A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley

Final Report
of the
San Joaquin Valley Drainage Program

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Chapter 2. THE PROBLEM

The San Joaquin Valley, which forms the southern portion of California's Central Valley, is bounded on the east by the Sierra Nevada and on the west by the Coast Ranges (Figure 1). It is made up of two geologic features — the San Joaquin Basin, drained by the San Joaquin River, and the Tulare Basin, a hydrologically closed basin that is is drained by the river only in extremely wet years. The two basins divide the San Joaquin Valley roughly into its northern and southern halves.

The general study area includes the entire San Joaquin Valley, from the drainage divide of the coastal mountains to the 1,000-foot elevation of the Sierra Nevada foothills. The principal study area comprises lands that are now directly affected by or contribute to agricultural subsurface drainage problems, as well as lands likely to be directly affected in the future. Most of these lands are on the western side of the valley and at its southern end.

A BRIEF HISTORY

The conditions associated with agricultural drainage in the San Joaquin Valley are not new to the region. Inadequate drainage and accumulating salts have been persistent problems in parts of the valley for more than a century, making some cultivated land unusable as far

Agricultural land south of Los Banos damaged by salt deposits caused by evaporation from ground water lying only a few feet below the land surface.

back as the 1880s and 1890s (Ogden, 1988). Widespread acreages of grain, first planted on the western side of the valley in the 1870s and 1880s, were irrigated with water from the San Joaquin and Kings rivers. This type of farming spread until, by the 1890s, the rivers' natural flows were no longer adequate to meet the growing agricultural demand for water. Poor natural drainage conditions, coupled with rising ground-water levels and increasing soil salinity, meant that land had to be removed from production and some farms ultimately abandoned.

The development of irrigated agriculture in the San Joaquin Valley since 1900 owes a great deal to the improvements in pump technology that took place in the 1930s. These achievements led to the development of large turbine pumps that could lift water hundreds of feet from below ground. In time, heavy pumping triggered severe ground water overdraft because more water was being extracted than was being replaced naturally. Ground water levels and hydraulic pressure fell rapidly, and widespread land subsidence began to occur. By the late 1950s, estimated overdraft in Kern County had reached 750,000 acre-feet per year.

Initial facilities of the Federal Central Valley Project transported water from Northern California through the Sacramento-San Joaquin Delta and the Delta-Mendota Canal in 1951 to irrigate 600,000 acres of land in the northern part of the San Joaquin Valley. This water primarily replaced and supplemented San Joaquin River water that was diverted at Friant Dam to the southern San Joaquin Valley.

The CVP's San Luis Unit and the State Water Project, each authorized in 1960, began delivering Northern California water to agricultural lands in the southern San Joaquin Valley in 1968. Together they provide water to irrigate about 1 million acres. Authorization of the San Luis Unit also mandated construction of an interceptor drain to collect irrigation drainage water from its service area and carry it to the Delta for disposal. The Bureau of Reclamation's 1955 feasibility report for the San Luis Unit described the drain as an earthen ditch that would drain 96,000 acres. By 1962, Reclamation's plans had changed to a concrete-lined canal to drain 300,000 acres. In 1964, alternative plans added a regulating reservoir to temporarily retain drainage (USBR, 1964). A decision was made in the mid-1970s to use the reservoir to store and evaporate drainage water until the drainage canal to the Delta could be completed.

At this same time, questions were raised about the potential effects of untreated agricultural drainage on the quality of water in the Delta and San Francisco Bay. This concern was reflected in a rider added to the CVP appropriations act by Congress in 1965, which stated that ". . . the final point of discharge for the interceptor drain for the San Luis Unit shall not be determined until development by the Secretary of the Interior and the State of California of a plan which shall conform with the water quality standards of the State of California as approved by the Administrator of the Environmental Protection Agency." This proviso remains in effect today.

Initially, the San Luis Drain was conceived as a State/Federal facility, but the State twice declined to participate. The Bureau of Reclamation began construction in 1968 and, by 1975, had completed 85 miles of the main drain, 120 miles of collector drains, and the first phase of the regulating reservoir (Kesterson). In 1970, Kesterson Reservoir became part of a new national wildlife refuge managed jointly by Reclamation and the U.S. Fish and Wildlife Service.

Diked ponds in Kesterson Reservoir fed by the San Luis Drain (open canal in mid-photo) in the early 1980s.

Federal budget constraints and growing environmental concern about releasing irrigation runoff into the Delta halted work on the reservoir and the drain.

In 1975, the Bureau of Reclamation, the California Department of Water Resources, and the State Water Resources Control Board formed the San Joaquin Valley Interagency Drainage Program to find a solution to valley drainage problems that would be economically, environmentally, and politically acceptable. This group's recommendation was to complete the drain to a discharge point in the Delta near Chipps Island (IDP, 1979). In 1981, Reclamation began a special study to fulfill requirements for a discharge permit from the State Water Resources Control Board.

The 1983 discovery of deformities and deaths of aquatic birds at Kesterson Reservoir altered the perception of drainage problems on the western side of the valley. Selenium poisoning was determined to be the probable culprit. In 1984 the San Joaquin Valley Drainage Program was established as a joint Federal and State effort to investigate drainage and drainage-related problems and to identify possible solutions.

In 1985, the Secretary of the Interior ordered that discharge of subsurface drainage to Kesterson be halted, and the feeder drains leading to the San Luis Drain and the reservoir were plugged in 1986. The reservoir is now closed. The vegetation has been plowed under, and low-lying areas were filled in 1988.

Contamination-related problems similar to those identified at Kesterson are now appearing in parts of the Tulare Basin, which receives irrigation water from the State Water Project, in addition to other surface and ground water supplies. Wildlife deformities and deaths have been observed at several agricultural drainage evaporation ponds.

THE AREA OF CONCERN

The chief area of concern in this study is the western side of the San Joaquin Valley from the Sacramento-San Joaquin Delta on the north to the Tehachapi Mountains south of Bakersfield. This area coincides generally with the Federal Delta-Mendota Canal and San Luis Unit irrigation service areas and the State Water Project service area. Figure 2 shows those service areas, the Friant-Kern Service area on the eastern side of the valley, and the general study area boundary. Lands now directly affected by, contributing to, or likely to be directly affected by agricultural drainage problems make up the principal study area shown on Figure 1. To aid planning and analysis, the principal study area has been divided into the Northern, Grasslands, Westlands, Tulare, and Kern subareas. Subarea boundaries are based on hydrologic considerations, political boundaries, current drainage practices, and/or the nature of the drainage-related problems.

The San Joaquin Valley is a gently sloping, nearly unbroken alluvial plain, about 250 miles long and an average of 45 miles wide, that is characterized by a mild, dry climate. The temperate climate, productive soils, and the application of water by farmers have combined to make this one of the world's most productive agricultural areas. Nearly all crops grown commercially in the region require irrigation.

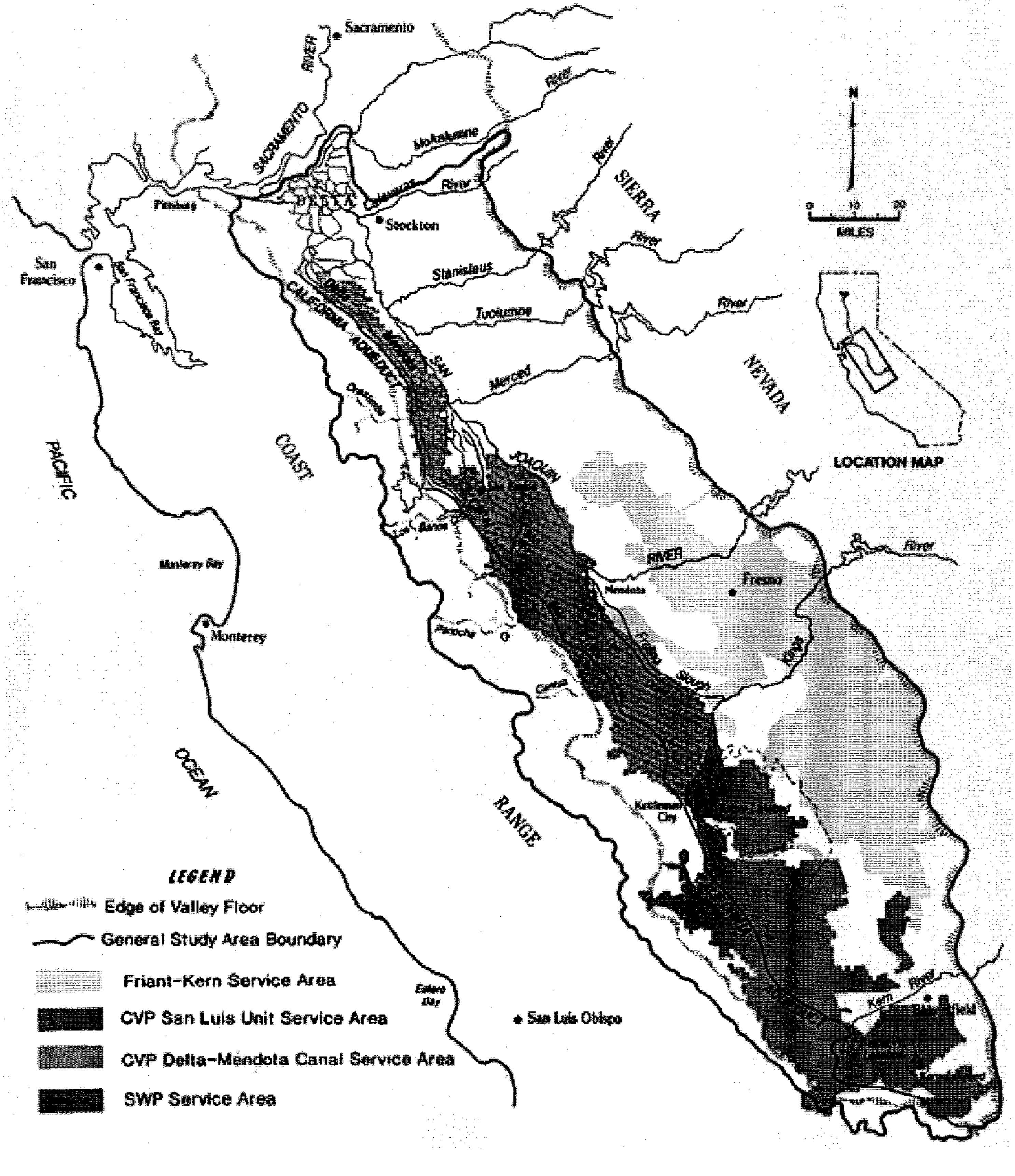
Soils on the western side of the valley are derived from the marine sediments that make up the Coast Range and are high in salts and trace elements that occur in a marine environment. Irrigation of these soils has dissolved these substances and accelerated their movement into the shallow ground water (Gilliom, et al., 1989a). Where water tables are high and agricultural drains are necessary, drainage water frequently contains elevated concentrations of these constituents.

The principal study area includes remnant natural and managed habitats of importance to a diversity of fish and wildlife species. Habitats include the Grasslands area, a large grasslands/wetlands complex in the southern San Joaquin Basin, where for several decades commingled surface and subsurface agricultural drainage water was used for habitat management; the San Joaquin River, into which an estimated 35,000 to 56,000 acre-feet per year of collected subsurface agricultural drainage water is currently discharged; evaporation ponds (primarily in the Tulare Basin), where subsurface drainage water is discharged and concentrated and which are used extensively by aquatic birds; and the beginnings of agroforestry plantations that are watered with subsurface drainage water and used by several terrestrial wildlife species.

The principal study area is predominantly rural. Communities tend to have fewer than 10,000 residents whose main economic existence is tied directly to agriculture. Although the population is sparse, compared to the central and eastern portions of the San Joaquin Valley, demographic shifts are occurring with an influx of people into the Tracy-Los Banos area from the San Francisco Bay region and into the Bakersfield area from the Los Angeles basin. Migrant farm workers also are major contributors to the area's economy and population.

Figure 2

MAJOR FEDERAL AND STATE IRRIGATION FACILITIES AND SERVICE AREAS



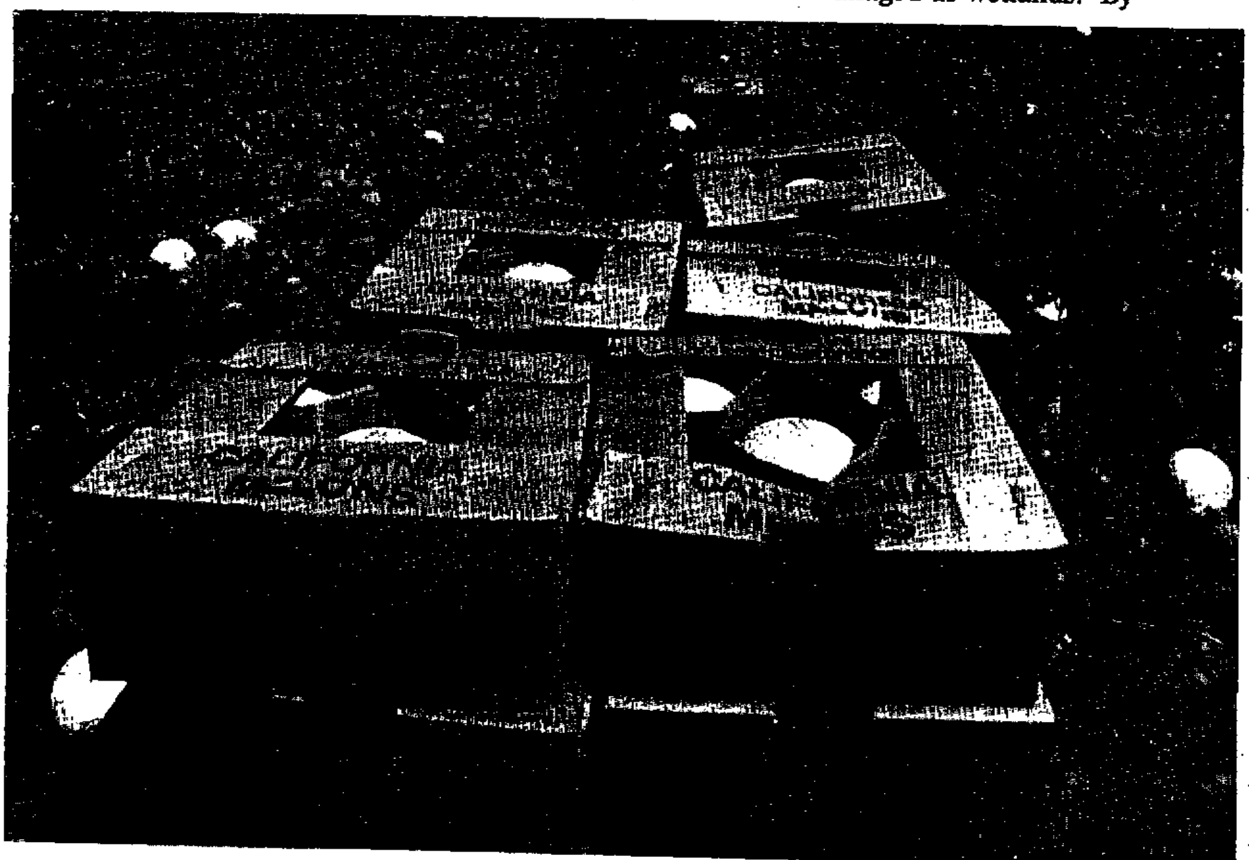
INTERESTS AFFECTED BY DRAINAGE PROBLEMS

Agriculture

Agriculture provides the economic base of the western side of the San Joaquin Valley (Archibald, 1990). About 90 percent of the 2,544,000 irrigable acres in the principal study area are in irrigated crop production at any one time. A diverse range of crops is grown there. Fruits and nuts are important in the Northern, Grasslands, and Kern Subareas, while the predominant crops in the Tulare and Westlands Subareas are field crops and cereal grains. Cotton is the leading field crop in both subareas.

Irrigation practices, methods, and efficiencies vary subarea by subarea. In 1980, the predominant method in the San Joaquin Valley was surface irrigation. The methods chosen depend on many factors — types of crops cultivated, cost of water, soil types, and current irrigation and drainage management practices. Farming practices and irrigation efficiencies are influenced by variations in soil type, climate, slope of the terrain, crops grown, and a grower's experience.

If current irrigation practices continue, areas in which ground-water levels are 5 feet or less from the surface of irrigated lands will continue to expand in the Westlands, Tulare, and Kern subareas. Such areas in the Northern and Grasslands subareas are unlikely to increase as long as they can be drained to the San Joaquin River. The total area in the western side at that level now is about 847,000 acres, of which 90,000 acres are managed as wetlands. By



Melons are an important crop in both the Grasslands and Westlands subareas.

2000, high ground-water levels may be adversely affecting about 1 million acres of irrigated land (W.C. Swain, 1990a and 1990b), or about 40 percent of irrigable farmland in the principal study area. This will reduce crop productivity, cause loss of farm income through conversion from salt-sensitive to salt-tolerant crops, increase costs of drainage management, and force land out of production.

Fish and Wildlife

[The following section is supported by information in the Drainage Program's Technical Report, Fish and Wildlife Resources and Agricultural Drainage in the San Joaquin Valley, California, October 1990.*]*

Before settlement of the San Joaquin Valley began in the 19th century, the richly diverse landscape supported large populations of both resident and migratory species of fish and wildlife. Today, most of these aquatic, wetland, riparian forest, and valley oak savannah habitats have been converted to agricultural, municipal, and other uses. Less than 1 percent of the freshwater lakes, only about 7 percent of the riparian forests, and less than 15 percent of the original wetlands remain. As a result, some native plants and animals have vanished from the landscape, and the continued existence of many others is in serious jeopardy. The populations of birds that once lived in or visited the valley as migrants have been greatly reduced, and the grizzly bear, the pronghorn antelope, and the gray wolf have disappeared entirely.

Impoundments on and diversions from the San Joaquin River and its tributaries have dramatically reduced the valley's fisheries. Native fish have declined drastically and introduced species are now dominant. Chinook salmon, once sufficiently abundant to have at least a spring run and a fall run, have been greatly reduced in population.

About 200,000 acres of private and public land and water in the San Joaquin Valley are presently managed as parks, refuges, and preserves, primarily for the benefit of fish and wildlife. These areas, which protect the surviving native habitats, include State and Federal wildlife areas, State fishery facilities, private duck clubs, special management areas, and private nature preserves. Until recently, about half the water supplies used in these areas was provided by agricultural drainage, but use of drainage water for such purposes has been discontinued on almost all wildlife areas because it may endanger the health of fish and wildlife. The location of major public wildlife areas in the San Joaquin Valley is shown in Figure 3.

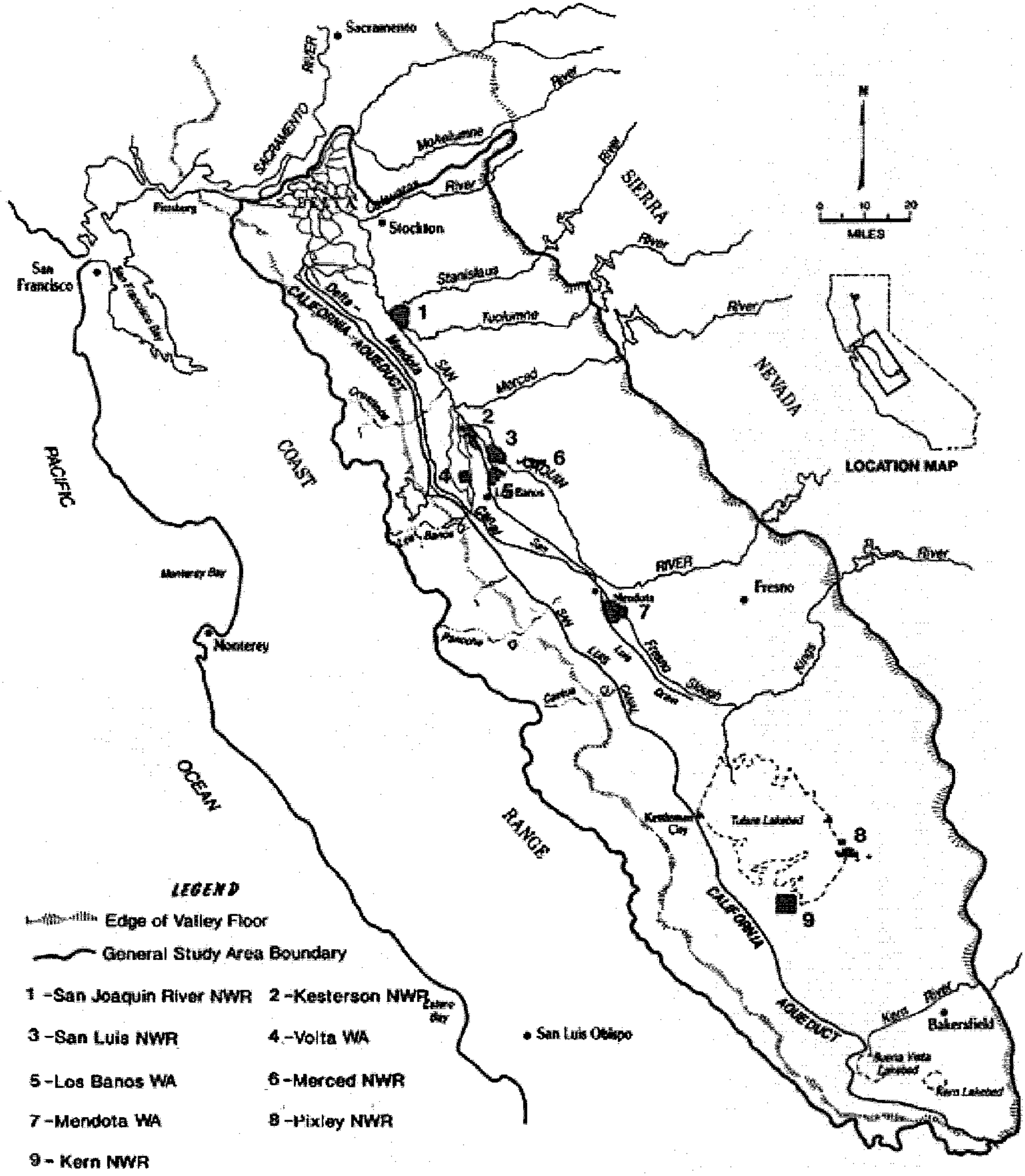
Laboratory research has demonstrated that elevated waterborne and/or dietary concentrations of several trace elements in some San Joaquin Valley drainage waters are toxic to fish and wildlife. Selenium is the most prominent of these; other constituents of concern include arsenic, boron, chromium, molybdenum, and salts.

Water Quality

The State of California, through the State Water Resources Control Board (State Board) and the nine Regional Water Quality Control Boards (Regional Boards), is responsible for protecting the quality of the State's water for beneficial uses. Regulation of deleterious waste discharges into both surface and ground water of the State is their responsibility. The Central Valley Regional Water Quality Control Board has adopted and the State Board has approved objectives for allowable concentrations of selenium, boron, and molybdenum at various sites on the San Joaquin River and tributaries (CVRWQCB, 1988a). [The U.S. Environ-

Figure 3

MAJOR PUBLIC WILDLIFE AREAS IN THE SAN JOAQUIN VALLEY



WA=Wildlife Area-State NWR=National Wildlife Refuge-Federal mental Protection Agency, however, has disapproved certain of the Board's objectives, and the matter is presently unresolved.] State water-quality objectives now and in the future will limit the discharge of agricultural drainage water to be assimilated by these streams. The Regional Boards issue permits for construction and operation of drainage-water evaporation ponds. Since events at Kesterson, the Regional Boards have become more concerned about the operation and eventual closure of these facilities.

Actions proposed by the Drainage Program are consistent with the State's present water-quality objectives. However, concern over the quality of the State's surface and ground water is expected to continue growing and introduction of agricultural drainage water into either body will likely be more strictly regulated in the future. In anticipation of these developments and in view of new scientific findings, assumptions based on more stringent objectives have been included in the alternative plans in Chapter 5 to show changes in required actions and associated costs.

Public Health

For the most part, contaminated agricultural drainage water is most likely to harm humans through indirect contact, such as consumption of contaminated fish or wildlife, plants, or livestock (Klasing and Pilch, 1988). Hazards intensify when contaminants are bioconcentrated by plants and animals or by evaporation, as in evaporation ponds. Direct dermal contact with drainage water contaminants studied to date is unlikely to pose significant health risks; however, inhalation of some particulate sediments (chromium, nickel, and silica, for example) has been shown to cause adverse health effects under some conditions.

Public health effects have been considered during this study, and plans were based on a criterion to minimize potential adverse public health risks from any drainage-water management strategy. Conclusions from studies of various potentially harmful constituents of drainage water as public health risks are presented in Chapter 3.