11 Groundwater Supply Sustainability

11.1 Water Supply Overview

Zone 7 adaptively manages its water supply with regard for current hydrologic conditions, water demands, water quality conditions, and future water supply, demand and operations forecasts. Surface water is imported to augment local supplies and sustainably manage the groundwater basin. The program includes:

- Calculating the long-term natural groundwater balance (supply and demand - *Section 11.2*)
- Importing, artificially recharging, and banking surface water to meet future demands (*Section 11.3.1*).
- Implementing a conjunctive use program that utilizes the full storage capacity of the groundwater basin (*Section 11.3.2*).
- Limiting Zone 7's long-term groundwater pumping to sustainably manage the basin (*Section 11.3.3*).
- Promoting increased and sound recycled water use (*Section 8.2.3*).
- Identifying and planning for future supply needs and demand impacts (*Section 9*).

These program components are described in more detail in Zone 7's Groundwater Management Plan (*Zone 7, 2005a*).

11.2 Natural Groundwater Balance

11.2.1 Natural Sustainable Supply

The Main Basin's "natural," sustainable, groundwater yield is defined as the amount of water that can be pumped from the groundwater basin and replenished by long-term average, natural supply. The Main Basin's "natural" sustainable groundwater yield consists of the components listed in *Figure 11-A*. The long-term, natural sustainable yield is primarily based on local precipitation and natural recharge over a century of hydrologic records and projections of future recharge conditions. However, applied water recharge is also included in the "natural" sustainable yield, because of its steady sustainable contribution to groundwater recharge.

The long-term, natural sustainable yield in the Main Basin is estimated to be about 13,400 AF annually (*Zone 7, 1992*). While the natural sustainable yield approximates long-term-average natural recharge, the actual amount of natural recharge varies from year to year depending on the amount of local precipitation and irrigation during the year. For the 2014 WY, the natural recharge was about 6,098 AF, approximately 46% of average for the Natural Sustainable Yield Supply Components (*Figure 11-A*).

Figure 11-A: Natural Sustainable Yield Supply Components

SUPPLY COMPONENT	**2014 WY (AF)**	**SUSTAINABLE AVERAGE (AF/Yr)**
Natural Stream Recharge	1,059	5,700
Arroyo Valle Prior Rights	0	900
Rainfall Recharge	1,169	4,300
Applied (Irrigation) Water Recharge	1,969	1,600
Subsurface Groundwater Flow	1,000	900
Subsurface Inflow	*1,000*	*1,000*
Basin Overflow	*0*	*-100*
TOTAL	**6,098**	**13,400**

11.2.2 Natural Sustainable Demand

The natural sustainable yield is allocated as shown in *Figure 11-B*. Long-term monitoring of each demand component checks whether each demand component is within the acceptable range:

Figure 11-B: Natural Sustainable Yield Demand Components

DEMAND COMPONENT	**2014 WY (AF)**	**SUSTAINABLE AVERAGE (AF/Yr)**
Municipal pumping by Retailers	7,456	7,214*
City of Pleasanton	*3,740*	*3,500**
*Cal Water Service**	*3,085*	*3,069**
*DSRSD**	*645*	*645**
Other groundwater pumping**	1,055	1,186
Agricultural pumping	636	400
Mining Area Losses***	5,198	4,600
TOTAL	**14,345**	**13,400**

* Retailer Groundwater Pumping Quota (GPQ) for a Calendar Year

** For drinking water supply

*** Mining Area discharges diverted to other ponds were not considered as losses (*Section 10.3.3.3*)

As a condition to the water supply contracts that Zone 7 has with its retailers, each retailer is limited to an annual independent Groundwater Pumping Quota (GPQ), which is generally based on average historical uses and is pro-rated based on the agreed upon natural sustainable yield of the groundwater basin. Together, the retailers are permitted to pump a total average of 7,214 AF annually per calendar year without paying recharge fees to Zone 7. Averages are maintained by allowance of "carry-overs" when less than the average is used in a given year. A retailer must pay a "recharge fee" for all groundwater pumped exceeding their GPQ, unless the retailer has sufficient carry-over credit from a previous year of un-pumped GPQ allocation. Such carryover is limited to 20% of the GPQ. This practice helps avoid a repeat of historical over-drafting of the basin by the larger municipal users.

For the 2014 WY, the estimated total for these demand components was 14,345 AF; approximately 945 AF above the long-term sustainable yield of 13,400 AF. The main contributor to this single-year exceedance was mining area losses which were about 600 AF above the sustainable yield allocation of 4,600 AF.

11.2.3 Long-Term Net Sustainable Yield

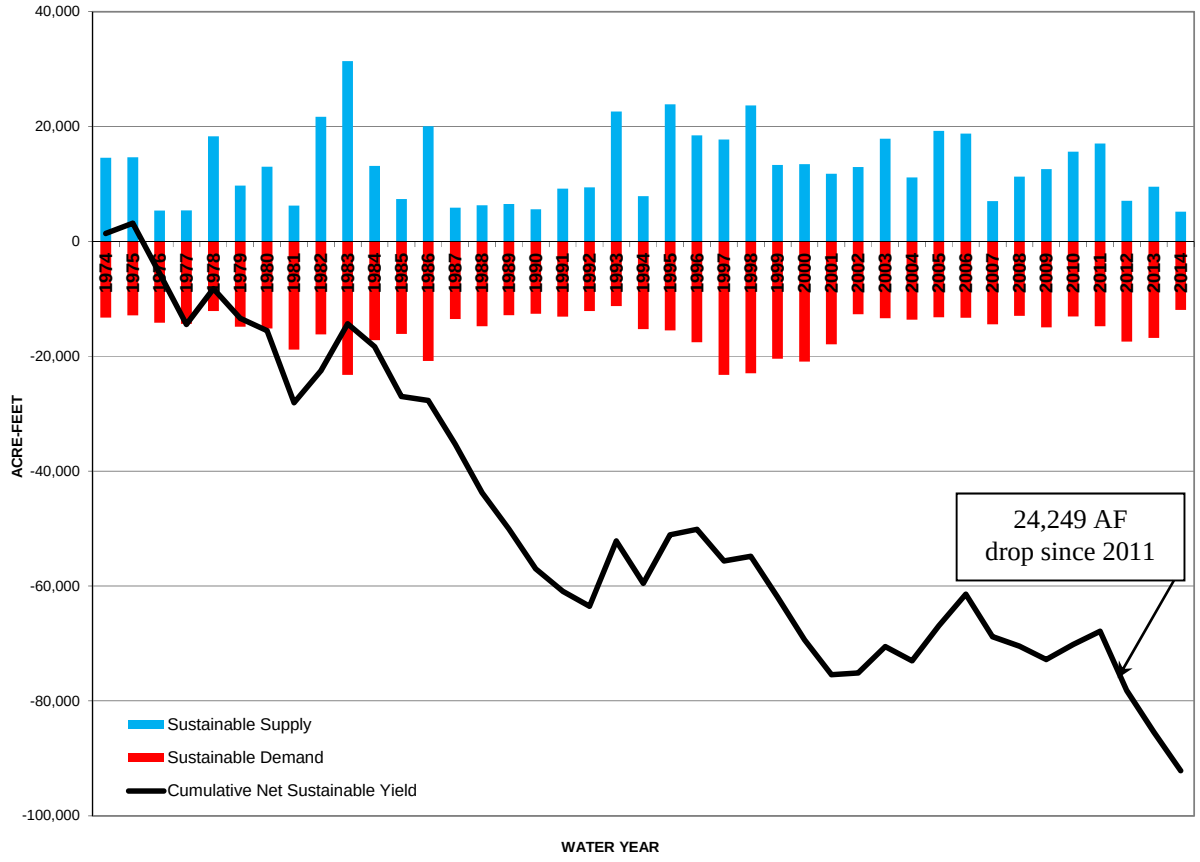
The graph below in *Figure 11-C* presents long-term natural sustainable supply and demand and the cumulative net sustainable yield (supply minus demand) since 1974. The graph shows a cumulative net loss in the sustainable yield of about 92,122 AF since 1974. *Figure 11-C* also indicates a significant drop in the actual sustainable net supplies between the end of the 2011 WY and the end of the 2014 (24,249 AF which includes a 6,714 AF drop during the 2014WY). The main reason for the net loss of Sustainable Yield supplies is Mining Use demands, which accounts for 282,645 AF of the total sustainable yield demand since 1974 (average 6,894 acre-feet per year [AF/yr]). This is 94,045 AF more than what would have been lost if Mining Use demands had averaged the 4,600 AF/Yr estimated evaporation for that demand. Future Mining Area demands, however, should drop by 4,000 AF/Yr to 5,000 AF/Yr as most mining releases are now being captured in Cope Lake and Lake I, and subsequently recharged back into the groundwater basin (*Sections 4.3* and *10.3.3.3*). Mining Area dewatering operations are expected to cease altogether when aggregate reserves have been sufficiently depleted and extraction halts. Currently, completion of aggregate mining is expected by 2058.

In addition to the higher-than-average Mining Area water demands from the end of the 2011 WY to the end of the 2014 WY (21,910 AF including 5,198 AF for the 2014 WY), drought conditions have resulted in Rainfall Recharge supplies being only 40% of that assumed for the Sustainable Yield supply (see *Figure 10-7*). This portion of the Sustainable Supply deficit caused by lower rainfall and runoff recharge will be offset in the future when average and above average rainfall returns to the Livermore Valley.

Fortunately, since the 1960's, Zone 7 has been importing and recharging SWP water (artificial recharge) in excess of what it has pumped from the groundwater basin for its own demands

during that time. This surplus of artificially-recharged supply has mostly made up for the excess Sustainable Yield demands, and has kept the groundwater basin from experiencing the overdraft that *Figure 11-C* seems to suggest. Additional detail on Zone 7's management and conjunctive use of its imported supplies, and their significance to the long-term sustainability of local groundwater is discussed in *Section 11.3*. The net effect of the natural and imported groundwater supply and demand components are displayed in *Figures 10-7* and *10-8*

Figure 11-C: Long-Term Net Natural Groundwater Balance (without surface water imports)



11.3 Zone 7 Supply and Demand

11.3.1 Supplemental Sources

Zone 7 ensures that local water supplies (e.g., groundwater) are not depleted by importing approximately 75% of the Valley's water supply (delivered to Zone 7's retailers and agricultural

customers) and recharging the Main Basin with surplus surface water when available (artificial recharge). These surplus surface water supplies, which are accounted for by calendar year, come from the following sources:

- **State Water Project (SWP deliveries via the South Bay Aqueduct [SBA])** - As a SWP contractor, Zone 7 imports supplies from the SWP through the SBA. As of 1998, Zone 7 has had an annual maximum SWP contract amount of 80,619 AF per year (AF/yr) referred to as the "Table A Contract Amount." However, actual SWP deliveries are usually allocated in any given year by the DWR at a lower level based on numerous factors, including hydrologic conditions. Currently, the long-term reliable yield of the SWP is approximately 60% of the Table A amount (48,370 AF/yr). This should increase if the California Water Fix is implemented by the State.

- **Arroyo Valle Water Rights (Lake Del Valle)** – Zone 7 has water rights for a portion of the natural flows into Lake Del Valle. Accordingly, Zone 7 coordinates releases from the reservoir into the Arroyo Valle to maintain downstream flows and recharge through the streambed at the levels that would have occurred had the reservoir not been constructed. Additional releases of Arroyo Valle water can be made from the lake when such water is available for Zone 7. Maintaining minimum flows is a condition of Zone 7's water rights permit for the Arroyo Valle water and allows Zone 7 the ability to use other portions of Arroyo Valle water for supply to its treatment plants and for supplemental aquifer recharge.

- **Byron-Bethany Irrigation District (BBID)** - Zone 7 has a contract with Byron-Bethany Irrigation District (BBID) for up to an additional 5,000 AF/yr of supplemental water made available to Zone 7 as a transfer of BBID's pre-1914 water rights water. When available, it is delivered upon request to Zone 7 through the SBA and can be used to supply Zone 7's artificial recharge program as well as Zone 7's water treatment plants. This water is only available in years when BBID declares a surplus is available for the transfer and approvals from DWR and the US Bureau of Reclamation are received. It was not available in the 2014 WY.

- **Kern Groundwater Basin (storage rights only)** - Zone 7 has purchased water storage rights in the Semitropic Water Storage District (78,000 AF) and in the Cawelo Water Storage District (120,000 AF) groundwater basins in Kern County. These rights give Zone 7 the ability to remotely store surplus SWP water when available. When Zone 7 is ready to use the water locally; it can import that quantity of SWP water through an exchange procedure within the SWP system.

- **Yuba Accord –** In 2008, Zone 7 entered into a contract with DWR to purchase additional water under the Lower Yuba River Accord (Yuba Accord). The contract expires in 2025. There are four different types ("Components") of water available; Zone 7 has the option to purchase Components 2 and 3 water during drought conditions, and Component 4

water when Yuba County Water Agency has determined that it has water supply available to sell. Zone 7 estimates the average yield from the Yuba Accord to be 250 AF/yr. In the 2014 CY, Zone 7 received 377 AF.

- **Multi-Year Pool –** In 2013, DWR implemented the Multi-Year Water Pool Demonstration Program, intended to facilitate the transfer of water between SWP contractors and to serve as an alternative to the under-used Turnback Pool Program. This program remains a pilot program. Zone 7 did not participate in the Multi-Year Pool in 2014.

- **Dry Year Transfer Program –** The State Water Contractors, an organization composed of contractors of the SWP, facilitates the purchase of water from the Feather River watershed for transfer to SWP contractors during dry years. This is an optional program, and in 2014 Zone 7 did not purchase any water through this program.

Supplemental supply totals, which are based on the Calendar Year (CY) to be consistent with DWR's allocation and accounting of State Project Water, are summarized in *Figure 11-D* below:

Figure 11-D: Supplemental Sources for the 2014 Calendar Year

Source	**Available in 2014 CY (AF)**	**Used in 2014 CY (AF)**	**Carry-Over to 2015 CY (AF)**
State Water Project	**22,319**	**18,100**	**4,219**
Table A (5% Allocation for 2014)	*4,031*	*570*	*3,461*
Article 56	*18,288*	*17,530*	*758*
Lake Del Valle (AV Water Rights)	**2,535**	**192**	**2,343**
BBID	**0**	**0**	**0**
Kern Groundwater Basin	**107,108**	**14,769**	**92,339**
Semitropic	*81,953*	*9,935*	*72,018*
Cawelo	*25,155*	*4,834*	*20,321*
Other		**-3,931**	
Kern transfer to San Luis Reservoir		*-4,758*	*4,758*
Yuba		*377*	
Local Use to Arroyo Valle		*166*	
Local Use to DWVTP		*284*	
TOTAL	**131,962**	**29,130**	**103,659**

Other highlights for the 2014 CY include:

- Because of the continuing severe drought, the SWP Table A allocation amount was only 5%; and could only be taken by Zone 7 after September 1. This was the lowest allocation in the history of the SWP.

- Also because of the severe drought, Zone 7 curtailed its artificial recharge program early in the year, only releasing 1,721 AF to the local arroyos for the entire 2014 CY.

- Superb conservation by the Valley's residents, businesses and public agencies during the 2014 CY resulted in about 25% reduction in Valley-wide demand from the 2013 CY level.

- 4,758 AF of the 14,769 AF of water received from the Kern Groundwater Basin was sent to San Luis Reservoir for carryover to the 2015 CY.

11.3.2 Conjunctive Use Program

Zone 7 actively embraces a conjunctive use approach to Basin Management by integrating management of local and imported surface water supplies with the management of local conveyance, storage and groundwater recharge features, including:

- local arroyos (which are also used as flood protection facilities during wet seasons); and

- two former quarry pits (Lake I and Cope Lake).

A key component of Zone 7's conjunctive use program has been its artificial recharge program, which consists of releases of surface water to dry arroyos to recharge the groundwater basin. The timing and quantity of artificial recharge are typically dependent upon available supply, available recharge capacities, source water quality, and regulatory requirements. The historical artificial recharge for the Main Basin has averaged about 5,300 AF per year.

The location and timing of artificial recharge operations can be used as a water quality management tool as well as a temporal water storage activity. When practical to do so, Zone 7 prioritizes its SWP releases for recharge to occur in the spring and summer when TDS of the source water is low. Because each acre-foot that is subsequently pumped from the Basin removes water with higher TDS, the exchange process can eventually improve the salinity of the groundwater basin. The salt removal effectiveness of the conjunctive use is related to the difference in the TDS of recharge and pumped water and the annual volumes involved (see *Section 12.1*)

For the 2014 WY, Zone 7's Conjunctive Use Program included the following activities and highlights:

- Zone 7 released 5,228 AF of imported surface water to the local arroyos, of which about 3,800 AF artificially recharged the groundwater basin.

- Because of the severe drought, EBRPD was allowed to only divert a total of 111 AF into Shadow Cliffs for maintaining the lake level to facilitate recreational opportunities and recharging the basin.

- The 2014 WY marked the start of active recharge operations using Cope Lake and Lake I. Lake I facilitates recharge directly to the upper aquifer through a gravel face on the western edge of the lake. For the 2014 WY, the water source was capture of mining releases, however, these lakes will be available to store, convey and artificially recharge imported surface water in the future.

- About 166 AF of local use water was sent to the Arroyo Valle and 284 AF was sent to the DVWTP.

Looking farther into the future, Zone 7 plans to increase its conjunctive use to keep up with growing demands. Acquisition of additional former quarries (Lakes A through H) will become the area's future "Chain of Lakes" allowing enhanced artificial recharge and regional flood protection projects to be fully implemented (see *Section 4.3*).

11.3.3 Zone 7 Groundwater Pumping

Historically, Zone 7's annual groundwater production has varied with the availability of surface water and the capacity to treat that surface water. Whereas, groundwater pumping by the retailers is accounted for in the natural sustainable yield demands, Zone 7's groundwater pumping is accounted for among the conjunctive use demands (i.e., withdrawals from the artificially-recharged supplies).

In normal years, Zone 7 operates its wells to augment production during demand peaks and whenever a shortage or interruption occurs in its surface water supply or treatment. However, Zone 7 has also pumped groundwater as a salt management strategy. The decision of which well(s) to pump first is based on pumping costs, pressure zone needs, delivered aesthetic water quality issues, groundwater levels, and demineralization facility capacity. Although reduced groundwater pumping may have a positive impact on groundwater storage and delivered water quality, increased groundwater pumping has a beneficial impact on the basin's salt loading because much of the salt in the pumped groundwater eventually leaves the basin as wastewater export.

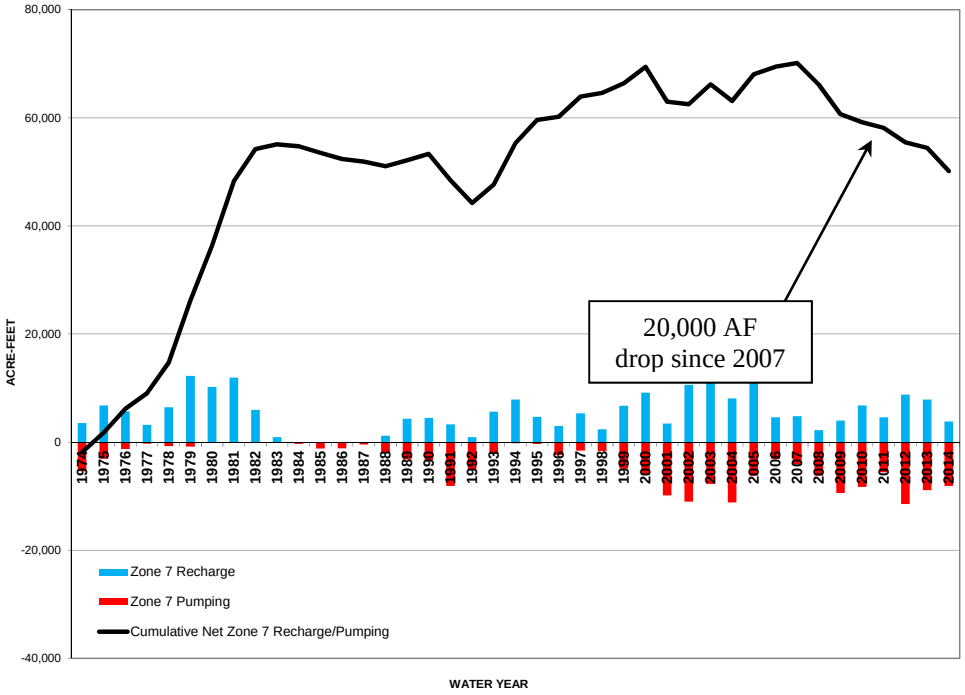
For the 2014 WY, Zone 7 pumped 8,122 AF of groundwater (not including 645 AF pumped as DSRSD's Groundwater Pumping Quota – *Section 11.2.2*). Of the groundwater pumped, an estimated 214 AF was exported as brine waste from the Mocho Groundwater Demineralization Plant (MGDP) and 31 AF was pumped-to-waste during well start-ups; leaving 7,877 AF for potable water deliveries. This groundwater production represented 24% of Zone 7's total treated water production for the 2014 WY. Including groundwater pumped by others, groundwater

comprised about 42% of the total potable water supplied to the Valley *(Figure 11-1*). Zone 7's treated surface water made up the other 58% of regional potable water deliveries in the 2014 WY, compared to the annual average of 75%.

11.3.4 Long-Term Net Zone 7 Recharge/Pumping

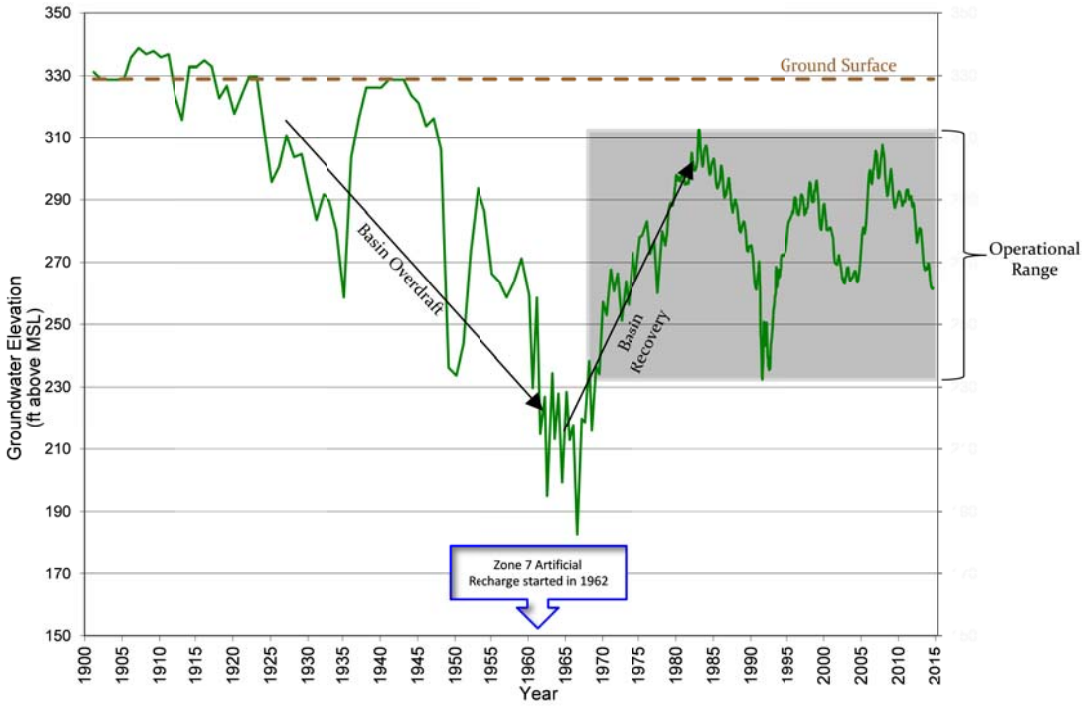
Since 1974, Zone 7 has artificially recharged over 51,000 AF more water than it has pumped (see graph below in *Figure 11-E*). This has helped offset the above average net natural sustainable yield demands of late (primarily from mining use - see *Section 11.2.3*), and has kept the Main Basin's water levels mostly above the historical lows (see *Figure 11-F* below).

Figure 11-E: Long-Term Net Zone 7 Recharge/Pumping



Between 1974 and 2007 Zone 7 had artificially recharged approximately 70,000 AF more than it had pumped during that same time. As also shown in *Figure 11-E*, Zone 7 has pumped about 20,000 AF more than it has artificially recharged since 2007. This is primarily due to the recent drought conditions and lower-than-average SWP allocations over that same time period. However, the surplus artificial recharge that was accomplished before 2007 has kept the overall net groundwater storage above historical lows (see *Figure 10-8*).

Figure 11-F: Groundwater Basin Management: Historical Groundwater Elevations at Fairgrounds Key Well



11.4 Groundwater Model

Zone 7 maintains a numerical groundwater model of the basin for predicting the consequences of proposed groundwater basin management actions. The model, originally created in Visual MODFLOW, has been converted to Groundwater Vistas and uses MODFLOW-SURFACT to perform the modeling calculations. In 2006, Zone 7 and HydroMetrics WRI (HydroMetrics) reevaluated, recalibrated, and revised the model as described in the Annual Report for the Groundwater Management Program – 2005 WY (*Zone 7, 2006d).*

The active part of the groundwater model encompasses the Amador, Bernal, Bishop, Camp, Castle, Dublin, and Mocho II Subbasins of the Valley. The model consists of three layers: the upper aquifer (Layer 1), an aquitard (Layer 2), and the lower aquifer (Layer 3). Most municipal water supply production wells in the basin are screened in the lower aquifer (Layer 3). Many small private wells are screened in the upper aquifer (Layer 1).

In addition to modeling for salt in groundwater (*Section 12.3*), the groundwater model has been used for water supply well siting and planning (*WMP, 2003*). More recently, for Zone 7's Water Supply Evaluation (*WSE, 2010*), the groundwater model was used to identify the maximum amount of groundwater Zone 7 could pump using existing wells during a six year drought without going below historical lows. In 2014 the model was used to predict the impacts that a

third and fourth year of drought, combined with Zone's planned groundwater pumping, would have on groundwater levels.

11.4.1 Groundwater Model Improvements

In December 2013, DWR awarded Zone 7 a Proposition 84 Local Groundwater Assistance Program grant of $200,000 to update the groundwater model so that it can better evaluate future groundwater management and salt mitigation strategies. The approved scope of work for the project includes:

- Converting the model software from MODFLOW SURFACT to MODFLOW NWT,
- Incorporating the MODFLOW Streams and Lakes Packages,
- Adding additional layers to the model that represent hydrostratigraphic boundaries identified in recent geologic studies, and
- Recalibrating the model using both water elevation and salt concentration datasets.

It is anticipated that the updated groundwater model will be capable of incorporating data from Zone 7's watershed modeling software.

In 2014, Zone 7 and its consultant HydroMetrics Water Resources Inc. worked on converting the model software to MODFLOW NWT, incorporating the Streams and Lakes packages, and adding additional layers to the model. This project's completion date was extended to allow new data from the ongoing drought to be incorporated.

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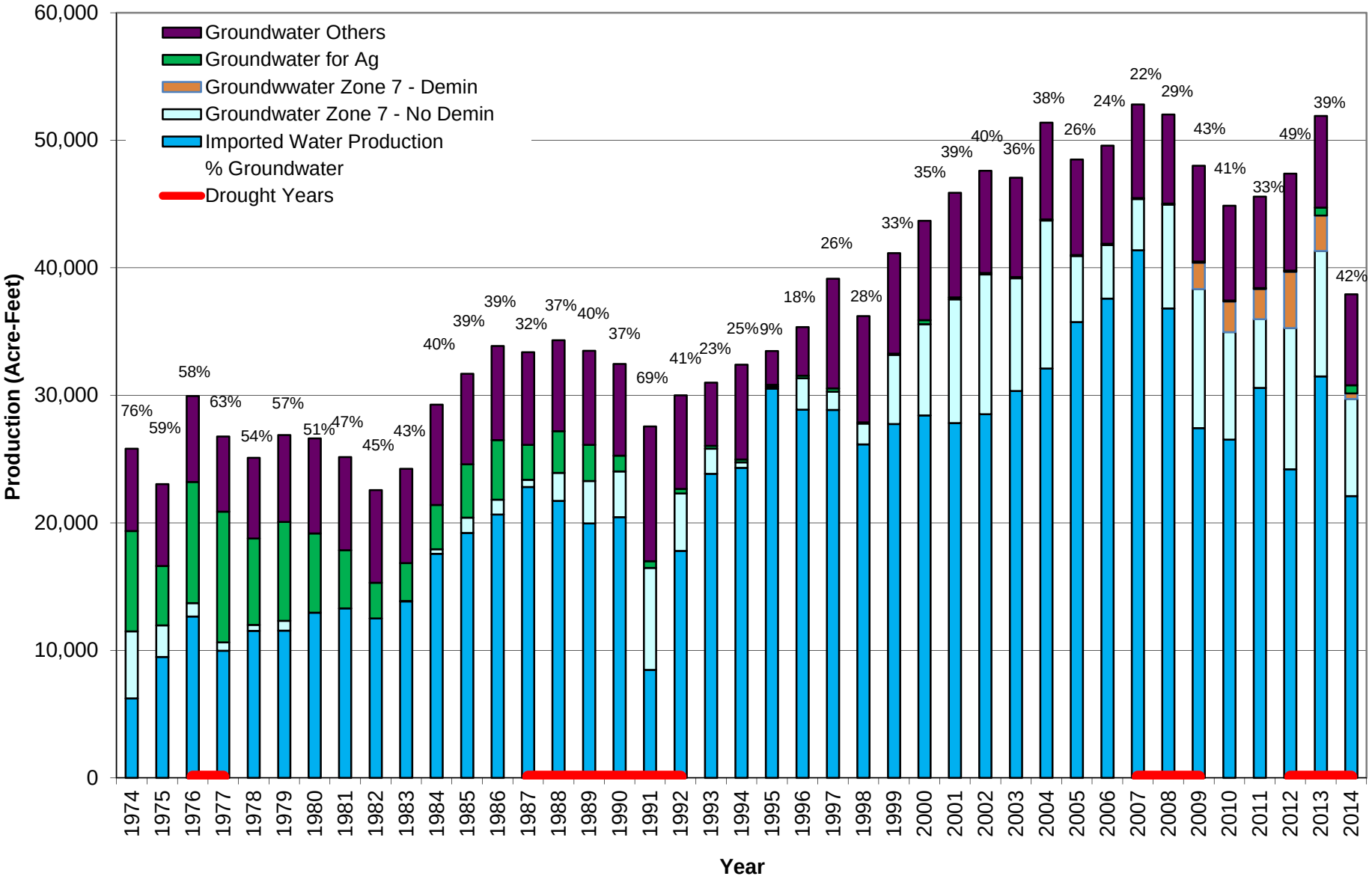
FIGURE 11-1
VALLEY WATER PRODUCTION FROM IMPORTED WATER AND GROUNDWATER
1974 TO 2014 CALENDAR YEARS



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3/27/2015

Figure 11-1