Chapter 2

Environmental Setting

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2.1 Introduction

This chapter describes the physical and biological resources within the study area that are relevant to the Conservation Strategy. This chapter includes a land use section that provides an overview of the major land use and open space management agencies operating within the study area. The physical resources section provides a characterization of the topography, geology and soils, climate, and hydrology of the study area. The biological resources section includes a discussion of biological diversity, natural communities, land cover types, and focal species in the study area. Together, the land use, physical resources, and biological resources sections provide the necessary context for the biological goals and objectives upon which Chapter 3, "Conservation Strategy," is based.

2.2 Land Use

This section examines existing land use conditions and land use plans in east Alameda County. This section provides history and context for land use in the study area; reviews existing land use conditions and relevant land use plans; presents the criteria used to determine land use categories; and discusses significant existing open spaces in the study area and an open space type classification system.

2.2.1 Existing Conditions

East Alameda County encompasses 271,485 acres (approximately 424 square miles) and represents 52% of Alameda County, which has a land area of 525,540 acres (approximately 821 square miles). Alameda County is located north of Santa Clara County, west of San Joaquin County, and south of Contra Costa County (see Figure 1-1 for the regional location of the study area). East Alameda County is situated east of the San Leandro Hills and Walpert Ridge (Corbett 2005). The cities of Dublin, Livermore, Pleasanton, a portion of the city of Hayward, and surrounding unincorporated areas are the major developed areas of east Alameda County (Alameda County Community Development Agency 2002). The cities of Dublin, Livermore, and Pleasanton are completely included in the study area.

According to the most recent Census data, the population of east Alameda County is approximately 171,652, about 12% of the population of the entire county, which is 1,443,741 (U.S. Census Bureau 2000). In east Alameda County, Livermore has the most residents, with a population of 80,723(City of Livermore 2009); followed by Pleasanton, with a population of 68,755 (City of Pleasanton 2009a); and Dublin, with a population of 46,934 (City of Dublin 2009a).

Located between the urban areas surrounding the San Francisco Bay and the Central Valley, east Alameda County has had considerable growth pressure in the recent past. In 1990, the population was approximately 133,000 and will most likely exceed 250,000 by 2010, representing an 88% growth (Alameda County Community Development Agency 2002). The Association of Bay Area Governments (ABAG) has projected that the populations of Livermore, Pleasanton, and Dublin will grow to 89,600; 75,300; and 56,800 by the year 2015, and 95,500; 79,100; and 62,700 by the year 2020, respectively (Association of Bay Area Governments 2006).

Dublin was incorporated in 1982 (City of Dublin 2009b), Livermore was incorporated in 1876 (City of Livermore 2009), and Pleasanton was incorporated in 1894 (City of Pleasanton 2009a). Dublin was incorporated to accommodate the increasing demand for commercial and residential development in the area, and has experienced a more recent increase in growth compared to Livermore and Pleasanton, which have grown steadily since incorporation (City of Dublin 2009b). Recent growth in the region and the subsequent impacts on residents' quality of life are major concerns for the region (Alameda County Community Development Agency 2002).

The County and Cities of Livermore, Pleasanton, and Dublin maintain a strong commitment to protecting the natural and agricultural resources within and surrounding their respective jurisdictions. Reflecting this vision, the County and Cities of Livermore and Pleasanton have each adopted an Urban Growth Boundary (UGB), while Dublin has adopted Planning Area Boundaries as an ultimate build-out line. More detail on the open space policies and UGBs is provided in Sections 2.2.4 and 2.2.3.1 below for each participating jurisdiction.

2.2.2 Land Use Categories

Understanding the current land use patterns and potential future land uses in the study area were an important step in developing the strategy discussed in Chapter 3. This understanding, in conjunction with an assessment of the biological resources in the study area allowed for the development of a conservation strategy that is informed by the current land use patterns in the county. Furthermore, land use designations aid the process by informing agencies as to the areas that are currently protected, areas that are likely to be affected, and areas where conservation will need to occur. The general plans for the cities of Dublin, Livermore, and Pleasanton and Alameda County were used to identify the future extent and location of urban and rural development in the study area.

Land use designations vary across jurisdictions and are in many more categories than necessary for conservation planning purposes, so the designations were simplified and standardized. The process by which a land use map was developed and how land use categories for the Conservation Strategy were assigned is described below.

2.2.2.1 Land Use Methodology

Land use planning designations for Alameda County and the cities of Dublin, Livermore, and Pleasanton were used to develop a single land use map for the Conservation Strategy. Future land uses were assumed to be consistent with the County's general and specific plans (East County Area Plan [2002]; South Livermore Valley Area Plan [adopted by Alameda County Board of Supervisors on February 3, 1993]); and the general plans for the City of Dublin [2008], City of Livermore [2004], and the City of Pleasanton [2009b]). The County's general and specific plans project future land use to 2010, and the Dublin, Livermore, and Pleasanton general plans project future land use to 2025. Using these projections for this strategy is appropriate given the strength of each jurisdiction's commitment to constraining future growth within established UGBs (see Section 2.2.3 below for a discussion of local land use controls).

One hundred five land use planning designations from the four land use authorities were aggregated into the following three simplified land use planning categories:

- Urban/Developed;
- Private agriculture, and/or Rangelands; and
- Public Lands.

Development of these categories was guided by the nature of the potential activities that will require a discretionary permit within each land use category and their relative impact on biological resources. For example, the many urban land use categories (e.g., commercial, industrial, mixed use) were combined into a single land use category, "Urban/Developed," because all of the land uses result in similar effects on biological resources. Table 2-1 shows general plan land uses and the land use categories to which they were converted for this strategy. Some land use designations were split into two or more of the land use categories for this strategy.

2.2.2.2 Generalized Land Use Categories

Historically, agriculture has played a major role in the economy of Alameda County (Alameda County Community Development Department 2008). Agriculture continues to be an important part of modern east Alameda County, as the majority of land is used for agriculture, primarily ranching (Alameda County Community Development Agency 2007). Other land uses include residential, industrial, commercial, open space, parklands, public watersheds, and mixed use. Many of these land uses also incorporate grazing, which results in some overlap in land use designations. Generalized land use and planning designations are shown on Figure 2-1.This map depicts land use designations that include both developed and undeveloped areas (for actual land cover, see Section 2.4.1.1).

The Urban/Developed land use planning category includes all industrial, commercial, mixed use, institutional, public facilities, public/quasi-public, circulation, and major educational facilities land use designations. The study area is 271,485 acres, of which 42,088 acres (approximately 15.5%) are categorized as Urban Development.

The Agriculture and Rangelands land use planning category includes lands that are actively used for or have been used in the recent past (fallow) for agricultural production. In the study area, most of this land is either in vineyards, used for livestock production, or is in dry land farming. The Agriculture and Rangelands land use planning category comprises 167,449 acres (approximately 61.7%) of the study area.

The Public Lands land use planning category includes lands that are used for park or recreation purposes. This category includes lands that are considered publicly owned open space or regional parks that may contain some trails but do not have extensive park facilities or amenities. This category comprises 61,949 acres (approximately 23%) of the study area. It should be noted that many of these public lands are rangeland and are grazed by livestock. The Public Lands land use category does not encompass all open space lands in the study area. For example, many private conservation easements or small public open space areas are designated as different land use categories in planning documents. Others are currently used as rangelands, and thus appear under the Agriculture and Rangeland designation on Figure 2-1. Section 2.2.4 discusses existing open space in the study area.

Special Land Use Designations

There are other areas within the study area that have special designations by state (Williamson Act; see discussion below), or under county or city general plans. These are overlay designations that are additive to the underlying jurisdictional general plan designations. The areas are shown in Figure 2-1 and include County Resource Management, Livermore Resource Management, Pleasanton Wildlands, and Wind Resource Area. Williamson Act lands are described but not shown on Figure 2-1.

County Resource Management

This includes areas outside the County UGB, east of the city of Dublin and the area surrounding SFPUC watershed lands in the southwestern part of the study area (Figure 2-1). This designation is intended mainly for land designated for long-term preservation as open space but may include low intensity agriculture, grazing, and very low-density residential use. Allowable uses include agriculture, grazing, recreational, and open spaces (Alameda County Community Development Agency 2002).

Livermore Resource Management

This area is located north of Livermore and east of the city of Dublin (Figure 2-1). It overlaps with lands designated as County Resource Management (Alameda County Community Development Agency 2002). It is intended mainly for land designated for long-term preservation as open space, but may include low-intensity agricultural or residential uses. The Resource Management designation provides for agricultural uses, recreational uses, habitat protection, watershed management, public and quasi-public uses, secondary residential units, active sand and gravel and other quarries, reclaimed quarry lakes, and similar and compatible uses. This designation is also applied to areas unsuitable for development because of public health and safety hazards or environmentally sensitive features. One single-family home per parcel is allowed provided that all relevant development standards are met (City of Livermore 2004).

Pleasanton Wildlands

This area is located south of the city of Pleasanton, bordered by Interstate (I-) 680 on the west and extending south to San Antonio Reservoir (Figure 2-1). This area is outside of the city of Pleasanton; it is within Alameda County and is under County jurisdiction. The area includes lands identified as wildlife corridors and valuable plant and wildlife habitats such as arroyos, the San Antonio Reservoir area, highly vegetated areas, and other natural areas necessary to maintain significant populations of plant and animal species.

Wind Resource Area

Alameda County, along with the Golden Gate Audubon Society and several private wind energy companies, are currently developing a regional conservation plan for the wind resource area. This area is located in the northeastern part of Alameda County, extending to the Contra Costa and San Joaquin County lines on the north and east, and through the Altamont Hills to the west (Figure 2-1). This area has special designation due to existing wind energy facilities and the intention to continue to develop and utilize wind resources in the future. This designation is primarily to facilitate real estate disclosures about existing wind energy facilities and the potential for future wind facility uses. The designation also restricts changes in land use that are incompatible with future wind energy generation (Alameda County Community Development Agency 2002).

California Land Conservation Act of 1965 (Williamson Act)

The purpose of the California Land Conservation Act of 1965 (California Government Code 51200–51295), commonly known as the Williamson Act, is to provide incentives, through reduced property taxes, to deter the early conversion of agricultural and open space lands. In return for the preferential tax rate, the landowner is required to sign a contract with the county or city agreeing not to develop the land for a minimum 10-year period. Contracts are automatically renewed annually unless a party to the contract files a notice of nonrenewal or petitions for cancellation. All lands defined by the state as “prime farmland, other than prime farmland, and open space land” are eligible for coverage by a Williamson Act contract. Land classified as other than Prime Farmland or open space land can be placed under contract if it is located in an area designated by a county or city as an agricultural preserve. Approximately 24% of Alameda County is under Williamson Act contract. Nearly all of that is in the study area and comprises nonprime agricultural land. There are several parcels of prime farmland south of Livermore. Nearly all of this is under permanent agricultural conservation easements held by the Tri-Valley Conservancy.

However, on July 28, 2009, the Governor of California signed the austere 2009–2010 Budget Act (Assembly Bill 1, Fourth Extraordinary Session and various associated bills), which drastically affected the Williamson Act. During this budget term, counties and cities will not be reimbursed by the state for property taxes not received as a result of land that is not developed. This enactment is a strong disincentive for counties and cities to continue their Williamson Act programs, and to enter into any additional contracts. The repercussions of the 2009–2010 Budget Act may impact Williamson Act lands in Alameda County.

2.2.3 Land Use Controls

The existing boundaries of urban growth are discussed below for the county and each participating city.

2.2.3.1 Boundaries to Urban Growth

The establishment of an UGB is an important mechanism utilized by cities and counties to encourage growth within a specified area to avoid urban sprawl. Development within an UGB reduces impacts on farmland, wildlife habitat, energy consumption, and pollution. The UGB also creates buffers between communities. Areas outside of the UGB may not be suitable for development due to significant natural resources, agricultural uses, or issues related to public health and safety. Conversely, some areas within the UGB may not be suitable for development for the same reasons. The following sections describe UGBs established in Alameda County and the cities of Dublin, Livermore, and Pleasanton.

Alameda County

Measure D was passed in November 2000 by the Alameda County electorate. The measure, called the Save Agriculture and Open Space Lands Initiative, amended segments of Alameda County's general plan, which includes the East County Area Plan (ECAP) (Alameda County Community Development Agency 2002). The Initiative had several purposes: to preserve and enhance agriculture and agricultural lands; to protect natural resources, wildlife habitats, watersheds, and open space lands of Alameda County; and to limit suburban sprawl.

To accomplish these goals, Measure D amended the general plan to establish the County's UGB. The County's UGB focuses urban-type development in and near existing cities (Alameda County Community Development Agency 2002). Urban development within the UGB allows for efficient delivery of public services and utilities, avoiding increased costs to taxpayers and impacts to the environment (Alameda County Community Development Agency 2002).

Measure D applies to all areas of Alameda County, providing the UGB was established after the adoption of this measure. General and specific plans for cities within Alameda County have been amended, or will be amended, to comply with Measure D. Since Pleasanton's UGB was adopted in 1996, prior to the passage of Measure D, it is exempt from this requirement. The County UGB in the Conservation Strategy study area encompasses the cities of Dublin, Livermore, and Pleasanton (Figure 2-1).

Dublin

The general plan for the city of Dublin designates Planning Area Boundaries to limit the development that occurs outside of the city limits (City of Dublin 2008). The planning area limits are defined by the Primary Planning Area Boundary, the Eastern Extended Planning Area Boundary, and the Western Extended Planning Area Boundary (City of Dublin 2008).

The Primary Planning Area is entirely within the city limits of Dublin. The Eastern Extended Planning Area (approximately 4,200 acres) utilizes a Development Elevation Cap Policy, which does not allow development above 770 feet without a new specific plan or an amendment to the current general plan (City of Dublin 2008). The Eastern Extended Planning Area is the largest remaining area in Dublin available for development. An Urban Limit Line for the Western Extended Planning Area (approximately 500 acres) was adopted in November 2007 and follows the existing city limit line. The Urban Limit Line was defined to protect natural resources in the hills west of Dublin. Development outside the Urban Limit Line is not permitted without an amendment to the land use designation in the city's general plan (City of Dublin 2008).

Livermore

The city of Livermore is entirely within an UGB (City of Livermore 2004). The UGB was established in order to protect agricultural and natural resources and to prevent future urban development outside Livermore (City of Livermore 2004). The UGB was finalized after two initiatives were passed. The first, passed by local voters in March of 2000, is the *South Livermore Urban Growth Boundary Initiative*, which defines the UGB around the southern portion of the city (City of Livermore 2004). The second, passed by the Livermore City Council in December of 2002, is the *North Livermore Urban Growth Boundary Initiative*, and defines the UGB around the northern portion of Livermore (City of Livermore 2004).

Pleasanton

The city of Pleasanton defines an UGB in the general plan, passed by voters in 1996 (City of Pleasanton 2009b). Areas outside of the Pleasanton UGB are designated unsuitable for development due to important natural resources, agricultural resources, parks and recreation, regional significant wildlands, or scenic ridgelines (City of Pleasanton 2009b). The UGB is also used to protect public health and safety and to create a buffer between communities. Although the UGB is intended to permanently designate areas where development will not occur, there are provisions under the initiative that allow for adjustments (City of Pleasanton 2009b). If a proposed amendment is otherwise consistent with the general plan; would not have a significant adverse affect on agriculture, wildlands, or scenic ridgeline views; is contiguous with existing urban development; would not induce further adjustments to the UGB; and would provide for urban public facilities and services in an efficient and timely manner, the adjustment to the UGB may be granted (City of Pleasanton 2009b).

2.2.4 Open Space (Public Lands and Private Easements)

Alameda County and the cities of Livermore, Pleasanton, and Dublin are closely connected to the surrounding natural landscapes. As described above, the Public Lands land use planning category provides an incomplete picture of open space areas within the study area. Missing are private conservation easements and small public lands that may be important conservation areas. It is critical to understand the location and biological values of all open space in the study area so that the Conservation Strategy can identify gaps in local protection and help to fill those gaps.

The following section provides an overview of existing open space within the study area.

2.2.4.1 Existing Conditions

For the purposes of this study, open space land in East Alameda County consists of public lands or private lands within existing protections through conservation easements or deed restrictions (see “Open Space Classification” section below for further explanation and examples). Public and private open space lands in the study area are subject to a variety of resource-management regimes. As a result, the level of habitat protection varies amongst the existing open space, providing different habitat for the focal species and natural communities.

Management for natural resources on these lands helps support focal species and other native species and maintains the functions of natural communities. Because some of these existing open space lands will be relied upon to support the Conservation Strategy, existing open space need to be distinguished by their value to the strategy. To do this, open space areas have been categorized as described below.

The value of protected open space areas for focal species and natural communities is greatest when land use protections and stewardship are in place in perpetuity. Type 1 open space lands (see "Open Space Classification" below for definition of land types) are considered lands protected in perpetuity. The value of open space for the strategy is similarly improved when a natural resource management plan is in place and adequate funding exists to maintain or enhance populations or natural communities. Open space areas that do not have land use protections in perpetuity but do have ecological protection as their primary management goal may still support the Conservation Strategy. However, because of the lack of permanent and irrevocable protections and adequate stewardship funding, there is a risk of changes in land use or resource management emphasis in the future. The categories that fall under this are Type 2 Open Space lands.

The following classification of open space was developed to account for differences in land use protections and resource management emphasis and to assist in the development of the Conservation Strategy.

2.2.4.2 Open Space Classification

The protection and resource management status of open space lands has been evaluated and classified based on the level of land use protection and the general level of ecological management. Each open space unit within the study area was assigned to one of four resource management types (Type 1, 2, 3, or 4) using the decision-making process shown in Figure 2-2. The location of all open space categories is shown on Figure 2-3. The amount of land protected as open space is summarized in Table 2-2.

Type 1 Open Space is permanently protected public or private land subject to conservation easement or deed restriction, where the primary purpose and management goal of the land is for ecological protection. This is considered the most protection. Examples of Type 1 Open Space include the areas under conservation easement at Brushy Peak Regional Preserve, the Ohlone Conservation Bank, or other private lands subject to a conservation easement. Many of these areas are managed using livestock grazing.

Type 2 Open Space includes public lands where the primary intent of land management is for ecological protection but the land is not subject to irrevocable protection such as a conservation easement or deed restriction.

Type 2 Open Space lands could become changed to Type 1 lands, or reduced in protection to become Type 3 or 4 lands. Examples of Type 2 Open Space include Ohlone and Sunol Wilderness, the portion of Brushy Peak Regional Preserve not under conservation easement, Sycamore Grove Park, and Springtown Alkali Sink. Many of these areas are managed using livestock grazing.

Type 3 Open Space involves public lands that may contain some land uses other than ecological protection. These lands would include parklands classified as parks, open space, or special protection units where something other than ecological protection is designated as the primary use (e.g., recreation, watershed protection). Type 3 could also include private lands under agricultural easement to preserve livestock grazing or dry land farming. Also included would be the undeveloped portions of watersheds under ownership or management by a public agency, including SFPUC, California Department of Water Resources (DWR), Zone 7, and Alameda County Water District (ACWD). Other large examples of Type 3 Open Space includes Site 300 (Lawrence Livermore National Laboratory), Carnegie State Vehicular Recreation Area, and Del Valle Regional Park. This area is considered least protected out of the other types. Public access is varied. It could potentially be more protected to become Type 2 lands or these lands could be sold for development. Recreation activities in these parks are often not conducive to management of natural resources.

Type 4 Open Space consists of developed portions of public lands, such as Camp Parks Military Reservation, that retain some ecological value. It includes public golf courses, some landscaped areas, and developed neighborhood parks. Type 4 would also include private lands under agricultural easements to preserve vineyards, orchards, or other cultivated agriculture.

Of the 271,485-acre study area, 67,976 acres (25%) are currently protected as open space (Types 1 through 4) (Table 2-2). These areas range from urban parks to county and state parks of varying size. Protected open space also includes private or public lands protected by conservation easements or deed restrictions. It should be noted that while the open space designations were assigned based on the level of protection on each parcel, these designations are not representative of the type and quality of management that occurs there. In other words, a parcel that is designated as Type 4 Open Space could well be managed better and more consistently than a parcel that is designated as Type 1 Open Space.

2.2.4.3 Protection and Resource Management Status of Open Space Lands

Open space lands in the study area are managed by several different agencies for a variety of purposes. The following section provides an overview of local land management agencies with holdings in the study area and the major open space units that they manage and operate.

California Department of Parks and Recreation

In east Alameda County, California Department of Parks and Recreation owns Bethany Reservoir State Recreation Area (802 acres), Carnegie State Vehicular Recreation Area (3,850 acres), and Lake Del Valle State Recreation Area (5,005 acres) (State of California 2008; Figure 2-3). Bethany Reservoir is the northern terminus of the California Aqueduct. The associated Bethany Reservoir State Recreation Area provides opportunities for water recreation, including fishing and windsurfing as well as biking along the California Aqueduct Bikeway. Carnegie State Vehicular Recreation Area is located on the eastern edge of the study area. The park straddles the Alameda/San Joaquin County line. The park provides active riding area on a diversity of terrain ranging from rolling hills to steep canyons. Lake Del Valle State Recreation Area surrounds Lake Del Valle and provides hiking, horseback riding, and water recreation. It is also the eastern gateway to the 28-mile Ohlone Trail. This park is operated by EBRPD.

East Bay Regional Park District

The EBRPD offers and maintains 1,700 square miles (over 100,000 acres) of regional parks in Alameda and Contra Costa Counties. EBRPD maintains 14 regional parks, 19 regional preserves, nine regional recreation areas, 13 regional shorelines, and 15 regional trails (East Bay Regional Park District 1997). EBRPD is currently in the process of preparing an HCP for several of their park lands in Contra Costa County.

EBRPD manages approximately 85,000 acres of regional parks, which are typically large parklands with high biological value that also have recreational opportunities. To be considered under this classification under EBRPD standards, a regional park must be at least 500 acres, including land and water, and must include scenic or natural resources in at least 70% of the park area (East Bay Regional Park District 1997). Regional parks also have the capacity to accommodate a range of recreational activities, as long as recreational areas are less than 30% of the overall park area (East Bay Regional Park District 1997). Regional parks in the study area are Del Valle Regional Park (5,005 acres), Pleasanton Ridge Regional Park (3,387 acres), and Vargas Plateau Regional Park (1,043 acres) (Figure 2-3).

Regional preserves, including wilderness areas, are ecologically valuable areas with significant natural or cultural features (East Bay Regional Park District 1997). A regional preserve may include such essential features as open space, wilderness, scenic beauty, flora, or fauna; or archeological, historic, or geological resources (East Bay Regional Park District 1997). Regional preserves have irrevocable protection within the EBRPD (some regional preserves also have irrevocable conservation easements associated with them). Regional preserves in the study area provide important protections for focal species and natural communities targeted by this Conservation Strategy. Regional preserves in the study area are Sunol Regional Wilderness (6,881 acres), Ohlone Regional Wilderness (8,714 acres), Brushy Peak Regional Preserve (406 acres), and Mission Peak Regional Preserve (470 acres) (Figure 2-3).

Lawrence Livermore National Laboratory Site 300

Site 300, located in eastern Alameda and western San Joaquin Counties north of Corral Hollow Road (Figure 2-3), is owned and operated by Lawrence Livermore National Laboratory for the purpose of conducting unique scientific experiments. Research includes explosives tests and fabrication, reactions of materials under high pressure and temperature (shock physics), and hydrodynamic tests, among others (Lawrence Livermore National Laboratory 2008a). The site is approximately 7,000 acres in size, 803 acres of which is in the Conservation Strategy study area.

Site 300 is inhabited by a diverse assemblage of flora and fauna. From its southern boundary within the Corral Hollow Creek floodplain, the property rises in a series of southeast-northwest trending ridges to nearly the northern perimeter. Several ephemeral streams flow through Site 300 during the wet winter months and discharge into Corral Hollow Creek at the southern boundary of the site. Most flow is direct runoff with a very small contribution from both intermittent and perennial springs (Lawrence Livermore National Laboratory 2008b).

Less than 5% of the property-area is developed. Developed areas with buildings are generally separated from wildland settings with high-security fences, and very few of these developed areas provide habitat for native flora and fauna. The most common vegetation types found at Site 300 are California annual grassland, native grassland, coastal sage scrub, and oak woodlands. California annual grassland covers about 5,647 acres of the property. The native perennial grassland community is dominated by pine (one-sided) bluegrass and purple needlegrass and covers about 723 acres of the property. Stands of native grasslands are confined mainly to the northern half of the facility. Occurrence of native grass-dominated vegetation appears to be associated with annual controlled burning. Another major vegetation community, coastal sage scrub, occurs in the southwestern part of the site and covers approximately 108 acres (Lawrence Livermore National Laboratory 2008b).

Livermore Area Parks and Recreation District

Livermore Area Recreation and Park District (LARPD) defines open space parks and preserves as “larger land areas with outstanding natural or cultural features warranting conservation for their natural value, educational benefit and enjoyment by the public” (Livermore Area Recreation and Park District 2008). Within the study area, LARPD currently owns and operates two open space parks: Sycamore Grove Park/Veterans Park (774 acres) and Holdener Park (55 acres); and one open space preserve, Garaventa Wetlands Preserve (24 acres). LARPD owns 507 acres of Brushy Peak Regional Preserve (the remainder is owned by EBRPD), but the entire Preserve is managed by East Bay Regional Park District (Livermore Area Recreation and Park District 2008). Overall, LARPD parks and preserves represent 1,360 acres of natural open space (Livermore Area Recreation and Park District 2008). LARPD also owns and manages several trail facilities.

San Francisco Public Utilities Commission Watershed Lands

The SFPUC owns, leases, and manages 63,000 acres of watershed lands across three counties in California (San Francisco Public Utilities Commission 2008). The Alameda Watershed, which is split between Santa Clara and Alameda Counties, includes 36,000 acres of SFPUC watershed lands, of which 23,000 acres are located in Alameda County (Figure 2-3; San Francisco Public Utilities Commission 2008). The Alameda Watershed is used primarily for water storage and supply from two major reservoirs: San Antonio and Calaveras. Water supplies for Calaveras Reservoir originate from local runoff. San Antonio Reservoir is supplied by local sources as well as water from the Hetch Hetchy Aqueduct that transfers water from the Sierra Nevada. While the primary purpose of SFPUC watershed lands is for watershed protection, the agency also uses the watershed lands for several other purposes, including quarry operations, plant nurseries, utilities routing, and water conveyance. The entire areas is managed under a grazing management plan to enhance native flora and fauna. This watershed is valuable for wildlife and plant life, supporting more than 17 types of natural communities (San Francisco Public Utilities Commission 2008). SFPUC is currently preparing an HCP for operations and maintenance within its Alameda Watershed lands.

Tri-Valley Conservancy

The Tri-Valley Conservancy oversees conservation easements and manages lands in eastern Alameda County, including north and south Livermore, south Pleasanton, west Altamont Hills area, and the future Chain of Lakes Recreation Area. The purpose of the Tri-Valley Conservancy is “to permanently protect the fertile soils, rangelands, open space, and biological resources and to support a viable agricultural economy in the Tri Valley Area” (Tri-Valley Conservancy 2005). The Tri-Valley Conservancy protects lands through acquisitions, conservation easements, deed restrictions, conditional transfers, reverter clauses, management agreements, leases, mutual covenants, and donations. The Tri-Valley Conservancy also has ongoing stewardship programs for acquired lands. The Tri-Valley Conservancy got its start in 1994 in southern Livermore with the approval of the South Livermore Valley Area Plan (City of Livermore 1993) and the dedication of numerous agricultural easements on vineyards to ensure this land use persisted in that area. The original purpose of the Tri-Valley Conservancy has expanded to other areas of the Tri-Valley region, including the north Livermore Valley (Tri-Valley Conservancy 2008). The Tri-Valley Conservancy now operates throughout most of the study area in Livermore, Dublin, Pleasanton, San Ramon, and Sunol.

2.3 Physical Resources

This section describes the physical setting of the study area, including location, topography, geology and soils, and hydrology. Sources used to map and describe the physical setting of the study area are listed below:

- U.S. Geological Survey (USGS) data on topography and hydrology (U.S. Geological Survey 1999),
- geologic maps of the area (California Department of Conservation 1990),
- soil survey information (Welch 1981; Welch et al. 1966),
- serpentine and alkaline soils derived from soil survey information (Welch 1981; Welch et al. 1966),
- aspect and slope derived from USGS data on topography and hydrology (U.S. Geological Survey 1999), and
- watershed data from California Interagency Watershed Map (CalWater version 2.2.1) (California Interagency Watershed Mapping Committee 1999).

Topography, hydrology, and soil data were downloaded from agency websites and imported into ArcMap, where files were clipped and converted into the projection for the study area.

2.3.1 Location

The study area covers approximately 271,485 acres in the eastern portion of Alameda County. The study area is bounded by the Contra Costa County line to the north, the San Joaquin County line to the east, the Santa Clara County line to the south, and the ridgeline of the East Bay Hills to the west. The western boundary of the study area is the western boundary of the Alameda Creek watershed.

2.3.2 Topography

The topography of the study area is extremely variable, ranging from steep ridges of the northern Diablo Range in the east to rolling hills of the East Bay

Hills in the west to expansive valleys in the north-central and northeast portions of the study area. Elevations in the study area range from 3,840 feet along Valpe Ridge in the Diablo Range to 10 feet in the extreme northeast corner of the study area, near the Delta-Mendota Canal. Other important low points in the study area include the Sunol Valley at approximately 125 feet above mean sea level and the extensive Livermore Valley, ranging from 400 to 500 feet and containing the cities of Livermore, Pleasanton, and Dublin. Notable peaks and other high points in the study area include Cedar Mountain at 3,675 feet, Man Ridge at 3,500 feet, and Wauhab Ridge at 3,200 feet, all of which are located within the northern Diablo Range in the southeast portion of the study area (Figure 2-4).

2.3.3 Geology and Soils

2.3.3.1 Regional Geologic Context

The Conservation Strategy area is located within the central portion of the Coast Ranges Geomorphic Province. In the San Francisco Bay Area (Bay Area), the Coast Ranges Province is characterized by a series of northwest-trending en-echelon ridges and valleys bounded by active faults of the San Andreas system, which forms the boundary between the Pacific and North American tectonic plates (Norris and Webb 1990). From west to east, these faults include the San Gregorio, the San Andreas, the Hayward-Rodgers Creek, Calaveras, Concord-Green Valley, Greenville, and Ortigalita, together with a number of smaller structures.

2.3.3.2 Geology of the Study Area

The study area can be divided into four distinctive geologic domains: the East Bay Hills, northern Diablo Range, Livermore Valley, and Mount Diablo uplift. The northwest-trending East Bay Hills are located on the western edge of the study area and are bounded on the west by the Hayward fault and on the east by the Calaveras fault. The Hayward fault zone is a complex deformational front that shows an overall right-lateral sense of separation but includes fault strands characterized as west-vergent thrusts, steeply dipping east-vergent thrusts, and vertical or near-vertical faults (Crane 1995). At the latitude of the study area, the central portion of the East Bay Hills uplift exposes deep marine sedimentary rocks of Cretaceous age, variously mapped as the Panoche Formation (Wagner et al. 1991) and as yet unnamed sandstone and shale (Graymer et al. 1996). Along the east flank of the uplift, the primarily right-slip Calaveras fault juxtaposes markedly different geologic formations. On both sides of this fault zone, the substrate is a complexly faulted and folded terrain. To the immediate west of the Calaveras fault zone along the plan area boundary, the substrate is largely composed of shallow marine sandstone, conglomerate, and shell breccia of the Miocene Briones Formation. East of the Calaveras fault, surface exposures consist of surficial alluvial and landslide deposits of Holocene age (Graymer et al. 1996).

The southern and eastern portion of the plan area encompasses the northern Diablo Range, which is the easternmost principal uplift of the central Coast Ranges province. The structure of the Diablo Range is broadly antiformal, with a core of Franciscan rocks such as Eylar Mountain terrain (sandstone, siltstone, conglomerate and chert), Melange terrane, and Undivided Franciscan greenstone (Graymer at al. 1996), flanked by younger sedimentary strata (Norris and Webb 1990). The Altamont Hills, in the northeastern-most corner of the plan area, are characterized by the sands, pebbles, and white sandstone of the Miocene-Age Neroly Formation and Cierbo Formation, as well as interbedded deep marine sandstone and shale of Late Cretaceous age. South and west of the Altamont Hills, the structure of the Diablo Range is largely influenced by the presence of the northwest-striking Ortigalita fault, just east of the range’s crest. The area directly on the fault juxtaposes conglomerate and sandstone of the Panoche Formation (Great Valley Group) against Franciscan bedrock (Wagner et al. 1991; Graymer et al. 1996). The Panoche Formation is overlain by an east-dipping sequence of clastic sedimentary strata ranging in age from Eocene through Quaternary of marine and shell marine origin (Sullivan and Waters 1980).

The Livermore Valley, containing the cities of Livermore and Pleasanton, lies south and west of the Diablo Range and east of the East Bay Hills. This valley, an east-west trending valley, unique to this area, is a deep alluviated depression (Ollenburger 1986) containing sediments deposited as part of the Livermore Gravels Formation. The Greenville fault forms the eastern border of this valley, separating it from the western foothills of the Diablo Range. It is postulated that the Greenville Fault is connected to the Concord Fault at depth by a buried “blind” thrust fault system (Wetlands Research Associates 2004). It is this interaction of the Greenville and Concord Faults that has created the Mount Diablo uplift, a presently active (Crane 1995), Late Quaternary tectonic feature located in the north-central portion of the study area. The bedrock structure of the Mount Diablo uplift is composed of rocks of the Miocene Green Valley/ Tassajara Formation and is postulated to contain deposits of the Livermore Gravels Formation (Graymer et al. 1996). The core of the Mount Diablo uplift, located just north of the plan area, contains older Franciscan rocks, flanked by east- and westward-younging sedimentary strata of Eocene through Pliocene age.

2.3.3.3 Soils

Because of the geologic, microclimatic, and topographic diversity of the study area, the soils are also very diverse, and a large number of individual soil units have been mapped. These have been organized into four soil associations consisting of soil units of similar texture and composition and related derivation. Following is a general overview of soil characteristics in the study area, by geographic position (Soil Conservation Service 1966) (Figure 2-5).

- **East Bay Hills.** Soils in the moderately sloping to very steep areas of the East Bay Hills are mainly silt loam soils assigned to the Millsholm–Los Gatos–Los Osos association. Soils in the more gently sloping easternmost portion of these hills are clay loams and gravelly loams of the Positas-Perkins association.
- **Northern Diablo Range.** The portion of the Diablo Range that falls within the study area is characterized by clay soils of the Altamont-Diablo association to the north and various rocky loams of the Vallecitos-Parrish association to the south.
- **Livermore Valley.** The Livermore Valley floodplain supports very gravelly soils assigned to the Yolo-Pleasanton association, interspersed with loams and clays of the Rincon-San Ysidro association.
- **Mount Diablo Uplift.** The soils of the Mount Diablo uplift are largely clays of the Altamont-Diablo association cut by creek beds containing clay and loam of the Clear Lake–Sunnyvale association.

Of particular importance from a conservation perspective are the study area's serpentine and alkali soils. Serpentine soils are typically very shallow, nutrient-poor (i.e., containing low levels of nitrogen, potassium, phosphorous, and molybdenum essential for normal plant growth), and high in magnesium, and may contain elevated levels of the heavy metals chromium and nickel that are toxic to many plant species (Kruckeberg 1954, 1984). Water availability in serpentine soils may also be limited (Davis et al. 1997). As a result, serpentine soils support limited and highly specialized floras and vegetation associations that often include a high number of endemic (i.e., largely or entirely restricted to serpentine soils) and special-status species (Kruckeberg 1984, Safford et al. 2005). The only serpentine soil found in the study area is eroded Henneke rocky loam soil type. These soils are found only in the southern portion of the study area, with large deposits in the northern Diablo Range, in areas such as Cedar Mountain, and in smaller areas found in the East Bay Hills (Figure 2-6).

Another soil type that can support rare and sometimes endemic flora is alkali soils. Alkali soils are created through the process of alkalization—the accumulation of exchangeable sodium in soils. This accumulation generally occurs when water evaporation or absorption pushes the soil solution to a point where calcium and magnesium are no longer soluble and the relative proportion of sodium increases as a result (Richards 1954). As a result of this relatively high level of sodium, alkali soils support a number of endemic and special-status species. Alkali grasslands and alkali wetlands occur only on alkali soils and contain a variety of halophytic plant species (species adapted to high salinity levels). Alkali soils of the plan area include the Pescadero clay and Solano fine sandy loam, which are found only in the northeastern portion of the study area

(Figure 2-6). There are approximately 4,234 acres of alkali soils within the study area, most of which exist in small exposures scattered throughout the northeastern portion of the study zone, particularly in drainages or depressions. However, there are two large expanses of alkali soils that support unique wetland and grassland habitats in the study area: Springtown Alkali Sink, located just north and east of the city of Livermore, and the Mountain House Grasslands and Wetlands complex in the northeast corner of the study area. The characteristics of both of these unique areas are discussed later in this chapter in Section 2.4.3.6, “Wetlands.”

2.3.4 Climate

Climatically, the study area is intermediate between the moderate, marine Mediterranean conditions of the Bay Area and the more marked seasonality of the interior Central Valley. The study area is characterized as a standard Mediterranean climate in that it has extended periods of precipitation during the winter months and virtually no precipitation from spring through autumn. For the period January 1903–December 2008, average annual maximum temperature in Livermore was 73.2° F; average minimum was 45.5° F. During that same period, the warmest month is July and the coolest is January (Western Regional Climate Center 2009).

The wet season generally extends from November through April, while rainfall from May through October tends to be minimal. Annual average rainfall varies significantly due to topography and related orographic and rain shadow effects. The average annual rainfall varies in the study area and fluctuates depending on elevation and aspect. For example, at Calaveras Reservoir, in the southwest corner of the study area, average annual precipitation was 20.10 inches for the period August 1959–June 1977; in Livermore for the period of January 1903–December 31, 2008 average annual precipitation was 14.22 inches (Western Regional Climate Center 2009). Just outside of the study area to the east, average annual rainfall in Lone Creek Canyon was 7.65 inches for the period October 1943–June 1969 (Western Regional Climate Center 2009). However, average rainfall figures can be somewhat misleading because, in addition to seasonal variation, droughts in California are not uncommon. Snow may occur in the mountains in the southern half of the study area, where the headwaters for the watersheds are located, but it melts quickly and does not provide significant flow in the late spring to early summer.

2.3.4.1 Global Climate Change

Global climate change is the observed increase in mean global temperature due to an increase in greenhouse gas emissions, primarily carbon dioxide, as a result of human industrialization (Intergovernmental Panel on Climate Change 2007).

Global climate change is also predicted to include secondary global effects such as sea-level rise and changing weather patterns.

Current global and regional trends suggest that climate change is likely to have an effect on the study area. However, current or near-term forecasting technology for modeling changes in climate at the regional or county scale is not effective. Most global climate models predict temperature increases. The change in temperature over the past century is a global average of 0.6^{o}C (33°F). To make predictions of future climate change, the baseline is set using the historical average from 1961 to 1990. A temperature increase as high as 6^{o}C (42.8°F) is predicted under climate change scenarios (Intergovernmental Panel on Climate Change 2007). According to the Intergovernmental Panel on Climate Change (2007), temperatures during the twenty-first century are predicted to increase from 2 to 3°C (35.6–37.4°F) along the western, southern, and eastern continental edges to more than 5°C (41°F) in the northern region. California-based models project average annual temperatures to rise by 3^{o}C (37.4°F) during the next 50 years (Hayhoe et al. 2004, Cayan et al. 2008). There is considerable uncertainty on whether precipitation will increase or decrease over the next half century as a result of climate change. Model predictions for California range from a 6 millimeter (0.24 inch) decrease in precipitation to a 70 millimeter (2.8 inch) increase (Hayhoe et al. 2004). Consequently, it is likely that the climate in the study area would shift to be either warmer and wetter or warmer and dryer.

Second, range and distribution of species and natural communities may shift (Parmesan 1999; Pimm 2001; Walther et al. 2002; Easterling et al. 2000). (*Range* is the area over which a species occurs or potentially occurs, whereas *distribution* refers to where a species is located within its range.) This is of particular concern for narrowly distributed species that already have restricted ranges due to urban growth or altitudinal gradients.

Also, increases in disturbance events, such as fire or flooding, could increase the distribution of disturbance-dependent land cover types, such as annual grassland within the study area (Brown and Hebda 1998; Lenihan et al. 2003; Fried et al. 2004; California Climate Change Center 2006; Rogers and Westfall 2007). An increase in the frequency and intensity of disturbance could increase the likelihood that these events will harm or kill individual covered species, many of which are already quite rare. Events that occur with unpredictable or random frequency (called *stochastic events*) such as those described above can have an inordinately negative effect on rare species.

Third, the number or density of individuals found in a particular location may change. This may be triggered in large part by changes in resource availability associated with an increase or decrease in precipitation (Martin 1998; Dukes and Mooney 1999; Walther et al. 2002; Lenihan et al. 2003; Millar et al. 2006; Pounds et al. 2006). Changes such as these may benefit one species at the expense of another.

Fourth, over a longer time period, species may change in outward appearance and behavior. Changes in climate may favor different adaptive strategies or appearances that may lead to genetic shifts (Davis and Shaw 2001).

2.3.5 Hydrology

The Alameda Creek watershed is by far the largest watershed in the county, covering more than 635 square miles (including 77% of the county), and stretching from Mount Diablo (Contra Costa County) in the north, to Mount Hamilton in the south (Santa Clara County), to Altamont Pass in the east. The general drainage pattern is east to west through three major arroyos: Arroyo las Positas, Arroyo Mocho, and Arroyo del Valle. These arroyos join Arroyo de la Laguna in Pleasanton, which drains the Livermore Valley in a southerly direction approximately 18 miles to San Francisco Bay via Niles Canyon and Alameda Creek outside of the study area (Zone 7 Water Agency 2006) (Figure 2-7).

Runoff from the northern region flows to tributaries of Alameda Creek. Runoff from much of the southern part of the watershed is either collected and stored in Calaveras and San Antonio Reservoirs, which are part of San Francisco's water system (SFPUC owns 36,000 acres of the watershed), or is collected in Lake Del Valle. Most of the watershed is undeveloped, and is either in private rangelands or public lands. Only about 7% of the total acreage of the watershed is developed.

For about 39 miles, Alameda Creek flows from its headwaters on the northwestern slopes of the Diablo Range in Santa Clara County to south San Francisco Bay. Headwater elevations are close to 4,000-feet, with stream gradients downstream through the upper reaches varying from between 1 and 5%. Alameda Creek is an intermittently perennial stream in the upper watershed, but in the Sunol Valley, where principal stream channels are broad and the substrate is characterized by deep, coarse alluvium, a high rate of infiltration results in dry reaches during the summer months. Many of the tributaries that supply flows to Alameda Creek are historically intermittent and can be isolated from the mainstem beginning in early to midsummer (Welch et al. 1961). This is especially true of streams, both natural and channelized, that drain the Livermore Valley. For example, the natural hydrology of the Alameda Creek watershed has been altered by water supply activities as well as by development and flood control.

Discharges from quarries in the Pleasanton area contribute intermittent flow in Arroyo de la Laguna, which joins Alameda Creek just upstream of Niles Canyon (Gunther et al. 2000). Most of the flow for Arroyo de la Laguna comes from releases from Lake del Valle, as well as flow from Arroyo los Positas, San Ramon creek, and Alamo Creek. Arroyo de la Laguna is the main tributary that feeds into Alameda Creek from the northwest (Figure 2-7). Arroyo de la Laguna's channel drains approximately 400 square miles of Alameda Creek watershed in the Tri-Valley region (Alameda County Resource Conservation District 2006).

Arroyo Mocho is a tributary of Arroyo de la Laguna, and its headwaters are located southeast of Livermore (Alameda Creek Alliance 2009). Arroyo Mocho has intermittent perennial flow due to fault zone seepage (Smith 1998) and the Zone 7 Artificial Recharge program that releases water from the South Bay Aqueduct into Arroyo Mocho and recharges groundwater resources (RMC 2006). This in turn has disrupted the natural hydrologic regime in Arroyo Mocho and permanently altered the ecology of the stream downstream of Livermore. The Upper watershed is unaffected by Zone 7's artificial releases; and the "hydrologic regime" remains mostly "natural".

Arroyo Valle joins Arroyo de la Laguna from the north. Flows in Arroyo Valle below Lake Del Valle are regulated by DWR's dam operations (i.e., "flood releases" and Zone 7's and ACWD's "water rights" releases; whereas above the Lake the flow regime is "natural". Sinbad Creek drains the valley created by Sunol Ridge and Pleasanton Ridge (Leidy et al. 2003). It is 7.5 miles long and drains a 6.44-mile area, joining Arroyo de la Laguna 0.5 mile upstream of Alameda Creek (Herron et al. 2004).

Arroyo Las Positas is the major drainage feature through the Livermore Valley, draining approximately 7,000 acres. The creek originates in the Altamont Hills and continues in a westerly direction, following I-580 to the confluence with Arroyo Mocho, also a tributary to Alameda Creek. Arroyo Seco drains into Arroyo Las Positas from the north (Oakland Museum of California 2009). Arroyo Los Positas is a gaining stream in its upper reaches providing for perennial flows along its entire length.

Stonybrook Creek is a tributary to Alameda Creek. The Stonybrook Creek watershed lies within Alameda County, about 7 miles east of Hayward. The watershed runs north to south and has a drainage area of 6.9 square miles. Elevations within the basin range from 160 feet at its mouth to 2,191 feet. Its mouth joins Alameda Creek in Niles Canyon, approximately 13 river miles upstream from San Francisco Bay (Love 2001).

Upper Alameda, La Costa and Indian Creeks and Arroyo Hondo occur south of San Antonio Reservoir. Indian and La Costa Creeks both flow northward and terminate at the San Antonio Reservoir (Leidy et al. 2003) (Figure 2-7). Calaveras Reservoir sits in the southwestern portion of the watershed, in both Alameda and Santa Clara Counties, while San Antonio Reservoir is to the north in Alameda County (SFPUC 2007).

Three major reservoirs have a significant impact on present hydrologic conditions in Alameda Creek. Del Valle Reservoir was completed in 1968 and is operated as a component of DWR's State Water Project (SWP). Del Valle Reservoir is managed as regulatory storage for the South Bay Aqueduct and for flood control and recreation. Del Valle Reservoir captures the entire flow of the Arroyo Valle watershed. ACWD and Zone 7 each have storage rights in Del Valle Reservoir of 7,500 acre-feet (af). The Del Valle watershed connects to Arroyo de la Laguna in the Livermore Plain. Part of the ACWD storage may be released to Arroyo Del Valle Creek, where it flows to Arroyo de la Laguna and Alameda Creek for recharge in the Niles Cone area.

SFPUC completed San Antonio Reservoir in 1965 on San Antonio Creek, 1.5 miles upstream of its confluence with Alameda Creek. San Antonio Reservoir stores water from the Hetch Hetchy Aqueduct and the SWP. It also captures all flows from the headwater streams of San Antonio Creek.

SFPUC completed Calaveras Reservoir in 1925, but hydrologic conditions may have been altered as early as 1913 when construction of the dam began. Calaveras Dam is located about 0.8 mile upstream of the Alameda Creek confluence. Calaveras Reservoir captures the flow from Calaveras Creek and the large Arroyo Hondo tributary watershed. In addition, flows from upper Alameda Creek are diverted about 3 miles upstream of the Calaveras Creek confluence through the Alameda Creek Diversion Dam tunnel into Calaveras Reservoir. Calaveras Reservoir spills relatively infrequently, about once in 5 years on average, and spills are relatively small, averaging 275 cubic feet per second (Hagar et al. 1993).

2.4 Biological Resources

2.4.1 Methods

2.4.1.1 Land Cover Mapping

One of the primary data sources for the Conservation Strategy is a detailed map of land cover types within the study area based on the geographic information system (GIS). A *land cover type* is defined as the dominant character of the land surface discernible from aerial photographs, as determined by vegetation, water, or human uses. Land cover types are the most widely used units in analyzing ecosystem function, habitat diversity, natural communities, wetlands and streams, and covered species habitat. Data sources, mapping standards, and the classification and interpretation of land cover types are discussed below.

Data Sources

The following are the primary sources of information for the land cover mapping in the study area:

- true-color aerial photographs (1.5 foot-resolution) flown in November 2005 (acquired from AirPhoto USA);
- digital ortho photography (1-meter [3.3-foot] resolution) flown in January 2005 (acquired from National Agriculture Imagery Program); and
- digital ortho photography (4-inch resolution) flown in 2007 (acquired from Zone 7).

The ancillary data sources listed below were used to obtain information not available in the primary sources and to check the mapped information for accuracy:

- wetlands in north Livermore and Alameda County from the *Vasco-Laughlin Resource Conservation Plan* (Jones & Stokes 2001);
- Alameda Rare Plants data provided by California Native Plant Society;
- Review of the land cover data layer in the north Livermore area by CNPS, especially with regard to polygons characterized as alkali meadow and scald, alkali wetland, valley sink scrub, seasonal wetland, and California annual grassland;
- rare species occurrence point data from CNDDB (2009) [some land covers could be verified by the presence of associated rare plants];
- local roads provided by the Environmental Science Research Institute (2008);
- serpentine and alkaline soils derived from soil survey information (Welch 1981; Welch et al. 1966); and
- land cover data from the SFPUC Alameda Creek watershed HCP, digitized in 2003 and based on 2001 aerial photos.

In addition to using existing data sets, ICF International staff conducted field visits in accessible portions of the study area to develop and verify land cover mapping. An initial field visit was conducted on January 25, 2008, to develop the land cover classification and to perform preliminary verification of aerial photograph signatures. Other field visits were conducted in August and September 2008 to verify land cover types and consistency of mapping and to collect additional data for land cover type descriptions. Initial mapping was verified by visual inspection from locations accessible by public roads and roads on state-owned and private lands. Areas were selected for field verification on the basis of the land cover types that were difficult to distinguish in aerial photos and accessibility. Once field visits were conducted, land cover mapping was revised on the basis of field findings.

Land Cover Type Classification

A classification system for land cover types was developed for the study area based primarily on CDFG's widely used classification system (California Department of Fish and Game 2003a, 2007), which in turn is based on the vegetation classification system developed for the *Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995). Additional input was obtained from field visits by ICF International staff and based on experience in mapping similar habitats in adjacent counties.

The land cover classification system (Table 2-3) was developed with input from vegetation and wildlife specialists familiar with the study area. The land cover classification was developed with the criteria listed below.

- Each land cover type must be distinguishable on the digital aerial photography based on a unique and consistent signature, or with the use of ancillary data such as soil types or geologic substrate.
- Each land cover type should be useful to the Conservation Strategy in terms of defining the location and extent of an important vegetation type, habitat for covered species, or unique natural community.
- The land cover type classification should be compatible with existing local, regional, and national land cover classification schemes when possible while reflecting the unique nature of many vegetative communities in Alameda County.

A list of land cover types is given in Table 2-3. A comparison of land cover types and common statewide and regional vegetation classification systems is presented in the same table (Table 2-3). An effort was also made to ensure that the land-cover classification of this Conservation Strategy was as consistent as possible with that of the other large conservation plans, including the East Contra Costa County HCP/NCCP and the Alameda Watershed HCP.

Mapping Procedures

ArcGIS 9.0 software was used to create a GIS dataset of land cover types. The land cover classification also defined the minimum mapping unit that was used for each land cover type. *Minimum mapping units* are the smallest area mapped for each type. Minimum mapping units range from 0.25 acre for wetland and riparian land cover types to 10 acres for most other land cover types. This range of minimum mapping units is sufficient for regional conservation planning and balances the need for high resolution (smaller minimum mapping unit) with schedule and budget limitations (larger minimum mapping unit). Minimum mapping units are also limited by the resolution of the imagery and the distinctiveness of the land cover signature relative to adjacent land cover.

A 10-acre minimum mapping unit was used for all land cover types, except for the land cover types noted below:

- all wetland and aquatic types, which were mapped at a 0.25-acre minimum mapping unit;
- rock outcrops, which had no minimum mapping unit (but due to aerial photo resolution had a likely minimum mapping unit of 0.1–0.25 acre); and
- riparian woodlands, which were mapped at a 0.25-acre minimum mapping unit.

The mapping process involved digitizing polygons on screen (a process known as *heads-up digitizing*) from the primary aerial photographs described above, followed by limited field verification.

Polygons were digitized for areas with distinct image signatures that met minimum mapping unit requirements. Digitizing was completed on screen by ICF staff. Digitizing was conducted while viewing the aerial imagery at mapping scales of 1:4,800 or 1:6,000. Staff was provided with grids of 0.25 acre and 10 acres to assist in maintaining the minimum mapping units during digitization. Once digitized, polygons were assigned to land cover types on the basis of the criteria in the land cover type definitions (described below under each land cover type).

During the mapping process, polygons with uncertain land cover types were flagged for verification. First, polygons were reviewed in-house by a senior botanist. However, in some cases, heavy shadows on the aerials photograph made desktop verification difficult. In these cases, upon completion of mapping, staff verified these ambiguous polygons in the field where access was available.

Serpentine bunchgrass grassland and serpentine chaparral were mapped based on the intersection of annual grassland and chaparral, respectively, with the serpentine soils and geology layers that support those natural communities.

Ancillary information was used to supplement the land cover information acquired by aerial photograph interpretation. Wetland data from the *Vasco-Laughlin Resource Conservation Plan* was used to verify and augment the wetlands mapping, especially for the alkali wetlands in the northern part of the study area. Data from Zone 7 was used as the stream layer for the study area. In addition, draft maps were presented to the Steering Committee and UAG. Within those groups, experts familiar with the vegetation in the study area provided feedback to increase the level of detail for certain land cover types in the study area, such as blue oak and valley oak woodlands, alkali grasslands, alkali wetlands, valley sink scrub, and sycamore alluvial woodlands.

Accuracy Assessment

A field accuracy assessment was performed to quantify the reliability of the oak woodlands (i.e., valley oak versus blue oak); coastal scrub, and chaparral land cover types. (A formal accuracy assessment could not be conducted for all land cover types due to the inaccessibility of large areas of the study area and limitations of project budget.) Field verification was conducted by two staff members, including one botanist. Field verification was performed by visual observation of land cover units from publicly accessible roads, sometimes using binoculars and views from vantage points where possible.

A polygon was classified in one of three ways. The first classification was "no change," meaning the polygon was mapped correctly. The second classification was "error," indicating a misinterpretation from the aerial imagery. The third classification was "change," indicating a land use change that occurred after the aerial photographs were taken.

As a result of the accuracy assessment, it was determined that the vast majority of oak woodlands in the area are dominated by blue oak. Valley oak woodlands in this area are difficult to discern during desktop mapping, and at the minimum mapping unit. Therefore, all oak woodlands in the Conservation Strategy study area were mapped as blue oak woodland land cover category. However, during plan implementation, valley oak woodlands may be located and mapped on specific parcels; therefore, this land cover category was retained, and is described below.

2.4.1.2 Focal Species

Ecology and Distribution

Species accounts of each of the 19 focal species (Table 1-1) are provided in Appendix D. These accounts summarize listing status, distribution in the study area, ecological information, and threats in the study area and the region. The accounts represent the best available scientific data for each species on which to base this Conservation Strategy. The species accounts are not intended to summarize all biological information known about a species. Rather, each account summarizes scientific information that is relevant to the species in the study area. The biological data in these accounts form the basis for the conservation strategy presented in Chapter 3.

Land cover types are the basic unit of evaluation for habitat modeling, analyzing potential impacts, and developing conservation strategies for focal species. Most focal species are associated with one or more distinctive land cover types. These land cover type associations, plus other habitat features, were used to develop habitat distribution models for 13 of the 19 focal species. These habitat associations provide additional information on the potential for species distribution and conservation needs in the study area.

2.4.1.3 Distribution of Potential Habitat

Habitat distribution models were developed for select focal species to predict where in the study area species are more likely to occur based on known habitat requirements. These models have been used to assist in filling the gaps in survey information for focal species and to assist in developing the Conservation Strategy for each species by highlighting the areas that have habitat attributes that support the species needs.[1] Habitat distribution models for 13 of the focal species are described in detail in the respective species account (and shown in Appendix D). Methods used for all models are described below.

Because of model limitations (see "Model Limitations" below), predictive models could not be developed for 6 of the 19 covered species. For longhorn fairy shrimp and vernal pool fairy shrimp, available location data and the resolution of the land cover mapping were insufficient to precisely identify potential habitat. For the callippe silverspot butterfly, the number of known occurrences within the study area was so low and the habitat requirements so general that habitat potential could not be modeled with confidence. For these species, range maps were produced based on expert knowledge of potential habitat rather than developing predictive habitat models using habitat associations. Livermore Valley tarplant and recurved larkspur did not require modeling due to the fact that suitable habitat within the study area is well known and highly restricted. Central California coastal steelhead does not currently occur in the study area due to barriers downstream of the study area in Alameda Creek. A potential habitat map was created to show habitat potential for this species should barriers be removed (rather than a suitable habitat map).

Model Structure and Development Methodology

The 13 habitat models described in the species accounts were designed to estimate the extent and location of key habitat characteristics of each species and to be repeatable and scientifically defensible, while remaining as simple as possible. The models are spatially explicit, GIS-based, "expert opinion models" based on identification of land cover types that provide important habitat for these species. Land cover types were identified as suitable habitat based on the known or presumed habitat requirements and use patterns of each species.

[1] Habitat distribution models have been developed on a regional scale using regional data. The models are intended for use in regional planning and do not provide accurate site-specific species information. For project planning, model results must always be field-verified.

When supported by appropriate data, the models also incorporate physical parameters, including:

- elevation limits, using an absolute limit when data supported a clear limit;
- soil type ;
- slope; and
- distance to highways and other urban development.

Further, in some cases, perimeter zones that were used to designate habitat are defined by a certain distance from a land cover type. For example, the California tiger salamander model identifies upland habitat for underground habitat and dispersal. Upland habitat was designated based on its distance from potential breeding sites (e.g., ponds, wetlands).

Determinations of suitable land cover types and additional physical parameters were based on available data from peer-reviewed scientific literature; survey reports; environmental documents; and local knowledge of the species, if available. When data were inconclusive or contradictory, general values were assumed in estimating suitable habitat. See below for a discussion of the model limitations.

Focal Species Locations

Documented occurrences of focal species within the study area were used to validate and refine the models. Sources of occurrence data are listed below:

- CNDDB (2009);

Tricolored Blackbird Portal (Information Center for the Environment, University of California, Davis 2009).The majority of species occurrence records come from the CNDDB (CNDDB 2009). CNDDB records represent the best available statewide occurrence data but are limited in their use for conservation planning, as discussed below.

California Natural Diversity Database Limitations

CNDDB records rely on field biologists to voluntarily submit information on the results of surveys and monitoring. As a result, the database is biased geographically toward areas where surveys have been conducted or survey efforts are greater (many areas have not been surveyed at all and this is not reflected in the database). The database may also be biased toward species that receive more survey effort. For example, there have been more surveys for California red-legged frog than other special-status wildlife because it is a listed species. Conspicuous diurnal species such as raptors likely receive greater survey effort than nocturnal species such as American badger. Plants typically receive less survey effort than wildlife. Additionally, negative survey results are not reflected in the database.

Data that are reported to the CNDDB are done so with varied precision. Some occurrences are very well documented with explicit locations (e.g., global positioning system [GPS] coordinates), while others are reported with more general location information. CNDDB staff qualitatively categorized each occurrence record into one of two categories: specific and nonspecific (California Natural Diversity Database 2009).

A *specific occurrence* has sufficient information to be located on a standard USGS 7.5-minute quadrangle map. This information may be based on political or natural features but has been very well described by the observer. These occurrences are mapped by CNDDB as points with an 80-meter (262.5-foot) radius or as specific polygons when information allows.

A *nonspecific occurrence* is a species occurrence that has been documented by the observer in very general terms. Sometimes the precise location is unclear or lacks critical information that does not allow it to be mapped accurately. These occurrences are mapped by CNDDB as circular features with a radius of 0.1, 0.2, 0.4, 0.6, 0.8, or 1.0 mile. These occurrences can also be mapped with non-specific polygons, such as the boundary of a park where an occurrence is known to occur.

Model Limitations

The precision of the habitat distribution models is limited by several factors, including the 10-acre/0.25-acre minimum mapping units used to map each land cover type. Areas of suitable habitat smaller than the mapping thresholds were not mapped and could therefore not be incorporated into the models. This constraint limited the degree of resolution of some habitat features potentially important to some species. For example, models developed for species which use wetland habitat likely underestimate the amount of habitat available on the landscape since small and seasonal wetland can often be overlooked during aerial photo interpretation. Plus, with a minimum mapping unit of 0.25 acre, many of those small patches of aquatic habitat would then be categorized as the surrounding habitat category (typically annual grassland or oak woodland), thus not adequately showing the maximum extent of aquatic habitat for that species.

The habitat distribution models were limited to distinguishing habitat uses based on key life history requirements such as breeding, foraging, or dispersal that are tied to land cover types. The data do not allow for further distinctions of habitat quality on a regional scale. To account for these limitations, conservative estimates of habitat parameters were used. This approach tends to overestimate the actual extent of suitable or required habitat for this species, but is consistent with current conservation planning practices when data are limited (Noss et al. 1997). In general the habitat models simply show where a species is more likely to occur than not, based on the basic life history requirements that have been reported in the scientific literature.

2.4.2 Biological Diversity in the Study Area

2.4.2.1 General Overview

Species richness, a measure of the number of species in a defined region, is the most readily available measure of diversity and is generally accepted as an index of biological wealth of a region. The number of species that are endemic or unique to a geographic region can provide a measure of biological distinctiveness that is recognized as another measure of biological wealth. When NatureServe, a nonprofit organization that provides scientific data for conservation efforts, examined the diversity and endemism of species for all 50 states in the United States, California ranked first in both categories (Stein 2002). The Bay Area Open Space Council is currently in the process of carrying out the Uplands Goals Project, a science-based effort to identify upland habitats, linkages, compatible uses and ecological processes required to preserve natural resources in the Bay Area (Bay Area Open Space Council 2004). A unique combination of climate, geography, and topography make California one of the most biologically diverse areas in the world. California is home to several of the nation's biological "hotspots" and has been identified as one of 25 "hotspots" of biodiversity worldwide (Stein et al. 2000).

With a geography that is bordered by the Pacific Ocean, includes San Francisco Bay, and expands eastward into the Sacramento and San Joaquin Valleys, the Bay Area is one of only six global hotspots of species rarity in the United States (California Department of Fish and Game 2003b). Nine counties comprise the Bay Area and account for just over 18,000 km^2, (6,950 $miles^2$) or nearly 5%, of the state. Within that 5%, 64 of the 194 natural communities occur (Wild 2002). This accounts for 33% of the natural communities in California. These natural communities were mapped by the California Gap Analysis project, a coordinated effort between the University of California, Santa Barbara and the USGS Biological Resources Division to assess the status of biodiversity in California.

More than a dozen major rivers flow into the Central Valley (which comprises the Sacramento and San Joaquin Valleys) from the Sierra Nevada, southern Cascade, and Coast Ranges, and these rivers flow into the Sacramento and San Joaquin Rivers. The Sacramento and San Joaquin Rivers converge in the Delta, a vast network of wetlands that ultimately empties into the Pacific Ocean via the San Francisco Bay (California Department of Fish and Game 2003b). From the south, several more rivers and creeks flow directly into San Francisco Bay and the bay itself is lined with tidal wetlands and marshes. These aquatic resources alone support over 200 species of birds, mammals, reptiles, and amphibians (California Department of Fish and Game 2003b). This interface with the San Francisco Bay, coupled with an assortment of upland habitat types with exceptional soil diversity and topography, makes the Bay Area a critical element in the biodiversity of California and of the world.

East Alameda County has important statewide examples of oak woodlands (California Department of Fish and Game 2003a) and vernal pool complexes (California Department of Fish and Game 1998). Although species counts and analyses specific to the study area have not been performed, these national and statewide studies strongly suggest that the biological diversity within the study area is high in most plant and animal groups relative to other parts of California and the United States. The highest density of nesting golden eagles in the world has been reported in the Diablo Range (Hunt and Hunt 2006). Grasslands are also dominant in east Alameda County, and they connect other ecological communities, such as oak woodlands and vernal pools. Serpentine habitats in the area support serpentine endemic plants (e.g. Cedar Mountain).

The following sections further discuss biodiversity and describe the various natural communities and land cover types of the Conservation Strategy.

2.4.3 Natural Communities and Land Cover Types

Natural communities are defined by the vegetative communities within them. Accordingly, the vegetative communities, or land cover types, within each natural community are described below and shown in Figure 2-8.

This Conservation Strategy includes seven natural communities, as defined by the groups of land cover types in Table 2-3:

- grassland;
- chaparral and coastal scrub;
- oak woodland;
- conifer woodland;
- riparian forest and scrub;
- wetlands; and
- open water.

In addition, two broad categories of nonnatural land cover types are defined and described below:

- cultivated agriculture; and
- developed.

The description of each natural community provides information on historical land cover, associated wildlife, ecosystem function, and threats. Each of the 37 land cover types used in this Conservation Strategy is discussed in one of the natural communities, as shown in Tables 2-3 and 2-4. When data are available, vegetation associations are also described for each land cover type. Vegetation associations are distinct units of plant communities defined by the dominant species of plants that are consistently found on the landscape. The results of the land cover mapping are summarized in Table 2-4 and described below for each land cover type. See Figure 2-8 for the land cover map using all land cover types.

2.4.3.1 Grassland

Grassland consists of herbaceous vegetation dominated by grasses and forbs. Grassland in the study area is classified into the six land cover types below:

- California annual grassland;
- nonserpentine native bunchgrass grassland;
- serpentine bunchgrass grassland;
- alkali meadow (including alkali scalds);
- valley sink scrub; and
- rock outcrop.

CDFG considers serpentine bunchgrass grassland, alkali meadow, and valley sink scrub as sensitive biotic communities (CNDDB 2009). Rock outcrops are most prominent in grassland communities in the northern portion of the study area, and serpentine seep is typically associated with grasslands; therefore, they are both discussed in this natural community.

Grassland Land Cover Types

Within the study area, California annual grassland was identified by its smooth, pale signature on aerial photograph, lacking the dark green signatures of woody plants taken during the summer months. Native grasslands could not be distinguished reliably from annual grasslands on the available imagery. Alkali meadows and scalds were mapped using a two-step process. First, heads up digitizing was used to determine where stands of annual grassland occur within the study area. Then, alkaline soils were overlayed with the stands of annual grassland in GIS to predict the presence of alkali meadows. Alkali meadows occur on alkaline soils of the Pescadero, Solano, Marvin, and Reyes soil series (Soil Conservation Service 1966). Finally, botanists from East Bay CNPS review several land cover polygons in the north Livermore area for accuracy. The land cover type of several of these polygons were modified based on the field experience of those individuals.

California Annual Grassland

California annual grassland occupies an estimated 116,828 acres (43%) of the study area (Table 2-4). This land cover type is found throughout the study area but is concentrated in the areas south of Pleasanton, northeast of Livermore, and in the eastern third of the study area between Livermore and the Alameda/San Joaquin County line (Figure 2-8).

California annual grassland is an herbaceous plant community dominated by nonnative annual grasses (Holland 1986, Sawyer and Keeler-Wolf 1995). In the study area, annual grassland was mapped where grasses and forbs dominate the land cover and where trees and shrubs comprise less than 10% canopy cover. The dominant species are mostly nonnative grasses from the Mediterranean basin, such as soft chess, red brome, wild oats, ripgut brome, and rat-tail fescue). In the spring, many of the annual grasslands are interspersed with a variety of native wildflowers typical of the inner Coast Ranges. Commonly found species of wildflowers in these grasslands include lupine, fiddleneck, popcornflower, California poppy, owl's clover, and clarkia (Jones & Stokes 2003). In some areas, nonnative weedy vegetation, such as thistles, mustards, and a variety of other weedy forbs, are also common.

Focal plant species that may be found in this land cover type include big tarplant and Congdon's tarplant. Focal wildlife species that could occur in California annual grasslands include San Joaquin kit fox, western burrowing owl, California red-legged frog, California tiger salamander, golden eagle, tricolored blackbird, and American badger. Alameda whipsnake may use grasslands adjacent to chaparral or scrub for movement. California red-legged frog and California tiger salamander breed in aquatic habitats (e.g., ponds) within grasslands, and use grasslands as movement and underground refugia habitat. Grassland provides potential habitat in the study area for all life stages of the federally endangered callippe silverspot butterfly (see the species account in Appendix D for more information). Several species of birds also use annual grasslands as important foraging habitat.

Nonserpentine Native Bunchgrass Grassland

Nonserpentine native bunchgrass grasslands are patchily distributed in the study area and generally occur as small patches within the larger annual grassland complex. Accordingly, nonserpentine native bunchgrass grasslands contain an abundance of nonnative annual grasses mixed with perennial grasses and forbs. Native grassland could not be distinguished from annual grassland on aerial photographs of the study area. Consequently, this land cover type was mapped as annual grassland.

Nonserpentine native bunchgrass grasslands are considered a sensitive biotic community and are dominated by native perennial bunchgrasses, such as purple needlegrass and Sandberg bluegrass. This community type likely occurred throughout most of the county in areas now characterized by annual grassland, urban development, and cultivated agriculture.

The extent of nonserpentine native bunchgrass grassland in the study area is unknown, though occurrences of this community have been reported near Bethany Reservoir and at the Lawrence Livermore National Laboratory Site 300 (on the border with San Joaquin County) (Jones & Stokes 2003). Additional stands have been reported near Brushy Peak Regional Preserve, in Sunol-Ohlone Regional Wilderness, and on private ranchlands south of Pleasanton (East Bay California Native Plant Society file information).

Serpentine Bunchgrass Grassland

Serpentine bunchgrass grassland occupies approximately 241 acres (0.09%) of the study area (Table 2-4). This land cover type is found strictly on serpentine soils or bedrock. In the study area, there are two primary stands of serpentine bunchgrass grassland: one just north of Calaveras Reservoir west of Alameda Creek, and another northeast of there on Apperson Ridge (Figure 2-8).

Serpentine grassland is considered a sensitive biotic community by CDFG. This unique type of open grassland occurs on soils derived from serpentine parent materials. The ultramafic rocks from which serpentine soils are derived are rich in magnesium, nickel, and heavy metals that may be toxic to plants and poor in calcium, nitrogen, and other nutrients required for normal plant growth (Kruckeberg 1984). Serpentine grassland is found at scattered locations in the North and South Coast Ranges and in the Sierra Nevada (Holland 1986), although most of the documented occurrences of serpentine grassland are in the Bay Area (CNDDB 2009).

The floristic composition of serpentine grassland is quite heterogeneous, both within and between sites, and dependent on both soil chemistry and the interaction of environmental factors such as slope exposure (McNaughton 1968), disturbance (Hobbs 1985; Hobbs and Mooney 1985, 1991), and annual variation in rainfall (Dobkin et al. 1987; Hobbs & Mooney 1991). Serpentine grassland is generally a mosaic of perennial bunchgrass stands and mixed assemblages of perennial and annual grasses and herbaceous wildflower species (McCarten 1987). Characteristic grass species in serpentine grassland include purple needlegrass, one-sided bluegrass, California melic, squirreltail, big squirreltail, prairie junegrass, California oatgrass, and annual fescue (Hobbs and Mooney 1985; Holland 1986; McCarten 1987; Hooper and Vitousek 1998; California Natural Diversity Database 2009). Wildflowers, most commonly California goldfields, tidy-tips, owl's-clover, California poppy, hayfield tarweed, and rosinweed, often form conspicuous patches of color within the grassland matrix. The flora is composed primarily of native species (although nonnative species such as soft chess can also be common) and is generally more diverse than the flora of grasslands on nonserpentine substrates (McNaughton 1968).

Serpentine grassland provides habitat for many plants that are endemic or near-endemic to serpentine soils, such as Sharsmith's onion.

Alkali Meadow and Scalds

Alkali meadow and scald is relatively rare in the study area. It is found on 977 acres (0.4%) in the northeast corner of the study area in scattered patches north of Livermore and in the Altamont Pass region (Table 2-4). The most notable areas where this land cover occurs include the Springtown Alkali Sink and the northeast corner of the study area between Bethany Reservoir and the Alameda/Contra Costa County line (Figure 2-8).

Dominant species in alkali meadows include saltgrass, wild barley, and alkali ryegrass. The associated herb cover consists of halophytes, including saltbush, alkali heath, alkali weed, alkali mallow, and common spikeweed. Alkali meadow (alkali grassland) community type is considered a significant natural community by CNDDB because of its rarity and the pressing threats to the remnant communities from land use conversion, invasive species, and changes in hydrologic regime within the watershed. Focal plant species that may be found in this land cover type include San Joaquin spearscale, recurved larkspur, Congdon's tarplant, palmate-bracted bird's-beak, and Livermore Valley tarplant.

Valley Sink Scrub

Valley sink scrub, also known as alkali sink scrub, was mapped on 410 acres (0.15%) of the study area. It generally occurs in the northern half of the study area, most notably in the Springtown Alkali Sink and adjacent to Frick Lake just northeast of Livermore, and in the northeast corner of the study area between Bethany Reservoir and the Alameda/Contra Costa County line in the Mountain House Alkali Grasslands and Wetlands complex. Valley sink scrub could also occur in any of the locations mapped as alkali meadow and scald, and the land cover should be mapped at the parcel scale during project review.

This community develops where clay-rich alkaline soils are seasonally saturated because of a shallow water table, low surface runoff, and slow infiltration (Bittman 1985). Valley sink scrub is rare compared with its historical extent, and most of the remaining occurrences are highly degraded (U.S. Fish and Wildlife Service 1998). This habitat is considered sensitive by CDFG (CNDDB 2009).

Valley sink scrub is dominated by a discontinuous shrub layer of iodine bush and alkali seepweed. The herbaceous layer consists of a patchwork of barren, salt-encrusted scalds and alkali grassland vegetation. Focal plant species that may occur in valley sink scrub include San Joaquin spearscale, palmate-bracted bird's beak, and Livermore Valley tarplant. Focal wildlife species that may occur or are known to occur in valley sink scrub include San Joaquin kit fox and western burrowing owl. California red-legged frogs and California tiger salamanders may use valley sink scrub for upland habitat or as habitat or for movement corridors.

Rock Outcrop

Rock outcrops are a rare land cover type, totaling 99 acres (0.04%) of the study area) (Table 2-4). They are primarily found in annual grasslands although they also can be present in chaparral and oak woodlands. This land cover type is likely underrepresented in the land cover map because these features are difficult to see on aerial photographs, particularly if they occur underneath a chaparral or woodland canopy. Accordingly, many small areas of rock outcrops are likely included in the chaparral/scrub, grassland, and oak woodland land cover types.

Rock outcrops are frequently encountered in grasslands. These outcrops are exposures of bedrock that typically lack soil and have sparse vegetation. Within the study area, several types of rock outcrops are present and are derived from sedimentary, volcanic, and metamorphic sources. Rock outcrops identifiable on aerial photographs were mapped based on their unique aerial photograph signatures. Rock outcrop signatures appear as textured areas with mottled coloring that contrasted in color and texture with the surrounding cover types on aerial photographs. There was no minimum mapping unit. The greatest concentrations of rock outcrops occurs in the north central part of the study area, just east of Brushy Peak Regional Preserve, in the Sunol-Ohlone Regional Preserve, and on private lands on Cedar Mountain.

Rock outcrops host common wildlife species such as western fence lizard and western rattlesnake. These species may use outcrops for basking and as foraging areas. Common birds include rock wren, and several species of raptors (e.g., prairie falcon) use rock outcrops for nesting or perching. In addition, the rock outcrops in the study area support unique seasonal pools, one of the few places in California where the rare longhorn fairy shrimp occurs. The rock outcrops that are known to support this species are shown in Figure D-5 in Appendix D.

Ecosystem Functions

The grassland types within the study area function as a dominant natural community, linking small and large patches of all other natural communities in the landscape such as oak woodland, riparian and aquatic communities, northern mixed chaparral/chamise chaparral, and northern coastal scrub/Diablan sage scrub. Rock outcrops, vernal pools, and seeps are contained within the larger matrix of grasslands, and in some cases, the functions and threats to the integrity of these land cover types differs from the larger grassland matrix. This section primarily addresses the grassland types.

Differences, where relevant, are noted for the land cover types contained within grasslands.

Grasslands provide critical upland habitat for a variety of amphibians dependent on adjacent aquatic habitats such as ponds and seasonal wetlands. These amphibians move through grasslands during the rainy season to disperse to other aquatic sites, and may find refugia within grasslands during the dry season. Grasslands are important for burrowing rodents such as ground squirrels and gophers. Rodent burrows, in turn, provide habitat for a variety of other species, including burrowing owls and amphibians seeking refugia. The diverse and abundant rodent community supports an assemblage of raptors that feed on them, including golden eagle, northern harrier, and white-tailed kite.

Grasslands also help maintain water quality through soil retention and by filtering out sediment and nutrients from runoff. They provide surface runoff areas, wildlife habitat, and forage for grazing livestock. The key characteristics of grassland habitat that contribute to these functions are a high cover of herbaceous vegetation and a low to absent cover of woody vegetation.

The replacement of native grasses and herbs by fast-growing nonnative annual grasses and herbs has affected ecosystem function in grasslands. Unlike perennial grasses, annual grasses generally do not develop extensive, long-lived root networks. These long-lived root networks are important to the function of the grassland ecosystem for a number of reasons, including protection of the topsoil from erosion and provision of habitat for a wide variety of soil microorganisms that create the base of the grassland food web. The production of plant biomass within grasslands has also shifted seasonally. In the past, native perennial grasses continued to grow actively into early summer and emerge from a period of dormancy early in fall. In contrast, nonnative annual grasses tend to dry out in late spring or early summer and germinate anew in fall. This shift has dramatic effects on the seasonal availability of forage for native herbivores such as insects and rabbits (and to a lesser extent, mule deer), as well as the type of seeds and cover available for smaller mammals.

The key natural disturbances that have shaped and continue to influence grassland composition and extent are fire and grazing. It is important to note that these two management tools should be utilized together to be most effective. Without some grazing pressure grassland can build up heavy biomass loads which in turn create very hot fires. Those hot fires can be detrimental to the seed bank as well as above ground vegetation. Periodic fire is an important influence on the grassland community. Historically, fires from both lightning strikes and human ignition, as well as soil conditions, kept woody vegetation from invading grassland and converting it into chaparral or oak woodland in higher elevation sites. At lower elevations, grassland was likely always the dominant vegetation community, kept open by native grazers such as tule elk and pronghorn, as well as by drought and fire. Prescribed burning has become an important management tool in grasslands and other natural communities. However, this technique is becoming increasingly difficult to implement due to cost, safety concerns from expanding urban and rural development, and difficulty obtaining permits because of air quality requirements.

Grassland is considered a fire-tolerant community. The direct effect of fire on grassland is to remove essentially all of the aboveground biomass. Fires in grasslands are therefore described as *stand-replacing fires*. The immediate effect of this biomass removal on annual grasses is negligible, as they have typically completed their growth cycle before fires occur (Howard 1998). Perennial bunchgrasses suffer a temporary loss of foliage, but regenerate immediately through tillering and regrowth of green foliage that typically remains in the center of grass tussocks (Steinberg 2002).

The immediate effect of a fire in grasslands is typically an increase in annual forb germination and flowering and an increase in overall productivity in response to the light and nutrients made available by the removal of the thatch layer (Harrison et al. 2003). In the 2 to 3 years following a fire, the elimination of the thatch layer may shift the species composition of grasslands towards annual forbs and small-seeded species such as purple needlegrass and little quaking grass (Howard 1998, Steinberg 2002). In the absence of grazing, however, a thatch layer will reestablish in approximately 3 years, and this effect will disappear. Burning appears to have little long-term effect on annual grassland (Heady 1988, Paysen et al. 2000, Kyser and Di Tomaso 2002). In grasslands that are already dominated by nonnative annual grasses, nonnatives may increase their dominance following fire by outcompeting natives for the newly available space and light. In many parts of the study area fire suppression continues. Current methods to mimic the natural disturbance that would be caused by fire include grazing, mowing, and prescribed burns. Those management techniques are discussed briefly in Chapter 3.

2.4.3.2 Chaparral and Coastal Scrub

Chaparral shrub communities are found throughout California on rocky, porous, nutrient-deficient soils and on steep slopes up to 2,000 meters (6,561.7 feet) in elevation (Keeley 2000). These communities are dominated by densely packed and nearly impenetrable drought-adapted evergreen woody shrubs, 1.5–4 meters (5–13 feet) tall, that possess small, thick, leathery sclerophyllous leaves (Hanes 1988, Keeley 2000). Herbaceous and arboreal growth forms are often lacking or play minor roles in this community (Keeley 2000). Chaparral species have both deep and shallow roots that allow them to tap water in several soil layers (Schoenherr 1992). The deep roots also allow chaparral to tolerate summer drought conditions and stay active during this period of water stress. Chaparral is divided into two land cover types in the study area:

- northern mixed chaparral/chamise chaparral; and

- mixed serpentine chaparral.

Collectively chaparral and coastal scrub communities consist of approximately 3.4% of the study area (Table 2-4). CDFG considers the latter a sensitive biotic community (CNDDB 2009).

Northern coastal scrub, in comparison, to chaparral scrub is generally characterized by low shrubs, usually 0.5–2 meters (1.6–6.6 feet) tall with soft non-sclerophyllous leaves, and interspersed with grassy openings (Holland 1986). Although coastal scrub is found in both northern and southern California, the form and variety of species varies greatly between the two regions. Coastal sage scrub in southern California is characterized by drought-deciduous shrubs that lose their leaves with the onset of arid summer conditions. In southern California, this community lacks a significant herb layer. Northern coastal scrub is characterized by the absence of drought-deciduous shrubs and the presence of an herb-rich community, which is likely a result of plentiful annual rainfall and regular summer fog (Heady et al. 1988, California Partners in Flight 2004). Northern coastal scrub is also less diverse floristically than coastal sage scrub and shrubs are generally taller and more densely spaced (California Partners in Flight 2004). The range of this northern coastal scrub can be defined as a narrow coastal strip from southern Oregon to Point Sur in Monterey County (Holland 1986; Heady et al. 1988). Because the range of northern coastal scrub is limited by climate, the Conservation Strategy study area supports some of the easternmost stands in the state.

Chaparral and northern coastal scrub land cover types provide core habitat for Alameda whipsnake. Alameda whipsnakes use these land cover types for breeding, foraging, and thermoregulation. Contiguous stands are necessary to support viable populations of Alameda whipsnakes throughout its range. Chaparral and northern coastal scrub land cover types provide upland habitat for California red-legged frogs, and foraging habitat for golden eagles. San Joaquin kit fox and American badger will move through and forage in scrub land cover types with low densities of shrub canopy cover. Areas with higher densities of shrubs are less suitable for both of those species.

Chaparral and Northern Coastal Scrub Land Cover Types

Northern Mixed Chaparral/Chamise Chaparral

Northern mixed chaparral/chamise chaparral occupies an estimated 2,684 acres, or approximately 1%, of the total study area (Table 2-4). This land cover type is found in the southeastern part of the study area. The largest stands are along Cedar Mountain Ridge southeast of Lake Del Valle and then further southeast between Mines Road and the Alameda/San Joaquin County line (Figure 2-8).

Northern mixed chaparral/chamise chaparral is classified by Holland (1986) as "broad-leaved sclerophyll shrubs, 2–4m tall, forming dense, often nearly impenetrable vegetation… [with] usually little or no understory vegetation [and] often considerable accumulation of leaf litter." Northern mixed chaparral/chamise chaparral appeared darker green in color on aerial photos than other chaparral types in all seasons, and frequently occupied larger areas. Ideally, chamise chaparral could be split into a separate land cover type but it could not be distinguished on the aerial photograph from northern mixed chaparral.

Dominant shrubs in this community in the study area are chamise, manzanita, scrub oak, and ceanothus. Other important species are toyon, coffeeberry, madrone, California bay, birchleaf mountain-mahogany, poison-oak, bush monkey flower, and California yerba santa. Some chaparral stands may be almost entirely composed of dense stands of chamise (Holland 1986).

Northern mixed chaparral may intermingle with northern coastal scrub/Diablan sage scrub, foothill pine and oak woodlands, and mixed oak woodland and forest. There seems to be a close association between northern mixed chaparral/ chamise chaparral and foothill pine and oak woodland in the study area.

Mixed Serpentine Chaparral

Mixed serpentine chaparral occupies an estimated 3,788 acres (1.4%) of the study area in at least 54 distinct patches (Table 2-4). Nearly all of the mixed serpentine chaparral is found along Cedar Ridge, between Cedar Mountain and the Alameda/Santa Clara County line. These stands are large and seem relatively contiguous on aerial photos. The site specific condition of the habitat or continuity of the land cover has not been confirmed. A small patch of mixed serpentine chaparral is located just north of Calaveras Reservoir on the west side of Alameda Creek. This patch is small and isolated, though there are patches of northern coastal scrub/Diablan sage scrub in the area (Figure 2-8).

Mixed serpentine chaparral consists of fire-adapted shrubs found on serpentine soils (California Partners in Flight 2004). Serpentine chaparral is generally more open than other chaparral types, and shrubs tend to be shorter and have leaves that are reduced, curled, or thickened (Hanes 1988, California Partners in Flight 2004). Dominant shrubs in this community in the study area are very similar to those discussed for northern mixed chaparral/ chamise chaparral, above. A common indicator shrub on serpentine soils is leather oak.

Northern Coastal Scrub/Diablan Sage Scrub

Northern coastal scrub/Diablan coastal scrub occupies an estimated 2,700 acres (1%) of the study area (Table 2-4). Though this land cover type is spread throughout the southern part of the county, most of it is concentrated in the south central part. The larger stands are located on or near SFPUC Alameda watershed lands. There are a few patches spread through the Pleasanton Hills between Pleasanton and Union City (Figure 2-8).

Northern coastal scrub/Diablan sage scrub is composed primarily of evergreen shrubs with an herbaceous understory in openings. This land cover type is usually found at elevations below 300 feet (California Partners in Flight 2004). On aerial photographs, northern coastal scrub/Diablan sage scrub appeared a distinctive shade of pale turquoise-green in summer images and pale tan in fall and winter images; this land cover type typically occurs on south facing slopes, often in relatively small stands interspersed with annual grassland and oak woodland.

Northern coastal scrub/Diablan sage scrub communities are dominated by California sagebrush and black sage, with associated species including coyote brush, California buckwheat, poison-oak, and bush monkey flower (Holland 1986). Northern coastal scrub/Diablan sage scrub occurs on both serpentine and nonserpentine substrate; however, northern coastal scrub that occurred on mapped serpentine soils was mapped as mixed serpentine chaparral. The dominant woody plants in this land cover type are nearly the same among different soil types.

Ecosystem Functions

Northern coastal scrub/Diablan sage scrub may intermingle with northern mixed chaparral/chamise chaparral, coastal prairie (grassland), and mixed evergreen forest (Heady et al. 1988) and serve as an important corridor for wildlife. In addition, small mammals tend to forage on grassland species that are close to shrub canopies because they afford greater protection (Keeley 2000). Because sage scrub species are less woody than chaparral species and tend to direct their energy to leaf growth, the structure of coastal scrub communities tends to be open with an herbaceous ground layer (California Partners in Flight 2004). This open structure is important to the white-crowned sparrow and the sage sparrow. Allen's hummingbird and the orange-crowned warbler are also associated with this land cover type. The leaves of sage scrub contain important nutrients for herbivorous insects, more so than northern mixed chaparral/chamise chaparral. Peak leaf nutrient levels in scrub appear to coincide with the height of bird breeding season and may be an important food source (California Partners in Flight 2004). California sage and black sage, members of both northern coastal scrub/Diablan sage scrub and northern mixed chaparral/chamise chaparral communities, are important food resources for small mammals, reptiles, and bird species. In addition, both communities have a relatively low proportion of nonnative species due to dense shrub canopies, soil types, and dry conditions, and thus are important resources to wildlife.

The fire-following forbs associated with northern mixed chaparral/chamise chaparral are abundant for 1 or more years after a fire and provide high-quality habitats for a diversity of insects and other wildlife. The unique flora of postfire chaparral contributes to its trait of supporting the highest concentration of special-status plants of any community in California (California Native Plant Society 2001). Many species that inhabit chaparral also inhabit adjacent grassland and oak woodlands; however, some birds and mammals are found largely in the dense cover and shade of mature chaparral stands.

Many of the plants in the chaparral and northern coastal scrub communities have evolved to be dependent on periodic fire for regeneration (Holland 1986, Hanes 1988, Schoenherr 1992). In fact, communities dominated entirely by chamise cannot sustain themselves in the absence of fire (U.S. Fish and Wildlife Service 2002). Some species of chaparral have peeling bark or volatile oils that promote fire (Schoenherr 1992). Many of the dominant shrubs, such as manzanita and ceanothus, have adapted to fire by resprouting from basal burls or woody root crowns following a fire event. Other species have seeds that require fire to initiate growth (U.S. Fish and Wildlife Service 2002, Rundel and Gustavson 2005). Regrowth is triggered by removal of the overstory, typically by fire. Chemicals in smoke and charred wood also stimulate germination in a wide variety of native forbs that lie dormant as seeds in the soil for decades before a fire. Fire occurrence that is too frequent, however, can lead to the elimination of these communities altogether and promote annual grassland succession.

2.4.3.3 Oak Woodland

One of the most common natural communities in the study area (22.1%), oak woodland is dominated by upland hardwood trees, usually various species of oaks. The oak-dominated land cover types that occur in the study area are listed below:

- blue oak woodland,
- valley oak woodland,
- coast live oak forest and woodland, and
- mixed evergreen forest/oak woodland.

These land cover types were defined as part of the oak woodland natural community, an upland tree-dominated community with at least 10% cover of hardwood tree species. Oak savannah land cover was not mapped as a separate category. Oak savannah is a transition land cover between grassland and oak woodland where oak trees are widely spaced and canopy cover is less than 10%. This community is common in the study area but due to the subjective nature of describing this land cover type when interpreting aerial photos, land covers were either categorized into grassland or oak woodland. Due to the density of trees being less than 10% oak savannahs were categorized as grassland. CDFG considers blue oak woodland and valley oak woodland sensitive biotic communities (CNDDB 2009).

Oak Woodland Land Cover Types

With the exception of blue oak woodland and valley oak woodland, the different oak woodland land cover types showed quite different signatures on aerial photographs, in terms of color and texture, and each typically occupied different landscape positions. Blue oak woodland and valley oak woodland were initially mapped as separate land cover types; however, during field verification of mapping efforts it was determined that there were inconsistencies in how valley oak woodland was mapped. It should be noted that in most areas species of oak are mixed though one species can be dominant. Since stands of valley oak woodland and black oak woodland were not able to be mapped using aerial photos, it will be necessary to ground truth oak stands that will either be affected by activities in the future or will serve as mitigation offsets.

Oak woodland-associated wildlife species addressed by the Conservation Strategy include California tiger salamander, California red-legged frog, Alameda whipsnake, golden eagle, and western burrowing owl. Alameda whipsnake may use oak woodland for movement between chaparral or coastal scrub habitats. California tiger salamanders use the grassy understory of open woodlands for dispersal or refuge and aquatic sites for breeding. The California red-legged frog uses this habitat type for breeding, foraging, and refugia. Golden eagles use woodlands and forest edges, when associated with dependable food supply, for roosting, nesting, and foraging. San Joaquin kit foxes may use this community for movement through the study area, though areas of high oak density would be less suitable. The ecotone between oak woodlands and annual grassland does provide movement habitat for San Joaquin kit fox and American badger. The western burrowing owl uses open woodlands with low-stature vegetation for foraging and burrowing. Some of these grasslands sites could be adjacent to oak woodlands.

Blue Oak Woodland

Blue oak woodland and forest occupies approximately 26,321 acres, or 9.7%, of the study area (Table 2-4). It is present in scattered locations in the southern half of the study area. This land cover typically occurs in the low to mid-elevation hills in slightly drier microclimates. Large stands of blue oak woodland occur on both west and east sides of Lake Del Valle, in the hills south of Pleasanton, and along the ridges in the south-central and southeastern portions of the county (Figure 2-8). There is potential for valley oak woodlands to be intermixed with blue oak woodland in all of these places, depending on the local site conditions. Though it is not mapped as a separate land cover, valley oak woodland is discussed below to highlight its unique attributes and differences from blue oak woodland.

Blue oak woodland was identified by the color of the canopy: pale to midgreen in summer imagery, in contrast to coast live oak, and leafless in winter. The canopy of blue oak woodland could be closed or relatively open. Aspect was important in distinguishing blue oaks from other deciduous oak species: blue oak woodland in the study area typically occurred on south-facing aspects; however, ridgetop stands of large, well-spaced blue oaks also occurred and could be difficult to distinguish from valley oaks.

Blue oak woodland is dominated by blue oak, a highly drought-tolerant species adapted to growth on thin soils in the dry foothills. Blue oaks grow slowly in these soils and may take decades to reach maturity. They generally occur on sites that are drier and have lower levels of nitrogen, phosphorus, and organic matter than those where valley oak or coast live oak are found (Griffin 1973, Baker et al. 1981). Although blue oaks can become established on south-facing slopes during wetter years or where mesic conditions are present, they are generally found on north-facing slopes (Griffin 1971). However, in the central California Coast Ranges, blue oak woodland is more common on south-facing slopes (Miles and Goudey 1997). California buckeye and foothill pine are associate tree species in this community.

The understory varies from shrubby to open, with a composition similar to that of the adjacent nonnative grassland. Understory species typically include annual grasses, hollyleaf cherry, poison-oak, and coffeeberry. Blue oak woodland is considered a sensitive community by CDFG when the following species are present: blue oak, valley oak, and coast live oak/grass (CNDDB 2009).

Valley Oak Woodland

Valley oak woodland is mapped as blue oak woodland on Figure 2-8. Due to difficulty differentiating between blue oak woodland and valley oak woodland and other mixed oak woodland alliance, these land cover types were all classified as blue oak woodland. During field verification, there were no standard rules that could be applied to the data set or the heads up digitizing that would allow this valley oak woodland to be mapped accurately. It should be noted that valley oak woodland could occur anywhere that blue oak woodland is mapped. Field verification would be necessary to confirm which type of oak woodland was present and what percentage consisted of valley oaks. For potential locations of valley oak woodland in the study area, see “Blue Oak Woodland,” above.

Although valley oak is typically found in alluvial soils in California, it also occurs in nonalluvial sites on broad ridgetops and midslope benches. Valley oak woodland is characterized by a fairly open canopy of mature valley oaks with a grassy understory, generally on valley bottoms and north-facing slopes (Griffin 1971, Holland 1986, Sawyer and Keeler-Wolf 1995). Valley oak woodlands often form a mosaic with annual grasslands, and are also found adjacent to other land cover types, including mixed oak woodland, blue oak woodland, and riparian woodland types. Valley oak woodland is generally denser on valley bottoms where the tree roots can penetrate to the groundwater, and less dense on ridges where trees need wider spacing to develop larger root systems (Griffin 1973).

Trees in the valley oak community are typically mature and well spaced. They are usually the only trees present in this open-canopy woodland and have no shrub layer, and the understory is dominated by nonnative annual grasses. As with most oak communities, regeneration typically is episodic, occurring periodically in “mast years” when acorn production is high and some acorns germinate by avoiding acorn predators such as acorn woodpeckers and California ground squirrels. Creeping wild rye, poison-oak, mugwort, and California rose are common native species in riparian portions of valley oak woodland.

Coast Live Oak Woodland and Forest

Coast live oak woodland and forest occupies approximately 1,221 acres, or 0.5%, of the study area (Table 2-4). The largest stands occur on the western side of the study area in the Pleasanton Hills just north of State Route 84 and south of Livermore between Arroyo Mocho and Lake Del Valle. There are also scattered patches on the ridges in the southwestern portion of the study area (Figure 2-8).

The coast live oak woodland and forest land cover type mostly includes stands of coast live oak, although California bay is often a major component, and other live oaks and scattered deciduous trees are often present.

Coast live oak woodland and forest was identified by its closed canopy and even dark green color that was the same in all seasons, and by its landscape position, occurring generally on north-facing valley slopes and valley bottoms. There was often an abrupt transition between annual grassland and coast live oak woodland, with coast live oak woodland occupying valley slopes and annual grassland occurring on the surrounding ridges. Coast live oak woodland also often occurred adjacent to other oak woodland types.

Grasses and herbs are common in this land cover type. Other species found in this land cover type include coffeeberry, bush monkey flower, redberry buckthorn, and California sagebrush (Allen et al. 1989). In addition, California blackberry, bugle hedge nettle, wood fern, and poison-oak can be present.

Across the Central Coast Ranges, stands occur at lower elevations (200–3,250 feet, mean 1,205 feet) on north and northeast aspects. Slopes are generally steep (36% on average), and parent material is primarily sedimentary sandstone and shale, with loam soils (Allen et al. 1989).

Mixed Evergreen Forest/Oak Woodland

Mixed evergreen forest/oak woodland is one of the most common woodland communities in the study area, occupying 32,497 acres, or 12%, of the study area (Table 2-4). It is present throughout the southern half of the study area. The largest contiguous stands are in the Pleasanton Hills, between Pleasanton and Union City, and along north facing slopes on the ridges of the south-central part of the study area (Figure 2-8).

Mixed evergreen forest/oak woodland is characterized by a diverse overstory often dominated by coast live oak. This land cover type contains a mix of co-dominant oaks such as coast live oak, blue oak, and valley oak. The canopy of this land cover type is generally more open and includes some deciduous species. In addition to the array of dominant oaks in this land cover type, a number of both broad-leafed evergreen and deciduous trees are present, including California bay, madrone, California buckeye, and black oak (Holland 1986; Sawyer and Keeler-Wolf 1995). Where shrubby, the understory consists of patches of toyon, poison-oak, and scrub oak. Where more open, the understory typically consists of annual grasses and shade-tolerant perennials, such as yerba santa and common snowberry.

Ecosystem Functions

Oak woodlands perform a variety of ecological functions, including nutrient cycling, water storage and transport, and wildlife habitat (Giusti et al. 2004). Oak woodlands share many of the same functions as the adjacent grassland and chaparral communities. However, the structure and food provided by the dominance of oak trees in this community distinguish it from the other natural community types. Oak woodland is one of the most biologically diverse communities in California, providing essential habitat for approximately 2,000 plant; 5,000 insect; 80 amphibian and reptile; 160 bird; and 80 mammal species (Merelender and Crawford 1998). Large acorn crops and a diverse insect fauna provide high-quality food for a wide variety of amphibians, reptiles, birds, and mammals.

Dense oak woodlands provide cool, shady refugia for wildlife during the hot, dry summer, and more sparse oak woodlands offer raptors ideal hunting perches. Open-canopy oak woodlands provide upland habitat for California tiger salamander, which live in burrows in the grassland understory or beneath isolated oaks. These oak woodlands also provide nesting and foraging habitat for a variety of bird species. The grassland understory provides habitat for fossorial rodents such as ground squirrels and gophers, which are prey for redtailed hawks, coyotes, and great horned owls. Rodent burrows, in turn, provide habitat for a variety of other species, including burrowing owls and amphibians.

Oak woodland is a fire-adapted ecosystem, and fire has likely played a large role in maintaining this community type in the study area. Fire creates the vegetation structure and composition typical of oak woodlands, and this natural community has experienced frequent, low-severity fires that maintain woodland or savannah conditions. In the absence of fire, the low or open understory that characterizes the land cover type is lost. Ultimately, closed-canopy oak forests are replaced by shade-tolerant species because oaks cannot regenerate and compete in a shaded understory. Soil drought may also play a role in maintaining open-tree canopy in dry woodland habitat

Recruitment of young oak trees into the population is an ongoing issue in much of California. Recruitment is often suppressed by livestock grazing and can also be influence by populations of non-native pigs. Acorns are an important food source for non-native pigs and grubbing in oak woodlands can uprooted seedlings and saplings.

A recent influence on oak woodlands is sudden oak death. The disease, first identified in 1995, has since spread to 12 counties and killed tens of thousands of oaks. Research indicates that coast live oaks and black oaks appear to be the most susceptible to this disease (Rizzo et al. 2003). Sudden oak death, caused by the pathogen *Phytophthora ramorum*, is a serious threat to oak woodlands and mixed evergreen forests in northern California. The pathogen can kill adult oaks and madrone; California bay, buckeye, and maple host the pathogen without being killed by it. Blue oak and valley oak have not shown symptoms of the pathogen. Sudden oak death has been confirmed in San Mateo, Santa Cruz, Alameda, Contra Costa, and Santa Clara Counties. As of April 2009 there are no confirmed locations of sudden oak death in the study area. However, there are confirmed locations just outside the study area near Castro Valley and surrounding Upper San Leandro Reservoir. It is unknown whether climatic or other factors will limit the spread of sudden oak death in the study area.

2.4.3.4 Conifer Woodland

In addition to hardwood-dominated upland land cover types, conifer-dominated land cover types also occur in the study area. The three conifer-dominated communities listed below occur in the study area:

- foothill pine–oak woodland,
- Coulter pine woodland, and
- Sargent cypress woodland.

Conifer Woodland Land Cover Types

Foothill Pine–Oak Woodland

Foothill pine–oak woodland occupies approximately 22,695 acres, or 8.4%, of the study area (Table 2-4). This land cover type dominates the southeastern corner of the study area, from Crane Ridge, north of Cedar Mountain, east to the Alameda/San Joaquin County line and south to the Alameda/Santa Clara County line (Figure 2-8). In addition, there are patches of this land cover type throughout the southwestern part of the study area, including some sparse patches in the Pleasanton Hills and throughout the ridges on SFPUC Alameda watershed lands.

Foothill pine–oak woodland was identified by the obvious signatures on aerial photographs of well-spaced emergent foothill pine crowns, which appear pale gray-green with clear shadows over the lower canopy of contrasting darker green evergreen oaks. Foothill pine–oak woodland often occurred along valley floors within chaparral communities in the eastern foothills, and also occurred adjacent to other oak woodland land cover types and on serpentine soils.

Found at elevations ranging from 200–2,100 feet, foothill pine integrates with blue oak and mixed oak woodlands at higher elevations, forming the foothill pine–oak woodland land cover type. Here, the canopy is dominated by emergent foothill pine with a typically dense understory of scattered shrubs, often those found in adjacent chaparral and scrub communities, and nonnative annual grasses and forbs. Oaks become more prevalent at lower elevations, often forming a closed canopy layer below the emergent pines, and the understory lacks an appreciable shrub layer. In the foothills to the east, associated canopy species include blue oak, interior live oak, coast live oak, and California buckeye (Griffin 1977). Closer to the coast, coast live oak, valley oak, blue oak, and California buckeye are typically found.

Associated shrub species include ceanothus species, bigberry manzanita, California coffeeberry, poison-oak, silver lupine, blue elderberry, California yerba santa, rock gooseberry, and California redbud.

Coulter Pine Woodland

Coulter pine woodland occupies approximately 74 acres, or 0.03%, of the study area (Table 2-4). Within the study area, Coulter pine woodlands occur on slopes at elevations ranging from 900–3,400 feet. These woodlands are bordered by mixed evergreen forest/oak woodland, blue oak woodland, and California annual grassland.

Three small stands of Coulter pine woodland occur in the southern portion of the study area. One stand is located in the Sunol Regional Wilderness, south of Maguire Peaks between Gear Road and Welch Creek; another occurs along

Indian Creek south of Wauhab Ridge. The third stand is on Rocky Ridge near the southern portion of Lake Del Valle (Figure 2-8). Coulter pine is common in the mountains of southern California and Baja California, Mexico. The study area represents the northern extent of the species' range. Small stands of this species are also found in Contra Costa, Marin, and Sonoma Counties.

Coulter pine is typically dominant in these closed canopy stands. Other tree species that are commonly associated with Coulter pine woodlands include bigcone Douglas-fir, black oak, canyon live oak, coast live oak, interior live oak, foothill pine, or ponderosa pine. The shrub layer can range from sparse to dense and the ground layer is typically sparse. Topographically, Coulter pine woodlands occur in uplands on all aspects. The soils tend to be shallow and well drained (Sawyer and Keeler-Wolf 1995).

Sargent Cypress Woodland

Sargent cypress woodland has been mapped from one location in the study area and occupies approximately 653 acres, or 0.2%, of the study area (Table 2-4). This large stand is located on the north side of Cedar Mountain and ranges from approximately 2,000–3,400 feet in elevation (Figure 2-8). This stand is bordered by mixed serpentine chaparral, foothill pine–oak woodland, blue oak woodland, and mixed evergreen forest/oak woodland. Sargent cypress woodland is likely overestimated on Cedar Mountain. In order to ensure that all of the land cover was captured, the area was mapped as one single polygon. Ground truthing was not possible, with except for viewing areas through binoculars from a distance. A more detailed map of the distribution of Sargent cypress woodland on Cedar Mountain would be beneficial to inform protection and management of this species and land cover type.

Sargent cypress is found in disjunct stands throughout many of the coastal counties of California. The stand in the study area may be highly disjunct from other stands. The nearest similar large stands occur in Marin County on Mount Tamalpais and in the Santa Lucia Mountains of Monterey County.

Sargent cypress is a common or dominant species in this stand. Other species that may be associated with Sargent cypress woodland include bigberry manzanita, valley oak, leather oak, silk tassel, California bay, foothill pine, interior live oak, and knobcone pine. Because of the inaccessibility of the Sargent cypress stand in the study area, exact species associates are uncertain. Sargent cypress woodland stands typically occur on ultramafic soil, and trees are generally less than 15 meters (49.2 feet) tall. The tree canopy of these stands is typically open and the shrub layer ranges from sparse to dense. The most common shrub in Sargent cypress woodlands is leather oak. The ground layer is typically sparse (Sawyer and Keeler-Wolf 1995, Barbour et al. 2007).

Ecosystem Functions

Similar to oak woodland, these forests and woodlands provide food, nesting, and cover to a variety of wildlife. However, the structure and food resources that conifer-dominated forests provide make them a valuable resource. Evergreen oaks such as coast live oak, as well as California bay, madrone, and foothill pine, provide year round shelter unlike the largely deciduous vegetation of riparian forest and scrub. A largely continuous, dense leaf canopy and abundant tree cavities act to shade wildlife, provide habitat for nesting and offer protection from predators. In addition, thick layers of leaf litter, ephemeral ponds, and wetlands can provide secondary habitat for soil invertebrates and amphibians by offering protection from desiccation and foraging habitat.

Mixed evergreen forest/oak woodland lacks drought adaptations and generally grows in more mesic habitats, typically on north-facing slopes (Griffin 1971, 1973). Survival of coast live oak appears to be higher for seedlings growing under a shrub canopy, apparently as a result of more mesic soil conditions under the shade of shrubs (Callaway and D'Antonio 1991; Muick 1991; Plumb and Hannah 1991; Parikh and Gale 1998). Coast live oak, the dominant species in this land cover type, has acorns that germinate relatively slowly and have a low rate of root elongation, which limits the ability of seedlings to survive under more xeric conditions (Matsuda and McBride 1986). The root system of coast live oaks consists mostly of lateral roots, a configuration that does not favor survival under xeric conditions (Callaway 1990).

A major factor influencing the distribution of conifer woodland land cover types is fire intensity and frequency. Throughout California the combination of logging and burning at the end of the nineteenth century resulted in the conversion of conifer-dominated forests to chaparral and oak-dominated woodlands. Periodic stand replacing fire is necessary to boost seed generation in many conifer species.

2.4.3.5 Riparian Forest and Scrub

Riparian vegetation in the study area was classified into four land cover types:

- mixed willow riparian scrub,
- sycamore alluvial woodland,
- mixed riparian forest and woodland, and
- desert olive scrub.

At the state level, riparian plant communities are considered sensitive because of habitat loss and their value to a diverse community of plant and wildlife species. Additionally, CDFG has identified them as a sensitive natural community (California Department of Fish and Game 2003a).

Riparian forest and scrub provide habitat for several focal wildlife species, including the California red-legged frog, foothill yellow-legged frog, and Alameda whipsnake. California red-legged frog uses riparian habitat type for breeding, foraging, and refugia. Foothill yellow-legged frog utilize aquatic habitat for thermoregulation, foraging, and avoidance of predators. Alameda whipsnake use riparian forest and scrub habitats for movement during dispersal. No focal plants are strictly associated with riparian forest and scrub land cover types.

Riparian Forest and Scrub Land Cover Types

Within the study area, riparian forest and scrub land cover types were identified primarily by their landscape position along creeks and around open water bodies. Several common riparian trees species—willows, cottonwood, and sycamore—appeared to hold their leaves after they turn color in fall, and early winter imagery clearly showed these distinctive yellow crowns, either in pure stands or mixed with the dark green canopies of coast live oak and bay in more mixed riparian woodland. The plant assemblage and width of riparian corridors found along the banks and floodplains of rivers and streams vary. Dominant influencing factors include the steepness of the channel, the frequency of disturbance, and the hydrologic regime present.

Sycamore Alluvial Woodland

Sycamore alluvial woodland occupies 597 acres comprising 17 distinct polygons in the land cover data set, which is about 0.2% of the total study area (Table 2-4). Each polygon represents a separate stand of sycamore alluvial woodland. The primary stands are along Alameda Creek, just southeast of San Antonio Reservoir, and south of Livermore along Arroyo Valle in Sycamore Grove Park (Figure 2-8).

Sycamore alluvial woodland was readily identified by the large, well-spaced sycamore crowns. In early winter aerial imagery, the large pale branches and halo of fallen golden-yellow leaves were visible. The landscape position, on broad alluvial valley floors, was also indicative of this land cover type.

The sycamore alluvial woodland land cover type is generally present on broad floodplains and terraces along low gradient streams with deep alluvium. Areas mapped as sycamore alluvial woodland are generally open canopy woodlands dominated by California sycamore, often with white alder and willows (*Salix* spp.). Other associated species include bigleaf maple, valley oak, coast live oak, and California bay.

The understory is disturbed by winter flows, and herbaceous vegetation is typically sparse or patchy. Typically, plants such as willows, coyote brush, mule fat, California buckeye, blackberry, Italian thistle, poison-oak, common chickweed and bedstraw populate the streambanks.

Although it occurs along streams, sycamore alluvial woodland undergoes extreme variation in water availability. During the rainy season, the stream channel and adjacent terraces are subject to flooding. During the summer drought, the streams are generally dry, and little moisture is available in the stony substrate. The alluvial substrate contains little soil and is nutrient poor. Flooding also subjects sycamore alluvial forest to frequent disturbance. However, this disturbance appears to benefit regeneration of western sycamores. Regeneration from seed appears to occur in pulses correlated with large flood events (Shanfield 1984). Trees that are damaged by flooding can also resprout from the roots and trunk (Shanfield 1984). Anthracnose, a fungal disease, can defoliate the trees in springtime (Holstein 1984). Heavy cattle grazing may inhibit recruitment of sycamore seedlings, although recruitment may occur under light grazing in favorable (wet) years (Smith 1989).

Mixed Riparian Forest and Woodland

Mixed riparian forest and woodland occupies approximately 2,323 acres, which is about 0.9% of the total study area (Table 2-4). Mixed riparian forest and woodland is found in association with streams throughout the study area. Stands of this land cover include sections of Arroyo de la Laguna as it passes Pleasanton, Arroyo Los Positas and Arroyo Mocho as they pass through Livermore, the upper reaches of Tassajara Creek, and several other stream courses in the study area (Figure 2-8).

Mixed riparian forest and woodland land cover types are similar to willow riparian forests and woodlands in species occurrences. They are found in and along the margins of the active channel on intermittent and perennial streams. Generally, no single species dominates the canopy, and composition varies with elevation, aspect, hydrology, and channel type. This land cover type captures much of the riparian woodland and forest in the study area and includes several associations that could not be distinguished on the aerial photographs. The major canopy species throughout the study area are California sycamore, valley oak, coast live oak, red willow, and California bay. Associated trees and shrubs include California black walnut, other species of willow, California buckeye, Fremont cottonwood, and bigleaf maple.

Focal species associated with this land cover type are the same as sycamore alluvial woodland and mixed willow riparian scrub.

Mixed Willow Riparian Scrub

Mixed willow riparian scrub occupies an estimated 664 acres in 39 unique stands, which is about 0.24% of the total study area (Table 2-4). Mixed willow riparian scrub occurs in and along the margins of the active channel on intermittent and perennial streams. In the study area, the most contiguous reach of willow riparian forest and scrub occurs along Arroyo Mocho, just southeast of Livermore, and along Arroyo Valle as it passes through Livermore (Figure 2-8).

In the east Bay Area, streamside habitat dominated by shrubby willows is classified as Central Coast Riparian Scrub (Holland 1986). Although red willow and arroyo willow remain the most common dominant canopy species in this habitat, the name of the land cover has been changed to mixed riparian forest and scrub to better reflect the conditions within the study area. Understory development in willow scrub or forest land cover types is dictated by canopy density. Where the canopy is more open and dominated by trees or scattered willow scrub, an understory of shrubs and herbs is present.

A range of conditions exists among the mixed willow riparian scrub community. Yellow willow, red willow, arroyo willow, and narrowleaf willow are the dominant canopy species in this habitat. Scrub communities typically consist of scattered willows and mule fat occurring in and along the margins of open sandy washes. Understory development in this land cover type is controlled by canopy density.

California red-legged frog and foothill-yellow legged frog utilize this land cover year-round for breeding and movement, though some of the stream course that pass through urban areas are less suitable. Alameda whipsnake uses riparian forest and scrub habitats for movement during dispersal. No covered plants are strictly associated with riparian forest and scrub land cover types. Riparian corridors in general are important as movement habitat for nearly all terrestrial species. These communities serve to connect the landscape as they move through other land cover types.

Ecosystem Function

While riparian land cover types occupy a very small percentage of the total land cover in the study area, they are particularly important because they are among the most structurally complex and richly diverse habitat types in terms of plant and animal associations.

Riparian communities support both terrestrial and aquatic species by providing movement corridors across the landscape and both nesting and foraging habitat. For example, California red-legged frog may be found in sycamore alluvial woodland year-round, while California tiger salamander and foothill yellow-legged frog may move through this land cover type. Riparian communities can also support high levels of invertebrate production; provide moist, cool refugia during the hot, dry summer; have moderate stream temperatures; help armor streambanks; and support the aquatic food chain by means of input of vegetative and other detritus. Denser canopies reduce direct solar radiation to streams and creeks, thereby lowering water temperatures and may increase habitat value for aquatic wildlife. However, algal growth, which increases aquatic insects, requires a partially open canopy for light. Increased light also improves feeding efficiency of steelhead in fast water. Differences in vegetative structure between riparian communities lead to varying effectiveness in providing these ecosystem functions. For example, mixed willow riparian scrub, with its lower vegetation structure, is often less effective in reducing stream temperatures than riparian woodland. On the other hand, it may provide better nesting and foraging habitat for migratory passerine birds that prefer the dense thicket habitat provided by scrub.

Riparian communities are shaped by their proximity to water and by periodic flooding that maintains the structure and composition of this land cover type. Wet-season flooding replenishes alluvial soils that are deficient in minerals and organic matter. Flooding also subjects riparian forest to frequent disturbance that benefits regeneration of certain species, including California sycamore, white alder, and black willow. Regeneration from seed appears to occur in pulses correlated with large flood events (Shanfield 1984). Additionally, trees that are damaged by flooding can resprout from the roots and trunk (Shanfield 1984). Flood and drought cycles of natural streams tend to result in a mosaic of structure and composition in riparian plant communities. This mosaic may be lost in altered flow regimes downstream of reservoirs.

2.4.3.6 Wetlands

Wetland habitat includes areas subject to seasonal or perennial flooding or ponding, or that possess saturated soil conditions and that support predominantly hydrophytic or “water-loving” herbaceous plant species. Because wetlands are periodically waterlogged, the plants growing in them must be able to tolerate low levels of soil oxygen associated with waterlogged or hydric soils. The presence of flood-tolerant species is often a good indication that a site is a wetland even if the ground appears to be dry for most of the year (Barbour et al. 1993), or if hydrologic influences are less obvious.

Wetland habitat in the study area is classified into three land cover types; vernal pools are described under seasonal wetlands:

- perennial freshwater marsh,
- seasonal wetland, and
- alkali wetland.

In general, wetlands represent a sensitive biotic community due to their limited distribution and importance to special-status plant and wildlife species statewide.

Wetland Land Cover Types

Within the study area, wetlands were identified and mapped on the basis of their aerial photograph signatures and landscape positions that would support wetland hydrology. In late season (May – July) aerial imagery, wetlands appear greener than surrounding annual grassland. The minimum mapping unit for all wetland land cover types was 0.25 acre. Wetland subtypes were distinguished based on the color and texture of the signature on aerial photos. On early spring (February – May) aerial imagery, perennial freshwater marsh appeared pale brown and rough in texture because the emergent plants (cattails and bulrushes) have died back and not yet started to grow. In contrast, seasonal wetlands appeared dark green, but they are difficult to distinguish from the surrounding annual grassland, which also appears dark green at this time of year. In early winter imagery, both types of wetlands appear dark green, the color of the seasonal wetlands contrasting with the adjacent annual grasslands, which at that time of year appeared brown.

The U.S. Fish and Wildlife Service's National Wetlands Inventory data layer was examined and compared with the aerial photographs to assist in the recognition of additional wetland areas, as was ICF International file data on wetlands that have been delineated north of Livermore.

Perennial Freshwater Marsh

Within the study area, perennial freshwater marsh occupies an estimated 62 acres at only 12 sites, which is 0.02% of the total study area (Table 2-4). The perennial freshwater marsh occurs primarily in small patches along stream courses or drainages as they pass through the valley floor (Figure 2-8). Perennial freshwater marsh is likely to have been underestimated in the land cover mapping due to the small size of these features and the difficulty of distinguishing marsh from the surrounding grassland on the spring aerial photos. Some perennial freshwater marsh is also difficult to distinguish from seasonal wetland during winter.

Perennial freshwater marsh is dominated by emergent herbaceous plants (reeds, sedges, grasses) with either intermittent flooded or perennially saturated soils. Freshwater marshes are found throughout the coastal drainages of California wherever water slows down and accumulates, even on a temporary or seasonal basis. A freshwater marsh usually features shallow water that is often clogged with dense masses of vegetation, resulting in deep peaty soils. Plant species common to coastal and valley freshwater marsh predominantly consist of cattails, bulrushes, sedges, and rushes. Dominant species in perennial freshwater wetland in the study area include rabbitsfoot grass, nutsedge, willow weed, and watercress. Dominant species in nontidal freshwater marsh are narrow-leaved cattail, rice cutgrass, bur-reed, alkali bulrush, and perennial peppergrass.

Focal species that may be found breeding in the perennial freshwater marsh land cover type include tricolored blackbird and California red-legged frog .

Seasonal Wetlands

Within the study area, seasonal wetlands occupy an estimated 547 acres in an estimated 80 distinct sites, which is 0.2% of the total study area (Table 2-4). These seasonal wetlands occur primarily in the northern half of the study area, particularly north of Livermore. Seasonal wetlands also occur in association with riparian land cover along Arroyo Las Positas and Altamont Creek. This land cover type often occurs adjacent to alkali wetland. These two land cover types were differentiated based on the underlying soils in the land cover mapping (Figure 2-8). Seasonal wetlands are likely underrepresented in the land cover map because of their typically small size and isolated locations, and difficulty in interpreting the photographic signature of individual features. However, large seasonal wetland complexes (i.e., groups of many small pools or wetlands) were easily visible on aerial photos.

Seasonal wetlands are freshwater wetlands that support ponded or saturated soil conditions during winter and spring and are dry through the summer and fall until the first substantial rainfall. The vegetation is composed of wetland generalists, such as hyssop loosestrife, cocklebur, and Italian ryegrass that typically occur in frequently disturbed sites, such as along streams. Common species in seasonal wetlands within the study area include watercress, water speedwell , and smartweeds (Jones & Stokes 2001). See the sections below on the Springtown Alkali Sink and Mountain House Alkali Grasslands and Wetlands for more details on the largest seasonal and alkali wetland complexes in the study area.

Vernal Pools

Vernal pools are seasonal wetlands that pond water on the surface for extended durations during winter and spring and dry completely during late spring and summer due to an underlying hardpan. This hardpan restricts the percolation of water and creates a “perched” seasonal water source. These ephemeral wetlands support rare and unique flora and fauna that are adapted to the drastic changes in hydrologic regime. They support specialized flora largely composed of native wetland plant species and fauna with life histories enabling them to tolerate the wide range of conditions in vernal pool communities.

Vernal pools in eastern Alameda and Contra Costa Counties occur in distinctive topography with low depressions mixed with hummocks or mounds. These depressions fill with rainwater and runoff from adjacent areas during the winter and may remain inundated during the spring to early summer (Tri-Valley Conservancy 2008). Vernal pools are most prevalent in California annual grasslands east and north of Livermore and in the northeast corner of the study area, northeast of Bethany Reservoir. Vernal pools are located in the grassland immediately west and north of the Springtown alkali sink, and adjacent to Cayetano Creek near its confluence with Arroyo Las Positas (Tri-Valley Conservancy 2008).

Alkali Wetlands

Within the study area, alkali wetlands occupy an estimated 717 acres, which is 0.4% of the total study area (Table 2-4). These wetlands occur primarily in the northern half of the study area, particularly along stream channels where alkali soils occur. Larger alkali wetland complexes occur in the Springtown Alkali Sink, north of Livermore, and just south of Bethany Reservoir near Mountain House (Figure 2-8). Alkali wetlands support ponded or saturated soil conditions and occur as perennial or seasonally wet features on alkali soils. Alkali wetlands were mapped where wetlands occurred in association with alkali soils (Figure 2-6).

The vegetation of alkali wetlands is composed of halophytic plant species adapted to both wetland conditions and high salinity levels. Typical species include those common to both seasonal and alkali wetlands, such as salt grass, alkali heath, and common spikeweed.

Alkali wetlands provide function and value for wildlife similar to those provided by seasonal wetlands. The array of wildlife species found in seasonal wetlands is also found in alkali wetlands. See the sections below on the Springtown Alkali Sink and Mountain House Alkali Grasslands and Wetlands for more details on the largest alkali wetland complexes in the study area.

Springtown Alkali Sink

The Springtown Alkali Sink is a biologically unique area that supports several state- and federally listed plant and wildlife species (Kohlmann et al. 2008). It encompasses approximately 1,150 acres at the northern edge of the city of Livermore and adjacent Alameda County. The sink is a topographic depression in which salts have concentrated; these salts, and the unique and complex surface and groundwater hydrology of the region, support an unusually high diversity and density of sensitive biotic communities and special-status species.

Boundary of the Sink

Historically, Springtown Alkali Sink occupied an irregularly shaped area of more than 3,000 acres. The historical boundaries of the sink can be determined through historical aerial photos and the extent of the saline-alkaline soils (Soil

Conservation Service 1966; Coats et al. 1988). The sink formerly extended west to the intersection of Hartford Avenue and North Livermore Avenue, east to Frick Lake, south almost to I-580, and north almost to the “May School Road” line (a line formed by extending May School Road to the east).

The extent of the sink has been greatly reduced by residential development in the south and agricultural operations in the north. High-quality habitats are currently found in two disjunct areas on either side of Vasco Road. This boundary is based largely on the extent of saline-alkaline soils of the Pescadero and Solano soil series, which indicates the historical extent of the sink. The larger of the two areas of the sink stretches from Ames Road in the east to North Livermore Avenue in the west. This area also includes a small watershed upstream of the intersection of Raymond Road and Ames Street that contains saline-alkaline soils and special-status species, and supports the hydrology of the sink. East of Vasco Road, the sink includes a high density of wetlands and special-status species, and the saline-alkaline soils along Brushy Peal Tributary. The most prominent feature in this area is Frick Lake, the only large saline vernal pool known to exist in the county.

Hydrology of the Sink

The sink is influenced by both surface and groundwater flows into the basin from fresh and saline sources. Surface flows to the sink come from seven south- and southwest-draining subbasins (Jones & Stokes 2003). The largest subbasins are those containing Brushy Peak Tributary and Altamont Creek; these contribute saline-alkaline flows from the east and northeast. The remaining six subbasins are considerably smaller than the Brushy Peak–Altamont Creek subbasin. In the past, the Brushy Peak–Altamont Creek subbasin contributed by far the largest proportion of surface water and groundwater entering the sink’s wetland and saline-alkaline habitats (Coats et al. 1988; Phillip Williams & Associates 1988; Questa Engineering Corporation 1998). Because of significant modifications to Altamont Creek and grading related to residential development, a greater proportion of the surface water and groundwater entering the sink’s lowland habitats now comes from subbasins to the north and northwest, particularly the subbasin that contains North Livermore Avenue (Questa Engineering Corporation 1998).

At present, the most prominent hydrologic feature in the sink is Frick Lake, located in the area’s northeastern corner. Frick Lake is a seasonally ponded basin that covers about 24 acres at high water. The lake is primarily fed by incidental precipitation and by runoff from rangelands to the east. Minor amounts of runoff also enter the lake from the north and south. Vegetation surrounding the lake suggests that its water is saline. Neither the chemistry nor the origin of the lake has been studied to date. Frick Lake may have formed as uplift along the Greenville Fault blocked westward-flowing drainages at the rangefront, pooling water behind a local topographic high; although Laughlin

Road follows the west margin of the lake, it was likely built on an existing elevated surface and does not appear to confine the lake.

The sink also contains a high density of seasonal wetlands and vernal pools. These pools fill with water in the winter and slowly dry during spring. The pools are formed in depressions within a mosaic of “hogwallow” or “mima mound” topography. The pools are fed by surface runoff in the complex microtopography and small channels that wind through the sink. These pools support a high diversity of aquatic and semiaquatic organisms, as described below.

The sink also receives significant influx of salts and flows just below the surface in a shallow groundwater layer. This shallow layer occurs from the surface to between 6 and 10 feet deep, above a semiconfining claypan/hardpan (Phillip Williams & Associates 1988; Questa Engineering Corporation 1998). Near the surface, groundwater flows into the sink through buried channels that may have been historical stream channels. These subsurface channels enter the sink from the northwest, north, and northeast. Although not well studied, they appear to extend as far west as North Livermore Avenue, as far north as Manning Road, and as far east as Laughlin Road (Questa Engineering Corporation 1998). These subsurface channels appear to play a major role in water budget and salt balance of the sink (Lamphier & Associates and SWA Group 2000), and point to the importance of preserving the groundwater hydrology within the larger watersheds of the sink.

Biotic Communities of the Sink

Biotic communities within the sink consist of valley sink scrub, alkali grassland, and California annual grassland. All three of those land cover types are described above under “Grassland,” in Section 2.4.3.1.

Special-Status Species of the Sink

The sink is unique, in part, because of its concentration of special-status species. Probably the most unique of these species is palmate-bracted bird’s beak, listed as endangered under the ESA and CESA. Other special-status plant species that occur in the sink include brittlescale, San Joaquin spearscale, hispid bird’s-beak, and Livermore Valley tarplant. Special-status wildlife species known to occur in the sink include California red-legged frog, California tiger salamander, vernal pool fairy shrimp, and western burrowing owl. San Joaquin kit fox may occasionally use the eastern portion of the sink.

Recent Changes and Continuing Threats

Recent land use changes have significantly reduced the extent of the sink and reduced its quality and functioning. Some of these changes continue to pose threats to the continued existence of the habitats and special-status species in the sink.

Land Use Changes to the Sink

Land use changes to the sink probably began with agricultural operations in the area, mostly livestock grazing, around the time of the California Gold Rush (i.e., circa 1850). By 1940, aerial photos show rural roads, including Raymond Road, Hartford Avenue, Vasco Road, and Laughlin Road, surrounding the sink (Jones & Stokes 2003). Vasco Road bisected the sink in 1940 as it does today, but all stream channels, including Altamont Creek and Brushy Peak Tributary, appear intact. Agricultural operations, including dryland farms, also surrounded the sink by 1940. No development occurred in the center of the sink until 1968, when the first of many residential subdivisions were built in and around the sink (Coats et al. 1988). With the increase in residents, the sink also experienced significant degradation from a variety of anthropogenic effects, including off-highway vehicles (OHVs); brush clearing for fire breaks; noise and light pollution from adjacent neighborhoods; and predation from pets, particularly house cats. Activities such as OHV use and brush clearing have been discontinued, but others, such as mountain bicycles, pets, and light and noise pollution, continue to degrade the functions of the sink. In the recent past a proposal was put forward to locate several acres of irrigated agriculture upstream of the sink. A change in land use of this magnitude would likely alter the hydrology of the sink even further.

Hydrologic Changes to the Sink

Altamont Creek was historically a shallow, braided channel that likely flooded parts of the sink's lowlands on an annual or biannual basis. This flooding provided important surface water and salt inputs to the sink. Altamont Creek was historically fed both by surface runoff and by outflow of shallow groundwater in the upland portions of the subbasin. In 1968 and again in 1985, Altamont Creek was widened, deepened, and channelized to increase its flood conveyance capacity (Coats et al. 1988). As a result, Altamont Creek no longer floods on an annual or biannual basis. Its current estimated flood cycle is 20 years (Questa Engineering Corporation 1998). Consequently, it now delivers significantly less surface water and soluble salts to wetlands and saline-alkali habitats in the lowland portions of the sink than it did in the past.

Beginning in 1968 and continuing through the 1980s, development has had significant impacts on drainage in the sink. For example, in the 1960s and 1970s, a number of small surface drainages were diverted. This caused gullies to form locally, lowered local groundwater levels, and reduced surface water flow into the lowland sink. Historical patterns of groundwater flowing into the sink may have been altered by recent development. Grading associated with residential development between Broadmore Street and Vasco Road may have reduced or diverted shallow subsurface flow into the sink from the watershed to the east, although subsurface flow from the north remains largely intact. Development has also likely reduced groundwater recharge by increasing the paved area in the basin and decreasing infiltration. Moreover, when Altamont Creek was channelized for flood control purposes, it was also substantially deepened. As a result, Altamont Creek may now intercept the shallow unconfined aquifer and drain groundwater that would otherwise enter the southern portion of the sink.

Mountain House Alkali Grasslands and Wetlands

The only site in Alameda County (besides the Springtown Alkali Sink) that supports alkali soils and intact stands of valley sink scrub and alkali grassland is an area of approximately 267 acres in the northeastern corner of the county referred to as the Mountain House Alkali Grassland and Wetlands complex. The site occurs near the intersection of Kelso and Bruns Roads between the Delta-Mendota Canal and the California Aqueduct. A small portion of the site extends into adjacent Contra Costa County.

In alkali grassland, dominant grasses include saltgrass and wild barley. The associated herb cover consists of halophytes, including saltbush, alkali heath, seepweed, alkali weed, saltmarsh sand spurry, and common spikeweed. Stands of iodine bush are also present, indicating valley sink scrub. Perennial wetlands at the site are abundant, dominated by stands of cattail, American bulrush, and rabbitsfoot grass. No formal biological surveys of this site have been conducted, so it is unknown whether special-status plants or wildlife are present. Special-status species that could occur on the site include San Joaquin spearscale, heartscale, California tiger salamander, California red-legged frog, and vernal pool tadpole shrimp. Cattle grazing occurs on the site but appears to be having only moderate impacts. Light to moderate livestock grazing may be beneficial to alkali grassland species because cattle reduce the cover of nonnative plants. Further study of this site is warranted to determine whether special-status species occur.

Ecosystem Functions

Wetland functional values are provided through several physical and biological processes (National Research Council 2001). Perennial and seasonal wetlands function as essential habitat for amphibians that depend on aquatic environments for reproduction and juvenile development. These wetlands also provide high levels of insect production, which in turn creates a major food source for amphibians, birds, and other insectivorous species. The cyclical nature of inundation and drought in seasonal wetlands allows these systems to support a unique suite of highly adapted biota. Perennial wetlands are permanent water sources during the dry season in an otherwise arid landscape and thus function as essential habitat for a wide variety of water-dependent wildlife.

Wetlands also perform important functions with regard to physical processes. For example, wetlands play an important role in regulating biogeochemical cycles such as the nitrogen cycle. Wetlands also mediate flows in local streams and springs by providing temporary surface water storage and gradual recharge to local aquifers. On a small scale, wetlands in the study area also reduce erosion and sedimentation by reducing surface runoff.

Marshes recharge groundwater supplies and moderate streamflow by providing water to streams. This is an especially important function during periods of drought. The presence of marshes in a watershed helps to reduce damage caused by floods by slowing and storing floodwater. As water moves slowly through a marsh, sediment and other pollutants settle down to the bottom of the marsh. Marsh vegetation and microorganisms also use excess nutrients for growth that can otherwise pollute surface water such as nitrogen and phosphorus from fertilizer.

2.4.3.7 Open Water

Open water land cover types consist of open water or aquatic habitats such as lakes, reservoirs, rivers, canals, and ponds (including quarry and stock ponds) that do not support emergent vegetation. Open water habitat in the study area is classified into five land cover types:

- pond,
- quarry pond,
- reservoir,
- stream, and
- canal/aqueduct.

Open water land cover types were historically less prevalent than they are currently. With the exception of stream land cover, lakes, reservoirs, and ponds did not exist in the study area until they were built to support livestock and provide a water supply for the human population.

Open Water Land Cover Types

Pond

There are estimated to be 686 ponds that occupy approximately 413 acres (0.15%) of the study area (Table 2-4). Ponds are scattered evenly through the study area, particularly in areas surrounded by California annual grassland, where grazing is likely to occur (Figure 2-8). Ponds are important habitat networks that facilitate species movement and increase breeding diversity.

Ponds are small (less than 20 acres) perennial or seasonal water bodies with little or no vegetation. If vegetation is present, it is typically submerged or floating. Ponds may occur naturally or may be created or expanded for livestock use (stock ponds). All ponds discernible on aerial photographs were mapped.

Ponds were easily discernible on the basis of two distinctive aerial photograph signatures. One signature— smooth, uniform, and dark black—indicates deeper and less turbid ponds. The other signature—light gray-brown—generally indicates a shallower or more turbid pond. The latter signature was more difficult to discern on the aerial photographs. Where discernible, this land cover type was mapped to the high water line. Some wetland land cover types were likely included as ponds if vegetation was sparse or not visible on photos. The minimum mapping unit was 0.25 acre. Additional ponds not discernible through the aerial photograph analysis are likely located through the study area.

The majority of the ponds in the study area are most often stock ponds that provide water to grazing livestock. Lands historically used for grazing, but currently protected as open space, also contain historical stock ponds in disrepair that may be a result of not using grazing as a management tool. Plants often associated with ponds include floating plants such as duckweed (*Lemna* spp.) or rooted plants such as cattails, bulrushes, sedges, rushes, watercress, and water primrose. Stock ponds are often surrounded by pasture with grazing livestock. Immediately adjacent to the stock pond, soil may be exposed due to the continued presence of livestock. Stock ponds without grazing may be overgrown and surrounded by wetland vegetation including willows, cattails, reeds, bulrushes, sedges, and tules, thus reducing habitat value for wildlife.

Focal species that use ponds during all or part of the year include California tiger salamander, California red-legged frog, and tricolored blackbird. These species rely on ponds and browsing animals for breeding sites. No focal plants are associated with ponds.

Quarry Pond

Quarry ponds occupy approximately 1,246 acres (0.46%) of the study area (Table 2-4) in 53 sites. Quarry ponds were differentiated from nonquarry ponds in aerial photos due to their location within quarries and their lack of vegetation. Quarry ponds are concentrated in eastern Pleasanton and western Livermore and along Alameda Creek, in the Sunol Valley (Figure 2-8).

The majority of quarry ponds lack vegetation because of a number of factors, including frequent fluctuations in water level, high levels of turbidity, and steep slopes. Quarry ponds that maintain constant water levels or that have been removed from active use (i.e., are fallow) have vegetation associations similar to those of other ponds. They may have a dense cover of tules, cattails, or willows along the pond margins, with limited emergent vegetation in the deeper interior sections.

The age and size of a quarry pond influences its biological productivity and potential to support wildlife and plant species. Like other aquatic resources, reclaimed or late-stage quarry ponds may provide foraging and resting habitat for a variety of wildlife species. These late-stage quarry ponds can support fish, waterfowl, and invertebrates. However, because most of the quarry ponds in the study area are in use and subject to high levels of turbidity and extreme fluctuations in water level, they do not support habitat for wildlife or plants. However, quarries in general can support breeding amphibians.

Quarrying operations for sand, aggregate, and gravel in the study area are located on wide alluvial floodplain terraces. Accordingly, development of quarry ponds can have a profound effect on the local hydrologic cycle and associated stream habitat and biota. The quarry ponds in the Sunol Valley tend to be deep and appear to be dug well below the depth of the local water table. Thus, these ponds may lower the local water table, reducing groundwater inputs into the stream and reducing available soil moisture for riparian plants. The effects of this hydrologic alteration may be compounded by groundwater intercepting and collecting in the quarry pond before it reaches the stream channel. Lowered local groundwater levels would also affect the stream by increasing surface water losses to groundwater during the dry season.

No focal species use quarry ponds in the study area as habitat, though western burrowing owls could use berms and levees around the edge of quarry ponds if California ground squirrels were present. The ability of this land cover type to support focal species is subject to its primary purpose and management directives.

Reservoir

Reservoirs cover 1,886 acres (0.69%) of the study area (Table 2-4). Reservoirs are open water bodies, larger than 20 acres, that are managed for water storage, water supply, flood protection, and/or recreational uses. These features were easily targeted on aerial photographs based on the smooth, uniform, dark signatures of open water. Where discernible, reservoirs were mapped to the high water line. The high water line was observed on the aerial photographs as either obvious rings of sparse vegetation or an open water signature.

The major reservoirs in the study area are San Antonio, Calaveras (partially in the study area), Lake del Valle, Chain of Lakes, and Bethany. San Antonio Reservoir, impounded by the James H. Turner Dam, was constructed in 1964 and is located 1.5 miles upstream of San Antonio Creek's confluence with Alameda Creek. San Antonio Reservoir can store approximately 50,500 af of water from a number of sources, including Alameda Creek, the Hetch Hetchy Aqueduct, and the SWP. Calaveras Reservoir was completed in 1925 and is located on Calaveras Creek, 0.8 mile upstream of its confluence with Alameda Creek. This reservoir is currently maintained at 30% of capacity because of seismic concerns. At full capacity, this reservoir can store approximately 96,900 af of water.

Lake del Valle is located approximately 5 miles south of Livermore. The lake is created by Del Valle Dam, which was placed on Arroyo del Valle. This lake receives water from the local watershed and the SWP and provides water for the South Bay Aqueduct. At full capacity, this reservoir can store approximately 77,100 af of water (DWR 2001).

Bethany Reservoir is located about 10 miles northwest of Tracy in Alameda County. The reservoir serves as a forebay for the South Bay Pumping Plant and a conveyance facility in this reach of the California Aqueduct. At full capacity, this reservoir can store approximately 4,804 af of water (DWR 2001).

Plants often associated with reservoirs include those plants common to deep water systems. Algae are the predominant plant life found in the open waters of reservoirs. Depending on reservoir temperature, water level, and other environmental conditions, algal blooms may occur, resulting in thick algal mats on the surface of the reservoir. If the reservoir edges are shallow, plant species similar to those found in ponds may be present. If the reservoir has steeper edges, water depth and fluctuations in reservoir height may prevent the establishment of vegetation. Upland and riparian trees that were not removed during the construction of the reservoir, or that were planted afterwards, may be present around the perimeter of the reservoir.

Focal species that could use the margins of reservoirs, or the inlets where streams flow into reservoirs, include California red-legged frog and tricolored blackbird.

Stream

The stream land cover type covers 244 miles within the study area (Table 2-4). Major streams in the study area include Alameda Creek, San Antonio Creek, Arroyo Valle, Arroyo Mocho, Arroyo Las Positas, Altamont Creek, and Tassajara Creek (Figure 2-7). Streams can be unvegetated along their banks or support various types of riparian vegetation. Streams that support riparian vegetation were categorized into one of the three riparian land cover types. For a complete picture of the extent of streams in the study area the stream and riparian land covers should be considered together.

The stream land cover type includes perennial, intermittent, and ephemeral watercourses characterized by a defined bed and bank. Perennial streams support flowing water year-round in normal rainfall years. These streams are often marked on USGS quadrangle maps with a blue line, and are known as *blue-line streams*. In the semiarid Mediterranean climate of the study area with its wet and dry seasons, perennial streamflows are enhanced in the dry season through groundwater aquifer contributions, flows from shallower springs/seeps, and reservoir releases. Intermittent (seasonal) streams carry water though most of the wet season (November–April) and are dry through most or all of the dry season (May–October) in a normal rainfall year. More specifically, in the wet season, intermittent streamflow occurs when the water table is raised, or rejuvenated, following early season rains that fill shallow subsurface aquifers. Intermittent flows can also be considered as the baseflows between storm events that continue on through much of the winter season. Ephemeral streams carry water only during or immediately following a rainfall event.

The stream land cover type is most closely associated with riparian plants (see the “Riparian Forest and Scrub” section above for discussion of riparian land cover types). The riparian plant composition and width of the riparian corridor vary depending on channel slope, magnitude and frequency of channel and overbank flows, and the frequency/duration of flooding flows that inundate the broader floodplain. Willows may become established in-channel in areas of sediment deposition, unless suppressed by intensive grazing. Woody debris, such as fallen trees that are submerged in streams, provides good habitat and shelter for fish and aquatic invertebrates.

Stream systems provide habitat for aquatic macroinvertebrates, which are an important food source for local and downstream populations of fish, birds, and other animals. Alameda Creek in the study area is used by rainbow trout. Further downstream, below the flood control drop structure (Bay Area Rapid Transit weir) adjacent to the Quarry Lakes Regional Recreation Area and outside of the study area, central California coast steelhead and Central Valley fall-run Chinook salmon have been observed. Central California coast steelhead use streams with suitable depths, velocities, and temperatures for juvenile rearing and feeding. Juvenile Central Valley fall-run Chinook salmon use the margins of rivers and streams after emerging from gravels to feed. They also use overhanging vegetation and substrate for cover. Focal species that rely on stream land cover include California red-legged frog, foothill yellow-legged frog, and tricolored blackbird. Alameda whipsnake and San Joaquin kit fox could use the riparian corridors adjacent to stream habitats for movement corridors.

Canal/Aqueduct

Canal/aqueduct land cover type covers 198 acres (0.07%) of the study area (Table 2-4). Both the California Aqueduct and the South Bay Aqueduct run through the northeast corner of the study area (Figure 2-8). Due to the nature of these human-made structures, canals and aqueducts are often managed for minimal vegetation to enhance the flow of water through the channels. They also convey a large amount of water and contain deep water with swift flow year-round. While these canals and aqueducts can serve as loafing habitat for some waterfowl species, they generally do not have much habitat value. In addition, because these waterways are so wide and deep, they create barriers to movement on the landscape for terrestrial species.

No focal species use the canal/aqueduct land cover type as habitat.

Ecosystem Functions

Open water land cover types perform a variety of functions in both biological and physical terms. Biologically, water is the most critical component required to support the life cycle of all aquatic and terrestrial species. Open water land cover types support the species at the lowest level of the food chain—algae. Aquatic invertebrates feed on algae and other plant debris in streams, ponds, and reservoirs. In turn, these invertebrates become food for fish, birds, bats, and other insect-feeding species. The cycle continues up the food chain, supporting species of the highest trophic levels, including large carnivores and humans.

Physically, stream systems, most notably natural stream systems, provide the essential conduits to convey flows, sediments, and nutrients across the watershed. Streams transport weathered minerals and eroded sediments from upper watershed source areas through intermediate watershed positions ultimately to lower watershed depositional areas or discharges beyond the watershed. While the general, and classical, characterization of watersheds into *upper erosional, middle transitional,* and *lower depositional* areas may often hold true, in greater detail, all areas of the watershed can witness erosion, transport, or storage functions. Nutrients from exposed soil and decomposed organic matter are also carried downstream with the sediment, across the valley floor, and finally into the estuary. Alluvial soils, high in organic content and nutrients, are excellent for agriculture. Sediment influx to estuaries helps maintain a marshland buffer along the shoreline that supports a myriad of wildlife.

Streams provide ecosystem functions and values much greater than the proportion of the landscape they occupy. Streams provide habitat for a wide array of aquatic insects that, in turn, function as food for amphibians, birds, and other insectivorous species. Perennial streams function as permanent water sources in an otherwise dry landscape. Streams also provide movement corridors between different terrestrial communities. In this way, networks of ephemeral, seasonal, and perennial streams link chaparral/scrub, oak woodland, riparian woodland, and grassland habitats. These links are not only important for the movement of wildlife, but also represent the fastest means of transporting energy and nutrients through a watershed. Thus, it is through stream networks that organic matter and minerals are transported from the highlands and deposited in the lowlands.

Stock ponds enhance all other habitats in terms of value for wildlife. Ephemeral ponds in particular, typically provide adequate breeding conditions for California tiger salamander and California red-legged frogs. Since these ponds dry in the summer, they are not suitable for non-native amphibians such as bullfrogs or fish. However, if ponds dry too early (June) they will not be wet long enough for CTS or CRLF to complete their breeding cycle. Many upland species rely on streams and ponds as water sources, especially during the dry summer months. Quarry ponds have little ecological value and contribute few ecological services. Quarrying operations can be sources of sediment in a watershed, as well as raising water temperature in streams downstream of water release points. This in turn can have a negative effect on native stream species, including migratory fishes.

Reservoirs are typically sediment sinks, obstructing the natural sediment transport of streams. Through natural processes, streams erode sediment from streambanks and move it downstream. In an unimpeded setting, sediment carried from the upper watershed is deposited along the length of the stream, thus creating an equilibrium of eroded and deposited sediment. When a dam is built across a stream, all but some of the finest sediment transported from the upper watershed drops out of suspension in the reservoir, where velocities are too low to maintain the sediment load. The resulting effect is that downstream reaches are sediment-starved, and no new sediment is available to replace eroded sediment downstream of the dam. This results in the stream downcutting and deepening and also results in a reduction in gravels suitable for steelhead and salmon spawning downstream of reservoirs.

In addition, large reservoirs fill with and store large amounts of turbid storm runoff. Settling of the finer clay and silt particles may take months, resulting in persistent releases of turbid water in winter and early spring. The slowly settling materials may also result in much higher turbidities near the bottom outlet valve than in the surface waters. While the natural streams upstream of reservoirs rapidly clear between storms, the streams downstream of reservoirs may be persistently turbid and interfere with steelhead and salmon feeding in winter and spring, reducing their growth and potential ocean survival. In addition, the slowly released fine sediments may result in silty substrate below the reservoirs, reducing survival of eggs in spawning gravels and abundance of insects. In addition, because the reservoirs are deep and store cool winter runoff, the water released out of the bottom of the reservoir can be much cooler than the surface water and also cooler than the stream upstream of the reservoir in late spring and summer.

The primary function of canals and aqueducts is to transport water for agricultural irrigation and for urban and suburban uses. The modification of channels results in a more linear alignment and does not allow a channel to meander as it would in its natural state. This results in higher flows and potential scour of the stream channel (e.g. Arroyo Mocho). Engineered channels are often constructed with high levees or channel walls. High walls keep flows within the channel and protect property that has been built adjacent to the stream.

2.4.3.8 Cultivated Agriculture

Cultivated agriculture encompasses all areas where the native vegetation has been cleared for irrigated agricultural use or dryland farming. This natural community does not include rangeland, which is characterized as an agricultural land use (most rangeland in the study area is classified as annual grassland and considered above in Section 2.4.3.1, "Grassland"). The irrigated agriculture community is classified into four land cover types:

- orchard,
- vineyard,
- developed agriculture, and
- cropland.

In all of these cases, the land may have been in production in the past but showed little or no sign of crop production currently (e.g., fallow fields). In some instances, these land cover types were indistinguishable on aerial photographs (e.g., newly planted orchards strongly resemble row crops). In such cases, the area in question was mapped as cropland.

Cultivated Agriculture Land Cover Types

Orchard

Orchards are those areas planted in fruit-bearing trees. Orchards were distinguished on the basis of tree cover, canopy characteristics, and distinctive production rows. Most orchards in Alameda County are olive orchards.

Orchards comprise an estimated 203 acres of the study area (0.1%) at 11 distinct sites (Table 2-4). There are two fallow orchards in western Pleasanton (Figure 2-8). The remaining orchards in the study area are located south of Livermore, intermixed with vineyards.

Some focal species may be found in orchards. For example, where natural open spaces abut, some individual San Joaquin kit foxes or American badgers may move through orchards. Orchards are less suitable as denning habitat for these species. Several species of birds, including western burrowing owl, tricolored blackbird, and golden eagle may forage around the edges of orchards. California red-legged frog and California tiger salamander may disperse through orchards between areas of more suitable habitat.

Vineyard

Vineyards are identified on the basis of a row production pattern and canopy characteristics. Vineyards appeared similar to orchards on the aerial photographs but were characterized by more closely spaced rows with a smaller, less dense vegetation canopy.

Vineyards occupy 2,684 acres of the study area (1.0%) (Table 2-4). Vineyards are mostly located south of Livermore, though some vineyard development is also starting north of Livermore (Figure 2-8). Vineyard development in natural habitats substantially degrades wildlife habitat. Some focal species are sometimes observed in vineyards (e.g., foraging and movement). In some areas, nonnative weedy vegetation, such as thistles, mustards, and a variety of other weedy forbs, may be found.

Developed Agriculture

Developed agriculture was identified by the presence of large agricultural buildings, such as greenhouses and shadehouses (associated with nurseries), corrals, wineries, barns/sheds, or housing. Aerial photographic signatures were generally distinctive because of their large agricultural structures or high densities of livestock.

This land cover type occupies 526 acres (0.2%) of the study area in small patches scattered throughout the study area (Table 2-4). Focal species that may be found in this land cover type include western burrowing owl (e.g., in some of the larger corrals that may be less intensively used), golden eagle, tricolored blackbird (foraging), San Joaquin kit fox, and American badger. This land cover can similarly be used by California red-legged frog and California tiger salamander as upland or movement habitat.

Cropland

Tilled land not appearing in the aerial photographs to support orchard or vineyard was mapped as cropland. Cropland is the most common of the farmland land cover types in the low-lying areas of the study area, occupying 7,923 acres (2.9%) (Table 2-4). Croplands are abundant throughout the Livermore Valley north and south of the city of Livermore (Figure 2-8).

Row-crops are those areas tilled and cultivated for agricultural crops such as corn, grain, strawberries, peppers, and pumpkins. These row-crops can also be converted to other agricultural uses. *Fallow fields* include fields that were not in production at the time of aerial photos, but may be utilized for grain, row-crops, and hay and pasture in subsequent years.

Hay and *pasture* include both dryland settings and irrigated areas. The key difference between hay production and pasture is that crops are harvested onsite and consumed offsite (hay is also cut, bailed, and trucked offsite), whereas pasture is consumed by livestock onsite. Common vegetation includes fast-growing forage grasses, such as wild oats and Italian ryegrass, as well as irrigated legumes such as alfalfa, sweet clover, and true clover. In some areas, nonnative weedy vegetation, such as thistles, mustards, and a variety of other weedy forbs, are also common.

Focal species expected to be found in this land cover type are tricolored blackbird, western burrowing owl, callippe silverspot butterfly, and golden eagle, all of which forage in grain crops and pastures. Western burrowing owls may also breed in agricultural settings if ground squirrel burrows are present. San Joaquin kit fox may move through this land cover type if it occurs near suitable grassland areas. California tiger salamander and California red-legged frog disperse through croplands to reach suitable breeding and upland habitat.

Ecosystem Functions

This land cover type has relatively low value for native plants and wildlife in terms of habitat that supports full life cycle needs of focal species. Nonetheless, cultivated agriculture does provide some benefit, although species composition and habitat value depends heavily on the planting cycle. For example, cropland has a higher value for terrestrial mammals (e.g., black-tailed jackrabbit) and herbivorous birds (e.g., red-winged blackbird) near harvest time, when the standing crop is mature and produces a quantity of food (e.g., fruit, seeds), than it does after the harvest when the cropland is fallow. Agricultural production methods can also have an impact on wildlife use. For example, production practices such as *clean farming*, where farm edges are maintained as vegetation-free areas, reduce cover and movement opportunities for wildlife; on the other hand, *wildlife friendly farming*, where native cover crops and hedgerows are used between crops and on farm edges, can increase opportunities for wildlife use in croplands.

In addition, cultivated agricultural lands often play a key role in providing connectivity between larger open space areas, especially in urbanized areas such as the Livermore Valley. Maintaining connectivity between patches of natural land cover that provide habitat supports a diversified genetic pool due to the ability of populations to disperse, comingle, and interbreed. Cultivated agriculture also often is associated with streams used for irrigation that may support riparian vegetation, trees (planted as windbreaks), and shrubs. These areas may provide habitat to songbirds, raptors, amphibians, and reptiles, as well as provide a movement corridor for other species.

2.4.3.9 Developed

Developed land cover types were mapped and described for the study area in order to describe the extent and distribution of modified lands. Developed areas were classified into the land cover types listed below:

- urban-suburban,

- rural-residential,
- landfill/solid waste,
- golf courses/urban parks,
- ornamental woodland; and
- ruderal.

Developed land cover types were mapped on the basis of their distinct signatures on aerial photographs and are readily distinguishable from naturally occurring signatures in any terrain. The minimum mapping unit for all developed land cover types was 10 acres.

Developed Land Cover Types

Developed land cover types cover 35,469 acres (13.1%) of the study area (Table 2-4). Developed areas comprise all types of development for residential, commercial, industrial, transportation, landfill, landscaping, and recreational uses (e.g., sites with structures, paved surfaces, horticultural plantings, golf courses, and irrigated lawns). Developed sites were mapped on the basis of their distinct signatures on aerial photographs. Developed areas are often characterized by geometric or regular shapes and are readily distinguished from naturally occurring signatures in any terrain.

Urban-Suburban

Urban-suburban areas comprise 28,973 acres (10.7%) of the study area (Table 2-4). The major urban-suburban area in the study area includes the cities of Livermore, Pleasanton, and Dublin. The urban-suburban land cover comprises areas where the native vegetation has been cleared for residential, commercial, industrial, transportation, or recreational structures, and is defined as one or more structures per 2.5 acres. These include areas that have structures, paved and impermeable surfaces, horticultural plantings, and lawns smaller than 10 acres (irrigated lawns larger than 10 acres were mapped as urban parks). Many small, rural residential areas were observed in the study area. Such areas were mapped as urban if they exhibited at least 10 acres of buildings, turf, and pavement. Rural residential areas of less than 10 acres that were adjacent to or surrounded by agriculture and/or natural land cover types were mapped as the adjacent land cover type.

Vegetation found in the urban-suburban land cover type is usually in the form of landscaped residences, planted street trees (i.e., elm, ash, liquidambar, pine, palm), and parklands. Most of the vegetation is composed of nonnative or cultivated plant species.

It is less likely that focal species would be found in urban-suburban areas. The exception would be western burrowing owl, which sometimes thrives in suburban areas that have been cleared for development (prior to development occurring). In addition, the alkali wetlands that occur in north Livermore (adjacent to urban development) support may alkali wetland species, including the palmate-bracted bird's beak.

Rural Residential

Rural residential areas comprise 3,198 acres (1.2%) of the study area (Table 2-4). Rural residential areas are mainly located in the foothills that surround the cities of Livermore, Pleasanton, and Dublin (Figure 2-8).

The rural residential land cover type is similar to the urban-suburban type except that it is typically much less dense (defined as less than one structure per 2.5 acres) and usually contains extensive landscaping and/or irrigated lands (including small areas of pasture).

Several covered species may be found in urban-suburban areas. Mobile species such as golden eagle, western burrowing owl, tricolored blackbird, San Joaquin kit fox, or American badger may move through rural residential land cover if it occurs adjacent to or near natural habitat. Similarly, California tiger salamander may utilize areas that have open grasslands and are near suitable breeding sites. Callippe silverspot butterfly will move through rural residential areas to disperse between patches of grassland.

Landfill

The landfill land cover type comprises 536 acres (0.2%) of the study area (Table 2-4). There are 14 landfills within the study area, only five of which are currently active (Figure 2-1). The two largest active landfills are the Altamont Landfill and Resource Recovery Facility and the Vasco Road Sanitary Landfill. The Altamont Landfill and Resource Recovery Facility has a 2,130-acre permitted facility boundary and a 472-acre permitted disposal area. The Vasco Road Sanitary Landfill has a 326-acre facility boundary and a 222-acre permitted disposal area (California Integrated Waste Management Board 2009).

Landfills are those areas where vegetation has been cleared and large amounts of soil have been moved for solid waste disposal. Typically, these areas are excavated pits into which refuse is placed and compacted. After a landfill is closed and capped, it may be returned to natural habitats through planting and management. Only active landfills were mapped in this category. Although inactive landfills were mapped as either ruderal or the natural land cover type in the surrounding area, often annual grassland, much of their area may be capped and not support ground-burrowing mammals.

Landfills are highly disturbed areas while in use. They often attract some wildlife, such as gulls, crows, pigeons, and rats.

Golf Courses/Urban Parks

Urban parks and golf courses comprise 2,759 acres (1.0%) of the study area Table 2-4). Urban parks are located within cities in the study area and tend to be smaller in scale than a county or regional park. Many serve as neighborhood or community parks. Urban parks and golf courses are located throughout the urbanized areas of the study area (Figure 2-8).

Golf courses and urban parks are composed predominantly of nonnative vegetation and provide limited habitat for native wildlife. Urban parks are unlikely to support any focal species. Golf courses on the fringe of urban areas are known to support California tiger salamander, California red-legged frog, western burrowing owl, or tricolored blackbird, particularly if ponds are present on or near the golf course. Habitat quality in and around golf courses is typically of lower quality because golf course apply fertilizers and other chemical treatments that may run off into waterways and onto adjacent lands during rain events.

Ornamental Woodland

The ornamental woodlands land cover type comprises only 40 acres (0.01%) of the study area (Table 2-4). Ornamental woodland was mapped primarily in areas surrounded by development, where the signatures on aerial photographs and locations did not meet the characteristics of oak or riparian woodlands. Ornamental woodland was included as a separate land cover type because some stands could provide habitat for raptors or other migratory birds. Ornamental woodlands are those areas where ornamental and other introduced species of trees, including eucalyptus, have been planted or naturalized and dominate, forming an open to dense canopy.

While ornamental woodland land cover does not provide appropriate habitat for most focal species, this land cover type may support breeding raptors, including the golden eagle.

Ruderal

This land cover type is relatively common in the study area (4,798 acres; 1.8%) and generally occurs on the edges of or within developed areas (Table 2-4). Areas mapped as ruderal are disturbed areas characterized by sparse nonnative, typically weedy vegetation. Most ruderal areas are vacant parcels surrounded by developed areas (Figure 2-8). Additional areas mapped as ruderal include most of the lands around gravel quarry ponds between Pleasanton and Livermore. Some areas mapped as ruderal may actually be cropland that has been left fallow for a year or more. Ruderal areas that have not experienced substantial disturbance (e.g., disking) for a number of years may develop into annual grasslands. The minimum mapping unit for the ruderal land cover type was 10 acres.

Where vegetation is present, ruderal land cover is dominated by a mixture of nonnative annual grasses and weedy species, such as black mustard, thistles, and wild radish, that tend to colonize quickly after disturbance. Wildlife common to ruderal habitats can include species closely associated with urban development, such as house sparrow, European starling, rock dove, western scrub-jay, black-tailed jackrabbit, raccoon, opossum, striped skunk, and house mouse. Focal species such as the western burrowing owl often use ruderal habitats in the Bay Area for both nesting and overwintering habitat. However, ruderal habitats frequently become overgrown with vegetation, which becomes fire-prone, dense, matted, and uninhabitable for wildlife species.

2.4.4 Habitat Connectivity and Wildlife Linkages

This section explains the importance of habitat connectivity and wildlife linkages (also known as *wildlife corridors*), summarizes potential wildlife linkages that may exist in the study area, and discusses focal and other species that might use and be affected by the fragmentation of these corridors.

Urban sprawl, roads, conversion of wildlands, and other anthropogenic influences are fragmenting habitat throughout California. Habitat fragmentation is one of the greatest threats to biodiversity because it impedes or prevents the exchange of individuals and genetic material among populations of wildlife and plants, thereby reducing genetic diversity. Genetic diversity is important in a population because it increases the chances that individuals can survive catastrophic events such as fire, disease, drought, or invasion by nonnative species. Moreover, entire populations may disappear by chance or from a catastrophic event. Habitat fragmentation may prevent suitable habitat from being recolonized from healthy populations after such an event. For larger species of mammals, long-distance movement and dispersal is an important aspect of their basic biology and is critical for their long-term survival. Habitat connectivity and wildlife linkages are particularly important in the current setting of climate change; species need to disperse to find suitable habitat they can tolerate, which is fluctuating due to shifting climate patterns. Maintaining and preserving wildlife corridors is critical to the persistence and survival of many species (California Wilderness Coalition 2001).

For the purposes of this strategy, *wildlife linkages* are defined as habitat areas that may allow for the long-distance movement of wildlife from one area to another. Linkages can be anything from a narrow strip of habitat that functions as a tunnel or conduit (i.e., only permit movement but not breeding or foraging) to a large area of intact habitat that is used for movement or dispersal and other life functions. There are two main reasons a species may need to use wildlife linkages. Some species require linkages for periodic migrations among different habitat types used for breeding, birthing, feeding, or roosting. Wildlife movement from one important habitat area to another may vary from daily to seasonal migration depending on the species. The second need for a linkage is the permanent immigration or emigration of individuals among habitat patches, allowing for gene flow and recolonization after local extinction (Beier and Noss 2000; Hilty et al. 2006; Groom et al. 2006).

Linkage requirements differ greatly from species to species. Specific characteristics of linkages, such as dimensions, location, and quality of habitat, can influence wildlife use. Wider linkages are more effective than narrower linkages (Merenlender and Crawford 1998, Hilty and Merelender 2004; Hilty et al. 2006; Groom et al. 2006). In addition, linkages that do not include adequate buffers from the urban interface or disturbed areas are not used as often. A linkage that does not function properly can become a “death trap” either by isolating individuals from a core population or by not delivering them to habitat that meets basic requirements for survival and reproduction (Groom et al. 2006).

All of the focal species, to some degree, rely on habitat linkages to maintain populations and their genetic integrity. However, some of the more mobile focal species rely on habitat linkages extensively for movement. For example, San Joaquin kit fox moves through the Altamont Hills between populations in the southern portion of its range and Contra Costa County. Golden eagle also moves extensively through the study area during migration and for local foraging while resident in the area. The Pacific Flyway, which diverges into east Alameda County, is an important migration movement corridor for raptors and other bird species. Bobcat and cougar also commonly traverse this area in search of food. These species are examples of relatively long-distance movement that requires consideration of habitat linkages at a larger scale. In contrast, California tiger salamander and California red-legged frog move over smaller distances, often from pond to pond or wetland to stream. Their movement needs must therefore be considered at a more local scale, within the study area.

Based on an assessment of the movement needs of the focal species and in order to assess and ultimately conserve connections at the scales discussed above, three categories of linkages are discussed below:

- grassland corridors in east Alameda County,
- aquatic-upland connectivity throughout the study area, and
- riparian/stream connectivity throughout study area.

2.4.4.1 Grassland Corridors

Historically, the grasslands in eastern Alameda County were all connected through the lowland valleys and stream systems through the Livermore Valley. The majority of this area has been converted to urban and agricultural uses, fragmenting and separating grassland habitat. The undeveloped northeastern portion of the study area is also bisected by I-580. This regional freeway creates a fairly impenetrable barrier between the northern and southern parts of the study area, with only a few linkages (undercrossings) under the freeway between Livermore and the Alameda/San Joaquin County line. Maintaining contiguity of this eastern part of the study area is important to the integrity of the grassland habitat complex and the wildlife populations that depend on it.

San Joaquin kit fox provides the best opportunity to discuss and perhaps study the connectivity of the grassland complex in the eastern part of the study area. The grassland complex in northeastern Alameda County contains a portion of the northernmost extent of the range for San Joaquin kit fox. Northern Contra Costa County is the northern extent of the taxon's range (USFWS 1998). The Altamont Hills in Alameda County are believed to provide an essential link to suitable kit fox habitat in the northern extreme of the species' range (H. T. Harvey & Associates 1997), allowing for genetic exchange between kit fox in Contra Costa and Alameda Counties and those further south in San Joaquin, Stanislaus, and Merced Counties.

The primary kit fox range in Alameda and Contra Costa Counties is in the Diablo Range along the eastern portion of the two counties. This area is characterized by annual grasslands with pockets of oak woodland and chaparral habitats. There appear to be three primary kit fox linkages that cross I-580 between the east edge of Livermore and the Alameda/San Joaquin County line. The main "corridor" is the wide grasslands flanking I-580 between Vasco Road and Grant Line Road. This area could also be breeding and foraging habitat for the kit fox (i.e., not just used for movement). In order for this corridor to remain functional over time, some area would need to be protected on either side of I-580 to ensure that the linkage remains open enough to facilitate kit fox movement. For the most part kit foxes moving through the Altamont Hills between northern and southern Alameda County are impeded by I-580. There are two sizeable underpasses along the stretch of freeway between Livermore and the county line: near Greenville Road in Livermore, and near the San Joaquin County line at the Grant Line Road exit and North Midway Road (Jones & Stokes 2003). There are likely additional crossing opportunities under I-580, through culverts (both water conveyance culverts and farm implement undercrossings) and along the edges of water transport canals (service roads). The importance of these small corridors to the connectivity of kit fox populations in Alameda County is unknown, but because they are so few in number and provide the only connections along a very large and generally impassable freeway, they merit further study and may warrant protection.

In addition to San Joaquin kit fox, these linkages likely provide passage for American badger; mule deer; California ground squirrel; and perhaps, in some instances, California red-legged frog; along with several other generalist wildlife species. In addition, Alameda County supports a relatively large population of nesting golden eagles (Hunt et al. 1998). Golden eagles use annual grasslands as their primary foraging habitat. They are sensitive to fragmentation of this habitat, and smaller patch sizes may lead to declines in prey populations.

2.4.4.2 Aquatic-Upland Corridors

Several special-status reptiles and amphibians rely on both aquatic and upland habitats to complete their life cycle. These species use ponds, streams, and other aquatic habitats that are interspersed within the annual grassland/oak woodland/chaparral complex in eastern Alameda County. Details about how this applies to particular focal species are discussed in the “Species Accounts” (Appendix D). Generally, aquatic habitats such as streams and ponds provide important breeding habitat, while the matrix of upland habitats between those aquatic habitats and riparian corridors that are often found along streams provide movement habitat. This movement habitat, or corridor, allows individuals from the same species but different populations to interact and ultimately breed. This allows genetic flow between and within populations and protects the species from genetic homogeneity, which over time could result in reduced numbers of individuals. To better understand the relationship between aquatic breeding resources within the study area, the spatial relationship between ponds and streams was examined through GIS analysis.

Using the pond data layer that was digitized during the land cover mapping process, a moving window analysis was used to highlight the relationship between ponds in the study area. The moving window had a radius of 1-mile (3.14 square miles). This distance was chosen as a conservative compromise between typical movement distances of California tiger salamander and California red-legged frog. Each time the moving window was moved to a new location the density of ponds in the 3.14 mile^2 areas was calculated. By repeating that process multiple times throughout the study area, a picture of the density of ponds and their relative distance to other ponds begins to emerge.

Figure 2-9 shows aquatic features in the study area in relationship to one another to estimate the degree of connectedness for species such as California tiger salamander and California red-legged frog that can move between aquatic features inter- or intraseasonally. Parts of the study area, with a higher density of aquatic features, that are “connected” have a higher probability that individual red-legged frogs or tiger salamanders could interact with other members of the local populations. The exception to that rule occurs along the I-580 corridor where the distance between aquatic resources is enough to provide reasonable connectivity to species, but the barrier that I-580 creates precludes that connectivity in most cases. Arroyo Las Positas provides a movement corridor under I-580 in several places (Jones & Stokes 2003).

Figure 2-9 also shows where there are longer distances between aquatic features. Some of these “gaps” in connectivity are the result of steeper topography, and thus a lack of stock ponds, but others are related to unnatural features on the landscape such as highways or reservoirs. Some of the areas where gaps in aquatic features emerge include:

- **area between Livermore and Dublin across Cayetano Creek** —low pond density in this area seems to leave populations between Cottonwood Creek and Cayetano Creek isolated from those in the eastern part of the study area;
- **east of Livermore and south of I-580**—this area has a low pond density relative to the rest of the study area;
- **north of Dublin, between Alamo Creek and Cottonwood Creek**—this is a connection which would allow species to move from Alameda County northwest into Contra Coast County;
- **East Bay Hills north of Alameda Creek**—there is relatively low pond density in the part of the study area. Sinbad Creek provides an aquatic connection through this part of the study area.

In Chapter 3, conservation opportunities are discussed with respect to how to create or restore habitats in these gaps that will increase regional connectivity for species dependent on aquatic features for at least part of their life cycle.

2.4.4.3 Stream-Riparian Corridors

The importance of streams and associated riparian areas for the connectivity of the study area is discussed in both the stream and riparian woodland land cover sections, above. At a landscape level, stream and riparian habitats connect the study area and serve and the primary source of nutrient movement through natural systems. At the species level, the primary functions of stream and riparian habitats are for movement and cover. Within the study area, these habitats provide movement and foraging habitat for several focal species, including Alameda whipsnake, San Joaquin kit fox, and California tiger salamander. These habitats also provide breeding habitat for California red-legged frog, foothill yellow-legged frog, and Central California coast steelhead.

Table 2-1. Simplified Land Use Planning Designations from Local General Plans

Land Use Category	Alameda County East County Area Plan (1994, amended 2000)	Dublin General Plan (updated 2007)	Livermore General Plan (2003)[i,ii]	Pleasanton General Plan (1996, currently being revised)
Buildout Date	2010	2005-2025	2003-2025	2005-2025
Urban/Developed Includes commercial, industrial, mixed uses, public uses, transportation-related developed uses, residential uses that have a density >1 DU/acre, rural lands that are occupied by residential uses.	Major Commercial (max 0.6 FAR, Downtown 1.0 FAR) Industrial (max 0.4 FAR) Mixed Uses (max 0.5 FAR) Major Public (max 0.6 FAR) Low Density Residential (1.0-4.0 DU/acre, 0.4 Commercial FAR) Medium Density Residential (4.1-8.0 DU/acre, 0.4 Commercial FAR) Medium/High Density Residential (8.1-12.0 DU/acre, 0.4 Commercial FAR) High Density Residential (12.1-25.0 DU/acre, 0.4 Commercial FAR) Very High Density Residential (25.1-75.0 DU/acre, 0.4 Commercial FAR)[iii] Rural Density Residential (1.0 DU/5 acres)[iv]	Public/Semi-Public (0.5 FAR, 580 sq ft per employee) Semi-Public (max 0.5 FAR, 590 sq ft per employee) General Commercial (0.2-0.6 FAR) Retail/Office (0.25-0.6 FAR, 200-450 sq ft per employee) Retail/Office and Automotive (0.25-0.5, 220 to 490 sq ft per employee) Neighborhood Commercial (0.25 to 0.6 FAR) General Commercial/Campus Office (0.2-0.8 FAR) Campus Office (0.25-0.8 FAR) Industrial Park (max 0.35 FAR) Business Park/Industrial (0.3-.4 FAR, 360-490 sq ft per employee) Business Park/Industrial and Outdoor Storage (0.25-0.4 FAR, 360-490 sq ft per employee) Mixed Use (0.3 to 1.0 FAR, 200-400 sq ft per employee) Medium/High-Density Residential and Retail Office (combined designation) Low-Density Single Family (0.5-3.8 DU/acre) Low Density Residential (0-6.0 DU/acre)	Service Commercial (0.3 FAR) Highway Commercial (0.3 FAR) Neighborhood Commercial (0.3 FAR) Community Serving General Commercial (0.3 FAR) Office Commercial (0.3 FAR) *Downtown Area (general designation)* Neighborhood Mixed Low Density (12.0-15.0 DU/ acre, 0.3 FAR) Neighborhood Mixed Medium Density (15.0-24.0 DU/acre, 0.3 FAR) Neighborhood Mixed High Density (24.0-38.0 DU, acre 0.3 FAR) Low Intensity Industrial (0.45 FAR) High Intensity Industrial (0.6 FAR) Vineyard Commercial Business and Commercial Park (0.3-0.5 FAR) Urban Low Residential (1.0-2.0 DU/acre)[v] Urban Low Medium Residential (2.0-3.0 DU/acre) Urban Medium Residential (3.0-4.5 DU/acre)	Commercial /Office (0.6 FAR) General and Limited Industrial (0.5 FAR) Business Park (0.6 FAR) Elementary School Middle School High School Other Public and Institutional (0.6 FAR) Mixed Use (20.0+ DU/acre, 2.0 FAR) Public Health and Safety Circulation[viii] Low Density (0-2.0 DU/acre) Medium Density (2.0-8.0 DU/acre) High Density (8.0+ DU/acre) Sand and Gravel Harvesting Rural Density (0-0.2 DU/acre)

Land Use Category	Alameda County East County Area Plan (1994, amended 2000)	Dublin General Plan (updated 2007)	Livermore General Plan (2003)[i,ii]	Pleasanton General Plan (1996, currently being revised)
Buildout Date	2010	2005-2025	2003-2025	2005-2025
		Single Family Residential (0.9-6.0 DU/acre) Medium-Density Residential (6.1-14.0 DU/acre) Medium/High-Density Residential (14.1-25.0 DU/acre) High-Density Residential (25.1+ DU/acre) Estate Residential (1.0 DU/acre)	Urban Medium High Residential (4.5-6.0 DU/acre) Urban High Residential (6.0-55.0 DU/acre)[vi] Rural Residential (1.0-5.0 DU/acre, min lot size of 1 acre) Residential Development Area Elementary School (K-6) Intermediate School (7-8) High School (9-12) Community College School – General Research & Development Post Office Fire Station Hospital Civic Center Cemetery Government Services Airport BART Station and Parking Circulation[vii]	
Agriculture Includes lands that are actively or have been used in the recent past (fallow) for agricultural uses. Includes wineries. Includes lands that are used as open rangeland or grazing land.	Large Parcel Agricultural (min parcel size of 100 acres, max 0.1 FAR, but not less than 20,000 square feet) Resource Management (min parcel size of 100 acres, max 0.1 FAR, but not less than 20,000 square feet)	Rural Residential (1.0 DU/100 acres)	Agriculture/Viticulture (1.0 DU/acre, 100 acre min site) Limited Agriculture (20 acre min) Large Parcel Agriculture (100 acre min site) Agricultural Preserve	Agriculture and Grazing

Land Use Category	Alameda County East County Area Plan (1994, amended 2000)	Dublin General Plan (updated 2007)	Livermore General Plan (2003)[i,ii]	Pleasanton General Plan (1996, currently being revised)
Buildout Date	2010	2005-2025	2003-2025	2005-2025
			Resource Management (1.0 DU/acre, 100 acre min size) Water Management (1.0 DU/acre, 100 acre min size) Hillside Conservation (1 .0 DU/20 acre to 10 DU/100 acre)	
Public Lands Includes lands that are used for park/recreation purposes Includes lands that are considered as publicly owned open space, or regional parks that may contain some trails, but do not have extensive park facilities/amenities. Note: many of these public lands also support open rangeland or grazing lands.	Water Management Lands (min parcel size of 100 acres, max 0.1 FAR) Major Parks (max 0.2 FAR) Major Public	Parks/Public Recreation Regional Park Open Space Public Lands Stream Corridor	Open Space, Parks, Trailways, Recreation Corridors, and Protected Areas Regional Open Space Open Space/Sand and Gravel	Parks and Recreation Wildlands (overlay designation)[ix] Water Management and Recreation

Notes:

DU = dwelling units

FAR = Floor Area Ratio

sq ft = square feet

i Included in the Livermore County General Plan Land Use Map is a region subject to the South Livermore Valley Specific Plan.

ii The City of Livermore also has Transferable Development Credit (TDC) receiving Site Designations which place additional provisions on land use designations. Refer to the General Plan Map for identification of TDC Receiver sites.

iii The text of the East County Area Plan includes the Very High Density Residential designation, which is not included in the Land Use Diagram.

iv The text of the East County Area Plan describes the density as 0.0-0.2 DU/acre.

v City of Livermore Rural Residential Land Use Designation includes two sub-designations. #1 1.0-1.5 DU/acre and #2 1.4-2.0 DU/acre.

vi City of Livermore Urban High Residential Land Use Designation includes six sub-designations. #1 6-8 DU/acre, #2 8-14 DU/acre, #3 14-18 DU/acre, #4 18-22 DU/acre, #5 22-38 DU/acre, and #6 38-55 DU/acre.

[vii] City of Livermore General Plan Circulation includes the following components: Freeway, Highway, Major Streets, Collector Streets, Local Streets, Intercounty Routes, Special Rural Routes, Rail Corridor, BART, Freeway Interchanges, Grade Separated Intersections, BART Stations, Intermodal Transport Facilities, and ACE Stations).

[viii] City of Pleasanton General Plan Circulation includes the following components: BART Station Freeway, Thoroughfare, Local/Collector Streets, Railroad, transportation Planning Areas.

[ix] Per the text of the City of Pleasanton General Plan (page 2-24) this is an "overlay" designation, which is additive to the underlying General Plan Map designation.

Table 2-2. Summary of Open Space in the Conservation Strategy as of October 2010

Open Space Classification	Acres in the Study Area	Percentage of Open Space in Study Area	Percentage of Total Study Area
Type 1	4,238	6.2	1.6
Type 2	24,106	36.5	8.9
Type 3	31,322	46.1	11.5
Type 4	8,310	12.2	3.1
Total	**67,976**	**100**	**25.0**

Table 2-3. Comparison of East Alameda County Conservation Strategy Land Cover Classification to Other State and Local Classification Systems

East Alameda County Conservation Strategy Land Cover Type	California Department of Fish and Game Vegetation Code[1]	California Wildlife Habitat Relationships[2] Habitat Type	Santa Clara Valley Habitat Plan[3] Land Cover Type	SFPUC Alameda Watershed HCP[4] Land Cover Type	East Contra Costa County HCP/NCCP[5] Land Cover Type	Comments
Grassland						
California annual grassland	42.000.00	Annual grassland	California annual grassland	Non-native grassland	Annual grassland	
Non-serpentine native bunchgrass grassland	41.150.00	Perennial grassland	Non-serpentine native grassland	Non-native grassland	Native grassland	Not mapped because it is not distinguishable on air photos
Serpentine bunchgrass grassland	41.280.00	Annual grassland, Perennial grassland	Serpentine bunchgrass grassland	Serpentine grassland	Not present	
Alkali meadow and scalds	45.500.00	Annual grassland, Saline emergent wetland	California annual grassland	Non-native grassland	Alkali grassland	
Valley sink scrub	36.800.00	Valley sink scrub	Not present	Not present	Not mapped	
Rock outcrop	None	None	Rock outcrop	Rock outcrop	Rock outcrop	
Chaparral and Coastal Scrub						
Northern mixed chaparral/chamise chaparral	37.000.01/ 37.101.00	Mixed chaparral/ chamise-redshank	Northern mixed chaparral/ chamise chaparral	Not mapped	Chaparral and scrub	
Mixed serpentine chaparral	37.000.06	Mixed chaparral	Mixed serpentine chaparral	Serpentine foothill pine-chaparral woodland	Not present	
Northern coastal scrub/Diablan sage scrub	32.000.00	Coastal scrub	Northern coastal scrub/Diablan sage scrub	Diablan sage scrub	Chaparral and scrub	
Oak Woodland						
Blue oak woodland	72.020.00	Blue oak woodland	Blue oak woodland	Blue oak woodland	Oak woodland, oak savanna	Includes Valley oak woodland in some parts of the study area.
Coast live oak forest and woodland	71.060.00	Coastal oak woodland	Coast live oak forest and woodland	Central coast live oak riparian forest, coast live oak riparian forest	Oak woodland	

East Alameda County Conservation Strategy Land Cover Type	California Department of Fish and Game Vegetation Code[1]	California Wildlife Habitat Relationships[2] Habitat Type	Santa Clara Valley Habitat Plan[3] Land Cover Type	SFPUC Alameda Watershed HCP[4] Land Cover Type	East Contra Costa County HCP/NCCP[5] Land Cover Type	Comments
Mixed evergreen forest/oak woodland	81.100.00	Montane hardwood-conifer	Mixed evergreen forest	Mixed evergreen forest/oak woodland	Oak woodland	
Conifer Woodland						
Foothill pine-oak woodland	87.130.05	Blue oak-foothill pine	Foothill pine-oak woodland	Not mapped	Oak woodland	
Coulter pine woodland	87.090.00	Montane hardwood-conifer	Not present	Not mapped	Not present	
Sargent cypress woodland	81.500.00	Closed-cone pine-cypress	Not present	Not mapped	Not present	
Riparian Forest and Scrub						
Sycamore alluvial woodland	61.311.00	Valley-foothill riparian	Central California sycamore alluvial woodland	Sycamore alluvial woodland	Riparian woodland/ scrub	
Mixed riparian forest and woodland	61.900.00	Valley-Foothill Riparian	Mixed riparian forest and woodland	White alder riparian forest, willow riparian forest/scrub	Riparian woodland/ scrub	
Mixed willow riparian scrub	61.200.00 63.902.00	Valley-foothill riparian	Willow riparian forest and scrub	Central coast arroyo willow forest	Riparian woodland/scrub	
Wetlands						
Perennial freshwater marsh	52.100.01	Fresh emergent wetland	Coastal and valley freshwater marsh	Freshwater marsh	Permanent wetland	
Seasonal wetland	44.000.00	Fresh emergent wetland	Seasonal wetlands	Not present	Seasonal wetland	
Alkali wetland	45.500.00 36.120.00	Freshwater emergent wetland	Not present	Not present	Alkali wetland	
Open Water						
Pond	None	Lacustrine	Pond (0.25-20 acres)	Pond	Pond	Defined as 0.25-20 acres

East Alameda County Conservation Strategy Land Cover Type	California Department of Fish and Game Vegetation Code[1]	California Wildlife Habitat Relationships[2] Habitat Type	Santa Clara Valley Habitat Plan[3] Land Cover Type	SFPUC Alameda Watershed HCP[4] Land Cover Type	East Contra Costa County HCP/NCCP[5] Land Cover Type	Comments
Quarry pond	None	Lacustrine	Not mapped	Quarry Pond	Not mapped	Defined by management
Reservoir (defined by management)	None	Lacustrine	Reservoir (defined by management)	Reservoir	Aquatic	
Riverine	None	Riverine	Riverine	Streams	Aquatic	
Canal/aqueduct	None	Riverine	Riverine	Streams	Aqueduct	
Cultivated Agriculture						
Developed agriculture	None	None	Not mapped	Not mapped	Not mapped	Includes nurseries, dairies, horse corrals
Cropland	None	Cropland	Grain, row-crop, hay and pasture, disked/short-term fallowed	Cultivated agriculture	Cropland	Dry land farming, irrigated agriculture, pasture
Orchard	None	Orchard-vineyard	Orchard and vineyard	Cultivated agriculture	Orchard	
Vineyard	None	Orchard-vineyard	Orchard	Cultivated agriculture	Vineyard	
Developed						
Urban-suburban	None	Urban	Urban-Suburban	Developed/ disturbed	Urban	
Rural-residential (<1 unit per 2.5 acres)	None	Urban	Rural—residential (<1 unit per 2.5 acres)	Developed	Urban	
Golf courses/urban parks	None	Urban	Golf courses/urban parks	Turf	Turf	
Landfill/solid waste	None	Urban	Landfill	Not present	Landfill	
Ornamental woodland	None	Eucalyptus, Urban	Ornamental woodland	Developed	Non-native woodland	Typically eucalyptus groves
Ruderal	None	None	Barren	None	Ruderal	

Notes:

[1] California Department of Fish and Game 2007

[2] CWHR = California Wildlife Habitat Relationships (Mayer and Laudenslayer 1988, 1999)

[3] Jones & Stokes June 2007 Preliminary Working Draft HCP/NCCP. Available at www.scv-habitatplan.org

[4] Jones & Stokes 2005. Alameda Watershed Habitat Conservation Plan. Prepared for the San Francisco Public Utilities Commission. Available at www.sfwater.org

[5] Jones & Stokes 2006. East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan. Available at www.cocohcp.org

Table 2-4. Land Cover Types and their Extent in the Study Area

Vegetation Type	# of Polygons	Acres[1]	Percent of Study Area (%)
Grasslands			
California annual grassland	452	116,828	43
Non-serpentine native bunchgrass grassland (not mapped)	NA	NA	NA
Serpentine bunchgrass grassland	9	241	0.09
Alkali meadow and scalds	41	977	0.4
Rock outcrop	22	99	0.04
Valley sink scrub	133	410	0.15
Chaparral and Coastal Scrub			
Northern mixed chaparral/chamise chaparral	92	2,684	1
Mixed serpentine chaparral	54	3,788	1
Northern coastal scrub/Diablan sage scrub	245	2,700	1
Oak Woodland			
Blue oak woodland	553	26,321	10
Valley oak woodland	NA	NA	NA
Coast live oak woodland and forest	72	1,221	0.5
Mixed evergreen forest/ oak woodland	394	32,497	12
Conifer Woodland			
Foothill pine—oak woodland	142	22,695	8
Coulter pine woodland	6	74	0.03
Sargent cypress woodland	1	653	0.2
Riparian Forest and Scrub			
Sycamore alluvial woodland	22	597	0.2
Mixed riparian forest and woodland	150	2,323	1
Mixed willow riparian scrub	39	664	0.2
Wetland[2]			
Perennial freshwater marsh	12	62	0.02
Seasonal wetland[3]	80	547[3]	0.2
Alkali wetland	427	717	0.3
Vernal Pool	See seasonal wetland		
Open Water (Aquatic)[2]			
Pond	686	413	0.2
Quarry pond	53	1,246	0.5
Streams	43	244[4]	0.2
Reservoir	13	1,886	1

Vegetation Type	# of Polygons	Acres[1]	Percent of Study Area (%)
Canal/aqueduct	9	198	0.1
Cultivated Agriculture			
Developed agriculture	29	526	0.2
Cropland	47	7,923	3
Orchard	12	203	0.1
Vineyard	31	2,684	1
Ruderal	49	4,798	2
Developed			
Urban-suburban	109	28,973	11
Rural—residential (< 1 unit per 2.5 acres)	123	3,198	1
Golf courses/urban parks	98	2,759	1
Landfill/solid waste	3	536	0.2
Ornamental woodland	3	40	0.01
Total	**5,109**	**271,485**	**100**

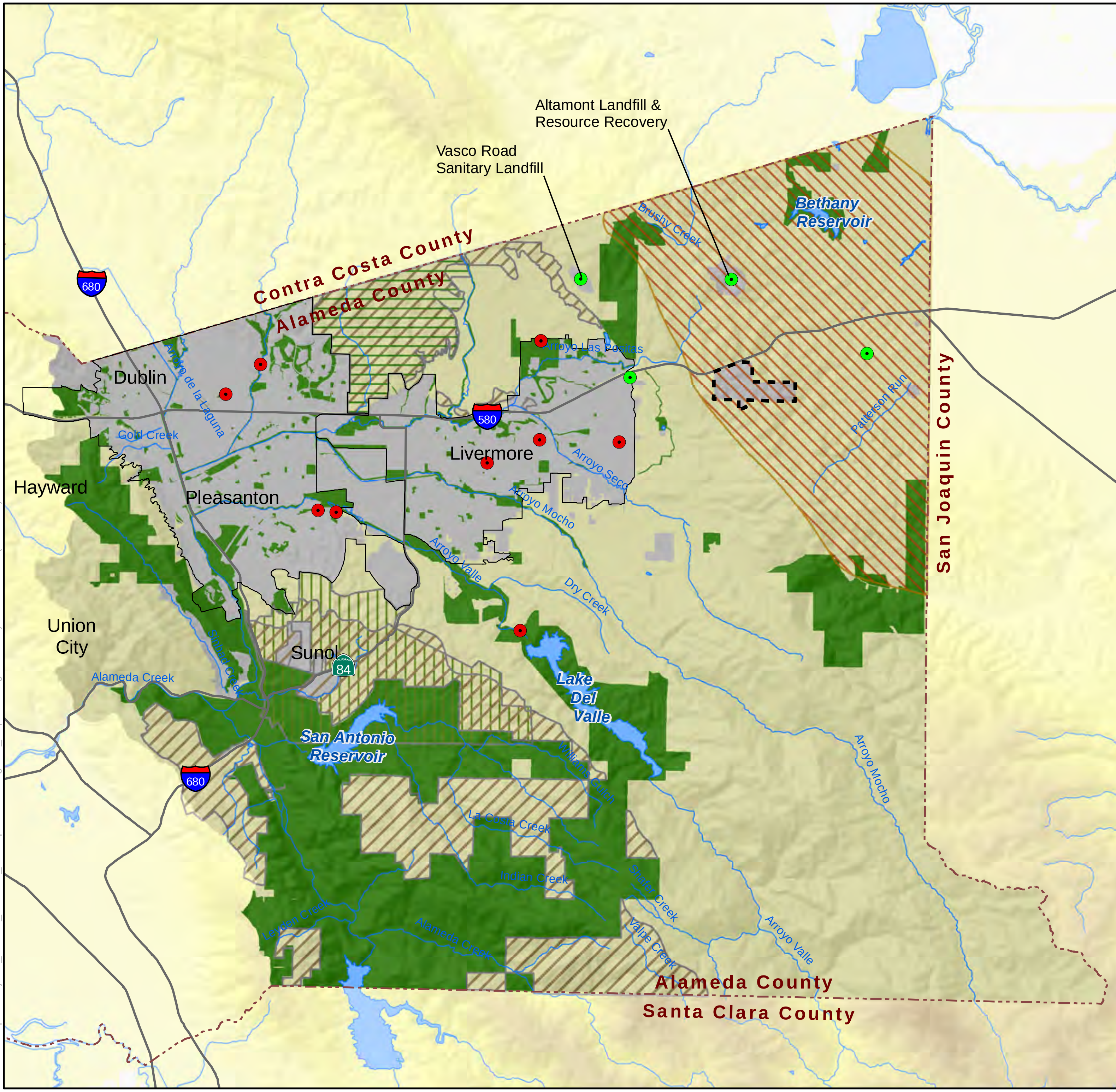
[1] Discrepancies between the total acreage of the study area (271,485) and the total of all land cover types shown in this table are the result of rounding land cover acreages to the nearest whole number.

[2] The number of polygons identified for each wetland or open water land cover type is equal to the total number of water bodies (e.g., 686 polygons for the pond land cover type indicates there are 686 mapped ponds in the study area). Numbers for wetlands indicate single wetlands or wetland complexes (e.g., seasonal wetlands).

[3] Seasonal wetlands include vernal pool complexes. While there are data available on many of the vernal pools that exist in the study area, the dataset is incomplete. In order to ensure that all seasonal wetlands are investigated to determine if they have vernal pool characteristics this land cover category has been kept general.

[4] The number represented in streams miles.

Figure 2-1
East Alameda County Simplified Land Use Planning Designations from Local General Plans
October 2010



Urban Growth Boundary
County Line
Highways
Streams
Lakes

Land Use Planning Designations
Public Land
Agriculture
Urban

Land Use Designations
County Resource Management
Livermore Resource Management
Pleasanton Wildland
Wind Resource Area

Solid Waste Facilities
Active
Closed
Future Solid Waste Permit Area

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Miles

Sources:
City of Livermore General Plan, 2003
City of Dublin Land Use, 2007
City of Pleasanton General Plan, 1996
Alameda County East County Area Plan, 2000
East Bay Regional Park District
Alameda County Community Development Agency, 2002

*The "Public Lands" classification is based on local government land use designations. Public open space is represented on a separate, open space map (Figure 3).

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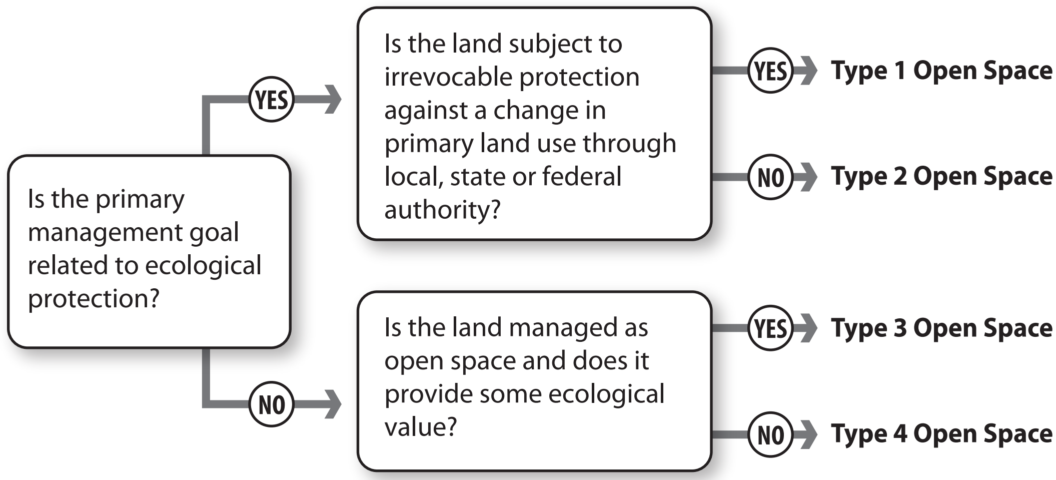

Open Space (Public Lands & Private Easements[1])

Criteria

Type 1: Permanently protected public or private lands subject to conservation easement or deed restriction, where the primary purpose and management goal of the land is for ecological protection For example, Type 1 Open Space includes conservation easements at Brushy Peak Preserve and Byron Airport.

Type 2: Public lands where the primary purpose of the land is for ecological protection but the land is not subject to irrevocable protection such as a conservation easement or deed restriction. Examples include Brushy Peak Preserve not under conservation easement and Morgan Territory Regional Preserve.

Type 3: Public lands that may contain some land uses other than ecological protection. These lands would include parklands classified as parks, open space or special protection units where something other than ecological protection is designated as the primary use (e.g., recreation, watershed protection). Type 3 could also include private lands under agricultural easement to preserve livestock grazing or dry land farming. Also included would be the undeveloped portions of drinking watersheds under ownership or management by a public agency. Examples include Los Vaqueros Watershed and Carnegie State Recreational Vehicle Area.

Type 4: This would consist of developed portions of public lands that retain some ecological value. It would also include public golf courses, some landscaped areas, and developed neighborhood parks. Type 4 would also include private lands under agricultural easements to preserve vineyards, orchards, or other cultivated agriculture. Examples include the South Bay Aqueduct and small lands around Clifton Court Forebay.

Note: [1]Private Easements include private lands that are protect through permanent easement or deed restriction for conservation or agricultural purposes.

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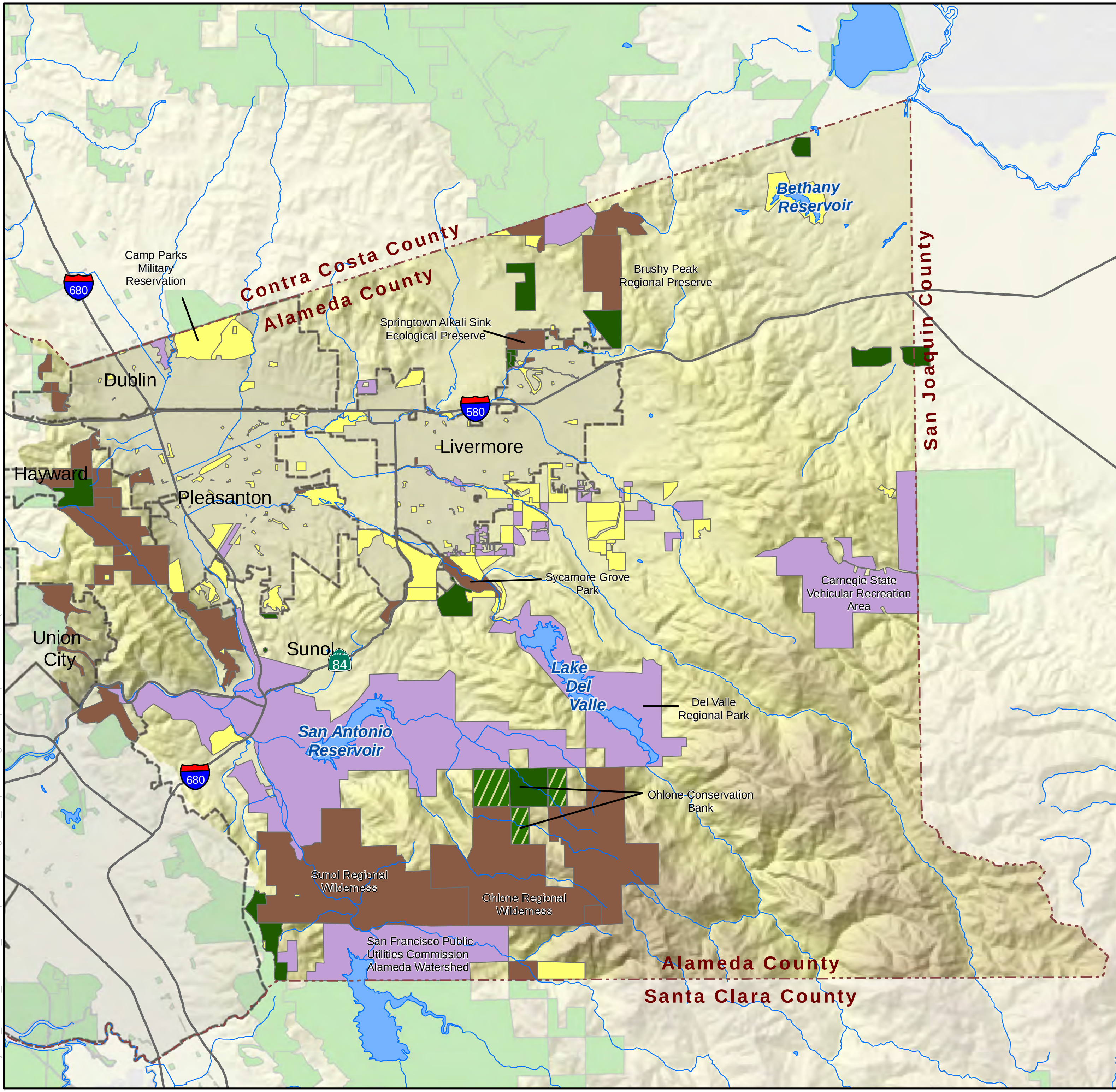
Figure 2-2
Criteria for Open Space Types

Figure 2-3 East Alameda County Open Space (Public Lands and Private Easements)

October 2010



County Line
City Limits
Highways
Streams
Lakes

Open Space Category
(See Fig. 2-4 for category explanation)

Type 1
Type 2
Type 3
Type 4
Proposed as Type 1-Pending Mitigation Banks

Sources:
Bay Area Open Space Council
California Legacy Project - California Resources Agency
San Joaquin County Council of Governemnts - HCP Report
East Bay Regional Park District

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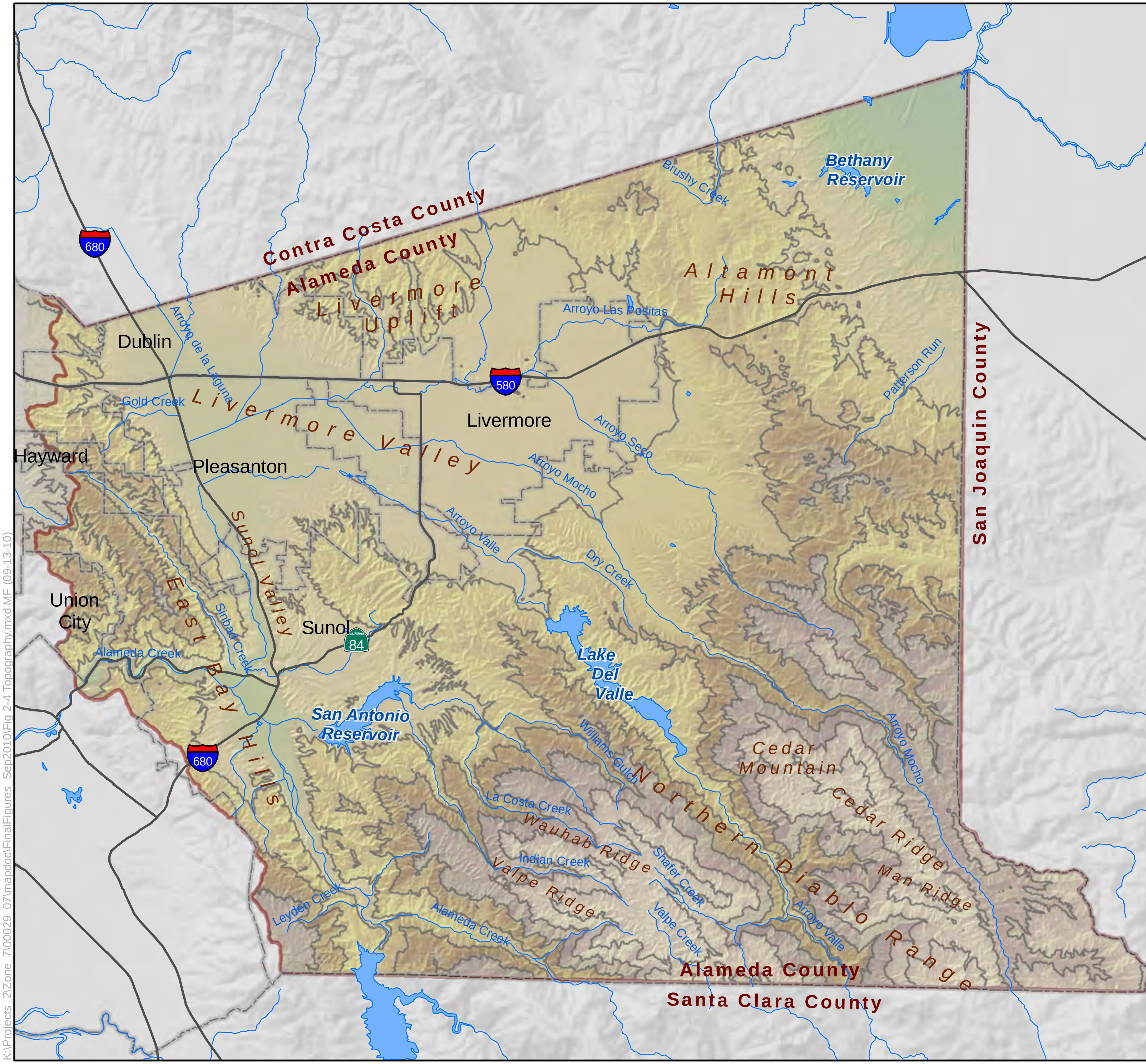
Figure 2-4
East Alameda County Topography

October 2010



Study Area Boundary

City Limits

Highways

Streams

Reservoirs

Elevation (ft)

High : 3842.7

Low : 4.68213

Source:
United States Geological Survey (USGS)
National Elevation Dataset
Downloaded October 2008

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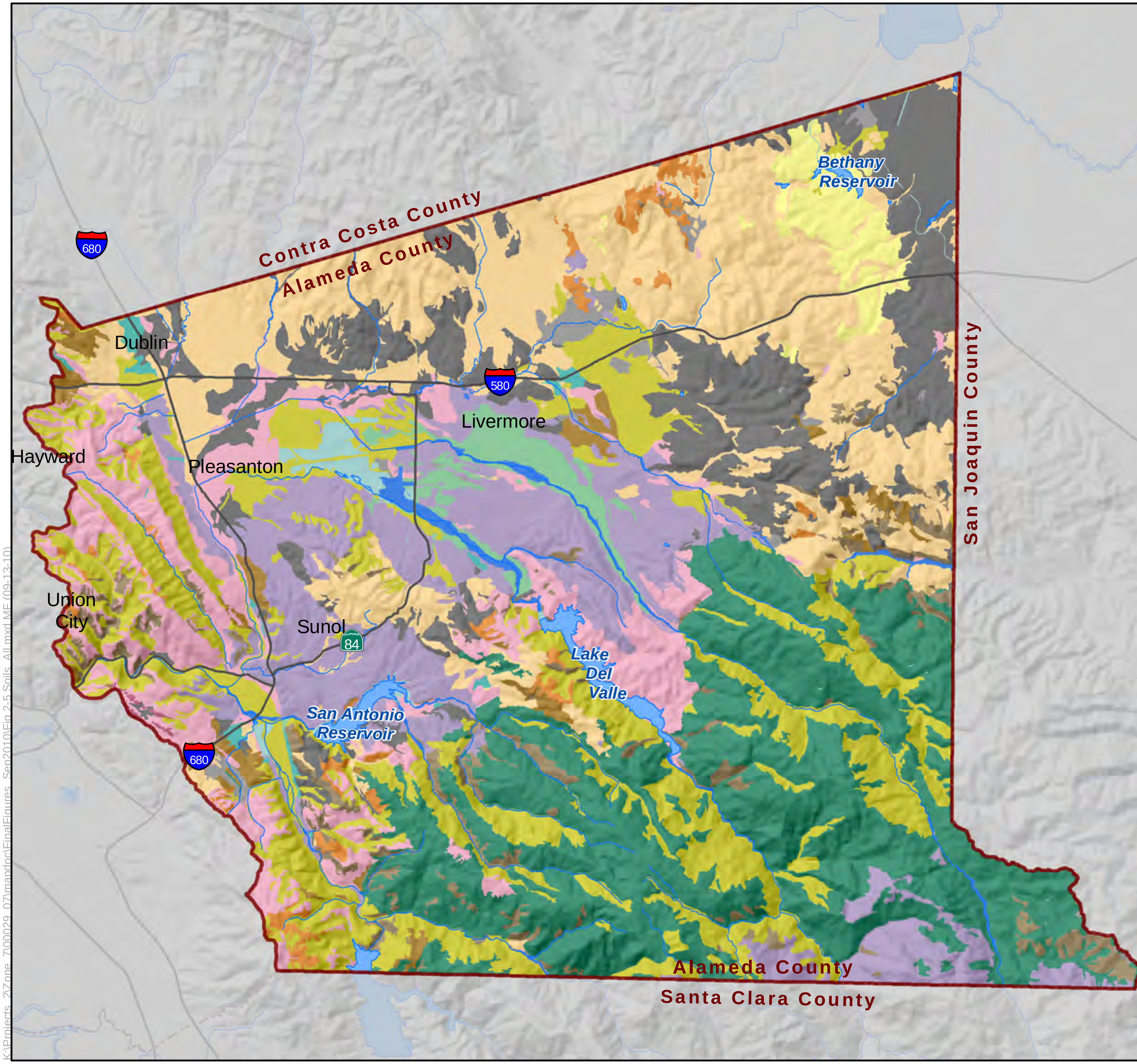
Figure 2-5
East Alameda County Soils

October 2010



Study Area Boundary
Highways
Streams
Reservoirs

Soil Type

- Clay
- Clay Loam
- Gravelly Loam
- Gravelly Sandy Loam
- Loam
- Riverwash
- Rock Land
- Rocky Clay
- Rocky Loam
- Rocky Sandy Loam
- Sandy Loam
- Shaly Loam
- Silt Loam
- Silty Clay
- Silty Clay Loam
- Water and other non-soil material

Source:
United States Department of Agriculture (USDA)
Natural Resources Conservation Service (NRCS) 2006.

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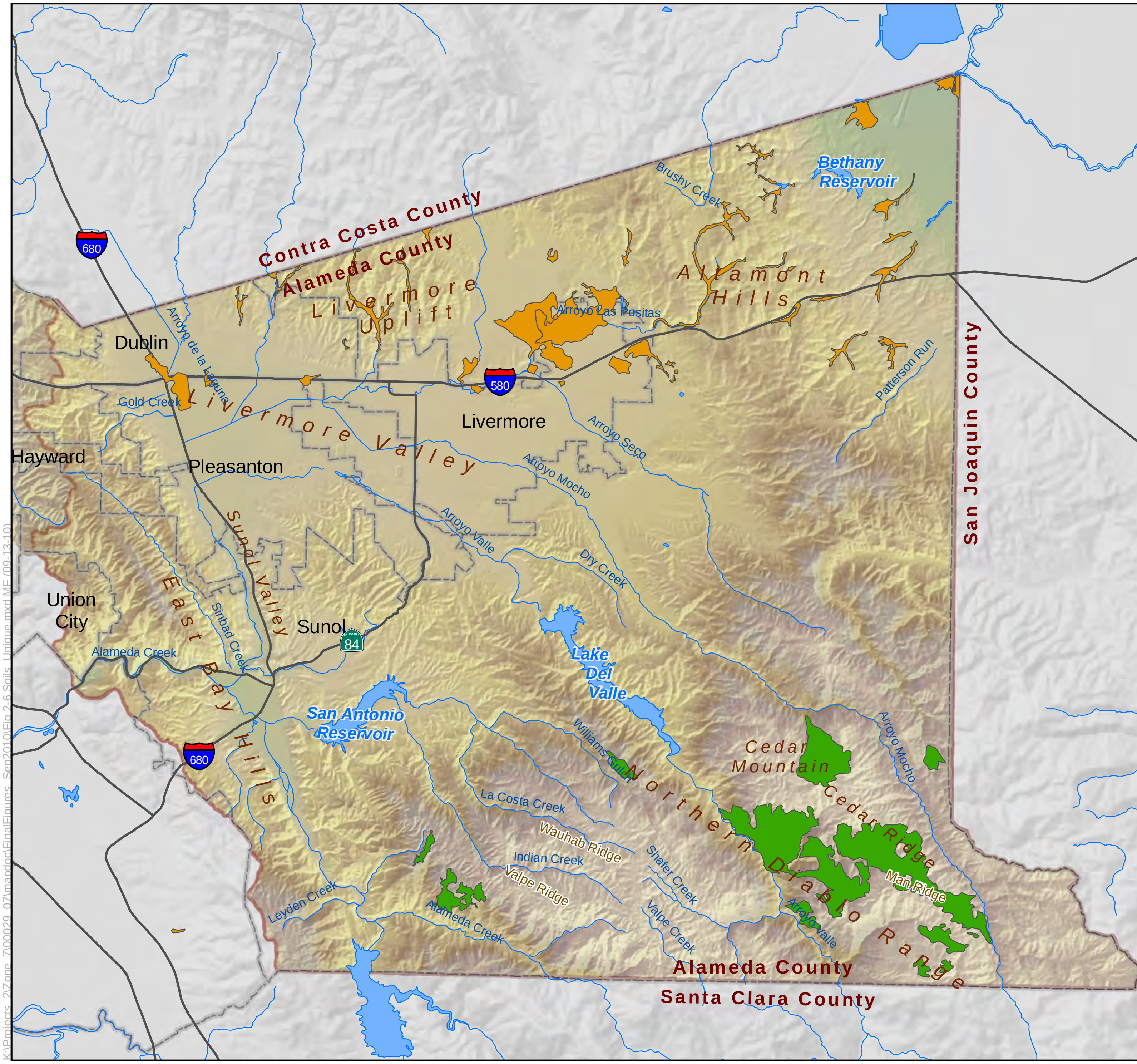
Figure 2-6
East Alameda County Unique Soil Resources

October 2010



- Study Area Boundary
- City Limits
- Highways
- Streams
- Reservoirs
- Alkali Soils
- Serpentine Soils

Source:
United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). Soil Survey Geographic (SSURGO) Database. Published 2006.

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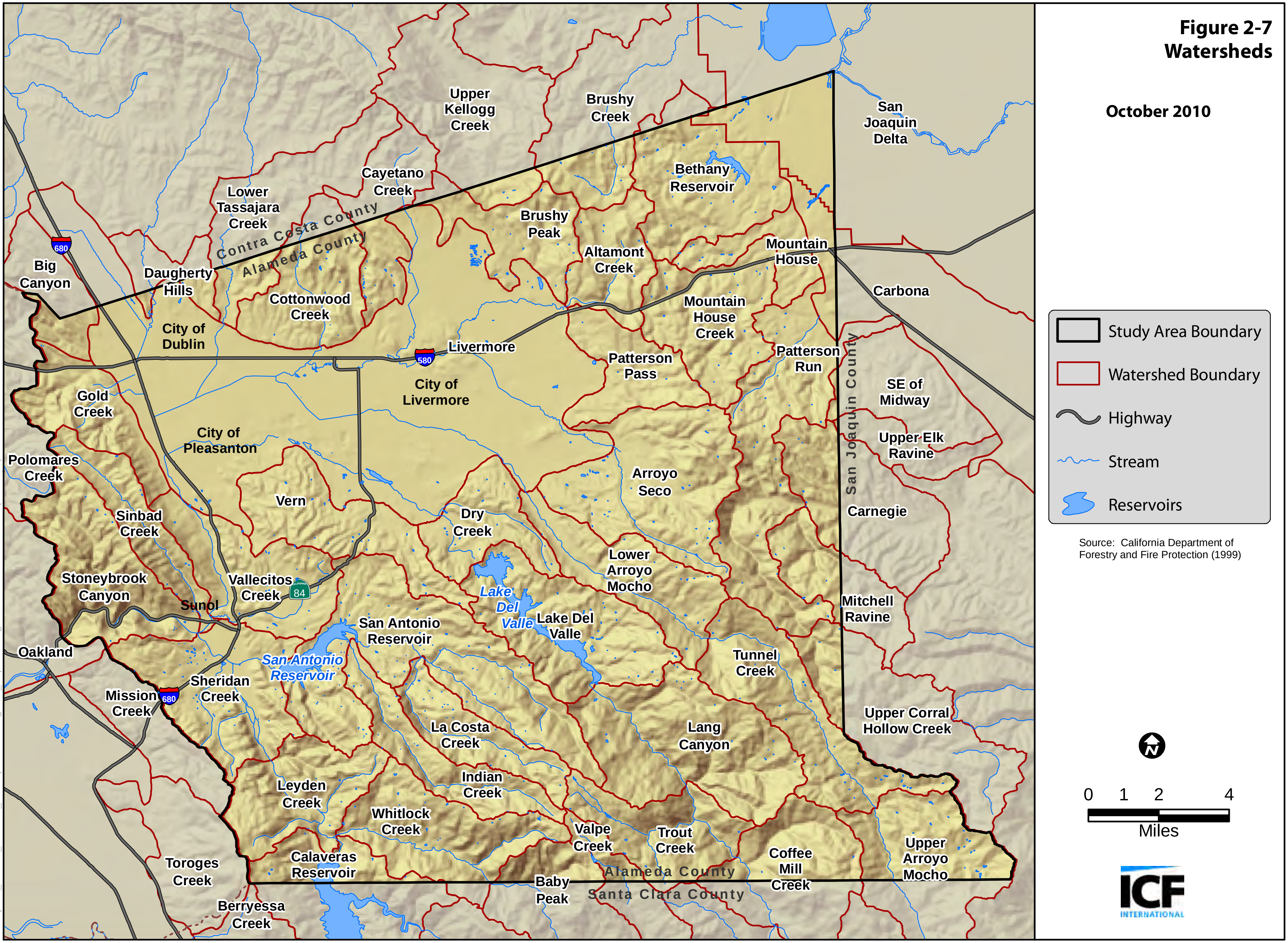
Figure 2-7
Watersheds

October 2010



Source: California Department of Forestry and Fire Protection (1999)

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Figure 2-8
East Alameda County Land Cover

October 2010

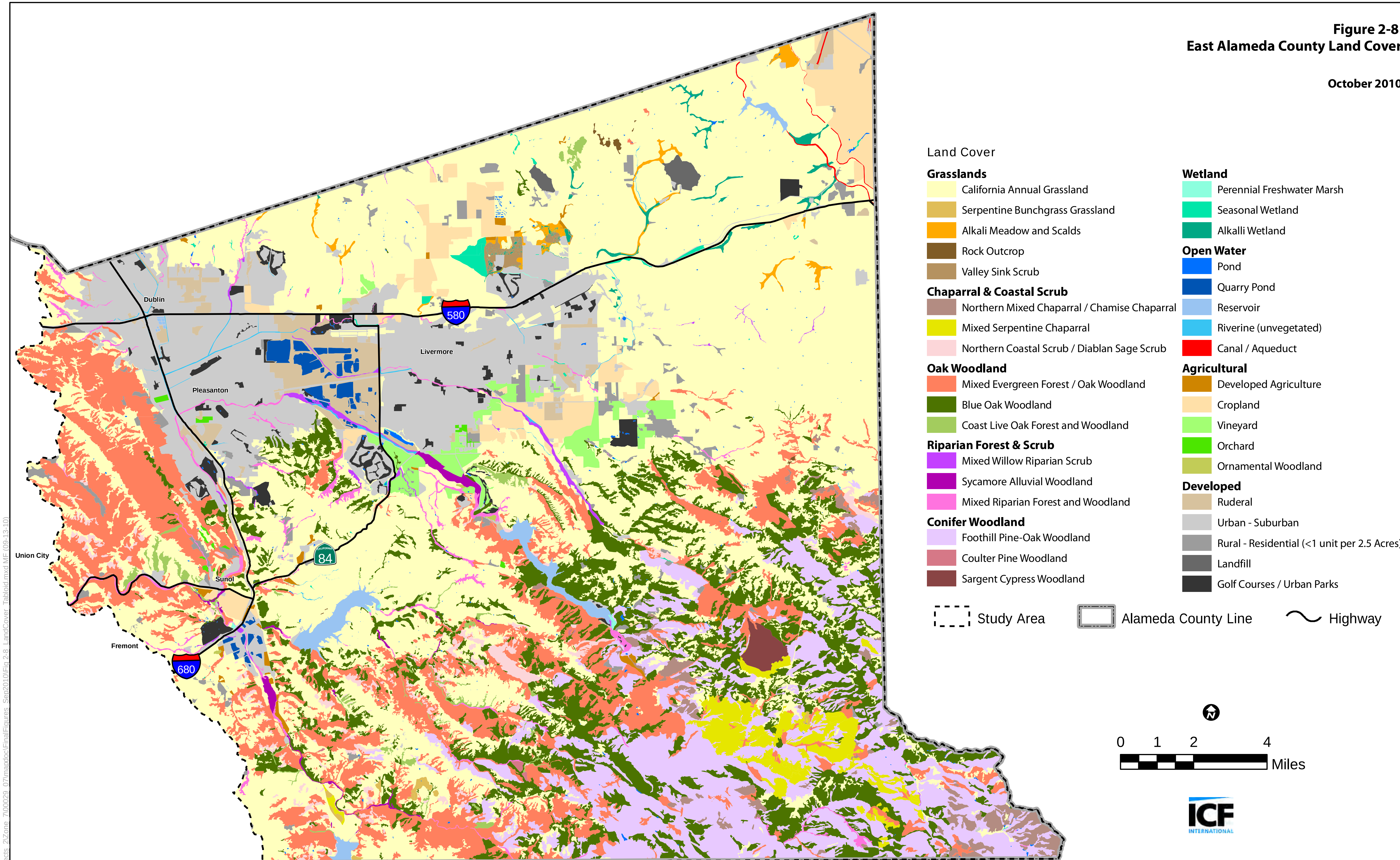
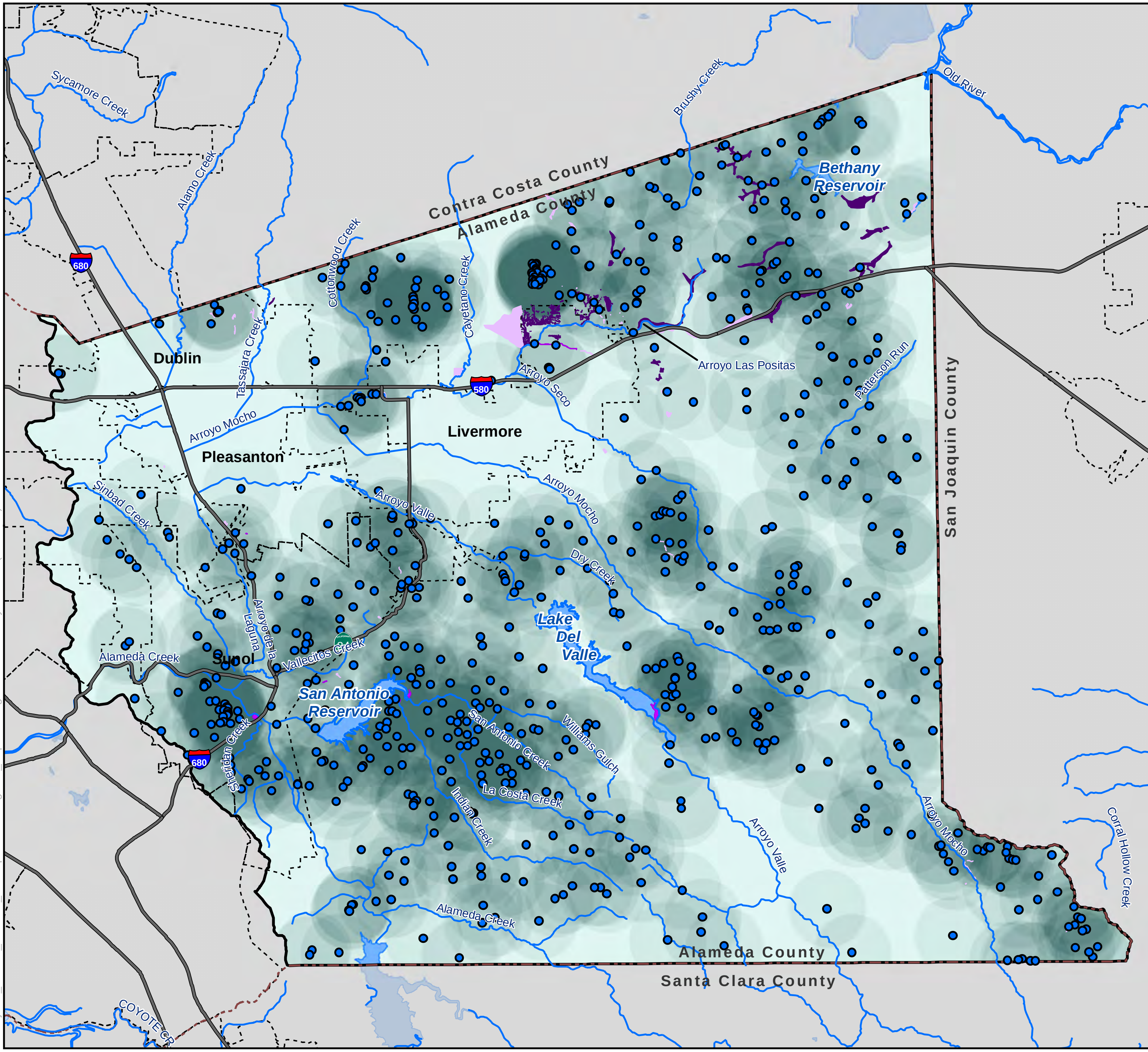


Figure 2-9
Pond Density

October 2010



Study Area Boundary

City Limit

Pond

Stream

Wetlands

Seasonal Wetland

Perennial Freshwater Marsh

Alkalli Wetland

Value

High : 9.85961

Low : 0

Note: Pond density = Number of Ponds/Acre as calculated using a moving circular window. In this analysis, the moving circular window has a radius of 1 mile and an area of 3.14 square miles.

The radius of 1 mile was determined based on the natural histories of California Tiger Salamander and California Red-legged Frog.

Sources: ESRI 2008

0 1 2 4

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