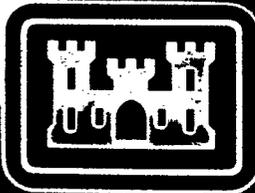


Draft Feasibility Report and Draft
Environmental Impact Statement
October 1982

Sacramento-San Joaquin Delta California



US Army Corps
of Engineers
Sacramento District

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SYLLABUS

The purpose of this study was to investigate water resource related problems in the Sacramento-San Joaquin Delta and to determine the need for and feasibility of improvements to solve these problems.

The principal areas of concern included flood problems to the islands which are exacerbated by the deterioration of Delta levees, salinity intrusion into the Delta when a levee fails and an island becomes inundated, a large unmet demand for recreation in and around the Delta waterways, subsidence of the islands, and protection of the fish and wildlife resources within the Delta area. This study has developed a potential solution to these problems, except for island subsidence. Subsidence will continue for as long as the islands are utilized for agricultural purposes.

The plan selected as a result of this investigation includes rehabilitation of about 165 miles of levees surrounding 15 islands and recreation facilities for boat launching, fishing, picnicking, and trail-oriented activities. The plan also includes acquisition of 650 acres for fish and wildlife mitigation and 6,000 acres for fish and wildlife enhancement. The project proposed in this plan would have an estimated first cost of \$415,000,000 and an average annual cost of \$28,000,000. With average annual benefits of \$54,000,000, the project has a benefit-cost ratio of 1.9 to 1.

It is recommended that, subject to certain conditions of non-Federal cooperation as outlined in this report, the proposed plan be authorized for construction. Estimated first and annual costs to the United States are \$350,000,000 and \$21,000,000, respectively. Estimated non-Federal first and annual costs are \$65,000,000 and \$7,000,000, respectively, including \$2,000,000 in annual operation and maintenance costs. These costs are based on traditional cost-sharing methods. Non-Federal interests will be expected to cost share to at least this level; however, non-Federal interests may be expected to financially participate significantly more under the Administration's cost-sharing principles when established.

Second Printing
August 1986

SACRAMENTO--SAN JOAQUIN DELTA, CALIFORNIA
DRAFT FEASIBILITY REPORT
AND
DRAFT ENVIRONMENTAL IMPACT STATEMENT

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OCTOBER 1982

SACRAMENTO-SAN JOAQUIN DELTA INVESTIGATION, CALIFORNIA

DRAFT FEASIBILITY REPORT AND DRAFT ENVIRONMENTAL
IMPACT STATEMENT FOR WATER RESOURCES DEVELOPMENT

THE STUDY AND REPORT

PURPOSE

This study was conducted as a joint effort with the State of California, Department of Water Resources (DWR) for the purpose of determining the Federal and State interest in providing additional flood protection, enhancing recreational opportunities, preserving scenic values, and controlling tidal intrusion into the Sacramento-San Joaquin Delta of California.

FEDERAL AUTHORITY

This report has been prepared as the final response to two Congressional resolutions and a Public Law which authorized Federal investigation of water resource problems in the Sacramento-San Joaquin Delta.

The resolution adopted by the Senate Committee on Public Works on 1 June 1948 is quoted below:

RESOLVED by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review reports heretofore submitted on the Sacramento River, California, for navigation and flood control with a view to determining if it is advisable to modify the existing projects in any way at this time, particularly to provide for the closing of Georgiana

Slough and replacement of the channel for navigation with a connecting channel between Georgiana Slough and the Mokelumne River, and particularly for the elimination of tidal flow into lower Sherman Island, Franks Tract, the area southerly of Dutch Slough and similar areas subject to tidal inundation so that the tidal prism of the Sacramento-San Joaquin Delta may be reduced to a minimum.

The resolution adopted by both the Senate and House Committees on Public Works on 31 January 1961 and 7 June 1961, respectively, is quoted below:

RESOLVED by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors, be and is hereby, requested to review the reports on the Sacramento-San Joaquin Basin Streams, California, published in House Document Number 367, Eighty-first Congress, and other pertinent reports with a view to determining the advisability of measures to preserve scenic values, and to preserve and enhance recreational and related opportunities in project areas in the Sacramento-San Joaquin Basin Delta region, consistent with the primary flood control purposes of existing and proposed levees and channel improvements.

Section 205 of the Flood Control Act approved 17 May 1950 is quoted, in part, as follows:

The Secretary of the Army is hereby authorized and directed to cause preliminary examinations and surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas to the United States and its territorial possessions, which include the following named localities . . . Sacramento and San Joaquin River Delta areas, California: Provided, that this examination and survey shall not duplicate the investigations authorized in House Resolution 618, 80th Congress, 2d Session.

House Resolution 618, 80th Congress, 2d Session, 27 May 1948, authorized the Department of Interior to investigate the feasibility and justify the

means for conservation, maintenance, and utilization of the fresh waters of the Sacramento and San Joaquin Rivers.

STATE AUTHORITY

In 1969, the California State Legislature requested DWR to develop a plan to improve flood protection in the Delta. In 1975, DWR published Bulletin No. 192, "Plan for Improvement of the Delta Levees" which presented possible courses of action. In 1976, the California Legislature adopted Senate Bill No. 1390, also known as the Nejedly-Mobley Delta Levees Act, directing DWR to further develop plans for preserving the Delta levees. That bill authorized the State's portion of the joint State-Corps of Engineers Sacramento-San Joaquin Delta Levees Study and is quoted in part from the State Water Code as follows:

12225. The plan for improvement of the Sacramento-San Joaquin Delta levees, as set forth in Bulletin No. 192 of the Department of Water Resources, dated May 1975, is approved as a conceptual plan to guide the formulation of projects to preserve the integrity of the Delta levee system.

12226. The department may prepare detailed plans and specifications for the improvement of the levees or levee segments specified in Section 12225.

12226.1 The department shall report on its recommendations to the Legislature concerning the improvement of the levees specified in Section 12225, including, but not limited to, recommendations concerning construction, cost-sharing, land use, zoning, flood control, recreation, fish and wildlife habitat, and esthetic values. . .

The State Legislature also authorized DWR to conduct an investigation to determine the feasibility of a subsidence control program in the Delta. That

authorization is quoted as follows from Section 12881.4 of the State Water Code:

SEC. 2. The Legislature finds and declares that:

(a) Peatlands in the Sacramento-San Joaquin Delta are subsiding up to three inches per year due to soil oxidation, compaction, and wind erosion.

(b) Because of continued subsidence, much of the Delta lands have fallen below sea level, and larger levees have had to be constructed in order to restrain tidal and flood waters from permanently inundating these valuable Delta agricultural lands.

(c) Without major levee works or without preventing subsidence, local levee maintenance districts will have increased economic difficulties in maintaining a viable levee system.

(d) A partial alternative to costly state and federal major levee works would be a subsidence control program undertaken along the landside of levees, if such control is determined to be economically and engineeringly viable.

SEC 3. The Department of Water Resources is hereby directed to undertake an investigation of the viability of a subsidence control program in the Sacramento-San Joaquin Delta. The department shall report its findings to the Legislature.

SCOPE OF THE STUDY

The Sacramento-San Joaquin Delta is a triangular shaped region located in north-central California at the confluence of the Sacramento and San Joaquin Rivers. As defined in the State Water Code (Section 12220), the legal Delta is a 1,100-square-mile area which extends into portions of six counties: Alameda, Contra Costa, Solano, Sacramento, San Joaquin, and Yolo. The legal Delta encompasses approximately 700,000 acres, and includes 700 miles of waterways interconnecting about 100 islands and tracts. Delta lands are protected by nearly 1,100 miles of manmade levees. Some of the levees are over 100 years old. Major population centers bordering the Delta include the San Francisco Bay Area, Sacramento, and Stockton.

The study area for this investigation is located within the legal Delta and encompasses approximately 270,000 acres comprising 57 major islands and tracts in Contra Costa, Sacramento, and San Joaquin Counties. The study area is bounded by the town of Walnut Grove on the north, and the cities of Tracy on the south, Antioch on the west, and Stockton on the east. Figure 1 shows the legal Delta boundary and the location of the study area. This is the general geographic area mentioned in the Congressional study authorities and includes the islands and tracts identified in DWR Bulletin No. 192, "Plan for Improvement of the Delta Levees," May 1975, as being the most in need of additional flood protection.

The Sacramento-San Joaquin Delta is one of the most intensively studied water resource areas in the United States. Federal, State, and local agencies have conducted a plethora of studies in the Delta. The wide-ranging subjects of these studies included flood control, water supply, navigation, recreation, water quality, fish and wildlife, and habitat evaluation and preservation. The current investigation is limited to studies of flooding, water quality degradation associated with flooding, recreation, and the preservation and enhancement of environmental values.

During the course of this investigation, many alternatives to assist in solving these water resource problems were investigated on a preliminary basis. From these alternatives, candidate plans were developed on the basis of support from local interests, environmental and social acceptability, and economic feasibility. Detailed studies of these candidate plans were then conducted and the most appropriate plan of improvement was selected.

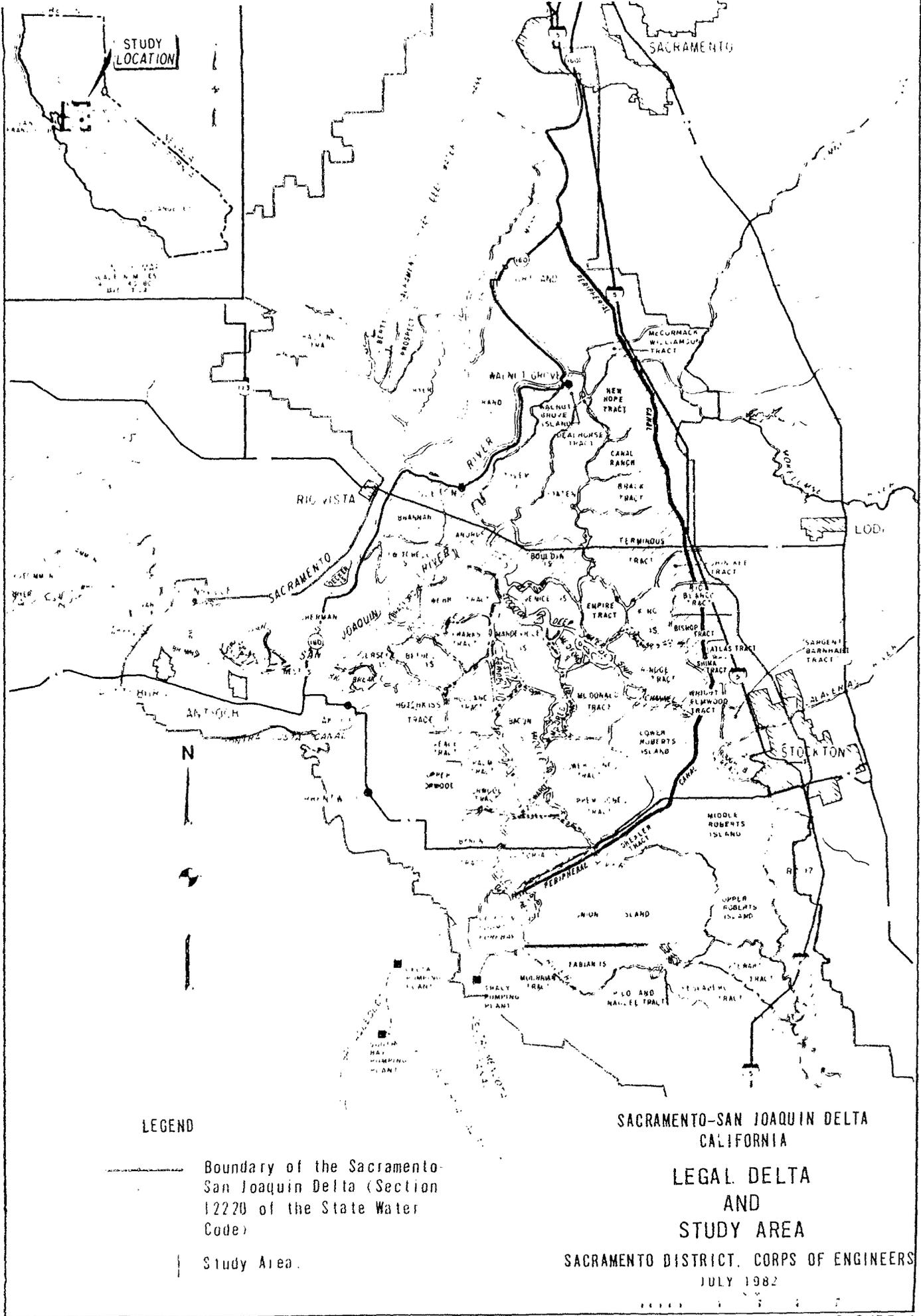


FIGURE 1

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C-102693

THE REPORT

This Feasibility Report discusses the investigation which was conducted to develop a selected plan of improvement. The report is arranged into three major segments: the main report, the Environmental Impact Statement, and the Plan Formulation Appendix. Attached to the EIS is an evaluation of the effects on water quality and wetlands of placing fill in the waters of the Delta. This evaluation is provided to meet requirements of Section 404(r) of the Clean Water Act (33 USC 1344). The draft Detailed Report of the Fish and Wildlife Service and endangered species informal consultation response are also attached to the EIS.

HISTORY OF THE INVESTIGATION

The Sacramento-San Joaquin Delta Investigation began in 1962, and a preliminary draft survey report was prepared in 1965. In May 1966, a public meeting was held to present the alternative solutions for flood control and recreation proposed in the report. The meeting resulted in an indication of opposition to the recreation proposals from landowners and a lack of State response to the proposed flood control improvements. Consequently, the draft report was not submitted to higher authority or distributed for public review and the study was discontinued.

Following the levee failure and resultant flooding of Andrus-Brannan Island in 1972, the California State Legislature passed Senate Bill No. 541 which delineated the State's policy concerning the Delta and the State's interest in the Delta levees. As a result of that law, the Secretary of the California State Resources Agency requested that the Corps resume the Delta

investigation, and on 28 August 1975 a public meeting was held in Stockton to inform the public that the investigation had been resumed and to invite comments and input. Representatives from the State Reclamation Board, Department of Water Resources, San Joaquin and Solano Counties, City of Stockton, Sierra Club, Central Delta Water Agency, Association of Bay Area Governments, California Central Valleys Flood Control Association, and other agencies supported resumption of the Corps investigation and endorsed the preservation, restoration, and maintenance of Delta levees. As a result of this response, the study was continued.

STUDY PARTICIPANTS AND COORDINATION

The DWR contributed extensively to this later investigation by conducting studies of land subsidence, seismicity hazards, the use of vegetation for erosion control, and by reviewing levee maintenance standards and practices. In addition, DWR provided data on recreation, economics, water quality, land values, and levee profile and cross-section surveys. The U.S. Fish and Wildlife Service (FWS) and the California Department of Fish and Game (DFG) provided evaluations of the fish and wildlife aspects of the investigation. In addition to these major contributors, Federal, State, and local agencies having primary responsibilities in specific problem areas provided information, advice, and comments.

A public involvement program was implemented early in the planning study to insure that the study would be responsive to public views and preferences. Actively involved in the program were other Federal, State, regional, and local governmental entities and officials; public and private organizations; and individuals.

In August 1979, DWR sponsored a workshop and public meeting in Stockton at which Corps representatives presented alternative solutions for flood control, recreation, and related problems of the Delta. At the request of California State Senator John Garamendi, DWR and the Corps subsequently held informal workshops at Rio Vista and Antioch in December 1979 to insure that all interests in the Delta had been given an opportunity to provide input to the study.

Following flooding in the Delta in 1980, numerous requests for information on the flood problems of the Delta and the status of the investigation were provided by the Corps to the media, institutions, other government agencies, and private citizens.

In March 1981, a conference was held in Sacramento on "The Future of the Delta." The conference was co-sponsored by the California Department of Water Resources, and the Institute of Governmental Affairs and University Extension, University of California, Davis. The conference was held in response to a request to the Governor and the South Pacific Division Engineer from the East Bay Municipal Utility District (EBMUD) to convene a conference to ". . . stimulate informal and candid exchange of ideas and information outside the traditional planning process." About 250 representatives from agriculture, environmental groups, water agencies, recreation interests, academia, all levels of Government, and the general public participated in the seminar. Conference participants were provided the opportunity to attend workshops on: Delta Levees; Impacts of the State Water Project (SWP) and Central Valley Project (CVP) on Water Supply and Quality; Land Use Planning; Ecological Perspectives on Flooding of Delta Islands; the Future of Delta Agriculture;

Flood Relief Programs; Fish and Wildlife; Recreation, Boating and Navigation; and the Future of the Delta.

Beginning on 27 May 1981, a series of meetings sponsored by the Central District Office of DWR was held with local interests to discuss State and local cost sharing for levee and recreation improvements. Representatives of Delta agriculture and recreation interests; Delta legislators; EBMUD; the Atchison, Topeka, and Santa Fe Railroad (AT&SF); the Port of Stockton; Delta cities and counties; and other State agencies attended these meetings.

PRIOR STUDIES AND REPORTS

A complete listing of Delta-related publications would be voluminous. Therefore, prior studies and reports summarized in this section are limited to Congressionally authorized Corps of Engineers investigations related to the Delta and studies conducted by other agencies that were of primary significance in the current investigation.

In July 1949, the Corps of Engineers produced a report entitled "Partial Review of Reports on Sacramento River, California, for Navigation and Flood Control, Georgiana Slough." The feasibility of closing Georgiana Slough and replacing it with a connecting channel between Georgiana Slough and the Mokelumne River was investigated. It was determined that the existing Georgiana Slough served as a suitable connecting channel between the Sacramento and Mokelumne Rivers for navigation, irrigation, and salinity repulsion. The report recommended substantial modification of the existing levee system along Georgiana Slough in order to provide adequate flood protection to the Delta area.

In December 1965, the Corps of Engineers developed a preliminary draft "Survey Report for Flood Control, Recreation, and Allied Purposes, Sacramento-San Joaquin River Delta, California" to determine the advisability of a multiple-purpose flood control, recreation, and water supply project for the Delta. Although this report was not reviewed by higher authority or the public, the findings of the study were summarized in May 1966 in an information pamphlet entitled "A Proposal for Flood Control and Recreation Development in the Sacramento-San Joaquin Delta. The pamphlet was distributed to many interested agencies, organizations and individuals. The report proposed a flood control and recreation project. The flood control features included rehabilitation of levees and placement of rock revetment in critically eroding areas. The recreation features consisted of a few large multiple-use recreation areas and numerous small automobile and boat access areas. As previously noted, there was lack of support for this plan in 1966.

In July 1979, the Corps published the "Sacramento-San Joaquin Delta Environmental Atlas." The atlas describes the natural resources of the Delta and delineates resources and land uses on small-scale maps and aerial photos.

In July 1980, a "Feasibility Report and Environmental Impact Statement for Navigation and Related Purposes" described and evaluated a plan for deepening the Suisun Bay and Sacramento River Deep Water Ship Channels from Suisun Bay to the Port of Sacramento. This report recommends Congressional authorization and has been submitted to the Secretary of the Army. Another navigation report, the "San Francisco Bay to Stockton, California (John F. Baldwin and Stockton Ship Channels), Avon to Stockton, Interim General Design Memorandum and EIS," dated September 1980, presents an updated plan for navigation channel modification between Avon and Stockton. This report was

approved, and the first contract for deepening the channel was awarded in August 1982 (initial bank protection works near Stockton were completed in 1972).

The State of California, Department of Fish and Game (DFG) published a report entitled "Restoration of Fish and Wildlife in the Sacramento-San Joaquin Estuary," in June 1978. The primary purpose of the report was to review, from a fish and wildlife perspective, facility construction and operation alternatives for the Central Valley Project (CVP) and State Water Project (SWP). In December 1980, DFG published a report entitled "Sacramento-San Joaquin Delta Wildlife Habitat Protection and Restoration Plan," which was partly funded by the U.S. Fish and Wildlife Service (FWS). This report documents the wildlife resources of the Delta.

DWR has prepared many bulletins and reports dealing with the flood control and water supply aspects of the Delta. Although many of these were used in research for the Corps Delta studies, only the most pertinent are listed below:

- a. "Delta Levees, What is Their Future?" September 1973.
- b. Bulletin No. 192, "Plan for Improvement of the Delta Levees," May 1975.
- c. "Phase II, Alternative Courses of Action to Provide Delta Protection and Adequate Water Supplies for California," March 1976.
- d. Bulletin No. 76, "Delta Water Facilities," July 1978.

e. Two reports, both entitled "Use of Vegetation to Reduce Levee Erosion in the Sacramento-San Joaquin Delta," June 1979 and June 1980.

f. "Sacramento-San Joaquin Delta Outdoor Recreation Survey," March 1980.

g. "Sacramento-San Joaquin Delta Recreation Concept Plan," September 1980.

h. "Seismicity Hazards in the Sacramento-San Joaquin Delta," October 1980.

i. "Subsidence of Organic Soils in the Sacramento-San Joaquin Delta," October 1980.

j. "Findings and Recommendations Based on the Inspection of Delta Levees During October 1980," December 1980.

COMPLETED WATER RESOURCE PROJECTS

The first levees in the Delta were constructed in the 1850's, and the Corps of Engineers has been actively involved in constructing projects in the Delta since 1877. Completed Corps projects are listed below in the order in which initial construction was completed.

COMPLETED CORPS PROJECTS

<u>Project Name</u>	<u>Project Purpose</u>
San Joaquin River, CA	Navigation
Mokelumne River, CA	Navigation
Sacramento River Shallow Draft Channel, CA	Navigation
Stockton and Mormon Channels, CA	Navigation
Sacramento River Flood Control Project, CA	Flood Control
Suisun Bay Channel, CA	Navigation
Middle River & Connecting Channels, CA	Navigation
Old River, CA	Navigation
Mormon Slough, Calaveras River, CA	Flood Control
Sacramento River Deep Water Ship Channel, CA	Navigation
Lower San Joaquin River & Tributaries, CA	Flood Control
Sacramento River Bank Protection Project, CA	Flood Control

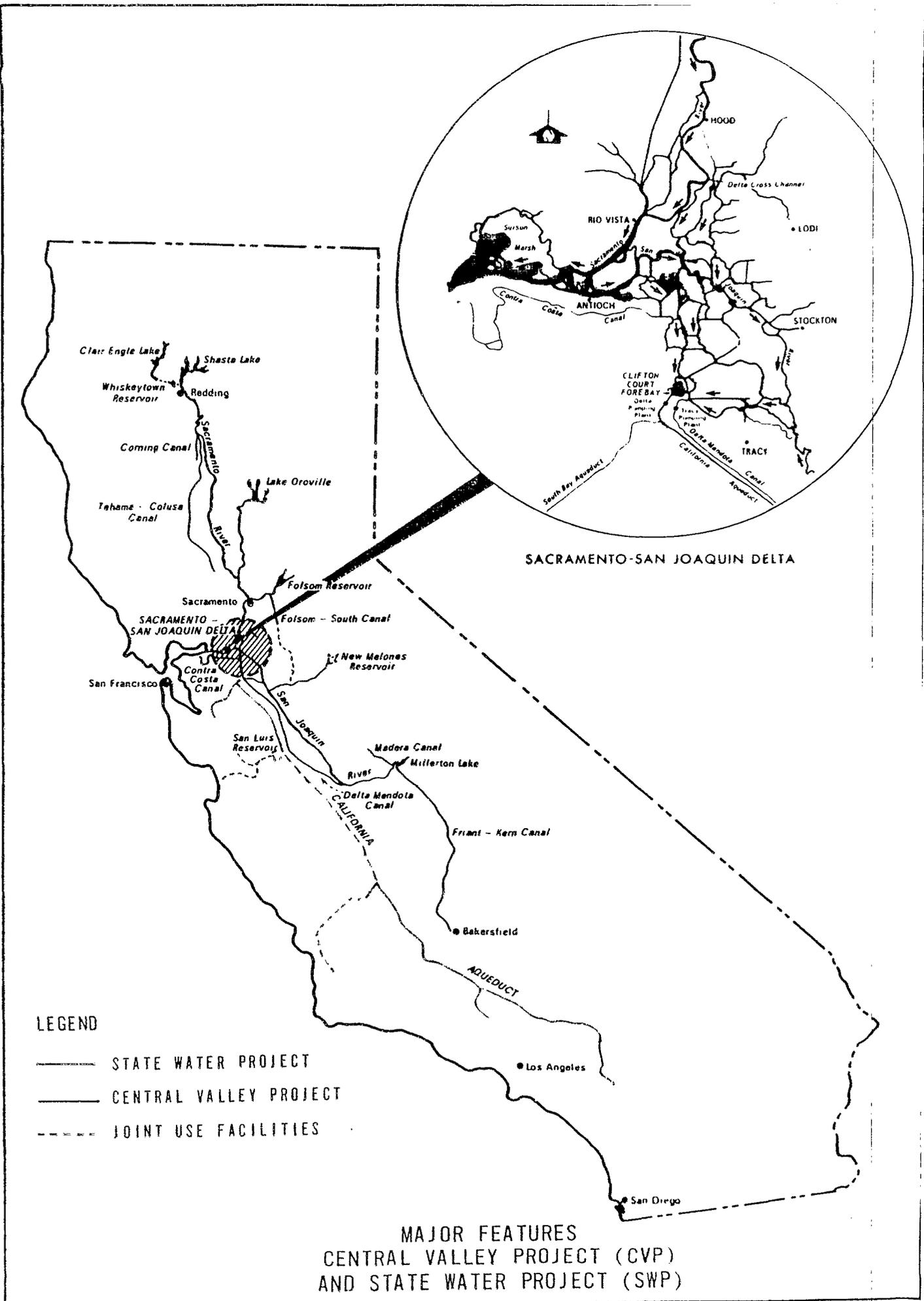
In addition, two major water distribution systems utilize Delta waterways. One is the Bureau of Reclamation's Central Valley Project (CVP), and the other is the State of California's State Water Project (SWP). The CVP provides irrigation water to the San Joaquin Valley while the SWP provides municipal and industrial water along with irrigation water to areas located throughout the State. Each of the projects has a pumping plant located in the Delta near the city of Tracy. The major features of the CVP and SWP are shown in Figure 2.

RESOURCES AND ECONOMY

OF THE STUDY AREA

ENVIRONMENTAL SETTING AND NATURAL RESOURCES

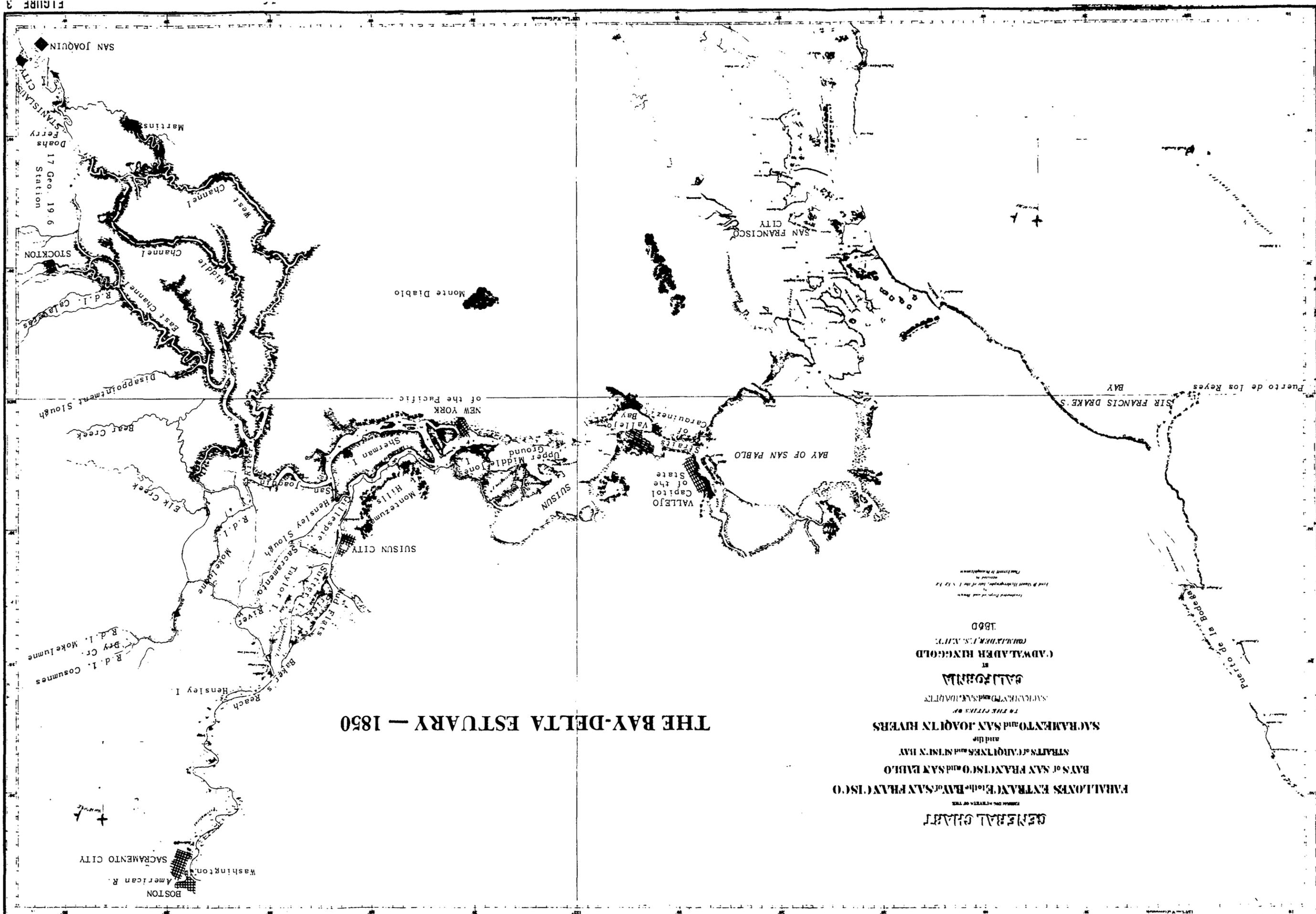
The Sacramento-San Joaquin Delta was originally a tidal marsh formed in an overflow area for the Sacramento and San Joaquin Rivers. Over 80 percent of this former marsh was leveed and developed for agriculture during the mid-1800's to early 1900's. Figure 3 depicts the Delta as it appeared in 1850



LEGEND

- STATE WATER PROJECT
- CENTRAL VALLEY PROJECT
- - - - JOINT USE FACILITIES

MAJOR FEATURES
CENTRAL VALLEY PROJECT (CVP)
AND STATE WATER PROJECT (SWP)



THE BAY-DELTA ESTUARY - 1850

GENERAL CHART
 SHOWING THE BAYS OF SAN FRANCISCO
 BAYS OF SAN FRANCISCO AND SAN PABLO
 STRAITS OF CAIROUTERS AND ST. JAMES BAY
 and the
 SACRAMENTO and SAN JOAQUIN RIVERS
 IN THE STATES OF
 CALIFORNIA
 and
 GADWALDHER HINGGOLD
 COMMANDER U.S. NAVY.
 1850

C-102703

FIGURE 3

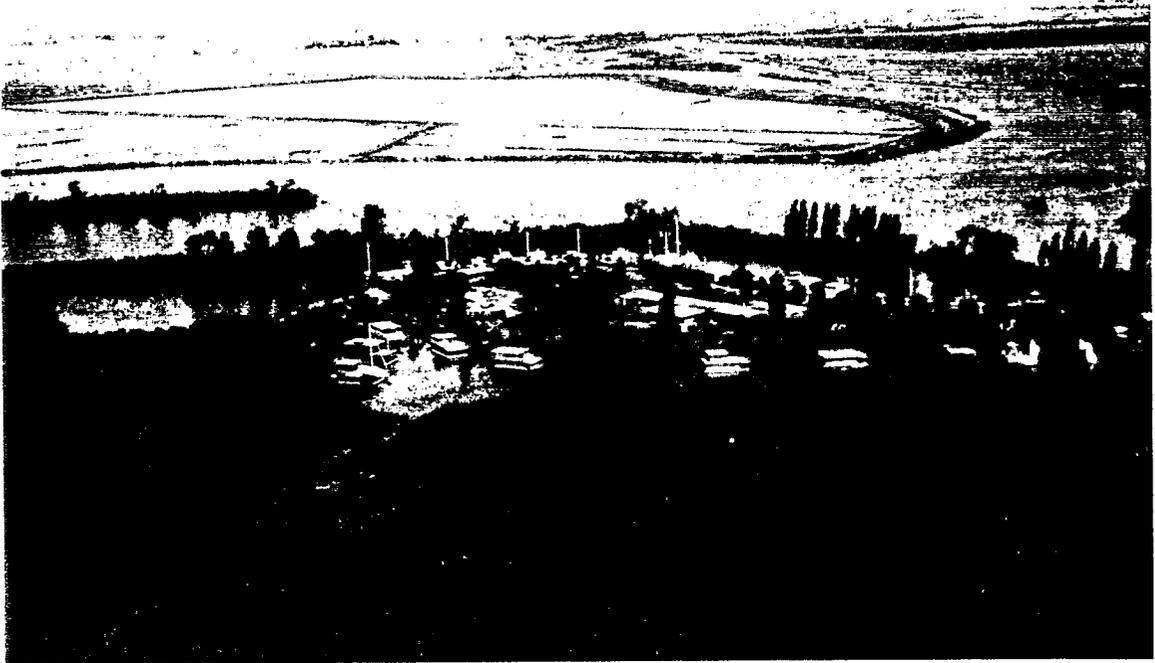
C-102703

prior to reclamation. Many of the 100 tracts and islands that were formed during this era have suffered levee failures. About 100 failures have occurred since the early 1900's. With the exception of three tracts, Big Break, Franks, and Lower Sherman, flooded islands have always been restored. In view of this tradition of restoration and in the absence of any evidence of a change in this approach, it is assumed that islands flooded in the future will continue to be restored.

The topography of the Delta is flat, with levees and dredged material disposal areas frequently constituting the highest ground. Land surfaces range in elevation from about 20 feet above mean sea level to about 25 feet below mean sea level.

The Delta is a structural and topographic basin underlain by an estimated 37,000 feet of sediments which accumulated during the Mesozoic and Cenozoic periods. Regional subsidence and deposition in a marine environment ended in late Eocene time. During middle and late Eocene time, the margins of the basin experienced mild uplift, folding, and faulting. From late Eocene to Pleistocene, the basin received continental fluvial deposits. Volcanic debris was also carried into the valley from the Sierra and Coast Range. Tectonic subsidence in the California Delta and the Sacramento Basin ended in Quaternary time. At the end of the Pleistocene period, about 10,700 years ago, the sea level began to rise and peat and detrital sediments accumulated.

Although traversed by several minor faults, the area shows little evidence of extreme crustal movements. The most intense seismic activity in recent history occurred during the 1906 San Francisco earthquake. At that time, the few levees in existence in the Delta were of low height. Subsequent



Tinsley Island — San Joaquin River



Rock Slough

earthquakes have been too small or too far away to cause any evident stress. The most recent significant seismic activity occurred near Livermore on the Greenville Fault. On 24 January 1980, a magnitude 5.5 earthquake occurred 2 miles north of Livermore, about 10 miles away from the south Delta. Two days later, a magnitude 5.2 earthquake occurred in the same area. Although there was some surface rupture in the fault zone, there was no known levee damage in the Delta, in spite of adverse conditions which included heavily saturated soils and high tides.

Soils within the Delta are primarily organic and are generally comprised of peats, organic silts, and clays. The peats, either fibrous or decomposed to clayey peats, are found in the centers of the islands at or near the ground surface. The organic material ranges in depth from a thin veneer along the eastern edge of the Delta to a maximum thickness of about 60 feet under a portion of Sherman Island in the western Delta. The average depth of peat is about 10 feet. With few exceptions, the mineral soils in the Delta are found along the eastern and southern perimeter, but even here the mineral soils are rich in organic matter or contain layers of organic material. Organic soils are excellent agricultural soils; however, drainage problems and the high water table reduce their potential productivity in the Delta.

Island subsidence, the lowering of islands, occurs throughout the central and western portions of the Delta, with the lowest elevations occurring on the west side. Peat and other organic soil areas have subsided more than those areas having mineral soils. The land surface in some areas of peat soil is subsiding at an average rate of about 3 inches per year. Seepage problems are compounded as the peat soils of the islands are lost by oxidation and erosion. Differences in elevation between water levels in the channels and

ground water in the islands continue to increase, and the resistance by the peat to upward movement of water from underlying sand aquifers is being reduced. Land subsidence is usually greatest toward the center of an island. However, along the channels, levees which have been constructed on peat must periodically be raised and widened as these organic foundation soils consolidate. Levee instability has become more acute in recent years due to these higher levees and increased hydrostatic pressures resulting from island subsidence. The problem is especially critical in the deep peat areas of the western and central Delta.

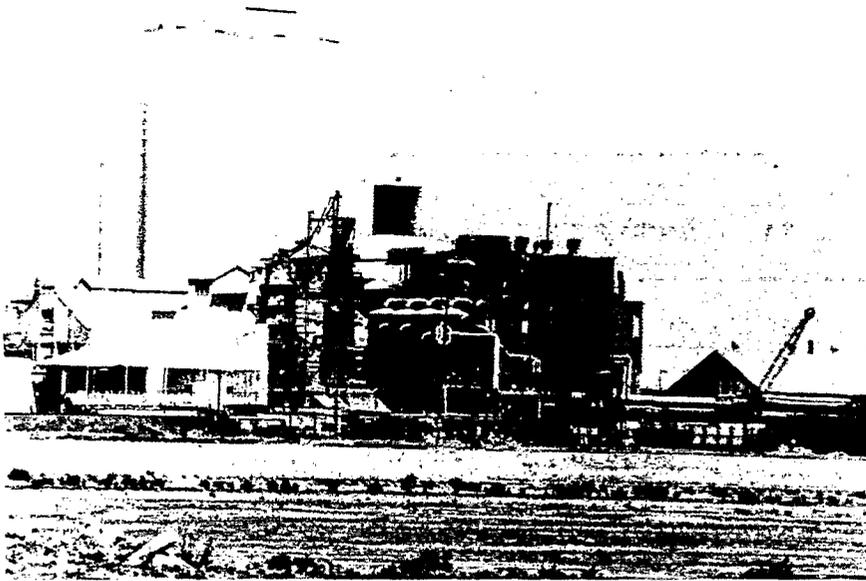
The land use in the Delta is almost entirely agricultural, and this use is not expected to change substantially in the future. Irrigated agriculture predominates, and the growing of field crops (safflower, sugar beets, field corn, and grain sorghum) constitutes the largest single use. Urban acreage in the study area accounts for little more than 1 percent of the area. The majority of the study area, 71 percent, lies within San Joaquin County, with the remainder about evenly divided between Sacramento and Contra Costa Counties. Land use within the Delta study area is tabulated below.

DELTA STUDY AREA LAND USE
1977

	CONTRA COSTA	SACRAMENTO	SAN JOAQUIN	TOTAL	PERCENT
Urban Acres:	<u>1,230</u>	<u>610</u>	<u>1,510</u>	<u>3,350</u>	<u>1.3</u>
Agricultural Acres:					
Orchards & Vineyards	0	1,060	1,840	2,900	1.1
Field Crops	14,210	18,660	81,310	114,180	42.7
Truck Crops	3,780	910	44,930	49,620	18.6
Grains & Hay	2,150	13,480	27,800	43,430	16.2
Alfalfa & Irrigated Pasture	8,460	1,410	22,290	32,160	12.0
Native Vegetation	9,900	480	10,520	20,900	7.8
Farmsteads	<u>170</u>	<u>50</u>	<u>550</u>	<u>770</u>	<u>.3</u>
	<u>38,670</u>	<u>36,050</u>	<u>189,240</u>	<u>263,960</u>	<u>98.7</u>
Total	39,900	36,660	190,750	267,310	100.0

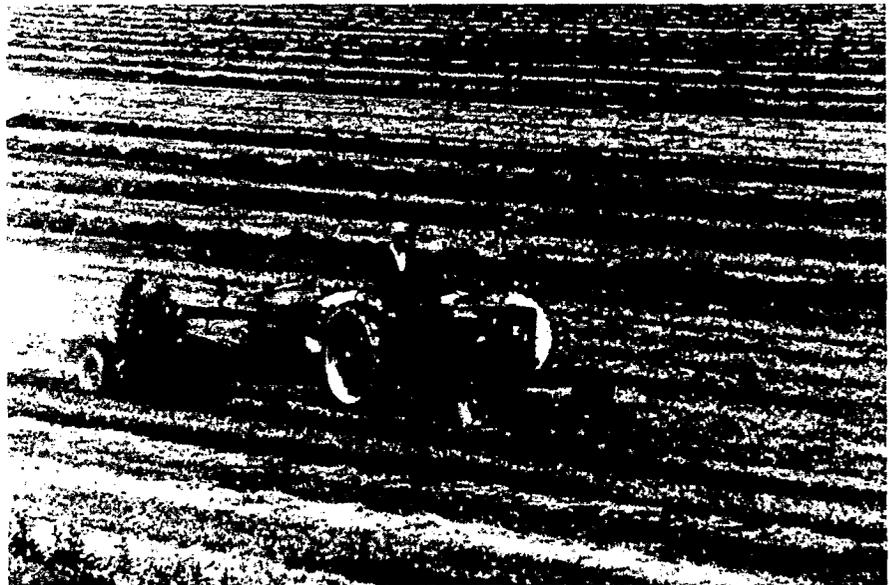
The 700 miles of channels and sloughs in the Delta afford opportunity for commercial shipping and provide a wonderland for boating and water sports. The Sacramento and Stockton Deep Water Ship Channels are maintained for commercial navigation to a depth of 30 feet below mean lower low water. The Delta's waterways also support an abundant sport fishery, particularly striped bass and catfish, and are of value to some commercial fishing interests. These waterways are also used to discharge floodwaters from the Central Valley and to transport irrigation water for the CVP and SWP.

The Delta climate is predominantly Mediterranean, influenced by a moist marine air mass and a warmer inland air mass. Mean temperatures vary from 70°F in the summer to 50°F in the winter, with extremes in excess of 100°F in the summer and below freezing in winter. About 82 percent of the precipitation falls from November to March, with most of the rain occurring in December and January. Rainfall averages about 16 inches per year. The

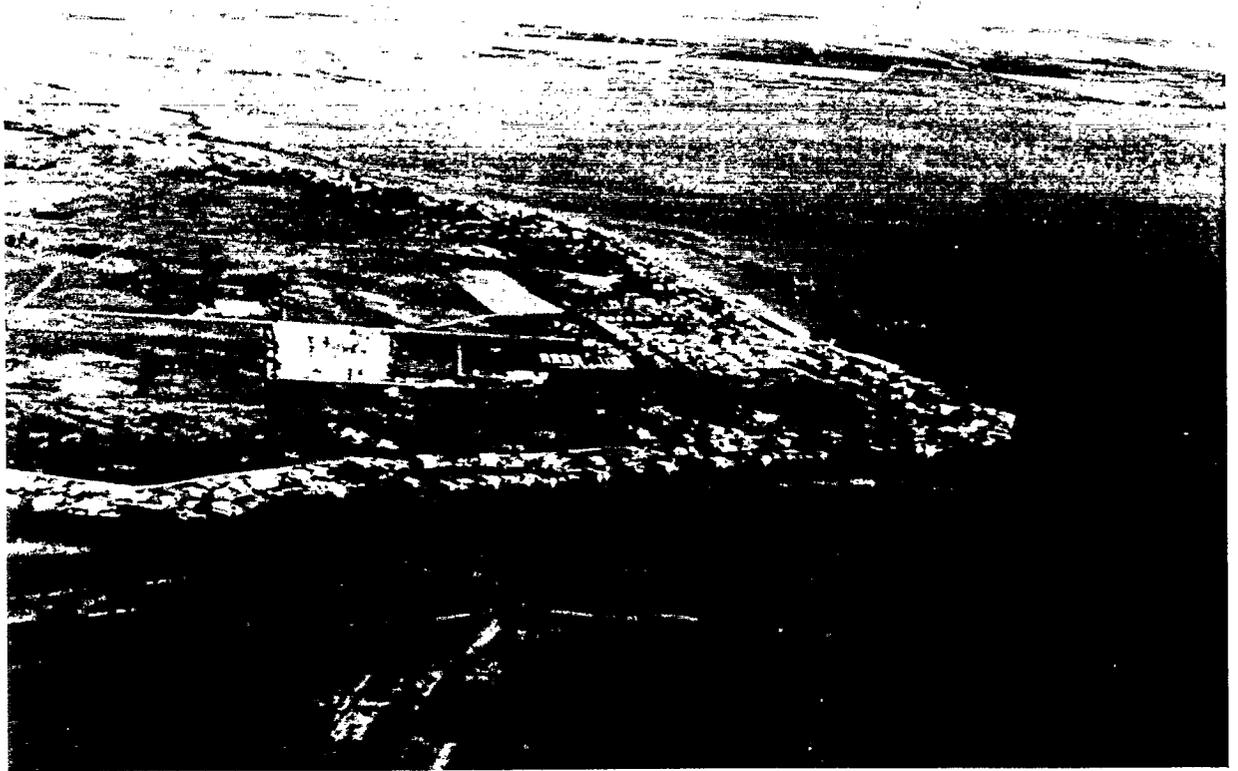


**Sugar beet processing
plant near Tracy**

Windrowing alfalfa



Tomato harvest



Bethel Island (left), Franks Tract (right)



Discovery Bay on Byron Tract

prevailing wind is from the west, and summer breezes are usually cool. Winds up to 25 miles per hour are common.

Air quality in the Delta is affected by indigenous and imported sources of pollution. Indigenous sources emanate from automobile and industrial emissions, agricultural burning, and peat duststorms. Air pollutants generated in the San Francisco Bay Area are imported into the Delta by ocean breezes through the Carquinez Strait. This condition occurs principally during the summer months. The Delta serves as an open space buffer between the Bay Area urban-industrial complex and the metropolitan areas of Sacramento and Stockton. Its vast area and geography have helped diminish, principally through dilution, the adverse effects of indigenous and imported pollutants.

Vegetative cover types in the Delta consist of freshwater marshes, riparian vegetation, valley grassland, and cultivated agriculture. Much of the native vegetation has been eliminated by man, but a few areas still exist. Today, the mid-channel nonleveed islands (approximately 24,500 acres), constitute the only remnants of the original Delta tidal marsh and still have almost entirely native flora. Some remnants of the Delta's native upland oak-grass woodland also persist. Diverse and abundant species of reptiles, amphibians, birds, and mammals inhabit today's complex Delta habitat which ranges from open water through riparian habitat to cultivated fields.

Delta waters support a large population of resident fish and anadromous fish ascending and descending the Sacramento, Mokelumne, Stanislaus, Calaveras, and San Joaquin River systems. The California Department of Fish and Game estimates that 25 percent of the State's warmwater and anadromous



Mokelumne River



Grant Line Canal

sport fishing and 80 percent of the commercial salmon catch is dependent on the Delta.

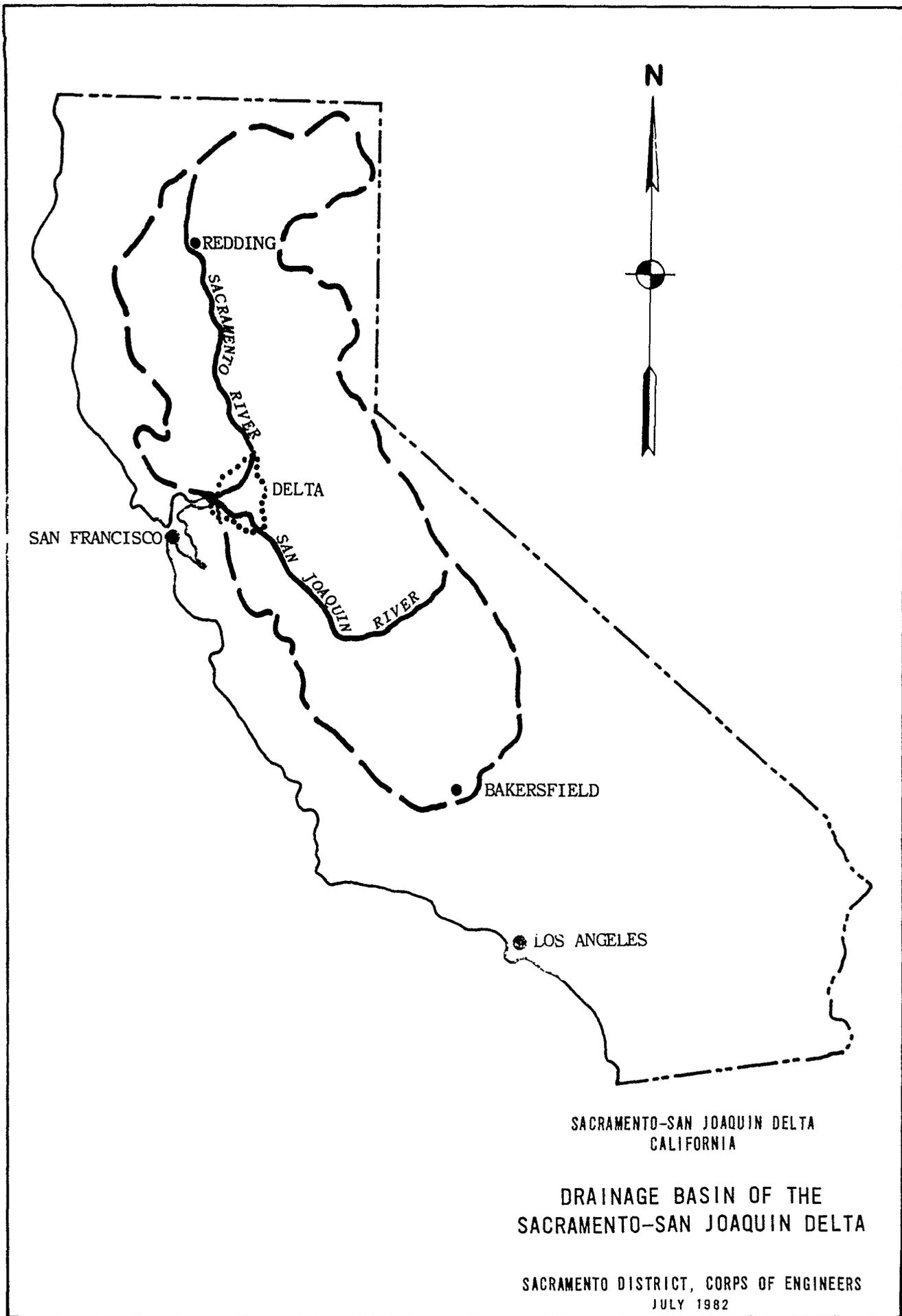
Listed below are 15 endangered, rare or threatened and plant and wildlife species whose distribution may include the Sacramento-San Joaquin Delta area. Currently, no fish appear on this list. Table 4.2 of the Environmental Impact Statement provides a listing of the Federal candidate species as well.

RARE OR THREATENED AND ENDANGERED SPECIES

<u>COMMON NAME</u>	<u>STATUS</u>	
	<u>Federal</u>	<u>California</u>
BIRDS		
American peregrine falcon	Endangered	Endangered
California black rail	-	Rare
Aleutian Canada goose	Endangered	-
California yellow-billed cuckoo	-	Rare
INSECT		
Lange's metalmark butterfly	Endangered	-
MAMMALS		
Salt marsh harvest mouse	Endangered	Endangered
San Joaquin kit fox	Endangered	Rare
REPTILE		
Giant garter snake	-	Rare
PLANTS		
Contra Costa wallflower	Endangered	Endangered
Antioch Dunes evening primrose	Endangered	Endangered
Solano grass	Endangered	Endangered
Soft bird's beak	-	Rare
Bogg's Lake hedge-hyssop	-	Endangered
Mason's lilaeopsis	-	Endangered
Colusa grass	-	Endangered

About one-third of California - approximately 64,600 square miles - is tributary to the Sacramento-San Joaquin Delta, and accounts for about one-half of all California river flows. The Delta drainage area is shown on Figure 4. Inflow to the Delta originates from three main sources: the Sacramento River; the San Joaquin River; and eastside rivers (Mokelumne, Cosumnes, and Calaveras). Delta inflow is dominated by the Sacramento River, which accounts for approximately 80 percent of the total inflow. Although a portion of the inflow is exported, the majority of flow continues through Suisun Bay and Carquinez Strait into San Francisco Bay. Before extensive water projects were implemented, natural flows into the Delta were estimated to average 29 million acre-feet annually. At the present time, about half this flow is diverted for agricultural use. Water loss within the Delta itself includes consumptive use for agriculture and evaporation from water surfaces. The movement of water in the Delta is subject to reversal about four times daily due to tidal changes and is heavily dependent upon the influences of inflows, use within the Delta, and exports. During summer months, the flow of water drawn to the export pumping plants near Tracy usually creates a north to south movement of water across the Delta. Consequently, in channels in the southern portion of the Delta, the direction of flow is upstream in reverse of normal streamflow.

The Peripheral Canal, rejected for funding by the California voters in June 1982, is an authorized but as yet unconstructed feature of the State Water Project. The Canal would transport water along the eastern edge of the Delta and release freshwater to Delta channels in a westerly direction, thereby providing positive downstream flows and eliminating reverse flows in the southern Delta. The Peripheral Canal, shown on Figure 1, is included in the without-project future condition. If this study results in an authorized



project, this matter will be more fully addressed and the detailed project analysis will reflect the situation as it exists at that time.

The overall effect of upstream regulation has been to redistribute Delta outflows, creating a relatively stable freshwater environment which persists in the Delta throughout the year. The California Water Resources Control Board has developed water quality criteria for the Delta that would more closely parallel natural conditions, (Water Right Decision 1485 dated August 1978). Under this decision the water quality standards include adjustments to reflect changes in hydrologic conditions experienced under different water year types, with less stringent requirements during dry years as opposed to wet years.

HUMAN RESOURCES

Archeological investigations indicate that the Delta has attracted human populations for at least the past 4,000 years. Over 200 archeological sites have been recorded. Most of these sites are located along the Mokelumne, Sacramento, and San Joaquin Rivers in Sacramento and San Joaquin Counties. A cultural resources literature review of the Sacramento-San Joaquin Delta was conducted in 1977 (Greenway and Soule, 1977). As a result of this review, it was concluded that because of the size of the Delta and the lack of a systematic archeological survey, it is likely that large numbers of unreported archeological sites still exist within the Delta boundaries, even with the extensive amount of disturbance that has occurred. Therefore, it appears that further archeological site reconnaissance will be required.

On a more recent note, Captain Pedro Fages is credited with the discovery of the Delta in 1772, which was considered an extension of San Francisco Bay. During the early 1850's unsuccessful gold seekers settled in the Delta as subsistence farmers. After the completion of the Central Pacific Railroad, unemployed Chinese laborers were hired to construct levees in the Delta. The Chinese laborers built the first system of levees around selected islands using only shovels and wheelbarrows. Between 1860 and 1866, private reclamation districts were formed with the assistance of a State Bureau of Reclamation Commissioner. Reclamation works have evolved from the early hand-constructed, mounded levees to the present day levees which are up to 100 feet wide and 25 to 30 feet high. Reclamation was essentially complete by 1930.

As a result of the cultural resources literature review referenced above, 46 historic sites have been included in the historic inventory for this study. The inventory does not include all sites within the region which have historical importance; however, it does include those having the most outstanding national, State, or local significance or character.

If the selected plan of improvement is authorized, a reconnaissance level cultural resources survey will be conducted of sufficient scope to provide a predictive model for the numbers, types, and quantities of sites in the area. The reconnaissance report will also discuss, in general terms, recommendations for further study and testing. The reconnaissance report and any additional studies will be coordinated with the State Historic Preservation Officer, the Advisory Council on Historic Preservation, and the National Park Service. Cultural sites within the project area will be evaluated for eligibility to the National Register of Historic Places and possible impacts to the sites

will be identified. Prior to the construction of any project, an appropriate mitigation plan will be developed in accordance with 36 CFR 800 and 33 CFR 305 procedures. The mitigation plan, developed in coordination with the Advisory Council on Historic Preservation and the State Historic Preservation Officer, will attempt to preserve, protect, and/or mitigate for unavoidable loss of significant cultural resources.

Due to the rural character of the Delta, the population of the study area has increased only slightly, at an average of 0.5 percent per annum between 1960 and 1980, while the three counties in the study area and the State as a whole grew at an average annual rate of 2 percent and 2.5 percent, respectively. The slow growth rate in the study area is expected to continue in the future.

As would be expected, housing characteristics in the Delta also differ from the surrounding areas because of the high percent of farm and recreational type homes. A vacancy rate of about 20 percent in the study area versus 6 percent for the three counties as a whole is due to the seasonal labor housing requirements of agriculture and the fact that a large number of recreational homes are used mainly during the summer and on weekends. Homes in the Delta also tend to be older and of lower economic value than homes in the surrounding urbanized areas, and the rate of growth in new housing, at 1.5 percent per annum, is about half the total average of the counties and the State.

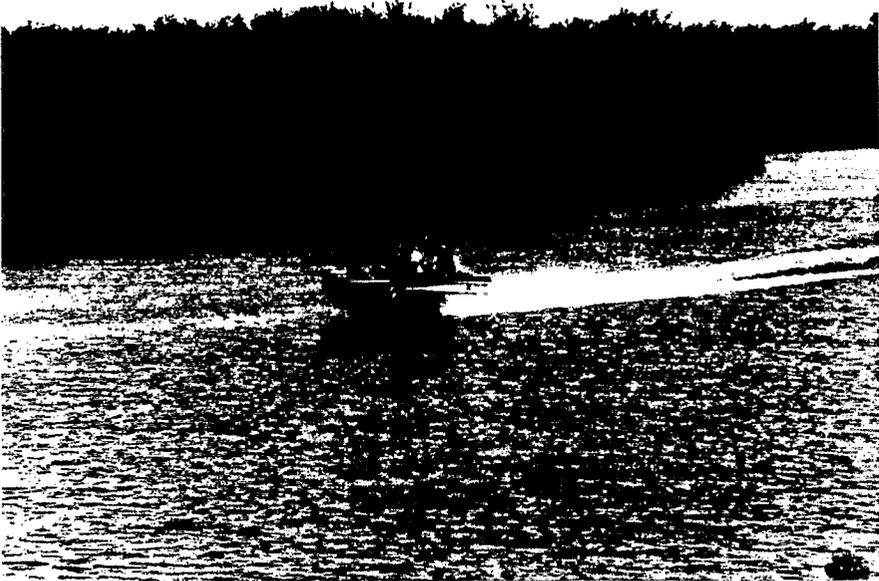
The primary source of noise in the study area is from road traffic along State Highway Routes 4, 12, and 160 as well as recreational boating in the waterways and sloughs. Additional noise is contributed by the trains, the

large oceangoing vessels using the deepwater ship channels, and farming activities.

The Delta is a major recreation resource in California, and the existing recreation activities are significant to the Delta's economy. The Delta, which has the largest recreation waterway in the western United States, continues to grow in popularity and offers such additional attributes as a temperate year-around climate; close proximity to the San Francisco, Sacramento, and Stockton metropolitan areas; an excellent sport fishery; and an esthetically pleasant environment. By far the most popular recreational activities are fishing and boating, which are primarily catered to by commercial facilities. Recreation use in the Delta has increased steadily since the mid-1940's, and camping facilities are typically used to capacity on weekends during the peak recreation season (June through August). It is widely acknowledged that current and future demand for recreation in the Delta is greatly in excess of existing facilities and is constrained by a lack of public facilities. Also, recreation use is almost totally water-based, which reflects the lack of available facilities for land-based users.

Leisure and cultural opportunities for Delta residents in the study area are mainly offered in the cities of Sacramento, Stockton, and Rio Vista. Stockton has the largest selection of facilities such as churches, libraries, theaters, parks, golf courses, and media sources (newspapers, radio stations, and television channels). These two communities also provide the majority of the health needs for the study area.

Seven elementary schools are located in or near the study area. Currently, these schools are about 70 percent filled, and no increase in



**Typical Delta
Recreation Activities**

enrollment is anticipated in the future. High schools which service the study area are located nearby in Stockton, Tracy, Galt, and Rio Vista. Educational opportunities beyond high school are readily available in the metropolitan areas near the study area.

DEVELOPMENT AND ECONOMY

The main source of revenue for governmental needs within the three counties is from redistribution of taxes from other governmental agencies. Property taxes and school taxes also provide major sources of revenue. Property values in the Delta counties have increased greatly in recent years due to new construction and high inflation. These conditions do not apply to the study area, however, since little new construction has occurred, and the value of agricultural land and improvements has increased at a slower rate than the value of urban property.

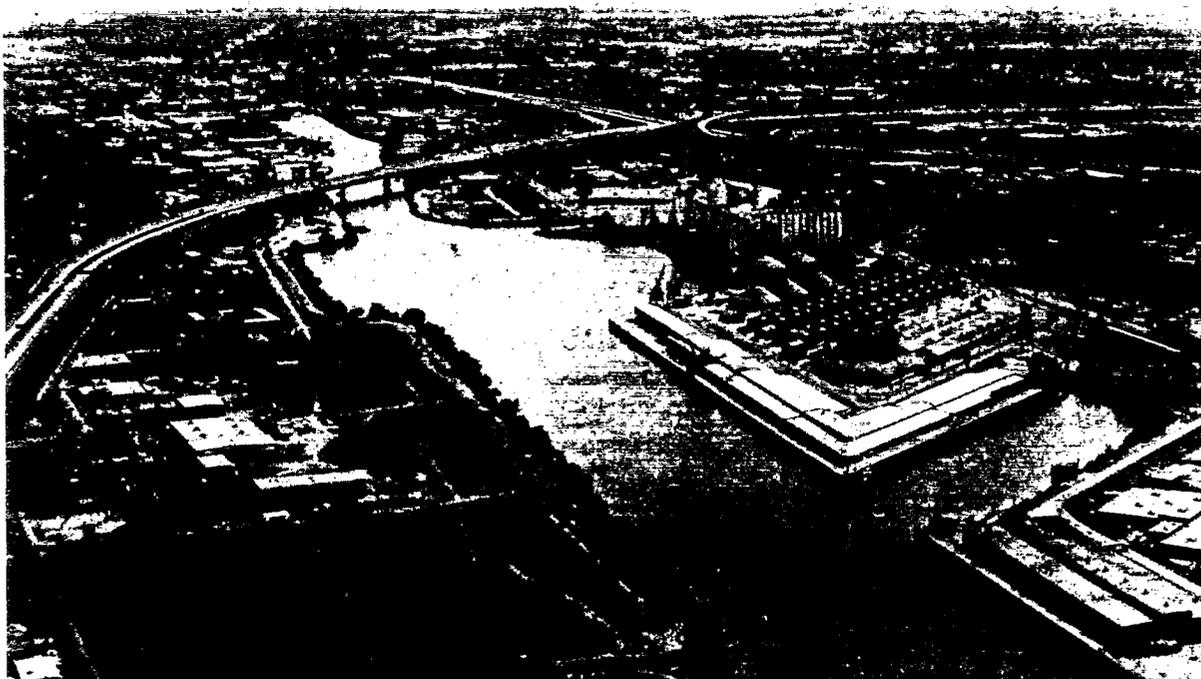
As is typical of most agricultural communities, the median income for the study area is lower than for the State and each of the three counties in the study area. Also, a large percentage of families in the study area live below the poverty level.

The main sources of employment in the study area are provided by agriculture and by service jobs related to summer recreation. Within the three-county area, the principal employer is government, followed by manufacturing, trades, and services. San Joaquin County qualifies as an area of "substantial and persistent unemployment" with unemployment at 12 percent in 1981. A major cause of unemployment is the mechanization of farming, which has substantially reduced farming jobs in recent years.

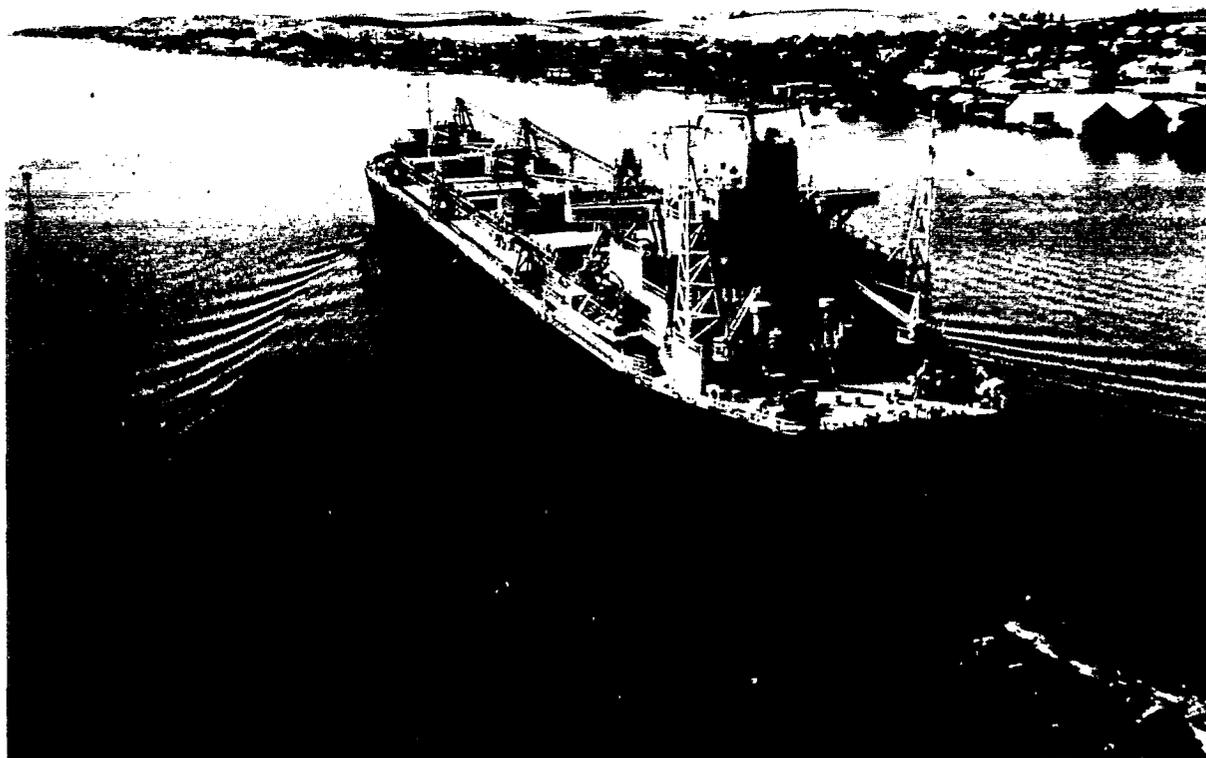
During the past 20 years, the overall growth of business and industrial activities in the three-county area has been more rapid than in the State. This activity, as measured by taxable retail sales, has grown at an average annual rate of 10 percent; and manufacturing and construction activity has increased at an annual rate of about 3 percent in the Delta counties and 6 percent in the State. Agriculture is the biggest business in the study area, where the irrigated farms tend to be small (with a weighted average of 226 acres in the study area as compared to a statewide average of 405 acres), family-owned, and intensively managed. The number and size of Delta farms have remained about the same through time, and although general trends in agriculture have been toward the takeover of family farms by corporations, both domestic and foreign, this trend is only marginally evident in the Delta.

Access to the Delta is limited. Two major roads, State Highways 4 and 12, bisect the Delta east to west, and State Highway 160 (the "River Road") follows the meandering course of the Sacramento River. Federal interstate highways 5 and 80 skirt the Delta. Most of the local roads are located on top of the levees. Many of the roads are neither paved nor continuous, and some are private. Several railroads serve the Delta region, but only the Atchison, Topeka, and Santa Fe (AT&SF) actually crosses the Delta. Major airports are located near the Delta, in the metropolitan areas of Sacramento, Stockton, Oakland, and San Francisco. Pipelines move considerable quantities of natural gas, petroleum, refined petroleum products, and fresh water through the Delta for use in other areas.

The nature of waterborne commerce in the Delta has changed radically through the years. Today, little freight is shipped between Delta ports. Most of the traffic now is between the two ports in the Delta (Sacramento and



Port of Stockton



**Wood chip carrier "SENDAI"
Sacramento River Deep Water Ship Channel
near Rio Vista**

Stockton) and ports in San Francisco Bay or beyond. Goods are carried in both shallow and deep-draft vessels and consist principally of bulk agricultural products, although diversification is being actively pursued. About 8 million tons of cargo annually moves through the Delta waterways. The Sacramento and Stockton Deep Water Ship Channels are maintained to a depth of 30 feet. The Corps of Engineers recently investigated the feasibility of enlarging these channels. Improvements for the Stockton project were authorized by Congress in 1965 and funded for construction in 1971. This initial construction involved bank protection for portions of the channel. Channel deepening was funded for construction in 1982 and involves deepening the Stockton Ship Channel from 30 feet to 35 feet. A similar project, deepening the Sacramento River Deep Water Ship Channel from 30 feet to 35 feet, has been recommended in a final Feasibility Report which has been submitted to the Secretary of the Army. In addition to commercial shipping, the Delta waterways provide passage for pleasure boats (houseboats, cruisers, water skiers) and fishermen's skiffs.

Additional information on the more significant resources of the study area is presented in the Environmental Impact Statement, which is a part of this report.

PROBLEMS AND OPPORTUNITIES

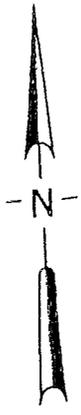
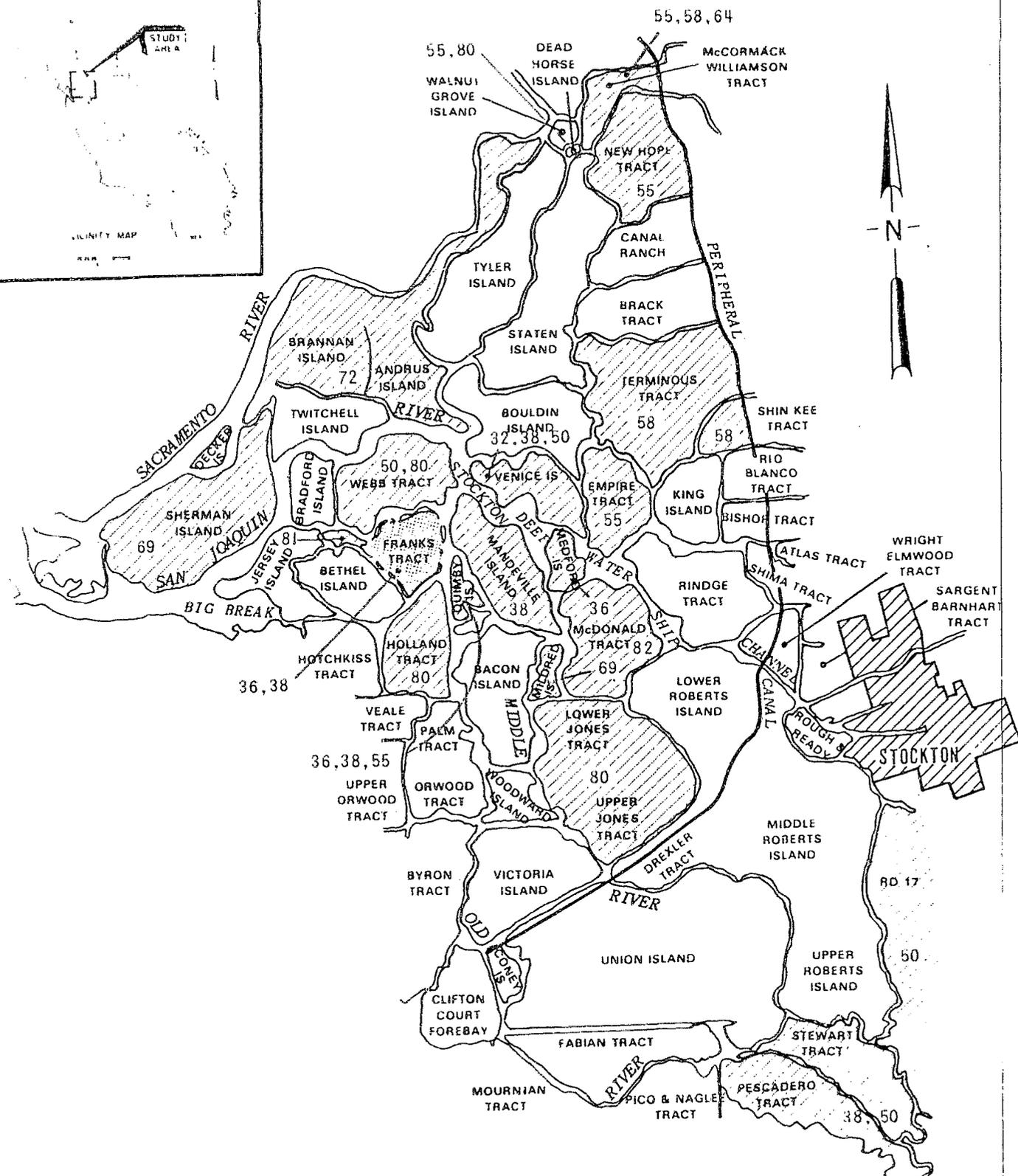
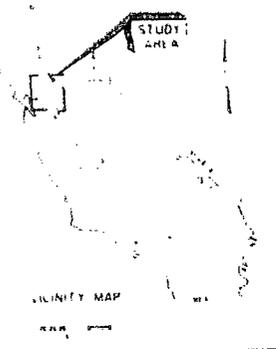
The primary water resource related problems in the Sacramento-San Joaquin Delta include inadequate flood protection, water quality degradation following levee failures during low Delta outflows; lack of public recreation facilities; and loss of fish and wildlife habitat. Any plan formulated to address the flood and water quality problems must also consider opportunities to improve the quality of the recreation experience and improve the natural

environment for fish and wildlife. The Federal Water Project Recreation Act of 1965 provides that recreation and fish and wildlife enhancement opportunities should receive full consideration in Federal water resource development. The Fish and Wildlife Coordination Act and the National Environmental Policy Act of 1969 also provide for consideration of fish and wildlife and the environment in the development of water resource projects.

FLOOD PROBLEMS

The major factors influencing Delta water stages result from a combination of high flows, high tide, and wind. Historically, the highest stages have usually occurred during December through February. Prior to development of the Federal Central Valley Project (CVP) in the 1940's, Delta flooding was characterized by the frequent inundation of vast tracts of land. With the advent of the CVP, flooding was then reduced to the inundation of individual islands or tracts due to overtopping. Since 1950, the construction of additional upstream dams has further reduced the threat of overtopping in peripheral areas; however, levee failures continue to be a serious problem. These failures are now more likely to be due to levee instability. This instability results from subsidence of the interior island land surface and resultant greater hydrostatic forces on the levees. Stability problems are also caused by the consolidation of levee foundation material.

Since 1950, 19 islands in the study area have been flooded and restored, some more than once, and flood fights have been waged and won on most of the remaining nonproject levees. Figure 5 shows the flooding that has occurred during the past 50 years (1932-82). About 40 failures have occurred during



LEGEND:
 [Shaded Box] 50 Year Flooded.
 [White Box] Not Restored.

SACRAMENTO-SAN JOAQUIN DELTA
 CALIFORNIA

HISTORICAL FLOODING
 1932-1982

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
 JULY 1982



C-102726

FIGURE 1

C-102726

this period. A brief description of recent flooding exemplifies the flood problem in the Delta.

The most recent flooding occurred 23 August 1982 when a levee failed on McDonald Island. The break in the levee was located on Middle River about 1 mile south of Columbia Cut. The levee failure occurred about 6 a.m. By 9:30 a.m. the Coast Guard reported that water was rushing through a 300 foot wide gap in the levee at 30 to 40 knots. Flood waters quickly inundated the 6,145 acre island. The width of the levee break eventually widened to 600 feet. About 70 persons were evacuated from the island by emergency forces. Local officials estimated crop loss damages to be \$5,300,000 and crop loss acreages as follows: potatoes, 436 acres; grass turf, 180 acres; milo, 75 acres; corn, 2,700 acres; sunflower, 200 acres; and grapes, 15 acres. About 750 acres of asparagus, wheat, and barley had been harvested before the levee failure. Pacific Gas and Electric Company officials reported that an underground natural gas storage facility with a capacity of 78 billion cubic feet was in no apparent danger. Preliminary estimates for closing the levee and dewatering the island were set at \$6,300,000. Immediately following the levee failure the McDonald Island Reclamation District initiated efforts to repair the break and restore the island.

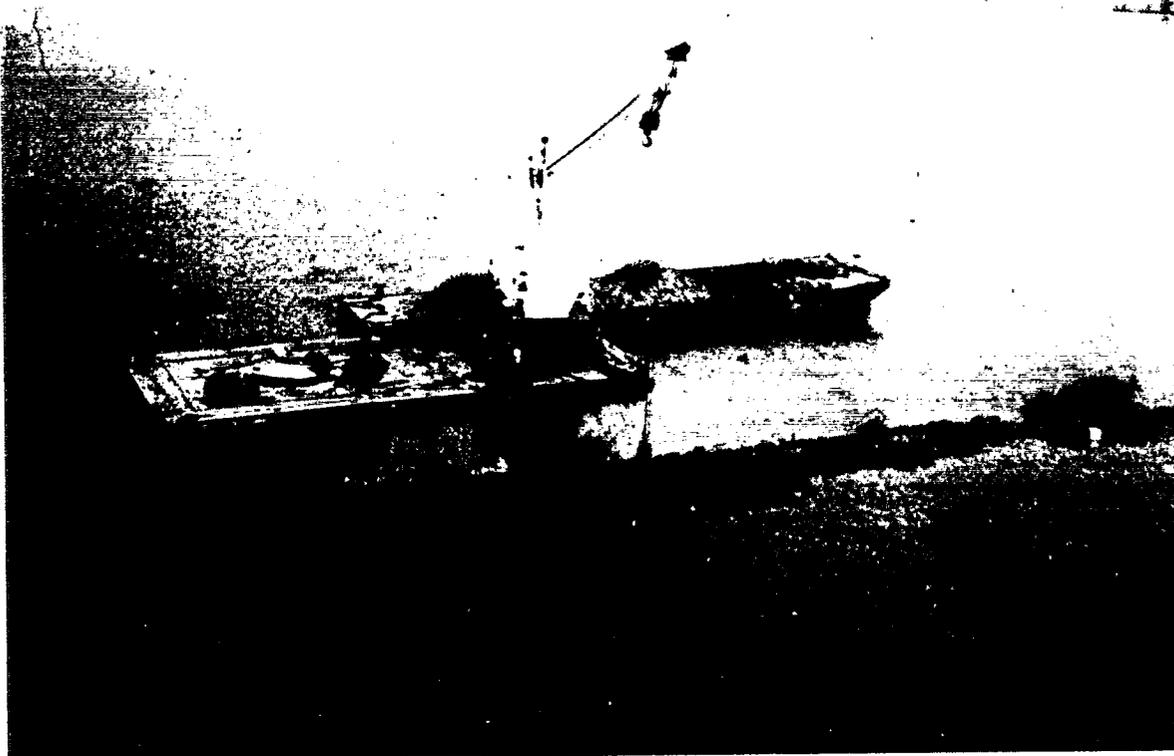
In mid-January 1980, a series of severe storms caused the major streams in the Sacramento and San Joaquin Basins to reach flood warning stage. High outflow, coinciding with the highest tides of the winter and gale force winds over the Delta, resulted in failure of the levee protecting Webb Tract around 5 p.m. on the 18th. A 12-foot rupture quickly enlarged to a width of 850 feet and depth of almost 60 feet. Floodwater from the San Joaquin River poured through the breach until the 5,400-acre tract was inundated to a depth of 20



McDonald Island — August 1982



Holland Tract — January 1982



Webb Tract — north levee repair — 1980



Webb Tract (left), San Joaquin River (right) — January 1980



Holland Tract — January 1980



Holland Tract (top left) — January 1980



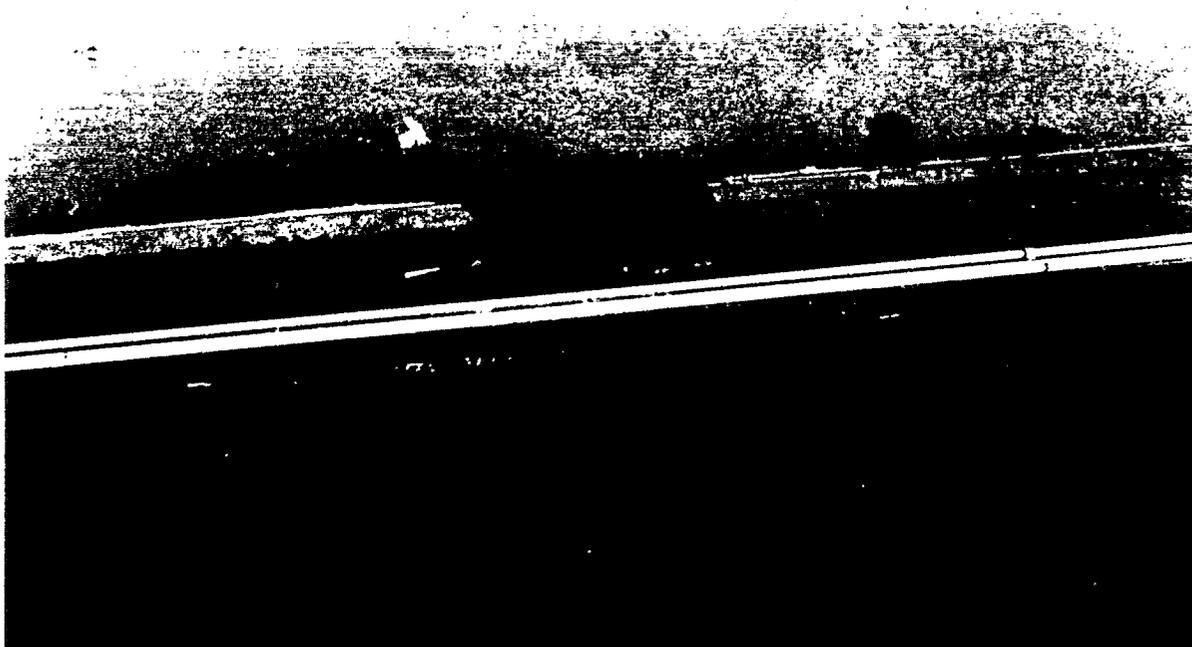
Holland Tract — January 1980



Jones Tract — September 1980

feet. An hour later, a saturated section of the nearby Holland Tract levee adjacent to the flooded Franks Tract gave way, and that tract of about 4,400 acres was flooded through a breach that ultimately widened to 250 feet and deepened to almost 40 feet. The 25 residents of the tract and an equal number of duck hunters were evacuated. Levees around other islands were severely eroded. On 1 February the area was declared a national disaster, and trouble spots on 24 islands were considered for emergency levee work. During this period, the Corps of Engineers Sacramento District Emergency Operations Center was operating 24 hours a day in cooperation with the State-Federal Flood Operations Center. By the latter part of February, flood fighting activities involved as many as 1,300 men and women on flood-fighting crews, with Army landing craft shipping men and material and helicopters providing aerial inspections. On 21 February, a levee on Dead Horse Tract failed, and preparations were made to evacuate people and livestock from Bradford Island. In addition, floodfighting was required on Bacon, Venice, Bouldin, Medford, McDonald, and Veale Tracts. The Bradford Island levee held, and with the advent of favorable weather patterns, the flood emergency was ended on 4 March.

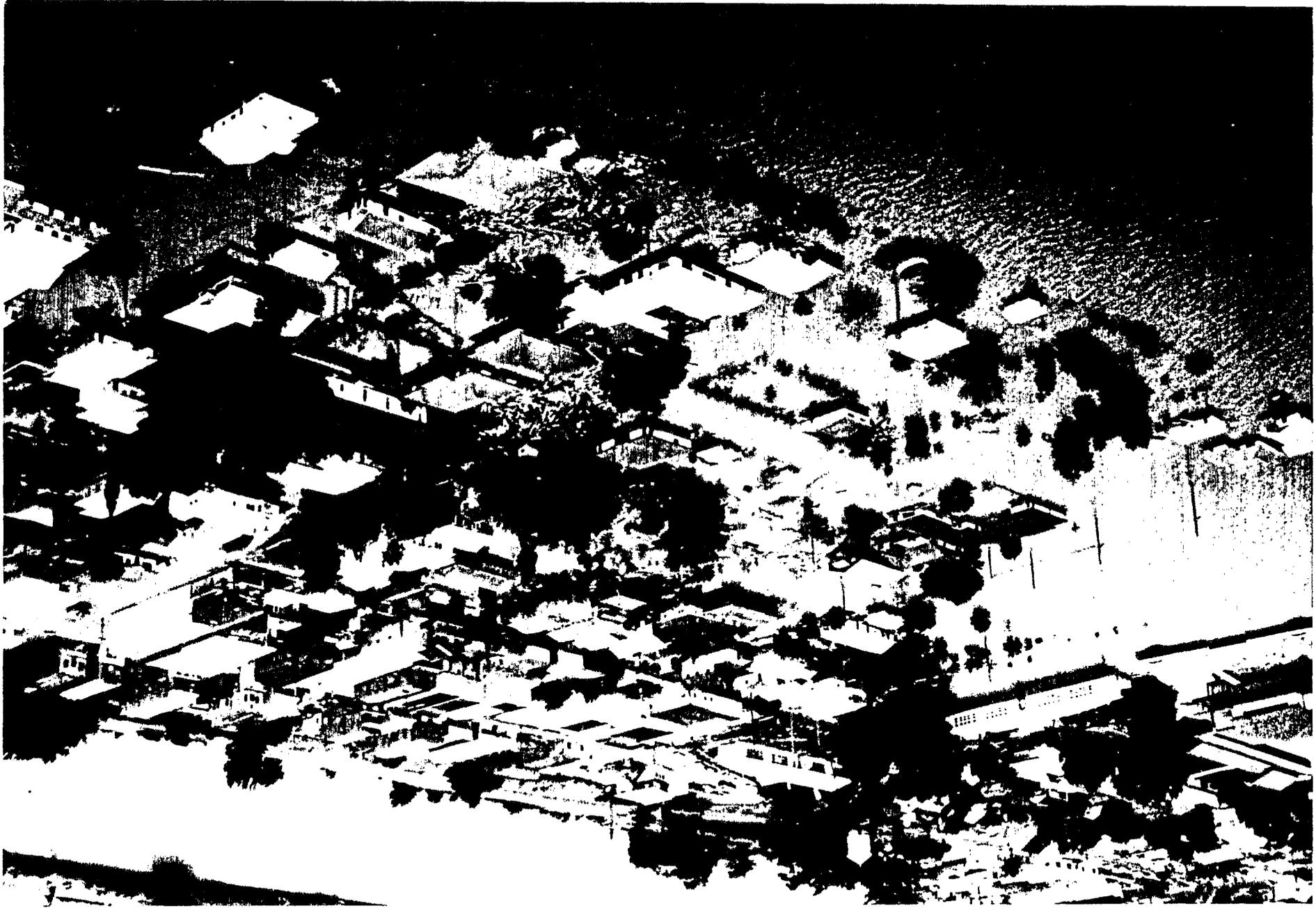
On the evening of 26 September 1980, during low flow Delta stages, a levee section on Lower Jones Tract failed, flooding 5,200 acres of land to a depth of about 10-15 feet. The initial 80-foot breach widened to 275 feet and deepened to 55 feet. Once again, this part of the Delta was declared a disaster area, and flood fighting efforts were concentrated on closing the breach and protecting the AT&SF railroad embankment which separated Upper and Lower Jones Tracts. The railroad embankment failed on 23 October, but by this time the breach on Lower Jones Tract had been closed and Upper Jones Tract was only partially flooded by the waters previously impounded in Lower Jones



Lower Jones Tract (top) — September 1980
Upper Jones Tract (bottom) — October 1980
EBMUD's Mokelumne Aqueduct (center)

Tract. Based on a 1981 price level, about \$50 million was expended during calendar year 1980 in the Delta areas for flood damages, levee repairs, and emergency costs.

Other recent examples of the seriousness of flooding in the Delta can be demonstrated by the 1972 flood of Andrus-Brannan Island and the Sherman Island flood of 1969. Failure of a private levee on Andrus Island occurred shortly after midnight 21 June 1972. Eventually, the breach widened to 500 feet. Andrus Island and the adjoining Brannan Island suffered flooding when the levee breach allowed an estimated 164,000 acre-feet of water onto the islands, which are 15 feet below sea level in some areas. The levee failure occurred at a high tide stage of about 3.7 feet m.s.l. and was due to instability rather than overtopping. The City of Isleton is located across Andrus-Brannan Island, opposite the levee break, on ground that varies from -8 feet to +10 feet m.s.l. elevation. Since it was estimated that it would take the floodwater several hours to reach the City of Isleton, the State Office of Emergency Services requested the Corps of Engineers to construct a ring levee to prevent flooding of the city. An 8,000-foot-long levee was constructed to a height of about 5 feet before rising floodwaters overtopped the temporary levee on the evening of 22 June, stopping all work. The floodwaters inundated about 35 percent of the City of Isleton, including the sewage treatment facilities. About 2,000 residents of the area were evacuated because of concern over the health problems that could develop without the sewer facilities. The area was declared a national disaster on 27 June, and the Federal Disaster Assistance Administration directed the Corps to undertake certain restoration activities and conduct engineering damage surveys. The levee breach was closed 26 July, and residents were allowed to return to their homes on 15 September. All auxiliary pumping was completed by the end of the



Town of Isleton, Andrus-Brannan Island — June 1972

C-102735

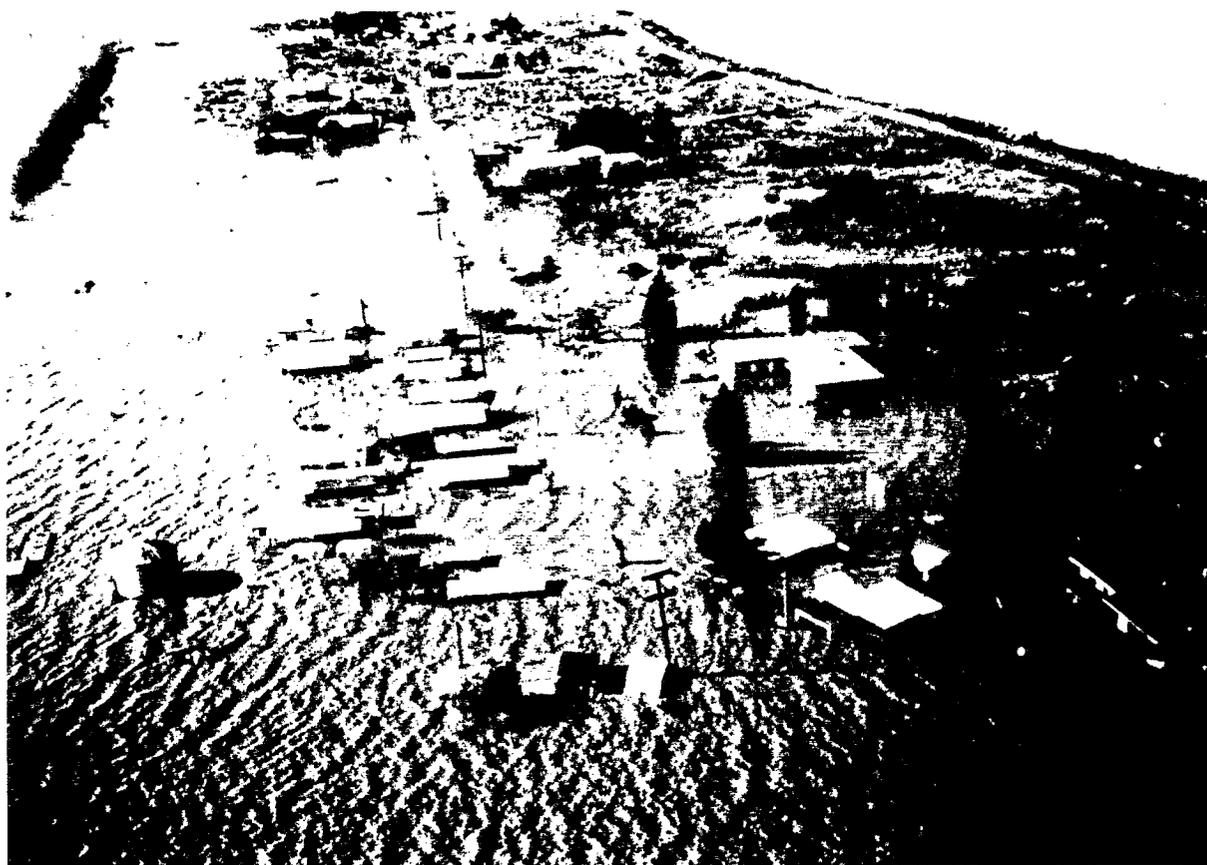
year. Total damages for this flood are estimated at about \$97 million in 1981 dollars.

The levee failure on Sherman Island occurred on 20 January 1969 during a period of moderately high water levels in the Delta. The privately owned levee suddenly developed a massive crack which enlarged within minutes to a gap 300 feet wide and 40 feet deep. The elevation of the island varies from about sea level to 10 feet below sea level. Structures on the island were flooded to depths of 4 to 5 feet and were a complete loss as a result of wind and wave action. Although the island is used primarily for agricultural purposes, additional damage and disruption occurred because about 200 people lived on the island; gas wells were in operation; a major Delta route (State Highway 160) traversed the island along with oil, gas, and high voltage power transmission lines; and a secondary power distribution system was located on the island. The Corps was once again called to the task of performing a most difficult repair of the break as the tide ebbed and flooded. Total damages to the island were estimated at \$22 million in 1981 dollars. This was the first of a series of levee breaks and flood fights during the first 4 months of 1969 when moderately high water levels, aggravated by driving rains and winds, caused unexpected erosion of numerous levee sections throughout the Delta.

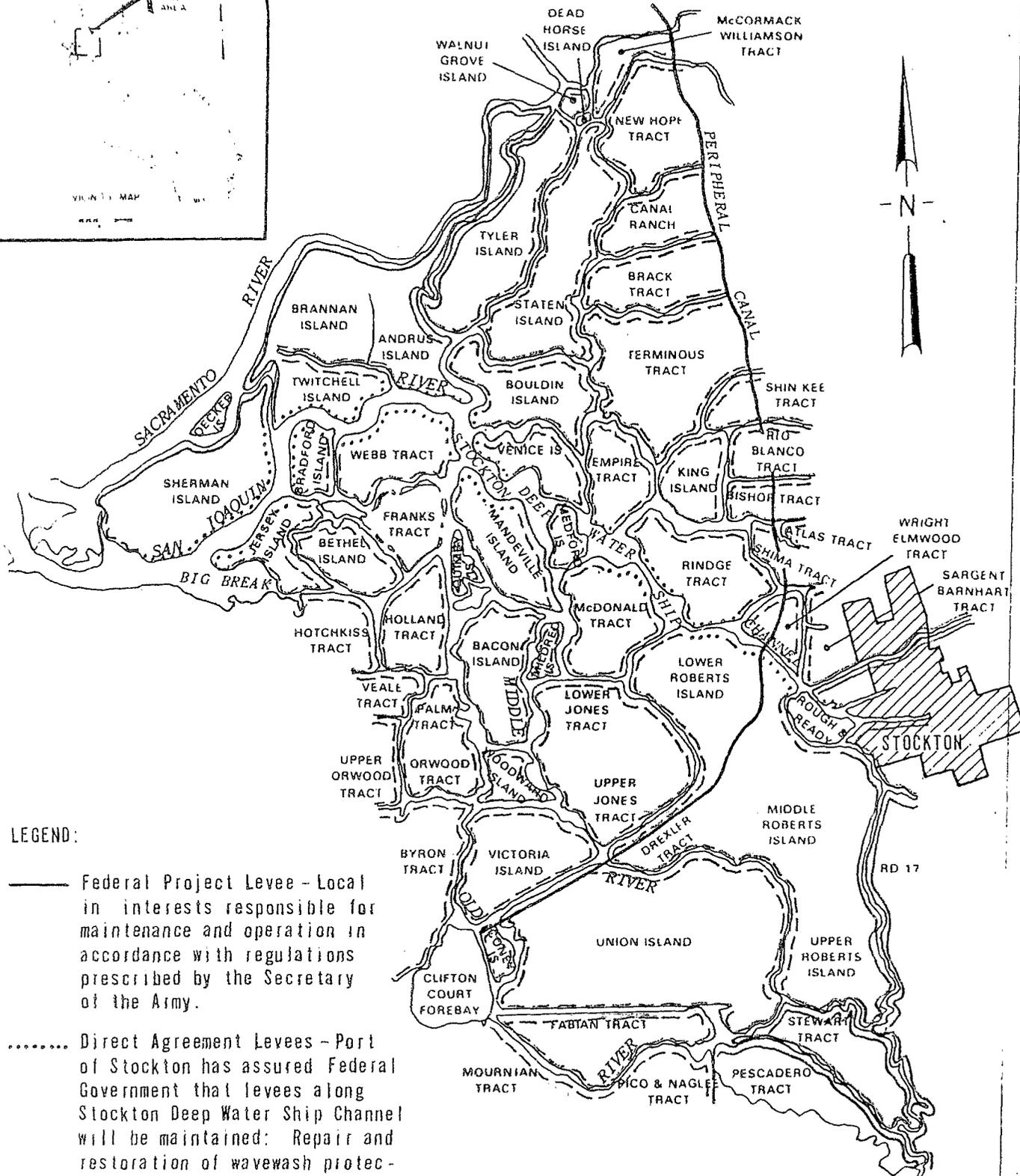
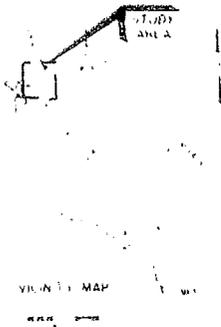
There are two types of levee systems in the Delta: Federal project levees and nonproject levees. The location and extent of these levee systems are shown on Figure 6. Federal project levees were either constructed or enlarged as part of Federal flood control projects or the Sacramento River Deep Water Ship Channel project. Federal project levees are maintained to Federal standards by the State of California either directly or by others under the State's supervision.



Sherman Island — January 1969



Sherman Island — January 1969



LEGEND:

— Federal Project Levee - Local interests responsible for maintenance and operation in accordance with regulations prescribed by the Secretary of the Army.

..... Direct Agreement Levees - Port of Stockton has assured Federal Government that levees along Stockton Deep Water Ship Channel will be maintained; Repair and restoration of wavewash protection by Federal Government, as determined to be necessary by the Secretary of the Army is authorized.

- - - Non Project Levee - Local interests responsible for maintenance and operation.

SACRAMENTO-SAN JOAQUIN DELTA
CALIFORNIA

DELTA LEVEE SYSTEM

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JULY 1982



Nonproject levees are classified as either private or direct-agreement levees. Private levees in the Delta were privately constructed and are privately owned and maintained. Neither the Federal nor the State Government has jurisdiction over these levees and neither has authority to require that needed maintenance be performed. Direct-agreement levees are those private levees which have been repaired or restored by the Corps of Engineers following major floods, and are maintained by agreement with the Federal Government. Direct agreement levees also include those flood control levees along the Stockton Ship Channel which are maintained by non-Federal interests, with bank protection maintained by the Corps of Engineers.

In the study area, Federal project levees comprise about 20 percent of all the levees, with the remaining 80 percent in various categories of nonproject levees. Flood protection provided by the present Delta levee system is generally inadequate except for the areas protected by Federal project levees. Table 1 summarizes the mileage of the two types of levee systems, project and nonproject, found within the study area.

The problem of inadequate flood protection is aggravated by poor foundation conditions, lack of proper design for existing conditions, and inadequate maintenance of the existing levees. Most of the non-project levees have stability problems caused by consolidation of the organic peat materials in the levees and their foundations. As subsidence of the peat soils in the interior of the islands continues, the water pressure on the levees becomes too great for the levees to withstand, causing a section of the levee to fail with subsequent flooding of the island. In areas where subsidence has been the greatest (greater than 10 feet since reclamation of the particular island or tract), project levees only comprise about 15 percent of the total levee

TABLE 1

DELTA LEVEE SYSTEM MILEAGE*

ISLAND	PROJECT LEVEE	NON- PROJECT LEVEE	TOTAL	ISLAND	PROJECT LEVEE	NON- PROJECT LEVEE	TOTAL
ANDRUS	19.2	6.2	25.4	ORWOOD		6.4	6.4
ATLAS	1.7	3.1	4.8	ORWOOD, UPPER		4.5	4.5
BACON	-	14.3	14.3	PALM		7.8	7.8
BETHEL	-	11.5	11.5	PESCADERO	5.5	8.3	13.8
BISHOP	-	5.8	5.8	PICO-NAGLEE		8.3	8.3
BOULDIN	-	18.0	18.0	QUIMBY		7.0	7.0
BRACK	-	10.8	10.8	RD 17	29.0	-	29.0
BRADFORD	-	7.4	7.4	RINDGE	-	15.7	15.7
BRANNAN	6.8	3.9	10.7	RIO BLANCO	-	3.2	3.2
BYRON	-	9.5	9.5	ROBERTS	26.6	19.1	45.7
CANAL RANCH	-	9.5	9.5	SARGENT-BARNHART	1.5	2.5	4.0
CONY	-	5.4	5.4	SHERMAN	8.7	9.8	18.5
DEAD HORSE	-	2.5	2.5	SHIMA	-	8.1	8.1
DREXLER	-	8.9	8.9	SHIN KEE	-	1.9	1.9
EMPIRE	-	10.3	10.3	STATEN	-	25.5	25.5
FABIAN	-	18.8	18.8	STEWART	18.9	-	18.9
HOLLAND	-	10.9	10.9	TERMINOUS	-	16.1	16.1
HOTCHKISS	-	8.4	8.4	TWITCHELL	2.5	9.5	12.0
JERSEY	-	15.6	15.6	TYLER	11.8	10.7	22.5
JONES	-	17.8	17.8	UNION	5.2	28.8	34.0
KING	-	9.0	9.0	VEALE	-	5.7	5.7
MANDEVILLE	-	14.3	14.3	VENICE	-	12.3	12.3
McCORMACK- WILLIAMSON	-	8.7	8.7	VICTORIA	-	15.1	15.1
McDONALD	-	13.7	13.7	WALNUT GROVE	0.7	2.0	2.7
MEDFORD	-	5.9	5.9	WEBB	-	12.8	12.8
MILDRED	-	7.3	7.3	WOODWARD	-	8.7	8.7
MOURNIAN	-	6.8	6.8	WRIGHT-ELMWOOD	-	6.8	6.8
NEW HOPE	-	12.3	12.3				
TOTAL					138.1	533.2	671.3

* Study area only. Does not include legal Delta.

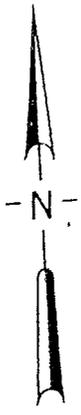
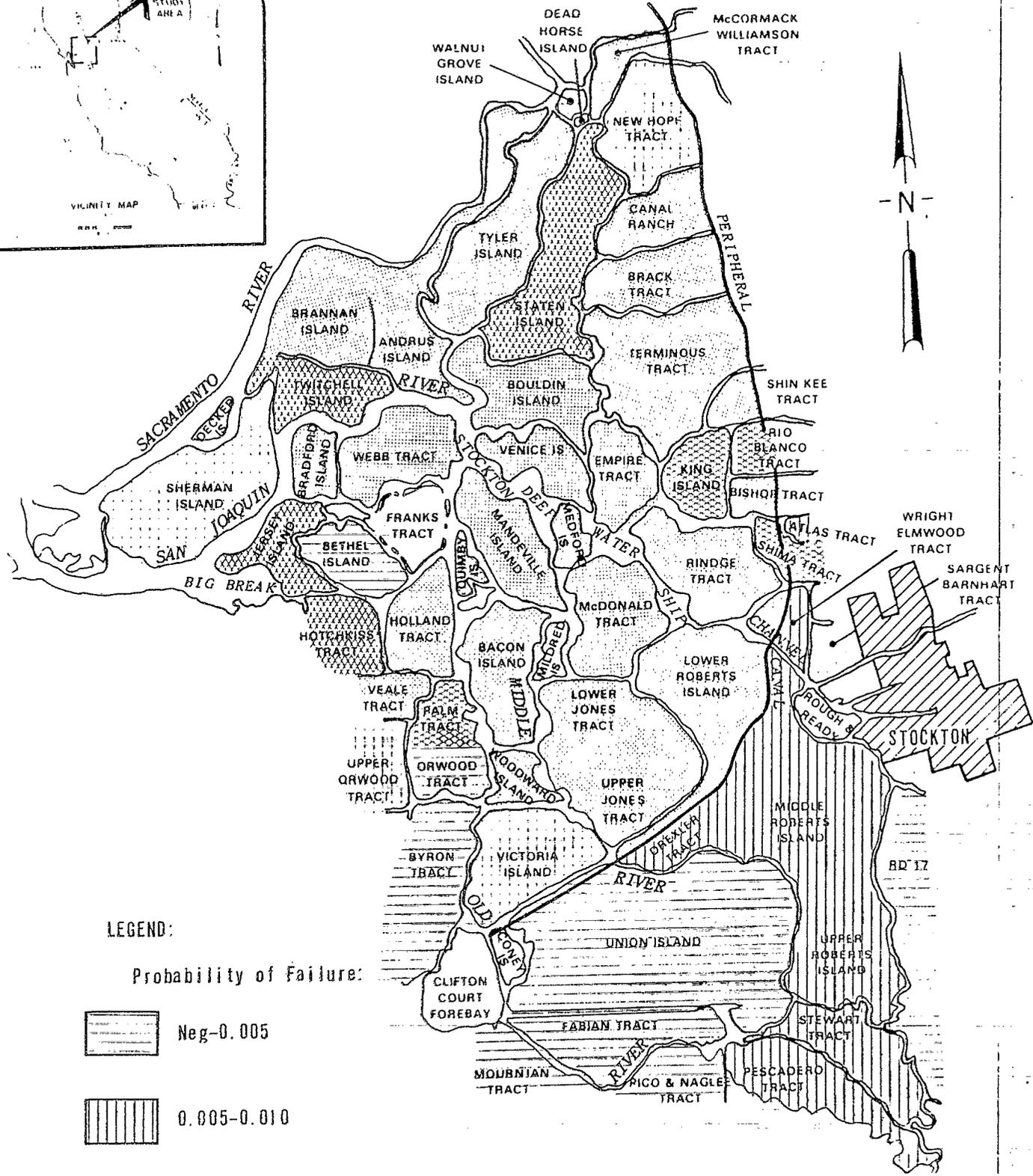
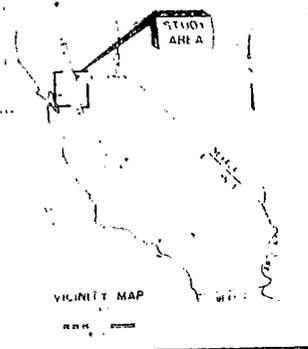
system. In addition, the levees are constantly being eroded by floodflows, tidal flows, and wave wash from winds and boat wakes. Most of the levees lack sufficient freeboard during high-water periods, and many miles of levees have experienced deterioration due to lack of adequate maintenance. If one island is flooded and its levee lost, the adjacent island levees become more vulnerable to wind-wave erosion.

There is no historical experience related to levee failure in the Delta area due to earthquakes. A geological hazard is believed to exist, and for those areas of the Delta where the soil properties are susceptible to seismic activity, levee systems could be vulnerable to damage.

Nineteen levee failures have occurred since 1950. Twelve of the failures were due to failure of the foundation materials by overstressing, and were generally located in the areas of deep peat.^{1/} The six remaining failures were due to overtopping. Stability failures are usually preceded by localized partial failure involving 200 to 1,000 feet of levee. The occurrence of partial failure is characterized by vertical sinking of the levee and formation of numerous cracks and sinkholes in the landside slope. Unless repair is immediate, the condition may become worse, until the levee completely fails. Also contributing to failure is excessive hydrostatic pressure in the peat under the landside toe of the levee. The existing probabilities of failure are summarized on Figure 7.^{2/} Details about existing and future probabilities are discussed in the Plan Formulation

^{1/} The cause of the 23 August 1982 levee failure on McDonald Island had not been determined at the time this report was completed. It is known that the levee was not overtopped.

^{2/} Does not include 23 August 1982 McDonald Island event.



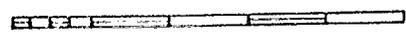
LEGEND:
Probability of Failure:

-  Neg-0.005
-  0.005-0.010
-  0.010-0.020
-  0.020-0.040
-  0.040

SACRAMENTO-SAN JOAQUIN DELTA
CALIFORNIA

PROBABILITY OF LEVEE FAILURE
UNDER PRESENT CONDITIONS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JULY 1982



FIGURE

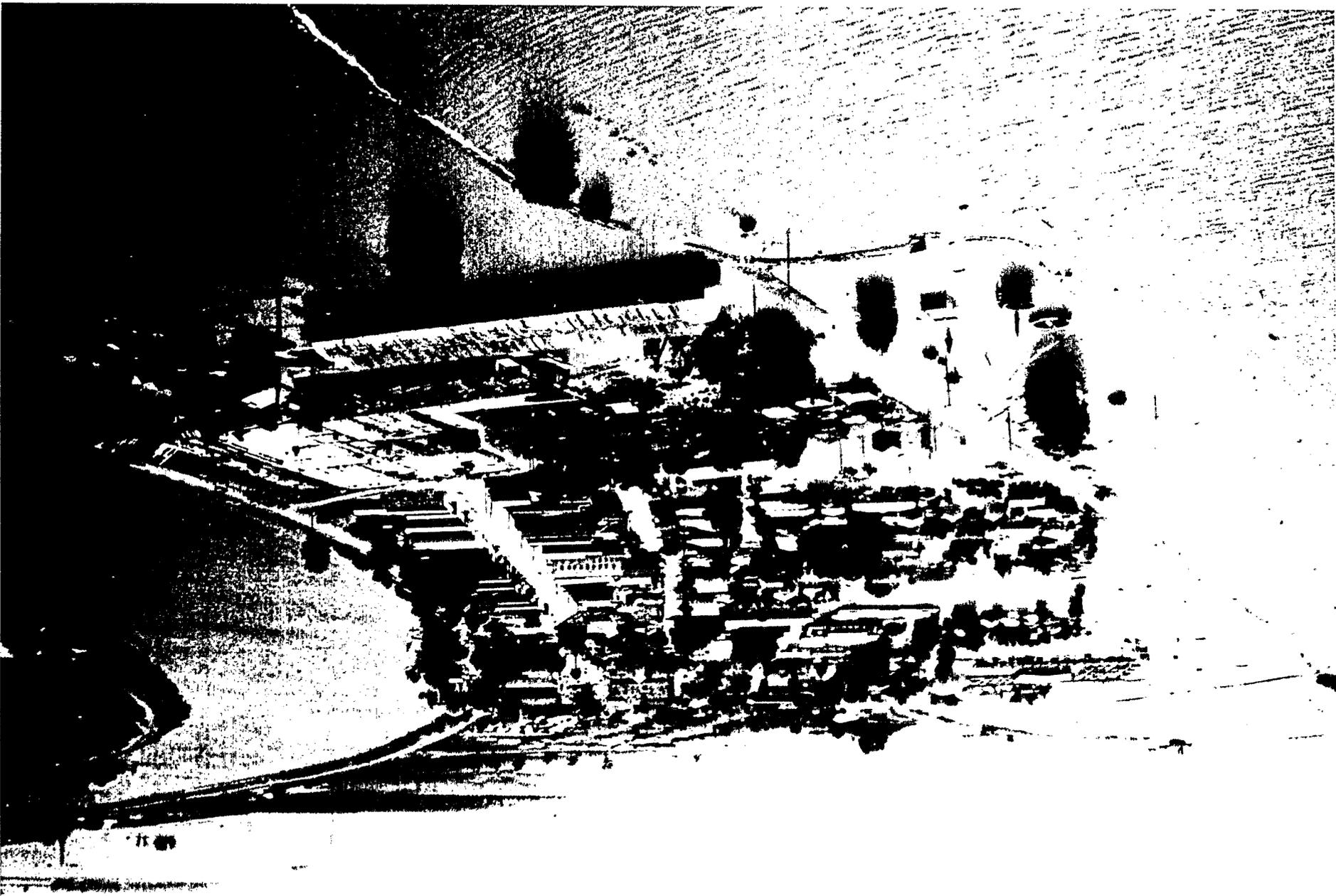
Appendix. Equivalent average annual flood damages attributable to these probabilities of failure amount to about \$46 million for the study area.

WATER QUALITY PROBLEMS

Maintenance of water quality in the Delta is of statewide as well as local importance. The Delta is a pool through which export water must pass in order to be diverted for use in water-deficient areas of California. The Delta channels also serve as a common source of water for Delta agricultural, industrial, urban, recreation, and fish and wildlife uses as well as an outlet to the Pacific Ocean for water that originates in the Sacramento and San Joaquin Valleys.

The Delta is subject to the intrusion of saltwater by tidal action through the San Francisco Bay. Salinity intrusion is presently controlled by Delta outflow augmented as necessary by additional SWP and CVP reservoir releases during low flow periods. Under California law, Delta water requirements must be met before any water is exported. If a Delta island floods during low flow periods, additional water from SWP and CVP reservoirs would be released and export pumping stopped or decreased to maintain Delta water quality standards. All water released to repel salinity intrusion would represent lost water which could have otherwise been used for CVP or SWP deliveries. This problem can be illustrated by the 1972 Andrus-Brannan flood. The flooding occurred during a low flow period and resulted in high salinity conditions from 21 June to 10 August. About 294,000 acre-feet of water was required to reduce salinity to prescribed levels. This water was obtained from sources originally intended for export and from increased releases from upstream reservoirs.

Town of Isleton, Andrus-Brannan Island — June 1972



C-102744

Water quality damages are based on the estimated value of the quantity of water released from upstream reservoirs specifically to repulse salinity intrusion due to levee failure. Equivalent average annual water quality damages attributable to levee failure in the study area are currently estimated at \$8 million.

RECREATION PROBLEMS AND OPPORTUNITIES

The major recreation problems in the Delta stem from (1) inadequate public recreation facilities, (2) inadequate public access, (3) public waterways surrounded by private levees, and (4) ownership controversies regarding the unleveed channel islands. With the exception of a few county facilities, Brannan Island State Recreation Area, and some public fishing areas and boat-launching ramps, public recreation facilities are lacking along the waterways in the Delta. And there are very few riding, hiking, and bicycling trails because of the lack of public lands, the high cost of construction, the narrow levees, and the scarcity of paved roads. Access for bank fishing is also limited, and most of the present shore fishing involves trespassing on private lands.

Nearly all recreation facilities in the Delta are provided by private enterprise, which caters almost exclusively to the boater. Poor access and few facilities have constrained use to the extent that demand is considerably greater than current use. For example, in 1980 it was determined that the actual use in the Delta was 12.3 million recreation days and that the potential demand, if sufficient facilities could be provided, would exceed 21 million recreation days annually. This results in a latent (or unsatisfied) demand of over 9 million recreation days, which is expected to grow to over 25



**Honker Cut and
Disappointment Slough**



**Village West Marina
14 Mile Slough**



**Disappointment Slough
and Bishop Cut**

million if present trends continue. Ownership controversies have also arisen regarding the unleveed channel islands, which are particularly attractive to boaters. Most of these lands, lying above tidal influence, were part of the initial reclaimed islands, but were later cut off from the remainder of the island because they were not economical to maintain. Because of the modification of the Delta waterways, the boundaries between publicly owned and privately owned lands are difficult to determine (the State's Constitution provides that river lands are publicly owned). Additionally, many of the higher unleveed islands have been taken over by squatters, thus preventing public use. To date, the State Lands Commission has not firmly established the State's claim to many of these unleveed islands, berms, and waterways in the Delta.

The potential levee rehabilitation project provides important opportunities for development of public recreation. Both land-based and water-based facilities could utilize the project levee structure and associated berms, and the development of recreation plans would provide an opportunity for counties, planning councils, and State agencies to implement some of their recreation plans and ideas. The project could also provide the opportunity for cultural, historic, and scenic preservation and a chance to centralize recreation development and use in carefully selected areas that would avoid sensitive natural habitat, provide controlled access, and reduce conflicts between the public and private landowners.

FISH AND WILDLIFE PROBLEMS AND OPPORTUNITIES

One of the major problems related to the conservation of fish and wildlife resources is the loss of riparian and wetland habitats. Millions of



Fish and wildlife habitat.

acres of these habitats once existed in the Delta; now only about 20,000 acres remain. Riparian habitat supports a greater variety of wildlife than any other type and maintains the diversity of the Delta ecosystem. Wetland habitat serves as a major contributor to the food web by trapping nutrients essential to fish and shellfish populations as well as providing the special habitat required for many species of wildlife.

In addition to resident species which depend on the Delta's habitat throughout the year, the Delta provides important waterfowl habitat to wintering populations and is a critical link in the Pacific Flyway. Since there are no significant wildlife refuges in the Delta, conflicts arise between wintering waterfowl and farmers growing winter grains. The U.S. Fish and Wildlife Service ranks this area as fourth in national priority for proposed land acquisition for migratory birds.

Many opportunities to preserve and enhance fish and wildlife resources arise through Federal and State involvement in a flood protection project for the Delta. These opportunities include the chance to preserve critical wetlands and riparian habitat, to preserve scenic values, to enhance the lands associated with the levee structures for the benefit of fish and wildlife, and to establish a National Wildlife Refuge and/or State Wildlife Management Area. Therefore, through this investigation, an opportunity has been provided to develop a comprehensive plan to preserve and enhance fish and wildlife resources in a manner which is also responsive to the flood control and recreation problems in the Delta.

RESULTS OF PUBLIC INVOLVEMENT

Coordination to date has indicated that a majority of flood control, maintenance, and reclamation districts in the Delta favor a flood control plan involving levee rehabilitation and erosion protection for the nonproject levees. There is support for any economically feasible alternative except one that involves a polder (master levee) concept. The polder concept is opposed because of loss of navigation and recreation opportunities, and disruption of irrigation and drainage systems. Most of the districts also recommend at least a 100-year flood protection level for agricultural islands and 300-year protection for urban islands. The DWR has expressed a preference for 100-year flood protection for urban islands and 50-year flood protection for agricultural islands. The DWR also recognizes that urban encroachment could be a major threat to Delta agricultural and recreational lands and recommends that maximum use should be made of regulatory actions to protect those lands. The flood control, maintenance, and reclamation districts and farmers also consider urban encroachment to be a problem, and many recommend that there be no urban growth on the agricultural islands and that development be constrained to an adequate level for agricultural activity only.

A recreation plan which would provide adequate public recreation areas while preserving agricultural, rural, and natural qualities is strongly supported by the State and counties in the Delta. The State of California has indicated its interest in sponsoring a recreation plan in conjunction with an acceptable Corps flood control plan, but the high cost of operation and maintenance for a recreation plan has been a constant concern to all potential non-Federal sponsors. A recurring suggested solution has been to charge recreation user fees to defray the costs. Another major concern of local

interests would be the increased trespass and vandalism potential stemming from additional recreation use, and some agricultural interests strongly oppose recreation plans which would allow more public intrusion into the Delta.

Environmental and conservation agencies and local environmental interests strongly endorse any elements in a formulated plan which would lead to the preservation of riparian and wetland habitats and fish and wildlife resources generally. They also endorse the establishment of a National Wildlife Refuge and/or State Wildlife Management Area as well as provisions for an increase in public recreational opportunities.

PLAN FORMULATION

Plan formulation is a creative and analytical process which involves (1) establishing planning objectives, (2) delineating specific criteria, (3) identifying management measures, and (4) formulating alternative plans. Plan formulation will be discussed briefly in this Feasibility Report. Details are provided in the Plan Formulation Appendix.

PLANNING OBJECTIVES

The two study objectives are National Economic Development (NED) and Environmental Quality (EQ). The NED objective is to efficiently increase the value of the Nation's output of goods and services and improve national income. The EQ objective is to enhance the quality of the environment by the management, conservation, preservation, creation, restoration, or improvement of the quality of natural and cultural resources.

The following planning objectives were established to address the problems and realize the opportunities identified in the Sacramento-San Joaquin Delta and to serve as guidelines for the formulation and evaluation of alternative plans:

a. Reduce flood damages in the Delta to increase agricultural production and protect economic development and environmental resources.

b. Control tidal intrusion into the Delta resulting from levee failure to maintain water quality.

c. Provide needed public access and recreation facilities to improve recreation opportunities.

d. Protect and enhance fish and wildlife habitat in the Delta.

e. Preserve scenic values.

FORMULATION AND EVALUATION CRITERIA

The alternative plans of improvement for flood control, recreation, and fish and wildlife purposes were directed toward providing contributions to the principal NED and EQ study objectives and were formulated on the basis of specific technical, economic, environmental, socioeconomic, and institutional criteria.

Plan effects were then evaluated in terms of their beneficial and adverse impacts on national economical development (NED), environmental quality (EQ), regional economic development (RED), and other social effects (OSE).

Formulation and evaluation of the alternative plans were based on the most likely conditions expected to exist in the future with and without the project. Two fundamental conditions have been assumed for the without-project condition. One assumption is that the Peripheral Canal, an authorized and as yet unconstructed feature of the State Water Project, will become operational in the Delta. The other assumption is that when levee failures occur in the future, the levees would be repaired and the islands would be restored. This second assumption reflects the desire of the California State Legislature (Senate Bill 541) that the physical characteristics of the Delta be preserved essentially in their present form. Since there is a possibility that one or both of these assumptions may in fact incorrectly depict the without-project condition in the future, a sensitivity analysis was conducted to determine the impact of these assumptions on the selection of the final plan. The Plan Formulation Appendix provides detailed information on these assumptions and the results of the sensitivity analysis. The sensitivity analysis is discussed further in this report in the section entitled Selection of Final Plan.

MANAGEMENT MEASURES

Within the framework of plan formulation criteria, a wide variety of measures were identified to meet the planning objectives for flood control, water quality (as affected by levee failure), recreation, and fish and wildlife. Many of the measures were eliminated from further consideration

because of limited economic feasibility, significant environmental problems, or limited potential for providing solutions. The measures that were retained provide the basis for formulating alternative plans. A no action measure was considered throughout the planning process for comparative purposes. A summary of the evaluated measures is presented in Table 2.

ALTERNATIVE PLANS

The measures that were retained were formulated into alternative plans. The no action measures for each of the planning objectives were formulated into a No Action Plan in order to provide a basis for comparison with the other alternative plans. The levee rehabilitation measure was developed into numerous alternatives. The remaining measures, which address the recreation and fish and wildlife objectives, were retained and formulated into plans which would complement the levee rehabilitation alternatives.

Levee Rehabilitation Alternatives

The levee rehabilitation measure was developed into a number of alternatives, which were distinguished from each other on the basis of economic approach and levee design. The economic analysis can be viewed from a system approach or an incremental approach. The system approach views the Delta as a "system" of interdependent islands with feasibility justified on the basis of one group of islands rather than on an island-by-island basis. The incremental approach views the Delta as a series of islands with widely varying characteristics. The islands are considered to be independent of one another, with economic justification based on an incremental or island-by-island basis. Both approaches were retained for detailed study.

TABLE 2
WATER RESOURCES MANAGEMENT MEASURES EVALUATED

Planning Objective Management Measures	Planning Objective Fulfillment	B/C Ratio	Assessment	
			Environmental Benefits	Status for Consideration
<u>Flood Control</u>				
No action	Fair	-	Fair	Retained
Levee rehabilitation	Excellent	>1:1	Good	Retained
Construction of barriers	Fair	<1:1	Adverse	Deleted
Construction of upstream dams	Fair	<1:1	Poor	Deleted
Public acquisition	Good	<1:1	Fair	Deleted
Flood proofing	Poor	<1:1	Poor	Deleted
<u>Water Quality</u>				
No action	Fair	-	Fair	Retained
Levee rehabilitation	Excellent	>1:1	Good	Retained
Construction of downstream barriers	Good	<1:1	Adverse	Deleted
Construction of upstream dams	Good	<1:1	Poor	Deleted
<u>Recreation</u>				
No action	Poor	-	Adverse	Retained
Land-based facilities	Excellent	>1:1	Good	Retained
Water-based facilities	Good	>1:1	Good	Retained
Day use facilities	Excellent	>1:1	Good	Retained
Overnight use facilities	Excellent	>1:1	Good	Retained
<u>Fish and Wildlife Enhancement</u>				
No action	Poor	-	Poor	Retained
Acquire public interest in land	Excellent	>1:1	Excellent	Retained
Establish Wildlife Management Area	Excellent	>1:1	Excellent	Retained
Select construction and management measures	Excellent	>1:1	Excellent	Retained

< = Less than

> = Greater than

An initial design consideration involved the concepts of rehabilitating individual islands or grouping the islands by closing off the waterways between islands to form a polder. Polders would involve the addition of rockfill at interconnecting waterways to effect a permanent closure between adjacent islands, with no water circulation across the polder. Both of these concepts were found to have merit and were retained for further study.

Another design consideration concerned the level of flood protection to be provided. Three levels were evaluated to provide (1) 300-year flood protection to all islands, (2) 300-year protection to the urban islands (Andrus-Brannan, Bethel, Byron, Hotchkiss, New Hope, and RD 17) and 100-year protection to the remaining agricultural islands, or (3) 300-year protection to the urban islands and 50-year protection to the remaining islands. The 300-year level of protection was selected for both urban and agricultural islands since net benefits maximized at this level of protection.

A third design consideration involved the method of rehabilitation. Stage construction (landside enlargement of existing levees, where the embankments are constructed in stages or intervals), setback levees, and sheet pile floodwalls were evaluated. Stage construction was determined to be the most economical method for nearly all the islands, although setback levees are recommended in some areas to preserve riparian habitat, and sheet pile floodwalls were used in urbanized areas in order to reduce relocation costs.

Recreation Alternative

Recreation measures (land-based, water-based, day use, and overnight use facilities) were formulated into a plan which extensively utilized the data

provided in the "Delta Recreation Concept Plan" prepared by DWR. Additional formulation was dependent upon (1) information gained at public meetings, (2) the capability of non-Federal interests to share the costs of a project, and (3) constraints imposed by the project design which involves linear, narrow levee areas. These limitations resulted in the formulation of a comprehensive plan which was moderate rather than extensive in scope. This plan was included with the levee rehabilitation alternatives.

Fish and Wildlife Enhancement Alternatives

Fish and wildlife measures included acquisition of public interest in land, selection of construction and management measures, and establishment of a Wildlife Management Area. Environmental quality planning procedures and data obtained from this process were particularly useful in developing these measures. These measures were formulated into a plan which complements the recreation and levee rehabilitation plans.

SELECTION OF CANDIDATE PLANS

The alternative plans were formulated in such a way that they exhibit the potential for becoming plans that are (1) complete (contain the necessary ingredients to realize desired benefits), (2) effective (alleviate the problems and realize the opportunities), (3) efficient (the most cost effective), and (4) acceptable (feasible from an economic, social, environmental, legal, political, and financial standpoint). This provided an effective way in which to identify the alternative plans that were to be considered as candidates for a selected plan. As a result of this screening process, four candidate plans were selected to meet the objectives of this

study. Two of these plans were designated as the NED and EQ plans. The candidate plans include (1) a System Flood Control Plan (EQ Plan), (2) a Modified System Flood Control Plan which addresses only the most vulnerable islands in the system, (3) an Incremental Flood Control Plan (NED Plan), and (4) a Polder Flood Control Plan. In addition, the No Action Plan was retained for comparative purposes.

CANDIDATE PLANS

This section contains (1) a brief description of the candidate plans, (2) an evaluation of the candidate plans, and (3) the rationale for selection of the plan of improvement. Details of the candidate plans are provided in the Plan Formulation Appendix.

DESCRIPTION OF CANDIDATE PLANS

No Action Plan

Under the No Action Plan, it was assumed that a comprehensive levee rehabilitation program would not be undertaken. In addition, island interiors would continue to subside, which would cause the probability of levee failure to increase in the future. The without-project future condition assumed that failed levees would continue to be restored in keeping with the State's philosophy of preserving the physical characteristics of the Delta in their present form. It was also assumed that the authorized Peripheral Canal would be constructed. Under the No Action Plan, equivalent average annual damages from flooding and salinity intrusion in the study area are estimated at \$54 million.

System Flood Control Plan (EQ Plan)

This plan was based on the concept that the Delta islands are interdependent and act as a unit or system. Economic justification was based on the system as a whole, rather than on an island by island basis. The plan would (1) reduce flooding, (2) maintain water quality by reducing the

frequency of salinity intrusion, (3) provide needed public access and recreation facilities, and (4) preserve and enhance fish and wildlife habitat and scenic values. The islands included in the system plan are identified in Figure 8.

Flood Control and Water Quality Features. - These features consist of levee rehabilitation, land use management, and fish and wildlife mitigation. The plan would provide a 300-year level of flood protection to 54 major islands and tracts in the study area. Levee rehabilitation is proposed for 47 of the 54 islands. The remaining seven islands, Fabian, Mournian, Pescadero, Pico-Naglee, Stewart, Union, and Walnut Grove would only require minimum improvements such as the addition of levee patrol roads and erosion protection material to comply with design criteria. Rehabilitation would primarily employ the stage construction method. The source of embankment material would depend upon (1) availability at time of construction, (2) economics, and (3) environmental impacts. Primary locations under consideration include dredged material disposal sites, the Peripheral Canal, the Montezuma Hills, and the Delta Pumping Plant. Sheet pile floodwalls would be used in the urban areas on Bethel Island and Hotchkiss Tract to eliminate the need to remove existing improvements.

Land use management would be a required feature of this plan in order to insure that adverse impacts are prevented or minimized and that the natural and beneficial flood plain values are preserved. The provisions for this requirement can be found in the Executive Order on Flood Plain Management (EO 11988) dated 24 May 1977. This feature would include the enactment and enforcement of land use plans accompanied by consistent zoning regulations, which would prevent project-induced urban development and growth on the

agricultural islands within the project area. Furthermore, non-Federal interests would be required to provide assurances that development on the urban islands would be limited to those areas incapable of sustained economic agricultural production. Development on urban islands would be required to be consistent with city and county General Plans and the California Environmental Quality Act. The land use regulation feature would be a prerequisite legal requirement of non-Federal interests. It is anticipated that the State would provide the necessary intent to provide assurances that this requirement would be satisfied.

Levee rehabilitation would result in the loss of 1,890 acres of riparian habitat, 720 acres of wetland vegetation, and 2,823 acres of upland vegetation as well as 2,821 acres of agricultural land. Coordination with the U.S. Fish and Wildlife Service (FWS) indicates that the most significant fish and wildlife impact would be the loss of scarce riparian habitat and that it would be feasible for the Corps to provide full compensation for project impacts on fish and wildlife. Several methods for compensation were presented in the draft Detailed Report of the Fish and Wildlife Service which is attached to the Environmental Impact Statement. Basically, the methods involve the purchase of land for development of replacement habitat, with evenly distributed sites no smaller than 15 acres in a configuration as close to circular as possible. The method selected for this report would involve the purchase of agricultural land for development into mature riparian habitat through natural establishment and succession of plant species. This natural process will culminate in full vegetative and fish and wildlife values in about 40 years, although important fish and wildlife values will also be furnished by earlier successional stages during the interim. Based on compensation requirements for the damages caused by levee construction

developed by FWS for the Incremental Flood Control Plan, it is estimated that about 3,165 acres of selected small parcels of agricultural land would be required for mitigation of impacts resulting from construction of the System Flood Control Plan. Coordination will continue to insure that the final mitigation measures are justifiable and publicly acceptable as part of the overall recommended plan.

Recreation Features. - Recreation features would be located on 45 sites in the study area and could consist of both large and small developments. These include 14 recreation areas, 23 fishing access sites, 8 boater destination sites, and 145 miles of bicycling, hiking, equestrian, and canoe trails. Figure 12 shows the types and locations of recreation facilities. Opportunities would be provided for shore-based and water-based activities to accommodate an additional annual use of 2.4 million recreation days. This would result in an increase of about 20 percent over existing use. The proposed recreation plan was carefully planned and extensively coordinated to respond to public recreation needs of the area, to preserve scenic values and environmental quality, and to be compatible as practical with agricultural interests, landowner concerns, and with the flood control features of the candidate plans.

Fish and Wildlife Enhancement Features. - These features include acquiring public interest in lands and constructing setback levees. They were designed to preserve and enhance the natural resources and scenic values of the Delta. The location of these features is shown in Figure 12. Specifically, these lands would include about 1,000 acres of significant upland and riparian habitat including critical habitat for the State designated rare, giant garter snake and California black rail; about 1,500

acres of channel tule islands with valuable riparian habitat and freshwater marshes; and about 3,500 acres of highly diversified habitat set aside for a Wildlife Management Area located on Little Mandeville, Medford, Mildred, Quimby, and Rhode Islands. The Wildlife Management Area would be administered by non-Federal interests. FWS indicated that the establishment of the fish and wildlife enhancement features would be consistent with the purpose of the National Migratory Bird Management Program administered by FWS. Coordination will continue with FWS to determine if the islands designated in the Wildlife Management Area should be included in the National Wildlife Refuge system. This determination would be made prior to submitting the final report. Specific design and development considerations for the Wildlife Management Area are discussed in the Description of the Selected Plan. An additional enhancement feature would involve construction of setback levees on Brack, Canal Ranch, McCormack-Williamson, and New Hope Tracts to avoid the loss of riparian habitat.

Economics of the Plan. - The first cost of this plan includes costs for levee rehabilitation; relocations; acquisition of lands, easements, and rights-of-way for levee rehabilitation and fish and wildlife mitigation and enhancement features; construction of recreation facilities; additional cost of setback levees for fish and wildlife enhancement; and engineering, design, supervision, and administration. The annual cost includes interest and amortization on the first cost as well as annual operation and maintenance costs for levee rehabilitation, recreation facilities, and a Wildlife Management Area. Operation and maintenance costs for the remaining lands acquired for fish and wildlife enhancement are considered to be negligible. The first and annual costs of the land use management feature would consist of implementation and administrative costs within existing State and county

planning units and are considered sufficiently small to be excluded from this analysis.

Benefits obtained from levee rehabilitation include reduction of physical flood losses, reduction of emergency costs, and water quality benefits (savings in water required to restore water quality following levee failure during periods of low Delta outflow). Recreation benefits stem from increased recreation use. Measurable fish and wildlife benefits result primarily from the recreation use associated with enhancement lands. Additional fish and wildlife benefits include reduced waterfowl losses due to disease, the contribution of the features to the National Migratory Bird Management Program, reduced crop depredation, and fishing and hunting and non-consumptive uses on the proposed Wildlife Management Area. A large number of intangible benefits to esthetics, fish and wildlife, open space, and related values would also result from the protection and enhancement of these significant natural areas. Table 3 summarizes the tangible costs and benefits of the plan.

Designation as the Environmental Quality (EQ) Plan. - The System Flood Control Plan is based on the concept that the Delta is an interrelated system of islands which act as one unit. This same premise applies to the environmental quality of the Delta. The system plan would reduce the probability of levee failure within the entire study area and thus has the opportunity of assisting the Delta to remain in its existing state. The adverse impacts associated with levee failure, such as increased salinity intrusion, loss of wildlife habitat, and loss of highly productive farmland, would be prevented throughout the study area. The System Flood Control Plan would provide the most comprehensive and complete protection against the

TABLE 3

SYSTEM FLOOD CONTROL PLAN
SUMMARY OF COSTS AND BENEFITS
(1 October 1981 prices; 1990-2040 project conditions;
7-5/8 percent discount rate)

FIRST COST ^{1/}		\$1,007,000,000
Flood Control and Water Quality	\$910,000,000	
Initial Construction ^{2/}	\$670,000,000	
Stage Construction	240,000,000	
Recreation	40,000,000	
Fish and Wildlife Enhancement	57,000,000	
ANNUAL COST		\$68,800,000
Flood Control and Water Quality	\$60,900,000	
Interest and Amortization	\$58,900,000	
Operation and Maintenance	2,000,000	
Recreation	\$4,000,000	
Interest and Amortization	\$3,000,000	
Operation and Maintenance	1,000,000	
Fish and Wildlife Enhancement	\$3,900,000	
Interest and Amortization	\$3,500,000	
Operation and Maintenance	400,000	
ANNUAL BENEFITS		\$73,100,000
Flood Control and Water Quality	\$51,900,000	
Recreation	13,100,000	
Fish and Wildlife Enhancement	8,100,000	
BENEFIT-COST RATIOS - Total Project		1.1:1
Flood Control and Water Quality	0.9:1	
Recreation	3.3:1	
Fish and Wildlife Enhancement	2.1:1	
NET BENEFITS (excess of benefits over costs)		\$4,300,000

^{1/} Rounded to nearest \$1,000,000

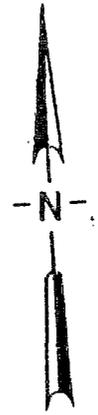
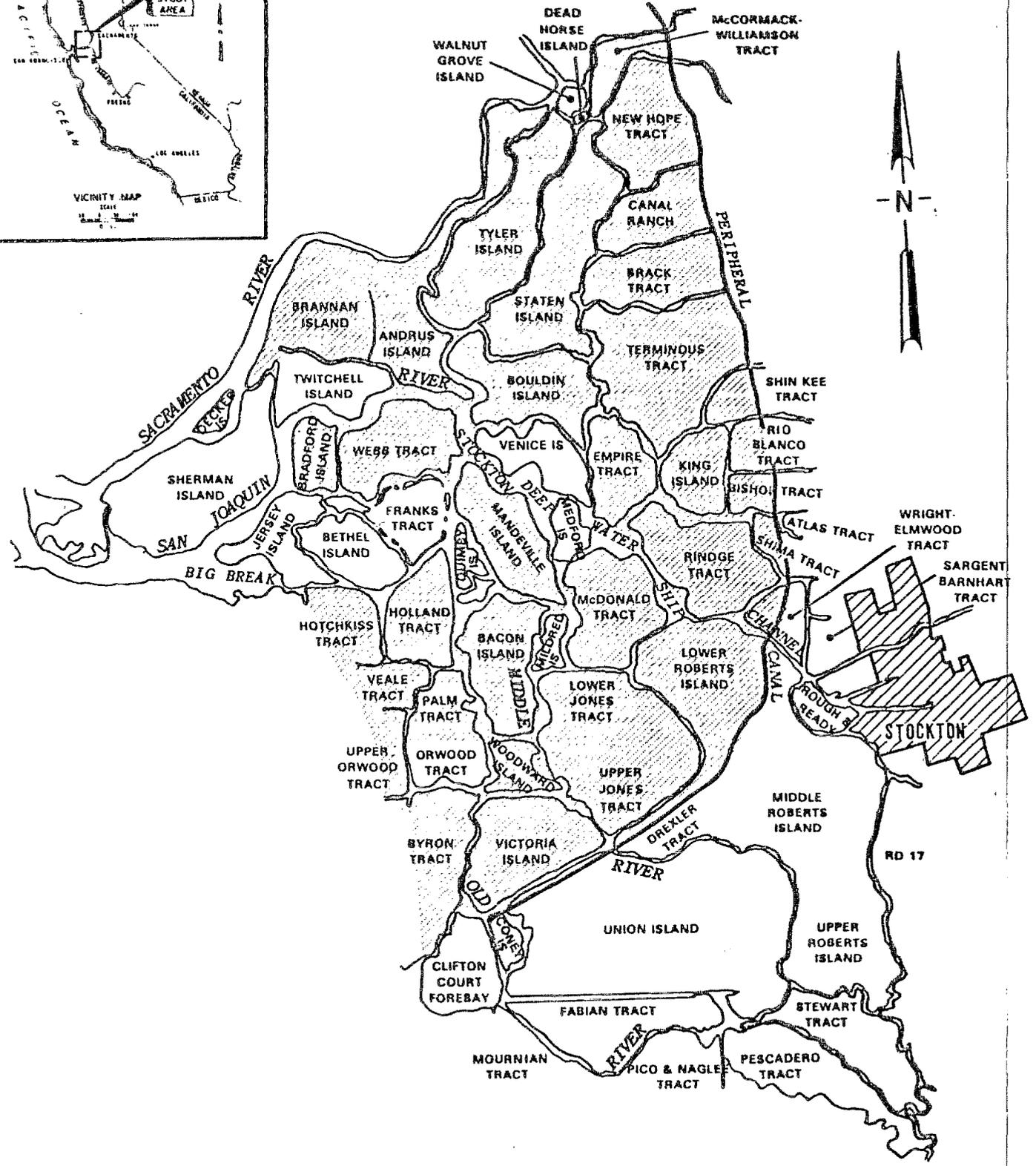
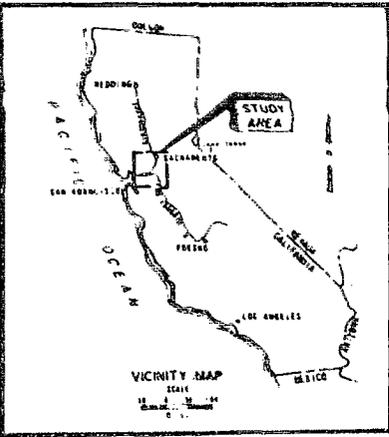
^{2/} Includes \$11,000,000 in fish and wildlife mitigation costs.

adverse environmental effects of flooding which are described under the No Action Plan in the Plan Formulation Appendix.

Modified System Flood Control Plan

This plan represents the formulation of an economically feasible system-type plan that would concentrate on the high flood hazard areas of the Delta. The plan was formulated by deleting from the System Flood Control Plan, islands with existing levees providing at least 50-year flood protection and islands for which levee improvements would have large negative net benefits (excess of benefits over costs). This plan would provide the same accomplishments as the previous plan by (1) reducing flooding, (2) maintaining water quality by reducing the frequency of salinity intrusion, (3) providing public access and recreation facilities, and (4) preserving and enhancing fish and wildlife habitat and scenic values. However, the flood control and water quality accomplishments would occur in only a portion of the study area. Figure 9 provides a location map of the islands included in the Modified System Flood Control Plan.

Flood Control and Water Quality Features. - The features consist of levee rehabilitation, land use management, fish and wildlife mitigation, and a Flood Hazard Mitigation Program. The plan would provide a 300-year level of flood protection to the 36 islands that remained in the system after islands with adequate flood protection and the most economically infeasible islands were deleted. Levee rehabilitation would employ the stage construction method except on Hotchkiss Tract, where sheet pile floodwalls would be used on portions of the tract.



LEGEND:
 ISLANDS INCLUDED IN PLAN

SACRAMENTO-SAN JOAQUIN DELTA
CALIFORNIA

MODIFIED SYSTEM FLOOD
CONTROL PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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FIGURE 9

Another feature is land use management. Land use regulations would be implemented by non-Federal interests to prevent urban development on the agricultural islands and to control development of agricultural lands on the urban islands included in this plan. This feature is described in the System Flood Control Plan.

Levee rehabilitation would result in the loss of 1,155 acres of riparian habitat, 365 acres of wetland vegetation, and 2,113 acres of upland vegetation as well as 1,845 acres of agricultural land. The compensation for this loss would be similar to the one discussed in the System Flood Control Plan except that it is estimated that the purchase of about 1,935 acres of agricultural land would be required to replace fish and wildlife values lost due to construction.

An additional feature that is not present in the System Flood Control Plan is the Flood Hazard Mitigation Program. The background for this feature relates to Public Law 84-99 and determinations made by the Corps of Engineers in 1980. Public Law 84-99 authorizes the Corps of Engineers to engage in flood emergency activities and to repair or restore flood control works threatened or destroyed by floods. The Corps has been involved in numerous flood fights and repair and restoration work in the Delta under this authority. However, following the Delta floods in 1980, it was determined that some of the Delta levees were reclamation levees rather than flood control levees; that they were poorly designed and maintained; and that a permanent solution to the flood problem should be encouraged. Following these findings, the Chief of Engineers clarified that Corps assistance in the Delta in the administration of Public Law 84-99 would be limited to supplementing local flood fight activities to save lives and prevent or mitigate property

damage, and to restore flood prevention structures. Levees described as flood control structures would be eligible for flood emergency assistance under the Public Law 84-99 authority. The Flood Hazard Mitigation Program provides that nonproject levees in the study area which are not authorized for flood control improvements as a result of this investigation would be considered eligible for flood emergency assistance under Public Law 84-99 provided non-Federal interests upgrade and maintain the levees to a prescribed Federal standard at their own expense, sufficient to provide a 50-year level of flood protection on agricultural islands and 100-year flood protection on urban islands. This feature would assist in maintaining the Delta as a system; and although it is a recommended feature of the plan, it would neither be required for project implementation nor be necessary for successful functioning of the other features of the plan. Refer to the Plan Formulation Appendix for details of this feature.

Recreation Features. - Recreation features would be the same as those discussed in the System Flood Control Plan.

Fish and Wildlife Enhancement Features. - These environmental features would be the same as those discussed in the System Flood Control Plan.

Economics of the Plan. - The costs and benefits of this plan are comprised of the same components as those discussed in the System Flood Control Plan. Table 4 summarizes the tangible costs and benefits of the plan.

TABLE 4

MODIFIED SYSTEM FLOOD CONTROL PLAN
 SUMMARY OF COSTS AND BENEFITS
 (1 October 1981 prices; 1990-2040 project conditions;
 7-5/8 percent discount rate)

FIRST COST ^{1/}		\$705,000,000
Flood Control and Water Quality	\$608,000,000	
Initial Construction ^{2/}	\$438,000,000	
Stage Construction	170,000,000	
Recreation	40,000,000	
Fish and Wildlife Enhancement	57,000,000	
ANNUAL COST		\$47,700,000
Flood Control and Water Quality	\$39,800,000	
Interest and Amortization	\$38,600,000	
Operation and Maintenance	1,200,000	
Recreation	\$4,000,000	
Interest and Amortization	\$3,000,000	
Operation and Maintenance	1,000,000	
Fish and Wildlife Enhancement	\$3,900,000	
Interest and Amortization	\$3,500,000	
Operation and Maintenance	400,000	
ANNUAL BENEFITS		\$65,100,000
Flood Control and Water Quality	\$43,900,000	
Recreation	13,100,000	
Fish and Wildlife Enhancement	8,100,000	
BENEFIT-COST RATIOS - Total Project		1.4:1
Flood Control and Water Quality	1.1:1	
Recreation	3.3:1	
Fish and Wildlife Enhancement	2.1:1	
NET BENEFITS (excess of benefits over costs)		\$17,400,000

^{1/} Rounded to nearest \$1,000,000

^{2/} Includes \$7,000,000 in fish and wildlife mitigation costs.

Incremental Flood Control Plan (NED Plan and Selected Plan)

This plan is based on the incremental economic approach and includes only the islands which are economically feasible on an individual basis. This plan would provide the same accomplishments as the System Flood Control Plan by (1) reducing flooding, (2) maintaining water quality by reducing the frequency of salinity intrusion, (3) providing public access and recreation facilities, and (4) preserving and enhancing fish and wildlife habitat and scenic values. However, the flood control and water quality accomplishments would occur in only a portion of the study area. Figure 10 identifies the islands included in the Incremental Flood Control Plan.

Flood Control and Water Quality Features. - The features consist of levee rehabilitation, land use management, fish and wildlife mitigation, and a Flood Hazard Mitigation Program. The plan would provide 300-year flood protection to 15 islands in the study area. Levee rehabilitation would employ the staged construction method except on Hotchkiss Tract, where sheet pile floodwalls would be used on portions of the tract. The land use management and flood hazard mitigation features would be the same as described in the previous plans.

Levee rehabilitation would result in the loss of 388 acres of riparian habitat, 160 acres of wetland vegetation, and 1,257 acres of upland vegetation as well as 1,126 acres of agricultural land. Each of these resources provides valuable, but varying degrees of fish and wildlife habitat. A detailed analysis using Habitat Evaluation Procedures (HEP) was performed by FWS to determine project impacts and suitable compensation for losses of fish and wildlife habitat. The analysis included an accounting of with-project values

which will include 1,514 acres of upland vegetation reestablished on project levees and 95 acres of wetland vegetation. The HEP analysis concluded that the purchase of 650 acres of selected small parcels of agricultural land for conversion to riparian habitat would be required to provide full compensation of project impacts on fish and wildlife.

Recreation Features. - These features would be the same as discussed in the System Flood Control Plan.

Fish and Wildlife Enhancement Features. - These features would be the same as those described in the System Flood Control Plan, except that the setback levee feature would only apply to Brack Tract.

Economics of the Plan. - The costs and benefits of this plan are comprised of the same components as those discussed in the System Flood Control Plan. Table 5 summarizes the tangible costs and benefits of the plan.

Designation as the National Economic Development (NED) Plan. - The NED Plan is the plan that addresses the planning objectives while reasonably maximizing net economic benefits to the national economy. The Incremental Flood Control Plan has been designated as the NED Plan since it is the candidate plan which reasonably maximizes net benefits.

Polder Flood Control Plan

This plan is based on the incremental economic approach and includes the optimum combination of economically feasible islands and polders. For further details on formulation, refer to the Polder Net Benefit Plan in the Plan

Formulation Appendix. The accomplishments for this plan would be similar to those in the previous plans except that this plan and any other polder-type plan would be characterized by the potentially major adverse impacts on navigation, recreation, fisheries, and esthetics that would result from closing off waterways in the Delta. Figure 11 shows the location of the islands included in the Polder Flood Control Plan.

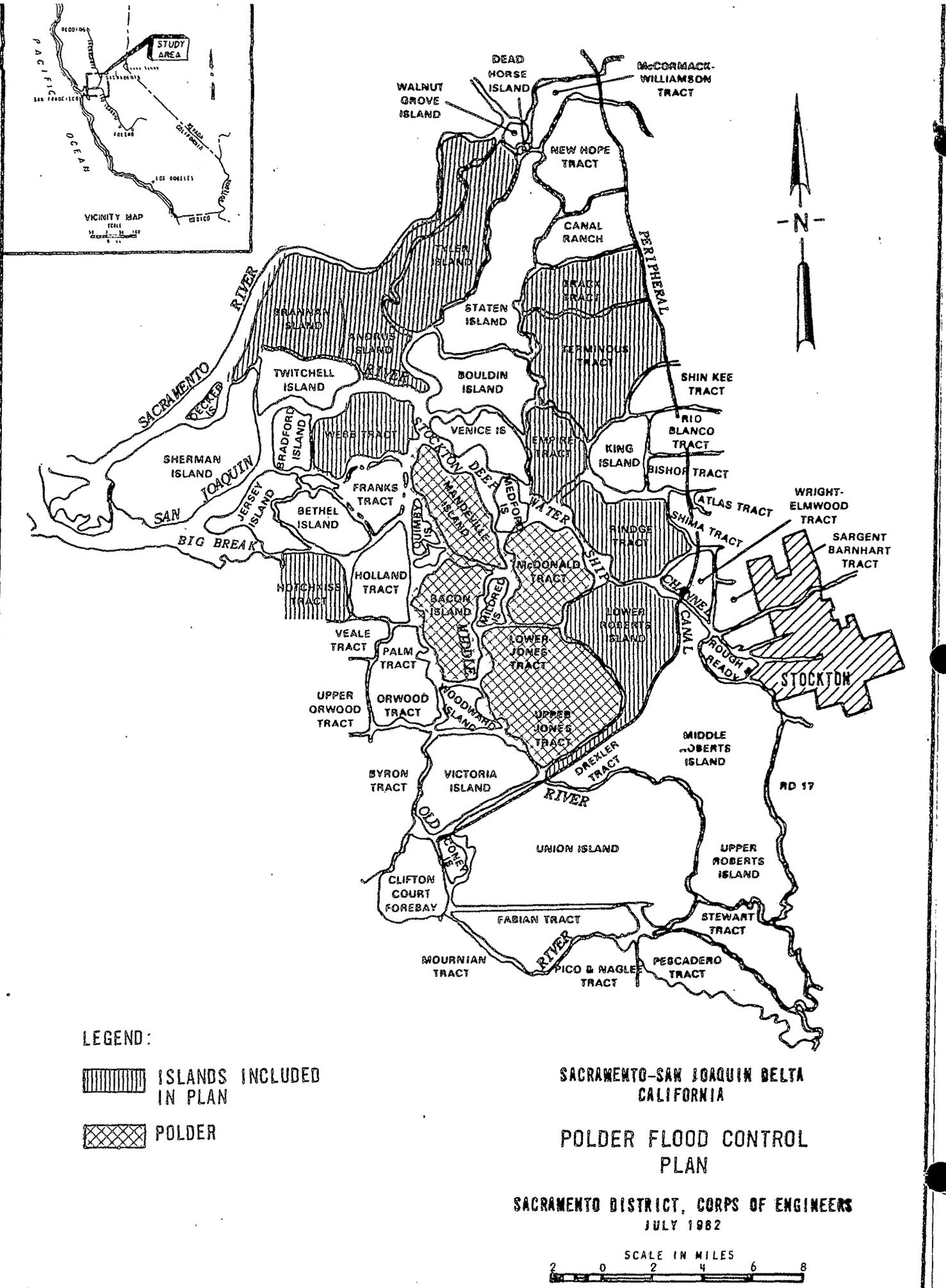
TABLE 5

INCREMENTAL FLOOD CONTROL PLAN
SUMMARY OF COSTS AND BENEFITS
(1 October 1981 prices; 1990-2040 project conditions;
7-5/8 percent discount rate)

FIRST COST ^{1/}		\$415,000,000
Flood Control and Water Quality		\$326,000,000
Initial Construction ^{2/}	\$225,000,000	
Stage Construction	101,000,000	
Recreation		40,000,000
Fish and Wildlife Enhancement		49,000,000
ANNUAL COST		\$28,100,000
Flood Control and Water Quality		\$20,900,000
Interest and Amortization	\$20,300,000	
Operation and Maintenance	600,000	
Recreation		\$4,000,000
Interest and Amortization	\$3,000,000	
Operation and Maintenance	1,000,000	
Fish and Wildlife Enhancement		\$3,200,000
Interest and Amortization	\$2,900,000	
Operation and Maintenance	300,000	
ANNUAL BENEFITS		\$53,800,000
Flood Control and Water Quality		\$32,600,000
Recreation		13,100,000
Fish and Wildlife Enhancement		8,100,000
BENEFIT-COST RATIOS - Total Project		1.9:1
Flood Control and Water Quality		1.6:1
Recreation		3.3:1
Fish and Wildlife Enhancement		2.5:1
NET BENEFITS (excess of benefits over costs)		\$25,700,000

^{1/} Rounded to nearest \$1,000,000

^{2/} Includes \$2,000,000 in fish and wildlife mitigation costs.



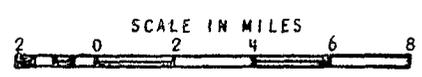
LEGEND:

-  ISLANDS INCLUDED IN PLAN
-  POLDER

SACRAMENTO-SAN JOAQUIN DELTA CALIFORNIA

POLDER FLOOD CONTROL PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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Flood Control and Water Quality Features. - The features consist of levee rehabilitation, land use management, fish and wildlife mitigation, and a Flood Hazard Mitigation Program. The plan would provide 300-year flood protection to the same 15 islands that were protected under the Incremental Flood Control Plan. Levee rehabilitation would employ the stage construction method except on Hotchkiss Tract, where sheet pile floodwalls would be used on portions of the tract.

Permanent rockfill closures would be placed between Mandeville and Bacon Islands, and between McDonald and Jones Tracts to form two polders, with no water circulation across the polder, i.e., there would be no connection from the closed waterways to Delta waters. The land use management and flood hazard mitigation features would be the same as described in the previous plans.

Levee rehabilitation would result in the loss of 388 acres of riparian habitat, 152 acres of wetland, and 997 acres of upland vegetation as well as 981 acres of agricultural land. Based on the HEP analysis conducted for the incremental plan, it is estimated that mitigation for losses to fish and wildlife vegetation resulting from levee rehabilitation would consist of the purchase of about 650 acres of agricultural land for conversion to riparian habitat. One approach to mitigation for losses to navigation, recreation, fisheries, and esthetics caused by closing the waterways might be a trade-off to convert the closed waterways to wetlands. This plan would include the acquisition of sufficient easements along the channels for preserving and enhancing riparian vegetation, and involve the conversion of the closed waterways (approximately 200 acres) to wetlands by dredging nearby channels to provide sufficient fill to bring the waterways to mean sea level. Existing

agricultural discharge would be used to create the wetlands. These areas would be incorporated into the overall Wildlife Management Area provided by the project. Further analysis would be needed to show how added wetlands could offer compensation for impacts to natural resource areas.

Recreation Features. - These features would be the same as in the System Flood Control Plan.

Fish and Wildlife Enhancement Features. - These features would be the same as described in the System Flood Control Plan, except that the setback levee feature would only apply to Brack Tract.

Economics of the Plan. - The costs and benefits of this plan are comprised of the same components as those discussed in the System Flood Control Plan with the addition of the cost of rock fill required to form the two polders. Table 6 summarizes the costs and benefits of the plan.

EVALUATION OF CANDIDATE PLANS

A plan to be recommended for implementation is selected from among the candidate plans. This section discusses the evaluation process used in plan selection.

A summary comparison of the measures and features of the candidate plans is provided in Table 7. This table illustrates that the plans only differ in two major aspects. One aspect is project size. The System Flood Control Plan addresses the entire study area while the Modified System Flood Control Plan covers about 60 percent of the study area. The remaining flood control plans,

TABLE 6

POLDER FLOOD CONTROL PLAN
SUMMARY OF COSTS AND BENEFITS
(1 October 1981 prices; 1990-2040 project conditions;
7-5/8 percent discount rate)

FIRST COST ^{1/}		\$415,000,000
Flood Control and Water Quality	\$326,000,000	
Initial Construction ^{2/}	\$230,000,000	
Stage Construction	96,000,000	
Recreation	40,000,000	
Fish and Wildlife Enhancement	49,000,000	
ANNUAL COST		\$28,300,000
Flood Control and Water Quality	\$21,100,000	
Interest and Amortization	\$20,500,000	
Operation and Maintenance	600,000	
Recreation	\$4,000,000	
Interest and Amortization	\$3,000,000	
Operation and Maintenance	1,000,000	
Fish and Wildlife Enhancement	\$3,200,000	
Interest and Amortization	\$2,900,000	
Operation and Maintenance	300,000	
ANNUAL BENEFITS		\$53,800,000
Flood Control and Water Quality	\$32,600,000	
Recreation	13,100,000	
Fish and Wildlife Enhancement	8,100,000	
BENEFIT-COST RATIOS - Total Project		1.9:1
Flood Control and Water Quality	1.5:1	
Recreation	3.3:1	
Fish and Wildlife Enhancement	2.5:1	
NET BENEFITS (excess of benefits over costs)		\$25,500,000

^{1/} Rounded to nearest \$1,000,000

^{2/} Includes \$18,000,000 in fish and wildlife mitigation costs.

**TABLE 7
COMPARISON OF CANDIDATE PLAN FEATURES**

MEASURES AND FEATURES	:	CANDIDATE PLANS			
		SYSTEM FLOOD CONTROL PLAN	MODIFIED SYSTEM FLOOD CONTROL PLAN	INCREMENTAL FLOOD CONTROL PLAN	POLDER FLOOD CONTROL PLAN
<u>Measures</u>					
Flood Control and Water Quality					
Levee Rehabilitation	:	X	X	X	X
Recreation					
Land-based facilities	:	X	X	X	X
Water-based facilities	:	X	X	X	X
Day use facilities	:	X	X	X	X
Overnight use facilities	:	X	X	X	X
Fish and Wildlife Enhancement					
Acquire public interest in land	:	X	X	X	X
Select construction and management measures	:	X	X	X	X
Establish Wildlife Management Area	:	X	X	X	X
<u>Features</u>					
Flood Control and Water Quality					
Levee rehabilitation	:	Provides 300-year protection to 54 islands using stage construction. Sheet pile floodwalls on Bethel and Hotchkiss.	Provides 300-year protection to 36 islands using stage construction. Sheet pile floodwalls on Hotchkiss.	Provides 300-year protection to 15 islands using stage construction. Sheet pile floodwalls on Hotchkiss.	Provides 300-year protection to 15 islands using stage construction. Includes 2 polders on 5 islands. Sheet pile floodwalls on Hotchkiss.
Land Use Management	:	Consists of land use plans and zoning to prevent project-induced growth.	Same as System Flood Control Plan.	Same as System Flood Control Plan.	Same as System Flood Control Plan.
Fish and Wildlife Mitigation	:	Purchase of 3,165 acres of agricultural land.	Purchase of 1,935 acres of agricultural land.	Purchase of 650 acres of agricultural land.	Purchase of 650 acres of agricultural land and conversion of about 200 acres of waterway to wetland.
Flood Hazard Mitigation Program	:	Not applicable.	Pertains to levee systems within the study area that are not protected by the project. Recommends non-Federal interests upgrade and maintain levees to a prescribed Federal standard in order to become eligible for consideration to receive PL 84-99 assistance.	Same as Modified System Flood Control Plan.	Same as Modified System Flood Control Plan.
Recreation					
Increased Opportunities for shore-based and water-based Activities	:	14 recreation areas, 23 fishing access sites, 8 boater destination sites, and 145 miles of trails.	Same as System Flood Control Plan.	Same as System Flood Control Plan.	Same as System Flood Control Plan. Two major recreation waterways, Connection Slough and Empire Cut, would be closed by polders.
Fish and Wildlife Enhancement					
Acquire Public Interest in Land	:	Acquire about 2,500 acres of significant habitat.	Same as System Flood Control Plan.	Same as System Flood Control Plan.	Same as System Flood Control Plan.
Establish Wildlife Management Area	:	Establish a 3,500-acre wildlife management area.	Same as System Flood Control Plan.	Same as System Flood Control Plan.	Same as System Flood Control Plan.
Special Construction Practices	:	Construct setback levees on portions of Brack, Canal Ranch, McCormack-Williamson, and Nev Hope to avoid loss of riparian habitat.	Same as System Flood Control Plan.	Construct setback levees on portions of Brack Tract to avoid loss of riparian habitat.	Same as System Flood Control Plan.

Incremental and Polder, concentrate on the 30 percent of the study area that contains two-thirds of the flood damage potential. The Flood Hazard Mitigation Program is recommended for all candidate plans except the System Flood Control Plan in order to encourage the maintenance of the Delta as a system. The other aspect of difference is that the Polder Flood Control Plan is distinguished from the other plans because it closes off two important and popular waterways, and results in significant adverse impacts.

Four accounts (NED, EQ, RED, and OSE) were used to organize information on the effects of the candidate plans on the human environment. A summary evaluation of the candidate plans is provided in Table 8, which includes comparisons of the plan descriptions, plan evaluation using the system of accounts, and implementation responsibility.

The final comparison of candidate plans is presented in Table 9 which summarizes the significant effects to the environmental quality objective.

SELECTION OF FINAL PLAN

Rationale for Selection

Plan selection is based on the comparisons provided in Tables 7, 8, and 9 and consideration of how well each plan meets the four tests of feasibility: completeness, effectiveness, efficiency, and acceptability.

The tables show that the candidate plans, with identical recreation and fish and wildlife enhancement features, vary only in the extent of Federal involvement in the flood control feature of the plan. The greater the extent

**TABLE 8
SUMMARY OF SIGNIFICANT ECONOMIC-ENVIRONMENTAL-SOCIAL EFFECTS
SACRAMENTO-SAN JOAQUIN DELTA CANDIDATE PLANS**

CANDIDATE PLANS	NO ACTION	SYSTEM FLOOD CONTROL PLAN (EQ PLAN)	MODIFIED SYSTEM FLOOD CONTROL PLAN	INCREMENTAL FLOOD CONTROL PLAN (NED PLAN) (SELECTED PLAN)	POLDER FLOOD CONTROL PLAN
I Plan Description	No action undertaken by the Federal Government to provide a comprehensive levee rehabilitation program. Corps assistance under PL 84-99 would be limited to emergency measures which could avert direct threats to life and property.	This plan was based on the concept that the Delta islands are interdependent and act as one unit or system. It considers levee rehabilitation for all of the islands in the study area. The plan would (1) reduce flooding, (2) maintain water quality, (3) provide public recreation, and (4) preserve and enhance fish and wildlife habitat and scenic values.	Same as System Flood Control Plan except it would concentrate on all the individual islands which currently have less than a 50-year level of flood protection. Plan accomplishments same as System Flood Control Plan except smaller in scope.	This plan was based on the concept that the Delta islands are independent of one another. It considers levee rehabilitation for only those islands which are economically feasible on an individual basis. Plan accomplishments same as System Flood Control Plan except smaller in scope.	Similar to the Incremental Flood Control Plan except it provides levee rehabilitation on the combination of polders and individual islands that would maximize the net NED benefits. Plan accomplishments same as System Flood Control Plan except smaller in scope.
II Plan Evaluation					
A. Contributions to Planning Objectives					
1. Flood Control and Water Quality	No contribution to this objective.	Provides 300-year flood protection to 54 major islands and tracts in the study area.	Provides 300-year flood protection to 36 islands and tracts.	Provides 300-year flood protection to 15 islands and tracts.	Provides 300-year flood protection to 15 islands and tracts, 5 of which would be formed into two polders.
2. Recreation	No contribution to this objective.	Provides recreation features on 45 sites in the study area. Features consist of 14 recreation areas, 23 fishing access sites, 8 boater destination sites, and 145 miles of biking, equestrian, and canoe trails.	Same as System Flood Control Plan.	Same as System Flood Control Plan.	Same as System Flood Control Plan.
3. Fish and Wildlife and Esthetics	No contribution to this objective.	Involves acquisition of sites in 25 areas which would include about 1,000 acres of significant upland and riparian habitat, about 1,500 acres of channel tule islands with riparian and freshwater marshes, and about 3,500 acres of highly diversified habitat to be used as a Wildlife Management Area.	Same as System Flood Control Plan.	Same as System Flood Control Plan.	Same as System Flood Control Plan.
B. Relationship to National Accounts					
1. NED Objective					
a. Total First Cost	None	\$1,007,000,000	\$705,000,000	\$415,000,000	\$415,000,000
b. Annual Cost	None	\$68,800,000	\$47,700,000	\$28,100,000	\$28,300,000
c. Annual Benefits		\$73,100,000	\$65,100,000	\$53,800,000	\$53,800,000
d. Net Benefits		\$4,300,000	\$17,400,000	\$25,700,000	\$25,500,000
e. B/C Ratio		1.1:1	1.4:1	1.9:1	1.9:1
2. EQ Objective					
a. Soils	Peat island interiors subside an average of 3 inches per year which increases hydrostatic pressure leading to unstable levee conditions.	Island subsidence would continue. Levees on 54 islands in the study area would be rehabilitated. Specific borrow site impacts have not yet been determined, but mitigation would be provided.	Subsidence would continue. 36 of the more unstable island levees would be rehabilitated. Specific borrow site impacts have not been determined, but mitigation would be provided.	Although subsidence would continue, 15 of the most unstable island levees would be rehabilitated. Specific borrow site impacts have not been determined, but mitigation would be provided.	Same as Incremental Flood Control Plan.
b. Water Quality	Salinity intrusion would continue following levee failures during periods of low Delta outflow.	Probability of levee failure would be reduced thereby helping to maintain water quality by controlling salinity intrusion. Temporary localized increases in turbidity would occur during the construction period.	Same as System Flood Control Plan except beneficial impacts would be about 15 percent less.	Same as System Flood Control Plan except beneficial impacts would be about 40 percent less. Temporary increases in turbidity would affect a much smaller portion of the Delta.	Similar to Incremental Flood Control Plan. In addition, 4 miles of waterways would be eliminated. Mitigation would convert the closed channels to wetlands.
c. Esthetics	Visual quality high from a terrestrial and water level vantage point. Levee failure would continue to result in temporary visual loss of wildlife and vegetation.	Visual quality preserved and enhanced on landside of islands. On the water-side, about 600 miles of new levee section would result in loss of about 2,610 acres of riparian and wetland vegetation which would have an adverse impact. Impacts from borrow sites will be determined if a plan of improvement is authorized and detailed design studies are conducted.	Same as System Flood Control Plan except that about 485 miles of new levee sections would result in loss of 1,520 acres of riparian and wetland vegetation and adverse visual impact on waterside of islands.	Same as System Flood Control Plan except that about 165 miles of new levee sections would result in the loss of 550 acres of riparian and wetland habitat and an adverse impact on the waterside of islands.	Similar to System Flood Control Plan except that about 155 miles of new levee section would result in loss of 540 acres of riparian and wetland habitat plus 200 acres of channel would be lost due to closure of Empire Cut and Connection Slough.

TABLE 8
SUMMARY OF SIGNIFICANT ECONOMIC-ENVIRONMENTAL-SOCIAL EFFECTS
SACRAMENTO-SAN JOAQUIN DELTA CANDIDATE PLANS
(Continued)

CANDIDATE PLANS	NO ACTION	SYSTEM FLOOD CONTROL PLAN (EQ PLAN)	MODIFIED SYSTEM FLOOD CONTROL PLAN	INCREMENTAL FLOOD CONTROL PLAN (NEO PLAN) (SELECTED PLAN)	POLDER FLOOD CONTROL PLAN
d. Vegetation	Levee failure would continue to cause periodic loss of fish and wildlife habitat and food sources. Private flood control projects would continue to adversely impact riparian and wetland habitat.	Vegetation lost: 1,890 acres riparian, 720 acres wetland, and 2,823 acres upland. The significant loss here is to riparian vegetation (27 percent of total available in legal Delta). Wetland and upland represent 6 percent of total now existing. Impacts from borrow sites have not yet been determined. Periodic losses due to levee failures would essentially be eliminated in the study area. Impacts would be fully compensated (mitigated). In addition, enhancement would lead to preservation of 6,000 acres of valuable habitat that might otherwise be lost.	Same as System Flood Control Plan except vegetation lost would amount to 1,155 acres riparian, 365 acres wetland, and 2,113 acres upland. Periodic losses due to levee failures would be reduced by 85 percent. Compensation would be provided.	Same as System Flood Control Plan except vegetation lost would amount to 388 acres riparian, 160 acres wetland, and 1,257 acres upland. Periodic losses due to levee failures would be reduced by 60 percent. Compensation would be provided.	Similar to System Flood Control Plan except vegetation lost would amount to 388 acres riparian, 152 acres wetland, and 997 acres upland. Periodic losses due to levee failure would be reduced by 60 percent. Compensation would not be possible.
e. Agriculture	Levee failures would continue to reduce agricultural productivity as well as impact on birds and mammals utilizing agricultural habitat.	264,000 acres of agricultural land would be provided with a high degree of flood protection. About 2,800 acres would be removed from production for construction of levee improvements, and an additional 3,165 acres would be used for mitigation. This would result in a total loss of about 2 percent of agricultural land, but loss of productivity due to levee failure would essentially be eliminated.	158,000 acres of agricultural land having less than 50-year flood protection would be provided with a high degree of flood protection. About 1,800 acres would be removed from production for construction of levee improvements, and an additional 1,935 acres would be used for mitigation. This would result in a total loss of less than 2 percent of the agricultural land in the study area. Loss of productivity in the study area due to levee failure would be reduced by 85 percent.	80,000 acres of the most highly damage-prone agricultural land would be provided with a high degree of flood protection. About 1,300 acres would be removed from production for construction of levee improvements, and an additional 650 acres would be used for mitigation. This would result in a total loss of less than 1 percent of agricultural land, but loss of productivity in the study area due to levee failure would essentially be reduced by 50 percent.	Similar to Incremental Flood Control Plan except that about 1,000 acres would be removed from production. Closure of two waterways would also result in disruption of irrigation and drainage systems requiring relocations.
f. Fish	Levee failures during low Delta outflows result in salinity intrusion which impacts the fisheries. Releases must be made from upstream reservoirs to flush out the saline waters and to restore water quality.	Flood protection to 54 islands and tracts would result in control of salinity intrusion in the Delta caused by levee failures and avoid the need to release water from upstream storage to restore water quality. However, the loss of about 1,890 acres of riparian vegetation would have an adverse impact on aquatic life.	Same as System Flood Control Plan except that this plan would provide about 85 percent of the salinity control as in the previous plan. About 1,155 acres of lost riparian vegetation would impact on aquatic life.	Same as System Flood Control Plan except that this plan would provide about 45 percent of the salinity control. About 390 acres of lost riparian vegetation would impact on aquatic life.	Similar to Incremental Flood Control Plan with the added impact on the fishery resulting from loss of 4 miles of waterways due to polders.
g. Wildlife	Levee failures would cause periodic impacts to wildlife resources. Severity would be dependent on duration and season.	Impacts due to levee failures would become insignificant. Specific borrow site impacts have not yet been determined. Levee rehabilitation would result in the loss of riparian and wetland habitat. Compensation and enhancement of habitat would be provided.	Impacts due to levee failures would be reduced by 85 percent in the study area. Specific borrow site impacts have not yet been determined. Levee rehabilitation would result in the loss of riparian and wetland habitat. Compensation as well as enhancement of habitat would be provided.	Impacts due to levee failures would be reduced by about 60 percent in the study area. Levee rehabilitation would result in the loss of riparian and wetland habitat. Specific borrow site impacts have not yet been determined. Compensation and enhancement of habitat would be provided.	Similar to Incremental Flood Control Plan except that compensation may not be possible.
h. Endangered Species	Levee failures would continue to adversely impact on endangered species habitat.	The Biological Assessment found that the 8 Federally listed and threatened and endangered species are not likely to be adversely affected. Preliminary conclusions are that the species Mason's lilaeopsis, a plant listed as endangered by the State, may be impacted by this project. Borrow site impacts have yet to be determined.	Same as System Flood Control Plan.	Same as System Flood Control Plan.	Same as System Flood Control Plan.
i. Cultural Elements	Elements are not identified or protected.	A cultural resources survey will be conducted if a plan of improvement is authorized. Impacts will be determined at that time.	Same as System Flood Control Plan.	Same as System Flood Control Plan.	Same as System Flood Control Plan.
j. Recreation	Lack of public access and facilities would continue. Problems associated with recreationists (peat fires, vandalism, litter, and trespass on private lands) would increase with time.	The 45 recreation sites would include fish and wildlife and esthetic enhancement. There would be a temporary adverse impact on fish and wildlife resources during construction. The long-term effect is that project recreation plans would concentrate use at developed sites and alleviate impacts on sensitive environmental and agricultural areas. Problems associated with recreationists, such as vandalism, litter, etc., should diminish as a result of park regulations and controls.	Same as System Flood Control Plan.	Same as System Flood Control Plan.	Similar to System Flood Control Plan except for adverse impact from closure of Connection Slough and Empire Cut which are popular waterways.

TABLE 8
SUMMARY OF SIGNIFICANT ECONOMIC-ENVIRONMENTAL-SOCIAL EFFECTS
SACRAMENTO-SAN JOAQUIN DELTA CANDIDATE PLANS
 (Continued)

CANDIDATE PLANS	NO ACTION	SYSTEM FLOOD CONTROL PLAN (EQ PLAN)	MODIFIED SYSTEM FLOOD CONTROL PLAN	INCREMENTAL FLOOD CONTROL PLAN (MED PLAN) (SELECTED PLAN)	POLDER FLOOD CONTROL PLAN
3. RED Account					
a. Employment/Labor Force	No effect.	Would provide ARA Employment Benefits for construction occurring on the 39 islands in San Joaquin County.	Would provide ARA Employment Benefits for construction occurring on the 24 islands in San Joaquin County.	Would provide ARA Employment Benefits for construction occurring on the 9 islands in San Joaquin County.	Same as Incremental Flood Control Plan.
b. Local Government Finance	Levee maintenance costs will increase as levee instability becomes worse with time.	Loss of tax revenue due to removal of agricultural land is estimated at \$206,000. Flood plain property values would increase, thereby increasing local tax revenues. Emergency flood fighting costs would be reduced.	Loss of tax revenue due to removal of agricultural land is estimated at \$135,000. Flood plain property values would increase, thereby increasing local tax revenues. Emergency flood fighting costs would be reduced.	Loss of tax revenue due to removal of agricultural land is estimated at \$35,000. Flood plain property values would increase, thereby increasing local tax revenues. Emergency flood fighting costs would be reduced.	Loss of tax revenue due to removal of agricultural land is estimated at \$60,000. Flood plain property values would increase, thereby increasing local tax revenues. Emergency flood fighting costs would be reduced.
4. OSE Account					
a. Leisure Opportunities	Latent (unsatisfied) demand is projected to exceed 25 million recreation days by the year 2000.	The recreation plan would accommodate an increase in actual use of about 20 percent and would meet 10 percent of projected latent demand.	Same as System Flood Control Plan.	Same as System Flood Control Plan	Recreation benefits would be reduced by the closure of two significant recreation waterways. Mitigation of this cannot be provided.
b. Transportation	Levee failure would continue to damage roads and disrupt traffic patterns.	An estimated 165 miles of roads would be relocated. Unimproved roads account for about half the relocations, and replacement would result in improved road surfaces. The New Hope Island bridge and about 1-3/4 miles of railroad tracks on Orwood, Upper Orwood, and Yeale Tracts would also be relocated. Impacts from flooding in the study area would essentially be eliminated.	About 100 miles of roads would be relocated resulting in upgraded surfaces on 55 miles of roads. The New Hope Island bridge and about 1-1/3 miles of railroad tracks on Upper Orwood and Yeale Tracts would also be relocated. Impacts from flooding would be reduced by about 60 percent.	About 50 miles of roads would be relocated resulting in upgraded surfaces on about 35 miles of the roads. Impacts from flooding would be reduced by about 30 percent.	About 45 miles of roads would be relocated with upgraded surfaces on 30 miles of the roads. Impacts from flooding would be reduced by about 30 percent.
c. Displacements of Homes/Residents	Due to levee failure, temporary relocations would continue to occur and impact visitors as well as residents.	About 200 homes and 515 residents would be permanently relocated due to initial project construction. Temporary relocations due to flooding in the study area would essentially be eliminated.	About 150 homes and 390 residents would be permanently relocated. Temporary relocations in the study area would be reduced by about 85 percent.	An estimated 10 homes and 25 residents would be permanently relocated. Temporary relocations in the study area would be reduced by about 60 percent.	Several homes and about 10 residents would be permanently relocated. Temporary relocations in the study area would be reduced by about 60 percent.
d. Health & Safety	Impacts on health and safety due to levee failure would continue.	Would provide 300-year flood protection to about 7,500 residents plus vacationers, recreationists, and periodic agricultural workers.	Would provide 300-year flood protection to about 5,000 residents plus visitors.	Would provide 300-year flood protection to about 3,000 residents plus visitors.	Same as Incremental Flood Control Plan.
III Implementation Responsibility					
A. Corps of Engineers	None	Design, prepare detailed plans and specifications, and construct project. Provide 50 percent of cost for recreation facilities and 75 percent of cost for fish and wildlife enhancement. Provide relocation costs for railroad bridges and tracks.	Same as System Flood Control Plan.	Same as System Flood Control Plan.	Same as System Flood Control Plan.
B. Non-Federal Interests	None	Provide all costs for lands, easements, rights-of-way, and relocations except for railroad bridges and tracks. Provide future land use plans accompanied by consistent zoning to insure no project-induced urban development on agricultural islands in compliance with EO 11988. Insure that development on urban islands is consistent with city and county General Plans and that such development is limited to those areas incapable of sustained agricultural production. Provide a cash contribution or repay through annual installments 50 percent of first cost (including lands) of the recreation features and provide 25 percent of cost for fish and wildlife enhancement. Operate and maintain all completed facilities for the project life in accordance with regulations prescribed by the Secretary of the Army and Section 221 of the 1970 Flood Control Act.	Same as System Flood Control Plan.	Same as System Flood Control Plan.	Same as System Flood Control Plan.

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TABLE 9

SIGNIFICANT EQ EFFECTS^{1/}
(With Mitigation and Enhancement)

<u>Significant Resources</u>	<u>Effects of No Action Alternative Plan 2/</u>			<u>Effects of Candidate Plans 3/ 4/</u>		
	<u>Ecological</u>	<u>Cultural</u>	<u>Esthetic</u>	<u>Ecological</u>	<u>Cultural</u>	<u>Esthetic</u>
Soils	Adverse	Adverse	Adverse	<u>Beneficial</u>	<u>Beneficial</u>	<u>Beneficial</u>
Water Quality	Adverse	None	None	<u>Beneficial</u>	None	None
Esthetics	None	None	None	None	None	<u>Adverse 5/</u>
Vegetation	Adverse	None	Adverse	<u>Beneficial</u>	None	<u>Beneficial</u>
Agriculture	Adverse	None	None	<u>Beneficial</u>	None	None
Fish	Adverse	None	Adverse	Adverse	None	Adverse
Wildlife	Adverse	None	None	<u>Beneficial</u>	None	<u>Beneficial</u>
Threatened & Endangered Species	Adverse	None	Adverse	None	None	None
Cultural	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Recreation	Adverse	Adverse	Adverse	<u>Beneficial</u>	None	<u>Beneficial</u>

1/ Underlined effects are more significant than others.

2/ Effects displayed are based on short-term future. Long-term future is likely to change significantly - - see EIS.

3/ All structural alternative plans have similar type of effects. Generally, the effects vary with the extent of levee construction. Any structural plan would be accompanied by the recreation and fish and wildlife enhancement features.

4/ The Polder Plan would result in significant adverse effects on water flow patterns, esthetics, fish, and recreation.

5/ The adverse esthetic effects from the improved levee system may be unavoidable due to levee design criteria; however, recreation and fish and wildlife mitigation and enhancement features provide beneficial esthetic effects.

of flood control provided by a plan, the closer the Delta comes to being preserved as a system. The benefits to the system, both tangible and intangible, are somewhat offset by the larger impacts resulting from project construction over a larger area.

From the standpoint of the four tests of feasibility, the System Flood Control Plan is the most comprehensive and complete plan since it provides a high degree of flood protection to the entire study area. However, the addition of the Flood Hazard Mitigation Program provides the potential for the other candidate plans to become complete as well.

The Incremental Flood Control Plan and the Polder Flood Control Plan are the most effective since they would alleviate a major portion of the flood problems while realizing the identified opportunities, and they are efficient since they accomplish the foregoing in the most cost effective manner. The Incremental Flood Control Plan is more cost effective, however, since the combined adverse NED and EQ effects are greater for the polder plan, while the combined beneficial NED and EQ effects are about the same.

These additional adverse impacts of the Polder Plan also make it less acceptable than the other candidate plans. The other plans are considered to be more workable with respect to potential acceptance by the public and more compatible with existing laws, regulations, and public policies. Based on the foregoing comparisons the Incremental Flood Control Plan was adopted as the selected plan since it provides the best overall response to the study objectives and is also the National Economic Development Plan.

Sensitivity Analysis

The sensitivity of the designation of the Incremental Flood Control Plan as the selected plan was measured in relation to the two fundamental assumptions that have been made for the without-project condition. These assumptions are that the Peripheral Canal would be built and that levee systems would continue to be restored when they fail.

The without-project assumptions were made on the basis of the best information available at the time the plans were formulated. However, one or both of these assumptions could change, especially with the recent rejection of a California proposition to provide State funding for the Peripheral Canal. Also, the anticipated future increases in levee failures and restoration costs may result in some islands remaining flooded.

The recreation and fish and wildlife enhancement features of the candidate plans are not significantly affected by the without-project assumption. Therefore, only the impacts of the without-project assumptions on the flood control feature are addressed.

The impact of changes in the assumptions on the equivalent annual benefits and costs of the candidate plans is summarized in Table 10.

Based on economic and environmental information, the following conclusions can be drawn from the sensitivity analysis.

TABLE 10
 SENSITIVITY ANALYSIS OF CANDIDATE PLANS
 (in \$1,000)

CANDIDATE PLANS	WITHOUT PROJECT CONDITION			
	With Peripheral Canal	Without Peripheral Canal	With Peripheral Canal	Without Peripheral Canal
	With Island Restoration	With Island Restoration	Without Island Restoration	Without Island Restoration
NO ACTION				
Annual Damages				
SYSTEM PLAN				
Number of Islands	54	54	54	54
Annual Costs ^{1/}	60,000	62,000	60,000	62,000
Annual Benefits	51,900	62,300	70,200	86,900
Net Benefits	-8,100	300	10,200	24,900
MODIFIED SYSTEM PLAN ^{2/}				
Number of Islands	36	41	36	41
Annual Costs ^{1/}	39,300	48,800	39,300	48,800
Annual Benefits	43,900	57,100	59,100	81,100
Net Benefits	4,600	8,300	19,800	32,300
INCREMENTAL PLAN (Selected Plan)				
Number of Islands	15	19	27	27
Annual Costs ^{1/}	20,700	28,600	29,300	31,500
Annual Benefits	32,600	46,300	53,600	68,700
Net Benefits	11,900	17,700	24,300	37,200
POLDER PLAN				
Number of Islands	15	19	27	27
Annual Costs ^{1/}	19,700	26,300	28,200	29,300
Annual Benefits	32,600	46,300	53,600	68,700
Net Benefits	12,900	20,000	25,400	39,400

^{1/} Does not include mitigation costs.

^{2/} Modified system of islands was not reformulated during sensitivity analysis with respect to the reclamation vs. no reclamation assumption.

1. The without-project assumptions -- Peripheral Canal and island restoration -- are conservative. If they prove to be incorrect, greater economic and environmental benefits would accrue to the project.

2. The System Flood Control Plan would be the designated EQ Plan under any and all assumptions.

3. In Table 10, the Polder Flood Control Plan appears to be the NED Plan since it displays slightly higher net benefits than the Incremental Flood Control Plan. However, when mitigation costs are taken into account, the Incremental Flood Control Plan becomes the NED Plan with the Peripheral Canal and island restoration assumptions.

4. In view of the similarity in net benefits for the Incremental and Polder Flood Control Plans and the additional environmental impacts of the polder plan from the closing of waterways, the Incremental Flood Control Plan would be designated as the selected plan regardless of which without-project assumptions withstand the test of time.

Refer to the Plan Formulation Appendix for details concerning the sensitivity analysis.

DESCRIPTION OF SELECTED PLAN

This section provides a brief summary description of the selected plan. A more detailed description is provided in the Plan Formulation Appendix.

It should be recognized that the authorization of the Incremental Flood Control Plan would, in fact, be a declaration that the Federal interest in participating in providing flood control improvements in the Delta would be limited to those locations where the improvements are economically justified. Based on current surveys, assessments, and the adopted without-project condition, levee improvements would be confined to 15 islands and tracts. The sensitivity analysis indicated that the without-project assumptions affect the number of economically justified islands and tracts. The ultimate number of islands and tracts which would receive flood control improvements would be dependent on the results of post-authorization studies including reevaluation of the assumed without project conditions.

PLAN COMPONENTS

The Incremental Flood Control Plan includes:

- o Levee rehabilitation
- o Land use management
- o Flood Hazard Mitigation Program
- o Recreation features
- o Fish and wildlife mitigation and enhancement

The selected plan features are shown in Figure 12. The components of the plan are described in detail in the Plan Formulation Appendix.

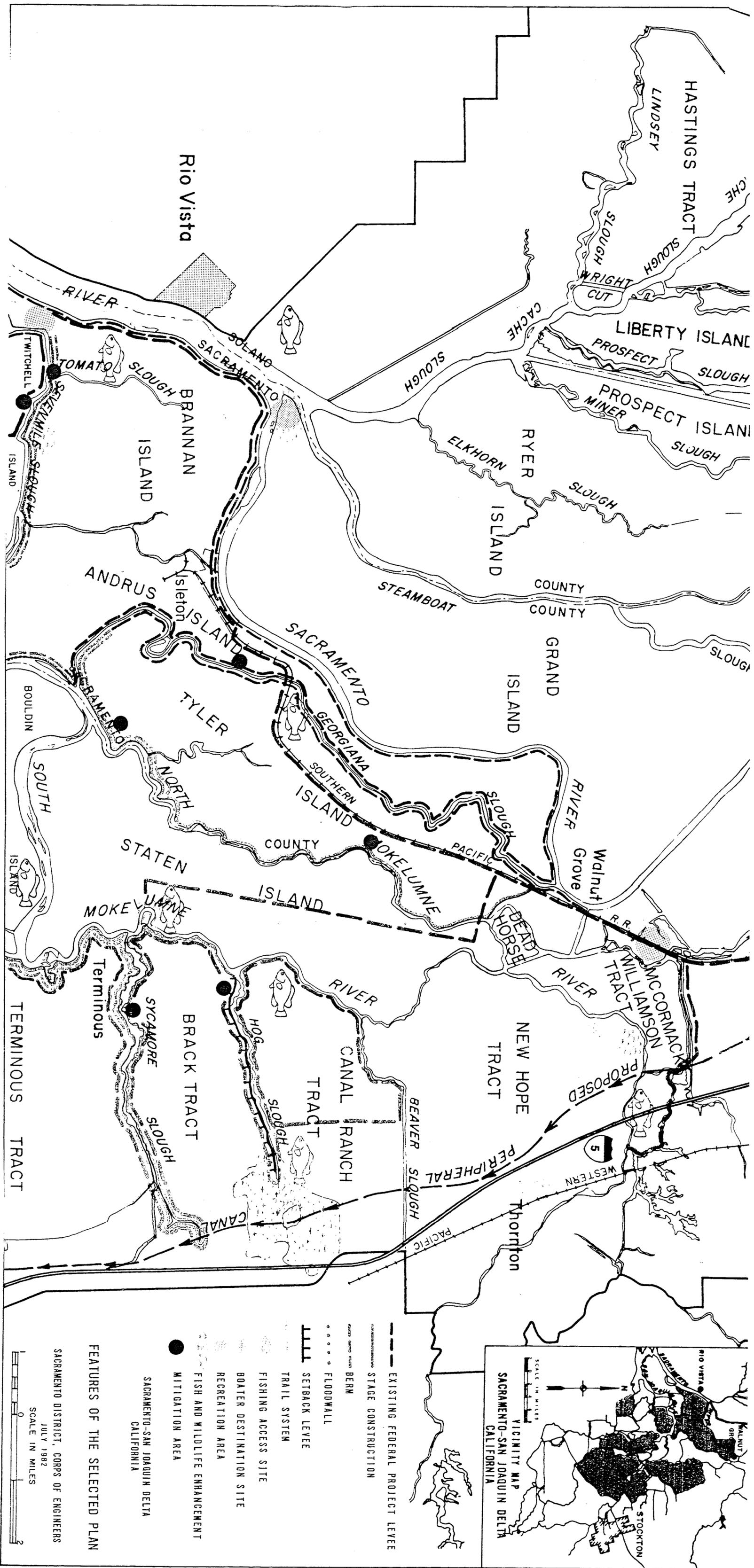


FIGURE 12 SHEET 1 OF 3

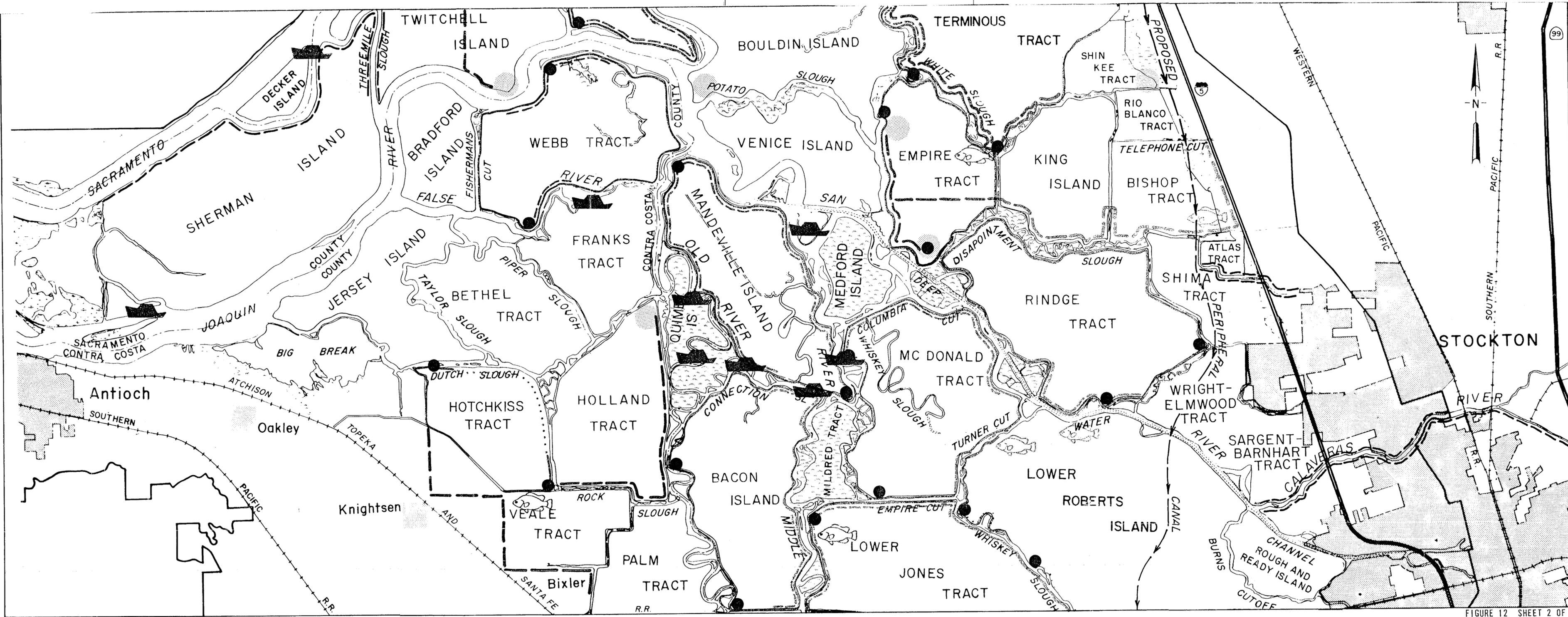


FIGURE 12 SHEET 2 OF 3

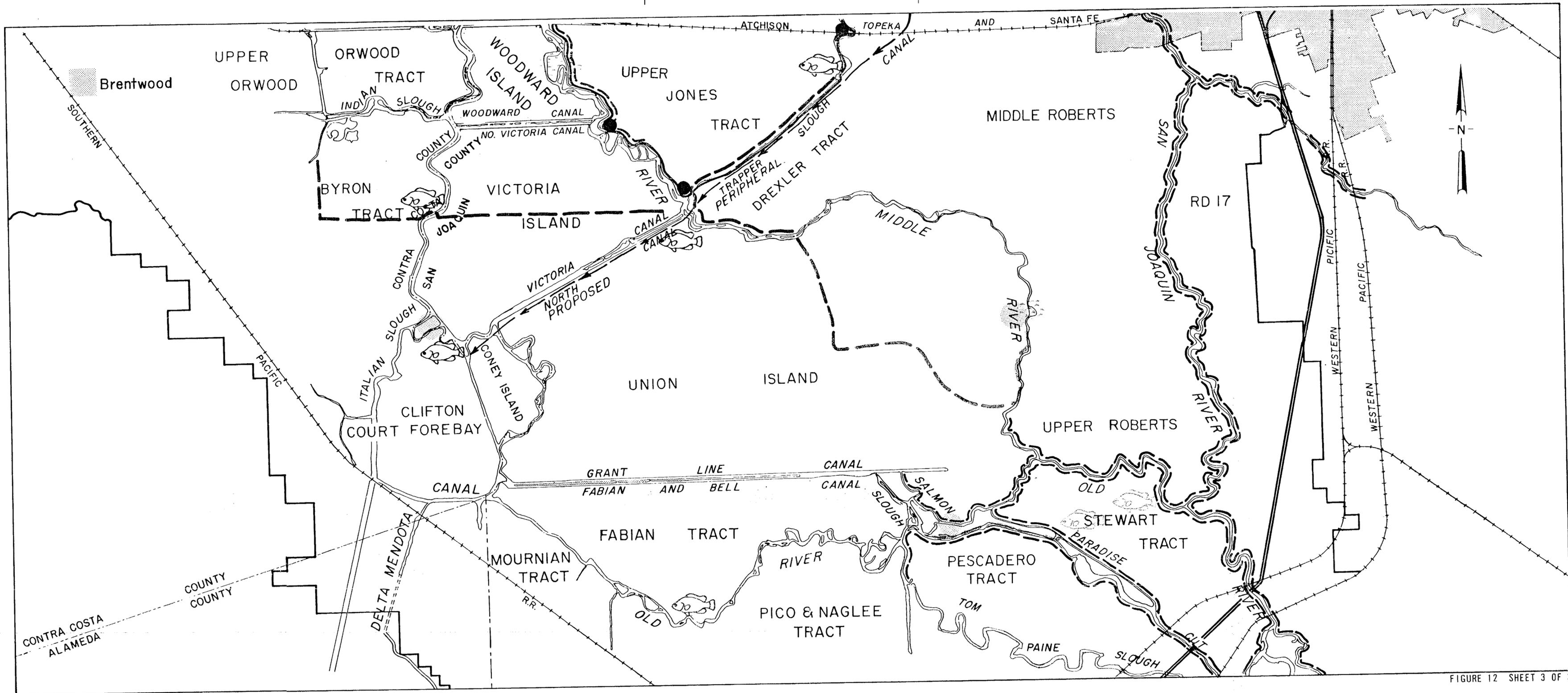


FIGURE 12 SHEET 3 OF 3

DESIGN AND CONSTRUCTION CONSIDERATIONS

About 165 miles of levee rehabilitation would primarily be accomplished by using the stage construction method. This method involves construction of a new design levee section on the existing levee alignment. The method requires periodic raising of the levee crown to accommodate expected levee settlement, hence the term stage construction. For stability purposes and the control of seepage, some levees would require construction of landside berms. Sheet pile floodwalls (the placement of sheet piles at the waterside levee crown) would be the method employed on portions of Hotchkiss Tract to avoid costly relocation of existing development. The levee setback alternative, which provides for the construction of levees along a new levee alignment landward of the existing levee, would be used on Brack Tract along Hog Slough as a fish and wildlife enhancement measure to protect existing riparian habitat. The source of embankment material would depend upon (1) availability at the time of construction, (2) economics, and (3) environmental impacts. Potential sources of material are shown in Table 2 of the Plan Formulation Appendix.

Depending on the availability of embankment material, several strategies could be pursued for developing and operating the Wildlife Management Area. At this time, it is assumed that the Wildlife Area would be operated on a lease-back basis to agricultural interests to allow farming to continue. Only certain crops would be allowed and portions of the crops would not be harvested but would be left as a food source for wildlife. This development strategy would require minimum levee improvements to protect the Wildlife Area. Levees would be improved to conform to the standards of the Flood Hazard Mitigation Program described in the Plan Formulation Appendix.

Alternatively, portions of the Wildlife Management Area could be used as stockpile areas for embankment material required for the project flood control features. Post-authorization studies would determine the viability of stockpiling embankment material in a manner that would bolster the existing levees. This may preclude the need to otherwise improve the levees. Future studies would also consider the feasibility of operating the Wildlife Area as a wetland area. This would be accomplished by filling the islands to near mean sea level. The filling could be accomplished with dredged material, surplus material, or disposal materials made available by non-Federal interests.

OPERATION AND MAINTENANCE CONSIDERATIONS

Operation and maintenance would be required for the project levees, recreation features, and fish and wildlife mitigation and enhancement features. Regulation and enforcement of the land use management plan would be an ongoing effort. Operation and maintenance of levee systems involved in the Flood Hazard Mitigation Program would not be an element of the selected plan.

PLAN ACCOMPLISHMENTS

The plan would greatly reduce the frequency of levee failures in the Delta. The plan would also reduce salinity intrusion, increase recreation opportunities, and provide fish and wildlife enhancement.

A summary of the benefits and costs for the Incremental Flood Control Plan is shown below. These calculations are based on a 1 October 1981 price level, a 50-year period of analysis, and a 7-5/8 percent discount rate.

SELECTED PLAN
BENEFITS AND COST

First Cost		\$415,000,000
Annual Cost		28,100,000
Interest and Amortization	\$26,200,000	
Operation and Maintenance	1,900,000	
Annual Benefits		53,800,000
Benefit-Cost Ratio		1.9:1

Additional NED employment benefits are derived from the Area Redevelopment Act which allows the Federal Government to cooperate with the States to help areas of substantial and persistent unemployment. San Joaquin County has been designated as eligible for assistance under the administration of the U.S. Department of Commerce. NED employment benefits to the project include an amount equivalent to that part of the construction costs which represents wages to workers who, in the absence of the project, would be unemployed. These employment benefits are estimated at \$650,000 (equivalent average annual).

EFFECTS OF THE PLAN ON THE ENVIRONMENT

The most significant environmental effects include the beneficial effects of the plan on agriculture, water quality, recreation, and fish and wildlife. A significant adverse effect may occur to esthetics on the levee systems since stone protection is the most economical and durable type of material for erosion control. This trade-off to obtain the other significant benefits appears highly desirable. Furthermore, more environmentally and esthetically acceptable erosion control methods are being evaluated and, although stone protection was used at this time to provide a cost estimate,

design studies do not assume that stone protection is the only viable erosion control method to be used in the Delta. In addition, recreation and fish and wildlife mitigation and enhancement features would provide beneficial esthetic effects in areas near the levees.

The most significant social effects result from beneficial increases in leisure opportunities and health and safety.

The effects of the selected plan on resources receiving national recognition and the compliance of the selected plan with environmental statutes are summarized in Tables 11 and 12.

EXECUTIVE ORDER 11990

The objective of Executive Order 11990, Protection of Wetlands, is to avoid to the extent possible the long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. Federal agencies are required to provide leadership and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands.

The selected plan is in compliance with Executive Order 11990. The unavoidable temporary loss of 95 acres of emergent wetland vegetation and permanent loss of 65 acres will be mitigated utilizing advice from the fish and wildlife agencies. Borrow areas will be selected in a manner that will not impact on wetlands, and the fish and wildlife enhancement features in the

TABLE 11
EFFECTS OF THE SELECTED PLAN ON RESOURCES OF PRINCIPAL NATIONAL RECOGNITION
(Without Mitigation)

Types of Resources	Principal Sources of National Recognition	Measurement of Effects
Air quality.	Clean Air Act, as amended (42 U.S.C. 1857h-7 et seq).	No effect.
Areas of particular concern within the coastal zone.	Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1451 et seq.).	Not applicable.
Endangered and threatened species critical habitat.	Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)	No adverse impact on listed species or critical habitat.
Fish and wildlife habitat.	Fish and Wildlife Coordination Act (16 U.S.C. Sec 661 et seq.).	+1,514 acres of upland; -388 acres riparian; -160 acres emergent. Net losses of habitat values would be compensated.
Flood Plains.	Executive Order 11988, Flood Plain Management.	No adverse net effect; prevention of potential secondary effects included in selected plan.
Historic and cultural properties.	National Historic Preservation Act of 1966, as amended (16 U.S.C. Sec. 470 et seq.).	Based on literature search: no effect. However, comprehensive field survey will be made during post-authorization planning.
Prime and unique farmland.	CEQ Memorandum of August 1, 1980; Analysis of of Impacts on Prime or Unique Agricultural Lands in Implementing the National Environmental Policy Act.	-1,126 acres of agricultural lands needed for levees (Soil Conservation Service surveys still uncompleted).
Water quality.	Clean Water Act of 1977 (33 U.S.C. 1251 et seq.).	Reduces temporary salinity intrusion and expensive combative measures.
Wetlands.	Executive Order 11990, Protection of Wetlands Clean Water Act of 1977 (42 U.S.C. 1857h-7 et seq.).	-160 acres of emergent vegetation.
Wild and scenic rivers.	Wild and Scenic Rivers Act, as amended (16 U.S.C. 1271 et seq.).	No effect.

TABLE 12

COMPLIANCE OF THE SELECTED PLAN WITH
WRC - DESIGNATED ENVIRONMENTAL STATUTES^{1/} ^{2/}

FEDERAL STATUS

Archeological and Historic Preservation Act, as amended, 16 U.S.C. 469 et seq	Partial
Clean Air Act, as amended, 42 U.S.C. 7401, et seq	Partial
Clean Water Act as amended, (Federal Water Pollution Control Act) 33 U.S.C. 1251 et seq	Partial
Coastal Zone Management Act, as amended, 16 U.S.C. 1451, et seq	N/A
Endangered Species Act, as amended, 16 U.S.C. 1531, et seq	Full
Estuary Protection Act, 16 U.S.C. 1221, et seq	Full
Federal Water Project Recreation Act, as amended, 16 U.S.C. 460-1(12), et seq	Full
Fish and Wildlife Coordination Act, as amended, U.S.C. 661, et seq	Partial
Land & Water Conservation Fund Act, as amended, 16 U.S.C. 4601-11, et seq	Full
Marine Protection Research & Sanctuaries Act, 22 U.S.C. 1401, et seq	N/A
National Historic Preservation Act, as amended, 16 U.S.C. 470a, et seq	Partial
National Environmental Policy Act (NEPA) as amended, 42 U.S. C. 4321, et seq	Full
Rivers & Harbors Act, 33 U.S.C. et seq	Full
Watershed Protection & Flood Preservation Act, 16 U.S.C. 1001, et seq	N/A
Wild & Scenic Rivers Act, as amended, 16 U.S.C. 1271, et seq	Full

EXECUTIVE ORDERS, MEMORANDA

Flood Plain Management (E.O. 11988)	Full
Protection of Wetlands (E.O. 11990)	Full
Environmental Effects Abroad of Major Federal Actions (E.O. 12114)	N/A
Analysis of Impacts on Prime and Unique Farmlands (CEQ Memorandum, 30 Aug 76)	Partial

LOCAL POLICIES

Sacramento County General Plan	Full
San Joaquin County General Plan	Full
Contra Costa County General Plan	Full

^{1/} It is expected that, as planning proceeds, the selected plan will be in full compliance with all requirements.

^{2/} The compliance categories are assigned based on the following definitions:

- (Full compliance.) All requirements of the statute, E.O., or other policy and related regulations have been met.
- (Partial compliance). Some requirements on the statute, E.O., or other policy and related regulations remain to be met.
- (Noncompliance). None of the requirements of the statute, E.O., or policy and related regulations have been met.
- N/A - Statute, E.O., or policy not applicable.

selected plan will include preservation of wetland areas that would otherwise be lost.

EXECUTIVE ORDER 11988

The objective of Executive Order 11988, Flood Plain Management, is to restore and preserve beneficial values served by flood plains and avoid to the extent possible the adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of flood plain development wherever there is a practicable alternative. Federal agencies are required to provide leadership and take action toward the fulfillment of this objective.

The flood protection and other features of the selected plan would preserve and enhance significant values served by the flood plains in the project area, and the land use management feature would cause the plan to be in full compliance with Executive Order 11988. This latter feature would require non-Federal interests to enact and enforce land use plans to prevent project-induced urban development on the agricultural islands within the project area. Land use regulations would also be required to limit development on urban islands to lands incapable of sustaining economic agricultural production. Development on urban islands would also have to be consistent with local General Plans.

PLAN IMPLEMENTATION

This section summarizes the cost-sharing requirements and procedures necessary to implement the flood control, recreation, and fish and wildlife enhancement and mitigation features of the project.

INSTITUTIONAL REQUIREMENTS

For the flood control purpose, levee rehabilitation is considered to be a local protection feature, which, under Section 3 of the 1936 Flood Control Act (Public Law 74-738), requires a non-Federal entity to provide all lands, easements, rights-of-way, and relocations for construction, as well as maintenance of the project. Administration, maintenance, and operation of the constructed work would also be a non-Federal requirement.

For the recreation purpose, Public Law 89-72, the Federal Water Project Recreation Act of 1965, provides the basis for established the policy that non-Federal public agencies should participate in and administer Federal project recreation and fish and wildlife enhancement areas. Implementing regulations require 50 percent of costs of recreational lands and facility development and all operation and maintenance costs be provided by non-Federal public agencies.

For the fish and wildlife features, the regulation requires that enhancement costs be shared 75 percent Federal and 25 percent non-Federal, unless the features support another Federal program. If FWS were to administer all the enhancement acreages as part of the National Migratory Bird Management Program, then all first costs and operation and maintenance

costs for the enhancement features would be eligible to become a Federal responsibility. Coordination with FWS will continue on this issue. For the purposes of this report, cost sharing of 75 percent Federal and 25 percent non-Federal is specified. Costs for fish and wildlife mitigation are cost-shared in the same proportion as the remainder of the project, excluding enhancement. The non-Federal sponsor(s) of the project would assume or arrange for administration, operation, and maintenance responsibilities.

PROJECT RESPONSIBILITIES

Federal Responsibilities

1. Prepare plans and specifications.
2. Contract for and supervise initial construction of the project.
3. Contract for and supervise future levee stage construction.
4. Pay the construction cost for initial levee rehabilitation and future stage construction.
5. Pay no more than one-half of construction costs for recreation.
6. Pay 75 percent of fish and wildlife enhancement costs.
7. Determine that if nonproject levees within the study area comply with a prescribed Federal construction and maintenance standard, they will be

eligible for consideration for rehabilitation after flood damages are incurred, pursuant to PL 84-99.

8. Conduct periodic inspections with the non-Federal sponsor to determine adherence to the post-construction maintenance requirements.

Non-Federal Responsibilities

Flood Control

1. Provide all lands, easements, rights-of-way, and relocations, except railroad bridges and tracks, for levee rehabilitation and maintenance.

2. Prior to levee construction, acquire all lands, easements, and rights-of-way for developing and maintaining wildlife mitigation areas.

3. Implement land use management, zoning, and other means necessary to insure that no future urban development on agricultural islands in the project area will occur as a result of the project works.

4. Insure that development on urban islands is consistent with city and county General Plans and the California Environmental Quality Act and that such development is limited to those areas incapable of sustained economic agricultural production.

5. Encourage the improvement and maintenance of nonproject levees within the study area to a Federal standard for flood control structures so

that if a levee fails, the structures may become eligible for consideration for rehabilitation in accordance with PL 84-99.

6. Prevent encroachment upon the project channels of any works detrimental to the flood control purpose of the project.

7. Hold and save the United States free from all damages arising from the construction and operation of the completed works, but not including damages due to the fault or negligence of the United States or its contractors.

8. Maintain and operate project facilities after completion of the project in accordance with regulations prescribed by the Secretary of the Army and Section 221 of the 1970 Flood Control Act.

9. Comply with the applicable requirements of "The Uniform Relocation Assistance and Real Property Acquisition Policies Act" of 1970 (PL 91-646).

Recreation

1. Provide all lands, easements, rights-of-way, and relocations specifically required for construction and maintenance of recreation facilities of which the Federal government will reimburse or credit 50 percent of the costs.

2. Pay, or contribute in kind, a cash share of the cost of recreation facilities, to be paid concurrently and proportionately with the

Federal contractual obligation for construction of recreation facilities which, when added to the cost of recreation lands, would amount to at least 50 percent of the total first cost of the recreation lands and facilities.

3. Administer, maintain, operate, and replace the recreational lands and facilities provided by the project in accordance with regulations prescribed by the Secretary of the Army.

4. Provide sufficient rights in lands at recreation sites to permit public use.

Fish and Wildlife Enhancement

1. Acquire all lands for enhancement of which the Federal Government will reimburse or credit 75 percent of the costs.

2. Pay 25 percent of the costs for acquisition and development of lands and construction of facilities for the Wildlife Management Area.

3. Maintain, operate, and replace lands and facilities provided by the project in accordance with regulations prescribed by the Secretary of the Army.

COST APPORTIONMENT

Cost apportionment for the Incremental Flood Control Plan is shown on Table 13. The total first cost for construction is \$415,000,000, with \$350,400,000 as the Federal share and \$64,600,000 as the non-Federal share.

TABLE 13
 COST APPORTIONMENT
 INCREMENTAL FLOOD CONTROL PLAN
 (1 October 1981 prices; 7-5/8 Percent Discount rate)
 \$1,000

	: TOTAL : PROJECT : COST	: FEDERAL				: TOTAL : FEDERAL	: NON-FEDERAL			
		: FLOOD : CONTROL	: RECREATION	: F&W : ENHANCEMENT			: FLOOD : CONTROL	: RECREATION	: F&W : ENHANCEMENT	: TOTAL : NON-FEDERAL
FIRST COST										
Initial Construction	\$314,000	\$193,000 ^{1/}	\$20,300	\$36,500	\$249,800	\$31,700 ^{2/}	\$20,300 ^{3/}	\$12,200	\$64,200	
Stage Construction	<u>101,000</u>	<u>100,600</u>	<u>-</u>	<u>-</u>	<u>100,600</u>	<u>400</u>	<u>-</u>	<u>-</u>	<u>400</u>	
TOTAL PROJECT FIRST COST	\$415,000	\$293,600	\$20,300	\$36,500	\$350,400	\$32,100	\$20,300	\$12,200	\$64,600	
ANNUAL COST										
Interest and Amortization ^{4/}	\$26,200	\$17,800	\$1,500	\$2,200	\$21,500	\$2,500	\$1,500	\$700	\$4,700	
Operation and Maintenance	<u>1,900</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>600</u>	<u>1,000</u>	<u>300</u>	<u>1,900</u>	
TOTAL PROJECT ANNUAL COST	\$28,100	\$17,800	\$1,500	\$2,200	\$21,500	\$3,100	\$2,500	\$1,000	\$6,600	

^{1/} Includes \$2,000 for lands, easements, rights-of-way, and relocations for fish and wildlife mitigation.

^{2/} Includes lands, easements, rights-of-way, and relocations only; \$31,400 for levee construction and \$300 for fish and wildlife mitigation.

^{3/} Includes \$6,777 for lands, easements, rights-of-way, and relocations for recreation.

^{4/} Based on present worth of stage construction.

PROCEDURES FOR IMPLEMENTATION

Future actions necessary for authorization and construction of the proposed plan of improvement are summarized as follows:

- o This report is to be reviewed within the Corps of Engineers, including the South Pacific Division, the Board of Engineers for Rivers and Harbors, and the Office of the Chief of Engineers.
- o The Chief of Engineers will seek formal review and comment by the Governor of California and interested Federal agencies.
- o Letters of intent from non-Federal sponsors would accompany the final feasibility report and would indicate (1) acceptance and support of the selected plan and (2) willingness to financially participate to some level (which may be unspecified) in implementation of the project, but at least consistent with traditional requirements.
- o Following the State and interagency review, the final report of the Chief of Engineers will be forwarded by the Secretary of the Army to the Congress, subsequent to obtaining the views of the Office of Management and Budget regarding the relationship of the project to the program of the President.
- o Congressional review of this feasibility report and possible authorization of the project would follow.

- o Pending project authorization for construction, the Chief of Engineers could include funds, when appropriate, in his budget requests for continuing planning and engineering of the project. The objective is to ready each project for a construction start in the shortest possible time by maintaining the momentum established with the feasibility study.
- o Following receipt of funds, continuing planning and engineering studies would be initiated, project formulation reviewed, and the plan reaffirmed to meet then current conditions.
- o If authorized by Congress for construction, and subsequent to appropriation of construction funds, formal assurances of local cooperation would be requested from non-Federal interests.
- o Surveys; materials investigations; and preparation of design criteria, plans, specifications, and an engineering estimate of costs would then be accomplished by the District Engineer. Bids for construction of the project would be invited and a contract awarded.

Following completion of construction, non-Federal interests would be responsible for operation and maintenance of flood control, recreation, and fish and wildlife enhancement and mitigation features.

It is not possible to project a schedule for the above steps because of the variables in the reviewing, advance planning, and funding processes. Once the project is authorized and initially funded, it could be possible to

complete design and initial levee construction within a 10-year period, if adequate funds are available.

VIEWS OF NON-FEDERAL INTERESTS

(Views of non-Federal interests will be obtained during review of this draft report and will be included in this section of the final report.)

DISTRICT ENGINEER'S DISCUSSION

(Tentative. To be finalized after further coordination with the public and concerned agencies and organizations.)

In the interest of the public, I have reviewed and evaluated the information contained in the environmental statement; other documents concerning the Sacramento-San Joaquin Delta; and views of other agencies, organizations, and individuals on economic, environmental, and other impacts of the plans for improvement of the Sacramento-San Joaquin Delta. I have reviewed the draft Detailed Report of FWS. Additional coordination will be conducted with FWS to develop recommendations acceptable to both agencies. In addition, I have personally inspected the project area and have participated in meetings with local Governmental officials, representatives of other agencies and organizations, and landowners and other concerned members of the public.

The possible consequences of rehabilitating the levees, providing recreation facilities, and purchasing fish and wildlife habitat were studied and evaluated for environmental impacts; social and economic effects; engineering feasibility; compliance with executive orders and legal statutes; appropriateness for meeting the stated objectives of the investigation; and implementability.

General legislation authorizing implementation of water resource projects, the most recent being the Water Resources Development Act of 1976, generally contained local cooperation requirements established by enactment of various laws. The Administration is currently reviewing project cost

sharing and financing across the entire spectrum of water resource development functions and has submitted proposed legislation to Congress for navigation projects. The basic principle governing the development of specific cost-sharing policies is that, whenever possible, the cost of services produced by water projects should be paid by their direct beneficiaries.

While specific cost-sharing policies applicable to the Sacramento-San Joaquin Delta project have not yet been established, non-Federal interests can expect that, under the Administration's financing and cost-sharing principles, the level of their financial participation may be greater than in the past.

RECOMMENDATION

(Tentative. To be finalized after further coordination with the public and concerned agencies and organizations.)

I recommend that the Incremental Flood Control Plan selected herein for flood control, recreation, and fish and wildlife enhancement be authorized for implementation as a Federal project. This project would include rehabilitation of levees, bank protection, construction of recreation facilities, and the purchase of lands and developments for fish and wildlife enhancement and mitigation with such modifications as in the discretion of the Chief of Engineers may be advisable. The total first cost of the project based on October 1981 price levels is presently estimated at \$415,000,000. Prior to implementation, non-Federal interests will be required to:

- o Provide all lands, easements, rights-of-way necessary for construction and maintenance of the flood damage reduction measures, including all relocations and alterations of buildings, roads, highways, bridges, sewers and utilities.
- o Acquire all lands for wildlife mitigation.
- o Adopt ordinances or land use regulations which are acceptable to the Secretary of the Army to prevent urban development on agricultural islands.
- o Adopt ordinances or land use regulations which are acceptable to the Secretary of the Army to insure that development on urban islands conforms to city and county General Plans and the California Environmental Quality Act and is limited to lands incapable of sustaining economic agricultural production.
- o Encourage the improvement and maintenance of nonproject levees within the study area to a Federal standard for flood control structures which would qualify for consideration for emergency repairs under Public Law 84-99.
- o Prevent encroachments on the project channels which would impair the flood control purpose of the project.
- o Hold and save the United States free from all damages arising from construction and operation of the completed works, except for

damages due to the fault or negligence of the United States or its contractors.

- o Maintain and operate project facilities after completion of each stage of the project in accordance with regulations prescribed by the Secretary of the Army and Section 221 of the 1970 Flood Control Act.
- o Comply with the applicable requirements of the "Uniform Relocation Assistance and Real Property Acquisition Policies Act" of 1970 (Public Law 91-646).
- o Provide all lands, easements, rights-of-way, and relocations specifically required for construction and maintenance of recreation facilities.
- o Pay, or contribute in kind, a cash share of the cost of recreation facilities, to be paid concurrently and proportionately with the Federal contractual obligation for construction of recreation facilities which when added to the cost of recreation lands would amount to 50 percent of total first cost of the recreation lands and recreation facilities.
- o Administer, maintain, operate, and replace the recreational lands and facilities provided by the project at no cost to the United States in accordance with regulations prescribed by the Secretary of the Army

- o Provide sufficient rights in lands at recreation sites to permit public use.

- o Acquire all lands for wildlife enhancement of which the Federal Government will reimburse or credit 75 percent of the costs.

- o Pay 25 percent of the costs for acquisition and development of lands and construction of facilities for the Wildlife Management Area.

- o Maintain, operate, and replace fish and wildlife management lands and facilities provided by the project in accordance with regulations prescribed by the Secretary of the Army and in accordance with Section 221 of the 1970 Flood Control Act.

ARTHUR E. WILLIAMS
Colonel, CE
District Engineer