Chapter 2
Water Resources and Related Conditions

This chapter addresses an essential step in the planning process – identifying and assessing existing and likely future conditions – to establish an understanding and basis for comparing the potential effects of alternative plans. This step includes describing water resources problems, needs, and opportunities to be addressed, and inventorying, forecasting, and analyzing the existing and likely future conditions in the study area. Identified problems, needs, and opportunities serve as the basis for planning objectives, which guide the formulation of alternative plans. The plan formulation process for Federal water resources studies and projects is specified in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) (WRC 1983) and further described in Chapter 3 Plan Formulation.

Water and Related Resources Problems, Needs, and Opportunities

Over the last 20 years, the Federal and California state governments, in collaboration with numerous stakeholders, have embarked on several large-scale programs to protect, improve, and balance competing uses in the Delta. The most comprehensive of these efforts are CALFED and the Delta Vision process. Common to these two programs is recognition that a healthy Delta ecosystem and a reliable water supply are necessary for a sustainable future in California. Also common to these programs is recognition that, key to any sustainable solution to the Delta crisis is increased water storage and flexibility to manage the water supply system to deliver water to meet environmental, urban, and agricultural needs. Based on the feasibility study authorities, and concerns expressed about existing and future water and related resources issues, the following is a summary of major water resources problems, needs, and opportunities in the study area.

Environmental Water Management

The Delta is the largest estuary on the West Coast and provides essential habitat for a diverse array of wildlife, resident and migratory fish, and other freshwater and estuarine organisms. Because of Delta ecosystem decline over the past decades, several of the resident and migratory fish species in the Delta have been listed under the Federal ESA and/or CESA, including delta smelt, winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, longfin smelt, and Green Sturgeon. The Delta has also been designated as critical habitat for delta smelt and Central Valley steelhead, and as Essential Fish Habitat by NMFS for managed species, including Pacific salmon. Many factors have been cited for the decline of the Delta ecosystem, and fish species in particular, including (Healey 2007; Baxter et al. 2008):

- Invasive species
- Low primary productivity (phytoplankton)

- Reduced and altered timing of inflows to the Delta
- Increased and altered timing of exports from the Delta
- Declining water quality due to increased discharges from wastewater treatment plants, agricultural drains, industrial operations, and nonpoint sources
- Changes in physical and chemical parameters such as flow and salinity
- Loss of wetlands and floodplains to urbanization and agricultural land conversion

To address the impacts of water operations and water quality deterioration on Delta ecosystem and fish populations, several environmental flow goals and objectives in the Delta and Central Valley have been established aimed at maintenance and recovery of endangered and threatened fisheries and wildlife. These objectives are outlined in programs such as the CALFED Ecosystem Restoration Program and Watershed Management, CVPIA, and Anadromous Fish Restoration Program.

In addition, environmental water management programs have been created to provide CVP and SWP operators with flexibility in meeting or exceeding environmental requirements in the Delta, and to support related water and environmental management objectives elsewhere in the Central Valley. Current environmental water management programs include CVPIA Section 3406 (b)(2) water, the CVPIA Section 3406 (b)(3) Water Acquisition Program, and the Anadromous Fish Restoration Program water supplies. The CALFED Environmental Water Account and CALFED Environmental Water Program are no longer implemented. These programs acquire water from a variety of sources and use various mechanisms to provide water for environmental use, including existing contract supplies, surplus supplies, and temporary and long-term water transfers. From late 1982 through 2014, over five million acre-feet of water was acquired by various entities for environmental purposes inside and outside the Delta (Hanak and Jexdimirovic 2014).

The CVPIA established fish and wildlife management as a co-equal priority with other CVP water uses. It also mandated creation of the Refuge Water Supply Program (RWSP) to secure and deliver a reliable, clean water supply to support the wetland habitat needs of nineteen federal, state, and private wildlife refuges in California's Central Valley. The refuges encompass a critical portion of the last remaining five percent of the historic wetlands that once existed in the Central Valley, providing birds of the Pacific Flyway habitat during vital migration periods.

Sections 3406(d)(1) through 3406(d)(4) of the CVPIA define requirements for refuge water supplies:

- **Level 2** – The amount of refuge water required based on the historic average of annual water received by the refuges prior to 1989. Reclamation is required to provide full Level 2 water supplies annually. For the Refuges, total Level 2 water supply needs are about 271,000 acre-feet.
- **Level 4** – The total amount of water identified for optimum wetlands and wildlife habitat development and management. Incremental Level 4 water supplies are the difference

between the defined Level 2 and Full Level 4 water supplies. For the Refuges, average annual Incremental Level 4 water supply needs total about 105,500 acre-feet.

CVPIA section 3406(d)(2) specifies that Incremental Level 4 water is to be acquired in cooperation with the State of California through "activities which do not require involuntary reallocations of project yield" (e.g., acquired from willing sellers). CVPIA section 3406(d)(3) specifies that costs associated with Incremental Level 4 water supplies (including acquisition and conveyance) are to be funded at 75 percent Federal costs and 25 percent state costs.

Table 2-1 shows CVPIA wildlife refuge water allocations in the Central Valley. Table 2-2 shows the actual delivery of Incremental Level 4 supplies for the Refuges. These illustrate the limited ability of current programs to provide reliable, long-term, and year-round water supplies that meet the established wildlife refuge needs. Since passage of the CVPIA, full Level 4 refuge supplies to all of the nineteen refuges have never been achieved. Refuges, without conveyance constraints, have received full Incremental Level 4 deliveries only in the wettest of years, i.e., 2011 and 2017. From 1994 to 2016, average annual Incremental Level 4 refuge water supply deliveries were less than 50 percent of total Incremental Level 4 demands.

Table 2-1. Level 2 and Level 4 Refuge Water Supply Contract Allocations

Refuge	Level 2 (acre-feet)	Incremental Level 4 (acre-feet)[1]	Total Level 4 (acre-feet)
North of Delta Refuges			
Sacramento NWR	46,400	3,600	50,000
Delevan NWR	20,950	9,050	30,000
Colusa NWR	25,000	0	25,000
Sutter NWR	23,500	6,500	30,000
Gray Lodge WA	35,400	8,600	44,000
Subtotal	***151,250***	***27,750***	***179,000***
South of Delta Refuges			
San Luis NWR			
San Luis Unit	13,350	5,650	19,000
West Bear Creek Unit	7,207	3,603	10,810
East Bear Creek Unit	8,863	4,432	13,295
Kesterson Unit	3,500	6,500	10,000
Freitas Unit	3,527	1,763	5,290
Merced NWR	13,500	2,500	16,000
Grasslands WA			
Salt Slough Unit	6,680	3,340	10,020
China Island Unit	6,967	3,483	10,450
Mendota WA	18,500	11,150	29,650
Volta WA	10,000	6,000	16,000
Los Banos WA	16,670	8,330	25,000
Grasslands RCD	125,000	55,000	180,000
Kern NWR	9,950	15,050	25,000
Pixley NWR	1,280	4,720	6,000
Subtotal	***244,994***	***131,521***	***376,515***
Total North and South of Delta	**39,6244**	**159,271**	**555,515**

Source: Reclamation 1989, Reclamation et al. 2001

Notes:

[1] Does not include conveyance losses.

Key:

NWR = National Wildlife Refuge RCD = Resource Conservation District WA = Wildlife Area

Table 2-2. Incremental Level 4 Water Acquisitions from 1994 to 2016

Contract Water Year	Year Type	Contract Quantity (acre-feet)[1]	Quantity Received (acre-feet)[1,2]	Adjusted Quantity Received (acre-feet)[3]	Percent of Total Incremental Level 4 Target
2016	Below Normal	46,906	24,397	29,316	22%
2015	Critical	13,500	8,519	15,503	12%
2014	Critical	13,500	7,980	15,034	11%
2013	Dry	44,226	33,925	37,606	29%
2012	Below Normal	52,363	46,759	48,771	37%
2011	Wet	94,628	81,810	79,266	60%
2010	Below Normal	71,902	62,238	62,238	47%
2009	Dry	37,550	31,726	35,693	27%
2008	Critical	42,995	30,308	34,459	26%
2007	Dry	41,111	41,111	43,858	33%
2006	Wet	84,410	83,822	81,016	62%
2005	Above Normal	76,024	70,962	67,218	51%
2004	Below Normal	73,610	67,710	64,389	49%
2003	Above Normal	70,000	70,000	66,381	50%
2002	Dry	85,390	85,390	79,770	61%
2001	Dry	68,100	63,005	60,295	46%
2000	Above Normal	68,000	67,748	64,422	49%
1999	Wet	48,178	43,618	43,429	33%
1998	Wet	6,300	6,300	5,481	4%
1997	Wet	69,800	69,800	60,726	46%
1996	Wet	37,150	36,395	31,664	24%
1995	Wet	88,009	88,009	76,568	58%
1994	Critical	38,814	29,415	25,591	19%
Average		**55,325**	**51,207**	**49,074**	**37%**

Source: Linda Colella, Bureau of Reclamation, October 20, 2017

Notes:

[1] These amounts do not include amounts from permanent acquisitions (6,300 AF as of 1998, with an additional 3,000 AF as of 2005).

[2] Quantity received represents the gross amount of water received by Reclamation. To represent the amount received by the refuges, conveyance losses must be deducted.

[3] This adjusted quantity received includes permanent acquisitions less estimated conveyance losses. An estimated conveyance loss percentage of 13 percent is used, based on the conveyance losses previously experienced by the Refuge Water Supply Program on deliveries.

Key:

AF = acre-feet

The RWSP acquires Incremental Level 4 supplies primarily through short-term (annual) and medium-term (multi-year) purchases or exchanges from willing sellers of both surface water and groundwater supplies, with preference for long-term purchases and permanent water rights acquisition. Funding for the RWSP is provided primarily from the CVPIA Restoration Fund through annual Congressional appropriations, with some funding from other sources. The Restoration Fund is coordinated with Reclamation's broader budget such that CVPIA-related activities use multiple funding sources. Available funding for water acquisitions varies annually based on level of appropriation, and the other competing CVPIA and RWSP needs (e.g., other CVPIA program activities or refuge conveyance improvements).

Table 2-3 shows RWSP historical acquisitions of Incremental Level 4 water supplies for the period 2006 to 2016. The average volume of short- and mid-term acquisitions during this period

was 41,145 acre-feet per year, with an average price of $158 per acre-foot. Note that the prices listed in Table 2-3 do not include conveyance costs.

Table 2-3. CVPIA Refuge Water Supply Program Incremental Level 4 Acquisitions (2006-2016)

Contract Water Year	Year Type[1]	Annual Contracts (acre-feet)	# of Short-term Contracts	Average Unit Cost ($/acre-foot)[2]	Total Costs of Short-term Contracts
2016	Below Normal	24,397	2	$343	$8,371,064
2015	Critical	8,519	1	$105	$894,495
2014	Critical	7,980	1	$85	$678,300
2013	Dry	33,925	4	$200	$6,781,905
2012	Below Normal	46,759	4	$192	$8,973,515
2011	Wet	81,810	7	$101	$8,292,353
2010	Below Normal	62,238	7	$144	$8,970,744
2009	Dry	31,726	3	$179	$5,681,927
2008	Critical	30,308	3	$179	$5,418,414
2007	Dry	41,111	2	$181	$7,429,980
2006	Wet	83,822	4	$120	$10,028,841

Source: Summarized from information provided by Sonya Nechanicky, Reclamation, Refuge Water Supply Program (August 2017).
Notes:
[1] Sacramento Valley 40-30-30 Water Year Hydrologic Classification Index used to define water year types.
[2] Costs do not include conveyance and other O&M fees for delivering supplies to refuges.
Key:
CVPIA = Central Valley Project Improvement Act

The relatively low average cost of historical acquisitions is influenced by the use of low-cost groundwater acquisition agreements and no-cost exchanges, as well as annual funding priorities for the RWSP (which also funds conveyance improvements and other actions). Groundwater acquisitions are negotiated to cover pumping costs with local water districts with excess pumping capacity and ability to deliver water of suitable quality to refuge lands. Therefore, those transactions are typically lower costs than acquisitions of surface water on the spot market that are affected by hydrologic conditions and CVP allocations south of the Delta. For example, the RWSP was not able to acquire surface water supplies during 2014 and 2015 (drought years) because of limited supplies and high prices. During some periods of this drought, prices for water supplies south of the Delta exceeded $1,000 per acre-foot[1]. Due to the high cost of water during some years, the RWSP has opted to use its limited funding for conveyance improvements and other actions. As a result, the average acquisition prices reported by the RWSP do not fully reflect these scarcity conditions, and are skewed towards accessible low cost transactions. The RWSP has secured 9,300 acre-feet of permanent water supplies for Incremental Level 4 since the program was initiated in 1994. The cost of these permanent acquisitions was $700 per acre-foot.

[1] In 2014, an auction held by Buena Vista Water Storage District located in Kern County yielded 20 bids at $1,000 per acre-foot or higher. Similarly, an auction held by Madera Irrigation District yielded bids in excess of $2,000 per acre-foot (Water Market Insider, WestWater Research 2014).

Incremental Level 4 refuge water supply targets established by the CVPIA are not being fully met at all refuges. Only during wet years has the program been able to acquire greater than 50 percent of supply targets at the refuges. For the period from 1994 to 2016, the RWSP acquired on average 56,406 acre-feet per year, representing about 43 percent of the Incremental Level 4 target of 131,521 acre-feet per year. When accounting for conveyance losses, average deliveries to the refuges to date represents about 37 percent of the total target (or 49,074 acre-feet). Historical deliveries have varied by location and by year type.

The RWSP is not able to meet the full Incremental Level 4 targets for the following key reasons:

- Funding constraints limit the annual volume of water the RWSP acquires. The RWSP initially acquired only surface water, expanding its acquisitions to include direct groundwater purchases in 2008 at a lesser cost than surface water. Beginning in 2014, transactions of uneven exchanges of groundwater and Level 2 surface water were incorporated to increase annual Incremental Level 4 acquisitions. However, there is limited volume of groundwater available in any given year for either purchase or use in exchanges. The combination of these methods has increased the efficiency of limited funds. The RWSP has generally been unable to acquire larger volumes of water because it is not able to compete on the water market for higher cost water transfers.

- The RWSP cannot carryover funds from year to year, limiting the program's ability to cover the high costs of more reliable, long-term acquisitions and weakening the program's position as a potential buyer on the competitive water market.

- Increased competition for surface water supplies south of the Delta further limits the availability of willing sellers and increases the price for water acquisitions. This is due to hydrological conditions (drought), regulatory constraints (Biological Opinions governing Delta operations), and the willingness of M&I and agricultural water users to pay higher prices to secure available supplies in all year types.

- Limited Delta conveyance restricts the RWSP's ability to acquire north-of-Delta supplies and deliver them to refuges south of the Delta. RWSP Incremental Level 4 supplies have a lower priority at the CVP and SWP pumping facilities in the south Delta.

- Lack of dedicated storage for refuge water supplies limits the RWSP's ability to carry-over Incremental Level 4 water from one year to the next.

- Conveyance limitations at some refuges prevent delivery of full Level 4 supplies. These limitations will continue until the RWSP completes remaining conveyance facilities improvements projects for those specific refuges.

Overall, challenges in meeting wildlife refuge allocations include the availability of limited water supplies, particularly during droughts; the ability of the Refuge managers to move and store water supplies without losses; water quality and groundwater pumping impacts; and the increasing cost of water supplies. Water pricing inflation and increasing conveyance costs, combined with static funding levels, will continue to constrain water deliveries to wildlife Refuges. These challenges are likely to increase into the future due to forecasted increases in

competition for the finite water resources in California, suggesting the need to provide reliable, long-term water supplies and improve operational flexibility for unmet environmental water needs. An expanded Los Vaqueros Reservoir could provide a dedicated, long-term Refuge water supply through dedicated storage and new conveyance facilities, while allowing environmental water management programs to improve operational flexibility.

Bay Area Water Supply Reliability

Ecosystem decline has put other beneficial uses of water supplies conveyed through the Delta at risk. Bay Area water agencies rely heavily on the Delta and other imported water supplies. CCWD customers receive more than 90 percent of their supply from the Delta, while the three Bay Area water agencies that receive SWP water – ACWD, SCVWD, and Zone 7 – each receive 40 to 65 percent of their supply from the Delta (ACWD 2015; SCVWD 2015; Zone 7 2016). Bay Area water agencies have each diversified their water supply portfolios to include increased conservation, water recycling, and multiple sources of supply, including local groundwater and storage. Although these diversified supply portfolios provide flexibility in responding to droughts and emergencies, Delta water remains an essential component of each of their water supply plans, making Bay Area water agencies especially vulnerable to Delta supply interruptions and statewide water supply shortages.

Water supply reliability in the Bay Area is strongly linked to statewide water supply problems and shortages. Many Bay Area water agencies rely on CVP and/or SWP Delta contract deliveries to meet a large portion of their demands. Many factors influence the amount of water available from the CVP and SWP for delivery to water users, including hydrology, the amount of water in storage, and facility and conveyance losses (see Table 2-4). In any given year, user allocations are based on available supplies and contractor requests, with the most significant supply reductions occurring in dry and critically dry years. Bay Area water agencies look to local supplies to meet demands within their service areas when CVP and SWP allocations are reduced. However, local dry periods often coincide with periods when imported CVP and SWP supplies also are reduced, and opportunities are limited to develop new local supplies.

Table 2-4. Simulated CVP and SWP Contract Deliveries to the Study Area by Water Year-Type for Existing Conditions

District	CVP Delivery (acre-feet per year) (Percentage of Total CVP Contract Amount)			SWP Delivery (acre-feet per year) (Percentage of Total SWP Contract Amount)		
	Long-Term Average	Critical Dry Period (1929-1934)	Single Dry Year (1977)	Long-Term Average	Critical Dry Period (1929-1934)	Single Dry Year (1977)
Contra Costa Water District	136,725 (70%)	105,416 (54%)	103,846 (53%)	N/A	N/A	N/A
Santa Clara Valley Water District	108,896 (71%)	151,200 (51%)	152,508 (48%)	62,899 (63%)	33,611 (34%)	10,617 (11%)
East Bay Municipal Utility District[1]	14,627 (11%)	44,687 (34%)	56,819 (43%)	N/A	N/A	N/A
Alameda County Water District	N/A	N/A	N/A	26,360 (63%)	13,916 (33%)	4,466 (11%)
Alameda County Flood Control and Water Conservation District, Zone 7	N/A	N/A	N/A	50,256 (64%)	26,556 (34%)	8,544 (11%)

Source: 2015 Delivery Capability Report (2015 Level of Development) (DWR)

Notes:

[1] East Bay Municipal Utility District has a CVP contract for delivery of up to 165 TAF of CVP M&I contract water supplies over a three consecutive dry year period (with a maximum of up to 133 TAF in a single dry year). Long-term average values shown in the table above represent an average of all years, including wet, above normal, and below normal water years when the district does not have contracted CVP water supplies.

Numbers in parentheses represent percentage of each district's total contract amount.

Entries shown as not applicable (N/A) indicate that the district does not have a contract for these supplies.

Key:
CVP = Central Valley Project
DWR = California Department of Water Resources
M&I = municipal and industrial
N/A = not applicable
SWP = State Water Project

Although contractors may be allocated less water than they request during dry years, their CVP and SWP allocations often are greater than these agencies' requests during wet years. Some Bay Area water agencies are unable to take advantage of higher wet year allocations because they lack local facilities to store excess water for use in dry years. To meet this challenge, South Bay Aqueduct (SBA) contractors have entered into agreements with the Semitropic Groundwater Banking and Exchange Program to store excess SWP allocations during wet years, enabling them to take water from storage during dry and critically dry years. However, banking and exchange programs face physical constraints in making deliveries under certain conditions, and such programs may not be sufficient to meet the needs of Bay Area water agencies during dry and critically dry periods. For example, as observed during 2014, banking programs may not be able to provide all requested water if calls for banked water exceed the capacity of the water bank to retrieve water. Additionally, for many water agencies (e.g., SBA water agencies) groundwater banks (e.g., Semitropic Groundwater Banking and Exchange Program) are located downstream from agency facilities, and recovery of banked supplies requires either back-pumping, which is extremely expensive, or complex water exchanges. In extremely dry water years, such as 2014, when CVP and SWP water allocations are very low, there may be insufficient water available to make the necessary exchanges to recover banked water.

During recent droughts, Bay Area water agencies experienced substantial cutbacks in water supply. Aggressive conservation programs, storage in local reservoirs and groundwater basins, and water transfers have helped these agencies manage water supplies and minimize the severity of rationing for their customers during dry years. However, as demands in and outside the study area increase, shortages in dry and critically dry years will also increase. Further, competition for California's finite water supplies amid future shortages may affect the ability of Bay Area water agencies to acquire water on the open market to supplement their local and contract supplies. There is an increasing need to improve dry-year water supply reliability for Bay Area water agencies and California as a whole, particularly beyond 2030.

Regulatory Constraints

Bay Area water supply reliability can also be adversely affected by regulatory actions to protect Delta fisheries, such as those included in BOs and water rights terms and conditions. Some of these regulations include environmental flow goals and objectives, which have been implemented through restrictions on water project export operations that curtail Delta pumping during specified time periods based on hydrologic and biologic conditions. Due to the continued decline in the Delta ecosystem and associated impacts to protected and threatened and endangered fish species, these regulatory actions are likely to continue to constrain water operations in the Delta, resulting in reduced CVP and SWP contract deliveries and adversely impacting Bay Area water supply reliability.

During spring 2007, because very few delta smelt were found during routine monitoring, water exports from the Delta were significantly reduced for 10 days to protect the fish. As a result, CVP pumping capacity was severely diminished and SWP pumping stopped altogether. The *NRDC et al. vs. Kempthorne et al.* decision was issued in September 2007 regarding the effects of CVP and SWP operations on Federally-listed delta smelt and its critical habitat. The decision was the result of legal action by conservation groups that challenged the validity of the 2005 USFWS BO, which included an adaptive management approach found to be legally insufficient. The decision invalidated the 2005 USFWS BO and established a proceeding to develop interim remedies, which resulted in a significant curtailment of CVP and SWP deliveries. A revised BA for the Coordinated Long Term Operation of the CVP and SWP was published in 2008, and the new operations include reducing CVP and SWP pumping allowances during spring and early summer. Reclamation released a Final EIS for the *Coordinated Long-Term Operation of the Central Valley Project and State Water Project* in November of 2015, and a ROD was signed on January 11, 2016. The ROD formalized Reclamation's decision to implement all of the Reasonable and Prudent Alternative actions in the 2008 USFWS BO and 2009 NMFS BO, as amended.

This interruption of water supply deliveries to Delta-dependent Bay Area water agencies is likely to continue as Delta ecosystem and fish population challenges continue. An expanded Los Vaqueros Reservoir, associated intakes equipped with state-of-the-art fish screens, and conveyance facilities would provide valuable operational flexibility to improve Bay Area supply reliability.

Emergency Water Supply

California's water operations rely on a fragile Delta levee system that is under increasing risks from floods, earthquake, and climate change. Failures along the Delta's 1,100 miles of levees

due to flood events are not a rare occurrence, with each of the 70 islands or tracts having flooded at least once since Delta lands were originally reclaimed. Since 1980, 27 Delta islands have been partially or completely flooded, including a 2004 levee break at Upper Jones Tract that caused nearly $100 million in damage. When levees fail, water rushes into Delta islands, many of which are 25 feet or more below sea level. The result is a lowering of Delta water levels that draws saltwater into the Delta from San Francisco Bay. Multiple levee failures, or a failure when Delta inflows are low, could cause saltwater intrusion as far south as the CVP and SWP pumping facilities, affecting the water supplies of millions of Californians.

Numerous earthquake faults running through or near the Delta also pose a threat to levee stability and, therefore, water supply reliability. As seismic strain continues to accumulate on Bay Area faults and increase the annual risk of seismic activity, aging levees are increasingly vulnerable to failure caused by earthquakes. A rare, large earthquake could flood 16 or more islands in the Delta, principally in the central and west Delta. Such an earthquake could significantly alter Delta flow patterns, resulting in severe, prolonged disruptions in water quality and aquatic habitat. Multiple levee failures from a major earthquake could cause water exports to shut down for several months. Mount and Twiss (2005) estimated that the probability is roughly two-in-three that either a large flood or seismic event will affect the Delta in the next 50 years. More recent estimates suggest annual probabilities of failures for hydraulic- and earthquake-related failures ranging from one percent to five percent for most of the Delta (Arcadis 2016). Sea level rise, land subsidence, and an aging levee system will contribute to this risk in the future.

Global climate change has the potential to exacerbate risks from flooding or earthquakes over time through possible, although uncertain, impacts related to future air temperatures and precipitation patterns, and the resulting implications on sea levels. Existing global climate changes may already be contributing to a rise in sea level. For example, sea levels recorded at the Golden Gate Bridge in San Francisco have risen 0.2 meters (0.7 feet) in the last century and are expected to rise another 0.5 meters (1.6 feet) by 2100 (Roos 2005). Impacts associated with a rise in sea level would likely be most significant in the Delta, where a rise in sea level would increase pressure on levees currently protecting low-lying lands. Roos (2005) reports that a 1-foot rise in sea level would increase the frequency of the 100-year peak high tide to a 10-year event. Additionally, a rise in sea level would cause increased salinity intrusion from the ocean, which could degrade freshwater supplies pumped from the Delta and necessitate increased reservoir releases upstream to dilute intruding seawater.

An expanded Los Vaqueros Project, as part of a regional water resources project, could provide a reliable source of emergency water supply in the event that Delta water deliveries were disrupted by a severe flood or earthquake, or constrained by regulatory actions. Water stored in an expanded Los Vaqueros Project could provide emergency supplies to a variety of Bay Area water agencies in the event of a prolonged disruption.

Bay Area Water Quality

Although California water quality standards have been maintained, the quality of water supplies in the study area has generally declined over the past century due to saline intrusion; polluted runoff from urban, agricultural, and other development; and changes to the physical environment. Because Bay Area water agencies typically blend water from various local and imported sources to attain a desired quality, water quality in the study area is a function of both

water source and volume. Providers in the study area use imported supplies from the Delta, local groundwater, and other surface water supplies. The ratio of local to imported supplies in any given year, and effectiveness of blending, depends on CVP and SWP allocations, the quality of supplies drawn from the Delta and the availability of local supplies.

Delta supplies, which provide a significant portion of the region's water, are subject to considerable seasonal and geographic variations in water quality due to hydrology, bathymetry, tidal effects, seawater intrusion, water supply operations, and numerous other factors. Seasonally-high salinity, bromide, and organic carbon concentrations found in water delivered to the Bay Area, particularly in the late summer and fall, can increase the cost of treatment, cause foul water odor and taste, and reduce the life of household appliances. High levels of bromide can also react with disinfectants used in conventional treatment processes to produce harmful by-products that pose a human health hazard (Chen et al. 2008). In addition, imported water of poor quality reduces the effectiveness of blending and limits the beneficial uses of the water for groundwater recharge and other purposes. Agencies without the ability to receive and store Delta water deliveries in excess of their immediate needs cannot take advantage of periods of higher water quality in the Delta; they must take deliveries coincident with demands, regardless of quality.

While local water supplies do not experience the wide seasonal variation in quality of Delta supplies, seawater intrusion into groundwater basins and urban and rural pollutants can be problematic. Local supplies are relied on heavily during dry and critically dry years when both the quantity and quality of Delta supplies are reduced, and imported supplies are a key resource for local groundwater recharge and management programs.

Various projects have been implemented to improve the quality of Bay Area water supplies. Delta water quality is monitored and regulated, groundwater is managed more effectively, treatment plants have been constructed, and projects such as the Los Vaqueros Project, which provides access to higher quality winter water, have been implemented. However, seasonal degradation of Delta water quality will likely continue into the future as rising demands for water in the Central Valley exert pressure on the Delta system and sea levels continue rising. As substitute supplies become scarcer in the future, it will become more difficult and costly for Bay Area water agencies to provide high quality water. Accordingly, the desire to improve or maintain the quality of water deliveries to M&I customers in the Bay Area will continue into the future.

Existing and Likely Future Resources Conditions in Study Area

One of the most important elements of any water resources evaluation is defining existing resource conditions in the study area and how these conditions may change in the future. The magnitude of change not only influences the scope of the problems, needs, and opportunities, but the extent of related resources that could be influenced by possible actions taken to address them. Defining the existing and likely future conditions is critical to establishing the basis for comparing alternative plans consistent with the P&G, NEPA, CEQA, and Reclamation policy guidance, including Reclamation Directives and Standards.

Existing Conditions Summary

The following sections summarize existing conditions for reservoir area infrastructure within the Investigation study area. Additional information can be found in Appendix A – Plan Formulation.

Physical Infrastructure

Existing infrastructure in the study area includes Los Vaqueros Reservoir, associated water management facilities, and various other public and private infrastructure, as described below.

Los Vaqueros Reservoir The Los Vaqueros Project is an offstream storage system that allows diversion of water from the Delta when water quality is favorable, for later release and blending with other Delta supplies when Delta water quality is poor. The project also provides emergency storage and, as secondary benefits, recreation and flood management. Table 2-5 summarizes the characteristics of Los Vaqueros Dam. Facilities associated with Los Vaqueros Reservoir are illustrated in Figure 2-1 and Table 2-6.

Table 2-5. Existing Los Vaqueros Dam Characteristics

Characteristic	Units
Reservoir Capacity (thousand acre-feet)	160
Maximum Reservoir Water Surface Elevation (msl)	507
Dam Crest Elevation (msl)	521
Maximum Dam Height Above Downstream Toe (feet)	230
Total Embankment Volume (million cubic yards)	3.8
Dam Crest Length (feet)	1,300

Key:
msl = mean sea level

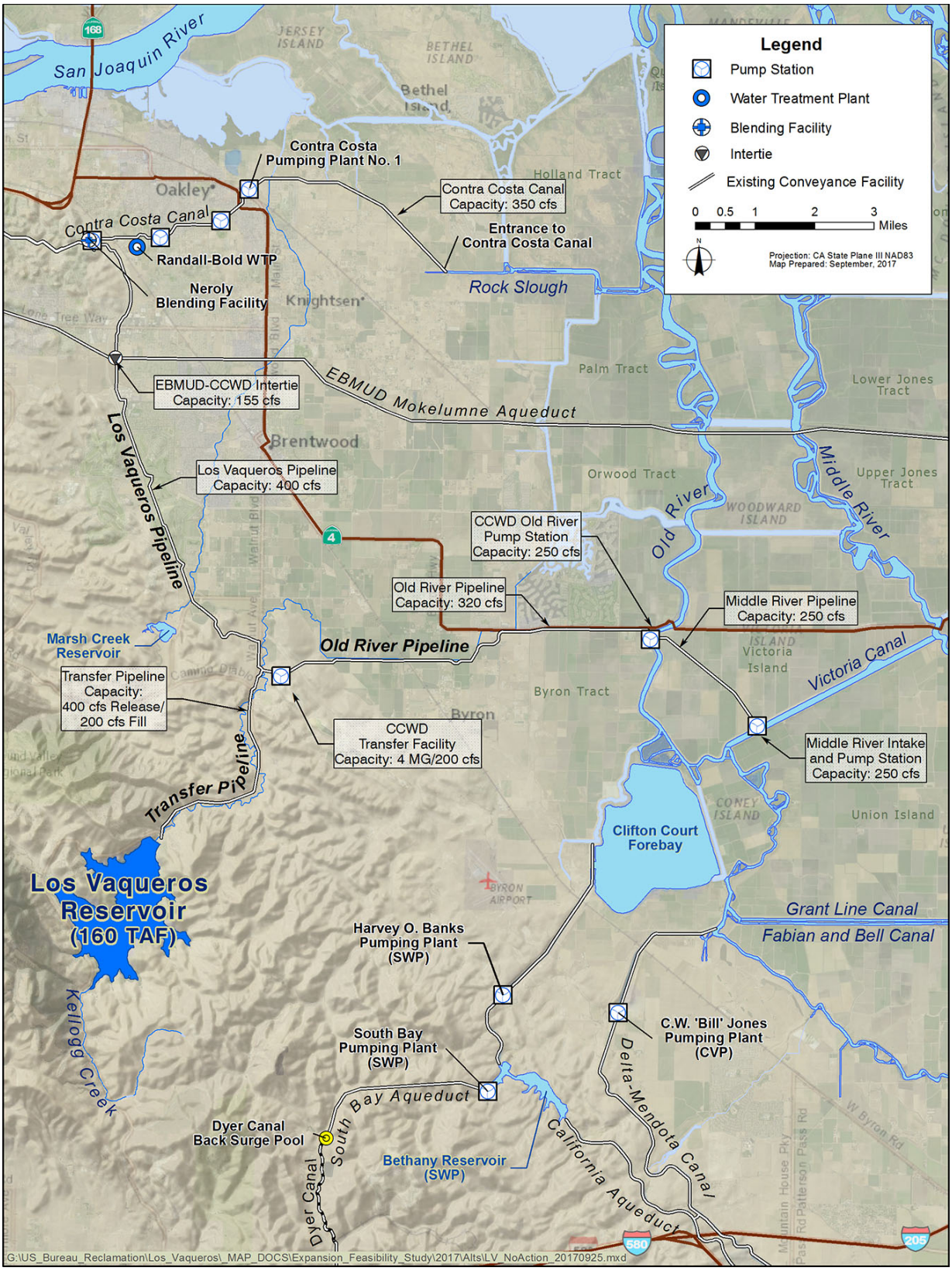

Figure 2-1. Existing Los Vaqueros Project Facilities

Table 2-6. Summary of Local Conveyance and Pumping Facilities in the Study Area

Facility	Type	Size or Capacity	Supply	Use
Contra Costa Water District (CCWD)				
Rock Slough Intake and Pump Station[1]	Pump Station	350 cfs	Rock Slough	Primary supply for Contra Costa Canal
Contra Costa Canal[1]	Canal	350 cfs	CCWD Delta Intakes	Distribution to CCWD & customers
Old River Intake & Pump Station	Pump Station	250 cfs	Old River	Supplies Los Vaqueros Reservoir & Contra Costa Canal
Old River Pipeline	78-inch Pipeline	320 cfs 34,500 feet	Old River Pumping Plant to Transfer Facility	Supplies Los Vaqueros Reservoir & Contra Costa Canal
Los Vaqueros Transfer Facility	Pumping Plant & Reservoir	200 cfs 4 million gallons	Old River Pipeline	Pumping to Los Vaqueros Reservoir; flow control
Los Vaqueros Transfer Pipeline	72-inch Pipeline	200 – 400 cfs 19,600 feet	Transfer Facility to Reservoir	200 cfs capacity to reservoir; 400 cfs capacity from reservoir to Transfer Facility
Los Vaqueros Pipeline	90-96 inch Pipeline	400 cfs 47,000 feet	Transfer Facility	Connects Transfer Facility with the Contra Costa Canal
Middle River Intake & Pump Station	Pump Station	250 cfs	Victoria Canal	Supplies Los Vaqueros Reservoir & Contra Costa Canal
EBMUD-CCWD Intertie	Intertie	155 cfs	Sacramento River and Mokelumne River	Supplies Los Vaqueros Reservoir & Contra Costa Canal and EBMUD system
Santa Clara Valley Water District (SCVWD)				
Central Pipeline	Pipeline	N/A	SBA	Terminal Reservoir; supplies Vasona Pumping Plant
Vasona Pumping Plant	Pump Station	N/A	Central & Alameda Pipelines	Delivers to Rinconada Force Main & Rinconada Water Treatment Plant (WTP)
Almaden Valley Pipeline	Pipeline	N/A	Almaden Reservoir	Conveyance to Calero Reservoir
Almaden-Calero Canal	Open Canal	N/A	Almaden Reservoir	Conveyance to Calero Reservoir
Anderson Force Main	Pipeline	N/A	Anderson Reservoir	Conveyance to Coyote Pumping Plant
Calero Pipeline	Pipeline	N/A	Calero Reservoir	Conveyance to Cross Valley Pipeline
Cross Valley Pipeline	Pipeline	N/A	San Luis Reservoir	Coyote Pumping Plant to Almaden Valley Pipeline
Stevens Creek Pipeline	Pipeline	N/A	Sevens Creek Reservoir	Conveyance to Rinconada WTP
Blending Facility	N/A	45 mgd	SFPUC	Blends SFPUC Hetch Hetchy purchases with groundwater
East Bay Municipal Utility District (EBMUD)				
Mokelumne Aqueduct	Pipeline	700 cfs	Mokelumne River	Primary conveyance for Mokelumne River supply
Freeport Regional Water Facility	Intake	185 mgd	Mokelumne River and Sacramento River	Supplies Mokelumne Aqueduct
South Folsom Canal	Open Canal	3500 cfs	American River (Lake Natoma)	Diverts water from the American River. Also supplies Mokelumne Aqueduct

Table 2-6. Summary of Local Conveyance and Pumping Facilities in the Study Area (contd.)

Facility	Type	Size or Capacity	Supply	Use
Alameda County Water District (ACWD)				
Various conveyance and distribution facilities				
Alameda County Flood Control and Water Conservation District, Zone 7 (Zone 7)				
Various conveyance and distribution facilities				

Notes:
[1] Facilities are owned by Reclamation but operated and maintained by Contra Costa Water District.
Key:
ACWD = Alameda County Water District
CCWD = Contra Costs Water District
cfs = cubic feet per second
EBMUD = East Bay Municipal Utility District
mgd = million gallons per day
N/A = not available
PP = pumping plant
SBA = South Bay Aqueduct
SCVWD = Santa Clara Valley Water District
SFPUC = San Francisco Public Utilities Commission
WTP = water treatment plant
Zone 7 = Alameda County Flood Control and Water Conservation District

Physical Environment

Elements of the physical environment in the study area are described in this section.

Topography, Geology, and Soils The study area is located in eastern Contra Costa County and a portion of northeastern Alameda County, southeast of Mount Diablo. The topography of the Los Vaqueros Dam site and adjacent area is dominated by northwest-southeast-trending ridge lines that reach an elevation of approximately 1,200 – 1,400 feet in the vicinity of the dam and reservoir. The elevations of intervening valley bottoms are approximately 400 feet above mean sea level (msl) near the dam and reservoir. The same topography extends to the southeast towards Bethany Reservoir in Alameda County. Near Los Vaqueros Reservoir, these ridges are separated by valleys of varying width; the ridges decline in elevation to the east and become relatively flat as the San Joaquin Valley is approached.

The study area soils are grouped into generalized soil associations that reflect the bedrock and various alluvial parent materials from which they were derived (Welch 1977). The soils are neutral to moderately alkaline; localized areas of alkaline soils and vegetation develop in some valley bottoms. The upland soils developed in sandstone and finer-grained bedrock that belong to the Altamont-Diablo-Fontana soil association, with Upper Cretaceous sandstone, shale, and conglomerate (CalTrans 2017). These soils are strongly sloping to very steep with well-drained clay and silty clay loam textures and have slight to high erodibility.

Geomorphology, Sedimentation, and Erosion Los Vaqueros Reservoir is located in the northwest-trending Diablo Ranges of the Coast Ranges geomorphic province, while several of the project proposed facilities would be located in the flat San Joaquin Valley section of the adjacent Great Valley geomorphic province. The Coast Ranges geomorphic province in the study area is composed of bedded and folded sedimentary rocks. The rocks are of two general ages; the older group is 65- to 144 million-years-old (Cretaceous age) marine sedimentary rocks, while the

younger group is 45- to 65-million-years-old (Tertiary age) marine and non-marine sedimentary rocks.

In the vicinity of the dam site abutments, the bedrock is mapped as the Cretaceous Panoche Formation (Wagner et al. 1990; Simpson and Schmoll 2001). In the vicinity of the dam site, the Panoche Formation is interbedded sandstone and claystone (URS and MWH 2004). The beds in this area dip between 15 - 40 degrees (Simpson and Schmoll 2001; URS and MWH 2004). The reservoir is underlain by marine shale bedrock (Wagner et al. 1990). The Panoche Formation interbedded sandstone and claystone extends to the southeast beyond Bethany Reservoir and dips to the northeast. To the east of the reservoir, the bedrock in the ridges and valleys is composed of a series of sedimentary rock formations (sandstone, siltstone, and claystone) of varying thicknesses and dip to the northeast. The more erosion-resistant sandstone beds tend to form the area's topographic ridges, while more erodible siltstones or claystones dominate in the valleys. One formation, Domengine marine sandstone, is notable because rock from this formation has been used as fill around road culverts; this rock has proven to be corrosive and requires replacement (ESA et al. 2005).

The pipelines extending from the Los Vaqueros Dam toward the Transfer Facility would be located within the Panoche Formation heading eastward until the lower elevations where it transitions into the alluvial sediments as mentioned above. The Transfer Facility is located in an area of tilted sandstone formations that include the Domengine, Markley, and Meganos Formations (Wagner et al. 1990). The Transfer-Bethany pipeline alignment continues within the Panoche Formation.

At the project site, areas that are susceptible to erosion are those that would be exposed during the construction phase and along the shoreline where soil is subjected to wave action. Typically, the soil erosion potential is reduced once the soil is graded and covered with concrete, structures, asphalt, or slope protection.

Climate and Hydrology This study area is characterized by a Mediterranean climate with steep to rolling hills of the eastern Diablo Range and a portion of the southern Delta. Vegetation is a mosaic of annual grasslands, croplands, oak woodlands, upland scrubs, wetland communities, and riparian scrubs and forests.

Within the Los Vaqueros watershed, valley/foothill woodland and forest, annual grasslands, upland scrub, aquatic, and riparian vegetation dominate the landscape. The Central Valley portions of the pipeline corridors are characterized by annual grasslands, upland croplands, intermittent streams, and seasonal wetlands. Current principal land uses vary within the watershed and along pipeline corridors and include agriculture, pasture lands, cattle grazing, and open space. Project activities are principally in undeveloped areas that support minimal or low-density residential, commercial, and industrial development.

The Delta, to the east of San Francisco Bay, represents the point of discharge for the Sacramento-San Joaquin River system. Water flows out of the Delta, into San Francisco Bay, and through the Golden Gate Bridge to the Pacific Ocean, creating an extensive estuary where salty ocean water and fresh river water commingle. Water from over 40 percent of California's land area is discharged into the Delta.

The primary factors that affect Delta hydrology are: (1) twice-daily tidal cycles that result in inflow and outflow through the Delta and San Francisco Bay; (2) freshwater inflow from the Sacramento and San Joaquin rivers; and (3) water management activities, including SWP and CVP reservoir storage and releases, as well as water exports from the south Delta. Additionally, winds and salinity/freshwater mixing generate a number of secondary currents. While these currents are low velocity, they are significant in transporting contaminants and mixing different sources of water.

Water Quality Principle water quality issues in the study area include salinity (sodium, magnesium, calcium, phosphates, nitrates, potassium, chlorine, bromide, and sulphate) and organic carbon. X2, the distance in kilometers from the Golden Gate of 2 parts per thousand salinity within the Delta, is used to regulate and manage salinity within the Delta.

The north Delta has better water quality in terms of salinity due to low salinity water inflow from the Sacramento River. The quality of water in the west Delta is strongly influenced by tidal exchange with San Francisco Bay. During low-flow periods, seawater intrusion results in increased salinity. In the south Delta, water quality is poorer due to a combination of low inflows of lower-quality water from the San Joaquin River, agricultural return flows that are pumped from Delta islands into Delta channels, and the effects of seawater intrusion from San Francisco Bay. Like salinity (and bromide), organic carbon concentrations are higher in the west and south Delta than in locations nearer to the Sacramento River. However, unlike salinity, organic carbon concentrations are typically lower in the summer and higher during the wetter, winter months.

Groundwater Resources The majority of the study area is located outside of any defined groundwater basins, but the eastern lowland portion of the study area (generally the San Joaquin Delta watershed) is located within the Tracy groundwater sub-basin (Basin Number: 5-22.15) of the San Joaquin Groundwater Basin. This sub-basin is defined by the unconsolidated and semi-consolidated sedimentary deposits bounded by the Diablo Range to the west, the Mokelumne River to the north, the San Joaquin River to the east, and Stanislaus County to the south (DWR 2004). The Tracy sub-basin is drained by the San Joaquin River as well as Corral Hollow Creek, a tributary. The water bearing deposits range from about a few hundred feet below ground surface near the Diablo Ranges (in the vicinity of the study area) to about 3,000 feet along the eastern margin of the basin. To the west of the Tracy sub-basin, groundwater can be found in stress fractures, joints, and faults in a series of sedimentary rock formations (sandstone, siltstone, and claystone) that vary in thickness. Groundwater movement is influenced by the characteristics of the fracture system, including the size and location of fractures, the interconnection between fractures, and the materials within the fracture.

Noise and Vibration The noise environment in the study area is influenced by agricultural operations and traffic on local roadways. Wind turbines located in the foothills south and southeast of the Los Vaqueros Reservoir can be heard by persons in close proximity (e.g., within approximately 1,500 feet) to wind energy generation machinery; however, the turbines are not a recognizable noise source beyond their immediate geographic area. Sound levels away from these noise sources can be quite low, depending on the amount of nearby human activity.

Hazardous Materials Existing hazardous materials use in the project region varies and includes petroleum hydrocarbons and those hazardous materials common to agriculture,

including pesticides, fertilizers, and fuels. Historical hazardous materials use involved the application of pesticides on the agricultural lands for growing crops. Hazardous materials may also be present in surface soils along roadways as a result of accidental releases. In addition, subsurface soil or groundwater contamination related to hazardous material use is present in isolated commercial and light industrial properties throughout the region.

Four known or potential areas of contamination have been identified by the Environmental Data Resources database within a 1-mile radius of the proposed Transfer-Bethany Pipeline. Most of these areas would not affect or be affected by project construction due to their distances from the pipeline alignment. The closest recorded site to any of the proposed project components is the Souza Ranch landfill, which is an active facility that disposes of biosolids. This permitted land-spreading facility is between Armstrong and Vasco roads, about a quarter mile east of the proposed Transfer-Bethany Pipeline. No violations or areas of concern are reported for this facility. In and around Byron Airport, there are other similar land-spreading facilities, but they are farther away from the proposed Transfer-Bethany Pipeline.

Other potential sites where hazardous materials are handled close to the proposed project components include a relatively new gasoline service station at the northeast corner of Bixler Road and State Route 4 and next to the proposed Delta-Transfer Pipeline; a boat storage yard at the southwest corner of that same intersection, also next to the proposed Delta-Transfer Pipeline; and the Unimin Sand Plant at the southwest corner of the intersection of Vasco and Camino Diablo roads, next to the proposed Transfer-Bethany Pipeline. However, none of these facilities were listed on any of the databases reviewed, which indicates that no reported leaks or spills are associated with these sites. In addition, according to the available databases reviewed as part of this analysis, no hazardous materials leaks or spills have occurred within the Los Vaqueros watershed.

Agricultural and Important Farmlands Within Contra Costa County, a large portion of the area east of the Los Vaqueros administrative watershed boundary is designated as Agricultural Land.[2] Much of this land is hilly and used for grazing livestock or dry-grain farming. Proposed conveyance facilities within the Agricultural Lands include portions of the Delta-Transfer Pipeline; all of the Transfer Facility expansion area; part of the Transfer-LV Pipeline; and the large majority of the Transfer-Bethany Pipeline to the Alameda County border. In addition, a possible component of the project, a pump station at the EBMUD-CCWD Intertie, would be on Agricultural Lands.

Lands designated as Agricultural Core[3] lie to the east of the city of Brentwood, west of the town of Discovery Bay, and north of the town of Byron. Much of the land in this designation is actively cultivated with intensive row crops. Proposed project facilities within the Agricultural Core include a portion of the Delta-Transfer Pipeline. The Delta-Transfer Pipeline will be

2 The purpose of the Agricultural Lands designation is to preserve and protect lands capable of and used for the production of food, fiber, and plant materials. This land use designation is not intended to exclude or limit other types of agricultural, open space, or non-urban uses.

3 The Agricultural Core designation applies to agricultural lands that are composed of prime (Class I or II) soils, as identified by the Land Use Capability Classifications of the Natural Resources Conservation Service. Prime soils are considered the best soils for farming a wide variety of crops.

generally parallel to the existing Old River Pipeline, which is located 50 feet into the 85-foot permanent easement owned by CCWD, and would not necessitate a new utility corridor.

Biological Resources

Biological resources in the region result from a wealth and diversity of climatic and vegetative associations within and adjacent to the study area. The study area supports a variety of habitats, with each of these habitats supporting its own assemblage of vegetation and wildlife species.

Fisheries and Aquatic Resources The Bay-Delta estuary is inhabited by 55 fish species (Baxter et al. 1999), of which about half are non-native introduced species. In addition, an estimated 100 macroinvertebrate species have been introduced into the estuary, primarily through ballast water discharges (Carlton 1979). Many non-native aquatic plants have also become established within the estuary.

Fish species identified for protection under the CESA and/or Federal ESA that are known to occur in the Delta include green sturgeon, delta smelt, longfin smelt, winter-run Chinook salmon, spring-run Chinook salmon, and Central Valley steelhead. USFWS and NMFS have designated all or part of the Delta as critical habitat for delta smelt, Central Valley steelhead, and winter-run and spring-run Chinook salmon.

Vegetation and Habitat Types The Los Vaqueros watershed encompasses 18,535 acres of land and 20 distinct Sawyer-Keeler-Wolf vegetation series (ESA 2004; Sawyer and Keeler-Wolf 1995). The watershed includes 1,489 acres of open-water habitat. Grasslands, including annual and native grasslands, are the most abundant Natural Communities Conservation Plan (NCCP) habitat types in the watershed and cover more than 12,819 acres. Valley/foothill woodland and forest is the next most abundant habitat type, which mostly includes oak woodlands; blue oak is the most common oak woodland type within the watershed. The 3,009 acres of valley/foothill woodland forest habitat are distributed in the western and northern regions of the watershed. Upland scrub habitats are most abundant on the western side of the watershed and cover 775 acres. Natural seasonal wetland habitat covers roughly 300 acres of habitat and includes just over 295 acres of alkali wetlands. Alkali wetlands are dominated by a variety of salt-tolerant plants such as saltgrass, bulrush, cattails (*Typha spp.*), and seepweed (*Suaeda moquinii*). Natural seasonal wetland habitat is also represented by vernal pools in the eastern portion of the watershed.

Nontidal freshwater and saline emergent habitat covers nearly 55 acres of land in the watershed and occurs mostly in created wetlands and stock ponds. Valley/foothill riparian habitat is predominantly represented by valley oak woodlands, though some areas are dominated by Fremont cottonwood. This habitat type covers nearly 69 acres and occurs along Kellogg Creek, both north and south of the reservoir, as well as along Adobe Creek in the northwestern part of the watershed.

Although the Central Valley historically contained an estimated 1,400,000 acres of wetlands, only about 123,000 acres remain today. Wetland habitats are important for sustaining waterfowl of the Pacific Flyway and supporting other wildlife species that depend on wetland habitat. Of the 19 CVPIA-designated wildlife refuges, 9 SOD refuges and managed wetlands are currently served, at least in part, via Mendota Pool along the San Joaquin River. These refuges and

managed wetlands include: Grassland Resource Conservation District, Los Banos Wildlife Area (WA), Mendota WA, the North Grasslands WA Complex's Salt Slough and China Island units, and the San Luis National Wildlife Refuge Complex's San Luis, West Bear Creek, Freitas, and Kesterson units. Additional refuges and managed wetlands, including East Bear Creek Unit, may also be served from this pool in the future.

The Delta-Transfer Pipelineue and Transfer-Bethany Pipeline areas support the following CALFED NCCP habitat types: natural seasonal wetland; valley/foothill riparian; grassland, valley/foothill woodland, and forest; and upland cropland. The Expanded Transfer Facility is located in an area where grasslands are the only vegetation type.

Wildlife A variety of wildlife is present in the study area, including kit foxes, various varieties of bats, badgers, pocket mice, lizards, snakes, tiger salamanders, and frogs. Avian species include eagles, hawks, blackbirds, owls, harriers, kites, larks, shrikes, and ospreys. Also, several beetle and shrimp species are in the study area. The variety of habitats in the study area support a wide range of wildlife species. Composition, abundance, and distribution of wildlife are directly related to the accessibility of these habitats.

Special-Status Species Special-status species include plants and animals in the study area that are legally protected or are otherwise considered sensitive by Federal, state, or local resource conservation agencies and organizations. These include:

- Species that are Federally-listed and/or state-listed as rare, threatened, or endangered
- Species considered as candidates or proposed for listing
- Species identified by CDFW as species of special concern
- Species identified as species of concern by USFWS
- Plants considered by the California Rare Plant Ranking System (formerly known as California Native Plant Society Lists) to be rare, threatened, or endangered
- Species afforded protection under local planning documents

Within the study area, within Los Vaqueros Watershed and western Delta, 52 special-status species, including 12 special-status plant species, were identified that are suitable for the habitat was determined to be present.

Wild and Scenic Rivers *The National Wild and Scenic Rivers Act of 1968*, as amended (Public Law 90-542; 16 USC 1271 – 1287), established the National Wild and Scenic Rivers System, which identifies rivers of the nation that possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. This act preserves the free-flowing condition of rivers that are designated and protects their local environments. *The California Wild and Scenic Rivers Act of 1972*, as amended (California Public Resources Code Section 5093.50 – 5093.70), aims to preserve designated rivers possessing extraordinary scenic, recreation, fishery, or wildlife values. There are no Wild and Scenic Rivers in the study area.

Cultural Resources

Cultural resources studies related to the installation and maintenance of the existing Los Vaqueros Reservoir resulted in the documentation of 75 historic properties and one sensitive location within the surrounding watershed. The sensitive location is the reburial site for human remains that were removed from Native American burial sites during construction of the original Los Vaqueros Reservoir. In 1992, the watershed, which comprises the Kellogg Creek Historic District, was found to be eligible for listing in the National Register of Historic Places as a Historic District (SSUAF 1992).

The prehistoric and historic occupation and use of the watershed was organized around the location and availability of resources, such as acorns, fresh water, bedrock outcrops, and marshes, among other factors. Many of these resources are located at the lower elevations of the watershed. Mission records indicate that, at the time of the Spanish settlement in California, the Kellogg Creek drainage was near the boundary of two neighboring political groups: the Volvons (speakers of the Bay Miwok language) and the Ssaoams (speakers of the Costanoan/Ohlonean language). The arrival of the Spanish explorers in 1775 threatened the cultural and political organization of these native groups. By 1806, almost all native people were living at the missions, and the surviving Ohlone, along with groups of Esselen, Yokuts, and Miwok, were transformed from hunters and gatherers into agricultural laborers (Levy 1978; Shoup et., al. 1995). By 1832, the population had decreased to less than 20 percent of its size at the time of initial contact with the Spanish (Levy 1978). Many of the surviving "converted" natives worked as *vaqueros* (cowboys) for the missions and spent much time grazing cattle. At that time, the Los Vaqueros area remained unclaimed and was therefore one of the areas the missions used for cattle ranching.

With the secularization of the missions in the mid-1830s, more than 800 patents of land (comprising more than 12 million acres) were issued to individuals by the Mexican government in what is now California (Ziesing 1997). Many of the mission lands, including those once used for cattle grazing, were quickly divided among elite Mexican families, leaving the remaining Native American populations of the former missions with nothing. As a result, many native people migrated back to their homelands and began working as *vaqueros* or servants for the new owners of the land.

After the Mexican War, which ended with Mexico relinquishing California to the United States, the discovery of gold in the Sierra Nevada in 1848 produced a major population increase in Northern California and, although Mexican livestock grants still covered most of the land, immigrants and squatters eventually appeared throughout the area. Land use changes resulted as livestock grazed most native grasses to extinction; woodlands were cut for lumber, railroad ties, and mine timbers; and agricultural development occurred on nearly all arable land.

By the 1870s, the public land on the northern and western edges of the Rancho Cañada de los Vaqueros land grant had been settled by homesteaders. This land was known as the Vasco area (named after a group of Basque cattle ranchers) and was used by the inhabitants for large scale stock raising and farming. The land of the current watershed and surrounding areas remained mostly undeveloped with few landowners until plans for a reservoir on this site began forming in the 1960s and 1970s (Ziesing 2000).

Socioeconomic Resources

The sections below describe social and economic resources in the Investigation study area.

Population California's population totaled an estimated 39 million in 2016. Approximately 2.8 million and 4.0 million of this population resided in the Sacramento and San Joaquin river basins, respectively (California Department of Finance 2014). The growth rate in the Sacramento and San Joaquin river basins was more than 17 percent and 20 percent from 2000 to 2010, respectively, significantly greater than the statewide rate of 10 percent for the same period. About three-fourths of the population in the Sacramento River basin resides in or near the City of Sacramento. Similarly, most of the population of the CVP service area is concentrated within urban areas. The CVP water service area includes various M&I water contractors and water districts that serve portions of the Sacramento, Stockton, and Bay Area metropolitan areas. Outside these population centers, most of the CVP water service area is rural, with irrigated agriculture the predominant land use and economic driver. Population in the Bay Area totaled an estimated 7.2 million in 2010. It is expected to grow by about 26 percent to more than 8.9 million by 2035 (Association of Bay Area Governments 2017).

Land Use The proposed project facilities are in southeastern Contra Costa County and northeastern Alameda County in an area that includes open space and agricultural land – the majority of which is used for grazing. The closest communities to any project component are the towns of Byron and Discovery Bay, at distances of 4 and 6 miles, respectively, east/northeast and northeast from the Los Vaqueros Reservoir watershed. The town of Byron has a relatively small population (fewer than 900 residents) and includes residential, commercial, and light industrial land uses. Discovery Bay, with about 9,000 residents, is known for its residential and water-based recreation land uses. None of the project facilities will be in the towns of Byron or Discovery Bay, although the Delta–Transfer Pipeline extends along State Route 4, which bounds the Discovery Bay community on the south.

Employment and Labor Force The Bay Area experienced a 9.8 percent increase in employment between 2010 – 2013, exceeding both California and the United States in job recovery. Two of the nine counties, San Francisco and Napa, have regained all the jobs lost during the 2007 – 2009 recession, with the other seven counties nearly reaching full recovery. The three fastest growing major occupation categories are computer and mathematical, food preparation, and sales and related occupations (Association of Bay Area Governments 2015).

Business and Industrial Activity In the Bay Area, the long-term industrial shift is continuing with steady growth in health, social services and education, leisure and hospitality, professional and business services and information, and a leveling off of declines in manufacturing employment and financial services. These changes show this area can be generalized as a highly technical, distributive, and local serving industry (Association of Bay Area Governments 2015).

Local Government and Finance Various urban jurisdictions dominate the study area. Local officials allocate financial resources for a diverse collection of activities, including police and public safety, reviewing development, and providing educational services within the jurisdictions. The two largest sources of revenue for most local jurisdictions are property taxes and funding received from the Federal and California state governments. These two sources provide a relatively stable revenue base for funding local programs. Public health and safety,

social services of various forms, and education represent the biggest expenditures at the local level. These activities serve as a safety net for the local population and are frequently the most visible local programs.

Public Health and Safety At Los Vaqueros Reservoir, water hazards are associated with recreational use; water management operations at a reservoir the size of Los Vaqueros Reservoir typically do not pose specific hazards to humans because water levels do not fluctuate rapidly. Downstream from Los Vaqueros Dam, the reservoir has a decreasing influence on flow conditions and associated water-related hazards.

Recreation and Public Access The region offers a variety of recreational opportunities in both urban and outdoor settings, such as Mount Diablo State Park. The Los Vaqueros watershed provides day-use opportunities for hiking, biking, boating, fishing, and horseback riding. Public vehicle access to the watershed is limited to (1) the marina, concession, and picnic area on the southern shore of the reservoir, and (2) the Interpretive Center, watershed offices, and day use facilities near the existing Los Vaqueros Dam on the north end of the watershed. Aside from the marina, facilities at the southern end of the reservoir include a concession building, trailheads, picnic area, and fish-cleaning stations. The public can rent electric boats at the marina near the concession building; private boats are prohibited on the reservoir. To protect the public water supply, activities involving body or clothing contact with the water also are not allowed at the reservoir. Two fishing piers along the west side of the reservoir and a fishing platform on the western edge of the dam allow visitors to fish along the western shoreline. The watershed has more than 39.2 miles of hiking-only trails, and about another 15.8 miles of multi-use trails. Hiking-only trails align the west side of the reservoir and extend north and south of the reservoir through the watershed. No public access is provided along the east side of the reservoir.

Aesthetics and Visual Resources Visual/aesthetic resources consist of the landforms, vegetation, rock and water features, and cultural modifications that create the visual character and sensitivity of a landscape. The visual character of eastern Contra Costa County is characterized by the rolling hills of grassland typical of the northern San Joaquin Valley, agricultural and rural landscapes, and the Delta. Topography in the valley and Delta is uniformly flat; as a result, human-made features (including poles and lines for electricity and phones, blow-off and air valves for underground water pipelines, residential and agricultural structures, fencing, elevated roadway, bridges, levees, canals, highway and local road signage, and other commercial signage) are visible in both near-field and far-field distances.

Views from the Los Vaqueros Reservoir and areas downstream of the dam are obstructed by ridgelines, which focus views on the natural character of the reservoir and hills. The visual character of the landscape downstream of the dam is a mixture of open grasslands, rolling hills with sparse oak savannah, and scrub habitat. The visual character of the landscape surrounding the other potential modification locations (Transfer Facility, Transfer-Bethany Pipeline, and Delta-Transfer Pipeline) is either predominately agricultural or open space characterized by rolling grassland hills.

Traffic and Transportation Major transportation routes in the study area include Interstates 5, 205, 580, and 680, State Route 4 and Bypass, and Byron Highway. County Roads in the study area include Vasco Road, Walnut Boulevard, Camino Diablo, Marsh Creek Road, Hoffman

Road, Byron Hot Spring Road, and Armstrong Road. Traffic in this area is usually moderate to heavy, especially on the interstates and highways. Weekday traffic within the east Contra Costa County area consists of commuter traffic during morning and evening peak-traffic periods, and a mix of trips generated by residential, agricultural, and commercial/industrial uses throughout the day. This area is served by two transit agencies that provide bus service to areas in eastern Contra Costa and Alameda counties: the Eastern Contra Costa Transit Authority and Livermore Amador Valley Transit Authority.

Utilities and Public Services Various county and local agencies provide solid waste removal and management, emergency services, public safety, and law enforcement services in the study area. Pacific Gas and Electric Company is responsible for providing electrical and natural gas service in the study area.

Water services are provided by CCWD to developed areas in the study area and other portions of eastern and central Contra Costa County. Treated water delivery to customers within the study area is the responsibility of cities, water districts, or other public agencies. Rural residences located throughout the study area in southeastern Contra Costa County obtain their water from local private wells. Irrigation water is provided by BBID, ECCID, and the SWP. BBID has several canals and water delivery facilities within the area. Potable water within the Los Vaqueros Reservoir watershed is provided by packaged membrane treatment plants located at the marina, Interpretive Center, and watershed offices on the north end of the watershed, and at the south end restrooms and fish cleaning stations.

Most of the study area is undeveloped and is not served by an integrated wastewater system. Wastewater conveyance and disposal in the study area is provided by the Discovery Bay Community Services District and Byron Sanitary District. In more rural locations, individual septic/leach field systems provide wastewater disposal. At the Los Vaqueros Reservoir day-use areas, wastewater from the public restrooms and other facilities are regularly pumped, captured in a holding tank, and hauled offsite by a contractor.

Water Supply The CVP and SWP are the largest users and exporters of Delta water. Water is exported through pumping and aqueduct facilities at Clifton Court Forebay, the Jones Pumping Plant, and the North Bay Aqueduct. In addition to CVP and SWP operations of these facilities, local agencies, including CCWD, municipalities, private entities, and agricultural users also operate their own diversion programs and infrastructure.

The CVP is the largest water storage and delivery system in California, covering 29 of 58 counties in California. The CVP consists of 20 reservoirs capable of storing over 11 MAF of water, 11 power plants, 500 miles of major canals and aqueducts, and many tunnels, conduits, and power transmission lines (Reclamation 2013). CVP water is used to irrigate about 3 million acres of farmland and supplies water to more than 2.5 million people and businesses through more than 250 long-term water contracts (Reclamation 2008, 2010). Most of the CVP service area lies within the Central Valley. About 90 percent of south-of-Delta contractual delivery is for agricultural uses.

The SWP provides water to 25 million Californians and 750,000 acres of irrigated farmland (DWR 2014). The SWP includes 34 storage facilities, reservoirs, and lakes; 20 pumping plants; four pumping-generating plants; five hydroelectric powerhouses; and about 700 miles of open canals and pipelines (DWR 2014). SWP water is delivered under long-term contracts to 29 public water agencies throughout California, including the San Joaquin Valley, Tulare basin, and Southern California service areas (DWR 2014).

In 2010, California received approximately 104 percent of its average rainfall. Water demands (applied water) in California for urban, agricultural, and environmental purposes were about 79.8 MAF. These purposes include water dedicated to wild and scenic rivers, irrigated agriculture, urban use, managed wetlands, required delta outflow, and instream flow. Approximately 6.4 MAF and 2.2 MAF were available from Federal and State projects, such as the CVP and SWP, respectively. An additional approximately 14.7 MAF was extracted from groundwater. Additional dedicated and developed water supplies included instream water (27.4 MAF), local projects (8.8 MAF), local imported deliveries (1.1 MAF), the Colorado Project (4.7 MAF), inflow and storage (0.1 MAF), reuse and seepage (14.1 MAF), and recycled water (0.3 MAF) (DWR 2014).

Environmental Justice Environmental justice considerations include disproportionate adverse impacts to minority, low income, and Native American populations. In the study area**,** only Census Tract 3031.00 and the community of Byron (Byron census-designated place) are considered minority and/or low-income communities.

Summary of Likely Future Conditions

Identification of the magnitudes of potential water resources and related problems, needs, and opportunities in the study area are based not only on the existing conditions, but also on estimates of how these conditions may change in the future if a project is not implemented to expand Los Vaqueros Reservoir. Predicting future changes in the study area is complicated by ongoing programs, projects, and potential changes in regulatory requirements. Several ecosystem restoration, water quality, water supply, and levee improvement projects are likely to be implemented in the future. Collectively, these efforts may improve ecosystem resources, Delta water quality, water supply, and levees. Much of these improvements would be based on separate opportunities that are not integrated in a single plan or part of an approved and funded program.

In addition, the potential effects of climate change, specifically sea level rise and changes in precipitation, could affect the Investigation project operations. Sea levels measured at stations in San Francisco have risen at a rate of 8 inches per century, based on measurements since 1900 (OEHHA 2013, DWR 2006). This could lead to flooding of low–lying areas, loss of coastal wetlands such as portions of the Delta system, erosion of cliffs and beaches, saltwater contamination of drinking water, impacts on roads and bridges, and harmful ecological effects along the coastline. Changes in geographic distribution, timing, and intensity of precipitation are projected for the Central Valley (Reclamation 2016), which could broadly impact rainfall runoff relationships important for water supply and flood management. It is expected that in the future, climate change may significantly reduce water held in snowpacks in the Sierra Nevada (Reclamation 2016). Further potential for reductions in water conservation space in existing reservoirs in the Central Valley is anticipated due to increasing needs for additional space for

flood management purposes stemming from shifts in the timing of flood runoff and magnitude of extreme events. These potential reductions could significantly impact available water supplies and the volume of water entering the Delta. During drought periods, supplies could be further reduced, and expected shortages would be substantially greater.