3 Groundwater Basin Evaluation and Management

3.1 Groundwater Storage

This section describes how Zone 7 calculates groundwater storage for the Main Basin as calculated and presents the groundwater storage estimate at the end of the 2013 Water Year (October 2012 through September 2013).

Groundwater Storage is the approximate amount of water stored in the Main Basin at the end of the water year. Zone 7 quantifies the total groundwater storage (Average Storage) by averaging the values computed by two independent methods:

- Groundwater Elevation (GWE)
- Hydrologic Inventory (HI)

Results and details for the two methods are presented in the following two sections: Sections 3.1.1 and 3.1.2, respectively. Operational or “Available” Storage, which is the approximate amount of water in storage available for production above the historical low groundwater surface, is calculated by subtracting the historical low storage value (128 thousand acre-feet [TAF]) from the current average total.

The two groundwater storage calculation methods tended to give results that were relatively close in value until about the 2000 Water Year (October 1999 through September 2000); they then began to diverge, with the GWE method resulting in values that were consistently higher than the HI method. Since the HI method is based on a running total, the difference between the two methods grew as time advanced beyond 2000. Starting in the 2008 Water Year (October 2007 through September 2008), Zone 7 revisited the calculations and has since implemented refinements to both methods that are believed to increase their accuracies. Specifically, for the GWE method, each node was divided into an upper and lower aquifer, and better attention is paid to whether the aquifer is confined or unconfined when calculating the storage for each node. Also the average water levels for each node is now determined using the groundwater elevation map and *ArcGIS Spatial Analyst*. For the HI method, the areal recharge model was improved and now runs with daily time-steps. The HI method now also includes estimated recharge from leaking water and sewer pipelines, which currently adds approximately 1 TAF per year to the HI total.

The improvements have resulted in the year-to-year storage from the two methods agreeing much more closely with the exception of the 2005 Water Year (October 2004 through September 2005) and 2009 Water Year (October 2008 through September 2009) (*Figure 3.1-6* and *Figure*

3.1-7). The 10 TAF difference in each of these two years keeps the 2013 values 21 TAF apart in spite of both methods estimating a 7 TAF drop from the prior year's values.

3.1.1 Groundwater Elevation Method

In the Groundwater Elevation (GWE) method of calculating groundwater storage, the Main Basin is divided into polygonal areas referred to as nodes (*Figure 3.1-1*). Each node has its own set of hydrogeologic parameters, such as storage coefficient, nodal thickness, and nodal area (*Figure 3.1-2*). The saturated thickness of the node is calculated using the nodal thickness, average groundwater elevations from the fall semiannual measuring event, and storage coefficient. The groundwater storage of each node is then calculated by multiplying the saturated thickness by the total area of the node. The total Main Basin groundwater storage is equal to the sum of all the nodal storage values for the 22 nodes in the Main Basin.

GWE storage calculations before 1992 were calculated assuming a constant storage coefficient for the entire node. *Figure 3.1-3* shows GWE groundwater elevations and storage volumes for the 1963 Water Year (October 1962 through September 1963) to the 1991 Water Year (October 1990 through September 1991). *Figure 3.1-4* shows the groundwater elevations and storage volumes for Water Years 1992 to 2013 using the newer GWE method. *Figure 3.1-1* shows the upper and lower aquifer groundwater elevations used to calculate the GWE method storage for the 2013 Water Year and includes the mean groundwater elevations for each node, calculated using *ArcGIS Spatial Analyst*.

The GWE method resulted in a calculated drop of total storage of about 7 thousand acre feet (TAF), from 228 TAF in the 2012 Water Year (October 2011 through September 2012) to 221 TAF at the end of the 2013 Water Year (October 2012 through September 2013).

3.1.2 Hydrologic Inventory Method

3.1.2.1 Overview

The Hydraulic Inventory (HI) method for determining basin storage calculates the volume difference between groundwater supply and groundwater demand. The difference between supply and demand is the net recharge, which is added to/subtracted from the previous year's ending storage value to arrive at the current year's ending storage value. The calculations assumed 212 TAF of storage at the beginning of the 1974 Water Year (October 1973 through September 1974) (from *DWR, 1974*). The groundwater supply and demand components of the hydrologic inventory are:

Figure 3.1-A: Groundwater Supply and Demand Components

SUPPLIES	**DEMANDS**
Natural Sustainable Yield – Supply • Natural stream recharge • Rainfall Recharge • Applied (Irrigation) Water Recharge • Subsurface Groundwater Inflow	**Natural Sustainable Yield – Demand** • Municipal Pumping by Others • Gravel Mining Water Use • Groundwater Basin Overflow
Artificial Stream Recharge	**Municipal Pumping by Zone 7**
Pipe Leakage	

The supply and demand components, described in more detail in the sub-sections below, are taken directly from the monitoring program results or calculated using the results of a monitoring program. The results of the HI method for the 2013 Water Year (October 2012 through September 2013) are shown in *Figure 3.1-5*. Historical HI method results from Water Years 1974 to 2013 are shown on *Figure 3.1-6* and *Figure 3.1-7*.

Similar to the GWE method, the HI method resulted in a calculated drop of total storage of about 7 TAF, from 207 TAF at the end of the 2012 Water Year (October 2011 through September 2012) to 200 TAF at the end of the 2013 Water Year (October 2012 through September 2013); however, the calculated total storage at the end of the water year is 21 TAF lower than the estimated total storage using the GWE method.

3.1.2.2 Supply Components

Natural Sustainable Yield (Safe Yield)

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 long-term, natural sustainable yield is calculated based on local precipitation and natural recharge over a century of hydrologic records and projections of future recharge conditions. Applied water recharge has been historically included in the "natural" sustainable yield, because of its sustainable contribution to groundwater recharge. The Main Basin's "natural" sustainable groundwater yield consists of the following components:

Figure 3.1-B: Natural Sustainable Yield Supply Components

SUPPLY COMPONENT	2013 WY (AF)	AVERAGE (AF/Yr)
Natural Stream Recharge	2,332	5,700
Arroyo Valle Prior Rights	1,370	900
Rainfall Recharge	2,708	4,300
Applied (Irrigation) Water Recharge	2,147	1,600
Subsurface Inflow	1,000	1,000
Basin Overflow	0	-100
TOTAL	**9,557**	**13,400**

Note: Water Years are tracked October of the previous year through September of the water year.

The long-term, natural sustainable yield in the Main Basin was 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 2013 Water Year (October 2012 through September 2013), the natural recharge was about 9,557 AF, approximately 71% of average.

Additional recharge from Zone 7's artificial recharge operations allows the groundwater basin to yield additional water, which is as sustainable as the supply of imported surface water. Since it relies on imports and artificial recharge, it is not accounted for in this subsection.

Stream Recharge

Stream recharge is broken down into the following three components:

- **Natural stream recharge** - rain runoff into the streams, including both urban and rural runoff from the watershed, which naturally recharges the basin's aquifers through the streambeds.

- **Artificial stream recharge –** Zone 7 contracted State Water Project (SWP) water released from the South Bay Aqueduct (SBA) of the SWP or from Lake Del Valle (a SWP reservoir, also operated by the California Department of Water Resources) into the arroyos for the purpose of augmenting the natural stream recharge.

- **Arroyo Valle Prior Rights recharge –** SWP or local water released from the SBA or Lake Del Valle to produce the amount of recharge that would have occurred if Lake Del Valle had not been constructed.

Streambed recharge is calculated from daily stream flow and stream discharge records. The three primary recharge streams (Arroyos Valle, Mocho, and Las Positas) have gages upstream and downstream of the reaches in which recharge occurs. Recharge typically is calculated as the difference between upstream inflows and downstream outflows. Stream recharge volumes for the 2013 Water Year (October 2012 through September 2013) are presented in the table below.

Figure 3.1-C: Stream Recharge Components

SOURCE	2013 WY (AF)	AVERAGE (AF/Yr)
Natural Stream Recharge	2,332	5,700
Arroyo Valle Prior Rights	1,370	900
Artificial Stream Recharge	7,887	5,300
TOTAL RECHARGE	11,589	18,800

Note: Water Years are tracked October of the previous year through September of the water year.

A set of synoptic discharge measurements performed on the Arroyo Las Positas in the 2012 Water Year (October 2011 through September 2012) indicated that the maximum recharge rate was about 1.5 cfs, which is about half of what had been previously estimated. As a result, the stream recharge from the Arroyo Las Positas was re-calculated using this revised value for the 2002 Water Year (October 2001 through September 2002) to 2013 Water Year (October 2012 through September 2013).

Areal Recharge

Over the last few years, Zone 7 observed a significant departure between the groundwater storage results derived from the groundwater elevation (GWE) and hydrologic inventory (HI) methods (Sections 3.1.1 and 3.1.2). One hypothesis was that the areal recharge calculation spreadsheet model used to calculate both rainfall and applied water recharge was underestimating groundwater recharge. Consequently, in the 2011 Water Year (October 2010 through September 2011) and the 2012 Water Year (October 2011 through September 2012), staff revamped the spreadsheet model, particularly with respect to the method for estimating rainfall runoff, in an effort to more accurately calculate areal recharge (*Zone 7, 2013*).

The updated areal recharge spreadsheet model was used to calculate rainfall and applied water recharge. The resulting annual recharge volumes are shown in the table below.

Figure 3.1-D: Areal Recharge Components

SOURCE	2013 WY (AF)	AVERAGE (AF/Yr)
Rainfall Recharge	2,708	4,300
Applied Water Recharge	2,147	1,600
TOTAL RECHARGE	4,855	5,900

Note: Water Years are tracked October of the previous year through September of the water year.

Subsurface Groundwater Flow

Subsurface inflow, which occurs primarily in the upper aquifer from the fringe basins to the Main Basin, is estimated based on gradients across the Main Basin boundaries, aquifer structure, and the hydraulic conductivities of the aquifer sediments. Subsurface inflow into the Main Basin is only thought to be significant from the Dublin and Camp fringe basins. For the annual hydrologic inventory, it has been assumed to be a constant 1,000 AF per year since the 2000 Water Year (October 1999 through September 2000). Prior to 2000, water levels were used to create rough estimates of hydraulic conditions across boundaries.

Subsurface basin overflow, which also occurs primarily in the upper aquifer, tends to discharge into the Arroyo De La Laguna and flows out of the basin to the San Francisco Bay through Alameda Creek when water levels are above elevation 295 feet in this portion of the Bernal Subbasin. For the entire water year, water levels in wells near the Arroyo De La Laguna remained below 295 feet. Consequently, there was no basin overflow from the upper aquifer into the Arroyo De La Laguna during the 2013 Water Year (October 2012 through September 2013).

Subsurface Groundwater flow volumes for the 2013 Water Year are presented in the table below.

Figure 3.1-E: Subsurface Groundwater Flow

SOURCE	**2013 WY (AF)**	**AVERAGE (AF/Yr)**
Subsurface Inflow (estimated)	1,000	1,000
Basin Overflow	0	-100
TOTAL SUBSURFACE FLOW	1,000	900

Note: Water Years are tracked October of the previous year through September of the water year.

Pipe Leakage

Starting in the 2012 Water Year (October 2011 through September 2012), Zone 7 staff estimated the volume of water leaking from all underground water pipes into the Main Basin. Zone 7 estimates pipe leakage from water supply and sewage pipes into the Main Basin by using the following formula (initially developed from leakage rate estimates by Emil Kuichling in 1897 and modified by Zone 7; see discussion in *Zone 7, 2013*):

Leakage [gpd] = Pipe length [mile] x

Minimum (3,000 [gpd/mile], Maximum (0, 50 [gpd/mile/yr] x Pipe Age [yr] – 500)).

The formula is based on the assumption that pipe leakage does not start until the pipe is at least 10 years old, after which it leaks at a rate of 50 gpd/mile for each year above 10 years old, up to a maximum of 3000 gpd/mile.

For the 2013 Water Year (October 2012 through September 2013) total pipe leakage into the Main Basin is estimated to be approximately 1,090 AF.

3.1.2.3 Demand Components

Natural Sustainable Yield (Safe Yield) Demand Components

The natural sustainable yield is allocated as follows, with Zone 7 monitoring to make sure each demand component is within the acceptable range:

Figure 3.1-F: Natural Sustainable Yield Demand Components

DEMAND COMPONENT	2013 WY (AF)	AVERAGE (AF/Yr)
Municipal pumping by Retailers	6,716	7,214*
Other groundwater pumping	1,197	1,186
Agricultural pumping	486	400
Mining Area Losses	8,391	4,600
TOTAL	**16,790**	**13,400**

Note: Water Years are tracked October of the previous year through September of the water year.
*Retailer Groundwater Pumping Quota (GPQ) for a Calendar Year

Annual variability with the demand components can be accommodated as long as the long-term average demands don't exceed the sustainable average recharge. For the 2013 Water Year (October 2012 through September 2013) the estimated total for these demand components was 16,790 AF; approximately 3,390 AF above the long-term sustainable yield of 13,400 AF. The largest contributor to this single-year exceedance was the stream export component of gravel mining dewatering operations, which has been ramping up over the last five years, but should drop dramatically next water year when Zone 7 begins to capture and recharge Vulcan's "stream discharge" in Zone 7's Cope Lake and Lake I (see Section 3.2.5).

Groundwater Pumping by Others

Zone 7 collects and compiles data for all large capacity pumping wells within the Main Basin. This includes daily and monthly pumping totals from the retailers. Records of other pumping wells are obtained from well owners when available. Pumping records from significant wells without meters are estimated from utility records or from the associated land use (e.g. number of acres irrigated).

In addition to the nine municipal wells operated by Zone 7 in Pleasanton (discussed below in Section 3.1.2.3), California Water Service Company (CWS) operated 12 wells in the Livermore area, and the City of Pleasanton operated three wells in Pleasanton in 2013. Production volumes from the municipal wells (total pumped minus the pumped-to-waste and brine discharge volume) for the 2013 Water Year (October 2012 through September 2013) and Calendar Year (January through December) are presented in *Figure 3.1-8*.

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 (discussed previously in Section 3.1.2.2). Together, the retailers are permitted to pump a total average of 7,214 AF annually without paying recharge fees to Zone 7; averages are facilitated by a system of allowed carry-overs if less 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 large municipal users.

During the 2013 Calendar Year (October 2012 through September 2013), CWS pumped 402 AF less than their GPQ and had 75 AF of "carry-over" water from the year before to end the year with 477 AF of carry-over for 2014. The City of Pleasanton, which had a carry-over from 2012 of 700 AF, pumped 16 AF above their GPQ and will carry-over 684 AF for 2014. Since DSRSD no longer has any municipal wells, Zone 7 pumped and delivered DSRSD's GPQ (645 AF) for them. The table below shows the individual GPQs, the carry-over amounts, and the amounts pumped in the 2013 Calendar Year for each retailer. The new carry-over amount will be added to the retailers' GPQ for the following calendar year.

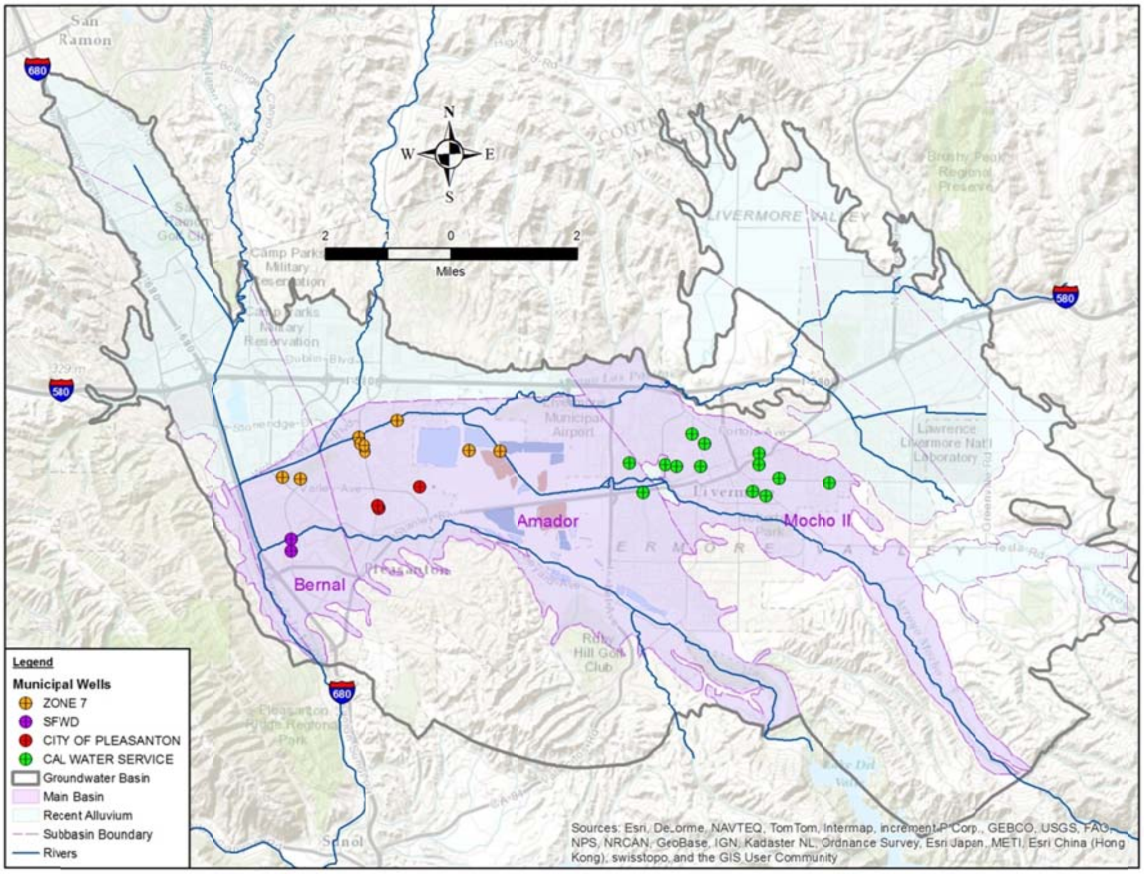
Figure 3.1-G: Retailer GPQ Values (in AF per Calendar Year)

RETAILER	GPQ	CARRY-OVER 2012	PUMPED IN 2013	CARRY-OVER TO 2014
City of Pleasanton*	3,500	700**	3,516	684
Cal Water Service*	3,069	69	2,667	477
DSRSD*	645	0	645 (by Zone 7)	0
City of Livermore (currently not used)	31	6.2**	0	6.2**
Total	**7,214**	**769**	**6,828**	**1,161**

* Total/Quota = Sum of * components (i.e., City of Livermore not included in totals)
** Maximum of 20% of GPQ can be carried over

The relative locations of the municipal supply wells are shown in *Figure 3.1-H* below:

Figure 3.1-H: Map of Municipal Wells



Mining Area Losses

Zone 7 calculates the total monthly evaporative losses for the water bodies exposed to the atmosphere by mining operation (often referred to as quarry lakes or mining ponds) using the net difference between total rainfall and evaporation over the total pond area. Mining area evaporation accounts for a large portion of the "Demand" component for the annual hydrologic inventory calculation; second only to "Municipal Pumping." For the 2013 Water Year (October 2012 through September 2013), 2,895 AF of water were lost due to mining area evaporation.

Mining activity losses also include groundwater lost due to export of moist gravels and pumped groundwater that has been discharged into a stream and is not subsequently recharged. The volume of this exported groundwater varies over time depending on the stage of mining in any given pit and the demand for aggregate resources. When the permitted gravel extraction is complete (currently estimated in 2058), the associated decrease in groundwater losses (i.e. pit dewatering, gravel washing, and moisture export) should eliminate this potential overdraft condition. For the near-term, Vulcan Materials, one of the active gravel mining companies, extended their discharge pipeline to Cope Lake so that the water generated by their pit dewatering operations will be captured in Cope Lake. Zone 7 has installed (May 2014) a pipeline from Cope Lake to Lake I to convey the Vulcan discharge water into the larger lake having a capacity for aquifer recharge (recharge capacity in Cope Lake, itself, is estimated to be negligible due to the former use of the lake as a sedimentation pond).

Figure 3.1-I: Mining Area Demand Components

DEMAND COMPONENT	2013 WY (AF)	AVERAGE (AF/Yr)
Mining discharges to stream	4,796	2,000-5,000
Mining area evaporation	2,895	3,200
Gravel mining operations	700	700
TOTAL MINING AREA LOSSES	**8,391**	**4,600**

Note: Water Years are tracked October of the previous year through September of the water year.

Zone 7 Groundwater Pumping

Figure 3.1-9 shows historical groundwater pumping from all sources and includes the percentage of all pumping by Zone 7. Historically, Zone 7's annual groundwater pumping has varied with the availability of imported surface water and the capacity to treat that surface water. In general, Zone 7 operates its wells for salt management, demand peaks, and whenever a shortage or interruption occurs in its surface water supply or treatment. The decision of which well(s) to pump first is based on pumping costs, pressure zone needs, delivered aesthetic water quality issues, salt management needs, 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.

Zone 7 pumped 9,532 AF of groundwater (including 645 AF pumped by Zone 7 for DSRSD), more than half of all groundwater pumped from the Main Basin (17,300 AF). The majority of groundwater that Zone 7 pumped came from the Amador Subbasin (7,198 AF) with the remainder coming from the Bernal Subbasin (2,332 AF). It is anticipated that during normal years groundwater pumped from the Mocho Wellfield will continue to be first in priority because of the salt removal and delivered water quality benefit when the Mocho Groundwater Demineralization Plant (MGDP) is operated.

The following summarizes Zone 7's groundwater pumping for the 2013 Water Year (October 2012 through September 2013):

Figure 3.1-J: Zone 7 Groundwater Pumping

ZONE 7 PUMPING BY WELLFIELD	2013 WY WELLFIELD (AF)
Amador Subbasin	
Mocho wellfield	4,275
COL wellfield	1,032
Stoneridge wellfield	1,891
Bernal Subbasin	
Hopyard wellfield	2,332
TOTAL PUMPING	**9,530**

Note: Water Years are tracked October of the previous year through September of the water year.

3.1.3 Total Operational Storage

One of Zone 7's groundwater basin management objectives is to maintain water levels above historical lows to minimize the risk of inducing land subsidence. Therefore, not all of the total groundwater storage is considered accessible. "Operational" or "Available" Storage is the approximate amount of storage available above the historical low groundwater surface. The remainder (approximately 128 TAF) is estimated reserves stored below historical lows. Stored groundwater at the end of the 2013 Water Year (October 2012 through September 2013) was 210 TAF, with 82 TAF groundwater available as operational storage (see *Figure 3.1-K* below), which is about 65% of the estimated historical maximum (based on 126 TAF estimated for the 1983 Water Year [October 1982 through September 1983]).

Figure 3.1-K: Groundwater Storage Summary (in Thousand AF)

Storage Calculation Method	2012 WY	Change in 2013 WY	2013 WY
Groundwater Elevations (GWE)	228	-7	221
Hydrologic Inventory (HI)	207	-7	200
Total Storage (avg of GWE & HI)	**217**	**-7**	**210**
OPERATIONAL STORAGE*	**89**	**-7**	**82**

* Operational Storage = Total Storage –Storage Below Historical Lows (128 TAF)

Note: Water Years are tracked October of the previous year through September of the water year.

3.2 Sustainable Water Supply

3.2.1 Overview

Zone 7 adjusts its water supply program to reflect current hydrologic conditions and available data while directing the program towards the best solution for the current water supply, water demand, and water quality conditions. The program includes:

- Calculating the long-term sustainable groundwater yield (Section 3.1.2.3)
- Limiting groundwater pumping to the sustainable replenishment quantities (Section 3.1.2.3).
- Importing and banking surface water to meet future demands (Section 3.2.3).
- Implementing a conjunctive use program that utilizes the full storage capacity of the groundwater basin (Section 3.2.4).
- Promoting increased and sound recycled water use (Section 2.6.2.3).
- Identifying and planning for future supply needs and demand impacts (Section 2.7).

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

3.2.2 Groundwater Production

Historically, Zone 7's annual groundwater production has varied with the availability of surface water and the capacity to treat that surface water. During wet years, Zone 7 imports extra surface water from the State Water Project's (SWP) South Bay Aqueduct (SBA) and artificially recharges it in the Main Groundwater Basin (currently using stream percolation in losing reaches). This recharge SWP water is then available to Zone 7 for pumping during dry years. As discussed earlier, the naturally-recharged, sustainable yield of the basin was contractually allocated to Zone 7's retailers based on respective historical use.

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, 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 2013 Calendar Year, Zone 7 pumped 10,432 AF of groundwater (including 645 AF pumped as DSRSD's Groundwater Pumping Quota [GPQ]). Of the groundwater pumped, an estimated 575 AF was exported as brine waste from the Mocho Groundwater Demineralization Plant (MGDP) and 29 AF was pumped-to-waste during well start-ups; leaving 9,828 AF for potable water deliveries. This groundwater production represented 22% of Zone 7's total treated water production for the 2013 Water Year (October 2012 through September 2013). Including groundwater pumped by others, groundwater comprised about 39% of the total potable water supplied to the Valley (*Figure 3.2-1*). Zone 7's treated surface water made up the other 61% of regional potable water deliveries in the 2013 Water Year, compared to the annual average of 75%.

3.2.3 Supplemental Water Sources

Zone 7 ensures that the groundwater supplies are not depleted by importing most of the Valley's water supply (approximately 75%) and recharging the Main Basin with surplus surface water when available. These surplus surface water supplies come from the following sources:

- **Arroyo Valle Water Rights (Lake Del Valle) –** Zone 7 has water rights to a portion of the natural flows into Lake Del Valle. Accordingly, Zone 7 coordinates releases from the reservoir into the Arroyo Valle to maintain flows and recharge through the streambed at the levels that would have occurred had the reservoir not been constructed. Additional releases can be made from the lake when 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.

- **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 California Department of Water Resources (DWR) at a lower level based on numerous factors, including hydrologic conditions. Currently, the long-term reliable yield of the SWP is 60% of the Table A amount (48,370 AF/yr). This may increase if a "Delta Fix" is implemented by the State.

- **Byron-Bethany Irrigation District (BBID)** - Zone 7 has a contract with Byron-Bethany Irrigation District for up to an additional 5,000 AF/yr of supplemental water made available as a transfer of pre-1914 water rights water. It is delivered to Zone 7 through the SBA and can be used to supply Zone 7's artificial recharge program. This water is only available in years when BBID declares a surplus is available for the transfer.

- **Kern Groundwater Basin (storage rights only)** - Zone 7 has purchased water storage rights (78,000 AF) in the Semitropic Water Storage District and 120,000 AF of storage in Cawelo Water Storage District groundwater basins in Kern County. These rights give Zone 7 the ability to store surplus SWP water when available, without importing it, and then when Zone 7 is ready to receive the water, it can import that quantity of SWP water through an in-lieu exchange procedure.

Figure 3.2-2 diagrams the main water supply and use components for the 2013 Calendar Year. Highlights of activities for the 2013 Calendar Year included the following:

- Zone 7 carried-over approximately 3,800 AF of local water in Lake Del Valle for use in 2013 and 200 AF for use in 2014.

- Zone 7 imported 40,800 AF of SWP water into the Valley (including 2,200 from BBID) and carried-over 18,000 AF of SWP for use in 2014. For the 2013 Calendar Year, SWP water available to Zone 7 was 35% of Zone 7's Table A Contract Amount plus Zone 7's 2012 SWP carried-over amount of 18,288 AF.

- Zone 7 released about 9,000 AF to the local arroyos for its artificial recharge program and to maintain a live-flowing stream on the Arroyo Valle to meet water rights permit conditions.

- Zone 7 used about 4,000 AF of its water stored at Semitropic, leaving total water storage in out-of-basin groundwater banks at about 107,200 AF (Semitropic at 82,000 AF and Cawelo at 25,200 AF).

3.2.4 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 recharge features, including:

- the groundwater basin;

- local arroyos (which are 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, natural flows, source water quality, and regulatory requirements. The historical artificial recharge for the Main Basin has averaged about 5,300 AF per year.

By artificially recharging more water than it has pumped, and by importing most of the water needed by the Valley's growing population, Zone 7 has managed the Main Basin's water levels above the historical lows.

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 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.

For the 2013 Calendar Year, Zone 7's Conjunctive Use Program included the following activities and highlights:

- Zone 7 released 9,000 AF of surface water for artificial recharge in 2013, of which about 8,400 AF actually recharged.

- Zone 7 allowed EBRPD to divert a total of 610 AF into Shadow Cliffs for maintaining the lake level and recharging the basin, integrating not only the imported surface supply with groundwater storage but also facilitating recreational opportunities.

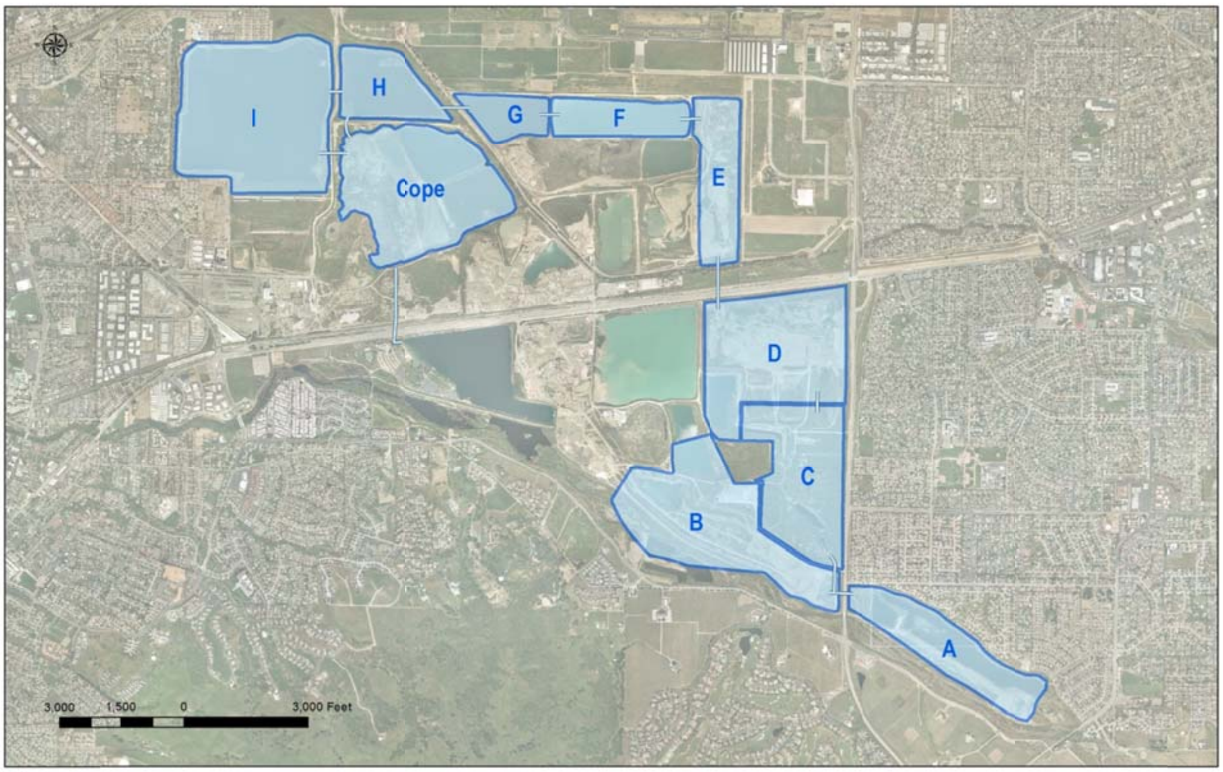
Looking into the future, Zone 7 is planning to increase its conjunctive use to keep up with growing demands. Acquisition of additional former quarries (Lakes A through H) will become the area's future "Chain of Lakes" allowing enhanced artificial recharge and regional flood protection projects to be fully implemented (see Section 3.2.5).

3.2.5 Chain of Lakes

This section describes Zone 7's Chain of Lakes Projects that contribute to Zone 7's ability to Program which monitors conditions and activities in the Chain of Lakes area because the gravel mining operations have an appreciable effect on groundwater levels, groundwater quality, and salt loading in the Main Basin. Many of the quarry pits have been dug deep into the Upper Aquifer, creating "windows" into the groundwater basin, and exposing groundwater to large evaporative losses. Groundwater is also pumped from some of the pits and discharged to others or to the arroyos to facilitate the gravel extraction in the active pits.

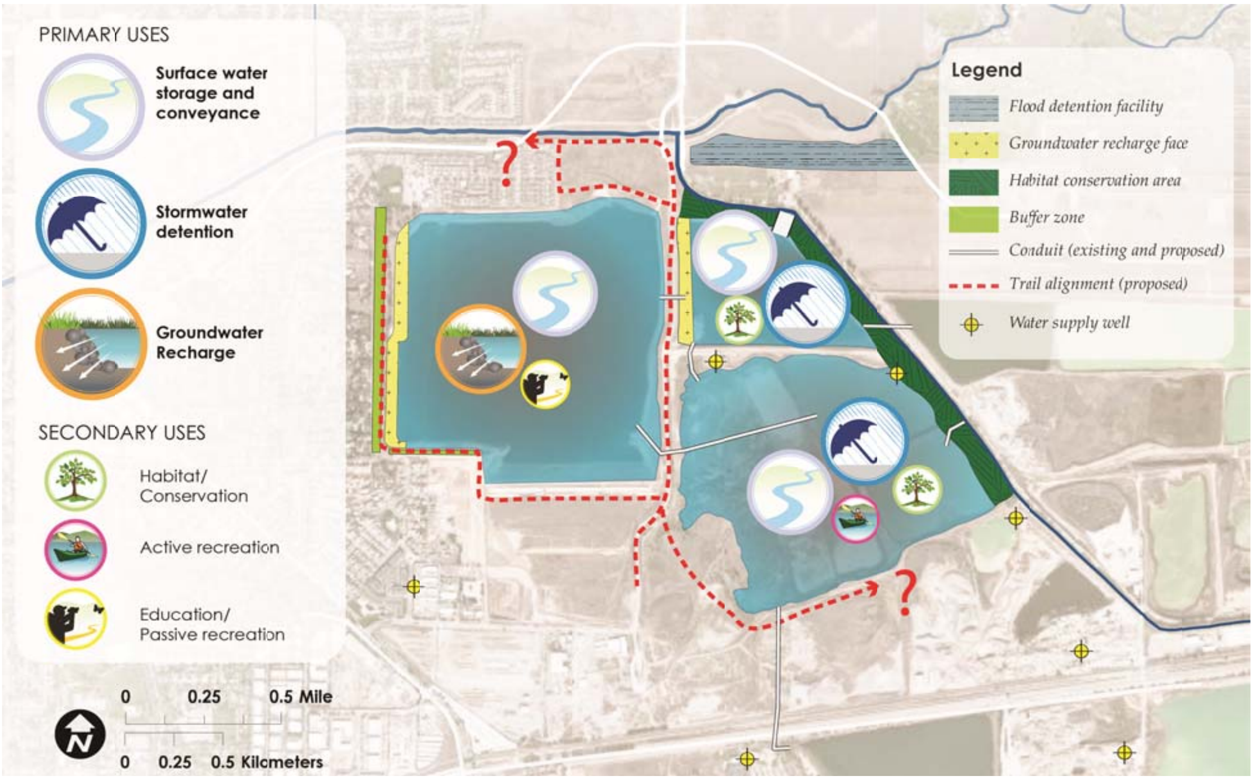
As mitigation for removal of aquifer material and interruption of groundwater movement resulting from the mining of aggregate resources and occasional placement of less permeable material in former pits between Livermore and Pleasanton, nine of the resulting quarry lakes, collectively called the Chain of Lakes (COL), have been or will be deeded to the Zone 7 Water Agency for water resources management purposes. These are the lakes with letter designations (Lakes A through I). In addition, Cope Lake was offered and later transferred to Zone 7 in an "as-is" condition.

Figure 3.2-A: Map of Future Chain of Lakes



In 2013, Zone 7 worked on conducting a Preliminary Lake Use Evaluation for the Chain of Lakes (Zone 7, 2014). This effort evaluated the suitability of each of the lakes in the future Chain of Lakes for seven potential uses. Three of the uses were designated as primary uses because they directly support Zone 7's mission of water supply and flood protection: surface water storage and conveyance, stormwater detention, and groundwater recharge. Four secondary uses were also identified: active recreation, passive recreation/education, habitat/conservation, and recycled water storage. All of the future lakes were included in the evaluation but an emphasis was put on Lakes H, I and Cope which are all currently or soon-to-be owned by Zone 7. These three lakes and their surrounding areas will also be included in the area covered by the City of Pleasanton's East Pleasanton Specific Plan which is currently under development.

Figure 3.2-B: Near-term recommendations for Lakes H, I, and Cope from Preliminary Lake Use Evaluation



Full implementation of the Chain of Lakes Preliminary Lake Use Evaluation is not expected before 2058 when the mining operations are projected to be complete. However, Zone 7 is working on several interim projects that are designed to convey, capture and recharge imported SWP water and mining discharge and/or detain peak stormwater flows.

In the 2013 Water Year (October 2012 through September 2013), Zone 7 staff collaborated with Vulcan Materials on a project to capture groundwater pumped as part of mining operations to minimize future groundwater discharges that would normally be lost as “basin outflow.” Vulcan produces varying quantities of groundwater, mostly from their quarry pit de-watering operations, and in the past had discharged a large portion of this pumped groundwater into the Arroyo Mocho (and eventually to the Bay) under an NPDES permit issued by the RWQCB. This groundwater capture project was jointly funded (Zone 7 and Vulcan) and extended Vulcan’s discharge pipeline past the Arroyo Mocho to Cope Lake. Once another pipeline project is completed the water can then be conveyed into Lake I where it will percolate through the sidewall and recharge the Amador Subbasin aquifers. It is estimated that, together, these projects have the potential to eliminate 2,000 AF to 5,000 AF of groundwater losses per year.

Another near-term recharge enhancement project is the Arroyo Mocho Diversion, which is anticipated to be in service by 2015. This project consists of a fish-friendly stream diversion facility on the Arroyo Mocho that will divert imported SWP water released to the Arroyo from the SBA into Lake H and then, in turn, convey the water into Lake I to further enhance Zone 7's artificial aquifer recharge capacity. Hanson Aggregates (Hanson) is responsible for the design, permitting and construction of the diversion facility per the existing agreement between Zone 7 and Hanson (formerly Kaiser Sand and Gravel), 1987, and the Livermore Amador Valley Quarry Reclamation (LAVQAR) Specific Plan, 1981. Zone 7 is assisting Hanson, as appropriate.

3.3 Sustainable Water Quality Management

3.3.1 Salt Management

3.3.1.1 Salt Management Plan

In 2004, Zone 7 prepared a Salt Management Plan (SMP) to address the increasing level of total salts in the Main Basin. Zone 7's SMP was designed to protect the long-term water quality of the Main Basin while expanding the area's use of recycled water. Recycled water is a critical part of the diverse water supply portfolio for the Livermore-Amador Valley. The SMP is a permit condition of the Master Water Recycling Permit, RWQCB Order No. 93-159, issued jointly to Zone 7, the City of Livermore, and Dublin San Ramon Services District. In May 2004, Zone 7, in cooperation with the other permittees, published the SMP to address the increasing level of salt in the Main Basin. The SMP was approved by the RWQCB in October 2004. The SMP was then incorporated into Zone 7's GWMP in 2005. The status of salt management has been updated in Zone 7's annual GWMP reports, copies of which are submitted to the RWQCB (to satisfy associated permit reporting requirements) and to DWR.

In February 2009, the State Water Board adopted a Recycled Water Policy (*State Water Board, Resolution No. 2009-0011*) which requires that Salt Nutrient Management Plans (SNMPs) be completed for all groundwater basins in California by May 2014. While this requirement does not apply to a basin where a plan has already been approved by the RWQCB, Zone 7 has been updating its SMP analysis (*Zone 7, 2004*) to verify the success of the SMP strategies in reducing salt loading to the groundwater basin and to evaluate future salt loading impacts of planned recycled water use increases over the Main Basin. Zone 7 is also moving forward to expand its SMP with an evaluation of nutrients.

3.3.1.2 Salt Management Strategy

The RWQCB has set the salt Basin Management Objective (BMO) at 500 mg/L for the Main Basin and 1,000 mg/L for the Fringe Basins (*California RWQCB, 2011*). The SMP identified potential salt management strategies so that the Main Basin BMO would be reached. The selected alternatives generally fall into three categories:

- Management of artificial recharge to take advantage of low TDS imported water when available;

- Pump and deliver more groundwater to customers so more salts are exported as wastewater; and

- Construct and operate groundwater demineralization facilities that remove salts from pumped groundwater and export salts as part of the waste by-products (concentrate/brine).

This plan led to the construction of Zone 7's first demineralization facility, the Mocho Groundwater Demineralization Plant (MGDP), which was completed in July 2009. The MGDP is designed to decrease or halt the build-up of salts in the groundwater basin while improving delivered drinking water quality.

Zone 7's Water Supply Operations Plan uses an adaptive management approach to select the combination of salt management strategies to be implemented in a given year. Multiple variables are balanced when making decisions, and priorities change from year to year; hence the need for a so-called adaptive or iterative management approach.

3.3.1.3 Salt Loading Calculation Method

Factors used to track salt loading include data and information collected from the various monitoring programs. The existing monitoring programs are designed to track salt loading from existing sources and for existing land use conditions. Future land use changes and any increased use of recycled water may require additional monitoring to track the resultant additional salt loading. The monitoring component of the SMP facilitates tracking any progress in salt removal.

Zone 7's salt loading calculations take into account the addition and removal of minerals in the Main Basin by tracking the salt mass associated with the recharge and discharge components of the hydrologic inventory (HI). In general, salts are added to or removed from the Main Basin by the following:

Figure 3.3-A: Components That Add or Remove Salts from the Main Basin

SALT ADDITION	SALT REMOVAL
• Natural stream recharge • Natural areal recharge • Artificial stream recharge • Subsurface groundwater inflow • Pipe leakage • Applied water (irrigation) recharge	• Municipal pumping, including brine export from the MGDP • Agricultural pumping • Mining area discharges and wet gravel export • Groundwater basin outflow

Some of the salt removed from the Main Basin by municipal groundwater pumping is:

- exported from the Valley as wastewater,
- exported as brine from the MGDP; or
- reapplied to Livermore Valley soils as irrigation water (calculated as applied water recharge).

Evaporation of groundwater in the mining area ponds and evapotranspiration have the effect of concentrating salts in the Main Basin as water is removed but the associated salts are left behind. In contrast, rainfall recharge dilutes the Main Basin salt concentrations as it adds essentially salt-free water to the system. Artificial recharge with SWP water dilutes the Main Basin salt concentrations while adding some salt to the system, depending on the salinity of the water imported (often varying seasonally or by hydrologic year type, with higher salt levels in the Fall and during dry years).

It is important to recognize that these salt loading calculations for the Main Basin are based on salt loading at the ground surface and expressed as a calculated basin-wide cumulative change in salt concentration. For the salt loading calculations, salt concentrations are represented by the average TDS concentrations of each inflow and outflow component of the hydrologic inventory (HI).

3.3.1.4 2013 Water Year Salt Loading

Hydrologic conditions and water operations in the 2013 Water Year (October 2012 through September 2013) resulted in a net calculated decrease of approximately 3,500 tons of salt from the Main Basin, after accounting for the 2,479 tons of salt removed by Zone 7's demineralization plant (Section 3.3.1.5). By comparison, 6,800 tons were removed in the 2012 Water Year (October 2011 through September 2012). The weighted average TDS concentration of all the waters recharging the Main Basin's aquifers in the 2013 Water Year was 504 mg/L, whereas the average TDS of the extracted groundwater was 464 mg/L. The inflow/outflow water and salt loading calculations for the 2013 Water Year are summarized on *Figure 3.3-1*.

Assuming that at the beginning of the 1974 Water Year (October 1973 through September 1974) there was a basin storage volume of 212,000 acre-feet and a TDS concentration of 450 mg/L (*DWR*, *1974*), the resulting TDS concentration at the end of the 2013 Water Year (October 2012 through September 2013) was approximately 740 mg/L. Historical salt loading results from Water Years 1974 through 2013 are shown on *Figure 3.3-2*. *Figure 3.3-3* shows several graphs depicting the salt loading and its effect on the basin over time.

Before Zone 7's demineralization plant was constructed in 2009, approximately 84,275 tons of salt had been added to the Main Basin since 1974. This is equivalent to an average increase of about 2,400 tons of salt per year and a total theoretical TDS increase of about 260 mg/L since the 1974 Water Year (October 1973 through September 1974). Since the 2009 Water Year (October

2008 through September 2009), there has been a net reduction in Main Basin salts by approximately 13,378 tons of salt. However, during this same period, the average basin-wide theoretical TDS increased by about 30 mg/L, due to several years of dry hydrologic conditions (especially in Water Years 2009, 2012, and 2013). The net reduction of water in storage during these water years causes average theoretical TDS to increase even though the total salt mass decreases (*Figure 3.3-3*, Graph 2 and Graph 3 – especially in the Amador Subbasin).

3.3.1.5 Groundwater Demineralization

Zone 7's Mocho Groundwater Demineralization Plant (MGDP) went online in July 2009 to reduce salt build-up in the groundwater basin while improving delivered water quality to meet targets established in Zone 7's Water Quality Policy. The MGDP is a reverse osmosis (RO) membrane-based treatment system producing product water with extremely low TDS. The demineralized water is blended with other groundwater (non-demineralized) or system water to achieve the desired overall delivered water TDS and hardness. The brine concentrate from the RO process is exported out of the watershed to San Francisco Bay by way of DSRSD's connection to the regional wastewater export pipeline operated by LAVWMA. Additional salt removal facilities may be required to keep pace with the additional salt loading projected for the basin as the overlying communities approach build-out and the use of recycled water increases. Since its construction the demineralization plant has removed 13,255 tons of salt from the Valley (see Figure 3.3-B below).

Figure 3.3-B: Salts Removed by Zone 7's Groundwater Demineralization Plant Operations

Water Year	Brine Volume Exported from Valley (AF)	Average Brine TDS Concentration (mg/L)	Salt Mass Exported (Tons)	Salt Removed per 1000 AF of Export (Tons)
2009	192	3,059	798	4,156
2010	675	3,010	2,760	4,089
2011	674	3,445	3,154	4,680
2012	935	3,198	4,064	4,340
2013	518	3,522	2,479	4,780
TOTAL	**2994**	**3,255**	**13,255**	**4,427**

Note: Water Years are tracked October of the previous year through September of the water year.

During the 2013 Water Year (October 2012 through September 2013), 2,539 AF of groundwater pumped from the Mocho Wellfield were routed through the demineralization plant's reverse osmosis (RO) membranes. As a result, 1,928 AF of very low-to-no-salt permeate was blended with system or other groundwater and fed into Zone 7's distribution system for delivery to Zone 7's customers. The RO process also generated approximately 518 AF of wastewater consisting of the water and the salts rejected by the membranes during the 2013 Water Year (October 2012 through September 2013). This concentrate, or brine, contained about 2,479 tons of salt and was exported from the Main Basin. The discharge volumes and salt concentrations of the exported brine are monitored by DSRSD and reported to Zone 7 staff periodically throughout the year.

3.3.2 Nutrient Management

3.3.2.1 Nutrient Management Strategy

In 1982, Zone 7 prepared a Wastewater Management Plan (*Zone 7, 1982*) that provided wastewater management policies for septic tanks in the Valley. Zone 7 also samples and tests groundwater annually for nutrients as part of its groundwater quality program. The primary nutrient of concern in the Main Basin is nitrate (Section 2.4.3), which has a BMO of 45 mg/L (measured as Nitrate [as NO_3]) for both the Main and Fringe Basins (*California RWQCB, 2011*). This is the Maximum Contaminant Level (MCL) for nitrate in drinking water.

Zone 7's current nutrient management policies for nitrate-generating activities (e.g., horse boarding facilities, vineyards, turf application and septic fields) include encouraging best management practices throughout the Valley to minimize the nutrient loading to the groundwater basin. Zone 7 has also been working with the Regional Water Quality Control Board to additionally manage nitrate loading in areas overlying existing nitrate hotspots. In the 2014 Water Year (October 2013 through September 2014) Zone 7 plans to review, and update, these nutrient management policies consistent with the State Board's new Recycled Water Policy (Section 2.6.2.3).

3.3.2.2 Current Nitrate Concentration

As part of the SMP update, Zone 7 calculated the current nitrate concentration (measured as NO_3) in each subbasin, aquifer, and the Main Basin (*Figure 2.4-F* and *Figure 2.4-G*). In the upper aquifer the total average nitrate concentration is 16 mg/L, with all subbasins between 9 and 27 mg/L. The average nitrate concentration in the lower aquifer is 13 mg/L, with all subbasins between 11 and 24 mg/L. The overall concentration for the Main Basin is 15 mg/L. All concentrations are well below the BMO (45 mg/L), however there are certain hotspots where the nitrate concentration does exceed the BMO (shown in *Figure 2.4-15* and described in detail in Section 2.4.3).

3.3.2.3 Nitrate Loading

Total nitrate loading will be calculated as part of the forthcoming nutrient evaluation as part of the update of the Salt Management Plan. Total nitrate loading is difficult to measure because nitrate converts back and forth between other nitrogen compounds (e.g., nitrite, total Kjeldahl nitrogen) in the unsaturated soil zone. Therefore, Zone 7 uses nitrogen as the metric for determining net nitrate loading in the Main Basin. The sources and losses of nitrogen in the Main Basin are shown in *Figure 3.3-C* below.

Figure 3.3-C: Sources and Losses of Nitrogen in Groundwater

NITROGEN SOURCES	NITROGEN LOSSES
Manure (Horse Boarding, Cattle)	Denitrification
Wastewater (Winery)	Soil texture (absorption)
Septic (Domestic and Commercial)	Plant Use
Irrigation (Turf and Agriculture)	Groundwater Pumping
Fertilizers	Mining Export
Nitrate in Source Water	

Preliminary nutrient loading calculations indicate that there is a net nitrogen loss from the Main Basin at about 28,000 pounds per year. These calculations will be finalized and included in the forthcoming Nutrient Management Plan.

3.3.3 Groundwater Resource Protection Programs

This section describes two Zone 7 programs that protect the groundwater basin.

- The Well Ordinance Program is designed to ensure that all wells in Eastern Alameda County are properly constructed and then sealed when they are no longer in use.
- Zone 7 uses the Toxic Site Surveillance Program to document and track progress on contamination assessments and clean-ups at sites across the groundwater basin that pose a potential threat to groundwater quality. Information on these cases is gathered from state, county, and local agencies, as well as from Zone 7's well permitting program.

3.3.3.1 Well Ordinance Program

The construction, repair, reconstruction, destruction or abandonment of wells within Zone 7's service area (Eastern Alameda County) is currently regulated by Alameda County General Ordinance Code, Chapter 6.88. Zone 7 administers the associated well permit program within its service area including within the three incorporated cities: Dublin, Livermore, and Pleasanton. As a result, any planned new well construction, soil-boring construction, or well destruction must be permitted by Zone 7 before the work is started. Additionally, all unused or abandoned wells must be properly destroyed; or, if there are plans to use the well in the future, a signed statement of future intent must be filed at Zone 7.

Zone 7 is in the process of drafting its own "Well Ordinance" to regulate the construction, repair, reconstruction, destruction or abandonment of wells within the Zone 7 service area. Once completed, and reviewed by the affected public agencies, the new Zone 7 ordinance will be presented to the Zone 7 Board of Directors and to the local city councils along with requests for rescission of their previous well ordinances, and for the adoption of the new ordinance. These actions are anticipated to take place in 2014.

Zone 7 issued 158 drilling permits in the 2013 Calendar Year. The following is a list of the quantity and types of permits issued:

- 67 for drilling associated with geotechnical investigations;
- 45 for drilling associated with contamination investigations, monitoring and clean-ups;
- 20 for the destruction of existing wells;
- 19 for new water supply wells;
- 5 for general groundwater monitoring; and
- 2 for cathodic protection wells.

In the 2013 Calendar Year, about 40% of the permitted well work was physically inspected by Zone 7 permit compliance staff. The others were allowed to proceed with self-monitoring and reporting efforts.

A copy of the current Zone 7 drilling permit application is available for download from the Zone 7 web- site. Zone 7 should receive permit applications at least five days prior to beginning any drilling. Well construction and destruction permit requirements are determined on a case-by-case basis, but generally follow DWR’s California Well Standards (Bulletins 74-81 and 74-90). This program allows Zone 7 to protect the groundwater basin from any negative impacts that would be threatened by poorly-constructed wells. There is currently no fee charged for a Zone 7 permit.

3.3.3.2 Toxic Site Surveillance Program

Each site in Zone 7’s Toxic Site Surveillance Program has been assigned a Zone 7 number, which corresponds to a file number containing reports or other information about the site. In addition, all sites are reviewed and given a priority designation (high, moderate, or low) based on criteria used by the RWQCB and ACEH that have been modified to meet Zone 7 standards. For example, a site is designated as high priority if contamination at the site is in groundwater at concentrations greater than the MCL and a water supply well is within 2,000 ft down-gradient of the site, or it is shown that drinking water or surface water will likely be impacted by the contamination at the site.

In general, the Toxic Site Surveillance Program has found two types of contamination threatening groundwater in the Livermore Valley Groundwater Basin:

- **Petroleum-based fuel products -** including total petroleum hydrocarbon as gasoline (TPHg), TPH as diesel (TPHd), benzene, toluene, ethylbenzene, xylene (collectively known as BTEX), and fuel oxygenates, such as methyl tertiary-butyl ether (MTBE) and tertiary-butyl alcohol (TBA). California has assigned clean-up standards (Title 22, California Code of Regulations) for the BTEX compounds and fuel oxygenates. However, a clean-up standard for total petroleum (TPHg or TPHd) has not officially been established.

- **Industrial chemical contaminants –** including the chlorinated solvents tetrachlorethylene (PCE), trichloroethylene (TCE), and their degradation by-products, such as vinyl chloride (VC) and dichloroethene (DCE). PCE is common in the dry cleaning business, and TCE is commonly used as a degreaser for electronics and automotive industries. Both PCE and TCE have an established maximum contaminant level (MCL,) of 5 micrograms per liter (μg/L) (*EPA National Primary Drinking Water Regulations*).

In 2013, Zone 7 tracked the progress of 58 active sites where groundwater contamination has been detected or contamination is threatening groundwater. Two sites were added to Zone 7's database in 2013. Seven contamination cases were closed during 2013, after they were determined to no longer pose a threat to drinking water. Most were closed after they were shown to meet the criteria for closure under one of the four scenarios outlined in the Low-Threat UST Case Closure Policy. An additional twelve cases have requested closure and are being reviewed by the lead agencies at the time of this report.

Maps have been generated that show the site locations, their priority, and their proximity to municipal supply wells for each main area of the groundwater basin: Livermore (*Figure 3.3-4*), Pleasanton-Sunol (*Figure 3.3-5*), and Dublin (*Figure 3.3-6*).

As summarized in the latest program report (*Zone 7, 2014*), presented to the Zone 7 Board in May 2014, 14 of the sites are designated as high priority: nine in Livermore, four in Pleasanton, and one in Sunol. Although several sites in Dublin have elevated levels of MTBE (i.e., >10,000 parts per billion [ppb]) and one has elevated levels of TCE, most are classified as moderate priority because they are not near drinking water supply wells and are outside the Main Basin.

Ten of the 14 high priority sites are fuel leak cases and the other four are the result of industrial solvent contamination. All of the ten fuel leak cases are being overseen by ACEH. Four cases have on-going active remediation, three cases are conducting post-remediation monitoring, two cases have closure requests pending, and one case is finalizing a remediation workplan. A domestic well in Sunol was impacted by one of these fuel leak sites and currently has a wellhead treatment system in operation.

Of the four high priority industrial solvent cases, two are being overseen by the RWQCB while the other two are not included in any of the Local Oversight Programs (LOP). Both of the RWQCB cases involve contamination from dry cleaner facilities; one in Pleasanton and one in Livermore. The Pleasanton site has implemented active remediation and is developing a closure plan with the RWQCB. The Livermore site has attempted remediation in the past but with limited success; low-level PCE contamination has now reached two municipal supply wells located down-gradient of the Livermore dry cleaner site. The water purveyor is currently using granulated-activated carbon (GAC) filters to ensure against any customer health impacts. The lateral and vertical extent of contamination has been determined and a remedial alternative pilot test was conducted in 2013. The responsible party (RP) has submitted a Revised Remedial Action Plan to the RWQCB for review.

The other two industrial solvent cases which are of concern to Zone 7, but are not currently included in any of the LOP cases, also involve PCE contamination: one in Pleasanton and one in Livermore. The contamination in Pleasanton has impacted a public supply well, which has required the well owner to utilize GAC to remove the contamination prior to public consumption. Zone 7 is in the process of investigating a potential source for this site in order for the RWQCB to consider taking it on as a formal case in the RWQCB's oversight program. For the site in Livermore, a potential Responsible Party has been identified, but the extent of contamination has not been determined. Zone 7 is working with the RWQCB to expedite opening this site as a formal case in the RWQCB's oversight program and begin directing its further investigation.

The full Toxic Site Surveillance Program 2013 Annual Report can be downloaded and viewed at http://www.zone7water.com/publications-reports/reports-planning-documents/175-toxic-sites-surveillace-annual-reports .

3.4 Groundwater Model

3.4.1 Description

Zone 7 maintains a numerical groundwater model of the basin for predicting the consequences of a proposed groundwater basin management action. 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 Water Year (*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).

Thus far, the groundwater model has been used to evaluate and simulate salt loading and mitigation options for the SMP, water supply well siting and planning for Zone 7's WMP; and demineralization plant siting for Zone 7's additional groundwater demineralization planning. Zone 7 last used the groundwater model in 2009 and 2010 to support long-term planning for Zone 7's Water Supply Evaluation in an effort to identify the maximum groundwater Zone 7 could pump using existing wells during a six year drought without going below historical lows.

3.4.2 Groundwater Model Improvements

On December 30, 2013, Zone 7 was awarded a grant (DWR Local Groundwater Assistance Program, funded by Proposition 84, for $200,000) to update the groundwater model so that it can better evaluate future groundwater management and salt mitigation strategies. The 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.

The Hydrologic Inventory (HI) of the Main Basin necessitates calculating various inflows and outflows for the groundwater basin and watershed. This "mass balance" approach considers both surface water and groundwater, as well as their interrelationships. In terms of future improvements to the associated modeling, staff plans that the updated groundwater model will be capable of incorporating data from Zone 7's watershed modeling software.

3.5 Capital Projects

3.5.1 Well Master Plan

Zone 7's Well Master Plan, adopted by the Zone 7 Board in 2005, identified the need for seven to nine new municipal water supply wells over the next 30 years to maintain Zone 7's potable water reliability goal based on Zone 7's then-current reliability goal of maintaining 100% reliability "even during worse-case drought conditions." Additional benefits of these new wells would include providing Zone 7 with the operational flexibility to be better able to pump back its stored water resources, optimizing groundwater production while maintaining groundwater levels above localized historic lows, and removing dissolved salts from more of the groundwater basin. A new reliability policy was adopted by the Zone 7 Board in November 2012 which may change the quantity and urgency of new supply wells needed by Zone 7 as new development continues in the Valley.

The first two wells (COL 1 and 2) were completed in 2008, and the next well (COL 5) is currently planned for completion in 2014. Another well (BV 1) is being planned for a site near Boulder Street and Valley Avenue in Pleasanton. With the adoption of new reliability goals, implementation of additional water conservation measures, and the Retailer's expansion of recycled water use; the need for new supply wells and the timing of their construction will be confirmed during future water supply planning efforts.

3.5.2 Groundwater Demineralization Plant

Zone 7 completed its Mocho Groundwater Demineralization Plant (MGDP) in December 2009 to reduce salt build-up in the groundwater basin and to improve delivered water quality. The MGDP was operated for a fourth year in Calendar Year 2013, although not continuously nor at full capacity during that time. Nonetheless, it was directly responsible for removing 2,479 tons of salt from the groundwater basin during the 2013 Water Year (October 2012 through September 2013).

Tentatively, Zone 7 plans to construct a second groundwater demineralization plant in about 2030. One issue of concern that could impede progress of these plans is that in order to extract more groundwater from the basin, there would need to be a way to replenish the groundwater at about the same rate in order to keep the groundwater supply sustainable. Although there are plans to increase the artificial recharge capacity of Zone 7's system, the actual water supply for the program and the actual percolation rate (and rate of plugging) for the Chain of Lakes has not been firmly established nor has the timing of transfer of the remaining lakes to Zone 7. These unknowns should be resolved in the coming years, well in advance of planning future demineralization facilities. Zone 7 staff is working on these sustainability issues during its Salt Management Plan Update and ongoing water supply evaluation and Chain of Lakes recharge planning efforts.

3.5.3 Monitoring Wells

No new monitoring wells were installed during the 2013 Water Year (October 2012 through September 2013). Three wells at the Mocho Wellfield (two old supply wells and one test well), that were no longer being used, were identified for destruction in order to eliminate the wells as potential vertical conduits for lower water quality to move into the lower aquifers. Two of the well destructions (3S/1E 8H 4 and 3S/1E 8H14) were completed in 2012 and the third well (3S/1E 8H 3) was destroyed in 2013 by Zone 7's contractor.