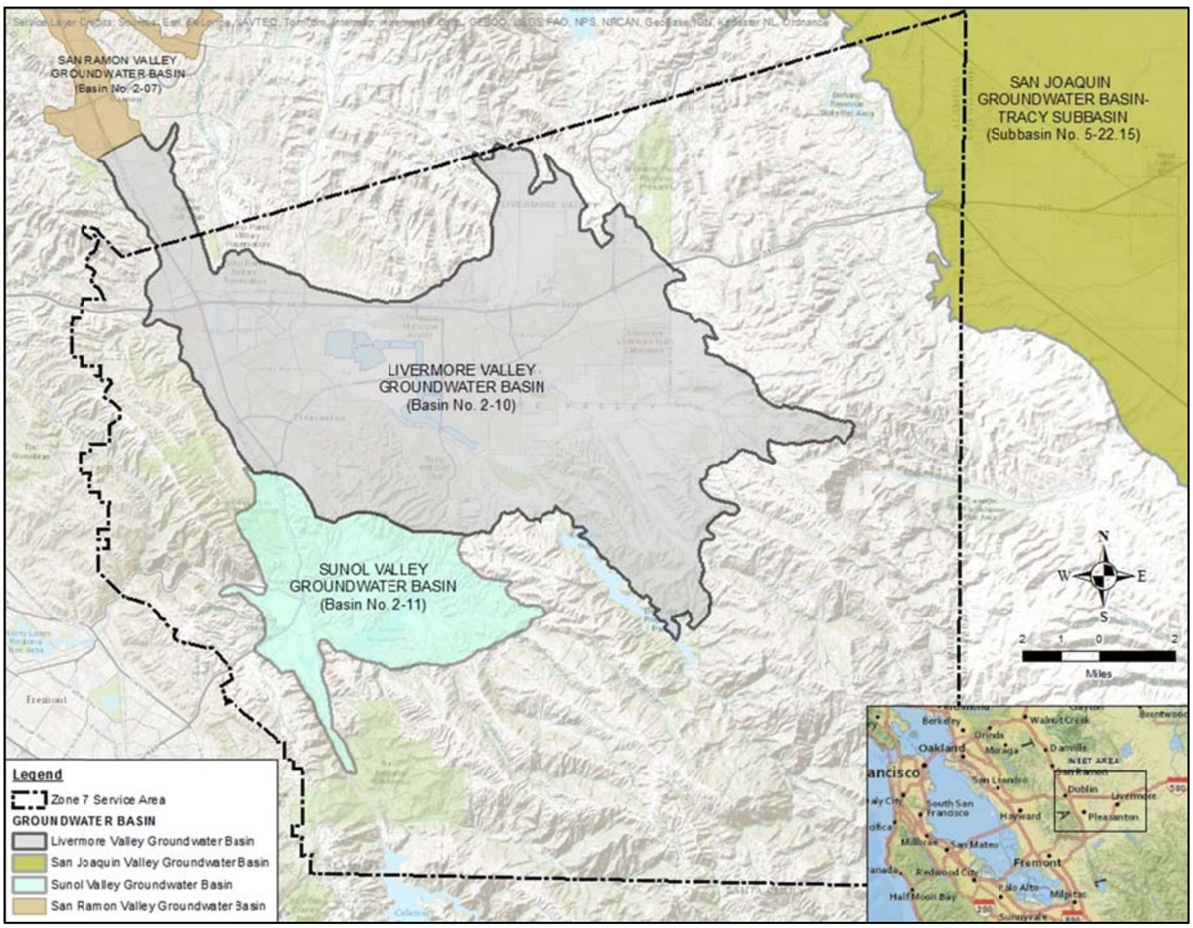
1 Background

1.1 Introduction

This report is the Annual Report for the Groundwater Management Program, 2016 Water Year, October 1, 2015 through September 30, 2016), primarily for the Livermore Valley Groundwater Basin (Basin 2-10, see *Figure 1-A* below). In addition to providing the results of the 2016 hydrology and groundwater management activities, this report serves as the most recent update for the Groundwater Management Plan (GWMP) for the Livermore Valley Groundwater Basin (*Zone 7, 2005a*).

Figure 1-A: Map of Groundwater Basins within Zone 7 Service Area



While Zone 7 officially adopted a GWMP for the Livermore Valley Groundwater Basin in 2005 (*Zone 7, 2005a*), it has been sustainably managing the basin for over 50 years. In response to the State of California's Sustainable Groundwater Management Act (SGMA, 2014, see

Section 11.3.2), Zone 7 prepared and submitted an Alternative Groundwater Sustainability Plan (Alternative GSP, *Zone 7, 2016c*) that is essentially Zone 7's GWMP, updated and re-formatted to address SGMA and GSP regulation requirements. Zone 7 will continue to report to the California Department of Water Resources (DWR) and the Regional Water Quality Control Board (RWQCB) annually but in compliance with the GSP Regulations and the Alternative GSP starting next year.

For this Annual Report, the results for each of the water resource monitoring, evaluation, and management programs are summarized in the Executive Summary, while the details are provided in the main report sections. In an effort to avoid duplication, material included in the Alternative GSP has not been repeated here.

Results for each of the monitoring, evaluation, and management programs are summarized in this Executive Summary, while the details are provided in the sections that follow:

INTRODUCTION:
- Section 1: Background

WATER BUDGET AND WATER QUALITY MONITORING PROGRAMS:
- Section 2: Precipitation and Evaporation
- Section 3: Surface Water Contributions and Losses
- Section 4: Chain of Lakes and Quarry Operations Impacts
- Section 5: Groundwater Elevations
- Section 6: Groundwater Quality/Inorganics
- Section 7: Land Surface Elevation
- Section 8: Wastewater and Recycled Water
- Section 9: Land Use
- Section 10: Water Budget

GROUNDWATER SUSTAINABILITY AND MANAGEMENT PROGRAMS:
- Section 11: Groundwater Supply Sustainability
- Section 12 Water Quality Sustainability

All of the data included in this report are conveyed based on the Water Year (WY) (i.e., October 1, 2015 through September 30, 2016); however, due to other reporting obligations, some information in Section 11 regarding retailer pumping is also compiled and reported on a Calendar Year (CY) basis (i.e., January 1 through December 31, 2016). Again, because the Alternative GSP wasn't filed until after the 2016 WY ended, this report is the last annual report that will be based on Zone 7's 2005 Groundwater Management Plan.

1.2 Groundwater Management Plan

Zone 7's GWMP (*Zone 7, 2005a*) is compliant with the Groundwater Management Planning Act and Senate Bill 1938. Annual GWMP reports, serve as updates to the 2005 GWMP. *Table 1-B* shows Groundwater Management Planning Act requirements, where each was addressed in the original 2005 GWMP, and where the updated information, if any, can be located in the Annual Report for the 2016 WY.

Table 1-B: Groundwater Management Planning Act Requirements

Water Code Reference	California Code of Regulations (GSP)	Requirement	Location in 2005 GMP	Location of update in this 2016 Water Year Annual Report
§10753.7(a)(3)	§354.8(a)(1)	Description of groundwater area to be managed/Plan Area		
	§354.8(a)(1)	Map	*Figures 1-1* and *2-1*	*Figure ES-1*, *Figure 1-A*, and *Figure 1-C*
	§354.8(b)	Description	Overview located in Chapter 1; also see Section 3.1.1.	Section 1.4
§10753.7(a)(1)	§354.10	Basin Management Objectives	Included in Section 1.4	Section 1.3
§10753.7(a)(2)		Plan to involve other agencies and the public	Included in Section 4.3	No update
§10753.7(a)(4)	§354.32-§354.40	Monitoring protocols	Sections 3.2, 3.3, and 4.5	Sections 2 through 9
§10753.8		Plan components		
	§354.16(c)	Control of saline water intrusion	Sections 4.6.5 and 5.1.2	Section 12.1
		Identification and management of wellhead protection areas and recharge areas	Sections 3.3, 5.1.4.2, and 5.1.4.4	Sections 10.2.3, 12.4, and 12.5
		Regulation of the migration of contaminated groundwater	Sections 3.5 and 5.1.4.5	Sections 6 and 12.5
		Administration of a well abandonment and well destruction program	Section 5.1.4.2	Section 12.4

Water Code Reference	California Code of Regulations (GSP)	Requirement	Location in 2005 GMP	Location of update in this 2016 Water Year Annual Report
	§354.18(b)(5)	Mitigation of conditions of overdraft	Sections 3.2, 3.3, 4.6.2, and 4.6.3	Sections 5 and 10.2
		Replenishment of groundwater extracted by water producers	Sections 3.3, 4.5.7, 4.6.2, and 4.6.3	Sections 10.2 and 11.4.3.3
	§354.18	Monitoring of groundwater levels and storage	Section 4.5.2	Sections 5 and 10
	§354.8(e)	Facilitating conjunctive use operations	Section 5.1.3	Section 11.4.3.2
		Identification of well construction policies	Section 5.1.4.2	Section 12.4
		Construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling and extraction projects	Section 5.1.4	Sections 8 and 12
		Development of relationships with state and federal regulatory agencies	Section 4.4	No update
	§354.8(f)	Review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination	Section 4.5	Section 9
§10753.2		Details of Public Hearing(s) and Plan Adoption	Section 5.3	No update

The Sustainable Groundwater Management Act (SGMA) was enacted in 2014. It created a framework for sustainable local groundwater management and requires that each high– and medium-priority basin be managed by one or more Groundwater Sustainability Agencies. SGMA designates Zone 7 as the exclusive Groundwater Sustainability Agency (GSA) for the groundwater basins (or portions of) located within the Zone 7 Service Area (*Figure 1-A*). In

January 2017, Zone 7 submitted its Decision to Become the Exclusive Groundwater Sustainability Agency for the Livermore Valley Groundwater Basin *(DWR Basin 2-10)* (*Zone 7, 2017*) to DWR. The Sunol Groundwater Basin is a low-priority basin so it does not currently require a GSA. The Tracy Subbasin has only a small portion in Alameda County so others have expressed an intent to form GSAs for more comprehensive management.

1.3 Groundwater Management Objectives

To meet the sustainable management goals, Zone 7 has developed and/or adopted a series of policies, ordinances, and basin management objectives that have expanded over time to adapt management actions to groundwater conditions. The primary objectives of the Zone 7 groundwater management program are to provide for:

- control and conservation of waters for beneficial future uses,
- conjunctive use of groundwater and surface water,
- importation of additional surface water for salt balance and to achieve sustainable groundwater management, and
- use of the groundwater basin to store imported surface water for subsequent recovery during drought periods.

In Zone 7's 2005 GWMP, a series of basin management objectives (BMOs) were identified as the guiding principles for basin management decisions. Those objectives addressed five SGMA sustainability indicators by creating programs to manage groundwater resources for the prevention of significant and unreasonable (1) lowering of groundwater levels, (2) reduction in basin storage, (3) degradation of groundwater quality, (4) inelastic land subsidence, or (5) depletion of surface water supplies such that beneficial uses are adversely impacted.

Because seawater intrusion is not a relevant issue for this inland basin, no objective or sustainability indicator is needed. These primary BMOs implemented by Zone 7 in the GWMP are repeated below, along with the SGMA sustainability indicator that relates to each of the BMOs:

- <u>Monitoring and maintenance of groundwater levels</u> through conjunctive use and management of regional water supplies (equivalent to the Sustainability Indicators for lowering of groundwater levels and depletion of storage):
  - maintain the balance between the combination of natural and artificial recharge and withdrawal,
  - maintain water levels high enough to provide emergency reserves adequate for worst credible drought and unplanned import outages,
  - store surface water supplies in the groundwater basin for use during emergencies and drought-related shortages,

- allow for gravel mining by optimizing groundwater levels while maintaining adequate reserves for municipal supply, and
- prevent overdraft that would otherwise occur from too much pumping (maintain total pumping at or below sustainable/safe yields);

- Groundwater quality monitoring and management, including tracking and addressing any water quality degradation (equivalent to the Sustainability Indicator for groundwater quality degradation):
  - protect and enhance the quality of the groundwater,
  - halt degradation from salt buildup (offset current and future salt loading),
  - reduce flow of poor quality shallow groundwater into deep aquifers,
  - offset impacts of water recycling and wastewater disposal through integrated SMP,
  - recharge with relatively low total dissolved solids (TDS)/hardness imported or storm/local surface water,
  - manage quality on a regional basis as measured at municipal wells (such as those operated by both the retail water agencies and Zone 7), protecting and improving groundwater quality within the Main Basin, and
  - minimize threats of groundwater pollution through groundwater protection;

- Monitor and prevent inelastic land surface subsidence from occurring as a result of groundwater withdrawals (equivalent to the Sustainability Indicator for prevention of inelastic land subsidence):
  - protect the storage capacity of aquifer,
  - maintain water levels above historic lows,
  - monitor and minimize any identified impacts of gravel mining on the Upper Aquifer by encouraging the implementation of mitigation measures by mining companies, and
  - monitor benchmark elevations and shift pumping to other wells if inelastic subsidence is detected;

- Monitor and manage changes in surface flow and surface quality, especially as they affect groundwater levels or quality, or are caused by groundwater pumping in the basin (equivalent to the Sustainability Indicator for prevention of depletion of surface water):
  - augment stream flow through artificial recharge releases to improve groundwater supply and quality, and
  - monitor and protect recharge capacity of local arroyos.

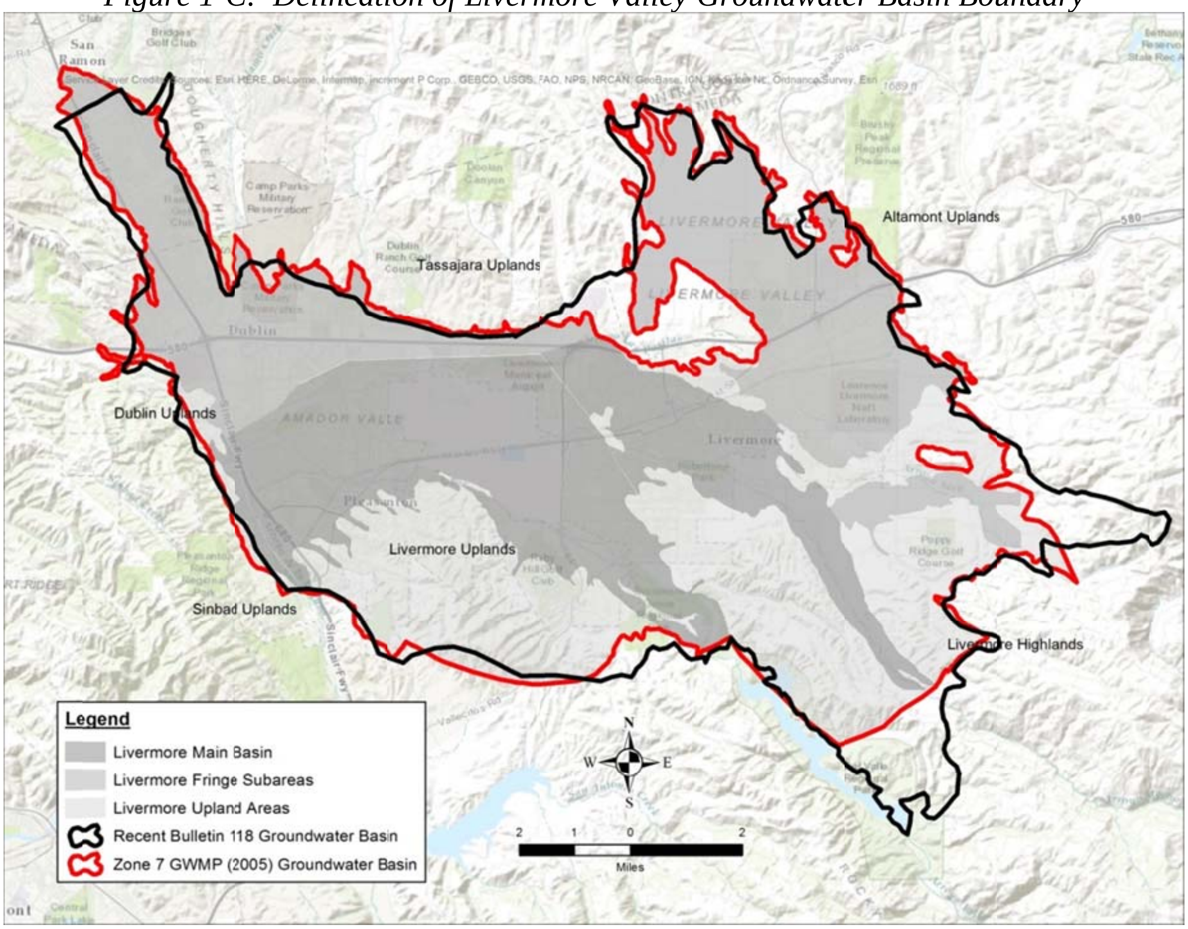
1.4 Description of Plan Area

1.4.1 Introduction

This section provides a brief summary of the Plan Area, in particular the hydrogeologic setting of the Livermore Valley Groundwater Basin. A more detailed description can be found in Zone 7's Groundwater Management Plan (*Zone 7, 2005a*) and the Alternative GSP (*Zone 7, 2016c*).

To be consistent with the State's "official" groundwater basin boundaries, Zone 7 used the updated (2016) DWR Bulletin 118 boundary for the Livermore Valley Groundwater Basin in its Alternative GSP and this annual report. This boundary differs slightly from the basin boundary used in the original GWMP and earlier annual reports. The recent DWR Bulletin 118 boundary for the Livermore Valley Groundwater Basin is shown in black on *Figure 1-C* below while the boundary used by Zone 7 in the former reports and plans is shown in red. This change has no material effect on Zone 7's management of the groundwater basin.

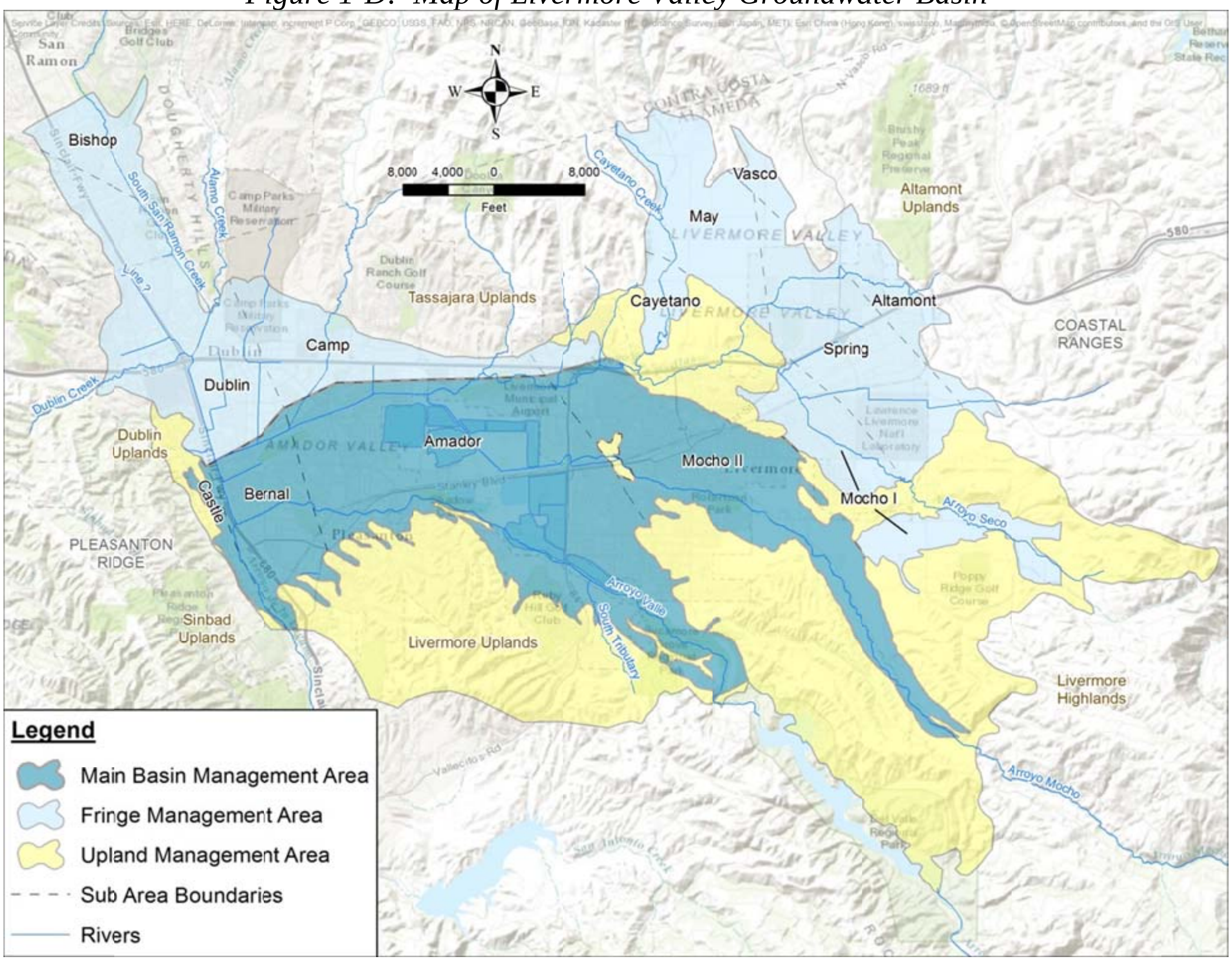
Figure 1-C: Delineation of Livermore Valley Groundwater Basin Boundary



1.4.2 Basin/Hydrogeologic Setting

The Livermore Valley Groundwater Basin is an inland alluvial basin underlying the east-west trending Livermore-Amador Valley (Valley) in northeastern Alameda County. The Valley covers about 42,000 acres, extends approximately 14 miles in an east-west direction, and varies from three to six miles in width. It is surrounded primarily by north-south trending faults and the hills of the Diablo Range. The Livermore Valley Groundwater Basin is located in the heart of the Valley and extends south into the uplands south of Pleasanton and Livermore. The Main Basin (see *Figure 1-D* below) is a portion of the Livermore Valley Groundwater Basin that contains the highest yielding aquifers and generally the best quality groundwater. Groundwater flow is generally from the southeast and east to the west, towards the municipal wellfields in the West Amador and Bernal Subareas.

Figure 1-D: Map of Livermore Valley Groundwater Basin



1.4.3 Geology

The Valley and portions of the surrounding uplands overlie groundwater-bearing materials. These materials consist of deposits from alluvial fans, streams, and lakes (of Pleistocene-Holocene age; less than about 1.6 million years old) that range in thickness from a few feet along the margins to nearly 800 feet (ft) in the west-central portion. The alluvium consists of unconsolidated gravel, sand, silt, and clay. The southeastern region of the Valley is the most important groundwater recharge area and consists mainly of sand and gravel that was deposited by the ancestral and present Arroyo Valle and Arroyo Mocho.

The Livermore Formation (Pleistocene age; 11,000 to 1.6 million years old), found below the majority of the alluvium in the groundwater basin, consists of beds of clayey gravels and sands, silts, and clays that are unconsolidated to semi-consolidated. However, the contact between the overlying alluvium and the Livermore Formation is nearly impossible to discern from drill cuttings and electrical logs. This formation is estimated to be 4,000 ft thick in the southern and western portion of the basin and yields low quantities of groundwater in the upland areas.

The Tassajara and Green Valley Formations, located in the Tassajara Uplands north of the Valley, are roughly Pliocene in age (1.6 to 5.3 million years old). They basically consist of sandstone, tuffaceous sandstone/siltstone, conglomerate, shale, and limestone. Faults and angular unconformities or stratigraphic disconformities along the formation-alluvium contacts inhibit groundwater movement from these formations to the alluvium of the fringe and Main Basins.

Other faults and depositional features define subarea boundaries and in some cases restrict lateral movement of groundwater. These include: the Parks Boundary, as well as the Livermore, Pleasanton, Calaveras, and Greenville faults (*Norfleet Consultants, 2004*).

1.4.4 Basin Management Areas

1.4.4.1 Main Basin and Subareas

The Main Basin is comprised of the Castle, Bernal, Amador and Mocho II Subareas (shown previously on *Figure 1-D*). It is bounded on the:

- North by the Parks Boundary which separates the Dublin and Camp Subareas of the fringe basin from the Bernal and Amador Subareas. This boundary was initially considered to be fault-related, but may be a depositional boundary between recent alluvium and older material;

- East by shallow bedrock separating the Mocho I (fringe basin) and Mocho II (Main Basin) Subareas;

- South by the tilted Livermore Formation in the Livermore Uplands; and

- West by Pleasanton Ridge, the Dublin Uplands, and the Calaveras Fault.

The Main Basin is hydraulically connected to the fringe areas through the shallow alluvium; however, subsurface inflow from the fringe subareas into the deeper portions of the Main Basin is considered to be minor. The deeper aquifers of the Main Basin are primarily recharged through vertical migration of groundwater within the Main Basin itself. The Main Basin aquifers have the highest transmissivity. All of the Valley's municipal supply wells are completed in Main Basin aquifers.

1.4.4.2 Fringe Management Area and Subareas

The Fringe Management Area is defined by areas outside of the Main Basin that contain thinner deposits of recent alluvium underlain by relatively shallow bedrock. These areas are also characterized by lower permeability aquifers overlain by clay-rich soils. Because the alluvium is generally thinner, the primary hydraulic connection between the Fringe Management Area and the Main Basin Management Area is through the Upper Aquifer. In general, Lower Aquifer units in the Main Basin do not extend into the Fringe Management Area. Areas of significant subsurface inflows through the Upper Aquifer from the Fringe Management Area into the Main Basin Management Area occur:

- along the northern and eastern boundaries between the two areas, currently estimated at about 900 AFY; and

- along the northwestern boundary (at the Bernal Subarea) of the Main Basin estimated to be about 100 AFY, as estimated by transect wells.

Similar to the Main Basin Management Area, nine subareas have been defined in the Fringe Management Area to delineate areas of similar groundwater conditions and provide a reference framework for locating wells. These subareas were defined in the 1970s using primarily inferred fault traces for many of the boundaries. Although the presence of some of the faults have either been re-interpreted or not confirmed, the subarea delineation provides a useful system for groundwater management and has been retained in subsequent groundwater documents. Subareas in the northwest include Bishop, Dublin, and Camp. Subareas in the northeast include Cayetano, May, Vasco, Altamont, Spring, and Mocho I (two parts) (*Figure 1-D*).

1.4.4.3 Uplands Management Area

The Uplands Management Area is primarily defined by areas without recent alluvium that are underlain by the Livermore Formation and older bedrock units. These consolidated units are more resistant to erosion and form low rolling hills around the more-gently sloping alluvial valley. Most of the precipitation that falls on the Uplands Management Area leaves the area as runoff and contributes to streams in the Fringe and the Main Basin Management Areas. A small amount of deep percolation of precipitation in the Uplands could also contribute to subsurface inflow. Subsurface inflow from the Livermore Uplands Management Area into the Main Basin Management Area has been estimated at about 360 AFY. Formal subareas have not been delineated in the Uplands Management Area because of the absence of significant groundwater pumping or the lack of need for localized groundwater management actions, based on a long history of groundwater level monitoring demonstrating uses/withdrawals are sustainable.

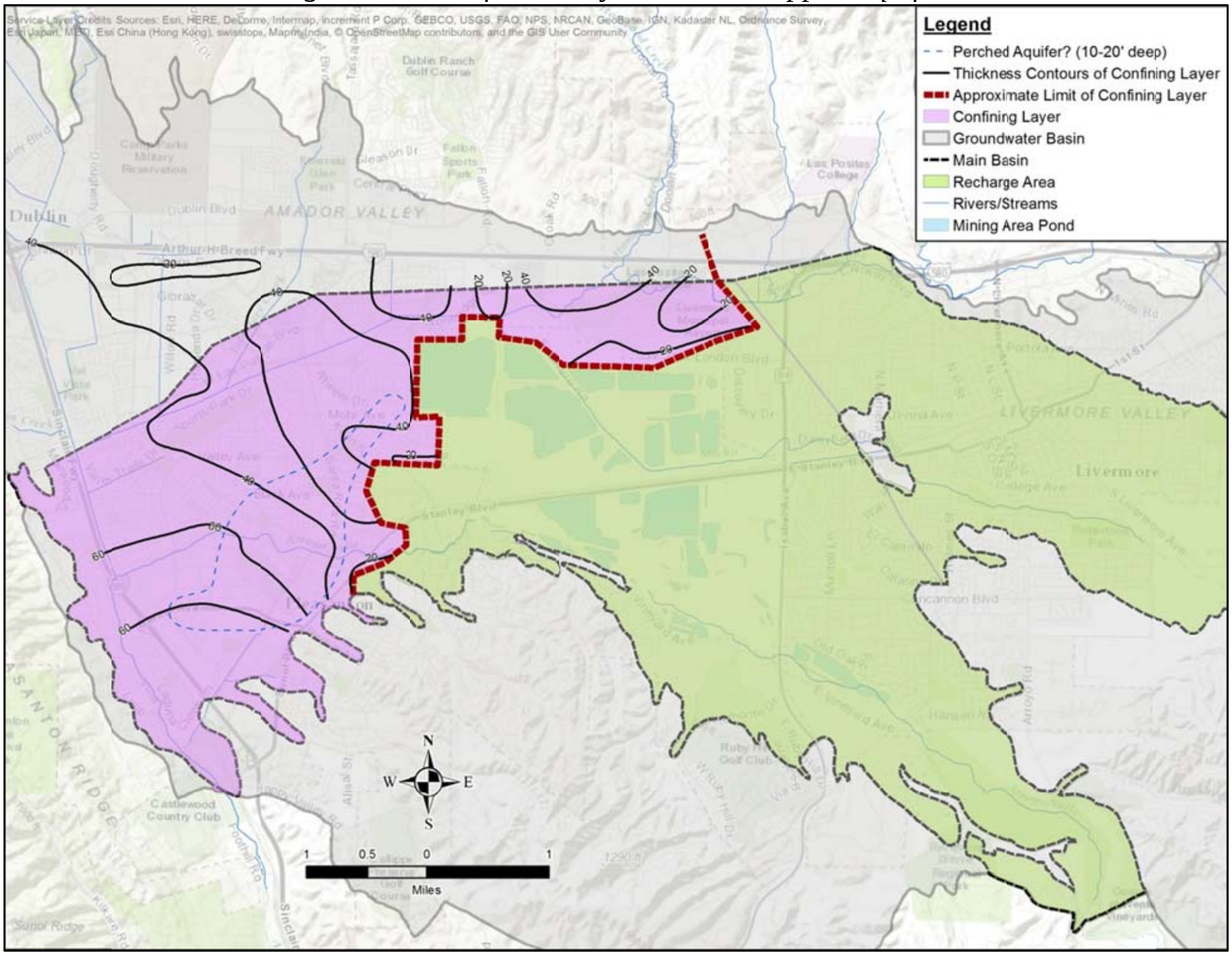
1.4.5 Aquifer Zones

Although multiple aquifers have been identified in the Main Basin alluvium, wells have been classified generally as being completed in either the Upper or Lower Aquifer Zone. Such differentiation is not applicable to the Fringe Basins. In the Main Basin the two zones are generally separated by a relatively continuous silty clay aquitard, that is up to 50 feet thick beneath the Upper Aquifer Zone (80 to 150 feet below ground surface [bgs]).

1.4.5.1 Upper Aquifer Zone

The upper aquifer zone consists of alluvial materials, including primarily sandy gravel and sandy clayey gravels. These gravels are usually encountered underneath a confining surficial clay layer typically 5 to 70 ft bgs in the west and exposed at the surface in the east. The overburden thicknesses have been contoured and are shown on *Figure 1-E* along with the limits of the confining layer and the main recharge area of the Main Basin. The base of the upper aquifer zone varies from 80 to 150 ft bgs. Groundwater in this zone is generally unconfined; however, when water levels are high, portions of the Upper Aquifer Zone in the western portion of the Main Basin can become confined.

Figure 1-E: Surficial Clays above the Upper Aquifer



1.4.5.2 Lower Aquifer Zone

All aquifers encountered below the confining aquitard in the central portions of the basin are known collectively as the Lower Aquifer Zone. The lower aquifer materials consist of coarse-grained, water-bearing units interbedded with relatively low permeability, fine-grained units. It is believed that the Lower Aquifer Zone derives most of its water from the Upper Aquifer Zone through the leaky aquitard(s) when piezometric heads in the upper zone are greater than those in the lower zone. Some replenishment may also come from the water-bearing members of the Livermore Formation that are in contact with the Lower Aquifer Zone.

1.4.6 Groundwater Characteristics

The northern extent of the Livermore Valley Groundwater Basin is dominated by a sodium rich water, while much of the western part of the basin near Pleasanton has a magnesium-sodium characteristic (i.e., both magnesium and sodium are dominant cations). The area along the eastern portion of the basin, beneath the Livermore area, has magnesium as the predominant cation. Most groundwater in the Main Basin, where all of the Valley's municipal supply wells are completed, is "hard" or "very hard" (i.e., $CaCO_3$ greater than 120 milligrams per liter [mg/L]). Groundwater tends to be the hardest in the western portion of the Main Basin. Groundwater of the Lower Aquifer zones is generally of better quality than the Upper Aquifer zone groundwater; however, both aquifer zones are designated for potable use.