# 3.0 AFFECTED ENVIRONMENT

## 3.1 Current Land Use

As an important agricultural region for both California and the United States, the Central Valley is predominantly rural, and agriculture is the primary land use. Crops include pastures, orchards and vineyards, vegetables, cotton, grains, and rice. Pastures, orchards, and vineyards are the most abundant croplands in the region. Ninety percent of irrigable land is in irrigated crop production at any one time (SJVDP 1990a).

The Demonstration Project lands considered for this action are currently under irrigated agricultural production; either active cultivation or rotational fallow cycle. Analysis of land use maps published by the California Department of Water Resources and aerial photographs for the project area indicate that lands in the study area have been under irrigated agricultural land use since the 1950's (BSK and Associates, 1998). Cropping patterns on these lands are typical of those found throughout the San Joaquin Valley and include cotton, alfalfa, sugar beets, wheat, barley, melons and tomatoes. Yields of cotton and alfalfa in the Alpaugh study area have averaged about 2.25 bales of lint per acre of cotton and 8.5 tons of alfalfa hay at 12% moisture per acre (Keller and Wegley, 1994). These crops are generally irrigated utilizing furrow or combination sprinkler-furrow systems. Standard farming practices including the application of pesticides and herbicides for weed and pest control have been utilized on these lands. Two evaporation basins were constructed on the Alpaugh properties and have been used in the past to dispose of subsurface agricultural drainage water. One of these ponds was used only for a limited time period and has been permanently closed, while the other is under interim closure regulatory status and could be used for drainage disposal in the future if the land is kept in production.

## 3.2 California Water Rights and CVP Water Allocations

The State Water Resources Control Board captures the history and definition of the various California Water Rights in Publication 94-2587, upon which this section is based. A water right is a legal entitlement authorizing water to be diverted from a specified source and put to beneficial use. Water rights are property rights, but their holders do not own the water itself--they possess the right to use it. The exercise of some water rights requires a permit or license from the State Water Resources Control Board, whose objective is to ensure that the State's waters are put to the best possible use and that the public interest is served.

Water right law in California and the rest of the West is markedly different from laws governing water use in the eastern United States. Seasonal, geographic, and quantitative differences in precipitation caused California's system to develop into a unique blend of two very different kinds of rights: riparian and appropriative. Other types of rights exist in California as well, among them reserved rights (water set aside by the federal government when it reserves land for the public domain) and pueblo rights (a municipal right based on Spanish and Mexican law).

Riparian rights usually come with owning a parcel of land that is adjacent to a source of water and entitles the landowner to use a correlative share of the water flowing past his or her property. No permits, licenses, or government approval are required to exercise these rights. Riparian rights apply only to the water which would naturally flow in the stream, and do not entitle a water user to divert water to storage in a reservoir for use in the dry season or to use water on land outside of the watershed. Riparian rights remain with the property when it changes ownership, although parcels severed from the adjacent water source, usually through subdivision of the parcel, generally lose their right to the water.

During the 1849 Gold Rush, water development proceeded on a scale never before witnessed in the United States as these "forty-niners" built extensive networks of flumes and waterways that carried water far from the original stream in order to work their claims. These self-governing, maverick miners applied the same "finders-keepers" rule to water that they did to their mining claims; it belonged to the first miner to assert ownership. To stake their water claims, the miners developed a system of "posting notice" which signaled the birth of today's appropriative right system. It allowed others to divert available water from the same river or stream, but their rights existed within a hierarchy of priorities. This "first in time, first in right" principle became an important feature of modern western water right law.

When California entered the Union in 1850, one of the first actions taken by its lawmakers was to adopt the common law doctrine of riparian rights. One year later, the Legislature recognized the appropriative right system as having the force of law. The appropriative right system continued to increase in use as agriculture and population centers blossomed and ownership of land was transferred into private hands.

The conflicting nature of California's dual water right system prompted numerous legal disputes. Unlike appropriative users, riparian right holders were not required to put water to reasonable and beneficial use. This clash of rights eventually resulted in a constitutional amendment (Article X, Section 2 of the California Constitution) that requires all use of water be "reasonable and beneficial". That is, one cannot simply pump water to avoid losing a water right without putting it to some use, such as municipal and industrial uses, irrigation, hydroelectric generation and livestock watering. More recently, the concept has been broadened to include recreational use, fish and wildlife protection and enhancement and aesthetic enjoyment. This doctrine of public trust has recently become extremely important, as both a result of changing attitudes and values, and also due in large part to the requirements of the Endangered Species Act. The courts have held it is the state's responsibility to weigh the potential value to society of a proposed or existing diversion against its impacts on trust resources. Consequently, not only legal rights of humans are to be considered, but also the requirements of the environment.

Up to the early 1900's, appropriators -- most of the miners and nonriparian farmers -- had simply taken control of and used what water they wanted. Sometimes notice was filed with the county recorder, but no formal permission was required from any administrative or judicial body. The Water Commission Act of 1914 established today's permit process. The Act created the agency that later evolved into the State Board and granted it the authority to administer permits and licenses for California's surface water. The act was the predecessor to today's Water Code provisions governing appropriation.

These post-1914 appropriative rights are governed by the aforementioned hierarchy of priorities developed by the forty-niners. An appropriative water right is an exclusive right to take a specific amount of water, from a specific source, for a specific use, at a specific location during a specific period of time. In times of shortage the most recent ("junior") right holder must be the first to discontinue use; each right's priority dates to the time the permit application was filed with the State Board. Although pre-and post-1914 rights are similar, post-1914 rights are subject to a much greater degree of scrutiny and regulation by the Board. Riparian rights still have a higher priority than appropriative rights. The priorities of riparian right holders generally carry equal weight; during a drought all share the shortage among themselves.

### 3.2.1 CVP Water Allocations

The Central Valley Project is a massive system of 20 dams and reservoirs as well as canals, powerplants, and other facilities. The CVP provides irrigation and urban water, produces commercial power and provides flood protection, navigation, fish and wildlife, waterfowl, recreation and water quality benefits. Project facilities extend from the Cascade Range near Redding to the Tehachapis and Bakersfield area in the southern part of the Central Valley.

CVP "Project Water" refers to all water that is developed, diverted, stored or delivered by the United States in accordance with the statutes authorizing the Project and in accordance with the terms and conditions of applicable water rights permits and licenses acquired by and/or issued to the United States (Bureau of Reclamation) pursuant to California law. The USBR is the holder of the actual water *"right"* according to state law. The districts or water users with whom it contracts to sell project water hold an *"allocation"* to a certain amount of project water as specified in each purchaser's individual CVP contract. The Contractor must make reasonable and beneficial use of Project Water or other water furnished pursuant to CVP contracts. Undergroundwater recharge which is consistent with applicable State law is considered a reasonable and beneficial use. (State Water Resources Control Board 1994).

The relationship between the district or water agency and its landowners is also contractual, therefore individual landowners do not hold any true water "*rights*", as defined under state law. The CVP water allocation is tied to the land, so if the land is sold the allocation goes with it. However, either a district or an individual may transfer, sell or exchange their CVP water allocation to others for beneficial uses within the State of California if such sale, transfer or exchange is authorized by applicable federal and state laws, guidelines or regulations. While it was the intent of CVPIA to encourage and facilitate long-term water transfers outside the water districts, these arrangements are usually made on a temporary, annual basis due, in large part, to the politics surrounding long-term out-of-district transfers and the limitations under the CVPIA Water Transfer Guidelines.

The CVP water contracts stipulate provisions under which a water supply is provided to water districts. The districts generate revenue by selling CVP water to individual users at rates sufficient to repay the appropriate share of capital costs and operation and maintenance costs. Two types of water service contracts are used by the CVP: long-term contracts for more than 10 years, and temporary contracts for one year. The Reclamation Act of 1956 provided for contract renewals of long-term (40 years) contracts to agricultural users. The CVP contracts stipulate that the USBR is obligated to provide water to its contractors subject to the available water supply and based on the assumption that the USBR will use all reasonable means to protect the CVP from shortages. When these long-term contracts are renewed under the 1992 Central Valley Project Improvement Act the new contract term will be 25 years. At the time of contract renewal the amount of water allotted to a district is updated based on a reassessment of the reasonable and beneficial use of the water within the district (crop water "Needs" assessment).

### 3.2.2 CVP Water Allocations for WWD

Unlike most water agencies, WWD must ration water to its farmers even in wet years. Its annual contract entitlement from the USBR's CVP is 1,150,000 acre-feet (AF). The safe yield of the underground aquifer adds only another 200,000 AF. The total is about 10 percent or 150,000 AF short of the 1.5 million AF required for a normal cropping year. The surface water supply is allocated based on parcel location and amount of irrigable acres.

The 400,000 acre WWD entered into a 40-year water supply contract with the USBR in 1963, that provided for the delivery of 900,000 AF annually. In 1965, at the USBR's urging, WWD merged with its western neighbor, Westplains Water Storage District (Westplains) which added 194,000 acres to WWD. Since Westplains did not have a water contract, the USBR committed an additional 250,000 AF for this added area. An additional 10,000 acres was annexed to the WWD after the merger with Westplains, bringing the WWD's total acreage to approximately 604,000 acres.

WWD's 604,000 acres is divided into 3 Priority Allocation Areas, based upon when each area was incorporated into the district, with the majority of the original WWD district lands being designated Priority I. The 900,000 AF delivered under the 1963 Contract, is allocated to about 337,000 acres in the WWD (Priority Area I), which provides approximately 2.6 AF per acre. The additional 250,000 AF provides approximately 1.3 AF for each of the 194,000 acres in the former Westplains area (Area II). The Priority III Area lands, which were annexed last, do not receive any allocation of CVP water until the needs in both Area I and II have been met. (See Figure 5).

Since the 1989-1990 water year, WWD's water supply has been greatly reduced. A five-year drought, which began in 1988, resulted in a reduced water supply for much of the state, specifically districts like WWD which export water from the Sacramento-San Joaquin River Delta. Further reductions have occurred from the listing of native fish species under the federal Endangered Species Act, more stringent Delta water quality standards, and the CVPIA reallocation of 800,000 AF of CVP's water supply for environmental purposes. During this time, CVP water supplies for WWD were some of the lowest on record, 25 to 50 percent of contract supply. Farmers had to rely on groundwater and water transfers to help meet crop water needs. In 1991, almost 125,000 acres or 21 percent of the WWD gross area were idled. Since 1989-1990, WWD has purchased over 1.4 million AF of short-term transfer water. To supplement this reduced contract water supply, WWD is providing assistance to farmers to improve on-farm water management and is aggressively pursuing other sources of water including water transfers from other districts and instituting a land retirement program of its own.

### 3.3 Physical Setting

#### 3.3.1 Climate

The climate in the study area is characterized by hot, dry summers with maximum temperatures in excess of 43 degrees C, and cool, moist, foggy winters with temperatures seldom below 0 degrees C. Total precipitation averages 4 to 8 inches per year, with most falling between October and April (Preston, 1981). Hourly precipitation, temperature, wind, and relative humidity data are collected by California Irrigation Management Information System (CIMIS) weather stations in the project vicinity. The CIMIS weather stations are operated and maintained by the California Department of Water Resources (DWR) and are used by local growers to guide irrigation scheduling. The CIMIS weather stations are located within the Westlands study area boundary and approximately 18 miles west of the Alpaugh study area respectively, and will provide reliable climatic data for the Demonstration Project.

#### 3.3.2 CVP Water Deliveries

The San Luis Canal (California Aqueduct) and Delta-Mendota Canal supply CVP water to the WWD. With an allocation of 1,150 taf/yr (thousand acre-feet per year) WWD is the CVP's largest contractor. WWD supplies primarily agricultural users; however, about 5.5 taf/yr is supplied to urban users such as Lemoore Naval Air Station. Water allocations are based on the amount and location of land owned within the water district and the availability of water in a given year. WWD Priority 1 lands are those within the original water district and are eligible for a larger portion of the available water allotment, or 2.6 acre-feet per acre under a full supply. Priority 2 lands were annexed at a later date and thus receive a lesser allocation of up to 1.3 acre-feet per acre under a full supply. (See Figure 4). Even when WWD receives their full CVP water allocation, the district still purchases about 200 taf/yr from other sources to meet its growers' normal crop needs.

The Friant-Kern Canal conveys CVP supply to 24 long-term contractors in the Tulare Lake Region. Among the largest contractors for Friant-Kern supply are Arvin-Edison Water Storage District, Lower Tule River Irrigation District, and Delano-Earlimart Irrigation District. The Cross Valley Water Districts and Kern County Water Agency (KCWA) entered into agreements in 1974 for participation in the Cross Valley Canal. Arvin-Edison Water Storage District (AEWSD) entered into water exchange agreements with ten agencies in the Friant-Kern Canal service area. The exchange water is delivered through the California Aqueduct and the Cross Valley Canal to AEWSD facilities. AEWSD receives 128 taf annually of exchange water and makes available to exchange entities the first 174 taf of its Class I and Class II CVP entitlements from the Friant-Kern Canal.

A small portion of the Alpaugh properties (approx. 400 acres) are in the Alpaugh Irrigation District (AID, total size 10,500 acres) and approximately 7100 acres lie within the Atwell Island Water District (AIWD, total size approx. 7100 acres), with an additional 450 acres outside of both districts. All of the properties have been irrigated in the past, however, only about 5,200 acres are currently irrigated in AID and approximately 3,600 acres are currently irrigated in AIWD, predominantly for cotton and alfalfa.

3.3.2.1 Alpaugh Irrigation District

The Alpaugh Irrigation District (AID), as described in the AID Water Conservation Plan (Summers Engineering 1996), was organized on March 22, 1915. In 1967 the AID began receiving a surface supply of federal water through a series of temporary water service contracts with the USBR. On October 7, 1975, the AID entered into a contract with the County of Tulare as a subcontractor for CVP water. This contract included an agreement with the Arvin-Edison Water Storage District for the exchange of CVP water utilizing the Friant-Kern and Cross Valley Canals. The AID current contract provides for a maximum of 100 acre feet of water to be transported annually through State Water Project facilities to the Cross Valley Canal. By exchange the Arvin-Edison Water Storage District takes delivery of Alpaugh's Cross Valley Canal water and allows its Friant-Kern Canal supply to be delivered to Alpaugh Irrigation District.

AID receives its CVP water supply by means of Deer Creek. Water from the Friant-Kern Canal is diverted into Deer Creek and flows approximately 21 miles to the Deer Creek check structure located on the westerly side of Highway 43 at the northeasterly corner of the District. (Keller, pers. comm.1998).

Prior to 1967 AID's only source of water was groundwater. CVP contracts have allowed the District to reduce the groundwater pumping when supplies are available. Typically surface supplies have only been available in wet years or years when excess supplies are available and can be purchased by the District. (Keller, pers.comm.1998) Using deep wells, the District supplies potable water to the community of Alpaugh and its residents elsewhere within the district.

AID lies at the southeasterly edge of the old Tulare Lake bed. The topography is basically level with ground elevations ranging from 200-210 feet across the district. Three booster pumps are required to lift the water in the main canal from the southerly to northerly end of the District. The booster pumps impact the flexibility and cost of water deliveries, which range from $45 per acre-foot to $55 per acre foot, depending upon available surface water supply. These water rates are based on operation and maintenance expenses. Groundwater pumping is still the District's primary source of water and is energy intensive. During wet years AID has been able to utilize excess waters available in the Homeland Canal located on the western side of the District, which if not used, would flow into the historic Tulare Lake. (Keller, pers. comm.1998).

All surface drainage within the AID remains within the District. Many of the water users have installed tailwater return systems which pump tailwater back into the existing delivery system. At other locations, surface drainage flows by gravity back into the District's open ditch delivery system. No return flow water leaves the District service area. (AID Water Conservation Plan, Summers Engineering, Inc.1996).

3.3.2.2 Atwell Island Water District

The Atwell Island Water District (AIWD) was established in 1977(Atwell Island Water Conservation Plan, 1993). Its current size is approximately 7,100 acres, with approximately 3,600 acres currently being irrigated, mostly in cotton and barley. AIWD as a sub-contractor of Tulare County, which has a contract with the USBR. started receiving CVP water in June of 1978. The Tulare County contract includes an exchange agreement with the Arvin-Edison Water Storage District, similar to the AID arrangement. AIWD's contract provides for a maximum of 1,055 acre-feet of water to be transported annually through the State Water Project facilities, San Luis Canal, to the Cross Valley Canal. The Arvin-Edison Water Storage District then takes delivery of AIWD's contract water and allows AIWD to take delivery of Arvin-Edison's Friant-Kern Canal water from the Deer Creek turnout through a wheeling arrangement with Alpaugh Irrigation District.

In June of 1993 AIWD, along with Hills Valley Irrigation District, entered into a contract for Cross Valley Canal water (non-CVP water) with the County of Tulare. Both districts acquired an additional 954 acre-feet of surface water supply. In 1996 AIWD sold 2,921 acre-feet of capacity and assigned a like amount of contract supply to Hills Valley for $282 per acre foot, or around $825,000. AIWD carried the financing at 7% for seven years and there is an outstanding balance of approximately $340,000. This balance can not be transferred to individual owners within the district because of restrictions on public assets being transferred to private parties. AIWD is considered to be a public entity.

AIWD gets its irrigation water through a wheeling arrangement with Alpaugh Irrigation District. AID charges AIWD $4.50 per acre-foot for wheeling with booster charges per lift being $2.50 to $3.50 per acre foot. One lift is required for the properties between the Main Canal and East 3rd with the remainder needing two lifts. The single lift area includes the south ½ of Section 10, the SW 1/4 of Section 11 and all of Sections 14 and 23 in Tulare County. The rest of the District requires two lifts. There is a 17% loss between the Deer Creek turnout and delivery to AID's reservoirs, and an additional 3-5% loss before the water gets to the growers (Keller, personal communication). Therefore, the water cost to the growers is $69-$70 per acre foot for CVP water, in addition to the lift and wheeling costs charged by AID. This estimate is for a combination of Class 1 and Class 2 water (Keller, pers.comm.1998). (Class 1 and Class 2 water refers only to water within the Friant Division. Class 1 water is a dependable supply of water stored in or flowing through Millerton Lake. Class 2 water is undependable as to availability and time of occurrence. It is available only after other contractual contingencies are met. (Jon Anderson, pers. comm. 1999).

If Class 2 water is available, which happens when between 800,000 and 2.2 million acre-feet of water is available for delivery from the Friant-Kern system, then it can be purchased from Delano-Earlimart and diverted into Deer Creek. The current cost of this water is $21.50 at the Deer Creek turnout. After water loss considerations, the cost to the growers would be $27 to $28 per acre-foot. The availability of Class 2 water is uncertain. Other sources of temporary water are often available from the Homeland Canal or flood flows from Deer Creek.

AIWD has a 640-acre groundwater well field. In addition, District farmers have privately-owned groundwater wells to sustain irrigation during periods when the District does not have surface or groundwater available. The deep groundwater is used for irrigation, the shallow groundwater is unsuitable for irrigation due to its high salinity content. There is no local recharge for this groundwater excluding the saline drainage water. The main source of the deep groundwater is the Sierra Nevada mountains approximately 40 miles to the east. The depth of the usable groundwater table typically ranges between 150-250 feet. The energy costs of extracting this water are high (Keller, pers.comm. 1998).

The elevation within the AIWD ranges from a low of about 200 feet to a high of 210 feet. All surface drainage remains within the District. Many of the water users have installed tailwater return systems which pump tailwater back into the existing delivery system. No return flow water leaves the AIWD service area. (Keller, pers.comm.1998). There is one evaporation pond within the district, however it is in "interim closure" status and has not been used in the past two years. There is one other evaporation pond adjacent to AIWD that is proposed for acquisition. This pond was filled only one time and was certified as closed by the Regional Water Quality Control Board in 1998.

### 3.3.3 Regional Geology

The Westlands Demonstration project site is located in the western San Joaquin Valley, an asymmetrical basin bounded by the Coast Ranges on the west, the Tehachapi Mountains on the south, the Sierra Nevada on the east and the delta of the San Joaquin and Sacramento Rivers on the north. The axis of the valley trough is closer to the Coast Ranges than to the Sierra Nevada. The basin is filled with alluvium overlying older Mesozoic and Cenozoic marine and continental sediments. The alluvial deposits underlying the central San Joaquin Valley were shed from the adjacent Coastal and the Sierra Nevada ranges and vary in thickness from 900 to 3,300 feet (Miller *et al.*, 1971). The Sierra Nevada consists mainly of granitic and metamorphic rocks of pre-Tertiary age while the Coast Ranges are composed primarily of folded and faulted beds of Cretaceous age marine shale and sandstone in the north and Cenozoic age sandstone and shale in the south (Prokopovich 1987). Bull (1964a and b), identified a series of alluvial fans derived from sediments from the coastal ranges that form the western margin of the San Joaquin Valley in the study area.

The Alpaugh demonstration site lies within the Tulare Basin. The Tulare basin is a subsidence basin characterized by a broad structural trough on its west and south sides. The Tulare basin is filled with sediments derived from the Coast Ranges and the Sierra Nevada. The Tehachapi Mountains form the southern basin boundary, while coalescing alluvial fans from Los Gatos Creek and the Kings River form the northern basin boundary. The Tulare Lake bed is the dominant geologic feature in the upper 4,000 feet of basin-fill materials (Fujii and Swain, 1995). Lake sediments in excess of 3,600 feet thick (Page 1986) rest on Pliocene age sediments, making the historic Tulare Lake bed more than 2,000,000 years old. Tulare Lake has fluctuated in size throughout its history into recent geologic times, and, at one time occupied most of the San Joaquin Valley (Fujii and Swain, 1995). The Corcoran Clay Member of the Tulare Formation underlies most of the western and central San Joaquin Valley (Page 1986). The Corcoran clay is a fine grained lacustrine (lake bed) deposit that serves as a regional aquitard, exerting a strong influence on the regional flow of groundwater.

3.3.3.1 Site Geology: Westlands Site

The Westlands demonstration site is located in the trough of the San Joaquin valley in Western Fresno County. A generalized geologic cross section for the project vicinity is shown in Figure 6. The site is underlain directly by flood basin deposits derived from overbank deposition from the San Joaquin River and Fresno Slough. The flood basin deposits consist of fine textured, moderately to densely compacted clays that range in thickness from 5 to 35 feet (Belitz and Heimes, 1990). The basin clays have low permeability and greatly impede the downward movement of water. The flood basin deposits at the site rest upon well sorted micaceous sand derived from the Sierra Nevada. The Sierran sands are highly permeable, reduced in oxidation state, and vary in thickness between 400 to 500 feet in the project vicinity. The Corcoran clay underlies the site at a depth of approximately 450 feet.

3.3.3.2 Site Geology: Alpaugh Site

The Alpaugh demonstration site is located on the southern margin of the ancestral Tulare lake bed in Kings and Tulare Counties. A generalized geologic cross section in the project vicinity is shown in Figure 6. The study area is underlain by lacustrine (lake bed) and marsh deposits of the Tulare Lake that consist of clay, silt and some sand with a thickness of up to 3,600 feet. These lakebed sediments are often reduced in oxidation state reflecting depositional environments that remained under water for long periods of time such as lakes, marshes or low lying flood plains with abundant organic matter. The Corcoran clay underlies the site at a depth of about 900 feet. The predominant surficial geological feature at the site is an elongate sand ridge that was formed by eolian (wind deposited) processes as the level of the ancestral Tulare Lake fluctuated. The sand ridge traverses the site from east to west and represents the boundary of an ancient shoreline of the Tulare Lake. The sand dune consists of well sorted, fine grained sand with a thickness of about 10 feet.

### 3.3.4 Trace Elements

Toxic and potentially toxic trace elements occur naturally in some soils on the western side of the San Joaquin Valley and in the Tulare Lake Basin. These elements, originally found in the geologic formations of the Coast Ranges, have been mobilized, transported, and concentrated in irrigation drainage water as well as shallow groundwater in the study area. The Final Report of the San Joaquin Valley Drainage Program identifies five substances of "primary concern" for the San Joaquin Valley (SJVDP 1990a). The trace elements identified include selenium, boron, molybdenum, and arsenic, all of which occur naturally in westside soils. Salt was the fifth substance of concern identified by the SJVDP.

Selenium is of primary concern because it is widely distributed throughout the study area and it has proven to be toxic to certain vertebrate species, especially in aquatic habitats. Presser and others (1990) identified the sources and fate and transport mechanisms for selenium in the vicinity of the Westlands study area. Water and mudflows have transported the selenium to the valley in particulate and dissolved forms derived from the weathering and erosion of source rocks. Decades of irrigation have transferred soluble selenium from the upper soils to the shallow groundwater, where its highest concentrations occur generally along the edge of the valley trough in the lower parts of the coast range alluvial fans. Tidball and others (1986) published a regional scale map showing total selenium concentrations in the upper 12 inches of soil ranging from less than 0.09 mg/kg in the Alpaugh study area, and up to 0.13 mg/kg in the Westlands study area. Regional scale groundwater quality maps published by the SJVDP show selenium concentrations in the shallow groundwater (less than 20 feet from the land surface) ranging from 50 to >200μg/l at the Westlands site, and 20 to 200 ug/l at the Alpaugh site (Figures 7 and 8). Current, site specific data for trace element concentrations in project soil and shallow groundwater are not available. Monitoring of selenium and boron concentrations in soil, ephemeral surface water, shallow groundwater, and biota will be an integral part of the Demonstration Project. A general monitoring plan for surface water, groundwater and soil is contained in Appendix 1.

### 3.3.5 Soils

A buildup of salts in the soil can adversely affect agricultural productivity. The arid soils on the westside of the San Joaquin Valley and the Tulare Basin contain substantial amounts of naturally occurring soluble salts. Growers have traditionally managed these salts by applying a leaching fraction of irrigation water in excess of crop requirements. The leaching fraction transports salt from the crop root zone into the shallow groundwater system or into a subsurface drainage system. Due to the environmental problems associated with selenium concentrations in drainwater, subsurface drainage systems are no longer a management option in the Westlands study area. About half the soluble salts in the crop root zone are derived from the soil (CH2M Hill 1988). A large quantity of salt is also added to the soil from the imported irrigation water that is applied. Dissolved solids (salt) concentrations in the CVP water delivered to the western San Joaquin Valley via the Delta-Mendota Canal have averaged about 400 mg/l since 1992 (USBR 1999). When crops consume the applied irrigation water, the salts are left behind in the soil. The SJVDP estimated that salt accumulates at a rate of approximately 0.8 tons/acre-year and 2.3 tons /acre-year in the soils in the Westlands and Tulare Subareas, respectively (SJVDP 1990b). Therefore, approximately 5600 tons/year and 18,400 tons/year of salt are deposited on the lands comprising the 7000 acre Demonstration Project in the Westlands study area, and the 8,000 acre Alpaugh Demonstration area, respectively.

Much higher concentrations of salt are found in irrigation water that is pumped from the confined aquifer in the region. The salt contained in the shallow groundwater beneath the retired parcels is another potential source of salt to the soil profile. If the water table is close enough to the land surface, groundwater can be directly evaporated from the water table to the atmosphere. This process is referred to as "bare soil evaporation". Belitz and Phillips (1994) estimated that bare soil evaporation occurs in the Westlands study site for areas underlain by Panoche clay loam (Calfax) soils when the depth to the water table is less than seven feet from the land surface. When the water table drops below this depth, bare soil evaporation ceases.

#### 3.3.5.1 Soils: Westlands Site

Soils in the Westlands study area consist of clays and loams which formed in alluvium derived from igneous and sedimentary rock. Individual soil mapping units in order of abundance in the project area include the Tranquillity clay, Calfax clay loam, Lethent Silt Loam, Lillis Clay, Posochanet silt loam and Ciervo Clay. The Tranquillity and Calfax mapping units are the predominant soil types in the study area and cover greater than 90% of the proposed Demonstration Project lands. The Tranquillity clay is a very deep, poorly to moderately drained saline-sodic soil found on low-lying alluvial fans and flood plains with slopes between 0 and 1%. The permeability of this soil is slow and the unit is suited to growing irrigated salt tolerant crops, or for wildlife habitat (USDA 1996). Runoff is low, and the hazard of water erosion is slight. Effective rooting depth for crops is limited by a transient high water table that occurs at a depth of 4 to 6 feet. The high water table is influenced by irrigation as well as the orientation of surface drainage features and the texture of soil layers. The depth to the water table varies and is commonly highest during irrigation applications in the winter and early spring. These soils generally require intensive management to reduce salinity and maintain agricultural productivity. The Calfax clay loam mapping unit covers about 20 % of the study area. These soils are saline, alkaline, deep, well drained and found typically on low lying alluvial fans. Permeability of the Calfax soil is moderately slow. Effective rooting depths of the crops grown on these soils is limited by a high water table that occurs at a depth of 4 to 6 feet. Surface water runoff is low and the hazard of water erosion is slight. (USDA 1996)

3.3.5.2 Soils: Alpaugh Site

Soils in the Alpaugh study area consist of silt and sand loams that are formed in alluvium derived from igneous and sedimentary rocks. Individual soil mapping units found in the study area in the order of abundance include the Posochanet silt loam, Nahrumb silt loam, the Westcamp silt loam, Excelsior fine sandy loam, and Lethent fine sandy loam. The Posochanet soils occur primarily in the central portion of the site and cover about 30% of the total study area. These soils are saline, alkaline, very deep, moderately well drained with slow permeability. Salinity ranges from 4 to 8 deci-Siemens/meter (ds/m) in the upper portion and 4 to 30 ds/m in the lower portion. Surface runoff is generally slow, with a low hazard of water erosion. Nahrumb silt loam occurs on basin rims and consists of mixed alluvium from granitic rocks. Nahrumb soils cover about 30% of the total surface area in the southeast part of the site. These soils are very deep, somewhat poorly drained, with very slow permeability. Salinity ranges from 1-16 ds/m in the upper part to 8-30 ds/m in the lower part. Surface runoff is very slow with low surface erosion hazard. Westcamp silt loam soils cover the northwest corner of the study area. The Westcamp soils are saline, alkaline soils that have a perched water table. These soils are very deep, somewhat poorly drained, with very slow permeability. A transient high water table occurs at a depth of 4-6 feet. Salinity ranges from about 2-16 ds/m. Excelsior fine sandy loam soils are found on the sand ridge that traverses the site from northeast to southwest. The sand ridge covers about 15 % of the total study area. The Excelsior soils are very deep, somewhat excessively drained alkaline soils. Permeability of the sand ridge soil is moderately rapid, runoff is very slow and hazard of water erosion is slight, however the potential for wind erosion is high when vegetation is sparse. Salinity ranges from 0-8 ds/m in the upper part and 2-16 in the lower part. The Lethent fine sandy loam occurs in a small area in the southwest part of the study area. This soil is saline, alkaline, very deep, and moderately well drained. Permeability is very slow and the hazard of water erosion is slight. (USDA 1986, 1997)

### 3.3.6 Hydrology

3.3.6.1 Hydrology: Westlands Site

The natural drainage in the WWD study area is to the east and northeast with ground surface elevations ranging from 165 feet above mean sea level (AMSL), U.S. Geological Survey (USGS) datum, in the southeast portion of the site to about 190 feet AMSL in the northwest portion of the site. The land surface in most of the study area has been laser leveled to facilitate irrigation of row crops. There are no perennial surface water bodies on the WWD study area properties. Shallow ephemeral surface water ponds may form on low lying portions of the study area due to localized sheet flow runoff during prolonged winter storm events. Surface water courses within the area consist principally of irrigation supply canals, and irrigation return flow ditches. Fresno Slough, which is located approximately one mile east of the study area, is the largest perennial surface water body in the vicinity of the project. Fresno Slough receives flood flow releases from the North Fork of the Kings River and serves as a storage reservoir for federal irrigation water from the Delta Mendota Canal. Fresno Slough also occasionally receives flood flows from Panoche Creek, which rises in the Coast Ranges to the west, and flows out onto the Panoche Fan during winter storm events.

3.3.6.2 Hydrology: Alpaugh Site

The natural drainage in the Alpaugh study area is to the north-northwest with ground surface elevations ranging from about 205 feet AMSL, in the southeast portion of the site to about 215 feet AMSL in the northeastern portion of the site. A pronounced sand ridge traverses the northern boundary of the site in a northeasterly direction. The sand ridge was formed from windblown sand deposited along the southern shore of the Tulare lakebed. Surface water courses within the Alpaugh area also consist primarily of irrigation supply canals and irrigation return flow ditches, although the site has an artificially constructed 40 acre wetland that is filled from surface irrigation water supplies. Shallow ephemeral surface water ponds may form on low lying portions of the site due to localized sheet flow runoff during winter storm events. The surrounding areas in the vicinity of the Alpaugh site receive periodic unregulated winter storm flows from Deer Creek, Poso Creek, and the White River. The study area parcels under consideration are generally not subject to long term flooding due to its higher topographic position with respect to the adjacent lower lying lands.

### 3.3.7 Regional Groundwater System

The groundwater flow system on the west side of the San Joaquin Valley and the Tulare Basin is strongly influenced by a fine textured, low permeability clay layer known as the Corcoran Clay member of the Tulare Formation. The Corcoran Clay is a thick lake bed deposit that divides the groundwater flow system into an upper semi-confined aquifer and a lower confined aquifer. The semi-confined aquifer underlying the west side of the San Joaquin groundwater basin consists of three distinct hydrogeologic units: Coast Ranges alluvium, Sierran Sand and flood basin deposits (Figure 5). The semi-confined aquifer in the Tulare basin contains these same basic hydrogeologic units, with the addition of Tulare Lake bed deposits in the center of the basin (Figure 5). These units all differ in texture, hydrologic properties and oxidation state. The flow system has undergone considerable change since the development of irrigated agriculture in the region. Under natural conditions recharge to the upper aquifer was primarily from infiltration of stream water from intermittent streams flowing from the Coast Ranges. According to Davis and Poland (1957) and Belitz and Heimes (1990), rainfall was an insignificant mechanism for recharging the aquifer system. Discharge from the aquifer system under natural conditions was primarily from evapotranspiration and to streams along the valley trough. The following two paragraphs are excerpts from Belitz and Heimes (1990), and provide an excellent description of the history of groundwater development on the west side of the central San Joaquin Valley (SJV).

Agricultural activity in the area and the groundwater flow system response on the west side of the SJV began as early as the 1870s, but large-scale farming and irrigation did not occur until the First World War. Irrigation with groundwater expanded rapidly in the 1920s and steadily increased until World War II. After World War II, the price of commodities stimulated increased agricultural growth and by the early 1950s nearly one million acre-feet of water was being pumped from the aquifer system within WWD. Most of the water was pumped from beneath the Corcoran Clay member of the Tulare Formation. The increase in irrigated acreage and in pumpage significantly altered the groundwater flow system. Percolation of irrigation water past crop roots greatly exceeded infiltration of intermittent stream water and replaced the latter as the primary mechanism of recharge. Discharge of water through wells and evapotranspiration from crops replaced natural evapotranspiration as the primary mechanism of discharge. Post-development recharge during 1961-77 was more than 40 times greater than the estimated pre-development values for the Central Valley. Pumping of groundwater affected the hydraulic head and the direction of flow in the system. The most pronounced changes occurred in the lower confined zone. By 1952, the potentiometric surface of the confined zone was drawn down 100 to 200 feet from the presumed predevelopment altitude. Agricultural pumpage in excess of recharge continued for more than a decade after 1952 and led to further lowering of the potentiometric surface of the confined zone. By 1967, the potentiometric surface had been lowered by hundreds of feet over much of the western valley. Pumping lifts exceeded 890 feet over parts of the area, and land subsidence of more than 2 feet occurred throughout the area, with local subsidence reaching as much as 28 feet.

As a result of land subsidence, increased pumping lifts, and water quality limitations, surface water was imported to the western valley in order to decrease pumpage. Beginning in 1967, surface water imported via the California Aqueduct began to replace groundwater as the primary source of irrigation supply in the area south of Mendota. The availability of surface water led to an increase in the total quantity of water applied, whereas the quantity of water removed from the system by wells decreased. The marked decrease in pumpage has allowed a recovery in hydraulic head. The rise in the potentiometric surface from 1967 to 1984 was nearly one-half the drawdown that occurred from predevelopment conditions to 1967. The potentiometric surface is defined as the level that water from the confined aquifer would rise to in a tightly cased well completed in the confined aquifer. Agricultural development also has affected the semi-confined zone. Increased rates of recharge resulting from percolation of irrigation water, combined with the rapid post-1967 decrease in pumpage, caused a rise in the altitude of the water table over much of the western valley. (Belitz and Heimes 1990).

A regional tile-drain collector system, which was installed during 1980-81, also has had appreciable effects on the groundwater flow system. This system underlies about 42,000 acres of land west and southwest of Mendota. During 1981-84, the drains collected an average of 6,900 acre-feet per year. By lowering water levels 1 to 3 feet in the drained area, the tile drain collector system was effective in decreasing the total area characterized by a water table within 5 feet of the land surface. Maps of depth to water table indicate that in April 1976 about 41 percent of the area later serviced by drains had a water table within 5 feet of the land surface. By April 1984, the size of this area had decreased to 6 percent of the drained area. In contrast, in an area of equivalent size, topographic relief, and geomorphic character, but not underlain by regional tile drains, the size of the area underlain by a water table within 5 feet of the land surface increased from 8 square miles in 1976 to 18 square miles in 1984. (Belitz and Heimes 1990).

The semi-confined aquifer above the Corcoran Clay is now nearly fully saturated in much of the western San Joaquin Valley. Water tables continue to rise, and the waterlogged area is expanding. From 1991 to 1997, the area underlain by a water-table within 5 feet of the land surface in WWD expanded from 38,000 acres to 228,000 acres. Similar trends have been observed in the Tulare Basin, with the area underlain by a water-table within 5 feet of the land surface expanding from 119,000 acres in 1991 to 301,000 acres in 1997 (CDWR 1997). The concept of mitigating the drainage problem by retiring the land from irrigated agriculture is straightforward. The high water table results from an imbalance in the water budget as water is being applied at the land surface at a rate that exceeds the carrying capacity of the groundwater system, resulting in high groundwater levels. By ceasing irrigation, the primary source of recharge to the shallow aquifer system is terminated, and should result in water table declines. (Belitz and Heimes 1990).

Vertical groundwater flow is substantial in the western San Joaquin Valley. According to Belitz and Heimes, (1990), the combined effect of pumping from below the Corcoran Clay and percolation of irrigation water from above the water table has been the development of a large downward flow gradient in the semi-confined aquifer and a groundwater flow divide in the western part of the valley (Figures 9 and 10).

3.3.7.1 Groundwater Modeling

During the late 1980's and early 1990's a group of U.S. Geological Survey (USGS) researchers collected and processed data specifically for the creation of a fully three-dimensional, calibrated groundwater model covering 550 square miles in the west central SJV. The Westlands Land Retirement Demonstration study area falls within the model domain. Results from these efforts are published in a series of publications (Belitz and Heimes 1990; Gronberg and Belitz 1992; Belitz and Phillips 1994). The Belitz and Phillips effort constitutes the most comprehensive study of the groundwater flow system of the west side San Joaquin Valley to date. The objective of the model studies was to evaluate the effects of four alternative drainage management options on regional, long-term groundwater table behavior. Land retirement was one of the management options studied. The management horizon of the groundwater model was 1990-2040. The study area was divided into 10 subareas characterized by different long-term recharge and pumping rates due to surface water allocations and land use characteristics. The model also distinguished between areas with on-farm drains, regional drains, or no drains. Changes in annual recharge and pumpage due to climatic variations were not considered, because of the long term management horizon of the model. Model predictions with respect to water table conditions were interpreted as representative of long-term average conditions for the entire region. The model considered the following major elements of the subsurface hydrology: groundwater recharge from irrigation, groundwater pumping, discharge to drains, bare-soil evaporation, aquifer storage in the semi-confined zone, and groundwater movement between the semi-confined zone, the confining layers, and the deep confined zone. The study concluded that land retirement leads to a declining water-table and the elimination of bare soil evaporation beneath the retired lands, but has little effect on the water table outside the retired areas.

Fio (1999) recently conducted a post-audit study of the Belitz model and utilized the model to analyze water-table response to land retirement at the Westlands Demonstration Project site. The model considers the same elements of subsurface hydrology as the Belitz model; namely, groundwater recharge from irrigation, groundwater pumping, discharge to drains, bare-soil evaporation, aquifer storage in the semi-confined zone, and groundwater movement between the semi-confined zone, the confining layers, and the deep confined zone. The model does not consider transport of solutes in the groundwater system. Slight modifications were made to the input parameters used by Belitz *et.al.*, (1994) for groundwater recharge and pumpage, evaporation, and drainflow as a result of the post-audit analysis. The time domain for the simulations is 2000-2050. An area of 10,000 acres was simulated for land retirement.

3.3.7.2 Site Groundwater Conditions

Depths to the water table in study area vary seasonally with the highest water levels generally corresponding to the irrigation season in the winter and spring, and the lowest water levels occurring in the summer and fall. The USBR and WWD collect water level data for numerous monitoring wells in the Westlands study area on a quarterly basis. The USGS and the California DWR have constructed several wells to monitor groundwater conditions in the Alpaugh study area. The wells are generally constructed to monitor the groundwater levels in the upper 100 feet of the semi-confined aquifer. Well construction and location information for existing monitor wells in the study area is included in Appendix 4.

The depth to the groundwater table beneath retired parcels of land is an important consideration. Direct evaporation of groundwater from a shallow water table can result in increasing soil salinity and increasing concentrations of toxic trace elements on or near the land surface. The conceptual model for land retirement assumes that the high water table conditions exists due to percolation of irrigation water applied on site . When the land is retired, irrigation ceases, and therefore the source of recharge to the high water table is cut off; resulting in a declining water table. This conceptual model assumes that lateral inflow from "up slope" lands that continue to be irrigated is small, and that the predominant direction of groundwater flow in the upper aquifer system is downward. It is not known that this is a valid conceptual model for down slope retired lands in the WWD. However, groundwater monitoring at a retired parcel of land in the Westlands study area supports this conceptual model of land retirement. The parcel was retired from irrigated agriculture in 1994 and the shallow water table beneath the parcel has declined to a depth ranging from about 15 to 17 feet below land surface (Figure 12). Groundwater monitoring for this Demonstration Project will be used to validate or refute the conceptual and numerical groundwater models and guide future decisions for the Land Retirement Program.

3.3.7.3 Groundwater Levels: Westlands Site

The Westlands study area is located in the Valley trough and is underlain by a flood basin clay deposit with a thickness of about 30 feet that rests directly upon coarser Sierran Sand deposits. Groundwater monitoring data indicate that perched water table conditions exist at the site. Belitz and Heimes (1990) noted perched conditions in the study area. According to the authors, "Pumping from the Sierran deposits has lowered groundwater levels in the Sierran Sand below the interface between the overlying flood basin deposits and the Sierran sands, producing an unsaturated zone " (between the two units). "The low diffusivity of the clays in the flood basin deposits has allowed these deposits to remain saturated as the water table in the semi-confined zone declined below the interface". Vertical groundwater flow gradients exceeding one are common in the study area and provide evidence that perched water table conditions exist in the shallow groundwater system. Water levels measured in the flood basin deposits range from less than 5 to greater than 10 feet below land surface, while water levels in the underlying Sierran Sands range from about 40 to 50 feet below land surface. The SJVDP published maps showing depths to groundwater ranging from less than 5 to 20 feet from land surface in the Westlands study area. (Figure 13).

3.3.7.4 Groundwater Levels: Alpaugh Site

Groundwater conditions in the Alpaugh study area have been monitored by the USGS and the California DWR. Groundwater level data in the Demonstration Project area has been published by Fujii and Swain (1995) and Beard *et al*., (1994). These data indicate that water levels in the upper semi-confined aquifer beneath the site range from about 6 to 11 feet below land surface. The SJVDP published maps showing depths to groundwater ranging from less than 5 to 20 feet from land surface in the Alpaugh Study area. (Figure 14).

### 3.3.8 Groundwater Quality

Decades of irrigation have degraded the shallow groundwater quality in the semi-confined aquifer in the study area. Naturally occurring salts and trace elements have been leached from the soil profile and mobilized to the shallow groundwater system. Direct evaporation and transpiration of crops have concentrated salts and trace elements where the water table is near the land surface. Salt is also being imported into the study area through application of irrigation water that has passed through the San Joaquin River Delta on its way to the San Joaquin Valley. Salt build up in the soil has traditionally been managed by applying a leaching fraction of irrigation water to transport the salts downward in the soil profile. In the absence of a subsurface drainage system, leaching is no longer a feasible salt management option for many growers in drainage impacted areas.

The shallow groundwater underlying the study area is generally alkaline, with high concentrations of dissolved minerals and trace elements. Table 1 shows the groundwater quality data available for Westlands and Alpaugh study area. Electrical Conductivity (EC) is used to estimate the salinity of groundwater samples. The SJVDP maps show the groundwater at the Westlands Study area ranges in EC from 5 to greater than 20 DS/m. (Seawater has an EC of about 45 DS/m). The SJVDP reported selenium concentrations ranging from 50 to greater than 200 µg/l. The freshwater aquatic criteria for selenium concentrations in water set by the U.S. EPA is 5 µg/l.

**Table 1. Land Retirement Demonstration Project, Groundwater Quality**

| **Westlands Site** | | | | | |
|---|---|---|---|---|---|
| EC (DS/m) | Se (ug/l) | B (mg/l) | As (ug/l) | Mo (ug/l) | Data Source |
| 5 - >20 | 50 - >200 | 8 - >16 | < 50 | 100- >1000 | SJVDP |
| **Alpaugh Site** | | | | | |
| EC (DS/m) | Se (ug/l) | B (ug/l) | As (ug/l) | Mo (ug/l) | Data Source |
| 8.9-43.8 | 2 - > 1000 | 6900-24,000 | 19-270 | 1600-14,000 | Fujii and Swain, 1995 |

## 3.4 Cultural Resources

### 3.4.1 Prehistoric Period

The project area has a long and complex, but poorly defined cultural history with distinct local patterns that extend back more than 11,000 years. The first generally agreed upon evidence for the presence of prehistoric peoples in the region is represented by the distinctive fluted spear points termed Clovis Points found on the margin of Tulare Lake. Clovis Points are found on the same surface with the bones of extinct animals such as mammoths, sloths, and camels (Wallace and Riddell 1991). Based on evidence from elsewhere, the ancient hunters who used these spear points existed during a narrow time range of 10,900 B.P. to 11,200 B.P. ( B.P. means Before Present based on radiocarbon ages).

The next cultural period represented, thought by most to be subsequent to the Clovis period, is another widespread complex that is characterized by chipped stone stemmed spear points and crescents. Termed the Western Pluvial Lakes Tradition this poorly defined early cultural tradition is known from a large number of, apparently, isolated surface finds in the project area, primarily in the Tulare Lake basin. The cultural tradition is thought to date to between 8,000 and 10,000 years ago and its practitioners may be the precursors to the subsequent cultural pattern.

About 8,000 years ago many California cultures shifted the main focus of their subsistence strategies from hunting to seed gathering as evidenced by the increase in food-grinding implements found in archeological sites dating to this period. This cultural pattern is best known for southern California, where it has been termed the Milling Stone Horizon (Wallace 1954, 1978), but subsequent studies suggest that the horizon may be more widespread than originally described. Some of the numerous manos and metates found within the project area may date to this period. Radiocarbon dates associated with this period vary between 8,000 and 2,000 B.P., although most cluster in the 6,000 to 4,000 B.P. range (Basgall and True 1985).

Cultural patterns as reflected in the archeological record, particularly specialized subsistence practices, became codified within the last 3,000 to 4,000 years. The archeological record becomes more complex, as specialized adaptations to locally available resources developed and populations expanded. Many sites of this time period contain stone mortars and pestles implying the intense exploitation of the acorn. The range of subsistence resources utilized and exchange systems expanded greatly from the previous period. Evidence of social stratification and craft specialization, and trade is indicated by well made artifacts such as charmstornes and beads, often found as mortuary items. Yokut ethnographic lifeways serve as good analogs for this archeological period. Several Yokut ethnographic villages along lakeshores and drainages within the region appear to have had large populations, some that may have exceeded 1,000 people. While no sites have been recorded for the project area, many artifacts from this period have been collected from the surface.

### 3.4.2 Historic Period

The arrival of non-native peoples into the region had drastic affects on native populations. Introduced diseases virtually wiped out entire villages and the overall native population was reduced by 60 percent or more of their late prehistoric levels. The Spanish made a number of incursions into the area to recover mission run-aways and stolen horses, but no permanent settlements were established. They destroyed several Yokut villages to gain control of the native peoples.

The area was sparsely populated by Euro-Americans during the Mexican Period but large herds of semi-wild horses and cattle were common. Mexican expeditions were mostly military ones sent to control the Yokuts and get revenge for their raids on Mexican resources. Two Mexican land grants were made- one between the Kings River and Cross Creek, the other on the north bank of the Kings River. Only the latter, Manuel Castro's Rancho Laguna de Tache, was occupied (Preston 1981).

The Gold Rush changed the region markedly. The need for meat led to the establishment of cattle ranches and market hunting of tule elk and waterfowl. The Tulare Lake basin became a major stock raising area serving the mining towns of the Sierras and cities of Stockton, Sacramento and San Francisco. Hogs were taken to the tules to root in the summertime and driven into the foothills in the fall to fatten up on oak acorns. The latter had a direct negative impact on one of the Yokuts main food resources. As the Gold Rush faded, the miners shifted to new pursuits and agriculture expanded.

Modern patterns of land use for the region were established between 1857-1871 (Preston 1981). During this time there was a shift in emphasis from livestock to growing crops facilitated by drainage and irrigation. However, dry farming of grain was the major crop on the alluvial lands. Droughts and floods during the period hastened this change. Thousands of cattle either starved or were drowned by flood waters. Some of the first efforts at major crops of cotton took place in the 1870s but it did not become important until the 1920's (Turner 1981). Tulare Lake was incrementally reduced in size by drainage and diversion. By 1922 the lake was almost completely diked and reduced to a small fraction of its former size. Also beginning about this time was the rise of agribusiness, small farms declined and corporate farms increased. The Great Depression of the 1930s also brought in waves of Dust Bowl migrants and many of the present residents can trace their ancestry to these people.

New farming techniques allowed for leveling for irrigation on a scale never before possible. These practices had devastating results to the regions prehistoric sites and very few remain undisturbed. It is these conditions that characterize the project areas today. Artifacts, many with plow and scraper scars, are widely dispersed from their original proveniences. As a result much of the scientific value of the prehistoric items has been lost forever except on the most general level of analysis. Nonetheless, there are small isolated areas within the project areas that may contain undisturbed prehistoric deposits. However, brief reconnaissances of Sand Ridge, one of the few unleveled areas, and formerly farmed parcels near Mendota failed to find any archeological sites or intact prehistoric or historic artifacts. Because of the region's high sedimentation rates undisturbed archeological sites may be present even in leveled areas but remain deeply buried by sediments.

The artifact collections from the project areas have both scientific and aesthetic values. Most of the scientific value of these remains is contained within the artifacts themselves since, with little exception, provenience data is at the most general level. Further, much of this locational data on these items resides in the memory of the collectors. Such information needs to be gathered quickly since even this rudimentary data will be lost, further reducing their scientific value. The aesthetic values of the collections are high and reflect some of the best chipped and ground stone technology known for prehistoric California.

## 3.5 Economic Setting

The two areas potentially affected by the retirement of productive agricultural land have both experienced rapid population growth in recent years and have economies based predominantly on agricultural production. The importance of agriculture in the region has resulted in a large number of migrant workers in the area, which complicates the estimation of population and income levels in the region. However, combining U.S. Bureau of the Census data with State of California and local school district data helps to evaluate the social and economic characteristics of the region.

Data are presented at the county level to show general trends and projections in the two areas. Local estimates for individual places are presented where data are available. The land targeted for retirement is located primarily in Fresno and Tulare Counties with a small portion in Kings County. Demographic and economic information is presented for all three counties.

### 3.5.1 Population

The population of the two land retirement areas has grown rapidly over the last two decades. Fresno County has grown at a 2.43 percent annual rate from 1980 to 1997, Kings County has grown at a 2.93 percent annual rate over the same period, and Tulare County has grown at a 2.15 percent rate. Historical population estimates are presented for each county in Table 2. Population data were obtained from the State of California, Department of Finance and from the U.S. Bureau of the Census.

**Table 2. Historical Study Area Population**

| County | 1980 | 1985 | 1990 | 1995 | 1997 |
|---|---|---|---|---|---|
| Fresno | 523,200 | 588,300 | 686,000 | 761,900 | 786,800 |
| Kings | 75,100 | 84,100 | 104,000 | 115,300 | 122,800 |
| Tulare | 250,800 | 283,700 | 319,400 | 351,700 | 360,400 |

The 1990 Census estimated that about 51 percent of the Fresno County population was white, not of Hispanic origin, 36 percent were Hispanic, and about 8 percent were Asian. Kings County had a similar breakdown, with 54 percent white, 34 percent Hispanic, and 3 percent Asian. Tulare County had 55 percent white, 39 percent Hispanic, and 4 percent

Asian. The California Department of Finance population projections indicate that by the year 2000 each of these counties will experience a 6 to 7 percent decline in the white population and a 4 to 6 percent increase in Hispanic population. The large Hispanic population is primarily a result of agricultural production in the area and migrant labor needed to perform many farm operations.

3.5.1.1 Alpaugh Population

Population estimates are not specifically available for Alpaugh because it is not an incorporated place. Therefore, population estimates were obtained for the Census Block Group which includes Alpaugh along with Angiola, Allensworth, and any other residences between the Tulare County line on the west and highway 43 to the east (Alpaugh Block Group). In 1990 there were 1,113 persons in the Alpaugh Block Group and the average household size was 3.34 persons per household. Approximately 41 percent of the reported Census population in the Alpaugh Block Group was of Hispanic Origin and 37 percent of those five years of age and older speak Spanish at home. These are indicators of the large percentage of migrant laborers who live in the area. However, the Census numbers are likely to underestimate the actual number of Hispanic residents due to the hesitancy of migrants to report their birth place and due to bias associated with census numbers in undercounting the population of rural areas with migrant labor.

The Alpaugh Water District has accounts for an estimated 307 hookups in the Alpaugh Unified School District area and 176 hookups in within Alpaugh. Using the proportion of hookups in Alpaugh and the estimated School District population, there are about 600 people in Alpaugh. Adjusting the U.S. Bureau of the Census school district estimate using the California Basic Educational Data System (CBEDS) enrollment estimate results in an estimated 675 people in Alpaugh. The CBEDS data estimate that 66.2 percent of the Alpaugh Unified School District students are Hispanic, which is substantially higher than the 1990 Census estimates.

3.5.1.2 Mendota Population

The population of Mendota was 6,821 people in 1990 based on the 1990 Census and as of January 1998 the population of Mendota was estimated by the California Department of Finance to be 7,600 people. The average household size was about 4.2 people per household in 1990. About 94 percent of the reported Census population is of Hispanic Origin and 85 percent of those five years of age and older speak Spanish at home.

The population of the Mendota Unified School District was estimated by the U.S. Bureau of the Census to be 9,735 people in 1995 with an estimated 2,789 children of ages 5 to 17 years. The CBEDS data estimates there were 2,062 students enrolled in Mendota Unified School District Schools in 1997, indicating that the U.S. Bureau of the Census estimates may be fairly accurate for Mendota. The CBEDS data also indicates 97.8 percent of those enrolled in Mendota Unified School District schools are Hispanic.

3.5.1.3 Tranquillity Population

Similar to Alpaugh, population estimates are not specifically available for Tranquillity. Population estimates were obtained for a Census Block Group which includes only the small area of Tranquillity (Tranquillity Block Group). Therefore, the block numbers are likely to be a good representation for Tranquillity. In 1990 there were 744 persons in Tranquillity and the average household size was 3.56 persons per household. Approximately 60 percent of the reported Census population is of Hispanic Origin and 58 percent of those five years of age and older speak Spanish at home.

Tranquillity is served by the Golden Plains Unified School District. The population of the Golden Plains Unified School District was estimated by the U.S. Bureau of the Census to be 7,185 people in 1995 with 2,128 children of ages 5 to 17 years. The CBEDS data indicate there were 1,984 students enrolled in Golden Plains schools in 1997, which supports the U.S. Bureau of the Census population estimates.

3.5.1.4 Population Projections

The California Department of Finance develops population projections at the county level. These projections can be used as a general indicator of the magnitude and location of expected growth in the future. Projections for each of the study area counties is presented in Table 3.

**Table 3. Study Area Population Projections**

| County | 2000 | 2010 | 2020 | 2030 | 2040 |
|---|---|---|---|---|---|
| Fresno | 811,180 | 953,460 | 1,114,400 | 1,308,770 | 1,521,360 |
| Kings | 126,670 | 154,617 | 186,610 | 223,910 | 265,940 |
| Tulare | 379,940 | 469,510 | 569,900 | 692,980 | 836,970 |

The county level population projections indicate past population growth in the area is going to decrease in the future. Growth from 1997 to 2040 is projected to be about 1.54 percent annually in Fresno County, 1.81 percent annually in Kings County, and 1.98 percent annually in Tulare County. The percentage of the total population that is Hispanic is projected to grow steadily over the next 40 years. By the year 2040, the Hispanic population is projected to account for more than 50 percent of the total population for all three counties.

### 3.5.2 Economic Base

The two study areas included in the analysis have lower than average levels of income compared to all of California, have experienced higher than average unemployment, and have a relatively high percentage of large percentage of earnings and employment in the agricultural sector. In addition, the study areas have lower than average levels of education which may be a hindrance to future growth in employment and income.

Per capita income statistics are available from the U.S. Bureau of the Census and from the Bureau of Economic Analysis. The U.S. Bureau of the Census per capita income estimates are based on income and household sizes actually reported by households in the 1990 Census for 1989 income. Per capita income reported by the Bureau of Economic Analysis are based on estimates of personal income for 1993. The U.S. Bureau of the Census also provides 1995 estimates of median household income and the percentage of households living in poverty. These estimates are based on modeling results using the 1990 Census data and updating to 1995. Per capita and household income estimates for the study area counties and for California are presented in Table 4.

**Table 4. Income and Poverty Estimates for the Study Areas and for California**

| Area | 1989 U.S. Bureau of the Census per capita income estimates | 1993 Bureau of Economic Analysis per capita income estimates | 1995 U.S. Bureau of the Census median household income estimate | 1995 U.S. Bureau of the Census percentage of households in poverty estimate |
|---|---|---|---|---|
| Fresno County | $11,824 | $17,215 | $30,984 | 36.3 |
| Kings County | $10,035 | $13,652 | $28,337 | 28.6 |
| Tulare County | $10,302 | $15,319 | $25,935 | 37.3 |
| California | $16,409 | $21,895 | $36,767 | 24.3 |

The U.S. Bureau of Labor Statistics estimated the 1996 unemployment rate in California to be 8.6 percent, compared to 13.6 percent for Fresno County, 13.7 percent for Kings County, and 15.4 percent in Tulare County. In addition, educational attainment levels in the two study areas were significantly lower than for the State of California based on 1990 Census data. Of the population 25 years of age or older, 76.2 percent of the California population were high school graduates and 23.4 percent were college graduates. The respective percentages for the three counties in the study areas were 66.2 percent high school graduates and 16.9 percent college graduates for Fresno County, 65.6 percent high school graduates and 9.0 percent college graduates for Kings County, and 60.2 percent high school graduates and 11.8 percent college graduates for Tulare County.

One measure of the importance of various industries to a region is the earnings attributable to each industry. Table 5 presents total earnings by industry using Bureau of Economic Analysis, Regional Economic Information System for data for 1996.

**Table 5. Earnings by Industry**

| Sector | Fresno County | Kings County | Tulare County |
|---|---|---|---|
| Agricultural Services | $532.02 | $67.67 | $371.33 |
| Mining | $24.76 | $0 | $0.56 |
| Construction | $580.59 | $42.77 | $197.43 |
| Manufacturing | $901.11 | $115.86 | $373.06 |
| Transportation/public utilities | $645.13 | $35.75 | $204.23 |
| Wholesale trade | $530.41 | $38.07 | $160,85 |
| Retail trade | $993.23 | $113.87 | $433.20 |
| Finance, insurance, real estate | $579.45 | $24.45 | $148.26 |
| Services | $2,369.63 | $174.57 | $634.55 |
| Government | $1,825.68 | $467.25 | $728.04 |
| **Non-farm income** | **$13,440.56** | **$1,541.90** | **$5,375.99** |
| **Farm income** | **$781.63** | **$124.61** | **$541.81** |

3.5.2.1 Alpaugh Economy

The economic data presented in this section are based on the 1990 Census and the population living in the Census Block Group which includes Alpaugh. More recent economic data are not available for detailed geographic areas. Approximately 59 percent of those people 16 years of age and older and employed work in the agriculture, forestry, and fisheries industry and about 21 percent work in the education or health industries. About 54 percent of employed persons 16 years of age or older have a farming occupation, 14 percent are in service occupations, 11 percent are in administrative support, and 11 percent are machine operators or non-farm laborers.

The median annual household income in 1989 was $15,050, average household income for all households was $22,117 per year, and per capita income was $6,516 for the area. This compares to 1989 median household income of $24,450 for Tulare County and $35,798 for all of California. Average household income was about $47,000 for all of California and $33,000 for households in Tulare County and per capita income for Tulare County was $10,302 in 1989 and $16,409 for all of California.

#### 3.5.2.2 Mendota Economy

Approximately 60 percent of those 16 years of age and older and employed work in the agriculture, forestry, and fisheries industry, about 7 percent work in retail trade, 6 percent work in general service industries, and 5 percent work in the education or health industries. About 56 percent of employed persons 16 years of age or older have a farming occupation, 12 percent are in sales or administrative support positions, and 15 percent are machine operators or non-farm laborers. The median annual household income in 1989 was $17,977, average household income for all households was $20,570 per year, and per capita income was $4,920 for Mendota. Mendota has the lowest level of income and largest percentage of agricultural laborers of the three places evaluated in this analysis.

#### 3.5.2.3 Tranquillity Economy

The information presented in this section is based on the 1990 Census data for the Census Block Group which includes Tranquillity. Approximately 39 percent of those 16 years of age and older and employed work in the agriculture, forestry, and fisheries industry, about 24 percent work in retail trade, and 12 percent work in the education or health industries. About 40 percent of employed persons 16 years of age or older are in sales or administrative support positions, 28 percent have a farming occupation, 10 percent are machine operators or non-farm laborers, and 8 percent are in service occupations.

The median annual household income in 1989 was $24,937, average household income for all households was $37,300 per year, and per capita income was $11,021 for the area. As with Alpaugh, income in Tranquillity is lower than for the rest of the county and California. Median 1989 household income was $26,377 for Fresno County and $35,798 for all of California. Average household income was about $47,000 for all of California and $35,690 for households in Fresno County and per capita income for Fresno County was $11,824 in 1989 and $16,409 for all of California.

### 3.5.3 Agricultural Economy

The 1997 Census of Agriculture provides recent information on cropping patterns, farm income, and farm expenses at the county level. In addition, the 1997 data can be compared to the 1992 data to determine if there are any trends in the types of crops grown and production inputs used in the area. These data are presented in Table 6.

**Table 6. 1997 and 1992 Crop Acreage from the Census of Agriculture**

| | Fresno County | | Kings County | | Tulare County | |
|---|---|---|---|---|---|---|
| Crop | 1997 | 1992 | 1997 | 1992 | 1997 | 1992 |
| Wheat | 37,613 | 26,233 | 71,415 | 36,162 | 33,797 | 34,503 |
| Barley | 6,897 | 19,281 | 11,735 | 13,119 | 6,587 | 14,866 |
| Rice | 4,771 | 6,936 | 0 | 0 | 0 | 0 |
| Cotton | 348,003 | 306,804 | 196,108 | 235,509 | 81,089 | 122,675 |
| Hay | 91,949 | 90,771 | 58,776 | 44,495 | 139,588 | 110,147 |
| Vegetables | 175,454 | 143,521 | 11,937 | 8,597 | 6,699 | 6,343 |
| Orchards | 445,144 | 367,375 | 31,482 | 22,587 | 305,384 | 282,903 |

Both crops and livestock contribute significantly to the local economy. Crop production accounted for 74 percent of total gross farm receipts in Fresno County in 1996, about 50 percent of gross farm receipts in Kings County, and 55 percent of gross farm receipts in Tulare County. Net farm income ranged from 11 percent to 22 percent of gross earnings and hired labor represented the single highest expense category of farm production expenses

Cotton, orchards, hay, and vegetables are the dominant crops grown in the region. Small grains are also grown, but mostly as a rotational requirement with other row crops. Orchards and vegetables generally require better soils than cotton and hay. As a result, land in areas with poor drainage that are more likely to be retired are predominantly cotton, hay, or non-productive land.

Bureau of Reclamation crop production reports for WWD, Alpaugh Irrigation District (AID), and the Atwell Island Water District (AIWD) indicate about 50 percent of WWD and AID irrigated land is in cotton and about one-third of AIWD land is in cotton. About one-third of AID is in alfalfa and 20 percent of AIWD land is in alfalfa. A small percentage of WWD land is in alfalfa although hay acreage has been increasing due to low cotton prices.

### 3.5.4 Recreation

Recreational uses in the Demonstration Project area include limited hunting opportunities on nearby federal and state wildlife refuges, primarily for waterfowl. At certain times of the year, some agricultural land is open to hunting. Access is limited as most of the lands are in private ownership. As most of the area is intensively farmed, there is very little opportunity for wildflower or wildlife viewing activities.

## 3.6 Biological Resources

### 3.6.1 Historical Distribution of Native Habitats, Flora and Fauna

Prior to the 1940s, the landscape of the study area consisted of open grasslands and scattered oak woodlands, as well as wetlands, vernal pools, riparian areas and the Tulare Lake shoreline. Human settlement was sparse, concentrated mostly in Fresno and Modesto. Rapid agricultural development and increased human settlement drastically changed the visual landscape by replacing grasslands with irrigated cropland and reducing extensive wetland, vernal pool, and riparian areas to scattered segments. Most of the land in the study area is dedicated to agricultural use. The Demonstration Project parcels are primarily irrigated agricultural fields with some idled land. These lands are rural in character with scattered houses and outbuildings.

Historically the habitat types that occurred within the areas proposed for Land Retirement were saltbush scrub, nonnative introduced grassland, alkali sink and sacaton bunch grass. Riparian and marshland habitats were also in abundance. Although only general descriptions are available to correlate habitat types with soil and hydrologic data, they do occur on alkaline, poorly drained soils. The major natural plant communities in the San Joaquin Valley included herbaceous (grasslands, vernal pools and marshes), shrublands, woodlands and riparian forests. Grasslands included several communities: nonnative grassland, pine bluegrass grassland, relictual interior dune grassland, valley needlegrass grassland and valley sacaton grassland (After Kuchler 1977 in USFWS 1998). Valley salt scrub, dominated by Valley saltbush (*Atriplex polycarpa*), occupied the valley floor in sandy, non-alkaline soils. (See Appendix 5 for species list). Other species were desert isocoma, goldfields, bird's eye gilia, and creamcups and included blunt-nosed leopard lizard, San Joaquin kit fox, desert spiny lizard, coast horned lizard and greater roadrunner. (Harvey 1999).

SJV shrublands were dominated by shrubs less than six feet tall. Grasses and forbs typical of grassland communities covered the ground between and under shrubs. Shrubs occurred in alkali sinks, on alluvial fans, on dune remnants, in riparian areas and in arid uplands. Alkali playas were often interspersed within this habitat type. The dominant plant species was iodine bush. Other plants were bush seepweed, alkali heath, saltgrass, desert isocoma, jackass clover, and goldfields. Located near wetlands, these upland habitats provided foraging habitat for waterfowl and shorebirds during wet months. In summer months, if the ephemeral pools remained, black-necked stilts and American avocets could find foraging and nesting habitat. Other species of birds utilizing this habitat were raven, western meadowlark, horned lark, American pipits, lesser nighthawk and sage sparrow. Mammals in the valley sink scrub included blacktailed hare, Tipton kangaroo rat, and San Joaquin kit fox. Reptilian species included blunt-nosed lizard, side-blotched lizard, western whiptail, kingsnake and western rattlesnake (Harvey 1999).

Alkali sinks were drainage basins with highly soluble salts that could have been alkaline. Halophytes, plants that tolerate alkaline and saline soils, dominated. Playas, shallow, temporary lakes formed in alkali sinks during periods of heavy rainfall. Alkali sinks supported scrub plant communities such as alkali playa, haplopappus shrubland, and valley sink scrub. Alluvial fans were fan-shaped areas of soil deposited by mountain streams where they entered valleys or plains. Typically these supported saltbush scrub dominated by common saltbush or spiny saltbush. Sandy deposits surrounding historical lake beds are termed Relictual Interior Dunes community. Chenopod scrub or goosefoot family were the dominate plants which includes the various saltbush scrubs, alkali playa and valley sink scrub (USFWS 1998).

### 3.6.2 Current Upland Habitat Conditions and Listed Species

Valley Sink scrub occurred in both areas proposed for the expanded Demonstration Project. Currently the lands proposed for retirement from irrigated agriculture have been predominantly laser-leveled row croplands, planted mostly to cotton, seed alfalfa, grain crops, tomatoes, and sugar beets. The lands generally have been in agricultural production for decades. Periodically the lands were in active cultivation, then fallowed and disced to control unwanted weedy vegetation.

Plant species supported by fallow fields include annual grasses such as soft chess, ripgut, wild oats, Mediterranean barley, five-hook bassia, silverscale, crownscale, parry's tarweed and russian thistle. Generally agricultural lands in the San Joaquin Valley have low wildlife values, some of which are intermittent. Croplands can provide a concentrated foraging opportunity for several bird species: Brewer's blackbird, western meadowlark, mourning dove, horned lark, and American crow. Intermittently habitat is provided for western kingbird, American pipit, mountain plover, northern harrier, burrowing owl, California horned lark and loggerhead shrike (Harvey 1999).

Many endemic species (species restricted in occurrence) occur in the SJV and are associated with extreme aridity. In the Central Valley there are 44 endemic plants, 14 of which are found solely in the SJV, and of 28 species and subspecies of endemic animals, 16 are associated with SJV arid grassland and shrubland communities. More endemic vertebrate species co-occur in the SJV than anywhere comparable in the continental United States (USFWS 1998).

Lying within the southern half of California's Central Valley, the SJV has approximately 8.5 million acres, with fewer than 150,000 acres remaining uncultivated. Few of these acres include the arid shrublands and grassland communities which can provide upland habitat. For the entire SJV, generally less than five percent of historical natural communities remain and those that do are highly fragmented. Natural communities have been altered permanently by the introduction of nonnative plants, which now dominate in many of the remaining undeveloped areas. The majority of the listed species and species of concern occur in arid grasslands and scrub lands of the valley and adjacent foothills. (USFWS 1998).

### 3.6.3 Biological Resources: Westlands Site

A baseline biological survey was conducted to identify species presence and to help direct initial Demonstration Project prior to any manipulation. This survey gives an indication of the level and type of species use, especially by threatened and endangered species and indicates their possible presence on other surrounding similar WWD parcels.

Few plant species generally were found on field peripheries, and no animal sign was found. The parcel which was out of production for about five years had the greatest diversity of plants and animals. Grasses and annual plants colonized the parcel, providing a seed source for birds and small mammals. Common inhabitants of the parcel were house mice and California voles. The only sensitive species found was a small flock of flying mountain plover, a federal candidate and state species of concern. Areas with recent cultivation within the past year had substantially lower numbers of both plant and animal species. Eleven plant species out of 35 identified were native. Also observed were 18 bird species and 7 mammal species on the project area. No listed faunal species were observed within or adjacent to the project area. Wildlife species observed were common bird species including crows, meadowlarks and northern harriers. Burrowing owls do inhabit the San Luis Drain right-of-way. No listed floral species were observed within or adjacent to the project area ( ESRP 1999). (See Appendix 5).

### 3.6.4 Biological Resources: Alpaugh Site

The 8000 acres in the Alpaugh area are similar to lands described for Westlands in that the majority are laser-leveled agricultural fields. These are located on the southern extreme of the historic Tulare Lake freshwater marsh. The land is traversed by a ridge of sand at 200 to 217 feet elevation, that probably stood out as an island at times, and formed the southern shore of the lake, depending upon the lake's fluctuation level. A few parcels have inclusions (up to 360 acres) of native lands that have never been cultivated or leveled. Some parcels have been idle without any activity other than grazing within the past ten years. Approximately 1000 acres of one parcel was enrolled in the Conservation Reserve Program in 1988 and idled for 11 years. Previously this land, like most of the others in the area, was cultivated with alfalfa and cotton. Unique to this parcel is that it was not leveled. The lands were grazed by sheep in spring 1998. Surveys were done on these areas to describe current habitat conditions, determine occurrence of sensitive species, evaluate site recovery since cultivation and its importance to the conservation of sensitive species. (Uptain, *et al.* 1998).

The vegetation in parts of the area provided a sparse habitat of five-hook bassia and saltgrass. In past flooded areas along Poso Canal a heavy cover of tules, five-hook bassia, sunflower and tamarisk grew. The sand ridge area had the most diverse existing habitat. The plant community is best described as being in a successional stage between ruderal and non-native annual grassland (Holland 1986 in Uptain *et al.* 1998). The sand ridge is dominated by wire lettuce, western ragweed, bushseepweed, and spikeweed. Low-angle slopes and siltier alkaline areas harbor spikeweed, wildoats, ripgut, prickly lettuce and foxtail chess. North facing slopes had patches of saltgrass in the lower areas. Goldenbush was in low density throughout the section. The totals for animal species observed was: 32 birds, 10 mammals, 4 reptiles and 4 amphibians. Eight species of sensitive wildlife were observed: white-faced ibis, tri-colored blackbird, burrowing owls, horned larks, San Joaquin pocket mouse and American badger, coachwhip, and western spadefoot toad. Sensitive species known to the site, but not observed during the survey time are blunt-nosed leopard lizard (last sighted by the owner in 1996) and burrowing owl. (Uptain *et al.* 1998).

The potential for sensitive wildlife species habitat on the property, especially on the sand ridge, was noted for San Joaquin kit fox, Tipton kangaroo rat, American badger, San Joaquin pocket mouse, coachwhip, western spadefoot toad, blunt-nosed leopard lizards and coast horned lizard. Although no sensitive plant species were observed in any areas, habitat along sand ridge is suitable for San Joaquin saltbush, Hoover's woolly star, and San Joaquin Woolly threads. Non-inundated lowlands characterized by clayey, alkaline soils have potential for recurved larkspur and alkali Mariposa lily. (Uptain *et al.* 1998).

### 3.6.5 Linkages of Upland Habitat for Sensitive Species

With only about five percent of historical natural communities remaining in the San Joaquin Valley and those left being highly fragmented, the need to establish linkages is essential to species recovery. Linkages are corridors of at least marginal habitat that can provide cover for species as they travel between blocks of habitat that support species life requirements. The introduction of nonnative plants permanently altered all valley habitats. The majority of the listed species and species of concern occur in arid grasslands and scrub lands of the San Joaquin Valley and the adjacent foothills and valleys. Exceptions are the riparian woodrat and brush rabbit which inhabit forested river corridors of the eastern San Joaquin Valley. Catastrophic events such as drought or floods are serious threats to species surviving solely in these habitat fragments. (USFWS 1998).

The closest block of native habitat for any of the species in the WWD is the Alkali Sink Ecological Reserve (ER), the Mendota Wildlife Area (WA), and the Kerman ER. The Alkali Sink ER is a 932 acre tract of land specifically purchased by the state as habitat for Fresno kangaroo rats and other alkali sink community species. Kerman ER is a 1775 acre tract near Alkali Sink ER that was also purchased by the state targeting similar species habitat in addition to Bakersfield small scale and Lost Hills saltbrush. Mendota WA is situated on the south side of State Highway 180 immediately south of Alkali Sink ER. About 6,819 acres of the Mendota WA lands are managed as seasonally flooded wetlands, 457 acres as semi-permanent wetlands, and 1,194 acres as permanent wetland. All these reserves are within one to ten miles of the proposed Demonstration Project parcels.

In the Alpaugh Area, the existing habitat areas for the blunt-nosed leopard lizard, San Joaquin kit fox and Tipton kangaroo rat are found mainly on Kern National Wildlife Refuge (NWR), Pixley NWR and Allensworth ER. Kern NWR forms the western end of a linkage between it and the Sierra foothills on the east. Primarily a wintering area for migratory waterfowl, shorebirds, marsh and waterbirds in the southern San Joaquin Valley, the refuge also provides habitat for sensitive species. The refuge consists of 10,618 acres, which includes both natural valley grasslands and developed marsh. Marsh habitat acreage varies from year to year because of limited water supply. Pixley NWR, approximately 15 miles northeast of Kern NWR, provides native Valley Sink Scrub and Valley Saltbush Scrub habitat. In addition, the refuge provides a wintering area for migratory waterfowl. Habitat on this refuge includes 5,992 acres of native valley grasslands and developed marsh habitat. Additional native habitat is found south of Pixley in the 2,924 acres that comprise Allensworth ER, owned and managed by California Department Fish and Game. As shown in Figure 3, the 8000 acres of the Demonstration Project would provide a linkage among the habitats on these public lands.

### 3.6.6 Environmental Contaminants

Common environmental contaminants that may occur on the land retirement parcels fall into a range of possibilities associated with agricultural activities. These could include, but are not limited to, problems with leaking underground storage tanks, contaminated soil from spilled pesticides, fuel or other petroleum products, asbestos in old farm structures, farmyard trash, farm dumps, agricultural drainage, pesticide use on and adjacent to the property, hazardous waste sites, groundwater contamination from various sources, mining discharges, airstrips and municipal and industrial discharges. These types of environmental contaminants are the subject of the Phase I surveys. These surveys do not include unregulated, naturally occurring selenium that has leached from project soils into the groundwater.

Selenium is a semi-metallic trace element which has biochemical properties similar to those of sulfur. The common forms are as a pure element (gray trigonal crystals) and as selenium compounds in waters in the form of selenite and selenate. Certain metal and organic selenides are common in bottom sediments (USDI 1998). Selenium chemistry is complex in that it can take many forms in soils and water. As with sulfur, selenium can form gaseous oxides, commonly selenium dioxide which has a characteristic "garlic odor". The selenium cycle involves solid, liquid, and gaseous forms and is unusual in that the gaseous phase occurs in winter, the opposite of most other cycles. Selenium is mobilized from dry soils by rising groundwater or streambank erosion so long as the water is oxygenated or polluted with nitrate (Dr. Alex Horne, in North State Resources/Stetson Engineers 1999).

The normal path of selenium bio-uptake is via the food chain: plants to small invertebrates to larger invertebrates to mammals and birds. Solid forms are harmless unless ingested directly, but they can be converted to soluble forms under oxidizing conditions such as flooding. Soluble selenium leached from the soil is taken up by algae and the roots of higher plants. Herbivores eating the plants or algae and predators will acquire selenium through their food. Selenate, selenide and other forms of selenium can be taken up directly via the gut or possibly gills. In most aquatic ecosystems the soluble form is rapidly reduced by algae and retained by many aquatic biota. In drylands, selenium passes to selenium-accumulator plants. Selenium toxicity in plants and smaller invertebrates either does not occur on a population level or is less obvious than effects at higher trophic levels. In particular, selenium accumulates in arid regions where other potentially toxic salts also increase. Only a specialized flora and fauna inhabit such saline regions under natural conditions and some tolerances to selenium and other potential toxins may have evolved. Selenium bio-uptake is undesirable as the selenium mimics sulfur and replaces it in sulfur-proteins such as cystine and methionine. When these proteins are assembled into enzymes, the molecular and electrostatic fit between the enzyme and its substrate are incorrect if selenium has replaced sulfur. The enzyme thus does not function properly (Dr. Alex Horne in North State Resources/Stetson Engineers 1999).

In permanently flooded wetlands, selenium is soon sequestered in the sediments. As selenium passes through to the sediments, however, toxicity can occur when bioaccumulated by organisms through pathways in the water and sediments . In seasonal wetlands, toxicity is increased as selenium sequestered in the wet sediments is oxidized in the dry period and released as soluble selenium when the wet season returns. (Dr. Alex Horne, pers. communication, 1999).

3.6.6.1 The Kesterson Reservoir Case Study

Agricultural drainage water in the SJV contains high concentrations of salt and trace elements. Awareness of the effects of the drainage water selenium concentrations in the San Joaquin Valley followed the events at Kesterson Reservoir. Located within the Grasslands area of northern Merced County, Kesterson Reservoir occupied 5900 acres, upon which 1280 acres had 12 evaporation ponds constructed to receive drainage water via the San Luis Drain. Subsurface drainage began to flow into the Reservoir in 1978 and increased dramatically by 1981. About 7000 acre-feet of subsurface drainage water was transported annually (Zahm 1986; Ohlendorf and Santolo 1994). In 1983 the presence of selenium in aquatic birds at Kesterson Reservoir was documented in the form of embryo deformities and mortality; a trend of body weight loss in adult birds; death of adult birds; trend of increasing selenium concentrations in bird samples; elevated levels of selenium in food chain organisms; and nesting failures. (Zahm 1986).

USBR halted the inflow of drainage water to Kesterson in 1986, but contaminants had accumulated in the soil and biota. In 1988 USBR dewatered the reservoir and filled all areas so they were above average winter groundwater levels. This action effectively converted Kesterson Reservoir from an aquatic to a terrestrial upland ecosystem. The upland habitat consisted of three habitat types. Grassland habitat (30%) consisted of mostly perennial grasses dominated by dense mats of salt grass with some areas of alkali scrub dominated by iodine bush. These were in the higher elevation, upland area that existed at the reservoir before it was dried and filled. The filled habitat (60%) included formerly low-lying areas filled with soil to prevent the occurrence of seasonal wetlands. These former wetlands became dominated by annual plant species characteristic of annual grassland habitats with some areas of alkali scrub. Open habitat (10%) was former cattail areas that were not filled, but were disced to prevent use by tri-colored blackbirds and were now sparsely vegetated with annual species such as bassia, prickly lettuce and clover. (Ohlendorf and Santolo, 1994).

A biological monitoring program at Kesterson began in 1987 to document habitat and faunal changes and selenium concentrations among selected plants and animals. Later in 1996, focused studies were initiated to assess risks to local and migratory animals exposed to selenium levels in soil and biota; provide a basis for adjusting management; verify effectiveness of cleanup actions; and provide a basis for modifying future biological monitoring. For studies, eggs are considered the most sensitive indicator of exposure for evaluating potential effects, but can only be collected for a short time period and may be difficult to collect for species such as the meadowlark. Most background information on selenium in birds is from liver concentrations. (CH2MHill, 1999).

The monitoring program focused on the areas that pose a higher risk or new conditions to wildlife such as perennial vegetation, detritus and selenium inventory in the food web, especially upper trophic level consumers and small mammals. Generally the plants, invertebrates, mammals and birds sampled were above threshold levels for concern (3.0-8.0

ppm) (dry wt basis). Many were above the suggested toxic threshold for adverse effects (8.0 ppm or greater). Numerous samples were at levels expected to cause chronic or reproductive toxicity in birds and mammals, but no effects have been observed during biological monitoring since the reservoir was filled (CH2MHill 1998). Although no observations during the monitoring were made of seleno-toxic affects, the sample sizes were insufficient to conclude a "no effect" determination at statistical confidence limits normally used (90-95% power). Low-level adverse selenium effects are still occurring at Kesterson as shown by work done with artificially incubated eggs collected from Kesterson in 1998 at the University of California, Davis (Dr. Joseph P. Skorupa, pers. communication 1999).

The potential for selenium-induced reproductive problems continues to exist in sensitive species whose clutches have elevated egg selenium levels. For black-necked stilts, reproductive effects begin in eggs exceeding 6 ppm (Skorupa 1998); for ducks, reproductive effects begin in eggs exceeding 10 ppm (Heinz 1996; Henny *In Press).* By contrast, reproductive effects for American Avocets do not begin until eggs exceed about 60 ppm (USDI 1998). At Kesterson, mallard, red-tailed hawk and some killdeer nests were unsuccessful in 1998 due to predation, abandonment, management activities and high winds. Terrestrial species, meadowlarks and barn swallows inhabiting Kesterson, have shown no signs of reproduction problems, but sample sizes were too small to rule out undetected low-level reproductive effects that could be occurring. Prior avian monitoring indicated that birds nesting at the site did not exhibit impaired reproduction. What is not known, however, is whether this is due to selenium ingestion being relatively low because of partial off-site foraging, selective foraging on dietary items low in selenium and /or reduced species-specific sensitivity to selenium (CH2MHill 1999).

The reproductive effects of selenium on terrestrial birds may differ substantially from aquatic species, in part due to species differences and/or differences in selenium availability in terrestrial versus aquatic environments. Unfortunately no field tests have been done on terrestrial species. Laboratory feeding studies on chickens and quail, summarized by Heinz (1996) demonstrated that these two terrestrial species were at least, and possibly more, sensitive to selenium than mallards. Selenium guidelines established to protect aquatic birds would then also protect terrestrial birds to selenium exposure. However, in the two environments the selenium exposure is very different in the susceptibility presented to species. Selenium in a dry upland habitat is less bioavailable than the same amount of selenium in an aquatic habitat. The risk to terrestrial species would be expected to be lower, even if the terrestrial species sensitivity to selenium was the same or greater than the aquatic species.

No well-documented cases are known of widespread selenosis among wild mammals comparable to the multiple examples available for fish and birds (Skorupa 1998). Studies done to collect selenium in a wide range of mammalian species suggest that the normal concentration of selenium in individual samples of hair is less than 3 mg/kg. Population averages normally range from about 0.5 to 1.5 mg Se/kg. Deficiency seems to be more common than excessive exposure. (USDI 1998). At Kesterson the mean selenium concentrations in the diets of mice are expected to be lower than 10 µg/g. Although sample sizes were small, neither body condition or liver weights of small mammals observed during 1984 indicated effects from selenium when concentrations were higher than those expected in the next 20 years. Whole-body analyses for species evaluated averaged about 11 µg/g. Selenium concentrations in small mammals are expected to remain below those measured in 1984. (CH2MHill 1997).

#### 3.6.6.2 Selenium Exposure Pathways

The Kesterson example identified two major exposure pathways to elevated selenium concentrations: the detritus pathway and ephemeral pools. A detritus pathway includes the plant litter, mushrooms and invertebrates feeding on decaying organic materials. Organisms feeding primarily on detritus have higher selenium concentrations than herbivores, omnivores, and carnivores. Detritus selenium samples were significantly lower in 1996 and 1997 than in 1988. Detritus from the open habitat type, where cattails were cut and left to decompose, had higher concentrations.

A second selenium exposure pathway described at Kesterson was ephemeral pools that form largely as a result of rainfall accumulation, rather than from rising groundwater. Pools 10-25 cm deep may occur over most of the reservoir if rainfall is a 100 year event. Surface water selenium concentrations in some pools can exceed the recommended levels of 2 µg/l to protect wetland resources. Pools formed by rising groundwater would contain selenium at concentrations about one to two orders of magnitude higher than those observed in pools formed from rainwater. The geometric mean selenium concentration for the surface water pools was 2.73 µg/l, indicating that the highest values were very atypical. That conductivity was relatively low, less than 3.0 dS/m in most pools, also indicated that the water was mainly rainfall rather than rising groundwater. (Ohlendorf and Santolo 1994).

Waterborne selenium concentrations that may occur in surface water pools can result in appreciable bioaccumulation of selenium by aquatic birds. Ephemeral, rainwater pools at Kesterson Reservoir that persisted for greater than one month during the winter season were observed to harbor abundant populations of algae, aquatic insects, and crustaceans. Shorebirds in the area prey on these fauna in these small ponds. If the surface water pools persisted throughout the nesting season, the selenium concentrations could be high enough to reduce egg hatchability or cause teratogenesis in bird embryos. The likelihood of these effects is difficult to predict because of the uncertainty in estimating waterborne selenium in ephemeral pools and in assessing biological effects on the basis of waterborne selenium concentrations. (Ohlendorf and Santolo 1994).

The extensive rainwater pools formed at Kesterson during the winter of 1998 contrasted with previous years' measurements. The 1997-1998 El Nino winter created extensive rainwater pools that persisted for much of the winter and into late spring and varied in depth from inches to three feet (90 cm), covering large areas of terrestrial habitats. Water samples ranged from 1.0 to 62 ppb total selenium with a geometric mean of 5.6 ppb Se. Whole body selenium (dry weight basis) in aquatic invertebrates from these pools ranged from 2.3 to 94 ppm with a mean of 21 ppm selenium. The selenium contamination followed a pattern previously established in the pools at Kesterson. All 1998 water samples were lower in selenium concentration than the 1997 samples from comparable pools. The egg data for stilts and killdeer collected in 1998 exhibited a level of selenium exposure sufficient to expect selenium-induced embryo toxicity, but only at a low incidence. (CH2MHill 1999).

Soil selenium concentrations in the top 15 cm are strongly influenced by rainfall infiltration. Selenate, in particular, is readily leached deeper into the soil profile with winter rains. This tends to decrease the inventory of soluble selenium available for dissolution in rainwater pools. About 5 % of the total selenium inventory in Kesterson surface soils is water-extractable, indicating that only a limited amount of the selenium is currently mobile and available for plant uptake or dissolution into rainwater pools. (Ohlendorf and Santolo 1994).

In the Tulare Basin, waterborne selenium concentrations of 10 µg/l were associated with average egg concentrations of 8 µg/g and with hatchability effects in evaporation ponds.

Waterborne concentrations of 10 to 20 μg/l associated with average egg selenium concentrations up to 25 μg/g and teratogenic effects. Similarly, waterborne selenium concentrations in the ranges that have been predicted for rainfall ponding within Kesterson are of concern for any aquatic birds that may nest there. (USDI 1998)

### 3.6.7 Agroforestry and Evaporation Ponds

Agroforestry is a land use system that involves deliberate retention, introduction or mixture of trees or other woody perennials in crop and animal production systems to take advantage of economic or ecological interactions among the components (S. Josiah and J. Kemperman 1998). Among the agroforestry practices utilized in the SJV are windbreaks and a combination of salt-tolerant ( halophytic) grasses, shrubs and trees designed to reduce the volume of highly saline agricultural wastewater. Selenium concentrations in drainage water applied to agroforestry plots compared to selenium in water drained from the them was 1:1.775. More studies are needed to determine the role of volatilization of selenium by trees and halophytes. (Cervinka 1994).

Agroforestry plots that utilize open furrow irrigation systems have been shown to attract shorebirds. Measurements of seleno-toxicity deformities in these animals were found to be the highest of any seen in the field (USDI 1998). No studies examining alternative irrigation systems for drainage water application and their exposure risks are known. No agroforestry plots exist on any of the proposed parcels, although there are plots on lands within one mile of one parcel in WWD. No agroforestry plots occur in the Alpaugh area.

Evaporation ponds can be the endpoint for water disposal in the agroforestry plots, but can also stand alone in operation. Irrigation drainage water containing from <1 to >1,000 micrograms selenium per liter is emptied into ponds ranging in size from 10 to 1,800 acres. Impairment of avian reproduction in the form of embryo teratogenesis was documented at about half of the evaporation ponds. Exposure-response data for adult stilts showed a loss of body weight, but no fatal poisoning of adults or alopecia was documented for any bird species. (Fujii 1998; SJVDP 1990; Skorupa and Ohlendorf 1991; CH2MHill *et al*. 1993; Ohlendorf *et al.* 1993; CH2MHill 1994 in USDI 1998).

No evaporation ponds are on any of the proposed parcels in the WWD area. In the Alpaugh area, there are two ponds. One pond was used one time in 1983 and then closed to the Regional Water Quality Control Board standards. The area revegetated and was part of the area surveyed by Uptain, et al 1998. A second 33 acre evaporation pond is currently in intermittent closure. Measures executed by the landowner exceeded requirements for intermittent closure for this pond. Discharges to this pond ceased in 1994. The selenium level for the soils tested in 1994 from the evaporation pond were below the detection limit for reporting purposes. Proper closure procedures would be required as part of any acquisition.

### 3.6.8 Consultation/Coordination for Endangered Species Act Compliance

Informal Consultation for the Demonstration Project was recommended by the Sacramento Ecological Services Endangered Species Division Chief and was initiated in May 1999 and is ongoing. Previous consultations for lands associated with the Demonstration Project in the Alpaugh area gave clearance for the acquisition of lands, but required separate consultation for other parcels and for management. The request sent to the FWS in May would cover these additional actions to accomplish Endangered Species Act compliance.

### 3.6.9 Risk of Selenium Exposure for Humans and Livestock

Selenium toxicity and deficiency syndromes have been noted in free-living animals. As early as 1295, Marco Polo noted that beasts of burden had foot problems when the animals consumed a particular plant that grew near Tibet. In 1860, the hair in horses manes and tails of Civil War calvary exhibited exfoliation near Fort Randall, South Dakota. The problems ceased after other forage was provided. Alkali disease or blind staggers were terms used to describe animals grazing on seleniferous forage. Teratogenic effects of selenium in avian species were reported as early as 1936 when deformed chicks hatched from hens fed grains very high in selenium. Despite convincing evidence that selenium toxicity in farm animals can occur, selenium deficiency is a greater problem in livestock than is excessive intake (Wilbur 1980 in Klasing and Schenker 1988). Selenium taken in levels in excess of nutritional requirements was reported to offer some protection against certain types of cancer and cardiovascular disease (Combs and Combs 1984 in Klasing and Schenker 1988).

The US population gets varying selenium amounts in its daily diet. Evidence in humans of acute selenium toxicity is rare and to date is as a consequence of self-medication, accidental, suicidal or occupational exposures. Chronic toxicity from intermediate levels of selenium exposure is difficult to demonstrate in the human population. Complex interactions between selenium and numerous extraneous factors may alter effective soil, plant, or animal concentrations of a specific selenium form. High selenium soils, for example may produce plants that are less toxic than soils of lower selenium content because of differences in the chemical form of selenium, soil pH, plant species and the presence of other elements that bind selenium. Human nutritional bioavailability may depend on the source of selenium, nutritional status and growth rate of the individual (Klasing and Schenker 1988).

Other world areas have experience in the transfer of toxic levels of selenium into animal foods. Such areas generally occur in regions of low rainfall where soils have developed from shales that are high in selenium. The west side of the SJV produces a wide variety of crops, including several vegetables, fruits, meat and dairy products for human consumption. Dietary selenium assessment for human health was performed on a six agricultural crops under contracts with the UC Salinity/Drainage Task Force. The calculated selenium intakes of <1 to 151 µg per day from individual crops are not considered an immediate public health concern. Selenium residue studies under field conditions are limited. A health warning based on the current data was not appropriate (Fan and Jackson, 1988). An evaluation was done of the potential impacts of selenium in animal products raised near the Kesterson National Wildlife Refuge (KNWR) showed that adults might increase daily selenium ingestion by 8 to 17 µg/day and children , 5 to 11 µg/day. National data for selenium levels for foods produced outside of areas like the Kesterson NWR for persons weighing 70 kg were estimated to be 60 to 216 µg of selenium consumed per day. The consumption rates of the study then are within accepted ranges for the daily intake of selenium (Fan and Norman 1988). The selenium levels in blood from beef cows in 95 herds in the KNWR area had levels that showed no evidence or suspicion of selenium toxicity in any of the domestic animals. (Dunbar, Norman and Oliver 1988).

## 3.7 Air Quality

### 3.7.1 Existing Air Quality Conditions

Both the federal government and the state of California have established ambient air quality standards to protect public health and welfare. Federal ambient air quality standards are based on evidence of acute and chronic health effects. Most state ambient air quality standards are based primarily on health effects data but can reflect other considerations, such as protection of crops, protection of materials, or avoidance of nuisance conditions. Standards have been adopted for six criteria pollutants: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter (PM10 and PM2.5), and airborne lead. Areas that violate a federal air quality standard are designated as nonattainment areas. Nonattainment designations for ozone, carbon monoxide, and PM10 include subcategories indicating the severity of the air quality problem. Areas that comply with federal air quality standards are designated as attainment areas. Areas that have been reclassified from nonattainment to attainment are designated as attainment/maintenance areas. Areas that lack monitoring data to demonstrate nonattainment status are designated as unclassified areas and are treated as attainment areas for regulatory purposes. The proposed Demonstration Project lands are located in Fresno, Kings and Tulare Counties, which are designated serious non-attainment areas for Ozone and PM10 (40 CFR Part 81).

### 3.7.2 Existing Air Emissions

Lands that will be retired under this action are irrigated farmlands at varying levels of production, though some have been fallow for a period of time. Actively farmed lands and fallowed lands can serve as a source of fugitive dust emissions, particulate emissions, and of minimal emissions from farm equipment engines.

### 3.7.3 Air Quality Planning

The federal Clean Air Act (CAA, 42 USC § 7401 et seq.), as amended, requires each state to develop, adopt, and implement a state implementation plan (SIP) to achieve, maintain, and enforce federal air quality standards throughout the state. Deadlines for achieving the federal air quality standards vary according to air pollutant and the severity of existing air quality problems. SIP documents are developed on a pollutant-by-pollutant basis whenever one or more air quality standards are being violated and must be submitted to and approved by Environmental Protection Agency (EPA). In California, the SIP consists of separate documents for different pollutants in different regions of the state. Local councils of governments and air pollution control districts have had the primary responsibility for developing and adopting the regional elements of the California SIP.

Section 176(c) of the Clean Air Act (CAA) (§ 176(c), 42 USC § 7401 et seq.) as amended, requires federal agencies to ensure that actions undertaken in nonattainment or maintenance areas are consistent with the CAA and with federally enforceable air quality management plans. Federal agencies are required to evaluate their proposed actions to make sure that they will not cause or contribute to new violations of any federal ambient air quality standards, that they will not increase the frequency or severity of any existing violations of federal ambient air quality standards, and that they will not delay the timely attainment of federal ambient air quality standards. EPA has promulgated separate rules that establish conformity analysis procedures for transportation-related actions and for other (general) federal agency actions. The EPA requires a formal conformity determination document for federally sponsored or funded actions in nonattainment areas or in certain designated maintenance areas when the total direct and indirect net emissions of nonattainment pollutants (or their precursors) exceed specified thresholds. Applicable threshold levels for federal actions in Fresno, Kings and Tulare Counties are 50 tons/year for ozone, and 70 tons/year for $PM_{10}$ (40 CFR Part 93).

The California Clean Air Act (CCAA) of 1988, 26 California Health and Safety Code (CH&SC) §40000 et seq., requires air pollution control districts and air quality management districts to develop air quality management plans to meet state ambient air quality standards for ozone, carbon monoxide, sulfur dioxide, and nitrogen dioxide. The California Air Resources Board is responsible for developing a plan for meeting state $PM_{10}$ standards. The CCAA, 26

CH&SC § 40910 et seq., does not set specific deadlines for achieving state air quality standards. Instead, attainment is required "as expeditiously as practicable," with various emission control program requirements based on the attainment status for ozone and carbon monoxide standards.