercedid.com/index.cfm/water/ag-water-management-plan/. Accessed: July 10, 2015.

Modesto Irrigation District (MID). 1999. *Water Management Plan for the Modesto Irrigation District*. Prepared in Accordance with Momorandum of Understanding Regarding Agricultural Water Management Practices Act of 1990 AB 3616.

Modesto Irrigation District (MID). 2012. *Modesto Irrigation District Agricultural Water Management Plan for 2012*. December. Available: http://www.mid.org/water/irrigation/WaterManagementPlan_2012.pdf. Accessed: July 10, 2015

National Agricultural Statistics Service. 2010. *Agricultural Overview, 2010*. Available: http://www.nass.usda.gov/Statistics_by_State/California/Publications/California_Ag_Statistics/2010cas-ovw.pdf. Accessed: December 2011.

Natural Resources Conservation Service (NRCS). 1999. *Soil Taxonomy, A basic system of soil classification for making and interpreting soil surveys*. Second Edition. Agricultural Handbook Number 436. Available: http://soils.usda.gov/technical/classification/taxonomy/. Accessed: September 25, 2012.

Oakdale Irrigation District (OID). 2012. Oakdale Irrigation District Agricultural Water Management Plan. Prepared by Davids Engineering, Inc. December 2012. Available: http://www.oakdaleirrigation.com/files/OID%202012%20AWMP%20-%20OID%20Web%20Version.pdf. Accessed: July 10, 2015.

Public Policy Institute of California (PPIC). 2005. *Urban Development Futures in the San Joaquin Valley*. Available: http://www.ppic.org/content/pubs/report/R_205MTR.pdf. Accessed: July 14, 2016.

Putnam, D., S. Orloff, and K. Bali. 2015a. *Drought Tip: Drought Strategies for Alfalfa*. University of California Agriculture and Natural Resources. ANR Publication 8522. July 2015. Available: http://anrcatalog.ucanr.edu.

Putnam, D., S. Orloff, and C. Brummer. 2015b. *Drought Tip: Managing Irrigated Pasture during Drought*. University of California Agriculture and Natural Resources. ANR Publication 8537. September 2015. Available: http://anrcatalog.ucanr.edu.

San Joaquin County. 2009. General Plan Update: Chapter 10: Natural Resources. Available: http://www.sjcgpu.com/pdf/backgroundreport/prd_br_10s.pdf. Accessed: January 2012.

———. 2010. *San Joaquin County General Plan*. Chapter 6. Public Review Draft Background Report. San Joaquin, CA.

———. 2014. San Joaquin County 2035 *General Plan Draft Environmental Impact Report*. October 2014. Agricultural and Forestry Resources. Prepared by ESA. Available: http://www.sjcgpu.com/pdf/San-Joaquin-2035-GP-DEIR-web_Part-4.pdf. Accessed: September 30, 2015.

South San Joaquin Irrigation District (SSJID). 2012. *2012 Agricultural Water Management Plan*. December. Prepared by Davids Engineering, Inc. Available: http://www.water.ca.gov/wateruseefficiency/sb7/docs/2014/plans/S.%20San%20Joaquin%20ID%20Final%202012%20AWMP%2020121221.pdf. Accessed: July 10, 2015.

———. 2013*. On-Farm Water Conservation Program 2014 Program Description*. November. Available: http://www.ssjid.com/assets/pdf/2014-Conservation-Program-Description.pdf. Accessed: July 12, 2015.

Stanislaus County. 2012. *Agricultural Element – Chapter 7*. Stanislaus, CA.

State Water Resources Control Board (State Water Board). 2016. *eWRIMS Database*. Available: http://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.shtml. Accessed: February 9.

Stevens, E. 2014. *Central Valley commute patterns signal regional shift*. Central Valley Business Journal. Available: http://cvbj.biz/2014/12/01/central-valley-commute-patterns-signal-regional-shift/. Accessed: July 14, 2016.

Stockton East Water District (SEWD). 2014. *Stockton Waste Water District Water Management Plan*. Final. Available: http://www.water.ca.gov/wateruseefficiency/sb7/docs/2014/plans/Stockton-Eeast_WD_WMP-Final_012014.pdf.

Sumner, D. A. 2016. *Hay, Milk and the Trade Consequences of California Water Troubles*. Presented at the Conference on Applied Methods for Ag & Resource Economics. A Festschrift for Richard E. Howitt. University of California Davis, May 23–24, 2016. Available: http://droughtimpacts.ucdavis.edu

The Pennsylvania State University. 2013. *Agricultural Alternatives Beef Cow-Calf Production. Cooperative Extension College of Agricultural Sciences*.

Turlock Irrigation District (TID). 2012. *Turlock Irrigation District 2012 Agricultural Water Management Plan*. December. Available: http://www.water.ca.gov/wateruseefficiency/sb7/docs/2014/plans/Turlock%20ID%20Final%20AWMP%2012-11-2012.pdf. Accessed: July 12, 2015.

U.S. Department of Agriculture (USDA). 1954. *Diagnosis and improvement of Saline and Alkali Soils.* Agriculture Handbook No. 60. February. Prepared by L. E. Allsison, L. Bernstein, C. A. Bower, J. W. Brown, M. Fireman, J. T. Hatcher, H. E. Hayward, G. A. Pearson, R. C. Reeve, L. A. Richards, and L. V. Wilcox. L.A. Richards, Editor. Soil and Water Conservation Research Branch – Agricultural Research Service.

———. 2012. *California Agricultural Statistics 2012 Crop Year*. USDA National Agricultural Statistics Service. Pacific Regional Office, California.

———. 2013. *California Agricultural Statistics 2013 Crop Year*. April 2015. USDA National Agricultural Statistics Service. Pacific Regional Office, California.

———. 2015. National Agricultural Statistics Service, Pacific Regional Field Office, California. Available: www.nass.usda.gov. Accessed: October 2.

———. 2016. *National Statistics Service Cropland Data Layer*. 2010 California Cropland Data Layer. Available: http://nassgeodata.gmu.edu/CropScape/. Accessed: August 2016. Washington, D.C.

U.S. Department of Interior (USDOI). 1982. *Operating Plan for New Melones Reservoir as Required by the February 2, 1982 Order of the United States Court of Appeals for the Ninth Circuit*. MP-2300 511. Sacramento, CA.

U.S. Salinity Laboratory Products and Services (USSL). 2012. *Agricultural Research Services*. Products & Services. Bibliography on Salt Tolerance.

Wetzel, W. C., I. L. Lacher, D. S. Swezey, S. E. Moffitt, and D. T. Manning. 2012. *Analysis Reveal Potential Rangeland Impacts if Williamson Act Eliminated*. Available: http://rangelandwatersheds.ucdavis.edu/publication%20list%20and%20files/CalAG_WillaimsonAct_Wetzel_et_al_2012.pdf. Accessed: May 16, 2016.